# Groundwater Response Action
# 100% Design Basis Report
# Lockheed Martin Middle River Complex
# 2323 Eastern Boulevard
# Middle River, Maryland

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# TABLE OF CONTENTS


**Section** **Page**

**ACRONYMS** ..... **v**

**1 INTRODUCTION** ..... **1-1**

1.1 PURPOSE ..... 1-1

1.2 GOALS ..... 1-2

1.3 SCOPE ..... 1-2

1.4 ORGANIZATION ..... 1-3

**2 BACKGROUND** ..... **2-1**

2.1 PHYSIOGRAPHY ..... 2-1

2.2 HYDROLOGY ..... 2-2

2.3 SURFICIAL AQUIFER GEOLOGY ..... 2-2

2.4 HYDROGEOLOGY ..... 2-3

2.5 GROUNDWATER FLOW ..... 2-4

2.6 CHLORINATED VOLATILE ORGANIC COMPOUNDS ..... 2-4

2.7 SOIL QUALITY ..... 2-5

2.8 UTILITY CROSS CONNECTION STUDY ..... 2-5

2.9 INJECTION PILOT TEST ..... 2-10

2.9.1 Approach and Results Summary ..... 2-10

2.9.2 Impacts on Remedy Design ..... 2-11

2.10 GROUNDWATER MODELING ..... 2-13

**3 DESIGN REQUIREMENTS** ..... **3-1**

3.1 DESIGN SUMMARY ..... 3-1

3.2 INJECTION VOLUMES ..... 3-2

3.3 INJECTION WELLS SPACING ..... 3-3

3.4 SUBSTRATE TYPE SELECTION ..... 3-4

# TABLE OF CONTENTS (continued)


**Section** **Page**

3.5 SUBSTRATE DOSING ..... 3-6

3.6 INJECTION AND MONITORING WELLS ..... 3-7

3.7 UNDERGROUND PIPING ..... 3-11

3.7.1 Construction Sequence ..... 3-12

3.7.2 Underground Utility Crossing ..... 3-16

3.7.3 Pressure Testing ..... 3-17

3.8 INJECTION PROCESS AND EQUIPMENT ..... 3-18

3.8.1 Amendment Solution Preparation ..... 3-19

3.8.2 pH Adjustment ..... 3-20

3.8.3 Design Capacity ..... 3-20

3.8.4 Process Equipment Summary ..... 3-23

3.8.5 Process Equipment Enclosures ..... 3-25

3.8.6 Control Systems - General ..... 3-26

3.8.7 Control System - Architecture ..... 3-30

3.8.8 Equipment Testing and Operator Training ..... 3-32

**4 IMPLEMENTATION PLAN ..... 4-1**

4.1 SOUTHEASTERN TCE AREA—TESTING AND INITIAL INJECTION EVENT ..... 4-1

4.2 SOUTHWESTERN TCE AREA—TESTING AND INITIAL INJECTION EVENT ..... 4-4

4.3 NORTHERN TCE AREA—TESTING AND INITIAL INJECTION EVENT ..... 4-6

4.4 PERFORMANCE MONITORING AND SUBSEQUENT INJECTION EVENTS ..... 4-9

4.5 START-UP, OPERATION, AND MAINTENANCE ..... 4-13

4.6 PERMITTING ..... 4-15

4.7 SUSTAINABILITY PRACTICES ..... 4-16

**5 REFERENCES ..... 5-1**

# APPENDICES

**APPENDIX A—100% DESIGN FOR BLOCK G SWALE RELOCATION**

**APPENDIX B—100% DESIGN FOR SOIL EXCAVATION – BLOCKS E AND G**

**APPENDIX C—FIGURES FROM THE *GROUNDWATER RESPONSE ACTION PLAN***

**APPENDIX D—CALCULATIONS**

**APPENDIX E—SPECIFICATIONS**

**APPENDIX F—EQUIPMENT AND MATERIALS VENDOR INFORMATION**

**APPENDIX G—PLC INPUT AND OUTPUT LIST**

# LIST OF TABLES


| | | Page |
|---|---|---|
| Table 3-1 | Estimated Ratio of Injection Volume to Pore Volume | 3-34 |
| Table 3-2 | Estimated Total Injection Volumes | 3-34 |
| Table 3-3 | Injection Well Parameters | 3-35 |
| Table 3-4 | Estimated Substrate Quantities by Target Pore Volume Concentration | 3-35 |
| Table 3-5 | Well Installation Information | 3-36 |
| Table 3-6 | Estimated Buffer Dosage | 3-37 |
| Table 3-7 | Design Flow-Rates | 3-37 |
| Table 3-8 | Key Equipment Items List | 3-38 |
| Table 3-9 | Control System Logic Summary | 3-42 |
| Table 4-1 | Southeastern TCE Area Full Scale Initial Injection Event | 4-19 |
| Table 4-2 | Southwestern TCE Area Full Scale Initial Injection Event | 4-20 |
| Table 4-3 | Northern TCE Area Full Scale Initial Injection Event | 4-21 |
| Table 4-4 | Performance Monitoring Frequency and Analytical Parameters | 4-22 |
| Table 4-5 | Monitored Natural Attenuation Sampling | 4-23 |

# 100% DESIGN DRAWINGS
## (Drawings follow the appendices)

| | |
|---|---|
| T-1 | Title Sheet |
| C-1 | Existing Conditions Plan |
| C-2 | Southeast TCE Area Remedy Layout |
| C-3 | Southwest TCE Area Remedy Layout |
| C-4 | North TCE Area Remedy Layout |
| C-5 | Typical Injection Well (No Conduit) |
| C-6 | Typical Injection Well (With Conduit) |
| C-7 | Southeast TCE Area Trench Construction Details |
| C-8 | Southwest TCE Area Trench Construction Details |
| C-9 | North TCE Area Trench Construction Details |
| E-1 | Electrical Symbols Legend |
| E-2 | Southeast TCE Area Electrical Site Plan (2 sheets) |
| E-3 | Southwest TCE Area Electrical Site Plan (2 sheets) |
| E-4 | North TCE Area Electrical Site Plan (2 sheets) |
| E-5 | Service Connection Details |
| E-6 | Electrical Equipment and Conduits (2 sheets) |
| E-7 | Internal Wiring Diagram (2 sheets) |
| E-8 | Single Line Electrical Diagram (2 sheets) |
| E-9 | Control Panel Layout |
| E-10 | Control System Bill of Materials |
| E-11 | Control System Architecture |
| E-12 | HMI Screen Layout |
| M-1 | General Process Flow Diagram |
| M-2 | Process and Instrumentation Diagram |
| M-3 | Equipment Container General Arrangement |
| M-4 | Oxygen Removal Contactor Side View Detail |
| M-5 | Injection Manifold Details |
| M-6 | GAC Treatment Details |
| M-7 | Lines Entrance Internal View Details |
| M-8 | Lines Entrance External View Details |
| M-9 | Container Construction Details |
| M-10 | Container Anchoring Details |

# ACRONYMS

| | |
|---|---|
| ARD | anaerobic-reductive dechlorination |
| bgs | below ground surface |
| BMP | best management practices |
| BTU | British thermal unit |
| $CaCO_3$ | calcium carbonate |
| CCTV | closed circuit television |
| cfm | cubic feet per minute |
| cVOCs | chlorinated volatile organic compounds |
| CY | cubic yard(s) |
| DHC | *dehalococcoides* |
| FNPT | female national pipe thread |
| fps | feet per second |
| ft | feet |
| ft/day | feet per day |
| GAC | granular activated carbon |
| gph | gallons per hour |
| gpm | gallons per minute |
| hp | horsepower |
| HPA | high pressure alarm |
| HD | heavy duty |
| HMI | human machine interface |
| ID | internal diameter |
| in. Hg | inches mercury |
| IP | internet protocol |
| IW | injection well |
| K | hydraulic conductivity |
| lb | pound |
| LMCPI | LMC Properties, Inc. |
| Lockheed Martin | Lockheed Martin Corporation |
| LPA | low pressure alarm |
| LVA | low vacuum alarm |
| mA | milliampere(s) |
| MDE | Maryland Department of the Environment |

| | |
|---|---|
| µg/L | microgram(s) per liter |
| mg/L | milligram(s) per liter |
| MH | manhole |
| MNA | monitored natural attenuation |
| MNPT | male pipe thread |
| MP | metering pump |
| MRAS | MRA Systems, Inc. |
| MRC | Middle River Complex |
| MST | Mission Systems & Training |
| msl | mean sea level |
| mV | millivolt(s) |
| MV | motorized valve |
| MW | monitoring well |
| NPDES | National Pollutant Discharge Elimination System |
| ORP | oxidation reduction potential |
| PCE | tetrachloroethane |
| P&ID | piping and instrumentation diagram |
| PID | photoionization detector |
| PLC | programmable-logic controller |
| psi | pound(s) per square inch |
| psig | pound(s)-force per square inch gauge |
| PT | pressure transmitter |
| PVC | polyvinyl chloride |
| RAP | remedial action plan |
| ROI | radius of influence |
| rpm | revolution(s) per minute |
| SV | solenoid valve |
| TCE | trichloroethene |
| Tetra Tech | Tetra Tech, Inc. |
| TOC | total organic carbon |
| UCC | utility cross connection |
| USDOT | United States Department of Transportation |
| VAC | volt(s) alternating current |
| VFD | variable frequency drive |
| VOC | volatile organic compound |

# Section 1
# Introduction

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this 100% design basis report for a groundwater response action at the Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland (Drawing T-1). This report further describes the groundwater response action selected in the *Groundwater Response Action Plan* for the Middle River Complex (Tetra Tech, 2012a).

The Middle River Complex consists of multiple parcels of land designated as tax blocks (referred to as blocks herein), all owned by Lockheed Martin. These are shown in Figure 1-2 of the *Groundwater Response Action Plan* (select figures from this report are in Appendix C). Block I contains currently operating facilities; surrounding Block I are the external Blocks A, B, D, E, F, G, and H. Some of these external blocks are used by Lockheed Martin Corporation for offices and parking, or are leased by others. This design basis report describes the required elements for the 100% complete design of the groundwater response action to be conducted in Blocks E, G and I (Drawing C-1); these three areas are also known as the southeastern trichloroethene (TCE) area, the southwestern TCE area, and the northern TCE area, respectively (Drawing C-1).

## 1.1 PURPOSE

This document provides the basis for a groundwater response action (GRA) design and describes the background, support, and details for groundwater remediation at the Middle River Complex. It presents the goals, design criteria, process equipment, piping layout, implementation, performance monitoring, and other elements necessary to implement the selected GRA as described in *Groundwater Response Action Plan* (Tetra Tech, 2012a) for the Middle River Complex. The soil cleanups for each block are being conducted under separate soil response action plans. Appendix A contains the 100% design to relocate a swale in Block G, and the 100% design to remove soil from Blocks E and G is attached as Appendix B.

## 1.2 GOALS

Lockheed Martin Corporation is committed to performance excellence, protecting and sustaining human health and the environment, and doing what's right. Groundwater remediation goals for the Middle River Complex were established in the August 2012 *Groundwater Response Action Plan* (Tetra Tech, 2012a). This document was approved by the Maryland Department of the Environment in September 2012. The three groundwater remediation goals are as follows:

1. Prevent exposure of workers, off-site residents, and surface water users to impacted groundwater that would cause regulatorily unacceptable risk.
2. Prevent regulatorily unacceptable risk to environmental receptors.
3. Reduce trichloroethene mass within the groundwater response action areas by 70%, as calculated based on the baseline performance monitoring data; more information on measurement of the mass reduction is included in Section 4.4 of this document. Additional information will also be included in a Performance Monitoring Plan submitted under separate cover.

Groundwater remediation goals 1 and 2 are achievable through land use controls. Achieving goal 3 is the overall objective of the GRA (*in situ* bioremediation via amendment injection) described in this document. The performance criteria used to evaluate the effectiveness of the selected GRA are described in section 4.4.

Lockheed Martin Corporation also desires to minimize environmental impacts and improve sustainability in their business efforts; therefore, sustainable remediation and construction practices to minimize the environmental impacts implementing the response action are also a Lockheed Martin goal. As part of minimizing environmental impacts, a necessary outcome of the response action design and implementation is to prevent the injected amendment (i.e., a solution injected into the subsurface to promote biological degradation of chlorinated volatile organic compounds [cVOCs] in groundwater) from reaching nearby surface water via groundwater or through preferential pathways, including site utilities (primarily storm drains).

## 1.3 SCOPE

The groundwater response action proposes to inject amendments in three areas of the Middle River Complex, as shown in Figure 6-10 1 of the *Groundwater Response Action Plan* (Tetra Tech, 2012a) (Appendix A). The overall scope of work for this 100% design consists of preparing a design basis report, drawings, diagrams, and specifications for injection wells,

associated distribution piping, and support facilities in each of the three response action areas. The design will detail the response action implementation strategy, including injection flows, volumes, sequencing, and performance monitoring. In general, implementation will include a significant testing effort using a tracer, and is expected to include three full scale amendment injection events conducted at 18-month intervals.

## 1.4 ORGANIZATION

This *100% Design Basis Report* is organized as follows:

Section 1—Introduction*:* Presents the purpose, goals, scope, and organization of the design basis report.

Section 2—Background*:* Briefly describes the Middle River Complex and its history, previous environmental investigations and results, and the nature and extent of contamination.

Section 3—Design Requirements*:* Presents the design summary, injection volumes and flow-rates, injection well design and layout, and piping and system design elements.

Section 4—Implementation Plan*:* Presents the plan for implementing the response action, including testing, injection, performance monitoring, and data evaluation.

Section 5—References*:* Lists references and citations used in compiling this report.

Appendices:

- Appendix A—100% Design for Block G Swale Relocation
- Appendix B—100% Design for Soil Excavation – Blocks E and G
- Appendix C—Figures from the *Groundwater Response Action Plan*
- Appendix D—Calculations
- Appendix E—Specifications
- Appendix F—Equipment and Materials Vendor Information
- Appendix G—PLC Input and Output List

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# Section 2
# Background

The Middle River Complex (MRC) is at 2323 Eastern Boulevard in Middle River, Maryland, approximately 11.5 miles northeast of downtown Baltimore, Maryland. The MRC is part of the Chesapeake Industrial Park and is comprised of approximately 161 acres, including 12 main buildings, an active industrial area, perimeter parking lots, an athletic field, a vacant concrete lot, a trailer and parts storage lot, and numerous grassy areas along its perimeter. The MRC is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Cove to the south, Cow Pen Creek to the west, and Wilson Point Road and Martin State Airport (MSA) to the east. Refer to Drawing T-1 for a map of the site location.

At the MRC, the primary activities of LMC Properties, Inc. (LMCPI), a wholly owned subsidiary of Lockheed Martin Corporation (Lockheed Martin), include facility and building management and maintenance. The site has three main tenants: MRA Systems, Inc. (MRAS), a wholly owned subsidiary of General Electric Company; Mission Systems & Training (MST), a division of Lockheed Martin Corporation; and Applied NanoStructured Solutions, LLC. MRAS designs, manufactures, fabricates, tests, overhauls, repairs, and maintains aeronautical structures, parts, and components for military and commercial applications. MST fabricates, assembles, tests, and supports vertical launch systems. Applied NanoStructured Solutions LLC, also a subsidiary of Lockheed Martin, is engaged in research and design of nanotechnology applications. The site history, characteristics, previous investigations, and other background information regarding the MRC can be found in Section 2 of the *Groundwater Response Action Plan* (Tetra Tech, 2012a). To avoid redundancy, only a very brief summary of the MRC conditions is presented here.

## 2.1 PHYSIOGRAPHY

The MRC is in the Western Shore of the Coastal Plain physiographic province, which is generally characterized by low relief. MRC topography slopes gently from sea level to 32 feet

above mean sea level (msl) (Cassell, 1977). The topography slopes from Eastern Boulevard to the southwest and south toward Cow Pen Creek and Dark Head Cove.

## 2.2 HYDROLOGY

The MRC is at the junction of Cow Pen Creek and Dark Head Cove (Drawing C-1). Both surface water bodies discharge into Dark Head Creek, a tributary to Middle River, which is a tributary to Chesapeake Bay. The MRC is approximately 3.24 miles (17,100 feet) upstream of Chesapeake Bay.

The MRC has no surface water bodies on-site. Wetlands have been identified at the site but are not within the footprint of these activities.

Excluding areas immediately adjacent to Cow Pen Creek and Dark Head Cove, surface water runoff discharges from the facility via storm drains. Lockheed Martin maintains a Maryland National Pollution Discharge Elimination System (NPDES) permit (Permit No.: 00-DP-0298, NPDES No.: MD0002852), issued by the Maryland Department of the Environment (MDE) Industrial Discharge Permits Division, Water Management Administration. The permit covers storm water discharges from the entire property.

## 2.3 SURFICIAL AQUIFER GEOLOGY

Groundwater contaminants at the MRC detected at concentrations above Maryland groundwater standards have been measured to depths up to approximately 35 feet below grade. For data evaluation and correlation, the surficial aquifer was divided into the upper (“A”), intermediate (“B”), and lower (“C”) surficial aquifer zones; there is no continuous confining layer between the zones. The upper, intermediate, and lower surficial aquifer wells are typically installed to depths of 15 - 20, 30 - 35, and 70 feet below grade (respectively) at the MRC.

Lithologic logging of the soils beneath the MRC has identified a very heterogeneous stratigraphy. The underlying soils are composed primarily of silty sands, fine- to medium-grained sands, silty clays, clayey silts, and plastic clay, with the primary lithology being clay to silty clay. Waterfront areas were historically been backfilled to their present elevation. Soils from fill areas are similar in appearance and composition to soils considered native to the MRC.

Lithology data collected for the groundwater investigation were used to construct geologic cross sections. Overall, the results of the groundwater investigation indicate complex arrangements of

predominantly clay, silty clay, silt, and clayey silt, with smaller, more permeable zones of silty sand and sand. Generalized cross sections showing the relative permeability of soils in the injection areas were generated for the *Groundwater Response Action Plan* (Tetra Tech, 2012a), and are included in Appendix C.

## 2.4 HYDROGEOLOGY

Previous investigations at the MRC encountered groundwater at depths ranging from less than one foot to nearly 18 feet below grade. Groundwater elevation data are shown in Table 2-4 of the *Groundwater Response Action Plan* (Tetra Tech, 2012a); this table is included in Appendix C. In the northern portion of the MRC, groundwater is found in silts, clays, and sand lenses in the subsurface. Low permeability clays and silty clays overlie and underlie the more permeable silty or sandy zones or lenses.

To the southwest, shallow groundwater flows in the sandy and silty materials extending to Cow Pen Creek. Approximately 13–18 feet of saturated sandy material is in this area. Groundwater is hydraulically confined by clay barriers above and below this unit. The upper sandy unit is separated from the lower sandy unit by approximately 35 feet of clay and clayey silt. The lower sandy unit occurs at approximately 50 feet below msl and is at least 17 feet thick in the area of well MW12, thinning to the northeast at well MW14. Groundwater in this lower sandy unit is hydraulically confined due to the thick, overlying clay unit and the underlying clay of the Arundel Formation.

Low average hydraulic conductivity (K) values have been reported for the shallow wells (the "A" wells), ranging from 0.0027 feet per day (ft/day) to 1.25 ft/day. The arithmetic average K for the "A" wells is 0.22 ft/day; the geometric mean K is 0.07 ft/day. Lower hydraulic conductivities are reported for upper wells to the south and west. Maximum K values for the upper wells (0.99-1.25 ft/day) are reported in the southernmost portion of the MRC, where sand-rich materials are present. In other areas of the MRC, K values range from 0.0027–0.3 ft/day.

K values for the intermediate ("B") wells are more consistent than those for the shallow wells, with an arithmetic average of 0.48 ft/day and a geometric mean of 0.22 ft/day. "B" well permeabilities are consistent with published lower values for clean sand or typical values of sand and silt mixtures. K values for the lower ("C") wells range from 0.35–9.16 ft/day. The average K of the lower wells (3.82 ft/day) is approximately 10 times the average K value for the upper

and intermediate zones. The arithmetic mean K for deep wells is 0.89 ft/day, and the geometric mean K is 3.02 ft/day. The calculated conductivities presented above are generally lower than the apparent conductivities determined from the pilot injection tests conducted in the "B" zone at three areas of the site (Section 2.8).

## 2.5 GROUNDWATER FLOW

For shallow wells, depths to groundwater table range from approximately less than one foot below grade (near the shoreline) to 14–18 feet below grade at the central and northern portion of the MRC (west of Building A and south of Building C). Depth to groundwater in the lower surficial aquifer wells ranges from less than one foot near the shoreline to 13.5 feet at the central and northern portion of the MRC. Groundwater flows radially from the hydraulically upgradient northern portion of the MRC at Eastern Boulevard to the southeast, south, and southwest toward Dark Head Cove and Cow Pen Creek. The sandy zones act as preferential groundwater pathways for the transport of contaminants that may originate upgradient in the clay rich materials (see Figure 2-11 in Appendix C).

## 2.6 CHLORINATED VOLATILE ORGANIC COMPOUNDS

Trichloroethene (TCE) and chlorinated volatile organic compound (cVOC)-degradation daughter products (i.e., dichloroethenes, vinyl chloride, etc.) have been detected in groundwater at concentrations exceeding both the federal and state drinking water standards, and state groundwater standards (all set to 5 micrograms per liter [µg/L]). TCE, a common industrial solvent and metal degreaser, has been detected in shallow groundwater in several areas at concentrations up to 19,000 µg/L. TCE and TCE-degradation daughter products have been detected in three fairly well-defined areas (Drawing C-1) at the MRC, indicating migration of cVOCs from their probable source areas. The three primary areas (see Figure 2-2 in Appendix C) are:

- *Southwestern TCE area*—The southwestern TCE area is larger than the southeastern TCE area, but has lower concentrations, with a maximum TCE concentration of 2,800 µg/L. One suspected source of TCE impacts in this area is a solvent spill from a waste oil tank north of Tilley Chemical which was part of Lockheed Martin operations at the site. Another possible TCE source in this area is the wastewater treatment plant that was south of Tilley Chemical and Chesapeake Park Plaza.

- *Southeastern TCE area*—The southeastern TCE area is near the on-site water tank and Dark Head Cove. Maximum reported concentrations of TCE in 2010 were 19,000 µg/L.

A suspected solvent release likely occurred southeast of former Building D, near the former location of the fuel storage tanks and the current water storage tank. Note that during the pre-remediation excavation, a small underground storage tank containing high concentrations of TCE was discovered; additional investigation is being conducted to delineate associated contamination and to determine if this is the primary source of TCE in the groundwater in this area.

- *Northern TCE area*—The northern TCE area is south of Building C. The maximum reported concentration of TCE in 2010 was 3,900 µg/L. A suspected solvent spill likely occurred south of Building C, and was possibly related to past handling and storage practices.

## 2.7 SOIL QUALITY

As described earlier in this document (Section 1-3), the portions of the southeast and southwest treatment areas are located in areas containing known soil contamination. The sampling and removal of impacted soils is anticipated in the future (described in the soil remedial action plans (RAPs) submitted under separate cover). The injection lines, injection wells, and other infrastructure associated with the groundwater response action will be installed before completion of the full scale soil response actions (soil removal). Therefore, to minimize possible disruption to the groundwater remediation infrastructure by the future soil excavation activities in those areas, the contaminated soil will be excavated along the utilities corridors for the groundwater remediation systems before the groundwater remediation infrastructure is installed. These soil removal activities are detailed in the 100% design for the soil removal in Blocks E and G (Appendix B).

Soil quality is unknown in the northern area, but soils there may also be impacted. In the northern area, soil will be sampled and analyzed prior to trenching to determine proper off-site disposition. More details regarding the sampling and analysis of soils in the three areas are provided in the Sampling and Analysis Plan to be submitted under separate cover.

## 2.8 UTILITY CROSS CONNECTION STUDY

A utility cross connection (UCC) investigation of the MRC was performed to determine the location, depth, and connectivity of the utilities in the three TCE areas (Tetra Tech, 2012b). The UCC investigation included a review of utility maps and implementation of field tasks in the three TCE areas. This investigation included the following activities:

- reviews of historical and current utility plans

- interviews of present and former MRC facility personnel
- a field reconnaissance
- geophysical surveys
- communication with stakeholders
- utility assessments, sewer cleaning, and closed circuit television (CCTV) inspections
- utility clearance and test pits
- managing investigation derived wastes
- field surveying

The methodology and results of this investigation are in the *Utility Cross Connection Investigation Report* (Tetra Tech, 2012b); the locations of the utilities referenced below can be found in that document. The following summarizes the significant findings and conclusions of the UCC study:

***Southeastern TCE area (Block E)***

- Underground utilities described in historical documents for the Block E study area include a storm drain line connecting drain inlet IL-20 to manhole MH-8, a former #2-fuel pipeline (two-inch diameter) that ran along the Block E fence line, a 10-inch-diameter fire water line (now abandoned) running along the southern perimeter of former Building D, and two fire water lines that connected the existing aboveground water storage tank to a former fire pump in the southeastern corner of the former Building D basement. Several drains are in the basement floor of former Building D, and these are shown in historical documents as connecting to the storm drain system south of the former Building D foundation.

- Underground utilities in the Block E study area were identified, including storm drains, electrical lines, domestic and fire water lines, fuel transfer line, and a telecommunication line.

- An unknown linear geophysical anomaly was detected along the median of Chesapeake Park Plaza; trenching in this area will have to cross this suspected utility. The anomaly runs from the western edge of the survey area, crosses underneath the roadway, and terminates at a concrete block in the southeastern corner of Block E. A geophysical anomaly was detected in the area of a former aboveground fuel storage tank west of the current aboveground water tank. The nature of these anomalies is unknown. The utility trench excavation will be performed in a particularly careful manner when crossing any unidentified geophysical anomaly.

- Block E study area storm drain systems consist of groups of steel grate-covered brick drain inlets, manholes, and concrete underground piping that discharge to Dark Head Cove via Outfalls 06 and 08 in or adjacent to the proposed area of groundwater remediation. Storm

sewer inlets in this area of Block E are generally in good condition. Two buried manholes (MH-8 and MH-9) were found during the 2011 Block E storm sewer interim remedial measures. These manholes have grated steel covers and previously acted as drain inlets for local runoff. Manhole MH-9 was raised to grade and a new cover was placed over the manhole opening. Manhole MH-9 is filled with rocks, which partially obstruct flow from the upstream pipe. However, large rocks used for backfill allow some water to flow through manhole MH-9 downstream to drain inlet IL-3.

- In 2009, incrustations (i.e., mineral accumulations from water seepage) primarily at the pipe joints, groundwater infiltration, and sediment accumulations were commonly found in most pipes. However, the storm drain lines in the Block E study area for Outfall 06 (from drain inletIL-1 to drain inlet IL-6, and from drain inlet IL-3 to manhole MH-9) and Outfall 08 (from drain inlet IL-24 to drain inlet IL-25) were cleaned in 2011 as part of the Block E storm-drain interim remedial measures. Several sections of large pipe were characterized as having root intrusion, and several contained small longitudinal cracks near joints. Medium pipe-offsets were observed in the line connecting drain inlet IL-3 to manhole MH-9. One small line (from drain inlet IL-5 to drain inlet IL-23) was nearly full of sediment in 2009. This line was cleaned and inspected in 2011. Groundwater seepage was observed in the pipe upstream of drain inlet IL-3.

- Storm drain lines are in the injection area of Block E, but they are shallow, with typical structure depths slightly less than three feet to nearly five feet below grade (maximum depth of 4.7 feet below grade). Drain inlets IL-24 and IL-25 (in the Chesapeake Park median east of Block E) are approximately 7.6 feet deep.

- Historical groundwater elevations in the Block E study area range from slightly less than three feet to slightly greater than five feet. Storm drain invert elevations in the Block E study area range from 2.75 feet at drain inlet IL-1 to 5.20 feet at drain inlet IL-3, and 5.48 feet at manhole MH-8. Invert elevations for storm drains in the median of Chesapeake Park Plaza range from 1.56 feet at drain inlet IL-25 to 2.50 feet at drain inlet IL-24. These elevations, and the presence of cracks and joint separations, suggest that storm drains in the Block E study area would be expected to intercept groundwater. As part of the Block E inspections, groundwater was observed flowing into a joint separation north of drain inlet IL-3; inflow encrustations were observed in the line from drain inlet IL-24 to drain inlet IL-25.

The presence of these utilities, particularly the storm drains and inlets, requires that the injections be conducted slowly and at low pressure. The tracer testing regime was developed to test areas of most potential concern (near the storm inlet in the northeastern portion of the injection area.

***Southwestern TCE area (Block G)***

- Historical features in the Block G study area include former buildings, a former sewage treatment plant, and utilities consisting of water lines, electrical lines, a sanitary sewer line, and storm drains. Several storm drains that discharge to Cow Pen Creek are along the western boundary of Block G. Historical documents show that a four-inch sanitary sewer line (possibly clay or cast iron) running to the former buildings may have once been connected to the existing six-inch diameter sanitary sewer pipe in the Chesapeake Park median.

- Underground utilities identified in the Block G study area include storm drains, sanitary sewer lines, electrical lines, domestic and fire water lines, and a telecommunication line.

- Several unknown areal or non-utility geophysical anomalies were identified in Block G. Several appear to be composite areas consisting of several small, discrete anomalies. One areal anomaly has the signature of a steel rod reinforced concrete pad. Five unknown linear geophysical anomalies were detected at Block G. Several of the unknown linear anomalies appear to be associated with the former sewage treatment plant and former Block G buildings. The nature of these anomalies is unknown at this time although test pitting has uncovered some buried debris in the area of the former building. More information about these anomalies could be obtained during the pre-remedial soil excavation in these areas. The utility trench excavation will be performed in a particularly careful manner when crossing any unidentified geophysical anomaly.

- Asphalt paving southwest of the concrete former building slabs and three pipes found along the Cow Pen Creek embankment appear to be part of a historical drainage distribution structure associated with the former sewage treatment plant.

- Primary storm drain systems in the Block G study area consist of groups of steel grated concrete drain inlets and underground concrete piping. The storm sewer drain inlets and concrete conduit pipes that were inspected were generally found in good condition (some minor cracks and no breakage were observed). Storm water discharges from a headwall in the downstream portion of the system to an open channel that carries runoff to Cow Pen Creek. Four metal pipes, ranging from four to 12 inches in diameter, were found protruding from the Block G embankment along Cow Pen Creek. One pipe was traced (using geophysical techniques) to a floor drain of a former building. The other pipes could not be fully traced due to weak instrument signals. The pipes were inaccessible to the CCTV equipment and could not be inspected or recorded.

- A six-inch-diameter sanitary sewer line runs along the median of Chesapeake Park Plaza. It could not be fully inspected due to obstructions and difficulty cleaning the pipe. A new sanitary sewer line was discovered in the study area during the manhole inspections. It runs from manhole SAN-MH-9, on the western end of the industrial area of Middle River Complex, and along the western Tilley Chemical building perimeter. Before encountering an obstruction that prevented further movement of the camera, 210 feet of the sanitary sewer line were inspected. There were no cross-connections between sanitary sewers observed or suspected.

- The Block G injection area has storm drain lines, but they are shallow, with typical structure depths of two to three feet below grade (maximum of 3.25 feet below grade). Sanitary sewer lines are deeper: the six-inch line in the median of Chesapeake Park Plaza is four to five feet below grade, and the six-inch sanitary sewer line along the Tilley Chemical building is 7.4 feet below grade.

- Historical groundwater elevations in Block G range from slightly greater than five feet to nearly 12 feet in the southwestern portion of Block G near Cow Pen Creek, from eight to 15 feet south of Chesapeake Park Plaza, to 17–22 feet near the Tilley Chemical building. Minimum (i.e., lowest) storm drain invert elevations for each system range from 7.34 feet at CB-2 in the southwestern portion of Block G to 14.21 feet at the outfall south of

Chesapeake Park Plaza. These elevations suggest that the storm drains may intercept groundwater at the top of the water table during periods of high groundwater recharge. The invert elevation of MH-9 (21.47 feet) indicates that the elevation of the six-inch-diameter sanitary sewer line running along the western perimeter of the Tilley Chemical building is at an elevation similar to the groundwater elevation (22 feet) in this area. Therefore, this pipeline may be susceptible to shallow groundwater infiltration at joint offsets and separations along this line during periods of recharge. Four test pits excavated in Block G encountered a large concrete slab at depths ranging from approximately 12 inches below grade in the western portion of the anomaly to 20 inches below grade in the eastern portion. Historical records indicate that the concrete slab may be a remnant of the former sewage treatment plant in Block G. A strong linear geophysical anomaly along the south side of the concrete slab indicates that an eight-inch cast iron pipe (shown on a historical map, but not found during the test pit activities) is likely within or beneath the concrete slab.

The findings in this block will be used during field activities to assist in utility avoidance.

***Northern TCE area (Block I)***

- Underground utilities shown in historical documents for the Block I study area include a storm drain line running from buried manhole MH-10B to a grate northeast of the Tilley Chemical building, a storm drain line running along the southern perimeter of Building C, a storm drain line running from the area of MH-8A south toward MH-10B, and a storm drain line running south and east of MH-11.

- Underground utilities identified in the Block I study area include storm drains, sanitary sewer lines, electrical lines, domestic and fire water lines, and a natural gas line.

- A series of unknown linear geophysical anomalies was detected east of the Tilley Chemical building and drum storage shed. A large, areal, geophysically anomalous area was detected in the southern and eastern survey area. This anomalous area is likely attributable to a concrete slab under the area.

- The current Block I storm sewer systems consist of groups of steel grated brick drain inlets, manholes, and underground concrete conduits that discharge to Dark Head Cove via Outfall 09. The Block I area storm drain system is extensive, consisting of currently used and abandoned lines. A storm drain manhole was discovered buried beneath the railroad berm. Two influent lines in this manhole were filled with sediment and, due to access limitations in the manhole, could be neither cleaned nor inspected using CCTV. Two pipe break-ins were observed in the conduit downstream of manhole MH-11. A four-inch sanitary sewer also runs east–west through the center of the study area.

- Although storm drains are found throughout the Block I study area, they are shallow, at a maximum depth of 3.89 feet below grade.

- Historical groundwater elevations in the Block I area range from 16–19 feet, with an elevation of nearly 26 feet at well MRC-MW60A. Storm drain invert elevations range from 18.52 feet at manhole MH-11 in the southeastern portion of Block I to 20.19 feet at drain inlet CB-7, in the northwestern portion of Block I. These storm drains may therefore intercept the upper surface of the groundwater table during periods of high groundwater

recharge and during groundwater injection if water table mounding increases to this elevation.

The significant utilities in the area east of the railroad berm were the primary reason that injection will not occur in that area. The presence of the concrete slab in the vicinity of the injections required slight modifications to some of the injection wells and piping.

## 2.9 INJECTION PILOT TEST

In November 2011, injection pilot tests were performed at three locations at the MRC and reported in the *Pilot Test Injection Report* (Tetra Tech, 2012c). The three testing locations were the southwestern TCE area, southeastern TCE area, and northern TCE area.

### 2.9.1 Approach and Results Summary

The injection test layout was similar at each of the above locations and included an injection well (typically screened at a depth interval of 15–35 feet below ground surface [bgs]) and three monitoring well clusters approximately five feet, 10 feet, and 15 feet from the injection well. Each monitoring well cluster consisted of two monitoring points: a deep interval (typically screened at 25–35 feet bgs) and a shallow interval (typically screened at 10–20 feet bgs). Nine 24-hour injection tests were performed, three at each test location: (1) a low-rate test, (2) an intermediate-rate test, and (3) a high-rate test. Each test involved injecting an aqueous sodium bromide tracer solution into the injection well and subsequent monitoring of the injection effects in nearby monitoring well clusters.

The bromide solution was prepared in 2,400-gallon storage tanks deployed at each of the test locations. The storage tanks were filled with potable water containing low levels of residual chlorine. The residual chlorine was removed from the injected stream by an on-line granular activated carbon (GAC) filter column. The injection at each location was performed using a battery operated pump with a speed controller to achieve the desired injection rate.

Data logging submersible pressure transducers monitored the injection influence in the monitoring well clusters and measured the injection well hydraulic head. Bromide samples were collected from the monitoring well clusters and from the nearby drain inlets. Changes in hydraulic head and bromide tracer detections were used to evaluate the injection radii of influence (ROI). The following average injection rates were used at each of three test area.

- low-rate test: 0.3 gallons per minute (gpm)
- intermediate-rate test: 0.5 gpm
- high-rate test: 1.0 gpm

The relatively high sustainable injection rates at all three test areas were somewhat contrary to expectations. Earlier test experiences with direct push injection (i.e., the 2008 *in situ* chemical oxidation pilot test; see Appendix E of the *Groundwater Response Action Plan* [Tetra Tech, 2012a]) and low calculated hydraulic conductivity values had led to the expectation that the sustained injection, especially at higher rates (i.e., greater than 0.5 gpm), would not be attainable without experiencing injected fluid daylighting, excessive injection pressures, and other complications. No daylighting was observed in any of the test areas. However, in Block E a low concentration of tracer was detected in one storm drain. Injection wells installed with filter sand packs and full grouting were used during the injection tests. Such wells are likely better suited for injection than the direct push injection points used in earlier studies.

The southeast TCE area had the highest calculated hydraulic conductivity among the tested areas—approximately two feet per day (ft/day). Even during the high-rate test, the water level in the southeast area injection well was only approximately five feet above the static level (approximately three feet below grade surface). The southwestern TCE area hydraulic conductivity was approximately one-half of the hydraulic conductivity for the southeastern TCE area. Correspondingly, the injection hydraulic head was approximately two times higher in the southwestern area.

The least conductive among the tested areas was the northern TCE area (two orders of magnitude lower hydraulic conductivity as compared to the southeastern TCE area). Injection pressures here were considerably higher than in both the southeastern and southwestern areas. The maximum wellhead pressure measured by the pressure gauge was 8.7 pounds-force per square-inch gauge (psig) during the high-rate test. In general, the injection pressures achieved in the northern TCE area were close to what was anticipated at all injection areas before the tests.

### 2.9.2 Impacts on Remedy Design

The main purpose of the injection tests was to determine if the main design parameters of the bioremediation system determined in the MRC *Groundwater Response Action Plan* (Tetra Tech, 2012a) are indeed achievable and realistic. Those parameters include injection rates and

volumes, radius of influence, injection pressures, spacing of the injection wells, and other design criteria. The impacts of the injection tests on the remedy design are summarized below:

- ***Design injection rates and volumes:*** The *Groundwater Response Action Plan* assumes a design injection rate of approximately 0.15 gpm per injection well, with an injection volume of approximately 3,000 gallons per well. The lowest injection rate during the test was approximately 0.3 gpm for all tested areas, with no indications of increased formation pressure during the injection. Therefore, higher injection rates and volumes can be considered for each injection location. Increased injection rates and volumes per well (increased to 5,000 gallons per well in this design) would result in fewer required injection wells, with an associated reduction in underground piping and maintenance effort.

- ***Injection radius of influence and well spacing:*** The radius of influence per injection well assumed in the *Groundwater Response Action Plan* (Tetra Tech, 2012a) was relatively low (10 feet), resulting in a fairly dense spacing of injection wells, as follows: approximately 20 feet between the injection wells in a row, and approximately 40 feet between the rows of injection wells. However, based on the tracer study and the observed hydraulic influence, the achieved ROI was at least 15 feet. ROI would likely be greater if injection continued over a longer period. Therefore, a reduced density grid of injection wells, with a ROI of 15 feet and a spacing of 30 feet between wells, can be used.

- ***Injection pressures:*** The injection tests demonstrate that low injection pressures can be achieved (e.g., less than 1 psig at the injection wellhead), even with moderately high injection rates (e.g., 0.5 gpm) in the southeastern and southwestern TCE areas.

- ***Preferential channeling and injected fluid daylighting:*** One indication of preferential channeling was a single detected concentration of a bromide tracer in the southeastern TCE area drain inlet 120 feet from the injection point after the high-rate injection test (the expected radius of influence for the injection was 10 feet). The impact this will have on the full scale design and implementation is in the selection of a flexible injection piping layout, an especially conservative injection scenario, and careful monitoring during injection implementation. The design also includes provisions for using extraction wells as a water source for the injection solution (or for depressing the groundwater level). Finally, the design will enable the operator to use a considerably longer injection time and will allow using less injection wells for injection at any given time.

- ***Reduced system in northern TCE area:*** The injection tests indicate that the northern TCE area is considerably less permeable compared to two other areas (approximately two orders of magnitude lower conductivity). Tracer was found in both shallow and deep monitoring wells, indicating a more direct hydraulic communication between the shallow and deep zones. The fracturing performed in the 2008 in situ bioremediation study (a similar chemical injection scenario), and the abundance of underground utilities, further complicate injection activities in this area. We therefore recommend a reduced array of injection wells (compared to the number of wells recommended in the *Groundwater Response Action Plan* [Tetra Tech, 2012a]); the number of injection wells has been reduced from 148 to 71, with the same total injection volume.

- ***Residual chlorine removal from potable water by granular activated carbon (GAC):*** GAC is a proven method of removing residual chlorine from aqueous sources. The GAC equipment selected for the injection tests provides a reliable method of chlorine removal and can be easily scaled up for full sale implementation.

- ***Limitation of groundwater mounding:*** Injection tests indicate that groundwater mounding quickly diminished with increased distance from the injection wells. The full scale injections will be managed in a way to keep groundwater mounding below drain inlet inverts and other utilities, to the extent possible.

## 2.10 GROUNDWATER MODELING

Groundwater flow and transport were modeled to help guide remediation planning. Modeling results are presented in the *Groundwater Response Action Plan* (Tetra Tech, 2012a). The numerical groundwater flow model was initially constructed based on a conceptual model that had been developed using site-specific hydrogeological data, including lithology, geology, hydrogeologic parameters, and surrounding surface water features. The model was then calibrated to groundwater level data collected during groundwater monitoring events in 2008 and 2009, to data from groundwater pumping tests in 2007, and to data from water level recorders installed in selected monitoring wells and at surface water locations in 2009.

The groundwater contaminant transport model was developed based on the site's current contaminant profile and checked via initializing particles in the model at the locations of suspected source areas. A 10-year half-life for the natural degradation of TCE was estimated. This was based on site specific data and values from found in the scientific literature for anaerobic conditions, a range of approximately one to 13 years (Aronson and Howard, 1997; Wiedemeier, et al., 1999 were used for this estimation). The estimated value (10-year half-life) is conservative. This conservative value was used due to the low site pH and the concentration trend data available. Following calibration, the groundwater flow and transport model simulated various remediation scenarios to help guide the conceptual design and effectiveness evaluations. The model analysis focused on the three major TCE areas at the site. Additional simulations were performed using the southeastern TCE area to indicate the general performance of injection scenarios in the other TCE areas.

For injection scenarios, the model grid detail was increased substantially in the southeastern TCE area so that a relatively dense network of injection wells could be simulated with sufficient accuracy. Predictive simulations of selected injection well system designs and various operational modes were run to enable examination of the viability and effect of injection, with

and without local groundwater extraction. Results of these simulations provide significant foundational information toward the selection of the recommended remedial alternative.

The contaminant transport model also facilitated estimation of the current mass of TCE in the areas being simulated. Groundwater TCE concentrations, total organic carbon and bulk density data from soil samples collected at the site, literature values for the partitioning coefficients for the subject compounds, and estimates of porosity were used to complete the estimate. The estimated current mass of TCE in the eastern area (including the northern and southeastern TCE areas) is approximately 110 pounds, and the estimated current mass in the western area is approximately 34 pounds; therefore, the total estimated TCE mass in the areas of active remediation is approximately 150 pounds. It is understood that the future TCE mass estimates may change significantly as the new data are obtained in the course of remedial system construction, the new sampling locations are added, and/or the previously unidentified TCE sources are found. The mass flux of contaminants to surface water was also simulated over a 100-year period. Under a scenario that included no active treatment (similar to current conditions), a total of approximately 7.5 pounds of TCE and 1.9 pounds of 1,4-dioxane were estimated to be discharged to surface water over the 100-year period. The maximum annual discharge of TCE to surface water from the western TCE area (to Cow Pen Creek) would be 0.2 pounds in Year 8, and the maximum discharge of TCE to surface water from the eastern TCE area (to Dark Head Cove) would be 0.03 pounds in Year 55.

# Section 3
# Design Requirements

The groundwater response action for this site is focused on three areas with high concentrations of trichloroethene (TCE) in groundwater: the southeastern TCE area, the southwestern TCE area, and the northern TCE area (Drawing C-1). To implement this response action, amendments will be injected into the subsurface using rows of semi-permanent injection wells connected by underground conveyance piping to injection equipment in each of the three TCE areas. The injection equipment and piping are designed for a 10-year operational life, continuous automatic operation, and flexibility in selecting and setting parameters such as the number of operational injection wells, substrate type and dosage, and injection rates, volumes, and durations. Calculations used to develop the design parameters in this section are in Appendix D. Specifications for the design of this response action are in Appendix E, and equipment and material information is in Appendix F.

## 3.1 DESIGN SUMMARY

The groundwater response action design for the Middle River Complex (MRC) consists of the following:

- installation of 24 injection wells arranged in five rows in the southeastern TCE area (Drawing C-2)
- installation of 39 injection wells arranged in seven rows in the southwestern TCE area (Drawing C-3)
- installation of eight injection wells in the northern TCE area (Drawing C-4); note that this addresses only the area west of the railroad berm, a smaller area than that described in the *Groundwater Response Action Plan* (Tetra Tech, Inc. [Tetra Tech], 2012a)
- use of four-inch-diameter Schedule 80 polyvinyl chloride (PVC) injection wells (riser and screen) for all areas
- installation of nine monitoring wells (Drawings C-2, C-3, and C-4)
- individual underground lines from each injection well to the injection equipment container in each area

- Contingency conduit run to select wells to allow groundwater extraction from these wells in the future
- potable water connections (for injection solution preparation) at each area
- in-line, continuous potable water treatment before injection (to remove residual chlorine and dissolved oxygen)
- injection equipment housed in shipping containers (enables the use of one system in different locations, if required)
- automated operation, with an ability to change the injection well configurations via remote control
- ability to inject different substrate types (e.g., soluble, slow release), pH buffers, and chlorinated volatile organic compound (cVOC)-degrading bacteria cultures into the treated potable water stream before injection

The subsequent sections describe the design process and groundwater system elements in detail.

## 3.2 INJECTION VOLUMES

Injection volume is an important performance factor when designing an adequate amendment distribution system for *in situ* bioremediation. The main design requirement for injection volumes is that the total injection volume must be adequate to distribute the amendments in the area within the 1,000 microgram per liter (µg/L) TCE contour in each of the three areas throughout the contaminated interval.

The most conservative design uses an amendment injection volume approximately equal to the entire pore volume of the area of concern. However, for the MRC, this approach would lead to unrealistically high injection volumes (i.e., several million gallons) and significant contaminant displacement; thus, an injection volume smaller than the entire formation pore volume will be used. The injection volumes were calculated based on the injection tests performed at the site in November 2011 (Tetra Tech, 2012c). The ratio of injection volume to pore volume within the achieved radius of influence (ROI) was calculated. This calculated ratio of injection volume to pore volume ratio (10.2%) was then used to extrapolate the volumes required for each injection area. The calculation procedure can be summarized as follows:

- actual observed ROI per injection volume was derived directly from the November 2011 pilot tests (Tetra Tech, 2012c)
- formation pore volume within the pilot test ROI was calculated

- ratio of injection volume to the pore volume was calculated (10.2%)
- formation pore volume of each TCE area was calculated
- injection volume for each TCE area was calculated (formation volume x 10.2%)

Calculations for the ratio of injection volume to formation pore volume are in Table 3-1. The actual observed ROI was determined based on the injection tests performed at the MRC in November 2011 (Tetra Tech, 2012c). Approximately 2,700 gallons of fluid with tracer were injected in each TCE area. In two test areas (southeastern and northern TCE areas), the tracer was reliably detected 15 feet from the injection point. In the southwestern area, the tracer was detected 10 feet from the injection point. However, based on the high tracer concentration detected and the observed delay in tracer transport in the southwestern area, the injected fluid likely moved farther than 10 feet from the injection point and it was assumed that an ROI of approximately 15 feet was achieved after injecting approximately 2,700 gallons in the southwestern TCE area.

The overall injection volumes for each TCE area for each injection event are calculated based on the areal extent of the high concentration TCE areas (set at the 1,000 milligrams per liter [µg/L] TCE contour), injection interval thickness, formation porosity, and injection volume to formation pore volume ratio. The results of this calculation for each TCE area are in Table 3-2. Note that due to the reduced system size in the northern TCE area (no injection east of the railroad berm), the area used for the pore volume calculation there was estimated at 50% of the total 1,000 µg/L TCE contour area. These calculations estimate that the total injection volume in each area (per injection event) will be as follows:

- southeastern TCE area 130,000 gallons
- southwester TCE area 250,000 gallons
- northern TCE area 45,000 gallons

## 3.3 INJECTION WELLS SPACING

The design requirements for injection well spacing, as detailed in this section, are:

- Design should include the minimum wells required for effective injection.
- Effective injection requires direct injection to 50% of the treatment area during each injection event.

- Spacing to be designed based on the estimated 15 foot radius of influence achieved during the pilot injections as well as the groundwater flow velocity at the site.

Determining the proper spacing between injection wells is a major cost and performance factor when designing an adequate amendment distribution system for *in situ* bioremediation. The most conservative design uses a dense array of injection wells. The total injection volume needed to achieve proper amendment distribution is the key parameter that determines spacing between the injection wells and, therefore, the number of injection wells. This parameter was determined for each TCE area using methods described in the previous section of this report (Section 3-2, Table 3-2).

The spacing arrangement of the injection wells must allow for resultant injection rates that are conservative and achievable, and resultant injection durations that are reasonable. Several different configurations with different spacing between the injection wells were considered. After several iterations, approximately 30 feet was selected as the spacing distance between injection wells in a row, with approximately 60 feet spacing between rows; this allowed the injection to meet project goals with the fewest number of wells. The configuration resulting from this spacing is as follows:

- 24 injection wells arranged in five rows in the southeastern TCE area (Drawing C-2)
- 39 injection wells arranged in seven rows in the southwestern TCE area (Drawing C-3)
- eight injection wells in the northern TCE area (Drawing C-4)

Variables considered for the spacing calculation are as follows:

- Four to six wells in any area should be operating at the same time, to avoid preferential channeling and daylighting of injected fluid. The active injection wells are selected to maximize the distances between active wells. These distances will be considerably greater than the radii of hydraulic mounding observed during the injection tests at these rates. The intent is to disperse the injection locations and thus to reduce mounding.
- The injection rate in each well will be below the lowest injection rates utilized during the injection tests (0.25 gpm design injection rate versus 0.3 gpm the lowest injection rate).
- The injection duration was calculated based on the design injection rate of 0.25 gpm per injection well, the number of wells operating, and the total injection volume for each area.

Table 3–3 contains the results of this calculation for each TCE area. As shown in the table, the injection well spacing selected will result in a reasonable injection scenario, even with fairly

conservative injection parameters (such as an injection rate of 0.25 gallons per minute [gpm] with a limited number of injection wells operating simultaneously). For example, amendment injection in the southeastern TCE area, performed with only four injection wells operating simultaneously at an injection rate of 0.25 gpm, will require 88 days of injection. In this scenario, the injection wells (in groups of four) are switched after approximately 15 days of injection.

## 3.4 SUBSTRATE TYPE SELECTION

The design requirements for the substrate selection, as detailed in this section, are:

- Substrate must have fast- and slow-release elements.
- Substrate emulsion must be highly stable.
- Emulsion must be miscible in water to allow transfer via standard metering pumps.

The various carbon substrates available for enhanced bioremediation of chlorinated hydrocarbons fall into two general categories: soluble electron donors and generally non-soluble slow-release electron donors. Soluble electron donor substrates include lactate, ethanol, and other short-chain hydrocarbons. These materials dissolve in water and are typically used quickly by microorganisms. An advantage of soluble electron donors is that delivery and distribution are more easily achieved in a heterogeneous environment, and application from a given point can cover a larger area than is the case with slow-release electron donors. These two advantages are expected to be helpful at this site due to its varied geologic environment. The disadvantage of soluble electron donors is that they are generally consumed in three to six months.

Slow–release electron donors include hydrogen–releasing compounds, vegetable oil, and chitin. These compounds slowly release fatty acids into the groundwater, which in turn are metabolized by microbes in an anaerobic reductive-dechlorination process. Many of these substrates persist for months or years before being exhausted. Emulsified vegetable oils that have been engineered to exhibit enhanced transport properties while slowly releasing carbon are commercially available. An added benefit of these oils is that they can preferentially partition contaminants from the dissolved phase into the oil. The main drawback of the non-soluble oil-based emulsions is that they can de-emulsify in the formation and their transport can be significantly retarded.

Substrate formulations containing both soluble and slow-release electron donors are also now available and preferred because they combine the advantages of both approaches. The substrate

recommended for MRC bioremediation is LactOil™ from JRW Remediation (see Appendix F), a combination of a slow-release soy vegetable oil (45%) and fast-release soluble ethyl lactate (35%). The formulation is a non-coalescing low surface tension microemulsion (generally < 1 micron, -68V Zeta potential) which is completely miscible (particles dispersed) with water at all ratios without any observable phase separation. LactOil™ offers the following advantages:

- it contains a significant portion of both soluble and slow-release substrate (with a life span of 18 months), offering the advantages of both approaches
- it is a stable microemulsion with a long shelf life (6 months if unopened, 2 months if opened) and will not require on-site preparation
- it is completely miscible with water and can be transferred into the dilution water stream using conventional metering pumps
- the small size (generally < 1 micron) and non-coalescing nature of the microemulsion will potentially allow the vegetable oil portion to travel greater distances from a release point as compared to non-emulsified vegetable oil

Note that the selected injection approach (a system of injection wells and an automated substrate injection system) will allow the use of different types of substrate (if warranted) without equipment modification.

## 3.5 SUBSTRATE DOSING

The design requirements for the substrate dosing, as detailed in this section, are:

- The initial substrate dose must attain a target pore–volume substrate concentration of 400 milligrams per liter (mg/L) calculated using the pore volume (of each TCE area) within the 1,000 µg/L TCE contour; the target substrate concentration used is based on the electron donor demand as calculated for the southwestern TCE area, which is the highest calculated for three TCE areas (Appendix D).
- Substrate dosing for the subsequent injection events will be determined based on the remedy performance monitoring data.

The calculated doses are provided in Table 3–4. The quantities estimated for the initial injection event in each area are as follows:

- southeastern TCE area: 5,150 pounds/620 gallons
- southwestern TCE area: 10,040 pounds/1,220 gallons
- northern TCE area: 1,640 pounds/200 gallons

Note that these substrate quantities are calculated for the initial injection event in each area. Substrate quantities and concentrations for additional injection events should be adjusted based on the results of each preceding injection event. The substrate distribution monitoring approach and evaluation criteria are described in Section 4-4 Monitoring the performance of the bioremediation effort will provide the appropriate data to adjust these parameters.

## 3.6 INJECTION AND MONITORING WELLS

The design requirements for the substrate dosing, as detailed in this section, are:

- Injection wells must have adequate surface area to allow injection of the required flow rates and volumes, accounting for losses due to bio-fouling.
- Wells must address the contaminated interval and be designed with the screen beginning at the maximum depth to minimize injected fluid discharges to the surface.
- Wells must be constructed to minimize upward flow of injected fluid through the annular space.
- Underground connections must be designed for the maximum injection pressure and allow cleaning of the injection wells and measurement of groundwater levels.
- Design must include electrical conduit to allow future pumping from a subset of the injection wells.
- Well boxes (surface completion) must be rated for truck traffic.

Injection and monitoring wells will be installed at the MRC as part of the groundwater response action implementation.

***Injection wells—***The injection wells will be screened from approximately 10 feet below the top of the groundwater table to the bottom of the intermediate “B” zone. These screen intervals were selected to address the areas of highest TCE concentrations, limit the intrusion of the injected fluid into the vadose zone, and reduce channeling and daylighting of the injected fluid. Therefore, typical injection well screened intervals would be:

- 20–35 feet below ground surface (bgs) in the southeastern TCE area
- 20–35 feet bgs in the northern TCE area
- 15–35 feet bgs in the northern portion of the southwestern TCE area

- 20–35 feet bgs for the 10 injection wells placed in the two rows closest to the surface water in the southwestern area (IWW-30 through IWW-39), to limit the possibility of injected materials infiltrating the surface water

Injection well depths and screening intervals are in Table 3-5. Screened intervals for individual injection wells may be adjusted based on groundwater table elevations, the vertical distribution of targeted contaminants, and the depth to the low hydraulic conductivity clayey layer at the well location. Care will be taken to obtain a good grout seal above the screened interval to prevent vertical flow of injected amendment through the annular space of the injection well to the surface.

Borings for the injection wells will be advanced using a sonic rig (Roto-Sonic method) operated by a Maryland–licensed driller. The Roto-Sonic method involves a drill rod/override casing setup (with temporary casing) to install the well to its total depth. Soil will be continuously sampled during drilling using a 10-foot-core barrel. Soil/sediment samples will be collected for screening, including lithologic characterization, visual observations (e.g., staining, discolorations, etc.), and odor detection. Soil/sediment samples will be screened for volatile organic compounds (VOCs) using a portable photoionization detector (PID) and a sealed bag headspace technique. A qualified field geologist will perform lithologic logging. All pertinent information, including boring location, soil/lithology descriptions, and PID readings, will be included on soil boring log forms. Soil/sediment samples for laboratory analysis will not be collected.

Construction details for typical injection wells are shown in Drawings C-5 and C-6. The injection wells will be constructed using four-inch-diameter flush threaded Schedule 80 polyvinyl chloride (PVC) well casing and manufactured PVC well screens (Johnson Screens or equivalent). Well screens will be 15–20 feet long with 0.010-inch slotted openings.

A sand filter pack of washed 20×40 mesh (0.0331×0.0165 inch) silica sand will be placed around the well screen at least one foot above the top of the well screen. The required depth to sand will be confirmed using a weighted tape. Following placement of the sand pack, each well will be pre-developed via the drill rig using a combination of surging and air lifting to settle the sand pack around the well screen. A five-foot-thick bentonite seal will be installed above the sand pack and allowed to hydrate during installation.

Grout, consisting of Type II Portland cement and powdered bentonite gel, will be placed above the bentonite seal to the bottom of the trench (approximately 30 to 36 inches below the ground

surface as shown on Drawings C-5 and C-6). Grout will be made by mixing a 94-pound bag of Type II Portland cement with nine pounds of powdered sodium bentonite and no more than eight gallons of water per bag of cement. Well construction details will be recorded in the field logbook and on a well construction form.

***Monitoring wells—***Nine monitoring wells will be installed in the locations shown in Drawings C-2 through C-4:

- four monitoring wells in the southeastern TCE area (SEMW-1I, -2I, -3I, and -6I)
- three monitoring wells in the southwestern area TCE area (SWMW-1I, -2I, and -5I)
- two monitoring wells in the northern TCE area (NMW-1I and -3I)

Depth and screened interval data for monitoring wells are in Table 3-5. Screened intervals for individual monitoring wells may be adjusted based on groundwater table elevations and depth to the low hydraulic conductivity clayey layer. Borings for the injection wells will be advanced using a sonic rig (Roto-Sonic method) operated by a Maryland-licensed driller. Soil/sediment sampling and evaluation will be the same as detailed above for the injection well installation. Monitoring wells will be constructed using two-inch-diameter flush threaded Schedule 40 PVC well casing and manufactured PVC well screens (Johnson Screens or equivalent). Well screens will be 10–20 feet long with 0.010-inch wire slotted openings.

A sand filter pack will be installed in the same manner as was done for the injection wells. Following placement of the sand pack, each well will be pre-developed via the drill rig using a combination of surging and air lifting to settle the sand pack around the well screen. A two-foot-thick bentonite seal will be installed above the sand pack and allowed to hydrate during installation. Grout will be placed above the bentonite seal to approximately one foot below the ground surface.

***Well development—***Following well installation, each injection and monitoring well will be developed to remove fines from the well filter pack and casing and to ensure a hydraulic connection between the well and the geologic formation. Well development will be performed as soon as possible following installation, after at least 24 hours have elapsed following well construction (to allow the grout to set up). Wells will be developed by gentle surging and air lifting to remove fines and sediment from the sand pack and well screen. Development will begin at the bottom of the well screen, work up incrementally to the top of the screened interval, and

then back down to the bottom of the well. Development will be considered complete when the monitored water quality parameters stabilize in accordance with the information contained below, or when a minimum of three saturated well casing volumes have been removed, or when the well is purged dry. Development will be considered complete when three consecutive readings, taken at five-minute intervals, are achieved, as follows:

- ±0.1 standard units for pH
- ±3% for specific conductance and temperature,
- ±10% for dissolved oxygen (DO) and oxidation–reduction potential (ORP)
- less than 50 nephalometric turbidity units for turbidity

All development water, decontamination water, and recovered soil will be collected in United States Department of Transportation (USDOT) -approved containers and temporarily stored in a facility-approved location pending disposal at a Lockheed Martin Corporation- (Lockheed Martin)-approved off-site facility.

***Underground connections—***Underground injection connections will be completed following injection well installation and development. Trenches will be excavated to each injection well and the well casing will be accessed. Each injection well will have a four-inch Schedule 80 PVC tee approximately two to three feet below ground surface. A section of four-inch Schedule 80 PVC pipe will be cemented into the four-inch tee and extend to the grade surface. The four-inch tee will have a suitable plumbing adapter (see Drawings C-5 and C-6) connected to an individual half-inch internal diameter (ID) underground line (flexible polyethylene pipe, suitable for direct burial with a 216 pounds per square inch [psi] pressure rating) to the injection equipment-container location (see Drawings C-5 and C-6). A drop tube (half-inch ID) extending below the static groundwater level will be installed inside the injection well, as shown in Drawings C-5 and C-6. The drop tube will eliminate cascading and subsequent aeration of the injected fluid.

The injection wells will be sealed using expandable plugs with a bypass. The expandable plugs will have a backpressure rating of 35 psi. The bypass will be half-inch male pipe thread (MNPT). A quarter-inch brass air relief valve and a pressure gauge will be connected to the half-inch bypass as shown in Drawings C-5 and C-6. After the injection line connections are completed to each well, a locking, traffic rated flush mounted well cover, 18 inches in diameter and 18 inches high, will be secured over the well casing to protect each injection well. A concrete pad

(six inches thick by 24 inches square) will be installed around the well cover as shown in Drawings C-5 and C-6.

Several injection well rows in the southeastern and southwestern TCE areas (Drawings C-2 and C-3) will also have two-inch Schedule 40 PVC electrical conduit headers to allow their use as extraction wells. At these wells, conduit will be brought into the well box and capped; conduit will also be run out of each well box to the next well with conduit. This will allow wire to be easily pulled to each well if needed in the future. Injection well boxes with contingency power conduits will be 18-inch diameter. The wellhead design for wells with the contingency electrical conduit is shown in Drawing M-2.

## 3.7 UNDERGROUND PIPING

The design requirements for the substrate dosing, as detailed in this section, are:

- Individual lines must be run to each well (see below for rationale).
- Piping must be capable of transporting the injection flow design flow and pressure (pressure testing requirements are below).
- Injection lines must use continuous length tubing with no joints underground
- Lines must be buried deep enough to prevent freezing (frost line 20 inches).
- Electrical service must be run underground to each system container (60 amps, 120 volt AC).
- A potable water line must be run to each system container.
- Waste materials must be managed per regulations and Lockheed Martin requirements.
- Utilities must be located and avoided per regulations and Lockheed Martin requirements.
- Erosion and sedimentation control measures must be placed per Baltimore County requirements.

Injection wells will be connected to the injection equipment container by individual lines. The decision to use individual lines versus a common piping header with local connections to the injection wells is based on the following advantages:

- full control of each injection well from a central location
- ability to shut down individual wells in case of overpressure

- remote injection–well activation/deactivation
- simple wellhead plumbing and connections
- direct injection flow/pressure control and easy verification for each well

### 3.7.1 Construction Sequence

Underground injection connections will be completed following injection well installation and development. Trenches to each injection well will be excavated and the well casing will be accessed. Each injection well will connect to the injection equipment-container location via an individual half-inch ID underground line (flexible polyethylene pipe, suitable for direct burial with a 216 psi pressure rating). Typical wellhead connections are shown in Drawings C-5 and C-6. The trench routing for the southeastern, southwestern, and northern TCE areas are shown in Drawings C-2, C-3, and C-4, respectively.

As described in Sections 3-5, several rows of injection wells in the southeastern and southwestern TCE areas will also have two-inch Schedule 40 PVC electrical conduit header as a contingency to allow the use of these wells as extraction wells. The southeastern TCE area will have the contingency electrical conduit installed to injection well rows #2 and #4, as shown in Drawing C-2. The southwestern TCE area will have the contingency electrical conduit in injection well rows #4 and #6 (Drawing C-3).

Underground piping connections to sources of potable water will also be installed in each of the TCE areas; no direct water connections to public water lines will be used. Potable water connection locations are as follows:

- southeastern TCE area: Lockheed Martin-owned water line in existing pump house shed (Drawings C-2 and C-7)
- southwestern TCE area: tie-in to Lockheed Martin-owned existing water main (Drawing C-3 and C-9)
- northern TCE area: Lockheed Martin-owned water line in the existing boiler building (Drawing C-4)

Each potable water connection will include a double check valve backflow preventer to prevent process water from flowing into the potable water line.

Electrical service will be required at each equipment container location; the power requirements for the systems are 60 amps, 120 volt AC. Power conduit lines may be installed underground in

the same trench as the injection lines and potable water lines or via a separate underground or overhead line. Electrical power connection locations are as follows:

- southeastern TCE area: power source in existing pump house shed (Drawing C-2)
- southwestern TCE area: power source in existing service panel attached to power pole. Panel owned by Lockheed Martin (Drawing C-3)
- northern TCE area: power source in existing chemical building (Drawing C-4)

The underground trenches will be excavated to a depth of approximately 36 inches, to ensure freeze protection and piping mechanical integrity (the maximum frost depth in the MRC site area is slightly less than 20 inches).The trenches are designed to both minimize the environmental footprint and to reduce installation time and cost. To accomplish this, the trench width will be as narrow as practical to accommodate piping.

The required trench width will vary depending on the number of lines and pipes in the trench. In general, trench width will vary from approximately one foot in the sections that carry few injection lines (e.g., four to six lines) to a maximum of three feet where multiple injection lines, electrical conduit, and potable water lines are installed. Piping will be surrounded by sand bedding material, and trenches will be backfilled and compacted. The trench cross sections for the southeastern, southwestern, and northern areas in Drawings C-7,C-8, and C-9 (respectively) show trenching design details, such as trench depth and width, number and types of lines, surface completion, and other details.

Drawings M-7 and M-8 show the entrance details of the underground piping into the equipment containers.

In the southwestern and southeastern TCE areas, a swale will be relocated, and soil will be excavated and backfilled before installation of the infrastructure. The swale relocation and soil removal designs are included in Appendices A and B, respectively. Note that drawings included in the groundwater system 100% design show the trenches as if they will be excavated, backfilled, and completed at the surface, starting with current site conditions.

Trenching will be limited in scale and include restoration of the disturbed areas to pre-construction grades and elevations in the north and southeast areas; grades will change slightly in the southwest area due to the swale relocation. Trench dimensions and construction

methods will minimize erosion. (Erosion and sedimentation control drawings are included with the swale relocation and soil excavation designs).

As shown in Drawing C-3, eight injection lines and a potable water line must pass under Chesapeake Park Plaza in the southwestern TCE area. Underground utilities such as electrical power, water, fire water, and sewer along Chesapeake Park Plaza will have to be crossed. Because this is a four-lane Baltimore County road; shutting down this road must follow county requirements and have all necessary approvals. In addition to utility clearing and crossing procedures described in Section 3.7.2 (below), Tetra Tech will follow all relevant Baltimore County procedures regarding earthwork in the presence of underground utilities. Following installation of the below–grade piping, backfill must be placed and the road resurfaced per Baltimore County requirements and specifications.

Storm water runoff will not increase as a result of response action activities. The following trench construction practices will minimize soil erosion and storm water runoff during trenching:

- Asphalt and concrete pavement will be saw cut in sections to ensure clean trench boundaries. During surface finishing, a tack coat will be required for replacement paving, and the joint between the new and existing pavement must be sealed.

- A single continuous length of ¾-inch flexible polyethylene (PEX) piping between each wellhead and equipment container will be used for installation. This will minimize the number of joints and pressure testing requirements.

- The trench will be excavated, the pipe will be installed, and the trench will be immediately backfilled using the excavated materials (material placed during pre-remediation excavation) as a backfill, except in the north area, in the trench through Chesapeake Park Plaza, and in the trench near Tilley Chemical; in these areas, the soil will be removed and replaced with sand bedding. Backfilling will proceed in successive six-inch lifts to within two inches of final grade. Each lift will be machine compacted.

- A minimum four inches of sand bedding material will be used for piping installation, depending on the piping installation geometry at that location.

- Excess soil, concrete, and asphalt pavement will be placed in roll-offs immediately after trench excavation.

- To avoid erosion and runoff, trench and piping installation will proceed in sections, with each section completed and backfilled before continuing to the next. The length of trench left open at any time will not exceed a length in which piping is expected to be installed over a two-day period. Erosion and sedimentation controls are detailed in the erosion and sediment control plan submitted as part of the permit application to Baltimore County, and as described in Appendices A and B.

- Asphalt pavement and concrete surfaces will be restored to match existing conditions and County requirements (except as noted below) as soon as possible to allow a resumption of normal traffic. Paving will consist of an aggregate base/drainage layer and bituminous concrete. In the southeastern and southwestern TCE areas, concrete will be replaced with crushed stone. Chesapeake Park Plaza (County owned) will be restored according to County requirements.

Material and soils management for installation of the groundwater system includes the following (and does not include additional materials associated with the swale relocation and soil removal described in Appendices A and B, respectively):

- *Asphalt and bituminous pavement and base material removal and potential recycling (Block I and portions of Block G only).* Material volume is estimated at 25 cubic yards (CY) (Appendix D).

- *Sand bedding materials installation (Block I and portions of Block G only).* The volume of sand bedding material estimated is 20 CY, with an average eight-inch sand depth and trench width averaging two feet (Appendix D).

- *Soil disposal (excavations for Block I and Block G area near Chesapeake Park Plaza only).* Soil disposal volume is estimated at 150 CY (Appendix D).

- *Proper off-site disposal of drill cuttings produced during injection and monitoring well installation.* Material volume is estimated at 60 CY based on eight-inch borehole diameter.

- *Proper off-site disposal of decontamination and development water.* Volume estimated is approximately 2,000 gallons.

The specifics of piping installation in each TCE area are discussed below:

- ***Southeastern TCE area:*** All injection wells and distribution piping in this area are located in a little used area of the facility with no road crossings. However, a storm water line, a fuel-oil line, and possibly a fire water line will have to be crossed. Drawings C-2 and C-7 show details for distribution piping routing, trench construction, and the existing underground utilities. Total trench length in this area is approximately 810 feet, of which about 250 feet is in an area covered by concrete (the old foundation of Building D basement); this concrete will be removed during the soil excavation activities (Appendix B).

- ***Southwestern TCE area:*** Most of the injection wells and distribution piping are in an open area between Chesapeake Park Plaza and Cow Pen Creek, so the piping installation in this area should be uncomplicated. However, eight injection wells (Drawing C-3) will be installed on the other side of Chesapeake Park Plaza, necessitating a road crossing. Several underground utilities (water, electrical, sanitary sewer) along Chesapeake Park Plaza (Drawing C-3) will have to be crossed. Drawings C-3 and C-8 show details regarding the distribution piping routing, trench construction, and the existing underground utilities. Total trench length in this area is 1,600 feet, of which

approximately 150 feet is through asphalt (Chesapeake Park Plaza and the parking area), and 100 feet is through old concrete foundations in the southern portion of this area; this concrete will be removed during soil excavation activities.

- ***Northern TCE area:*** The northern area is the smallest of three high concentration areas, but it is the most complicated in terms of injection wells and distribution piping installation. Numerous obstacles exist, such as aboveground structures, a railroad berm, and underground utilities. Therefore, the injection wells will be installed in a portion of the TCE area west of the railroad tracks (Drawing C-4). Drawings C-4 and C-9 show details for distribution piping routing, trench construction, and the existing underground utilities. Total trench length in this area is approximately 300 feet, all of which is within the asphalt and concrete of the operating facility.

### 3.7.2 Underground Utility Crossing

As stated earlier, trenching in all three areas will cross existing underground utilities such as water, electrical, sanitary sewer, and others. Procedures for identifying and crossing utilities along the trench routes are described in this subsection. Trench routing and excavation will be coordinated with LMC Properties Inc. (LMCPI). Utility clearance work and documentation will conform to the provisions of the Lockheed Martin *Remediation Contractor's Energy, Environment, Safety, and Health (EESH) Handbook, Revision 1* (June 10, 2009) or the latest update. Tetra Tech will obtain all access agreements, required clearances, and permits before beginning any trenching, including:

- notifying the Miss Utility underground utility location center (1-800-257-7777; www.missutility.net)
- reviewing the utility cross connection (UCC) report and facility and site utility maps
- using a private utility locating firm to identify any subsurface utilities or anomalies.
- following Executive Order-28 and Lockheed Martin "Minimum Requirements for Intrusive Fieldwork" work plans, completing the digging authorization form, and obtaining the required signatures

A geophysical survey will locate and mark all underground utility lines along the trench. A combination of electromagnetic resistivity/conductivity and line–locating, and ground-penetrating radar (GPR) will identify all underground utilities along the trenching route. All underground utilities and anomalies will be marked in accordance with Lockheed Martin's remediation contractor's handbook (Lockheed Martin, 2009) and other procedures for intrusive work. All utilities within a 10-foot corridor along the trench route will be identified using the appropriate technology and the ground surface will be marked with paint.

At each location where a trench crosses an underground utility, the trench excavation will be hand dug in five-to-eight-foot long trench sections. New piping and an existing utility at each crossing location will be separated by at least six inches of sand bedding. It is expected that in most cases new piping will be at a lower depth than the existing underground utilities.

### 3.7.3 Pressure Testing

Pressure testing will ensure the integrity of the process piping in the equipment containers. Pressure testing is not required if underground injection lines between equipment containers and wellheads are continuous lengths of pipe (i.e., no joints). Pipe will be inspected as it is unrolled. It will be ensured that there are no rocks or angular objects in the pipe bedding material.

Pressure testing of the process piping, connections, instruments, and equipment inside equipment containers will be performed as described in this section. Potable water lines from each source to their respective equipment containers will also be pressure tested as described below. The pressure testing procedure that will be used is adapted from the *Handbook of Polyethylene Pipe* (Plastic Pipe Institute, 2006), as follows:

- After installation, the piping system will be filled with water and any trapped air will be bled off. The lowest element in the system will be subjected to a test pressure that is 1.5 times the high pressure set point and will be checked for leakage. Test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water filled pipe, the pipe expands. During this initial expansion, sufficient make-up water must be added to the system at hourly intervals for three hours to maintain test pressure. After about four hours, initial expansion should be complete and the actual test can start.

- When the test begins, the pipe full of water is subjected to a constant test pressure of 1.5 times the high pressure set point for a period no longer than three hours, after which. Any water deficiency must be replaced and measured. The amount of added make-up water required to return to the test pressure will be measured.

- System design high pressure set point will be set to 40 pounds per square inch psi.

- An alternative leakage test consists of maintaining the test pressure (described above) over a period of four hours, then dropping the pressure by 10 psi. If the pressure then remains within 5% of the target value for one hour, this indicates no leakage in the system.

- Under no circumstances will the total testing time exceed eight hours. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section must be permitted to “relax” for eight hours before the next attempted test sequence.

- Air testing is not recommended.

## 3.8 INJECTION PROCESS AND EQUIPMENT

The design requirements for the injection and process equipment, as described below, are:

- The potable water inlet must contain a backflow preventer.
- Equipment must remove the majority of the dissolved oxygen and chlorine from the potable water stream (complete removal is not required).
- Equipment must be sized to allow mixing and injection of the design volumes of substrate and pH adjustment solution.
- The distribution manifold shall be designed to allow simultaneous injection to a minimum of 6 wells.
- The equipment must be housed in a heated and air conditioned structure (temperature held between 40 and 80 degrees Fahrenheit.
- The enclosure must include a high level alarm in the sump to shut down the inlet potable water flow if necessary; two different types of level switches shall be provided for this purpose.
- The control system must prevent injection to the wells at a high pressure, and shut down the system.
- The control system shall control injection of the substrate and pH adjustment solutions based on the total flow to the wells. a) High differential pressure across the GACs and membrane contactor; b) Low-vacuum at the inlet to the membrane contractor vacuum pump; c) High or low pressure at the membrane contactor outlet.
- The control system shall allow remote monitoring of the system functions (controlled access), call-out alarms and limited manipulation of system parameters.

Shipping containers will house the process equipment and store the substrate in each TCE area. Injection and solution preparation processes and equipment for containers in the southeastern and southwestern TCE areas will be identical. One container from these areas will also be used for initial testing and the first injection event in the northern area. Following testing and the initial injection event, Tetra Tech, Inc. (Tetra Tech) will recommend to Lockheed Martin whether or not to construct a dedicated container for the northern area. At this time, it is assumed that the third container will *not* be required. Amendment solution preparation and injection equipment and instrumentation are described in the following sections.

The selected equipment modules (containers) vendor (NES) is responsible for providing the entire equipment packages in turn-key condition ready for immediate use. The equipment vendor

will also fabricate, program, install, and integrate the control panels. The Tetra Tech lead design engineer will oversee the process equipment and control panel fabrication, installation, programming, and testing at the vendor's facility.

### 3.8.1 Amendment Solution Preparation

The injected solution will consist of a low concentration of substrate diluted in treated and pH-adjusted potable water. De-chlorinating cultures may also be added to the injected solution, if required. Dilution water will therefore represent the major portion of the injected solution (approximately 99%). Total injection volumes estimated for the southwestern, southeastern, and northern TCE areas are approximately 250,000 gallons, 130,000 gallons, and 40,000 gallons, respectively.

Untreated potable water is undesirable as dilution water because residual disinfectants (e.g., chlorine, chloramine) can negatively affect bacterial populations. Moreover, potable water typically contains significant dissolved oxygen levels, which can also negatively affect anaerobic degradation. Therefore, the design includes treating potable water by removing residual disinfectants and dissolved oxygen before using it for amendment injection. Moreover, site groundwater pH (5 to 6 standard units) is generally below the optimal range for bioremediation; therefore, provisions must be made to adjust (increase) the pH of the injected solution.

Removing residual disinfectant is relatively simple. Granular activated carbon (GAC) is a proven, well-understood technology for this purpose. GAC was successfully used for this purpose during the injection tests performed at the MRC site in November 2011 (Tetra Tech, 2012c). Carbon use and vessel size for the required water volumes will be modest and the treatment cost will be low; it is expected that the initial carbon bed will last throughout the entire project.

However, removing dissolved oxygen is more complex. The selected process for removing dissolved oxygen is based on a semi-permeable hollow membrane contactor that removes dissolved gases (such as oxygen) using an in-line cartridge, similar to a filter cartridge. The selected technology (Liqui-Cel® Membrane Contactors; see Appendix F) allows dissolved gasses to be transferred from an aqueous stream without dispersion.

The membrane contactors contain thousands of hollow Celgard® microporous, polypropylene fibers, knitted into an array wound around a distribution tube. The aqueous stream will not

penetrate the pores because the hollow fiber membrane is hydrophobic. The gas/liquid interface is immobilized at the pore by applying a higher pressure to the aqueous stream relative to the gas stream. It is expected that the system will remove greater than 80% of the dissolved oxygen; this will be confirmed during start-up.

Potable water sources used to prepare the injection solution are domestic water lines near the equipment container in each source area. Such lines exist near the southeastern and northern TCE areas, and a vault has been identified as a preliminary potable water connection in the southwestern TCE area. The vault is located across Chesapeake Park Plaza and some distance from the selected equipment container location in this area (see Drawing C-3).

### 3.8.2 pH Adjustment

Groundwater pH in some locations within the treatment areas (primarily in the southeastern and southwestern TCE areas) is below the optimal range for anaerobic degradation. The optimal growth pH for *Dehalococcoides ethenogenes* strain 195 (the only known bacterium capable of complete reductive–dechlorination of tetrachloroethane [PCE] to ethene) is between pH 6.8 and 7.5. Likewise, optimal pH ranges for several *Desulfitobacterium* species capable of reductive dechlorination of chlorinated ethenes and ethanes are near neutral. Thus, the system design provides for increasing the pH of the groundwater to improve the bioremediation system performance.

Common chemicals used to raise pH include caustic (sodium hydroxide), magnesium hydroxide, lime (calcium hydroxide), and baking soda (sodium bicarbonate). Sodium bicarbonate was selected for initial pH adjustment for the following reasons:

- it is safe and easy to handle
- its maximum pH is approximately 8.5, so it cannot be overdosed
- it is relatively soluble (compared to lime and magnesium hydroxide)

A sodium bicarbonate buffering solution will be prepared in a 330-gallon tank. A maximum of 200 pounds of sodium bicarbonate can be dissolved in a 330-gallon tank (based on sodium bicarbonate's solubility of 7.5 grams per liter at 10 degrees Celsius). To ensure complete dissolution, 150 pounds of sodium bicarbonate will be mixed in 300 gallons of water, resulting in a six percent solution.

The sodium bicarbonate solution will be prepared by personnel during regular site visits. Sodium bicarbonate powder will be stored in bags inside the equipment containers. To avoid personnel injury, bag handling procedures must fully comply with Lockheed Martin requirements regarding the maximum lift weight and handling practices. If necessary, bags smaller than the standard 50-pound bags will be used. Sodium bicarbonate will be placed in a tank with treated water using a lifting device (see the Lift-*N*-GO II™ product sheet in Appendix F), and the tank's contents will be mixed using a conventional sump pump with a side outlet to create a circular fluid motion inside the tank.

Sodium bicarbonate dosing estimated here is based on a comparison of site groundwater alkalinity and a typical well-buffered aqueous–system alkalinity. Existing analytical data indicate that the typical alkalinity of MRC groundwater is between 20–40 mg/L (expressed in equivalent hardness units of calcium carbonate [$CaCO_3$]), while well–buffered aqueous systems typically have alkalinity of at least 100 mg/L. Therefore, MRC groundwater alkalinity must increase from its current level of 20 mg/L to 100 mg/L. The typical pH range encountered in MRC site groundwater is less than neutral (i.e., pH<7). At this pH, virtually all alkalinity exists as bicarbonate ($HCO_3^-$). Therefore, the design buffer dosage is estimated as the mass of sodium bicarbonate needed to increase the concentration of bicarbonate ($HCO_3^-$) in groundwater by 80 mg/L. Actual injection dosage will be determined by testing.

The bicarbonate dosage calculation is based on the formation pore volume in each TCE area; calculation results are summarized in Table 3-6. As shown, weekly bicarbonate dosages (administered as a 6% solution) during the first injection event are expected to be as follows: 260 gallons for the southwestern TCE area, 170 gallons for the southeastern TCE area, and 90 gallons for the northern TCE area. Note that this estimation is preliminary; more site-specific data are needed to finalize the bicarbonate dose. However, the preliminary estimate indicates that the buffering system capacity, as designed, can satisfy the site's groundwater buffering demand.

Site-specific data regarding buffer demand will be collected before system startup. During injection wells installation in each area, soil and groundwater alkalinity will be recorded to fine-tune the required bicarbonate dosage. Soil and groundwater samples will be collected from five locations in the southwestern TCE area, from four locations in the southeastern area, and from two locations in the northern area.

Sodium bicarbonate will be added slowly to each of the aforementioned samples to determine the amount required to increase the pH of the aqueous portion of the sample to eight (titration curve). The amount of sodium bicarbonate required for pH adjustment will be calculated separately for each area, and that amount will be used in the initial injection event. Note that the pH adjustment system is designed such that different chemicals and different injection rates could be used if warranted, based on the results of the sampling/testing and the initial injection. Note also that sodium bicarbonate dosage is not based on pH level of the injected solution, but on the pH of groundwater in each area, and its associated alkalinity adjustment requirement; thus, a pH-based continuous control is not applicable here. Overdosing is not possible due to a small buffer tank size (the buffering solution would be expended faster with no negative consequences), even if an incorrect pump rate is set.

### 3.8.3 Design Capacity

Table 3-7 summarizes the design and maximum flows of water, substrate, and pH buffer solution for each TCE area. The average and maximum design capacities of the injection equipment are important parameters that significantly influence overall equipment configuration and system operation. Optimizing these systems for these demands requires determining both the optimal equipment sizes and capacities needed for the expected operating range, and providing reasonable excess capacity to assure flexible operations without adversely affecting functionality or cost. Table 3-3 shows likely initial operating ranges (conservatively low) for the bioremediation systems at the site. As shown on this table, total injection rates for the southwestern, southeastern, and northern TCE areas will be 1.5 gpm (six wells @ 0.25 gpm), 1 gpm (four wells @ 0.25 gpm), and 0.5 gpm (two wells @ 0.25 gpm), respectively. The total maximum flow capacity for each system is based on the capacity of the backflow preventer (12 gpm). This allows for a maximum simultaneous operation of all injection wells[1], with the following injection rates per well:

- southwestern TCE area 0.30 gpm per well (39 wells)
- southeastern TCE area 0.50 gpm per well (24 wells)

[1] *Note that a simultaneous operation of all injection wells is not a recommended operational practice, as it may lead to excessive mounding, injected fluid daylighting, and preferential channeling, unless it is shown via testing to be possible without any of these adverse effects.*

- northern TCE area 1.5 gpm per well (eight wells)

### 3.8.4 Process Equipment Summary

The characteristics and sizes of major equipment items are summarized in Table 3-8 below. The overall amendment solution preparation process is illustrated in the general process flow diagram (Drawing M-1). The general sequence of the process is as follows:

1. *Potable water inlet:* backflow preventer and water meter/totalizer
2. *Residual chlorine removal:* GAC treatment
3. *Dissolved oxygen removal:* hollow membrane contactor with vacuum pump
4. *Amendments injection:* substrate and sodium bicarbonate dosing into common manifold via metering pumps
5. *Distribution manifold to individual injection wells:* injection flow is split between injection wells and directed into individual lines leading to the injection wells

The elements of the process above are described in detail below. Refer to the process and instrumentation diagram (Drawing M-2) for process details and equipment nomenclature. Appendix F contains the equipment manufacturers' information.

- *Untreated water inlet:* Untreated potable water will enter the equipment building from a pressurized domestic water line. A ½-inch backflow preventer (double check-valve type, BFP-1 in Drawings M-7 to M-9) will be installed at the inlet. A ½-inch conventional mechanical water meter-totalizer will be installed inside the equipment container for water usage tracking. An automatic ½-inch electrical actuated valve with a fail-safe spring-return will also be installed on this line to stop the flow of potable water to the system in case of system shut down.

- *Granular activated carbon:* At the next step, the water stream is treated by granular activated carbon (GAC-1 in Drawings M-7 to M-9) to remove residual chlorine. GAC treatment for chlorine is usually selected based on 3–5 gpm of flow per cubic foot of activated carbon. The GAC vessels are sized conservatively: approximately 8 cubic feet (200 pounds [lbs]) of activated carbon for the southwestern and southeastern area systems and 6.5 cubic feet (180 lbs) of activated carbon for the northern area system. It is expected that a carbon changeout will not be required during the initial injection events in each area

- *Dissolved oxygen removal:* The final step in preparing the solution water is to remove dissolved oxygen. The dissolved oxygen removal package will consist of a membrane contactor, an inlet particulate filter (< 5 microns) to remove carbon dust from the stream, and a vacuum pump. The selected membrane contactor (Liqui-Cell®, model 4×28 Extra-Flow) has a maximum flow capacity of 30 gpm. Appendix F contains dimensions and operational data.

- *Substrate dosing:* Substrate will be introduced directly into the manifold at the effluent of the dissolved oxygen removal contactor, and before the distribution manifold to the injection wells. A metering pump (e.g., solenoid diaphragm type) with a sufficient flow and pressure range to supply the required substrate quantities will be used (MP-1 in Drawings M-7 to M-9). The metering pump (MP-1) will discharge into the substrate injection line with a check valve and a shut-off valve connected to the main one-inch manifold via a reducing tee. The metering pump MP-1 will vary the substrate dosage in proportion to the injection flow using a signal from a flow transmitter (FMT-1 in Drawings M-7 to M-9). As a result, a constant predetermined substrate concentration will be maintained in the injection stream, regardless of the injection flow. Metering pump MP-1 would be automatically deactivated in the absence of flow in the main injection line. Substrate overdosing due to setting the incorrect metering pump rate is not possible due to a small tank size (substrate would simply be expended faster with no negative consequences).

- *pH adjustment dosing:* pH adjustment dosing will be performed in a manner similar to the substrate dosing: a predetermined pH buffer concentration will be maintained in the injection stream regardless of changes in injection flow. A metering pump (e.g., solenoid diaphragm type) with a sufficient flow and pressure range to supply the required pH buffer quantities will be used (MP-2 in Drawings M-7 to M-9). The metering pump MP-2 will vary the dosage in proportion to the injection flow in response to a signal from a flow transmitter (FMT-1 in Drawings M-7 to M-9). As a result, a constant predetermined-pH buffer concentration will be maintained in the injection stream regardless of the injection flow. The metering pump MP-2 would be automatically deactivated in the absence of flow in the main injection line. A static mixer installed in the injection line will ensure good mixing of the sodium bicarbonate and substrate in the water stream.

- *The dehalococcoides (DHC) cultures* injection line will be similarly constructed, but the cultures will be displaced from the shipping container using an inert gas (e.g., argon); this will require an operator on site.

- *Distribution manifold:* Each container system will contain a 10-branch piping manifold to direct the substrate solution stream to individual injection wells; when the wells to which injection is directed are adjusted, it will be necessary to disconnect the previous wells' tubing and connect the new wells' tubing prior to adjusting the injection via the control system. Each of the branches will have a ¼-inch multi-turn needle valve for flow control. Downstream of the needle valve will be a normally closed solenoid valve to allow automated operation and control. Downstream of a solenoid valve will be a high-pressure switch to close the injection line if the injection pressure exceeds a predetermined set point. Each injection line will also have a flow meter/totalizer and a pressure gauge. The distribution manifold details are shown in the piping and instrumentation diagram (P&ID) in Drawings M-7 to M-9 and on the container detail drawings (Drawings M-13 to M-15).

- *Injection well instrumentation:* Each injection well will have a ½-inch internal diameter (ID) line entering through a tee in the trench, as shown in Drawings M-1 and M-2. The top of each injection well casing will be sealed using a four-inch-diameter test plug rated for 35 pounds-force per square-inch gauge (psig) backpressure. The selected plug will

have a half-inch MNPT bypass line. A quarter-inch vent valve and a pressure gauge will be installed at top of the well, as shown in Drawings M-1 and M-2.

### 3.8.5 Process Equipment Enclosures

Process equipment will be housed in custom-designed shipping containers; construction details are shown in Drawing M-10. For general reference and examples of custom-designed containers, refer to container vendor information in Appendix F. Tetra Tech will provide two container systems. The equipment containers will have the following features:

- internal length: 39 feet
- internal height: 100 inches
- internal width: 7 feet
- gross weight rating: 60,000 pounds
- one end of the container will consist of a six-foot access doorway and there is a 36-inch side-entrance door
- two-inch wall thickness
- high efficiency insulation
- wall-mounted combination air conditioner/heat pump (8,700 British thermal units [BTU]), thermostat controlled)
- internal lighting; minimum lighting intensity of 50 foot candles
- 100 amp electrical service panel (230 or 110 volts alternating current [VAC] single phase service)
- three-quarter-inch plywood walls and floors
- reinforced floors
- grounding of the container will comply with National Electric Code, 2011, Article 250 “Grounding and Bonding”

Process equipment such as the distribution manifold, flow meter, process piping, hollow membrane cartridge, and other lightweight instrumentation will be mounted on the side walls of the container. The electrical and control components will also be wall mounted. Heavier equipment items such as the sodium bicarbonate tank, substrate tote, and GAC vessel will be placed on the floor and secured. The floor construction will be able to support the full weight of the equipment. Drawing M-3 shows the equipment layout within the containers and

Drawings M-4, M-5, and M-6 show equipment details. Refer to Drawing E-8 for the electrical single line diagrams for the containers.

Wind load calculations indicate that tie downs are not required for the containers. However, tie downs will be utilized; the tie down design is shown on Drawing M-11. The tie downs will consist of helical screw anchors will be installed at each corner of the container.

Based on geotechnical investigations in each of the three areas, concrete pads are not required.

The air conditioning/heat pump unit is sized based on the basic heat balance calculations provided in Appendix D, assuming a temperature difference of 35 degrees Fahrenheit for both air conditioning and heating. This temperature differential will allow the air conditioning to maintain 80 degrees Fahrenheit inside the containers at an ambient (outside) temperature of 115 degrees Fahrenheit. For cold periods, this temperature differential would allow the heater to maintain 35 degrees Fahrenheit inside the containers with a temperature outside of 0 degrees Fahrenheit. The calculated requirement for air conditioning is 4,760 BTU and for heating is approximately 4,760 BTU. To allow a proper safety factor, the selected air conditioning/heat pump size is 8,700 BTU.

No individual piece of equipment has a holding time longer than 90 days.

Based on the National Electrical Code, the equipment container electrical classification is determined based on material type, material properties, and the likelihood that an ignitable mixture will be present. For a fire or explosion to occur flammable or combustible material must be present, the material must be mixed with air in proportions required to produce an ignitable mixture, and there must be sufficient release of energy to cause ignition of the mixture. Based on the application of the above principles, the equipment containers are non-classified areas.

### 3.8.6 Control Systems - General

The remediation system process is purposefully designed so that equipment and instrument failures will not cause immediate threat to personnel safety and/or catastrophic equipment damage. The following control system features are designed specifically for this purpose:

- The injection system uses potable water pressure; thus, no pumps are needed for injection. The expected pressure drop at the design flow is very low (<2 psi at 1.5 gpm for the entire system).

- There are no tanks to fill or empty; thus, no potential for overfill as all amendments are injected and mixed in-line.

- Fail safe system shut down (no power or control input is needed to shut down the system, as the valves are shut down by spring return).

- The injection process is streamlined, resulting in a low number of functional elements (equipment and instrumentation); thus, the probability of a system failure is reduced.

Control systems will be identical for both equipment containers. Each injection system will have the interlocks and alarms necessary to operate the system in a manual fashion or continuously in an automatic mode. Each system is based on a programmable logic controller (PLC), a local human machine interface (HMI), and a cellular gateway (cellular transmission) to enable remote parameter monitoring and direct control over the process by users authorized by Lockheed Martin. In the operation and maintenance plan (under separate cover), Tetra Tech will designate locations for remote parameter monitoring and process control; these locations will have a computer with an internet access and an approved IP address to access the PLC. Only computers with the IP addresses on the authorized list could access the PLCs. Lockheed Martin will approve the level of access for different users. Certain users will only be able to monitor the process parameters while other users will be able to manipulate the process (e.g., shut down the wells or shut down the system). The P&ID (Drawing M-2) details the control system elements and functions for each TCE area. Table 3-9 summarizes inputs and outputs for the PLCs (common logic for all three areas). More detailed PLC input and output lists are included in Appendix G.

Here is a summary of the control system logic that will apply to all three TCE areas:

1. *General alarms.* Nine (9) general alarm conditions trigger a shutdown of the injection process and the operator's involvement to clear the alarms and restart the system. All general alarms are "latching" type which means that the system remains shutdown even if an alarm condition clears (e.g. interrupted power returns, high pressure decreases, etc,). The authorized operators will be notified via computer (email) and telephone (text message) when a general alarm occurs. These alarms are as follows:

    a) High differential pressure alarm (DPSA-1) across the GACs and membrane contactor.

    b) Low-vacuum alarm (LVA-1) at the inlet to the membrane contractor vacuum pump (vacuum pump failure).

    c) High-pressure alarm (HPA-1) at the membrane contactor outlet. The high pressure alarm set-point is adjustable by on-site operator or by authorized operator remotely.

d) Low-pressure alarm (LPA-1) at the membrane contactor outlet. The low pressure alarm set-point is adjustable by on-site operator or by authorized operator remotely.

e) Inlet valve MV-1 failure to close alarm (limit switch LSC-1).

f) Inlet valve MV-1 failure to open alarm (limit switch LSO-1).

g) Secondary containment high level alarm (LSHH-1 and redundant LSHH-2).

h) VDC power supply failure.

i) Utility power failure/interruption.

2. The system shutdown is achieved by:

a) Closing the motorized valve MV-1 (spring return to close when de-energized) on the inlet water line

b) Closing all solenoid valves SV-101 to 110 on the individual injection lines (spring-return to close when de-energized)

c) De-activating pumps VP-1, MP-1 and MP-2.

3. *Individual injection line alarms.* A high-pressure alarm (HPA) condition HPA-101 to 110 on any individual injection line closes the solenoid valve SV-101 to 110 on this particular line and notifies the operator(s) via computer (email) and telephone (text message).

4. *Notification alarms.* Four (4) notification alarms are utilized. These alarm conditions do not cause a forced system shutdown but require operator's notification and may need actions such as a site visit to rectify a problem. Operator(s) notification will be via computer (email) and telephone (text message). These notification alarms are as follows:

a) Unexpected low flow alarm (e.g. flow drops >15% over 1 minute). This condition is likely to occur if any solenoid valve (SV-101 through SV-110) fails to open or fails to remain open. The low flow alarm set-point (% reduction and time period) is adjustable by on-site operator or by authorized operator remotely.

b) Unexpected high flow alarm (e.g. flow increases >15% over 1 minute). This condition is likely to occur if any solenoid valve (SV-101 through SV-110) fails to close or if a leak/lines break occurs in the system process piping. The high flow alarm set-point (% increase and time period) is adjustable by on-site operator or by authorized operator remotely.

b) High temperature in the enclosure

c) Low temperature in the enclosure

5. *System Status Monitoring*

The authorized users will frequently monitor the system status remotely over a cellular network and the internet. The process information (current flow, pressure, injection wells

status, alarms condition, all power equipment status) will be displayed as a series of pages when the system is accessed. These data could also be accessed directly via an HMI screen by a local operator at the site.

6. *Process Data Logging* Two process variables will be monitored and recorded by the control system.

   a) Flow meter (FMT-1) at the membrane contactor outlet will be recorded periodically (e.g. once per 15 minutes).

   b) Pressure transmitter (PT-1) at the membrane contactor outlet will be recorded periodically (e.g. once per 15 minutes).

   The recorded historical values will be available for download by authorized remote users at any time during system operation. These data could also be downloaded directly by a local operator at the site using a laptop computer.

7. *Alarms History*

   Each alarm event will be logged and recorder. Each alarm record will contain the alarm name, type, date and time. The alarms historical records will be available for download by authorized remote users at any time during system operation. These data could also be downloaded directly by a local operator at the site using a laptop computer.

8. *System Status History*

   System status includes a record of the injection wells solenoid valves position (SV-101 to 110), metering pumps status (MP-1 and MP-2) and vacuum pump status (VP-1). A separate system status record will be created each time when a configuration is changed (via operator's input or due to an alarm condition). The system status historical records will be available for download by authorized remote users at any time during system operation. These data could also be downloaded directly by a local operator at the site using a laptop computer.

9. The speed of substrate metering pump MP-1 will be adjusted in proportion to the total injection flow (measured by FMT-1) to maintain a predetermined constant substrate-concentration. MP-1 is deactivated if the flow declines below a low measurement level limit of the flowmeter FMT-1 ( 0.28 gpm). A scaling factor for MP-1 is calculated in advance and entered into the pump via a built-in key-pad by an on-site operator.

10. The speed of pH buffer metering pump MP-2 will be adjusted in proportion to the total injection flow (measured by FMT-1) to maintain a predetermined constant buffer-concentration. MP-2 is deactivated if the flow declines below a low measurement level limit of the flowmeter FMT-1 (0.28 gpm). A scaling factor for MP-1 is calculated in advance and entered into the pump via a built-in key-pad by an on-site operator.

11. The system is shut down in the event of power loss, as both MV-1 and solenoid valves SV-101 to 110 are fail close (spring return) if de-energized. No control system input is required for this action.

The control system bill of materials and the control system architecture are shown in Drawings E-10 and E-11, respectively. The control panel makes extensive use of a local HMI touch screen panel for functions such as operating individual solenoid valves, operating all on/off/auto switches, re-setting the alarms, and other functions. Note that all of the above functions will also be available to a remote operator(s) over an internet connection (cellular gateway). Using a local HMI panel streamlines the control panel by having only a few physical on/off/auto switches and indicator lights (five switches, shutdown switch, and power indicator). Drawing E-9 contains the control panel layout. The control panel enclosure will house all PLC components, an uninterruptable power supply, communication gear, and other components (Drawing E-9).

### 3.8.7 Control System – Architecture

The control system consists of a main process PLC and local HMI housed in a control panel and monitored by an operator located in a remote office. The PLC will control the injection process via hard-wired input/output to instrument devices located in each injection container. The local HMI will display the process information, trend process variables, and display process alarms. Alarm notification will be handled by the local HMI and sent via an internet connection in the form of an email and a text message. Communications between the main process PLC and the local HMI will be via Ethernet cable. Each TCE area container control system will communicate with the remote monitoring/control station through its own internet connection via the cellular gateway located in each container. Multiple cellular service providers are available in the area. The cellular service provider will be selected by Tetra Tech based on technical requirements, such as ease of system configuration, signal strength, and other parameters. Each control system cellular gateway will have its own internet protocol (IP) address, thus two data packages are required from the selected cellular carrier. The local HMI will be the main interface with the control system for the operator when at the injection container. A laptop will be used by the operator at the site for a direct access to PLC. Alarms and historical trending data will be downloaded by the operator for later use.

Security will be implemented by means of IP filtering. The selected cellular modem (Sierra Wireless Raven) incorporates the capability of assigning the static (or range of) IP addresses allowed to access the unit. Therefore, only the computers with IP addresses from the approved

list could be used for access. Additionally, two different access levels with different passwords will be used:

a) Monitoring only (more inclusive). The users on this list will only be able to monitor the process parameters.
b) Monitoring and control (more restrictive). In addition to system monitoring, the users on this list will also be able to manipulate the process: switch the injection wells on and off, activate/deactivate the metering pumps, change set-points, shut down the system.

See Drawing E-9 for details of the control panel layout, Drawing E-10 for the control system's bill of material and Drawing E-11 for the general system architecture.

Each control system will consist of the following key components or approved equal:

1. The PLC platform will be Allen-Bradley CompactLogix®
2. The HMI platform will be an Automation Direct C-More® touch panel, model EA7-T12C. In addition, the following items are required from Automation Direct:
3. Sierra Wireless cellular modem package (Raven V2221E-VA modem with bracket and external antenna). The selected modem can utilize either Verizon or AT&T for cellular connectivity. For clarity, Verizon is assumed as a selected carrier.
4. Date plan and dedicated static IP address (Verizon is assumed as carrier by AT&T could also be used if desired).

Note that no additional software is required for a remote system monitoring and control. The control system integrator will utilize the PLC programming software (RSLOGIX 5000) and the HMI programming software (C-more) to program the PLC and to configure the HMI screen.

The general layout of the SCADA system screens is shown on Drawing E-12. The HMI screen layout will be configured with the following pages:

1. Main Screen. Project title and links to other pages. This screen will be displayed when the system is accessed via internet.
2. Process Diagram. This screen will display a basic process flow diagram with the current inlet valve and metering pumps status and also current flow and pressure indicated.
3. Switches. This screen will display the switches position for the following elements: system power, inlet valve, metering pumps, vacuum pump, injection wells solenoid valves. Each switch position can be changed remotely over internet by authorized users or at the site by system operator.
4. Alarms. This screen will display the current alarms status. The alarms can only be re-set by an on-site operator.

5. Analog set-points. This screen will display the current set-point values (maximum and minimum pressure, high and low flow percentage, etc.). An authorized operator will be able to adjust these set-point values.

6. Alarms history. The alarms history can be downloaded in a tabular format via a separate file. Each alarm event record will have and alarm name, type, data and time. The memory size will be sufficient for at least of 1 year of system operation.

7. System status history. The system status history (all switches position) can be downloaded in a tabular format via a separate file. A separate system status record with a time stamp will be created at each status change (e.g. any switch status change). The memory size will be sufficient for at least of 1 year of system operation.

### 3.8.8 Equipment Testing and Operator Training

The equipment container vendor (NES) will fabricate, program, install and integrate all process equipment and the control panels. The Tetra Tech lead design engineer (Engineer) will oversee the fabrication of process equipment and control panels, installation, programming, and testing at the vendor's facility in Attleboro, MA. The Engineer will also participate in PLCs programming and debugging.

After the system installation is complete, the equipment and instrumentation function check will be performed, including an alarms and interlocks check. Finally a full "wet" test will be performed under the direction of the Engineer at the vendor's facility. A "wet" test will involve operation of each equipment container using potable water. Potable water will also be used in place of substrate and sodium bicarbonate solution to simulate metering pumps operation. Injection flow in individual lines will balanced similar to actual field operations. Metering pump PID loops will be adjusted and checked. All process alarms and interlocks will be simulated and checked for proper functioning. Remote operator's alarms notification, remote data access and remote control functions will also be checked and verified. Any problems or errors that are found during this testing will be resolved.

Based on the scope of the "wet" test, it is not anticipated that the vendor's personnel will be needed for the field deployment and start-up of the equipment modules. However, the vendor's personnel will be available to travel to the site and perform any troubleshooting and/or equipment repair if necessary.

The Engineer will debrief and train the designated equipment operators (Tetra Tech personnel from a local office) during the field equipment start-up. The information and experience

developed during the “wet” test at the vendor’s facility will be used as an initial basis for this training. Additionally, the actual site parameters developed during the start-up such as the injection pressures at injection wells will be used to fine-tune the operator’s training inputs.

**Table 3-1**

**Estimated Ratio of Injection Volume to Pore Volume**
**Lockheed Martin Middle River Complex**
**Middle River, Maryland**

| Parameter | Value | Unit |
|---|---|---|
| Achieved injection test ROI | 15 | feet |
| Injection test interval thickness | 20 | feet |
| Estimated formation porosity | 0.25 | (unitless) |
| Actual injection test volume to achieve ROI | 2,700 | gallons |
| Formation pore volume within achieved ROI cylinder | 26,440 | gallons |
| Ratio of actual injection volume to pore volume to achieve ROI | 10.2% | not applicable |

ROI radius of influence

**Table 3-2**

**Estimated Total Injection Volumes**
**Lockheed Martin Middle River Complex**
**Middle River, Maryland**

| Location | 1,000 µg/L TCE contour area (square feet) | Formation porosity (estimated) | Injection interval thickness (feet) | Calculated pore volume within 1,000 µg/L TCE contour (gallons) | Injection volume to pore volume ratio | Calculated injection volume (gallons) |
|---|---|---|---|---|---|---|
| Southwest TCE area | 65,000 | 25% | 20 | 2,431,000 | 10.2% | 248,300 |
| Southeast TCE area | 33,000 | 25% | 20 | 1,234,200 | 10.2% | 126,100 |
| North TCE area | 10,500 | 25% | 20 | 392,700 | 10.2% | 40,200 |
| **TOTAL** | 108,500 | — | — | 4,057,900 | 10.2% | 414,600 |

TCE trichloroethene
µg/L microgram(s) per liter

**Table 3-3**

**Injection Well Parameters**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | Total injection volume (gallons) | Number of injection wells | Injection volume per well (gallons) | Conservative injection rate per well (gallons per minute) | Maximum number of wells operating simultaneously* | Injection event duration (days) | Injection duration for each well (days) |
|---|---|---|---|---|---|---|---|
| Southwest TCE area | 248,300 | 39 | 6,370 | 0.25 | 6 | 115 | 18 |
| Southeast TCE area | 126,100 | 24 | 5,260 | 0.25 | 4 | 88 | 15 |
| North TCE area | 40,200 | 8 | 5,030 | 0.25 | 2 | 56 | 14 |
| **Totals** | 414,300 | 71 | — | — | 12 | | |

TCE trichloroethene

*Conservative estimation

**Table 3-4**

**Estimated Substrate Quantities by Target Pore Volume Concentration**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | Calculated pore volume within 1,000 µg/L TCE contour (gallons) | Target pore volume substrate active ingredients concentration (mg/L) | Substrate active ingredients content | Calculated total mass of substrate per injection event (pounds) | Substrate volume per injection event (gallons) |
|---|---|---|---|---|---|
| Southwest TCE area | 2,431,000 | 400 | 80% | 10,040 | 1,220 |
| Southeast TCE area | 1,234,200 | 400 | 80% | 5,150 | 620 |
| North TCE area | 392,700 | 400 | 80% | 1,640 | 200 |
| **Totals** | 4,057,900 | — | — | 16,830 | 2,040 |

µg/L microgram(s) per liter
mg/L milligram(s) per liter
TCE trichloroethene

## Table 3-5

## Well Installation Information
## Locckheed Martin Middle River Complex
## Middle River, Maryland

| Well ID | Northing | Easting | Well Type | Diameter (inches) | Depth to Top of Screen (ft bgs) | Depth to Bottom of Screen (ft bgs) | Top of sand filter pack (ft bgs) | Bottom of sand filter pack (ft bgs) | Top of bentonite seal (ft bgs) | Bottom of bentonite seal (ft bgs) | Bottom of cement/ bentonite grout (ft bgs) | Top of cement/ bentonite grout (ft bgs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOUTHEASTERN TCE AREA** | | | | | | | | | | | | |
| IWE -1 through IWE-24 | | | Injection | 4" | 20 | 35 | 19 | 35.5 | 14 | 19 | 14 | 3 |
| SEMW-1I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| SEMW-2I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| SEMW-3I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| SEMW-6I | | | Monitoring | 2" | 10 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| **SOUTHWESTERN TCE AREA** | | | | | | | | | | | | |
| IWW -1 through IWW-29 | | | Injection | 4" | 15 | 35 | 14 | 35.5 | 9 | 14 | 9 | 3 |
| IWW -30 through IWW-39 | | | Injection | 4" | 20 | 35 | 19 | 35.5 | 14 | 19 | 14 | 3 |
| SWMW-1I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| SWMW-2I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| SWMW-5I | | | Monitoring | 2" | 10 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| **NORTHERN TCE AREA** | | | | | | | | | | | | |
| IWN -1 through IWN-8 | | | Injection | 4" | 20 | 35 | 19 | 35.5 | 14 | 19 | 14 | 3 |
| NMW-1I | | | Monitoring | 2" | 20 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |
| NMW-3I | | | Monitoring | 2" | 10 | 30 | 19 | 30 | 17 | 19 | 17 | 2 |

Horizontal Coordinate System: NAD83 Maryland State Plane Zone, US FOOT
ft bgs - feet below ground surface

**Table 3-6**

**Estimated Buffer Dosage**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | Pore volume within 1,000 µg/L TCE contour (gallons) | Increase in target pore volume bicarbonate alkalinity (mg/L) | Total sodium bicarbonate buffer required (pounds) | Projected injection event duration (days) | Weekly dosage of sodium bicarbonate (pounds/week) | Weekly volume of 6% sodium bicarbonate solution (gallons/week) |
|---|---|---|---|---|---|---|
| Southwest TCE area | 2,431,000 | 80 | 2230 | 115 | 135 | 259 |
| Southeast TCE area | 1,234,200 | 80 | 1132 | 88 | 91 | 173 |
| North TCE area | 392,700 | 80 | 360 | 56 | 45 | 87 |

µg/L microgram(s) per liter
mg/L milligram(s) per liter
TCE trichloroethene

**Table 3-7**

**Design Flow-Rates**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Parameter | Southwest TCE area | | Southeast TCE area | | North TCE area | |
|---|---|---|---|---|---|---|
| | Design | Maximum | Design | Maximum | Design | Maximum |
| Water flow | 1.5 gpm | 12 gpm | 1.0 gpm | 12 gpm | 0.5 gpm | 12 gpm |
| Substrate flow | 0.4 gph | 2.5 gph | 0.3 gph | 2.5 gph | 0.15 gph | 2.5 gph |
| pH-buffering solution flow | 1.5 gph | 2.5 gph | 1 gph | 2.5 gph | 0.5 gph | 2.5 gph |

TCE trichloroethene
gpm gallon(s) per minute
gph gallon(s) per hour

**Table 3-8**
**Key Equipment Items List**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 1 of 4**

| P&ID symbol | Description | Manufacturer | Sizes/capacities/models | | |
|---|---|---|---|---|---|
| | | | Southwest TCE area | Southeast TCE Area | North TCE area |
| GAC-1 | Liquid phase carbon vessel, polyglass construction, 150 psig maximum working pressure | Siemens, PG series | Model PG200, 200 lbs of carbon, 10 gpm max flow | Model PG200, 200 lbs of carbon, 10 gpm max flow | Container from southeast or southwest will be used |
| MC-1 | Oxygen removal membrane contactor | Liqui-Cell® extra flow series | Model 4×28 extra-flow, 30 gpm max | Model 4×28 extra-flow, 30 gpm max | Container from southeast or southwest will be used |
| VP-1 | Vacuum pump, twin cylinder rocking piston type, staged. 29 in. Hg max vacuum, ⅓ hp, 115 VAC, 2.6 cfm open flow | GAST | Model 72R547-V116-D303X | Model 72R547-V116-D303X | Container from southeast or southwest will be used |
| MP-1 | Substrate metering pump, 115 VAC, analog 4–20 mA speed control input, PVC head and fittings | LMI series, solenoid diaphragm | Model B92-1-498SI; 2.5 gph, 100 psi max | Model B92-1-498SI; 2.5 gph, 100 psi max | Container from southeast or southwest will be used |
| MP-2 | pH buffer metering pump, 115 VAC, analog 4–20 mA speed control input, PVC head and fittings | LMI series, solenoid diaphragm | Model B92-1-498SI; 2.5 gph, 100 psi max | Model B92-1-498SI; 2.5 gph, 100 psi max | Container from southeast or southwest will be used |
| V-101 to V-110 | Metering needle valve, ¼” FNPT, brass, 0.125” orifice, 20 turns to open | Hoke Valve | 2300 Series Model 2331F4B | 2300 Series Model 2331F4B | Container from southeast or southwest will be used |
| SV-101 to 110 | Solenoid valve, 150 psi max pressure, ⅜" FNPT, 115VAC, 10.1 watts, normally closed | ASCO valve | 8210G093 | 8210G093 | Container from southeast or southwest will be used |

**Table 3-8**

**Key Equipment Items List**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 2 of 4**

| P&ID symbol | Description | Manufacturer | Sizes/capacities/models | | |
|---|---|---|---|---|---|
| | | | Southwest TCE area | Southeast TCE area | North TCE area |
| FMT-1 | Paddle type electronic flow-sensor, transmitter with totalizer function (0.3–20 feet per second or 0.25–15 gpm for ½" Schedule 80); ½" PVC Schedule 80 fitting, field mounted transmitter | Georg Fischer Signet Model 2536 Integral Mount Paddlewheel, Field mounted 8550-type transmitter | Sensor: 3-8512-P0 Transmitter: 3-8550-1 Fitting: MPV8T005F Adapter kit: 3-8051 | Sensor: 3-8512-P0 Transmitter: 3-8550-1 Fitting: MPV8T005F Adapter kit: 3-8051 | Container from southeast or southwest will be used |
| MV-1 | Electrical actuated ball-valve, spring return if de-energized, normally closed, ½" FNPT, 115 VAC, 200 psi max, actuator with 2 limit switches | Johnson Controls | VG1241BL+943BUB | VG1241BL+943BUB | Container from southeast or southwest will be used |
| PF-1 | Bag housing for #4 filter bags (304SS, 150 psig pressure rating, 1-inch FNPT side connections, 5"diameter x 24" long); #4 bag cartridge, 5 micron rating | Rosedale | Housing 6-18-1P-2-150-S-B-PB; Cartridge model PL-R2-PEMF-3-P4 | Housing 6-18-1P-2-150-S-B-PB; Cartridge model PL-R2-PEMF-3-P4 | Container from southeast or southwest will be used |
| FT-1 and FT-101 to FT-110 | Bronze multi-jet water meter, ½" union couplings, 145 psi max, 0.125 to 13 gpm range | Dwyer Instruments | WM-A-C-01 | WM-A-C-01 | Container from southeast or southwest will be used |
| NA | Bag lifting device | RonI, Inc. | 200 lb capacity, LIFT-*N*-GO II™ HD | 200 lb capacity, LIFT-*N*-GO II™ HD | Container from southeast or southwest will be used |
| BFP-1 | Series 007 Double Check Valve Assembly, includes 2 shut off valves and strainer, bronze, 1/2 " MNPT, 175 psi max, 12 gpm maximum flow | Watts | 007-QT-S | 007-QT-S | Container from southeast or southwest will be used |

**Table 3-8**

**Key Equipment Items List**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 3 of 4**

| P&ID symbol | Description | Manufacturer | Sizes/capacities/models | | |
|---|---|---|---|---|---|
| | | | Southwest TCE area | Southeast TCE area | North TCE area |
| PR-1 | Series 252A pressure regulator, bronze, ½" MNPT, 300 psi max, 12 gpm maximum flow, outlet pressure 3 to 15 psi | Watts | Series 252A, Spring #145 | Series 252A, Spring #145 | Container from southeast or southwest will be used |
| AC-1 | Through the wall air conditioner with 8,700 BTU/hr heat pump and 3,900 BTU/hr backup heat pump, 115VAC | Amana | PBH092E12AX | PBH092E12AX | Container from southeast or southwest will be used |
| PT-1 | Pressure transmitter (0 to 30 psig), 316SS body, current and voltage output, 1/4" MNP process connection | Dwyer | 626-08-GH-P1-E5-S1 | 626-08-GH-P1-E5-S1 | Container from southeast or southwest will be used |
| VS-1 | Adjustable vacuum switch (2.7 to 28.4 "Hg), 5 A @ 250 VAC, 3 A @ 28 VDC, 1/8" MNP process connection | Dwyer | AVS-150 | AVS-150 | Container from southeast or southwest will be used |
| DPS-1 | Adjustable differential pressure switch (7 to 13 psi), AC: 3 VA, 0.25A @ 120 VAC; 5 VA, 0.25A @ 175 VDC, 1/4" MNP process connection | Dwyer | A4-1 | A4-1 | Container from southeast or southwest will be used |
| DPS-1 | Adjustable differential pressure switch (7 to 13 psi), AC: 3 VA, 0.25A @ 120 VAC; 5 VA, 0.25A @ 175 VDC, 1/4" MNP process connection | Dwyer | A4-1 | A4-1 | Container from southeast or southwest will be used |
| LSHH-1 | Secondary containment level switch, Buna-N float, brass stem and slosh guard, electrical rating 20 VA, 25' PVC cable, NC | Gem Sensors | Series L750, #149350 | Series L750, #149350 | Container from southeast or southwest will be used |

**Table 3-8**

**Key Equipment Items List**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 3 of 4**

| P&ID symbol | Description | Manufacturer | Sizes/capacities/models | | |
|---|---|---|---|---|---|
| | | | Southwest TCE area | Southeast TCE area | North TCE area |
| LSHH-2 | Redundant secondary containment level switch, electro-optical, polysulfone body, 1/4" NPT mounting and 3/8" conduit | Gem Sensors | Series ELS –1100, #143585 | Series ELS –1100, #143585 | Container from southeast or southwest will be used |
| Fire extinguisher | 10-lb, with wall bracket, rechargeable | ULINE | S-9874 | S-9874 | Container from southeast or southwest will be used |
| Eye wash station | Gravity-fed, 9-gallons capacity, certified by CSA to meet the ANSI Z358.1 Standard. | HAWS | 7501 | 7501 | Container from southeast or southwest will be used |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| bhp | brake horsepower | gpm | gallons per minute | mA | milliamps | psi | pounds per square inch |
| BTU/hr | British thermal unit per hour | HD | heavy duty | max | maximum | psig | pounds-force per square inch gauge |
| cfm | cubic feet per minute | hp | horsepower | MNPT | male national pipe thread | | |
| FNPT | female national pipe thread | in. Hg | inches mercury | NA | not applicable | PVC | polyvinyl chloride |
| gph | gallons per hour | lb(s) | pound(s) | P&ID | process and instrument drawing | rpm | revolutions per minute |
| | | | | | | VAC | volts alternating current |

**Table 3-9**

**Control System Logic Summary**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 1 of 3**

| Condition | Device | PLC input type | Action type | Action description |
|---|---|---|---|---|
| **GENERAL ALARMS** | | | | |
| Liquid In Secondary Containment | LSHH-1, LSHH-2 | Discrete signal | General alarm (latching) | When Liquid Sensed: De-Energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| High Pressure | PT-1 | Analog signal | General alarm (latching) | When > 30 pounds per square inch gauge (psig): de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| Low pressure | PT-1 | Analog signal | General alarm (latching) | When < 5 psig: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| High differential pressure | DPS-1 | Discrete signal | General alarm (latching) | When > 10 psig: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| Low vacuum | VS-1 | Discrete signal | General alarm (latching) | When < 20 inches of mercury: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| MV-1 fails to open | LSO-1 | Discrete signal | General alarm (latching) | When triggered: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| MV-1 fails to close | LSC-1 | Discrete signal | General alarm (latching) | When triggered: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |

**Table 3-9**

**Control System Logic Summary**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 2 of 3**

| Condition | Device | PLC input type | Action type | Action description |
|---|---|---|---|---|
| Loss of power | CS-1 | Discrete signal | General alarm (latching) | When triggered: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| VDC power supply failure | CS-2 | Discrete Signal | general alarm (latching) | When triggered: de-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. Send operator notification |
| High flow | FMT-1 | Analog signal | Notification alarm | When flow increases > 15% In < 1 minute: send operator notification |
| Low pressure | PT-1 | Analog signal | General alarm (latching) | When < 5 psig: De-energize MV-1, SV-101 to SV-110, MP-1, MP-2, VP-1. send operator notification |
| **NOTIFICATION ALARMS** | | | | |
| Individual injection well high pressure | PS-101 TO PS-110 | Discrete signal | Local alarm (latching) | When set-point exceeded (1 psig for southeast area, 2 psig southwest area, 8 psig for north area): de-energize individual solenoid valve (PS-101 to PS-110). Send operator notification. |
| High flow | FMT-1 | Analog signal | Notification alarm (latching) | When Flow Increases > 15% In < 1 Minute: Send Operator Notification |

**Table 3-9**

**Control System Logic Summary**
**Lockheed Martin Middle River Complex, Middle River, Maryland**
**Page 3 of 3**

| Condition | Device | PLC input type | Action type | Action description |
|---|---|---|---|---|
| Low flow | FMT-1 | Analog signal | Notification alarm (latching) | When Flow Decreases > 15% In < 1 Minute: Send Operator Notification |
| High equipment enclosure temperature | HTS-1 | Discrete signal | Notification alarm (latching) | When > 80 degrees Fahrenheit ($^0$F): Send Operator Notification |
| Low equipment enclosure temperature | HTS-1 | Discrete signal | Notification alarm (latching) | when < 40$^0$F: send operator notification |
| **PID LOOPS** | | | | |
| Substrate metering pump control signal | MP-1 | Analog signal from FMT-1 | Control signal | Signal to local pump control. Adjust speed in proportion to flow. Scaling factor entered by operator. |
| Buffer metering pump control signal | MP-2 | Analog signal from FMT-1 | Control signal | Signal to local pump control. Adjust speed in proportion to flow. Scaling factor entered by operator. |

# Section 4
# Implementation Plan

This section focuses on the specifics of implementing the response action in each of the three trichloroethene (TCE) impacted areas. In general, the implementation plan includes installation of the wells and piping, tracer testing in each area, baseline monitoring, initial injection, and performance monitoring. Additional injection events will then be designed and implemented based on the results of the initial injection event and subsequent performance monitoring. It is assumed several injection events will be conducted at approximately 18-month intervals.

Tetra Tech, Inc. (Tetra Tech) will complete an implementation work plan detailing the work to be completed. The plan will include, but will not be limited to, the following items:

- completion and evaluation of the tracer testing program, including recommendations for using tracer data in system operation
- a performance monitoring plan with sampling and analysis plan
- completion of injection events and evaluation of operational and performance data

## 4.1 SOUTHEASTERN TCE AREA—TESTING AND INITIAL INJECTION EVENT

Site-specific conditions related to implementation the response action in the southeastern TCE area can be summarized as follows:

- Injection test results indicate that the southeastern TCE area is the most permeable area. The hydraulic conductivity of this area is approximately one order of magnitude greater than the value used in the groundwater model. It is expected that low injection pressure will be required even if moderately high injection rates are used.
- The depth to groundwater table is approximately eight feet below ground surface. The thickness of the vadose zone here in combination with the low injection pressures allows for a certain safety margin to avoid the injected fluid daylighting.
- A complicating factor in this area is a detection of bromide tracer in the drain inlet approximately 120 feet from the injection point during the pilot test. A potential preferential pathway in this area may be present and testing is designed accordingly. A

long-duration tracer test using a bromide tracer (described below) will be performed to investigate this suspected pathway

- This TCE area is the least complex in terms of construction: it is entirely within Lockheed Martin Corporation (Lockheed Martin) property, water and power utilities are nearby, no road crossings are needed, and few crossings of underground utilities are needed.

The specifics of the southeastern TCE area dictate the following preliminary response action implementation sequence:

1. Before injection testing, Tetra Tech will follow the recommendations in the Block E interim remedial measures report (Tetra Tech, 2012d) and test the plugging of the storm sewer line at MH-10 (IL-3).

2. Twenty–four injection wells will be installed in the locations shown in Drawing C-2.

3. The equipment container will be constructed with process equipment as shown in the construction drawings. The container will be completed as a ready to run turnkey package and delivered to the site. The equipment container designed for the southwestern TCE area can be used if necessary.

4. Underground injection lines, potable water line, and power supply will be installed and connected to the container.

5. Baseline performance monitoring sampling will be conducted using the monitoring wells installed in the area for the injection pilot test and the newly installed monitoring wells (SEMW-1, -2I, -3I, -4I, -5I, -5S, and -6I) and also the existing monitoring wells MW-74A, MW-74B, and MW-72B (Section 4.4). These sampling results will be input into the existing groundwater model, which was prepared using software including *MODFLOW-2000* and *MT3D* version 5.2. The groundwater model will calculate the TCE and chlorinated volatile organic compound (cVOC) mass in the injection area.

6. Test injections using water (with chlorine and dissolved oxygen removed), tracer, and pH buffer (sodium bicarbonate) will be performed. Injection equipment will be tested and operating procedures will be developed during testing. To be conservative, this tracer test will encompass the entire injection volume estimated per well (Table 3-3 - 5,300 gallons per well or 21,000 gallons total, over 15 days of continuous injection).More information on the tracer is in Section 4.5. The test injection program is briefly summarized as follows:

    - Simultaneously inject tracer into the four injection wells that are closest to the storm sewer line with a drain inlet (MH-10/IL-3), the location where tracer was previously detected (IWE-6, IWE-12, IWE-17 and IWE-21 in Drawing C-2).

    - Set injection rate at 0.25 gallons per minute (gpm) per injection well.

    - Measure groundwater table mounding and pressure heads in the injection interval and adjust injection rates as necessary. The injection rate will be adjusted to maintain an

injection pressure of less than 10 feet of head and groundwater mounding of less than two feet in the monitoring wells.

- Visually examine and track utilities, outfalls, and channels for the injected solution. Samples will be collected to detect small quantities of tracer in utilities and outfalls. Monitoring of the test will include, at a minimum:

  - Groundwater levels will be continuously measured using down well pressure transducers. Transducers will be installed in at least one shallow- and three intermediate-depth wells and will operate throughout the injection testing. Wells to be monitored include SEMW-2I, -3I, -5S, and -5I.

  - Bromide sampling will be performed in at least one shallow- and three intermediate-wells before injection, at least three times during injection, and following injection at each set of wells. Laboratory analysis of these samples will be required. Wells to be sampled include SEMW-2I, -3I, -5S, and -5I.

  - Bromide sampling will be performed in at least three storm drain features in each area before injection, at least three times during injection, and following injection at each set of wells. Laboratory analysis of these samples will be required.

  - Details of the monitoring will be outlined in the implementation work plan prepared for all areas.

The next steps of the implementation sequence will depend on the outcome of the injection test. Several possible outcomes are considered here. All decisions on the path forward based on the tracer testing will be made by Tetra Tech in conjunction with Lockheed Martin.

1. *Tracer is not detected in any storm drain features, via laboratory testing.*

   a. A full injection event will be performed as described in Table 4-1 (assuming that no changes are required based on the results of the tracer testing).

2. *Tracer is detected in one or more storm drain feature locations while injecting close to the storm sewer line.*

   a. The test will be repeated using four injection wells in the central area of the plume, farther from the storm sewer line and the drain inlet where tracer was detected (IWE-4, IWE-9, IWE-15 and IWE-23 in Drawing C-2).

   b. If tracer is not detected, proceed to Step 1a above (full scale injection event), except injection into the wells near the storm drain line where tracer was detected will not occur.

   c. If tracer is detected, an attempt will be made to determine the injection rates and injection well configuration that would result in no detection of tracer.

3. *Tracer is detected during all repeat tests described in Step 2 above, with injection locations farther from the storm drain.*

a. Remedy implementation will be re-evaluated. Groundwater extraction in conjunction with injection will be considered, or an alternative remedy will be developed.

b. A test using groundwater extraction can be considered in critical locations.

***Initial full scale injection event—***The initial full scale injection event will be performed after testing is complete. The following details the initial injection event, with the assumption that the injection testing will show that the injection can proceed safely at the design rates and volumes. These parameters may have to be adjusted based on the testing results.

For the full scale implementation, the design volume will be injected into several injection wells simultaneously. After completion of injection into one set of wells, the injection will be switched to another group of wells until all injection wells have received the design volume of injection fluid. The well configurations are selected such that the injection locations are spread out as far as possible to minimize groundwater mounding and allow for the return of the groundwater table to static conditions between injections. The design injection volumes and substrate quantities are taken from Tables 3-2, 3-3, and 3-4 in Section 3. The parameters for the full scale injection event (involving all injection wells and design injection volumes) are in Table 4-1. Injection parameters for subsequent events may be adjusted based on the results of the performance monitoring associated with the first event; performance monitoring parameters are discussed in Section 4.4.

## 4.2 SOUTHWESTERN TCE AREA—TESTING AND INITIAL INJECTION EVENT

Site-specific conditions related to implementing the response action in the southwestern TCE area can be summarized as follows:

- Injection test results indicate that the southwestern TCE area is approximately half as permeable as the southeastern TCE area. Low injection pressures would probably be required if moderate injection rates are used.

- Depth to the groundwater table is approximately two to three feet below ground surface. Such a shallow groundwater table is a potentially complicating factor, as it creates a potential for injection fluid to daylight.

- This area is the most complex in terms of construction: water and power utilities are relatively distant, connections to public utilities may be required, road crossing is necessary, multiple crossings of underground utilities must occur, and overall trenching distances are long.

The specifics of the southwestern TCE area dictate the following preliminary remedy implementation sequence:

1. Tetra Tech will investigate if water connections can be made without crossing the Chesapeake Park Plaza road.

2. Thirty-nine injection wells will be installed in the locations shown in Drawing C-3.

3. Tetra Tech will construct the mobile equipment container with process equipment as shown in the construction drawings. The container will be completed as a ready to run turnkey package and delivered to the site.

4. Underground injection lines, potable water line, and power supply will be installed and connected to the container.

5. Baseline performance monitoring sampling will be conducted, using the monitoring wells installed in the area for the injection pilot test and the newly installed monitoring wells (SEMW-1, -2I, -3I, -4I, -4S, and -5I), and also existing monitoring wells MW12A, MW12B, and MW14B (Section 4.4). TCE and cVOC mass in the injection area will be calculated based on these results using the existing groundwater model.

6. Test injections will use water (with chlorine and dissolved oxygen removed), tracer, and pH buffer. Injection equipment will be tested and operating procedures will be developed during these tests. To be conservative, this tracer test will encompass an entire estimated injection volume per well (Table 3-3, 6400 gallons per well or approximately 40,000 gallons total over 18 days of continuous injection).The test injection program is briefly summarized as follows:

    - Simultaneously inject into six injection wells in the central portion of the area (e.g., IWW-4, IWW-14, IWW-19, IWW-26, IWW-32, and IWW-37 in Drawing C-3).

    - Set injection rate at 0.25 gpm per injection well.

    - Measure groundwater table mounding and pressure heads in the injection interval. The injection rate will be adjusted to maintain an injection pressure of less than 10 feet of head, and groundwater mounding of less than two feet in the monitoring wells.

    - Visually examine and track utilities, outfalls, and channels for the injected solution. Samples will be collected to detect small quantities of tracer in utilities and outfalls. Test monitoring will include, at a minimum:

        - Groundwater levels will be continuously measured using down well pressure transducers. Transducers will be installed in at least two shallow- and two intermediate-depth wells and operate throughout the injection testing. Wells to be monitored include SWMW-4S, SWMW-4I, MW-12A, and MW-12B.

        - Sampling for bromide will be performed in at least two shallow- and two intermediate-depth wells before injection, at least three times during the injection,

and following the injection at each set of wells. Laboratory analysis of these samples will be required. Wells to be sampled include SWMW-4S, SWMW-4I, MW-12A, and MW-12B.

- Sampling for bromide will be performed in at least three storm drain features in each area before injection, at least three times during the injection, and following the injection at each set of wells. Laboratory analysis of these samples will be required.

- Inject in to six wells in the southern portion of the area (IWW-30, IWW-31, IWW-36, IWW-37, IWW-38, and IWW-39 in Drawing C-3), repeating the steps above.

7. The injection rates and well injection configuration will be adjusted based on the tracer test results.

8. A full injection event will be performed as described in Table 4-2 (assuming that no changes are required based on the results of the tracer testing).

9. Performance monitoring and additional injection events will be based on performance monitoring results (Section 4.4).

For the full scale implementation, the design volume will be injected into several injection wells simultaneously. After completion of injection into one set of wells, the injection will be switched to another group of wells until all injection wells have received the design volume of injection fluid. The well configurations will be selected such that the injection locations will be spread out as far as possible to maximize the return of the groundwater table to static conditions between injections. The design injection volumes and substrate quantities are taken from Tables 3-2, 3-3, and 3-4 in Section 3. The parameters for the full scale injection event involving all injection wells and design injection volumes are in Table 4-2.

## 4.3 NORTHERN TCE AREA—TESTING AND INITIAL INJECTION EVENT

Site-specific conditions related to implementing the response action in the northern TCE area can be summarized as follows:

- Injection test results indicate that the northern TCE area is approximately two orders of magnitude less permeable than the southeastern TCE area. Relatively high injection pressures would probably be required even if low injection rates are used.

- Depth to the groundwater table is approximately 10–12 feet below ground surface. The thickness of the vadose zone may contribute to a safety margin to avoid the injected fluid daylighting.

- The potential for preferential channeling is high here due to numerous underground utilities and the hydraulic fracturing performed in the 2008 anaerobic reductive dechlorination (ARD) pilot test that was included as part of the Groundwater Response Action Plan (Tetra Tech, 2012a).

- This area is moderately complex in terms of construction: the area is entirely within the Lockheed Martin property, water and power utilities are close, overall trenching distances are short, and relatively few injection wells are present. However, this is an active industrial area, a roadway crossing is necessary, and extensive coordination with the facility management will be necessary.

The specifics of the northern TCE area dictate the following preliminary remedy implementation sequence:

1. A specific implementation plan will be developed and coordinated with facility management.

2. Eight injection wells will be installed in the locations shown in Drawing C-4.

3. Underground injection lines, potable water line, and power supply will be installed and connected to the container.

4. After completion of tracer testing and the initial injection event in either the southeastern or southwestern TCE areas, the equipment container from one of the other areas will be transported to the location shown in Drawing C-4 and will be connected to the injection lines and power and water sources.

5. When the tracer test and initial injection in the northern TCE area are finished, the container will be disconnected and returned to its original area and re-connected to power and water sources.

6. Baseline performance monitoring sampling will be conducted using the monitoring wells installed in the area for the injection pilot test and the newly installed monitoring wells (NMW1I, -2S, -2I, and 3I) and also the existing monitoring well MW-81B (Section 4.4). TCE and cVOC mass in the injection area will be calculated using the existing groundwater model based on these results.

7. Test injections using water (with chlorine and dissolved oxygen removed), tracer, and pH buffer will be performed. Injection equipment will be tested and operating procedures will be developed during testing. To be conservative, this tracer test will encompass an entire injection volume estimated per well (Table 3-3, 5,000 gallons per well or approximately 10,000 gallons total over 14 days of continuous injection).The test injection program is briefly summarized as follows:

    - Inject tracer into two injection wells simultaneously (e.g., IWN-3 and IWN-4 in Drawing C-4), at a rate of 0.25 gpm per injection well.

    - Measure groundwater table mounding and pressure heads in the injection interval. The injection rate will be adjusted to maintain an injection pressure of less than

10 feet of head and groundwater mounding of less than two feet in the monitoring wells.

- Visually examine and track utilities, outfalls, and channels for the injected solution. Samples will be collected to detect small quantities of tracer in utilities and outfalls. Monitoring of the test will include, at a minimum:

  - Continuous measurement of groundwater levels will be performed using down well pressure transducers. Transducers will be installed in at least one shallow- and three intermediate-depth wells and will operate throughout the injection testing. Wells to be monitored include NMW-1I, NMW-2S, NMW-2I, NMW-3I, and MW-81B.

  - Sampling will be performed for bromide in at least one shallow- and three intermediate-depth wells before injection, at least three times during the injection, and following the injection at each set of wells. Laboratory analysis of these samples will be required. Wells to be monitored include NMW-1I, NMW-2S, NMW-2I, NMW-3I, and MW-81B.

  - Sampling for bromide will be performed in at least three storm drain features in each area before injection, at least three times during injection, and following injection at each set of wells. Laboratory analysis of these samples will be required.

8. Wells will be switched and the test repeated three additional times so that all injection wells receive the design injection volume.

9. The injection rates and well configuration will be adjusted based on the tracer test results.

10. A full injection event will be performed as described in Table 4-3 (assuming that no changes are required based on the tracer testing).

11. Performance monitoring and additional injection events will be based on performance monitoring results.

Before full scale implementation, the decision whether to construct a third equipment container for this location will be made; it has been assumed that this container will not be constructed. Following mobilization and installation of one of the other equipment containers at this location, the design volume will be injected into two injection wells simultaneously. After a completed injection into one set of wells, the injection will be switched to another group of wells until all injection wells have received the design volume of injection fluid.

The well configurations will be selected such that the injection locations are spread apart as far as possible to maximize the return of the groundwater table to static conditions between injections. The design injection volumes and substrate quantities are taken from Tables 3-2, 3-3,

and 3-4 in Section 3. The parameters for the full scale injection event involving all injection wells and design injection volumes are in Table 4-3.

## 4.4 PERFORMANCE MONITORING AND SUBSEQUENT INJECTION EVENTS

The baseline performance monitoring event will be conducted before tracer testing in the three TCE areas. Following the initial injection event at each location, performance monitoring will be conducted one, three, six, and 12 months following injection completion in each area. Sampling parameters will include volatile organic compounds (VOCs) and monitored natural attenuation (MNA) parameters, as follows:

- VOCs, including TCE, cis-1,2-dichloroethene, and vinyl chloride
- biodegradation byproducts and end-products (e.g., ferrous iron, sulfide, nitrite, nitrogen, and the dissolved gases ethane, ethane, and methane)
- electron acceptors (e.g., sulfate, nitrate, ferric iron)
- general water quality parameters and biogeochemical indicators (e.g., total organic carbon [TOC], alkalinity, chlorides)
- organic fatty acids (an indicator of substrate presence)
- genetic material (*dehalococcoides* [DHC] and functional genes to determine the presence of microorganisms capable of degrading TCE to ethene)
- field parameters (e.g., oxidation reduction potential [ORP], dissolved oxygen, pH, temperature, specific conductance)

This list of parameters is comprehensive; not all wells will be sampled for all parameters. The plan for performance monitoring before and following the initial injections in the three areas is in Table 4-4. Note that any groundwater monitoring completed at the site in addition to the performance sampling program will be conducted as part of the annual site monitoring program, and is not addressed here. The performance monitoring sampling will also include surface water monitoring in two locations:

- Near Outfall 08 (Drawing C2) in southeastern TCE area
- Near monitoring well MW-12A (Drawing C2) in southwestern TCE area.

Surface water samples will be analyzed for the following parameters:

- VOCs, including TCE, cis-1,2-dichloroethene, and vinyl chloride
- TOC and selected ions (e.g. bromide)
- organic fatty acids (an indicator of substrate presence)
- field parameters (e.g., ORP, dissolved oxygen, pH, temperature, specific conductance)

Following receipt of the performance monitoring results, a remedy performance evaluation will be conducted for each area, based on the results and observations made during the initial injection event. Performance evaluation criteria include:

- The ability to inject an adequate volume of dilute substrate into the subsurface at acceptable pressures (generally, 10 feet of pressure head or less) without groundwater mounding greater than approximately two feet at a distance of 10 feet from the injection well. If the achievable injection rate under these parameters is less than 0.05 gpm in any area, the feasibility of injecting the required volumes will be re-evaluated. The injection rate will be determined during initial injection testing. This was generally shown to be possible in the pilot injection testing, but should be confirmed in all injection areas during testing.

- During initial testing and the first round of substrate injection, another major evaluation criterion will be the areas affected by the injection; that is, those areas exhibiting a TOC concentration of 100 milligrams per liter (mg/L) at intervals of one, three, six, and nine months following injection. The goal for the initial injection is for 50–75% of the active TCE treatment areas to have TOC concentrations greater than 100 mg/L. The results of injection testing indicate that this should be achievable with the current injection plan.

- Achievement of bio-geochemical conditions favorable for ARD, which include establishing suitable reducing conditions (generally defined as ORP <-100miiliVolts and dissolved oxygen [DO] <0.5 mg/L) and maintaining proper pH (pH >6.5). These parameters will be determined (measured) at intervals of one, three, six, and nine months following injection. The goal for the initial injection is for 50–75% of the active TCE treatment areas to have ORP <-050 milliVolts, DO <0.5mg/L, pH >6.8,

- *The reduction in the concentrations of TCE and its daughter products.* A quantitative remediation goal is required to evaluate reductions in TCE and its daughter products. The goal for the MRC response action is to reduce TCE mass in the active remediation areas by 70%. This provides an aggressive and achievable target for the design and implementation of the response action.

- Groundwater modeling indicates that an estimated 90 pounds of TCE are currently in the areas proposed for active remediation (i.e., areas within the current 1,000 µg/L TCE contour as shown on the Design Drawings). The initial mass of TCE and its daughter products will be recalculated before remediation using results from the baseline performance sampling event. Mass removal will be measured by obtaining the results of post remediation performance monitoring from the same wells. All TCE mass calculations (baseline and performance monitoring) will be used as input into the groundwater model;

the same assumptions used to develop the estimate of TCE contaminant mass above will then be used to determine the TCE mass at that time. The future TCE mass reductions will be compared with the fixed-in-time baseline TCE mass estimate. A fixed set of monitoring wells will be used for TCE mass reduction calculations. The treatment areas will be fixed based on the current 1,000 μg/L for the purposes of TCE reduction estimates.

- The results of groundwater monitoring following each injection event will be compared against this goal. This evaluation will be based on a calculation of the initial TCE mass (considering the baseline round of performance sampling) and the TCE mass from post injection sampling events, as calculated using the groundwater model. Although the reduction of daughter products is not part of the remediation goal, additional modifications to the injection protocol (pH adjustment, bioaugmentation, etc.) may be considered to address residual cis-1,2-dichloroethene and vinyl chloride concentrations, following attainment of the TCE-reduction goal.

- In addition to the primary criteria outlined above, populations of DHC and the necessary functional genes will be monitored; the minimum target population of DHC will be 10,000 cells per liter or greater. Methanogens and iron and sulfide reducing bacteria will also be measured to provide additional information on biological activity in the treatment areas.

The evaluation will determine if any of the following adjustments are required:

- adjustments to the injection wells/rates/volumes to limit preferential channeling (utilities, outfalls, channels) and maximize distribution and remedial effectiveness

- adjustment of substrate and pH-buffer dosing

- addition of DHC to the subsequent injection

- optimal injection well sets for injection (injection into more wells at any one time could reduce overall injection times)

- installation of additional injection wells to improve distribution

- addition of localized groundwater extraction to enhance substrate distribution and/or limit displacement of contamination or injected fluid

- optimization of performance sampling to eliminate unnecessary wells and analytes and adjusting sampling frequency, as appropriate

Recommendations and conclusions made in the remedy evaluation phase will determine whether the injection and sampling protocol should be adjusted and if the second injection event should be performed. The remedy will be evaluated approximately 18 months following the completion of the initial injection event. Any changes to the injection and sampling protocol must be documented in a work plan before initiating the subsequent events, and all data and

recommendations from each performance monitoring event will be documented in a performance documentation report submitted semiannually during remediation.

If response action objectives are met following this second injection event, or the data indicate that MNA will be sufficient to achieve the objectives within three years, injection activities will be discontinued and MNA begun in the remediation areas. A third injection event would be conducted if the response objectives have not been met or if constituent concentrations rebound during the MNA phase and the response action objectives are no longer being met. The injection protocol for the third event will be based on the evaluation discussed above; the evaluation will also consider whether the scope of the third injection can be decreased to address only remaining "hot spots."

The third injection event (which may cover a smaller area than the others, based on performance sampling results) will then be completed, if required. It is assumed that three injection events will be required to meet project goals. If the initial two injections show limited or no success (for example, less than 40% reductions in TCE mass, or less than 50% of the injection area with a TOC concentration of greater than 100 mg/L), some contingencies may be incorporated into the third injection event.

After each injection event, site conditions will be analyzed to determine if the active treatment areas should undergo MNA monitoring. The MNA evaluation will include a review of TCE mass reduction:

- If the TCE reduction has met the goal of 70% within the injection areas, the injections will be discontinued and MNA will be initiated in the injection areas (or additional remedial actions may be performed to address residual cis-1,2-dichloroethene and vinyl chloride concentrations).
- If the TCE reduction is less than 50%, additional injections, injection with contingencies, and/or alternative remedial options will be considered.
- If the TCE mass reduction is between 50% and 70%, the following options will be considered: an additional full scale injection, targeted injections in hot spot areas, injections with contingencies, or MNA.

The decision regarding the next action if TCE reductions are between 50% and 70% will be primarily based on: (a) TCE concentration trends in performance monitoring wells, (b) relative concentrations of cis-1,2-dichloroethene and vinyl chloride, (c) geochemical conditions in the aquifer (pH, ORP, dissolved oxygen, etc.), (d) microbial populations in the aquifer, (e) other

indicators of successful bioremediation (chloride, ethene, and ethane), and (f) the success in amendment distribution during the previous injection events.

The MNA sampling program for the southeastern, southwestern, and northern TCE areas is in Table 4-5. As stated above, Tetra Tech will prepare a performance monitoring work plan with a sampling and analysis plan before beginning performance sampling.

## 4.5 START-UP, OPERATION, AND MAINTENANCE

Tracer testing will be the first use of the injection wells and injection equipment in each area, so start-up and shakedown procedures for the equipment will be conducted as part of the tracer testing. The following activities should be performed as part of the start-up for each area. This list is not comprehensive, but is intended to provide a general indication of the level of effort associated with the start-up. Following completion of the system design, Tetra Tech will complete a detailed operation and maintenance plan that includes start-up procedures. The operation and maintenance plan should include the following:

- *Introduction and site history:* a brief section detailing site background
- *Response action description:* a description of the remedy, including the implementation strategy, and applicable layout drawings and piping and instrumentation diagrams
- *System start-up:* a description of the activities included in start-up of the various components of the systems, including:
    - *Potable water:* Before injection, the potable water valve will be opened to allow water to flow into the system; valves should be set to bypass the granular activated carbon (GAC) unit. The pressure of the potable water will be noted to determine if booster pump operation is expected. The system piping will be inspected for leaks and any leaks repaired. Potable water will then be allowed to slowly enter the GAC unit. Once filled, the GAC unit will be allowed to sit for 24 hours to completely de-gas the carbon.
    - *GAC testing:* Following preparation of the GAC vessel, flow will be directed through the carbon vessel and total chlorine measured before and after GAC filtering using a Hach® kit with a detection range from 0.02–3.5 mg/L of total chlorine. This will be done to confirm that the GAC is properly removing chlorine from the potable water stream.
    - *Flow testing:* At the beginning of the test in each area, the contractor will determine that the total flow-rate matches the design. For example, for the test in the southwestern area, a flow-rate of 0.25 gpm will be injected into six injection wells; the total flow will be confirmed as 1.5 gpm. If the flow does not match the expected rate, each individual line will be tested.

- *Tracer mixing and injection:* Before tracer testing, a sodium bromide tracer solution will be prepared in a temporary 200-gallon tank placed inside the equipment container for the duration of the tracer test. This tank is not a part of the permanent system design. The tank will be filled with treated potable water and solid sodium bromide and mixed using a submersible pump. The substrate metering pump will inject this water into the injection feed. The sodium bromide concentration in the tank and the metering pump speed will be set so that the sodium bromide concentration injected into the wells is approximately 500 mg/L. For a 1 gpm total injection rate (four wells @ 0.25 gpm), this corresponds to six pounds per day (lbs/day) of sodium bromide (90 pounds for the entire 15-day injection event)

Following completion of the testing, the metering pump speed will be adjusted via the programmable logic controller (PLC) to maintain the appropriate substrate concentration in the injected water, as follows:

- *pH buffer mixing and injection:* The 6% sodium bicarbonate solution (300 gallons) will be prepared using the tank in the system container. 150 pounds of sodium bicarbonate (several bags) will be added to the tank during the test and mixed using a submersible pump.

- *Air relief in injection lines:* As the potable water and tracer are injected, the air relief valves at the injection wellheads will be opened periodically to release air or other gases accumulated in the well casing.

***Operation and maintenance—***Operation and maintenance procedures for the system include schedule, activities, and waste management. The operation and maintenance schedule will require 24-hour oversight of the injection process during the first day of full-scale injection testing at each location, primarily to make visual observations of any daylighting or escape of fluid to site utilities. This will be followed by one week of daily oversight, until it is determined that the system can operate with a limited potential of fluid surfacing. The system can be operated for several days without overnight supervision, followed by weekly site visits. Daily oversight of the system following each transition of injection wells will also be required until the potential for daylighting (i.e., or fluid escape) is deemed limited. However, biweekly site visits are required during the entire injection event.

- *Routine operation and maintenance to be conducted during each maintenance event includes:* (a) recording the injection flow-rate and adjusting it as necessary based on design criteria; (b) confirming injection flow from substrate and pH-buffering systems; (c) recording information from all pressure and flow instrumentation; (d) measuring water levels at a minimum of four injection wells and four monitoring wells; (e) checking the system for leaks and repairing as necessary; and (f) maintaining equipment according to the manufacturer's recommendations.

- *Additional maintenance to be conducted at least biweekly includes:* measuring dissolved oxygen and pH in the injection fluid stream using field instrumentation and measuring chlorine in the injection stream using a field test kit.

- *Additional maintenance to be conducted at least monthly includes:* measuring groundwater levels and field parameters of at least eight injection wells and of all monitoring wells associated with performance monitoring (this can be combined with the performance monitoring events, as appropriate).

- *Maintenance to be performed as-needed includes:* repair or replacement of system equipment, valves, and instruments, and GAC replacement.

- *System monitoring over SCADA includes:* daily system parameters check using a remote computer by authorized personnel.

- *Waste management:* describes the handling of environmental wastes (primarily purge water and GAC) that will be produced by the response action. These wastes will be properly collected, sampled, and disposed of at a Lockheed Martin-approved facility.

- *System shutdown:* includes the steps taken for temporary system shutdown (between injection events), including methods for shutting off potable water and electricity and removing sensitive electronic components from the containers.

- *System relocation:* includes the methods used to move a container system from one location to another, including placement and anchoring of the container and methods of disconnecting and reconnecting injection piping, potable water lines, and electrical service.

- *Appendices:* presents manufacturers' information on system components and the forms to be completed during site visits.

## 4.6 PERMITTING

Several permits must be obtained before implementing the final design; however, they are not associated with the effort detailed herein. The following permits are required:

- A Baltimore County grading permit is required for any land disturbance and grading that disturbs greater than 5,000 square feet or more than 100 cubic yards of fill material. Grading plans have been submitted to Baltimore County for review and approval.

- As a condition of receiving a grading permit, a storm water management plan will be submitted to Baltimore County for review and approval. The storm water management plan will be prepared in accordance with the *Maryland Storm Water Design Manual*, (Maryland Department of the Environment [MDE], 2000), including the 2009 revisions and subsequent supplements. Lockheed Martin has obtained a waiver for this requirement.

- The MDE/United States Environmental Protection Agency "General Permit for Storm Water Discharge" is required.

- An erosion and sediment control plan has been submitted to Baltimore County for review by the Baltimore County Soil Conservation District. It was prepared in accordance with the 1994 *Maryland Standards and Specifications for Soil Erosion and Sediment Control* (MDE, 1994); draft standards and specifications published in early 2010 will also be considered. Baltimore County has coordinated review of these plans with the Critical Areas Commission.

- A joint application was submitted to MDE, since the project will disturb land within the Chesapeake Bay Critical Area. This information is circulated to various offices within MDE, including tidal and non-tidal wetlands divisions, and to the United States Army Corp of Engineers.

- Baltimore County building permits will be required for the two injection enclosures.

- Injecting chemicals into groundwater is regulated by MDE's Underground Injection Control Program. Any injection wells used for the proposed response action would be classified as Class V wells, defined as shallow wells used to place a variety of fluids below the land surface, including wells used to inject chemicals for *in situ* groundwater treatment. Information regarding the proposed nature and type of injection well operation(s) will be submitted to MDE's Groundwater Permits Division. MDE will then determine whether the injection wells would be authorized by rule, whether an individual permit will be required, and/or whether additional information and/or operational requirements will be needed to comply with state regulations. Tetra Tech is leading this effort and the information will be submitted to the MDE for approval in time for system start-up.

- An access agreement has been reached with Tilley Chemical Company to install injection wells and infrastructure on their property.

- Permits will be required to install piping across Chesapeake Park Plaza, a Baltimore County road, and in that road's right of way

- MDE and Baltimore County well construction permits will be required; this process is under way.

- North American Electric must be notified and informed of the nature of the injection activities occurring adjacent to their property.

- LMC Properties, Inc. (LMCPI) must be kept informed of work progress and schedule. Additionally, the power and water supply in the north and southeast areas will be obtained from LMCPI; close coordination will be required.

- If adjustments or contingences to the initial system are required, additional permits may be required

## 4.7 SUSTAINABILITY PRACTICES

Sustainability considerations were factored into determining the preferred response action alternative and developing this design basis report. These considerations, in conjunction with

Lockheed Martin's "Go Green" program, must also be applied to the final design and implementation of the response action. Sustainable practices in general are those that consider economic and natural resources, ecology, human health and safety, and quality of life. For remediation projects, sustainability means implementing projects in a manner that not only meets traditional remediation requirements (e.g., protection of human health and the environment, compliance with regulations, and meeting mass removal goals), but that also considers sustainable practices with a goal of minimizing the overall environmental "footprint."

*Environmental footprint* relates to the effects on environmental media (e.g., air, soil, groundwater, surface water) and society that are direct or indirect consequence of performing the remedial action. Minimizing the environmental footprint of a specific project might involve reducing toxic air and greenhouse gas emissions (e.g., carbon dioxide, methane, and nitrous oxide), reducing unnecessary or inefficient energy use, promoting renewable energy over conventional sources, reducing soil erosion and nutrient depletion, reducing adverse effects to ecological receptors and ecosystems, and reducing water consumption or waste generation.

To improve the overall net environmental benefit of a remedial action, implementation of the response action will follow best management practices (BMPs) for sustainability. This includes resource management practices to minimize material demands, water consumption, energy usage, toxicity, and emissions of greenhouse gases and criteria pollutants. Considerations to encourage the sustainability of the response action should include items such as:

- considering equipment and material construction practices during equipment specification, and selecting compatible materials that are recycled or have manufacturing processes that emit lower greenhouse gas and criteria pollutants, and that require less energy and water demand.
- using locally available resources to reduce transportation impacts
- installing variable frequency drives (as applicable) and high efficiency motors on all major rotating equipment
- purchasing electricity from a renewable energy provider
- reducing process waste generation and landfilling by using reusable or recycled media (e.g., reactivated GAC) and reducing the width and depth of trenches
- continual optimization of the remedial system operation and groundwater monitoring program to ensure that equipment operates efficiently, treatment processes do not become

redundant over time (e.g., discontinuing treatment in clean areas), and performance monitoring does not collect unnecessary data

This response action has a relatively small environmental footprint associated with construction and operation, except for its significant water use. The effect on storm water management in the injection areas will be minor because, after trenching, the surface cover and grade will be returned to pre-existing conditions. In addition, the small equipment enclosures will be installed in areas that are already impermeable, so no net change in permeable surface area will occur. All equipment used will be low horsepower and will run only intermittently, so overall energy use is expected to be relatively low.

**Table 4-1**

**Southeastern TCE Area Full Scale Initial Injection Event**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | |
|---|---|
| Total volume for injection event | 127,000 gallons |
| Total number of injection wells | 24 |
| Number of wells operating simultaneously | 4 |
| Injection rate per well | 0.25 gallons per minute |
| Total system injection rate | 1.0 gallon per minute |
| Injection volume per well | 5,300 gallons |
| Injection duration for each well configuration | 14.7 days |
| Number of injection well rotations | 6 |
| Total injection event duration | 88 days |
| Total substrate quantity per injection event | 5,150 pounds |
| Average substrate concentration in injected solution | 0.50% |
| Injection wells configuration #1 | IWE-1, IWE-7, IWE-13, IWE-23 |
| Injection wells configuration #2 | IWE-6, IWE-12, IWE-17, IWE-21 |
| Injection wells configuration #3 | IWE-2, IWE-8, IWE-14, IWE-19 |
| Injection wells configuration #4 | IWE-5, IWE-11, IWE-16, IWE-20 |
| Injection wells configuration #5 | IWE-3, IWE-9, IWE-15, IWE-18 |
| Injection wells configuration #6 | IWE-4, IWE-10, IWE-22, IWE-24 |

Note: the actual injected substrate concentration will be slightly higher than shown because the final 360 gallons of treated water at each well will be injected without substrate to reduce the potential for fouling the wells between events. This equates to injecting potable water only for the last 24 injection hours for each set of wells.

**Table 4-2**

**Southwestern TCE Area Full Scale Initial Injection Event**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | |
|---|---|
| Total volume for injection event | 249,000 gallons |
| Total number of injection wells | 39 |
| Number of wells operating simultaneously (maximum) | 6 |
| Injection rate per well | 0.25 gallons per minute |
| Total system injection rate | 1.5 gallons per minute |
| Injection volume per well | 6,390 gallons |
| Injection duration for each well configuration | 17.8 days |
| Number of injection well rotations | 7 |
| Total injection event duration | 124 days |
| Total substrate quantity per injection event | 10,140 pounds |
| Average substrate concentration in injected solution | 0.48% |
| Injection wells configuration #1 | IWW-1, IWW-9, IWW-11, IWW-22, IWW-23, IWW-33 |
| Injection wells configuration #2 | IWW-8, IWW-15, IWW-16, IWW-29, IWW-30, IWW-39 |
| Injection wells configuration #3 | IWW-2, IWW-7, IWW-10, IWW-24, IWW-28, IWW-38 |
| Injection wells configuration #4 | IWW-3, IWW-12, IWW-21, IWW-25, IWW-34, IWW-36 |
| Injection wells configuration #5 | IWW-6, IWW-13, IWW-20, IWW-27, IWW-31, IWW-37 |
| Injection wells configuration #6 | IWW-4, IWW-14, IWW-17, IWW-26, IWW-32 |
| Injection wells configuration #7 | IWW-5, IWW-19, IWW-32, IWW-35 |

Note: the actual injected substrate concentration will be slightly higher than shown because the final 360 gallons of treated water at each well will be injected without substrate to reduce the potential for fouling the wells between events. This equates to injecting potable water only for the last 24 injection hours for each set of wells.

**Table 4-3**

**Northern TCE Area Full Scale Initial Injection Event**
**Lockheed Martin Middle River Complex, Middle River, Maryland**

| Location | |
|---|---|
| Total volume for injection event | 40,200 gallons |
| Total number of injection wells | 8 |
| Number of wells operating simultaneously | 2 |
| Injection rate per well | 0.25 gallons per minute |
| Total system injection rate | 0.5 gallons per minute |
| Injection volume per well | 5,025 gallons |
| Injection duration for each well configuration | 14 days |
| Number of injection well rotations | 4 |
| Total injection event duration | 56 days |
| Total substrate quantity per injection event | 1,640 pounds |
| Average substrate concentration in injected solution | 0.48% |
| Injection wells configuration #1 | IWN-3, IWN-4 |
| Injection wells configuration #2 | IWN-2, IWN-8 |
| Injection wells configuration #3 | IWN-1, IWN-6 |
| Injection wells configuration #4 | IWN-5, IWN-7 |

Note: the actual injected substrate concentration will be slightly higher than shown because the final 360 gallons of treated water at each well will be injected without substrate to reduce the potential for fouling the wells between events. This equates to injecting potable water only for the last 24 injection hours for each set of wells.

**Table 4-4**

**Performance Monitoring Frequency and Analytical Parameters**
**Lockheed Martin Middle River Complex**
**2323 Eastern Boulevard, Middle River, Maryland**

| Sampling event | Baseline | | | | | | | 1 Month | | | | | | | 3 Months | | | | | | | 6 Months | | | | | | | 12 Months | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Well | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and functional Genes | Field | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field |
| **SOUTHEASTERN AREA** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW-74A | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| MW-74B | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| MW-72B | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| SEMW-1I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| SEMW-2I | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| SEMW-3I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| SEMW-4I | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| SEMW-5S | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| SEMW-5I | x | x | x | x | x | | x | x | x | | | | | x | x | x | | | | | x | x | x | x | x | x | | x | x | x | x | x | x | | x |
| SEMW-6I | x | x | x | x | x | | x | x | x | | | | | x | x | x | | | | | x | x | x | x | x | x | | x | x | x | x | x | x | | x |
| **SOUTHWESTERN AREA** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW-12A | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| MW-12B | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| MW-14B | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| SWMW-1I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| SWMW-2I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| SWMW-3I | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| SWMW-4S | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| SWMW-4I | x | x | x | x | x | | x | | x | | | | | x | x | x | | | | | x | x | x | x | x | x | | x | x | x | x | x | x | | x |
| SWMW-5I | x | x | x | x | x | | x | | x | | | | | x | x | x | | | | | x | x | x | x | x | x | | x | x | x | x | x | x | | x |
| **NORTHERN AREA** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW-81B | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| NMW-1I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| NMW-2S | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| NMW-2I | x | x | | | | | x | | x | | | | | x | x | x | | | | | x | x | x | | | | | x | x | x | | | | | x |
| NMW-3I | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |

VOCs - volatile organic compounds
TOC - total organic carbon
Anions, cations, alkalinity - chloride, ferrous iron, ferric iron, sulfide, sulfate, nitrate, nitrite, nitrogen, alkalnity
Gases - methane, ethane, ethene
Fatty acids - volatile fatty acids
DHC and funtional genes - dehalococcoides, dehalobactor, tce reductase, vc reductase
Field - pH, oxidation-reduction potential, dissolved oxygen, specific conductance

**Table 4-5**

**Monitored Natural Attenuation Sampling**
**Lockheed Martin Middle River Complex**
**Middle River, Maryland**

| Sampling event | Semi-Annual | | | | | | | Annual | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Well | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field | VOCs | TOC | Anions Cations Alkalinity | Gases | Fatty acids | DHC and Functional Genes | Field |
| **SOUTHEASTERN AREA** | | | | | | | | | | | | | | |
| MW74B | x | x | | | | | x | x | x | x | x | | x | x |
| SEMW-1I | x | x | | | | | x | x | x | x | x | | | x |
| SEMW-3I | x | x | | | | | x | x | x | x | x | | x | x |
| SEMW-5S | x | x | | | | | x | x | x | x | x | | | x |
| SEMW-5I | x | x | | | | | x | x | x | x | x | | | x |
| **SOUTHWESTERN AREA** | | | | | | | | | | | | | | |
| MW-12A | x | x | | | | | x | x | x | x | x | | x | x |
| MW-12B | x | x | | | | | x | x | x | x | x | | x | x |
| SWMW-1I | x | x | | | | | x | x | x | x | x | | | x |
| SWMW-3I | x | x | | | | | x | x | x | x | x | | x | x |
| SWMW-5S | x | x | | | | | x | x | x | x | x | | | x |
| SWMW-5I | x | x | | | | | x | | x | x | x | | | x |
| **NORTHERN AREA** | | | | | | | | | | | | | | |
| MW-60A | x | x | | | | | x | x | x | x | x | | x | x |
| MW-60B | x | x | | | | | x | x | x | x | x | | x | x |
| NMW-1I | x | x | | | | | x | x | x | x | x | | | x |
| NMW-3I | x | x | | | | | x | x | x | x | x | | | x |

VOCs - volatile organic compounds
TOC - total organic carbon
Anions, cations, alkalinity - chloride, ferrous iron, ferric iron, sulfide, sulfate, nitrate, nitrite, nitrogen, alkalnity
Gases - methane, ethane, ethene
Fatty acids - volatile fatty acids
DHC and funtional genes - dehalococcoides, dehalobactor, tce reductase, vc reductase
Field - pH, oxidation-reduction potential, dissolved oxygen, specific conductance

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# Section 5
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# APPENDIX A—100% DESIGN FOR BLOCK G SWALE RELOCATION

# Stormwater Management Report (100% Submittal) Design of Swale Abandonment and Subsurface Pipeline Replacement, Block G Southwestern TCE Bioremediation Area Lockheed Martin Middle River Complex Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech

May 2012

Michael Martin, P.G.
Regional Manager

Christopher Pike, P.E.
Project Manager

# TABLE OF CONTENTS


**Section** **Page**

**ACRONYMS** ..... iii

**1 INTRODUCTION** ..... **1-1**

1.1 BACKGROUND ..... 1-1
1.2 SITE DESCRIPTION – EXISTING CONDITIONS ..... 1-1
1.3 PROPOSED CONDITIONS – GENERAL CONDITIONS ..... 1-2

**2 EXISTING DRAINAGE ANALYSIS** ..... **2-1**

2.1 METHODOLOGY AND SOFTWARE ..... 2-1
2.2 DETAILED DRAINAGE DESCRIPTION ..... 2-2
2.3 SITE SOILS ..... 2-6
2.4 HYDRAULIC AND HYDROLOGIC ANALYSIS ..... 2-6

**3 PROPOSED DRAINAGE ANALYSIS** ..... **3-1**

3.1 METHODOLOGY AND SOFTWARE ..... 3-1
3.2 DETAILED DRAINAGE DESCRIPTION ..... 3-1
3.3 HYDRAULIC AND HYDROLOGIC ANALYSIS ..... 3-4
3.4 CONCLUSION ..... 3-6

**4 REFERENCES** ..... **4-1**


# APPENDICES


**APPENDIX A TR-55 ROUTING REPORT (EXISTING CONDITIONS)**

**APPENDIX B TR-55 ROUTING REPORT (PROPOSED CONDITIONS)**

**APPENDIX C SUPPLEMENTAL CHECK DATA**

**APPENDIX D EXISTING CONDITIONS, BLOCK G SWALE REVIEW**

**APPENDIX E PHOTOGRAPHS**

**APPENDIX F SOIL RESOURCE REPORT**

## LIST OF FIGURES


Figure 1-1 Existing Conditions Plan with Location Map ..... 1-3
Figure 1-2 Proposed Conditions Plan ..... 1-4
Figure 2-1 Existing Conditions Drainage Analysis ..... 2-3
Figure 2-2 Soils Map ..... 2-7
Figure 3-1 Proposed Conditions Drainage Analysis ..... 3-2


## LIST OF TABLES


Table 2-1.a Soil Conservation Service Curve Number, Existing Conditions ..... 2-8
Table 2-1.b Manning's "n" Values ..... 2-8
Table 2-2 Drainage Area Hydrographs ..... 2-8
Table 2-3 Reservoir Routing ..... 2-9
Table 2-4 Peak Runoff (Q) at Various Points of Interest ..... 2-10
Table 3-1 Drainage Area Hydrographs ..... 3-5
Table 3-2 Peak Runoff at Various Points of Interest ..... 3-5
Table 3-3 100-Year Storm Peak Runoff Comparison at Various Points of Interest ..... 3-6


## 100% CONSTRUCITON SET PLAN LIST
## (UNDER SEPARATE COVER)


G-1 Cover Sheet
G-2 Notes and Legend
C-1 Existing & Demolition Plan
C-2 Site Layout Plan
C-3 Site Grading Plan & Profile
C-4 Stormwater Management Details
C-5 Erosion & Sediment Control Plan (Pre)
C-6 Erosion & Sediment Control Plan (Post)
C-7 Erosion & Sediment Control Plan Details I
C-8 Erosion & Sediment Control Plan Details II
C-9 Seeding Specifications

# ACRONYMS

| | |
|---|---|
| CB | catch basin |
| cfs | cubic feet per second |
| CMP | corrugated metal pipe |
| CN | curve number |
| CPP | Chesapeake Park Plaza |
| DA | drainage area |
| DDF | depth duration frequency |
| IDF | Intensity Duration Frequency |
| Lockheed Martin | Lockheed Martin Corporation |
| MDE | Maryland Department of the Environment |
| MRC | Middle River Complex |
| n | Manning's roughness coefficient; a measure of the roughness of a flow channel |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | National Resources Conservation Service |
| PDS | Partial Duration Series |
| PF | Precipitation Frequency |
| Q | flow rate |
| RCP | reinforced concrete pipe |
| SCS | Soil Conservation Service |
| SfB | Sassafras Urban Land Complex |
| SWM | stormwater management |
| Tc | time of concentration |
| Tetra Tech | Tetra Tech, Inc. |
| Tilley Chemical | Tilley Chemical Company, Inc. |
| TR-55 | Technical Release – 55 |
| Ur | Urban Land |
| USDA | United States Department of Agriculture |

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# Section 1
# Introduction

## 1.1 BACKGROUND

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this Stormwater Management (SWM) Report for the 100% Design Package as part of the Block G *Design of Swale Abandonment and Subsurface Pipeline Replacement* in Lockheed Martin's Middle River Complex (MRC) in Baltimore County, Maryland. This report was prepared in conjunction with a set of project construction documents and specifications for these stormwater modifications.

This report discusses the existing and proposed hydraulic and hydrologic conditions of a small drainage system that is composed of portions of Block G, Block I, Block E ("Lot 1" Tilley Chemical Company, Inc. [Tilley Chemical]), and the Chesapeake Park Plaza right-of-way. The report focuses on relocating an existing swale in Block G. The swale, which is typically dry but receives runoff from the drainage system, is located in the same area as a proposed injection well field. The stormwater must be diverted and controlled so that it will not damage the wellheads, but must be designed and constructed in a manner that will not cause or aggravate stormwater drainage issues elsewhere.

Information regarding the injection well field's design is available in further detail under separate cover. The general size, layout, and location are sufficient for stormwater management design purposes.

## 1.2 SITE DESCRIPTION – EXISTING CONDITIONS

The focus area is on the southern portion of Block G, located in the southwestern corner of the Lockheed Martin's Middle River Complex (Figure 1-1, Existing Conditions Plan with Location Map). Block G is comprised of about 13.5 acres, but the focus area of Block G is only 1.2 acres. The total analyzed drainage area coming into the Block G focus area is about 2.7 acres, including off-site inflow. The focus area has the aforementioned swale (or "main swale") and a small side

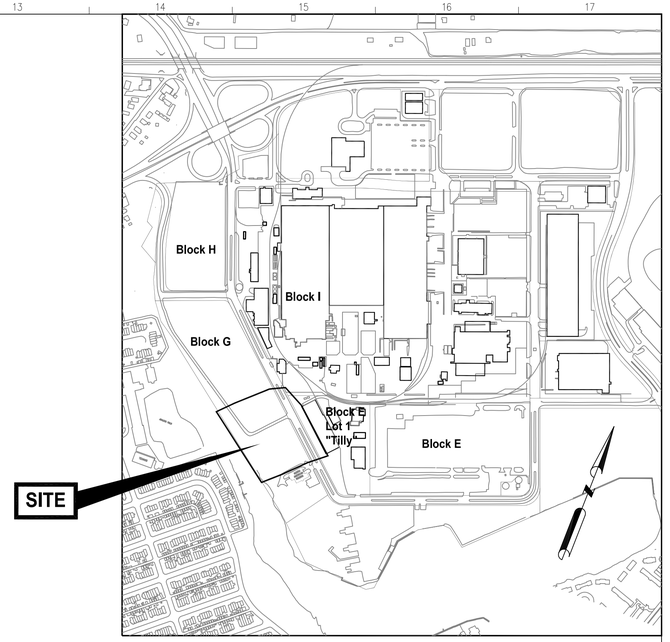
swale. Cow Pen Creek runs southeast along the southwest boundary of the site, and is the ultimate outfall. The area also has a large concrete foundation and an asphalt driveway (the building is demolished).

## 1.3 PROPOSED CONDITIONS – GENERAL DESCRIPTION

The proposed injection well field and proposed stormwater modifications are shown on Figure 1-2, Proposed Conditions Plan. The major stormwater modifications include:

- diversion of flow at Chesapeake Park Plaza,
- a traditional stormwater detention facility with outlet structure, and
- extension of a storm pipe to route the stormwater back to the current outfall at Cow Pen Creek.

These modifications are described in detail in Section 3 “Proposed Conditions”.




LOCKHEED MARTIN MIDDLE RIVER COMPLEX

SCALE: 1" = 500'

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DRAWN: CSG - 06-16-2011
CREW: AN & RB - 06-07&08-2011
HORIZ. DATUM: MARYLAND STATE PLANE 1983
VERT. DATUM: NAVD 88
SCALE: 1"=30'
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K:\LMC - Mital\112IC02948 Block G\Data\Adjusted\Lockheed 060711_Adjusted.crd
ALL CB'S 1.67'x2.5' UNLESS NOTED

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BLOCK G SWALE - EXISTING & DEMOLITION PLAN

INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
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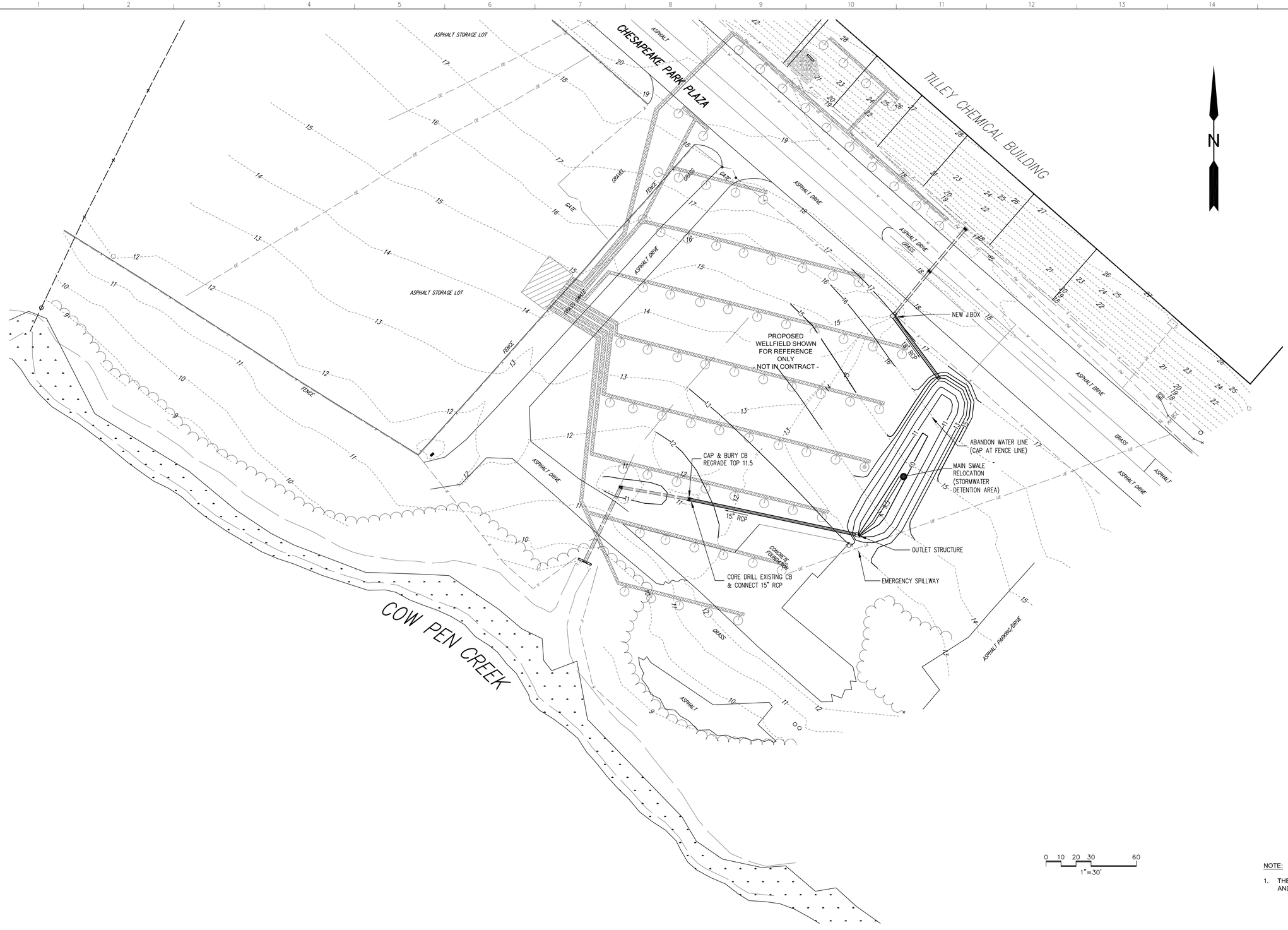
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | FIGURE 1-1 |

EXISTING CONDITIONS PLAN W/ LOCATION MAP




NOTE:

1. THE PROPOSED WELL FIELD LAYOUT IS SHOWN FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE.

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G-1
FIGURE 1-2
PROPOSED CONDITIONS

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|---|---|---|---|
| | | | |

BLOCK G SWALE - SITE LAYOUT PLAN

INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | FIGURE 1-2 |

PROPOSED CONDITIONS PLAN

# Section 2
# Existing Drainage Analysis

This section provides an analysis of the existing drainage patterns in the target area, as well as a discussion of site soils and hydrology.

## 2.1 METHODOLOGY AND SOFTWARE

The Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), has established procedures for evaluating small watersheds like the target drainage area. Their publication, *Urban Hydrology for Small Watersheds (Technical Release 55 [TR-55])*, presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs (United States Department of Agriculture [USDA], 1986). TR-55 was used evaluate the subject area.

AutoDesk's AutoCAD® Civil 3D® software, in particular its Hydraflow extensions, was also used in this evaluation. Hydraflow Hydrographs software is used for watershed analysis and detention pond design (Autodesk, 2011a), while Hydraflow Express provides flexible calculators for solving hydraulics and hydrology problems for culverts, open channels, and hydrology (Autodesk, 2011b). Hydraflow Storm Sewers Extension is used in storm sewer design and analysis (Autodesk, 2011c).

**TR-55 (Soil Conservation Service [SCS]):** AutoDesk's Hydraflow Hydrographs software was used to route time of concentration (Tc) lines through drainage areas to determine various peak flows throughout the site. A detailed analysis was performed to isolate flows in certain areas. A simplified analysis was also performed to check that the isolated flows were not being overly compounded when combined in the detailed analysis. The detailed analysis is provided in Appendix A, and the simplified analysis is provided in Appendix C.

**Block G Swale Review:** Once the detailed routing was performed, AutoDesk's Hydraflow Express was utilized to take a snapshot depth of the open channel flow in the main swale using

Manning's Equation and a known flow rate. Manning's Equation is an empirical equation that applies to liquid flow in open channels, and is a function of the channel velocity, flow area and channel slope. Additionally, Hydraflow Express was used as a check against the TR-55 routing by taking a simplified snapshot of the Chesapeake Park Plaza culvert. The main swale snapshot is provided in Appendix D, and the Chesapeake Park Plaza culvert analysis is provided in Appendix C.

**Rational Method and Storm Pipe Analysis:** AutoDesk's Hydraflow Storm Sewers Extension was also utilized as a check against the TR-55 routing by modeling the two culvert areas (the culvert under Chesapeake Park Plaza and the discharge pipe into Cow Pen Creek). Profiles of these storm pipe systems are provided in Appendix C.

Appendix E contains photographs of the key features in the target area.

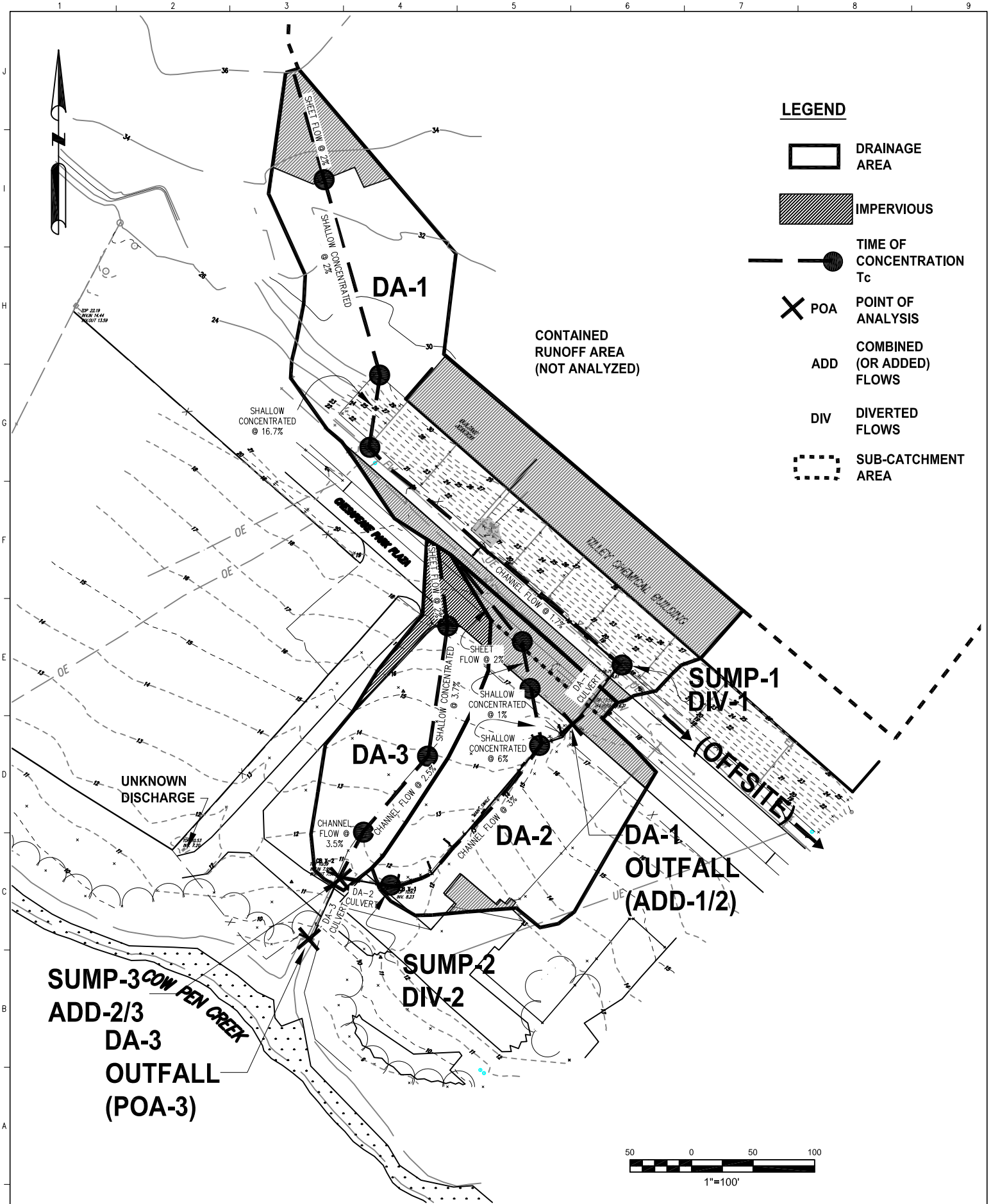
## 2.2 DETAILED DRAINAGE DESCRIPTION

The focus area of Block G accepts runoff from Block I (known also as the "Industrial Area"), Block E (Lot 1, Tilley Chemical Company, Inc. [Tilley Chemical]), and Chesapeake Park Plaza, as well as its own on-site runoff. As an advance statement, there is little to no peak control in this system. There are a few sumps to help capture surface flow, but otherwise the system generally drains unimpeded to Cow Pen Creek.

The TR-55 routing diagram is provided below as Figure 2-1, and the hydrograph report is provided as Appendix A. The site is broken down into 3 drainage areas (DAs):

1. DA-1: Industrial Area and Tilley Chemical
2. DA-2: Main Swale Open Area and Chesapeake Park Plaza Surface Runoff
3. DA-3: Side Swale Open Area

As shown on the figure, the Tc begins in DA-1 with sheet flow on a small patch of asphalt in Block I, concentrates and runs down a steep grassy area, and then channel flows down a swale (or ditch) between Chesapeake Park Plaza and Tilley Chemical (Appendix E, Photo 1). Flow also accumulates in the ditch from the roof drain leaders of Tilley Chemical.

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STORMWATER MODIFICATIONS – BLOCK G
INJECTION WELL FIELD
SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 2-8-12 |
| PROJECT NO.: | 112IC03043 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SNL |
| CHECKED BY: | CSG/SK |
| SHEET: | FIG. 2-1 (C-SWM) |

EXISTING CONDITIONS DRAINAGE ANALYSIS

At the end of this ditch there is a lawn basin with a sump (SUMP-1), which either leads the captured flows through a culvert under Chesapeake Park Plaza (also referred to as "the loop road"), or overflows, allowing stormwater to continue along the ditch past the sump area. The captured flow discharges into the Block G focus area (DA-1 Outfall). Just past the sump area (Diversion-1), the bottom of the ditch is raised slightly to help the sump catch the run-off, and then the ditch continues off-site into an area outside the scope of this analysis. In a major storm, the ditch acts as a pond, the sump becomes overwhelmed, and there is some spillover diverted into the continued ditch.

The Tilley Chemical Building, which is adjacent to the ditch area, stands about 10 feet above the ditch, raised by a 4:1 earth slope. The bottom toe of the slope meets the drainage ditch, where there is a large splash pool with a 15-inch reinforced concrete pipe (RCP) outfall pipe (*Photo 2*). Per discussion with a Tilley Chemical representative (Tilley Chemical, 2011), this pipe comes from the northeast side of Tilley Chemical where there is a manually-operated containment storage area; the containment area is not opened or operated during storm events (*Photo 3*). Any flows upstream of the containment area, and any flow that is directed to the drainage ditch via the pipe were not included as part of the model. According to the Tilley Chemical representative, the operator of the containment area waits for the rain to stop and for runoff to complete filling the containment area, before the release valve is opened and allowed to drain.

As stated earlier, the stormwater that enters the SUMP-1 lawn basin at the end of the ditch is routed through a 15-inch RCP culvert under Chesapeake Park Plaza, and discharges into the Block G focus area (*Photo 4*), where it combines with drainage area DA-2. DA-2 begins with surface run-off from the Chesapeake Park Plaza; this run-off accumulates in the main swale that is already receiving flow from the DA-1 outfall. The combination of the outflow from the DA-1 culvert and the DA-2 overland flow is labeled as ADD-1/2 on the hydrology model. There is a catch basin (CB) in the median of Chesapeake Park Plaza that adds to the DA-1 culvert before discharge, but for modeling convenience this basin and its collection area were considered part of the DA-2 drainage area.

At the end of the main swale, there is a lawn basin with a sump (SUMP-2), which drains through an 18-inch corrugated metal pipe (CMP) that leads to the end of the area defined by the Tc line for DA-3. The combination of outflow from the DA-2 culvert flow and the overland flow from

DA-3 is labeled as ADD-2/3 on the hydrology model. In large storm events, SUMP-2 is subject to localized flooding, and the excess flow gets diverted as uncontrolled overland flow out to Cow Pen Creek (Diversion-2).

DA-3 receives surface run-off from the Chesapeake Park Plaza; this run-off accumulates into the side swale. At the end of the side swale, there is a lawn basin containing a sump (SUMP-3). The bottom of this lawn basin junctions with the 18-inch outfall of DA-2 (ADD 2/3), and subsequently leads the combined flows into a 24-inch CMP, where it ultimately outfalls into Cow Pen Creek, a tributary to the Chesapeake Bay (DA-3 Outfall).

The watershed routing model showed that during the 100-year storm event the 24-inch culvert can handle the combined flows, and that SUMP-3 will not overbank into uncontrolled overland flow. However, the invert of the 24-inch headwall in Cow Pen Creek has an elevation of 6.8 feet above sea level, while the 100-year floodplain line has an elevation of 9 feet. In a 100 year storm event, the entire 24-inch culvert will be completely submerged in flood waters, and the SUMP-3 lawn basin and the 18-inch DA-2 culvert will be partially submerged. Both the TR-55 software (Hydraflow Hydrographs) and the storm pipe routing software (Hydraflow Storm Sewers) allow for tailwater input. When tailwater was modeled as 9 feet in either software, SUMP-3 was basically “at capacity”, but did not overbank. Since these are just small sumps with little tolerance for other variables such as overland flow velocity or unanticipated flows, it is a safe assumption that SUMP-3 will in fact overbank as uncontrolled overland flow out to Cow Pen Creek, but most likely only for a few minutes. See Appendix C for Hydraflow Storm Sewer analysis results.

Given the 100-year flood plain line and the incoming headwaters, hydraulic jump or inlet surcharge was initially a concern at SUMP-3. Hydraulic jump is an abrupt rise in water level that can occur when liquid travelling at high velocity discharges into a zone of lower velocity. However, after modeling the area using the software mentioned earlier, it does not appear that a hydraulic jump or inlet surcharge will happen under existing conditions. Certain modifications could, however, cause an undesired situation in this area.

The data regarding the main swale was used as input in Manning’s Equation to estimate open channel flow in that area. The results indicate that the stream may become about one foot deep

and 30 feet wide in a large storm event (aside from the localized flooding in SUMP-2). There is little to no flow in this stream during dry weather. However, a small pilot channel, approximately 0.5 foot wide and 0.5 foot deep, is present in the stream bed; it has most likely developed over time.

## 2.3 SITE SOILS

The data for soils was obtained from the Geospatial Data Gateway website (http://datagateway.nrcs.usda.gov/GDGHome.aspx) by the United States Department of Agriculture (USDA) NRCS. A *Custom Soil Resource Report* for the site was generated from the website, and is provided as Appendix F. A soils map of the site is shown in Figure 2-2, below. Based on the USDA Soil Survey for Baltimore County, Maryland, the following soil types are present within the site:

- SfB – Sassafras-Urban Land Complex, 0 to 5 percent slopes, HSG B Soil
- Ur – Urban Land 0 to 8 percent slopes, HSG C Soil
- Composite SCS curve numbers (CN) were applied based on land cover and soil classification.

## 2.4 HYDRAULIC AND HYDROLOGIC ANALYSIS

Storms and rainfall events will undeniably affect hydraulic and hydrologic conditions within the target drainage area. Depth Duration Frequency (DDF) data for 1-, 2-, 10-, and 100-year frequency storm events in Baltimore County was input into TR-55 using the 24-hour duration rainfall depths (in inches) provided in Table 2-2 of the Maryland Stormwater Design Manual (Maryland Department of the Environment [MDE], 2000). The manual does not provide Intensity Duration Frequency (IDF) data. The National Oceanic and Atmosphere Administration's (NOAA's) National Weather Service Hydrometeorological Design Studies Center website (http://hdsc.nws.noaa.gov/hdsc/pfds/) provides precipitation frequency (PF) estimates based on the frequency analysis of partial duration series (PDS), and reports it in the form of both DDF and IDF tables; this data is collected and reported by various stations throughout the United States. The "Baltimore WSO City" station appears to be the closest station

to the site, and the data provided for that location was used when reviewing/checking data via the rational method[1] Appendix C contains this rainfall data as IDF.

**Figure 2-2 Soils Map**

The standard SCS/NRCS unit hydrograph was used (484), and because of the short flow distances, a one (1) minute time interval was used. The following two tables (Table 2-1a and 2-1b) provide the curve number (CN) and the Manning's "n" values used for establishment of the Tc line in the TR-55 routing analysis. The CN is an empirical parameter used to predict direct runoff or infiltration from rainfall excess, and is based on a given site's hydrologic soil group, land use, treatment, and hydrologic condition. The Manning's "n" value is a measure of the roughness of the surface material present in open flow channels. A composite curve number for each drainage area was derived based on the percentage of each land use type in each area (Table 2-2).

[1] There are two other nearby stations, and all three stations show a higher rainfall depth than the 2000 MDE stormwater manual. Regardless, the same data set should be used to model existing and proposed conditions.

**Table 2-1.a**

**Soil Conservation Service Curve Number, Existing Conditions**
**Middle River Complex, Middle River, Maryland**

| Land Use | Curve Number |
|---|---|
| Block G lawn areas, good condition (Sassafras Urban Land Complex, Type B Soil) | 61 |
| Block I and Block E lawn areas, good condition (Urban Land, Type C Soil) | 74 |
| Impervious Areas (Block I asphalt patch, Tilley Chemical Company, Inc. roof, Chesapeake Park Plaza, other minor asphalt or concrete areas) | 98 |

**Table 2-1.b**

**Manning's "n" Values**
**Middle River Complex, Middle River, Maryland**

| Type | n |
|---|---|
| Smooth Surfaces (concrete, asphalt) | 0.011 |
| Reinforced Concrete Pipe (RCP) | 0.013 |
| Corrugated Metal Pipe (CMP) | 0.023 |
| Grass Areas (medium length) | 0.20 |

**Table 2-2**

**Drainage Area Hydrographs**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number | Type | Description | Acres | Curve Number (composite) | Tc |
|---|---|---|---|---|---|
| 1 | SCS Runoff | DA-1, Industrial Tilley Area | 1.52 | 83 | 9.4 |
| 6 | SCS Runoff | DA-2, Open Area | 0.74 | 69 | 6.7 |
| 7 | SCS Runoff | DA-3, Open Area | 0.45 | 68 | 6.9 |

DA = drainage area
SCS = Soil Conservation Service
Tc = time of concentration

Conveyances such as storm pipes or swales are typically reviewed or sized to contain rainfall from a 10 year storm event. The existing system provides acceptable conveyance for the 10-year storm event based on NOAA's "Baltimore WSO City" PF (as IDF). However, since the well field's proposed location is adjacent to the main swale, part of this study was to gauge how deep/wide it would become in a major storm event (i.e. the 100-year storm). Using Hydraflow Express, a typical cross-section of the upper end of the swale was defined, and then the outflow rate of the Chesapeake Park Plaza was applied. The same was done in the lower end of the swale, using the Combination ADD-1/2 flow rate. An "n" of 0.20 was used. According to the analysis results, the upper section of the swale will be about 1.1 feet deep and 23 feet wide (with a cross-sectional area of 11 square feet.), and the lower section of the swale will be about 1.0 foot deep and 64 feet wide (with a cross-sectional area of 22 square feet). Appendix D provides a graphic representation of the typical sections.

The site was scrutinized in detail to examine various peak flows, flow diversions, and flow combinations. Drainage areas (Table 2-2), reservoir routing (Table 2-3), and peak flows (Table 2-4) at select points of interest are summarized in the tables below. Appendix A contains additional routing and flow information.

**Table 2-3**

**Reservoir Routing**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number | Type | Description | Inflow Hydrograph | Outflow Hydrograph |
|---|---|---|---|---|
| 2 | Reservoir | Sump 1 - CPP Ditch | 1 | 3,4 (Diverts) |
| 3 | Diversion 1 | Loop Road Culvert | 2 | 8 |
| 4 | Diversion 2 | Ditch - Continued Offsite | 2 | 5 |
| 5 | Reach | Ditch - Continued Offsite (Check) | 4 | N/A |
| | | | | |
| 9 | Reservoir | Sump 2 | 8 (Combines 3, 6) | 10, 11 (Diverts) |
| 10 | Diversion1 | Culvert To Sump 3 | 9 | 12 |
| 11 | Diversion 2 | Overland Flood to Bay | 9 | 14 |
| 14 | Reach | Overland Flow (Check) | 11 | N/A |
| | | | | |
| 13 | Reservoir | Sump 3 to Outfall | 12 (Combines 7, 10) | N/A - Outfall |

CPP = Chesapeake Park Plaza

A "check" is the diverted overbanked flow (Modeled as a Reach). See Figure 2-1.

**Table 2-4**

**Peak Runoff (Q) at Various Points of Interest**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number | Name | $Q_1$ | $Q_2$ | $Q_{10}$ | $Q_{100}$ |
|---|---|---|---|---|---|
| 3 | Chesapeake Park Plaza culvert (DA-1 Outfall) | 2.8 | 3.9 | 7.8 | 9.0 * |
| 4 | Diversion to continued ditch (offsite) | - | - | - | 2.9 |
| 6 | DA-2 On-Site Flow | 0.5 | 0.9 | 2.5 | 4.4 |
| 8 | Combination (ADD-1/2) | 3.3 | 4.8 | 10.2 | 13.4 * |
| 10 | DA-2 Culvert to junction w/ DA-3 | 3.3 | 4.9 | 8.7 | 8.9 |
| 11 | Diversion as Overland Flood to Bay | - | - | 1.5 | 4.6 |
| 7 | DA-3 On-site Flow | 0.3 | 0.5 | 1.5 | 2.6 |
| 12 | Combination (ADD-2/3) | 3.5 | 5.4 | 10.2 | 11.5 |
| 13 | Cow Pen Creek Outfall | 3.5 | 5.3 | 10.2 | 11.5 |

* These two flows were used to generalize the depth/width of the main swale in a major storm
ADD – The arithmetic sum of two flows at each interval (however, flows may not peak at the same time): for instance, ADD-1/2 during $Q_1$ is 2.8 + 0.5 = 3.3
All flow rates (Q) are in cubic feet per second (cfs)
$Q_x$ – flow rate (in cubic feet per second, subscript is the storm event)
DA = drainage area

The existing flow and conveyance data, along with the well field design, provided enough information to base a decision on whether to reroute the swale, enclose the swale, do both, or do neither. This is discussed further in the proposed condition analysis.

# Section 3
# Proposed Drainage Analysis

The proposed design is to re-route the swale south-southeast of the proposed injection well field. The routing design includes a diversion of the drainage area (DA)-1 flow at Chesapeake Park Plaza, a traditional stormwater detention facility with outlet structure, and the extension of a storm pipe to route the stormwater back to the current outfall at Cow Pen Creek

The proposed storm sewer design also incorporates secondary improvements, as feasible, such as addressing the existing uncontrolled overflow at SUMP-2.

Incidental work includes demolition of portions of the concrete foundation currently present on the site to install the storm sewer pipe, other utility abandonment, excavation and earthwork, and fine re-grading of the existing ground surface to modify various existing surface flows.

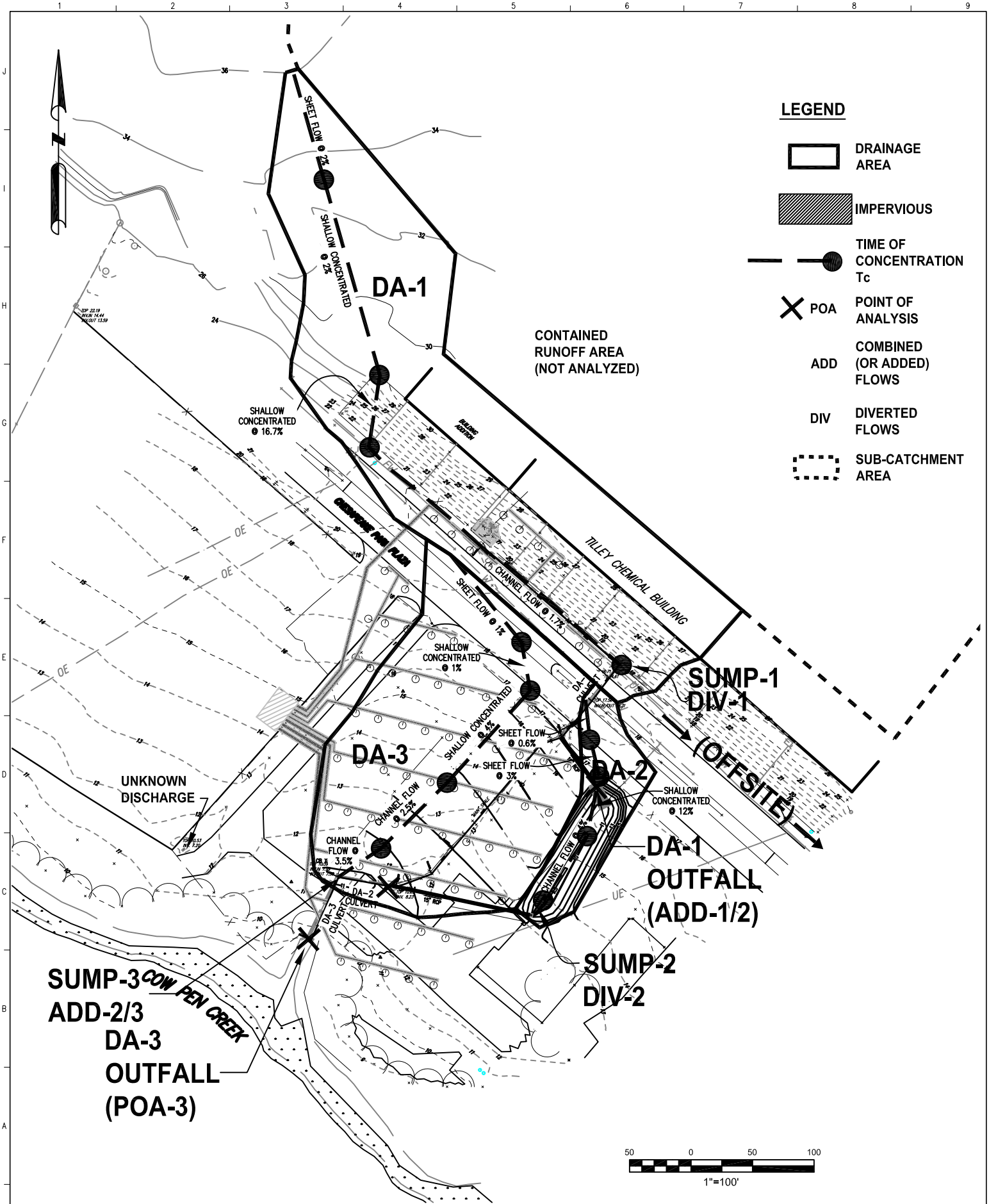
## 3.1 METHODOLOGY AND SOFTWARE

The methodology and software used to model the proposed drainage design are the same as those used for the existing drainage analysis. Similarly, the Technical Release-55 (TR-55) routing, rainfall data, and soil types used to model the proposed design are also the same as those used for existing conditions. The TR-55 diagram for the proposed design is provided below as Figure 3-1; the report generated from the modeling is attached as Appendix B.

## 3.2 DETAILED DRAINAGE DESCRIPTION

The total proposed area of analysis is the same size and shape as the existing conditions. The site is broken down into 3 drainage areas (DAs), similar to the existing conditions:

1. DA-1: Industrial Area and Tilley Chemical (Unchanged from Existing Conditions)
2. DA-2: Proposed Block G Swale Relocation
3. DA-3: Proposed Well Field

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
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STORMWATER MODIFICATIONS – BLOCK G
INJECTION WELL FIELD
SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 2-8-12 |
| PROJECT NO.: | 112I03043 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SNL |
| CHECKED BY: | CSG/SK |
| SHEET: | FIG. 3-1 (C-SWM) |

PROPOSED CONDITIONS DRAINAGE ANALYSIS

No modifications are proposed in DA-1; it is unchanged from the existing conditions. Part of the design study was to ensure that flow would not back up into the Chesapeake Park Plaza culvert more than current conditions or aggravate upstream drainage patterns.

The project modifications begin with a proposed junction box at the current outfall of the Chesapeake Park Plaza culvert at Block G. This box will provide a 90 degree bend, out of which an 18-inch concrete pipe will extend the culvert to the head of a proposed stormwater detention area.

Drainage area DA-2 covers a small portion of the Chesapeake Park Plaza roadway and the proposed stormwater detention area (i.e. relocated Block G swale). The combination of the outflow from the DA-1 culvert and the DA-2 overland flow is labeled as ADD-1/2 on the hydrology model.

The stormwater detention area will be constructed with a 4-foot wide bottom and with side slopes of 1 vertical to 4 horizontal (1:4), and will be sized to hold the 100-year storm event. This design is provided in the construction documents, under separate cover. The proposed stormwater detention area is designed with an outlet structure (denoted as SUMP-2 to match existing conditions). This structure will attenuate flow to match existing conditions, particularly the 100-year storm event, and help reduce the existing uncontrolled overbank flow. This proposed outlet structure includes a 12-inch orifice and a rectangular weir (6 inches wide with an 18-inch rise). The outlet of the structure is a proposed 15-inch concrete pipe, which will junction with the existing lawn basin (former SUMP-2). The inlet at former SUMP-2 will be capped and buried to function as a junction box, and the outflow will run into the DA-3 sump and combine, similar to what occurs under existing conditions (ADD-2/3).

Next to the proposed outlet structure is an emergency spillway (Diversion-2) set at an elevation of 12.5 feet. Although flow is not expected to overbank, the spillway will be strategically placed to divert overland flow out to Cow Pen Creek and away from the wellheads or nearby structures.

In the proposed design, DA-3 will remain similar to existing conditions, except it will be enlarged and the surface grading will be changed to avoid noticeable accumulation of water across the wellheads. DA-3 receives surface run-off from the Chesapeake Park Plaza; this run-off begins to accumulate over the well field and channelizes as it approaches the Cow Pen Creek

storm system. Although the model states the words “concentrated” and “channelized” flows, depths are expected to be minimal across the well field (a few inches deep during a major storm) and can be alleviated locally by simply raising the individual well-head collars a few inches above grade.

Similar to existing conditions, the DA-3 Tc line will run into a lawn basin (SUMP-3), and the bottom of this lawn basin will junction with the 18-inch outfall of DA-2 to create a combine (ADD 2/3). Again, per the existing conditions, this will further lead the combined flows into a 24-inch corrugated metal pipe (CMP), where it will ultimately outfall into Cow Pen Creek, a tributary to the Chesapeake Bay (DA-3 Outfall). The existing storm culvert will remain functional per the existing conditions.

## 3.3 HYDRAULIC AND HYDROLOGIC ANALYSIS

The hydraulic and hydrologic analysis for the proposed design was performed in the same manner as the analysis for existing conditions: within the target drainage area for 1-, 2-, 10-, and 100-year frequency storm events using the TR-55 software (Hydraflow Hydrographs).

At present, no traditional development is proposed for the site; therefore, the site was analyzed for quantity and flow mitigation only, not quality management. The proposed injection well field contains approximately 80 total wellheads on about 7 runs, and each wellhead has a box and concrete collar with a total area of about 5 square feet. Wellheads are spaced about 18 feet apart on each run and each run is spaced about 40 feet apart. The total added impervious surface area is about 400 square feet, over roughly 66,000 square feet of pervious area (about 0.6% cover). These (proposed) wellheads are “temporary”, meaning removal is planned once remediation is complete.

Per the Maryland Stormwater Design Manual (Chapter 2), channel protection storage volume ($Cp_v$, 24 hour extended detention of post-developed one-year, 24 hour storm event) is not required for direct discharges to tidal waters and therefore was not considered. Over bank flood protection ($Q_{p10,}$ control of the peak discharge rate from the ten-year, 24 hour storm event) and extreme flood volume ($Q_f$, control of the peak flow rate from the 100-year, 24 hour storm event) are optional unless required by local approval authority. Regardless, because of the concern over

potential damage to the proposed well field in a large storm, the proposed SWM design considered both the overbank flood protection ($Q_{p10}$) and the extreme flood criteria, $Q_f$ (or $Q_{100}$).

The site was scrutinized in detail to examine various peak flows, flow diversions, and flow combinations, as were the existing conditions. For consistency, reservoir routing was not changed from existing conditions. Drainage areas (Table 3-1), peak flows (Table 3-2), and a comparison of the 100-year peak flows at select points of interest (Table 3-3) are summarized in the tables below. Appendix B contains additional routing and flow information.

**Table 3-1**

**Drainage Area Hydrographs**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number | Type | Description | Acres | Curve Number (composite) | Tc |
|---|---|---|---|---|---|
| 1 | SCS Runoff | DA-1, Industrial Tilley Area | 1.52 | 83 | 9.4 |
| 6 | SCS Runoff | DA-2, Open Area | 0.16 | 70 | 5.5 |
| 7 | SCS Runoff | DA-3, Open Area | 1.03 | 67 | 7.0 |

DA = drainage area SCS = Soil Conservation Service Tc = time of concentration

**Table 3-2**

**Peak Runoff at Various Points of Interest**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number. | Name | $Q_1$ | $Q_2$ | $Q_{10}$ | $Q_{100}$ |
|---|---|---|---|---|---|
| 3 | Chesapeake Park Plaza culvert (DA-1 Outfall) | 2.8 | 3.9 | 7.7 | 8.6 |
| 4 | Diversion to continued ditch (offsite) | - | - | - | 3.3 |
| 6 | DA-2 On-Site Flow | 0.1 | 0.2 | 0.6 | 1.1 |
| 8 | Combination (ADD-1/2) | 2.9 | 4.2 | 8.3 | 9.6 |
| 10 | DA-2 Culvert to junction w/ DA-3 | 2.3 | 3.0 | 5.3 | 6.6 |
| 11 | Diversion as Overland Flood to Bay | - | - | - | - |
| 7 | DA-3 On-site Flow | 0.6 | 1.1 | 3.2 | 5.8 |
| 12 | Combination (ADD-2/3) | 2.8 | 3.9 | 7.8 | 11.5 |
| 13 | Cow Pen Creek Outfall | 2.8 | 3.9 | 7.8 | 11.5 |

ADD – The arithmetic sum of two flows at each interval (flows may not peak at the same time): for instance, ADD-1/2 during $Q_1$ is 2.8 + 0.1 = 2.9
$Q_x$ – flow rate (in cubic feet per second, subscript is the storm event)
All flow rates (Q) are in cubic feet per second (cfs).
DA = drainage area

**Table 3-3**

**100-Year Storm Peak Runoff Comparison at Various Points of Interest**
**Middle River Complex, Middle River, Maryland**

| Hydrograph Number | Name | Existing Conditions | Post-Design Conditions |
|---|---|---|---|
| 10 | DA-2 Culvert to junction w/ DA-3 | 8.9 | 6.6 |
| 7 | DA-3 On-site Flow | 2.6 | 5.8 |
| 13 | Cow Pen Creek Outfall | 11.5 | 11.5 |

DA = drainage area

Elevations of the 100 year storm for proposed conditions were reviewed in a manner similar to existing conditions to check for overbanking, and the issue appears to be eliminated at SUMP-2.

Using Hydraflow Storm Sewers modeling, the proposed systems (Chesapeake Park Plaza and Cow Pen Outfall) were again analyzed for back-checking against the TR-55 data. The data sets are comparatively similar, and there does not appear to be any new or aggravated stormwater issues caused by the proposed conditions.

## 3.4 CONCLUSION

The following key items summarize this report:

- Stormwater that would typically flood the field under existing conditions is relocated away per the proposed design.
- All peak flows at the Cow Pen Creek outfall, including the 100-year peak flow, are controlled, thus keeping the changes “internal”.
- The proposed design does not appear to cause or aggravate local stormwater issues, such as upstream flooding.
- Secondary existing issues such as the overbanking at SUMP-2 have been addressed as found when feasible.

This analysis, along with its appendices and the construction documents (provided under separate cover), should satisfy the stormwater design and analysis requirements for the proposed well field.

# Section 4
# References


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2. Autodesk, 2011b. *Hydraflow Hydrograph Extension.* Software for AutoCAD® Civil 3D®, San Rafael, California. September.

3. Autodesk, 2011c. *Hydraflow Storm Sewers Extension.* Software for AutoCAD® Civil 3D®, San Rafael, California. September.

4. Maryland Department of Environment (MDE), 2000.*2000 Maryland Stormwater Design Manual Volumes I & II.* Prepared by Center for Watershed Protection and Maryland Department of Environment Water Management Administration, Baltimore, Maryland. October.

5. MDE, 2011. *2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control.* MDE Water Management Administration in association with Natural Resources Conservation Service and Maryland Association of Soil Conservation Districts. May.

6. National Oceanic and Atmosphere Administration (NOAA), 2011. National Weather Service Hydrometeorological Design Studies Center website (http://hdsc.nws.noaa.gov/hdsc/pfds/). September.

7. Tetra Tech, 2011. *90% Design Report: Design of Swale Abandonment and Subsurface Pipeline Replacement, Block G Southwestern TCE Bioremediation Area Lockheed Martin Middle River Complex.* March 2012

8. Tilley Chemical Company, Inc. (Tilley Chemical), 2011. Personal communication between warehouse foreman (name not obtained) (Tilley Chemical) and Casey Grabowski (Tetra Tech) on 06/22/2011 re: normal operating/draining procedures for Tilley Chemical's containment area. June.

9. United States Department of Agriculture (USDA), 1986. *Urban Hydrology for Small Watersheds (Technical Release 55 [TR-55]).* USDA National Resources and Conservation Service (NRCS), Conservation Engineering Division. June.

10. USDA, 2011. *Custom Soil Resource Report for Baltimore County, Maryland. LMC – Block G.* USDA NRCS Geospatial Data Gateway website. (http://datagateway.nrcs.usda.gov/GDGHome.aspx). September.

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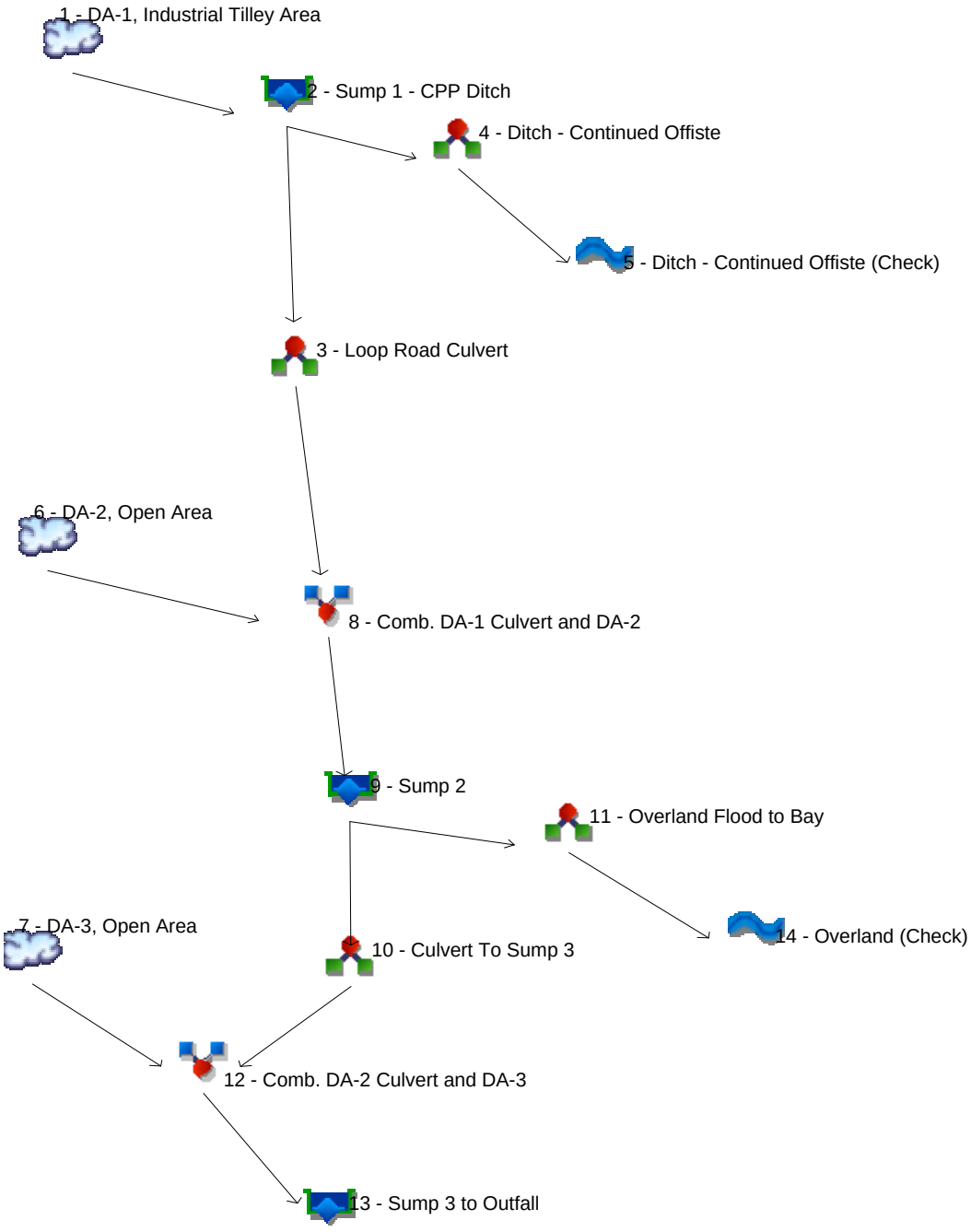
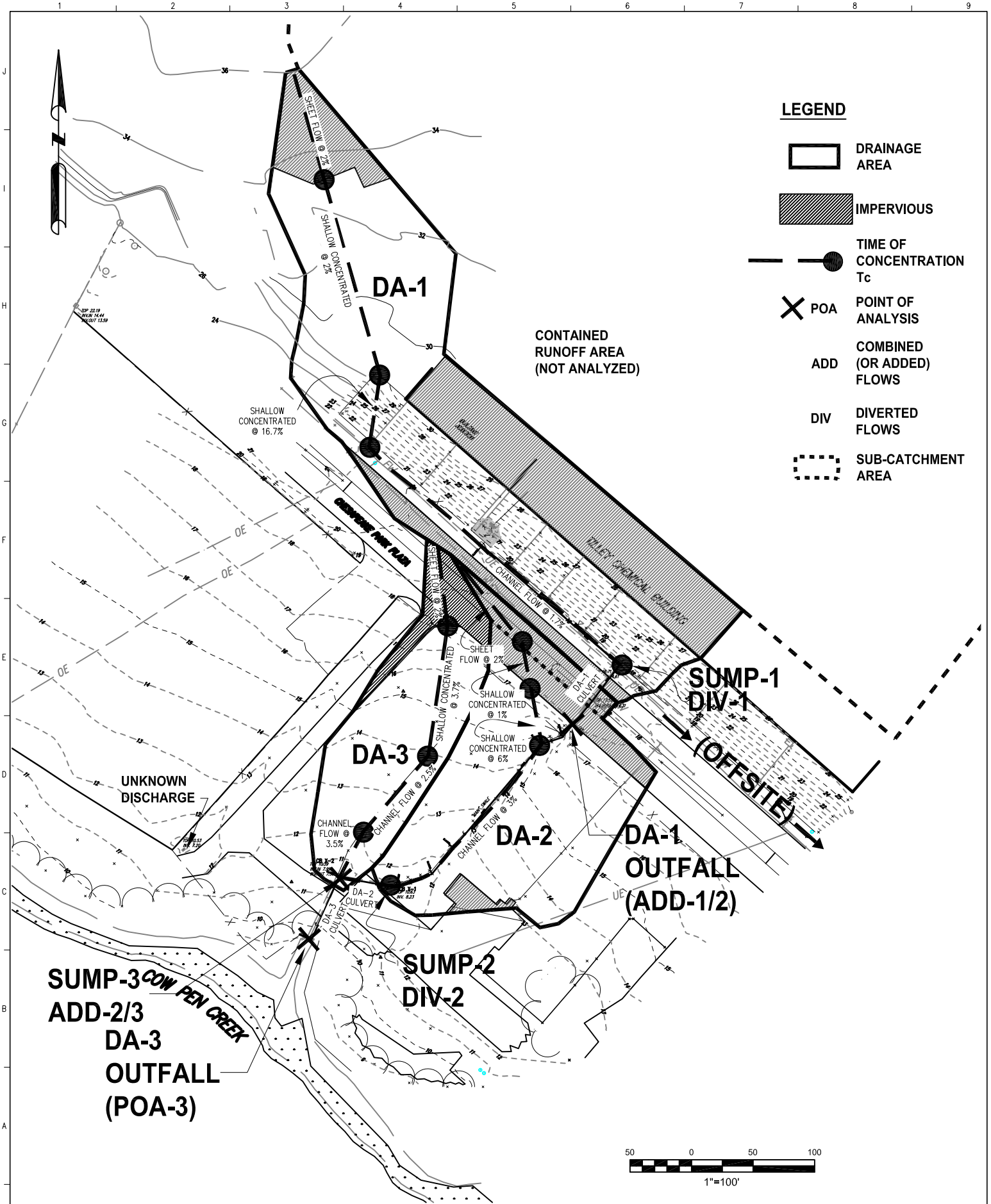
# APPENDIX A —TR-55 ROUTING REPORT (EXISTING CONDITIONS)

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25



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STORMWATER MODIFICATIONS – BLOCK G
INJECTION WELL FIELD
SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 2-8-12 |
| PROJECT NO.: | 112IC03043 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SNL |
| CHECKED BY: | CSG/SK |
| SHEET: | FIG. 2-1 (C-SWM) |

EXISTING CONDITIONS DRAINAGE ANALYSIS

# Hydrograph Return Period Recap



| Hyd. No. | Hydrograph type (origin) | Inflow hyd(s) | Peak Outflow (cfs) | | | | | | | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1-yr | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | |
| 1 | SCS Runoff | ------ | 2.760 | 3.924 | ------- | ------- | 7.830 | ------- | ------- | 12.03 | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 1 | 2.763 | 3.921 | ------- | ------- | 7.773 | ------- | ------- | 11.94 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 2 | 2.763 | 3.921 | ------- | ------- | 7.773 | ------- | ------- | 8.999 | Loop Road Culvert |
| 4 | Diversion2 | 2 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 2.941 | Ditch - Continued Offiste |
| 5 | Reach | 4 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 0.827 | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | ------ | 0.506 | 0.921 | ------- | ------- | 2.520 | ------- | ------- | 4.448 | DA-2, Open Area |
| 7 | SCS Runoff | ------ | 0.275 | 0.520 | ------- | ------- | 1.471 | ------- | ------- | 2.628 | DA-3, Open Area |
| 8 | Combine | 3, 6, | 3.265 | 4.835 | ------- | ------- | 10.21 | ------- | ------- | 13.43 | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 8 | 3.270 | 4.865 | ------- | ------- | 10.22 | ------- | ------- | 13.43 | Sump 2 |
| 10 | Diversion1 | 9 | 3.270 | 4.865 | ------- | ------- | 8.710 | ------- | ------- | 8.867 | Culvert To Sump 3 |
| 11 | Diversion2 | 9 | 0.000 | 0.000 | ------- | ------- | 1.507 | ------- | ------- | 4.561 | Overland Flood to Bay |
| 12 | Combine | 7, 10, | 3.545 | 5.373 | ------- | ------- | 10.18 | ------- | ------- | 11.49 | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 12 | 3.547 | 5.337 | ------- | ------- | 10.19 | ------- | ------- | 11.51 | Sump 3 to Outfall |
| 14 | Reach | 11 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 0.948 | Overland (Check) |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 2.760 | 1 | 720 | 6,245 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 2.763 | 1 | 720 | 6,245 | 1 | 15.35 | 13.5 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 2.763 | 1 | 720 | 6,245 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 718 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | 707 | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 0.506 | 1 | 719 | 1,224 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 0.275 | 1 | 719 | 689 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 3.265 | 1 | 720 | 7,469 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 3.270 | 1 | 720 | 7,469 | 8 | 9.78 | 20.4 | Sump 2 |
| 10 | Diversion1 | 3.270 | 1 | 720 | 7,469 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | 712 | 0 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 3.545 | 1 | 720 | 8,158 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 3.547 | 1 | 720 | 8,158 | 12 | 8.33 | 16.4 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | 705 | 0 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

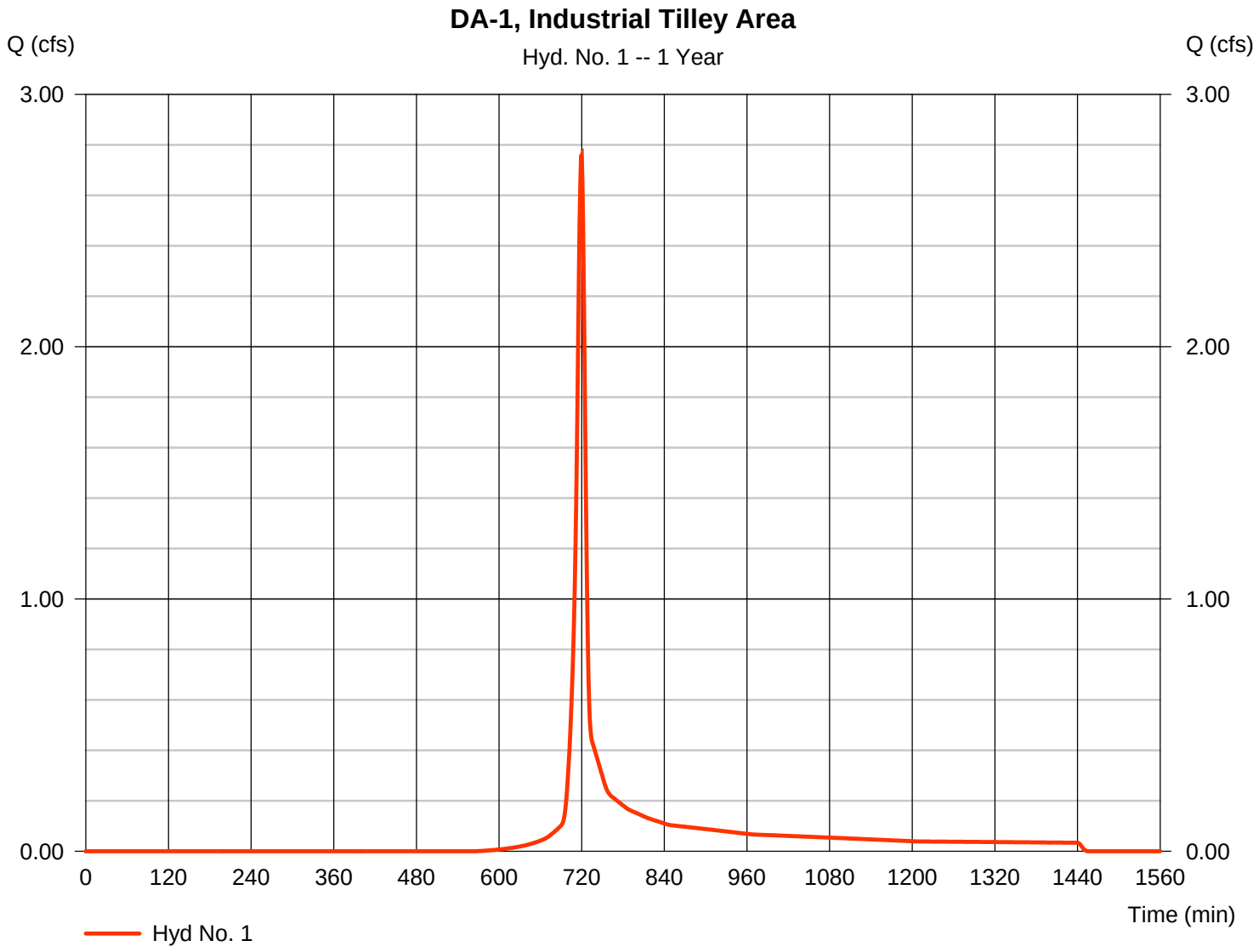
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 2.760 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 6,245 cuft |
| Drainage area | = | 1.520 ac | Curve number | = | 83* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 9.40 min |
| Total precip. | = | 2.60 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# TR55 Tc Worksheet



## Hyd. No. 1

DA-1, Industrial Tilley Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 90.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 2.20 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.07** | **+** | **0.00** | **+** | **0.00** | **=** | **1.07** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 161.00 | | 60.00 | | 0.00 | | |
| Watercourse slope (%) | = 2.00 | | 16.70 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =2.28 | | 6.59 | | 0.00 | | |
| **Travel Time (min)** | **= 1.18** | **+** | **0.15** | **+** | **0.00** | **=** | **1.33** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 9.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 15.50 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.63 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})267.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 7.02** | **+** | **0.00** | **+** | **0.00** | **=** | **7.02** |

**Total Travel Time, Tc ..... 9.40 min**

# Hydrograph Report

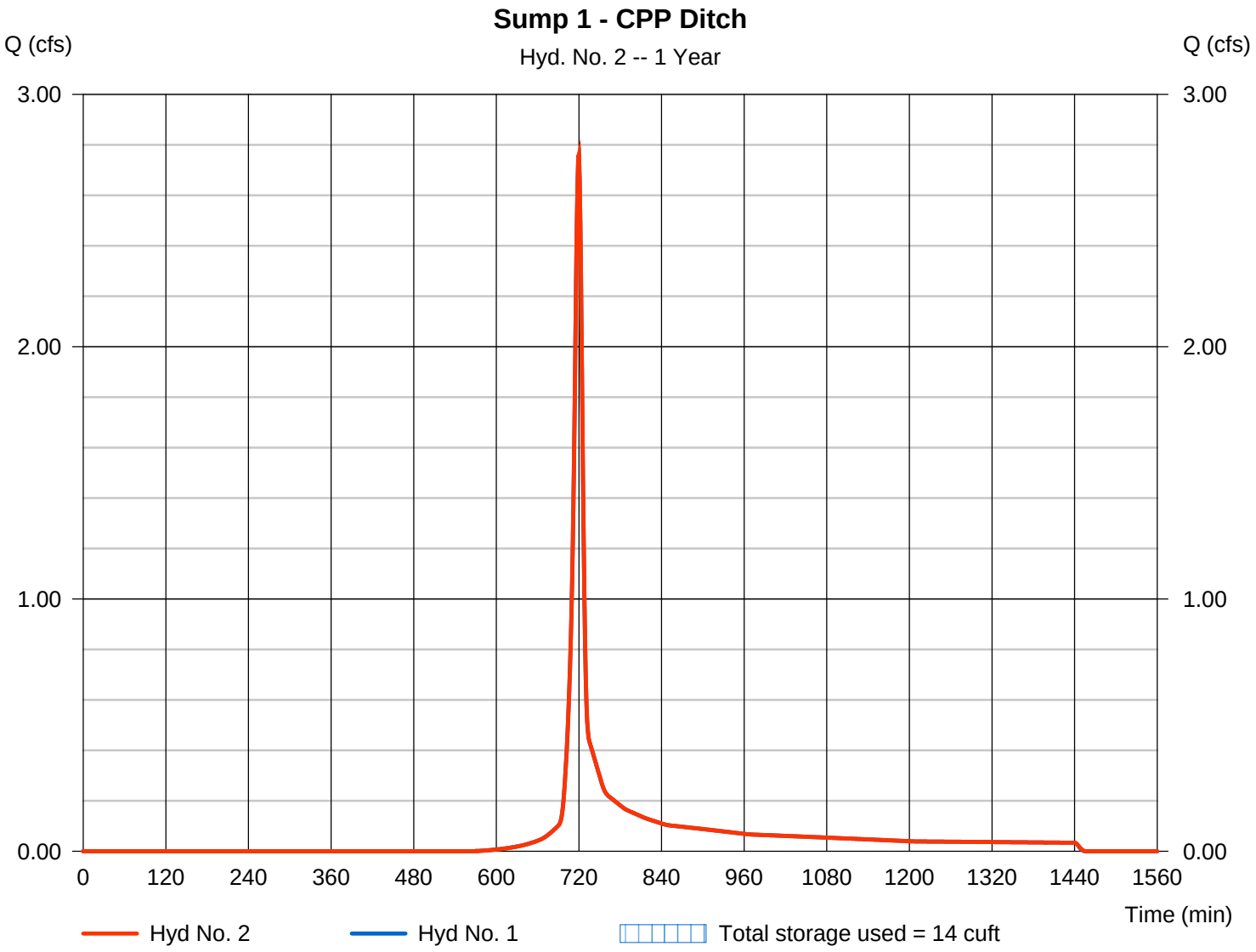
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 2.763 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 6,245 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 15.35 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 14 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Pond No. 3 - Sump 1- CPP Ditch

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 14.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 14.50 | 16 | 0 | 0 |
| 0.50 | 15.00 | 16 | 8 | 8 |
| 1.00 | 15.50 | 16 | 8 | 16 |
| 1.50 | 16.00 | 16 | 8 | 24 |
| 2.00 | 16.50 | 16 | 8 | 32 |
| 2.50 | 17.00 | 40 | 14 | 46 |
| 3.00 | 17.50 | 140 | 42 | 88 |
| 3.50 | 18.00 | 790 | 210 | 298 |
| 4.00 | 18.50 | 2,160 | 709 | 1,008 |
| 4.50 | 19.00 | 3,520 | 1,406 | 2,414 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 15.00 | | | |
| **Span (in)** | = 15.00 | | | |
| **No. Barrels** | = 1 | | | |
| **Invert El. (ft)** | = 14.50 | | | |
| **Length (ft)** | = 75.00 | | | |
| **Slope (%)** | = 0.67 | | | |
| **N-Value** | = .013 | | | |
| **Orifice Coeff.** | = 0.60 | | | |
| **Multi-Stage** | = n/a | | | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 3.00 | 127.00 | | |
| **Crest El. (ft)** | = 17.50 | 18.50 | | |
| **Weir Coeff.** | = 3.330. | 2.60 | | |
| **Weir Type** | = Ciplti | Broad | | |
| **Multi-Stage** | = No | No | | |
| **Exfil.(in/hr)** | = 0 (by Wet area) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 14.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 8 | 15.00 | 1.10 ic | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 1.104 |
| 1.00 | 16 | 15.50 | 3.56 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 3.560 |
| 1.50 | 24 | 16.00 | 4.76 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 4.755 |
| 2.00 | 32 | 16.50 | 6.13 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 6.135 |
| 2.50 | 46 | 17.00 | 7.26 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 7.257 |
| 3.00 | 88 | 17.50 | 8.23 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 8.227 |
| 3.50 | 298 | 18.00 | 9.09 oc | --- | --- | --- | 3.53 | 0.00 | --- | --- | --- | --- | 12.63 |
| 4.00 | 1,008 | 18.50 | 9.89 oc | --- | --- | --- | 9.99 | 0.00 | --- | --- | --- | --- | 19.88 |
| 4.50 | 2,414 | 19.00 | 10.62 oc | --- | --- | --- | 18.35 | 116.74 | --- | --- | --- | --- | 145.71 |

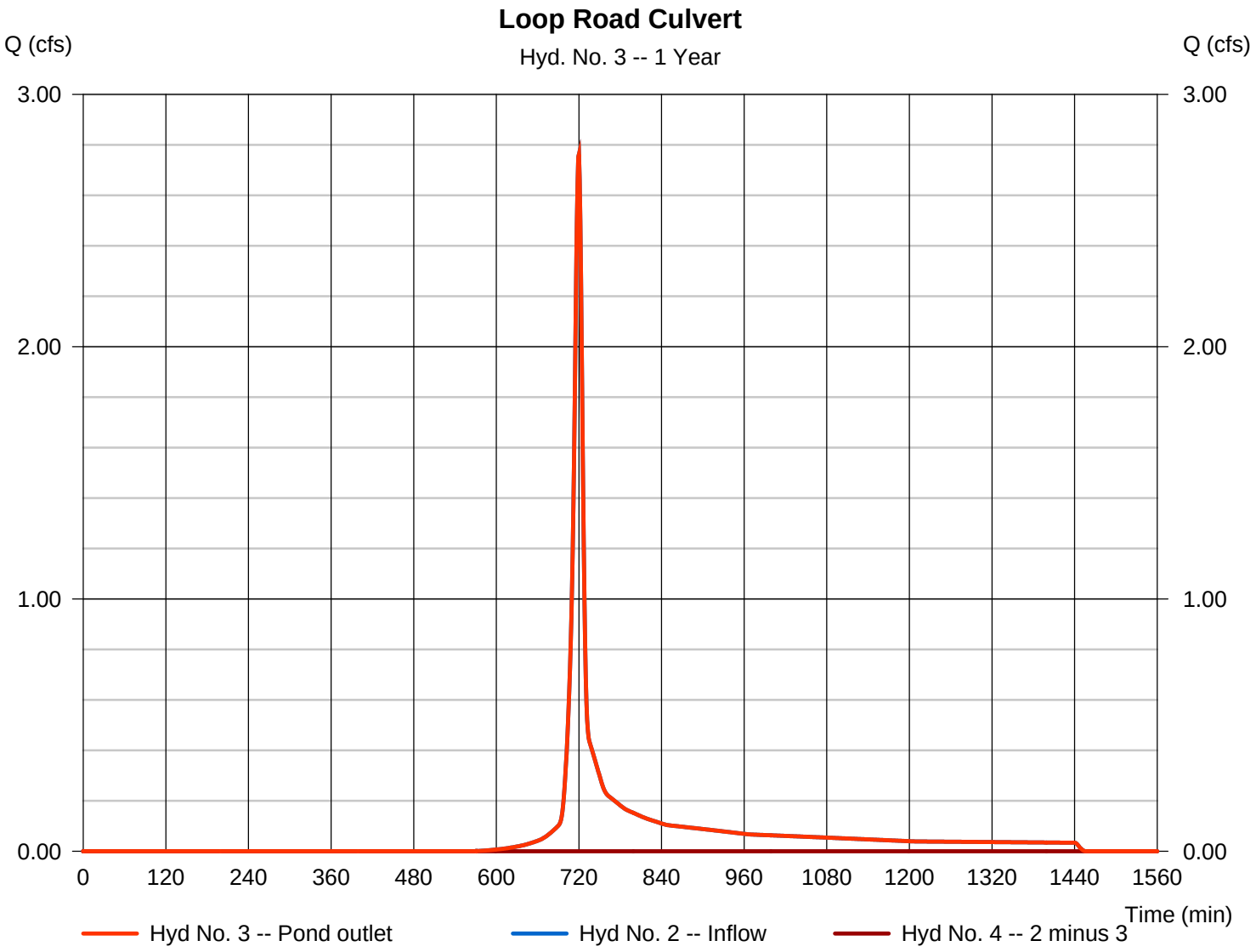
# Hydrograph Report



## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 2.763 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 6,245 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



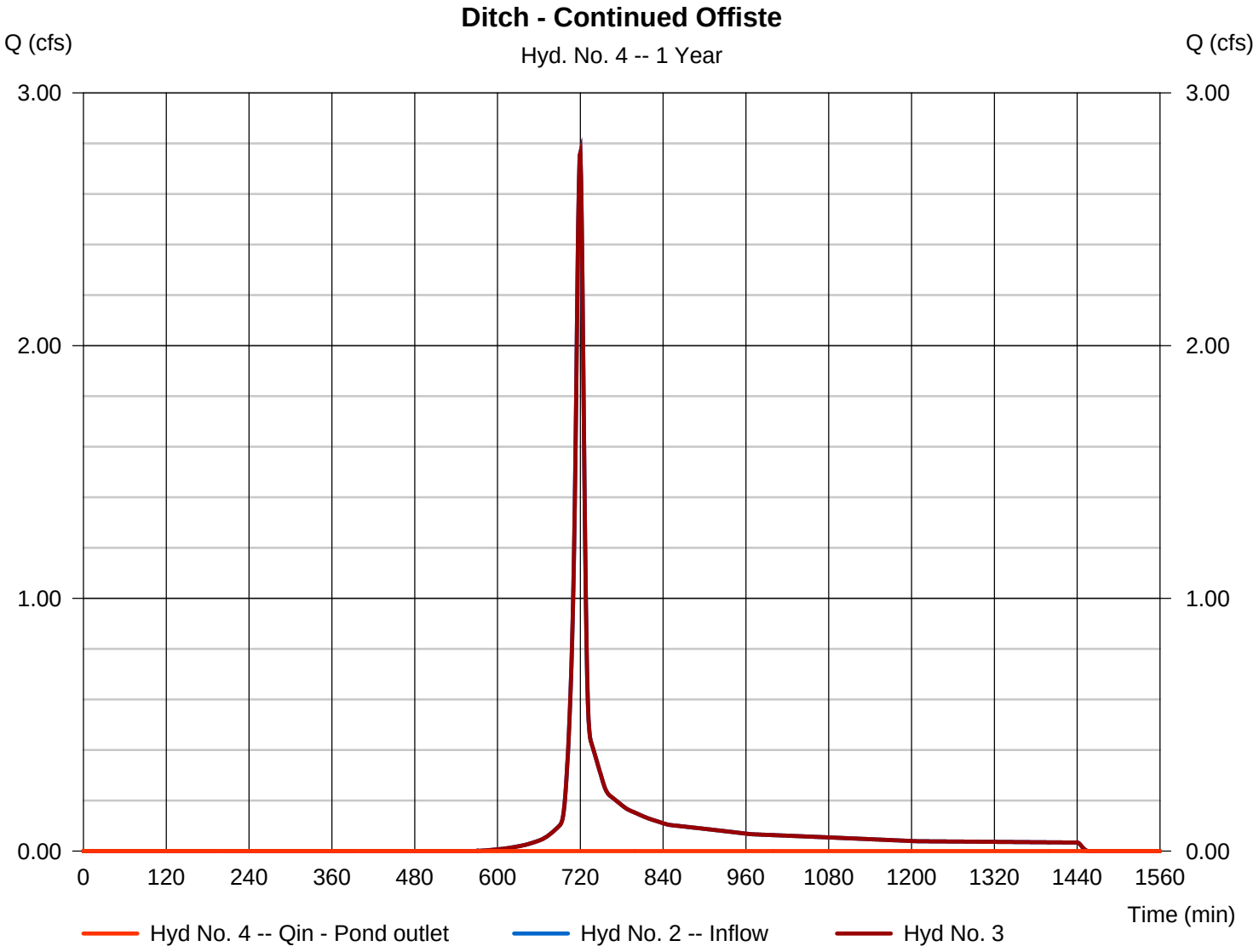
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 718 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

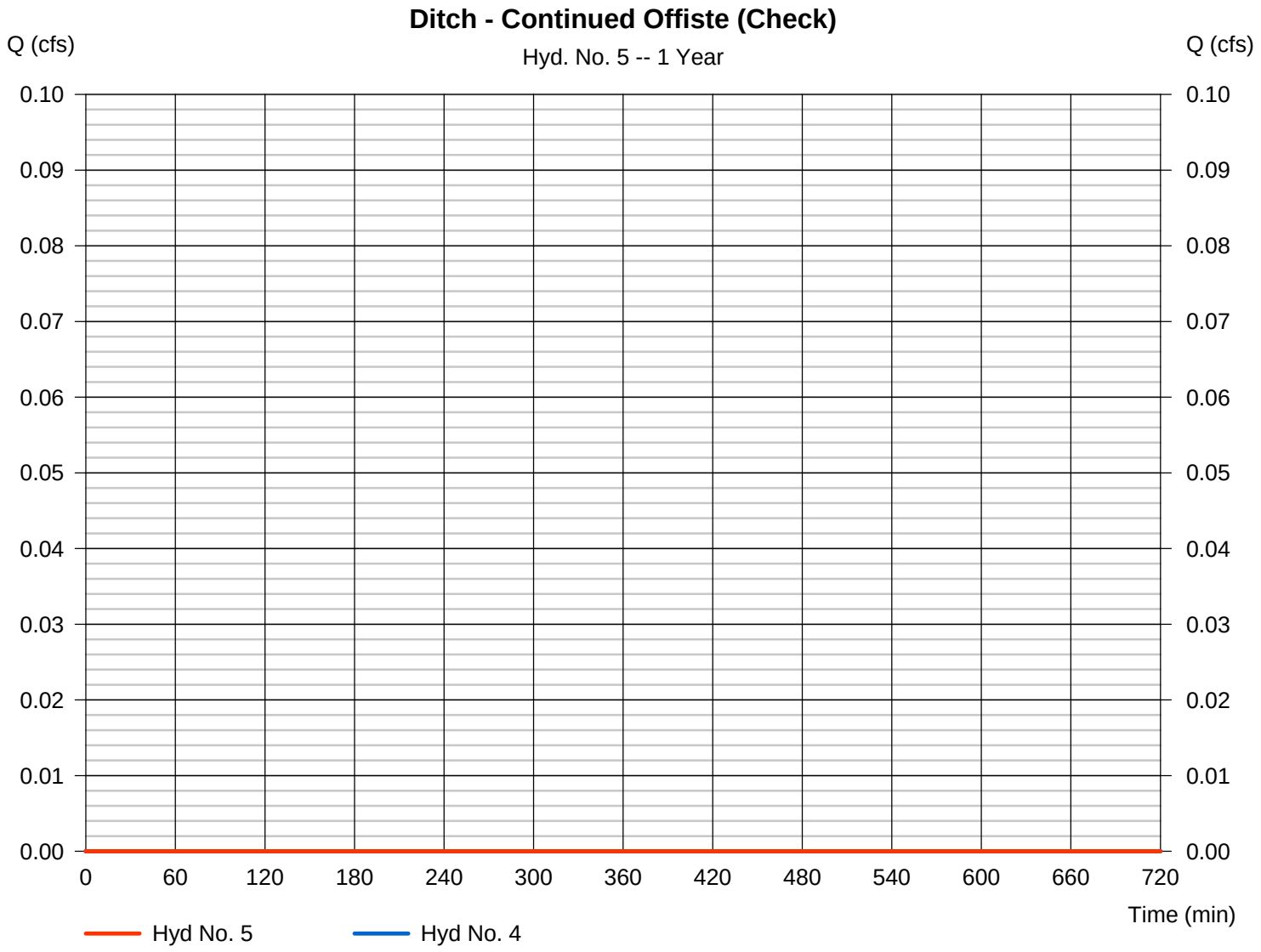
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 707 min |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 4 - Ditch - Continued Offiste | Section type | = | Triangular |
| Reach length | = | 500.0 ft | Channel slope | = | 1.6 % |
| Manning's n | = | 0.200 | Bottom width | = | 0.0 ft |
| Side slope | = | 1.0:1 | Max. depth | = | 0.0 ft |
| Rating curve x | = | 0.595 | Rating curve m | = | 1.333 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.0000 |

Modified Att-Kin routing method used.



# Hydrograph Report

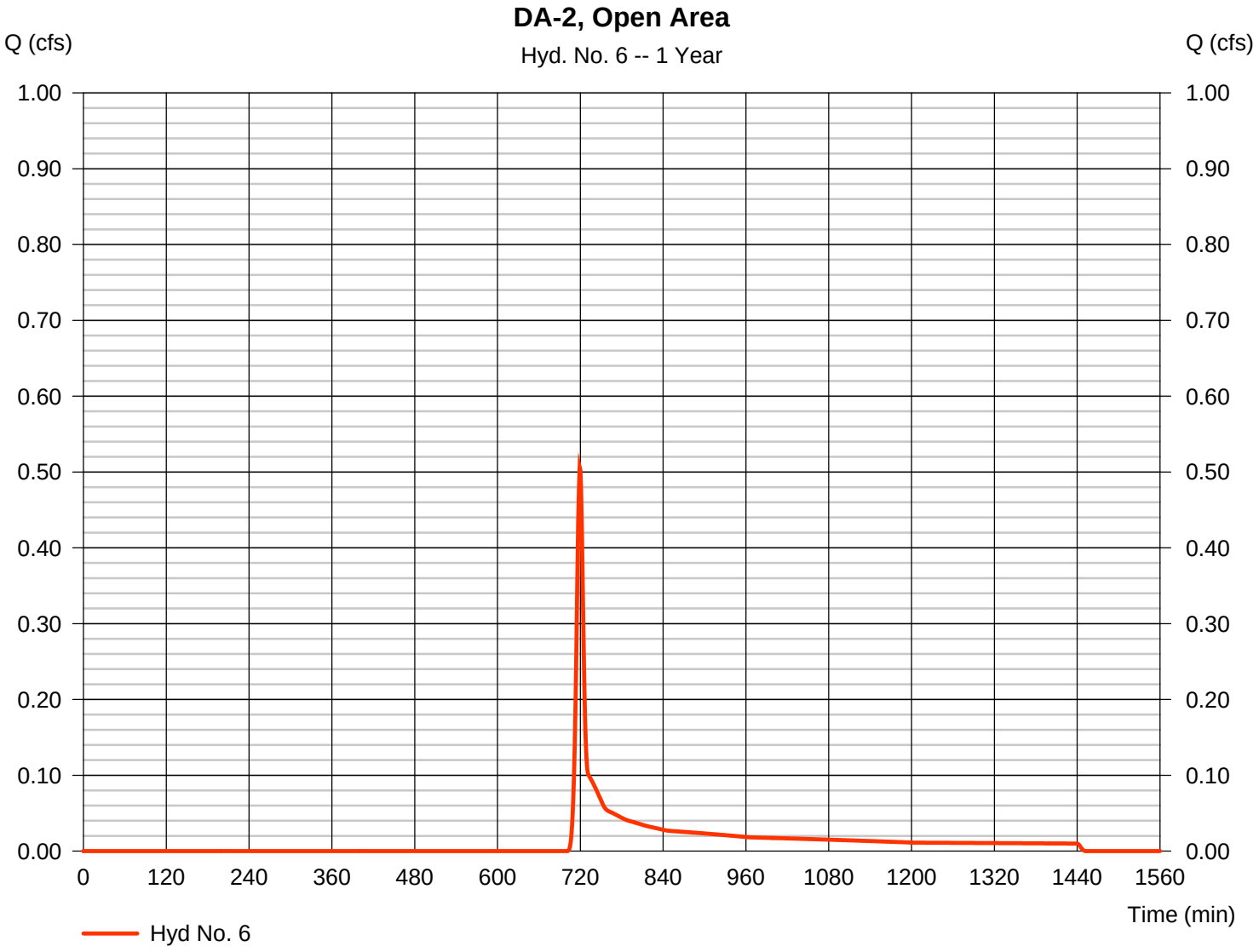


## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.506 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 1,224 cuft |
| Drainage area | = 0.740 ac | Curve number | = 69* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 6.70 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.140 x 98) + (0.020 x 98) + (0.580 x 61)] / 0.740



# TR55 Tc Worksheet



## Hyd. No. 6

DA-2, Open Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 80.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 1.30 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.20** | **+** | **0.00** | **+** | **0.00** | **=** | **1.20** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 40.00 | | 50.00 | | 0.00 | | |
| Watercourse slope (%) | = 1.00 | | 6.40 | | 0.00 | | |
| Surface description | = Paved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =2.03 | | 4.08 | | 0.00 | | |
| **Travel Time (min)** | **= 0.33** | **+** | **0.20** | **+** | **0.00** | **=** | **0.53** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 19.50 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 58.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 3.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.62 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})185.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 4.96** | **+** | **0.00** | **+** | **0.00** | **=** | **4.96** |

**Total Travel Time, Tc ..... 6.70 min**

# Hydrograph Report

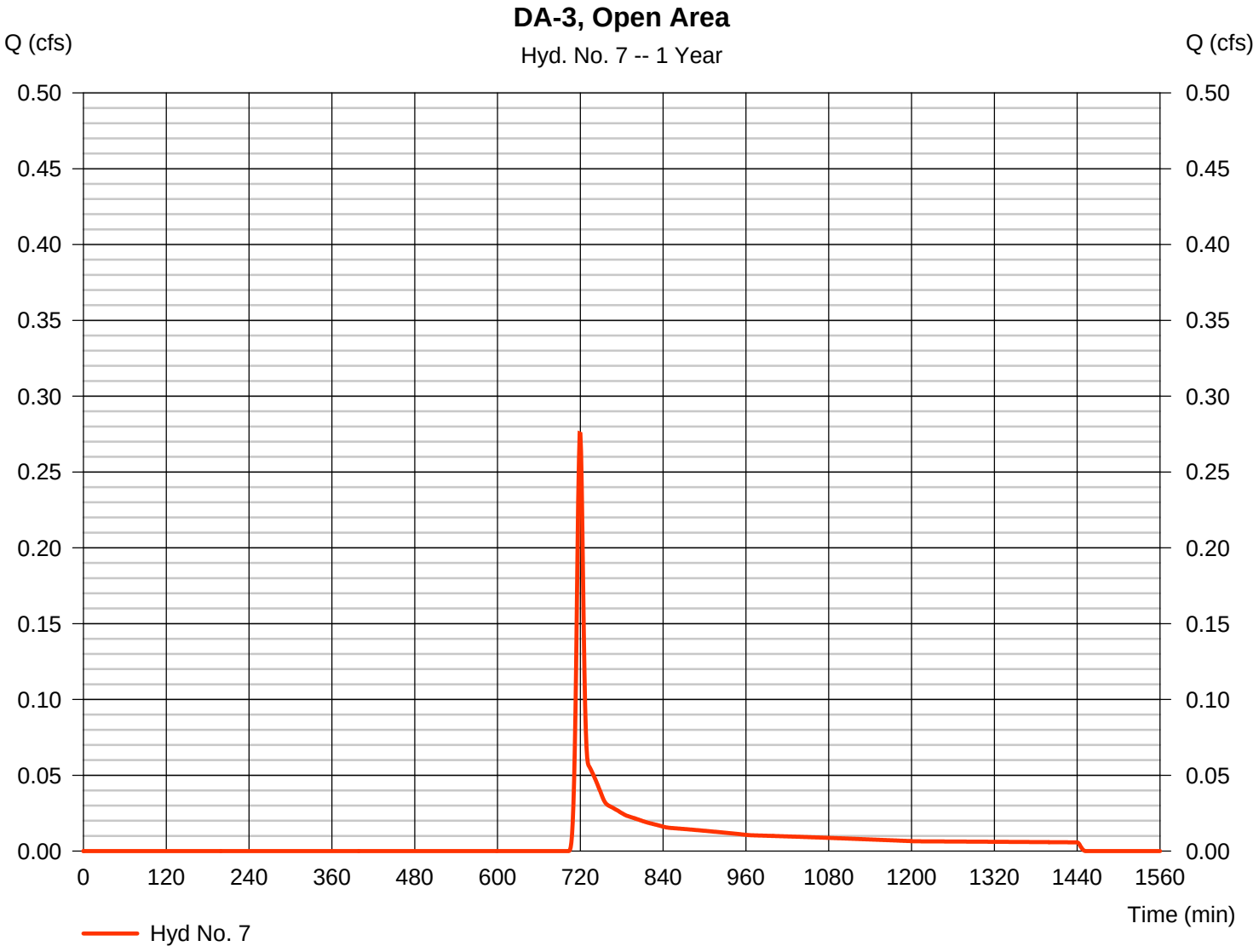


## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.275 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 689 cuft |
| Drainage area | = 0.450 ac | Curve number | = 68* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 6.90 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.080 x 98) + (0.370 x 61)] / 0.450



# TR55 Tc Worksheet



## Hyd. No. 7

DA-3, Open Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 64.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 2.20 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.82** | **+** | **0.00** | **+** | **0.00** | **=** | **0.82** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 107.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 3.70 | | 0.00 | | 0.00 | | |
| Surface description | = Unpaved | | Paved | | Paved | | |
| Average velocity (ft/s) | =3.10 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.57** | **+** | **0.00** | **+** | **0.00** | **=** | **0.57** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 7.70 | | 10.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 46.00 | | 62.00 | | 0.00 | | |
| Channel slope (%) | = 2.50 | | 3.50 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.200 | | 0.015 | | |
| Velocity (ft/s) | =0.36 | | | | | | |
| | | | 0.41 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})82.0 | | 42.0 | | 0.0 | | |
| **Travel Time (min)** | **= 3.84** | **+** | **1.71** | **+** | **0.00** | **=** | **5.55** |

**Total Travel Time, Tc ..... 6.90 min**

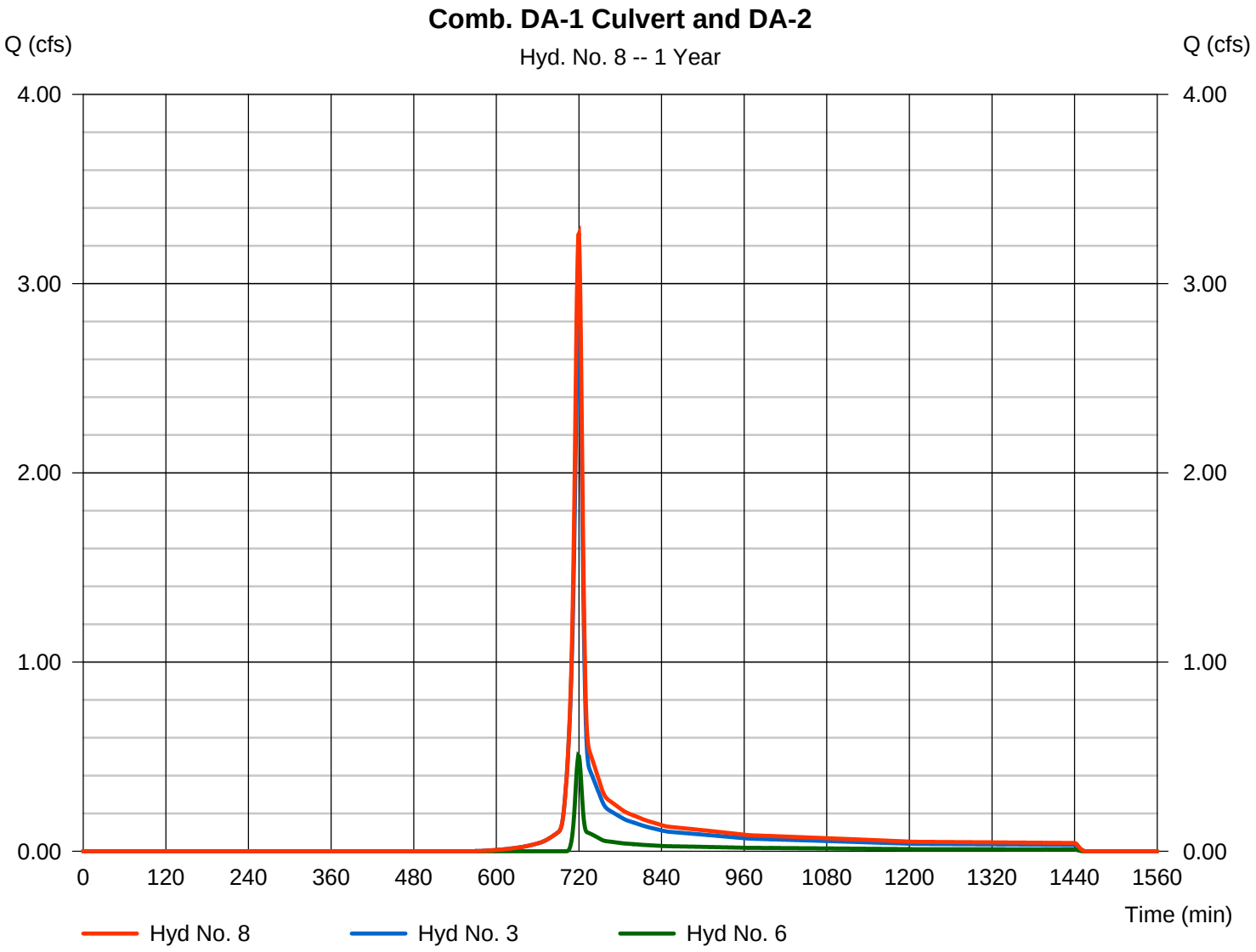
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 3.265 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 7,469 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.740 ac |



# Hydrograph Report

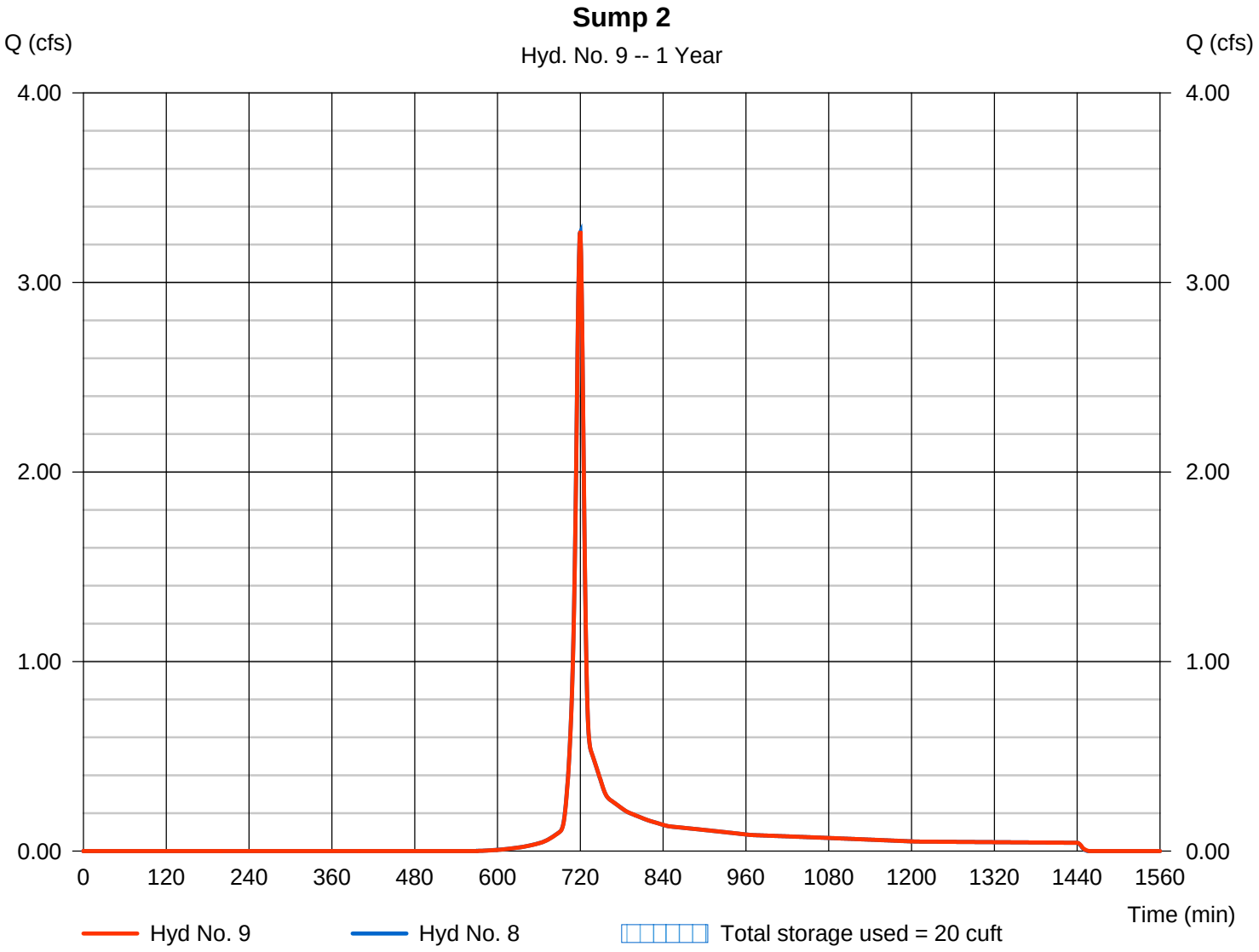
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.270 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 7,469 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 9.78 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 20 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Pond No. 2 - Sump 2

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 8.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 8.50 | 16 | 0 | 0 |
| 0.50 | 9.00 | 16 | 8 | 8 |
| 1.00 | 9.50 | 16 | 8 | 16 |
| 1.50 | 10.00 | 16 | 8 | 24 |
| 2.00 | 10.50 | 16 | 8 | 32 |
| 2.50 | 11.00 | 113 | 29 | 61 |
| 2.75 | 11.25 | 550 | 76 | 137 |
| 3.00 | 11.50 | 1,032 | 195 | 331 |
| 3.50 | 12.00 | 1,769 | 692 | 1,023 |
| 4.00 | 12.50 | 6,433 | 1,929 | 2,952 |
| 4.50 | 13.00 | 9,500 | 3,958 | 6,910 |
| 5.00 | 13.50 | 12,380 | 5,454 | 12,364 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 18.00 | | | |
| **Span (in)** | = 18.00 | | | |
| **No. Barrels** | = 1 | | | |
| **Invert El. (ft)** | = 8.50 | | | |
| **Length (ft)** | = 45.00 | | | |
| **Slope (%)** | = 0.50 | | | |
| **N-Value** | = .023 | | | |
| **Orifice Coeff.** | = 0.60 | | | |
| **Multi-Stage** | = n/a | | | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 50.00 | 190.00 | | |
| **Crest El. (ft)** | = 11.25 | 12.50 | | |
| **Weir Coeff.** | = 2.60 | 2.60 | | |
| **Weir Type** | = Broad | Broad | | |
| **Multi-Stage** | = No | No | | |
| **Exfil.(in/hr)** | = 0 (by Contour) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 8.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 8 | 9.00 | 0.86 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.856 |
| 1.00 | 16 | 9.50 | 2.52 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 2.521 |
| 1.50 | 24 | 10.00 | 3.34 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 3.344 |
| 2.00 | 32 | 10.50 | 6.00 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 6.003 |
| 2.50 | 61 | 11.00 | 7.80 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 7.803 |
| 2.75 | 137 | 11.25 | 8.56 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 8.563 |
| 3.00 | 331 | 11.50 | 9.26 oc | --- | --- | --- | 16.25 | 0.00 | --- | --- | --- | --- | 25.51 |
| 3.50 | 1,023 | 12.00 | 10.52 oc | --- | --- | --- | 84.44 | 0.00 | --- | --- | --- | --- | 94.95 |
| 4.00 | 2,952 | 12.50 | 11.64 oc | --- | --- | --- | 181.68 | 0.00 | --- | --- | --- | --- | 193.32 |
| 4.50 | 6,910 | 13.00 | 12.66 oc | --- | --- | --- | 300.95 | 174.66 | --- | --- | --- | --- | 488.27 |
| 5.00 | 12,364 | 13.50 | 13.61 oc | --- | --- | --- | 438.75 | 494.00 | --- | --- | --- | --- | 946.36 |

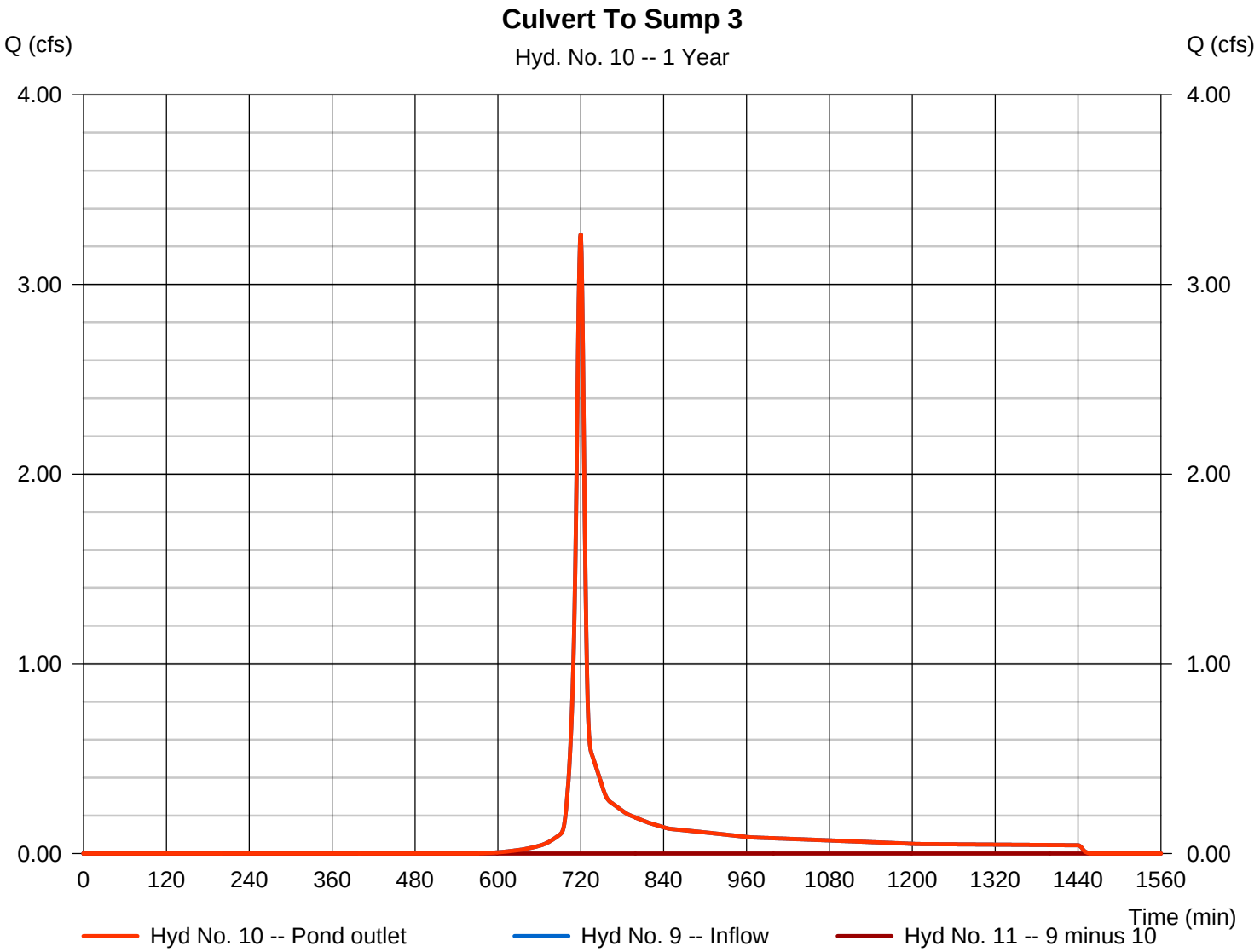
# Hydrograph Report



## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 3.270 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 7,469 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



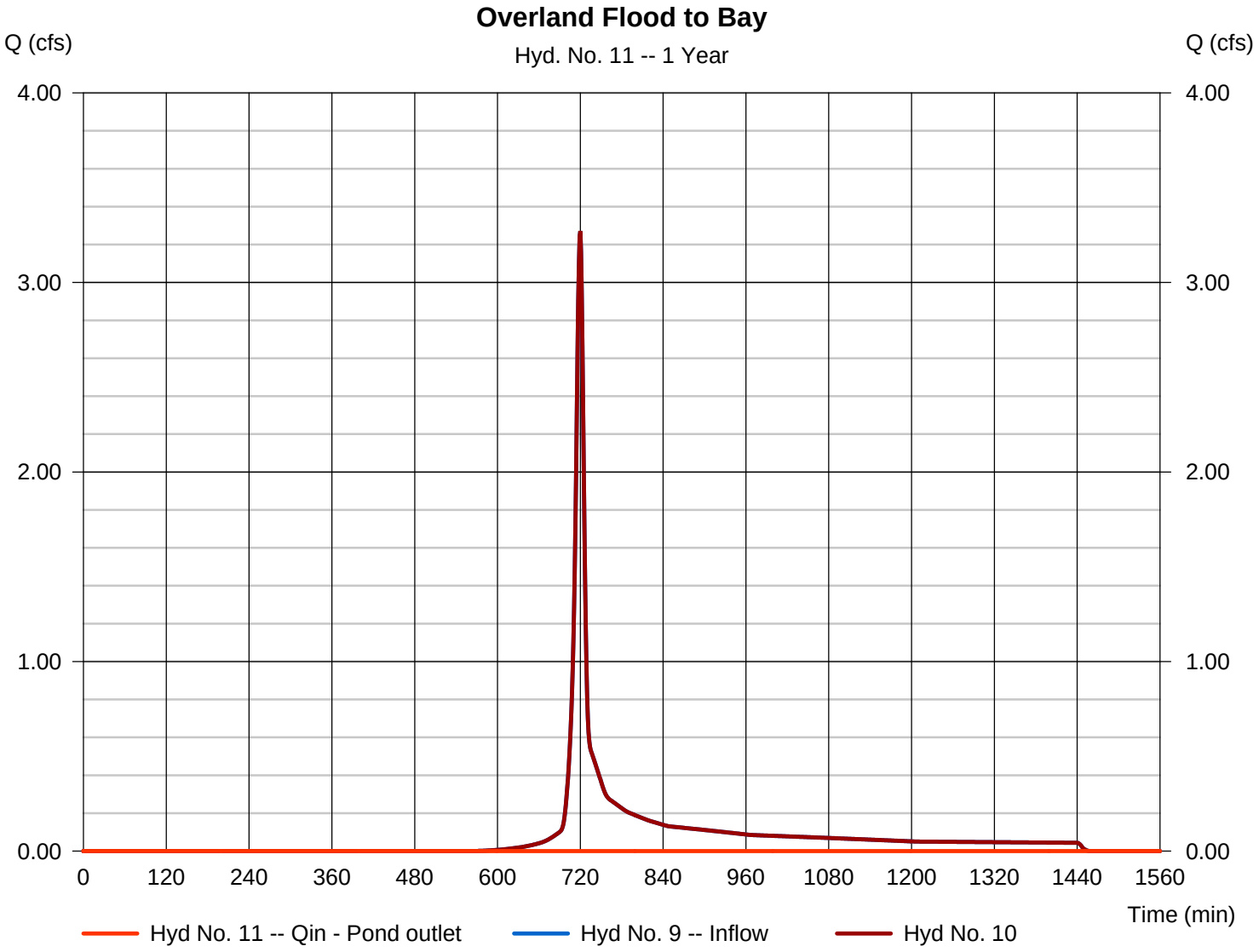
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 712 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



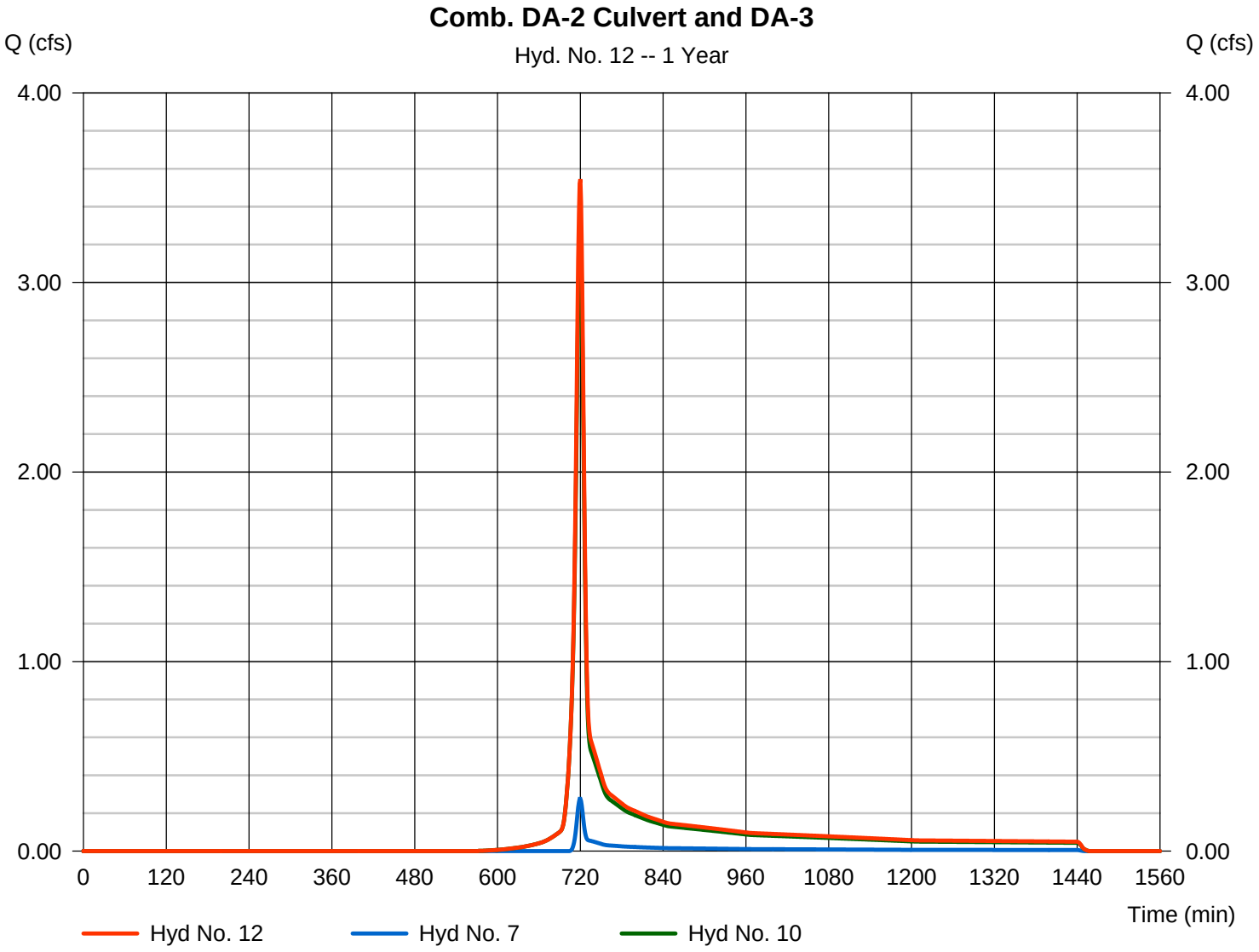
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 3.545 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 8,158 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 0.450 ac |



# Hydrograph Report

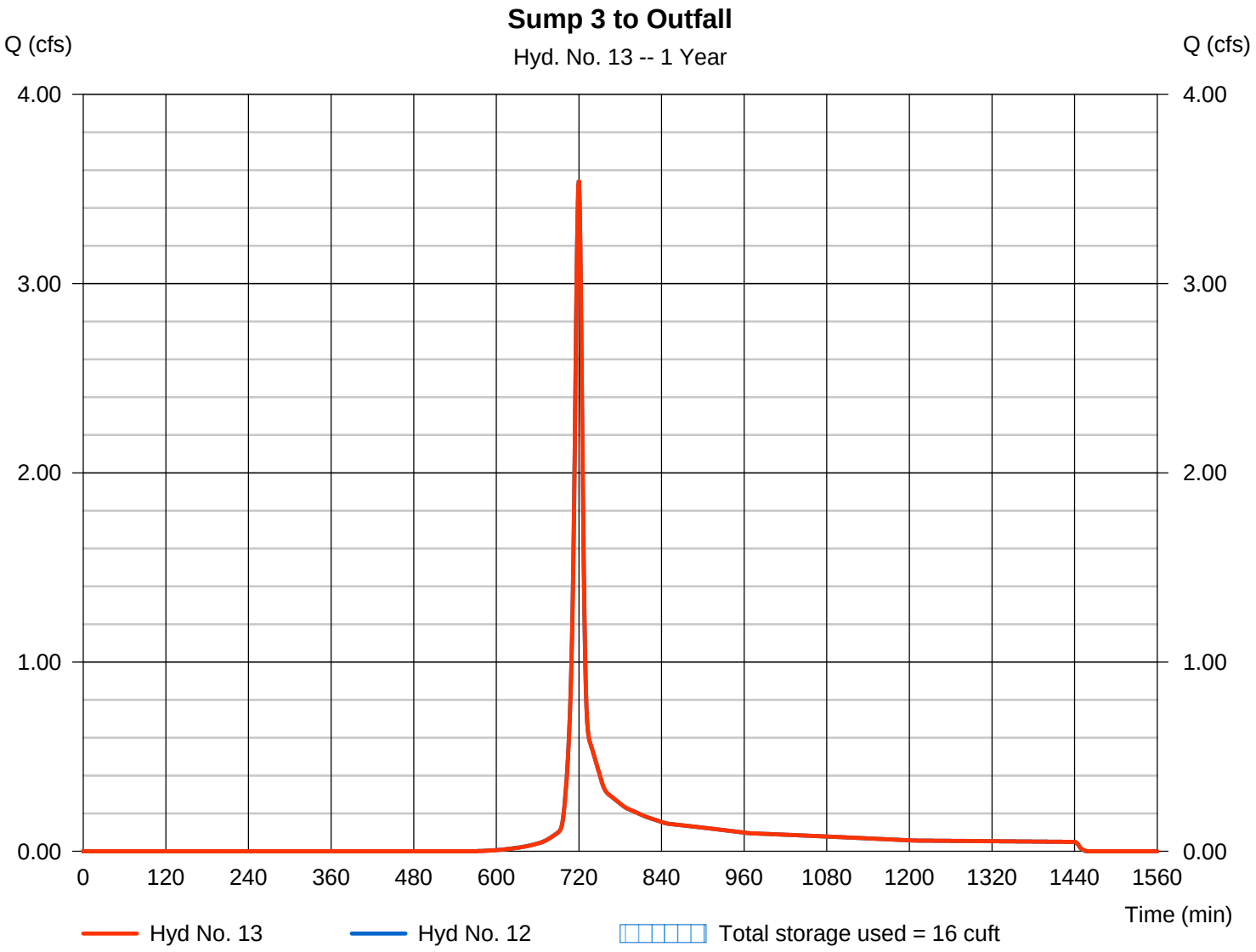
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.547 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 8,158 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 8.33 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 16 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Pond No. 1 - Sump 3

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 7.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 7.50 | 20 | 0 | 0 |
| 0.50 | 8.00 | 20 | 10 | 10 |
| 1.00 | 8.50 | 20 | 10 | 20 |
| 1.50 | 9.00 | 20 | 10 | 30 |
| 2.00 | 9.50 | 20 | 10 | 40 |
| 2.50 | 10.00 | 20 | 10 | 50 |
| 3.00 | 10.50 | 50 | 17 | 67 |
| 3.50 | 11.00 | 520 | 122 | 189 |
| 3.75 | 11.25 | 1,058 | 193 | 382 |
| 4.00 | 11.50 | 1,537 | 322 | 705 |
| 4.50 | 12.00 | 2,643 | 1,032 | 1,737 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 24.00 | | | |
| **Span (in)** | = 24.00 | | | |
| **No. Barrels** | = 1 | | | |
| **Invert El. (ft)** | = 7.50 | | | |
| **Length (ft)** | = 50.00 | | | |
| **Slope (%)** | = 1.00 | | | |
| **N-Value** | = .023 | | | |
| **Orifice Coeff.** | = 0.60 | | | |
| **Multi-Stage** | = n/a | | | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 65.00 | 75.00 | | |
| **Crest El. (ft)** | = 11.25 | 11.50 | | |
| **Weir Coeff.** | = 2.60 | 2.60 | | |
| **Weir Type** | = Broad | Broad | | |
| **Multi-Stage** | = No | No | | |
| **Exfil.(in/hr)** | = 0 (by Contour) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 7.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 10 | 8.00 | 1.48 ic | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 1.481 |
| 1.00 | 20 | 8.50 | 4.83 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 4.825 |
| 1.50 | 30 | 9.00 | 8.28 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 8.283 |
| 2.00 | 40 | 9.50 | 9.63 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 9.626 |
| 2.50 | 50 | 10.00 | 13.61 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 13.61 |
| 3.00 | 67 | 10.50 | 16.67 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 16.67 |
| 3.50 | 189 | 11.00 | 19.25 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 19.25 |
| 3.75 | 382 | 11.25 | 20.42 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 20.42 |
| 4.00 | 705 | 11.50 | 21.53 oc | --- | --- | --- | 21.13 | 0.00 | --- | --- | --- | --- | 42.65 |
| 4.50 | 1,737 | 12.00 | 23.58 oc | --- | --- | --- | 109.77 | 68.94 | --- | --- | --- | --- | 202.29 |

# Hydrograph Report

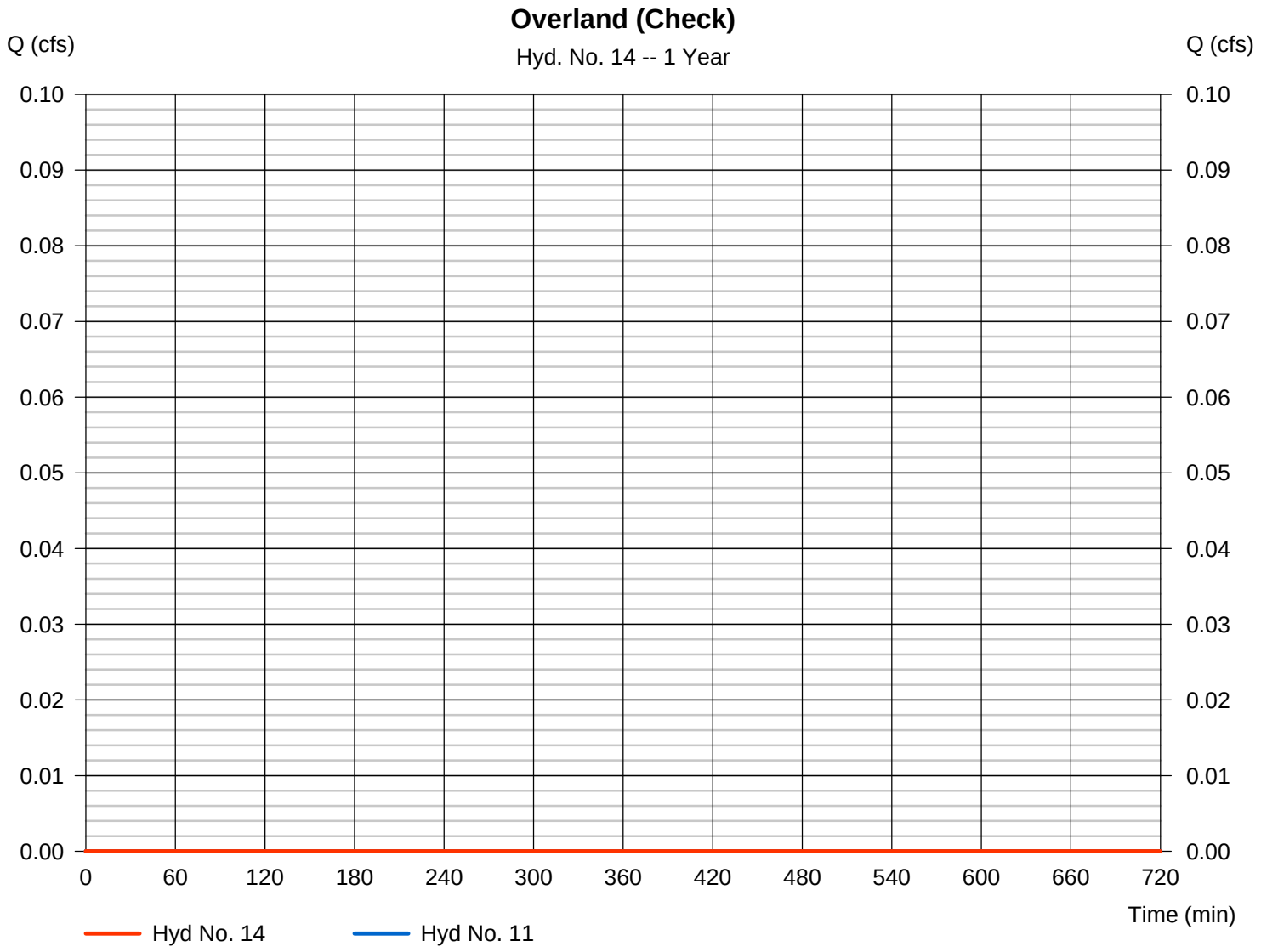
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 705 min |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.0004 |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 3.924 | 1 | 719 | 8,879 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 3.921 | 1 | 720 | 8,879 | 1 | 15.65 | 18.1 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 3.921 | 1 | 720 | 8,879 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 710 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | 598 | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 0.921 | 1 | 719 | 2,042 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 0.520 | 1 | 719 | 1,167 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 4.835 | 1 | 719 | 10,921 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 4.865 | 1 | 720 | 10,920 | 8 | 10.34 | 28.0 | Sump 2 |
| 10 | Diversion1 | 4.865 | 1 | 720 | 10,920 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | 720 | 0 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 5.373 | 1 | 720 | 12,087 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 5.337 | 1 | 720 | 12,087 | 12 | 8.63 | 21.4 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | 701 | 0 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

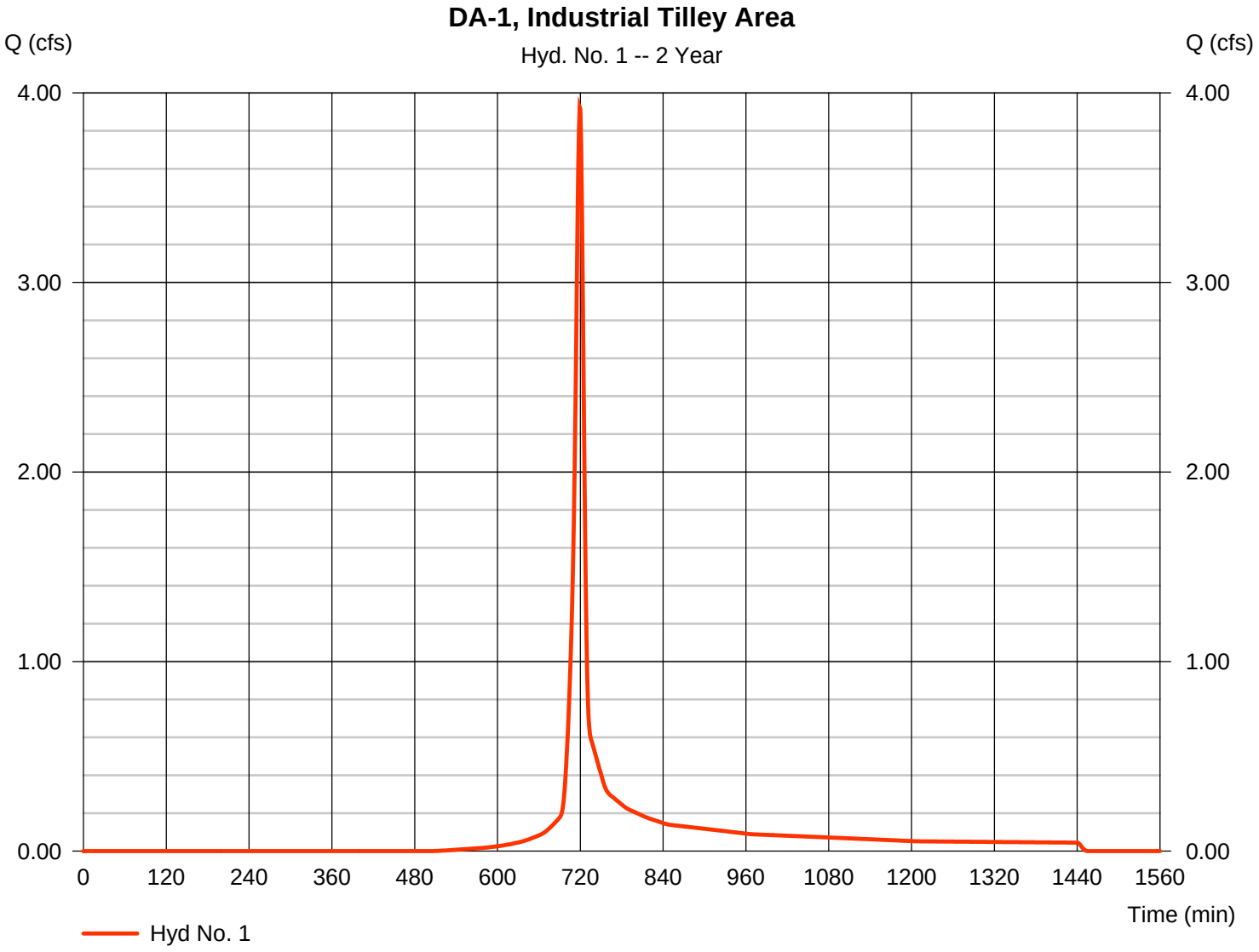
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 3.924 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 8,879 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

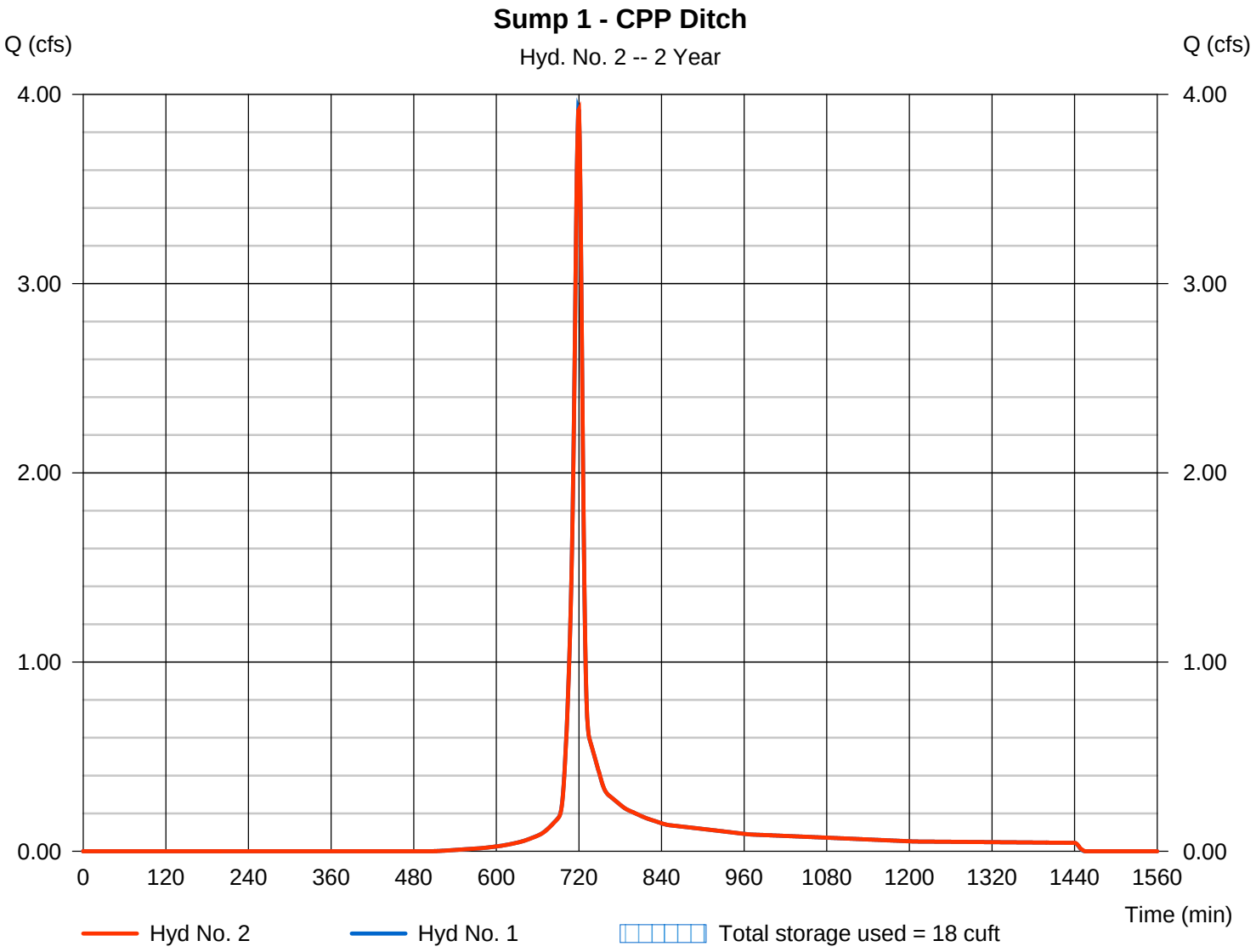
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.921 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 8,879 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 15.65 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 18 cuft |

Storage Indication method used.



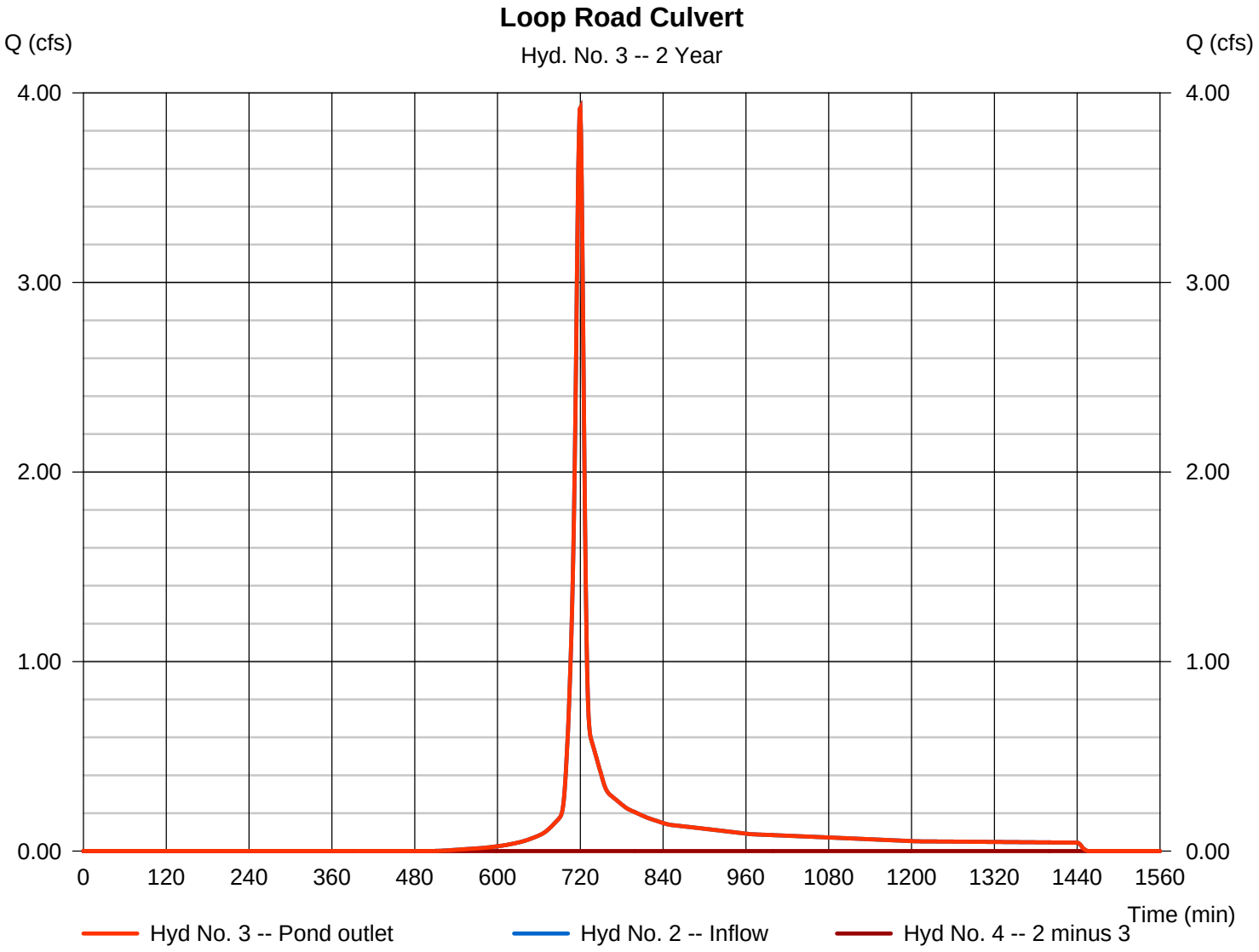
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 3.921 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 8,879 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



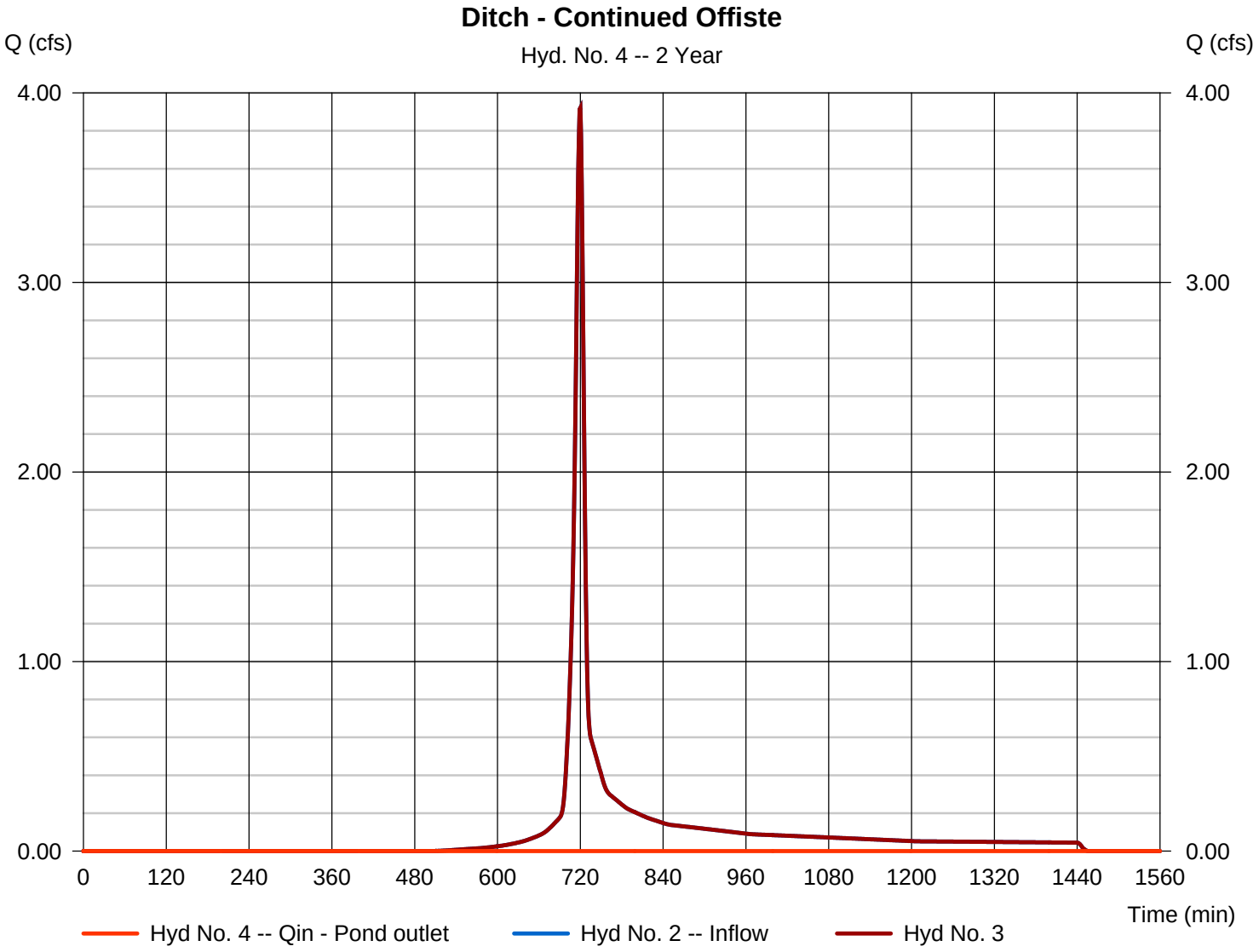
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 710 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

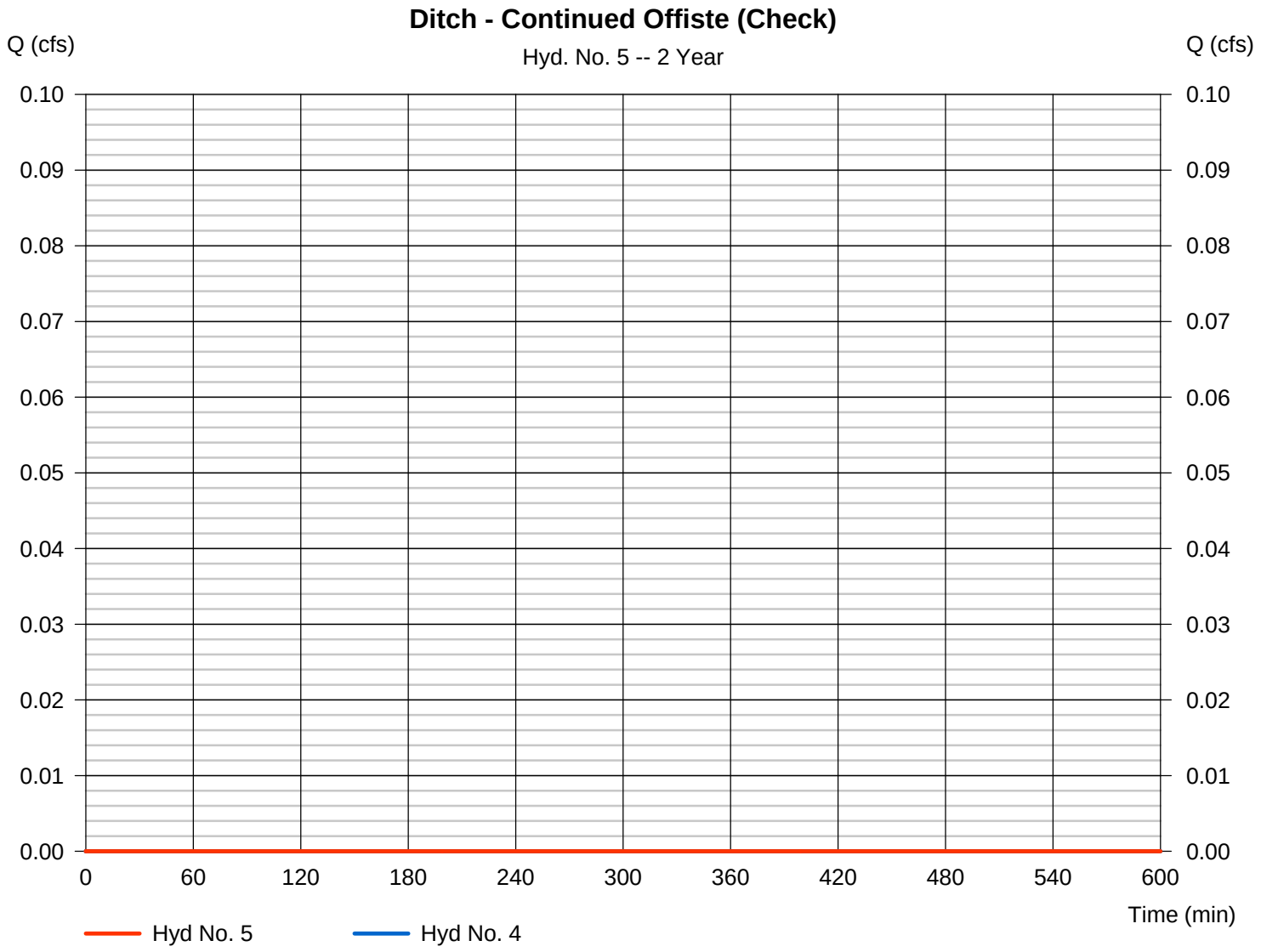
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | |
|---|---|---|---|
| Hydrograph type | = Reach | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 598 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hyd. No. | = 4 - Ditch - Continued Offiste | Section type | = Triangular |
| Reach length | = 500.0 ft | Channel slope | = 1.6 % |
| Manning's n | = 0.200 | Bottom width | = 0.0 ft |
| Side slope | = 1.0:1 | Max. depth | = 0.0 ft |
| Rating curve x | = 0.595 | Rating curve m | = 1.333 |
| Ave. velocity | = 0.00 ft/s | Routing coeff. | = 0.0004 |

Modified Att-Kin routing method used.



# Hydrograph Report

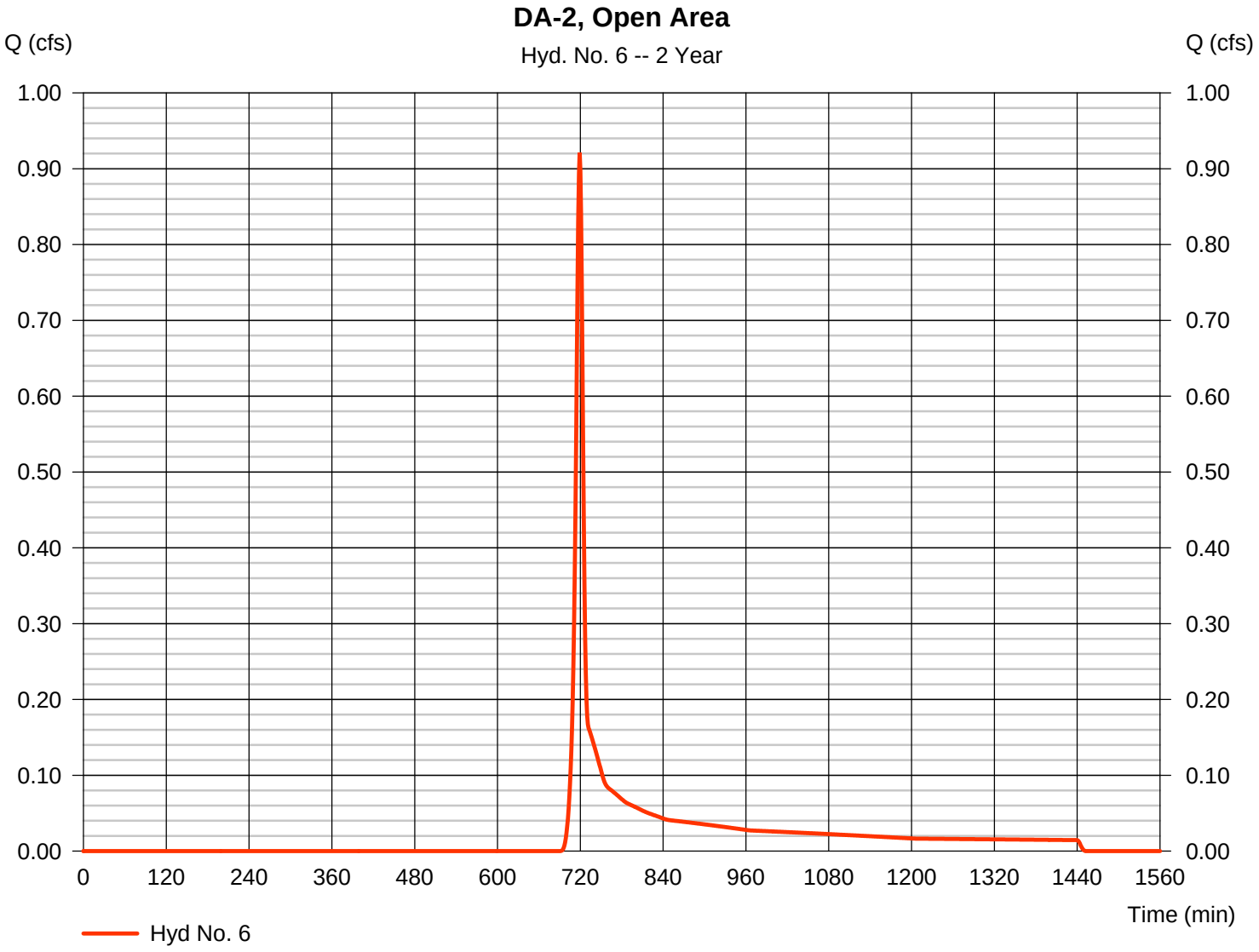


## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.921 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 2,042 cuft |
| Drainage area | = 0.740 ac | Curve number | = 69* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 6.70 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.140 x 98) + (0.020 x 98) + (0.580 x 61)] / 0.740



# Hydrograph Report

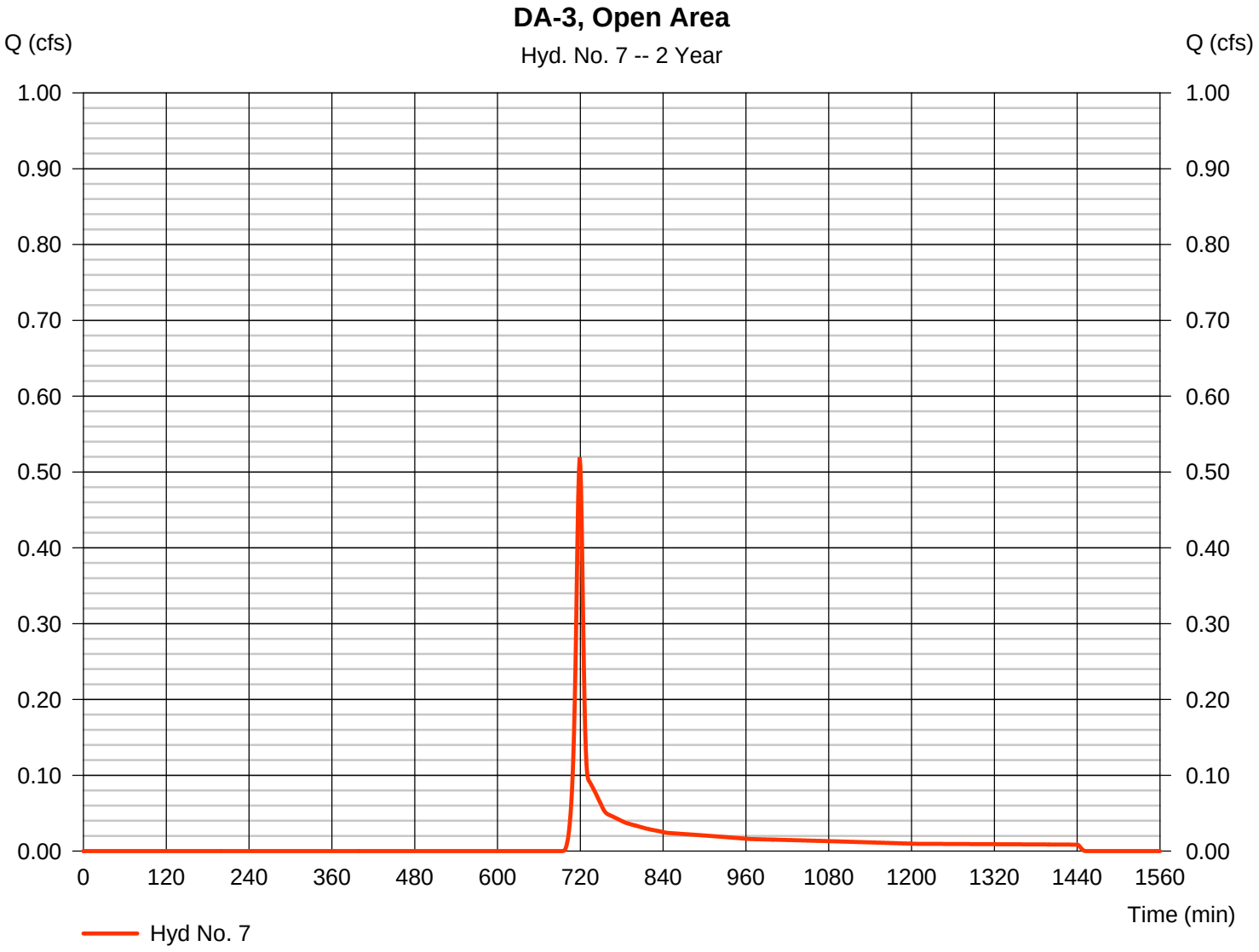
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.520 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 1,167 cuft |
| Drainage area | = 0.450 ac | Curve number | = 68* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 6.90 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.080 x 98) + (0.370 x 61)] / 0.450



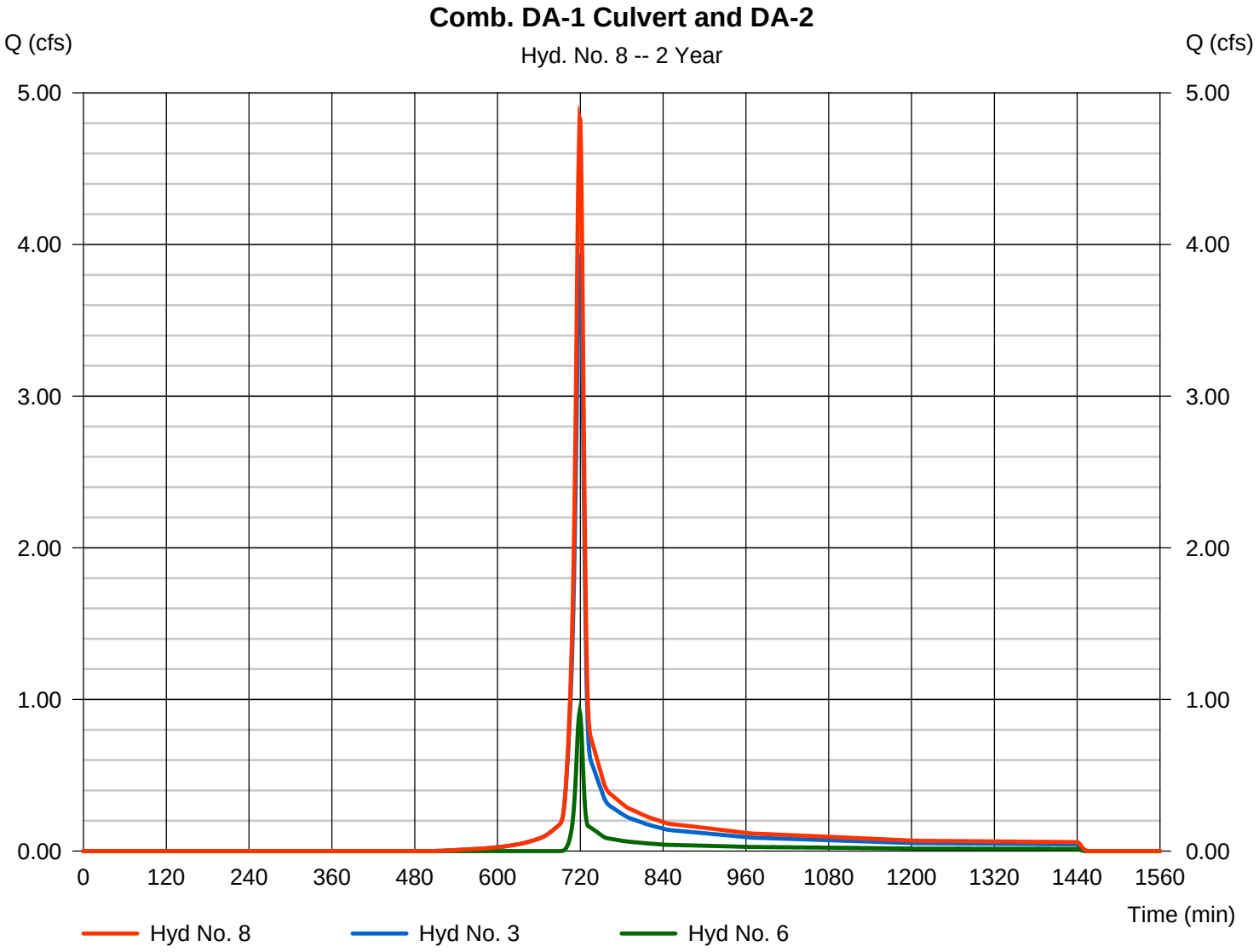
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 4.835 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 10,921 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.740 ac |



# Hydrograph Report

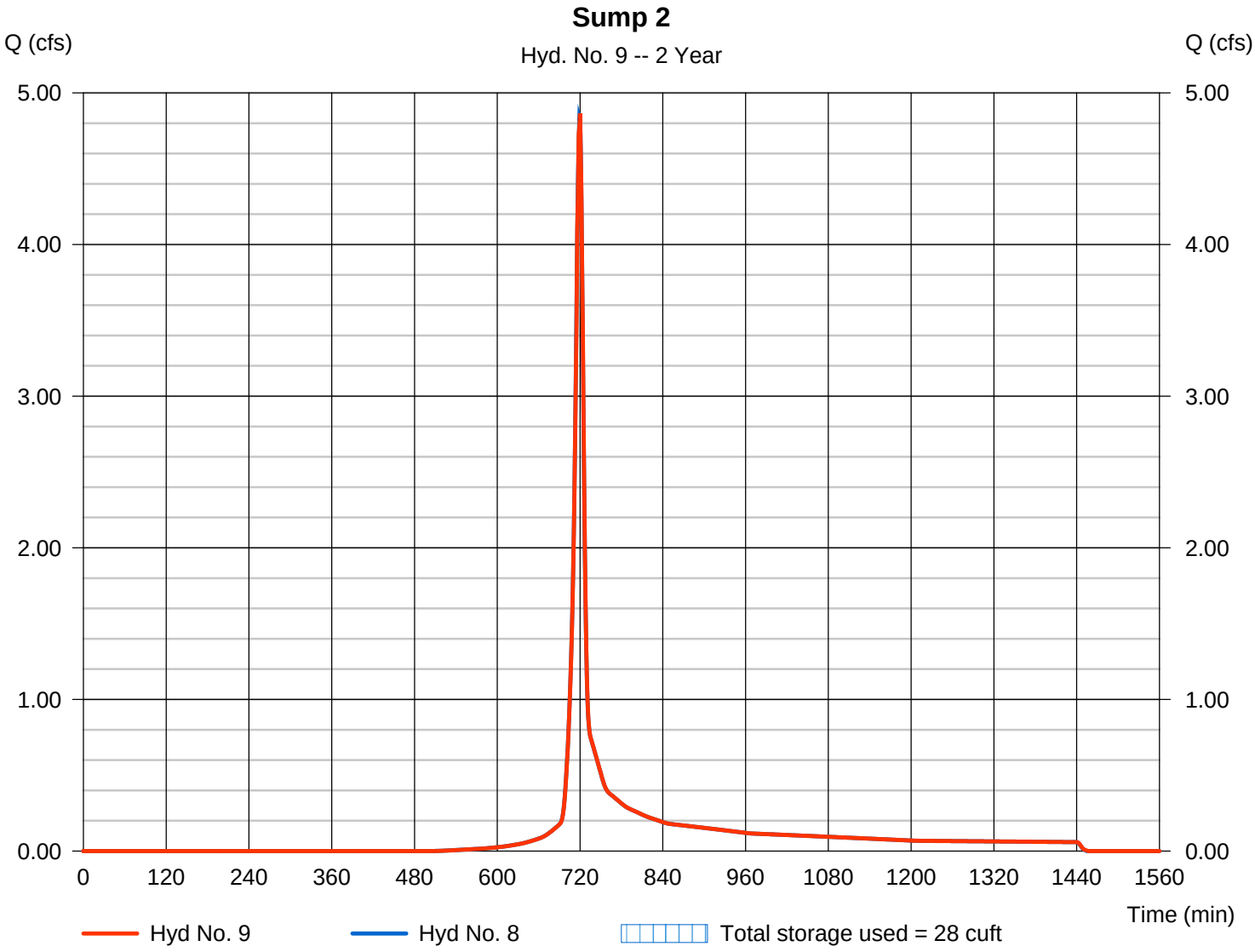
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 4.865 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 10,920 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 10.34 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 28 cuft |

Storage Indication method used.



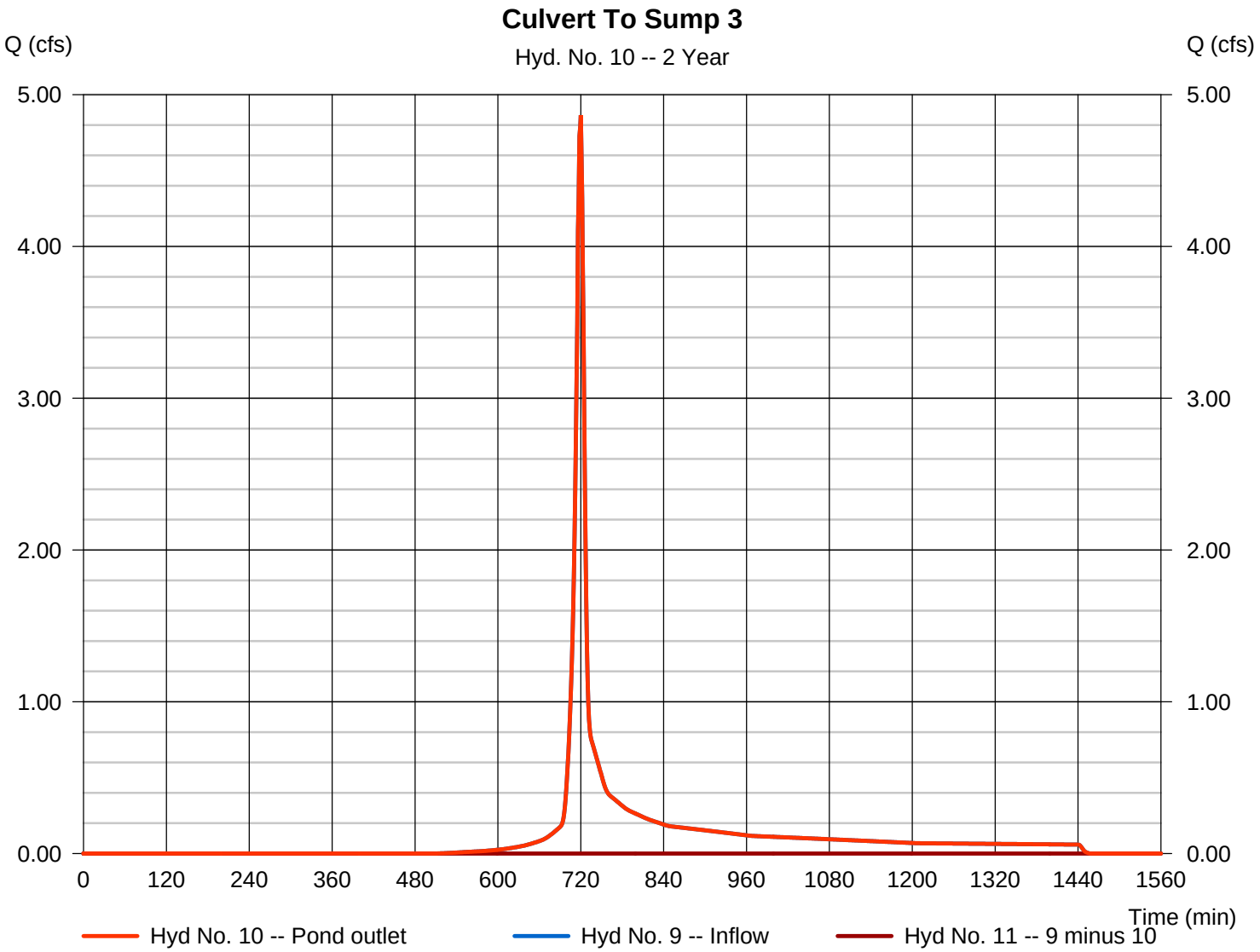
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 4.865 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 10,920 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



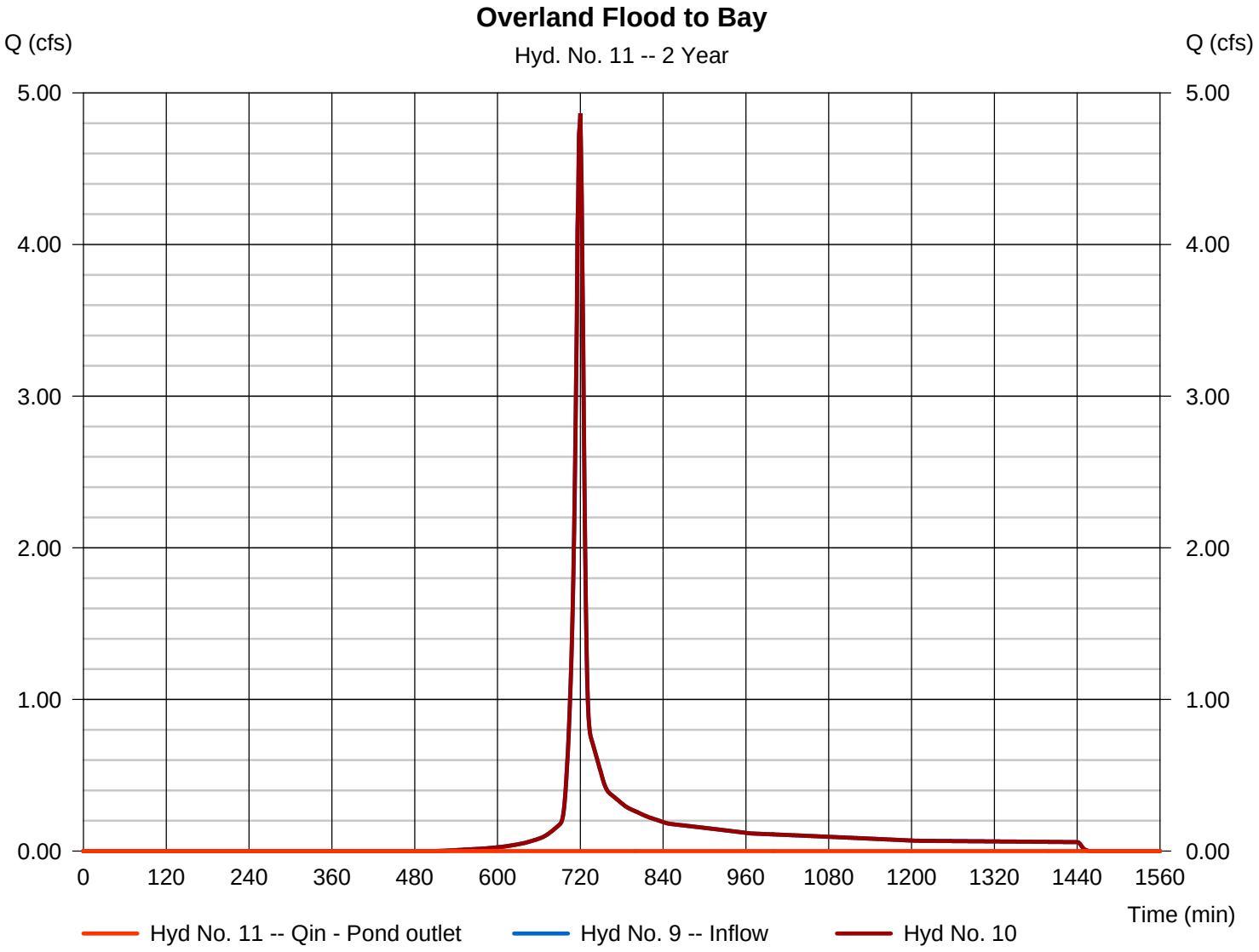
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



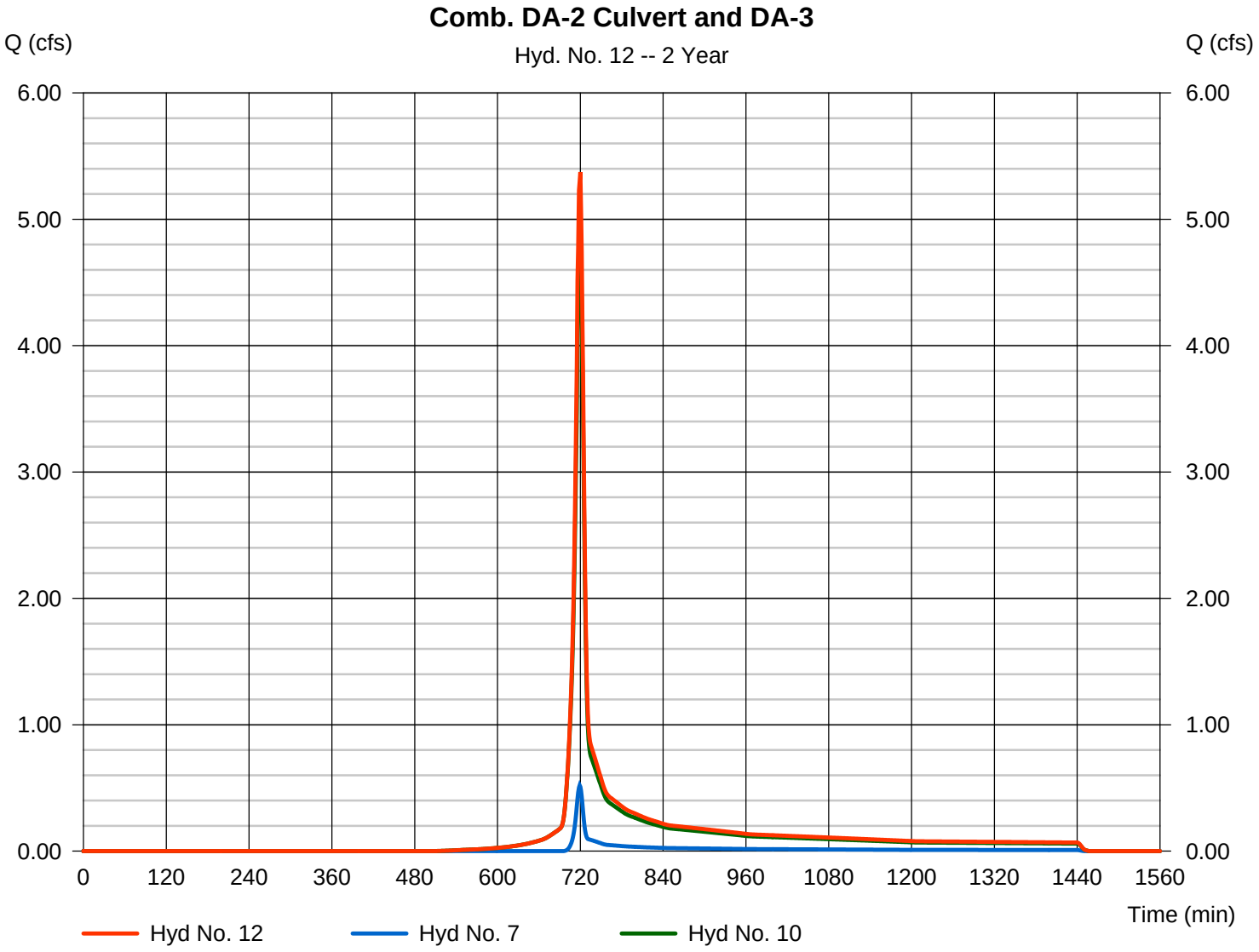
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 5.373 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 12,087 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 0.450 ac |



# Hydrograph Report

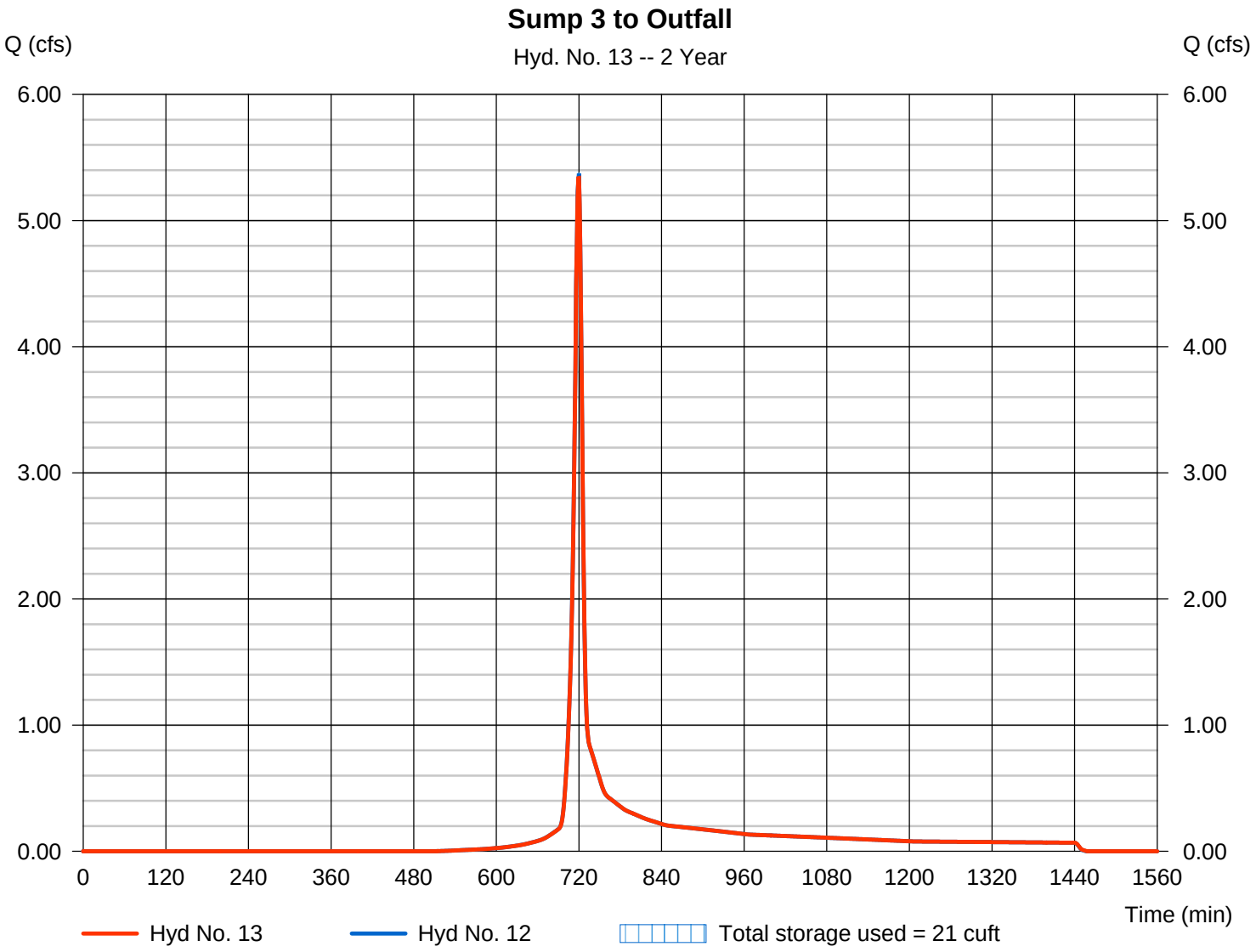
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 5.337 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 12,087 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 8.63 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 21 cuft |

Storage Indication method used.



# Hydrograph Report

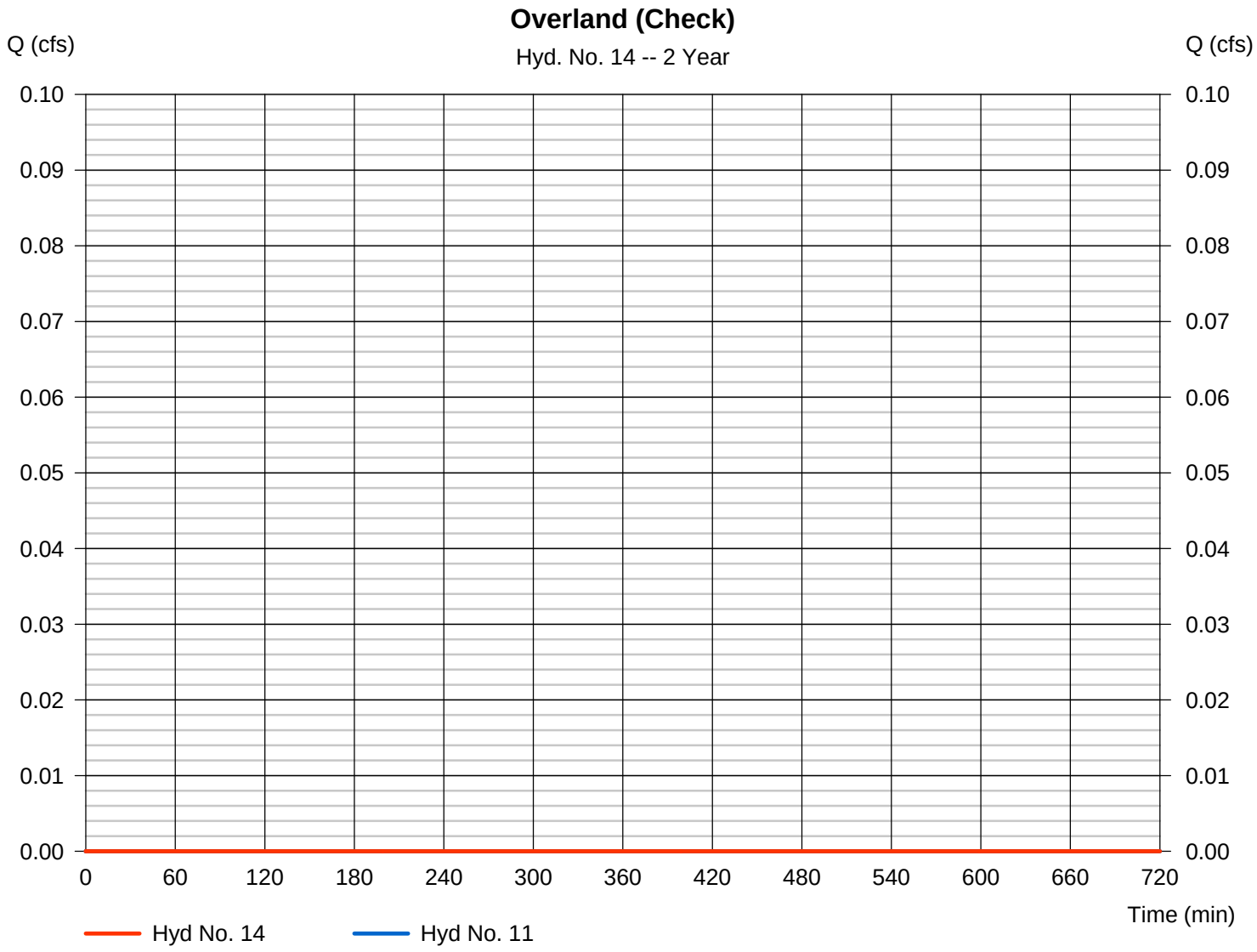
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 701 min |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.0005 |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 7.830 | 1 | 719 | 18,013 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 7.773 | 1 | 720 | 18,013 | 1 | 17.27 | 67.5 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 7.773 | 1 | 720 | 18,013 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 723 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | 707 | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 2.520 | 1 | 719 | 5,318 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 1.471 | 1 | 719 | 3,107 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 10.21 | 1 | 719 | 23,331 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 10.22 | 1 | 720 | 23,331 | 8 | 11.30 | 176 | Sump 2 |
| 10 | Diversion1 | 8.710 | 1 | 720 | 22,958 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 1.507 | 1 | 720 | 373 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 10.18 | 1 | 719 | 26,065 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 10.19 | 1 | 719 | 26,065 | 12 | 9.59 | 41.2 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | 694 | 0 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

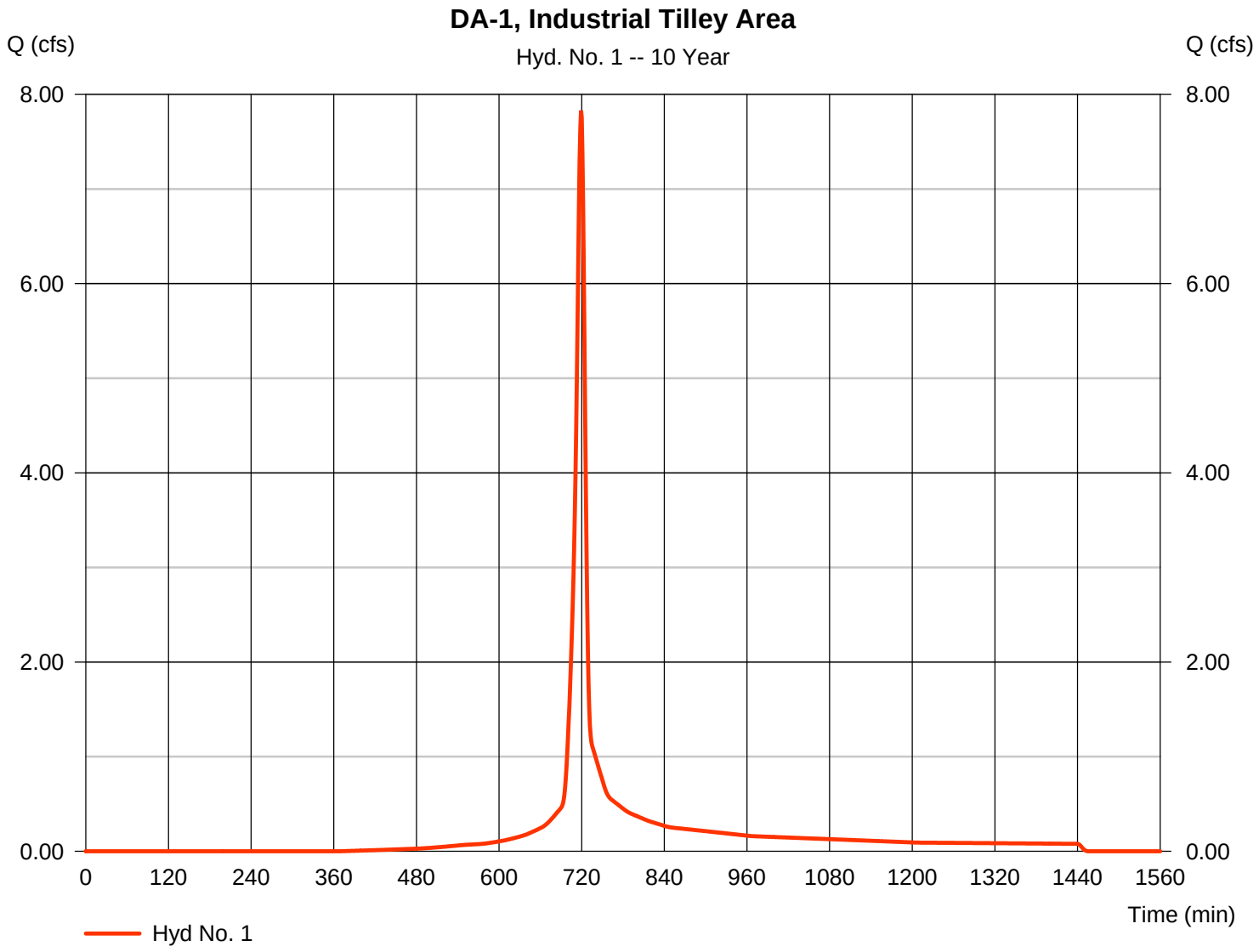
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 7.830 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 719 min |
| Time interval | = | 1 min | Hyd. volume | = | 18,013 cuft |
| Drainage area | = | 1.520 ac | Curve number | = | 83* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 9.40 min |
| Total precip. | = | 5.10 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

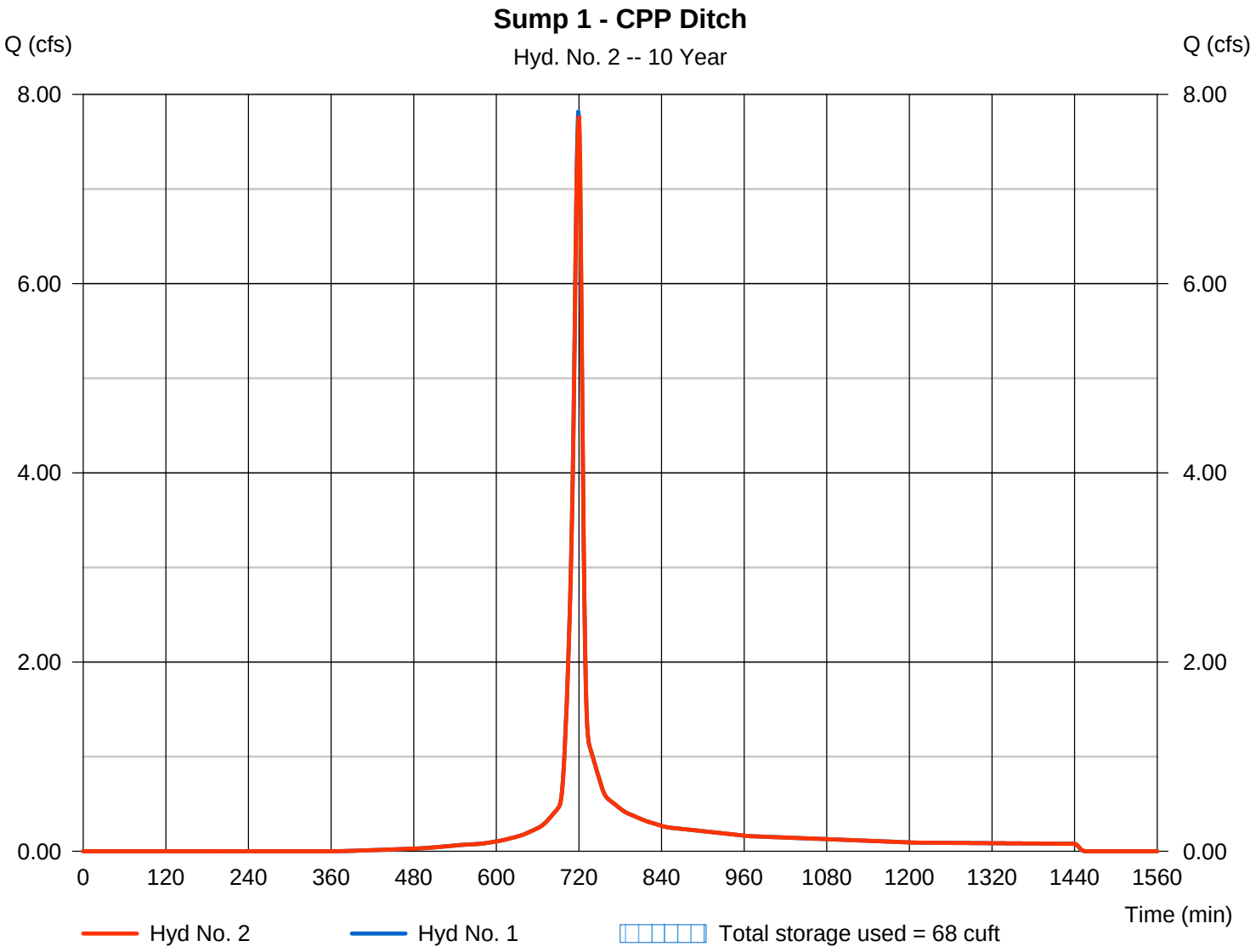
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 7.773 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 18,013 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 17.27 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 68 cuft |

Storage Indication method used.



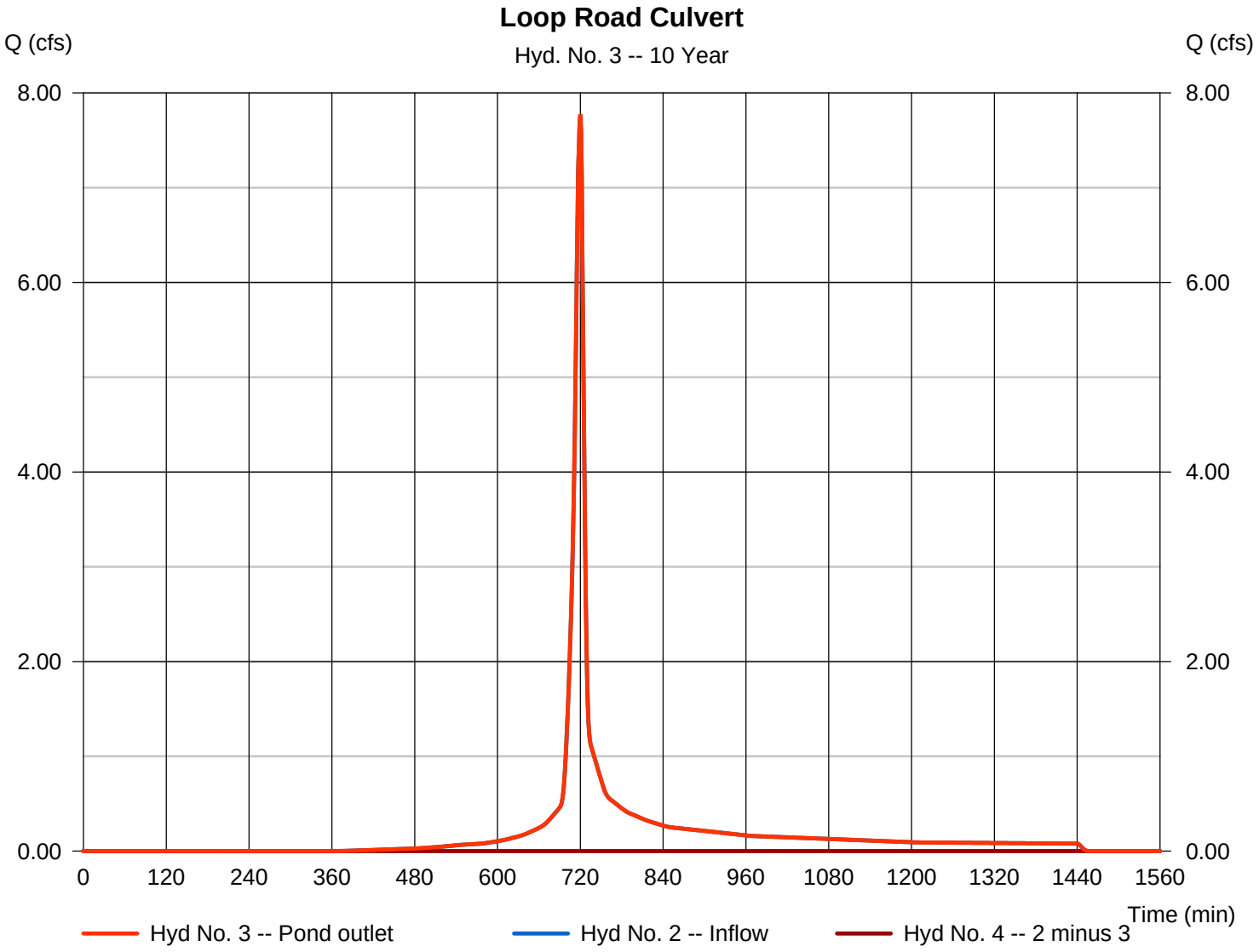
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 7.773 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 18,013 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



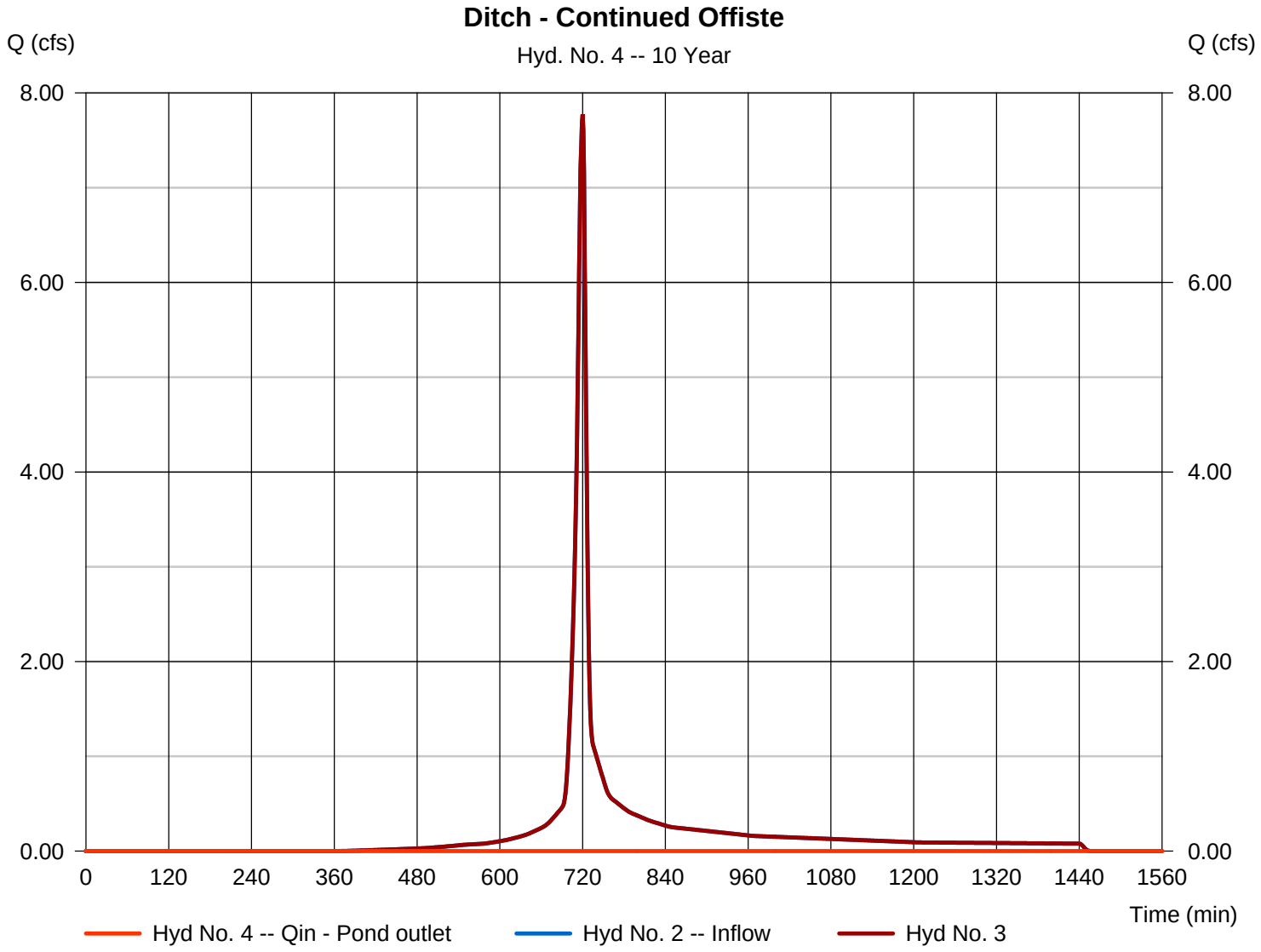
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 723 min |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

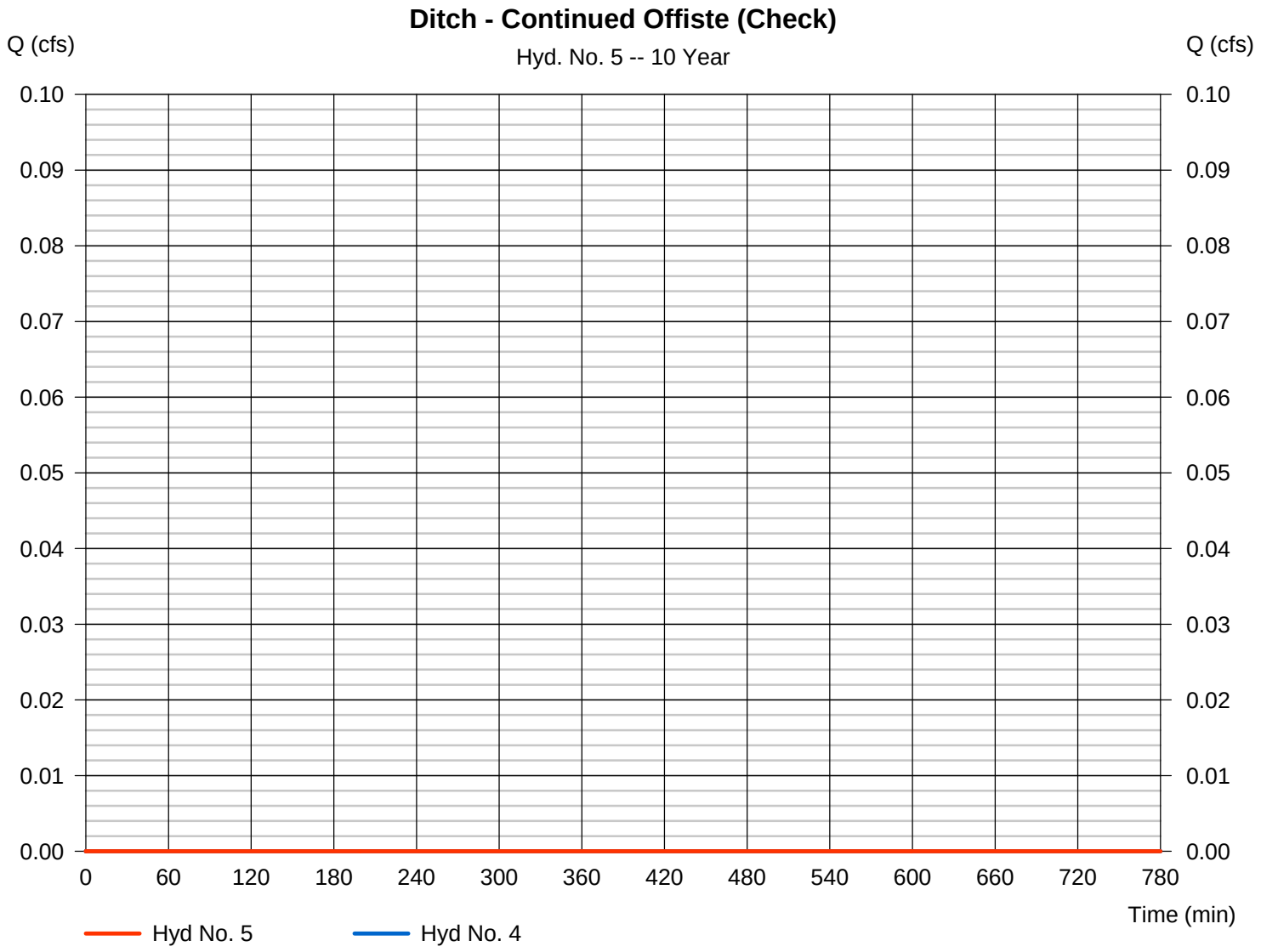
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 707 min |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 4 - Ditch - Continued Offiste | Section type | = | Triangular |
| Reach length | = | 500.0 ft | Channel slope | = | 1.6 % |
| Manning's n | = | 0.200 | Bottom width | = | 0.0 ft |
| Side slope | = | 1.0:1 | Max. depth | = | 0.0 ft |
| Rating curve x | = | 0.595 | Rating curve m | = | 1.333 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.0003 |

Modified Att-Kin routing method used.



# Hydrograph Report

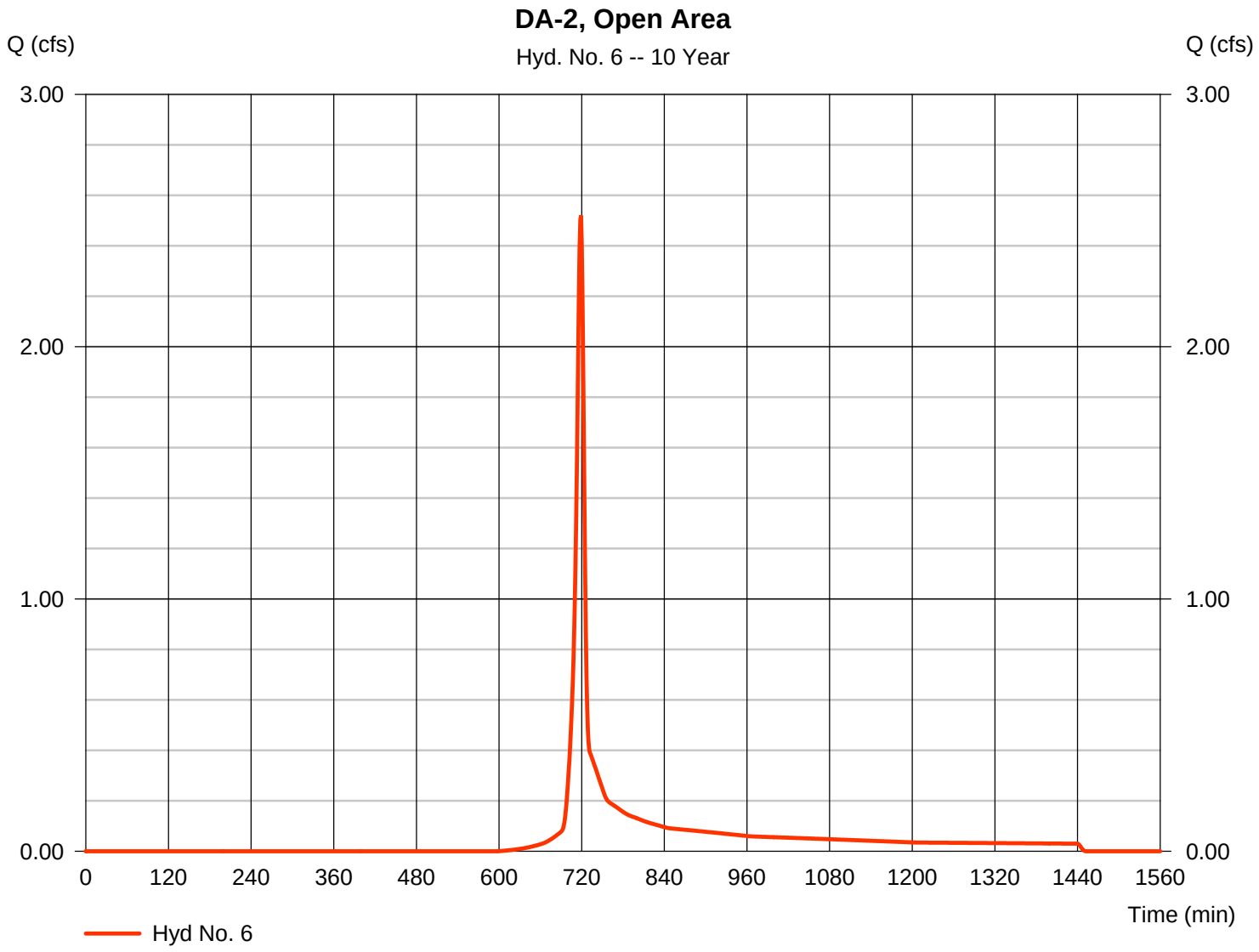
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 2.520 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 719 min |
| Time interval | = | 1 min | Hyd. volume | = | 5,318 cuft |
| Drainage area | = | 0.740 ac | Curve number | = | 69* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 6.70 min |
| Total precip. | = | 5.10 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.140 x 98) + (0.020 x 98) + (0.580 x 61)] / 0.740



# Hydrograph Report

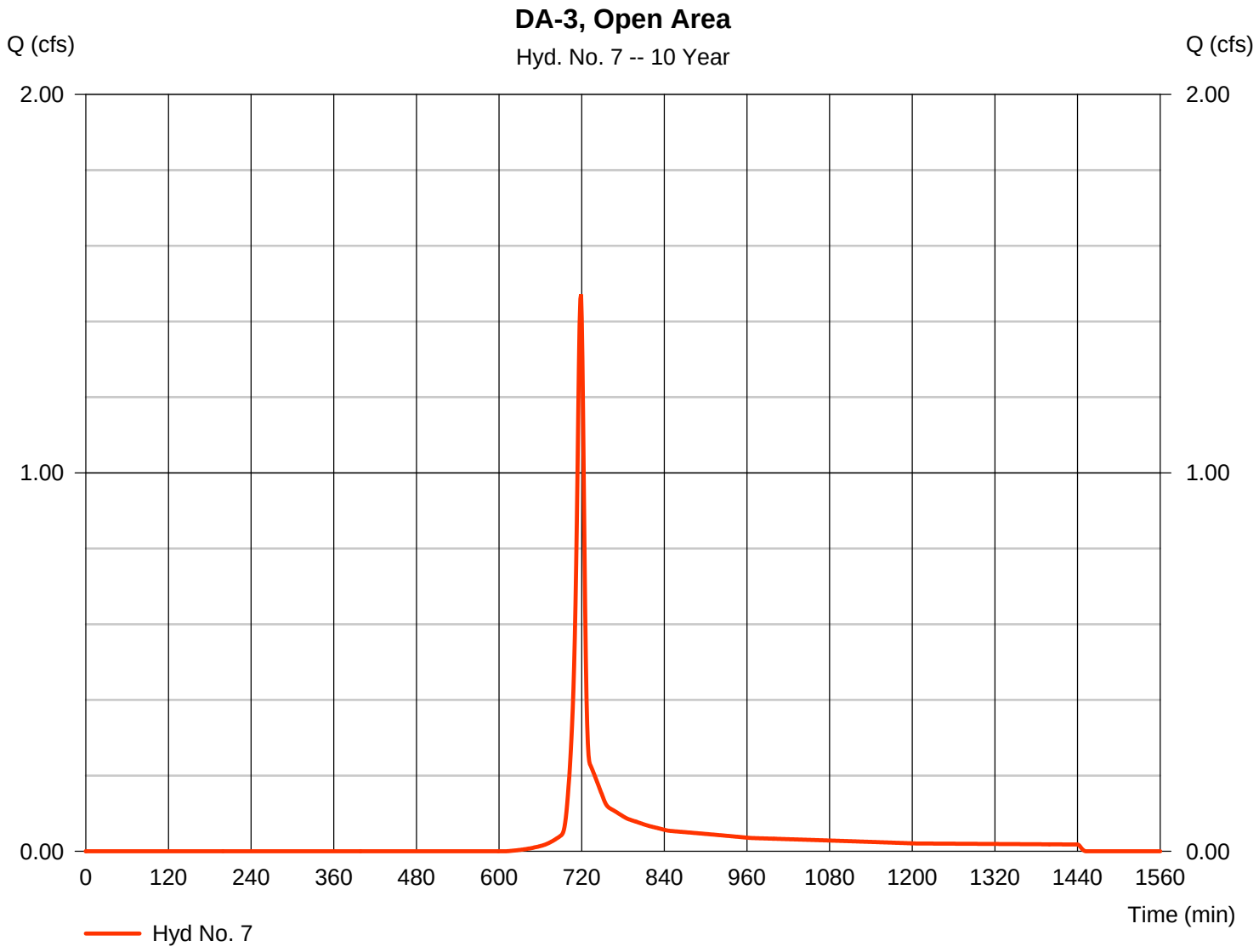
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.471 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 719 min |
| Time interval | = | 1 min | Hyd. volume | = | 3,107 cuft |
| Drainage area | = | 0.450 ac | Curve number | = | 68* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 6.90 min |
| Total precip. | = | 5.10 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.080 x 98) + (0.370 x 61)] / 0.450



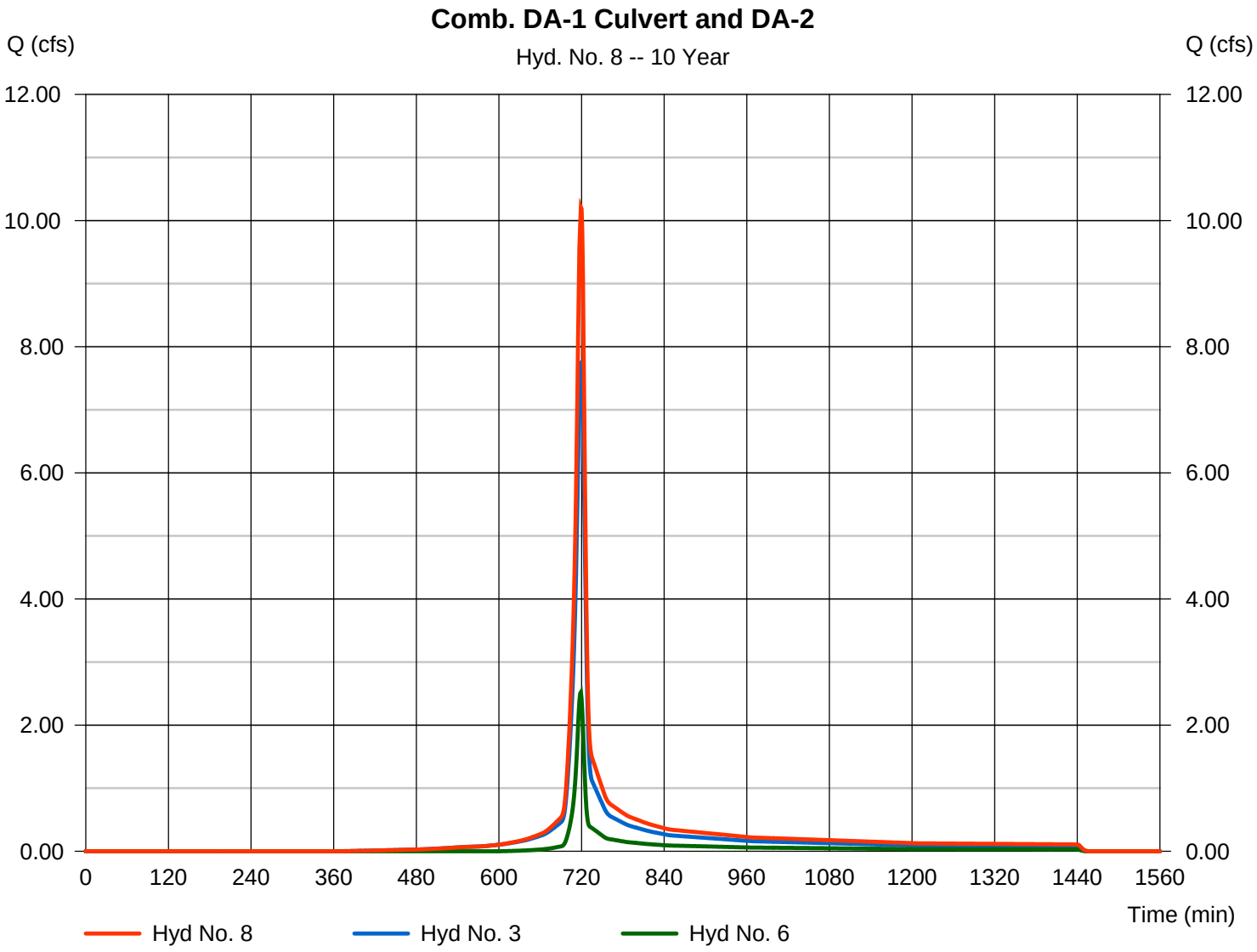
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 10.21 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 23,331 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.740 ac |



# Hydrograph Report

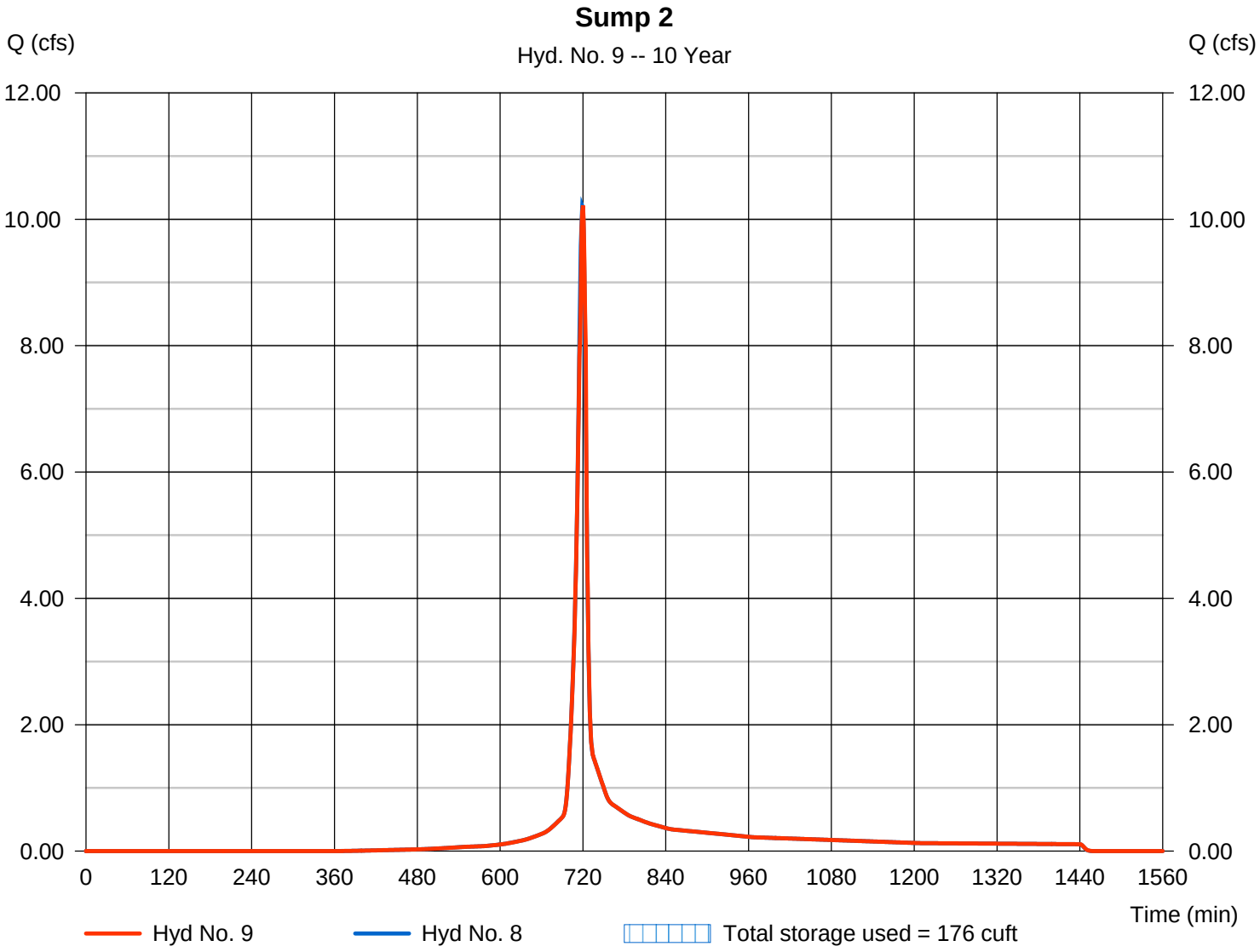
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 10.22 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 23,331 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 11.30 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 176 cuft |

Storage Indication method used.



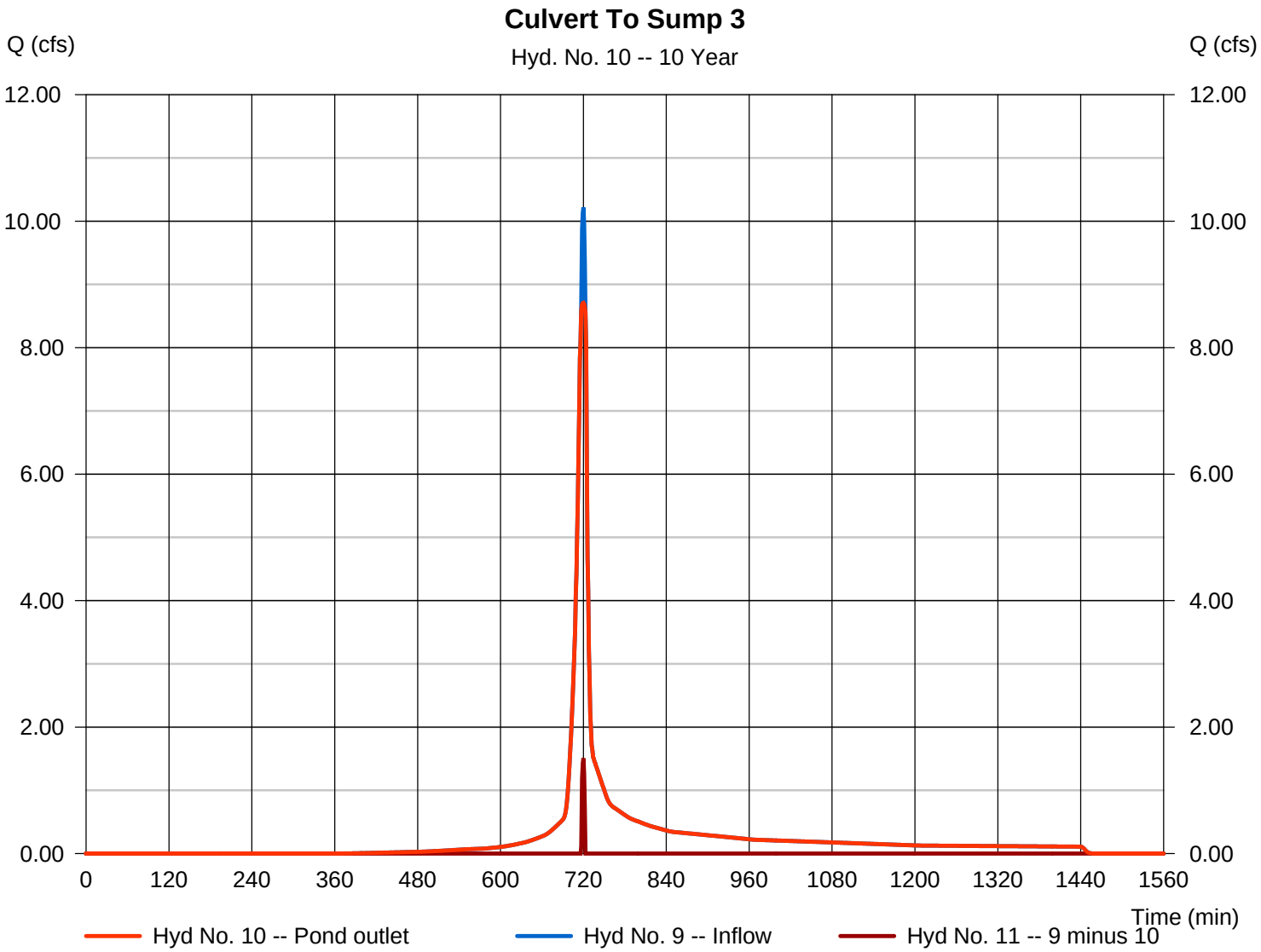
# Hydrograph Report



## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 8.710 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 22,958 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



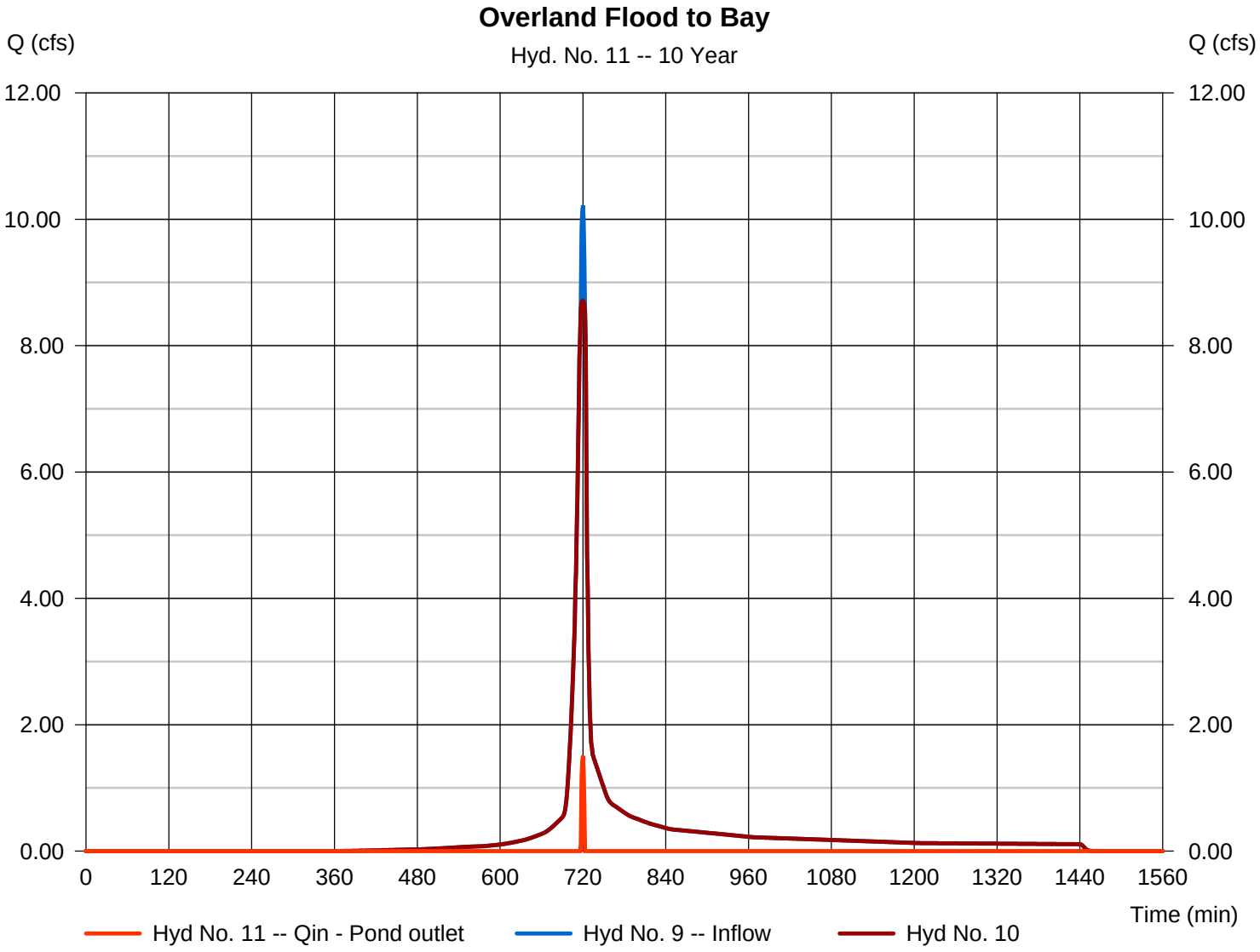
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 1.507 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 373 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



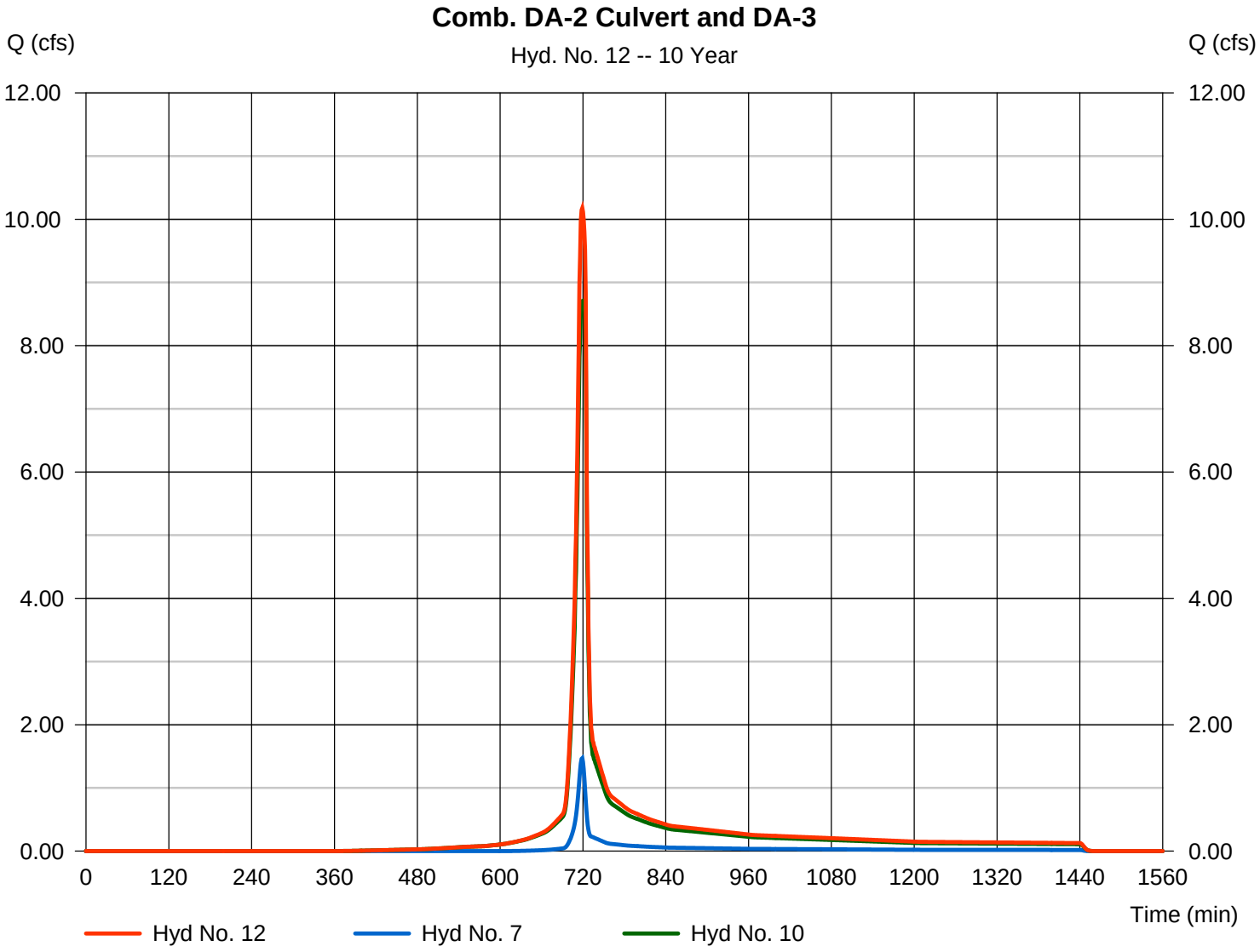
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 10.18 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 26,065 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 0.450 ac |



# Hydrograph Report

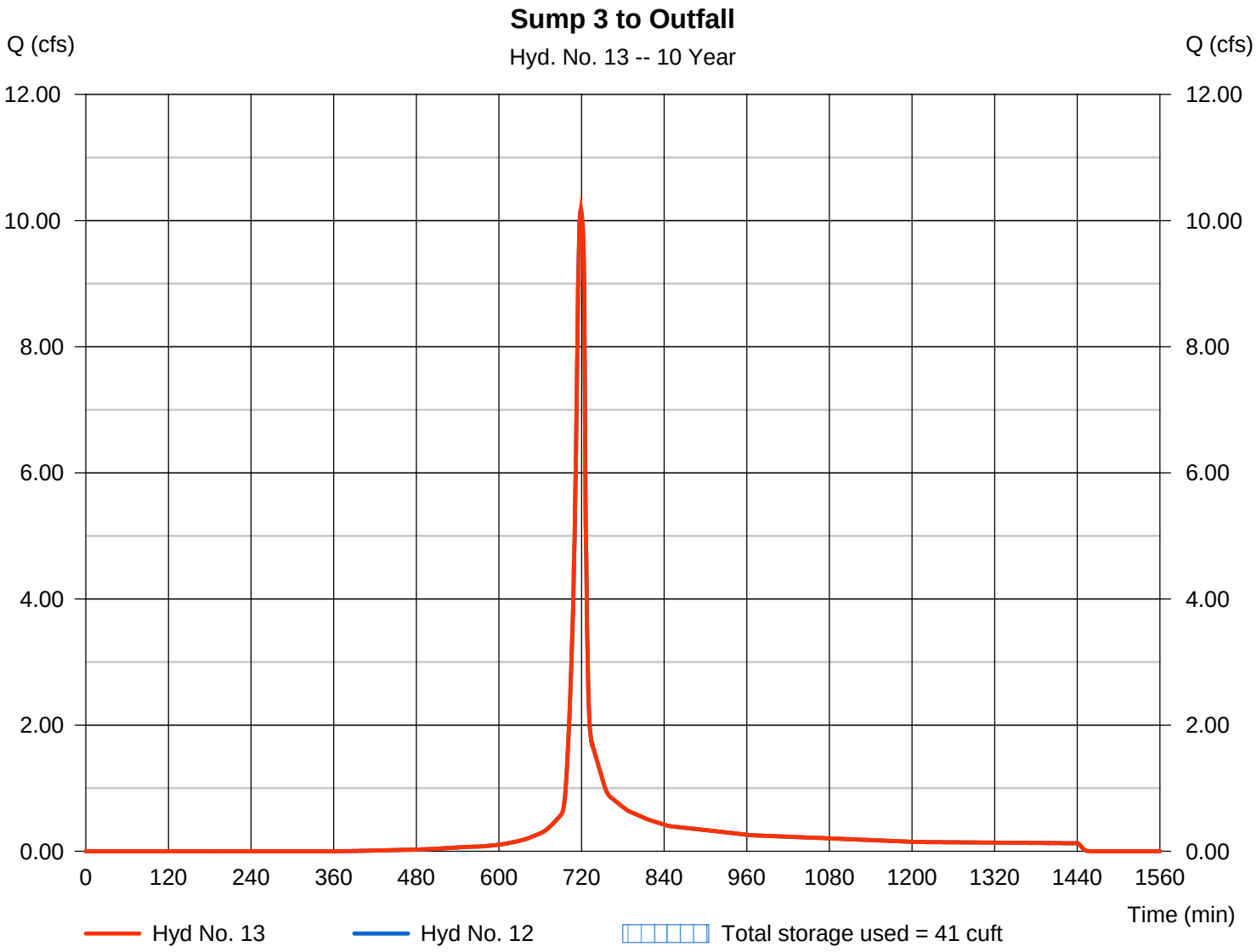
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 10.19 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 719 min |
| Time interval | = | 1 min | Hyd. volume | = | 26,065 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.59 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 41 cuft |

Storage Indication method used.



# Hydrograph Report

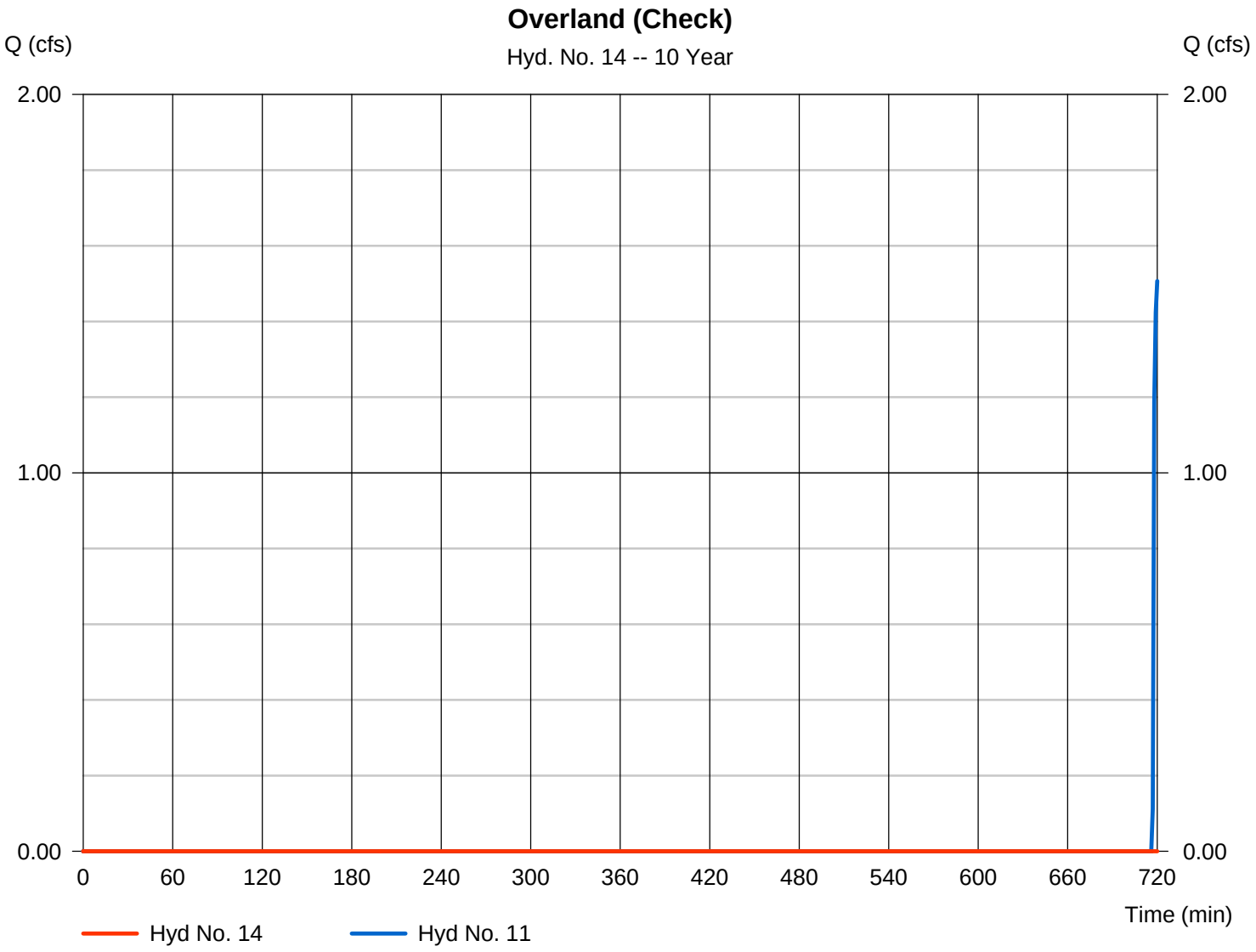
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 694 min |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.0004 |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 12.03 | 1 | 719 | 28,262 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 11.94 | 1 | 720 | 28,262 | 1 | 17.95 | 274 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 8.999 | 1 | 720 | 27,161 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 2.941 | 1 | 720 | 1,101 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.827 | 1 | 723 | 677 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 4.448 | 1 | 718 | 9,418 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 2.628 | 1 | 718 | 5,560 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 13.43 | 1 | 719 | 36,580 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 13.43 | 1 | 719 | 36,580 | 8 | 11.36 | 220 | Sump 2 |
| 10 | Diversion1 | 8.867 | 1 | 719 | 34,025 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 4.561 | 1 | 719 | 2,555 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 11.49 | 1 | 719 | 39,585 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 11.51 | 1 | 718 | 39,585 | 12 | 9.75 | 44.3 | Sump 3 to Outfall |
| 14 | Reach | 0.948 | 1 | 723 | 640 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

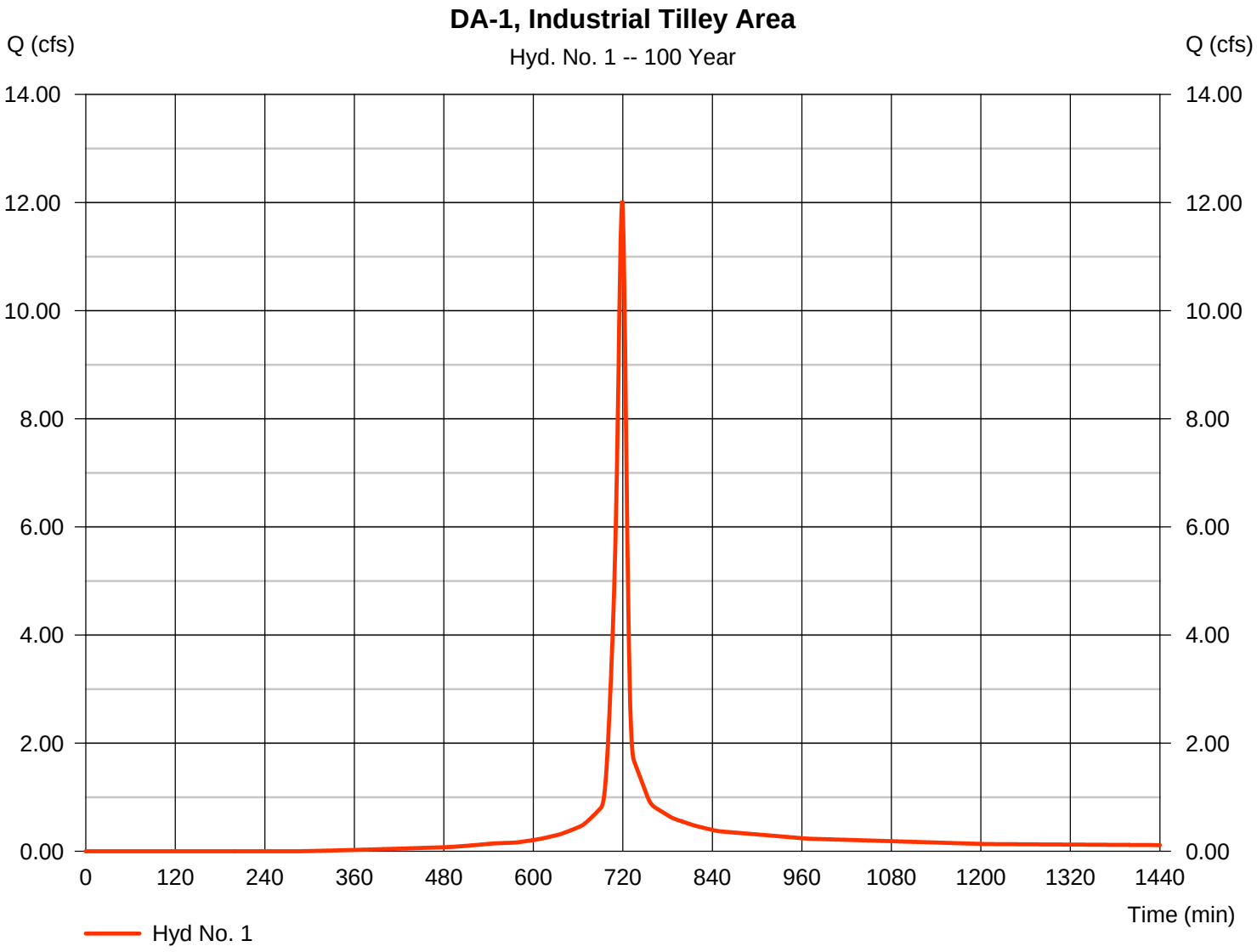
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 12.03 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 28,262 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 7.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

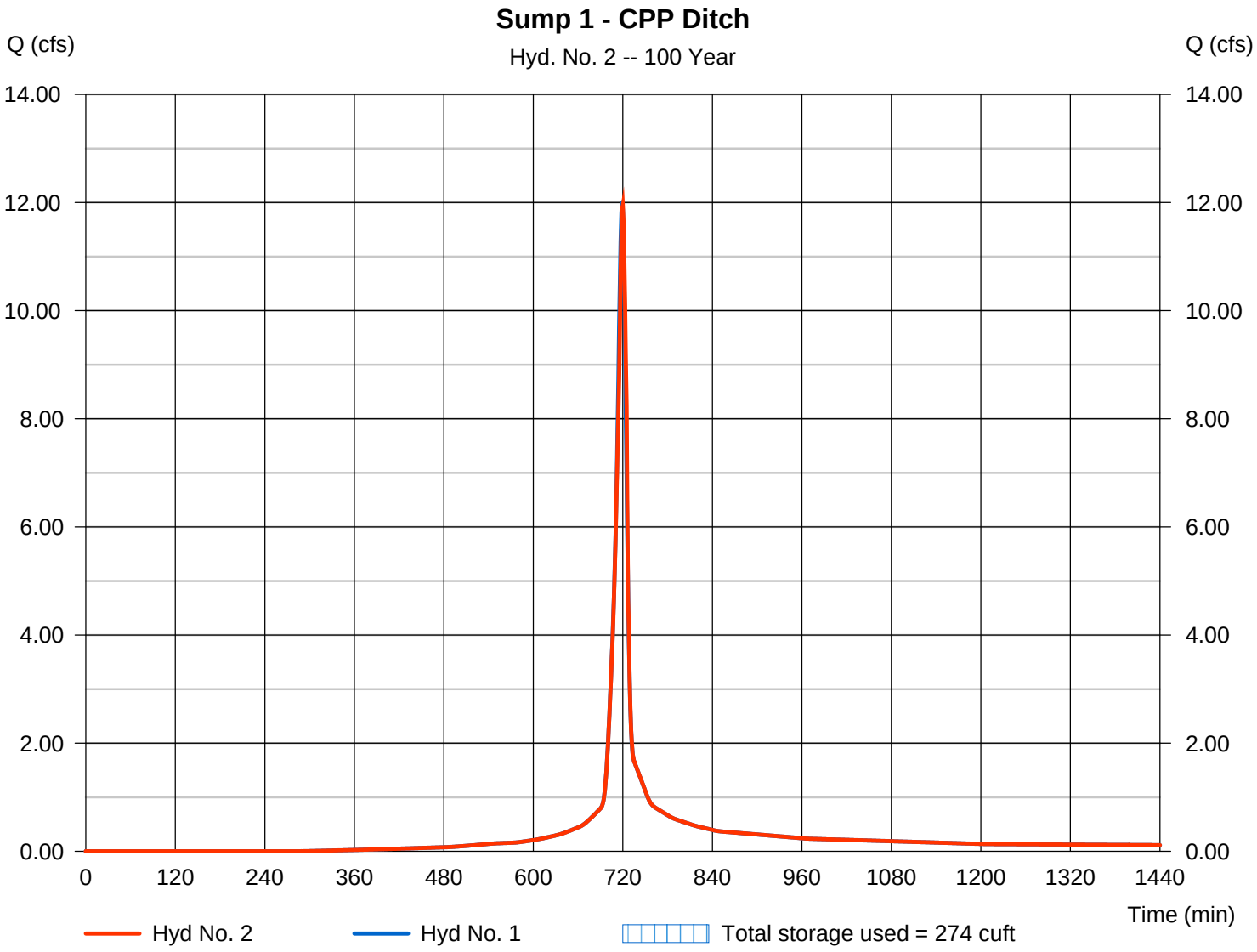
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 11.94 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 720 min |
| Time interval | = | 1 min | Hyd. volume | = | 28,262 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 17.95 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 274 cuft |

Storage Indication method used.



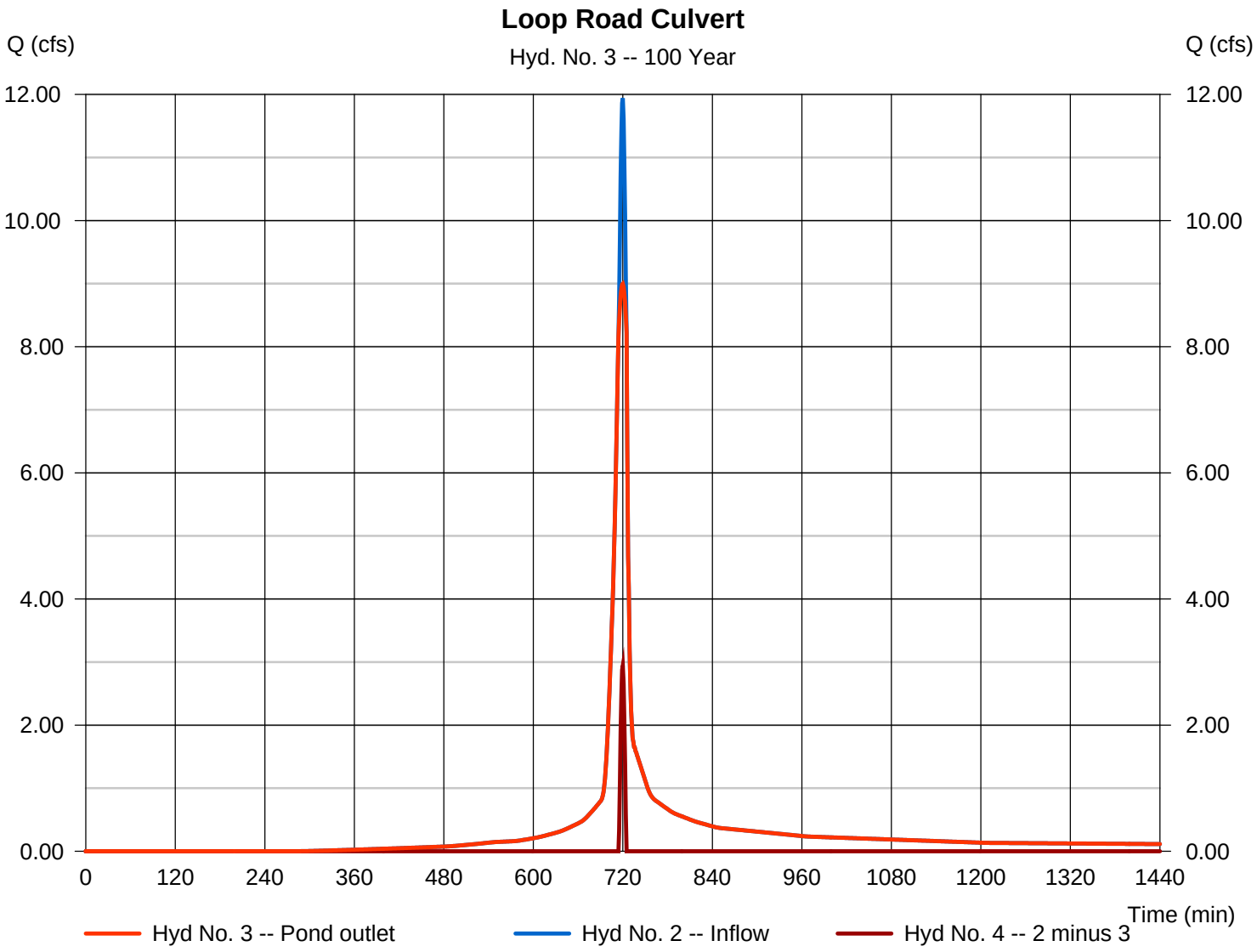
# Hydrograph Report



## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 8.999 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 27,161 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



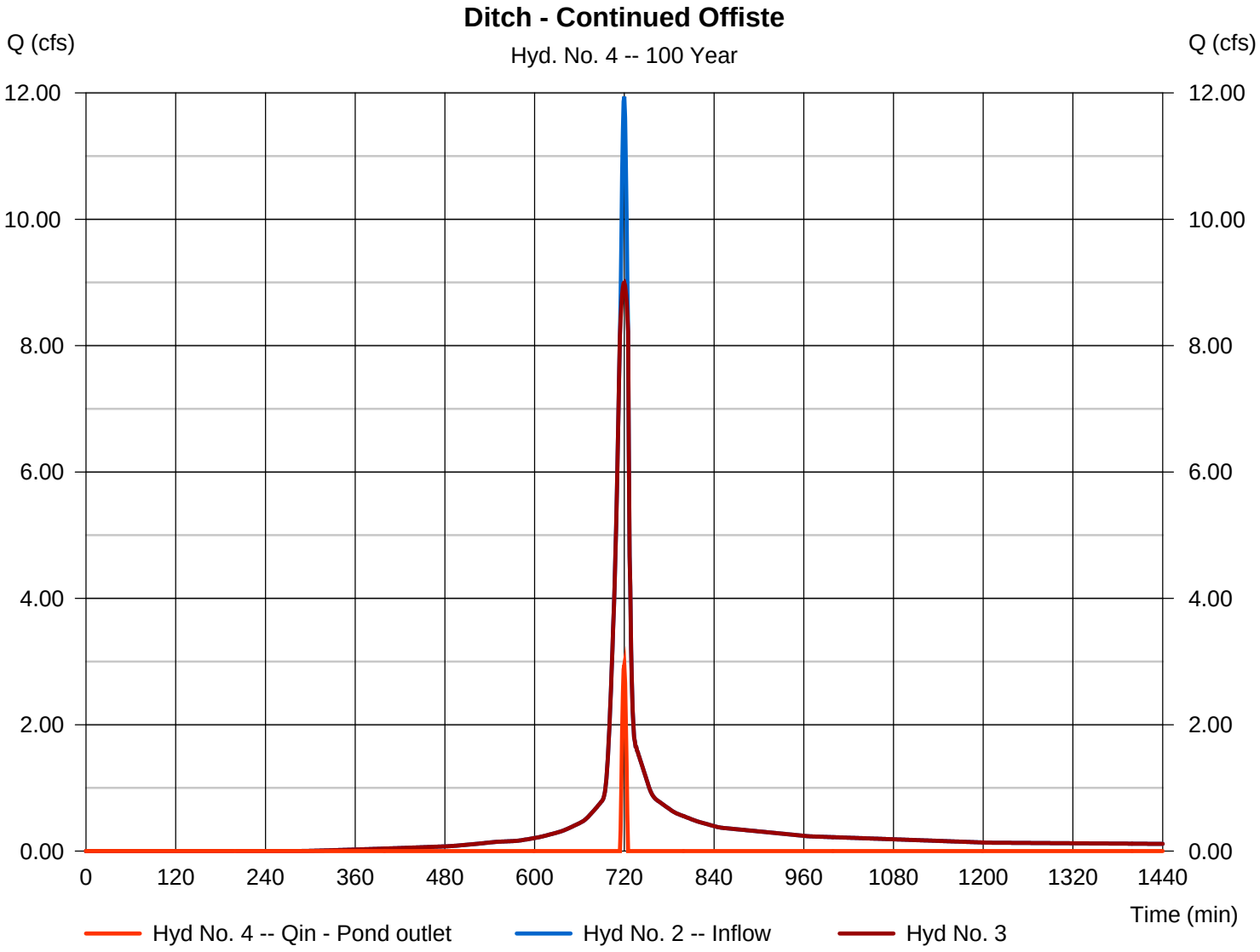
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 2.941 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 720 min |
| Time interval | = 1 min | Hyd. volume | = 1,101 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

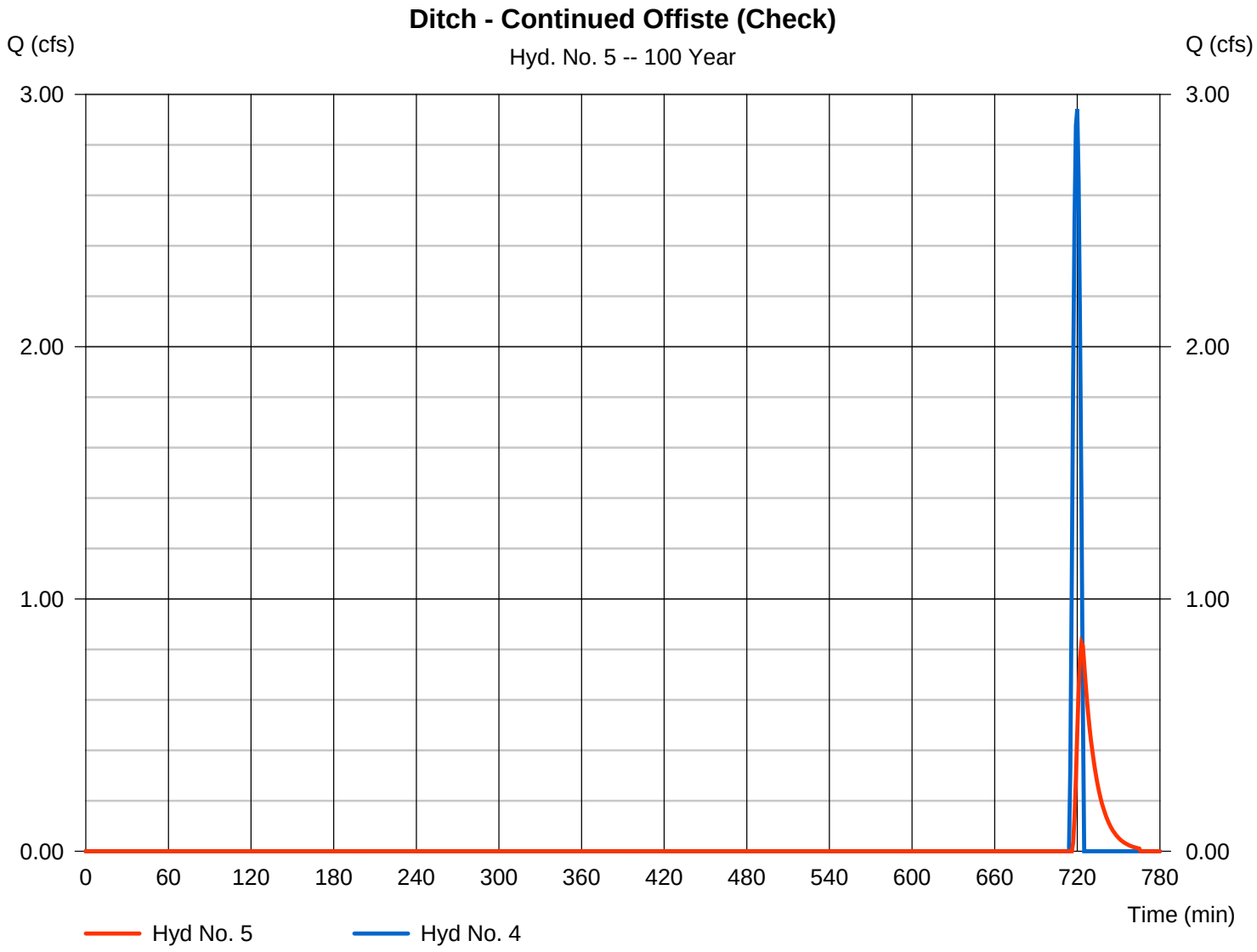
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.827 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 723 min |
| Time interval | = | 1 min | Hyd. volume | = | 677 cuft |
| Inflow hyd. No. | = | 4 - Ditch - Continued Offiste | Section type | = | Triangular |
| Reach length | = | 500.0 ft | Channel slope | = | 1.6 % |
| Manning's n | = | 0.200 | Bottom width | = | 0.0 ft |
| Side slope | = | 1.0:1 | Max. depth | = | 0.0 ft |
| Rating curve x | = | 0.595 | Rating curve m | = | 1.333 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.1003 |

Modified Att-Kin routing method used.



# Hydrograph Report

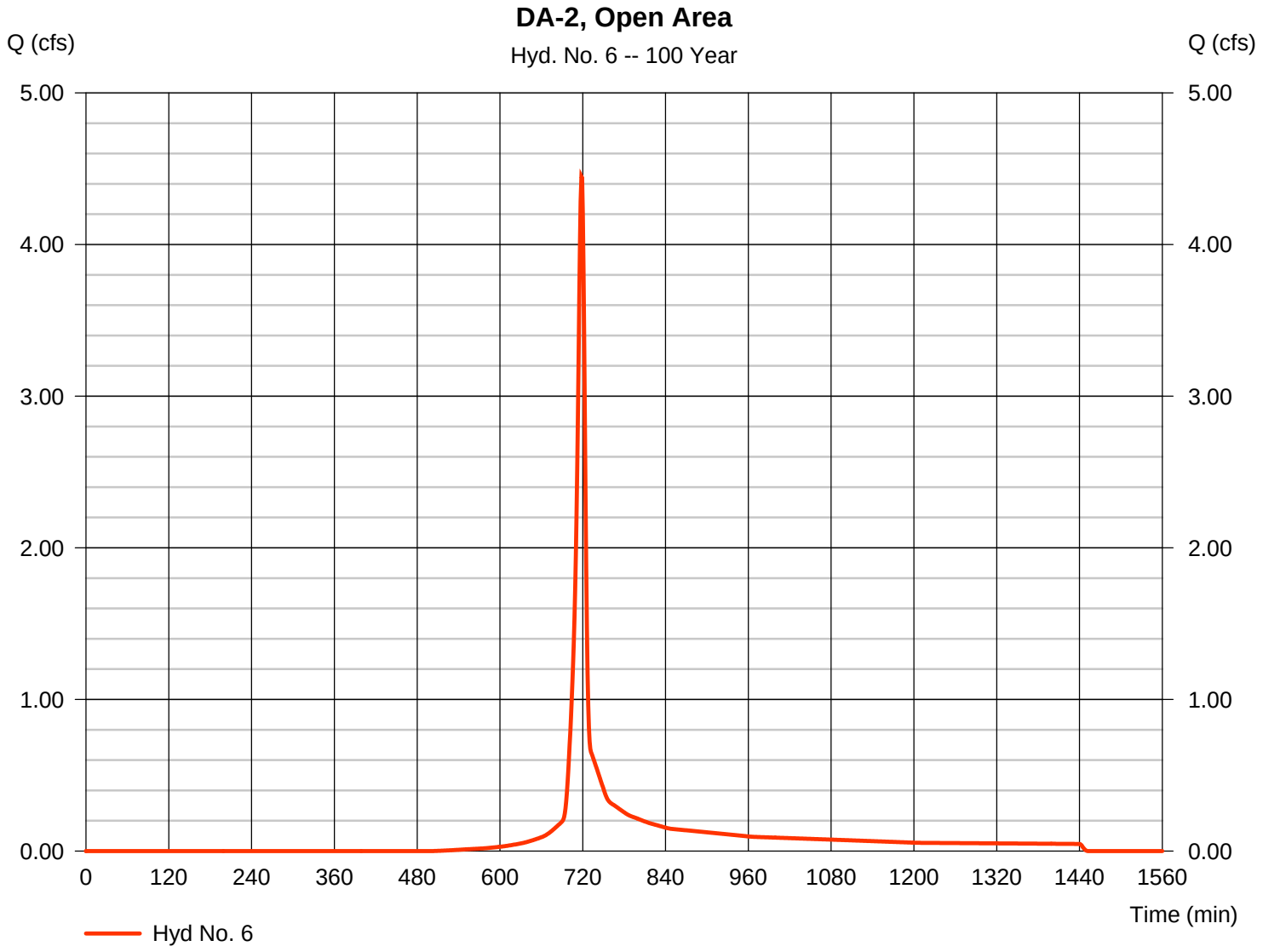
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 4.448 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 718 min |
| Time interval | = 1 min | Hyd. volume | = 9,418 cuft |
| Drainage area | = 0.740 ac | Curve number | = 69* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 6.70 min |
| Total precip. | = 7.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.140 x 98) + (0.020 x 98) + (0.580 x 61)] / 0.740



# Hydrograph Report

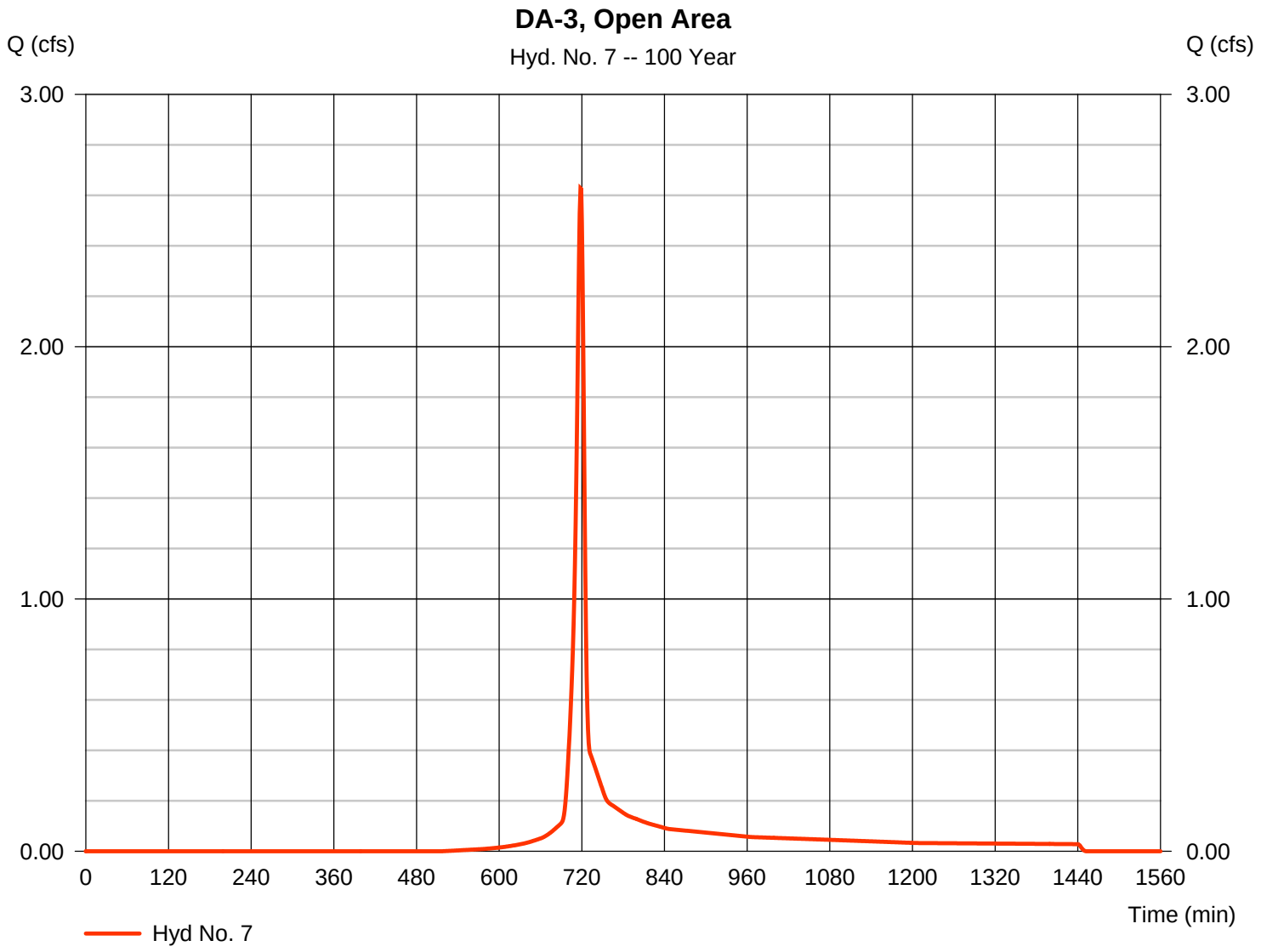
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 2.628 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 718 min |
| Time interval | = | 1 min | Hyd. volume | = | 5,560 cuft |
| Drainage area | = | 0.450 ac | Curve number | = | 68* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 6.90 min |
| Total precip. | = | 7.10 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.080 x 98) + (0.370 x 61)] / 0.450



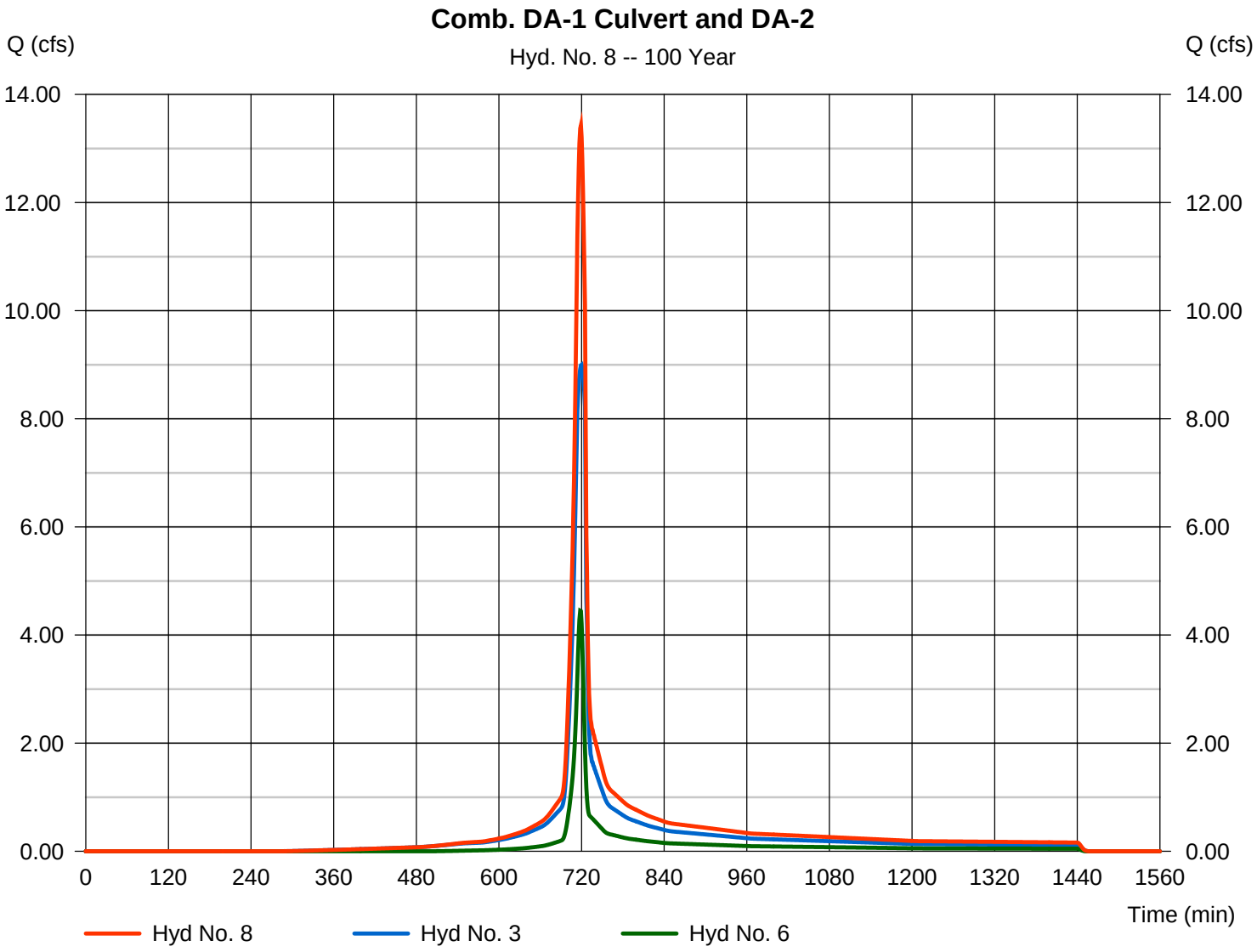
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 13.43 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 36,580 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.740 ac |



# Hydrograph Report

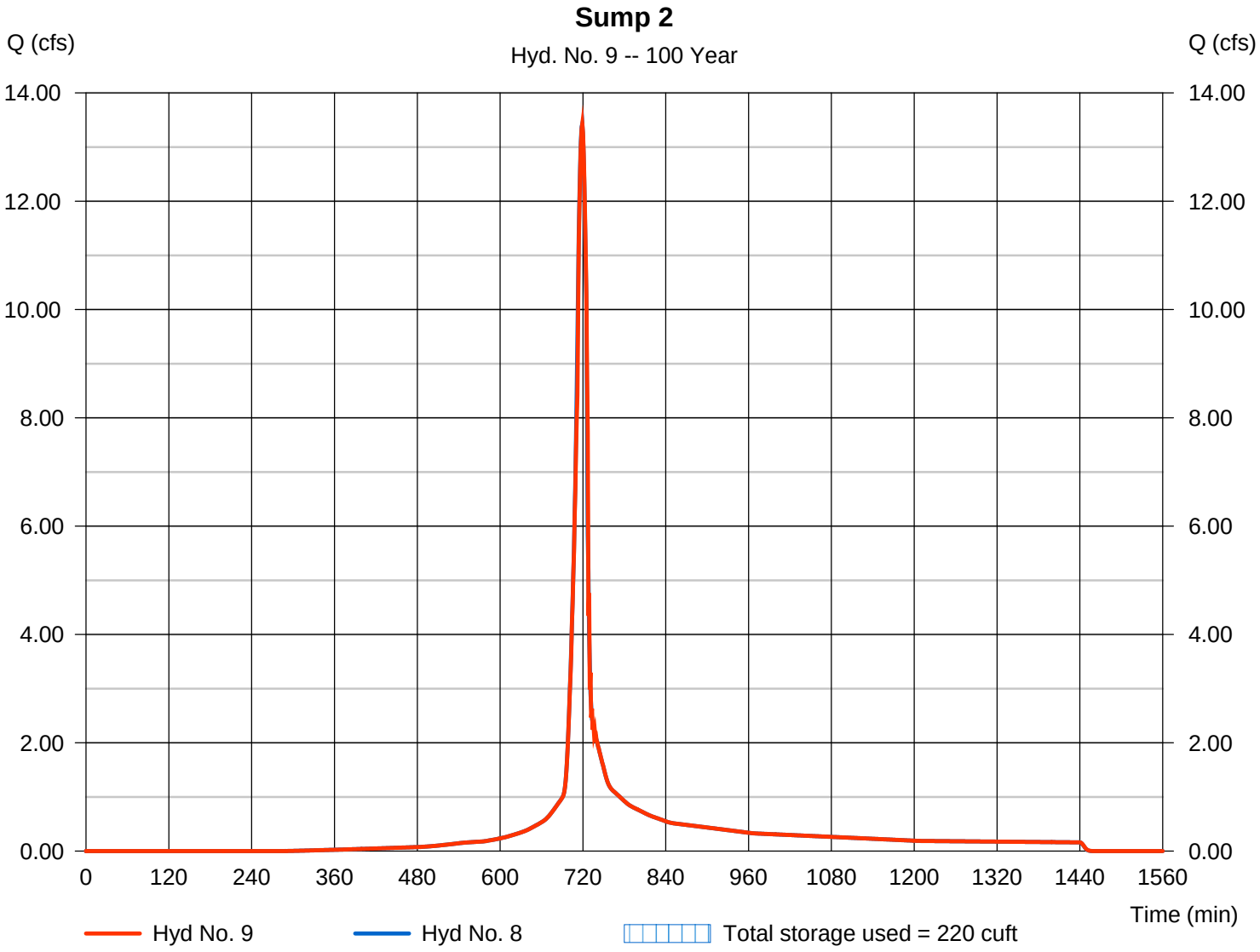
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 13.43 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 719 min |
| Time interval | = | 1 min | Hyd. volume | = | 36,580 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 11.36 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 220 cuft |

Storage Indication method used.



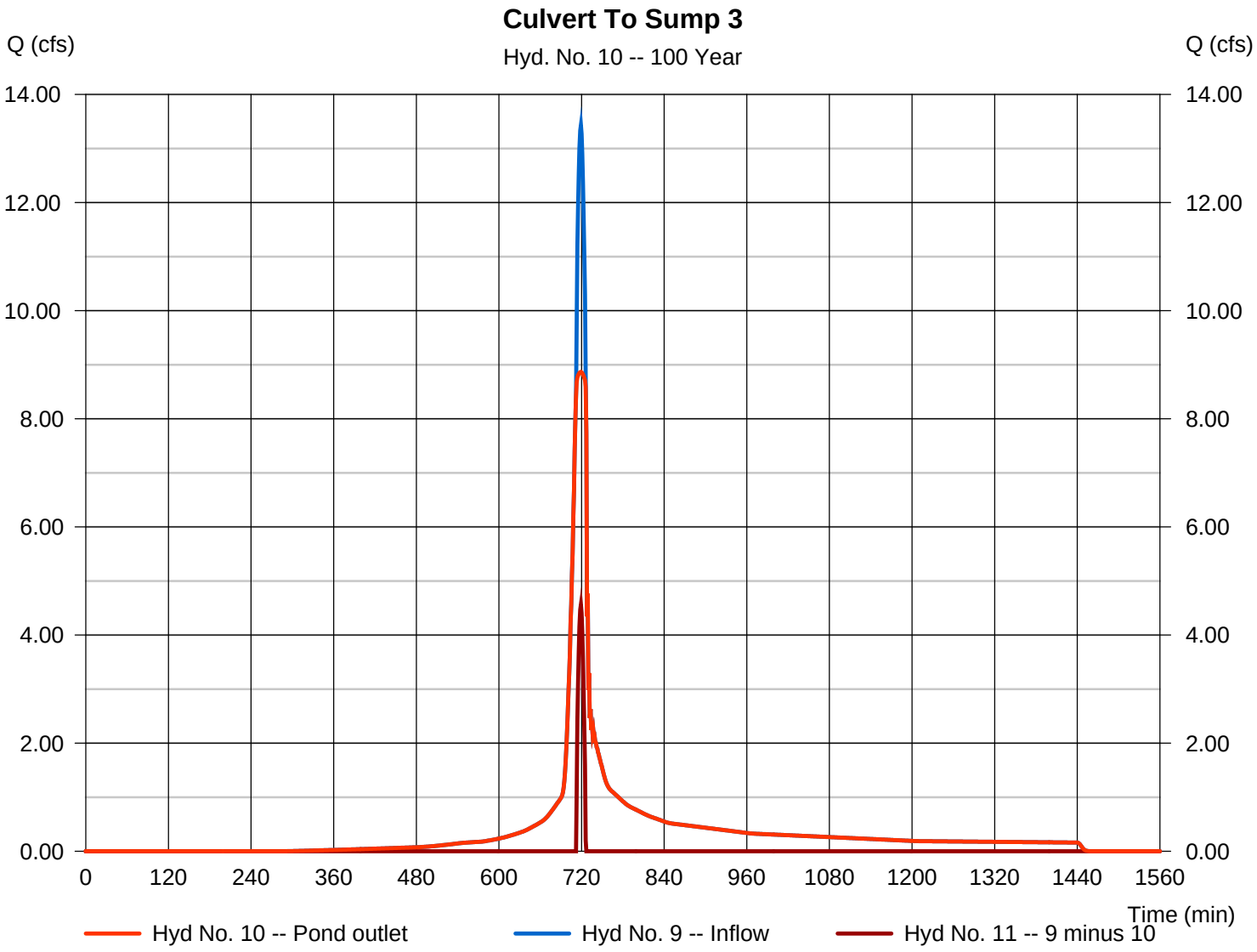
# Hydrograph Report



## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 8.867 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 34,025 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



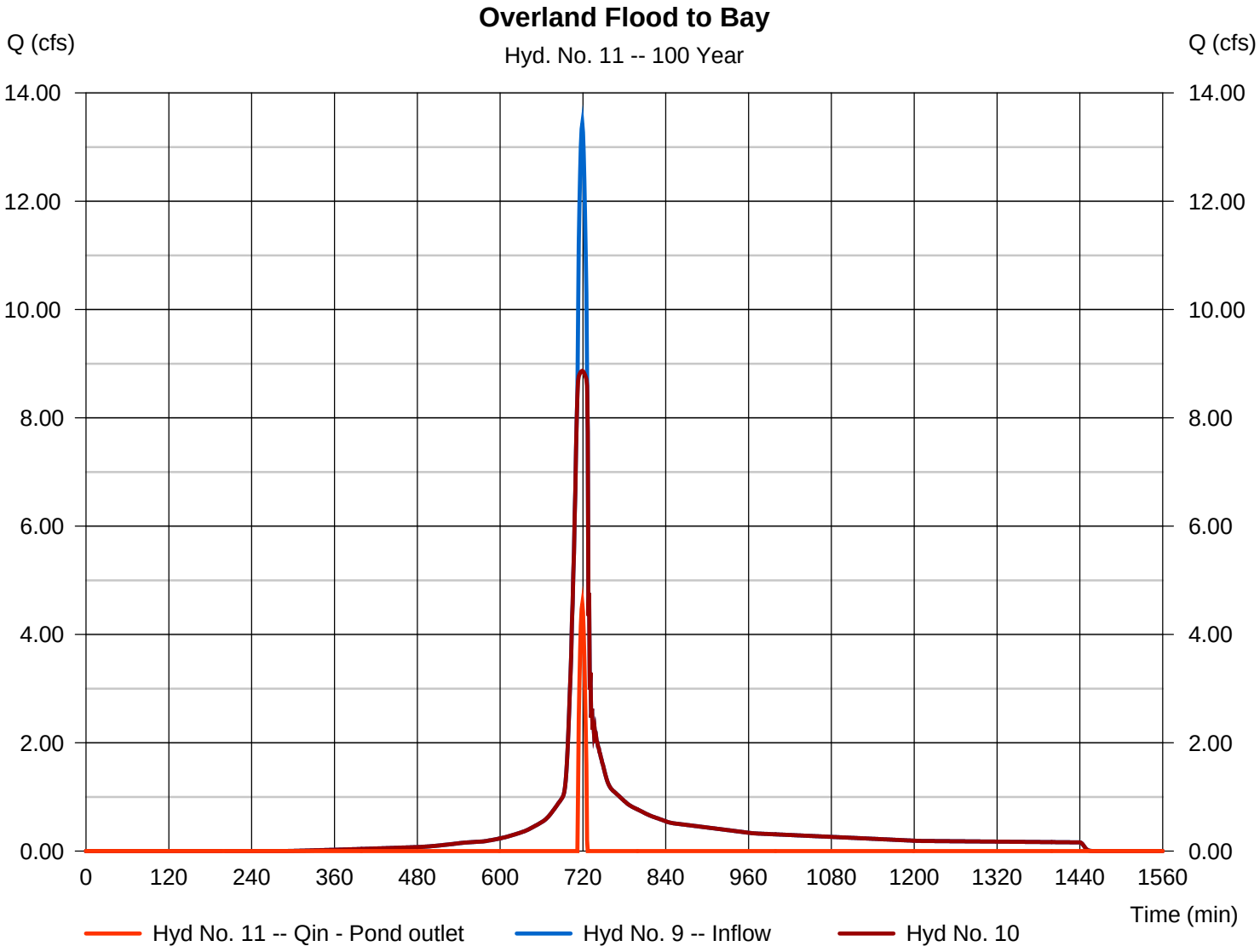
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 4.561 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 2,555 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



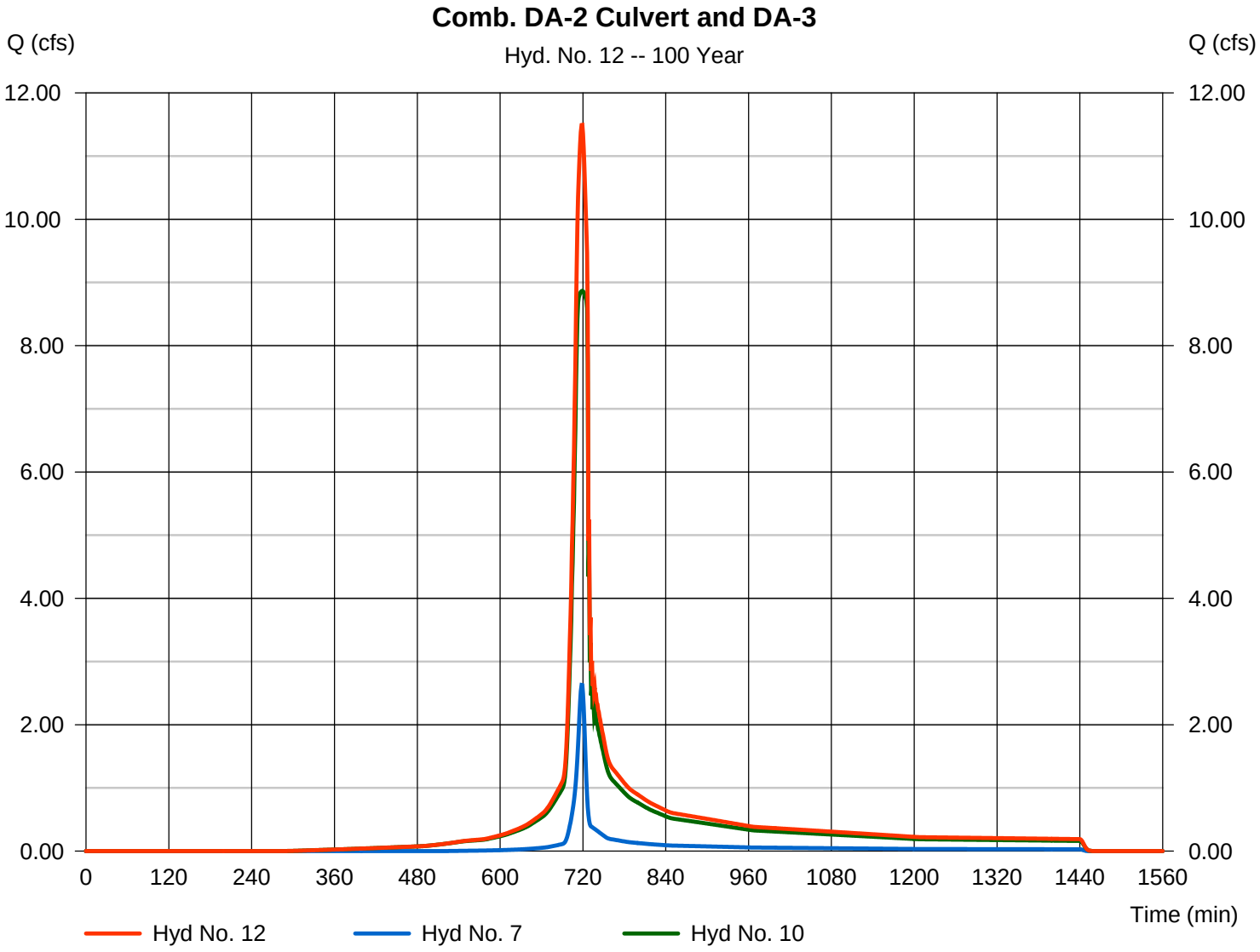
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 11.49 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 719 min |
| Time interval | = 1 min | Hyd. volume | = 39,585 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 0.450 ac |



# Hydrograph Report

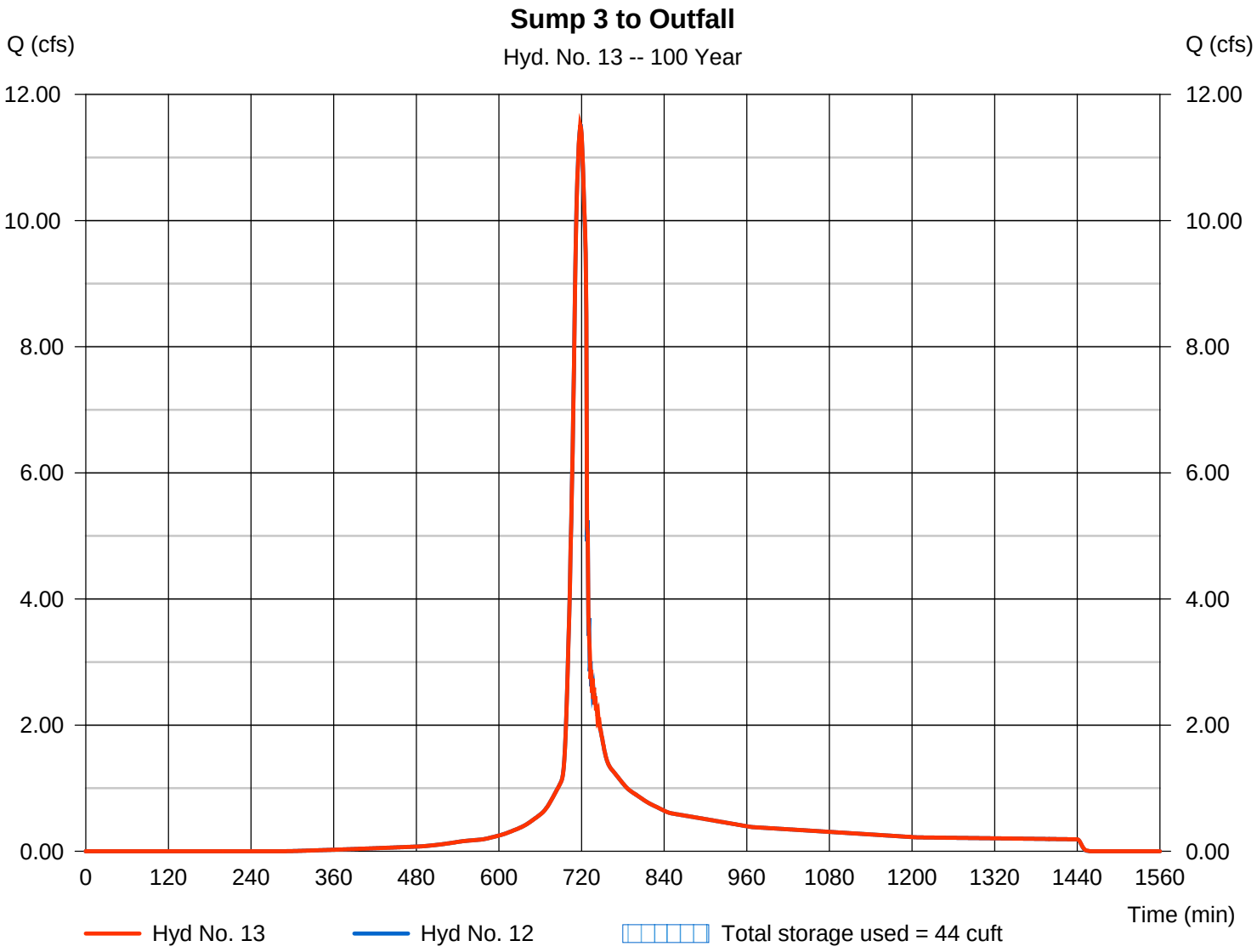
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 11.51 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 718 min |
| Time interval | = | 1 min | Hyd. volume | = | 39,585 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.75 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 44 cuft |

Storage Indication method used.



# Hydrograph Report

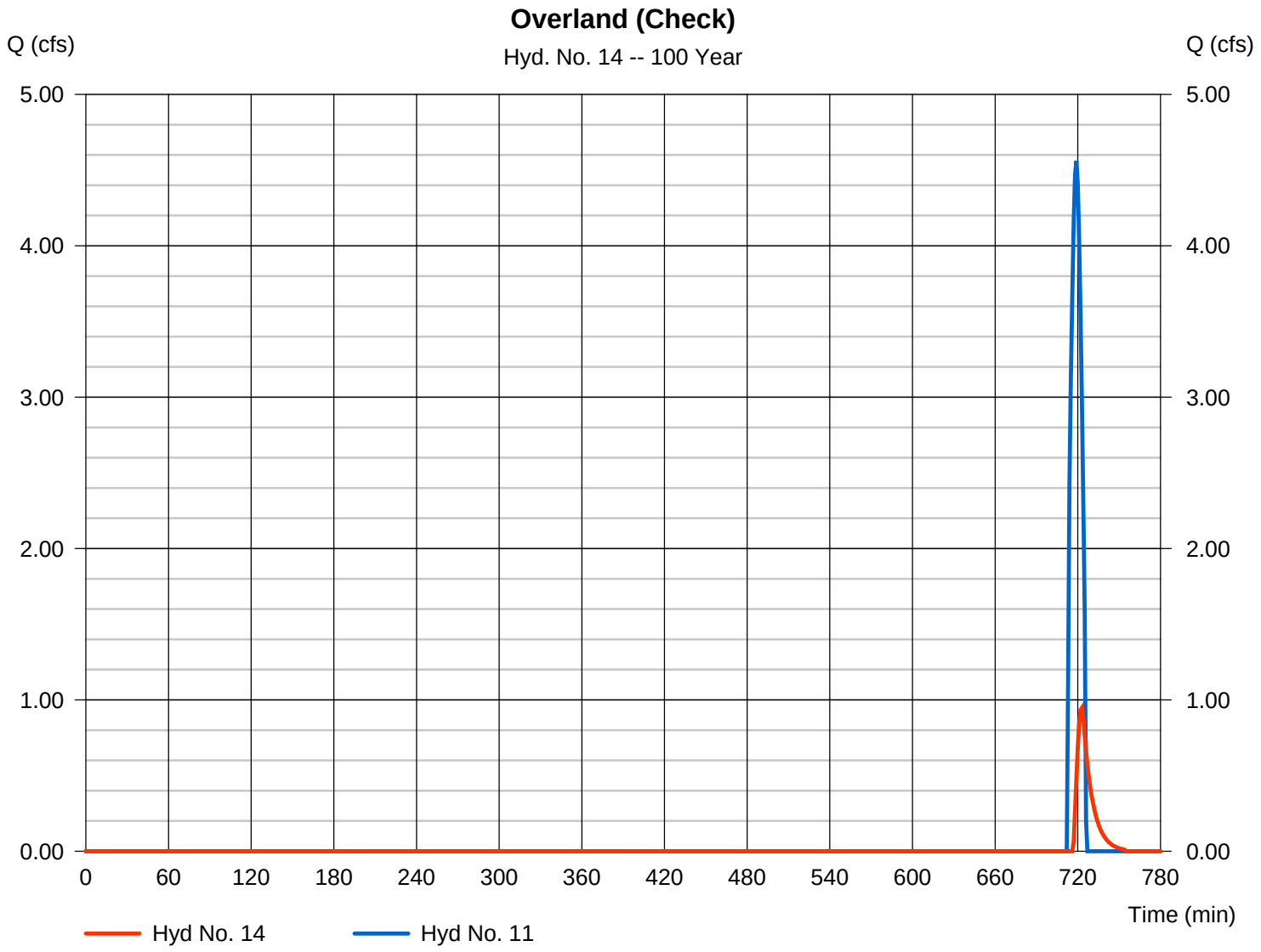
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Thursday, Feb 2, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.948 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 723 min |
| Time interval | = | 1 min | Hyd. volume | = | 640 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | 0.00 ft/s | Routing coeff. | = | 0.1353 |

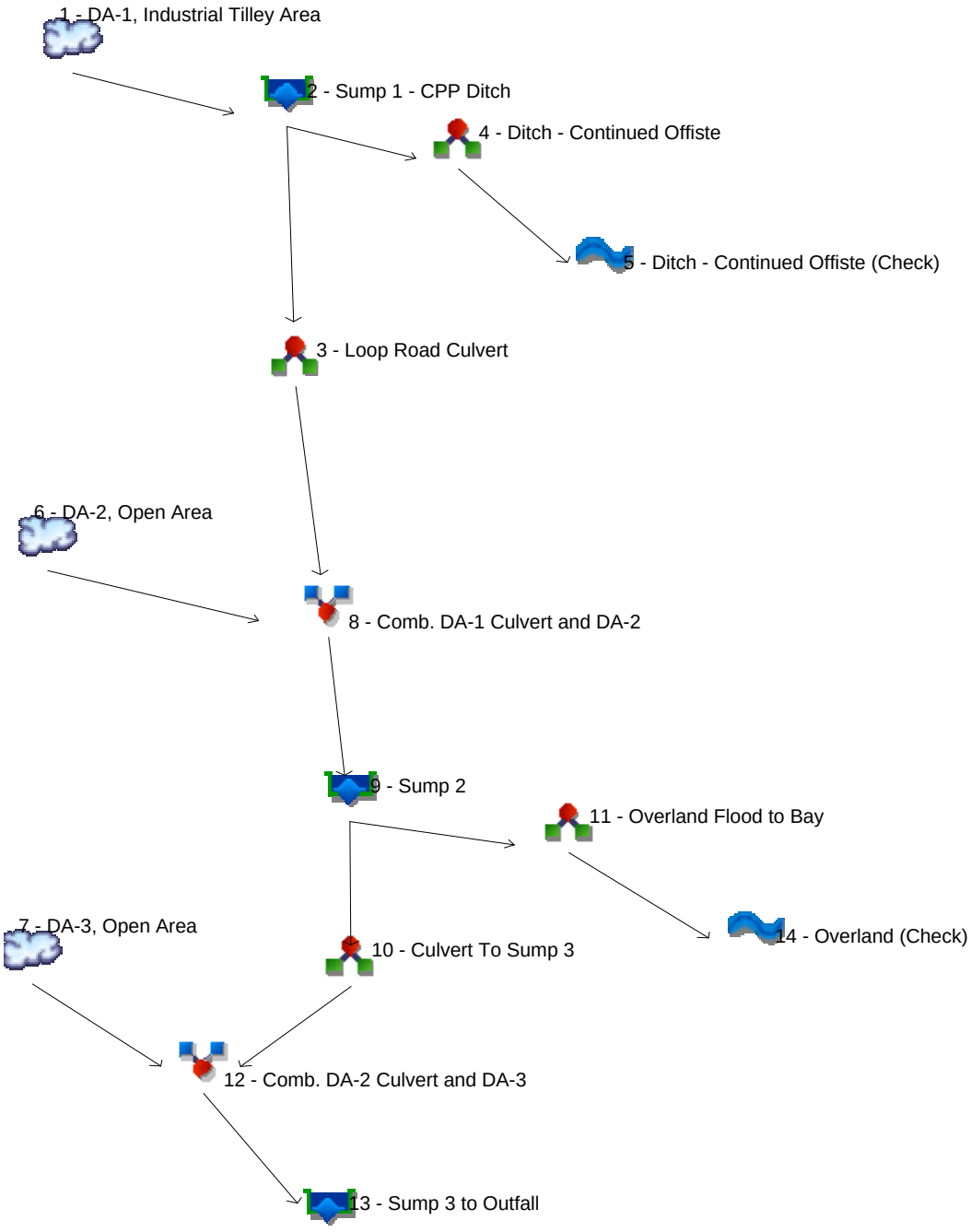
Modified Att-Kin routing method used.

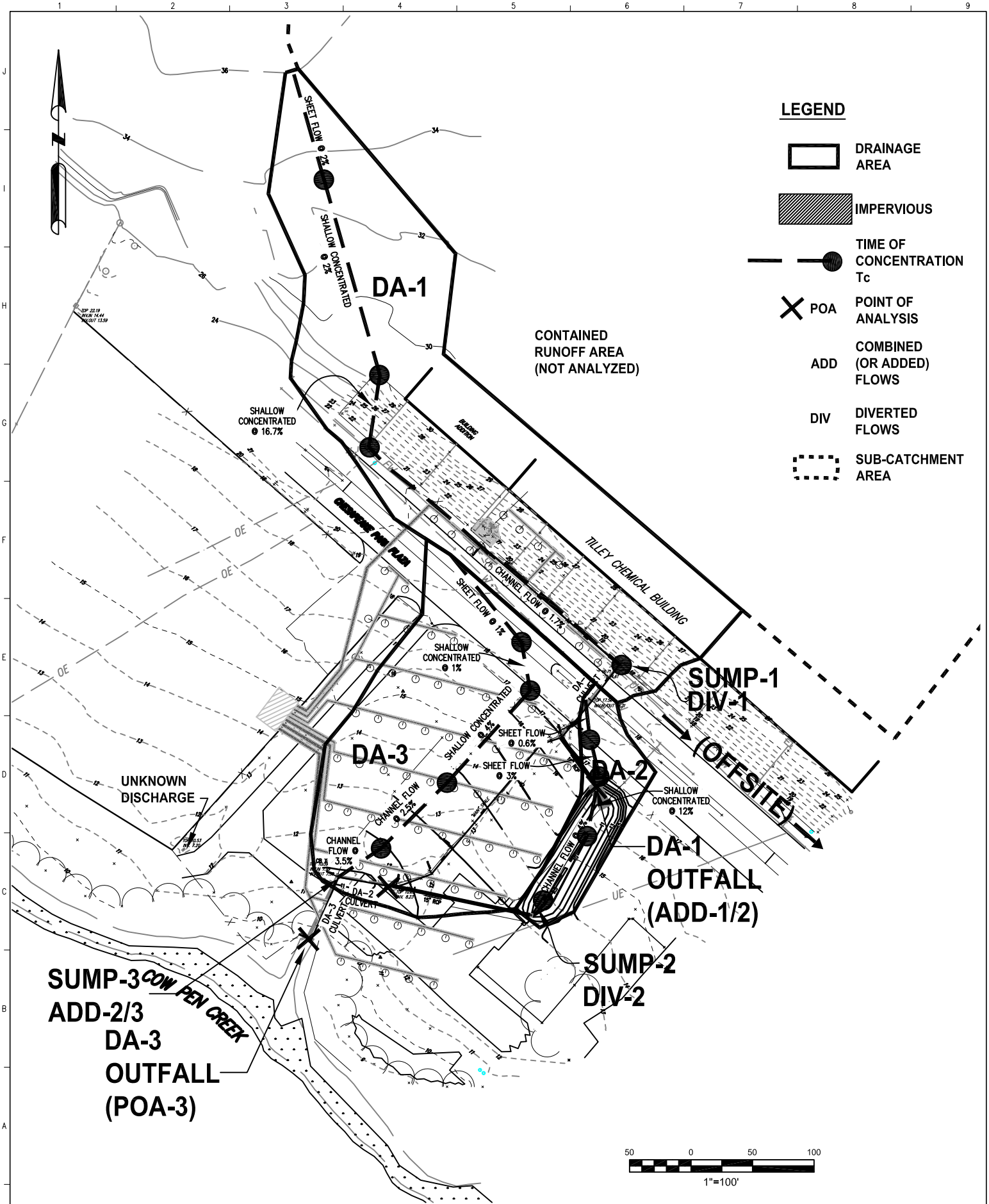


# APPENDIX B —TR-55 ROUTING REPORT (PROPOSED CONDITIONS)

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25



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|---|---|---|---|
| | | | |

STORMWATER MODIFICATIONS – BLOCK G
INJECTION WELL FIELD
SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 2-8-12 |
| PROJECT NO.: | 112I03043 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SNL |
| CHECKED BY: | CSG/SK |
| SHEET: | FIG. 3-1 (C-SWM) |

PROPOSED CONDITIONS DRAINAGE ANALYSIS

# Hydrograph Return Period Recap



| Hyd. No. | Hydrograph type (origin) | Inflow hyd(s) | Peak Outflow (cfs) | | | | | | | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1-yr | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | |
| 1 | SCS Runoff | ------ | 2.761 | 3.924 | ------- | ------- | 7.832 | ------- | ------- | 12.03 | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 1 | 2.763 | 3.920 | ------- | ------- | 7.743 | ------- | ------- | 11.94 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 2 | 2.763 | 3.920 | ------- | ------- | 7.743 | ------- | ------- | 8.610 | Loop Road Culvert |
| 4 | Diversion2 | 2 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 3.333 | Ditch - Continued Offiste |
| 5 | Reach | 4 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 1.672 | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | ------ | 0.135 | 0.238 | ------- | ------- | 0.630 | ------- | ------- | 1.094 | DA-2, Open Area |
| 7 | SCS Runoff | ------ | 0.562 | 1.098 | ------- | ------- | 3.229 | ------- | ------- | 5.840 | DA-3, Open Area |
| 8 | Combine | 3, 6, | 2.890 | 4.152 | ------- | ------- | 8.296 | ------- | ------- | 9.647 | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 8 | 2.302 | 2.971 | ------- | ------- | 5.300 | ------- | ------- | 6.649 | Sump 2 |
| 10 | Diversion1 | 9 | 2.303 | 2.992 | ------- | ------- | 5.300 | ------- | ------- | 6.649 | Culvert To Sump 3 |
| 11 | Diversion2 | 9 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 0.000 | Overland Flood to Bay |
| 12 | Combine | 7, 10, | 2.788 | 3.859 | ------- | ------- | 7.757 | ------- | ------- | 11.55 | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 12 | 2.790 | 3.857 | ------- | ------- | 7.760 | ------- | ------- | 11.55 | Sump 3 to Outfall |
| 14 | Reach | 11 | 0.000 | 0.000 | ------- | ------- | 0.000 | ------- | ------- | 0.000 | Overland (Check) |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 2.761 | 1 | 720 | 6,245 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 2.763 | 1 | 720 | 6,245 | 1 | 15.35 | 13.5 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 2.763 | 1 | 720 | 6,245 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 713 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | 699 | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 0.135 | 1 | 718 | 302 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 0.562 | 1 | 720 | 1,454 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 2.890 | 1 | 720 | 6,547 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 2.302 | 1 | 723 | 6,546 | 8 | 10.62 | 608 | Sump 2 |
| 10 | Diversion1 | 2.303 | 1 | 723 | 6,563 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | n/a | -17 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 2.788 | 1 | 721 | 8,017 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 2.790 | 1 | 721 | 7,987 | 12 | 9.06 | 31.1 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | n/a | -1 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

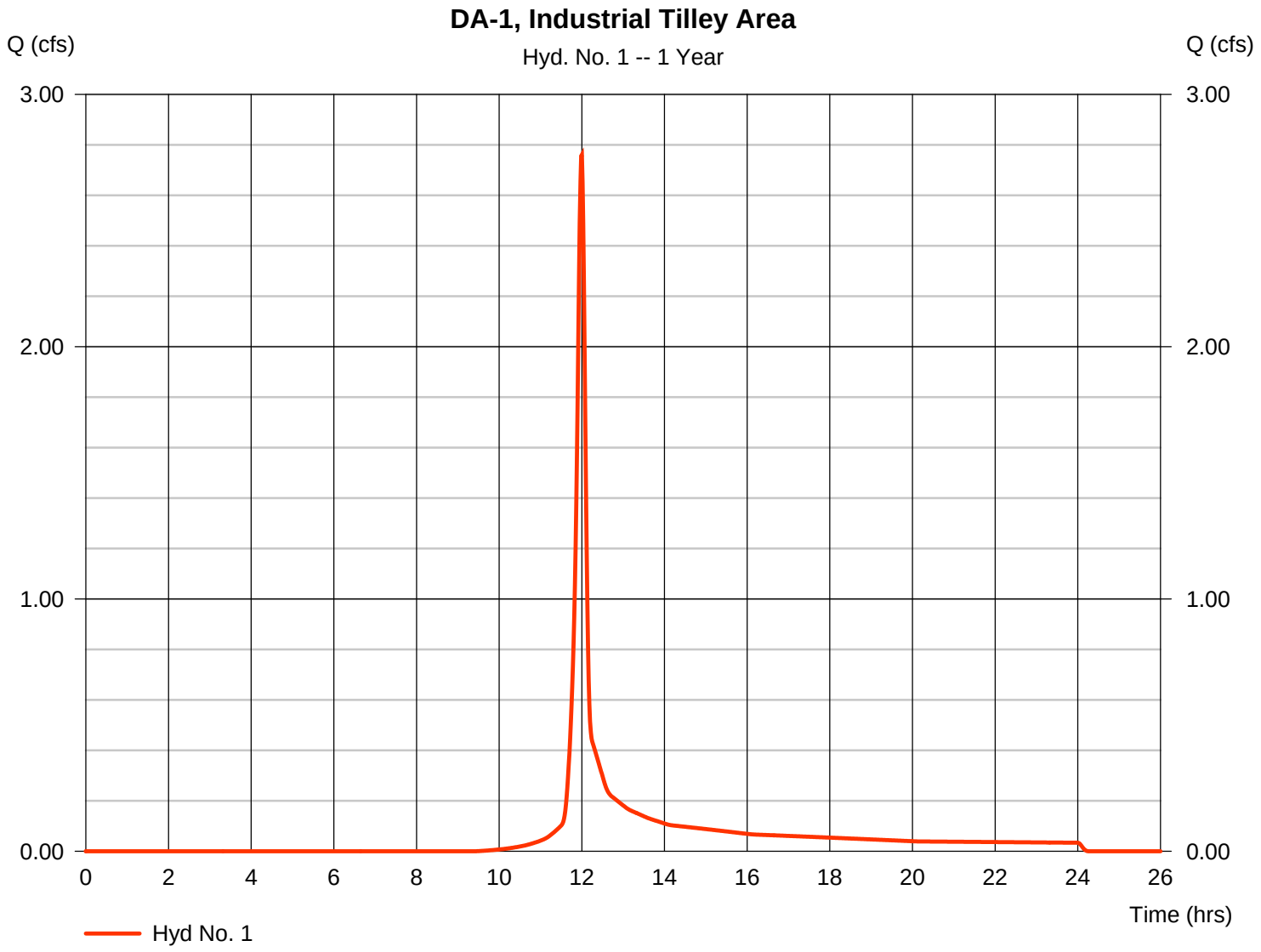
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 2.761 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,245 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# TR55 Tc Worksheet



## Hyd. No. 1

DA-1, Industrial Tilley Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 90.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 2.20 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.07** | **+** | **0.00** | **+** | **0.00** | **=** | **1.07** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 161.00 | | 60.00 | | 0.00 | | |
| Watercourse slope (%) | = 2.00 | | 16.70 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =2.28 | | 6.59 | | 0.00 | | |
| **Travel Time (min)** | **= 1.18** | **+** | **0.15** | **+** | **0.00** | **=** | **1.33** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 9.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 15.50 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.63 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})267.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 7.02** | **+** | **0.00** | **+** | **0.00** | **=** | **7.02** |

**Total Travel Time, Tc ..... 9.40 min**

# Hydrograph Report

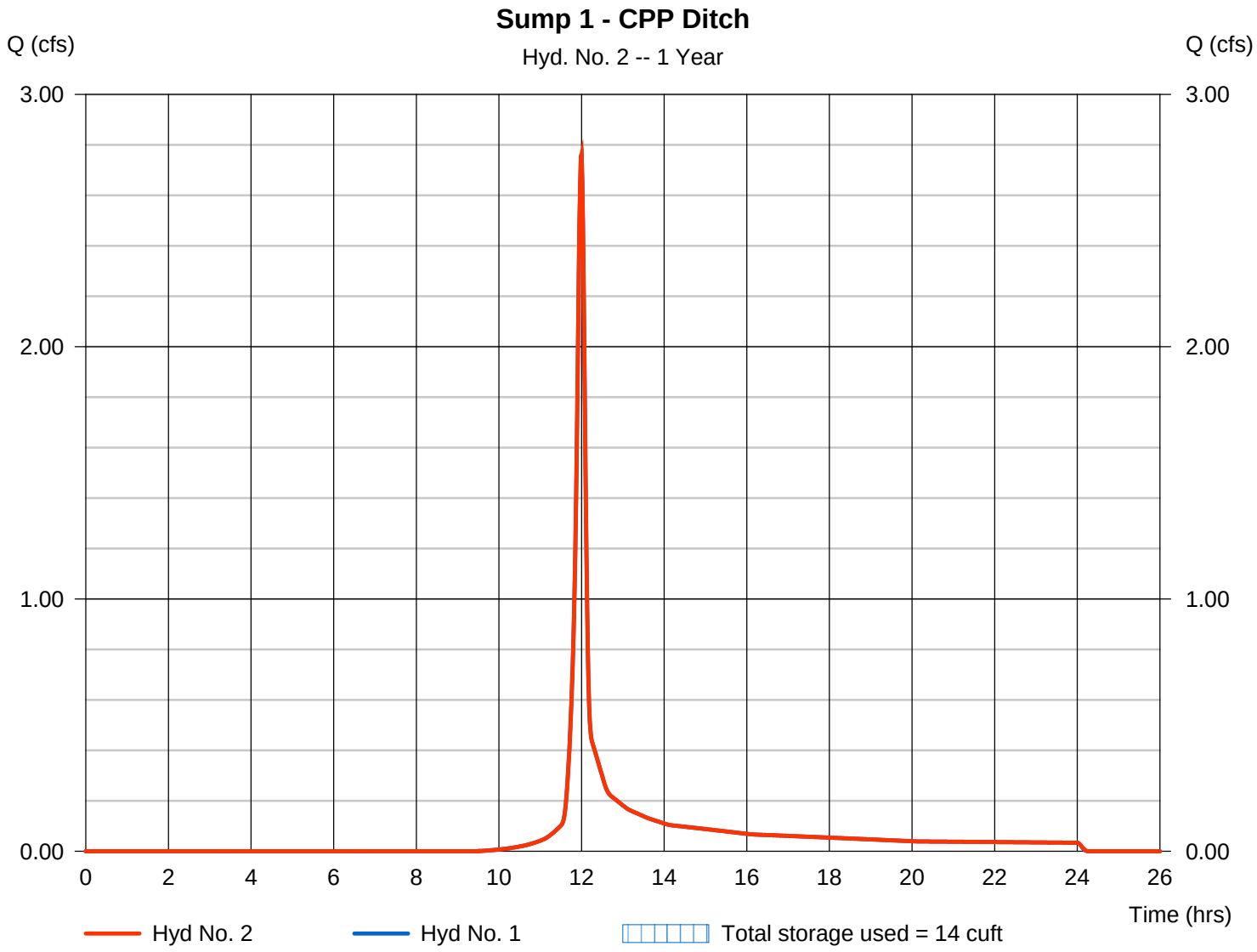
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 2.763 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 6,245 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 15.35 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 14 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Pond No. 3 - Sump 1- CPP Ditch

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 14.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 14.50 | 16 | 0 | 0 |
| 0.50 | 15.00 | 16 | 8 | 8 |
| 1.00 | 15.50 | 16 | 8 | 16 |
| 1.50 | 16.00 | 16 | 8 | 24 |
| 2.00 | 16.50 | 16 | 8 | 32 |
| 2.50 | 17.00 | 40 | 14 | 46 |
| 3.00 | 17.50 | 140 | 42 | 88 |
| 3.50 | 18.00 | 790 | 210 | 298 |
| 4.00 | 18.50 | 2,160 | 709 | 1,008 |
| 4.50 | 19.00 | 3,520 | 1,406 | 2,414 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 15.00 | | | |
| **Span (in)** | = 15.00 | | | |
| **No. Barrels** | = 1 | | | |
| **Invert El. (ft)** | = 14.50 | | | |
| **Length (ft)** | = 126.00 | | | |
| **Slope (%)** | = 0.90 | | | |
| **N-Value** | = .013 | | | |
| **Orifice Coeff.** | = 0.60 | | | |
| **Multi-Stage** | = n/a | | | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 3.00 | 127.00 | | |
| **Crest El. (ft)** | = 17.50 | 18.50 | | |
| **Weir Coeff.** | = 3.330 | 2.60 | | |
| **Weir Type** | = Ciplti | Broad | | |
| **Multi-Stage** | = No | No | | |
| **Exfil.(in/hr)** | = 0 (by Wet area) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 14.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 8 | 15.00 | 1.10 ic | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 1.104 |
| 1.00 | 16 | 15.50 | 3.58 ic | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 3.584 |
| 1.50 | 24 | 16.00 | 5.52 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 5.522 |
| 2.00 | 32 | 16.50 | 6.44 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 6.442 |
| 2.50 | 46 | 17.00 | 7.25 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 7.247 |
| 3.00 | 88 | 17.50 | 7.97 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 7.971 |
| 3.50 | 298 | 18.00 | 8.63 oc | --- | --- | --- | 3.53 | 0.00 | --- | --- | --- | --- | 12.17 |
| 4.00 | 1,008 | 18.50 | 9.25 oc | --- | --- | --- | 9.99 | 0.00 | --- | --- | --- | --- | 19.24 |
| 4.50 | 2,414 | 19.00 | 9.83 oc | --- | --- | --- | 18.35 | 116.74 | --- | --- | --- | --- | 144.92 |

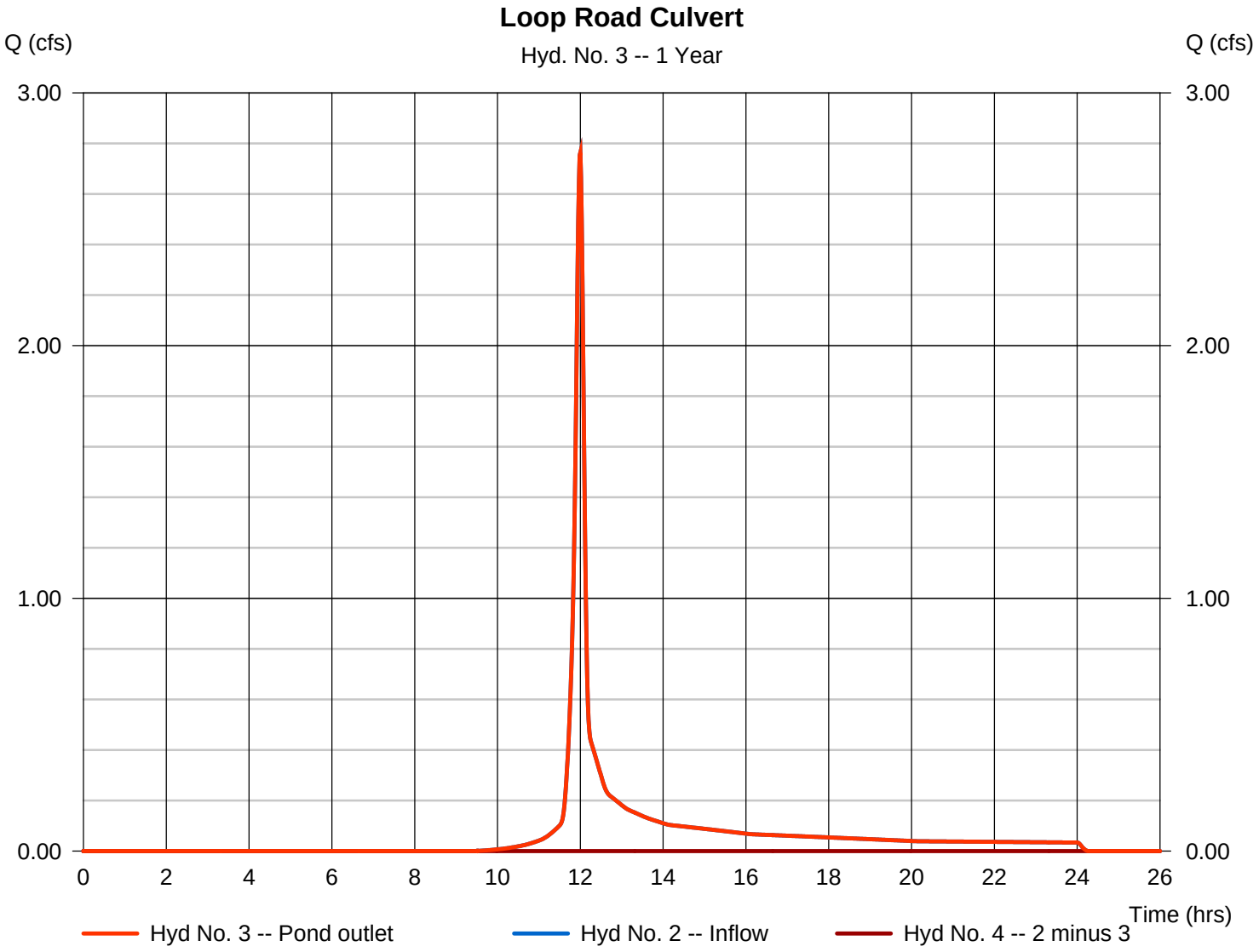
# Hydrograph Report



## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 2.763 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,245 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



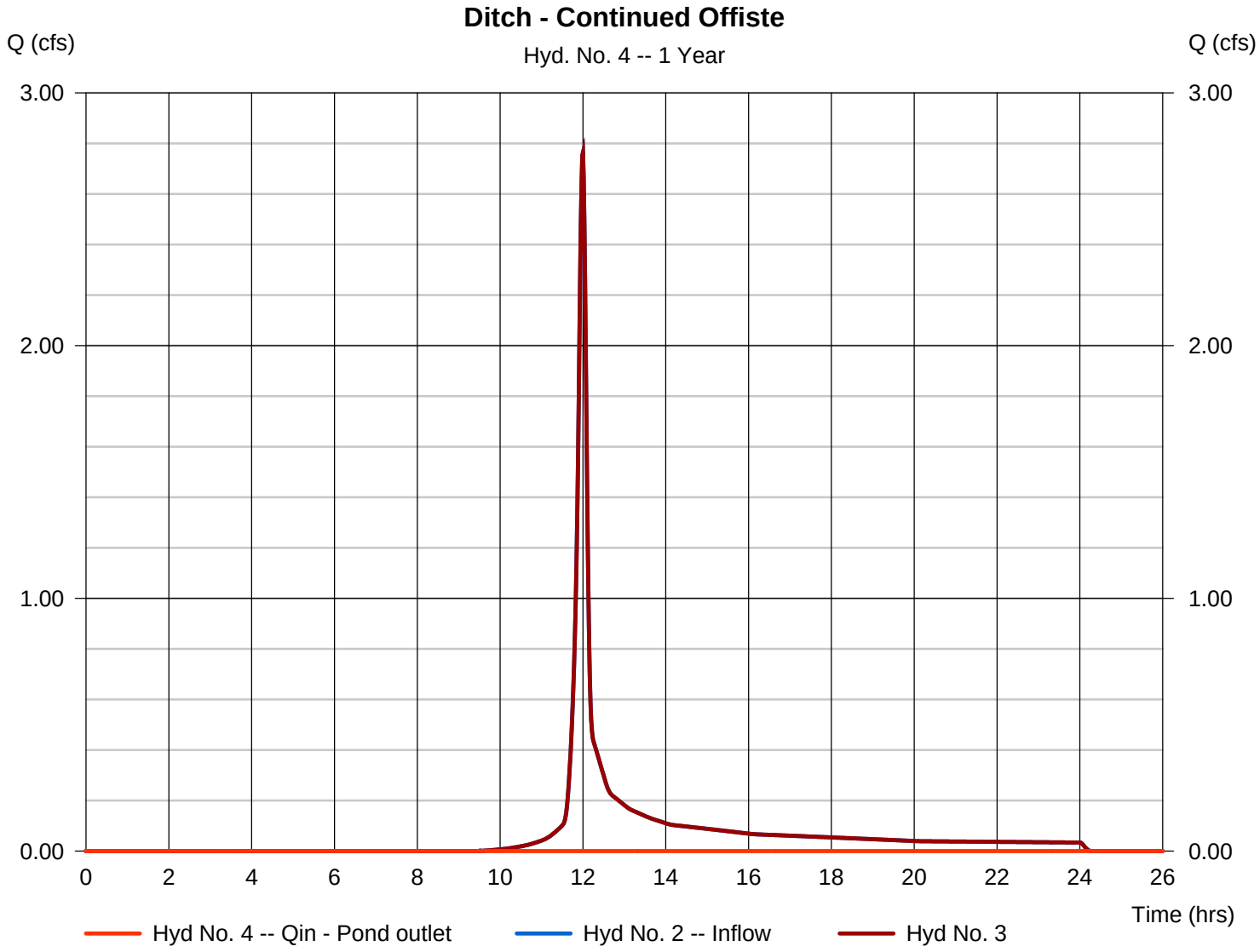
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 11.88 hrs |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

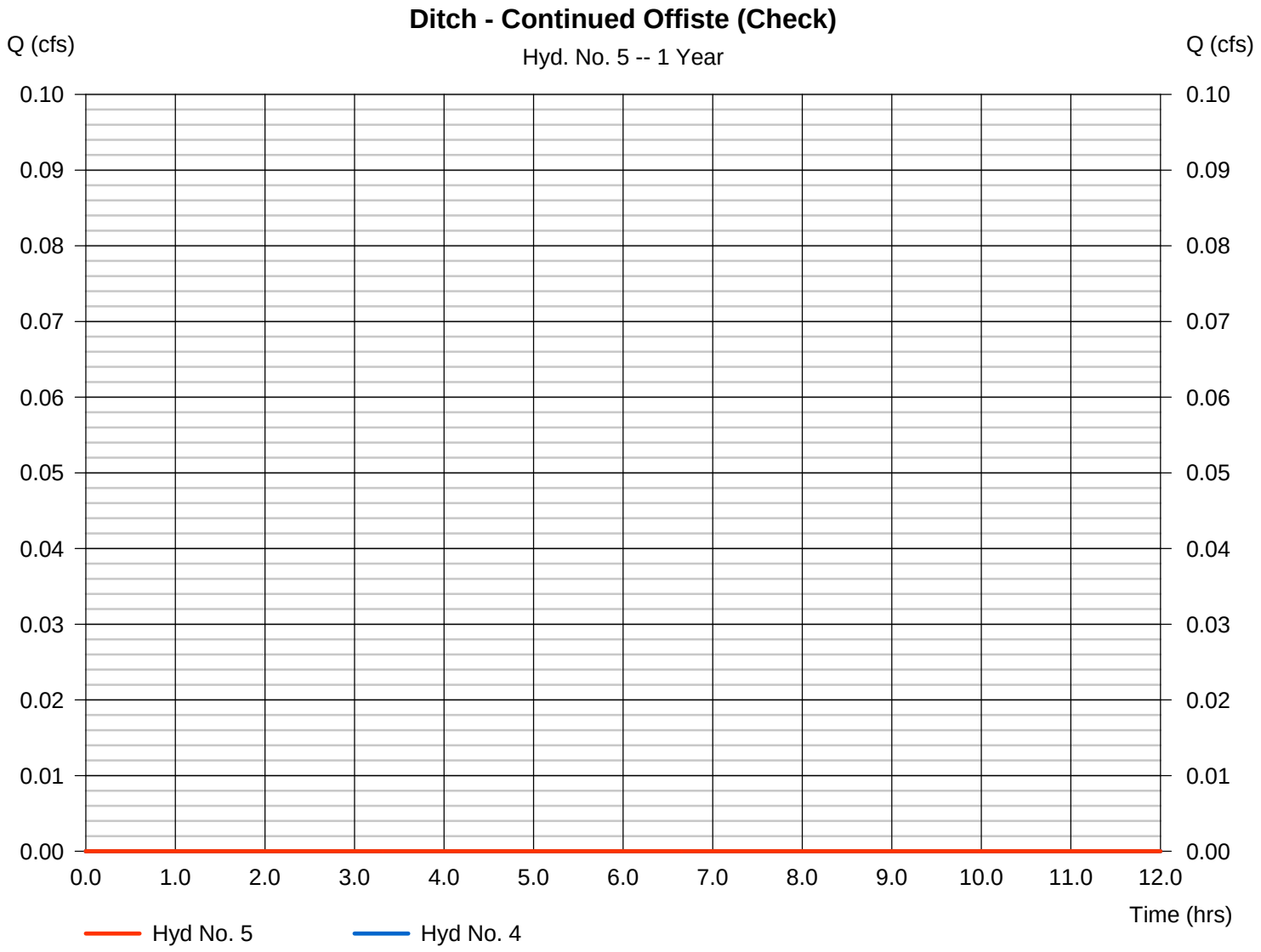
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | |
|---|---|---|---|
| Hydrograph type | = Reach | Peak discharge | = 0.000 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 11.65 hrs |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hyd. No. | = 4 - Ditch - Continued Offiste | Section type | = Triangular |
| Reach length | = 500.0 ft | Channel slope | = 1.6 % |
| Manning's n | = 0.200 | Bottom width | = 0.0 ft |
| Side slope | = 1.0:1 | Max. depth | = 0.0 ft |
| Rating curve x | = 0.595 | Rating curve m | = 1.333 |
| Ave. velocity | = 0.01 ft/s | Routing coeff. | = 0.0020 |

Modified Att-Kin routing method used.



# Hydrograph Report

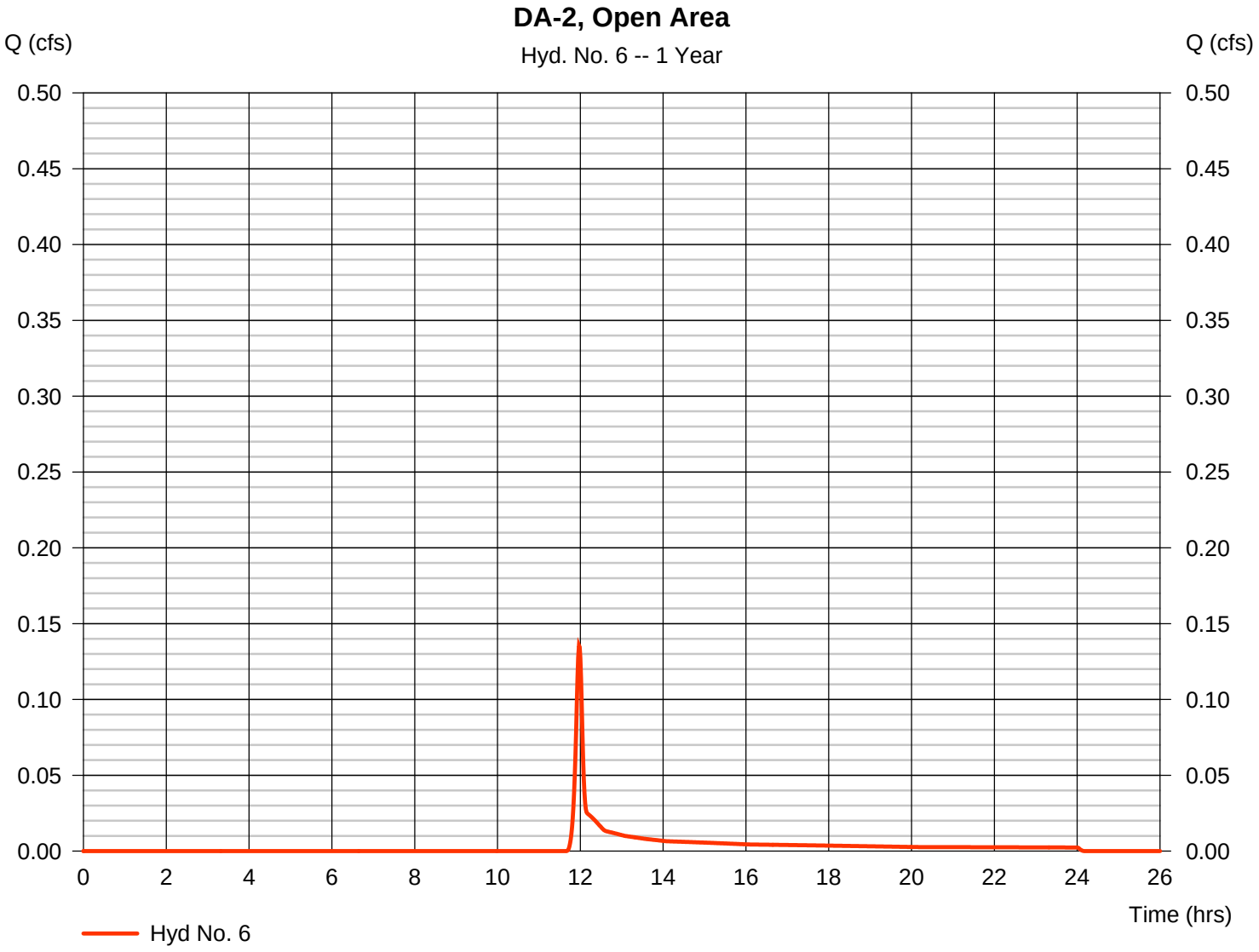
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.135 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 11.97 hrs |
| Time interval | = 1 min | Hyd. volume | = 302 cuft |
| Drainage area | = 0.160 ac | Curve number | = 70* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 5.50 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.040 x 98) + (0.120 x 61)] / 0.160



# TR55 Tc Worksheet



## Hyd. No. 6

DA-2, Open Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.200 | | 0.011 | | |
| Flow length (ft) | = 32.0 | | 30.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 3.20 | | 0.00 | | |
| Land slope (%) | = 0.60 | | 3.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.79** | **+** | **4.00** | **+** | **0.00** | **=** | **4.79** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 42.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 12.00 | | 0.00 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =5.59 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.13** | **+** | **0.00** | **+** | **0.00** | **=** | **0.13** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 10.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 8.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 4.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.84 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})66.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.60** | **+** | **0.00** | **+** | **0.00** | **=** | **0.60** |

**Total Travel Time, Tc ..... 5.50 min**

# Hydrograph Report

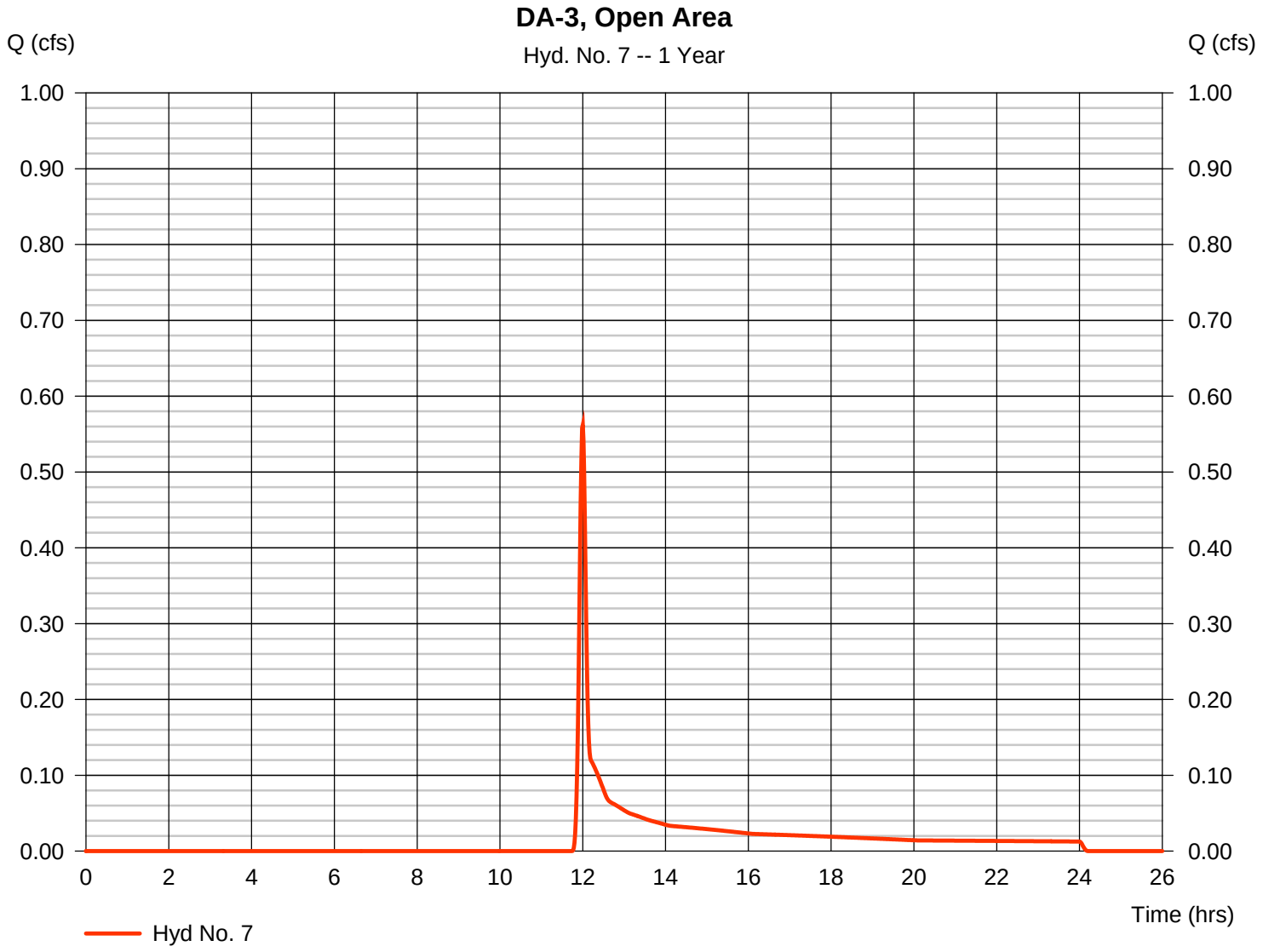
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.562 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 1,454 cuft |
| Drainage area | = 1.030 ac | Curve number | = 67* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 7.00 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.860 x 61) + (0.170 x 98)] / 1.030



# TR55 Tc Worksheet



## Hyd. No. 7

DA-3, Open Area

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 100.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 1.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.60** | **+** | **0.00** | **+** | **0.00** | **=** | **1.60** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 40.00 | | 100.00 | | 0.00 | | |
| Watercourse slope (%) | = 1.00 | | 4.00 | | 0.00 | | |
| Surface description | = Paved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =2.03 | | 3.23 | | 0.00 | | |
| **Travel Time (min)** | **= 0.33** | **+** | **0.52** | **+** | **0.00** | **=** | **0.84** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 19.50 | | 20.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 100.00 | | 70.00 | | 0.00 | | |
| Channel slope (%) | = 2.50 | | 3.50 | | 0.00 | | |
| Manning's n-value | = 0.200 | | 0.200 | | 0.015 | | |
| Velocity (ft/s) | =0.39 | | | | | | |
| | | | 0.60 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})80.0 | | 42.0 | | 0.0 | | |
| **Travel Time (min)** | **= 3.38** | **+** | **1.16** | **+** | **0.00** | **=** | **4.55** |

**Total Travel Time, Tc ..... 7.00 min**

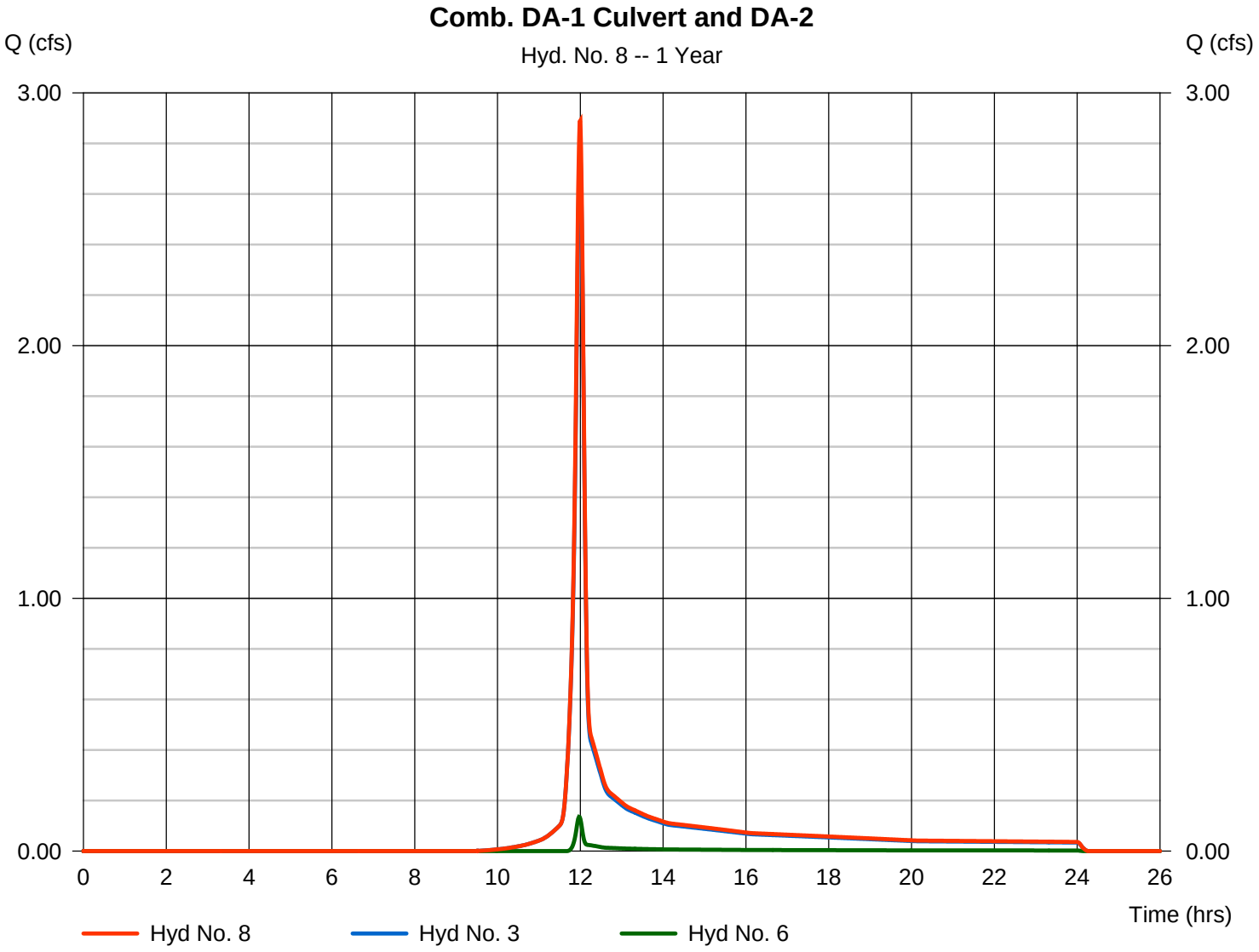
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 2.890 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,547 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.160 ac |



# Hydrograph Report

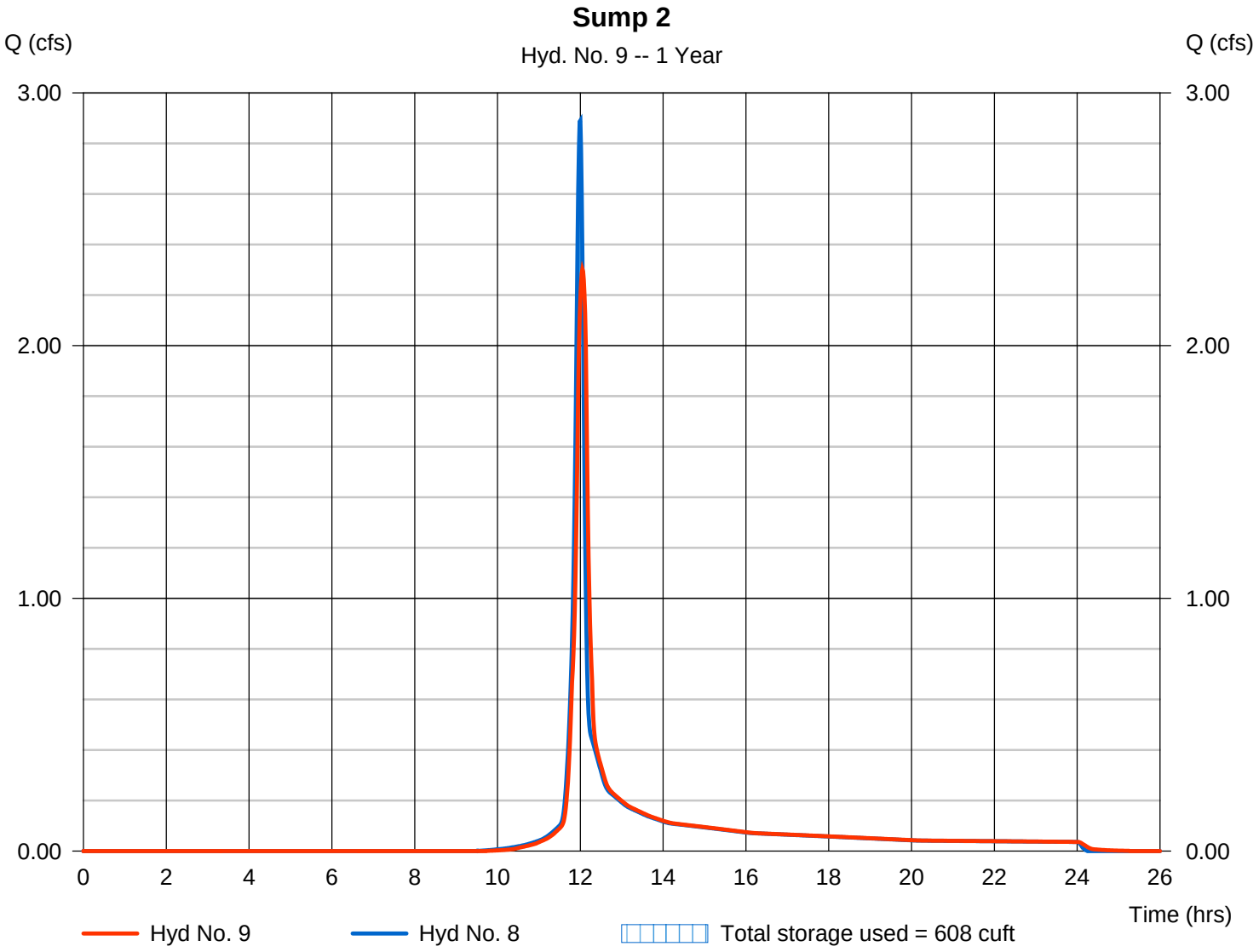
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 2.302 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 12.05 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 6,546 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 10.62 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 608 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Pond No. 2 - Sump 2

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 9.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 9.50 | 73 | 0 | 0 |
| 0.50 | 10.00 | 485 | 124 | 124 |
| 1.00 | 10.50 | 870 | 334 | 458 |
| 1.50 | 11.00 | 1,637 | 617 | 1,075 |
| 2.00 | 11.50 | 2,121 | 937 | 2,012 |
| 2.50 | 12.00 | 2,598 | 1,178 | 3,189 |
| 3.00 | 12.50 | 3,130 | 1,430 | 4,619 |
| 3.50 | 13.00 | 3,693 | 1,704 | 6,323 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 15.00 | 12.00 | 18.00 | |
| **Span (in)** | = 15.00 | 12.00 | 6.00 | |
| **No. Barrels** | = 1 | 1 | 1 | |
| **Invert El. (ft)** | = 9.50 | 9.50 | 11.00 | |
| **Length (ft)** | = 114.00 | 0.00 | 0.00 | |
| **Slope (%)** | = 0.90 | 0.00 | 0.00 | |
| **N-Value** | = .013 | .013 | .013 | |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | |
| **Multi-Stage** | = n/a | Yes | Yes | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 15.00 | | | |
| **Crest El. (ft)** | = 12.50 | | | |
| **Weir Coeff.** | = 3.330 | | | |
| **Weir Type** | = Ciplti | | | |
| **Multi-Stage** | = No | | | |
| **Exfil.(in/hr)** | = 0 (by Contour) | | | |
| **TW Elev. (ft)** | = 0.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 9.50 | 0.00 | 0.00 | 0.00 | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 124 | 10.00 | 0.67 ic | 0.66 ic | 0.00 | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.664 |
| 1.00 | 458 | 10.50 | 2.07 ic | 2.06 ic | 0.00 | --- | 0.00 | 0.00 | --- | --- | --- | --- | 2.059 |
| 1.50 | 1,075 | 11.00 | 2.99 ic | 2.97 ic | 0.00 | --- | 0.00 | 0.00 | --- | --- | --- | --- | 2.972 |
| 2.00 | 2,012 | 11.50 | 4.16 ic | 3.56 ic | 0.60 ic | --- | 0.00 | 0.00 | --- | --- | --- | --- | 4.162 |
| 2.50 | 3,189 | 12.00 | 5.48 oc | 3.78 ic | 1.70 ic | --- | 0.00 | 0.00 | --- | --- | --- | --- | 5.480 |
| 3.00 | 4,619 | 12.50 | 6.68 oc | 3.55 ic | 3.13 ic | --- | 0.00 | 0.00 | --- | --- | --- | --- | 6.675 |
| 3.50 | 6,323 | 13.00 | 7.34 oc | 3.75 ic | 3.58 ic | --- | 17.66 | 0.00 | --- | --- | --- | --- | 25.00 |

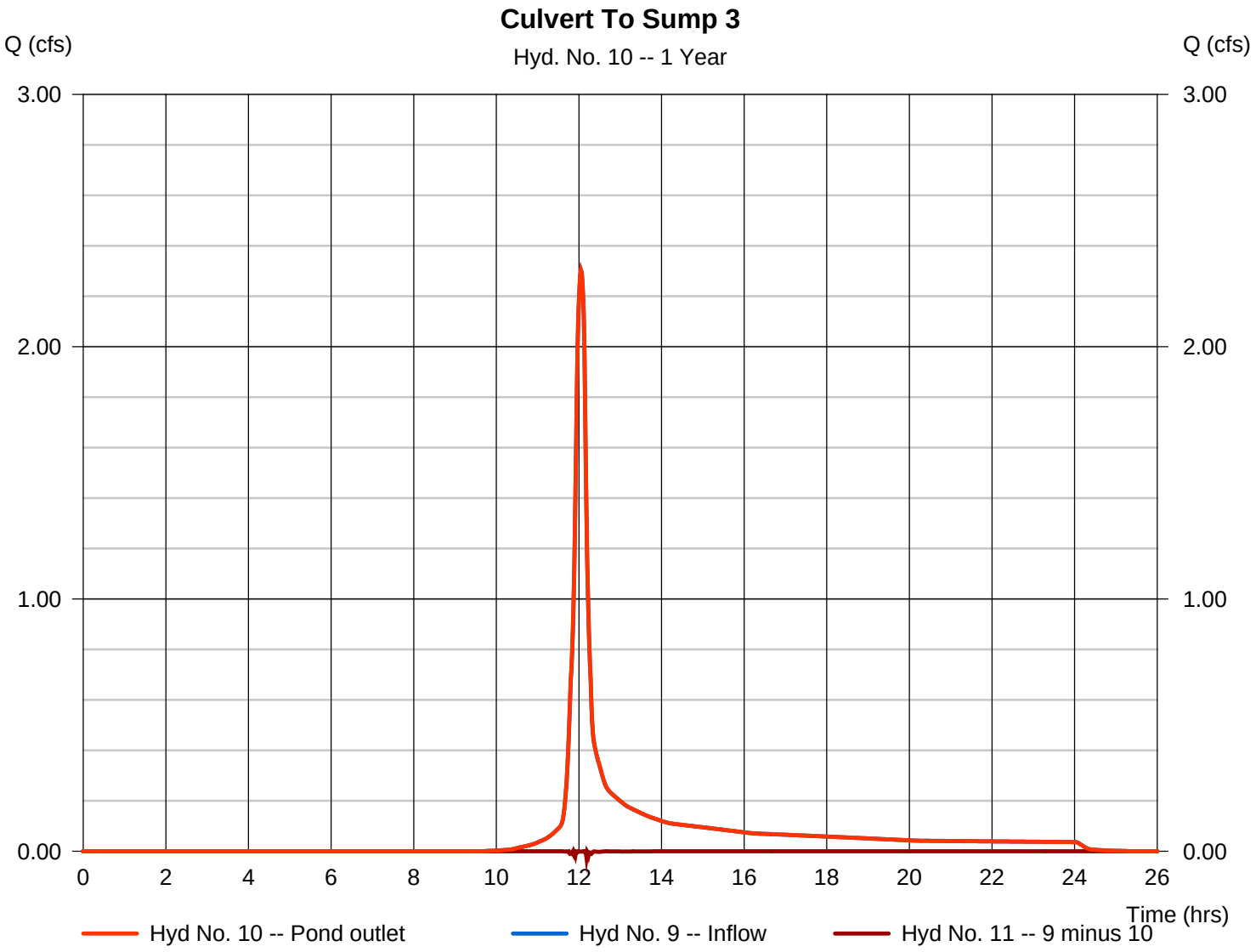
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 2.303 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.05 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,563 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



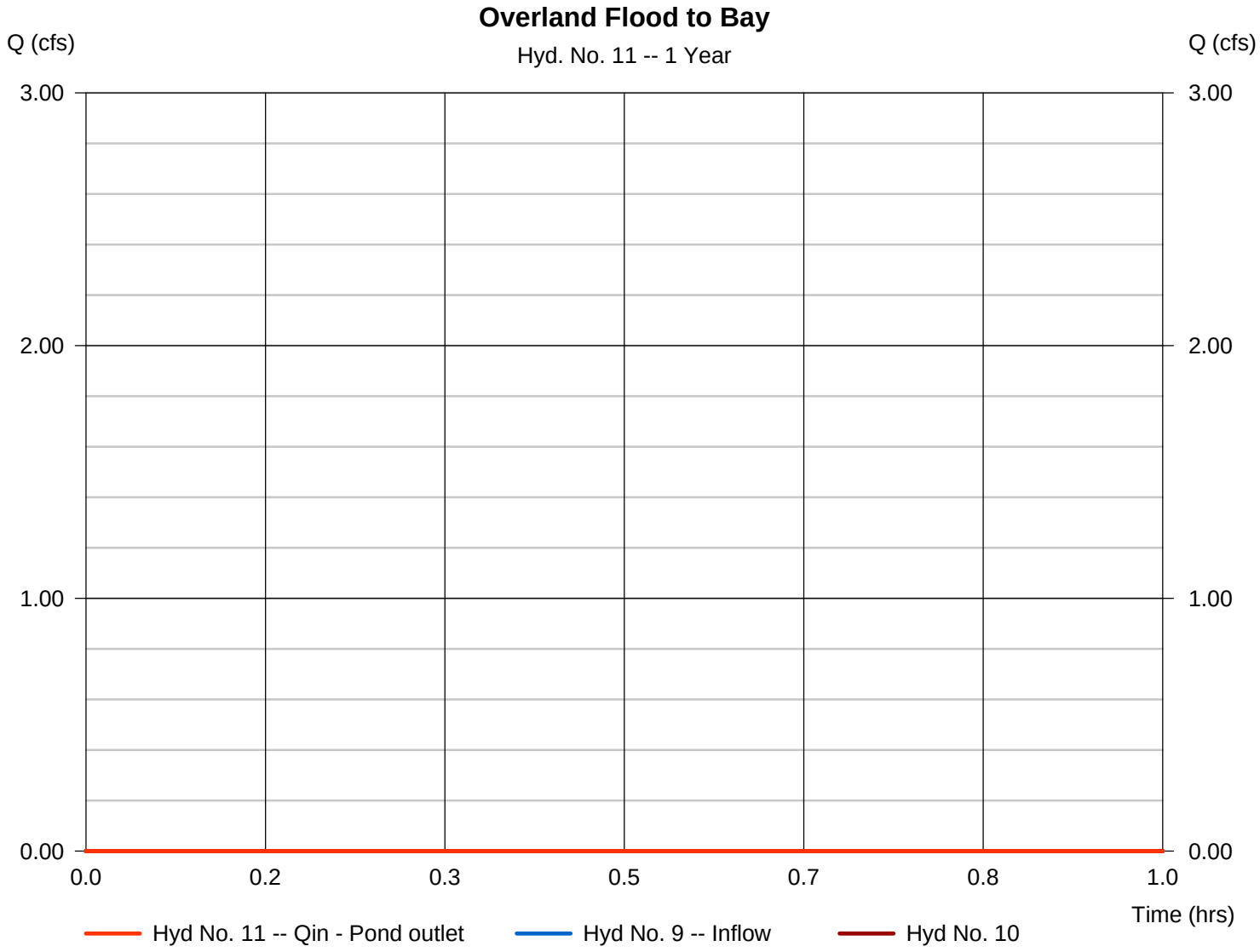
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 1 yrs | Time to peak | = n/a |
| Time interval | = 1 min | Hyd. volume | = -17 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



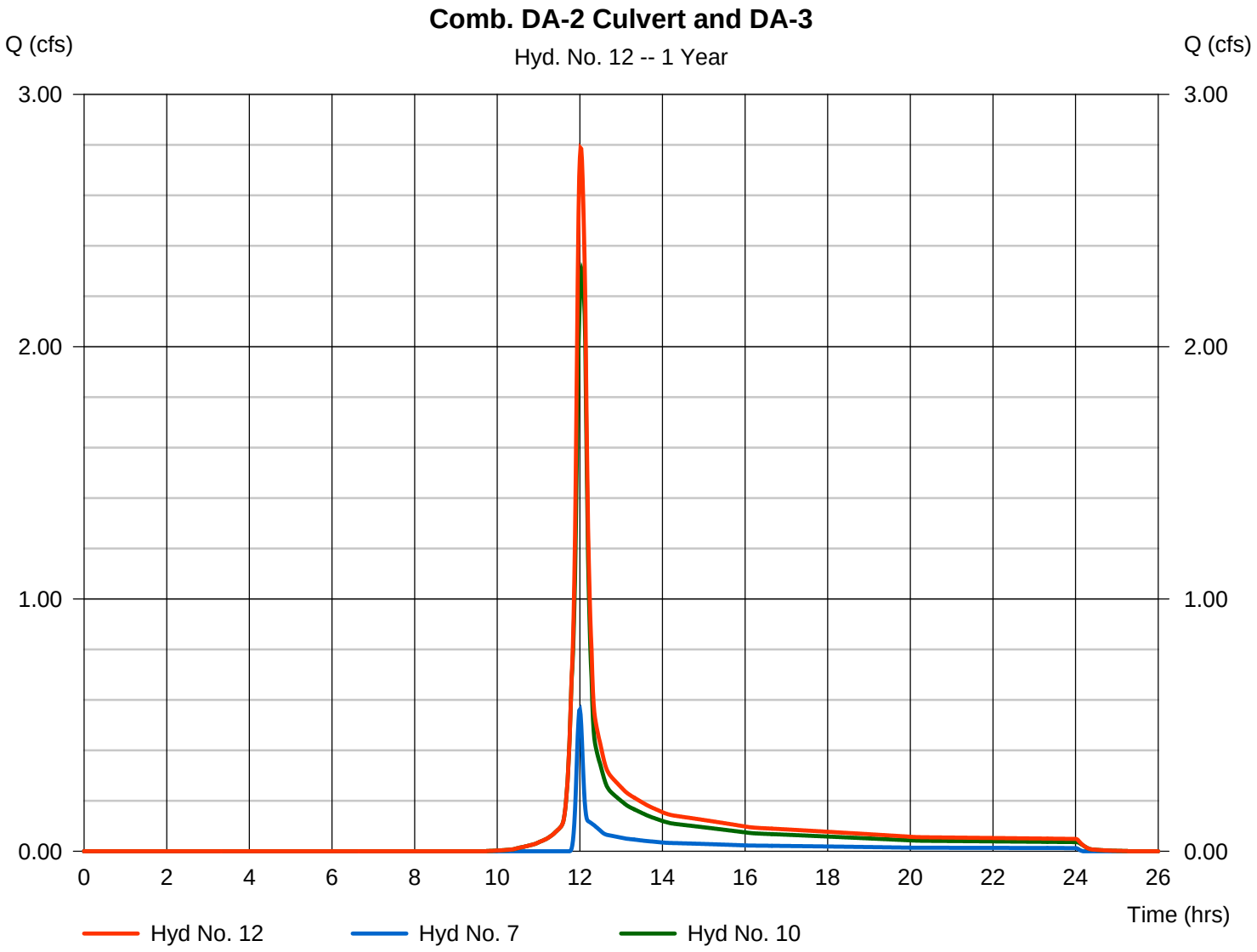
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 2.788 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.02 hrs |
| Time interval | = 1 min | Hyd. volume | = 8,017 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 1.030 ac |



# Hydrograph Report

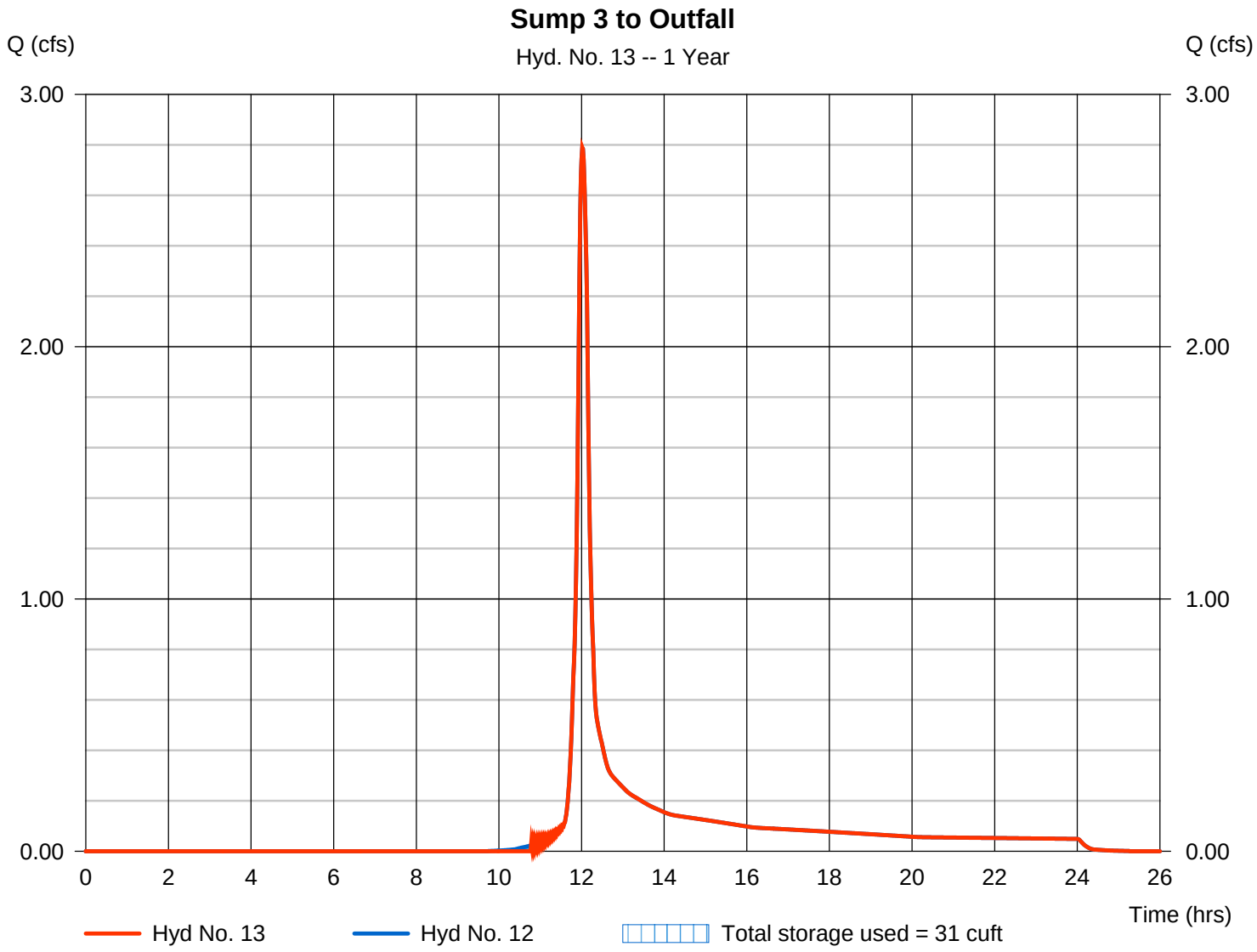
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 2.790 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | 12.02 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 7,987 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.06 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 31 cuft |

Storage Indication method used.



# Pond Report



## Pond No. 1 - Sump 3

### Pond Data

**Contours -**User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 7.50 ft

### Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 7.50 | 20 | 0 | 0 |
| 0.50 | 8.00 | 20 | 10 | 10 |
| 1.00 | 8.50 | 20 | 10 | 20 |
| 1.50 | 9.00 | 20 | 10 | 30 |
| 2.00 | 9.50 | 20 | 10 | 40 |
| 2.50 | 10.00 | 20 | 10 | 50 |
| 3.00 | 10.50 | 50 | 17 | 67 |
| 3.50 | 11.00 | 520 | 122 | 189 |
| 3.75 | 11.25 | 1,058 | 193 | 382 |
| 4.00 | 11.50 | 1,537 | 322 | 705 |
| 4.50 | 12.00 | 2,643 | 1,032 | 1,737 |

### Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 24.00 | | | |
| **Span (in)** | = 24.00 | | | |
| **No. Barrels** | = 1 | | | |
| **Invert El. (ft)** | = 7.50 | | | |
| **Length (ft)** | = 53.00 | | | |
| **Slope (%)** | = 1.20 | | | |
| **N-Value** | = .023 | | | |
| **Orifice Coeff.** | = 0.60 | | | |
| **Multi-Stage** | = n/a | | | |

### Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 65.00 | 75.00 | | |
| **Crest El. (ft)** | = 11.25 | 11.50 | | |
| **Weir Coeff.** | = 2.60 | 2.60 | | |
| **Weir Type** | = Broad | Broad | | |
| **Multi-Stage** | = No | No | | |
| **Exfil.(in/hr)** | = 0 (by Contour) | | | |
| **TW Elev. (ft)** | = 9.00 | | | |

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

| Stage ft | Storage cuft | Elevation ft | Clv A cfs | Clv B cfs | Clv C cfs | PrfRsr cfs | Wr A cfs | Wr B cfs | Wr C cfs | Wr D cfs | Exfil cfs | User cfs | Total cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 7.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 0.50 | 10 | 8.00 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 1.00 | 20 | 8.50 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 1.50 | 30 | 9.00 | 0.00 | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 0.000 |
| 2.00 | 40 | 9.50 | 9.47 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 9.468 |
| 2.50 | 50 | 10.00 | 13.39 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 13.39 |
| 3.00 | 67 | 10.50 | 16.40 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 16.40 |
| 3.50 | 189 | 11.00 | 18.94 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 18.94 |
| 3.75 | 382 | 11.25 | 20.08 oc | --- | --- | --- | 0.00 | 0.00 | --- | --- | --- | --- | 20.08 |
| 4.00 | 705 | 11.50 | 21.17 oc | --- | --- | --- | 21.13 | 0.00 | --- | --- | --- | --- | 42.30 |
| 4.50 | 1,737 | 12.00 | 23.19 oc | --- | --- | --- | 109.77 | 68.94 | --- | --- | --- | --- | 201.90 |

# Hydrograph Report

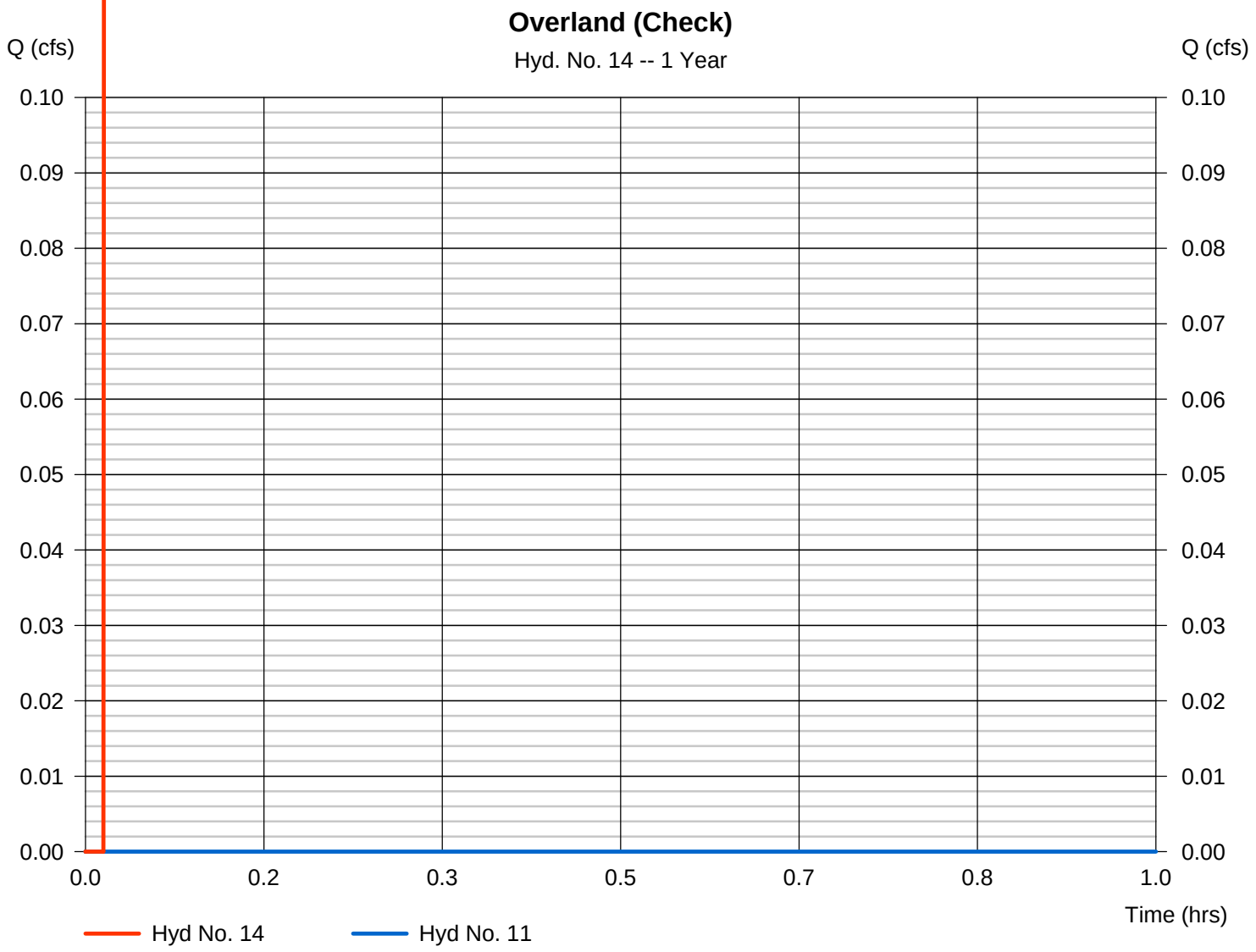


## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 1 yrs | Time to peak | = | n/a |
| Time interval | = | 1 min | Hyd. volume | = | -1 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | -1.#J ft/s | Routing coeff. | = | -1.#IND |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 3.924 | 1 | 719 | 8,879 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 3.920 | 1 | 719 | 8,879 | 1 | 15.57 | 17.1 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 3.920 | 1 | 719 | 8,879 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 717 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | 696 | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 0.238 | 1 | 718 | 496 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 1.098 | 1 | 719 | 2,505 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 4.152 | 1 | 719 | 9,375 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 2.971 | 1 | 724 | 9,373 | 8 | 11.00 | 1,074 | Sump 2 |
| 10 | Diversion1 | 2.992 | 1 | 724 | 9,404 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | n/a | -31 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 3.859 | 1 | 721 | 11,909 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 3.857 | 1 | 721 | 11,879 | 12 | 9.10 | 32.0 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | n/a | -1 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

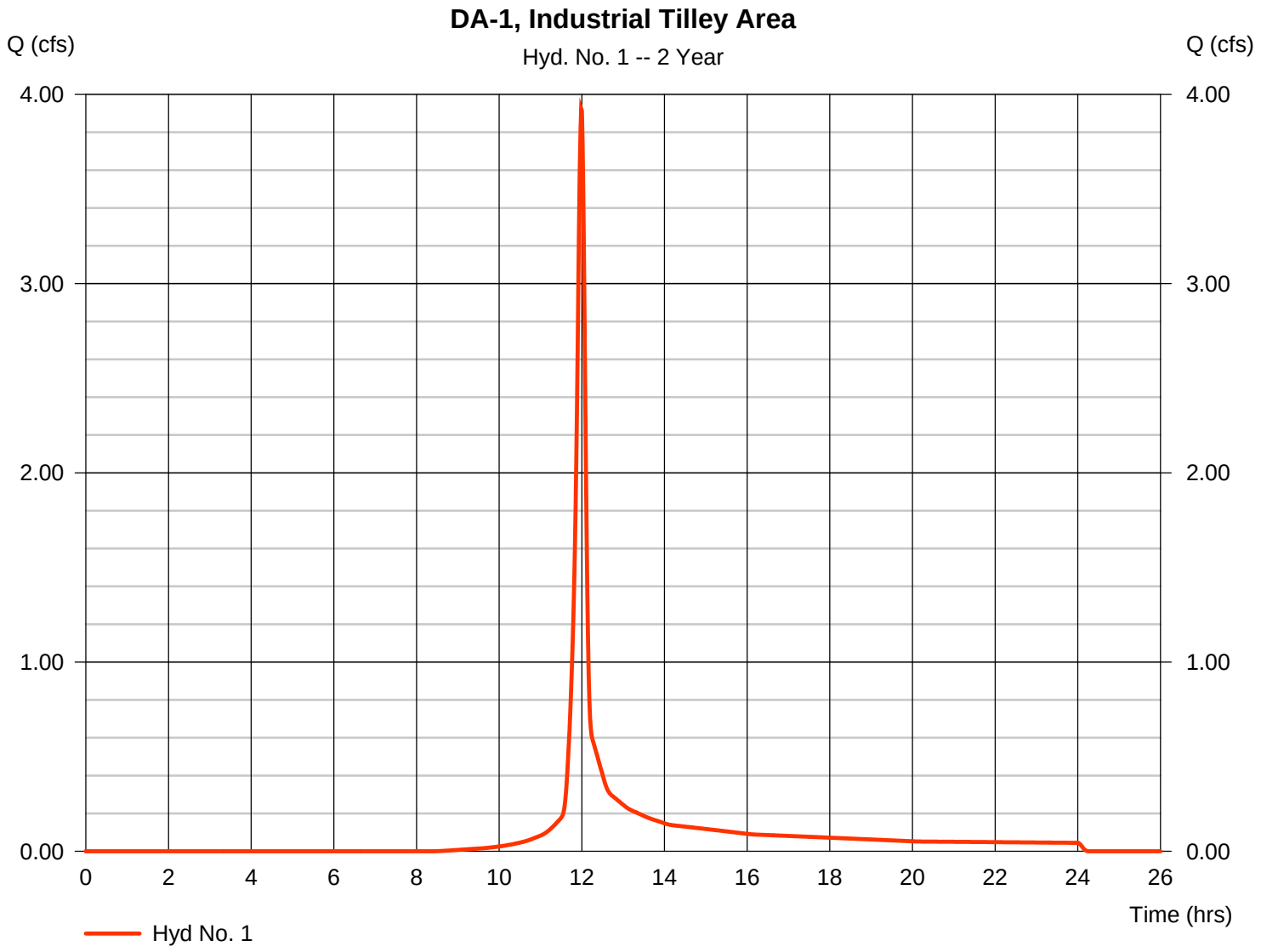
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 3.924 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 8,879 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

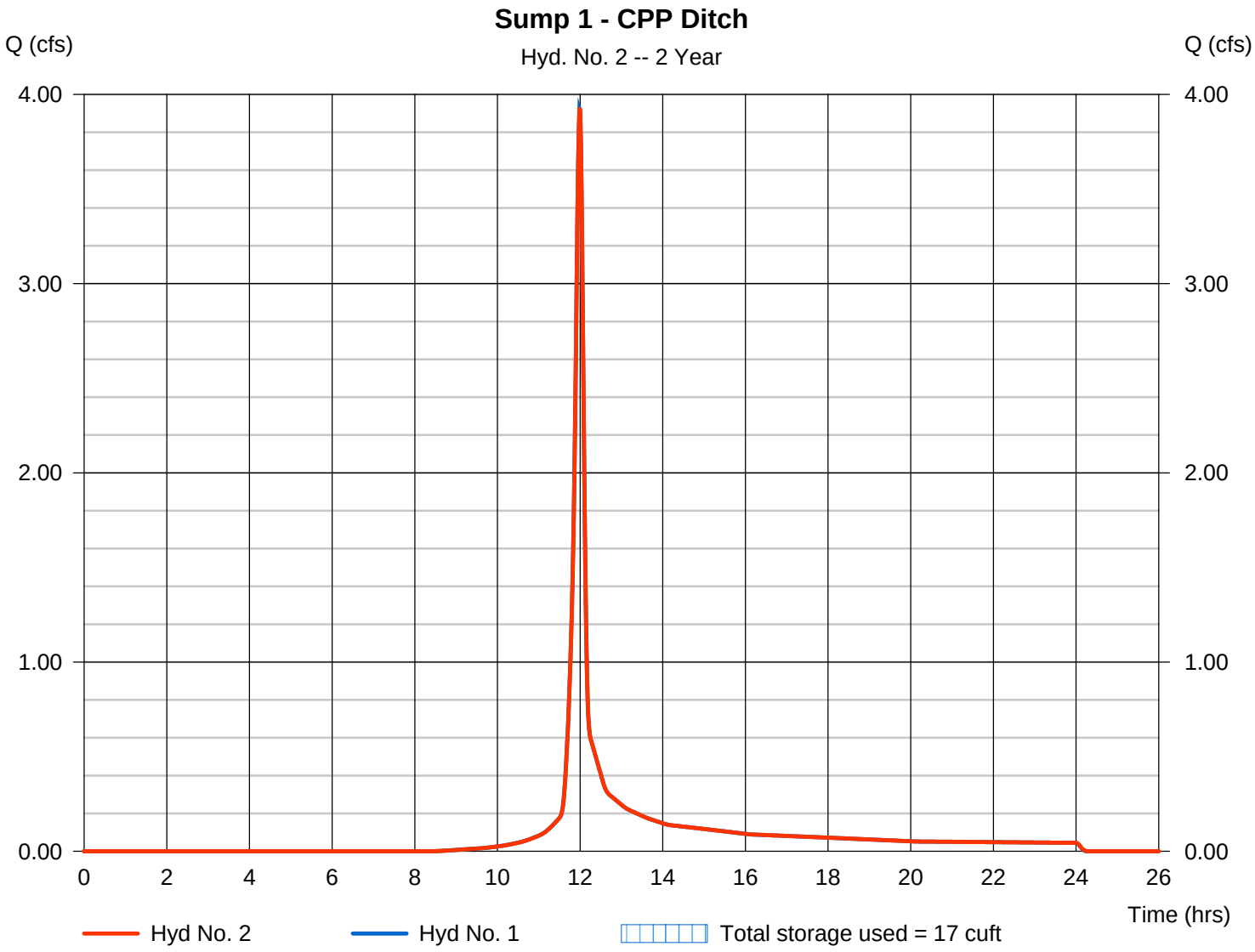
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.920 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 11.98 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 8,879 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 15.57 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 17 cuft |

Storage Indication method used.



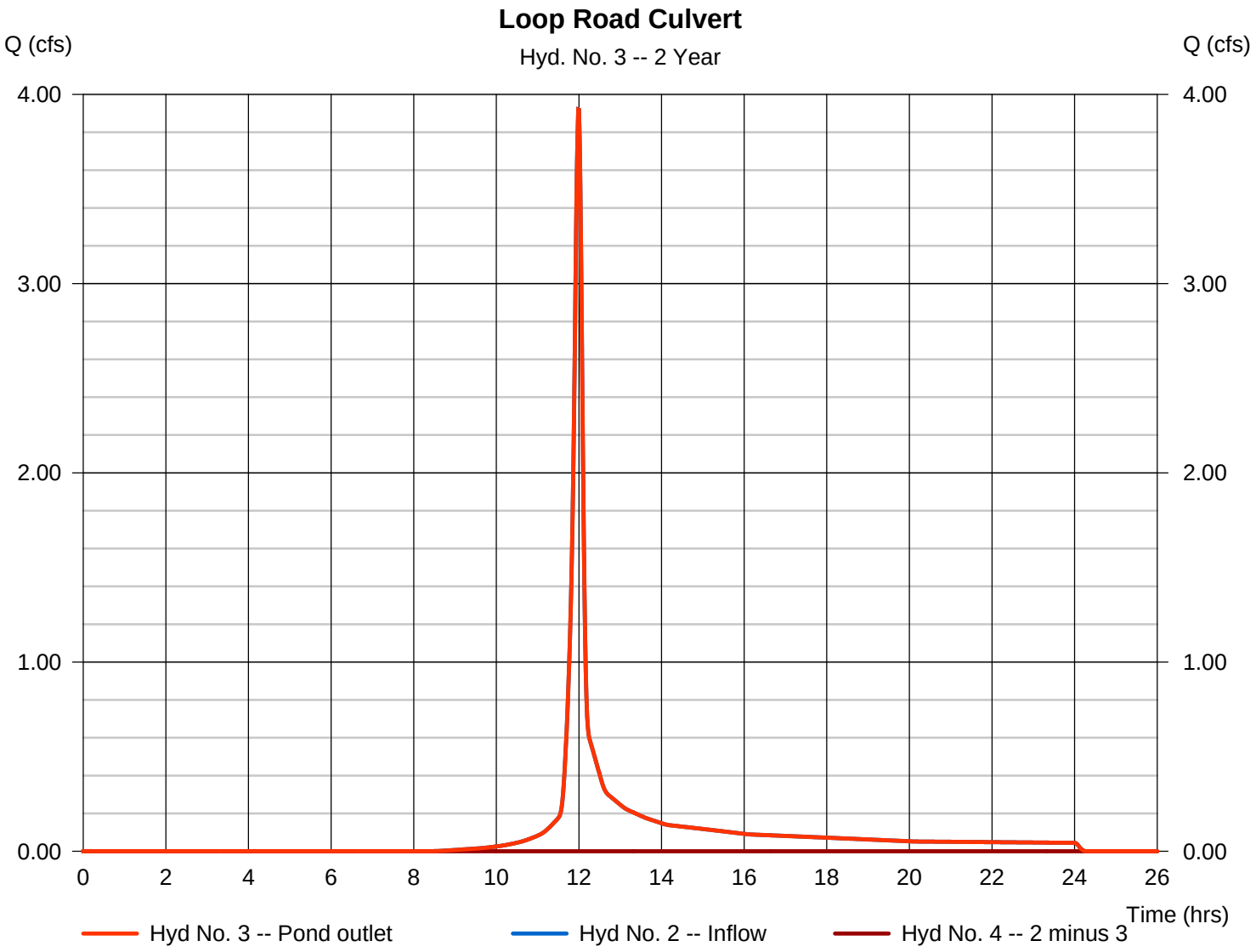
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 3.920 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 8,879 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



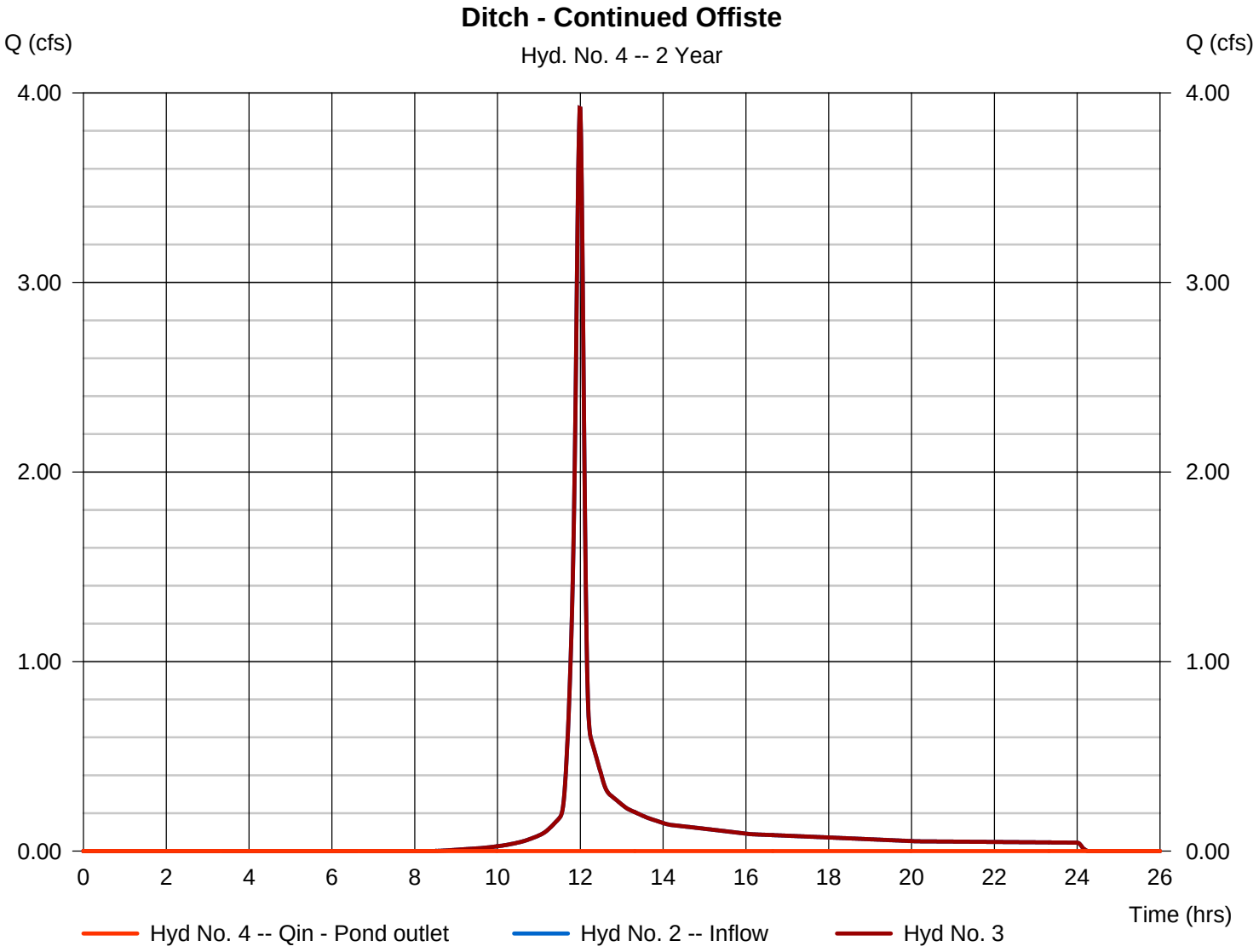
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.95 hrs |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

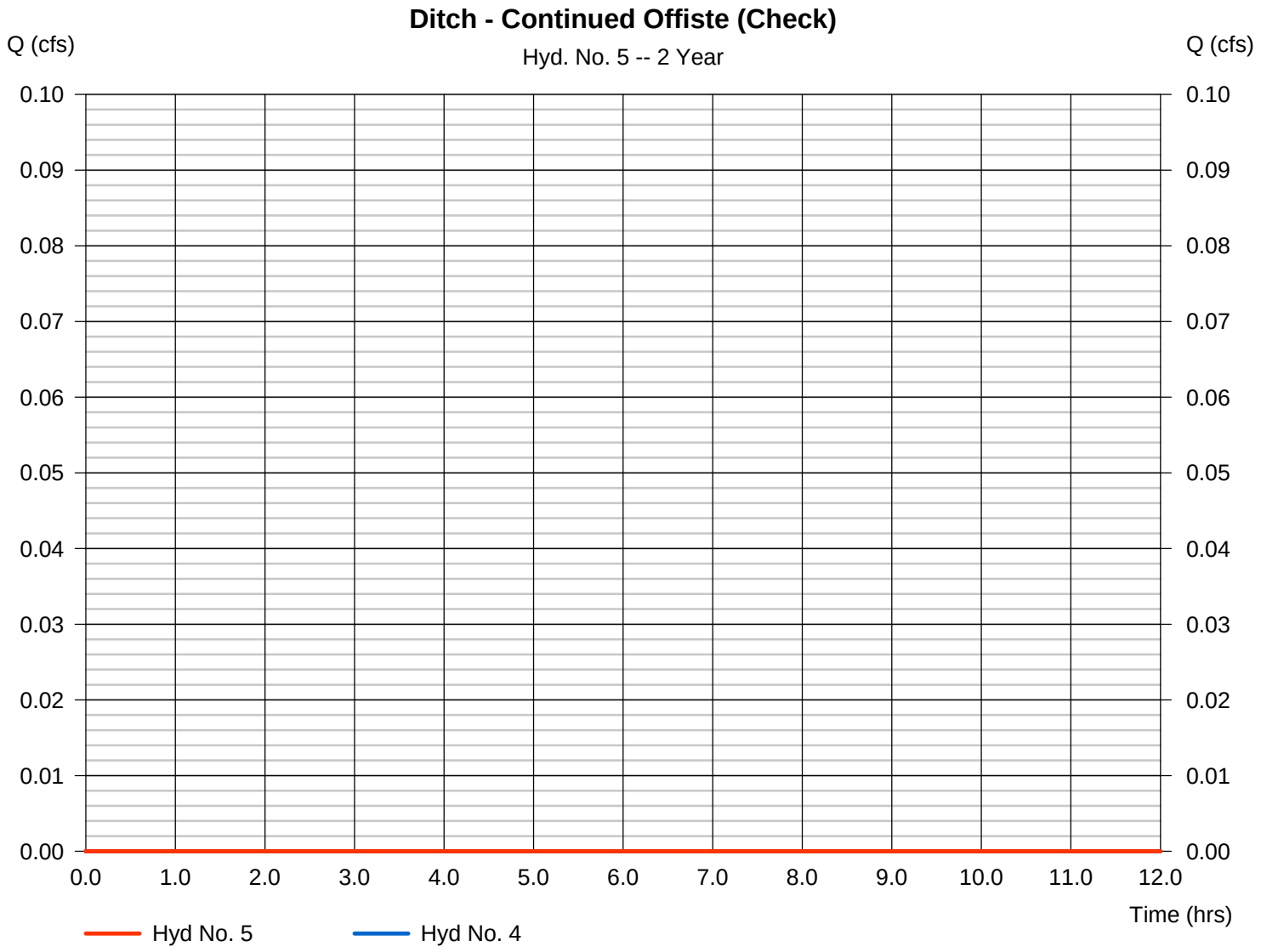
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | |
|---|---|---|---|
| Hydrograph type | = Reach | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.60 hrs |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hyd. No. | = 4 - Ditch - Continued Offiste | Section type | = Triangular |
| Reach length | = 500.0 ft | Channel slope | = 1.6 % |
| Manning's n | = 0.200 | Bottom width | = 0.0 ft |
| Side slope | = 1.0:1 | Max. depth | = 0.0 ft |
| Rating curve x | = 0.595 | Rating curve m | = 1.333 |
| Ave. velocity | = 0.01 ft/s | Routing coeff. | = 0.0024 |

Modified Att-Kin routing method used.



# Hydrograph Report

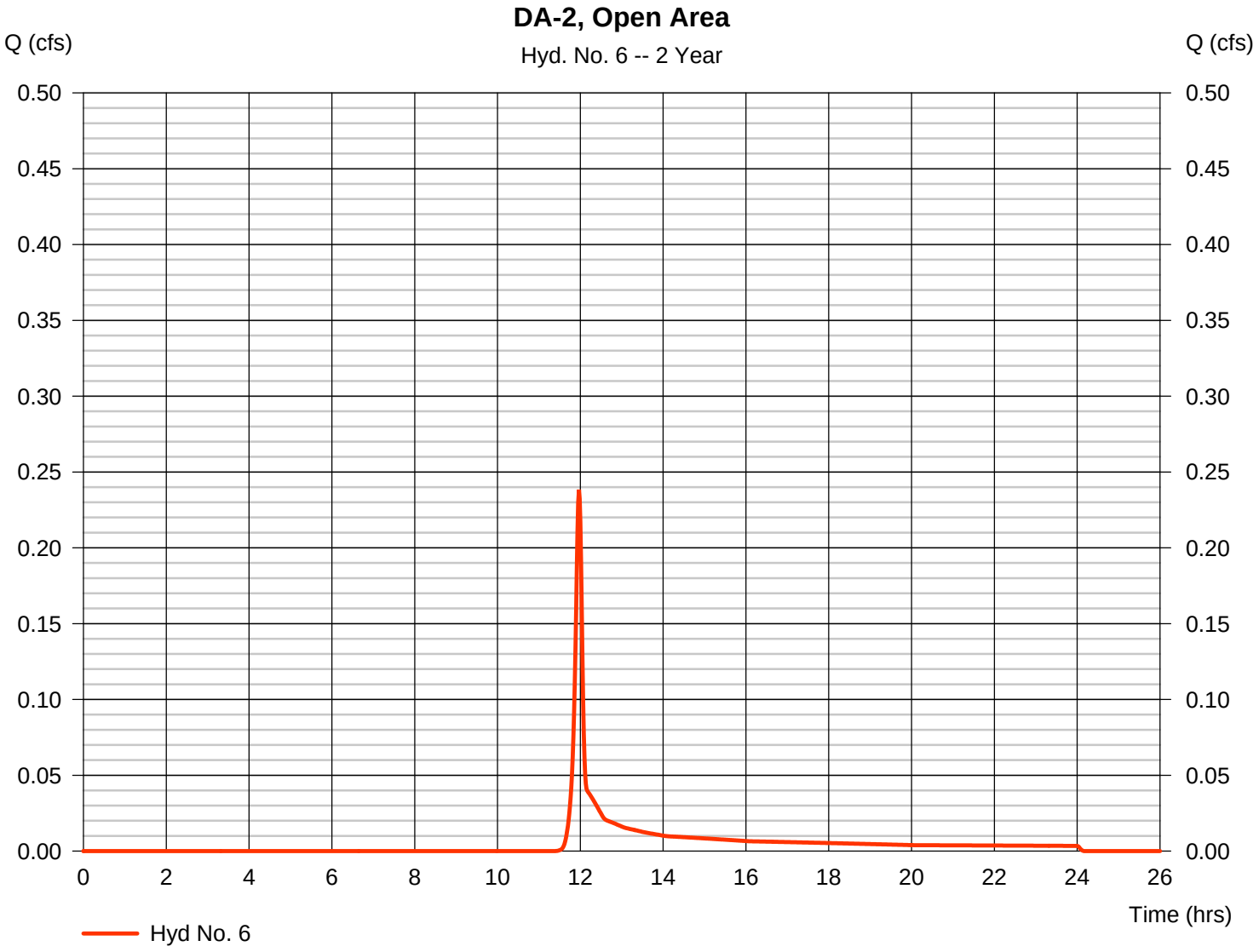
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.238 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.97 hrs |
| Time interval | = 1 min | Hyd. volume | = 496 cuft |
| Drainage area | = 0.160 ac | Curve number | = 70* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 5.50 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.040 x 98) + (0.120 x 61)] / 0.160



# Hydrograph Report

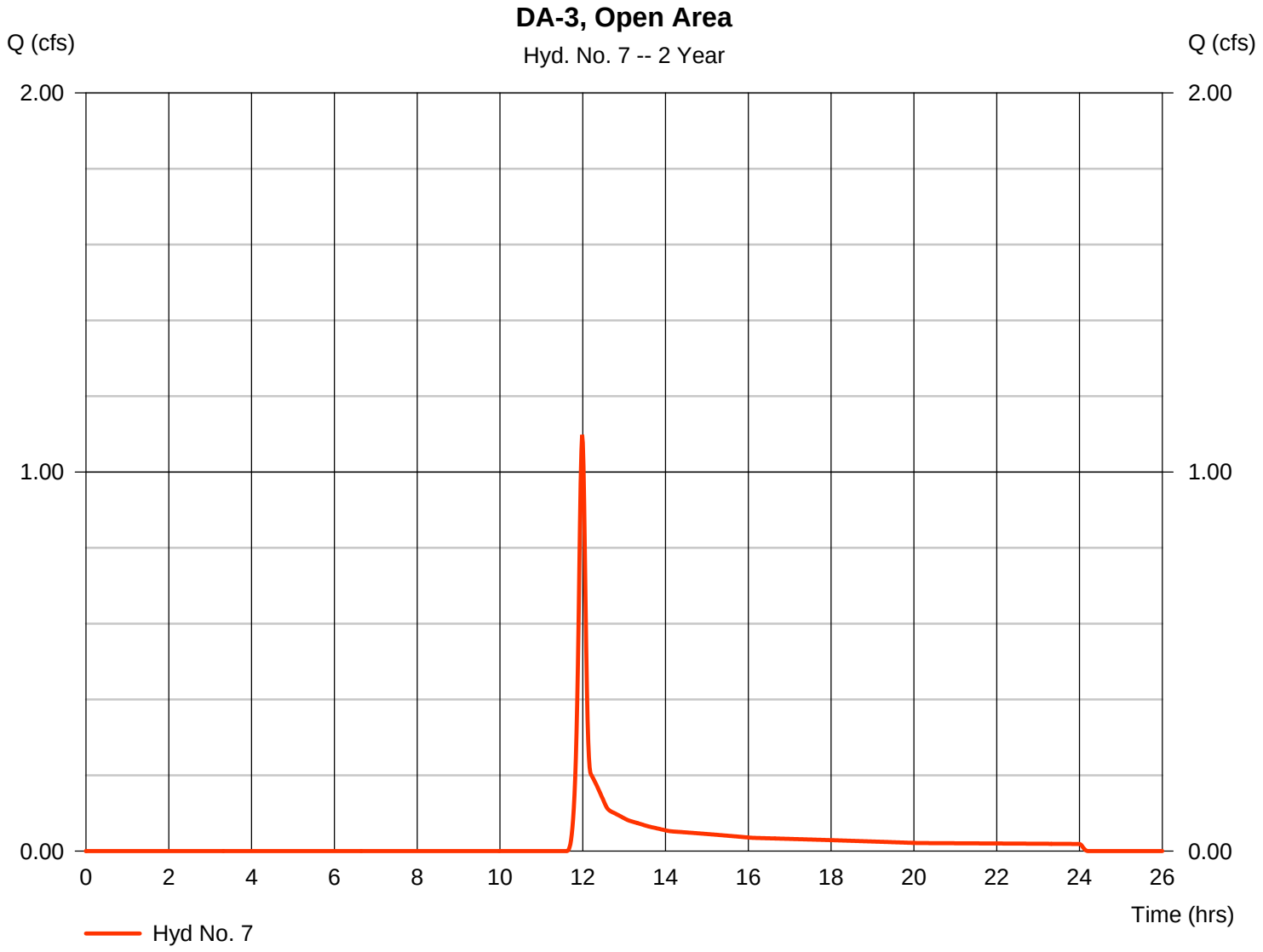
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 1.098 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 2,505 cuft |
| Drainage area | = 1.030 ac | Curve number | = 67* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 7.00 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.860 x 61) + (0.170 x 98)] / 1.030



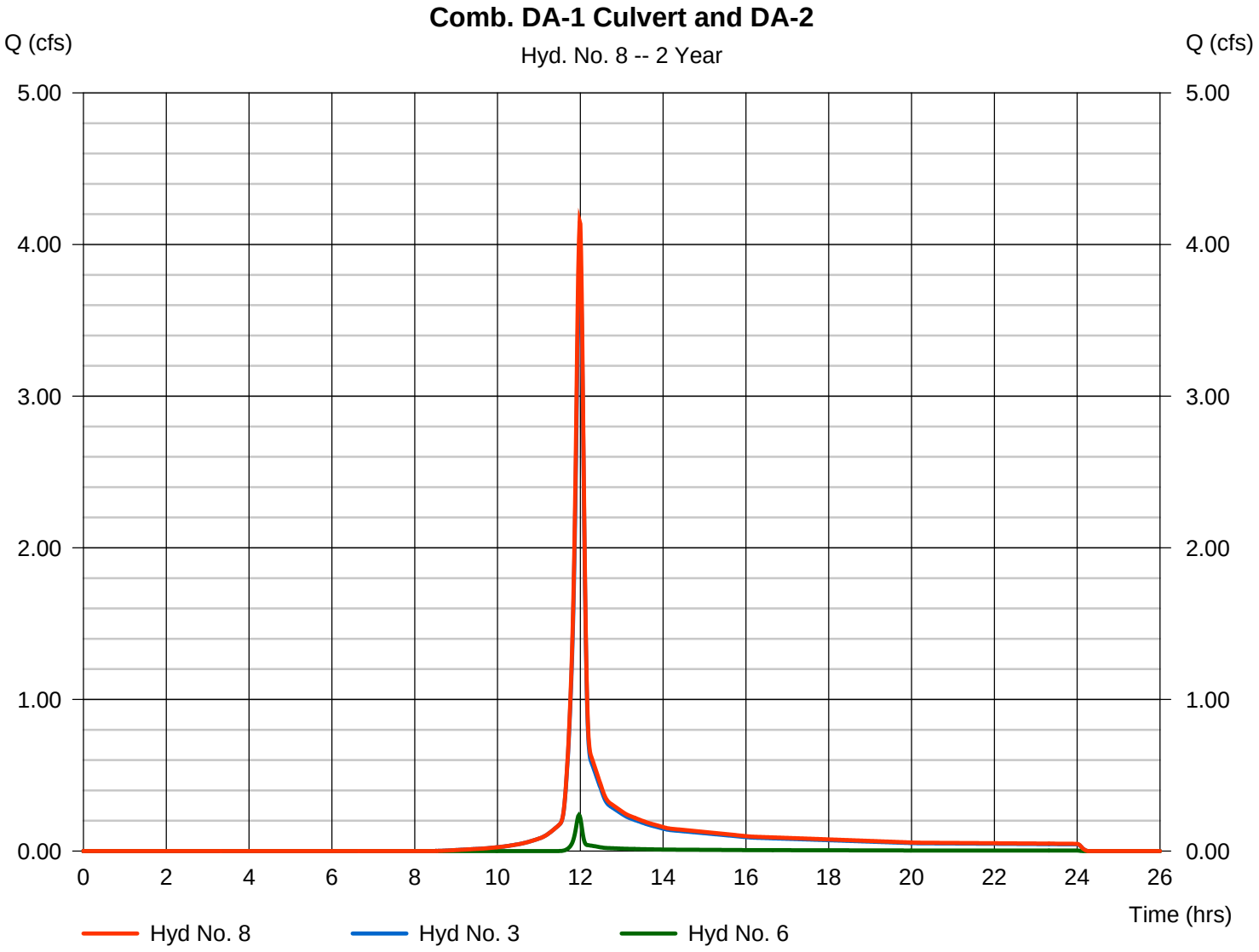
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 4.152 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 9,375 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.160 ac |



# Hydrograph Report

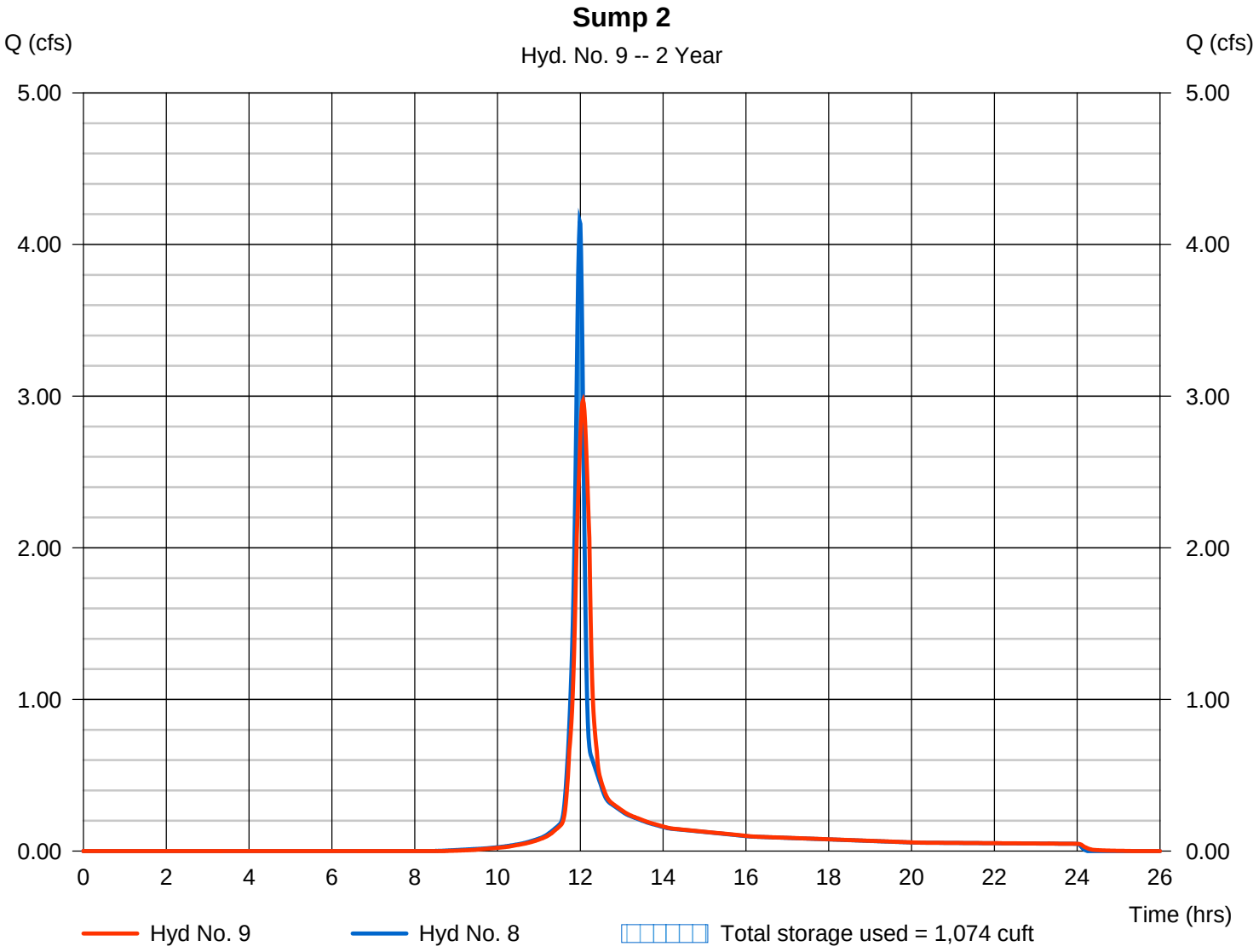
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 2.971 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 9,373 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 11.00 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 1,074 cuft |

Storage Indication method used.



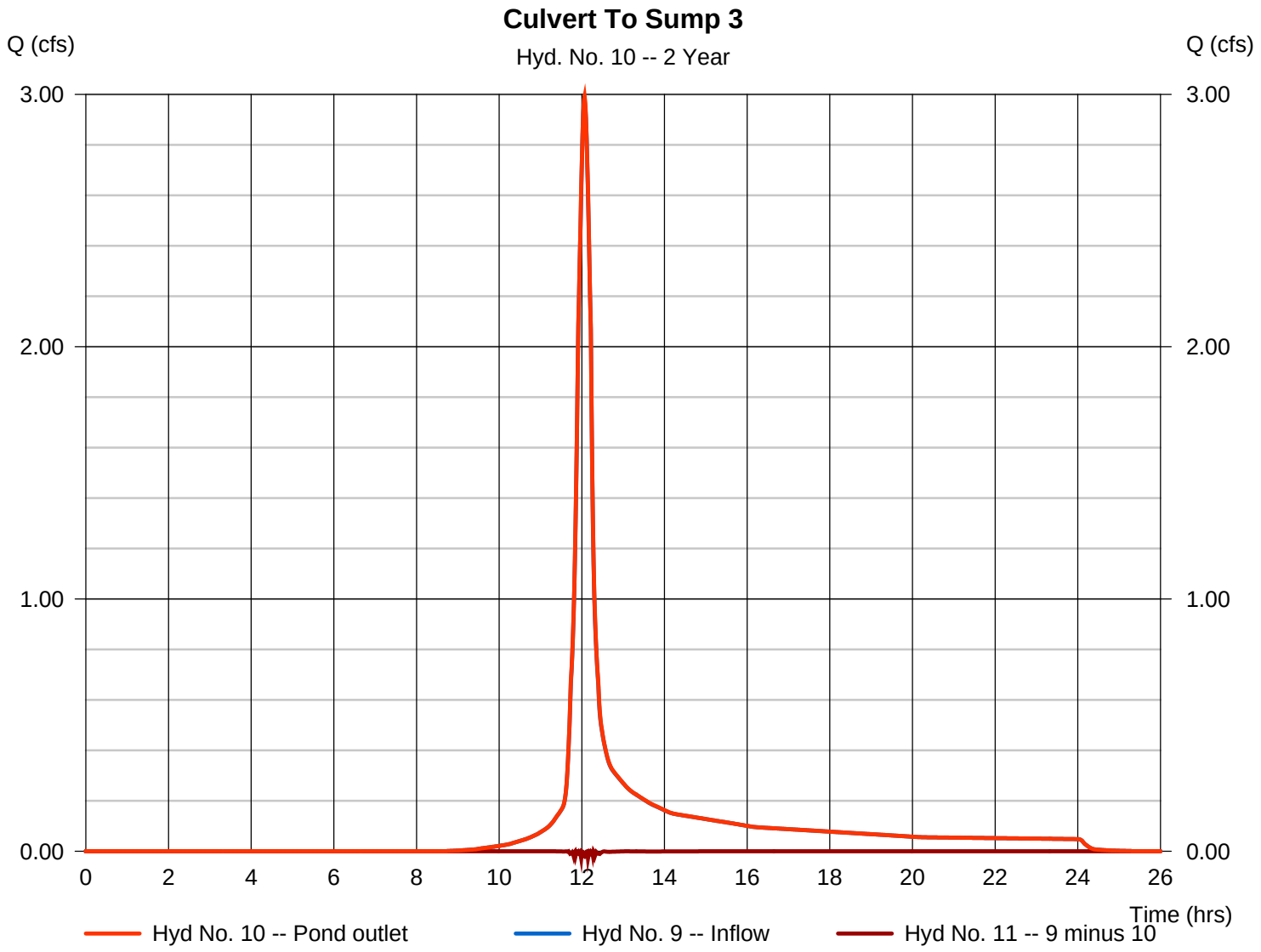
# Hydrograph Report



## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 2.992 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 12.07 hrs |
| Time interval | = 1 min | Hyd. volume | = 9,404 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



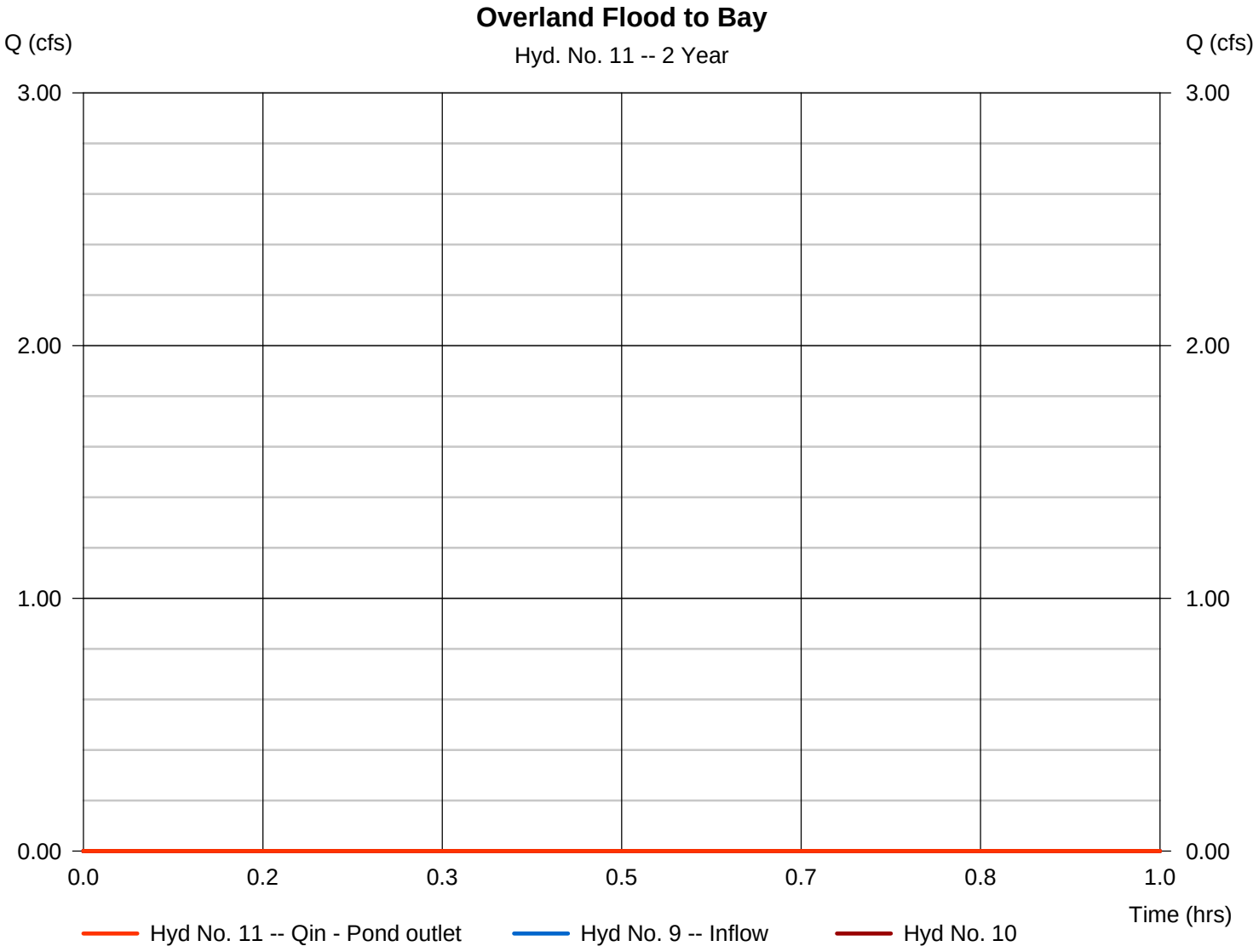
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = n/a |
| Time interval | = 1 min | Hyd. volume | = -31 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



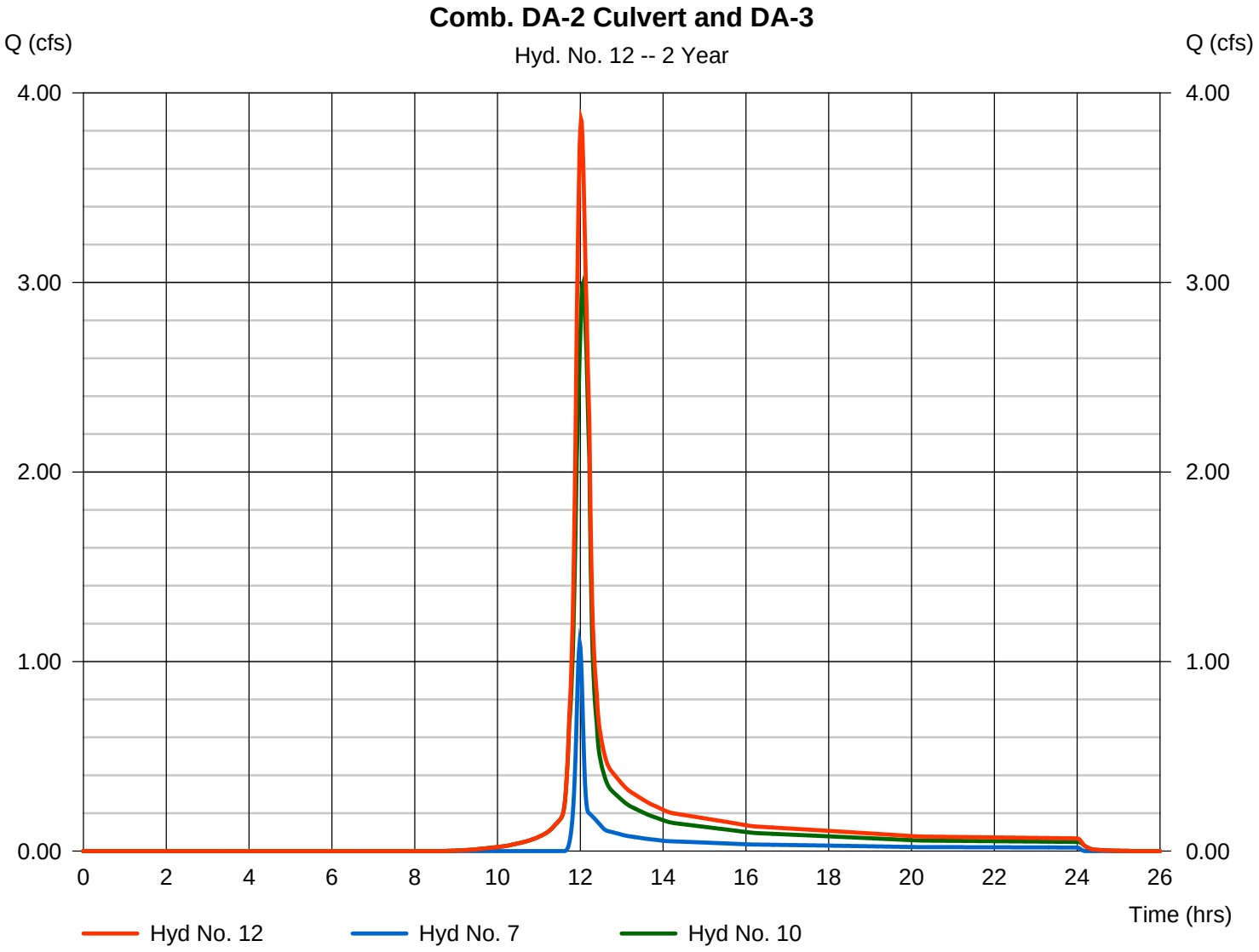
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 3.859 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 12.02 hrs |
| Time interval | = 1 min | Hyd. volume | = 11,909 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 1.030 ac |



# Hydrograph Report

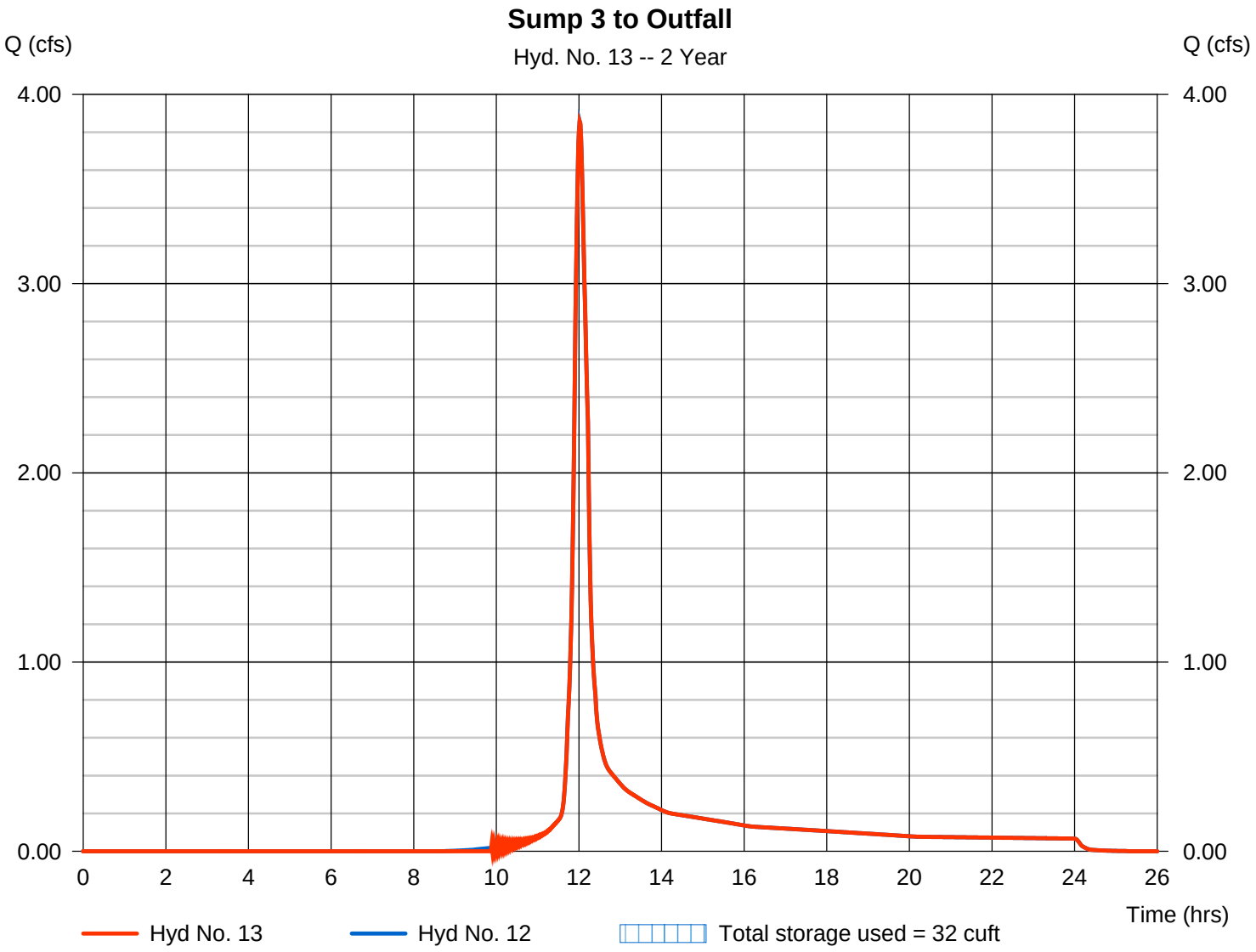
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.857 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.02 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 11,879 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.10 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 32 cuft |

Storage Indication method used.



# Hydrograph Report

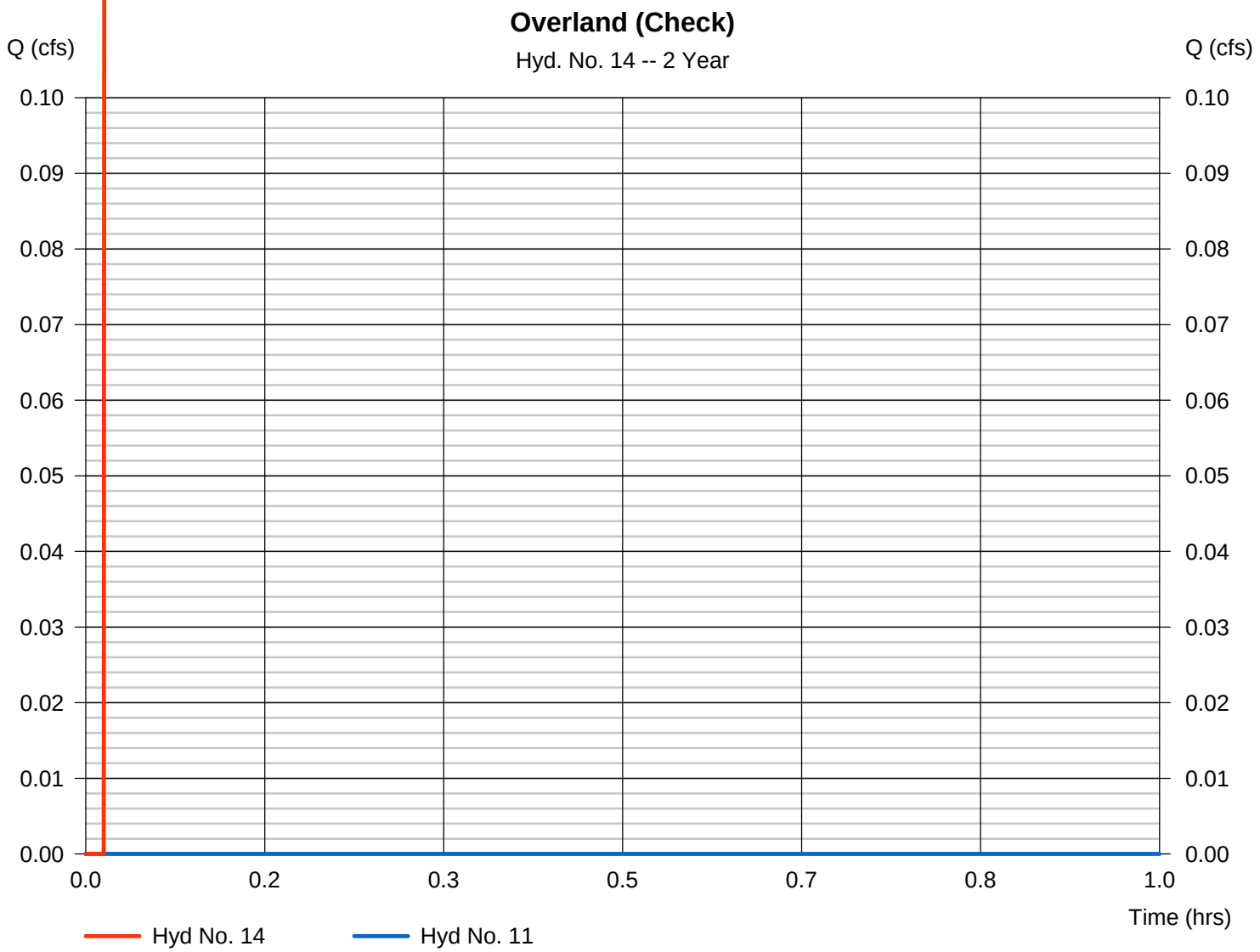
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 14

Overland (Check)

| | | | |
|---|---|---|---|
| Hydrograph type | = Reach | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = n/a |
| Time interval | = 1 min | Hyd. volume | = -1 cuft |
| Inflow hyd. No. | = 11 - Overland Flood to Bay | Section type | = Trapezoidal |
| Reach length | = 100.0 ft | Channel slope | = 1.0 % |
| Manning's n | = 0.100 | Bottom width | = 200.0 ft |
| Side slope | = 0.5:1 | Max. depth | = 1.0 ft |
| Rating curve x | = 0.043 | Rating curve m | = 1.652 |
| Ave. velocity | = -1.#J ft/s | Routing coeff. | = -1.#IND |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 7.832 | 1 | 719 | 18,013 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 7.743 | 1 | 720 | 18,013 | 1 | 17.34 | 74.2 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 7.743 | 1 | 720 | 18,013 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 0.000 | 1 | 711 | 0 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 0.000 | 1 | n/a | 0 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 0.630 | 1 | 718 | 1,264 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 3.229 | 1 | 719 | 6,828 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 8.296 | 1 | 720 | 19,278 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 5.300 | 1 | 724 | 19,276 | 8 | 11.93 | 3,020 | Sump 2 |
| 10 | Diversion1 | 5.300 | 1 | 724 | 19,331 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | n/a | -55 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 7.757 | 1 | 721 | 26,159 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 7.760 | 1 | 721 | 26,129 | 12 | 9.33 | 36.5 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | n/a | -1 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

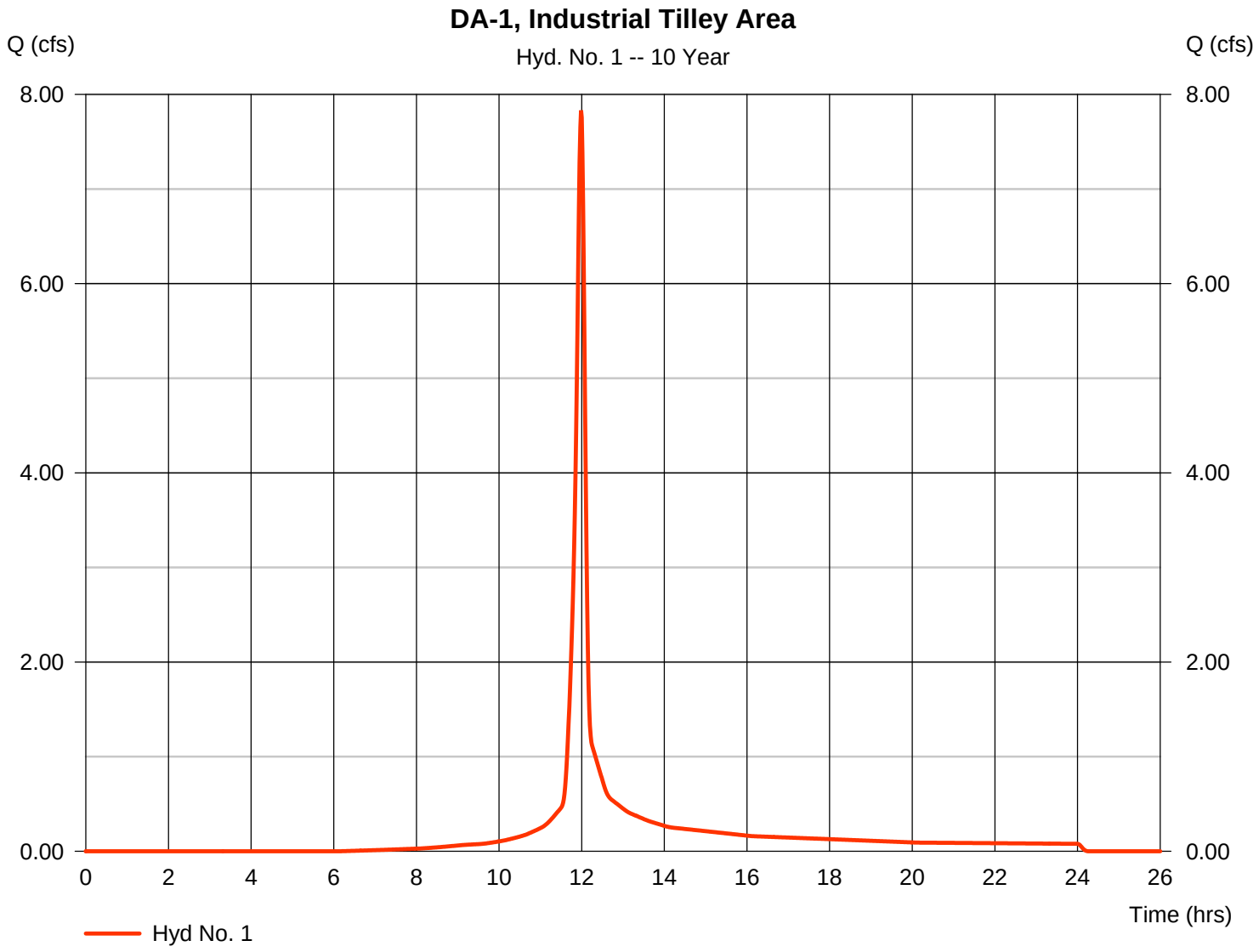
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 7.832 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 18,013 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 5.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

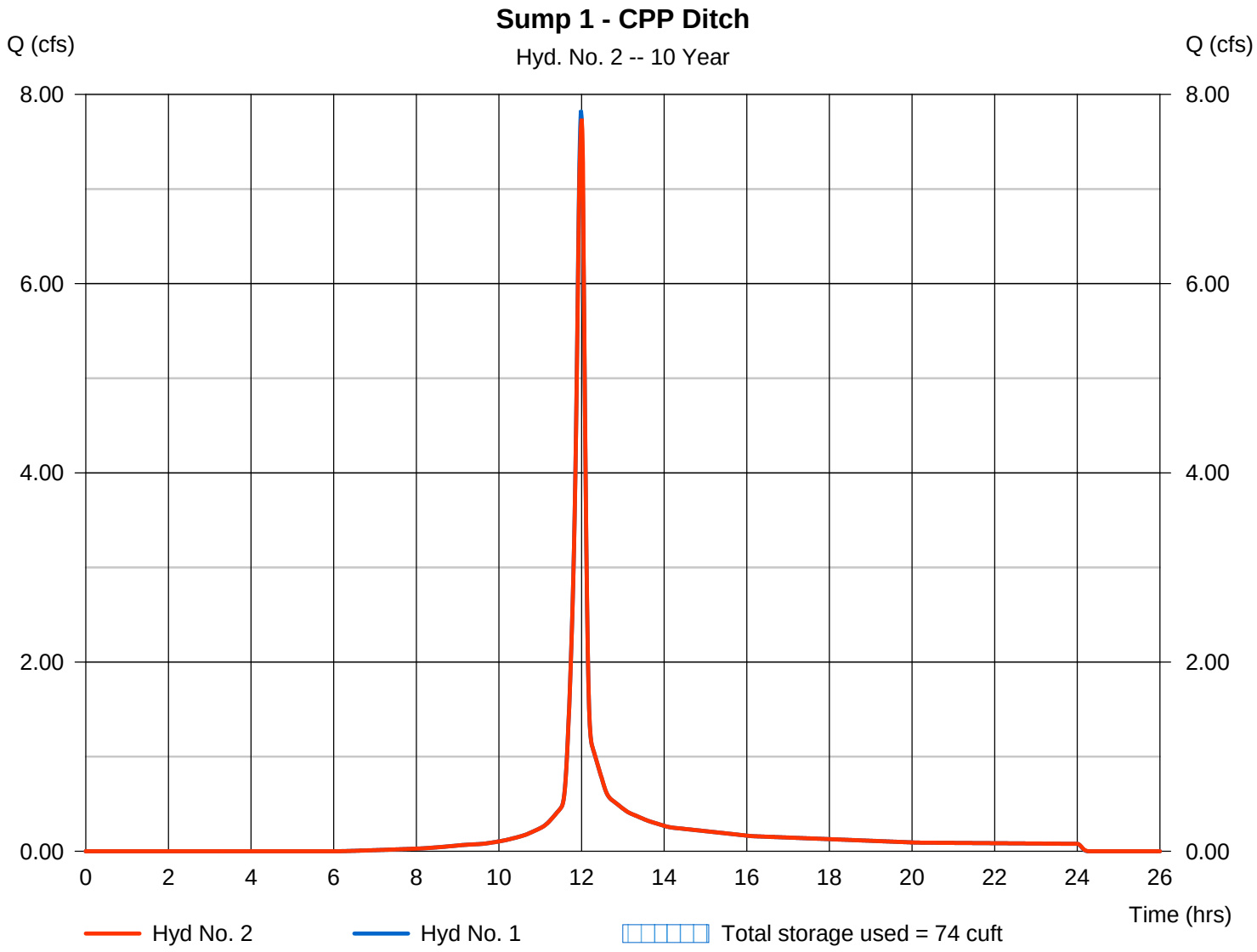
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 7.743 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 18,013 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 17.34 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 74 cuft |

Storage Indication method used.



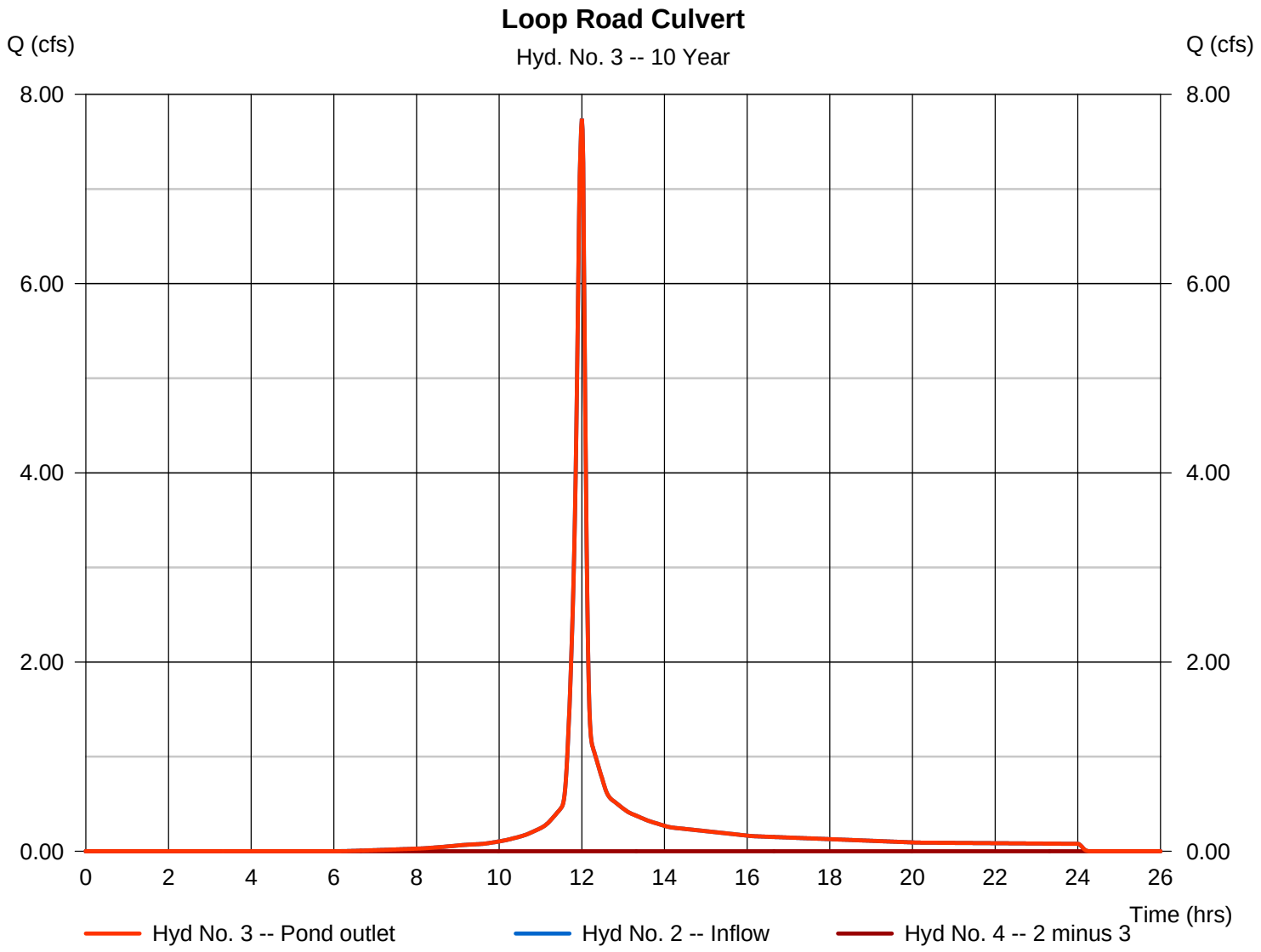
# Hydrograph Report



## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 7.743 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 18,013 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



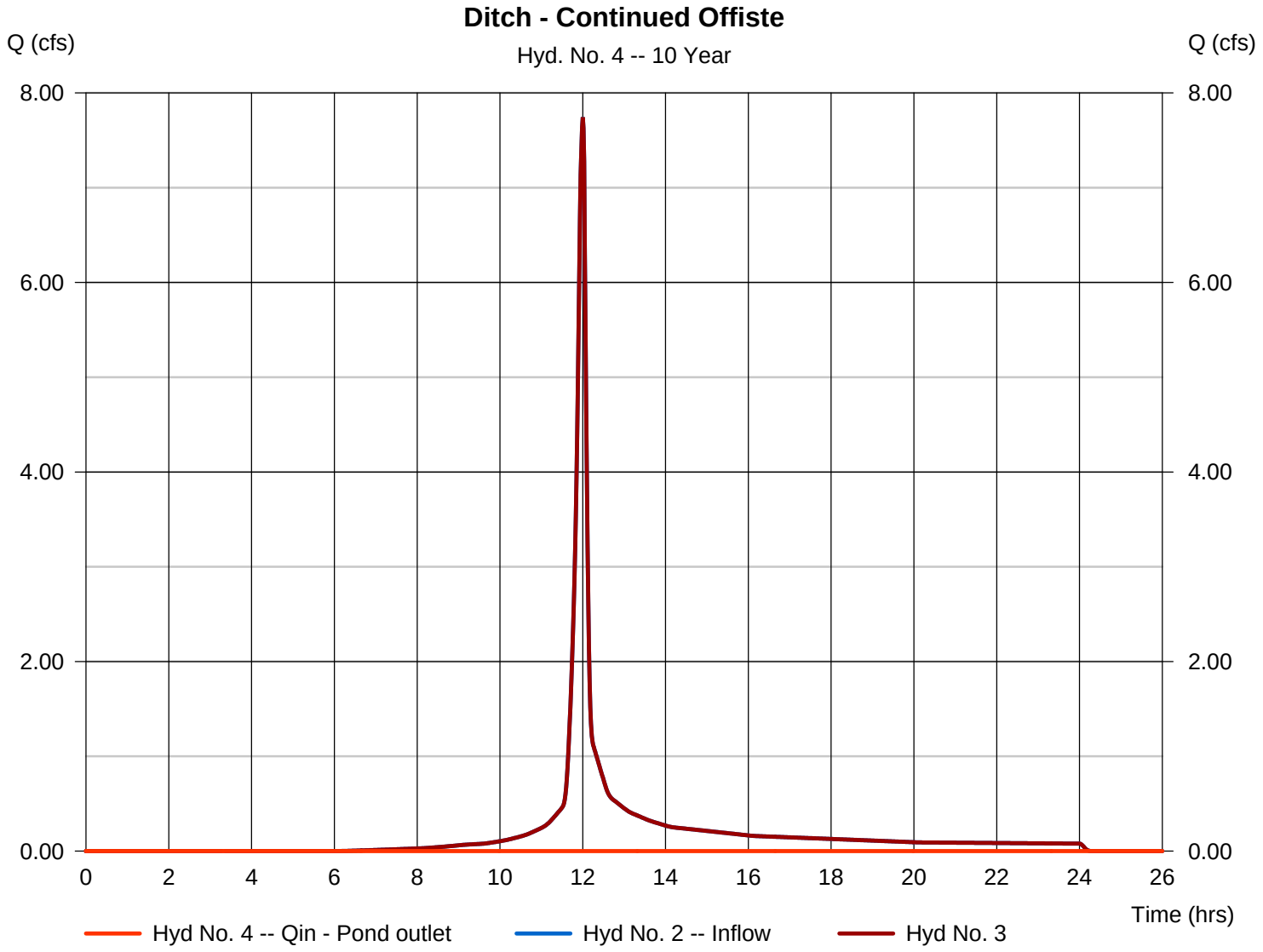
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 11.85 hrs |
| Time interval | = 1 min | Hyd. volume | = 0 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

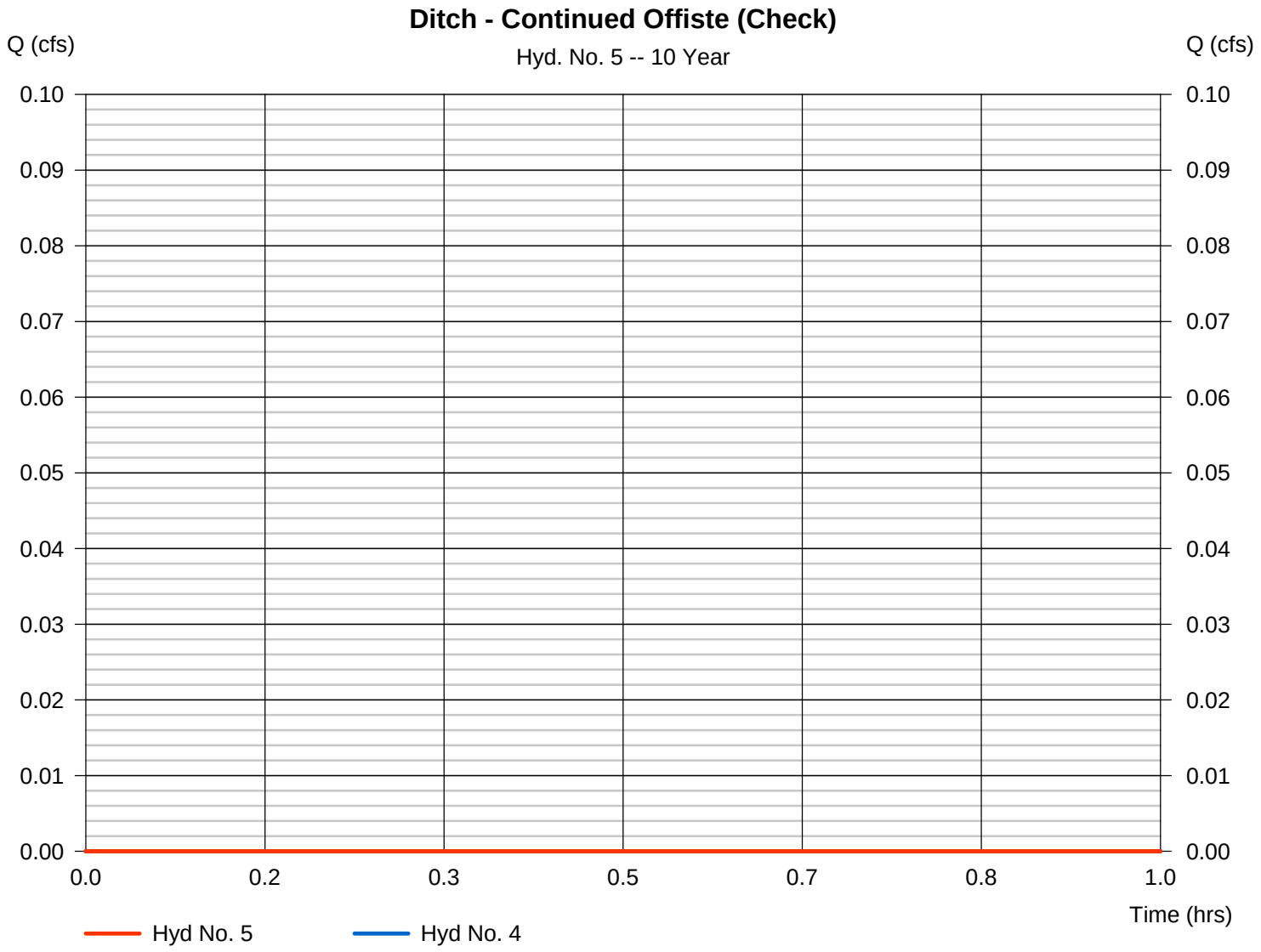
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | n/a |
| Time interval | = | 1 min | Hyd. volume | = | 0 cuft |
| Inflow hyd. No. | = | 4 - Ditch - Continued Offiste | Section type | = | Triangular |
| Reach length | = | 500.0 ft | Channel slope | = | 1.6 % |
| Manning's n | = | 0.200 | Bottom width | = | 0.0 ft |
| Side slope | = | 1.0:1 | Max. depth | = | 0.0 ft |
| Rating curve x | = | 0.595 | Rating curve m | = | 1.333 |
| Ave. velocity | = | 0.01 ft/s | Routing coeff. | = | 0.0024 |

Modified Att-Kin routing method used.



# Hydrograph Report

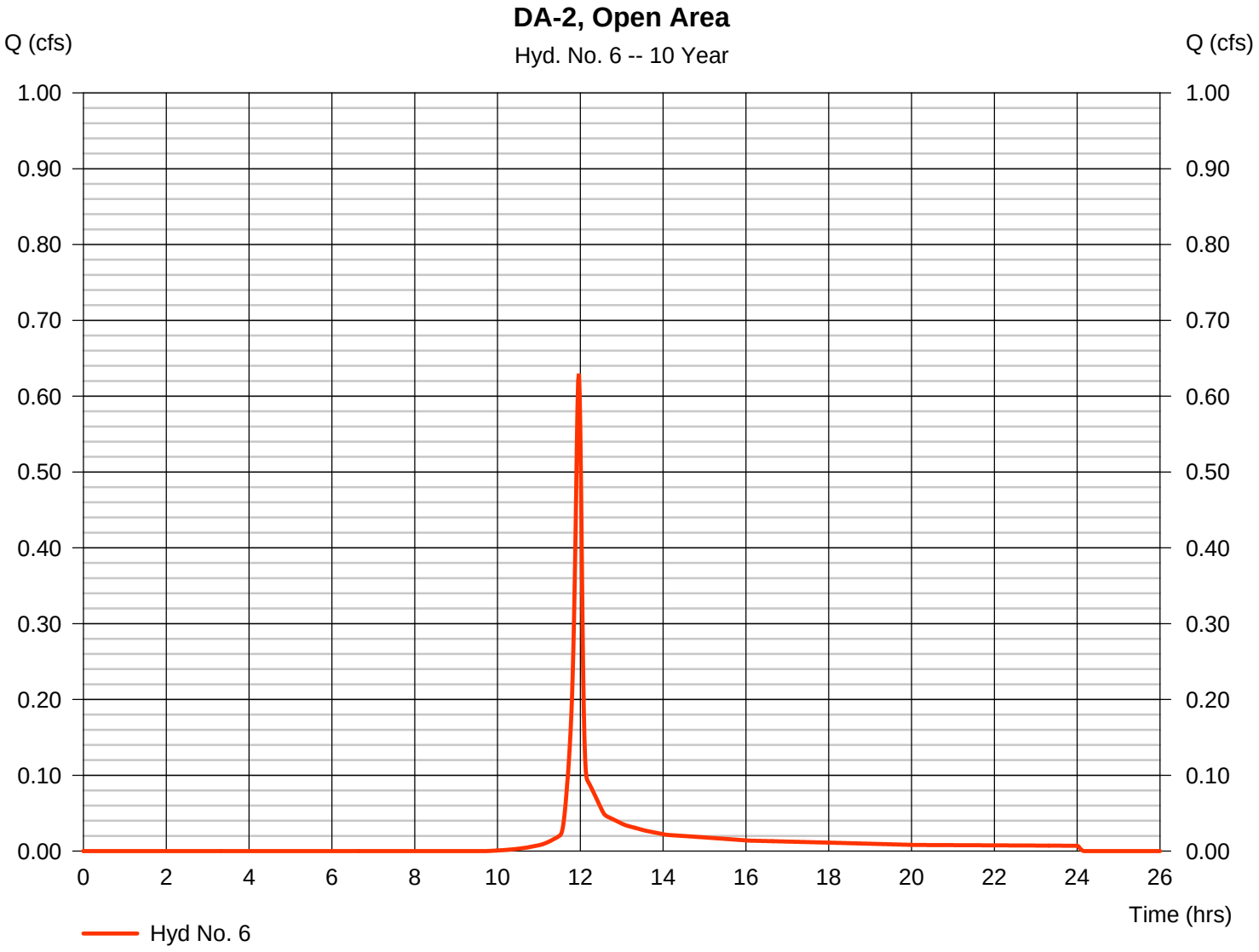
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.630 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 11.97 hrs |
| Time interval | = 1 min | Hyd. volume | = 1,264 cuft |
| Drainage area | = 0.160 ac | Curve number | = 70* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 5.50 min |
| Total precip. | = 5.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.040 x 98) + (0.120 x 61)] / 0.160



# Hydrograph Report

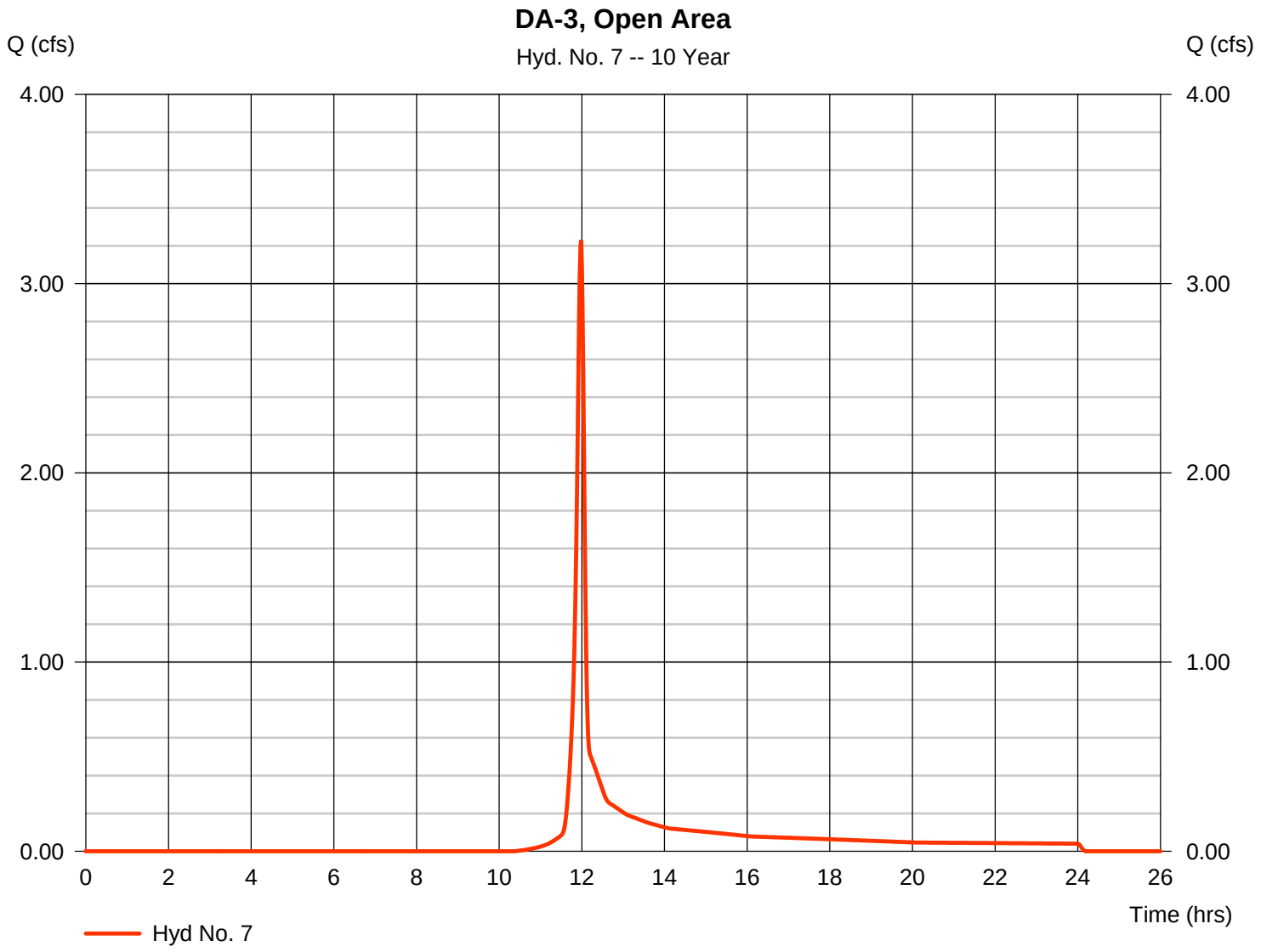
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 3.229 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,828 cuft |
| Drainage area | = 1.030 ac | Curve number | = 67* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 7.00 min |
| Total precip. | = 5.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.860 x 61) + (0.170 x 98)] / 1.030



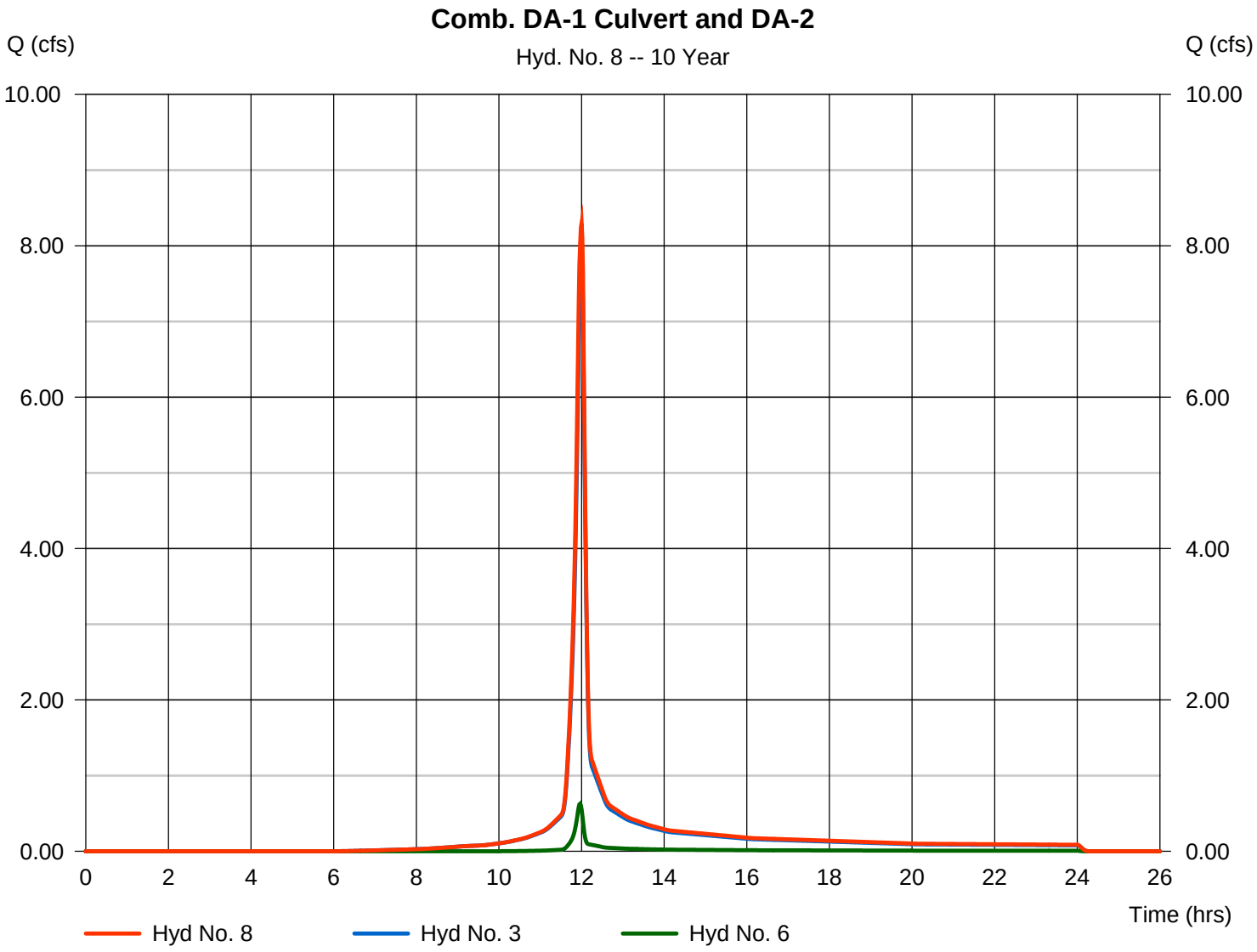
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 8.296 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 19,278 cuft |
| Inflow hyds. | = 3, 6 | Contrib. drain. area | = 0.160 ac |



# Hydrograph Report

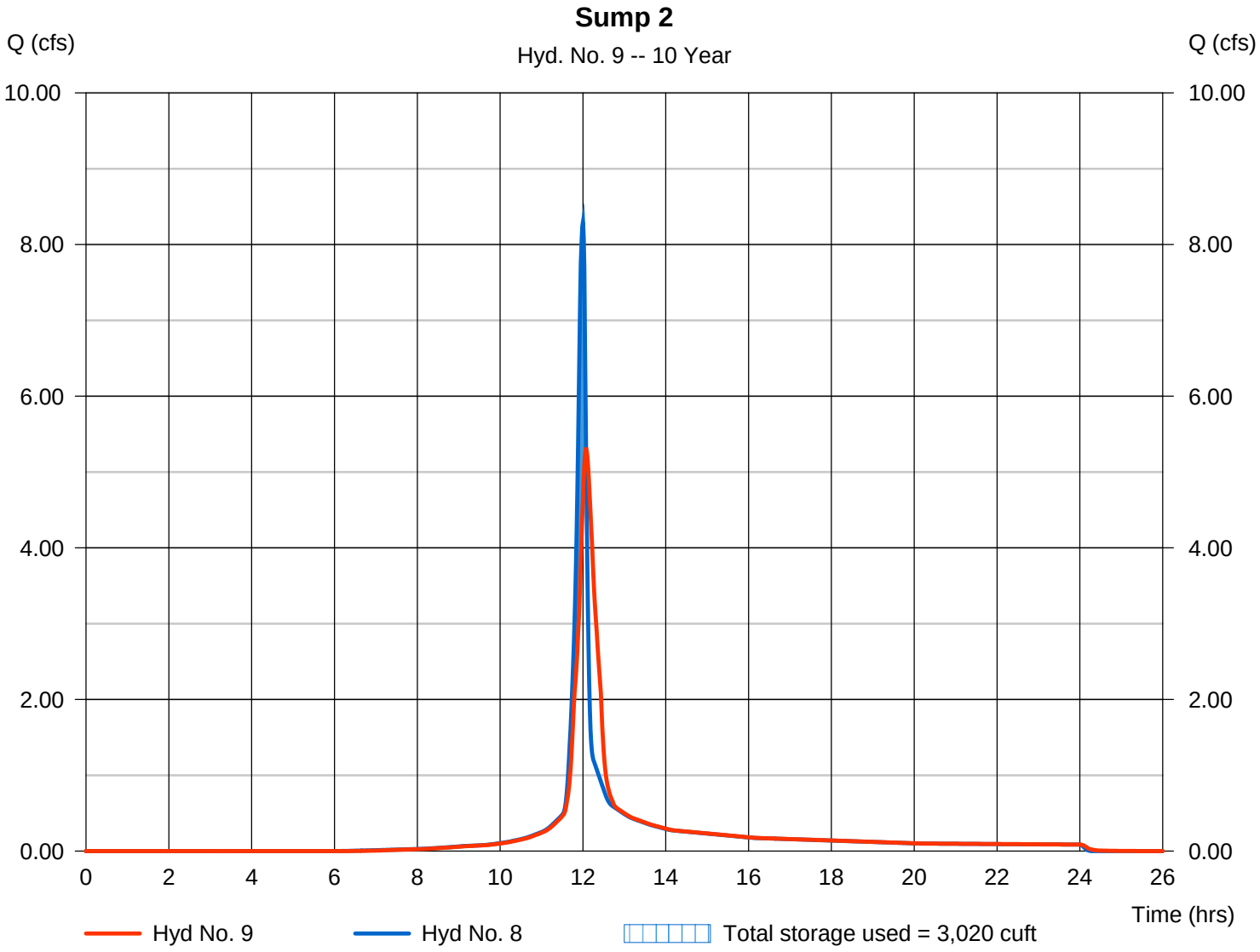
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 5.300 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 19,276 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 11.93 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 3,020 cuft |

Storage Indication method used.



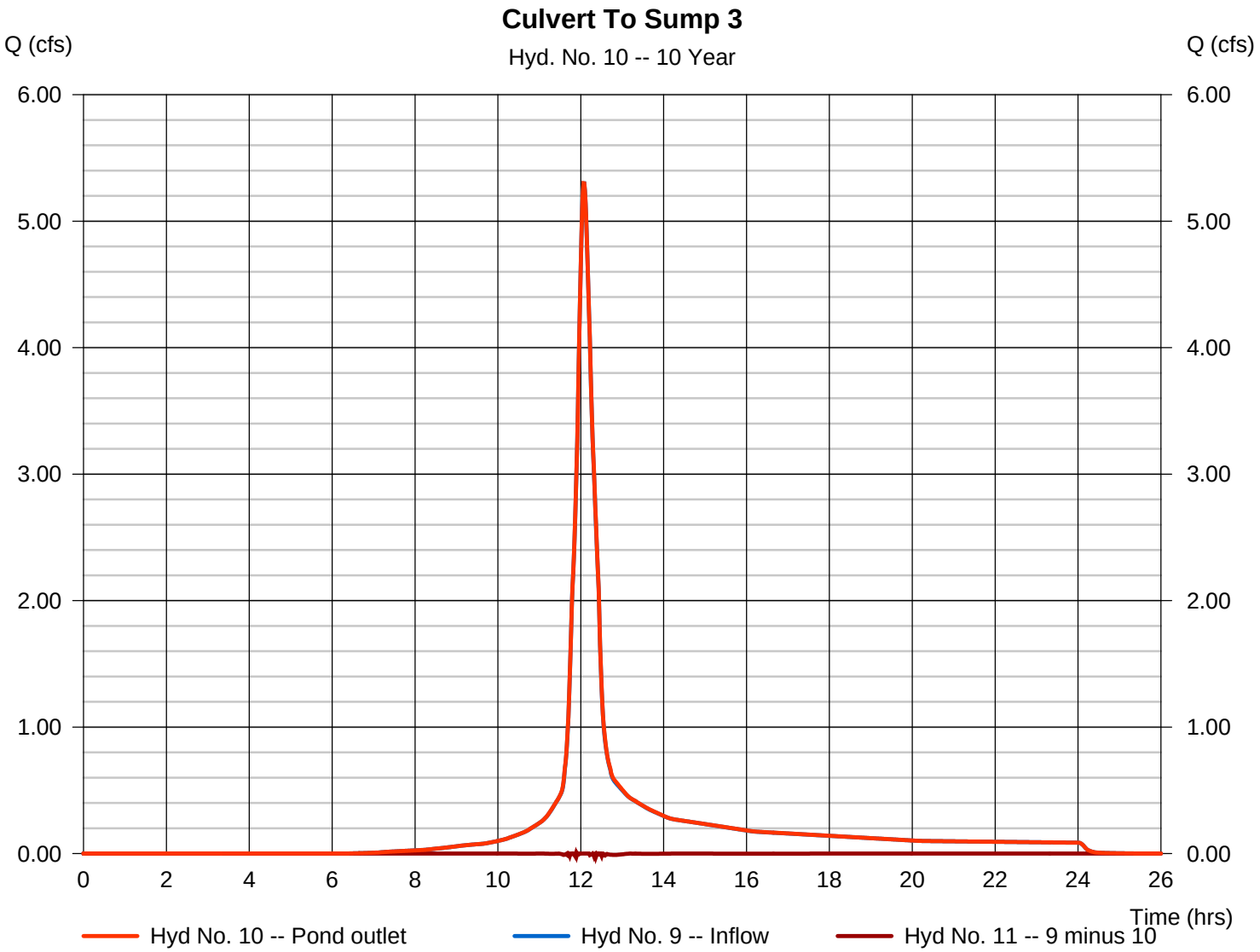
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 5.300 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 12.07 hrs |
| Time interval | = 1 min | Hyd. volume | = 19,331 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



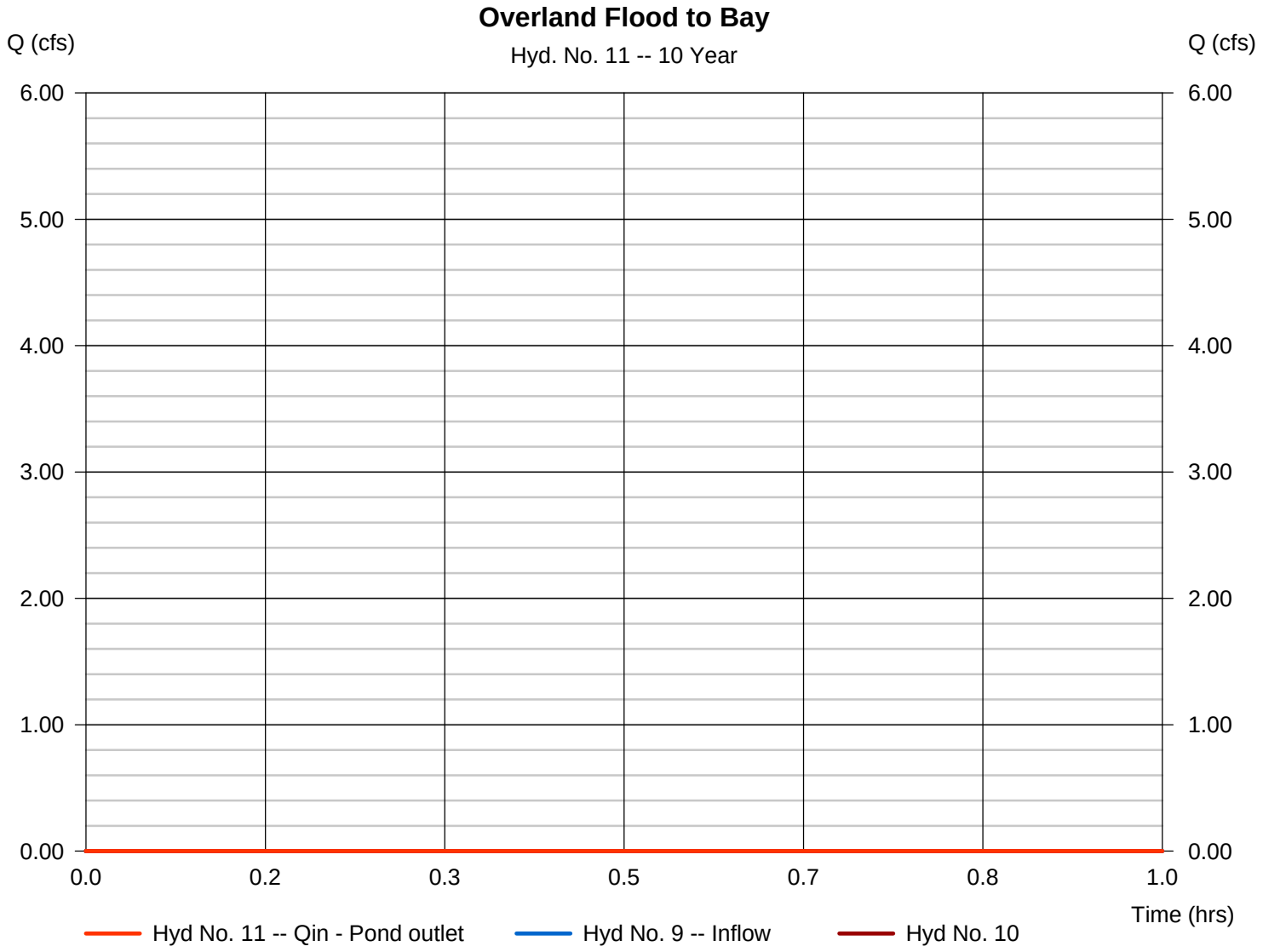
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = n/a |
| Time interval | = 1 min | Hyd. volume | = -55 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



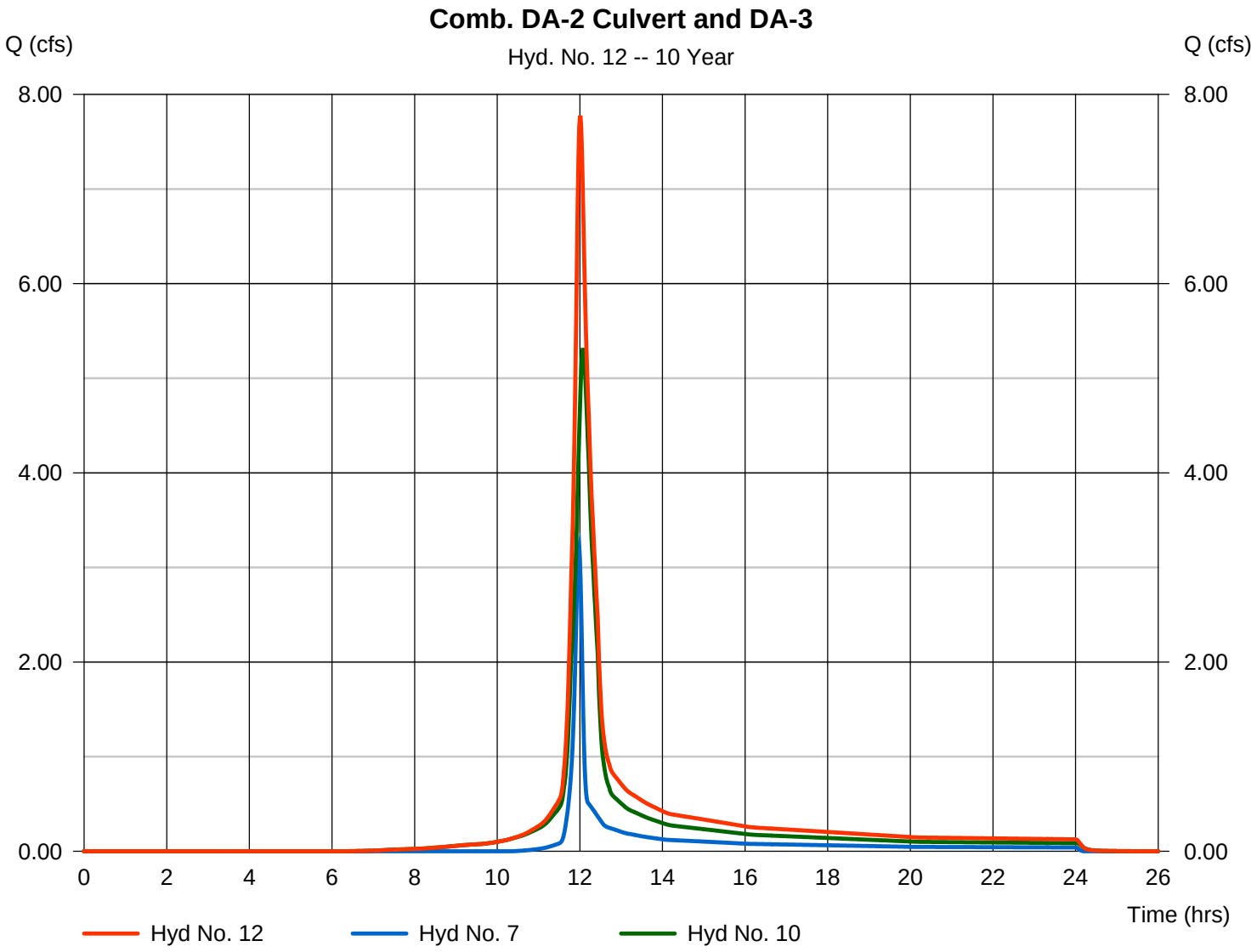
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 7.757 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 12.02 hrs |
| Time interval | = 1 min | Hyd. volume | = 26,159 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 1.030 ac |



# Hydrograph Report

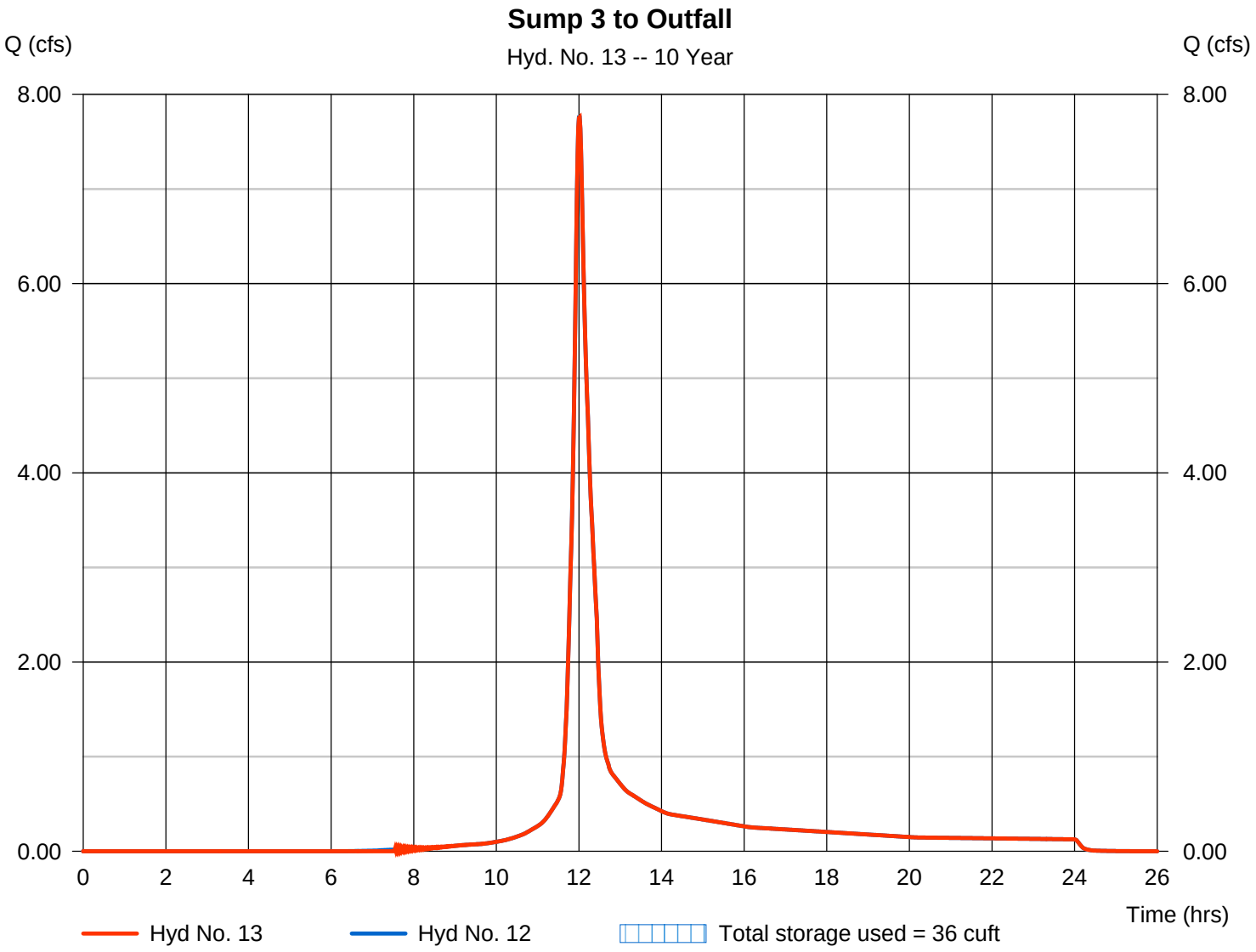
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 7.760 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.02 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 26,129 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.33 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 36 cuft |

Storage Indication method used.



# Hydrograph Report

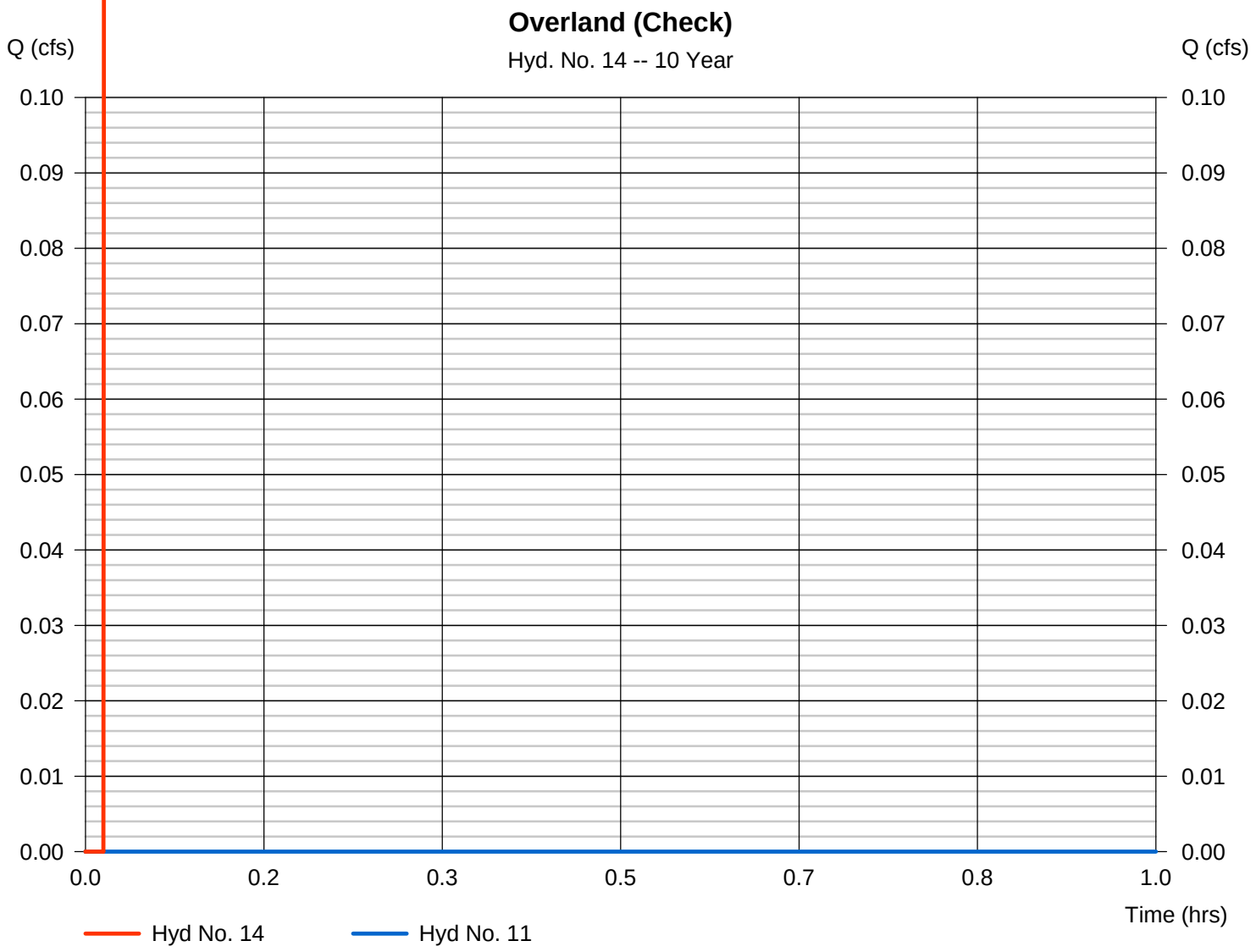
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | n/a |
| Time interval | = | 1 min | Hyd. volume | = | -1 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | -1.#J ft/s | Routing coeff. | = | -1.#IND |

Modified Att-Kin routing method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 12.03 | 1 | 719 | 28,262 | ------ | ------ | ------ | DA-1, Industrial Tilley Area |
| 2 | Reservoir | 11.94 | 1 | 720 | 28,262 | 1 | 17.99 | 290 | Sump 1 - CPP Ditch |
| 3 | Diversion1 | 8.610 | 1 | 720 | 26,957 | 2 | ------ | ------ | Loop Road Culvert |
| 4 | Diversion2 | 3.333 | 1 | 720 | 1,305 | 2 | ------ | ------ | Ditch - Continued Offiste |
| 5 | Reach | 1.672 | 1 | 724 | 1,300 | 4 | ------ | ------ | Ditch - Continued Offiste (Check) |
| 6 | SCS Runoff | 1.094 | 1 | 718 | 2,217 | ------ | ------ | ------ | DA-2, Open Area |
| 7 | SCS Runoff | 5.840 | 1 | 719 | 12,347 | ------ | ------ | ------ | DA-3, Open Area |
| 8 | Combine | 9.647 | 1 | 718 | 29,174 | 3, 6, | ------ | ------ | Comb. DA-1 Culvert and DA-2 |
| 9 | Reservoir | 6.649 | 1 | 726 | 29,173 | 8 | 12.49 | 4,588 | Sump 2 |
| 10 | Diversion1 | 6.649 | 1 | 726 | 29,271 | 9 | ------ | ------ | Culvert To Sump 3 |
| 11 | Diversion2 | 0.000 | 1 | n/a | -98 | 9 | ------ | ------ | Overland Flood to Bay |
| 12 | Combine | 11.55 | 1 | 719 | 41,618 | 7, 10, | ------ | ------ | Comb. DA-2 Culvert and DA-3 |
| 13 | Reservoir | 11.55 | 1 | 719 | 41,588 | 12 | 9.75 | 44.9 | Sump 3 to Outfall |
| 14 | Reach | 0.000 | 1 | n/a | -1 | 11 | ------ | ------ | Overland (Check) |

# Hydrograph Report

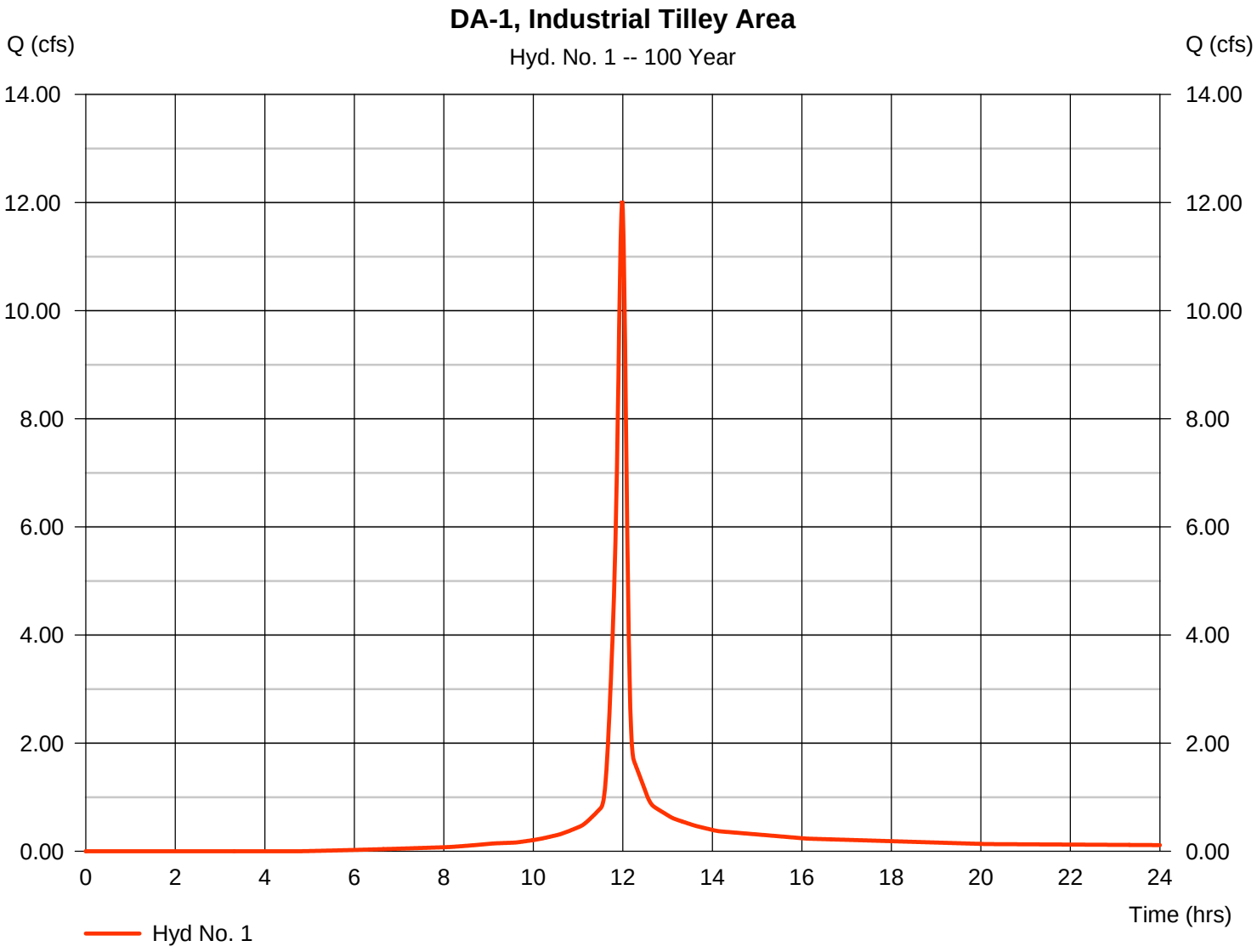
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 1

DA-1, Industrial Tilley Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 12.03 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 28,262 cuft |
| Drainage area | = 1.520 ac | Curve number | = 83* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 9.40 min |
| Total precip. | = 7.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.360 x 98) + (0.110 x 98) + (0.080 x 98) + (0.970 x 74)] / 1.520



# Hydrograph Report

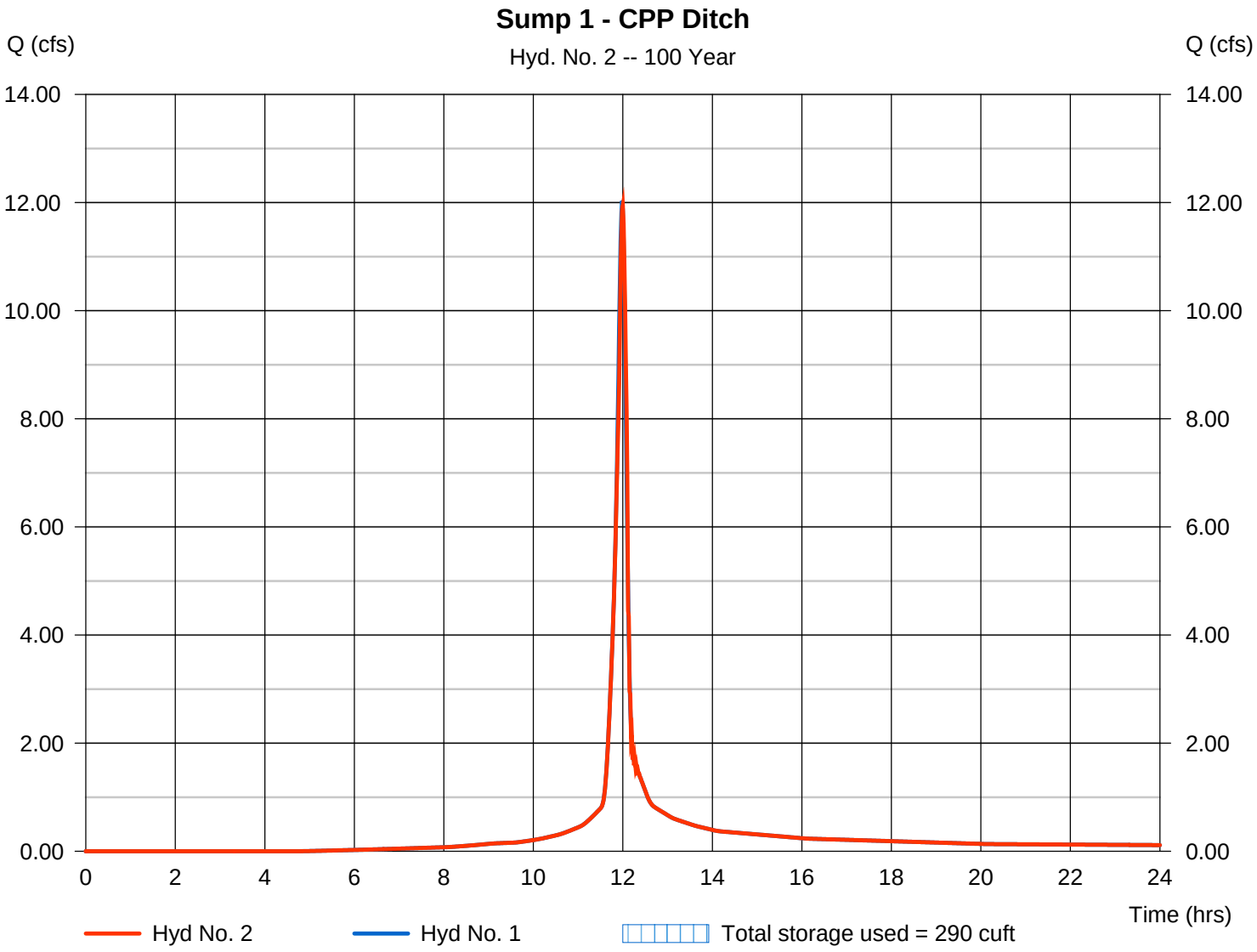
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 2

Sump 1 - CPP Ditch

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 11.94 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 28,262 cuft |
| Inflow hyd. No. | = | 1 - DA-1, Industrial Tilley Area | Max. Elevation | = | 17.99 ft |
| Reservoir name | = | Sump 1- CPP Ditch | Max. Storage | = | 290 cuft |

Storage Indication method used.



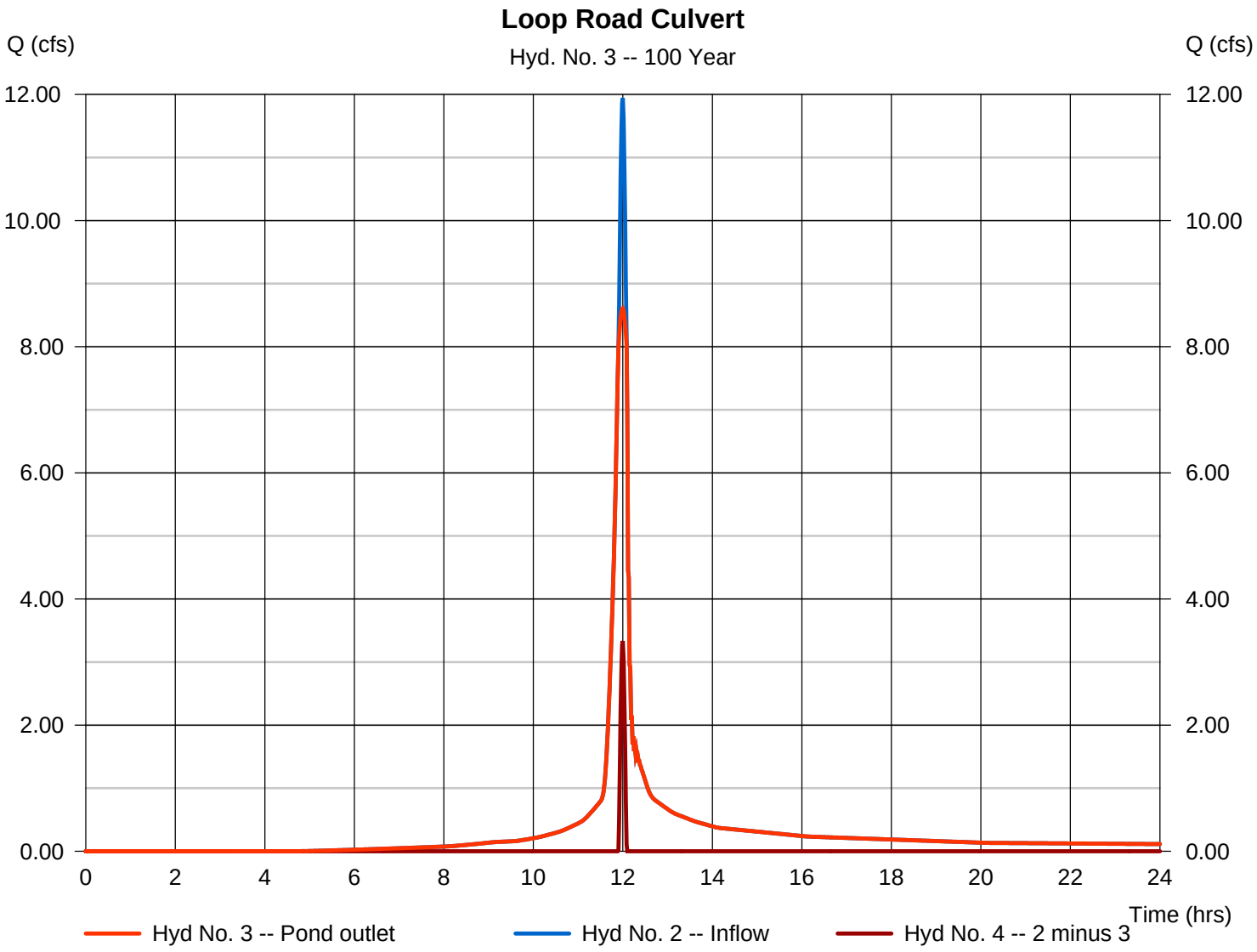
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 3

Loop Road Culvert

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 8.610 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 26,957 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 4 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



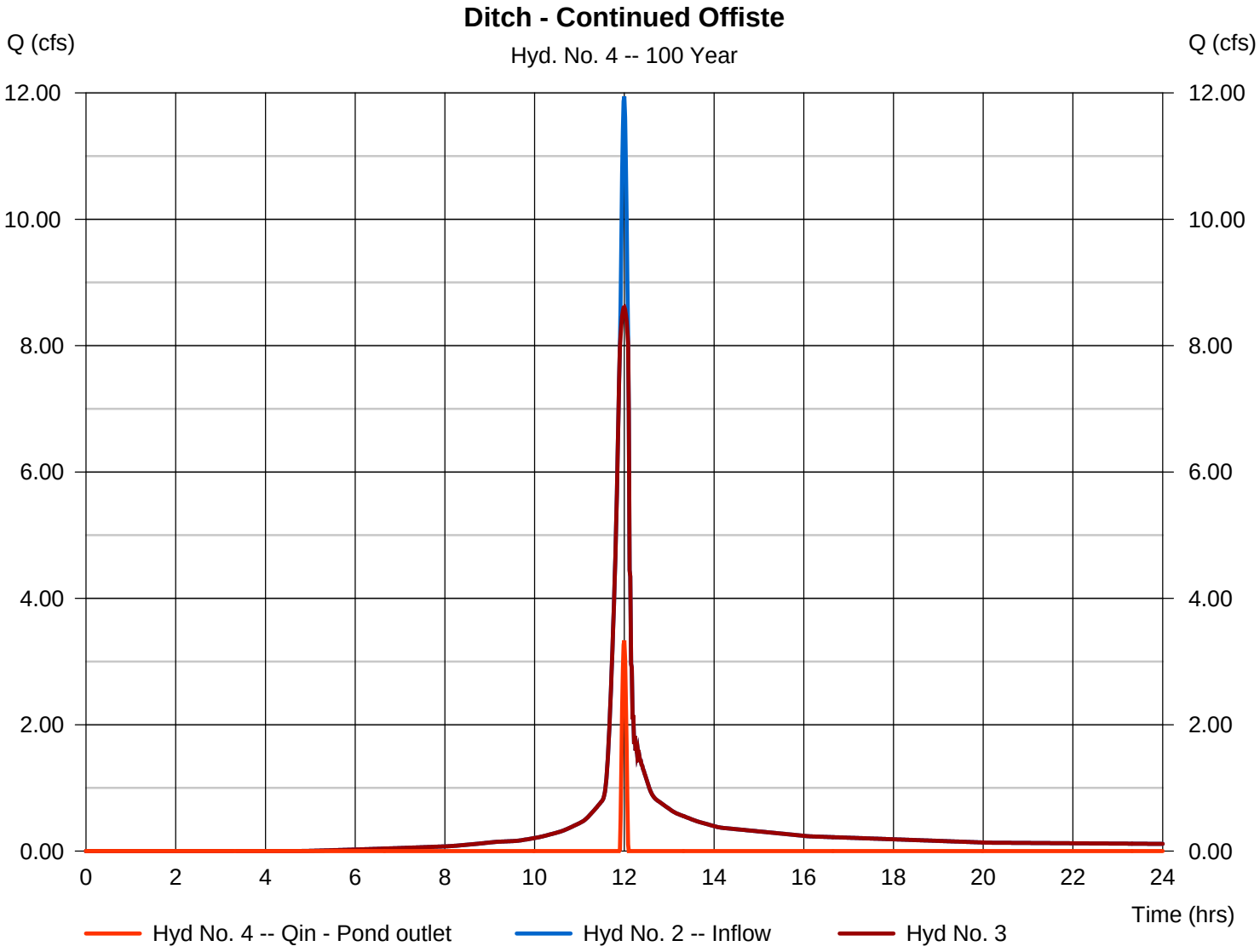
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 4

Ditch - Continued Offiste

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 3.333 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 12.00 hrs |
| Time interval | = 1 min | Hyd. volume | = 1,305 cuft |
| Inflow hydrograph | = 2 - Sump 1 - CPP Ditch | 2nd diverted hyd. | = 3 |
| Diversion method | = Pond - Sump 1- CPP Ditch | Pond structure | = Culv/Orf A |



# Hydrograph Report

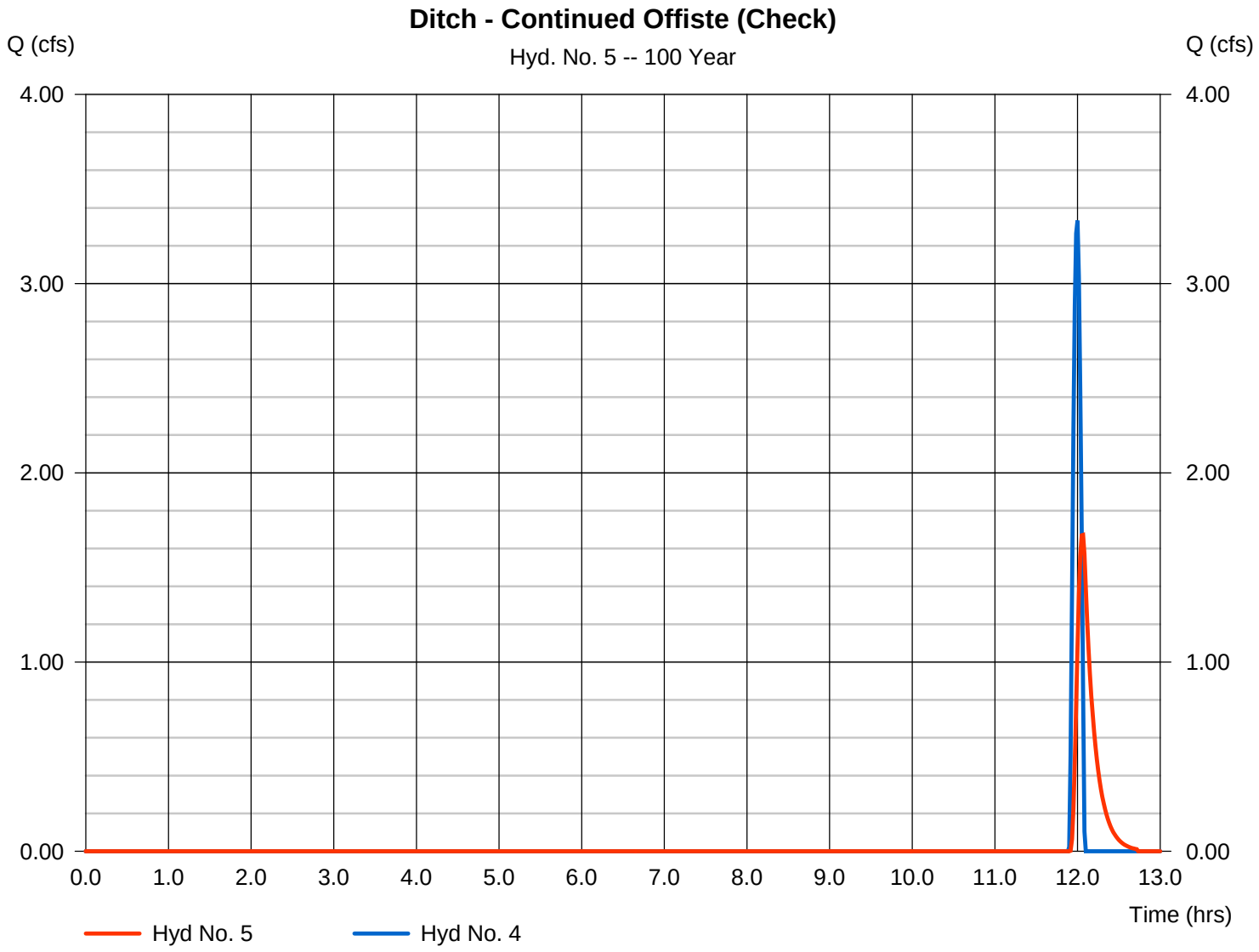
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 5

Ditch - Continued Offiste (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 1.672 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 1,300 cuft |
| Inflow hyd. No. | = | 4 - Ditch - Continued Offiste | Section type | = | Triangular |
| Reach length | = | 500.0 ft | Channel slope | = | 1.6 % |
| Manning's n | = | 0.200 | Bottom width | = | 0.0 ft |
| Side slope | = | 1.0:1 | Max. depth | = | 0.0 ft |
| Rating curve x | = | 0.595 | Rating curve m | = | 1.333 |
| Ave. velocity | = | 0.82 ft/s | Routing coeff. | = | 0.1229 |

Modified Att-Kin routing method used.



# Hydrograph Report

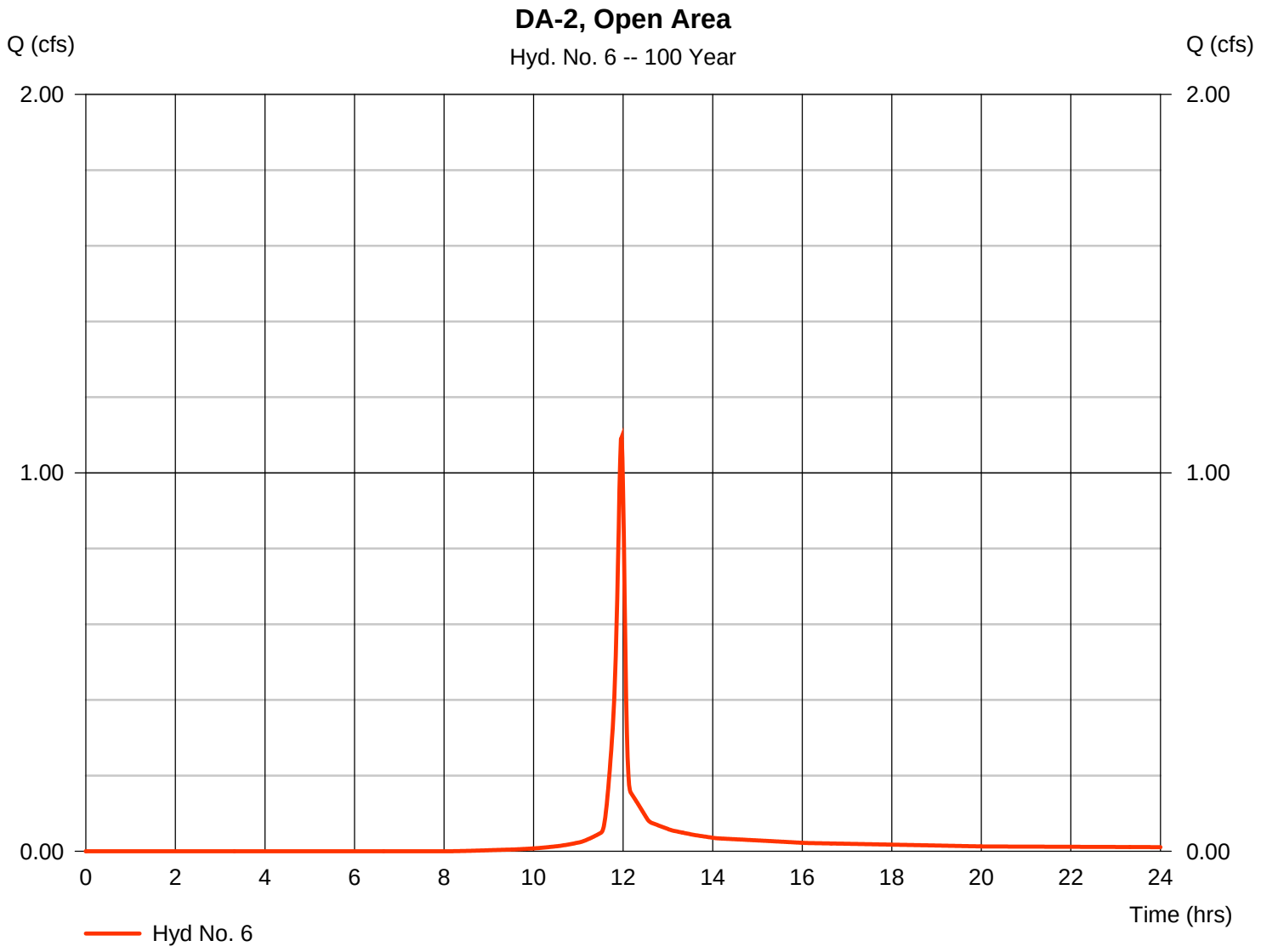
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 6

DA-2, Open Area

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.094 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 2,217 cuft |
| Drainage area | = | 0.160 ac | Curve number | = | 70* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.50 min |
| Total precip. | = | 7.10 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(0.040 x 98) + (0.120 x 61)] / 0.160



# Hydrograph Report

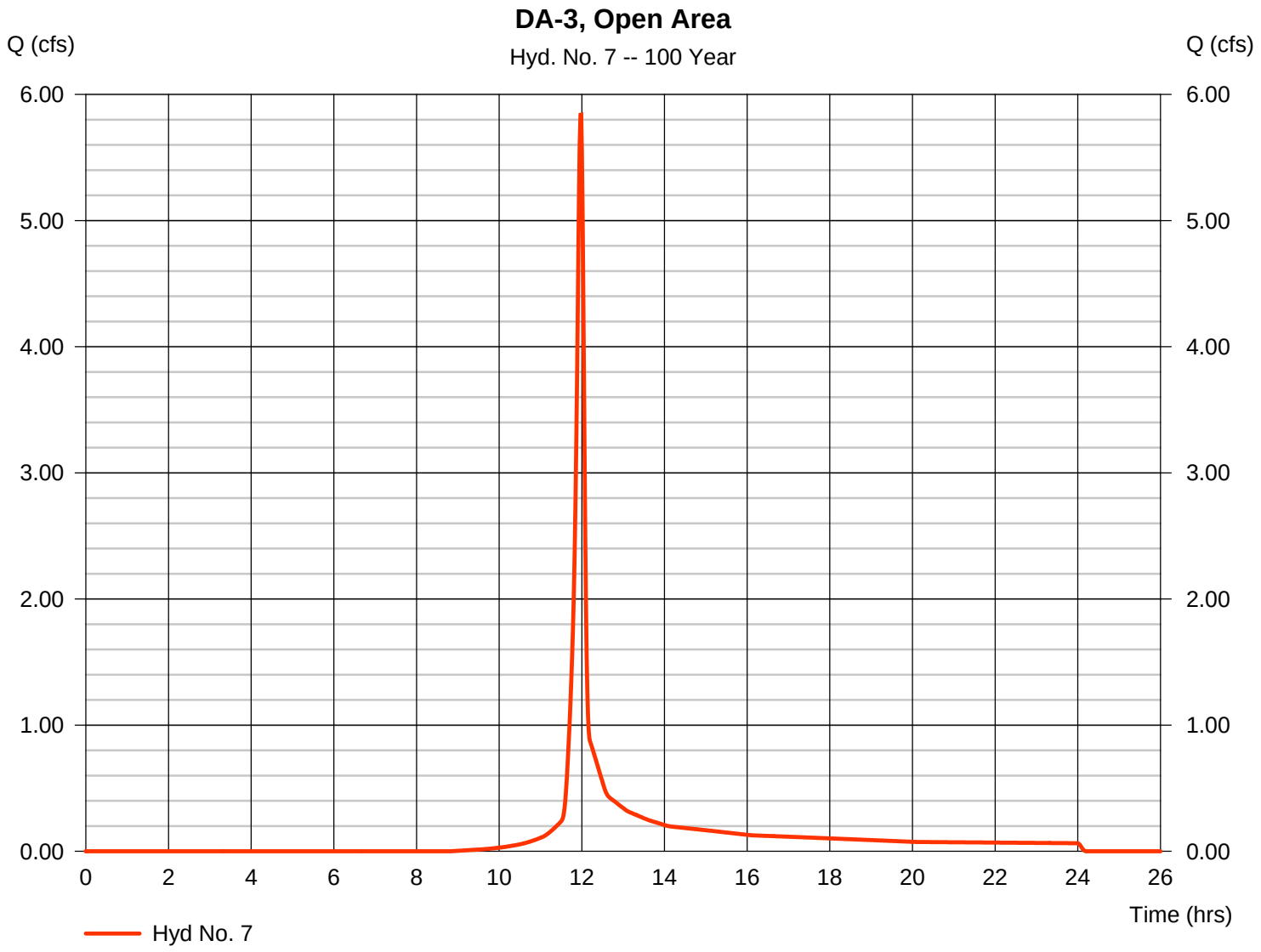
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 7

DA-3, Open Area

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 5.840 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 12,347 cuft |
| Drainage area | = 1.030 ac | Curve number | = 67* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 7.00 min |
| Total precip. | = 7.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.860 x 61) + (0.170 x 98)] / 1.030



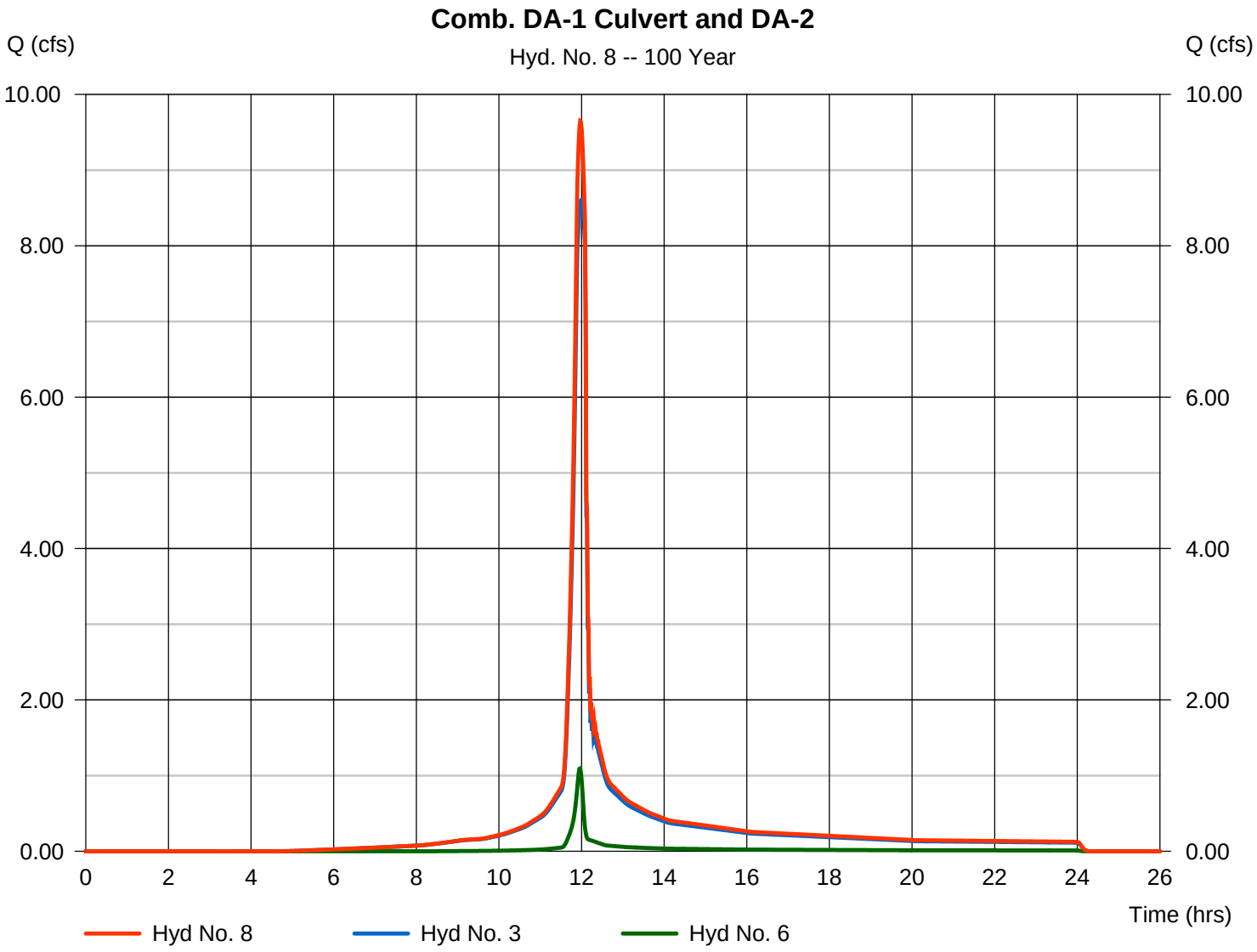
# Hydrograph Report



## Hyd. No. 8

Comb. DA-1 Culvert and DA-2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Combine | Peak discharge | = | 9.647 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 29,174 cuft |
| Inflow hyds. | = | 3, 6 | Contrib. drain. area | = | 0.160 ac |



# Hydrograph Report

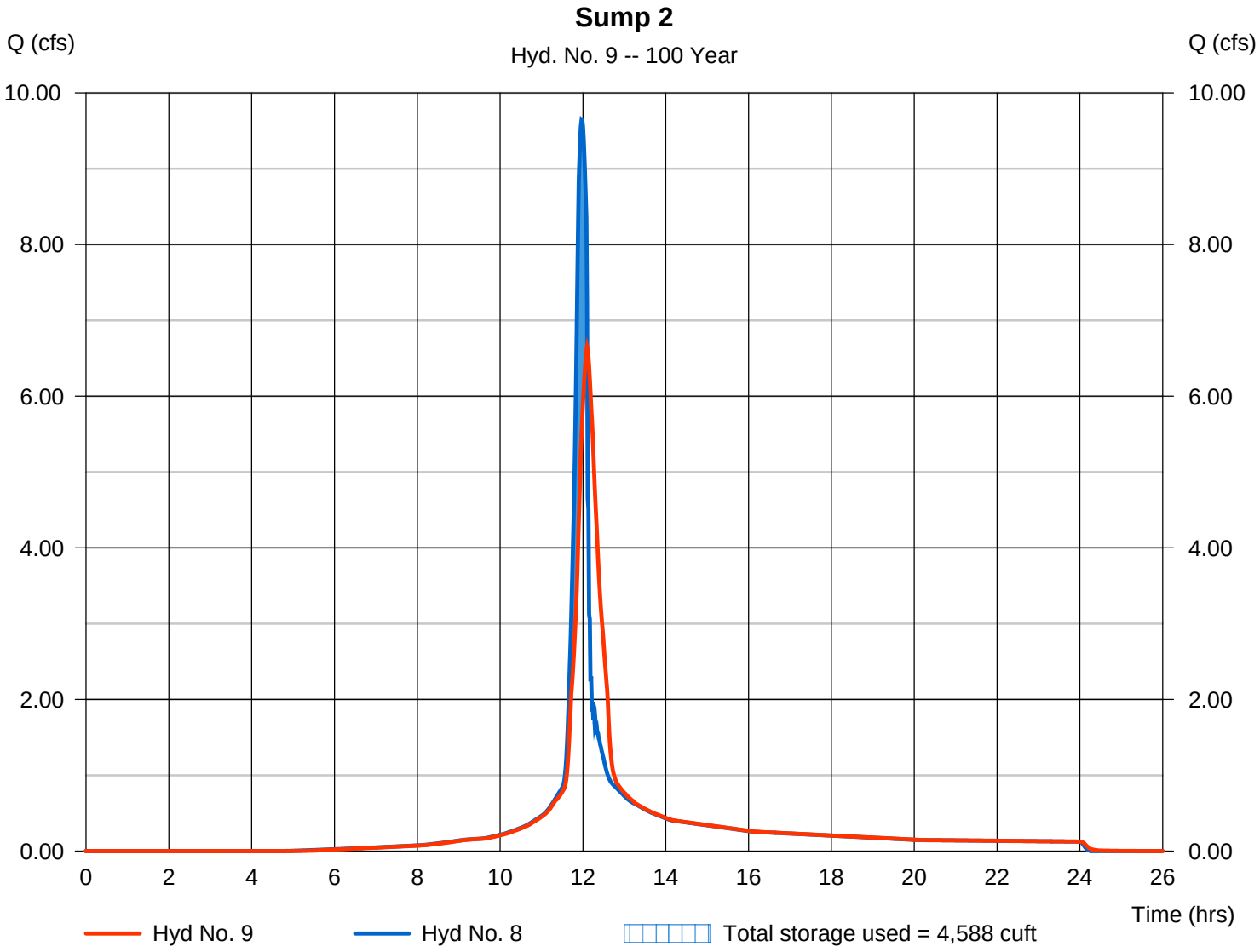
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 9

Sump 2

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 6.649 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 29,173 cuft |
| Inflow hyd. No. | = | 8 - Comb. DA-1 Culvert and DA-2 | Max. Elevation | = | 12.49 ft |
| Reservoir name | = | Sump 2 | Max. Storage | = | 4,588 cuft |

Storage Indication method used.



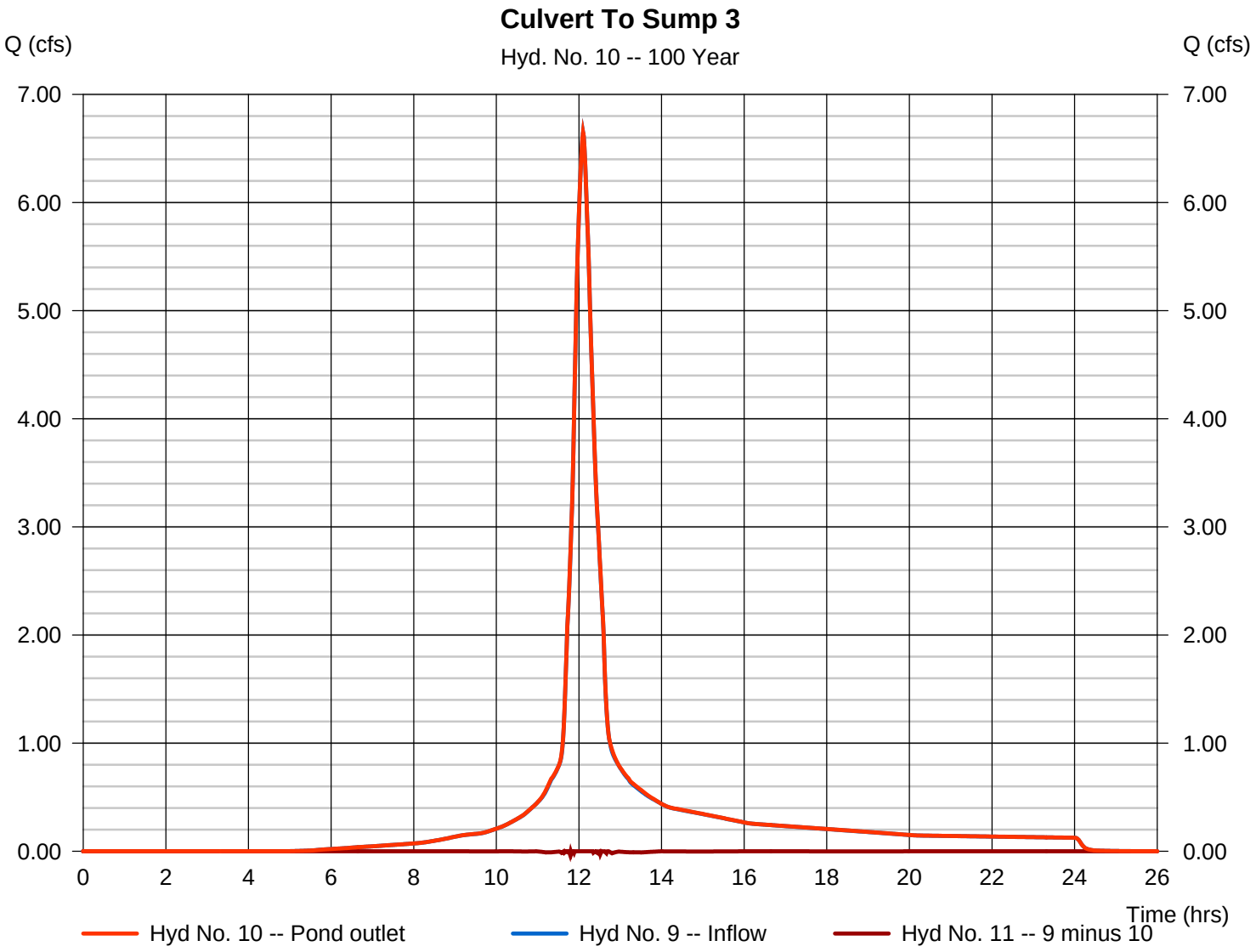
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 10

Culvert To Sump 3

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion1 | Peak discharge | = 6.649 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 12.10 hrs |
| Time interval | = 1 min | Hyd. volume | = 29,271 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 11 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



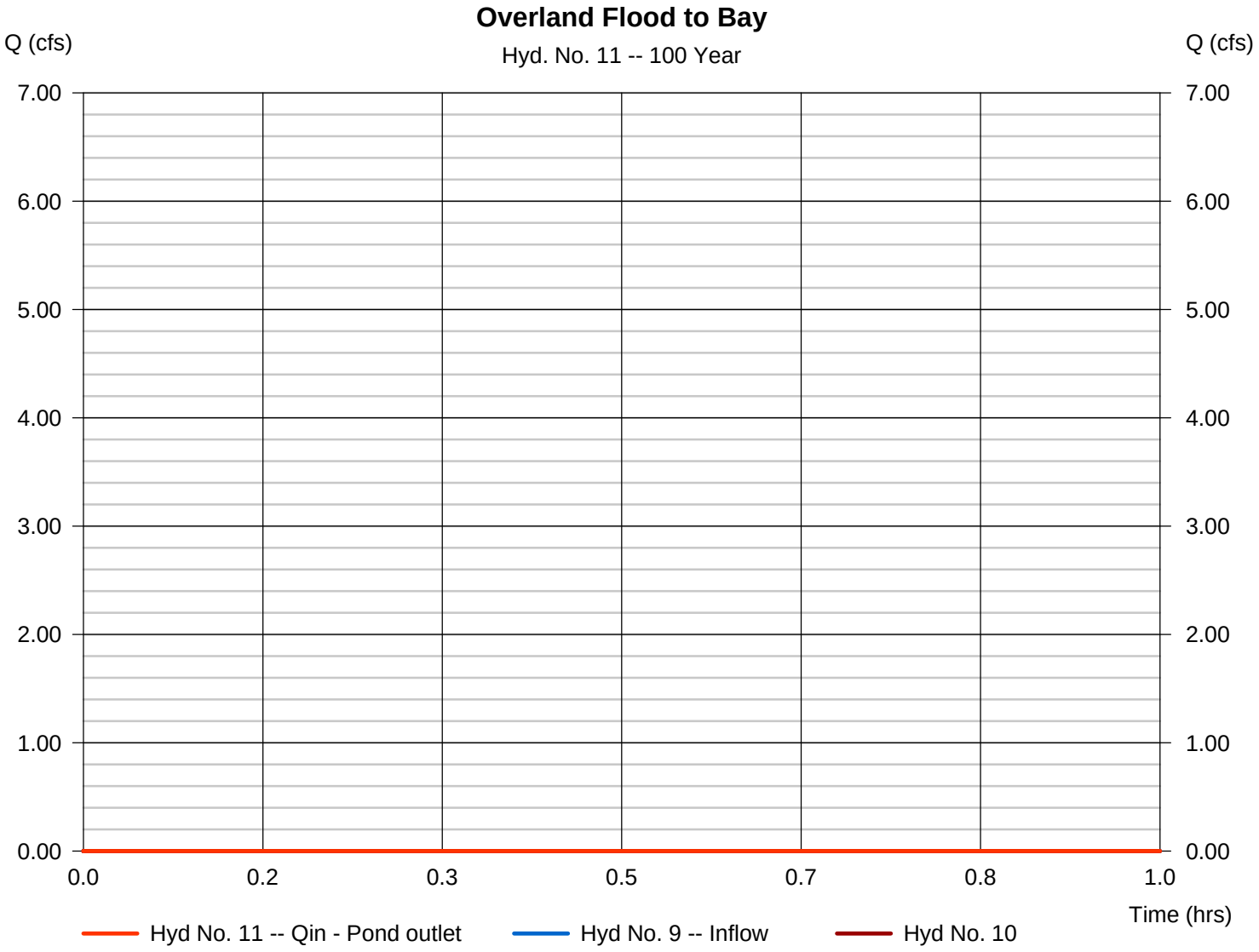
# Hydrograph Report



## Hyd. No. 11

Overland Flood to Bay

| | | | |
|---|---|---|---|
| Hydrograph type | = Diversion2 | Peak discharge | = 0.000 cfs |
| Storm frequency | = 100 yrs | Time to peak | = n/a |
| Time interval | = 1 min | Hyd. volume | = -98 cuft |
| Inflow hydrograph | = 9 - Sump 2 | 2nd diverted hyd. | = 10 |
| Diversion method | = Pond - Sump 2 | Pond structure | = Culv/Orf A |



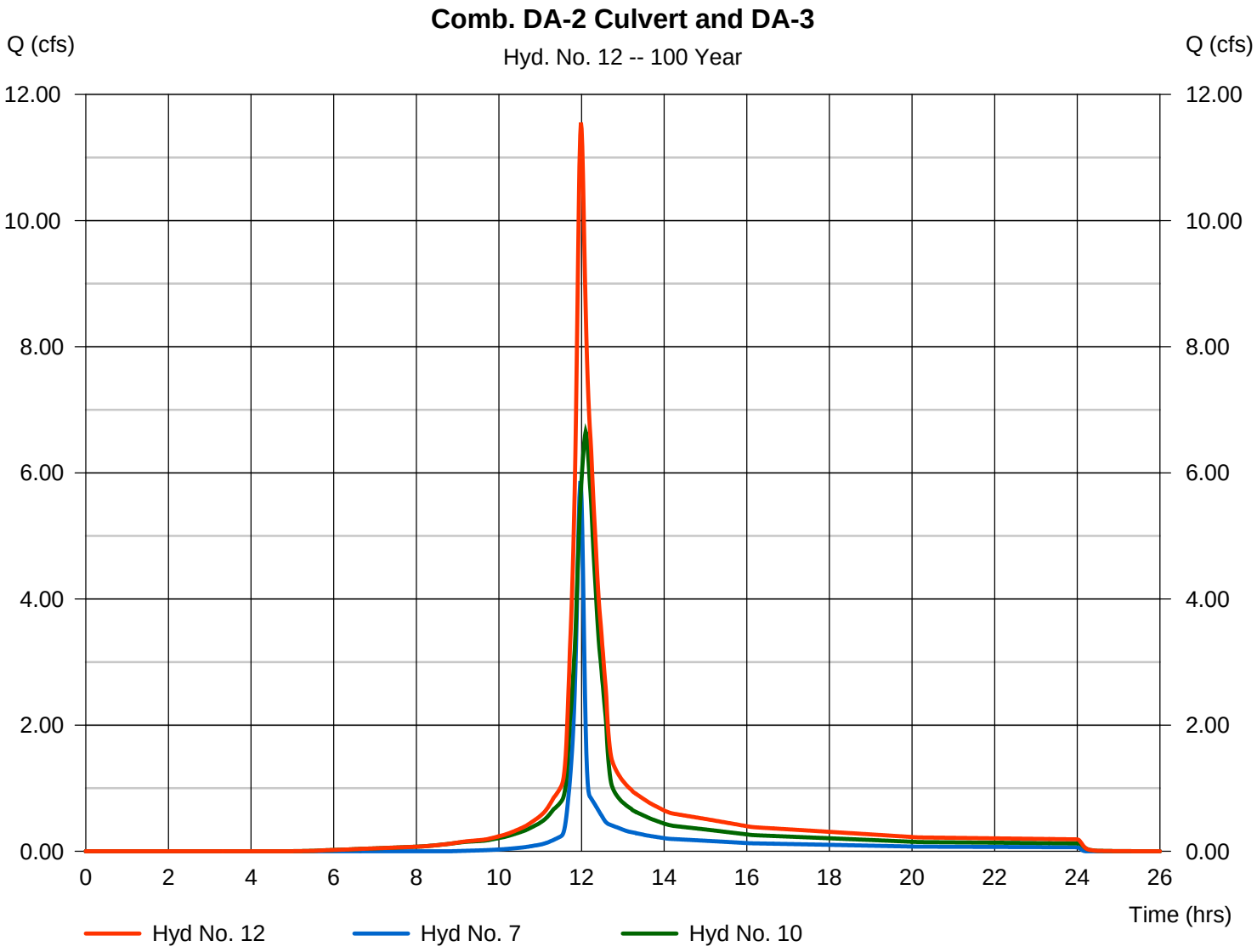
# Hydrograph Report



## Hyd. No. 12

Comb. DA-2 Culvert and DA-3

| | | | |
|---|---|---|---|
| Hydrograph type | = Combine | Peak discharge | = 11.55 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 11.98 hrs |
| Time interval | = 1 min | Hyd. volume | = 41,618 cuft |
| Inflow hyds. | = 7, 10 | Contrib. drain. area | = 1.030 ac |



# Hydrograph Report

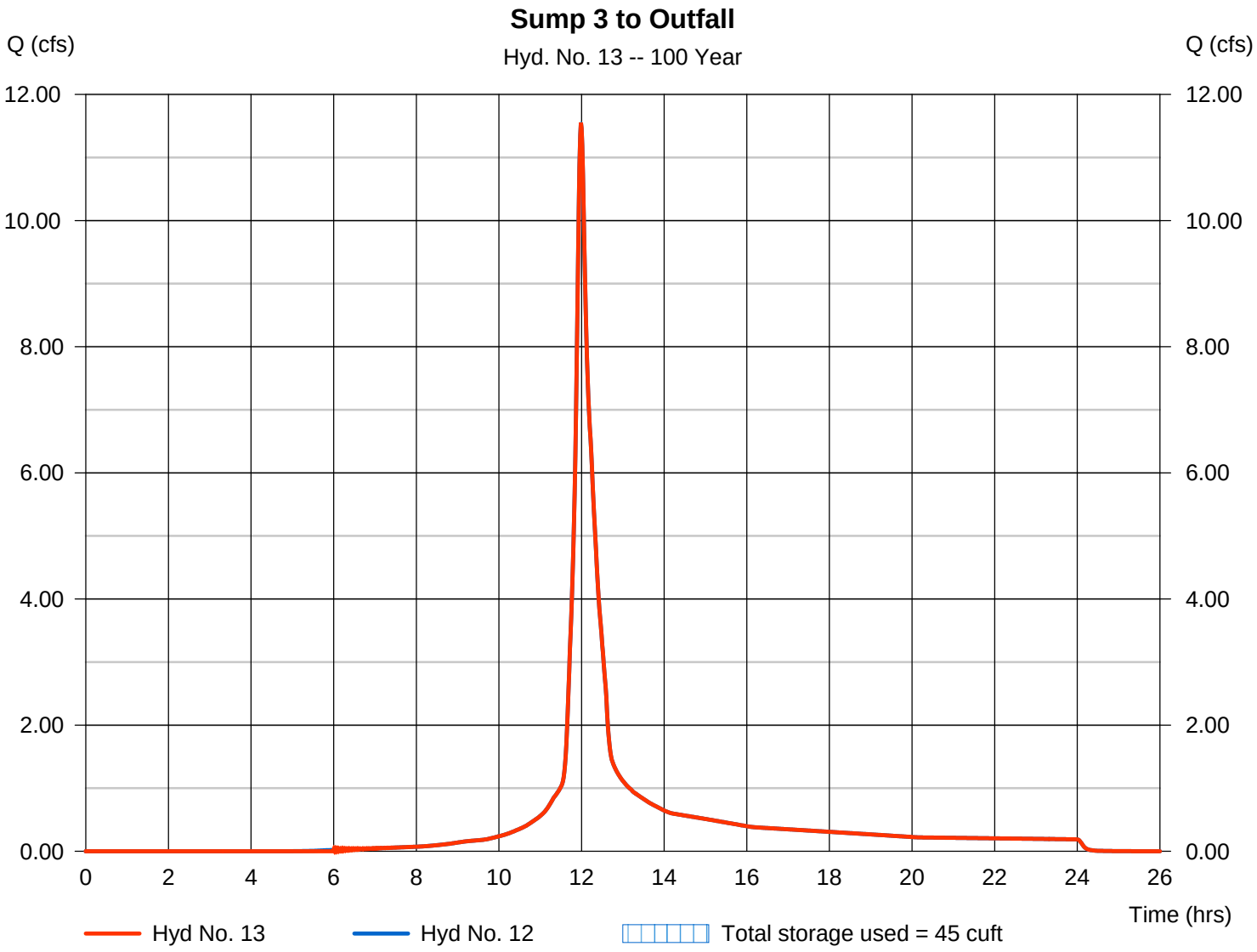
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 13

Sump 3 to Outfall

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 11.55 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.98 hrs |
| Time interval | = | 1 min | Hyd. volume | = | 41,588 cuft |
| Inflow hyd. No. | = | 12 - Comb. DA-2 Culvert and DA-3 | Max. Elevation | = | 9.75 ft |
| Reservoir name | = | Sump 3 | Max. Storage | = | 45 cuft |

Storage Indication method used.



# Hydrograph Report

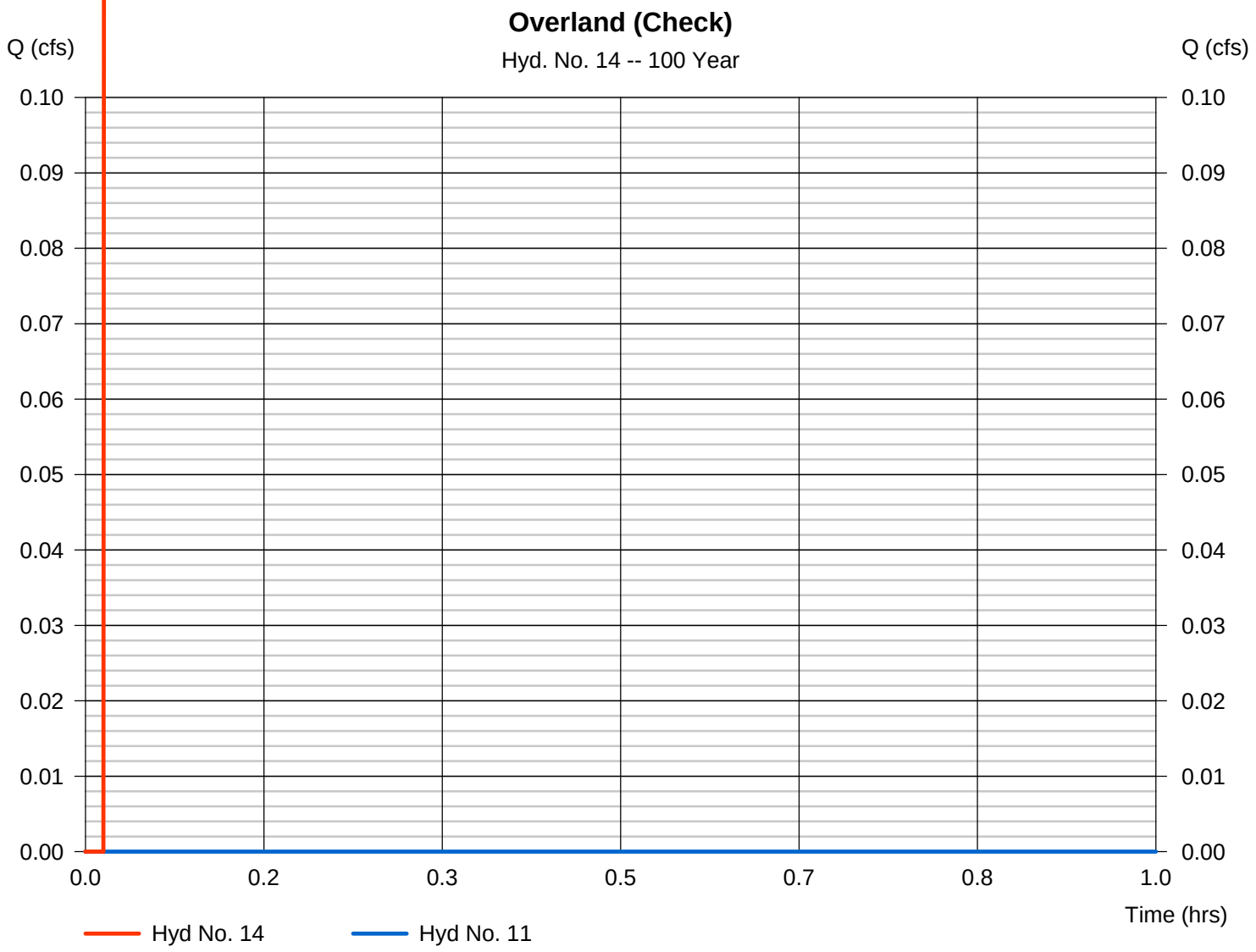
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Wednesday, Feb 8, 2012

## Hyd. No. 14

Overland (Check)

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reach | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | n/a |
| Time interval | = | 1 min | Hyd. volume | = | -1 cuft |
| Inflow hyd. No. | = | 11 - Overland Flood to Bay | Section type | = | Trapezoidal |
| Reach length | = | 100.0 ft | Channel slope | = | 1.0 % |
| Manning's n | = | 0.100 | Bottom width | = | 200.0 ft |
| Side slope | = | 0.5:1 | Max. depth | = | 1.0 ft |
| Rating curve x | = | 0.043 | Rating curve m | = | 1.652 |
| Ave. velocity | = | -1.#J ft/s | Routing coeff. | = | -1.#IND |

Modified Att-Kin routing method used.

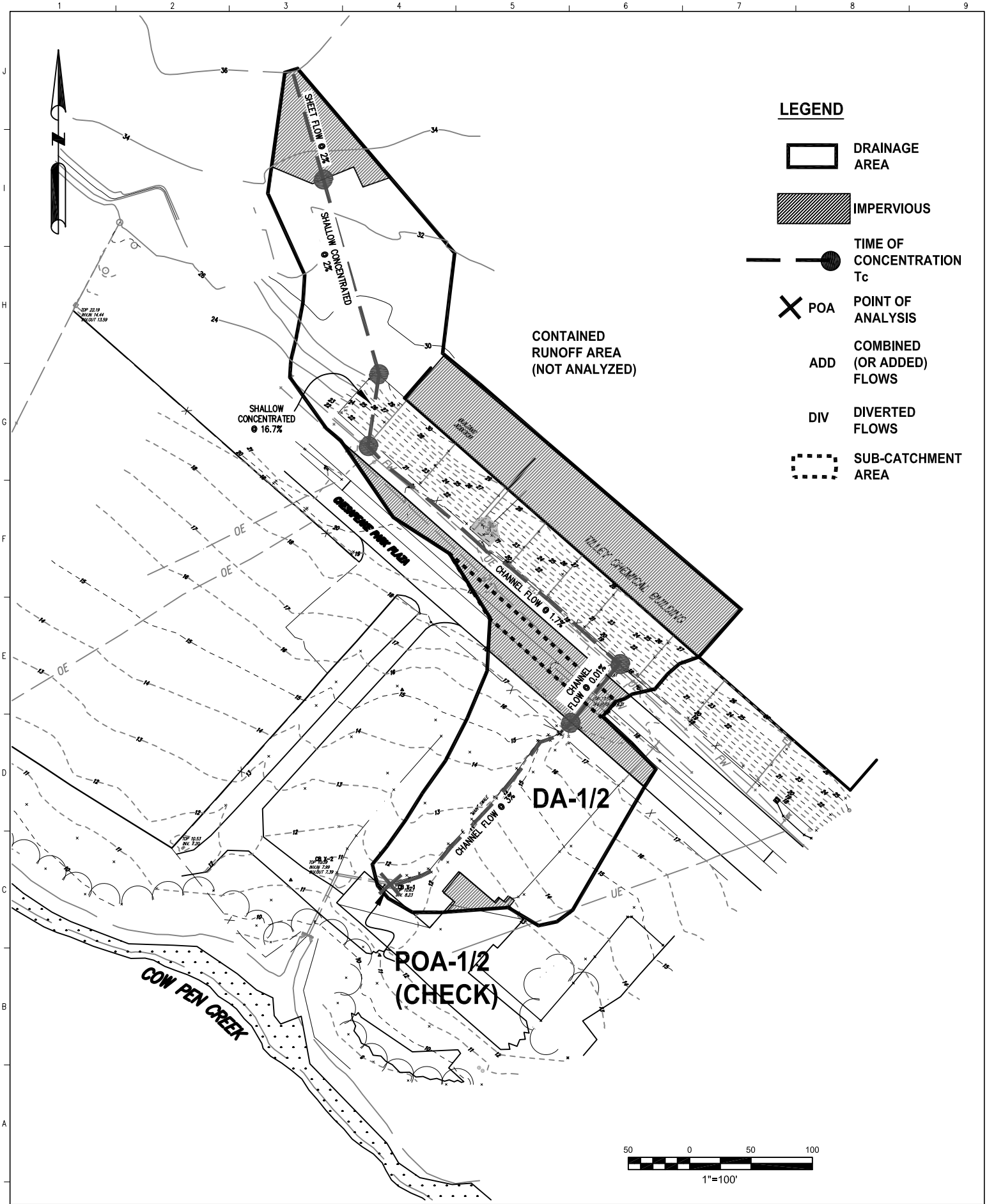


# APPENDIX C – SUPPLEMENTAL CHECK DATA

The following support documents were prepared to confirm general concepts or check for major errors in the input or software itself:

1. Existing Conditions DA-1/2 Simplified Check (TR-55 Report and Exhibit)
2. Existing Conditions Chesapeake Park Plaza Culvert - Simplified (Culvert Analysis)
3. Existing Conditions Chesapeake Park Plaza Culvert (Storm Sewer Analysis)
4. Existing Conditions Cow Pen Creek Outfall (Storm Sewer Analysis)
5. Proposed Conditions Chesapeake Park Plaza Culvert (Storm Sewer Analysis)
6. Proposed Conditions Cow Pen Creek Outfall (Storm Sewer Analysis)

The results of these check documents are prone to minor discrepancies with the report results. For example, in TR-55, when several small drainage areas are analyzed with individual time of concentration (Tc) lines, then combined, the results typically yield a different peak flow than if these areas were reviewed as a large, single area using a single Tc line.

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|---|---|---|---|
| | | | |

STORMWATER MODIFICATIONS – BLOCK G
INJECTION WELL FIELD
SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 2-8-12 |
| PROJECT NO.: | 112IC03043 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SNL |
| CHECKED BY: | CSG/SK |
| SHEET: | C-SWM-CHECK |

CHECK - EXIST CONDS. DRAINAGE ANALYSIS

# Watershed Model Schematic



1 - DA-1/2, Check

**Legend**

| Hyd. | Origin | Description |
|---|---|---|
| 1 | SCS Runoff | DA-1/2, Check |

# TR55 Tc Worksheet



## Hyd. No. 1

DA-1/2, Check

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 90.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 3.20 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.11** | **+** | **0.00** | **+** | **0.00** | **=** | **1.11** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 161.00 | | 60.00 | | 0.00 | | |
| Watercourse slope (%) | = 2.00 | | 16.70 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =2.28 | | 6.59 | | 0.00 | | |
| **Travel Time (min)** | **= 1.18** | **+** | **0.15** | **+** | **0.00** | **=** | **1.33** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 9.00 | | 1.23 | | 19.50 | | |
| Wetted perimeter (ft) | = 15.50 | | 3.93 | | 58.00 | | |
| Channel slope (%) | = 1.50 | | 0.70 | | 3.00 | | |
| Manning's n-value | = 0.200 | | 0.011 | | 0.200 | | |
| Velocity (ft/s) | =0.63 | | | | | | |
| | | | 5.20 | | | | |
| | | | | | 0.62 | | |
| Flow length (ft) | ({0})267.0 | | 60.0 | | 200.0 | | |
| **Travel Time (min)** | **= 7.02** | **+** | **0.19** | **+** | **5.36** | **=** | **12.57** |

**Total Travel Time, Tc ..... 15.00 min**

# Hydrograph Return Period Recap



| Hyd. No. | Hydrograph type (origin) | Inflow hyd(s) | Peak Outflow (cfs) | | | | | | | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1-yr | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | |
| 1 | SCS Runoff | ------ | 2.494 | 3.800 | ------- | ------- | 8.455 | ------- | ------- | 13.67 | DA-1/2, Check |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 2.494 | 1 | 723 | 6,940 | ------ | ------ | ------ | DA-1/2, Check |

# Hydrograph Report

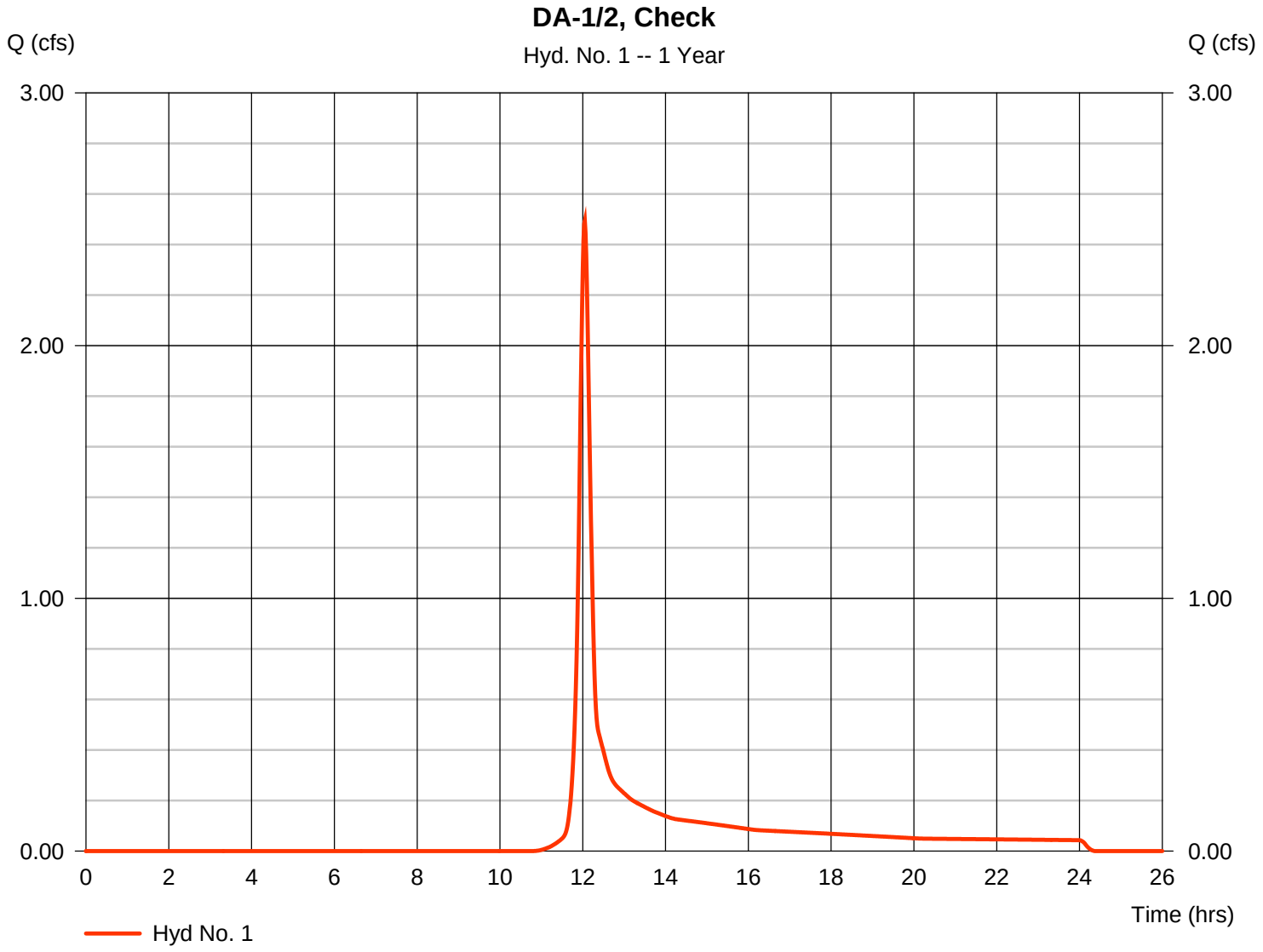
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Monday, Oct 17, 2011

## Hyd. No. 1

DA-1/2, Check

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 2.494 cfs |
| Storm frequency | = 1 yrs | Time to peak | = 12.05 hrs |
| Time interval | = 1 min | Hyd. volume | = 6,940 cuft |
| Drainage area | = 2.240 ac | Curve number | = 78* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 15.00 min |
| Total precip. | = 2.60 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.710 x 98) + (0.960 x 74) + (0.570 x 61)] / 2.240



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 3.800 | 1 | 722 | 10,354 | ------ | ------ | ------ | DA-1/2, Check |

# Hydrograph Report

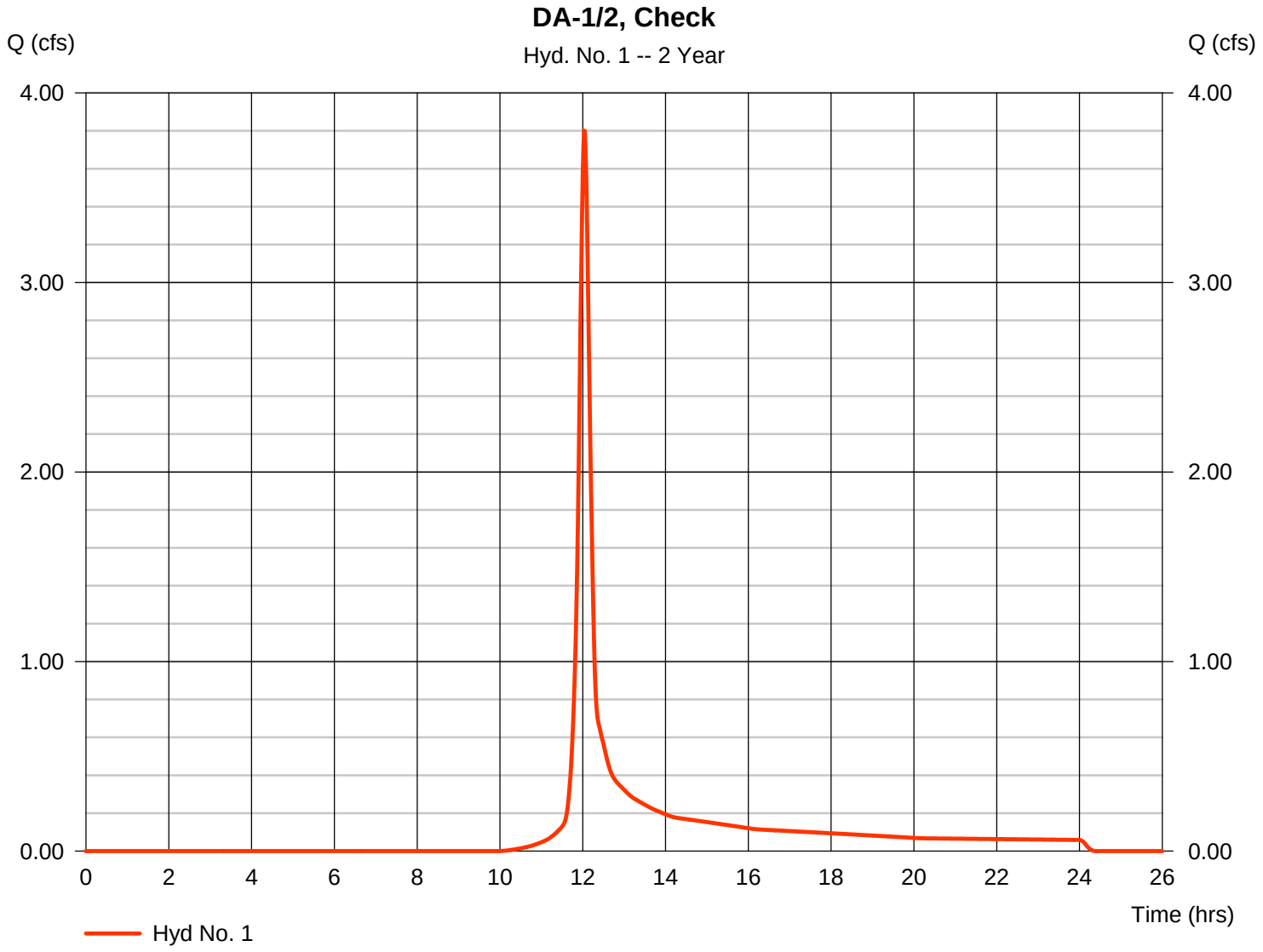
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Monday, Oct 17, 2011

## Hyd. No. 1

DA-1/2, Check

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 3.800 cfs |
| Storm frequency | = 2 yrs | Time to peak | = 12.03 hrs |
| Time interval | = 1 min | Hyd. volume | = 10,354 cuft |
| Drainage area | = 2.240 ac | Curve number | = 78* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 15.00 min |
| Total precip. | = 3.20 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.710 x 98) + (0.960 x 74) + (0.570 x 61)] / 2.240



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 8.455 | 1 | 722 | 22,741 | ------ | ------ | ------ | DA-1/2, Check |

# Hydrograph Report

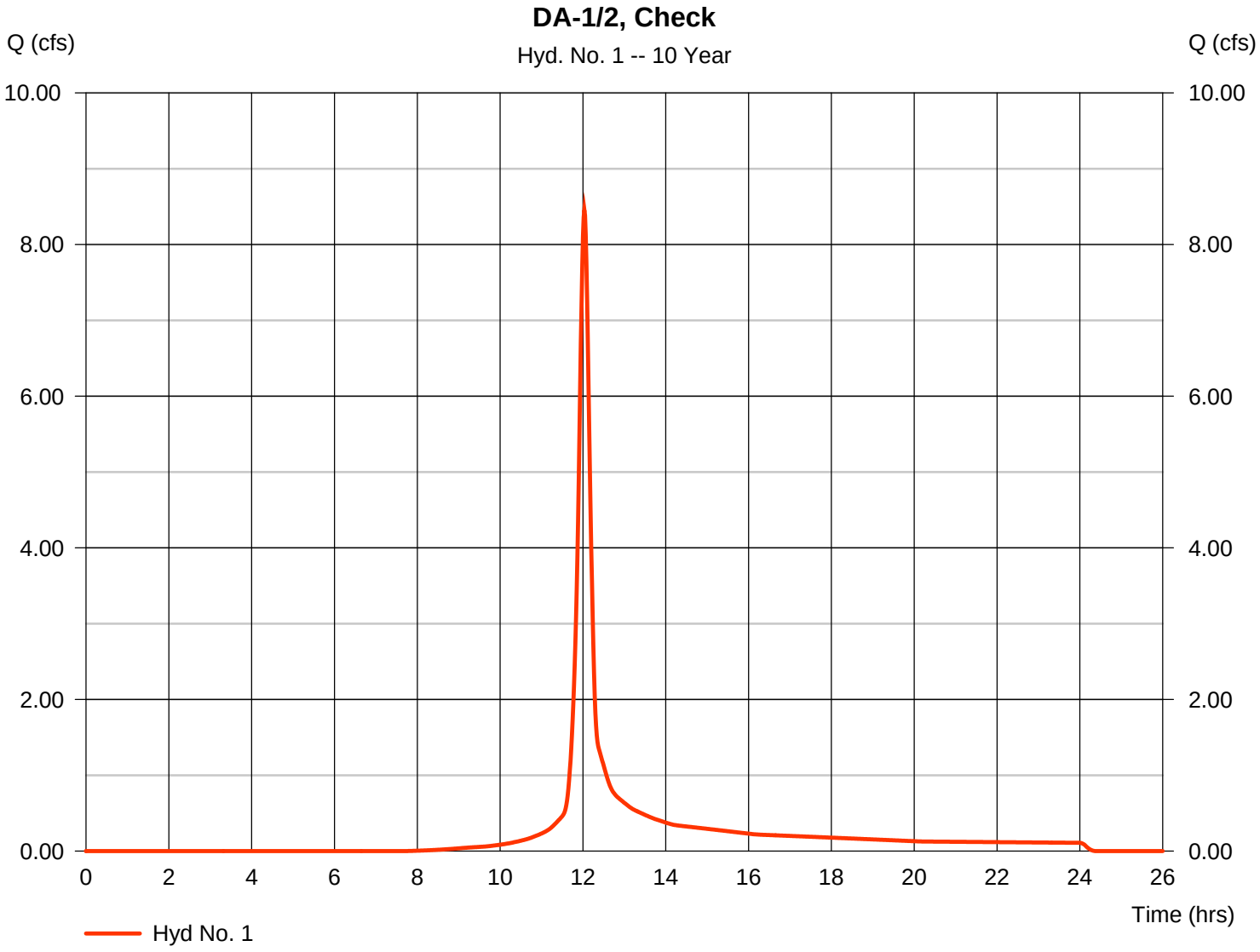
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Monday, Oct 17, 2011

## Hyd. No. 1

DA-1/2, Check

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 8.455 cfs |
| Storm frequency | = 10 yrs | Time to peak | = 12.03 hrs |
| Time interval | = 1 min | Hyd. volume | = 22,741 cuft |
| Drainage area | = 2.240 ac | Curve number | = 78* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 15.00 min |
| Total precip. | = 5.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.710 x 98) + (0.960 x 74) + (0.570 x 61)] / 2.240



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | SCS Runoff | 13.67 | 1 | 722 | 37,124 | ------ | ------ | ------ | DA-1/2, Check |

# Hydrograph Report

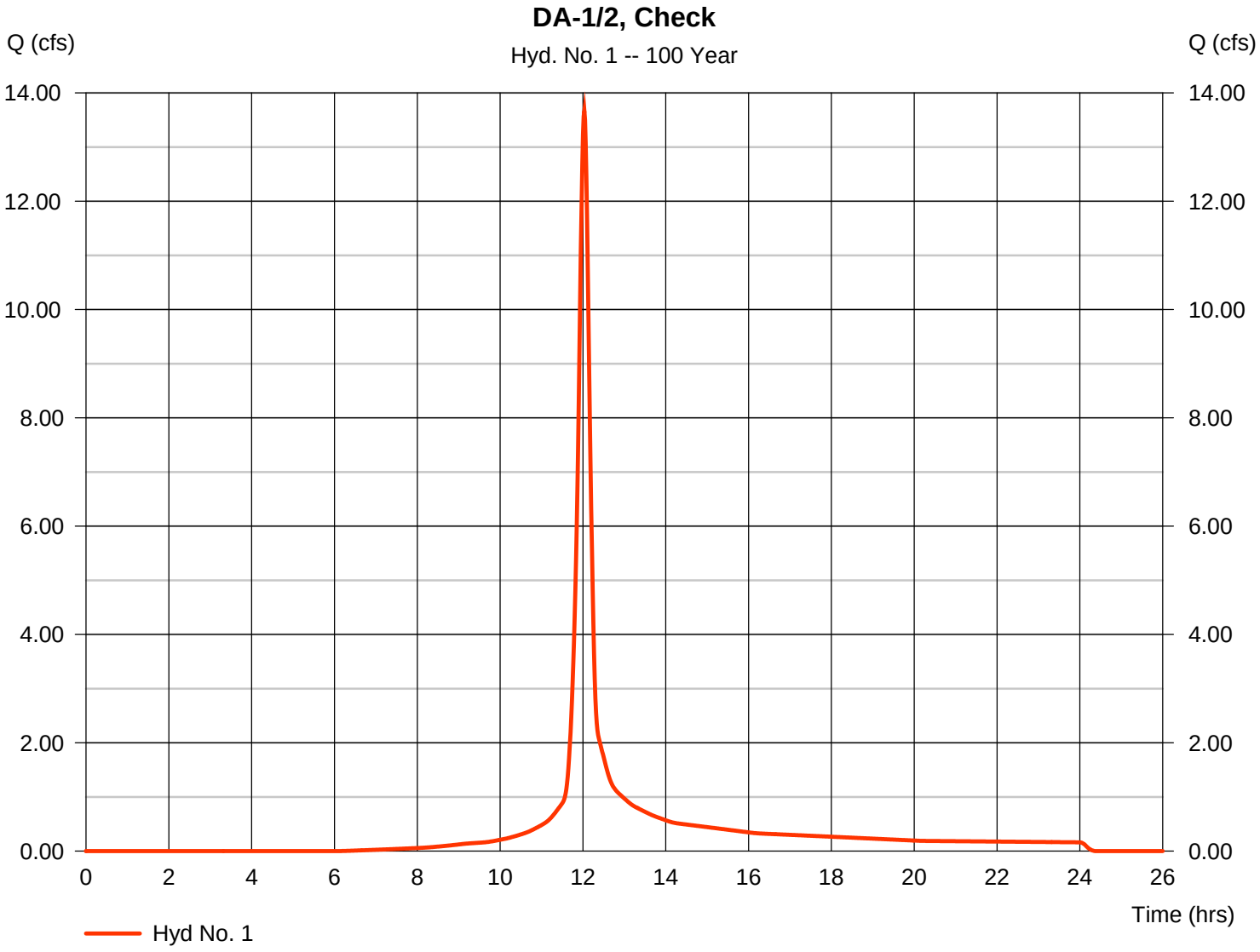
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Monday, Oct 17, 2011

## Hyd. No. 1

DA-1/2, Check

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 13.67 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 12.03 hrs |
| Time interval | = 1 min | Hyd. volume | = 37,124 cuft |
| Drainage area | = 2.240 ac | Curve number | = 78* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 15.00 min |
| Total precip. | = 7.10 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(0.710 x 98) + (0.960 x 74) + (0.570 x 61)] / 2.240



# Culvert Report



## Chesapeake Park Plaza - Simplified

| | |
|---|---|
| Invert Elev Dn (ft) | = 14.00 |
| Pipe Length (ft) | = 75.00 |
| Slope (%) | = 0.67 |
| Invert Elev Up (ft) | = 14.50 |
| Rise (in) | = 15.0 |
| Shape | = Cir |
| Span (in) | = 15.0 |
| No. Barrels | = 1 |
| n-Value | = 0.011 |
| Inlet Edge | = 0 |
| Coeff. K,M,c,Y,k | = 0.0045, 2, 0.0317, 0.69, 0.5 |

**Embankment**

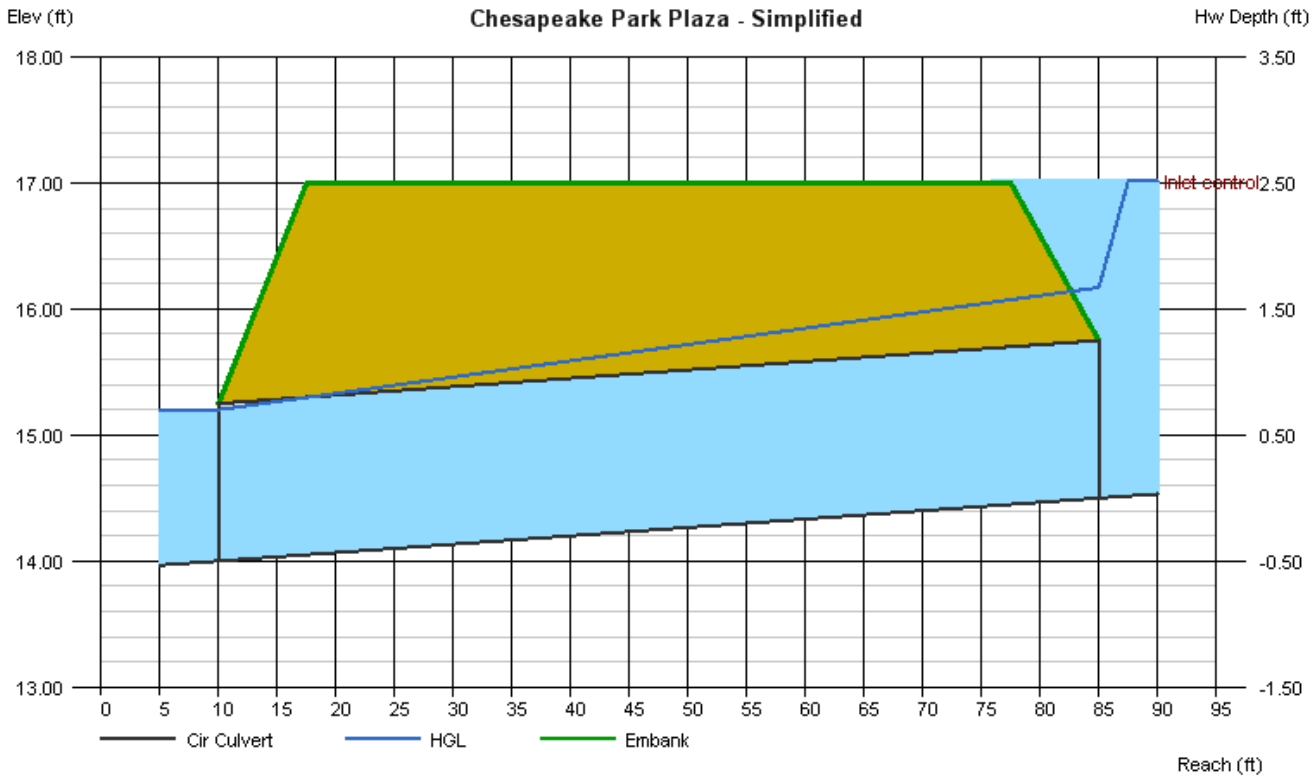
| | |
|---|---|
| Top Elevation (ft) | = 17.00 |
| Top Width (ft) | = 60.00 |
| Crest Width (ft) | = 500.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 2.00 |
| Qmax (cfs) | = 12.00 |
| Tailwater Elev (ft) | = 0 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 12.00 |
| Qpipe (cfs) | = 8.87 |
| Qovertop (cfs) | = 3.13 |
| Veloc Dn (ft/s) | = 7.32 |
| Veloc Up (ft/s) | = 7.23 |
| HGL Dn (ft) | = 15.20 |
| HGL Up (ft) | = 16.17 |
| Hw Elev (ft) | = 17.01 |
| Hw/D (ft) | = 2.01 |
| Flow Regime | = Inlet Control |



| Q | | | Veloc | | Depth | | HGL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | Pipe | Over | Dn | Up | Dn | Up | Dn | Up | Hw | Hw/D |
| (cfs) | (cfs) | (cfs) | (ft/s) | (ft/s) | (in) | (in) | (ft) | (ft) | (ft) | |
| 2.00 | 2.00 | 0.00 | 2.10 | 3.71 | 10.89 | 6.78 | 14.91 | 15.07 | 15.29 | 0.63 |
| 3.00 | 3.00 | 0.00 | 2.92 | 4.25 | 11.70 | 8.39 | 14.97 | 15.20 | 15.51 | 0.81 |
| 4.00 | 4.00 | 0.00 | 3.69 | 4.74 | 12.37 | 9.75 | 15.03 | 15.31 | 15.71 | 0.97 |
| 5.00 | 5.00 | 0.00 | 4.44 | 5.22 | 12.96 | 10.92 | 15.08 | 15.41 | 15.91 | 1.13 |
| 6.00 | 6.00 | 0.00 | 5.17 | 5.73 | 13.46 | 11.94 | 15.12 | 15.50 | 16.12 | 1.29 |
| 7.00 | 7.00 | 0.00 | 5.91 | 5.72 | 13.87 | 14.82 | 15.16 | 15.74 | 16.39 | 1.51 |
| 8.00 | 8.00 | 0.00 | 6.66 | 6.52 | 14.20 | 15.00 | 15.18 | 15.98 | 16.71 | 1.76 |
| 9.00 | 8.86 | 0.14 | 7.32 | 7.22 | 14.41 | 15.00 | 15.20 | 16.17 | 17.01 | 2.01 |
| 10.00 | 8.45 | 1.55 | 7.00 | 6.89 | 14.32 | 15.00 | 15.19 | 16.08 | 16.86 | 1.89 |
| 11.00 | 8.44 | 2.56 | 6.99 | 6.88 | 14.32 | 15.00 | 15.19 | 16.07 | 16.86 | 1.89 |
| 12.00 | 8.87 | 3.13 | 7.32 | 7.23 | 14.41 | 15.00 | 15.20 | 16.17 | 17.01 | 2.01 |

Note: Overflow will continue along the swale and discharge outside the analysis area

**NOAA Atlas 14, Volume 2, Version 3BALTIMORE WSO CITY**
**Station ID: 18-0470**
**Location name: Baltimore, Maryland, US***
**Coordinates: 39.2833, -76.6167**
**Elevation:**
**Elevation (station metadata): 14ft***
* source: Google Maps

**POINT PRECIPITATION FREQUENCY ESTIMATES**

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]**

| Duration | Average recurrence interval(years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 4.14 (3.76–4.57) | 4.97 (4.49–5.47) | 5.90 (5.34–6.52) | 6.59 (5.94–7.27) | 7.44 (6.67–8.22) | 8.08 (7.20–8.93) | 8.69 (7.72–9.65) | 9.29 (8.18–10.3) | 10.0 (8.75–11.2) | 10.6 (9.18–11.9) |
| 10-min | 3.31 (2.99–3.65) | 3.97 (3.59–4.37) | 4.73 (4.27–5.22) | 5.27 (4.75–5.81) | 5.93 (5.32–6.55) | 6.43 (5.74–7.11) | 6.91 (6.13–7.66) | 7.36 (6.49–8.20) | 7.93 (6.92–8.87) | 8.34 (7.22–9.39) |
| 15-min | 2.76 (2.50–3.04) | 3.32 (3.01–3.67) | 3.98 (3.60–4.40) | 4.44 (4.00–4.90) | 5.01 (4.49–5.54) | 5.42 (4.84–6.00) | 5.82 (5.16–6.46) | 6.19 (5.46–6.89) | 6.65 (5.80–7.45) | 6.98 (6.04–7.86) |
| 30-min | 1.89 (1.71–2.08) | 2.30 (2.08–2.53) | 2.83 (2.56–3.13) | 3.22 (2.90–3.55) | 3.71 (3.33–4.10) | 4.09 (3.64–4.52) | 4.46 (3.95–4.94) | 4.82 (4.25–5.36) | 5.29 (4.62–5.93) | 5.65 (4.90–6.36) |
| 60-min | 1.18 (1.07–1.30) | 1.44 (1.30–1.59) | 1.82 (1.64–2.00) | 2.10 (1.89–2.31) | 2.47 (2.21–2.73) | 2.77 (2.47–3.06) | 3.07 (2.72–3.41) | 3.38 (2.98–3.76) | 3.80 (3.31–4.25) | 4.13 (3.57–4.64) |
| 2-hr | 0.706 (0.637–0.782) | 0.860 (0.778–0.950) | 1.09 (0.982–1.20) | 1.27 (1.14–1.40) | 1.51 (1.35–1.67) | 1.72 (1.53–1.90) | 1.93 (1.70–2.14) | 2.15 (1.88–2.39) | 2.47 (2.13–2.76) | 2.72 (2.33–3.07) |
| 3-hr | 0.507 (0.458–0.564) | 0.617 (0.557–0.686) | 0.784 (0.705–0.870) | 0.914 (0.819–1.02) | 1.10 (0.980–1.22) | 1.25 (1.11–1.39) | 1.42 (1.24–1.58) | 1.59 (1.38–1.77) | 1.84 (1.57–2.06) | 2.04 (1.72–2.30) |
| 6-hr | 0.316 (0.287–0.349) | 0.383 (0.348–0.423) | 0.484 (0.438–0.534) | 0.566 (0.511–0.626) | 0.690 (0.616–0.761) | 0.794 (0.703–0.877) | 0.907 (0.795–1.01) | 1.03 (0.892–1.15) | 1.21 (1.03–1.36) | 1.37 (1.15–1.54) |
| 12-hr | 0.192 (0.173–0.215) | 0.232 (0.210–0.260) | 0.296 (0.266–0.331) | 0.350 (0.313–0.391) | 0.433 (0.382–0.483) | 0.506 (0.443–0.564) | 0.587 (0.507–0.656) | 0.678 (0.577–0.761) | 0.816 (0.678–0.924) | 0.937 (0.764–1.07) |
| 24-hr | 0.111 (0.103–0.122) | 0.135 (0.124–0.148) | 0.173 (0.159–0.190) | 0.207 (0.190–0.226) | 0.259 (0.235–0.282) | 0.305 (0.275–0.331) | 0.357 (0.319–0.386) | 0.416 (0.367–0.448) | 0.507 (0.440–0.545) | 0.588 (0.503–0.630) |
| 2-day | 0.064 (0.059–0.070) | 0.078 (0.072–0.085) | 0.100 (0.092–0.109) | 0.119 (0.109–0.130) | 0.147 (0.134–0.160) | 0.172 (0.156–0.187) | 0.200 (0.180–0.217) | 0.231 (0.205–0.250) | 0.278 (0.243–0.301) | 0.318 (0.274–0.344) |
| 3-day | 0.045 (0.042–0.049) | 0.055 (0.050–0.060) | 0.070 (0.065–0.076) | 0.083 (0.076–0.091) | 0.103 (0.094–0.112) | 0.120 (0.109–0.131) | 0.140 (0.125–0.151) | 0.161 (0.143–0.174) | 0.193 (0.169–0.209) | 0.221 (0.191–0.240) |
| 4-day | 0.036 (0.033–0.039) | 0.043 (0.040–0.047) | 0.055 (0.051–0.060) | 0.065 (0.060–0.071) | 0.081 (0.074–0.088) | 0.094 (0.086–0.102) | 0.109 (0.098–0.118) | 0.126 (0.112–0.136) | 0.151 (0.132–0.164) | 0.173 (0.149–0.187) |
| 7-day | 0.024 (0.022–0.026) | 0.029 (0.026–0.031) | 0.036 (0.033–0.039) | 0.043 (0.039–0.046) | 0.052 (0.048–0.056) | 0.061 (0.055–0.065) | 0.070 (0.063–0.075) | 0.080 (0.071–0.086) | 0.095 (0.084–0.103) | 0.108 (0.094–0.117) |
| 10-day | 0.019 (0.018–0.020) | 0.023 (0.021–0.024) | 0.028 (0.026–0.031) | 0.033 (0.031–0.036) | 0.040 (0.037–0.043) | 0.046 (0.042–0.049) | 0.052 (0.047–0.056) | 0.059 (0.053–0.063) | 0.068 (0.061–0.073) | 0.077 (0.068–0.082) |
| 20-day | 0.013 (0.012–0.014) | 0.015 (0.014–0.016) | 0.018 (0.017–0.020) | 0.021 (0.020–0.022) | 0.025 (0.023–0.026) | 0.027 (0.026–0.029) | 0.030 (0.028–0.032) | 0.034 (0.031–0.036) | 0.038 (0.035–0.040) | 0.041 (0.038–0.044) |
| 30-day | 0.011 (0.010–0.011) | 0.012 (0.012–0.013) | 0.015 (0.014–0.016) | 0.017 (0.016–0.018) | 0.019 (0.018–0.020) | 0.021 (0.020–0.023) | 0.023 (0.022–0.025) | 0.026 (0.024–0.027) | 0.029 (0.026–0.031) | 0.031 (0.028–0.033) |
| 45-day | 0.009 (0.008–0.009) | 0.010 (0.010–0.011) | 0.012 (0.012–0.013) | 0.014 (0.013–0.014) | 0.015 (0.014–0.016) | 0.017 (0.016–0.018) | 0.018 (0.017–0.019) | 0.019 (0.018–0.020) | 0.021 (0.020–0.022) | 0.022 (0.021–0.024) |
| 60-day | 0.008 (0.008–0.008) | 0.009 (0.009–0.010) | 0.011 (0.010–0.011) | 0.012 (0.011–0.012) | 0.013 (0.013–0.014) | 0.014 (0.014–0.015) | 0.015 (0.014–0.016) | 0.016 (0.015–0.017) | 0.018 (0.016–0.019) | 0.018 (0.017–0.019) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

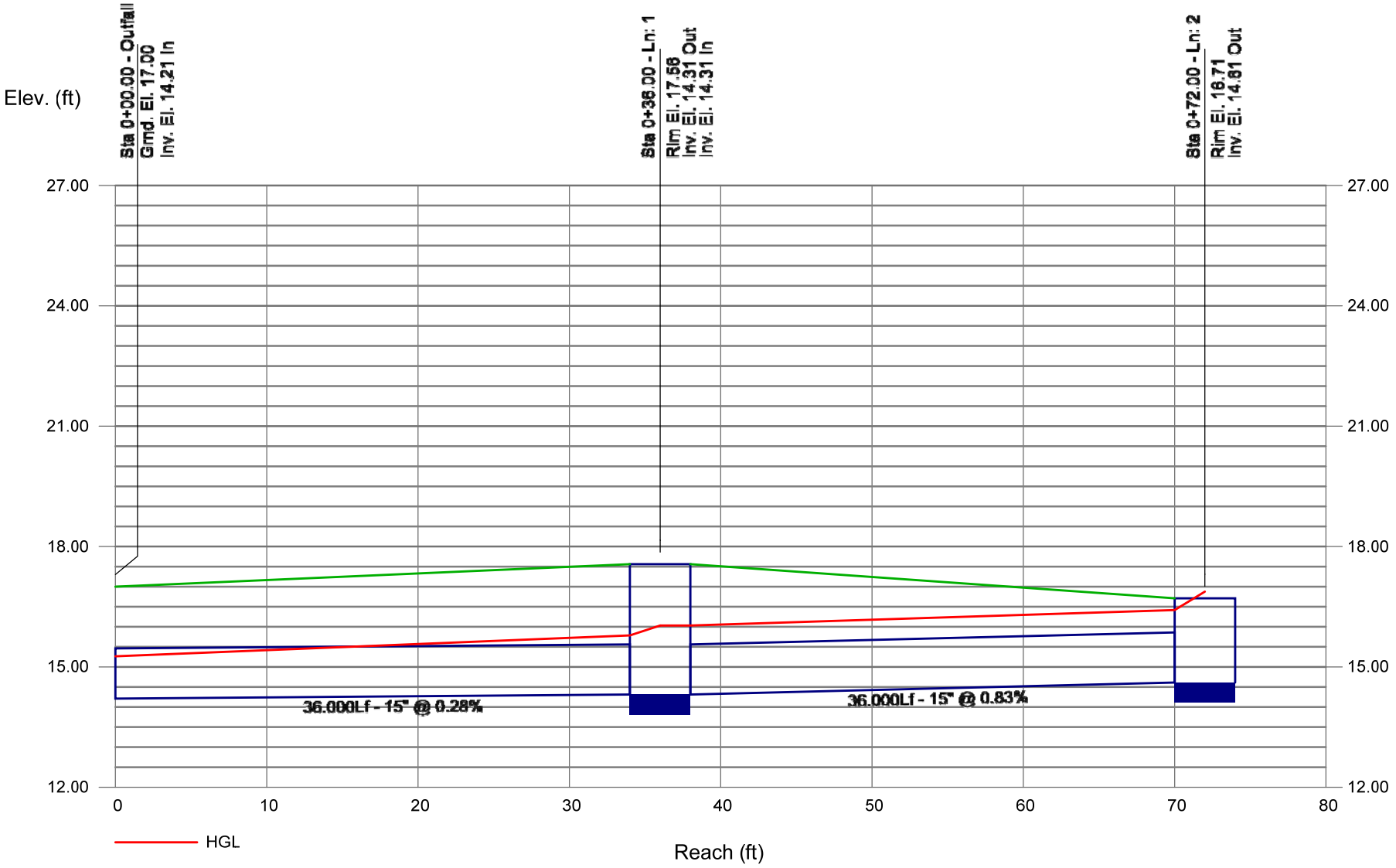
Please refer to NOAA Atlas 14 document for more information.

Back to Top

# Storm Sewer Profile

Proj. file: ChesParkPlazaCulvert-Ex.stm

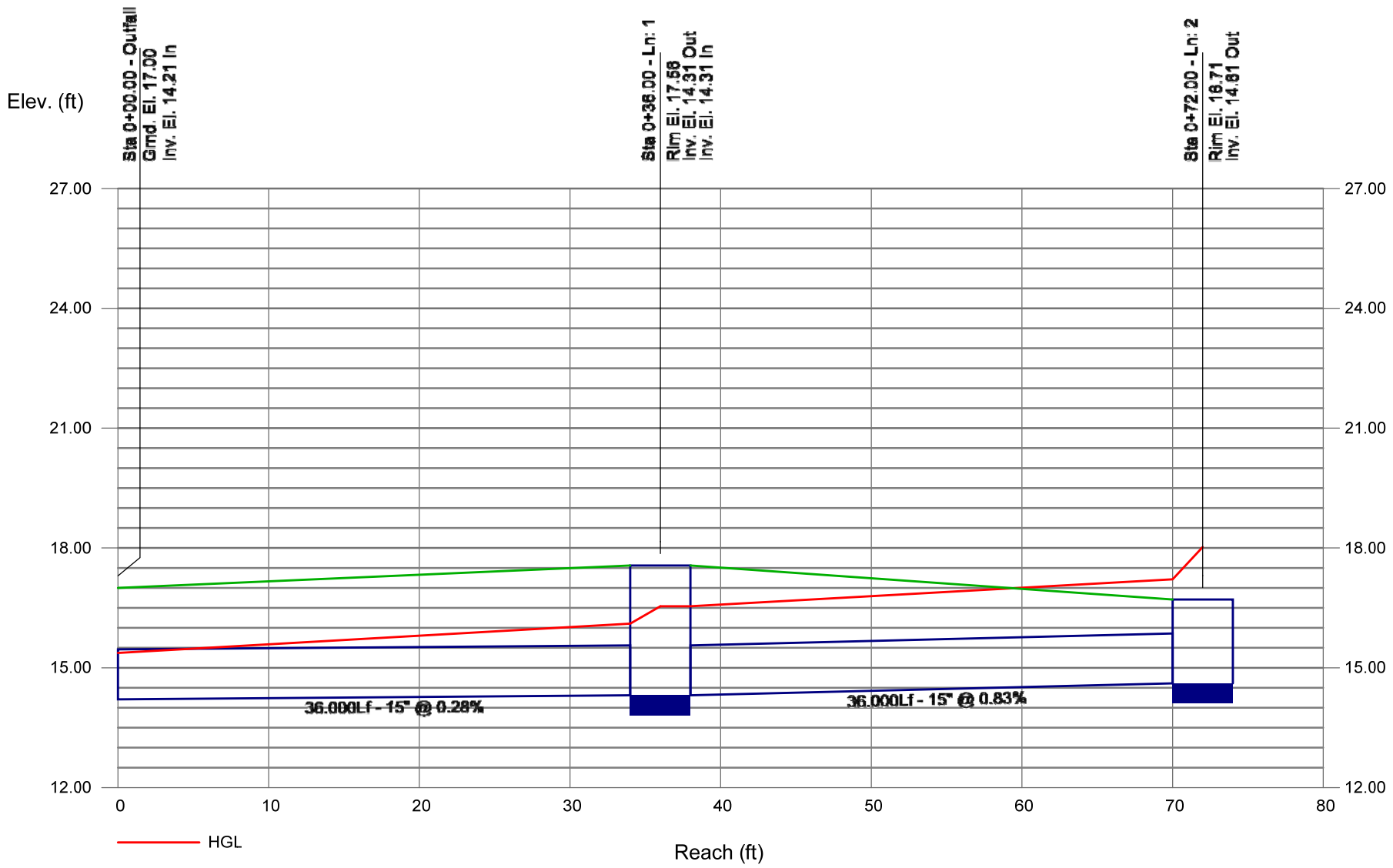
Chesapeake Park Plaza:
10-year storm, Existing Conditions



# Storm Sewer Profile

Proj. file: ChesParkPlazaCulvert-Ex.stm

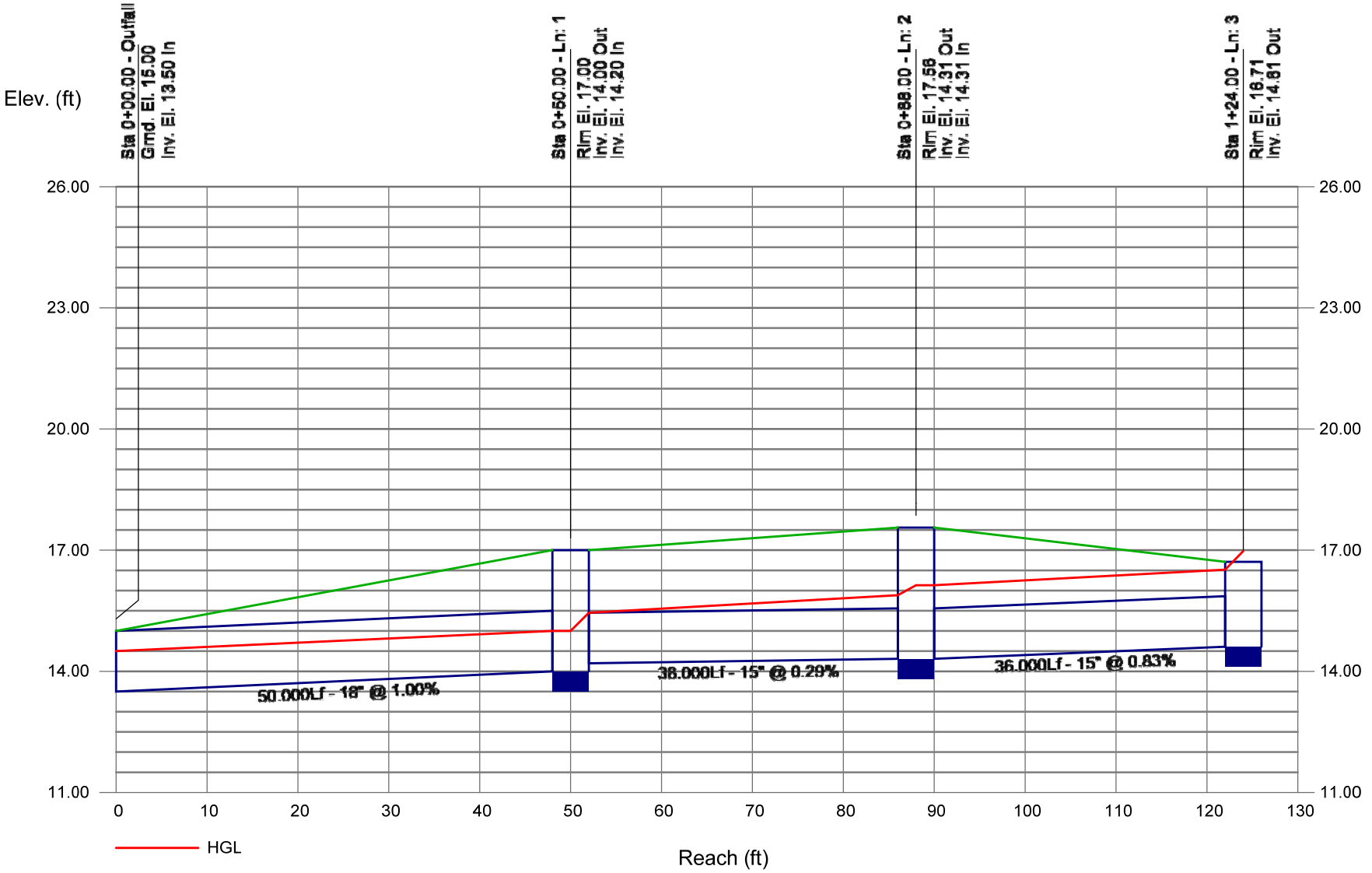
Chesapeake Park Plaza:
100-year storm, Existing Conditions



# Storm Sewer Profile

Proj. file: ChesParkPlazaCulvert-Pr.stm

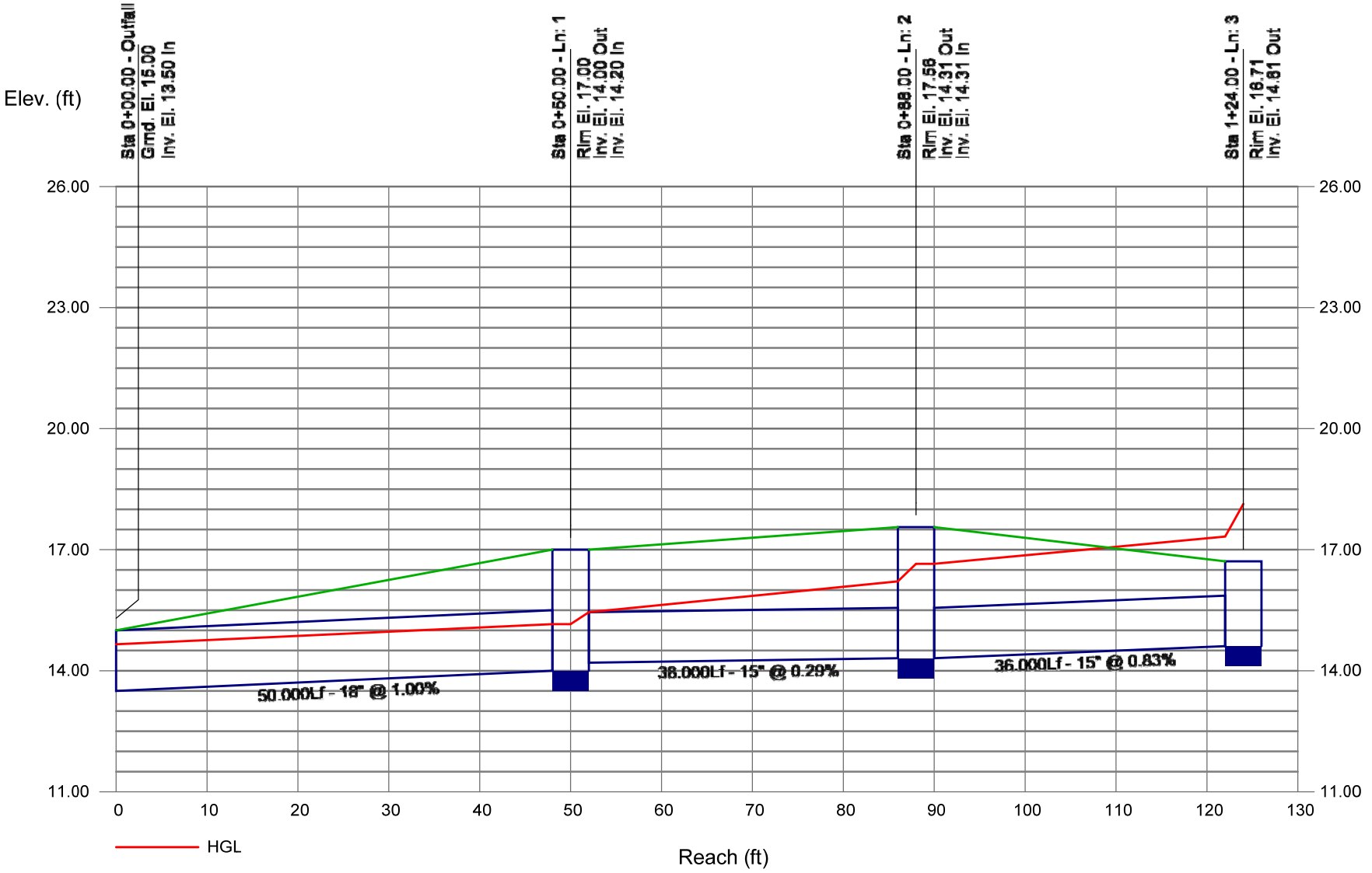
Chesapeake Park Plaza:
10-year storm, Proposed Conditions



# Storm Sewer Profile

Proj. file: ChesParkPlazaCulvert-Pr.stm

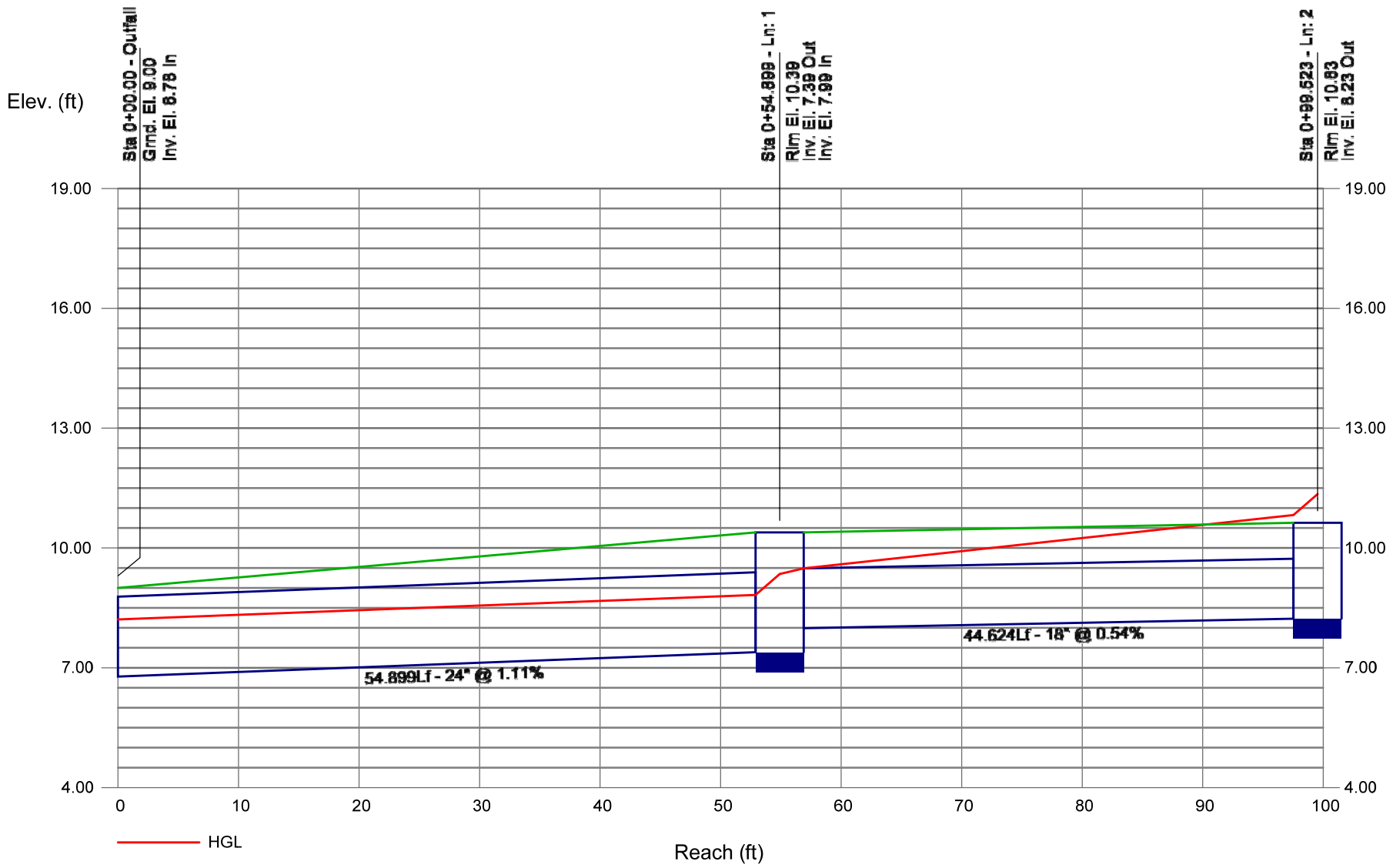
Chesapeake Park Plaza:
100-year storm, Proposed Conditions



# Storm Sewer Profile

Proj. file: CowPenOutfall-Ex.stm

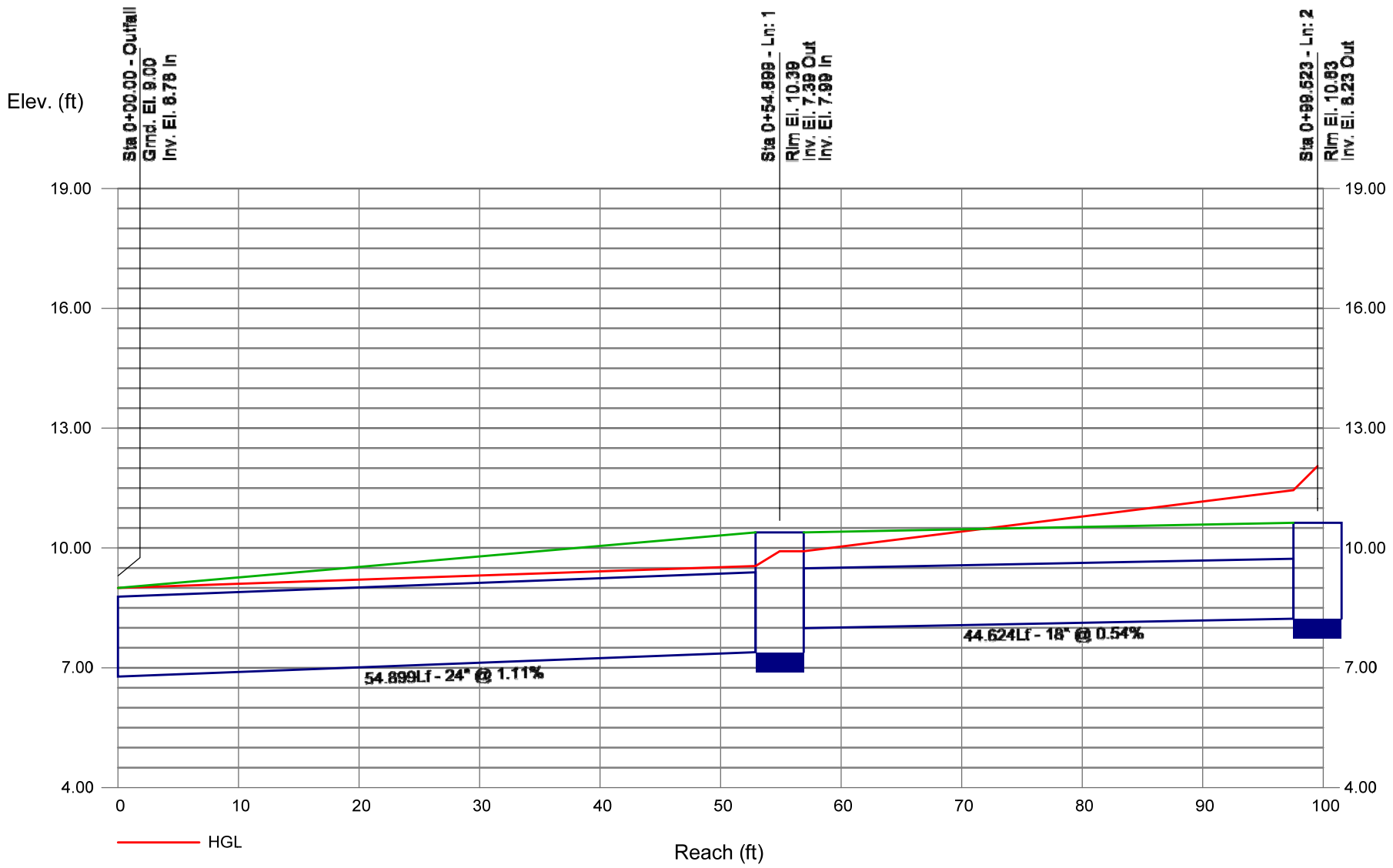
Cow Pen Creek:
10-year storm, Existing Conditions



# Storm Sewer Profile

Proj. file: CowPenOutfall-Ex.stm

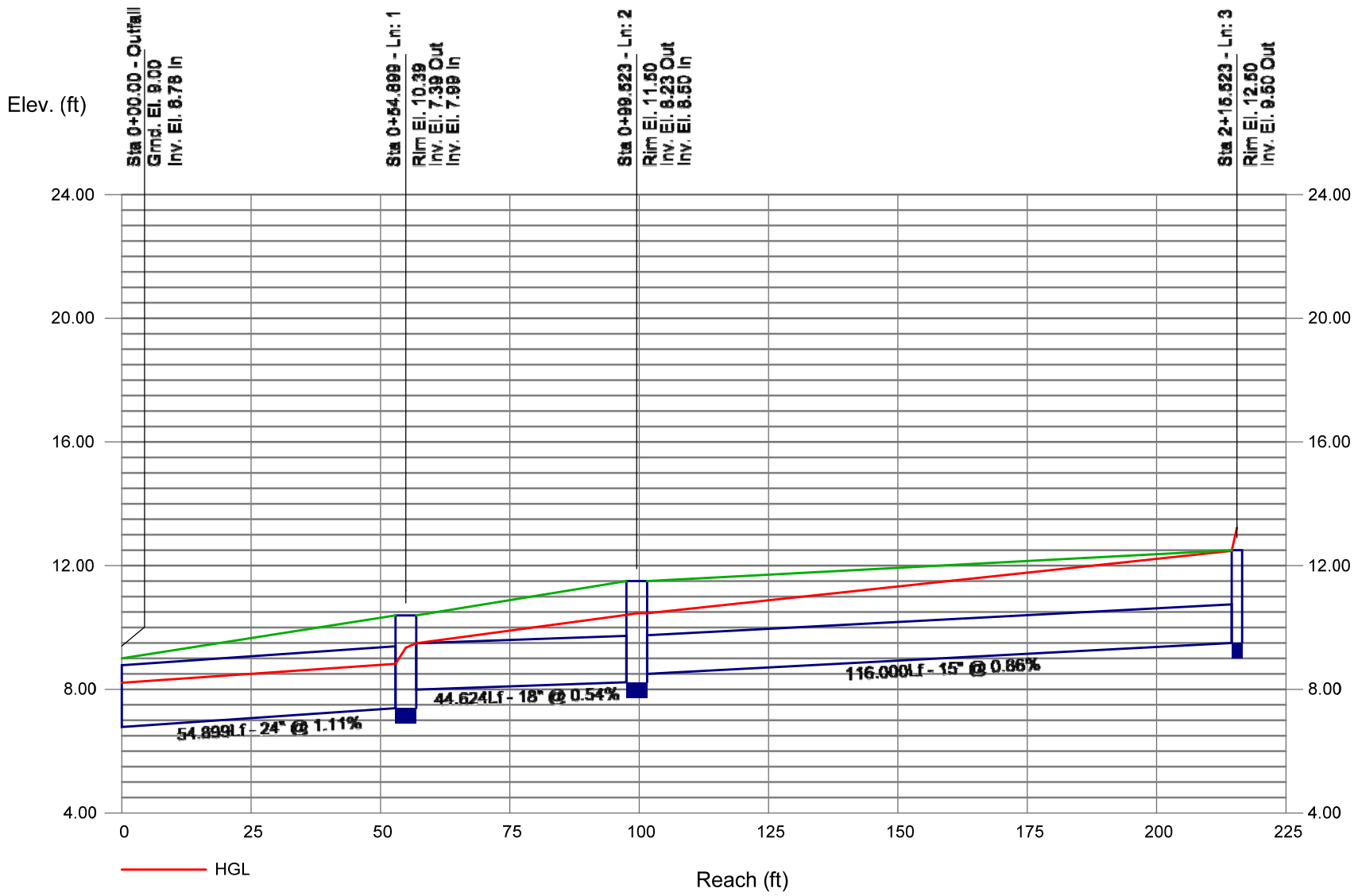
Cow Pen Creek:
100-year storm, Existing Conditions



# Storm Sewer Profile

Proj. file: CowPenOutfall-Pr.stm

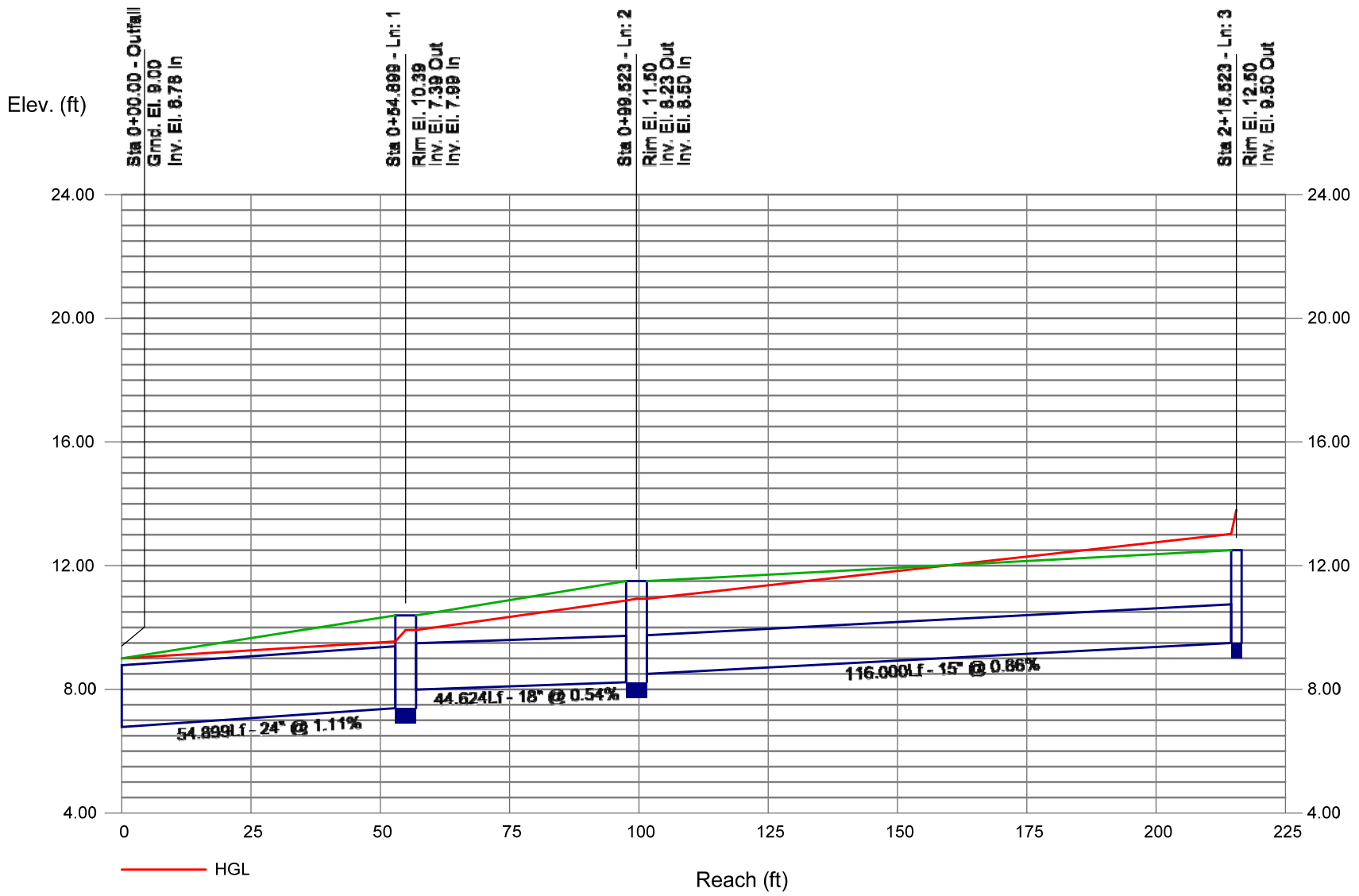
Cow Pen Creek:
10-year storm, Proposed Conditions



# Storm Sewer Profile

Proj. file: CowPenOutfall-Pr.stm

Cow Pen Creek:
100-year storm, Proposed Conditions



# APPENDIX D – EXISTING CONDITIONS, BLOCK G SWALE REVIEW

# Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Wednesday, Feb 1 2012

## BlockG Swale - Upper, 100 year

**User-defined**

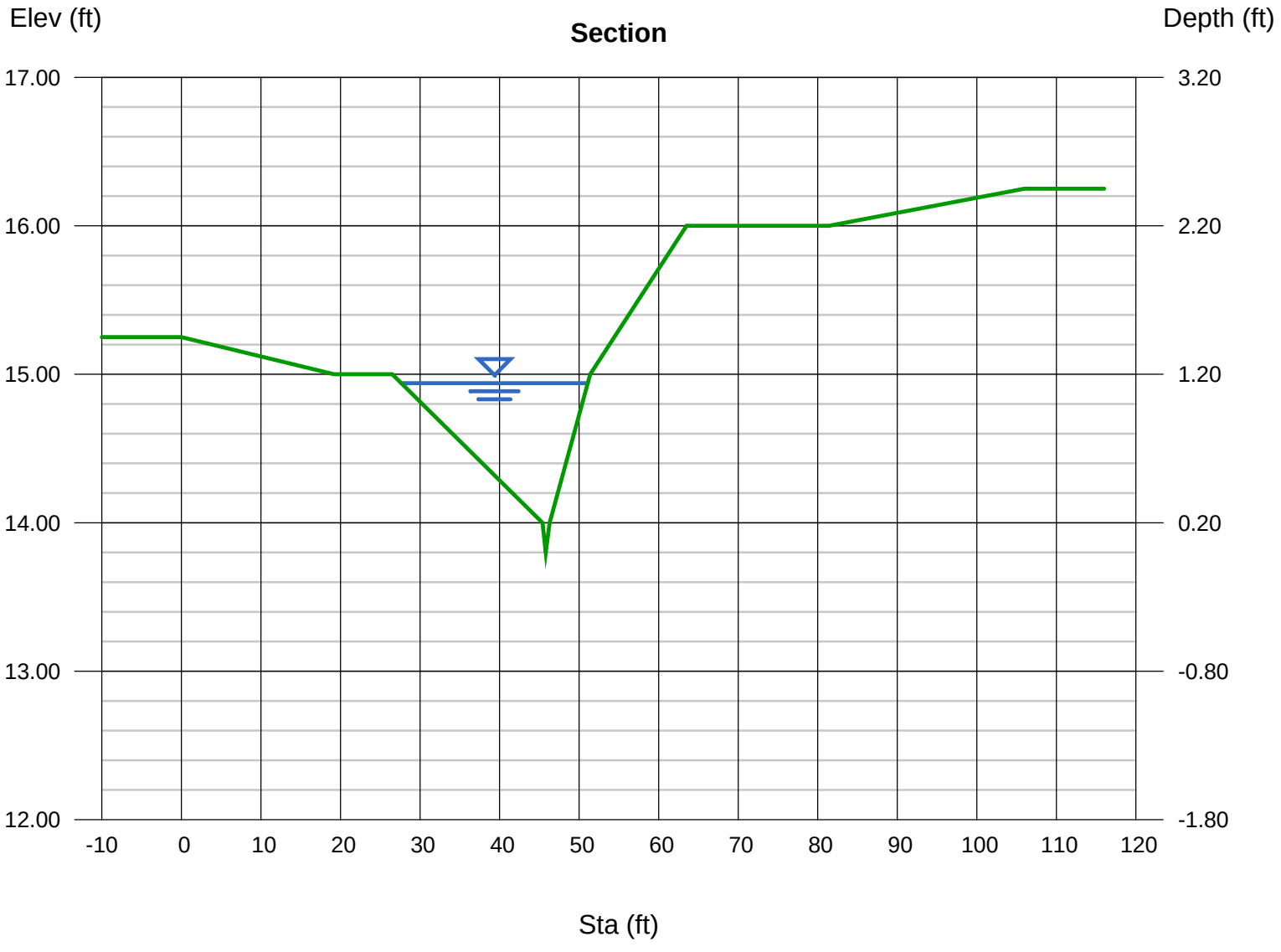
| | |
|---|---|
| Invert Elev (ft) | = 13.80 |
| Slope (%) | = 3.00 |
| N-Value | = 0.200 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 9.00 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.14 |
| Q (cfs) | = 9.000 |
| Area (sqft) | = 11.54 |
| Velocity (ft/s) | = 0.78 |
| Wetted Perim (ft) | = 23.66 |
| Crit Depth, Yc (ft) | = 0.67 |
| Top Width (ft) | = 23.46 |
| EGL (ft) | = 1.15 |



# Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. Wednesday, Feb 1 2012

## Block G Swale - Lower, 100 year

**User-defined**

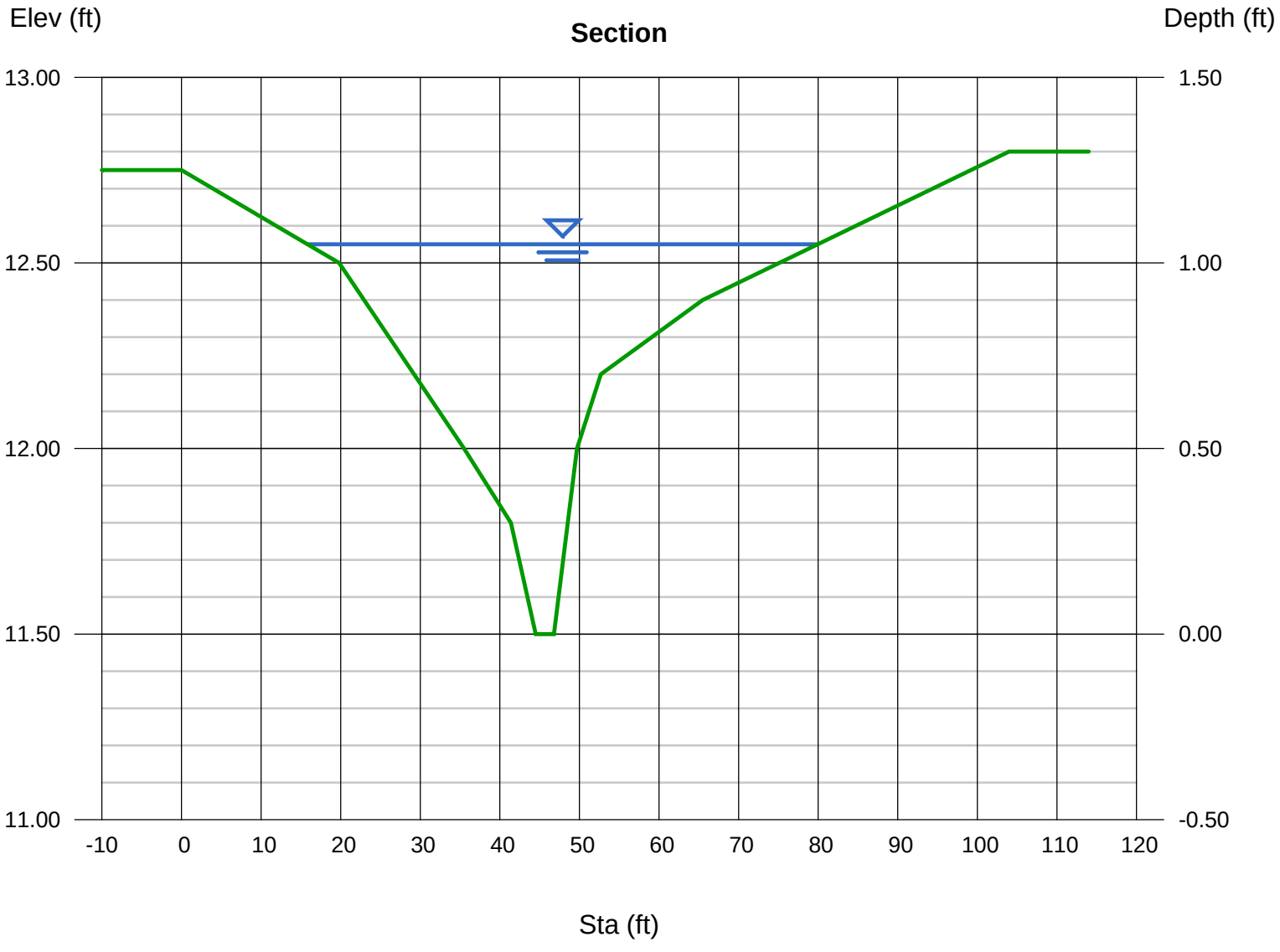
| | |
|---|---|
| Invert Elev (ft) | = 11.50 |
| Slope (%) | = 3.00 |
| N-Value | = 0.200 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 13.40 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.05 |
| Q (cfs) | = 13.40 |
| Area (sqft) | = 21.80 |
| Velocity (ft/s) | = 0.61 |
| Wetted Perim (ft) | = 64.18 |
| Crit Depth, Yc (ft) | = 0.57 |
| Top Width (ft) | = 64.10 |
| EGL (ft) | = 1.06 |



# APPENDIX E - PHOTOGRAPHS

**Photo 1: Catch Basin and Swale (Ditch) between Chesapeake Park Plaza and the Tilley Chemical Building**

**Photo 2: Splash Pool at Chesapeake Park Plaza from Containment Area**

**Photo 3: Tilley Chemical Building Containment Area**

**Photo 4: Block G Swale ("Main Swale")**

**Photo 5: Cow Pen Creek Outfall, 24-inch corrugated metal pipe (CMP)**

**Photo 6: Looking Southeast at the Block G Swale / Open Area**

**Photo 7: Looking Southwest at the Block G Swale / Open Area (towards Cow Pen Creek)**

**Photo 8: Looking East at the Block G Swale / Open Area (towards Tilly Chemical)**

**Photo 9: Looking Northeast at the Block G Swale / Open Area (from conc. foundation)**

**Photos 10a, 10b, and 10c:**

**Block G Swale general characteristics (depth, width, vegetation, wetness)**

**These pictures were taken mid-June 2011 and may be considered "typical summer conditions". No recent major storm or draught had taken place prior to this site visit.**

**Photos 11a and 11b: Catch basins at end of Block G Swale, leading into Cow Pen Creek (note dislodged grate and standing water)**

**Photo 12: Cow Pen Creek (at "typical" Medium/High Tide)**

# APPENDIX F — SOIL RESOURCE REPORT

United States Department of Agriculture

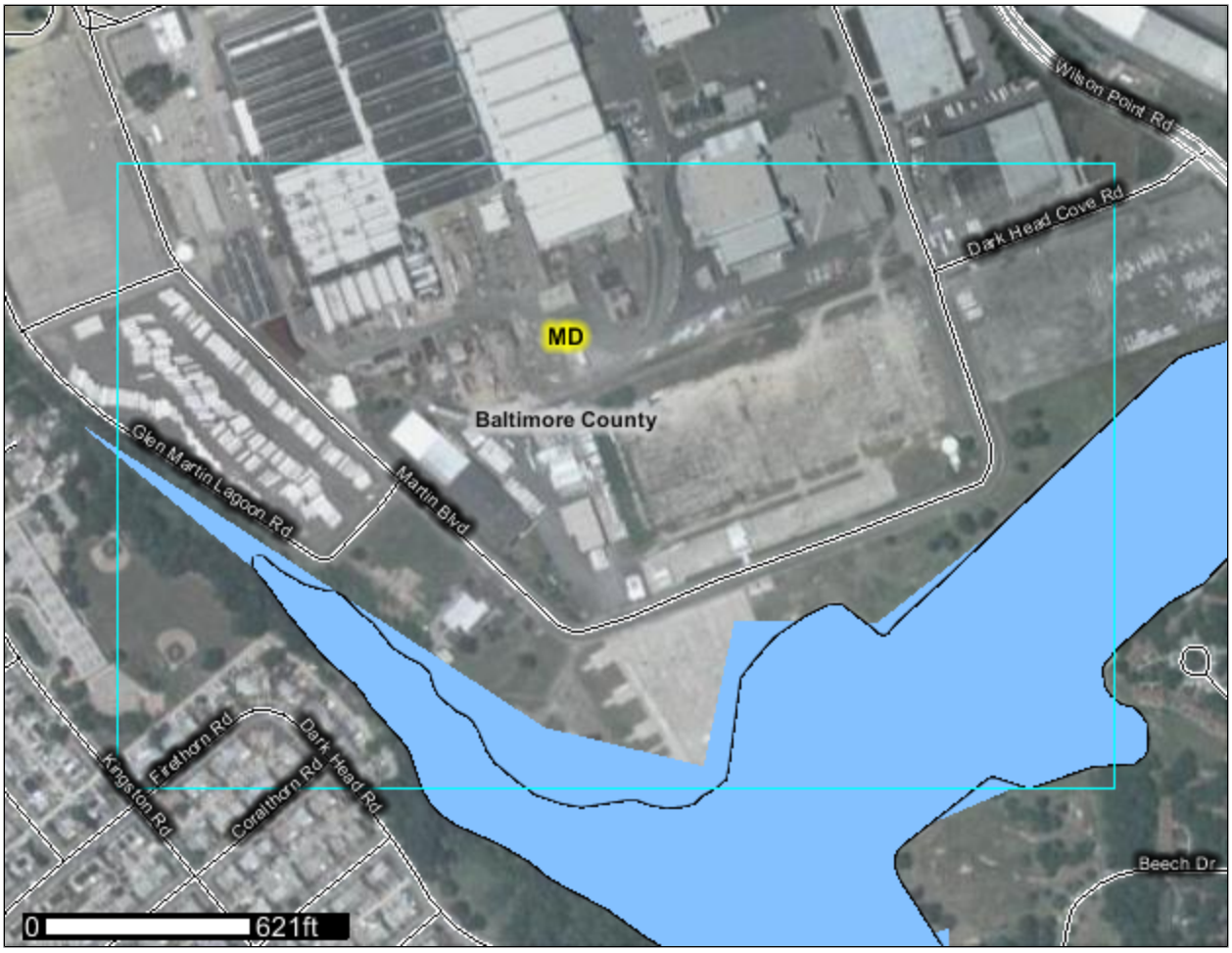
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Baltimore County, Maryland

## LMC- Block G




September 1, 2011

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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# Contents

**Preface**.....2
**How Soil Surveys Are Made**.....5
**Soil Map**.....7
Soil Map.....8
Legend.....9
Map Unit Legend.....10
Map Unit Descriptions.....10
Baltimore County, Maryland.....12
IsA—Issue silt loam, occasionally flooded.....12
KeB—Keyport silt loam, 2 to 5 percent slopes.....13
MkB—Mattapex-Urban land complex, 0-5 percent slopes.....14
SaC—Sassafras sandy laom, 5 to 10 percent slopes.....15
SbC—Sassafras loam, 5 to 10 percent slopes.....16
SfB—Sassafras-Urban land complex, 0 to 5 percent slopes.....17
Ur—Urban land 0 to 8 percent slopes.....19
W—Water.....19
**References**.....20

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Units

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

**Special Line Features**
- Gully
- Short Steep Slope
- Other

**Political Features**
- Cities

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

## MAP INFORMATION

Map Scale: 1:5,050 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 18N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Baltimore County, Maryland
Survey Area Data: Version 6, Feb 17, 2010

Date(s) aerial images were photographed: 6/21/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Baltimore County, Maryland (MD005) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| IsA | Issue silt loam, occasionally flooded | 0.9 | 0.7% |
| KeB | Keyport silt loam, 2 to 5 percent slopes | 0.4 | 0.3% |
| MkB | Mattapex-Urban land complex, 0-5 percent slopes | 2.9 | 2.2% |
| SaC | Sassafras sandy laom, 5 to 10 percent slopes | 0.1 | 0.1% |
| SbC | Sassafras loam, 5 to 10 percent slopes | 1.9 | 1.5% |
| SfB | Sassafras-Urban land complex, 0 to 5 percent slopes | 13.2 | 10.2% |
| Ur | Urban land 0 to 8 percent slopes | 88.7 | 69.0% |
| W | Water | 20.5 | 15.9% |
| **Totals for Area of Interest** | | **128.5** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Baltimore County, Maryland

## IsA—Issue silt loam, occasionally flooded

**Map Unit Setting**

*Elevation:* 0 to 250 feet
*Mean annual precipitation:* 40 to 50 inches
*Mean annual air temperature:* 52 to 57 degrees F
*Frost-free period:* 180 to 210 days

**Map Unit Composition**

*Issue and similar soils:* 80 percent
*Minor components:* 20 percent

**Description of Issue**

**Setting**

*Landform:* Flood plains, drainageways
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy alluvium

**Properties and qualities**

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 10 to 20 inches
*Frequency of flooding:* Occasional
*Frequency of ponding:* None
*Available water capacity:* High (about 9.9 inches)

**Interpretive groups**

*Land capability (nonirrigated):* 4w

**Typical profile**

*0 to 4 inches:* Silt loam
*4 to 19 inches:* Loam
*19 to 30 inches:* Fine sandy loam
*30 to 58 inches:* Fine sandy loam
*58 to 70 inches:* Silt loam

**Minor Components**

**Woodstown**

*Percent of map unit:* 10 percent
*Landform:* Depressions, drainageways, swales

**Potobac**

*Percent of map unit:* 10 percent
*Landform:* Flood plains, drainageways

## KeB—Keyport silt loam, 2 to 5 percent slopes

### Map Unit Setting

*Elevation:* 20 to 70 feet
*Mean annual precipitation:* 42 to 48 inches
*Mean annual air temperature:* 52 to 58 degrees F
*Frost-free period:* 180 to 220 days

### Map Unit Composition

*Keyport and similar soils:* 80 percent
*Minor components:* 20 percent

### Description of Keyport

#### Setting

*Landform:* Flats, depressions, fluviomarine terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Silty and clayey eolian deposits over fluviomarine sediments

#### Properties and qualities

*Slope:* 2 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* About 20 to 40 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* High (about 10.1 inches)

#### Interpretive groups

*Land capability (nonirrigated):* 2e

#### Typical profile

*0 to 10 inches:* Silt loam
*10 to 48 inches:* Silty clay loam
*48 to 80 inches:* Stratified silt loam to sandy loam

### Minor Components

#### Mattapex

*Percent of map unit:* 10 percent
*Landform:* Flats

#### Crosiadore

*Percent of map unit:* 5 percent
*Landform:* Flats, swales, depressions
*Landform position (three-dimensional):* Rise

**Lenni**

*Percent of map unit:* 3 percent
*Landform:* Flats, depressions, drainageways, swales
*Landform position (three-dimensional):* Dip

**Elkton**

*Percent of map unit:* 2 percent
*Landform:* Depressions, flats

## MkB—Mattapex-Urban land complex, 0-5 percent slopes

### Map Unit Setting

*Elevation:* 0 to 260 feet
*Mean annual precipitation:* 42 to 48 inches
*Mean annual air temperature:* 52 to 58 degrees F
*Frost-free period:* 180 to 220 days

### Map Unit Composition

*Mattapex and similar soils:* 50 percent
*Urban land:* 40 percent
*Minor components:* 10 percent

### Description of Mattapex

#### Setting

*Landform:* Flats, depressions, swales
*Landform position (three-dimensional):* Rise
*Down-slope shape:* Linear, concave
*Across-slope shape:* Linear, concave
*Parent material:* Silty eolian deposits over fluviomarine sediments

#### Properties and qualities

*Slope:* 0 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.57 in/hr)
*Depth to water table:* About 20 to 40 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 8.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 2e
*Land capability (nonirrigated):* 2e

#### Typical profile

*0 to 11 inches:* Silt loam
*11 to 15 inches:* Silt loam
*15 to 36 inches:* Silt loam
*36 to 60 inches:* Fine sandy loam

*60 to 80 inches:* Loamy sand

**Description of Urban Land**

**Setting**

*Landform:* Flats
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Minor Components**

**Udorthents, loamy**

*Percent of map unit:* 10 percent
*Landform:* Knolls, flats
*Down-slope shape:* Convex, linear
*Across-slope shape:* Convex, linear

## SaC—Sassafras sandy laom, 5 to 10 percent slopes

**Map Unit Setting**

*Elevation:* 40 to 330 feet
*Mean annual precipitation:* 42 to 48 inches
*Mean annual air temperature:* 52 to 58 degrees F
*Frost-free period:* 180 to 220 days

**Map Unit Composition**

*Sassafras and similar soils:* 75 percent
*Minor components:* 25 percent

**Description of Sassafras**

**Setting**

*Landform:* Knolls, hillslopes, low hills
*Landform position (three-dimensional):* Riser, dip
*Down-slope shape:* Convex, linear
*Across-slope shape:* Convex, linear

**Properties and qualities**

*Slope:* 5 to 10 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 7.8 inches)

**Interpretive groups**

*Land capability (nonirrigated):* 3e

**Typical profile**

*0 to 9 inches:* Sandy loam
*9 to 15 inches:* Sandy loam
*15 to 30 inches:* Loam
*30 to 37 inches:* Sandy loam
*37 to 80 inches:* Loamy sand

**Minor Components**

**Downer**

*Percent of map unit:* 15 percent
*Landform:* Flats

**Hambrook**

*Percent of map unit:* 5 percent
*Landform:* Flats, swales

**Ingleside**

*Percent of map unit:* 3 percent
*Landform:* Flats, swales

**Woodstown**

*Percent of map unit:* 2 percent
*Landform:* Depressions, swales

## SbC—Sassafras loam, 5 to 10 percent slopes

**Map Unit Setting**

*Elevation:* 30 to 330 feet
*Mean annual precipitation:* 40 to 50 inches
*Mean annual air temperature:* 52 to 57 degrees F
*Frost-free period:* 180 to 210 days

**Map Unit Composition**

*Sassafras and similar soils:* 85 percent
*Minor components:* 15 percent

**Description of Sassafras**

**Setting**

*Landform:* Broad interstream divides, fluviomarine terraces, interfluves
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy fluviomarine deposits

**Properties and qualities**

*Slope:* 5 to 10 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 8.3 inches)

**Interpretive groups**

*Land capability (nonirrigated):* 2e

**Typical profile**

*0 to 9 inches:* Loam
*9 to 15 inches:* Sandy loam
*15 to 30 inches:* Loam
*30 to 37 inches:* Sandy loam
*37 to 80 inches:* Loamy sand

**Minor Components**

**Woodstown**

*Percent of map unit:* 10 percent
*Landform:* Drainhead complexes, interfluves, swales
*Landform position (two-dimensional):* Footslope
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Hambrook**

*Percent of map unit:* 5 percent
*Landform:* Broad interstream divides, fluviomarine terraces, interfluves
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear

## SfB—Sassafras-Urban land complex, 0 to 5 percent slopes

**Map Unit Setting**

*Elevation:* 10 to 330 feet
*Mean annual precipitation:* 40 to 50 inches
*Mean annual air temperature:* 52 to 57 degrees F
*Frost-free period:* 175 to 220 days

**Map Unit Composition**

*Sassafras and similar soils:* 45 percent
*Urban land:* 35 percent
*Minor components:* 20 percent

**Description of Sassafras**

**Setting**

*Landform:* Knolls, fluviomarine terraces, broad interstream divides

*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy fluviomarine deposits

**Properties and qualities**

*Slope:* 0 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Moderate (about 7.8 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 1
*Land capability (nonirrigated):* 2e

**Typical profile**

*0 to 9 inches:* Sandy loam
*9 to 15 inches:* Sandy loam
*15 to 30 inches:* Loam
*30 to 37 inches:* Sandy loam
*37 to 80 inches:* Loamy sand

## Description of Urban Land

**Interpretive groups**

*Land capability (nonirrigated):* 8

## Minor Components

**Matapeake**

*Percent of map unit:* 5 percent
*Landform:* Broad interstream divides, fluviomarine terraces, interfluves
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Hambrook**

*Percent of map unit:* 5 percent
*Landform:* Broad interstream divides, fluviomarine terraces, interfluves, drainhead complexes, swales
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Phalanx**

*Percent of map unit:* 5 percent
*Landform:* Divides
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Woodstown**
*Percent of map unit:* 5 percent
*Landform:* Broad interstream divides, swales, fluviomarine terraces, depressions, interfluves, drainhead complexes
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear, concave
*Across-slope shape:* Linear, concave

## Ur—Urban land 0 to 8 percent slopes

**Map Unit Setting**
*Elevation:* 300 to 900 feet
*Mean annual precipitation:* 42 to 48 inches
*Mean annual air temperature:* 50 to 57 degrees F
*Frost-free period:* 160 to 220 days

**Map Unit Composition**
*Urban land:* 85 percent
*Minor components:* 15 percent

**Description of Urban Land**

**Setting**
*Parent material:* Human transported material

**Interpretive groups**
*Land capability (nonirrigated):* 8

**Minor Components**

**Udorthents**
*Percent of map unit:* 15 percent

## W—Water

**Map Unit Composition**
*Water:* 100 percent

# References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

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# LOCKHEED MARTIN CORPORATION
# BLOCK G SWALE REPLACEMENT
# SOUTHWESTERN TCE BIOREMEDIATION AREA
# MIDDLE RIVER, MARYLAND

## DRAWING LIST

GENERAL

| | |
|---|---|
| G-1 | COVER SHEET |
| G-2 | NOTES AND LEGEND |

CIVIL

| | |
|---|---|
| C-1 | EXISTING & DEMOLITION PLAN |
| C-2 | SITE LAYOUT PLAN |
| C-3 | SITE GRADING PLAN AND PROFILE |
| C-4 | STORM WATER MANAGEMENT DETAILS |
| C-5 & 6 | EROSION & SEDIMENT CONTROL PLANS |
| C-7 & 8 | EROSION & SEDIMENT CONTROL DETAILS |
| C-9 | SEEDING SPECIFICATIONS |

## SITE DATA:

1. OWNER: LMC PROPERTIES INC.
100 SOUTH CHARLES STREET
BALTIMORE, MD 21201-2725

2. PROPERTY ADDRESS: LOCKHEED MARTIN CORPORATION
103 CHESAPEAKE PARK PLAZA
MIDDLE RIVER, MARYLAND 21220

3. SOURCE OF TITLE: DEED: LIBER 4953 FOLIO 235, PLAT: 51/43

4. TAX ACCOUNT NUMBER: 04-15-1900014060 MAP 90 GRID 18 PARCEL 964

5. PARCEL AREA: 13.461± ACRES (BLOCK G PER PLAT)

6. ZONING: MH-IM, MAP NE 1-3, 1-4

7. TOPOGRAPHY: TOPOGRAPHY IS BASED ON A FIELD SURVEY PERFORMED BY TETRA TECH ON JUNE 7-8, 2011, AN & RB.

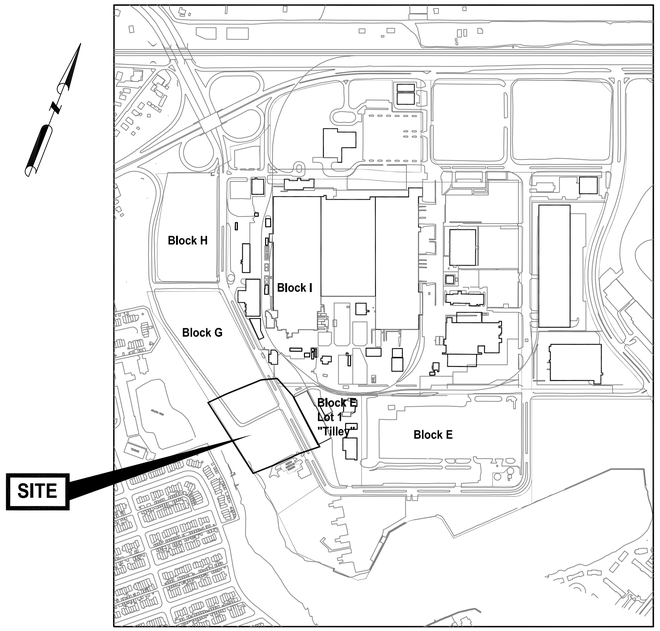
8. DATUM: HORIZONTAL=MARYLAND STATE PLANE 1983,
VERTICAL=NAVD 88

9. BOUNDARY: BOUNDARY LINE INFORMATION TAKEN FROM RECORDED PLAT E.H.K. JR. 51 FOLIO 43 "1ST AMENDED CHESAPEAKE PARK RE-SUBDIVISION" PREPARED BY MARYLAND SURVEYING AND ENGINEERING CO, INC. 4/24/84. BOUNDARY LINES HAVE BEEN ORIENTED TO THE BALTIMORE COUNTY METROPOLITAN DISTRICT GRID. SHOULD NOT BE CONSIDERED A BOUNDARY SURVEY.

10. UTILITIES: EXISTING UTILITIES INFORMATION ARE SHOWN ACCORDING TO FIELD SURVEYED SURFACE EVIDENCE DURING THE LOCAL TOPOGRAPHIC SURVEY (JUNE 2011). ALL UTILITIES ARE APPROXIMATE AND MUST BE VERIFIED PRIOR TO COMMENCING EXCAVATION OPERATIONS. UTILITY CROSS-CONNECTION INVESTIGATION WAS PEFORMED BY TETRA TECH IN NOVEMBER 2011 AND GAVE ADDITIONAL UTILITY INFORMATION. REFER TO FIGURE 4-2 & 4-3 OF THAT REPORT FOR BLOCK G.

11. WATERSHED 108 MIDDLE RIVER

12. REFERENCE PLANS: "SITE PLAN, CHESAPEAKE PARK, LMC PROPERTIES, INC." DATED 10/02/02 PREPARED BY TAI CONSULTING ENGINEERS, AND NOTED THEREON AS BEING OBTAINED FROM FIELD RUN SURVEY CONDUCTED BY DMW, INC. DURING JUNE 1999 FLOATED TO STATE GRID.




LOCKHEED MARTIN MIDDLE RIVER COMPLEX

0 200 500 1000
1"=500'

## CONSULTANT'S CERTIFICATION:

I CERTIFY THAT THIS PLAN OF EROSION AND SEDIMENT CONTROL REPRESENTS A PRACTICAL AND WORKABLE PLAN BASED ON MY PERSONAL KNOWLEDGE OF THE SITE, AND THAT THIS PLAN WAS PREPARED IN ACCORDANCE WITH THE REQUIREMENTS OF THE BALTIMORE COUNTY SOIL CONSERVATION DISTRICT AND THE CURRENT STATE OF MARYLAND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. I HAVE REVIEWED THIS EROSION AND SEDIMENT CONTROL PLAN WITH THE OWNER/DEVELOPER.

DATE _____ SIGNATURE _____

MD. LICENSE NO. _____ PRINTED NAME _____

## OWNER'S / DEVELOPER'S CERTIFICATION:

I/WE HEREBY CERTIFY THAT ANY CLEARING, GRADING, CONSTRUCTION AND/OR DEVELOPMENT WILL BE DONE PURSUANT TO THIS PLAN AND THAT ANY RESPONSIBLE PERSONNEL INVOLVED IN THIS CONSTRUCTION PROJECT WILL HAVE A CERTIFICATE OF ATTENDANCE AT A MARYLAND DEPARTMENT OF THE ENVIRONMENT APPROVED TRAINING PROGRAM FOR THE CONTROL OF SEDIMENT AND EROSION BEFORE BEGINNING THE PROJECT. I/WE ALSO CERTIFY THAT THE SITE WILL BE INSPECTED AT THE END OF EACH WORKING DAY, AND THAT ANY NEEDED MAINTENANCE WILL BE COMPLETED SO AS TO INSURE THAT ALL SEDIMENT CONTROL PRACTICES ARE LEFT IN OPERATIONAL CONDITION. I/WE AUTHORIZE THE RIGHT OF ENTRY FOR PERIODIC ON-SITE EVALUATIONS BY THE BALTIMORE COUNTY SOIL CONSERVATION DISTRICT BOARD OF SUPERVISORS OR THEIR AUTHORIZED AGENTS.

OWNER / DEVELOPER SIGNATURE _____ DATE _____

PRINTED NAME _____ TITLE _____

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT
APPROVED FOR SEDIMENT CONTROL

_____ DATE _____

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| MARK | DATE | DESCRIPTION | BY |
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BLOCK G SWALE - COVER SHEET
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | G-1 |
| | COVER SHEET |

## GENERAL NOTES:

THIS BLOCK G SWALE REPLACEMENT PROJECT IS PART OF A LARGER REMEDIATION PROJECT OF THE LOCKHEED MARTIN MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND.

THIS SITE SHOULD FOLLOW THE GENERAL GUIDELINES FOR SITE HEALTH AND SAFETY INCLUDING MONITORING AND DISPOSAL OF CONTAMINATED MATERIALS. ALL FILL SHALL BE "CLEAN FILL", WHICH MUST BE TESTED AND CERTIFIED CLEAN IN ACCORDANCE WITH APPROVED SOIL MANAGEMENT PLAN, WHETHER TAKEN FROM AN ON-SITE OR BORROW SOURCE.

1. GRID COORDINATES REFERENCE MARYLAND STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (MDSPCS NAD83). ELEVATION REFERENCE NORTH AMERICAN VERTICAL DATUM, 1988 (NAVD88).
2. GROUND SURFACE TOPOGRAPHY OF THIS PROJECT PREPARED BY TETRA TECH, NEWARK, DELAWARE (DATED 06/07 & 08/2011). GROUND SURFACE TOPOGRAPHY BETWEEN COW PEN CREEK AND CHESAPEAKE PARK PLAZA AND DELINEATED WETLANDS LIMITS SURVEYED BY TETRA TECH, NEWARK, DELAWARE DURING NOVEMBER AND DECEMBER 2009.
3. REFERENCE DRAWING TITLED "SITE PLAN, CHESAPEAKE PARK, LMC PROPERTIES, INC." REFER TO UTILITY CROSS-CONNECTION INVESTIGATION PERFORMED BY TETRA TECH IN NOVEMBER 2011. THE UTILITY CROSS-CONNECTION REPORT COVERS BLOCK G AREA AS A PART OF THE INVESTIGATION.
4. GROUNDWATER MONITORING WELL LOCATIONS SHOWN OBTAINED FROM TETRA TECH GIS DATABASE.
5. 1% ANNUAL CHANCE FLOOD (100-YEAR FLOOD) ELEVATION IS SHOWN ON THIS PLAN AS 9.0-FT NAVD88 BASED ON "FLOOD INSURANCE RATE MAP, BALTIMORE COUNTY, MARYLAND (UNINCORPORATED AREAS)" FLOOD INSURANCE MAP NUMBER 2400100435F [FEMA, SEPTEMBER 26, 2008]. THE 100-YEAR FLOOD ELEVATION IS INDICATED TO BE 8.7-FT BASED ON THE REVISED FEMA FLOOD STUDY [240010V000B] DATED 9/26/2008, AND 8.5-FT BASED ON THE PRELIMINARY FEMA FLOOD STUDY [240010V000C] DATED 9/30/2009.
6. CHESAPEAKE BAY CRITICAL AREA BOUNDARY OBTAINED FROM MARYLAND DEPARTMENT OF NATURAL RESOURCES WEBSITE. THE ENTIRE PROJECT SITE IS LOCATED WITHIN THE CHESAPEAKE BAY CRITICAL AREA, INTENSELY DEVELOPED AREA (IDA) CATEGORY.
7. UNDERGROUND UTILITY LOCATIONS SHOWN ARE APPROXIMATE. VERIFICATION OF UTILITY LOCATIONS MUST BE MADE PRIOR TO WORK ON-SITE. NOTIFY MISS UTILITY OF MARYLAND (1-800-257-7777; www.missutility.net) AT LEAST 48 HOURS, BUT NOT MORE THAN 10 WORKING DAYS, PRIOR TO THE DAY EXCAVATION WILL COMMENCE. MISS UTILITY OF MARYLAND IS NOT EXPECTED TO HAVE COMPLETE RECORD OF UTILITIES FOR THE MIDDLE RIVER COMPLEX. IN ADDITION TO NOTIFYING MISS UTILITY OF MARYLAND, VERIFY UTILITY LOCATIONS PRIOR TO BEGINNING ANY WORK USING A MINIMUM OF TWO PASSIVE METHODS (E.G., ELECTROMAGNETIC INDUCTION, GROUND PENETRATING RADAR, MAGNETIC LOCATORS, ACOUSTIC SURVEY, ETC.). REFER TO FIGURE 4-2 & 4-3 OF THE UTILITY CROSS-CONNECTION INVESTIGATION BY TETRA TECH IN 2011, WHICH INCLUDE THE HISTORICAL UTILITIES INFORMATION IN BLOCK G.
8. INSPECT THE SITE PRIOR TO CONSTRUCTION TO VERIFY EXISTING SITE CONDITIONS AND NOTIFY ENGINEER OF ANY DISCREPANCIES IMPACTING CONSTRUCTION.
9. THE SOLE LOCATION FOR INGRESS AND EGRESS TO THE SITE SHALL BE VIA CONSTRUCTION ENTRANCE WHICH SHALL BE CONSTRUCTED ACCORDING TO THE APPROVED EROSION AND SEDIMENT CONTROL PLAN. PROVIDE INGRESS/EGRESS CONTROL INTO THE SITE AS PART OF MOBILIZATION ACTIVITIES.
10. PROVIDE PROTECTION FOR EXISTING TREES TO REMAIN.
11. MAINTAIN WORK AREAS FREE FROM DUST AND ODORS.
12. THE STORM WATER POLLUTION PREVENTION PLAN IS COMPRISED OF THE EROSION CONTROL DRAWINGS, STANDARD DETAILS, AND SPECIFICATIONS.
13. ALL CONTRACTORS AND SUBCONTRACTORS INVOLVED WITH STORM WATER POLLUTION PREVENTION SHALL OBTAIN A COPY OF THE STORM WATER POLLUTION PREVENTION PLANS AND SPECIFICATIONS ALONG WITH KNOWLEDGE OF "2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL, DATED MAY 2011".
14. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES AS REQUIRED BY THE STORM WATER POLLUTION PREVENTION PLANS AND "2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL".
15. BEST MANAGEMENT PRACTICES AND CONTROLS SHALL CONFORM TO FEDERAL, STATE, OR LOCAL REQUIREMENTS OR MANUAL OF PRACTICE, AS APPLICABLE. THE CONTRACTOR SHALL IMPLEMENT ADDITIONAL CONTROLS AS DIRECTED BY THE OWNER'S REPRESENTATIVE OR AS DEEMED NECESSARY BY FIELD OBSERVATION.
16. SITE MAP MUST CLEARLY DELINEATE ALL STATE WATERS. PERMITS FOR ANY CONSTRUCTION ACTIVITY IMPACTING STATE WATERS OR REGULATED WETLANDS MUST BE MAINTAINED ON SITE AT ALL TIMES.
17. ALL WASH WATER (CONCRETE TRUCKS, VEHICLE CLEANING, EQUIPMENT CLEANING, ETC.) SHALL BE CONTAINED AND PROPERLY TREATED OR DISPOSED OF.
18. SUFFICIENT OIL AND GREASE ABSORBING MATERIALS AND FLOTATION BOOMS SHALL BE MAINTAINED ON SITE OR READILY AVAILABLE TO CONTAIN AND CLEANUP FUEL OR CHEMICAL SPILLS AND LEAKS.
19. DUST ON THE SITE SHALL BE CONTROLLED. THE USE OF MOTOR OILS AND OTHER PETROLEUM BASED OR TOXIC LIQUIDS FOR DUST SUPPRESSION OPERATIONS IS PROHIBITED.
20. THE CONTRACTOR SHALL TAKE THE NECESSARY MEASURES, INCLUDING WATER SPRINKLING TO PROVIDE DUST CONTROL DURING CONSTRUCTION.
21. RUBBISH, TRASH, GARBAGE, LITTER, OR OTHER SUCH MATERIALS SHALL BE DEPOSITED INTO SEALED CONTAINERS. MATERIALS SHALL BE PREVENTED FROM LEAVING THE PREMISES THROUGH THE ACTION OF WIND OR STORM WATER DISCHARGE INTO DRAINAGE DITCHES OR WATERS OF THE STATE. LEAVE THE SITE IN A CLEAN, SAFE, WELL DRAINING, AND NEAT CONDITION.
22. DISTURBED PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITY HAS STOPPED FOR AT LEAST 7 DAYS, SHALL BE TEMPORARILY STABILIZED AS SOON AS WEATHER PERMITS.
23. DISTURBED PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITY HAS PERMANENTLY STOPPED SHALL BE PERMANENTLY STABILIZED AS SOON AS WEATHER PERMITS.
24. IF THE ACTION OF VEHICLES TRAVELING OVER THE CONSTRUCTION ENTRANCE IS NOT SUFFICIENT TO REMOVE THE MAJORITY OF DIRT OR MUD, THEN THE TIRES MUST BE WASHED BEFORE THE VEHICLES ENTER A PUBLIC ROAD. IF WASHING IS USED, PROVISIONS MUST BE MADE TO INTERCEPT THE WASH WATER AND TRAP THE SEDIMENT BEFORE IT IS CARRIED OFF THE SITE.
25. ALL MATERIALS SPILLED, DROPPED, WASHED, OR TRACKED FROM VEHICLES ONTO ROADWAYS OR INTO STORM DRAINS MUST BE REMOVED IMMEDIATELY.
26. ON-SITE & OFF-SITE SOIL STOCKPILE AND BORROW AREAS SHALL BE PROTECTED FROM EROSION AND SEDIMENTATION THROUGH IMPLEMENTATION OF BEST MANAGEMENT PRACTICES. CONTRACTOR SHALL NOTE THE ADDITIONAL STOCKPILE AND BORROW AREA LOCATIONS ON THE SITE MAP, IF THEY ARE APPROVED BY THE OWNER'S REPRESENTATIVE.

## GENERAL NOTES (CONTINUED):

27. PROVIDE EROSION CONTROLS ON SLOPES AND SWALES TRAVERSING, BORDERING, OR LEAVING THE SITE. LIMIT THE WATER FLOW TO A NON-EROSIVE VELOCITY.
28. CONTRACTOR SHALL PLACE EROSION CONTROL BLANKETS ON ALL SLOPES 3:1 (H:V) AND STEEPER PER MANUFACTURERS REQUIREMENTS.
29. CONTRACTOR SHALL PROVIDE TEMPORARY SECURITY FENCING WHERE THE CONSTRUCTION SITE IS ACCESSIBLE FROM THE ADJACENT LOT. (SEE THE EROSION AND SEDIMENT CONTROL PLANS)
30. REMOVE ALL TEMPORARY MEASURES AT THE COMPLETION OF CONSTRUCTION, AFTER STABILIZATION HAS BEEN COMPLETED.
31. CONTRACTOR SHALL PROVIDE A ONE YEAR EROSION/STABILIZATION MONITORING PLAN (I.E. MONTHLY SITE WALK AND SITE VISITS AFTER MAJOR RAINFALL EVENTS).

## GENERAL GRADING NOTES AND CERTIFICATIONS:

1. THE PROPOSED GRADING SHOWN ON THIS PLAN MEETS THE REQUIREMENTS SET FORTH BY BALTIMORE COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT AND COMPLIES WITH ARTICLE 33, TITLE 5 OF THE BALTIMORE COUNTY CODE. HOWEVER, DUE TO BUILDING TYPES AND LAYOUT, SOME FIELD ADJUSTMENTS MAY BE REQUIRED. ALL CHANGES MUST COMPLY WITH THE ABOVE MENTIONED REQUIREMENTS.
2. ALL SWALES HAVE BEEN DESIGNED BY THE ENGINEER TO CONVEY RUNOFF ACCORDING TO BALTIMORE COUNTY DEPARTMENT OF PUBLIC WORKS DESIGN STANDARDS.
3. THERE SHALL BE NO CLEARING, GRADING, CONSTRUCTION OR DISTURBANCE OF VEGETATION IN WETLANDS, EXCEPT AS PERMITTED BY THE BALTIMORE COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT.

### OWNER'S / DEVELOPER'S CERTIFICATION - GRADING:

I/WE HEREBY CERTIFY THAT ALL GRADING ON THIS SITE WILL BE DONE IN ACCORDANCE WITH THE CURRENT GRADING REQUIREMENTS AS SET FORTH BY THE BALTIMORE COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT AND WITH THE REQUIREMENTS SPECIFIED IN ARTICLE 33, TITLE 5 OF THE BALTIMORE COUNTY CODE.

OWNER / DEVELOPER SIGNATURE | TITLE | DATE

PRINTED NAME

### OWNER'S / DEVELOPER'S CERTIFICATION - AIR QUALITY:

I ACKNOWLEDGE THAT I AM RESPONSIBLE UNDER THE CODE OF MARYLAND REGULATION (26.11.06.03) TO PREVENT PARTICULATE MATTER FROM BECOMING AIRBORNE DUE TO GRADING, LAND CLEARING, EXCAVATION, CONSTRUCTION OR OTHER RELATED ACTIVITIES. I HAVE RECEIVED A COPY OF "GUIDELINES TO THE AIR POLLUTION REGULATIONS FOR CONTROLLING EXCESS ABP (DUST) ON ACTIVITY SITES" WHICH INCLUDE A COPY OF COMAR 26.11.06.03. I WILL CONTACT THE ENVIRONMENTAL HEALTH SECTION AT 887-4065 AT LEAST THREE DAYS PRIOR TO BEGINNING WORK.

OWNER / DEVELOPER SIGNATURE | TITLE | DATE

PRINTED NAME

## LEGEND

*EXISTING*

- EDGE OF PAVEMENT
- COMMUNICATION PAD
- ELECTRIC BOX
- UTILITY POLE
- UTILITY MANHOLE
- FIRE HYDRANT
- TREE LINE
- WATER VALVE (WV)
- GAS VALVE (GV)
- MONITOR WELL
- CB — STORM SEWER INLET
- 15.87 — GROUND SHOT
- 15 — MAJOR CONTOUR (5')
- 14 — MINOR CONTOUR (1')
- OE — OVERHEAD ELECTRIC
- UE — UNDERGROUND ELECTRIC
- W — DOMESTIC WATER
- FW — FIRE WATER
- X — CHAIN LINK/WIRE
- G — GAS LINE
- 18" CMP — STORM SEWER (18" CORRUGATED METAL PIPE)
- BUILDING
- EXISTING WETLANDS

PROPOSED

- 15" RCP — STORM SEWER W/ JUNCTION BOX OR OUTLET STRUCTURE
- 15 — MAJOR CONTOUR (5')
- 14 — MINOR CONTOUR (1')
- UTILITIES TO BE REMOVED
- CONCRETE FOUNDATION TO BE REMOVED

SECTION NUMBER
X
C-X
SHEET SHOWN ON

SECTION INDICATOR

DETAIL NUMBER
-
FIRST SHEET CALLED OUT ON
FIRST SHEET SHOWN ON

DETAIL INDICATOR

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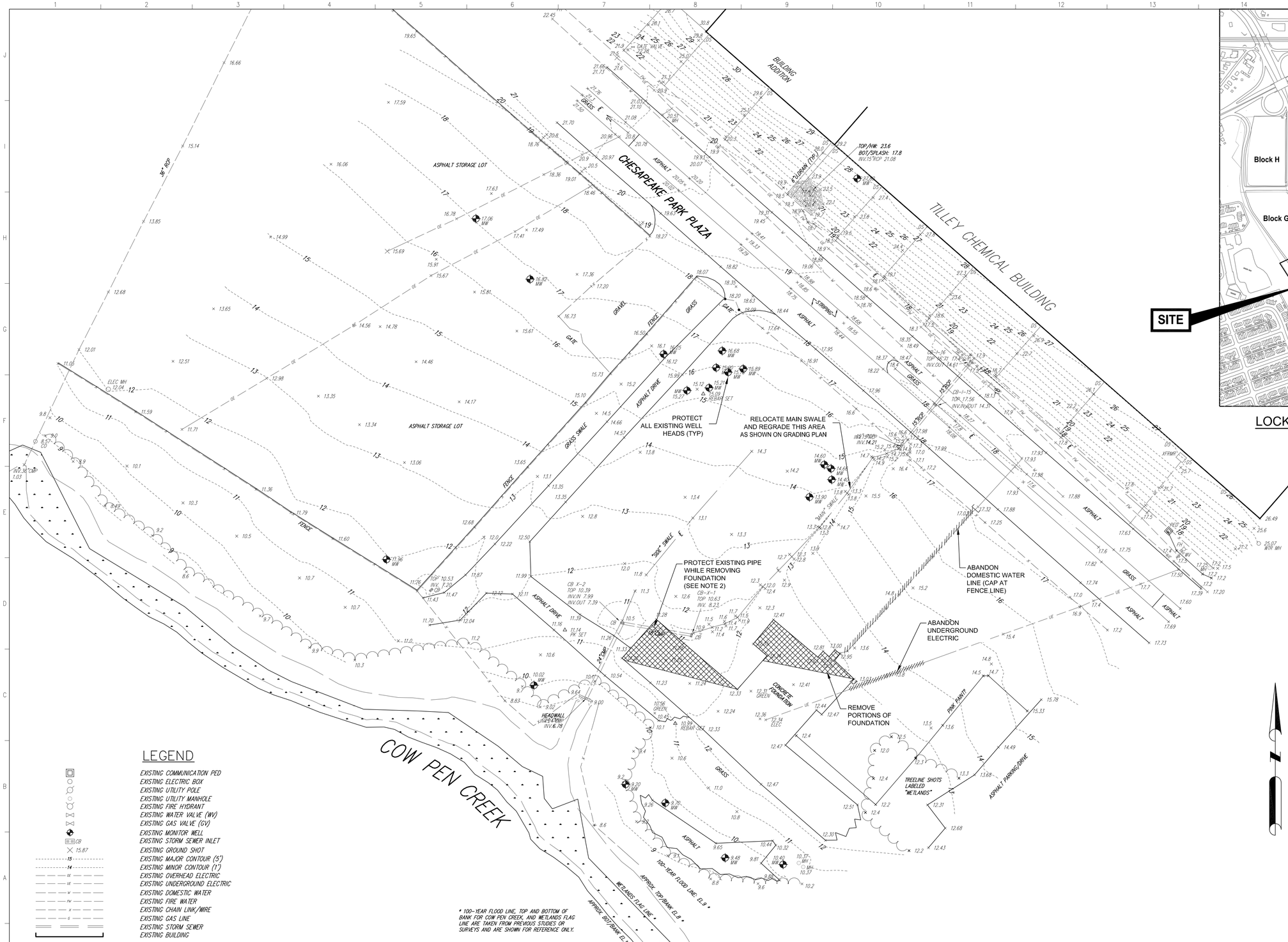
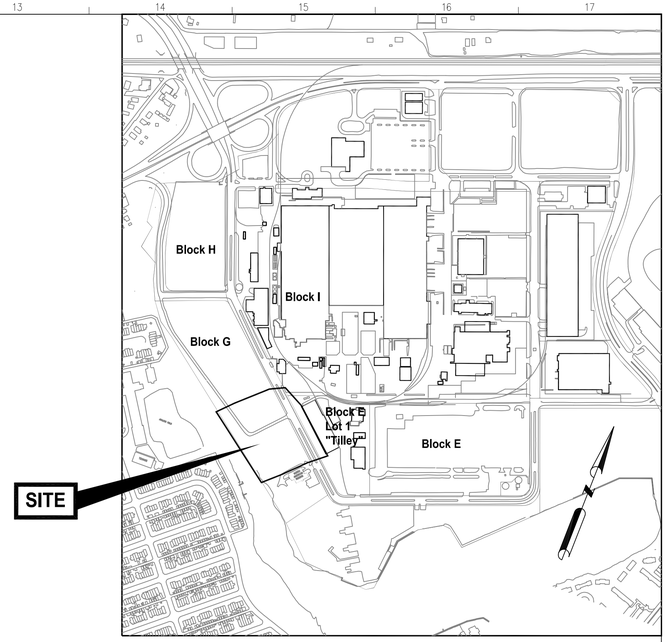
| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

BLOCK G SWALE - GENERAL NOTES AND LEGEND
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | G-2 |

NOTES AND LEGEND




LOCKHEED MARTIN MIDDLE RIVER COMPLEX

SCALE: 1" = 500'

## LEGEND

- EXISTING COMMUNICATION PED
- EXISTING ELECTRIC BOX
- EXISTING UTILITY POLE
- EXISTING UTILITY MANHOLE
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE (WV)
- EXISTING GAS VALVE (GV)
- EXISTING MONITOR WELL
- EXISTING STORM SEWER INLET
- EXISTING GROUND SHOT
- EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- EXISTING OVERHEAD ELECTRIC
- EXISTING UNDERGROUND ELECTRIC
- EXISTING DOMESTIC WATER
- EXISTING FIRE WATER
- EXISTING CHAIN LINK/WIRE
- EXISTING GAS LINE
- EXISTING STORM SEWER
- EXISTING BUILDING
- EXISTING WETLANDS
- UTILITIES TO BE REMOVED
- CONCRETE FOUNDATION TO BE REMOVED

* 100-YEAR FLOOD LINE, TOP AND BOTTOM OF BANK FOR COW PEN CREEK, AND WETLANDS FLAG LINE ARE TAKEN FROM PREVIOUS STUDIES OR SURVEYS AND ARE SHOWN FOR REFERENCE ONLY.

TT PROJECT NO.: 112IC02948
DRAWN: CSG - 06-16-2011
CREW: AN & RB - 06-07&08-2011
HORIZ. DATUM: MARYLAND STATE PLANE 1983
VERT. DATUM: NAVD 88
SCALE: 1"=30'
FILE: K:\LMC - Mital\112IC02948 Block G\Drawings\112IC02948-V-BASE.dwg
K:\LMC - Mital\112IC02948 Block G\Data\Adjusted\Lockheed 060711_Adjusted.crd
ALL CB'S 1.67'x2.5' UNLESS NOTED

0 30 60 90

NOTE:

1. EXISTING MONITORING WELLS SHALL BE PROTECTED.
2. IF FOUNDATION CANNOT BE REMOVED WITHOUT SACRIFICING THE EXISTING 18" CMP, THE CONTRACTOR SHALL REMOVE AND REPLACE WITH NEW 18" RCP. THIS WILL BE CONSIDERED A MODIFICATION TO THE CONTRACT, IF NEEDED.
3. REFER TO EROSION AND SEDIMENT CONTROL PLANS FOR SITE ACCESS AND SEQUENCE OF CONSTRUCTION.

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

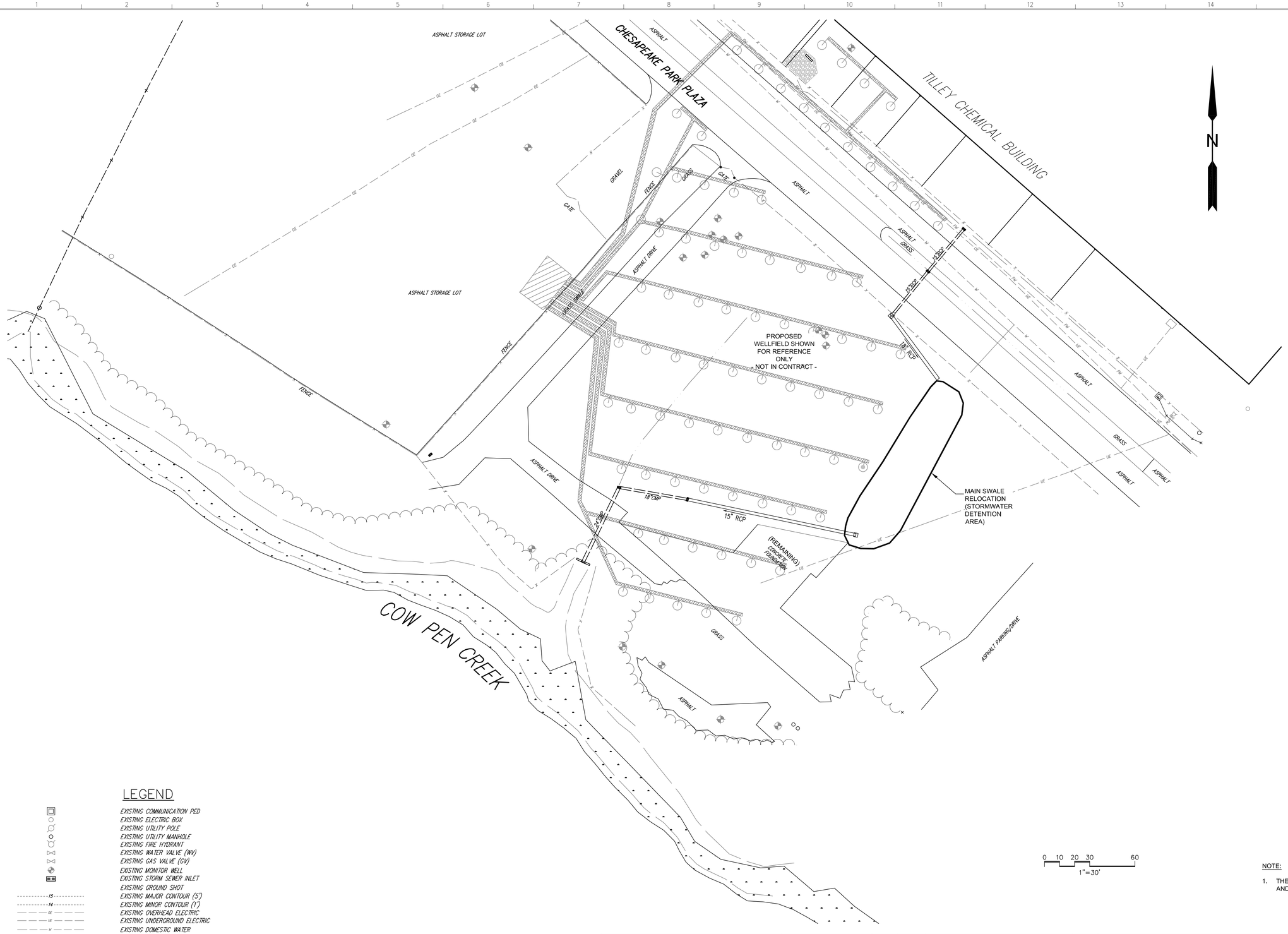
BLOCK G SWALE - EXISTING & DEMOLITION PLAN

INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-1 |

EXISTING & DEMOLITION PLAN




## LEGEND

- EXISTING COMMUNICATION PED
- EXISTING ELECTRIC BOX
- EXISTING UTILITY POLE
- EXISTING UTILITY MANHOLE
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE (WV)
- EXISTING GAS VALVE (GV)
- EXISTING MONITOR WELL
- EXISTING STORM SEWER INLET
- EXISTING GROUND SHOT
- EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- EXISTING OVERHEAD ELECTRIC
- EXISTING UNDERGROUND ELECTRIC
- EXISTING DOMESTIC WATER
- EXISTING FIRE WATER
- EXISTING CHAIN LINK/WIRE
- EXISTING GAS LINE
- EXISTING STORM SEWER
- EXISTING BUILDING
- EXISTING WETLANDS
- PROPOSED STORM SEWER STRUCTURE
- PROPOSED STORM SEWER

NOTE:

1. THE PROPOSED WELL FIELD LAYOUT IS SHOWN FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE.

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| | | | |

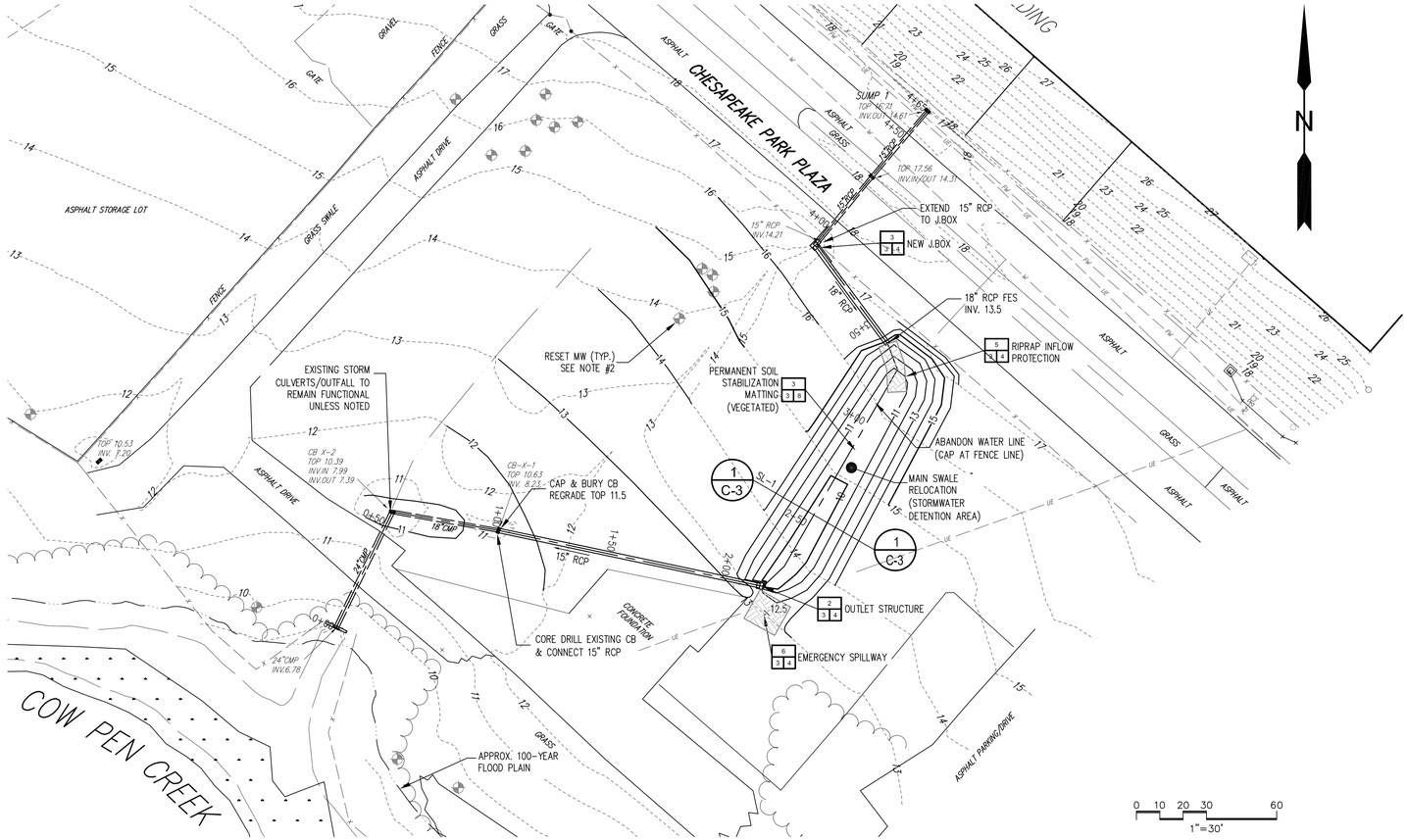
# BLOCK G SWALE - SITE LAYOUT PLAN

INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA

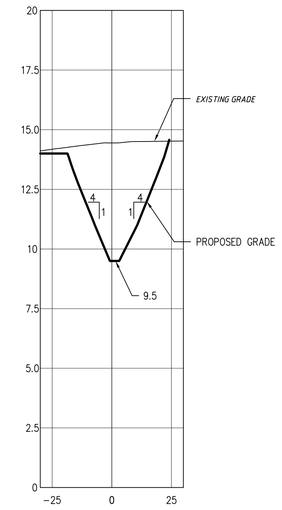
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-2 |

SITE LAYOUT PLAN




## PLAN: PROPOSED SITE GRADING

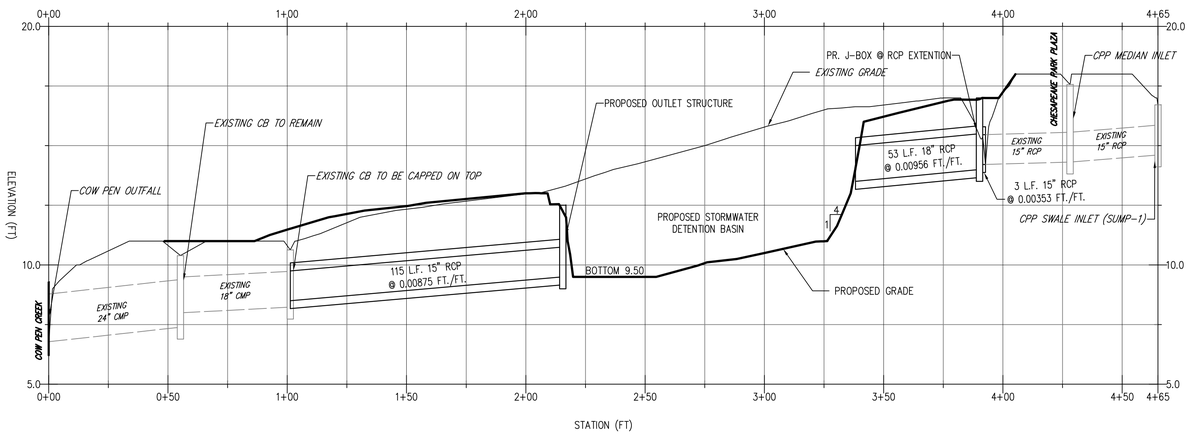



## 1/C-3 SECTION: PROPOSED BLOCK G SWALE

SCALE: HORIZ. 1" = 30' VERT. 1" = 3'

## LEGEND

- EXISTING COMMUNICATION PED
- EXISTING ELECTRIC BOX
- EXISTING UTILITY POLE
- EXISTING UTILITY MANHOLE
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE (WV)
- EXISTING GAS VALVE (GV)
- EXISTING MONITOR WELL
- EXISTING STORM SEWER INLET
- EXISTING GROUND SHOT
- EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- EXISTING OVERHEAD ELECTRIC
- EXISTING UNDERGROUND ELECTRIC
- EXISTING DOMESTIC WATER
- EXISTING FIRE WATER
- EXISTING CHAIN LINK/WIRE
- EXISTING GAS LINE
- EXISTING STORM SEWER
- EXISTING BUILDING
- EXISTING WETLANDS
- PROPOSED STORM SEWER STRUCTURE
- PROPOSED STORM SEWER
- 100-YEAR FLOOD PLAIN
- × 12.5 PROPOSED SPOT GRADE
- RIPRAP PROTECTION




## PROFILE: PROPOSED STORM SEWER SYSTEM

SCALE: HORIZ. 1" = 30' VERT. 1" = 3'

NOTES

1. CONTRACTOR SHALL ADHERE TO THE GRADING PLAN THAT IS APPROVED BY BALTIMORE COUNTY.
2. CONTRACTOR SHALL RAISE WELL HEADS TO THE PROPOSED GRADING ELEVATION SHOWN.

## OWNER'S / DEVELOPER'S CERTIFICATION - GRADING:

I/WE HEREBY CERTIFY THAT ALL GRADING ON THIS SITE WILL BE DONE IN ACCORDANCE WITH THE CURRENT GRADING REQUIREMENTS AS SET FORTH BY THE BALTIMORE COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT AND WITH THE REQUIREMENTS SPECIFIED IN ARTICLE 33, TITLE 5 OF THE BALTIMORE COUNTY CODE.

OWNER / DEVELOPER SIGNATURE _____ TITLE _____ DATE _____

PRINTED NAME _____

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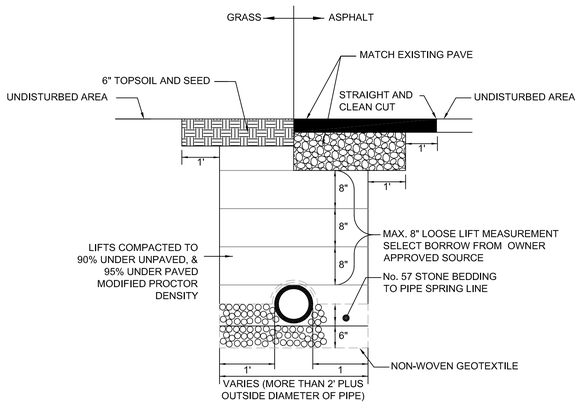
BLOCK G SWALE - GRADING PLAN & PROFILE
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

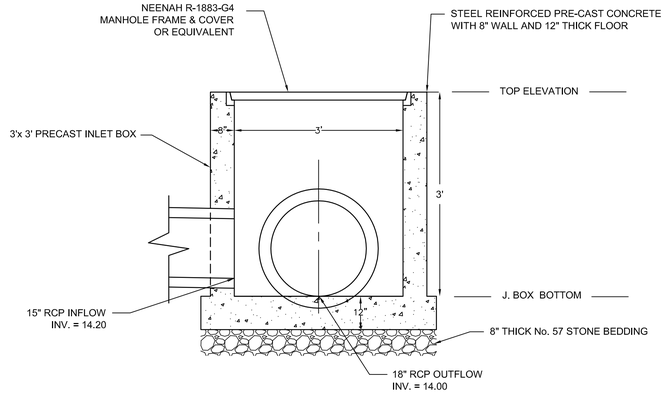
| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-3 |

SITE GRADING PLAN & PROFILE



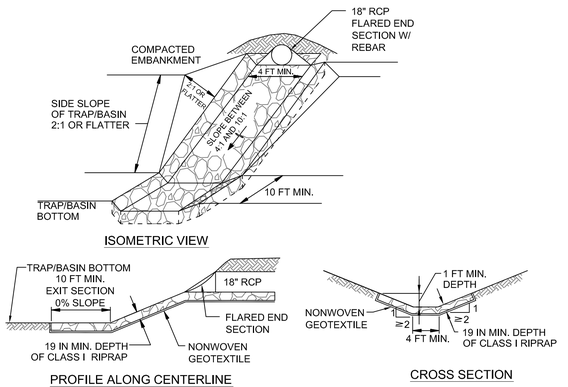

NOTE:
WARNING TAPE SHALL BE LOCATED 12 INCHES BELOW FINISHED GRADE.

1 / 3 4 TYPICAL TRENCH
NOT TO SCALE




3 / 3 4 JUNCTION BOX
NOT TO SCALE

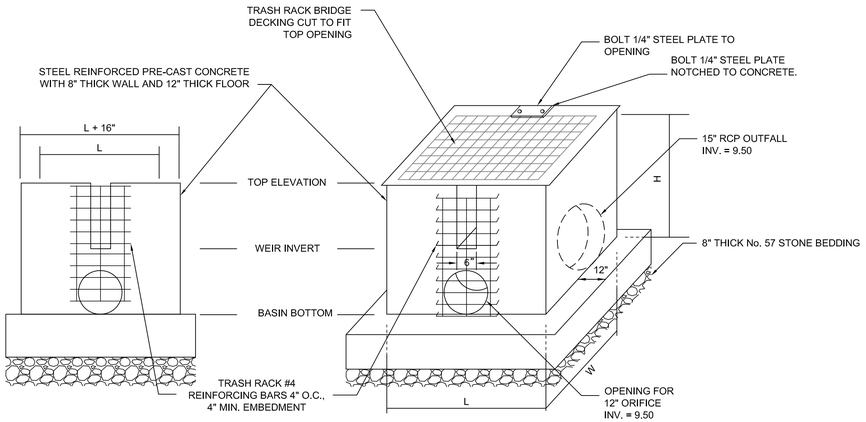
| SIZING CHART | L x W x H | BOTTOM | TOP ELEVATION |
|---|---|---|---|
| JUNCTION BOX | 3'x 3' x 3' | 14.00 | 17.00 |




## CONSTRUCTION SPECIFICATIONS

1. PROVIDE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SHEET C-7, UNDER THE BOTTOM AND ALONG SIDES OF ALL RIPRAP.
2. CONSTRUCT INFLOW CHANNEL WITH CLASS I RIPRAP OR EQUIVALENT RECYCLED CONCRETE LINING TO A MINIMUM DEPTH OF 19 INCHES (2 x $D_{50}$) AND A 1 FOOT DEEP FLOW CHANNEL. INFLOW RIPRAP PROTECTION CHANNEL MUST HAVE A TRAPEZOIDAL CROSS SECTION WITH 2:1 OR FLATTER SIDE SLOPES AND A 4 FOOT MINIMUM BOTTOM WIDTH.
3. INSTALL ENTRANCE AND EXIT SECTIONS AS SHOWN ON THE PROFILE.
4. BLEND RIPRAP INTO EXISTING GROUND.
5. MAINTAIN LINE, GRADE, AND CROSS SECTION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS. KEEP POINTS OF INFLOW AND OUTFLOW FREE OF EROSION.

5 / 3 4 MODIFIED RIPRAP INFLOW PROTECTION
NOT TO SCALE




| SIZING CHART | L x W x H | BASIN BOTTOM | WEIR INVERT | TOP ELEVATION |
|---|---|---|---|---|
| OUTLET STRUCTURE | 2'-0" x 2'-0" x 3'-0" | 9.50 | 11.00 | 12.50 |

2 / 3 4 OUTLET STRUCTURE
NOT TO SCALE

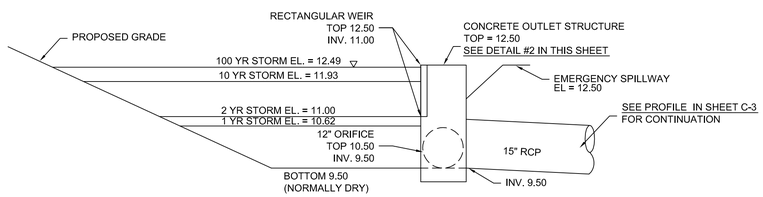
## STONE SIZE SPECIFICATIONS

| | SIZE RANGE | $D_{50}$ | $D_{100}$ | AASHTO | MIDSIZE WEIGHT*** |
|---|---|---|---|---|---|
| NUMBER 57* | 3/8" - 1 1/2" | 1/2" | 1 1/2" | M-43 | N/A |
| NUMBER 1 | 2" - 3" | 2 1/2" | 3" | M-43 | N/A |
| RIP-RAP** (CLASS 0) | 4" - 7" | 5 1/2" | 7" | N/A | N/A |
| CLASS I | N/A | 9.5" | 15" | N/A | 40 LB |
| CLASS II | N/A | 16" | 24" | N/A | 200 LB |
| CLASS III | N/A | 23" | 34" | N/A | 600 LB |

* THIS CLASSIFICATION IS TO BE USED ON THE UPSTREAM FACE OF STONE OUTLETS AND CHECK DAMS.
** THIS CLASSIFICATION IS TO BE USED FOR GABIONS.
*** OPTIMUM GRADATION IS 50 PERCENT OF THE STONE BEING ABOVE AND 50 PERCENT BELOW THE MIDSIZE.

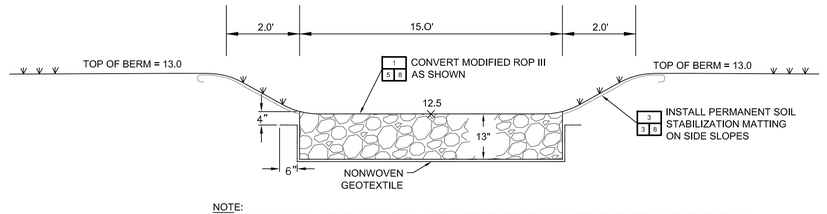
STONE MUST BE COMPOSED OF A WELL GRADED MIXTURE OF STONE SIZED SO THAT FIFTY (50) PERCENT OF THE PIECES BY WEIGHT ARE LARGER THAN THE SIZE DETERMINED BY USING THE CHARTS. A WELL GRADED MIXTURE, AS USED HEREIN, IS DEFINED AS A MIXTURE COMPOSED PRIMARILY OF LARGER STONE SIZES BUT WITH A SUFFICIENT MIXTURE OF OTHER SIZES TO FILL THE SMALLER VOIDS BETWEEN THE STONES. THE DIAMETER OF THE LARGEST STONE IN SUCH A MIXTURE MUST NOT EXCEED THE RESPECTIVE D $_{100}$ SELECTED FROM THIS TABLE. THE D $_{50}$ REFERS TO THE MEDIAN DIAMETER OF THE STONE. THIS IS THE SIZE FOR WHICH 50 PERCENT, BY WEIGHT, WILL BE SMALLER AND 50 PERCENT WILL BE LARGER.

NOTE:
RECYCLED CONCRETE EQUIVALENT MAY BE SUBSTITUTED FOR ALL STONE CLASSIFICATIONS FOR TEMPORARY CONTROL MEASURES ONLY. CONCRETE BROKEN INTO THE SIZES MEETING THE APPROPRIATE CLASSIFICATION, CONTAINING NO STEEL REINFORCEMENT, AND HAVING A MINIMUM DENSITY OF 150 POUNDS PER CUBIC FOOT MAY BE USED AS AN EQUIVALENT.




NOTE:
1. REFER TO SHEET C-3 FOR PLAN VIEW.
2. ALL JOINTS AND CONNECTIONS MUST BE WATERTIGHT.
3. THE PRINCIPAL SPILLWAY BARRELS SHALL BE IN ACCORDANCE WITH ASTM C-361.

4 / 3 4 DETENTION BASIN STORM ELEVATIONS
NOT TO SCALE




NOTE:
ELEVATIONS SHOWN ARE FINAL GRADING AFTER SETTLEMENT. THE ACHIEVEMENT OF PLANNED ELEVATIONS, GRADES, DESIGN WIDTH, CHANNEL SLOPES ARE CRITICAL TO THE SUCCESSFUL OPERATION OF THE EMERGENCY SPILLWAY.

6 / 3 4 EMERGENCY SPILLWAY
NOT TO SCALE

## OWNER'S / DEVELOPER'S CERTIFICATION - GRADING:

I/WE HEREBY CERTIFY THAT ALL GRADING ON THIS SITE WILL BE DONE IN ACCORDANCE WITH THE CURRENT GRADING REQUIREMENTS AS SET FORTH BY THE BALTIMORE COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT AND WITH THE REQUIREMENTS SPECIFIED IN ARTICLE 33, TITLE 5 OF THE BALTIMORE COUNTY CODE.

OWNER / DEVELOPER SIGNATURE | TITLE | DATE

PRINTED NAME

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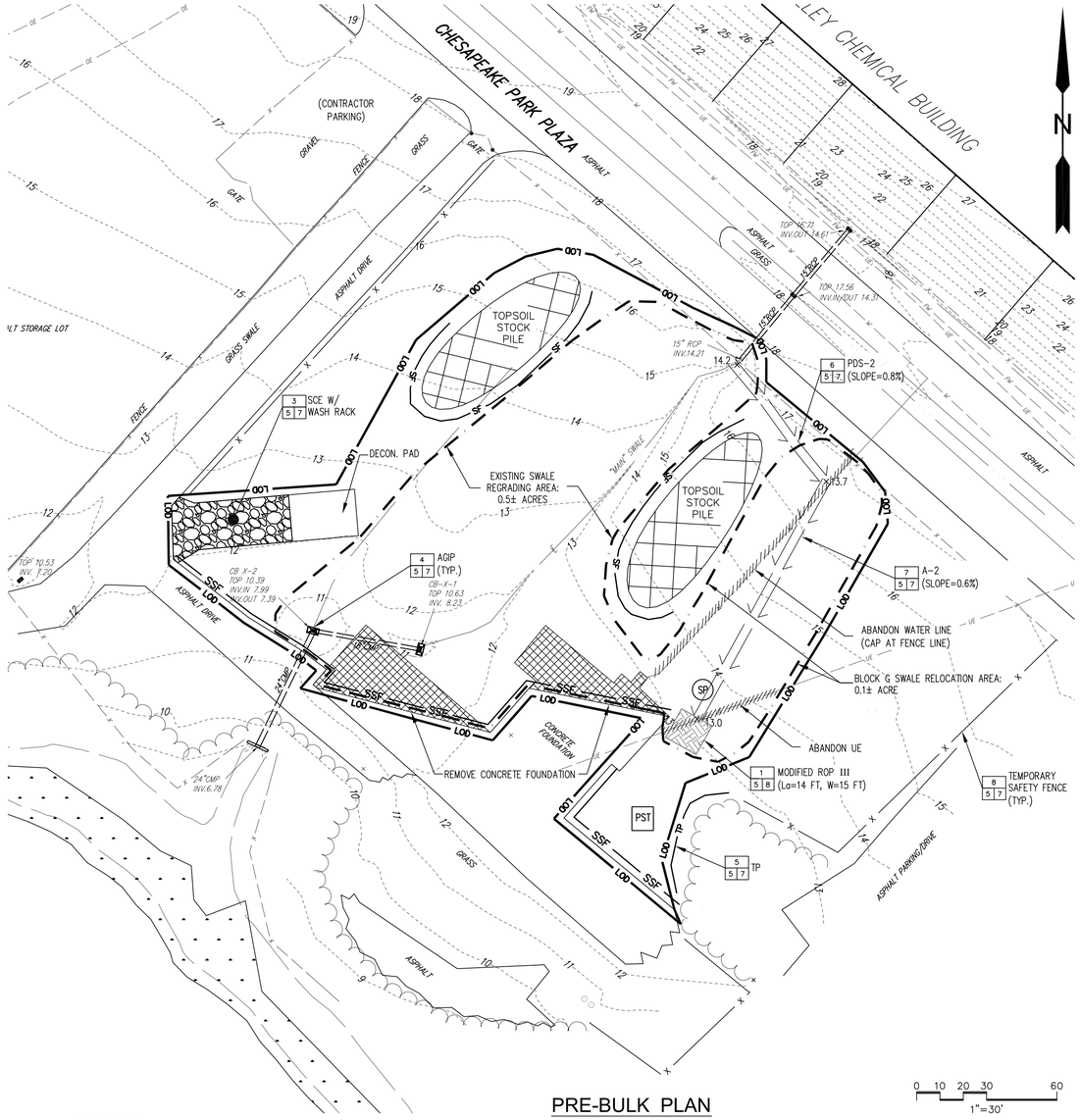
BLOCK G SWALE - STORMWATER MANAGEMENT DETAILS
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-4 |

STORM WATER MANAGEMENT DETAILS




## PRE-BULK PLAN

### LEGEND

- STABILIZED CONSTRUCTION ENTRANCE
- LIMIT OF GRADING
- TOPSOIL STOCKPILE AREA
- AT-GRADE INLET PROTECTION
- SF — SILT FENCE
- SSF — SUPER SILT FENCE
- TP — TREE PROTECTION
- LOD — LIMIT OF DISTURBANCE
- ROCK/RIPRAP PROTECTION
- PERIMETER DIKE/SWALE
- SP — SUMP PIT
- PST — PORTABLE SEDIMENT TANK

- *EXISTING COMMUNICATION PED*
- *EXISTING ELECTRIC BOX*
- *EXISTING UTILITY POLE*
- *EXISTING UTILITY MANHOLE*
- *EXISTING FIRE HYDRANT*
- *EXISTING WATER VALVE (WV)*
- *EXISTING GAS VALVE (GV)*
- *EXISTING MONITOR WELL*
- *EXISTING STORM SEWER INLET*
- *EXISTING GROUND SHOT*
- *EXISTING MAJOR CONTOUR (5')*
- *EXISTING MINOR CONTOUR (1')*
- *EXISTING OVERHEAD ELECTRIC*
- *EXISTING UNDERGROUND ELECTRIC*
- *EXISTING DOMESTIC WATER*
- *EXISTING FIRE WATER*
- *EXISTING CHAIN LINK/WIRE*
- *EXISTING GAS LINE*
- *EXISTING STORM SEWER*
- *EXISTING BUILDING*
- *EXISTING WETLANDS*
- UTILITIES TO BE REMOVED
- CONCRETE FOUNDATION TO BE REMOVED
- × 12.5 — PROPOSED SPOT GRADE

## BALTIMORE COUNTY SPECIFIC EROSION AND SEDIMENT CONTROL PLAN GENERAL NOTES:

1. REFER TO "2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL" FOR STANDARD DETAILS AND DETAILED SPECIFICATIONS OF EACH PRACTICE SPECIFIED HEREIN.
2. WITH THE APPROVAL OF THE SEDIMENT CONTROL INSPECTOR, MINOR FIELD ADJUSTMENTS CAN AND WILL BE MADE TO INSURE THE CONTROL OF ANY SEDIMENT. CHANGES IN SEDIMENT CONTROL PRACTICES, REQUIRE PRIOR APPROVAL OF THE SEDIMENT CONTROL INSPECTOR AND THE BALTIMORE COUNTY SOIL CONSERVATION DISTRICT.
3. AT THE END OF EACH WORKING DAY, ALL SEDIMENT CONTROL PRACTICES WILL BE INSPECTED AND LEFT IN OPERATIONAL CONDITION.
4. FOLLOWING INITIAL SOIL DISTURBANCE OR REDISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN: A.) THREE CALENDAR DAYS AS TO THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES, AND ALL SLOPES GREATER THAN THREE HORIZONTAL TO ONE VERTICAL (3:1), AND B.) SEVEN DAYS AS TO ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE WHICH WILL REMAIN IDLE OVER FOURTEEN DAYS.
5. ANY CHANGE TO THE GRADING PROPOSED ON THIS PLAN REQUIRES RE-SUBMISSION TO BALTIMORE COUNTY SOIL CONSERVATION DISTRICT FOR APPROVAL.
6. DUST CONTROL WILL BE PROVIDED FOR ALL DISTURBED AREAS. REFER TO "2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL", PG. H-22, FOR ACCEPTABLE METHODS AND SPECIFICATIONS FOR DUST CONTROL.
7. ANY VARIATIONS FROM THE SEQUENCE OF OPERATIONS STATED ON THIS PLAN REQUIRES THE APPROVAL OF THE SEDIMENT CONTROL INSPECTOR AND THE BALTIMORE COUNTY SOIL CONSERVATION DISTRICT PRIOR TO THE INITIATION OF THE CHANGE.
8. EXCESS CUT OR BORROW MATERIAL SHALL GO TO, OR COME FROM, RESPECTIVELY, A SITE WITH AN OPEN GRADING PERMIT AND APPROVED SEDIMENT CONTROL PLAN.
9. THE FOLLOWING ITEM MAY BE USED AS APPLICABLE: REFER TO MARYLAND'S GUIDELINES TO WATERWAY CONSTRUCTION" BY THE WATER MANAGEMENT ADMINISTRATION OF THE MARYLAND DEPARTMENT OF THE ENVIRONMENT, REVISED NOVEMBER 2000, FOR THE STANDARD DETAILS AND DETAILED SPECIFICATIONS OF EACH PRACTICE SPECIFIED HEREIN FOR WATERWAY CONSTRUCTION.
10. PUMPING SEDIMENT-LADEN WATER INTO WATERS OF THE STATE IS STRICTLY PROHIBITED. ANY PORTABLE DEWATRING DEVICE MUST BE LOCATED WITHIN THE LIMITS OF DISTURBANCE.

## ADDITIONAL STATE OF MARYLAND EROSION AND SEDIMENT CONTROL PLAN GENERAL NOTES:

1. THE CONTRACTOR SHALL NOTIFY THE ADMINISTRATION (WMA) AT (410)537-3510 SEVEN (7) DAYS BEFORE COMMENCING ANY LAND DISTURBANCE ACTIVITY AND, UNLESS WAIVED BY THE ADMINISTRATION, SHALL BE REQUIRED TO HOLD A PRE-CONSTRUCTION MEETING BETWEEN PROJECT REPRESENTATIVES AND A REPRESENTATIVE OF WMA.
2. THE CONTRACTOR MUST NOTIFY WMA IN WRITING AND BY TELEPHONE AT THE FOLLOWING POINTS:
   a. THE REQUIRED PRE-CONSTRUCTION MEETING
   b. FOLLOWING INSTALLATION OF SEDIMENT CONTROL MEASURES.
   c. DURING THE INSTALLATION OF SEDIMENT BASINS (TO BE CONVERTED INTO PERMANENT STORMWATER MANAGEMENT STRUCTURES) AT THE REQUIRED INSPECTION POINTS (SEE INSPECTION CHECKLISTS). NOTIFICATION PRIOR TO COMMENCING CONSTRUCTION OF EACH STEP IS MANDATORY.
   d. PRIOR TO REMOVAL OR MODIFICATION OF ANY SEDIMENT CONTROL STRUCTURE(S).
   e. PRIOR TO REMOVAL OF ALL SEDIMENT CONTROL DEVICES.
   f. PRIOR TO FINAL ACCEPTANCE.
3. THE CONTRACTOR SHALL CONSTRUCT ALL EROSION AND SEDIMENT CONTROL MEASURES PER THE APPROVED PLAN AND CONSTRUCTION SEQUENCE AND SHALL HAVE THEM INSPECTED AND APPROVED BY THE AGENCY INSPECTOR OR WMA INSPECTOR PRIOR TO BEGINNING ANY OTHER LAND DISTURBANCES.
4. THE CONTRACTOR SHALL PROTECT ALL POINTS OF CONSTRUCTION INGRESS AND EGRESS TO PREVENT THE DEPOSITION OF MATERIALS ONTO PUBLIC ROADS. ALL MATERIALS DEPOSITED ONTO PUBLIC ROADS SHALL BE REMOVED IMMEDIATELY.
5. THE CONTRACTOR SHALL APPLY SOD OR SEED AND ANCHORED STRAW MULCH, OR OTHER APPROVED STABILIZATION MEASURES TO ALL DISTURBED AREAS AND STOCKPILES WITHIN SEVEN (7) CALENDAR DAYS AFTER STRIPPING AND GRADING ACTIVITIES HAVE CEASED IN THE AREA. MAINTENANCE SHALL BE PERFORMED AS NECESSARY TO ENSURE CONTINUED STABILIZATION. (REQUIREMENT MAY BE REDUCED TO THREE (3) DAYS FOR SENSITIVE AREAS.)
6. PRIOR TO REMOVAL OF SEDIMENT CONTROL MEASURES, THE CONTRACTOR SHALL STABILIZE AND HAVE ESTABLISHED PERMANENT STABILIZATION FOR ALL CONTRIBUTORY DISTURBED AREAS USING SOD OR AN APPROVED PERMANENT SEED MIXTURE WITH REQUIRED SOIL AMENDMENTS AND AN APPROVED ANCHORED MULCH. WOOD FIBER MULCH MAY ONLY BE USED IN SEEDING SEASON WHERE THE SLOPE DOES NOT EXCEED 10% AND GRADING HAS BEEN DONE TO PROMOTE SHEET FLOW DRAINAGE. AREAS BROUGHT TO FINISHED GRADE DURING THE SEEDING SEASON SHALL BE PERMANENTLY STABILIZED AS SOON AS POSSIBLE, BUT NO LATER THAN SEVEN (7) CALENDAR DAYS AFTER ESTABLISHMENT. WHEN PROPERTY IS BROUGHT TO FINISHED GRADE DURING THE MONTHS OF NOVEMBER THROUGH FEBRUARY, AND PERMANENT STABILIZATION IS FOUND TO BE IMPRACTICAL, TEMPORARY SEED AND ANCHORED STRAW MULCH SHALL BE APPLIED TO DISTURBED AREAS. THE FINAL PERMANENT STABILIZATION OF SUCH PROPERTY SHALL BE APPLIED BY MARCH 15 OR EARLIER IF GROUND AND WEATHER CONDITIONS ALLOW.
7. THE SITES APPROVAL LETTER, APPROVED EROSION AND SEDIMENT CONTROL PLANS, DAILY LOG BOOKS, AND TEST REPORTS SHALL BE AVAILABLE AT THE SITE FOR INSPECTION BY DULY AUTHORIZED OFFICIALS OF WMA AND THE AGENCY RESPONSIBLE FOR PROJECT.
8. SURFACE DRAINAGE FLOWS OVER UNSTABILIZED CUT AND FILL SLOPES SHALL BE CONTROLLED BY EITHER PREVENTING DRAINAGE FLOW FROM TRAVERSING THE SLOPES OR BY INSTALLING PROTECTIVE DEVICES TO LOWER THE WATER DOWN SLOPE WITHOUT CAUSING EROSION. DIKES SHALL BE INSTALLED AND MAINTAINED AT THE TOP OF A CUT OR FILL SLOPE UNTIL THE SLOPE AND DRAINAGE AREA TO IT ARE FULLY STABILIZED, AT WHICH TIME THEY MUST BE REMOVED AND FINAL GRADES DONE TO PROMOTE SHEET FLOW DRAINAGE. PROTECTIVE METHODS MUST BE PROVIDED AT POINTS OF CONCENTRATED FLOW WHERE EROSION IS LIKELY TO OCCUR.
9. PERMANENT SWALES OR OTHER POINTS OF CONCENTRATED WATER FLOW SHALL BE STABILIZED WITH SOD OR SEED WITH AN APPROVED EROSION CONTROL MATTING, RIP-RAP, OR BY OTHER APPROVED STABILIZATION MEASURES.
10. TEMPORARY SEDIMENT CONTROL DEVICES MAY BE REMOVED, WITH PERMISSION OF WMA INSPECTOR AND AGENCY INSPECTORS, WITHIN THIRTY (30) CALENDAR DAYS FOLLOWING ESTABLISHMENT OF PERMANENT STABILIZATION IN ALL CONTRIBUTORY DRAINAGE AREAS. STORMWATER MANAGEMENT STRUCTURES USED TEMPORARILY FOR SEDIMENT CONTROL SHALL BE CONVERTED TO THE PERMANENT CONFIGURATIONS WITHIN THIS TIME PERIOD AS WELL.
11. NO PERMANENT CUT OR FILL SLOPE WITH A GRADIENT STEEPER THAN 3:1 WILL BE PERMITTED IN LAWN MAINTENANCE AREAS. A SLOPE GRADIENT OF UP TO 2:1 WILL BE PERMITTED IN NON-MAINTENANCE AREAS PROVIDED THAT THOSE AREAS ARE INDICATED ON THE EROSION AND SEDIMENT CONTROL PLAN WITH A LOW-MAINTENANCE GROUND COVER SPECIFIED FOR PERMANENT STABILIZATION. SLOPE GRADIENT STEEPER THAN 2:1 WILL NOT BE PERMITTED WITH VEGETATIVE STABILIZATION.
12. FOR FINISHED GRADING, THE CONTRACTOR SHALL PROVIDE ADEQUATE GRADIENTS TO PREVENT WATER FROM PONDING FOR MORE THAN TWENTY FOUR (24) HOURS AFTER THE END OF THE RAINFALL EVENT. DRAINAGE COURSES AND SWALE FLOW AREAS MAY TAKE AS LONG AS FORTY-EIGHT (48) HOURS AFTER THE END OF A RAINFALL EVENT TO DRAIN. AREAS DESIGNATED TO HAVE STANDING WATER SHALL NOT BE REQUIRED TO MEET THIS REQUIREMENT.
13. SEDIMENT TRAPS AND BASINS ARE NOT PERMITTED WITHIN 20 FEET OF A FOUNDATION THAT EXISTS OR IS UNDER CONSTRUCTION. NO STRUCTURE MAY BE CONSTRUCTED WITHIN 20 FEET OF AN ACTIVE SEDIMENT TRAP OR BASIN.

## ADDITIONAL STATE OF MARYLAND EROSION AND SEDIMENT CONTROL PLAN GENERAL NOTES (CONTINUED):

14. THE WMA INSPECTOR HAS THE OPTION OF REQUIRING ADDITIONAL SAFETY OR SEDIMENT CONTROL MEASURES, IF DEEMED NECESSARY.
15. ALL TRAP DEPTH DIMENSIONS ARE RELATIVE TO OUTLET ELEVATION. ALL TRAPS MUST HAVE A STABLE OUTFALL. ALL TRAPS AND BASINS SHALL HAVE STABLE INFLOW POINTS.
16. VEGETATIVE STABILIZATION SHALL BE PREFORMED IN ACCORDANCE WITH THE STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. REFER TO APPROPRIATE SPECIFICATIONS FOR TEMPORARY SEEDING, PERMANENT SEEDING, MULCHING, SODDING, AND GROUND COVERS.
17. SEDIMENT SHALL BE REMOVED AND THE TRAP OR BASIN RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO ONE QUARTER OF THE TOTAL DEPTH OF THE TRAP OR BASIN. TOTAL DEPTH SHALL BE MEASURED FROM THE TRAP OR BASIN BOTTOM TO THE CREST OF THE OUTFALL.
18. SEDIMENT REMOVED FROM TRAPS (AND BASINS) SHALL BE PLACED AND STABILIZED IN APPROVED AREAS, BUT NOT WITHIN A FLOODPLAIN, WETLAND, OR TREE-SAVE AREA. WHEN PUMPING SEDIMENT LADEN WATER, THE DISCHARGE MUST BE DIRECTED TO A SEDIMENT TRAPPING DEVICE PRIOR TO RELEASE FROM THE SITE. A SUMP PIT MAY BE USED IF SEDIMENT TRAPS THEMSELVES ARE BEING PUMPED OUT.
19. ALL WATER REMOVED FROM EXCAVATED AREAS (E.G., UTILITY TRENCHES) SHALL BE PASSED THROUGH AN APPROVED DEWATERING PRACTICE OR PUMPED TO A SEDIMENT TRAP OR BASIN PRIOR TO DISCHARGE FROM THE SITE (I.E., VIA FUNCTIONAL STORM DRAIN SYSTEM OR TO STABLE GROUND SURFACE).
20. SEDIMENT CONTROL FOR UTILITY CONSTRUCTION FOR AREAS OUTSIDE OF DESIGNATED CONTROLS OR AS DIRECTED BY ENGINEER OR WMA INSPECTOR;
   a. CALL MISS UTILITY AT 1-800-257-7777 48 HOURS PRIOR TO THE START OF WORK.
   b. EXCAVATED TRENCH MATERIAL SHALL BE PLACED ON THE HIGH SIDE OF THE TRENCH.
   c. TRENCHES FOR UTILITY INSTALLATION SHALL BE BACKFILLED, COMPACTED, AND STABILIZED AT THE END OF EACH WORKING DAY. NO MORE TRENCH SHALL BE OPENED THAN CAN BE COMPLETED THE SAME DAY, UNLESS;
   d. TEMPORARY SILT FENCE SHALL BE PLACED IMMEDIATELY DOWNSTREAM OF ANY DISTURBED AREAS INTENDED TO REMAIN DISTURBED FOR MORE THAN ONE DAY.
21. WHERE DEEMED APPROPRIATE BY THE ENGINEER OR INSPECTOR, SEDIMENT BASINS AND TRAPS MAY NEED TO BE SURROUNDED WITH AN APPROVED SAFETY FENCE. THE FENCE MUST CONFORM TO LOCAL ORDINANCES AND REGULATIONS. THE DEVELOPER OR OWNER SHALL CHECK WITH LOCAL BUILDING OFFICIALS ON APPLICABLE SAFETY REQUIREMENTS. WHERE SAFETY FENCE IS DEEMED APPROPRIATE AND LOCAL ORDINANCES DO NOT SPECIFY FENCING SIZES AND TYPES, THE FOLLOWING SHALL BE USED AS A MINIMUM STANDARD: THE SAFETY FENCE MUST BE MADE OF WELDED WIRE AND AT LEAST 42 INCHES HIGH, HAVE POSTS SPACED NO FARTHER APART THAN 8 FEET, HAVE MESH OPENINGS NO GREATER THAN 2 INCHES IN WIDTH AND 4 INCHES IN HEIGHT WITH A MINIMUM OF 14 GAUGE WIRE. SAFETY FENCE MUST BE MAINTAINED AND IN GOOD CONDITION AT ALL TIMES.
22. OFF-SITE SPOIL OR BORROW AREAS ON STATE OR FEDERAL PROPERTY MUST HAVE PRIOR APPROVAL BY WMA AND OTHER APPLICABLE STATE, FEDERAL, AND LOCAL AGENCIES; OTHERWISE APPROVAL MUST BE GRANTED BY THE LOCAL AUTHORITIES. ALL WASTE AND BORROW AREAS OFF-SITE MUST BE PROTECTED BY SEDIMENT CONTROL MEASURES AND STABILIZED.
23. SITES WHERE INFILTRATION DEVICES ARE USED FOR THE CONTROL OF STORMWATER, EXTREME CARE MUST BE TAKEN TO PREVENT RUNOFF FROM UNSTABILIZED AREAS FROM ENTERING THE STRUCTURE DURING CONSTRUCTION. SEDIMENT CONTROL DEVICES PLACED IN INFILTRATION AREAS MUST HAVE BOTTOM ELEVATIONS AT LEAST TWO (2) FEET HIGHER THAN THE FINISH GRADE BOTTOM ELEVATION OF THE INFILTRATION PRACTICE. WHEN CONVERTING A SEDIMENT TRAP TO AN INFILTRATION DEVICE, ALL ACCUMULATED SEDIMENT MUST BE REMOVED AND DISPOSED OF PRIOR TO FINAL GRADING OF INFILTRATION DEVICE.
24. WHEN A STORM DRAIN SYSTEM OUTFALL IS DIRECTED TO A SEDIMENT TRAP OR SEDIMENT BASIN AND THE SYSTEM IS TO BE USED FOR TEMPORARILY CONVEYING SEDIMENT LADEN WATER, ALL STORM DRAIN INLETS IN NON-SUMP AREAS SHALL HAVE A TEMPORARY ASPHALT BERMS CONSTRUCTED AT THE TIME OF BASE PAVING TO DIRECT GUTTER FLOW INTO THE INLETS TO AVOID SURCHARGING AND OVERFLOW OF INLETS IN SUMP AREAS.
25. SITE INFORMATION:
   a. TOTAL AREA OF BLOCK G = 13.1 ACRES
   b. AREA WITHIN LIMITS OF DISTURBANCE = 1.3 ACRES
   c. AREA TO BE ROOFED OR PAVED = 0 ACRES
   d. TOTAL CUT = 640 CUBIC YARDS
   e. TOTAL FILL = 220 CUBIC YARDS
   f. OFF-SITE WASTE / BORROW AREA LOCATION - LOCATIONS NOT YET DETERMINED

REFER TO DRAWING FOR LIMITS OF DISTURBANCE, CUT/FILL AREA IN BLOCK G.

## SEQUENCE OF OPERATIONS NOTE:

REFER TO SHEET C-6.

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT

APPROVED FOR SEDIMENT CONTROL

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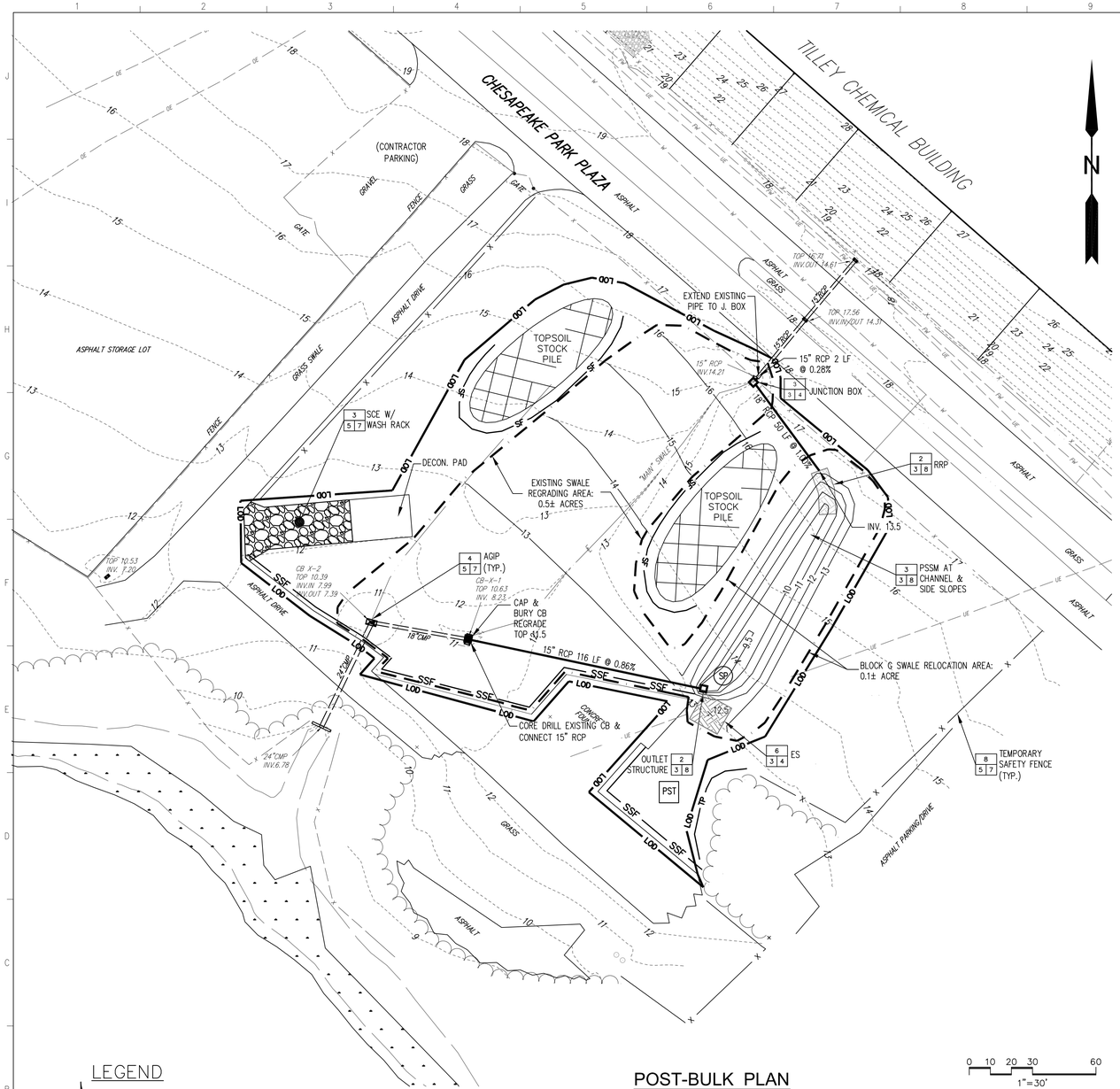
# BLOCK G SWALE - EROSION & SEDIMENT CONTROL PLAN

INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112I002948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-5 |

EROSION & SEDIMENT CONTROL PLAN - PRE




0 10 20 30 60
1"=30'

## TRAFFIC AND STOCKPILE NOTE:

ALL CONSTRUCTION TRAFFIC SHALL ENTER AND EXIT VIA A STABILIZED CONSTRUCTION ENTRANCE. A WASH RACK SHALL BE PROVIDED AT THE SCE IF VEHICLES BEGIN TO TRACK MUD ONTO ASPHALT DRIVE. CONTRACTOR SHALL REMOVE OR IMPORT DIRT AS REQUIRED. ANY STOCKPILE AREA CREATED FOR THIS PROJECT SHALL BE MANAGED BY A SEDIMENT CONTROL DEVICE AT ALL TIMES.

TEMPORARY STOCKPILES SHALL BE:

1. LOCATED WITHIN THE LIMIT OF DISTURBANCE (LOD).
2. SIDE SLOPES MUST BE MAINTAINED AT NO STEEPER THAN A 2:1 RATIO.
3. THE STOCKPILE AREA MUST BE KEPT FREE OF EROSION.
4. STOCKPILES MUST BE STABILIZED IN ACCORDANCE WITH THE 3/7 DAY STABILIZATION REQUIREMENT.
5. DRAIN TO A FUNCTIONING SEDIMENT SEDIMENT CONTROL DEVICE. POSITIONED TO NOT IMPEDE UPON, OR IMPAIR THE FUNCTION OF SAID DEVICE.
6. POSITIONED TO NOT ALTER DRAINAGE DIVIDES.
7. STOCKPILES CONTAINING CONTAMINATED MATERIAL MUST BE COVERED WITH IMPERMEABLE SHEETING.

## STANDARD STABILIZATION NOTE:

FOLLOWING INITIAL SOIL DISTURBANCE OR REDISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN THREE (3) CALENDAR DAYS AS TO THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES, AND ALL SLOPES GREATER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1) AND SEVEN (7) DAYS AS TO ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE.

## INLET PROTECTION NOTE:

THE CONTRACTOR IS REQUIRED TO INSTALL INLET PROTECTION ON ALL STORM DRAIN INLETS WITH THE EXCEPTION OF THE FOLLOWING:

1. ANY INLET OUTFALLING DIRECTLY INTO A SEDIMENT TRAPPING DEVICE.*
2. INLETS ON PRIVATE OR PUBLIC PAVED ROADWAYS OPEN TO THE PUBLIC.

ALL INLET PROTECTION WILL BE INSTALLED AS DIRECTED BY THE INSPECTOR IN ACCORDANCE WITH THE 2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL, PAGE E-23 (OR AS MAY BE AMENDED). THE REMOVAL OF ANY INLET PROTECTION DEVICES WILL REQUIRE APPROVAL FROM THE INSPECTOR.

*STORM DRAINS SHALL BE FLUSHED PRIOR TO TRAPPING DEVICE REMOVAL.

## MAINTENANCE NOTE:

SILT FENCE, SUPER SILT FENCE, AND INLET PROTECTION SHALL BE INSPECTED AND MAINTAINED EACH DAY AND AFTER EACH STORM EVENT BY THE CONTRACTOR. MAINTENANCE INCLUDES, BUT IS NOT LIMITED TO, REMOVAL OF ALL ACCUMULATED SEDIMENT. GEOTEXTILE FABRIC SHALL BE REPLACED AS NEEDED TO ENSURE PROPER FUNCTION. ANY DAMAGED OR REMOVED SILT FENCE/SUPER SILT FENCE SHALL BE REPAIRED OR REPLACED BY THE END OF EACH DAY.

ALL OTHER EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CHECKED ON A WEEKLY AND AS-NEEDED BASIS (BEFORE AND AFTER RAIN EVENTS) BY A PERSON EXPERIENCED IN EROSION AND SEDIMENT CONTROL PRACTICES, AND SHALL BE REPAIRED IN ACCORDANCE WITH THE FOLLOWING:

1. SILT FENCES SHALL BE REPAIRED TO THEIR ORIGINAL CONDITIONS IF DAMAGED. SEDIMENT SHALL BE REMOVED FROM THE SILT FENCES WHEN IT REACHES 25% OF FENCE HEIGHT.
2. THE CONSTRUCTION ENTRANCES AND ASPHALT DRIVE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOW OF MUD ONTO PUBLIC RIGHT-OF-WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING OF THE CONSTRUCTION ENTRANCE AND ASPHALT DRIVE AS CONDITIONS NEEDED OR REQUESTED BY THE OWNER'S REPRESENTATIVE.
3. ALL SEEDED AREAS SHALL BE CHECKED REGULARLY TO SEE THAT A GOOD STAND IS MAINTAINED. AREAS SHOULD BE FERTILIZED, WATERED, AND RESEEDED AS NEEDED.

ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MAINTAINED IN FULLY FUNCTIONAL CONDITION UNTIL NO LONGER REQUIRED FOR A COMPLETED PHASE OF WORK OR FINAL STABILIZATION OF THE SITE.

## SEQUENCE OF OPERATIONS:

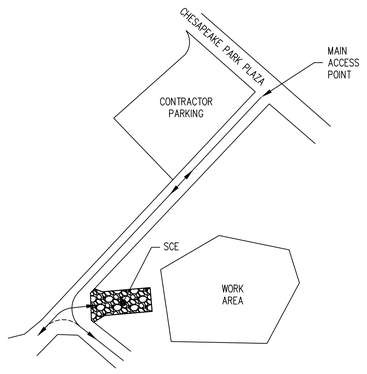
- OWNER INTENDS TO FURNISH AN APPROVED GRADING PLAN AND NPDES CONSTRUCTION STORMWATER PERMIT UNLESS THE PERFORMING CONTRACTOR SEEKS A DESIGN MODIFICATION.
- THE CONTRACTOR SHALL VERIFY THAT ALL APPLICABLE EARTH DISTURBANCE PERMITS, PLANS, AND CERTIFICATES PERTAINING TO EROSION AND SEDIMENT CONTROL HAVE BEEN APPROVED, SIGNED, AND POSTED ON-SITE (IF REQUIRED). CONTRACTOR SHALL APPLY FOR (BE THE PERMITTEE) THE NPDES CONSTRUCTION ACTIVITY PERMIT AND COMPLY WITH ALL SUBSTANTIVE REQUIREMENTS OF SUCH PERMITS.
- CONTACT MISS UTILITY TO LOCATE ALL SITE UTILITIES WITHIN LIMITS OF DISTURBANCE. FOLLOWING UTILITY LOCATION, VISIT SITE TO VERIFY SITE CONDITIONS.
- IF SIGNIFICANT CHANGES TO E&S PERIMETER CONTROLS DEFINED IN APPROVED GRADING PLAN AND GRADING PERMIT ARE MADE, CONTRACTOR MUST COORDINATE CHANGE WITH OWNER AND BALTIMORE COUNTY AND RECEIVE APPROVAL BEFORE PROCEEDING WITH WORK. EMERGENCY MEASURES SHALL BE TAKEN AS NECESSARY TO PREVENT ENVIRONMENTAL DAMAGE.
- PRIOR TO COMMENCEMENT OF CONSTRUCTION ACTIVITIES, THE CONTRACTOR SHALL SCHEDULE A PRE-CONSTRUCTION MEETING WITH THE OWNER.

PRE-BULK PLAN

1. NOTIFY BALTIMORE COUNTY DEPARTMENT OF PERMITS, APPROVALS AND INSPECTIONS, SEDIMENT CONTROL, (410) 887-3226 AT LEAST 48 HOURS PRIOR TO BEGINNING WORK. IF A PROJECT REQUIRES EITHER STATE, OR FEDERAL PERMITS DUE TO IN-STREAM CONSTRUCTION, IT SHALL BE NECESSARY TO NOTIFY THE MARYLAND DEPARTMENT OF THE ENVIRONMENT, INSPECTION AND COMPLIANCE PROGRAM, (410) 537-3510 AT LEAST 5 DAYS PRIOR TO BEGINNING WORK.
2. IF APPLICABLE, ORANGE HIGH VISIBILITY FENCE SHALL BE MANUALLY INSTALLED ALONG THE LIMIT OF DISTURBANCE, WHERE THE LIMIT IS WITHIN 50 FEET OF THE FOREST BUFFER/CONSERVATION EASEMENT. THIS SHALL BE COMPLETED BY AND INSPECTED AT, THE PRE-CONSTRUCTION MEETING.
3. CLEAR AND GRUB FOR SEDIMENT & EROSION CONTROL MEASURES OR DEVICES ONLY.
4. INSTALL ALL SEDIMENT & EROSION CONTROL MEASURES AND DEVICES AS SHOWN. ADDITIONAL MEASURES MAY BE REQUIRED BY FEDERAL, STATE, AND LOCAL STANDARDS OR DEEMED APPROPRIATE IN THE FIELD.
5. NOTIFY BALTIMORE COUNTY DEPARTMENT OF PERMITS, APPROVALS AND INSPECTIONS, SEDIMENT CONTROL, UPON COMPLETION OF SAID INSTALLATION.
6. WITH THE APPROVAL OF BALTIMORE COUNTY DEPARTMENT OF PERMITS, APPROVALS AND INSPECTIONS, SEDIMENT CONTROL, AND THE SEDIMENT CONTROL INSPECTOR, CLEAR AND GRUB REMAINDER OF SITE.
7. REMOVE PORTIONS OF CONCRETE FOUNDATION, WATER LINE, AND UNDERGROUND ELECTRIC LINE AS SHOWN.
8. REMOVE ALL CONTAMINATED SOIL OFFSITE. IF NECESSARY, STOCKPILE TOPSOIL TEMPORARILY AT THE LOCATIONS SHOWN ON THE PLAN.

POST-BULK PLAN

9. STABILIZE THE DISTURBED AREA USING TEMPORARY SEEDING PER THE SPECIFICATIONS IN SHEET C-9.
10. EXCAVATE NEW BLOCK G SWALE AREA AND REGRADE EXISTING SWALE AREA AS SHOWN. ALL FILL MATERIAL SHALL BE FREE OF CONTAMINATION.
11. INSTALL TEMPORARY SUMP PIT, PUMP, AND PORTABLE SEDIMENT TANK AS NEEDED.
12. REMOVE AGIP FROM CB-X-1 AND PROVIDE INLET PROTECTION AT THE OUTFALL PIPE (18" CMP) TO PREVENT SEDIMENT RELEASING DOWNSTREAM.
13. CORE DRILL CB-X-1 FOR THE PROPOSED 15" RCP CONNECTION AT UPSTREAM. CONTRACTOR MAY INSTALL A NEW CB INSTEAD OF CORE DRILLING.
15. INSTALL STORM SEWER STRUCTURES INCLUDING JUNCTION BOX AND OUTLET STRUCTURE. PROVIDE TEMPORARY INLET PROTECTION AT THE FACE OF OUTLET STRUCTURE UNTIL THE DRAINAGE AREA IS STABILIZED.
16. INSTALL THE PROPOSED STORM SEWER PIPES AND CONNECT IT TO THE EXISTING STORM SEWER CONVEYANCE SYSTEM AS SHOWN.
17. REMOVE THE INLET PROTECTION FROM CB-X-1 AND CAP THE CB WITH METAL COVER.
18. FINALIZE THE SITE GRADING ACCORDING TO THE GRADING PLAN (SHEET C-3).
19. MAINTAIN EROSION AND SEDIMENT CONTROL DEVICES IN FULLY FUNCTIONAL CONDITION THROUGHOUT CONTRACT PERIOD. CONTRACTOR IS REQUIRED TO USE ADDITIONAL DEWATERING PRACTICES IF/WHEN NECESSARY.
20. UPON STABILIZATION OF SITE WITH ESTABLISHED VEGETATION AND WITH PERMISSION OF THE SEDIMENT CONTROL INSPECTOR, REMOVE SEDIMENT CONTROL MEASURES AND STABILIZE THOSE AREAS DISTURBED BY THIS PROCESS.




TRAFFIC FLOW DIAGRAM
FORWARD
REVERSE

## LEGEND

- SCE — STABILIZED CONSTRUCTION ENTRANCE
- LIMIT OF GRADING
- TOPSOIL STOCKPILE AREA
- AT-GRADE INLET PROTECTION
- SF — SILT FENCE
- SSF — SUPER SILT FENCE
- TP — TREE PROTECTION
- LOD — LIMIT OF DISTURBANCE
- ROCK/RIPRAP PROTECTION
- PERIMETER DIKE/SWALE
- SP — SUMP PIT
- PST — PORTABLE SEDIMENT TANK

- EXISTING COMMUNICATION PED
- EXISTING ELECTRIC BOX
- EXISTING UTILITY POLE
- EXISTING UTILITY MANHOLE
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE (WV)
- EXISTING GAS VALVE (GV)
- EXISTING MONITOR WELL
- EXISTING STORM SEWER INLET
- EXISTING GROUND SHOT
- 15 — EXISTING MAJOR CONTOUR (5')
- 14 — EXISTING MINOR CONTOUR (1')
- OE — EXISTING OVERHEAD ELECTRIC
- UE — EXISTING UNDERGROUND ELECTRIC
- W — EXISTING DOMESTIC WATER
- FW — EXISTING FIRE WATER
- X — EXISTING CHAIN LINK/WIRE
- G — EXISTING GAS LINE
- S — EXISTING STORM SEWER
- EXISTING BUILDING
- EXISTING WETLANDS
- PROPOSED STORM SEWER STRUCTURE
- PROPOSED STORM SEWER
- 13 — PROPOSED CONTOUR
- × 12.5 — PROPOSED SPOT GRADE

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT
APPROVED FOR SEDIMENT CONTROL
DATE

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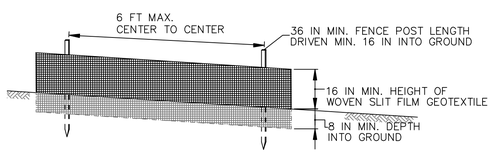
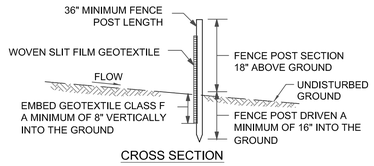
BLOCK G SWALE - EROSION & SEDIMENT CONTROL PLAN
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-6 |

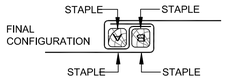
EROSION & SEDIMENT CONTROL PLAN - POST




ELEVATION




CROSS SECTION




TOP VIEW - JOINING TWO
ADJACENT SILT FENCE SECTIONS

## CONSTRUCTION SPECIFICATIONS

1. USE WOOD POSTS 1¾ X 1¾ ± 1/16 INCH (MINIMUM) SQUARE CUT OF SOUND QUALITY HARDWOOD. AS AN ALTERNATIVE TO WOODEN POST USE STANDARD "T" OR "U" SECTION STEEL POSTS WEIGHING NOT LESS THAN 1 POUND PER LINEAR FOOT.
2. USE 36 INCH MINIMUM POSTS DRIVEN 16 INCH MINIMUM INTO GROUND NO MORE THAN 6 FEET APART.
3. USE WOVEN SLIT FILM GEOTEXTILE AS SPECIFIED IN THIS SHEET AND FASTEN GEOTEXTILE SECURELY TO UPSLOPE SIDE OF FENCE POSTS WITH WIRE TIES OR STAPLES AT TOP AND MID-SECTION.
4. PROVIDE MANUFACTURER CERTIFICATION TO THE AUTHORIZED REPRESENTATIVE OF THE INSPECTION/ENFORCEMENT AUTHORITY SHOWING THAT THE GEOTEXTILE USED MEETS THE REQUIREMENTS.
5. EMBED GEOTEXTILE A MINIMUM OF 8 INCHES VERTICALLY INTO THE GROUND. BACKFILL AND COMPACT THE SOIL ON BOTH SIDES OF FABRIC.
6. WHERE TWO SECTIONS OF GEOTEXTILE ADJOIN: OVERLAP, TWIST, AND STAPLE TO POST IN ACCORDANCE WITH THIS DETAIL.
7. EXTEND BOTH ENDS OF THE SILT FENCE A MINIMUM OF FIVE HORIZONTAL FEET UPSLOPE AT 45 DEGREES TO THE MAIN FENCE ALIGNMENT TO PREVENT RUNOFF FROM GOING AROUND THE ENDS OF THE SILT FENCE.
8. REMOVE ACCUMULATED SEDIMENT AND DEBRIS WHEN BULGES DEVELOP IN SILT FENCE OR WHEN SEDIMENT REACHES 25% OF FENCE HEIGHT. REPLACE GEOTEXTILE IF TORN. IF UNDERMINING OCCURS, REINSTALL FENCE.

1 | 5 7 SILT FENCE
NOT TO SCALE

## GEOTEXTILE SPECIFICATIONS

| | | WOVEN SILT FILM | | WOVEN MONOFILAMENT | | NONWOVEN GEOTEXTILE | |
|---|---|---|---|---|---|---|---|
| | | MINIMUM AVERAGE ROLL VALUE* | | | | | |
| PROPERTY | TEST METHOD | MD | CD | MD | CD | MD | CD |
| GRAB TENSILE STRENGTH | ASTM D-4632 | 200 LB | 200 LB | 370 LB | 250 LB | 200 LB | 200 LB |
| GRAB TENSILE ELONGATION | ASTM D-4632 | 15% | 10% | 15% | 15% | 50% | 50% |
| TRAPEZOIDAL TEAR STRENGTH | ASTM D-4533 | 75 LB | 75 LB | 10 LB | 60 LB | 80 LB | 80 LB |
| PUNCTURE STRENGTH | ASTM D-6241 | 450LB | | 900LB | | 450LB | |
| APPARENT OPENING SIZE** | ASTM D-4751 | U.S. SIEVE 30 (0.59 MM) | | U.S. SIEVE 70 (0.21 MM) | | U.S. SIEVE 70 (0.21 MM) | |
| PERMITTIVITY | ASTM D-4491 | 0.05 SEC$^{-1}$ | | 0.28 SEC$^{-1}$ | | 1.1 SEC$^{-1}$ | |
| ULTRAVIOLET RESISTANCE RETAINED AT 500 HOURS | ASTM D-4355 | 70% STRENGTH | | 70% STRENGTH | | 70% STRENGTH | |

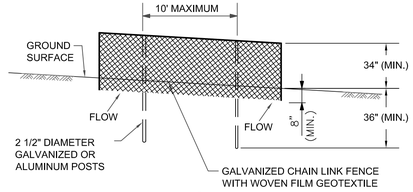
* ALL NUMERIC VALUES EXCEPT APPARENT OPENING SIZE (AOS) REPRESENT MINIMUM AVERAGE ROLL VALUES (MARV). MARV IS CALCULATED AS THE TYPICAL MINUS TWO STANDARD DEVIATIONS. MD IS MACHINE DIRECTION; CD IS CROSS DIRECTION.

** VALUES FOR AOS REPRESENT THE AVERAGE MAXIMUM OPENING.

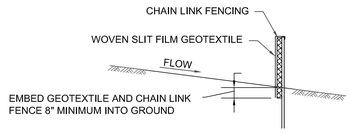
GEOTEXTILES MUST BE EVALUATED BY THE NATIONAL TRANSPORTATION PRODUCT EVALUATION PROGRAM (NTPEP) AND CONFORM TO THE VALUES IN THIS TABLE.

THE GEOTEXTILE MUST BE INERT TO COMMONLY ENCOUNTERED CHEMICALS AND HYDROCARBONS AND MUST BE ROT AND MILDEW RESISTANT. THE GEOTEXTILE MUST BE MANUFACTURED FROM FIBERS CONSISTING OF LONG CHAIN SYNTHETIC POLYMERS AND COMPOSED OF A MINIMUM OF 95 PERCENT BY WEIGHT OF POLYOLEFINS OR POLYESTERS, AND FORMED INTO A STABLE NETWORK SO THE FILAMENTS OR YARNS RETAIN THEIR DIMENSIONAL STABILITY RELATIVE TO EACH OTHER, INCLUDING SELVAGES.

WHEN MORE THAN ONE SECTION OF GEOTEXTILE IS NECESSARY OVERLAP THE SECTIONS BY AT LEAST ONE FOOT. THE GEOTEXTILE MUST BE PULLED TAUT OVER THE APPLIED SURFACE. EQUIPMENT MUST NOT RUN OVER EXPOSED FABRIC. WHEN PLACING RIPRAP ON GEOTEXTILE, DO NOT EXCEED A ONE FOOT DROP HEIGHT.




ELEVATION

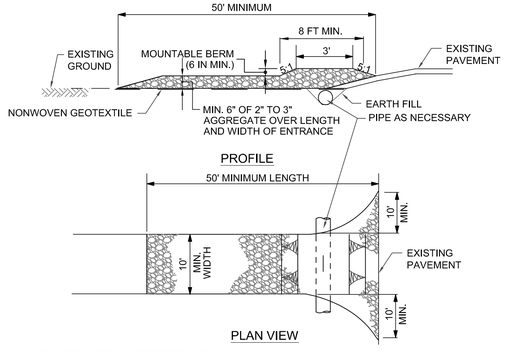



CROSS SECTION

## CONSTRUCTION SPECIFICATIONS

1. INSTALL 2 3/8 INCH DIAMETER GALVANIZED STEEL POSTS OF 0.095 INCH WALL THICKNESS AND SIX FOOT LENGTH SPACED NO FURTHER THAN 10 FEET APART. DRIVE THE POSTS A MINIMUM OF 36 INCHES INTO THE GROUND.
2. FASTEN 9 GAUGE OR HEAVIER GALVANIZED CHAIN LINK FENCE (2 3/8 INCH MAXIMUM OPENING) 42 INCHES IN HEIGHT SECURELY TO THE FENCE POSTS WITH WIRE TIES OR HUG RINGS.
3. FASTEN WOVEN SLIT FILM GEOTEXTILE AS SPECIFIED IN THIS SHEET, SECURELY TO THE UPSLOPE SIDE OF CHAIN LINK FENCE WITH TIES SPACED EVERY 24 INCHES AT THE TOP AND MID SECTION. EMBED GEOTEXTILE AND CHAIN LINK FENCE A MINIMUM OF 8 INCHES INTO THE GROUND.
4. WHERE ENDS OF THE GEOTEXTILE COME TOGETHER, THE ENDS SHALL BE OVERLAPPED BY 6 INCHES, FOLDED, AND STAPLED TO PREVENT SEDIMENT BYPASS.
5. EXTEND BOTH ENDS OF THE SUPER SILT FENCE A MINIMUM OF FIVE HORIZONTAL FEET UPSLOPE AT 45 DEGREES TO THE MAIN FENCE ALIGNMENT TO PREVENT RUNOFF FROM GOING AROUND THE ENDS OF THE SUPER SILT FENCE.
6. PROVIDE MANUFACTURER CERTIFICATION TO THE INSPECTION/ENFORCEMENT AUTHORITY SHOWING THAT GEOTEXTILE USED MEETS THE REQUIREMENTS AS SPECIFIED.
7. REMOVE ACCUMULATED SEDIMENT AND DEBRIS WHEN BULGES DEVELOP IN FENCE OR WHEN SEDIMENT REACHES 25% OF FENCE HEIGHT. REPLACE GEOTEXTILE IF TORN. IF UNDERMINING OCCURS, REINSTALL CHAIN LINK FENCING AND GEOTEXTILE.

2 | 5 7 SUPER SILT FENCE
NOT TO SCALE

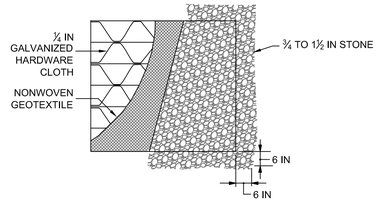



PLAN VIEW

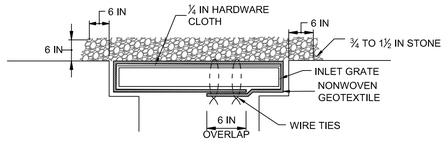
## CONSTRUCTION SPECIFICATIONS

1. PLACE STABILIZED CONSTRUCTION ENTRANCE IN ACCORDANCE WITH THE APPROVED PLAN. VEHICLES MUST TRAVEL OVER THE ENTIRE LENGTH OF THE SCE. USE MINIMUM LENGTH OF 50 FEET (*30 FEET FOR SINGLE RESIDENCE LOT). USE MINIMUM WIDTH OF 10 FEET. FLARE SCE 10 FEET MINIMUM AT THE EXISTING ROAD TO PROVIDE A TURNING RADIUS.
2. PIPE ALL SURFACE WATER FLOWING TO OR DIVERTED TOWARD THE SCE UNDER THE ENTRANCE, MAINTAINING POSITIVE DRAINAGE. PROTECT PIPE INSTALLED THROUGH THE SCE WITH A MOUNTABLE BERM WITH 5:1 SLOPES AND A MINIMUM OF 12 INCHES OF STONE OVER THE PIPE. PROVIDE PIPE AS SPECIFIED ON APPROVED PLAN. WHEN THE SCE IS LOCATED AT A HIGH SPOT AND HAS NO DRAINAGE TO CONVEY, A PIPE IS NOT NECESSARY. A MOUNTABLE BERM IS REQUIRED WHEN SCE IS NOT LOCATED AT A HIGH SPOT.
3. PREPARE SUBGRADE AND PLACE NONWOVEN GEOTEXTILE, AS SPECIFIED IN THIS SHEET.
4. PLACE CRUSHED AGGREGATE (2 TO 3 INCHES IN SIZE) OR EQUIVALENT RECYCLED CONCRETE (WITHOUT REBAR) AT LEAST 6 INCHES DEEP OVER THE LENGTH AND WIDTH OF THE SCE.
5. MAINTAIN ENTRANCE IN A CONDITION THAT MINIMIZES TRACKING OF SEDIMENT. ADD STONE OR MAKE OTHER REPAIRS AS CONDITIONS DEMAND TO MAINTAIN CLEAN SURFACE, MOUNTABLE BERM, AND SPECIFIED DIMENSIONS. IMMEDIATELY REMOVE STONE AND/OR SEDIMENT SPILLED, DROPPED, OR TRACKED ONTO ADJACENT ROADWAY BY VACUUMING, SCRAPING, AND/OR SWEEPING. WASHING ROADWAY TO REMOVE MUD TRACKED ONTO PAVEMENT IS NOT ACCEPTABLE UNLESS WASH WATER IS DIRECTED TO AN APPROVED SEDIMENT CONTROL PRACTICE.

3 | 5 7 STABILIZED CONSTRUCTION ENTRANCE
NOT TO SCALE




PLAN / CUT AWAY VIEW

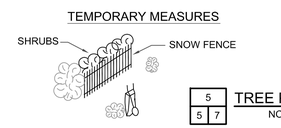



CROSS SECTION

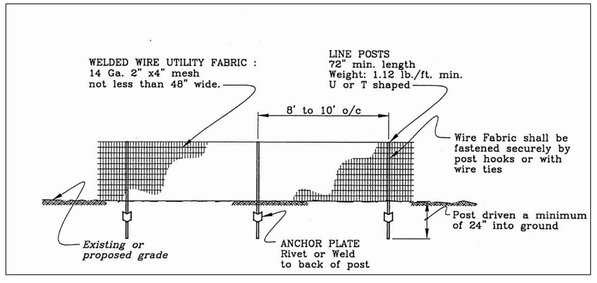
## CONSTRUCTION SPECIFICATIONS

1. USE NONWOVEN GEOTEXTILE AS SPECIFIED IN THIS SHEET.
2. LIFT GRATE AND WRAP WITH NONWOVEN GEOTEXTILE TO COMPLETELY COVER ALL OPENINGS. SECURE WITH WIRE TIES AND SET GRATE BACK IN PLACE.
3. PLACE CLEAN ¾ TO 1½ INCH STONE OR EQUIVALENT RECYCLED CONCRETE 6 INCHES THICK ON THE GRATE.
4. STORM DRAIN INLET PROTECTION REQUIRES FREQUENT MAINTENANCE. REMOVE ACCUMULATED SEDIMENT AFTER EACH RAIN EVENT TO MAINTAIN FUNCTION AND AVOID PREMATURE CLOGGING. IF INLET PROTECTION DOES NOT COMPLETELY DRAIN WITHIN 24 HOURS AFTER A STORM EVENT, IT IS CLOGGED. WHEN THIS OCCURS, REMOVE ACCUMULATED SEDIMENT AND CLEAN, OR REPLACE GEOTEXTILE AND STONE.

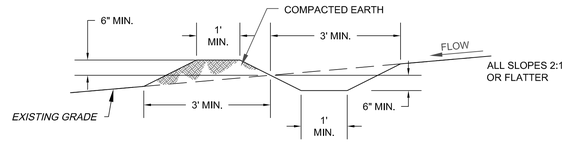
4 | 5 7 AT GRADE INLET PROTECTION
NOT TO SCALE




5 | 5 7 TREE PROTECTION
NOT TO SCALE



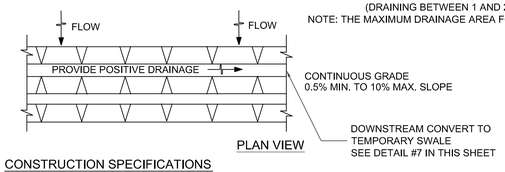

8 | 5 7 TEMPORARY SAFETY FENCE
NOT TO SCALE




CROSS SECTION

FLOW CHANNEL STABILIZATION

PD/S-1: SEED AND MULCH AND TACK (DRAINING ≤ 1 ACRE) (NOT ALLOWED FOR CLEAR WATER DIVERSION.)
PD/S-2: SEED WITH SOIL STABILIZATION MATTING OR LINE WITH SOD (DRAINING BETWEEN 1 AND 2 ACRES)
NOTE: THE MAXIMUM DRAINAGE AREA FOR THIS PRACTICE IS 2 ACRES.

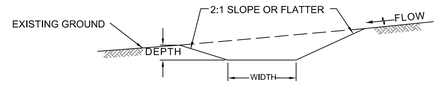



PLAN VIEW

## CONSTRUCTION SPECIFICATIONS

1. REMOVE AND DISPOSE OF ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SO AS NOT TO INTERFERE WITH PROPER FUNCTION OF DIKE/SWALE.
2. EXCAVATE OR SHAPE DIKE/SWALE TO LINE, GRADE, AND CROSS SECTION AS SPECIFIED. BANK PROJECTIONS OR OTHER IRREGULARITIES ARE NOT ALLOWED.
3. COMPACT FILL.
4. CONSTRUCT DIKE/SWALE ON AN UNINTERRUPTED, CONTINUOUS GRADE, ADJUSTING THE LOCATION DUE TO FIELD CONDITIONS AS NECESSARY TO MAINTAIN POSITIVE DRAINAGE.
5. PROVIDE OUTLET PROTECTION AS REQUIRED ON APPROVED PLAN.
6. STABILIZE DIKE/SWALE WITHIN 3 DAYS OF INSTALLATION. STABILIZE DIKE/SWALES USED FOR CLEAR WATER DIVERSION WITHIN 24 HOURS OF INSTALLATION.
7. MAINTAIN LINE, GRADE, AND CROSS SECTION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS, AND MAINTAIN POSITIVE DRAINAGE. KEEP PERIMETER DIKE/SWALE AND POINT OF DISCHARGE FREE OF EROSION AND CONTINUOUSLY MEET REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT.
8. UPON REMOVAL OF DIKE/SWALE, GRADE AREA FLUSH WITH EXISTING GROUND. WITHIN 24 HOURS OF REMOVAL STABILIZE DISTURBED AREA WITH TOPSOIL, SEED, MULCH, OR AS SPECIFIED ON APPROVED PLAN.

6 | 5 7 PERIMETER DIKE/SWALE
NOT TO SCALE

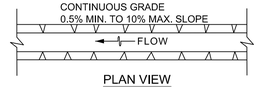



CROSS SECTION

| SWALE TYPE | A | B |
|---|---|---|
| MIN. DEPTH | 1 FT MIN. | 1 FT MIN. |
| BOTTOM WIDTH | 4 FT MIN. | 6 FT MIN. |

FLOW CHANNEL STABILIZATION

A-1 SEED WITH STRAW MULCH AND TACK. (NOT ALLOWED FOR CLEAR WATER DIVERSION.)
A-2/B-2 SEED WITH SOIL STABILIZATION MATTING OR LINE WITH SOD.
A-3/B-3 4 TO 7 INCH STONE OR EQUIVALENT RECYCLED CONCRETE PRESSED INTO SOIL A MINIMUM OF 7 INCHES AND FLUSH WITH GROUND.




PLAN VIEW

## CONSTRUCTION SPECIFICATIONS

1. REMOVE AND DISPOSE OF ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SO AS NOT TO INTERFERE WITH PROPER FUNCTION OF TEMPORARY SWALE.
2. EXCAVATE OR SHAPE TEMPORARY SWALE TO LINE, GRADE, AND CROSS SECTION AS SPECIFIED. BANK PROJECTIONS OR OTHER IRREGULARITIES ARE NOT ALLOWED.
3. STABILIZE TEMPORARY SWALE WITHIN THREE DAYS OF INSTALLATION. STABILIZE SWALES USED FOR CLEAR WATER DIVERSION WITHIN 24 HOURS OF INSTALLATION.
4. CONSTRUCT FLOW CHANNEL ON AN UNINTERRUPTED, CONTINUOUS GRADE, ADJUSTING THE LOCATION DUE TO FIELD CONDITIONS AS NECESSARY TO MAINTAIN POSITIVE DRAINAGE.
5. PROVIDE OUTLET PROTECTION AS REQUIRED ON APPROVED PLAN.
6. MAINTAIN LINE, GRADE, AND CROSS SECTION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS, AND MAINTAIN POSITIVE DRAINAGE. KEEP TEMPORARY SWALE AND POINT OF DISCHARGE FREE OF EROSION, AND CONTINUOUSLY MEET REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT.
7. UPON REMOVAL OF TEMPORARY SWALE, GRADE AREA FLUSH WITH EXISTING GROUND. WITHIN 24 HOURS OF REMOVAL STABILIZE DISTURBED AREA WITH TOPSOIL, SEED, AND MULCH, OR AS SPECIFIED ON APPROVED PLAN.

7 | 5 7 TEMPORARY SWALE
NOT TO SCALE

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT
APPROVED FOR SEDIMENT CONTROL
DATE

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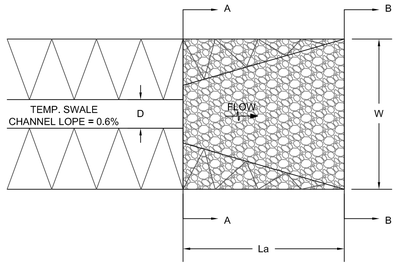
100% REVIEW

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

# BLOCK G SWALE - EROSION & SEDIMENT CONTROL PLAN
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-7 |

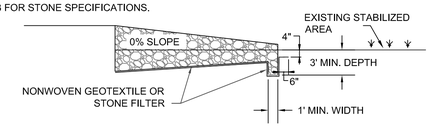
E & S DETAILS I



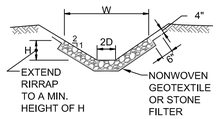

PLAN

| RIPRAP | D | W | La | T |
|---|---|---|---|---|
| CLASS I | 1' | 15' | 14' | 19" |

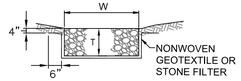
NOTE:
REFER TO SHEET C-3 FOR STONE SPECIFICATIONS.




PROFILE




SECTION A-A

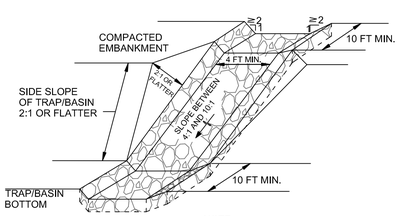



SECTION B-B

1 | 5 8 MODIFIED ROCK OUTLET PROTECTION III
NOT TO SCALE

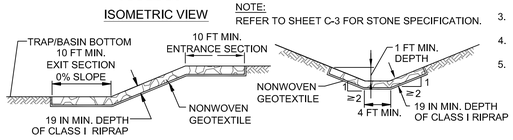
CONSTRUCTION SPECIFICATIONS

1. RIPRAP AND STONE MUST CONFORM TO THE SPECIFIED CLASS.
2. USE NONWOVEN GEOTEXTILE AS SPECIFIED IN SHEET C-7. AND PROTECT FROM PUNCTURING, CUTTING, OR TEARING. REPAIR ANY DAMAGE OTHER THAN AN OCCASIONAL SMALL HOLE BY PLACING ANOTHER PIECE OF GEOTEXTILE OVER THE DAMAGED PART OR BY COMPLETELY REPLACING THE GEOTEXTILE. PROVIDE A MINIMUM OF ONE FOOT OVERLAP FOR ALL REPAIRS AND FOR JOINING TWO PIECES OF GEOTEXTILE TOGETHER.
3. PREPARE THE SUBGRADE FOR GEOTEXTILE OR STONE FILTER ( ⅜ TO 1½ INCH MINIMUM STONE FOR 6 INCH MINIMUM DEPTH) AND RIPRAP TO THE REQUIRED LINES AND GRADES. COMPACT ANY FILL REQUIRED IN THE SUBGRADE TO A DENSITY OF APPROXIMATELY THAT OF THE SURROUNDING UNDISTURBED MATERIAL.
4. EXTEND GEOTEXTILE AT LEAST 6 INCHES BEYOND EDGES OF RIPRAP AND EMBED AT LEAST 4 INCHES AT SIDES OF RIPRAP.
5. CONSTRUCT RIPRAP OUTLET TO FULL COURSE THICKNESS IN ONE OPERATION AND IN SUCH A MANNER AS TO AVOID DISPLACEMENT OF UNDERLYING MATERIALS. PLACE STONE FOR RIPRAP OUTLET IN A MANNER THAT WILL ENSURE THAT IT IS REASONABLY HOMOGENOUS WITH THE SMALLER STONES AND SPALLS FILLING THE VOIDS BETWEEN THE LARGER STONES. PLACE RIPRAP IN A MANNER TO PREVENT DAMAGE TO THE FILTER BLANKET OR GEOTEXTILE. HAND PLACE TO THE EXTENT NECESSARY.
6. WHERE NO ENDWALL IS USED, CONSTRUCT THE UPSTREAM END OF THE APRON SO THAT THE WIDTH IS TWO TIMES THE DIAMETER OF THE OUTLET PIPE, AND EXTEND THE STONE UNDER THE OUTLET BY A MINIMUM OF 18 INCHES.
7. CONSTRUCT APRON WITH 0% SLOPE ALONG ITS LENGTH AND WITHOUT OBSTRUCTIONS. PLACE STONE SO THAT IT BLENDS IN WITH EXISTING GROUND.
8. MAINTAIN LINE, GRADE, AND CROSS SECTION. KEEP OUTLET FREE OF EROSION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS. AFTER HIGH FLOWS INSPECT FOR SCOUR AND RIPRAP DISLODGED RIPRAP . MAKE NECESSARY REPAIRS IMMEDIATELY.




ISOMETRIC VIEW

NOTE:
REFER TO SHEET C-3 FOR STONE SPECIFICATION.



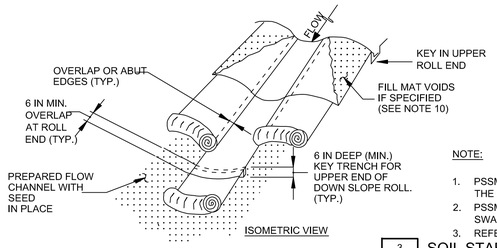

PROFILE ALONG CENTERLINE

CROSS SECTION

CONSTRUCTION SPECIFICATIONS

1. PROVIDE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SHEET C-7, UNDER THE BOTTOM AND ALONG SIDES OF ALL RIPRAP.
2. CONSTRUCT INFLOW CHANNEL WITH CLASS I RIPRAP OR EQUIVALENT RECYCLED CONCRETE LINING TO A MINIMUM DEPTH OF 19 INCHES (2 x $D_{50}$) AND A 1 FOOT DEEP FLOW CHANNEL. INFLOW RIPRAP PROTECTION CHANNEL MUST HAVE A TRAPEZOIDAL CROSS SECTION WITH 2:1 OR FLATTER SIDE SLOPES AND A 4 FOOT MINIMUM BOTTOM WIDTH.
3. INSTALL ENTRANCE AND EXIT SECTIONS AS SHOWN ON THE PROFILE.
4. BLEND RIPRAP INTO EXISTING GROUND.
5. MAINTAIN LINE, GRADE, AND CROSS SECTION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS. KEEP POINTS OF INFLOW AND OUTFLOW FREE OF EROSION.

2 | 3 8 RIPRAP INFLOW PROTECTION
NOT TO SCALE



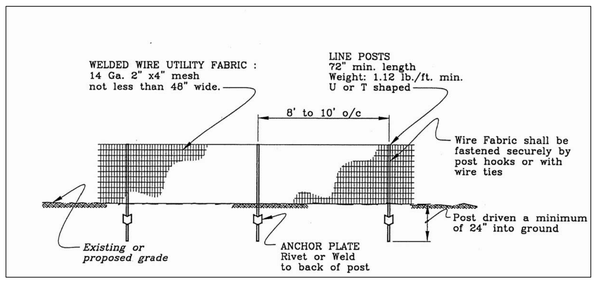

NOTE:

1. PSSMC SHALL BE PROVIDED ON THE BOTTOM OF THE SWALE. THE CHANNEL SLOPE IS 2%.
2. PSSMS SHALL BE PROVIDED ON THE SIDE SLOPES OF THE SWALE. THE SIDE SLOPE IS MAX 2H:1V.
3. REFER TO SHEET C-3 FOR STONE SPECIFICATION.

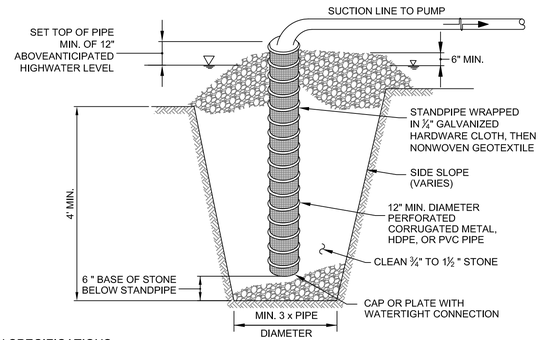
3 | 3 8 SOIL STABILIZATION MATTING
NOT TO SCALE

CONSTRUCTION SPECIFICATIONS

1. USE MATTING THAT HAS A DESIGN VALUE FOR SHEAR STRESS EQUAL TO OR HIGHER THAN THE SHEAR STRESS 2 lb/ft² FOR TEMPORARY STABILIZATION 7 lb/ft² FOR PERMANENT STABILIZATION.
2. FOR TEMPORARY STABILIZATION, USE TEMPORARY SOIL STABILIZATION MATTING MADE OF DEGRADABLE (LASTS 6 MONTHS MINIMUM) NATURAL OR MAN-MADE FIBERS (MOSTLY ORGANIC). MAT MUST HAVE UNIFORM THICKNESS AND DISTRIBUTION OF FIBERS THROUGHOUT AND BE SMOLDER RESISTANT. CHEMICALS USED IN THE MAT MUST BE NON-LEACHING AND NON-TOXIC TO VEGETATION AND SEED GERMINATION AND NON-INJURIOUS TO THE SKIN. IF PRESENT, NETTING MUST BE EXTRUDED PLASTIC WITH A MAXIMUM MESH OPENING OF 2x2 INCHES AND SUFFICIENTLY BONDED OR SEWN ON 2 INCH CENTERS ALONG LONGITUDINAL AXIS OF THE MATERIAL TO PREVENT SEPARATION OF THE NET FROM THE PARENT MATERIAL.
3. FOR PERMANENT STABILIZATION, USE PERMANENT SOIL STABILIZATION MATTING MADE OF OPEN WEAVE SYNTHETIC, NON-DEGRADABLE FIBERS OR ELEMENTS OF UNIFORM THICKNESS AND DISTRIBUTION THROUGHOUT. CHEMICALS USED IN THE MAT MUST BE NON-LEACHING AND NON-TOXIC TO VEGETATION AND SEED GERMINATION AND NON-INJURIOUS TO THE SKIN. IF PRESENT, NETTING MUST BE EXTRUDED PLASTIC WITH A MAXIMUM MESH OPENING OF 2x2 INCHES AND SUFFICIENTLY BONDED OR SEWN ON 2 INCH CENTERS ALONG LONGITUDINAL AXIS OF THE MATERIAL TO PREVENT SEPARATION OF THE NET FROM THE PARENT MATERIAL.
4. SECURE MATTING USING STEEL STAPLES OR WOOD STAKES. STAPLES MUST BE "U" OR "T" SHAPED STEEL WIRE HAVING A MINIMUM GAUGE OF NO. 11 AND NO. 8 RESPECTIVELY. "U" SHAPED STAPLES MUST AVERAGE 1 TO 1 ½ INCHES WIDE AND BE A MINIMUM OF 6 INCHES LONG. "T" SHAPED STAPLES MUST HAVE A MINIMUM 8 INCH MAIN LEG, A MINIMUM 1 INCH SECONDARY LEG, AND MINIMUM 4 INCH HEAD. WOOD STAKES MUST BE ROUGH-SAWN HARDWOOD, 12 TO 24 INCHES IN LENGTH, 1x3 INCH IN CROSS SECTION, AND WEDGE SHAPE AT THE BOTTOM.
5. PERFORM FINAL GRADING, TOPSOIL APPLICATION, SEEDBED PREPARATION, AND PERMANENT SEEDING IN ACCORDANCE WITH SPECIFICATIONS. PLACE MATTING WITHIN 48 HOURS OF COMPLETING SEEDING OPERATIONS, UNLESS END OF WORKDAY STABILIZATION IS SPECIFIED ON THE APPROVED EROSION AND SEDIMENT CONTROL PLAN.
6. UNROLL MATTING IN DIRECTION OF WATER FLOW, CENTERING THE FIRST ROLL ON THE CHANNEL CENTER LINE. WORK FROM CENTER OF CHANNEL OUTWARD WHEN PLACING ROLLS. LAY MATTING SMOOTHLY AND FIRMLY UPON THE SEEDED SURFACE. AVOID STRETCHING THE MATTING.
7. OVERLAP OR ABUT EDGES OF MATTING ROLLS PER MANUFACTURER RECOMMENDATIONS. OVERLAP ROLL ENDS BY 6 INCHES (MINIMUM), WITH THE UPSTREAM MAT OVERLAPPING ON TOP OF THE NEXT DOWNSTREAM MAT.
8. KEY IN THE TOP OF SLOPE END OF MAT 6 INCHES (MINIMUM) BY DIGGING A TRENCH, PLACING THE MATTING ROLL END IN THE TRENCH, STAPLING THE MAT IN PLACE, REPLACING THE EXCAVATED MATERIAL, AND TAMPING TO SECURE THE MAT END IN THE KEY.
9. STAPLE/STAKE MAT IN A STAGGERED PATTERN ON 4 FOOT (MAXIMUM) CENTERS THROUGHOUT AND 2 FOOT (MAXIMUM) CENTERS ALONG SEAMS, JOINTS, AND ROLL ENDS.
10. IF SPECIFIED BY THE DESIGNER OR MANUFACTURER AND DEPENDING ON THE TYPE OF MAT BEING INSTALLED, ONCE THE MATTING IS KEYED AND STAPLED IN PLACE, FILL THE MAT VOIDS WITH TOP SOIL OR GRANULAR MATERIAL AND LIGHTLY COMPACT OR ROLL TO MAXIMIZE SOIL/MAT CONTACT WITHOUT CRUSHING MAT.
11. ESTABLISH AND MAINTAIN VEGETATION SO THAT REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT ARE CONTINUOUSLY MET IN ACCORDANCE WITH VEGETATIVE STABILIZATION.




4 | 6 8 TEMPORARY SAFETY FENCE
NOT TO SCALE

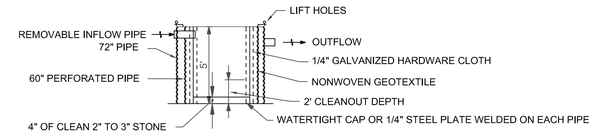



ELEVATION

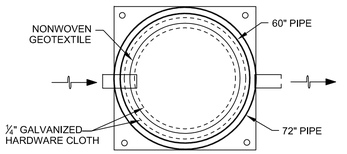
CONSTRUCTION SPECIFICATIONS

1. USE 12 INCH OR LARGER DIAMETER CORRUGATED METAL, HDPE, OR PVC PIPE WITH 1 INCH DIAMETER PERFORATIONS, 6 INCHES ON CENTER. BOTTOM OF PIPE MUST BE CAPPED WITH WATERTIGHT SEAL.
2. WRAP PIPE WITH ¼ INCH GALVANIZED HARDWARE CLOTH AND WRAP NONWOVEN GEOTEXTILE AS SPECIFIED IN SHEET C-7, OVER THE HARDWARE CLOTH.
3. EXCAVATE PIT TO THREE TIMES THE PIPE DIAMETER AND FOUR FEET IN DEPTH. PLACE ¾ TO 1½ INCH STONE OR EQUIVALENT RECYCLED CONCRETE, 6 INCHES IN DEPTH PRIOR TO PIPE PLACEMENT.
4. SET TOP OF PIPE MINIMUM 12 INCHES ABOVE ANTICIPATED WATER SURFACE ELEVATION.
5. BACKFILL PIT AROUND THE PIPE WITH ¾ TO 1½ INCH CLEAN STONE OR EQUIVALENT RECYCLED CONCRETE AND EXTEND STONE A MINIMUM OF 6 INCHES ABOVE ANTICIPATED WATER SURFACE ELEVATION.
6. DISCHARGE TO A STABLE AREA AT A NONEROSIVE RATE .
7. A SUMP PIT REQUIRES FREQUENT MAINTENANCE. IF SYSTEM CLOGS, REMOVE PERFORATED PIPE AND REPLACE GEOTEXTILE AND STONE. KEEP POINT OF DISCHARGE FREE OF EROSION.

5 | 6 8 SUMP PIT
NOT TO SCALE




ELEVATION




PLAN VIEW

CONSTRUCTION SPECIFICATIONS

1. PROVIDE 1 CUBIC FOOT OF STORAGE FOR EACH GALLON PER MINUTE OF PUMP CAPACITY. REQUIRED STORAGE VOLUME MAY BE ATTAINED BY PLACEMENT OF TANKS IN PARALLEL WITH INFLOW EVENLY DISTRIBUTED AMONG TANKS. OVERTOPPING OF TANKS IS NOT PERMITTED.
2. USE 60 INCH DIAMETER CORRUGATED METAL OR PLASTIC PIPE WITH 1 INCH DIAMETER PERFORATIONS, 6 INCHES ON CENTER FOR THE INNER PIPE. LINE PIPE WITH NONWOVEN GEOTEXTILE, AS SPECIFIED IN SHEET C-7, SANDWICHED BETWEEN, AND ATTACHED TO, ¼ INCH HARDWARE CLOTH.
3. OVERLAP GEOTEXTILE 8 INCHES MINIMUM AT VERTICAL SEAM AND AT THE BOTTOM PLATE.
4. ANCHOR GEOTEXTILE AT BOTTOM OF TANK WITH 4 INCHES OF 2 TO 3 INCH CLEAN STONE OR EQUIVALENT RECYCLED CONCRETE.
5. USE 72 INCH CORRUGATED METAL OR PLASTIC OUTER PIPE WITH PERMANENT OUTFLOW PIPE WITH INVERT LOWER THAN INFLOW PIPE
6. INFLOW PIPE MUST DISCHARGE INTO INNER PIPE AND BE REMOVABLE.
7. PLACE TANK ON LEVEL SURFACE AND DISCHARGE TO A STABLE AREA AT A NONEROSIVE RATE.
8. A PORTABLE SEDIMENT TANK REQUIRES FREQUENT MAINTENANCE. REMOVE ACCUMULATED SEDIMENT FROM INNER PIPE WHEN IT REACHES TWO FEET IN DEPTH. IF SYSTEM CLOGS, PULL OUT INNER PIPE, REMOVE ACCUMULATED SEDIMENT, AND REPLACE GEOTEXTILE. KEEP POINT OF DISCHARGE FREE OF EROSION.

6 | 6 8 PORTABLE SEDIMENT TANK
NOT TO SCALE

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT
APPROVED FOR SEDIMENT CONTROL

DATE

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100% REVIEW

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

BLOCK G SWALE - EROSION & SEDIMENT CONTROL PLAN
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-8 |

E & S DETAILS II

# MARYLAND AVIATION ADMINISTRATION SEEDING SPECIFICATIONS

REFERENCES TO ITEM #S NOTED BELOW ARE FOUND IN MARYLAND AVIATION ADMINISTRATION'S MANUAL ENTITLED SPECIFICATIONS FOR PERFORMING LANDSCAPING ACTIVITIES FOR THE MARYLAND AVIATION ADMINISTRATION DATED JULY 2006.

## SOIL TESTS

1. FOLLOWING INITIAL SOIL DISTURBANCES OR RE-DISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN THREE CALENDAR DAYS FOR THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES, AND ALL SLOPES GREATER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1) AND SEVEN DAYS FOR ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE.

2. OCCURRENCE OF ACID SULFATE SOILS (GRAYISH BLACK COLOR) WILL REQUIRE COVERING WITH A MINIMUM OF 12 INCHES OF CLEAN SOIL WITH 6 INCHES MINIMUM CAPPING OF TOP SOIL. NO STOCKPILING OF MATERIAL IS ALLOWED. IF NEEDED, SOIL TESTS SHOULD BE DONE BEFORE AND AFTER A 6-WEEK INCUBATION PERIOD TO ALLOW OXIDATION OF SULFATES.

3. THE MINIMUM SOIL CONDITIONS REQUIRED FOR PERMANENT VEGETATIVE ESTABLISHMENT ARE:
   a. SOIL PH SHALL BE BETWEEN 6.0 AND 7.0.
   b. SOLUBLE SALTS SHALL BE LESS THAN 500 PARTS PER MILLION (PPM).
   c. THE SOIL SHALL CONTAIN LESS THAN 40% CLAY BUT ENOUGH FINE GRAINED MATERIAL (>30% SILT PLUS CLAY) TO PROVIDE THE CAPACITY TO HOLD A MODERATE AMOUNT OF MOISTURE.
   d. SOIL SHALL CONTAIN 1.5% MINIMUM ORGANIC MATTER BY WEIGHT.
   e. SOIL MUST CONTAIN SUFFICIENT PORE SPACE TO PERMIT ADEQUATE ROOT PENETRATION.
   f. IF THESE CONDITIONS CANNOT BE MET BY SOILS ON SITE, ADDING TOPSOIL IS REQUIRED IN ACCORDANCE ITEM 901 OR AMENDMENTS MADE AS RECOMMENDED BY CERTIFIED AGRONOMIST.

## ITEM 903 SEEDING

DESCRIPTION
903-1.1 GENERAL. THIS ITEM PROVIDES SPECIFICATION FOR SEEDING OF AREAS AS DESIGNATED ON PLANS OR AS DIRECTED BY THE OWNER. THE SPECIES, MIXTURES, AND METHODS OF APPLICATION PROVIDED IN THIS ITEM HAVE BEEN DESIGNED TO REDUCE THE ATTRACTIVENESS OF AIRPORT GROUND TO WILDLIFE. ONLY MAA-APPROVED SPECIES, MIXTURES, AND RATES OF APPLICATION PROVIDED IN THIS ITEM MAY BE USED TO ESTABLISH VEGETATION. ALL ACTIVITIES ASSOCIATED WITH SEEDING INCLUDING SOIL PREPARATION, SEED APPLICATION, FERTILIZATION, AND MAINTENANCE SHALL ALSO CONFIRM TO THESE APPROVED STANDARDS.

MATERIALS

903-2.1 SEED. ALL SEED SHALL COMPLY WITH THE MARYLAND SEED LAW (AGRICULTURAL ARTICLE OF THE ANNOTATED CODE OF MARYLAND). ONLY MAA-APPROVED SPECIES, MIXTURES, AND RATES OF APPLICATION PROVIDED IN THIS ITEM MAY BE USED TO ESTABLISH VEGETATION. SEED WILL BE SAMPLED AND TESTED BY AN INSPECTOR FROM THE TURF AND SEED SECTION, MARYLAND DEPARTMENT OF AGRICULTURE (MDA), ANNAPOLIS, MARYLAND. ALL LAWN AND TURF SEED AND MIXTURES SHALL BE FREE FROM FOLLOWING STAT-LISTED RESTRICTED NOXIOUS WEEDS:

CORN COCKLE (AGROSTEMMA GITHAGO),
BENTGRASS (AGROSTIS SPP.)*,
REDTOP (AGROSTIS GIGANTEA)*,
WILD ONION (ALLIUM CANADENSE),
WILD GARLIC (ALLIUM VINEALE),
BINDWEED (CALSTEGIA SPP.),
DODDER (CUSCUTA SPP.) ,
BERMUDA GRASSS (CYNODON DACTYLON),
ORCHARDGRASS (DACTYLIS GLOMERATA),
TALL FESCUE (FESTUCA ARUNDINACEA)*,
MEADOW FESCUE (FESTUCA PRATENSIS)*,
VELVETGRASS (HOLCUS LANATUS),
ANNUAL BLUEGRASS (POA ANNUA),
ROUGH BLUEGRASS (POA TRIVIALIS)*,
TIMOTHY (PHLEUM PRATENSE), AND
JOHNSON GRASS (SORGUM HALEPENSE),

* THESE SPECIES MAY BE INCLUDED AS A LABELED COMPONENT OF A MIXTURE WHEN EACH IS PRESENT IN EXCESS OF FIVE PERCENT OF THE MIXTURE BY WEIGHT.

RESTRICTED NOXIOUS-WEED SEED MAY NOT EXCEED 0.5 PERCENT BY WEIGHT OF ANY SEED MIXTURE. IN ADDITION, ALL SEED IN MARYLAND SHALL BE FREE FROM THE FOLLOWING LISTED PROHIBITED NOXIOUS WEEDS: BALLOON VINE (CARDIOSPERMUM HALICACABUM), QUACKGRASS (ELYTRIGIA REPENS), SORGHUM, SICKLEPOD (SENNA OBTUSIFOLIA), CANADA THISTLE (CIRSIUM ARVENSE), PLUMELESS THISTLE (CARDUUS SPP. - INCLUDES MUSK THISTLE, AND CURLED THISTLE), AND SERRATED TUSSOCK (NASSELLA TRICHOTOMA).

903-2.1.1 APPROVED SPECIES. THE FOLLOWING TABLE CONTAINS SPECIES THAT ARE APPROVED BY MAA FOR USE IN SEED MIXTURES. PURITY REQUIREMENTS AND GERMINATION REQUIREMENTS ARE ALSO PROVIDED.

APPROVED PLANT SPECIES

| MAA SEED MIXTURES | PURITY* NOT LESS THAN % | MINIMUM % GERMINATION** | PURE LIVE SEED FACTOR |
|---|---|---|---|
| CERTIFIED TURF-TYPE TALL FESCUE (FESTUCA ARUNDINACEA) | 98 | 90 | 1.13 |
| CERTIFIED KENTUCKY BLUEGRASS (POA PRATENSIS) | 90 | 80 | 1.39 |
| HARD FESCUE (FESTUCA LONGIFOLIA) | 98 | 90 | 1.13 |
| CHEWINGS RED FESCUE (FESTUCA RUBRA COMMUTATA) | 98 | 90 | 1.13 |
| ANNUAL RYEGRASS (LOLIUM MULTIFLORUM) | 95 | 85 | 1.24 |
| PERENNIAL RYEGRASS (LOLIUM PERENNE) | 90 | 80 | 1.39 |
| FOWL MEADOW GRASS (POA PALUSTRIS) | 90 | 80 | 1.39 |
| LITTLE BLUESTEM (ANDROPOGON SCOPARIUS) | 62 | 94 | 1.71 |

* THE PERCENTAGE WEIGHT OF PURE SEED PRESENT SHALL BE FREE OF AN AGRICULTURE SEEDS, INERT MATTER, AND OTHER SEEDS DISTINGUISHABLE BY THEIR APPEARANCE.

** THE PERCENT OF GERMINATION SHALL BE ACTUAL SPROUTS AND SHALL NOT INCLUDE HARD SEEDS UNLESS SPECIFICALLY PERMITTED BY THE OWNER.

903-2.1.2 PURITY. ALL SEED SHALL BE FREE OF ALL STATE-DESIGNATED NOXIOUS WEEDS LISTED IN PARAGRAPH 2.1.1 AND CONFORM TO MAA SPECIFICATIONS. TO ENSURE COMPLIANCE, OWNER REQUIRES SAMPLING AND TESTING OF SEED BY THE TURF AND SEED SECTION, MARYLAND DEPARTMENT OF AGRICULTURE (MDA). THE CONTRACTOR SHALL FURNISH THE OWNER WITH DUPLICATE SIGNED COPIES OF A STATEMENT BY THE TURF AND SEED SECTION CERTIFYING THAT EACH LOT OF SEED HAS BEEN LABORATORY TESTED WITHIN SIX MONTHS TO DATE OF DELIVERY. THIS STATEMENT SHALL INCLUDE THE FOLLOWING INFORMATION:
- NAME AND ADDRESS OF LABORATORY,
- DATE OF TEST,
- LOT NUMBER,
- THE RESULTS OF TESTS AS TO NAME, PERCENTAGES OF PURITY AND OF GERMINATION,
- PERCENTAGE OF WEED CONTENT FOR THE SEED FURNISHED,
- AND, IN THE CASE OF A MIXTURE, THE PROPORTIONS OF EACH KIND OF SEED.

SEED SHALL BE FURNISHED IN STANDARD CONTAINERS WITH THE SEED NAME, LOT NUMBER, NET WEIGHT, PERCENTAGES OF PURITY, GERMINATION RATE AND HARD SEED, AND PERCENTAGE OF MAXIMUM WEED SEED CONTENT CLEARLY MARKED. ALL SEED CONTAINERS SHALL BE TAGGED WITH A MDA SUPERVISED MIX PROGRAM SEED TAG.

903-2.1.3 MIXTURES AND APPLICATION RATES. ONLY SEED MIXTURES AND APPLICATION RATES DESCRIBED IN THIS ITEM MAY BE USED UNLESS OTHERWISE APPROVED BY THE OWNER. SEED MIXTURES SHALL MEET CRITERIA DETAILED IN PARAGRAPH 903-2.1.2. SEED MIXTURES HAVE BEEN FORMULATED TO MINIMIZE THE ATTRACTIVENESS OF AREAS TO WILDLIFE OF COMMON LANDSCAPE SCENARIOS. THE APPROPRIATE SEED MIXTURE FOR APPLICATION WILL BE DESIGNATED BASED ON ENVIRONMENTAL CONDITIONS AND MAY VARY FROM SITE TO SITE. ALL PLATING RATES LISTED ARE IN POUNDS OF PURE LIVE SEED (PLS) PER ACRE.

SEED MIXTURES, APPLICATION SCENARIOS, AND RATES FOR *PERMANENT COOL-SEASON GRASSES* ARE AS FOLLOWS:

a. SEED MIXTURE NO. 1 - RELATIVELY FLAT AREAS (GRADE LESS THAN 4:1) SUBJECT TO NORMAL CONDITIONS AND REGULAR MOWING (APPLICATION RATE = 234 LBS PLS/ACRE);
b. SEED MIXTURE NO. 2 - SLOPED AREAS (GRADE GREATER THAN 4:1) NOT SUBJECT TO REGULAR MOWING (APPLICATION RATE = 115 LBS PLS/ACRE); AND
c. SEED MIXTURE NO. 3 - WETLANDS AND THEIR ASSOCIATED BUFFER ZONES (APPLICATIONS RATE = 131 LBS PLS/ACRE).

SEED MIXTURE NO. 1: RELATIVELY FLAT AREAS REGULARLY MOWED AND EXPOSED TO NORMAL CONDITIONS (APPLICATION RATE = 234 LBS PLS/ACRE)

| SEED | RATE OF APPLICATION (LBS OF PLS/ACRE) |
|---|---|
| 85% CERTIFIED TURF-TYPE TALL FESCUE | 192 |
| 10% CERTIFIED KENTUCKY BLUEGRASS | 28 |
| 5% PERENNIAL RYEGRASS | 14 |
| SUPPLEMENTAL SEED | |
| ANNUAL RYEGRASS | 25 |

SEED MIXTURE NO. 2: SLOPED AREAS NOT SUBJECT TO REGULAR MOWING (APPLICATION RATE = 115 LBS PLS/ACRE)

| SEED | RATE OF APPLICATION (LBS OF PLS/ACRE) |
|---|---|
| 75% HARD FESCUE | 85 |
| 20% CHEWINGS FESCUE | 23 |
| 5% KENTUCKY BLUEGRASS | 7 |
| SUPPLEMENTAL SEED | |
| REDTOP | 3 |

SEED MIXTURE NO. 3: WETLAND AREAS AND THEIR ASSOCIATED BUFFER ZONES (APPLICATION RATE = 131 LBS PLS/ACRE)

| SEED | RATE OF APPLICATION (LBS OF PLS/ACRE) |
|---|---|
| 60% FOWL MEADOW GRASS | 83 |
| 30% CHEWINGS FESCUE | 34 |
| 10% PERENNIAL RYEGRASS | 14 |
| SUPPLEMENTAL SEED | |
| REDTOP | 3 |

903-2.1.4 SEEDING SEASONS. APPLICATION OF SEED AND SEED MIXTURES SHALL OCCUR WITHIN A SPECIFIED SEEDING SEASON UNLESS OTHERWISE APPROVED BY THE OWNER. NO SEED OR SEED MIXTURES ARE TO BE APPLIED ON FROZEN GROUND OR WHEN THE TEMPERATURE IS AT OR BELOW 35 DEGREES FAHRENHEIT (7.2 DEGREES CENTIGRADE). UNDER THESE CONDITIONS, A LAYER OF MULCH SHOULD BE APPLIED IN ACCORDANCE WITH ITEM 905, MULCHING, TO STABILIZE THE SITE, AND PERMANENT SEEDING SHOULD OCCUR IN THE SUBSEQUENT SEEDING SEASON. SEED APPLICATION MAY OCCUR DURING THE SEEDING SEASON DATES LISTED BELOW. SEEDING PERFORMED AFTER OCTOBER 20 SHOULD BE A TEMPORARY COVER OF ANNUAL RYEGRASS AND FOLLOWED BY OVER SEEDING OF THE APPROPRIATE SEED MIXTURE DURING THE SPRING SEEDING SEASON.

| SEEDING SEASONS | |
|---|---|
| PERMANENT COOL-SEASON GRASSES | MARCH 1 TO APRIL 20 AND AUGUST 1 TO OCTOBER 20, INCLUSIVE |
| TEMPORARY COVER OF ANNUAL RYE/ REDTOP | MARCH 1 TO APRIL 30 AND AUGUST 1 TO NOVEMBER 30, INCLUSIVE |
| TEMPORARY COVER OF WARM-SEASON GRASSES *(LITTLE BLUESTEM ONLY)* | MAY 1 TO JULY 31, INCLUSIVE. RATE OF APPLICATION SHOULD BE 13.6 LBS. PLS PER ACRE. |

SEEDING SEASONS ARE BASED ON TYPICAL YEARS AND CAN BE SUBJECT TO VARIATION, WHICH MAY BE MODIFIED BY THE OWNER BASED ON SEASONAL TRENDS.

IF THE TIME REQUIRED TO COMPLETE ANY OF THE OPERATIONS NECESSARY UNDER THIS ITEM, WITHIN THE SPECIFIED PLANTING SEASON OR ANY AUTHORIZED EXTENSIONS THEREOF, EXTENDS BEYOND THE CONTRACT PERIOD, THEN SUCH TIME WILL BE CHARGED AGAINST THE CONTRACT TIME, AND LIQUIDATED DAMAGES WILL BE ENFORCED WITH RESPECT TO THIS PORTION OF WORK.

903-2.2 LIME. LIME SHALL CONSIST OF GROUND LIMESTONE AND CONTAIN AT LEAST 85 PERCENT TOTAL CARBONATES. LIME SHALL BE GROUND TO A FINENESS SO THAT AT LEAST 90 PERCENT WILL PASS THROUGH A NO. 20 MESS SIEVE AND 50 PERCENT WILL PASS THROUGH A NO. 100 MESH SIEVE. DOLOMITIC LIME OR A HIGH MAGNESIUM LIME SHALL CONTAIN AT LEAST 10 PERCENT MAGNESIUM OXIDE. LIME SHALL BE APPLIED BY APPROVED METHODS DETAILED IN SECTION 903-3.3 OF THIS ITEM. THE RATE OF APPLICATION WILL BE BASED ON THE RESULTS OF SOIL TESTS.

903-2.3 FERTILIZER. FERTILIZER SHALL BE STANDARD COMMERCIAL FERTILIZER (SUPPLIED SEPARATELY OR IN MIXTURES) AND MEET THE REQUIREMENTS OF APPLICABLE STATE AND FEDERAL LAWS (O-F-241) AS WELL AS STANDARDS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. NITROGEN-PHOSPHORUS-POTASSIUM (N-P-K) CONCENTRATIONS SHALL BE DETERMINED FROM ANALYSIS OF SOIL SAMPLES. *(APPROVED FERTILIZER RATE: 21 POUNDS OF 10-10-10 PER 1,000 SQUARE FEET.)* METHODS OF FERTILIZER APPLICATION SHALL CONFORM TO STANDARDS DESCRIBED IN SECTION 903-3.3 OF THIS ITEM. FERTILIZER SHALL BE FURNISHED IN STANDARD CONTAINERS THAT ARE CLEARLY LABELED WITH NAME, WEIGHT, AND GUARANTEED ANALYSIS OF THE CONTENTS (PERCENTAGE OF TOTAL NITROGEN, AVAILABLE PHOSPHORIC ACID, AND WATER-SOLUBLE POTASH). MIXED FERTILIZERS SHALL NOT CONTAIN ANY HYDRATED LIME OR CYANAMIDE COMPOUNDS. FERTILIZERS FAILING TO MEET THE SPECIFIED ANALYSIS MAY BE APPROVED BY THE OWNER, PROVIDING SUFFICIENT MATERIALS ARE APPLIED TO CONFORM WITH THE SPECIFIED NUTRIENTS PER UNIT OF MEASURE WITHOUT ADDITIONAL COST TO OWNER.

THE FERTILIZERS MAY BE SUPPLIED IN THE FOLLOWING FORMS:

a. A DRY, FREE-FLOWING FERTILIZER SUITABLE FOR APPLICATION BY A COMMON FERTILIZER SPREADER;

b. A FINELY GROUND FERTILIZER SOLUBLE IN WATER, SUITABLE FOR APPLICATION BY POWER SPRAYERS; OR

c. A GRANULAR OR PELLET FORM SUITABLE FOR APPLICATION BY BLOWER EQUIPMENT.

THE RATE OF APPLICATION WILL BE BASED ON RESULTS OF SOIL TESTS PERFORMED BY THE UNIVERSITY OF MARYLAND SOIL TESTING LABORATORY. BY LAW, PERSONS APPLYING FERTILIZER TO STATE-OWNED LAND SHALL FOLLOW THE RECOMMENDATIONS OF THE UNIVERSITY OF MARYLAND AS SET FORTH IN THE "PLANT NUTRIENT RECOMMENDATIONS BASED ON SOIL TESTS FOR TURF MAINTENANCE" AND THE "PLANT NUTRIENT RECOMMENDATIONS BASED ON SOIL TESTS FOR SOD PRODUCTION" (SEE APPENDIX B). APPLICATION OF THE FERTILIZER SHALL BE IN A MANNER THAT IS CONSISTENT WITH THE RECOMMENDATIONS OF THE UNIVERSITY OF MARYLAND COOPERATIVE EXTENSION.

### CONSTRUCTION METHODS AND EQUIPMENT

903-3.1 GENERAL. THIS SECTION PROVIDES APPROVED METHODS FOR THE APPLICATION OF AND INCLUDES STANDARDS FOR SEEDBED PREPARATION, METHODS OF APPLICATION, AND EQUIPMENT TO BE USED DURING THE PROCESS. LIME AND FERTILIZER SHALL BE APPLIED TO SEEDED AREAS BEFORE THE SEED IS SPREAD. THE MIXTURE OF SEED WILL BE DETERMINED FOR SITES BASED ON ENVIRONMENTAL CONDITIONS AS DESCRIBED IN PARAGRAPH 903-2.1.3.

903-3.2 ADVANCE PREPARATION. AREAS DESIGNATED FOR SEEDING SHALL BE PROPERLY PREPARED IN ADVANCE OF SEED APPLICATION. THE AREA SHALL BE TILLED AND GRADED PRIOR TO APPLICATION OF LIME AND FERTILIZER, AND THE SURFACE AREA SHALL BE CLEARED OF ANY STONES LARGER THAN 1 INCH IN DIAMETER, STICKS, STUMPS, AND OTHER DEBRIS THAT MIGHT INTERFERE WITH SOWING OF SEED, GROWTH OF GRASSES, OR SUBSEQUENT MAINTENANCE OF GRASS-COVERED AREAS. DAMAGE CAUSED BY EROSION OR OTHER FORCES THAT OCCUR AFTER THE COMPLETION OF GRADING SHALL BE REPAIRED PRIOR TO THE APPLICATION OF FERTILIZER AND LIME. THE CONTRACTOR WILL REPAIR SUCH DAMAGE, WHICH MAY INCLUDE FILLING GULLIES, SMOOTHING IRREGULARITIES, AND REPAIRING OTHER INCIDENTAL DAMAGE BEFORE BEGINNING THE APPLICATION OF FERTILIZER AND GROUND LIMESTONE.

IF AN AREA TO BE SEEDED IS SPARSELY SODDED, WEEDY, BARREN AND UNWORKED, OR PACKED AND HARD, ALL GRASS AND WEEDS SHALL FIRST BE CUT OR OTHERWISE SATISFACTORILY DISPOSED OF, AND THE SOIL THEN SCARIFIED OR OTHERWISE LOOSENED TO A DEPTH NOT LESS THAN 5 INCHES (125 MM). CLODS SHALL BE BROKEN AND THE TOP 3 INCHES (75 MM) OF SOIL SHALL BE WORKED INTO A SATISFACTORY CONDITION BY DISCING OR BY USE OF CULTIPACKERS, ROLLERS, DRAGS, HARROWS, OR OTHER APPROPRIATE MEANS.

AN AREA TO BE SEEDED SHALL BE CONSIDERED A SATISFACTORY SEEDBED (WITHOUT REQUIRING ADDITIONAL TREATMENT) IF IT HAS RECENTLY BEEN THOROUGHLY LOOSENED AND WORKED TO A DEPTH OF NOT LESS THAN 5 INCHES; THE TOP 3 INCHES OF SOIL IS LOOSE, FRIABLE, AND IS REASONABLY FREE FROM LARGE CLODS, ROCKS, LARGE ROOTS, OR OTHER UNDESIRABLE MATTER; APPROPRIATE AMOUNTS OF FERTILIZER AND LIME HAVE BEEN ADDED; AND, IF IT HAS BEEN SHAPED TO THE REQUIRED GRADE IMMEDIATELY PRIOR TO SEEDING. FOR SLOPE AREAS STEEPER THAN 3:1 (THREE HORIZONTAL TO ONE VERTICAL), THE SUBSOIL SHALL BE LOOSE TO A DEPTH OF 1 INCH.

AFTER COMPLETION OF TILLING AND GRADING, LIME AND FERTILIZER SHALL BE APPLIED WITHIN 48 HOURS ACCORDING TO THE SPECIFIED RATE (PARAGRAPHS 903-2.2 AND 2.3) AND METHODS (PARAGRAPHS 903-3.3.1 AND 903-3.3.2) APPROVED BY OWNER. THE SEEDING MIXTURE SHALL BE APPLIED WITHIN 48 HOURS AFTER APPLICATION OF LIME AND FERTILIZER. TO FIRM THE SEEDED AREAS, CULTIPACKING SHALL OCCUR IMMEDIATELY AFTER SEEDING.

903-3.3 METHODS OF APPLICATION. LIME, FERTILIZER, AND SEED MIXES SHALL BE APPLIED BY EITHER THE DRY OR WET APPLICATION METHODS THAT HAVE BEEN APPROVED BY OWNER AND ARE DETAILED BELOW.

### 903-3.3.1 DRY APPLICATION METHOD

a. LIMING. IF SOIL TEST RESULTS INDICATE THAT LIME IS NEEDED, THE FOLLOWING PROCEDURES WILL BE USED: FOLLOWING ADVANCE PREPARATION OF THE SEEDBED, LIME SHALL BE APPLIED PRIOR TO THE APPLICATION OF ANY FERTILIZER OR SEED AND ONLY ON SEEDBEDS THAT HAVE BEEN PREPARED AS DESCRIBED IN PARAGRAPH 903-3.2. THE LIME SHALL BE UNIFORMLY SPREAD AND WORKED INTO THE TOP 2 INCHES OF SOIL, AFTER WHICH THE SEEDBED SHALL BE PROPERLY GRADED AGAIN.

b. FERTILIZING. FOLLOWING ADVANCE PREPARATIONS (AND LIMING IF NECESSARY), FERTILIZER SHALL BE SPREAD UNIFORMLY AT THE SPECIFIED RATE TO PROVIDE NO LESS THAN THE MINIMUM QUANTITY STATED IN PARAGRAPH 903-2.3.

c. SEEDING. SEED MIXTURES SHALL BE SOWN IMMEDIATELY AFTER FERTILIZATION OF THE SEEDBED. THE FERTILIZER AND SEED SHALL BE LIGHTLY RAKED TO A DEPTH OF 1 INCH FOR NEWLY GRADED AND DISTURBED AREAS.

d. ROLLING. AFTER THE SEED HAS BEEN PROPERLY COVERED, THE SEEDBED SHALL BE IMMEDIATELY COMPACTED USING A CULTIPACKER OR AN APPROVED LAWNROLLER.

### 903-3.3.2 WET APPLICATION METHOD/HYDROSEEDING

a. GENERAL. THE CONTRACTOR MAY ELECT TO APPLY SEED AND FERTILIZER AS PER PARAGRAPHS C AND D OF THIS SECTION IN THE FORM OF AN AQUEOUS MIXTURE BY SPRAYING OVER THE PREVIOUSLY PREPARED SEEDBED USING METHODS AND EQUIPMENT APPROVED BY OWNER. THE RATES OF APPLICATION SHALL BE AS SPECIFIED IN PARAGRAPHS 903-2.1 THROUGH 903-2.3.

b. SPRAYING EQUIPMENT. THE SPRAYING EQUIPMENT SHALL HAVE A CONTAINER OR WATER TANK EQUIPPED WITH A LIQUID LEVEL GAUGE CAPABLE OF READING INCREMENTS OF 50 GALLONS OR LESS OVER THE ENTIRE RANGE OF THE TANK CAPACITY. THE LIQUID LEVEL GAUGE SHALL BE MOUNTED SO AS TO BE VISIBLE TO THE NOZZLE OPERATOR AT ALL TIMES. THE CONTAINER OR TANK SHALL ALSO BE EQUIPPED WITH A MECHANICAL POWER-DRIVEN AGITATOR CAPABLE OF KEEPING ALL THE SOLIDS IN THE MIXTURE IN COMPLETE SUSPENSION AT ALL TIMES UNTIL USED.

THE SPRAYING EQUIPMENT SHALL ALSO INCLUDE A PRESSURE PUMP CAPABLE OF DELIVERING 100 GALLONS PER MINUTE AT A PRESSURE OF 100 POUNDS PER SQUARE INCH. THE PRESSURE PUMP ASSEMBLAGE SHALL BE CONFIGURED TO ALLOW THE MIXTURE TO FLOW THROUGH THE TANK WHEN NOT BEING SPRAYED FROM THE NOZZLE. ALL PUMP PASSAGES AND PIPELINES SHALL BE CAPABLE OF PROVIDING CLEARANCE FOR 5/8-INCH SOLIDS. THE POWER UNIT FOR THE PUMP AND AGITATOR SHALL HAVE CONTROLS MOUNTED SO AS TO BE ACCESSIBLE TO THE NOZZLE OPERATOR. A PRESSURE GAUGE SHALL BE CONNECTED TO AND MOUNTED IMMEDIATELY BEHIND THE NOZZLE.

THE NOZZLE PIPE SHALL BE MOUNTED ON AN ELEVATED SUPPORTING STAND IN SUCH A MANNER THAT IT CAN BE ROTATED THROUGH 360 DEGREES HORIZONTALLY AND INCLINED VERTICALLY FROM AT LEAST 20 DEGREES BELOW TO AT LEAST 60 DEGREES ABOVE THE HORIZONTAL. THERE SHALL BE A QUICK-ACTING, THREE-WAY CONTROL VALVE CONNECTING THE RECIRCULATING LINE TO THE NOZZLE PIPE AND MOUNTED SO THAT THE NOZZLE OPERATOR CAN CONTROL AND REGULATE THE AMOUNT OF FLOW OF MIXTURE TO BE SUPPLIED SO THAT MIXTURES MAY BE PROPERLY SPRAYED OVER A DISTANCE VARYING FROM 20 FEET TO 100 FEET. ONE SHALL BE A CLOSE-RANGE RIBBON NOZZLE, ONE A MEDIUM-RANGE RIBBON NOZZLE, AND ONE A LONG-RANGE JET NOZZLE. FOR EASE OF REMOVAL AND CLEANING, ALL NOZZLES SHALL BE CONNECTED TO THE NOZZLE PIPE BY MEANS OF QUICK-RELEASE COUPLINGS. IN ORDER TO REACH AREAS INACCESSIBLE TO THE REGULAR EQUIPMENT, AN EXTENSION HOSE AT LEAST 50 FEET IN LENGTH SHALL BE PROVIDED TO WHICH THE NOZZLES MAY BE CONNECTED.

c. MIXTURES. LIME SHALL BE APPLIED SEPARATELY IN THE QUANTITY SPECIFIED, PRIOR TO THE FERTILIZING AND SEEDING OPERATIONS. LIME SHOULD BE ADDED TO AND MIXED WITH WATER AT A CONCENTRATION NOT TO EXCEED 220 POUNDS OF LIME FOR EVERY 100 GALLONS OF WATER. AFTER LIME HAS BEEN APPLIED, THE TANK SHOULD BE EMPTIED AND RINSED WITH FRESH WATER. SEED AND FERTILIZER SHALL BE MIXED TOGETHER IN THE RELATIVE PROPORTIONS SPECIFIED, BUT THE RESULTING CONCENTRATIONS SHOULD NOT EXCEED 220 POUNDS OF MIXTURE PER 100 GALLONS OF WATER AND SHOULD BE APPLIED WITHIN 30 MINUTES TO PREVENT FERTILIZER BURN OF THE SEEDS.

ALL WATER USED SHALL BE OBTAINED FROM FRESH WATER SOURCES AND SHALL BE FREE FROM INJURIOUS CHEMICALS AND OTHER TOXIC SUBSTANCES HARMFUL TO PLANT LIFE. BRACKISH WATER SHALL NOT BE USED AT ANY TIME. THE CONTRACTOR SHALL IDENTIFY ALL SOURCES OF WATER TO THE OWNER AT LEAST TWO WEEKS PRIOR TO USE. THE OWNER MAY TAKE SAMPLES OF THE WATER AT THE SOURCE OR FROM THE TANK AT ANY TIME AND HAVE A LABORATORY TEST THE SAMPLES FOR CHEMICAL AND SALINE CONTENT. THE CONTRACTOR SHALL NOT USE ANY WATER FROM ANY SOURCE THAT IS DISAPPROVED BY THE OWNER FOLLOWING SUCH TESTS.

ALL MIXTURES SHALL BE CONSTANTLY AGITATED FROM THE TIME THEY ARE MIXED UNTIL THEY ARE FINALLY APPLIED TO THE SEEDBED. ALL SUCH MIXTURES SHALL BE USED WITHIN30 MINUTES FROM THE TIME THEY WERE MIXED OR THEY SHALL BE WASTED AND DISPOSED OF AT A LOCATION ACCEPTABLE TO THE ENGINEER.

d. SPRAYING. LIME SHALL BE SPRAYED UPON PREVIOUSLY PREPARED SEEDBEDS ON WHICH THE LIME, IF REQUIRED, SHALL HAVE BEEN WORKED IN ALREADY. THE MIXTURES SHALL BE APPLIED USING A HIGH-PRESSURE SPRAY WHICH SHALL ALWAYS BE DIRECTED UPWARD INTO THE AIR SO THAT THE MIXTURES WILL FALL TO THE GROUND IN A UNIFORM SPRAY. NOZZLES OR SPRAYS SHALL NEVER BE DIRECTED TOWARD THE GROUND IN SUCH A MANNER THAT MIGHT PRODUCE EROSION OR RUNOFF. PARTICULAR CARE SHALL BE EXERCISED TO ENSURE THAT THE APPLICATION IS MADE UNIFORMLY, AT THE PRESCRIBED RATE, AND TO GUARD AGAINST MISSES AND OVERLAPPED AREAS. PREDETERMINED QUANTITIES OF THE MIXTURE SHALL BE USED IN ACCORDANCE WITH SPECIFICATIONS TO COVER SPECIFIED SECTIONS OF KNOWN AREAS. TO CHECK THE RATE AND UNIFORMITY OF APPLICATION, THE APPLICATOR WILL OBSERVE THE DEGREE OF WETTING OF THE GROUND OR DISTRIBUTE TEST SHEETS OF PAPER OR PANS OVER THE AREA AT INTERVALS AND OBSERVE THE QUANTITY OF MATERIAL DEPOSITED THEREON.

ON SURFACES THAT ARE TO BE MULCHED AS INDICATED BY THE PLANS OR DESIGNATED BY THE OWNER, SEED AND FERTILIZER APPLIED BY THE SPRAY METHOD NEED NOT BE RAKED INTO THE SOIL OR ROLLED. HOWEVER, ON SURFACES ON WHICH MULCH IS NOT TO BE USED, THE RAKING AND ROLLING OPERATIONS WILL BE REQUIRED AFTER THE SOIL HAS DRIED.

### 903-3.4 MAINTENANCE OF SEEDED AREAS.

THE CONTRACTOR SHALL PROTECT SEEDED AREAS AGAINST TRAFFIC OR OTHER USE BY WARNING SIGNS OR BARRICADES, AS APPROVED BY THE ENGINEER. SURFACES GULLIED OR OTHERWISE DAMAGED FOLLOWING SEEDING SHALL BE REPAIRED BY REGRADING AND RESEEDING AS DIRECTED. THE CONTRACTOR SHALL MOW, WATER AS DIRECTED, AND OTHERWISE MAINTAIN SEEDED AREAS IN A SATISFACTORY CONDITION UNTIL FINAL INSPECTION AND ACCEPTANCE OF THE WORK.

WHEN EITHER THE DRY OR WET APPLICATION METHOD OUTLINED ABOVE IS USED FOR WORK PERFORMED OUT OF SEASON, THE CONTRACTOR WILL BE REQUIRED TO ESTABLISH A GOOD STAND OF GRASS OF UNIFORM COLOR AND DENSITY TO THE SATISFACTION OF THE ENGINEER. IF AT THE TIME WHEN THE CONTRACT HAS BEEN OTHERWISE COMPLETED IT IS NOT POSSIBLE TO MAKE AN ADEQUATE DETERMINATION OF THE COLOR, DENSITY, AND UNIFORMITY OF SUCH STAND OF GRASS, PAYMENT FOR THE UNACCEPTED PORTIONS OF THE AREAS SEEDED OUT OF SEASON WILL BE WITHHELD UNTIL SUCH TIME AS THESE REQUIREMENTS HAVE BEEN MET.

SEEDING NOTES:
1. PERMANENT SEED MIXTURE IS RECOMMENDED FOR THIS AREA BY THE BALTIMORE COUNTY SOIL CONSERVATION DISTRICT/MARYLAND AVIATION ADMINISTRATION (BCSCD/MAA) VEGETATIVE ESTABLISHMENT DETAILS AND SPECIFICATIONS FOR PROJECTS WITHIN 3 MILES OF THE MARTIN STATE AIRPORT DOCUMENT, JULY 1, 2004.

WETLAND SEEDING MIXTURE

| SPECIES | APPLICATION RATE (LBS/AC) | SEEDING DATES | SEEDING DEPTHS (INCHES) |
|---|---|---|---|
| FOWL MEADOW GRASS | 83 | 3/01 - 4/20<br>8/01 - 10/20 | 1 |
| CHEWINGS FESCUE | 34 | 3/01 - 4/20<br>8/01 - 10/20 | 1 |
| PERENNIAL RYEGRASS | 14 | 3/01 - 4/20<br>8/01 - 10/20 | 1 |

TEMPORARY SEEDING MIXTURE

| NO. | SPECIES | APPLICATION RATE (LBS/AC) | SEEDING DATES | SEEDING DEPTHS (INCHES) | FERTILIZER RATE (10-10-10) | LIME RATE |
|---|---|---|---|---|---|---|
| 1 | ANNUAL RYEGRASS | 50 | 10/21 - 2/28 | 1/4 - 1/2 | 600 LBS/AC<br>(15 LB/1000 SF) | 2 TONS/AC<br>(100 LB/ 1000 SF) |

PERMANENT SEEDING MIXTURE

| SPECIES | APPLICATION RATE (LBS/AC) | SEEDING DATES | SEEDING DEPTHS (INCHES) | FERTILIZER RATE (10-10-10) | | | LIME RATE |
|---|---|---|---|---|---|---|---|
| | | | | N | P205 | K20 | |
| CERTIFIED TURF-TYPE TALL FESCUE | 192 | 3/01 - 4/20<br>8/01 - 10/20 | 1 | APPLICATION RATES BASED ON SOIL TESTING | | | |
| CERTIFIED KENTUCKY BLUEGRASS | 28 | 3/01 - 4/20<br>8/01 - 10/20 | 1 | | | | |
| PERENNIAL RYEGRASS | 14 | 3/01 - 4/20<br>8/01 - 10/20 | 1 | | | | |

BALTIMORE COUNTY SOIL CONSERVATION DISTRICT
APPROVED FOR SEDIMENT CONTROL

______________________ ______________
DATE

TETRA TECH

C-1
FIGURE 1-2
PROPOSED CONDITIONS

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

BLOCK G SWALE - SEEDING SPECIFICATIONS
INJECTION WELL FIELD - SOUTHWESTERN TCE BIOREMEDIATION AREA
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 3-06-12 |
| PROJECT NO.: | 112IC02948 |
| DESIGNED BY: | YL/CSG |
| DRAWN BY: | YL/SL |
| CHECKED BY: | CSG/YL |
| SHEET: | C-9 |

SEEDING SPECIFICATIONS

# TECHNICAL SPECIFICATIONS

**FOR**

# DESIGN OF SWALE ABANDONMENT AND SUBSURFACE PIPELINE REPLACEMENT, BLOCK G SOUTHWESTERN TCE BIOREMEDIATION AREA Middle River, Maryland

**FOR:**

## LOCKHEED MARTIN CORPORATION

Prepared by:
Tetra Tech, Inc.

May 2012

**LMC Middle River Complex Design of Swale Abandonment and Subsurface Pipeline Replacement, Block G Southwestern TCE Bioremediation Area**

**Specifications Table of Contents (03/21/2012)**


**DIVISION 01 – GENERAL**

01 01 00 Scope of Work

01 02 00 Contractor Work Plan

01 31 00 Project Meetings & Coordination

01 33 00 Submittals

01 35 10 Environmental Protection

01 41 00 Regulatory Requirements

01 42 00 Abbreviations & Definitions

01 45 00 Quality Control

01 50 00 Temporary Facilities

01 55 00 Traffic Control

**DIVISION 02 – EXISTING CONDITIONS**

02 41 00 Demolition and Deconstruction

**DIVISION 03 - CONCRETE**

03 40 00 Pre-Cast Concrete

**DIVISION 31 - EARTHWORK**

31 00 00 Excavation, Backfill, and Compaction

31 00 01 Excavation Support and Protection

31 02 00 Off-site Waste Disposal

31 03 00 Dewatering and Water Control

31 05 19 Geotextiles

31 11 00 General Site Preparation (Clearing and Grubbing)

**DIVISION 32 - EXTERIOR IMPROVEMENTS**


32 11 23 Aggregate and/or Graded-Crushed Aggregate For Roadways

32 12 17 Hot Mix Bituminous Pavement

32 92 19 Seeding, Soil Supplements, and Mulching

32 93 00 Exterior Plants and Landscaping


**DIVISION 33 - UTILITIES**


33 40 00 Storm Drainage Utilities

PART 1. GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall provide all services and materials necessary for the installation of the Block G Swale, Design of Swale Abandonment and Subsurface Pipeline Replacement, located at Southwestern TCE Bioremediation Area, Middle River, Maryland as shown in the Technical Drawings.

1. List of Drawings

a. G-1 Cover Sheet
b. G-2 Notes and Legend
c. C-1 Existing & Demolition Site Plan
d. C-2 Site Layout Plan
e. C-3 Site Grading Plan and Profile
f. C-4 Storm Water Management Details
g. C-5 & 6 Erosion and Sediment Control Plans
h. C-7 & 8 Erosion and Sediment Control Details
i. C-9 Seeding Specifications

B. A Scope of Work is provided as Attachment A of this Section, and is provided to create a uniform Schedule of Values and Measurement of Payment. The Scope is broken down into the following structure:

Section 1: Mobilization and Demobilization
Section 2: Site Preparation and Temporary Facilities
Section 3: Site Work and Restoration

C. The work shall be complete and include furnishing, as applicable or required, all Contractor's safety devices, labor, tool, materials, supplies, and services; and performing all operations necessary for or incidental to a complete project in conformance with the attached Basis of Design Report, Technical Drawings, and Technical Specifications.

D. The Contractor shall furnish all labor, materials, equipment and incidentals to install the above listed systems and equipment, including the piping, wiring, and instrumentation interconnections between all specified components and auxiliary equipment.

E. Contractor shall be responsible for the field erection of materials oversized for shipment.

F. Contractor will provide one (1) year warranty for parts and workmanship, or as specified in the individual part warranties, whichever is greater.

1.2 REFERENCE SPECIFICATIONS

This section refers to all technical specification divisions.

1.3 SUBMITTALS

The Contractor shall submit the following to the Owner for review, comment, and approval prior to pre-construction conference in accordance with Section 01 33 00, "Submittals":

A. Contractor's markup drawings.

B. Product information for any proposed additions or changes per the Contractors markup drawings showing all important details, layout of components, materials of construction and dimensions.

SECTION 01 01 00

ATTACHMENT “A” – SCOPE OF WORK

Section 1: Mobilization and Demobilization

Mobilization and Demobilization consists of the following construction components:

1. Provide and Execute, the Contractor Work Plan, including Project Close-out.

2. Execute the Health and Safety Plan including quality control, spill control, health and safety, traffic control, and site security.

3. Provide permits, bonds, warranties, fees, insurance, and other similar expenses required by the contract.

4. Mobilization and Demobilization of all equipment, tools, materials, supplies, temporary facilities and utilities, and personnel required to perform the work.

5. Compliance with all regulatory requirements.

6. Pre-construction and construction period planning, management, scheduling, submittals, reporting, project closeout, administration and documentation.

7. Close out the project per the Contractor Work Plan, Health and Safety Plan, and Division 1 Specifications, including permits, and record drawings

8. All other requirements and miscellaneous items not included in other pay items.

Section 2: Site Preparation and Temporary Facilities

Site Preparation and Temporary Facilities consist of the following construction components:

1. Execute the Erosion and Sedimentation Control Plan, and provide and execute a Dewatering Plan

2. Stake-out limits of construction locations and other important features such as proposed swale centerline, storm sewer pipe and outlet structure locations

3. Post project and safety signs, tree protection fencing, flagging, and other access restrictions

4. Layout and construct the construction laydown area including stabilized construction entrance.

5. Set up the contractor’s office (trailer with power and telephone connections if necessary).

6. Abandon/cap existing domestic water line as shown on the Technical Drawings.

7. Remove concrete foundation area as shown on the Technical Drawings.

Section 3: Site Work and Restoration

The Site Work and Restoration consist of the following components:

1. Furnish all earthwork, including proposed Block G swale excavation and site re-grading, as shown in the Technical Drawings and as described in the design report and technical specifications. This includes modifying the existing stormwater systems to be disturbed and constructing the new stormwater system.

2. Furnish all proposed exterior improvements such as seeding and sodding (topsoil) and landscaping per the technical drawings and specifications.

3. Repair or replace asphalt, concrete, fence, grass, trees, decorative planting, or other permanent site features that were disrupted during construction to visual acceptance or otherwise working condition.

4. Remove all remaining erosion and sediment control, dewatering, and temporary features once the site is stabilized.

5. Close out Erosion and Sediment Control Plan and Dewatering Plan as part of Project Closeout.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The contractor shall provide a Work Plan (WP) a minimum of 10 days prior to the issuance of the Notice to Proceed. The WP shall identify project personnel and organization, equipment, material, instructions, records, forms, construction procedures, and schedule to be used and followed in performing the work in compliance with the Project Manual of this project.

## 1.2. RELATED SECTIONS

01 33 00 Submittals

## 1.3. CONTENTS OF THE WORK PLAN

The WP shall outline the overall construction sequencing and procedures to be followed during the site work activities. The plan shall contain a thorough and concise summary of how the work will be accomplished and shall include at a minimum:

A. Contractor's technical approach including work sequence, major milestones, health and safety, and general work procedures.

B. Construction Project Organization Chart showing lines of authority and responsibility. Number of personnel to be utilized on the job should be indicated in appropriate organizational elements. If significant changes in the organization are expected to occur during the life of the project or phases of construction, these should be discussed. Necessary substitutions, due to change of employment status and other unforeseen circumstances, must be submitted in writing for approval by the Owner prior to conducting work.

C. Names, qualifications, and work experience of all contractor supervisors, health and safety personnel, and employees with quality control responsibilities. If the personnel identified in the WP are not available at the start of the project, the Contractor shall submit, prior to mobilization, the names and qualifications of substitute personnel, with equal or more extensive experience, to the Owner Field Representative for approval.

D. Equipment to be utilized for the site activities.

E. Discussion of regulatory requirements applicable to the project and how compliance will be assured. Personnel training requirements should be listed and compliance demonstrated.

F. Proof of Contractors' permits required to successfully complete this Contract.

G. Procedures for scheduling and managing submittals. The schedule should identify the work tasks and completion date, and show the critical path to completion. The schedule should be prepared using Microsoft Project, or approved equivalent, and will be updated and submitted to the Owner every two weeks.

H. Provide names of personnel trained in spill control and list dedicated equipment to be provided on-site.

I. A description of provisions for controlling erosion, diverting surface run-off from excavations, and dewatering including pumping, if necessary.

J. Reporting procedures, including proposed reporting format.

K. Identification of proposed waste disposal facilities that are approved by the Owner.

L. An Air Monitoring Plan, containing at minimum:

a. A list of the air quality parameters to be sampled and the methods to be used for sampling. At minimum, the sampling should include Real Time Dust (RTD), Particulate Matter, Lead, Polyaromatic Hydrocarbons (PAHs), and Mercury Vapor;
b. Copies of the Standard Operation Procedures, equipment list, equipment manuals, and forms to be used for the monitoring;
c. The proposed monitoring locations, including a map showing the locations;
d. The duration and frequency of monitoring;
e. Methodology for compensating for meteorological conditions; and
f. The Quality Assurance/Quality Control methodology to be used.

M. A Health and Safety Plan (HASP), meeting at minimum the requirement of the Occupational Safety and Health Administration requirements for the type of work to be performed and the requirements of the Owner. At minimum, the HASP must include:

a. An emergency action plan, which includes the procedures for response to an accident, the location of the nearest emergency facilities, and emergency numbers;
b. A list of personal protective equipment to be used for each task;
c. A site history;
d. A description of the scope of work to be performed;
e. Task specific hazards and safe work practices associated with these tasks;
f. A list of potential chemical hazards, and the appropriate controls;
g. A monitoring plan, as needed, for the hazards;
h. A site control plan;
i. A spill containment plan;
j. A list of the site specific training and medical monitoring requirements, including the information for every individual working on-site; and
k. All other pertinent information as required by federal, state, local, and Owner requirements.

1.4. NOTIFICATION OF CHANGE

After submittal of the WP, the contractor shall notify the Owner in writing, on a prescribed form, of any proposed change. At a minimum, the Contractor shall state the date and time of the submission of the form, the detailed description of the proposed change, the technical merit of the proposed change, the methods to implement the proposed change, the impact of the proposed change on other units or operations, the cost and schedule to implement the proposed change, and the person(s) of the Contractor and/or its subcontractor(s) who have proposed the change and will be responsible to implement the change.

1.5. SUBMITTALS

The Contractor shall submit the following to the Owner for approval in accordance with Section 01 33 00, “Submittals”:

A. Work plan, including Health and Safety Plan and Air Monitoring Plan.

B. Copies of Daily Log pages.

1.6. PROJECT ORGANIZATION

A. Site Manager

1. The Contractor shall designate a Site Manager, who shall be responsible for overall management of the WP and have the authority to act on behalf of the Contractor.

2. The Site Manager for this Contract shall be an individual experienced in hazardous materials remediation whose responsibility is to insure compliance with the Contract plans and specifications.

3. The Site Manager shall be on-site whenever work is in progress.

B. Personnel

1. A staff shall be maintained under the direction of the Site Manager to perform all project activities.

2. The personnel shall be fully qualified, by experience and technical training, to perform their assigned responsibilities and shall be hired directly by and work for the Contractor and its subcontractors.

1.7. CONTROL

The WP is the means by which the Contractor and the Owner are assured that the construction complies with the requirements of the Contract Drawings and Technical Specifications. The plan shall be adequate to cover all construction operations.

1.8. DOCUMENTATION

A. The Contractor shall maintain a daily log of work activities, including the work of suppliers and subcontractors. This log shall be in an acceptable form and indicate a description of trades working on the project, the number of personnel working, the weather conditions and delays encountered, and acknowledgement of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, the log shall include factual evidence that required activities have been performed, including, but not limited to, the following:

1. Type, number, and progress of activities.

2. All documentation and submittals that are required for the current activities.

3. Nature of defects, causes for rejection, etc.

4. Proposed remedial action.

5. Corrective actions taken.

6. Any proposed change(s) that are outstanding.

7. Schedule of current activities and upcoming activities within the next week.

B. The Log shall cover both conforming and defective or deficient features, and shall include a statement that supplies and materials incorporated in the work comply with the Contract. Legible copies of the log shall be furnished daily to the Owner's Representative. The Contractor shall keep records of the pre-final and final inspections, including a "punch list" of items which do not conform to the approved plans and specifications. For each item on this list, the Contractor shall document corrective actions taken.

1.9. NOTIFICATION OF NON-COMPLIANCE

The Owner will provide written notification to the Contractor of any non-compliance with the foregoing requirements. After receipt of such notice, the contractor shall immediately take corrective action. If the contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. GENERAL

The Contractor shall perform all work related activities in compliance with the WP.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Contractor is responsible for coordinating and communicating project activities with the Owner, and all lower tier subcontractors or other parties, including utility companies, as designated by the Owner.

This Section covers the requirements for the Pre-Construction Conference, Pre-Work Conference, and progress meetings. Also provided is a suggested agenda for the progress meetings.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 02 00 | Contractor Work Plan |
| 01 33 00 | Submittals |
| 01 45 00 | Quality Control |

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Sample Daily Progress Summary.

B. Sample Weekly Site Safety Summary.

C. Summary of Contractor’s Quality Control Plan.

D. Agenda for Progress Meetings.

E. Meeting Minutes from the Progress Meetings.

# PART 2. PRODUCTS

## 2.1. GENERAL

A. The choice of quantity and type of labor, materials, and construction equipment shall be at the discretion of the Contractor, but must be available in the quality and quantity to perform the work as specified in the Contract and schedule.

B. The Contractor shall furnish equipment which will be efficient and appropriate to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the project schedule. If at any time such equipment appears to the Owner to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Owner may order the Contractor to increase the efficiency, change the character, or increase the equipment, and the Contractor shall conform to such order. Failure by the Owner to give such an order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

PART 3. EXECUTION

3.1. GENERAL PROCEDURES

A. Prior to beginning work the Contractor shall meet with the Owner and arrange the schedule for the project. Once the project is started, it shall be carried to completion without delay.

B. Phasing of work shall be clearly established and verified with the Owner prior to commencing work in any area. No cutting or removal work shall begin until authorized by the Owner.

C. Any utility service interruptions or outages required by the Contractor in performing the work shall be prearranged and shall occur only during those scheduled times.

3.2. PRE-CONSTRUCTION CONFERENCE

A. The Contractor shall meet with the Owner after the Award of Contract, but prior to the Notice to Proceed, to review and discuss submittal, safety, payrolls, labor relations, environmental protection, progress schedules, payment, and procurement of materials. The principle features of work shall also be reviewed and any questions regarding the contract and the work site will be addressed.

B. After this meeting but prior to the Pre-work Conference, the Contractor shall submit the Work Plan (WP) and Health and Safety Plan (HASP) to the Owner for review. The Contractor will also submit samples of the daily progress summary and the weekly site safety summary, and a brief summary of the Contractor's Quality Control Plan for review by the Owner prior to the Pre-work conference. The Contractor shall submit all required submittals to the Owner within ten (10) working days after the Pre-construction Conference.

C. The contractor must coordinate site work with the Owner, including, but not limited to, work hours, access, traffic controls, and security. Initial planning for the coordination should be discussed prior to the Pre-work Conference.

3.3. PRE-WORK CONFERENCE

A. After the Notice to Proceed has been issued and just prior to the mobilization to the site and commencement of work, the Contractor shall meet with the Owner on-site, ready to begin work. Attendance by the Contractor's superintendent, quality control personnel, safety personnel, and any major subcontractor's job superintendents will be required.

B. The purpose of the meeting is to define the Contractor's Quality Control Plan, to thoroughly review the WP, and to develop a mutual understanding of the specific requirements established by the contract. The specifics of the Contractor's HASP will be discussed so that the emergency and safety requirements are understood by all of those directly related to the site work. The schedule of work, particularly for the initial start-up period, will also be discussed. Questions concerning the administrative requirements outlined during the Pre-construction Conference or any other aspect of the project may also be addressed.

3.4. PROGRESS MEETINGS

A. The Contractor shall schedule progress meetings at a minimum of once per week. The

Contractor will administer the progress meetings by preparing the agenda, preparing and distributing the minutes, and presiding at all meetings.

B. In attendance shall be the Contractor's Superintendent, Quality Control Supervisor, and Safety and Emergency Response Coordinator; any Subcontractors or Suppliers, as appropriate to the agenda; and others as appropriate.

C. Suggested agenda for the progress meeting(s) include, but are not limited to:

1. Review of work progress since the previous meeting.
2. Field observations, problems, and conflicts.
3. Problems which impede the project schedule and proposed corrective actions.
4. Review of off-site delivery schedule.
5. Corrective measures and procedures to regain projected schedule.
6. Updates to the project schedule.
7. Progress intended for the subsequent two weeks work period
8. Coordination of schedules.
9. Review submittal schedule.
10. Maintenance of quality and safety standards.
11. Pending changes and substitutions.
12. Review proposal changes for effect on project schedule and on completion date.
13. Any other applicable business.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Contractor shall provide timely four (4) sets, unless otherwise directed, of the submittals required by this Section for review, comment, and approval, as required or deemed necessary by the Owner.

## 1.2. RELATED SECTIONS

Related sections are listed in the attached Submittal Table.

## 1.3. SUMMARY OF SUBMITTALS

The submittals which the Contractor is required to provide include, but are not limited to, those summarized on the Submittal Table. The submission dates represent the minimum number of working days for prior to, and maximum number of working days for after, the referenced bench mark dates.

## 1.4. SHOP DRAWINGS, MANUFACTURER'S PRODUCT DATA, AND SAMPLES

A. Shop Drawings

1. Engineering data covering all equipment and fabricated materials that will become a permanent part of the work under this Contract shall be submitted for review. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation drawings, scheduled information, setting diagrams, actual shop-work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection, and test reports including performance curves and certifications, manufacturer's certificates, as applicable to the work.

2. To aid in expediting the project, shop drawings submitted by the Contractor's Subcontractors (i.e., Supplier, Manufacturer, etc.) for review shall be sent directly to both the Contractor and the Owner for preliminary checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.

3. The Contractor shall check all of his Subcontractors' shop drawings regarding measurements, size of members, materials, and details to satisfy themselves that they conform to the intent of the Contract Drawings and Technical Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the Subcontractor for correction before final submission to the Owner.

4. Each final submittal shall have affixed to it the following Certification Statement, signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data and I have checked and coordinated each item with other applicable reviewed shop drawings and all Contract requirements."

5. All deviations from the Contract Drawings or Technical Specifications shall be identified on each submittal and will be tabulated in the Contractor's letter of transmittal. Such submittal shall, as pertinent to the deviations, indicate essential details for all changes proposed by the Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

6. Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

7. Submittals shall be sequentially numbered, with re-submittals of the same or supplementary information numbered with the original submittal number and a "-Revision 1" for the second submittal, "-Revision 2" for the third submittal, and so forth.

B. Manufacturer’s Product Data

1. Manufacturer’s Product Data, as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliances and applicability, roughing in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

2. Manufacturer’s product data shall also include, if requested by the Owner, items of disposable clothing, safety equipment, breathing apparatus, communication devices, items of equipment to be used on the site, and any other items which are required for the safety and health of all personnel on the site. This information shall be submitted to the Owner's Site Representative to verify that the requirements for materials have been met. This information shall be required for, at a minimum, the concrete mix, crushed stone, seed mixture, gratings, and concrete manholes.

C. Samples

Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, and units of work to be used by the Owner for independent inspection and testing, as applicable to the work.

D. Submission Requirements

1. Coordination of Submittal Items

Prepare and transmit each submittal within the time specified in the individual work sections of the Specifications, so that the installation will not be delayed by processing times including revision and re-submittal (if required), coordination with

other submittals, testing, purchasing, fabrication, delivery, and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the work.

2. Number of Submittals Required

   a. Shop drawings: Submit four (4) copies.
   b. Manufacturer's Product Data: Submit four (4) copies.
   c. Samples: Submit four (4) pieces or the number stated in the respective Specification Sections or as directed by the Owner.
   d. All other submittals: Submit four (4) copies or pieces, unless stated elsewhere in the Technical Specification or as directed by the Owner.

3. All submittals, regardless of origin, shall have the following identification data, as applicable, contained thereon or permanently adhered thereto:

   a. Date of submission and dates of any previous submissions.
   b. Project Name and Contract Number.
   c. Contractor's name and address.
   d. Supplier's name and address.
   e. Manufacturer's name and address.
   f. Submittal or re-submittal number.
   g. Title or identification of submittal.
   h. References to applicable Section and part of the Technical Specification paragraphs or to applicable Contract Drawings.
   i. Contractor's Certification Statement.
   j. Deviations from Contract Documents, to be adequately stated.

E. Resubmission Requirements

Make any corrections or changes in the submittals required by the Owner and resubmit until approved.

F. Review of Shop Drawings, Manufacturer's Product Data, and Samples.

1. After review by the Owner, shop drawings, manufacturer's product data, and samples will be returned to the Contractor denoted with the following classifications:

   a. Approved.
   b. Approved except as noted. Re-submittal not necessary.
   c. Approved except as noted. Re-submittal necessary.
   d. Disapproved. Re-submittal necessary.
   e. Receipt acknowledged.
   f. Submittal not required.

2. Re-submittals will indicate any changes that have been made in addition to those requested by the Owner.

3. No portion of the work requiring a shop drawing, manufacturer's product data, or sample shall be commenced nor shall any material be fabricated or installed prior to review of that shop drawing, manufacturer's product data, or sample by the Owner and the submittal returned to the Contractor denoted "APPROVED" or

"APPROVED AS NOTED, RE-SUBMITTAL NOT NECESSARY". The Owner will not be responsible for any expense or delay due to Contractor's corrections or remedies required to accomplish conformity.

4. Any need for more than one re-submission, or other delay in obtaining Owner's review of submittals, will not entitle Contractor to a schedule extension.

5. It may be expected that the Owner will review and return submittals to the Contractor within seven (7) working days of their receipt by Owner.

G. Distribution

Distribute reproduction of shop drawings, manufacturer's product data, and samples returned to the Contractor marked "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT REQUIRED," where required, to the job site file and elsewhere as directed by the Owner.

1.5. CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall photographically record progress of construction on a biweekly basis and provide 3-1/2 inch x 5-inch glossy photographs and negatives.

B. Each photographic print shall have attached to the backing a label, approximately 4 inches wide by 2 inches high containing thereon in typed lettering:

1. Project name and Contract number.
2. Contractor's name.
3. Photographer's name.
4. Photographer's numbered identification of exposure.
5. Date and time of exposure.
6. Orientation of view.
7. Short description of view.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. GENERAL

The Contractor shall timely present all submittals in accordance with this Section.

| SUBMITTAL TABLE | | | |
|---|---|---|---|
| **SECTION** | **TITLE** | **LIST OF SUBMITTAL** | **SUBMISSION DATE** |
| 01 01 00 | Scope of Work | • Contractor's Markup Drawings<br>• Product information | • Prior to pre-work conference |
| 01 02 00 | Contractor Work Plan | • Contractor Work Plan<br>• Health and Safety Plan<br>• Air Monitoring Plan | • A minimum of 10 days prior to the issuance of the Notice to Proceed |
| 01 31 00 | Project Meetings & Coordination | • Sample Daily Progress Summary<br>• Sample Weekly Site Safety Summary<br>• Summary of Contractor's Quality Control Plan<br>• Agenda for Progress Meetings<br>• Meeting Minutes from the Progress Meetings | • Prior to the pre-work conference<br><br><br>• Weekly |
| 01 35 10 | Environmental Protection | • Erosion and Sediment Control Plan Modifications<br>• Spill Report<br>• Spill Control Plan | • Prior to pre-work conference<br>• Immediately upon the occurrence<br>• Prior to pre-work conference |
| 01 41 00 | Regulatory Requirements | • Grading Permit & Notifications<br>• Erosion and Sediment Control Permit | • Prior to pre-work conference |
| 01 45 00 | Quality Control | • Quality Control Plan<br>• Quality Control Project Summary Report | • Prior to pre-work conference<br>• Within 30 days of the final compliance inspection |
| 01 50 00 | Temporary Facilities | • Proposed temporary facilities information | • Prior to pre-work conference |
| 02 41 00 | Demolition & Deconstruction | • Preconstruction Submittals:<br>1. Existing Conditions Records & Survey Results<br>2. Certificates & Notification to Federal, State, Regional, & Local authorities, and the Owner<br>• Closeout Submittals; Receipts | • 10 days prior to commencement of work<br><br><br><br>• Within 30 days after the final compliance inspection |
| 03 40 00 | Pre-Cast Concrete | • Pre-cast Concrete Units: Shop Drawings, Design Details of Steel Reinforcement Size and Placement, Supporting Design Calculations, Manufacturer's Certificate<br>• Product Data including embedded items: trash rack, frame and cover, etc.<br>• Design Data and Test Reports | • Prior to pre-work conference<br><br><br><br>• At the time of delivery |

| | | | |
|---|---|---|---|
| 31 00 00 | Excavation, Backfill, & Compaction | • Product Data<br>• Laboratory Test Data<br>• Field Density Test Results | • At time of delivery<br><br>• Daily |
| 31 00 01 | Excavation, Support, & Protection | • Shop Drawings | • Prior to pre-work conference |
| 31 02 00 | Off-site Waste Disposal | • Name, Qualifications, and State Identification Numbers of the Proposed Off-site Waste Transportation<br>• Name, Location, Qualifications, and State Identification Number of the Proposed Off-site Disposal Facility.<br>• Shipment Manifests<br>• Certificate of Disposal<br><br>• Sampling and Analysis Plan | • Prior to pre-work conference<br><br><br><br>• Prior to any shipment of waste leaving the site<br>• Upon receiving receipt from off-site disposal facility<br>• Prior to pre-work conference |
| 31 03 00 | Dewatering & Water Control | • Dewatering Plan<br>• Field QC Reports and Photographs | • Prior to pre-work conference<br>• Weekly |
| 31 05 19 | Geotextiles | • Product Data Sheet | • Prior to pre-work conference |
| 32 11 23 | Aggregate &/or Graded-Crushed Aggregate for Roadways | • Product Data<br>• Test Reports | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 12 17 | Hot Mix Bituminous Pavement | • Product Data<br>• Laboratory Test Data | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 92 19 | Seeding, Soil Supplements, & Mulching | • Product Data<br>• Laboratory Test Data | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 93 00 | Exterior Plants & Landscaping | • Product Data | • At time of delivery to site |

| | | | |
|---|---|---|---|
| 33 40 00 | Storm Drainage Utilities | • Shop Drawings<br>• Product Data<br>• Core-drill Method and Equipment<br>• As-built drawings | • Prior to pre-work conference<br><br>• Within 30 days of final compliance inspection |

END OF SECTION

# PART 1. GENERAL

## 1.1 SCOPE OF WORK

A. This Section describes the work required by the Contractor for the protection of the environment throughout the course of the project, except for those measures specifically set forth in other sections of these Specifications. Compliance with the provisions of this section by lower-tier subcontractors will be the responsibility of the Contractor. Items to be considered under this section are air, water, and land resources and shall include noise, equipment fuel management, land resource management, and management of other chemicals.

B. This section also details the requirements the Contractor and lower-tier contractors must follow regarding spill control procedures to be followed during completion of this project.

## 1.2 RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |

## 1.3 DEFINITIONS

Environmental protection shall be defined as the retention of the environment in its natural state, to the greatest extent possible, during the project implementation, and the enhancement of the natural appearance in its final condition.

## 1.4 SUBMITTALS

A. Should the Erosion and Sediment Control Plan (E&SCP) require a modification due to field conditions, the Contractor shall submit two copies of the proposed modifications to the E&SCP to the Owner for approval in accordance with Section 01 33 00, “Submittals”.

B. Submit a spill report to the Owner immediately after the occurrence of such spill in accordance with Section 01 33 00, “Submittals”.

C. A spill control plan shall be submitted under this section with the Site-Specific Health and Safety Plan.

# PART 2. PRODUCTS

The Contractor shall provide all labor, equipment, and materials necessary for environmental protection that could arise as a result of Contractor activities or conditions during the course of this project.

PART 3. EXECUTION

3.1 GENERAL

The Contractor shall be responsible for complying with all applicable federal, state, and local laws concerning the prevention, abatement, and control of all environmental pollution arising from the project activities in accordance with Section 01 41 00, “Regulatory Requirements”.

3.2 PROTECTION OF LAND RESOURCES

A. The Contractor shall confine project activities to work areas designated by the Owner and/or construction oversight firm, and, at all times, perform work in a manner that minimizes the interference with or the disturbance to fish, wildlife, and vegetation.

B. The Contractor shall implement measures to prevent lubricants, chemicals, and fuels from entering natural land features.

3.3 BURNING

Under no circumstances shall the burning of debris or waste materials be conducted at the site.

3.4 SPILL CONTROL

A. Contractor shall ensure that all tanks containing hazardous materials which are required to complete the activities presented herein are located on-site such that any spill would be confined/contained.

B. The Contractor shall follow appropriate federal, state, and local regulations applicable and/or relevant to spill control in accordance with Section 01 41 00, “Regulatory Requirements”.

C. The Contractor shall immediately report all hazardous materials spills to the Owner.

D. The Contractor shall be responsible for the timely cleanup of all hazardous materials spills and affected media, including the provision of all labor, equipment, and materials necessary for the cleanup. Cleanup of affected areas shall be subject to approval by the Owner.

3.5 TEMPORARY CONTROLS

A. All construction machinery and vehicles shall be equipped with practical sound-muffling devices and operated in a manner to cause the least noise, consistent with efficient performance of work. In addition, in order to minimize noise disturbances, the operation of machinery and large vehicles shall be confined to the hours of 8:00 a.m. to 7:00 p.m. Monday through Friday.

B. The Contractor shall maintain all excavations, stockpiles, access roads, waste areas, and all other areas free from dust to such a degree as to avoid causing a hazard or nuisance. Earth surfaces subject to dusting may be kept moist with water or dust may be controlled by other measures, if approved by Owner. Dusty materials in piles or in transit shall be covered to prevent blowing. The Contractor will maintain a mobile water tank complete with spray bar and pump on-site, if dust control is to be performed by water sprinkling.

C. The Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be

adequate to prevent damage to the work, the site, and adjacent property.

D. Erosion and Sediment Control

1. The Contractor shall use the Erosion and Sediment Control measures specified on the technical drawings as the Erosion and Sediment Control Plan (E&SCP), and shall specify additional applicable erosion and sediment control measures and Best Management Practices (BMPs) in accordance with the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control (MDE, 2011) The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations.

2. The Contractor shall obtain an approval of the Erosion and Sediment Control Plan and a Grading Permit through Baltimore County if required.

3. The Contractor shall use the Erosion and Sediment Control measures to control adverse effects from erosion and sedimentation during construction activities.

4. The Contractor shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. The Contractor shall design, construct, and maintain, as a minimum, the erosion control BMPs specified in the E&SCP. Protective erosion control measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations that will disturb the natural protection.

5. The Contractor shall construct or install temporary and permanent erosion and sediment control, as indicated on the drawings. BMPs may include, but not be limited to, vegetation cover, slope stabilization, silt fences, construction of terraces, interceptor channels, inlet and outfall protection, and diversion channels.

6. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and to maintain natural vegetation to the greatest extent possible. Any temporary measures shall be removed after the area has been stabilized.

3.6 NOTIFICATION OF NON-COMPLIANCE

Failure of the Owner to notify the Contractor of non-compliance does not relieve the Contractor of responsibility of compliance with the aforementioned federal, state, or local laws or regulations. In the event the Owner issues such a notice, the Contractor shall immediately inform the Owner of the proposed corrective action(s) and take such action(s) as may be appropriate. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost because of any such stop orders shall be made the subject of a claim for extension of time, or for excess costs or damages by the Contractor.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

The Contractor shall comply with all applicable federal, state, and local laws, ordinances, rules and regulations. The Contractor shall comply with all authorities having jurisdiction over the work. The list of regulations provided in this specification does not necessarily include all regulations which may be applicable to site activities and off-site transportation and disposal. All necessary permits or certificates of inspection shall be paid for and obtained by the Contractor.

1.2. REFERENCES

The following references are part of this specification to the extent referenced. These publications shall be the latest edition and are referred in the text by the basic designation only:

FEDERAL LAWS

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation and Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 94-469 | Toxic Substance Control Act (TSCA) of 1976, as amended |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 40 CFR 260 | Hazardous Waste Management Systems, General |
| 40 CFR 261 | Identification and Listing of Hazardous Wastes |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Wastes |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Wastes |
| 40 CFR 264 | Standards for Hazardous Wastes TSDF Owners and Operators |
| 40 CFR 265 | Interim Standards for Hazardous Wastes TSDF Owners and Operators |
| 40 CFR 270 | Hazardous Waste Permits Program |
| 49 CFR 172 | Hazardous Materials |
| 49 CFR 173 | General Shipment Requirements |
| 49 CFR 174-77 | Transporter Requirements |

| | |
|---|---|
| 49 CFR 178-79 | Container Specifications |

STATE OF MARYLAND LAWS

Annotated Code of Maryland, Environmental (Consolidated)
Annotated Code of Maryland, Health (Consolidated)

STATE OF MARYLAND REGULATIONS

| | |
|---|---|
| Title 09 | Department of Labor, Licensing, and Regulation |
| Title 10 | Department of Health and Mental Hygiene |
| Title 26 | Department of the Environment |

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1 FEDERAL REGULATIONS

A. Conduct all site work in accordance with PL 91-596 and 29 CFR 1910.120, including hazardous waste cleanup or chemical spills.

B. Identify all hazardous wastes in accordance with PL 94-850/98-616 and 40 CFR 261.

C. Manage all hazardous wastes in accordance with PL 94-850/98-616, 40 CFR 260, and 40 CFR 262.

D. Transport all hazardous wastes in accordance with PL94-850/98-616, 40 CFR 263, and 49 CFR 172 through 49 CFR 179.

E. Dispose of all hazardous wastes at off-site facilities which are in compliance with PL 94-850/98-616, 40 CFR 264, 40 CFR 265, and 40 CFR 270.

3.2 STATE REGULATIONS

A. All Contractor activities within the State of Maryland boundaries shall be in compliance with Maryland State labor laws.

B. Transportation and disposal of non-hazardous wastes must comply with the Maryland State Regulations.

C. Transportation of wastes through states other than Maryland shall be in compliance with all applicable requirements of those states.

D. Hazardous waste treatment and disposal facilities shall be in compliance with all requirements of the state in which they are operated.

3.3 LOCAL REQUIREMENTS

Ascertain and comply with all applicable county and municipal ordinances, codes, rules and regulations, and obtain all required permits including public health requirements, and seasonal load limits which may be imposed to cover transportation on certain roads. It is required to obtain a Grading Permit from Baltimore County, and Contractor shall adhere to the requirements of the permit.

END OF SECTION

PART 1. GENERAL

1.1. ABBREVIATIONS

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| AFBMA | Anti-Friction Bearing Manufactures Association |
| ANSI | American National Standards Institute |
| ARAR | Applicable or Relevant and Appropriate Requirements |
| ASTM | American Society for Testing and Materials |
| cfm | Cubic feet per minute |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CRSI | Concrete Reinforcing Steel Institute |
| DOT | Department of Transportation |
| EPA | United States Environmental Protection Agency |
| gpd | gallons per day |
| gpm | gallons per minute |
| HASP | Health and Safety Plan |
| HVAC | Heating, Ventilating, Air Conditioning |
| LMC | Lockheed Martin Corporation |
| MCL | Maximum Contaminant Level |
| MDE | Maryland Department of the Environment |
| MDTA | Maryland Transportation Authority |
| MRC | Middle River Complex |
| MVA | Motor Vehicle Administration |
| NCP | National Contingency Plan |
| NFPA | National Fire Protection Association |
| NIOSH | National Institute of Occupational Safety and Health |
| NPDES | National Pollution Discharge Elimination System |
| ODS | Operational Data Store |
| OSHA | Occupational Safety and Health Administration |
| PCA | Portland Cement Association |
| PPE | Personal Protective Equipment |
| psi | Pounds per Square Inch |
| psig | Pounds per Square Inch Gauge |
| QA | Quality Assurance |
| QC | Quality Control |
| QCP | Quality Control Plan |
| RCRA | Resource Conservation and Recovery Act of 1976, as amended |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SHA | State Highway Administration |
| SSPC | Steel Structure Painting Council |
| TSCA | Toxic Substances Control Act of 1976, as amended |
| TSDF | Treatment, Storage, and Disposal Facility |
| TSP | Total Suspended Particulates |
| USDH | United States Department of Health and Human Services |
| USDOT | United States Department of Transportation |
| USEPA | United States Environmental Protection Agency |
| WP | Work Plan |

1.2. DEFINITIONS

A. Completion of Work – Completion of all required on-site activities.

B. Construction Documents – Documents pertaining to the completion of the project, including Technical Drawings and Specifications.

C. Contractor – The entity entering into the Contract with Owner to perform the work described in the Contract Documents.

D. Decontamination Area – Areas constructed by the Contractor, Materials, equipment, and personnel shall receive decontamination or cleaning in these areas.

E. Decontamination (equipment) – A thorough rinsing of the equipment with a high-pressure steam sprayer to remove all surface contamination.

F. Decontamination (personnel) – This encompasses the procedure for performing proper decontamination. This item is detailed in the HASP.

G. Design Engineer – The engineer preparing the Technical Drawings and Technical Specifications.

H. Hazardous Waste – A material that has been sampled, analyzed, and meets the RCRA definition of a hazardous waste.

I. Managing Contractor – The entity who is the Owner's representative for the design and construction of the project.

J. Manufacturer – The entity actually supplying any equipment or material component for one or more of the items of the project.

K. Manufacturer's Representative – Person designated by the manufacturer to coordinate the supply and installation of equipment.

L. Non-Hazardous Waste – A material which has been sampled, analyzed, and exceeds the Owner Type B cleanup criteria, but does not satisfy the RCRA definition of hazardous waste.

M. Owner – Lockheed Martin Corporation, who will be represented by its Design Engineer and its Managing Contractor.

N. Product – Materials, systems, and equipment.

O. Project Manager – Lockheed Martin Corporation technical lead.

P. Project Manual – The compilation of documents which govern the work to be performed which includes instructions to Offerors, Contract Forms, Contract Conditions, Technical Specifications, and Contract Drawings.

Q. Provide – To furnish and install in place.

R. Shop Drawings – Equipment specific drawings prepared by Manufacturer and showing all necessary equipment fabrication data.

S. Site – Block G, Lockheed Martin Middle River Complex as shown in the Construction Documents.

T. Site Manager – Contractor's Field Representative who has the overall responsibility to manage and execute the work in accordance with the Project Manual and subsequent amendments.

U. Supplier – The entity actually supplying one or more equipment items.

V. Support Plans – Documents required for the start of work as outlined in the Technical Specifications including, but not limited to, the WP, QCP, and HASP.

W. Technical Drawings – These drawings prepared by the Engineer showing the design of the swale relocation and construction of the project.

X. Technical Specifications – Specifications prepared by the Design Engineer for the Contractor.

Y. Treatment, Storage, and Disposal Facility – A licensed Type I, II, or III treatment, storage, and disposal facility

Z. Work – All engineering, labor equipment, and material required to design, procure, and install a complete storm sewer system and grading as specified herein.

AA. Work Area – The area in which the Contractor can work and perform construction activities. The Contractor shall not go outside of this area without prior approval of Owner.

1.3. NOTE

Due to the nature of the work and the type of equipment required, it is possible and acceptable, that the same entity be at once Contractor, Supplier, and Manufacturer or any combination thereof.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION – NOT APPLICABLE

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This section describes the minimum requirements the Contractor shall address and abide by with respect to quality control.

## 1.2. RELATED SECTIONS

A. 01 33 00 Submittals

B. Division 1 Sections for project management and coordination.

C. All other Division Sections for specific test and inspection requirements.

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Quality Control Plan

Submit a Quality Control Plan detailing the quality control organization and procedures to be used during the project. The Quality Control Plan should be prepared for general construction only.

B. Quality Control Project Summary Report

Submit a Quality Control Project Summary Report that will summarize the overall quality of the data obtained and the work completed during the project. This report shall be submitted within 30 days after the final compliance inspection.

# PART 2. PRODUCTS – NOT APPLICABLE

# PART 3. EXECUTION

## 3.1 QUALITY CONTROL PROCEDURES

Through quality control (QC) procedures, the Contractor assures the Owner that the Contractor and all lower-tier contractors comply with the requirements of the specifications presented herein. The controls shall be adequate to cover all contract operations. The quality of all work shall be the responsibility of the Contractor. Sufficient inspections and tests of all items of work, including that of lower-tier contractors, shall be performed on a continuing basis to ensure conformance with respect to the quality of work. The Contractor shall furnish qualified personnel, appropriate facilities, instruments and testing devices necessary for the performance of the QC function. The controls shall be adequate to cover all operations both on and off-site, keyed to the proposed work sequence, and correlated by the Contractor's QC personnel.

## 3.2 QUALITY CONTROL RECORDS

The Contractor shall maintain up-to-date records of QC operations, activities, and tests performed. These records shall include the work of suppliers and lower-tier contractors. The records shall cover both conforming and defective or deficient features.

## 3.3 INSPECTIONS

A. After the substantial completion of work, the Contractor, in conjunction with the Owner, shall conduct a completion inspection of the work and develop a list of any items that do not conform to the approved specifications presented herein. Such a list shall include the estimated date by which the deficiencies will be corrected. The substantial completion inspection and any deficiency correction required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment thereof. The Contractor shall keep records of the inspection, including the list of deficiency items. For each item on this list, the Contractor shall document the corrective actions taken.

B. Following corrective action measures, the Contractor, in conjunction with the Owner, shall make a final completion inspection to ascertain that all deficiencies have been corrected.

## 3.4 QUALITY CONTROL PROJECT SUMMARY REPORT

Within 30 days of completion of the final compliance inspection, the Contractor shall submit to the Owner a Contractor Quality Control Project Summary Report. This report will summarize and state the overall quality of data obtained (where applicable) and work completed during the project. The report will certify the acceptability of data and work based on the QA/QC requirements defined in the Contractor quality control plan.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This section describes the provision, layout, installation, maintenance, and removal of all Contractor temporary facilities and utilities necessary to complete the project work tasks.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 02 41 00 | Demolition and Deconstruction |

## 1.3. SUBMITTALS

Submit in accordance with Section 01 33 00, “Submittals”, information on all proposed temporary facilities to be used on-site including, but not limited to, a layout sketch of the laydown area, size of the facility, anticipated duration on-site, and potential impacts of the facility prior to placement of the temporary facility on-site.

# PART 2. PRODUCTS

The Contractor shall provide all labor, materials, and equipment necessary to provide temporary facilities to the site. Facilities may include, but not be limited to:

A. Field office and support trailer(s).

B. Material staging areas.

C. Sanitary facilities.

D. Rubbish and waste collection.

E. Fire protection and safety equipment.

## 2.1. FIELD OFFICE AND SUPPORT TRAILER(S)

The Contractor shall locate the field office trailer to a location approved by the Owner if necessary.

## 2.2. MATERIAL STAGING AREAS

The Contractor shall construct and maintain material staging areas for raw material at locations approved by the Owner. The areas shall be designed by the contractor to be as compact as possible, but yet to provide adequate space for intended uses. If the areas are to be used for storing construction materials and no potential of spills, the area(s) shall be well drained. If the stored materials contain hazardous constituents or have potential of spills and will likely cause environmental impacts, the area(s) shall have containment structures with precipitation protection as appropriate.

2.3. SANITARY FACILITIES

At least one portable chemical toilet shall be brought to the site, set up adjacent to the office trailer (or other locations agreed to by the Owner), and regularly maintained by the Contractor.

2.4. RUBBISH AND WASTE COLLECTION

The Contractor shall be responsible for collection of wastes and rubbish generated throughout the site activities, (i.e., trash, used supplies, office waste, etc.). These wastes are not anticipated to be large in volume and may be collected and deposited through the Contractor's normal waste disposal methods. All waste and rubbish generated on-site shall be removed at regular intervals, as needed.

2.5. FIRE PROTECTION AND SAFETY EQUIPMENT

The Contractor shall be responsible for providing and maintaining fire protection and health and safety equipment to the temporary facilities throughout the site activities in accordance with the technical specifications, regulatory requirements from federal, state, and local governments, and/or generally accepted industry practices.

PART 3. EXECUTION

3.1. INSTALLATION AND MAINTENANCE OF FACILITIES

A. The Contractor shall provide all temporary utilities including, but not limited to, electricity, telephone, and sanitary waste removal. The Contractor shall be responsible for all site contractor and lower-tier contractor utility costs.

B. The Contractor shall locate all temporary facilities on-site and properly secure them to withstand all anticipated weather conditions. The Contractor shall maintain all contractor temporary facilities and equipment. Maintenance shall extend beyond the structures to all parking areas and all exterior portions of the support areas. The Contractor shall comply with all applicable federal, state, and local regulations and codes with respect to the construction, maintenance, and removal of temporary facilities.

3.2. SECURITY

It is the responsibility of the Contractor to assure that their equipment, materials, facilities, etc. are properly secured during the course of the project. Neither the Owner nor any of their representatives shall be responsible for loss, theft, or damage to Contractor equipment, materials, or facilities until completion of the project.

A height of 6’ temporary security fencing is recommended wherever the construction site is currently accessible, such as from the adjacent parking lot of North American Electric to the southeast.

3.3. REMOVAL OF FACILITIES

The Contractor shall remove all temporary facilities upon completion of the project in accordance with the provisions of this section and Section 02 41 00 Demolition and Deconstruction. All areas occupied by temporary facilities shall be restored to the original contour and condition existing prior to the project. The Contractor shall disconnect and remove all temporary utilities at the completion of work. Contaminated materials and equipment will be decontaminated, subject to the approval of the Owner, and removed from the site.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

This section describes the minimum requirements the Contractor shall address and abide by with respect to traffic control.

1.2. REFERENCES

A. Maryland State Highway Administration (MD SHA)

B. 2008 Standard Specifications for Construction and materials, as amended

PART 2. PRODUCTS

The Contractor shall provide for traffic control as appropriate with flaggers, barricades, flashing lights, and warning signs, both on site and at other appropriate locations, to ensure safety.

PART 3. EXECUTION

The Contractor shall be responsible for proper coordination of traffic control activities with applicable federal, state, and local regulations, including:

A. Acquisition of permits and the submission of temporary traffic control plans to perform work in the right-of-way if required.

B. Coordination of large construction vehicles entering and exiting the property shall take place on suitable roads.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

| | |
|---|---|
| 01 35 10 | Environmental Protection |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |
| 31 00 00 | Excavation, Backfill, and Compaction |

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6 (2006) Safety Requirements for Demolition Operations

1.3 PROJECT DESCRIPTION

A. General Requirements

1. Do not begin demolition or deconstruction until authorization is received from the Owner. Remove rubbish and debris from the project site. In the interest of occupational safety and health, perform the work in accordance with this section.

1.4 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the LMC. Repair or replace damaged items as approved by the Owner. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Owner prior to performing such work.

A. Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

B. Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which is indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Owner.

C. Facilities

Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Owner. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.5 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.6 SUBMITTALS
Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

A. Preconstruction Submittals

Existing Conditions Photos or Video file

B. Certificates

Demolition and Deconstruction Plan - Prior to the start of the demolition activity, the Contractor must provide a list of the materials and describe methods for the removal and disposal of portions of the concrete foundation (slab) and the existing utility abandonment.

Notifications

C. Closeout Submittals

Receipts

1.7 QUALITY ASSURANCE

Submit timely notification of demolition and deconstruction projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the local air pollution control district/agency and the Owner in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

A. Dust and Debris Control

Prevent the spread of dust and debris and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Vacuum and dust the work area as needed.

1.8 PROTECTION

A. Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Owner prior to beginning such work.

B. Protection of Personnel

Before, during and after the demolition and deconstruction work continuously evaluate the condition of the structure being demolished and deconstructed and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.9 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Owner showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top and invert of storm sewer systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

A. Utilities and Related Equipment

1. Disconnecting Existing Utilities

Remove existing utilities as indicated and as uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Owner. When utility lines are encountered but are not indicated on the drawings, notify the Owner prior to further work in that area. This work will also include the cutting and capping of any existing utilities, either by the Contractor or the appropriate utility provider.

B. Paving and Slabs
Remove sawcut concrete and asphaltic concrete paving and slabs including aggregate base as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored as directed by the Owner. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense.

3.2 CONCURRENT EARTH-MOVING OPERATIONS
Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings if necessary.

3.3 DISPOSITION OF MATERIAL
A. Title to Materials
All demolition material shall be removed from the site and disposed of in accordance with the specifications.

B. Salvaged Materials and Equipment
There shall be no salvage of demolition materials.

C. Special Instructions

No more than one type of Operational Data Store (ODS) is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

1. Activity name and unit identification code

2. Activity point of contact and phone number

3. Type of ODS and pounds of ODS contained

4. Date of shipment

D. Transportation Guidance

Refer to Section 3.5.

E. Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material as referenced in Specification 31 02 00 OFF-SITE WASTE DISPOSAL.

3.4 CLEANUP

Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

## 3.5 DISPOSAL OF REMOVED MATERIALS

A. Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified in the Waste Management Plan.

B. Burning on LMC Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on LMC property.

C. Removal to Spoil Areas on LMC Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on LMC property.

D. Removal from LMC Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from LMC property for legal disposal. Dispose of waste soil as directed.

## 3.6 REUSE OF SALVAGED ITEMS

There shall be no salvage of demolition materials.

END OF SECTION

PART 1. GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 211.2 | (1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete |
| ACI 305R | (2010) Specification for Hot Weather Concreting |
| ACI 306.1 | (1990; R 2002) Standard Specification for Cold Weather Concreting |
| ACI 318 | (2008; Errata 2010; Errata 2010) Building Code Requirements for Structural Concrete and Commentary |

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

| | |
|---|---|
| ACPA 01-102 | (2000) Concrete Pipe Handbook |
| ACPA 01-110 | (1984) Design Manual for Sulfide and Corrosion Prediction and Control |
| ACPA QPC | (2005; Ver 3.0) QCast Plant Certification Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010) Structural Welding Code - Steel |
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A185/A185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |
| ASTM A36/A36M | (2008) Standard Specification for Carbon Structural Steel |
| ASTM A496/A496M | (2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement |
| ASTM A497/A497M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete |

| | |
|---|---|
| ASTM A615/A615M | (2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A706/A706M | (2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A767/A767M | (2009) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement |
| ASTM A775/A775M | (2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A82/A82M | (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A884/A884M | (2006) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement |
| ASTM C 1064/C 1064M | (2008) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete |
| ASTM C 1107/C 1107M | (2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C 1116/C 1116M | (2010a) Standard Specification for Fiber-Reinforced Concrete |
| ASTM C 1244 | (2005ae1) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill |
| ASTM C 138/C 138M | (2010b) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete |
| ASTM C 143/C 143M | (2010) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C 1478 | (2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |
| ASTM C 150/C 150M | (2011) Standard Specification for Portland Cement |
| ASTM C 171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C 173/C 173M | (2010b) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C 192/C 192M | (2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C 309 | (2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |

| | |
|---|---|
| ASTM C 31/C 31M | (2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33/C 33M | (2011) Standard Specification for Concrete Aggregates |
| ASTM C 330 | (2009) Standard Specification for Lightweight Aggregates for Structural Concrete |
| ASTM C 39/C 39M | (2010) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 443 | (2010) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C 494/C 494M | (2010a) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C 595/C 595M | (2010) Standard Specification for Blended Hydraulic Cements |
| ASTM C 618 | (2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C 877 | (2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections |
| ASTM C 891 | (2011) Installation of Underground Precast Concrete Utility Structures |
| ASTM C 920 | (2011) Standard Specification for Elastomeric Joint Sealants |
| ASTM C 923 | (2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C 989 | (2010) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM C 990 | (2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C231/C231M | (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260/C260M | (2010a) Standard Specification for Air-Entraining Admixtures for Concrete |

CSA STANDARDS (CSA)

| | |
|---|---|
| CSA A23.4 | (2009; Update 2010) Precast Concrete - Materials and Construction |

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

| | |
|---|---|
| NPCA QC Manual | (2005; R 2006) Quality Control Manual for Precast Plants |

1.2. SYSTEM DESCRIPTION

Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least 3 years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades.

A. Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318, ASTM, ACPA 01-102, Chapter 7-Design for Sulfide Control. Design shall also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings. Submit drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Owner. These drawings shall demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings. Submit cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

B. Custom-Made Precast Units

Submit design calculations for custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices. Submit drawings furnished by the precast concrete producer for approval by the Owner. Show on these drawings complete design, installation, and construction information in such detail as to enable the Owner to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

C. Proprietary Precast Units

Products manufactured under franchise arrangements shall conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, shall conform to the requirements in this specification. Submit standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

D. Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

E. Concrete Mix Design

1. Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design and proportions for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

2. Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of 4,500 psi.

3. Water-to-Cement Ratio

Furnish concrete, that will be exposed to freezing and thawing, containing entrained air and with water-cement ratios of 0.45 or less. Furnish concrete which will not be exposed to freezing, but which is required to be watertight, with a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. Furnish reinforced concrete exposed to deicer salts, brackish water or seawater with a water-cement ratio of 0.40 or less for corrosion protection.

4. Air Content

The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

| NOMINAL AGGREGATE | MAXIMUM SIZE | AIR CONTENT % | |
|---|---|---|---|
| | | SEVERE EXPOSURE | MODERATE EXPOSURE |
| 10 mm (3/8 inch) | 6.0 to 9.0 | 4.5 to 7.5 | |
| 13 mm (1/2 inch) | 5.5 to 8.5 | 4.0 to 7.0 | |
| 19 mm (3/4 inch) | 4.5 to 7.5 | 3.5 to 6.5 | |
| 25 mm (1.0 inch) | 4.5 to 7.5 | 3.0 to 6.0 | |
| 38 mm (1.5 inch) | 4.5 to 7.0 | 3.0 to 6.0 | |

1.3. SUBMITTALS

All submittals are the responsibility of the precast concrete producer. . Submit the following in accordance with Section 01 33 00 “Submittals”:

A. Pre-cast concrete units shop drawings, design details of steel reinforcement and placement, supporting design calculations, Manufacturer’s certificate.

B. Product Data for materials used in the construction of pre-cast structures, such as standard pre-cast units, proprietary pre-cast units, reinforcing bars, and embedded items (trash rack, frame and cover, etc.)

C. Design data and test reports, indicating the methods used in the design of the structures, the concrete batches used, and the results of quality testing.

1.4. QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual and/or ACPA QPC. Meet requirements written in the subparagraphs below.

A. NPCA and ACPA Plant Certification
The precast concrete producer shall be certified by the National Precast Concrete Association's and/or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

B. Qualifications, Quality Control and Inspection

1. Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

2. Quality Control Procedures

a. Submit quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and/or ACPA QPC. Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

1.) Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C 143/C 143M.
2.) Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064/C 1064M.
3.) Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C 31/C 31M, ASTM C 192/C 192M, ASTM C 39/C 39M.
4.) Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C231/C231M or ASTM C 173/C 173M for normal weight aggregates and ASTM C 173/C 173M for lightweight aggregates.
5.) Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C 138/C 138M.

b. Submit test reports as Follows:

1.) Copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.
2.) Copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete items.
3.) Sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.
4.) Copies of in-plant QA/QC inspection reports, upon the request of the Owner.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Owner for quality and final acceptance.

B. Storage

Store units off the ground or in a manner that will minimize potential damage.

C. Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

PART 2. PRODUCTS

2.1. MATERIALS

Materials shall conform to the following specifications.

A. Cement

Cement shall be portland cement, or portland cement in combination with pozzolan or ground granulated blast furnace slag conforming to appropriate specifications listed below. Restrict usage of cement in concrete that will have surfaces exposed in the completed structure so there is no change in color, source, or type of cement. Furnish cement conforming to ASTM C 150/C 150M, Type I, II, III or V. Furnish blended cements that conform to ASTM C 595/C 595M.

B. Fly Ash and Pozzolans

Fly ash is used as a supplementary cementitious material (SCM) conforming to ASTM C 618, Class [C or F] with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

C. Ground Granulated Blast-Furnace Slag
Ground granulated blast furnace slag is used as a supplementary cementitious material conforming to ASTM C 989, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

D. Water

Furnish water potable or free of deleterious substances in amounts harmful to concrete or embedded metals.

E. Aggregates

Fine and coarse aggregates shall "be tested and evaluated for alkali-aggregate reactivity in accordance with ASTM C 1260. The fine and coarse aggregates shall be evaluated separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing shall have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, the aggregate(s) shall be rejected or additional testing using ASTM C 1260 and ASTM C 1567 shall be performed. The additional testing using ASTM C 1260 and ASTM C 1567 shall be performed using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. GGBF slag shall be used in the range of 40 to 50 percent of the total cementitious material by mass. Class F fly ash shall be used in the range of 25 to 40 percent of the total cementitious material by mass."

1. Selection
Furnish aggregates conforming to ASTM C 33/C 33M. Provide aggregates not containing any substance, which may be deleteriously reactive with the alkalies in the cement.

2. Aggregates for Lightweight Concrete

ASTM C 330

F. Admixtures

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

1. Air-Entraining
ASTM C260/C260M

2. Accelerating, Retarding, Water Reducing Moderate to High

ASTM C 494/C 494M

G. Reinforcement

1. Reinforcing Bars
   a. Deformed Billet-steel: ASTM A615/A615M
   b. Deformed Low-alloy steel: ASTM A706/A706M

2. Reinforcing Wire

   a. Plain Wire: ASTM A82/A82M
   b. Deformed Wire: ASTM A496/A496M

3. Welded Wire Fabric

   a. Plain Wire: ASTM A185/A185M
   b. Deformed Wire: ASTM A497/A497M

4. Epoxy Coated Reinforcement

   a. Reinforcing Bars: ASTM A775/A775M
   b. Wires and Fabric: ASTM A884/A884M

5. Galvanized Reinforcement

   Provide galvanized reinforcement conforming to ASTM A767/A767M.

H. Synthetic Fiber Reinforcement

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inch.

I. Inserts and Embedded Metal

All items embedded in concrete shall be of the type required for the intended task, and meet the following standards.

1. Structural Steel Plates, Angles, etc.: ASTM A36/A36M

2. Hot-dipped Galvanized: ASTM A153/A153M

3. Proprietary Items: In accordance with manufacturers published literature

J. Accessories

Submit proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.

1. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C 443.

2. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C 877.

3. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C 990.

4. Elastomeric Joint Sealants: ASTM C 920

K. Pipe Entry Connectors

Pipe entry connectors shall conform to ASTM C 923 or ASTM C 1478.

L. Grout

Nonshrink Grout shall conform to ASTM C 1107/C 1107M. Cementitious grout shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

## PART 3. EXECUTION

### 3.1. FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual and/or ACPA QPC unless specified otherwise.

A. Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturer's recommendations and do not allow to build up on the form casting surfaces.

B. Reinforcement

Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch. Provide concrete cover not less than 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

C. Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations. Submit product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

D. Synthetic Fiber Reinforced Concrete

Add fiber reinforcement to the concrete mix in accordance with the applicable sections of ASTM C 1116/C 1116M and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.2. CONCRETE

A. Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

B. Concrete Placing

Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

1. Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
b. Free from frost all concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact.
c. Do not use frozen materials or materials containing ice.
d. In cold weather the temperature of concrete at the time of placing shall not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

2. Hot Weather Concreting

Recommendations for hot weather concreting are given in detail in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90 degrees F.

C. Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

1. Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C 171.
b. Cover with burlap or other absorptive material and keep continually moist.

c. Use of a membrane-curing compound applied at a rate not to exceed 200 square ft/gallon, or in accordance with manufacturers' recommendations according to ASTM C 309.

2. Curing with Heat and Moisture
Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

D. Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

1. Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

2. Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted but no major imperfections, honeycombs, or other major defects shall be permitted.

3. Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

E. Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

F. Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

1. Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

2. Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3. Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

G. Shipping Products

Do not ship products until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3. INSTALLATION

A. Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

B. General Requirements

1. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.

2. Lift products by suitable lifting devices at points provided by the precast concrete producer.

3. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with ASTM C 891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.

4. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

C. Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.4. FIELD QUALITY CONTROL

A. Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

a. Vacuum Testing

Prior to backfill vacuum test system according to ASTM C 1244.

b. Water Testing

Perform water testing according to the contract documents and precast concrete producer's recommendations.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This Section covers the requirements for performing the following work, as shown on the Contract Drawings and as specified:

A. Excavating, backfilling, and compacting for structures, piping, and utilities.
B. Site grading
C. Restoration of surfaces.
D. All other related and incidental work.

All work within this section should adhere to the Maryland State Highway Administration (MD SHA) 2008 Standard Specifications for Construction and Materials, as updated, unless specified by the Construction Drawings, Technical Specifications, or geotechnical report, or as directed in the field.

If earthwork measurement and payment items are not specified by LMC, the Contractor shall use MD SHA's 2008 Standard Specifications for Construction and Materials, as updated, as a basis for measurement and payment of earthwork.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 03 40 00 | Pre-cast Concrete |
| 31 02 00 | Off-Site Waste Disposal |
| 31 11 00 | General Site Preparation (Clearing and Grubbing) |
| 32 92 19 | Seeding, Soil Supplements, and Mulching |
| 33 40 00 | Storm Drainage Utilities |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

American Society for Testing and Materials (ASTM)

| | |
|---|---|
| ASTM D 422 | Particle-Size Analysis of Soils |
| ASTM D 698 | Laboratory Compaction Characteristics of Soil Using Standard Effort |
| ASTM D 1556 | Density and Unit Weight of Soil in Place by the Sand Cone Method |
| ASTM D 1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort |
| ASTM D 2167 | Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D 2922 | Density of Soil and Soil Aggregate in Place by Nuclear Methods |

Code of Federal Regulations (CFR)

29 CFR 1926.360, .651, .652, and .653

State of Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Product Data: Name of fill material sources and suppliers.

B. Laboratory Data: Maximum dry density test results (according to ASTM D 1557 or AASTHO T-180) as outlined in paragraph 3.9.A for material used as bedding, embedment, fill, or backfill material.

C. Field density test results (according to ASTM D 1556 or ASTM D 2922) as outlined in paragraph 3.4 for material used as bedding, embedment, fill, or backfill material.

1.5. DEFINITIONS

A. Select Fill - Sand, gravel and similar material free of clay, loam, organic material and debris containing stones, pebbles or lumps less than two inches in greatest dimension.

B. Unstable material - Debris, topsoil, peat and materials containing peat; and, all wet, soft or loose material that will not remain in position when cut for excavation, or that does not provide sufficient bearing capacity to satisfactorily support structures.

C. Unsuitable material - Excavated material that does not meet Specification requirements for backfilling, to include unstable material.

D. Common Fill - Consists of select fill as defined above or imported sand or other granular material as approved by the Owner.

E. Bedding - Granular material consisting of crushed rock or pea gravel for surrounding pipes and culverts during trench installation.

1.6. PROPERTY PROTECTION AND SAFETY

A. Buildings, poles, roadways, walkways, landscape vegetation, and all other property shall be protected unless their removal is authorized.

B. The Contractor shall contact underground utility locator service to locate and mark all utilities prior to commencing work. If any unknown utilities are encountered during excavation, the Contractor shall immediately notify the Owner. The Contractor shall preserve intact any utilities encountered.

C. The Contractor shall maintain safe passage for local traffic and provide all necessary barricades, warning lights, signs, signals, and flagmen where required.

D. All excavation work shall comply with 29 CFR 1926.650, 1926.651, 1926.652, and 1926.653.

## PART 2. PRODUCTS

### 2.1. MATERIALS

A. All fill material shall be free of contamination. The Contractor shall provide the Owner with the names of all fill sources or suppliers. The Contractor shall provide evidence, satisfactory to the Owner, documenting that the material is free of contamination. A letter provided by the borrow pit owner or operator certifying that the material is natural material not previously excavated from the borrow pit will be considered sufficient

B. The Owner may collect random samples of fill material to verify that it is uncontaminated.

C. Backfill material for structures shall be select fill, and shall meet the guidelines listed in the geotechnical report and the structural portion of the Construction Drawings.

D. Bedding material for piping and utilities shall meet the MD SHA Aggregate requirement as stipulated by the type of utility. All aggregate gradations will be confirmed using AASTHO Method T-27.

E. Backfill material over bedding material for piping and utilities shall be select fill.

F. Geotextile shall be in accordance with Section 31 05 19 “Geotextiles”.

G. Waning tape shall be detectable by bright green color and written in red “Sewer underneath” on it.

### 2.2. MATERIAL TESTING

Fill material beneath bedding material for piping, culverts, and foundations shall be tested by the Contractor in accordance with ASTM D 422 and ASTM D 1557.

## PART 3. EXECUTION

### 3.1. CLEARING

Before the removal of topsoil and commencing excavation, the surface areas within the grading limits shall be cleared of all vegetation, rubbish, and other objectionable matter in accordance with Section 31 11 00, “General Site Preparation”. Cleared material shall be properly disposed of off-site in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

### 3.2. EXCAVATING

A. Excavation of soil shall be performed by any practicable method consistent with maintaining the integrity and protection of the work, workers, and the public.

B. Excavation shall proceed in a manner that minimizes the volume of surface water runoff from precipitation and groundwater infiltration that may collect in the excavation.

C. If dust is generated during excavation of soils, the Contractor shall cease operations immediately until a method of control in accordance with Section 01 35 10, "Environmental Protection", has been approved by the Owner, and dust control measures have been implemented.

D. The Contractor shall be responsible for collecting waters that may accumulate in the excavation.

E. Excavating operations shall include the removal of all materials encountered within the required widths and depths of the excavation, regardless of the nature of the materials, the condition of the materials at the time they are excavated, or the manner in which they are excavated.

F. Excavated materials meeting the requirements of these Specifications may be used as backfill material.

G. Stockpiled material shall not obstruct roads, ditches, or drainage swales.

H. All trash, debris, and excess excavated material shall be disposed offsite in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

I. Unstable material in excavations shall be removed to the extent and depths as required, or as directed by the Owner. The excavation shall be filled to the proper grade with approved select fill. The fill shall be compacted according to the requirements of these Specifications. Whenever the material encountered is in the Contractor's opinion unstable, he shall immediately notify the Owner to make a determination whether the soil is suitable for support. All notifications shall be substantiated in writing by the Contractor.

J. The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12 inches (6 inches per side) to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Contractor shall not over excavate intentionally; however, if over excavation is required, the over excavated volume will be replaced with compacted bedding material.

J. Pipe trenches shall be excavated so that pipes can be laid straight at uniform grade without deflection.

K. If suspected contaminated soil or materials are encountered, the Contractor shall cease operations and notify the Owner for further instructions.

3.3. BACKFILLING AND COMPACTING - GENERAL

A. Unless otherwise directed, excavations shall be backfilled as soon as possible after structures are built or pipes are laid; and the work is inspected, tested as required, and accepted; and when permission to backfill has been given by the Owner. Prior to backfilling, all rubbish, debris, forms and similar materials shall be removed from the excavation or trench. Backfilling shall not be done in freezing weather, with frozen materials, or when in-place materials are frozen.

B. Backfill shall be brought up to adjacent finished grade minus the depth of any required top soil or gravel. Any excavations improperly backfilled, shall be reopened to the depth required for proper compaction, and shall then be refilled and properly compacted with the surface restored to required grade.

C. Each layer of backfill material shall be compacted to the density specified in this Section. Compaction densities shall be the percentage of the maximum dry density obtainable at optimum moisture content, as determined by ASTM D 1557 or AASTHO T-180. Field density tests shall be made in accordance with ASTM D 1556 or D 2922. The moisture content of each layer of back fill shall be controlled as required.

D. Failure of the compacted material to reach the required density is cause for rejection of the work in the affected area(s). Unless the Contractor can rework and compact the material to the required density, the Contractor shall remove the material in the areas affected. Subsequently, the Contractor shall replace the rejected work with material that can be compacted to the required density. Field density tests and rejection of the non-compliant compacted material shall be repeated until test results are accepted by the Owner. Under structures, the material shall be placed in lifts not to exceed 8 inches in thickness and compacted to not less than 95% of maximum dry density (ASTM D 1557 or AASHTO T-180).

3.4. FILLING, BACKFILLING, AND COMPACTING FOR PIPE TRENCHES

A. Bedding shall be installed on approved subgrades as detailed on the Contract Drawings. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings and bodies of conduits.

B. Place initial backfill stone below the pipe and both sides of the pipe. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. The bedding materials shall not be more than 6 inches in layers to the height of pipe spring line.

C. Provide construction fabric around the perimeter of stone bedding and overwrap adjacent edges at least 18 inches. Top edges shall face down grade.

D. Place backfill and fill soil materials over the pipe in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Coordinate backfilling with utilities testing.

E. Compact each layer of back fill soil material at 90 percent under unpaved areas and at 95 percent under paved areas according to ASTM D 1557 or AASHTO T-180.

F. Warning tape shall be located below finished grade as shown on the Drawing.

G. Place appropriate surface material according to the paved or unpaved finished grade as shown on the Drawing.

3.5. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

3.6. RESTORATION OF SURFACES

A. Damaged or disturbed surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

B. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

C. The finished surfaces over trenches shall be left slightly mounded.

3.7. CONSTRUCTION TESTING

A. Laboratory testing

One laboratory maximum dry density test (ASTM D 1557 or AASTHO T-180) shall be performed for each material to be used as bedding or backfill material.

B. Field testing

Field density tests shall be performed according to ASTM D 1556 or ASTM D 2922.

1. For general filling and backfilling, one test shall be performed for every lift. At minimum, one test per lift for each 250 linear feet of trench bedding and backfill material.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads. Prevent surface water from entering excavations by grading, dikes, or other means. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation. Monitor vibrations, settlements, and movements.

## 1.2. RELATED SECTIONS

01 33 00 Submittals
01 50 00 Temporary Facilities
31 00 00 Excavation, Backfill, and Compaction
31 03 00 Dewatering and Water Control

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Shop Drawings: For excavation support and protection system.

## 1.4. QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at the project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

a. Existing utilities and subsurface conditions.
b. Proposed excavations.
c. Proposed equipment.
d. Monitoring of excavation support and protection system.
e. Working area location and stability.
f. Coordination with waterproofing.
g. Abandonment or removal of excavation support and protection system.
h. Environmental Concerns
i. Health and Safety Concerns

## 1.5. PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of utility.

2. Do not proceed with interruption of utility without Owner’s written permission.

B. Project-Site Information: All geotechnical information provided for this Project is for information only. Owner will not be responsible for interpretations or conclusions drawn from the data. Contractor is responsible for making additional test borings and conducting

other exploratory operations necessary for excavation support and protection.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2. PRODUCTS

### 2.1. MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners may be site-fabricated mechanical interlock or roll-formed corner shape with continuous interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches (100 mm)

E. Tiebacks: Steel bars, ASTM A 722/A 722M.

F. Tiebacks: Steel strand, ASTM A 416/A 416M.

## PART 3. EXECUTION

### 3.1. PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

F. Where required, install systems as defined in 3.2, 3.3, 3.4 and 3.5 this section.

3.2. SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment].

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3. SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4. TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5. BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Owner.

Install internal bracing, if required, to prevent spreading or distortion of braced frames.

2. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6. REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.

2. Fill voids immediately with approved backfill compacted to density specified in Section 31 00 00 “Excavation, Backfill, and Compaction”.

3. Repair or replace, as approved by Owner, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave certain excavation support and protection systems permanently in place, including capping and finishing, as shown on Contract Documents.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

A. The Contractor shall collect, containerize, and temporarily store on site all waste resulting from work at the Site. This includes, but is not limited to:

1. Surplus excavated non-contaminated soil

2. Excavated contaminated soil

3. Discarded health and safety personal protection equipment (PPE) as applicable

4. General construction debris, waste materials, and refuse

5. Contaminated water due to dewatering activities

B. The Contractor shall provide all labor, material, and equipment necessary to transport and dispose off-site all waste generated by work at the Site in accordance with the results of the waste characterization and with all applicable local, state, and federal regulations.

1.2 RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |
| 31 00 00 | Excavation, Backfill, and Compaction |

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest edition and are referred in the text by the basic designation only.

Code of Federal Regulations (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 29 CFR 1926 | Excavations |
| 40 CFR 260 | Hazardous Waste Management Systems: General |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Waste |
| 40 CFR 264 | Standards for Hazardous Wastes and Operators |
| 40 CFR 265 | Interim Standards for Hazardous Wastes and Operators |
| 49 CFR 172 | Hazardous Materials |
| 49 CFR 173 | General Shipment Requirements |
| 49 CFR 174-175 | Carriage by Rail |
| 49 CFR 178-179 | Carriage by Aircraft |

Federal Laws

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

U.S. Environmental Protection Agency (EPA) Publications

| | |
|---|---|
| SW-846 | Test Methods for Evaluating Solid Wastes Physical/Chemical Methods, July 1982 |

Maryland State Laws

Environment Article §§9-204, 9-252, and 9-314, Annotated Code of Maryland

Maryland State Regulations

| | |
|---|---|
| COMAR 11.07.01 | Transportation of Hazardous Waste; |
| COMAR 26.04.07 | Solid Waste Management; |
| COMAR 26.13 | Disposal of Controlled Hazardous Substances; |
| COMAR 26.14 | Hazardous Substances Response Plan |

1.4 SUBMITTALS

The Contractor shall submit the following to the Owner for approval in accordance with Section 01 33 00, “Submittals”:

A. Name, qualifications, and State identification numbers of the proposed Subcontractor(s) for off-site waste transportation. For transportation of hazardous waste, a written certificate shall be provided that the off-site transportation firm is approved for the waste in accordance with 40 CFR 716 and 49 CFR 172 through 179. A copy of the EPA and State permits and a 24-hour point of contact shall be included.

B. Name, location, qualifications, and State identification number of the proposed off-site disposal facilities that are approved by the Owner. For disposal of hazardous waste, a written certificate shall be provided that the disposal facility is approved for the waste in accordance with 40 CFR 716. A copy of EPA and State permits and a 24-hour point of contact shall be included.

C. A Shipment Manifest for each shipment of hazardous waste to be transported to the off-site disposal facility in accordance with all applicable Federal, State, and local regulations. The Contractor shall submit the Shipment Manifests to the Owner's Site Representative for signature prior to any shipment of waste leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests and return the signed original to the Contractor. The Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date at which it was received by the facility.

D. A Certificate of Disposal shall be submitted for each shipment of hazardous waste disposed by the off-site disposal facility. Certificates of Disposal shall include the following information:

1. The identity of the disposal facility by name, address, Owner and State Identification Number.

2. The identity of the waste shipment affected by the Certificate of Disposal including reference to the Shipment Manifest number.

3. A statement certifying the fact of disposal of the identified waste shipment, including the date(s) of disposal and the disposal method used.

E. A signed receipt or manifest from the off-site disposal facility for each shipment of non-hazardous waste. This receipt shall document the nature and weight of waste disposed and the date of disposal.

F. A Sampling and Analysis Plan, containing at minimum:

a. The field sampling approach, which will discuss how sampling locations and quantities will be determined;
b. The sampling methodology to be used, for both confirmatory and waste characterization samples;
c. The laboratory analysis to be performed on the samples, based on sample material and location;
d. The field quality assurance/quality control methods; and
e. Copies of forms to be used during the sampling and a sample data package.

## PART 2. PRODUCTS – NOT APPLICABLE

## PART 3. EXECUTION

### 3.1 WASTE CHARACTERIZATION

Waste characterization will be conducted in accordance with a Sampling and Analysis Plan. The characterization of the waste shall also conform to the requirements of the off-site disposal facility.

### 3.2 IDENTIFICATION OF OFF-SITE WASTE DISPOSAL FACILITY

A. Based on the results of the waste characterization, the Contractor shall identify an appropriate method of disposal in accordance with all local, State, and Federal regulations. The method(s) of waste disposal shall be approved by the Owner.

B. The Contractor shall identify one (or more) Owner approved off-site disposal facility and submit the necessary information regarding each facility for Owner approval in accordance with Section 01 33 00, “Submittals”.

### 3.3 WASTE TRANSPORTATION

A. The Contractor shall select one or more waste transportation firms and submit the necessary information regarding each firm for approval by Owner in accordance with Section 01 33 00, “Submittals”.

B. Waste shall be transported to the Owner approved off-site disposal facility in accordance with all applicable local, State, and Federal regulations. In particular, off-site transportation of hazardous waste shall conform to all the requirements of 40 CFR 263 and 49 CFR 171 through 49 CFR 179.

C. A Shipment Manifest shall be prepared by the Contractor for each shipment of hazardous waste and submitted to the Owner's Site Representative for signature prior to any shipment leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests

and return the signed original to the Contractor. The Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date received by the facility.

3.4 WASTE DISPOSAL

A. Waste shall be disposed of at the Owner approved off-site disposal facility in accordance with all local, State, and Federal regulations. The Contractor shall ensure that all wastes are accepted at the facility; that the facility is properly permitted to accept the stated wastes; and that the facility provides the stated services. Waste shall be disposed of by the method(s) identified by the Contractor and approved by the Owner.

B. The Contractor shall also ensure that all disposals are at a facility which complies with state regulations concerning treatment, storage and disposal of non-hazardous solid waste, and the facility complies with the local solid waste disposal plan.

C. Hazardous waste shall be disposed of in accordance with all the relevant provisions of 40 CFR 264.

D. The Contractor shall submit to the Owner's Site Representative a signed receipt from the off-site disposal facility for each shipment of non-hazardous waste in accordance with Section 01 33 00, “Submittals”.

E. The Contractor shall submit to the Owner a Certificate of Disposal for each shipment of hazardous waste in accordance with Section 01 33 00, “Submittals”.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

A. Furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Ensure erosion control, stability of excavations and constructed slopes, so that excavation does not flood, and that damage to subgrades and permanent structures is prevented. Prevent surface water from entering excavations by grading, dikes, berms, or other means. Contain surface water and ground water that has entered the excavation area, collect the water in tanks and transport it to the off-site treatment facility. Decontaminate and remove the dewatering system when no longer required for construction.

1.2. RELATED SECTIONS

01 33 00 Submittals
01 41 00 Regulatory Requirements
01 35 10 Environmental Protection
31 00 00 Excavation, Backfill, and Compaction
31 00 01 Excavation Support and Protection

1.3. SUBMITTALS

A. Dewatering Plan

B. Field quality-control reports and photographs

1. Provide documentation that dewatering plan is functioning or provide changes to dewatering plan during construction.

2. Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.4. QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing MD SHA / Baltimore County notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Pre-installation Conference: Conduct conference at project site.

1. Review methods and procedures related to dewatering including, but not limited to, the following:

a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.

1.) Geotechnical conditions.
2.) Proposed site clearing and excavations.
3.) Existing utilities and subsurface conditions.

4.) Coordination for interruption, shutoff, capping, and continuation of utility services.
5.) Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6.) Coordinate transport system to off-site treatment facility.
7.) Testing and monitoring of dewatering system.
8.) Environmental Concerns
9.) Health and Safety Concerns

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system as needed to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

3.2. INSTALLATION

A. Install dewatering system utilizing wells, well points, sumps or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches (600 mm) below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Water from excavation areas should be assumed to be contaminated and needs to be disposed off-site at the Owner approved water treatment plant. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all labor, equipment and materials, and perform all operations in connection with installation of the geotextiles fabric. Geotextiles shall be installed for reinforcement and separation of gravel roadways, parking areas, foundation drainage, and rock riprap areas and as silt fences.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 11 23 | Aggregates and/or Graded-Crushed Aggregate For Roadways |
| 33 40 00 | Storm Drainage Utilities |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

American Society for Testing and Materials (ASTM)

| | |
|---|---|
| ASTM D 3786 | Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics Diaphragm Bursting Strength Tester Method |
| ASTM D 4355 | Standard Test Method for Determining UV (ultraviolet) Resistance |
| ASTM D 4491 | Standard Test Method for Water Permeability of Geotextiles by Permittivity |
| ASTM D 4533 | Standard Test Method for Determining Trapezoidal Tear. |
| ASTM D 4632 | Standard Test Method for Grab Breaking Load and Elongation of Geotextiles |
| ASTM D 4759 | Determining the Specification Conformance of Geosynthetics. |
| ASTM D 4873 | Identification, Storage, and Handling of Geotextiles |
| ASTM D 4833 | Standard Test Method for Determining Puncture Strengths |

State of Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

Maryland Department of the Environment (MDE)

2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control

## 1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Product Data Sheet for Geotextiles or Filter Fabric

PART 2. PRODUCTS

2.1. GEOTEXTILE FABRIC MATERIAL

The fabrics provided shall be woven or nonwoven geotextile that meets the standards and specifications of MD SHA or MDE for geotextiles (i.e. Grab Strength, Seam Strength, Puncture, Trapezoid Tear, Apparent Opening Size, U.S. Sieve, Permittivity, Ultraviolet Degradation, etc).

A. Geotextiles installed for gravel roadways and parking lots shall meet MD SHA or MDE's requirements for roadway stabilizing fabric.

B. Geotextiles (nonwoven) installed beneath riprap shall meet MD SHA or MDE's requirements for riprap separation fabric.

C. Geotextiles installed as sediment control (silt) fences shall meet MD SHA or MDE's requirements for sediment control fence fabric.

2.2. DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

2. Geotextile rolls shall be marked or tagged in accordance with ASTM D 4873 and with the following information:

a. Manufacturer's name
b. Production dates
c. Product identification
d. Roll number
e. Roll dimensions

B. Acceptance at the Site

1. Perform inventory and surface inspection for defects and damage of all geotextile rolls upon delivery.

2. Unroll and inspect any geotextile roll that shows signs of damage.

3. Damaged geotextiles shall be rejected upon delivery to the site and shall be replaced with new geotextile at no additional cost to the Contract.

C. Storage and Protection

1. Provide onsite storage area protected from ultraviolet light for geotextile rolls from time of delivery until installed.

2. Store and protect geotextile rolls from dirt, excessive heat and cold, water, ultraviolet light exposure, and other sources of damage in accordance with ASTM D 4873.

3. Preserve the integrity and readability of geotextile roll labels.

D. Handling

No hooks, tongs or other sharp instruments shall be used for handling geotextile. Geotextile shall not be dragged along the ground.

PART 3. EXECUTION

3.1. SURFACE PREPARATION

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction shall be in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

3.2. INSTALLATION

At the time of installation, geosynthetic materials shall be rejected if they have defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, storage, or placement. Visual review of the geosynthetic materials shall be performed during, after installation and prior to placement of any overlying materials.

The geosynthetic materials shall be protected at all times during construction from contamination by surface run-off and any fabric so contaminated shall be removed and replaced with uncontaminated materials.

Any materials damaged by exposure to sunlight, siltation prior to covering, or mechanical damage during installation or during covering, shall be replaced at no additional cost to the contract.

A. Installation

Prior to geotextile deployment, subgrades and surfaces shall be inspected and approved by the Contractor Officer.

1. Geotextile Deployment

Handle geotextiles in a manner to ensure they are not damaged. Comply with the following:

a. Install the geotextile as recommended by the manufacturer.
b. Weigh down geotextile with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material.
c. Prevent damage to underlying layers during placement of geotextile.
d. During geotextile deployment, do not entrap stones or excessive fine material that could cause clogging of drains or filters in or beneath geotextile.
e. Visually examine entire geotextile surface. Ensure no potentially harmful foreign objects are present. Remove foreign objects encountered or replace geotextile.
f. Overlap adjacent edges at least 18 inches. Top edges shall face down grade.
g. All workmanship shall conform to OSHA and all applicable safety regulations.

2. Defects and Repairs

   Repair holes or tears in geotextile as directed by the Owner in accordance with manufacturer's requirements.

B. Interface with Other Products

Ensure the following when placing soil or rock materials on top of a geotextile.

1. Geotextile and underlying lining materials are not damaged.

2. Minimal slippage of geotextile on underlying layers occurs.

3. No excess tensile stresses occur in geotextile.

4. Overlapping of adjacent edges is maintained.

5. Minimum of 6 inches of material is required over any geotextiles before heavy equipment is allowed on the cover material. Small areas that require compaction will be completed with hand-operated compactors.

6. Rock shall not be dropped on fabric from a height of more than 18 inches.

C. Silt Fences

If MD SHA standards are not available, the following specifications may be used:

1. Geotextile filter cloth material shall be pervious sheets of strong rot-proof plastic fabric meeting the requirements of AASHTO M 288 for sediment control fabrics with a geotextile minimum tensile strength of 210 lbs. Fabric shall be a minimum of 24 inches in height.

2. Post spacing: Posts shall be spaced at a maximum of 8 ft apart. Fences in areas of concentrated flows shall be 4 ft apart.

3. Posts shall be driven 12 inches into the ground.

4. Posts: Wood posts shall be nominal 1.5 in. x 1.5 in., made from oak or similar hardwood, and a minimum of 3 ft long.

5. Filter fabric shall be attached to the posts with wire staples or other appropriate fasteners.

6. Preassembled silt fence in general compliance with items 1 through 4 above may be used instead of a field-constructed silt fence with the approval of the Owner.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to prepare the site for construction. The work includes, but is not limited to implementing the following procedures prior to any intrusive activities.

A. Site Debris Removal

B. Clearing and Grubbing

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 35 10 | Environmental Protection |
| 31 02 00 | Off-Site Waste Disposal |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 93 00 | Seeding, Soil Supplements, and Mulching |

# PART 2. PRODUCTS

Fill materials shall conform to the provisions of Section 31 00 00, “Excavation, Backfill, and Compaction”.

# PART 3. EXECUTION

## 3.1. GENERAL

A. Generation of airborne particulate matter shall be controlled at all times using methods approved by the Owner.

B. All work for this project shall be in strict accordance with the Contract Drawings and Technical Specifications. All methods of work for this project shall also comply with Federal, State, and local ordinances, unless otherwise noted in the Contract Drawings and Technical Specifications.

C. The Contractor shall be responsible for limiting all work to the immediate project area. All areas disturbed by the Contractor that are outside the limits of work shall be restored by the Contractor to their original condition at no additional cost to the contract.

D. Maximum protection shall be provided for existing utilities which are to remain in service. Contractor shall provide all temporary service. The Contractor is responsible for locating and protecting all under ground and above ground utilities. The Contractor shall utilize the underground utility locator service and all other techniques required to locate the utilities prior to construction.

E. The Contractor shall thoroughly inspect the Site prior to construction to verify existing Site conditions.

## 3.2. PROTECTION OF EXISTING FEATURES

A. The Contractor shall use all means necessary to protect the existing features that are to remain.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements, to the satisfaction of the Owner.

3.3. CLEARING, GRUBBING, AND WASTE DISPOSAL

A. General

1. Except as otherwise directed, cut, grub, remove, and dispose of all shrubs, roots, and any other material, which may interfere with the work, within the areas defined on the Contract Drawings and as approved by the Owner. In general, clearing and grubbing will be performed at all areas to be excavated and at areas where earth or rock-fill will be placed. Clearing shall extend a maximum of 10 feet outside the limits of all excavations and fill areas except in sensitive wetland areas.

2. Materials removed as a result of clearing and grubbing shall be disposed off-site at a facility approved by the Owner.

3. The Contractor shall backfill and grade all holes resulting from clearing and grubbing. Backfilling and grading shall be performed in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

4. The Contractor shall protect all trees 2 inches in diameter and greater that are not to be removed and are in danger of being damaged. The trees shall be protected by completely encircling with planking or with snow fencing unless otherwise approved by the Owner.

5. In the performance of clearing and grubbing, the Contractor shall preserve and protect all public and private property, existing lawns, trees, plants, and other vegetation that are to remain within or adjacent to the project and shall use every precaution necessary to prevent damage or injury thereto. The Contractor shall repair all injuries to bark, trunk, limbs, and roots of remaining plants using tree surgery methods, tools, and materials which are approved by the Owner in accordance with Section 01 35 10, “Environmental Protection”.

6. The Contractor shall reseed, in accordance with Section 32 92 19, “Seeding, Soil Supplements, and Mulching”, all areas which have been disturbed by work on-site.

7. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct, on the part of the Contractor in the execution of the work, such property shall be restored by the Contractor, at his expense, to a condition equal to that existing before such damage or injury was done, or he shall make good such damage or injury in such other manner as may be acceptable to Owner.

8. On-site burning shall not be permitted.

B. Clearing

1. Clearing operations shall consist of the complete removal and disposal of all trees, brush, and vegetation. Trees and other vegetation in areas to be cleared shall be cut within 1-½ inches of the ground surface.

2. Trees and brush may be chipped for reuse during final grading.

C. Grubbing

1. Grubbing shall consist of the removal of all stumps, roots, and buried logs. All tap roots, lateral roots, or other projections over 2 inches in diameter shall be removed to a depth of 3 feet below the natural ground surface. All holes caused by grubbing operations shall be backfilled and graded in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

2. All disturbed areas shall be fertilized and seeded immediately upon establishing final grade in accordance with Section 32 92 19 “Seeding, Soil Supplements, and Mulching”. The Contractor shall be responsible for implementing adequate erosion and sedimentation control measures during the course of construction in accordance with Section 01 35 10, “Environmental Protection”.

D. Waste Disposal

All wastes and debris generated by the site preparation activities shall be disposed of off-site in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of aggregate for access roads, construction laydown area, and for the subgrade of roadways.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 03 40 00 | Pre-Cast Concrete |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 31 05 19 | Geotextiles |
| 32 12 17 | Hot Mix Bituminous Pavement |

## 1.3. REFERENCES

A. The publication listed below form a part of this specification to the extent referenced. The publication shall be the latest edition and is referred to within the text by the basic designation only.

1. Maryland State Highway Administration (MD SHA)

a. 2008 Standard Specifications for Construction and Materials

B. References shall also include those listed within the MD SHA specifications, such as MSTM, AASHTO, and ASTM.

## 1.4. SUBMITTALS

Submit for following in accordance with Section 01 33 00, “Submittals”.

A. List of materials to be used, including sources and suppliers

B. Test reports for aggregates and other materials

## 1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

B. Modification of References

Where term “Engineer” or “State” is used in MD SHA Standard Specifications, it shall be construed to mean “Owner”.

1.6. DELIVERY, STORAGE, AND HANDLING

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall be handled in a manner that ensures delivery in sound, undamaged condition.

PART 2. PRODUCTS

2.1. FILL

Fill shall be select or common as defined in Section 31 00 00, “Excavation, Backfill, and Compaction”, and soil or gravelly materials free of debris, peat, contamination, or excess moisture. Fill may be imported, excavated from the access road drainage ditches and excess excavation from site grading and construction.

2.2. BEDDING

Bedding material for piping and utilities shall be granular material consisting of the appropriate aggregate for each utility as described in the MD SHA “Standard Specifications for Construction and Materials” and the gradation confirmed via AASHTO Test Method T-27.

2.3. GEOTEXTILE

Geotextile shall be in accordance with Section 31 05 19, “Geotextiles”.

2.4. ROADWAYS OR WALKWAYS

Subgrade: Materials for subgrade and base course construction shall be in accordance with MD SHA’s “Standard Specifications for Construction and Materials”.

Surface Course: Adhere to Section 32 12 17 “Hot Mix Bituminous Pavement“ for asphalt roads.

PART 3. EXECUTION

3.1. PREPARATION

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 “Excavation, Backfill, and Compaction”.

3.2. CONSTRUCTION

A. Geotextile: Geotextile shall be in accordance with Section 31 05 19, “Geotextiles”.

B. Subgrade: Lay down in an 8-inch loose layer and method compact to no less than 95% of maximum dry density (ASTM D 1557 or AASHTO T-180). Compaction testing should be performed by Contractor, as well as proof roll testing for stability.

C. Surface Courses: Adhere to Section 32 12 17 “Hot Mix Bituminous Pavement“ for asphalt roads. Surfacing shall be sloped to prevent adequate drainage.

3.3. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

3.4. RESTORATION OF SURFACES

A. Disturbed areas shall be revegetated in accordance with Section 32 92 19, “Seeding, Soil Supplements, and Mulching”.

B. Damaged surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

C. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

3.5. MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted at the end of the project.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of asphalt surface courses of roadways.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 32 11 23 | Aggregates and/or Graded-Crushed Aggregate for Roadways |

1.3. REFERENCES

A. The publication listed below form a part of this specification to the extent referenced. The publication shall be the latest edition and is referred to within the text by the basic designation only.

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

B. References shall also include those listed within the MD SHA specifications, such as AASHTO, ASTM, Maryland State Method of Test (MSMT) and the Asphalt Institute (AI).

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”.

A. Product Data: List of materials and formula to be used, including sources, suppliers, and laboratory

B. Lab Data: Test report for mix formula and materials, including grain size chart

1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

B. Modification of References

Where term “Engineer” or “state” is used in MDSHA Standard Specifications, it shall be construed to mean Owner.

1.6. DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.7. ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the ambient air and surface temperatures are at least 40 degrees F and rising. Place mixtures used as intermediate and base layers when the ambient air and surface temperatures are at least 32 degrees F and place polymer modified surface mixes when the ambient air and surface temperatures are at least 50 degrees F.

1.8. CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory within 12 months of commencing work.

PART 2. PRODUCTS

2.1. AGGREGATES AND MINERAL FILLER

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

A. Coarse Aggregates, Fine Aggregates, and Mineral Filler shall meet MD SHA grading requirements based on the selected mix design.

B. Aggregate physical property requirements shall meet the requirements provided by MD SHA.

2.2. ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to Viscosity Grade, Performance Grade, and Penetration Grade specified by MD SHA for the specified performance grade. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Owner. The supplier is defined as the last source of any modification to the binder.

2.3. MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a Superpave mix design has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. All mix designs must be field verified.

2.4. RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI

MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP allowable shall be determined in conformance with MSMT 412 and M323. Crushed glass my not be used in surface mixes

## PART 3. EXECUTION

### 3.1. PREPARATION

A. The job mix shall be delivered to the site per MD SHA Specifications. The material shall be delivered heated at a uniform temperature to avoid local overheating, and shall be free of moisture.

B. Surface Preparation of Underlying Course: Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter using cleaning methods as necessary. If the time period between the placements of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty, clean between lifts and apply a tack coat.

C. Spraying of Contact Surfaces: Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

### 3.2. PLACEMENT

Machine spreading; shoveling, raking, and tamping; and hand-spreading (in lieu of machine-spreading) shall conform to MD SHA Standards and Specifications.

### 3.3. COMPACTION OF MIXTURE

A. Compact the mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot.

B. Before continuing rolling, correct variations by removing or adding materials as necessary.

C. Refer to MD SHA Specifications for additional instructions, ASTM and AASHTO requirements, and restrictions.

### 3.4. JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.5. FIELD QUALITY CONTROL

A. Contractor (or asphalt subcontractor) is responsible for sampling and approving the source/plant samples (MSMT 451, Method A) per MD SHA Specifications. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

B. Contractor (or asphalt subcontractor) is responsible for field verification via coring method MSMT 459. A MD SHA certified technician is required to perform QA/QC testing. Contractor (or asphalt subcontractor) is responsible for sampling and approving field mixture samples (MSMT 457) per MD SHA Specifications.

3.6. PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F.

END OF SECTION

PART 1. GENERAL

1.1. REFERENCES

Furnish all labor, materials, equipment, and incidentals necessary to perform all seeding, and mulching as shown on the Contract Drawings and described in the Technical Specifications. This work shall include, but not be limited to final grading, tilling and cleaning the seed bed; seeding; fertilizing; mulching; specified watering; and maintaining the seeded area through the required mowings. The areas to be seeded and mulched include: areas cleared and grubbed, storage areas, backfill areas, and areas around proposed Block G swale location.

Note: Should the Contractor wish to sod rather than seed, the Contractor shall provide a sodding specification to the Owner for review and approval before sodding.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |

1.3. REFERENCES

The publication listed below form a part of this specification to the extent referenced. The publication shall be the latest edition and is referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 602 (2007) Agricultural Liming Materials

ASTM D 4427 (2007) Peat Samples by Laboratory Testing

ASTM D 4972 (2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications of Construction and Materials

1.4. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 “Submittals”:

A. Product data for seed formula demonstrating testing, purity, and germination.

B. Laboratory testing of on-site or borrowed topsoil with soil amendment recommendations.

PART 2. PRODUCTS

2.1. MATERIALS

A. Seed shall meet the MD SHA requirements for testing, purity, and percent germination:

B. Fertilizer shall be a commercial fertilizer supplied in 50 lb. bag or bulk. Fertilizer supplied in bulk form shall be accompanied with a certification giving the analysis and weight.

C. All soil conditioners shall be horticultural grade.

D. Mulch shall be either small grain straw or for hydro mulching shall be commercially available wood cellulose fiber or wood pulp for use in spray applicators. Mulch shall be free of noxious weeds.

E. On-Site Topsoil: Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Topsoil Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 “Excavation, Backfill, and Compaction”.

F. Off-Site Topsoil: Conform to requirements specified in paragraph entitled "Topsoil Composition." Additional topsoil shall be furnished by the Contractor.

G. Erosion and Sediment (blanket, fabric, netting) shall conform to Section 33 40 00 “Storm Drainage Utilities”.

H. Topsoil is subject to the requirements of the MD SHA 2008 Specifications for Construction and Materials. Topsoil shall be stockpiled separately from common fill. All topsoil shall meet the following additional requirements:

1. Contractor to provide required representative samples to an independent testing agency for analysis and recommended treatment, including payment of all costs incurred for testing and analysis.

2. Test reports shall include specific recommendations regarding exact types, time and rates of application of soil additives and fertilizers based upon soil test results and type of material to be planted. Include the following in topsoil analysis:

    a. pH factor
    b. Percent organic matter
    c. Soluble salts
    d. Available nutrients
    e. Percent clay, sand and silt particles

3. Before delivery of imported topsoil, furnish the Owner’s representative with a written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owner(s), analysis of topsoil, depth to be stripped, previously used herbicides, and crops grown during past 2 years.

4. All topsoil shall be screened, natural, fertile agricultural soil capable of sustaining vigorous plant growth, not in frozen or muddy condition. Imported topsoil shall be typical of locality and shall come from a well-drained site free of flooding, not from bogs or marshes. Topsoil is to be free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and

foreign matter. Visually or mechanically screen material prior to re-spreading operation.

5. Topsoil: pH range of 6.0 to 7.5, a minimum of 1.5 percent organic material content; free of stones 3/4 inch or larger in any dimension and meeting the following requirements.

   a. Sand Content: 2.000 mm to 0.05 mm, greater than 60%
   b. Silt Content: 0.05 mm to 0.005 mm, greater than 30% silt plus clay
   c. Clay Content: 0.005 mm and smaller, less than 40%.

6. Screening: No more than 60% of material passing #100 mesh consists of clay as determined by Bouyoucous hydrometer or by decantation method. Mechanically screen topsoil to conform to following gradations:

| | SIEVE DESIGNATIONS | % PASSING |
|---|---|---|
| a. | 3/4" | 100% |
| b. | 1/4" | 97-100% |
| c. | #200 | 20-65% |

These limits may be modified as recommended by the nursery or testing laboratory.

## PART 3. EXECUTION

### 3.1 SEEDING AND MULCHING

A. Seeding

1. Lawn Area - Apply SHA “Turfgrass” seed mix (or a fescue/ryegrass/bluegrass mix that visually matches the existing turf) at 3 lbs./1000 square feet for the period of March 1 thru October 31. Substitute winter ryegrass for perennial ryegrass for the period of November 1 thru February 28.

2. Apply seed uniformly with a cyclone seeder, drill, cultipacker seeder or hydroseeder (slurry includes seed and fertilizer) on a firm, moist seedbed. Maximum seeding depth should be ¼ inch on clayey soils and ½ inch on sandy soils, when using other than hydroseeder method of application.

3. Apply seed within twenty four hours after seed bed preparation. Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

4. Seeding must be accomplished in a time frame that allows seed germination prior to October 15.

B. The contractor shall fine grade and remove all sticks, stones, debris, clay lumps, sod clods, and other undesirable materials in the top three inches of soil. The top three inches of soil shall be loosened by raking, discing, or other acceptable means before seeding. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. The Owner shall approve the seed bed prior to seeding.

C. Soil Amendments: Soil amendments shall adhere to the recommendations of the testing lab or nursery. A typical mix for seeding is as follows: apply 800 lbs/1000 sq. yds. of pulverized agricultural limestone, 192 lbs/1000 square yards of 10-20-20 commercial analysis fertilizer and 50 lbs/1000 square yards of 38-0-0 urea form fertilizer.

D. Mulching:

1. Straw shall be un-rotted small grain straw applied at 125-140 lbs/1000 square feet. Mulch materials shall be relatively free of all kinds of weeds. Spread uniformly by hand or mechanically for uniform distribution of hand spread mulch, divide area into approximately 1,000 square yards section and place 125-140 pounds of mulch in each section.

2. Wood cellulose mulch shall be applied via hydro-mulching at a rate of 1,250 pounds per acre.

E. Watering: Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

F. Restoration: Restore to original condition existing turf areas which have been damaged during construction operations at the Contractor's expense.

G. Seeded lawn areas shall be maintained by the Contractor and shall be guaranteed for a period of one (1) year. Maintenance may include aeration, mowing, dethatching, or overseeding, In the event previously seeded areas fail to establish an adequate ground cover, the Contractor shall redo this work to the satisfaction of the Owner.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

Provide soil preparation, fertilizing, tree, shrub, groundcover, and planting, staking and guying, weed control fabric, erosion control material and root control barrier installation and a mulch topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 92 19 | Seeding, Soil Supplements, and Mulching |

1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300 (1995) Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance

ANSI Z133.1 (2006) Arboricultural Operations - Safety Requirements for Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush

ANSI Z60.1 (1996) Nursery Stock

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA P5 (2005) Standard for Waterborne Preservatives

AWPA T1 (2004; R 2005) Use Category System: Processing and Treatment Standard

AWPA U1 (2004; R 2005) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A 580/A 580M (2008) Standard Specification for Stainless Steel Wire

ASTM C 602 (2007) Agricultural Liming Materials

ASTM D 1972 (1997; R 2005) Standard Practice for Generic Marking of Plastic Products

ASTM D 4427 (2007) Peat Samples by Laboratory Testing

ASTM D 4972 (2001; R 2007) pH of Soils

ASTM D 5268 (2007) Topsoil Used for Landscaping Purposes

ASTM D 5539 (1994; R 2008) Seed Starter Mix

ASTM D 5852 (2000; R 2007) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method

ASTM D 6629 (2001; R 2007) Selection of Methods for Estimating Soil Loss by Erosion

L.H. BAILEY HORTORIUM (LHBH)

LHBH (1976) Hortus Third

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.4. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 “Submittals”:

A. Product data including graphics for trees and shrubs, including botanical names, common names, quality, fungicide and pesticide treatment, and size.

B. Nursery certifications, warranties, and plant care data

C. Product data or samples for other materials (pea gravel, weed control fabric)

1.5. DELIVERY, STORAGE, AND HANDLING

A. The Owner will inspect plant materials at the project site and approve them upon delivery. Plants shall be tagged for size and quality.

B. Branched Plant Delivery: Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

C. Soil Amendment Delivery: Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, gypsum, sulfur, iron, and lime may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates.

D. Plant Labels: Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels shall be legible for a minimum of 60 days after delivery to the planting site.

E. Store and protect plants not planted on the day of arrival at the site as follows:

1. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

2. Heel-in bare root plants.

3. Protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

4. Keep plants in a moist condition until planted by watering with a fine mist spray.

5. Do not store plant material directly on concrete or bituminous surfaces.

F. Root Control Barrier and Weed Control Fabric: Store materials on site in enclosures or under protective covering in dry location. Store under cover out of direct sunlight. Do not store materials directly on ground.

G. Handling: Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem. Remove damaged plants from the site.

H. Time Limitation: Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch shall be a maximum of 24 hours.

1.6. TIME RESTRICTIONS AND PLANTING CONDITIONS

A. Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

B. Plant all plants between March 1 and October 31. All plantings not within the March-October timeframe must first obtain approval from the Owner. Do not plant when ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7. GUARANTEE

All plants shall be guaranteed for at least one year beginning on the date of inspection by the Owner to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period. Transplanted plants require no guarantee.

## PART 2. PRODUCTS

2.1. PLANTS

A. Regulations and Varieties: Furnish nursery stock in accordance with ANSI Z60.1, except as otherwise specified or indicated. Each plant or group of planting shall have a "key" number indicated on the nursery certifications of the plant schedule. Plants specified shall be low maintenance varieties, tolerant of site's existing soils and climate. Plants of the same specified size shall be of uniform size and character of growth. Plants shall be chosen with their mature size and growth habit in mind to avoid over-planting and conflict with other plants, structures or underground utility lines. All plants shall comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

B. Shape and Condition: Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

C. Growth of Trunk and Crown: A height to caliper relationship shall be provided in accordance with ANSI Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

D. Deciduous Trees and Shrubs: Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

E. Evergreen Trees and Shrubs: Well developed symmetrical tops with typical spread of branches for each particular species or variety.

F. Ground Covers and Vines: Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section. Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANSI Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

G. Root Ball Size: All box-grown, field potted, field boxed, collected, plantation grown, bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls shall conform to ANSI Z60.1. All wrappings and ties shall be biodegradable. Root growth in container grown plants shall be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

H. Mycorrhizal fungi inoculums: Before shipment, root systems shall contain mycorrhizal fungi inoculum.

2.2. TOPSOIL

A. Refer to Section 32 92 19 “Seeding, Soil Supplements, and Mulching” for topsoil and soil supplement requirements.

B. Planting Soil Mixtures shall be 100% topsoil with plant-specific additives as recommended by the nursery (i.e. peat, lime, clay, vermiculite, etc)

2.3. FERTILIZER

Fertilizer for groundcover, wildflowers and grasses are not permitted for the trees, plants, or shrubs described in this section. Use fertilizer for trees, plants, and shrubs as recommended by the nursery. Synthetic chemical fertilizers are not permitted. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not permitted.

2.4. WEED CONTROL FABRIC

Roll Type Polypropylene or Polyester Mats: Fabric shall be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric shall be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight shall be 5 ounces per square yard with a minimum thickness of 20 mils with a 20 year (minimum) guarantee.

2.5. MULCH

Refer to Section 32 92 19 “Seeding, Soil Supplements, and Mulching” for mulching requirements. Mulch shall be free from noxious weeds, mold, pesticides, or other deleterious materials.

2.6. STAKING AND GUYING MATERIAL

A. Staking Material:

1. Tree Support Stakes: Rough sawn, hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes shall be minimum 2 inches square by 8 feet long, pointed at one end.

2. Ground Stakes: 2 inches square by 3 feet long, pointed at one end

B. Guying Material:

1. Guying Wire: 12 gauge annealed galvanized steel, ASTM A 580/A 580M.

2. Guying Cable: Minimum five-strand, 3/16 inch diameter galvanized steel cable [plastic coated].

3. Hose Chafing Guards: New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

C. Flags: White, 12 inches long, fastened to guying wires or cables.

D. Turnbuckles: Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts shall be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1 1/2 inches, minimum.

E. Deadmen: 4 by 8 inch rectangular or 8 inch diameter by 36 inch long, pine wood material.

F. Metal Anchors, Driven: Malleable iron, arrow shaped, galvanized, sized 3 to 10 inches for tree calipers 2 to 12 inches, respectively.

G. Screw Anchors: Steel, screw type with welded-on 3 inch round helical steel plate, minimum 3/8 inch diameter, 15 inches long.

2.7. ANTIDESICCANTS

Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film shall form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity.

2.8. EROSION CONTROL MATERIALS
Refer to Section 01 35 10 “Environmental Protection” for Erosion and Sediment Practices.

2.9. ROOT CONTROL BARRIER

Flexible and permeable geotextile fabric with permanently attached time-released nodules. Pre-formed barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material. Color to be black or grey.

2.10. WATER
Source of water to be suitable quality for irrigation and shall not contain elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

2.11. MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.12. PESTICIDES

Pesticides and herbicides are not permitted unless approved by the Owner. An Integrated Pest Management Plan shall be submitted if an approval as requested.

2.13. LANDSCAPE GRAVEL

Landscape gravel “pea gravel” shall match the existing on-site landscape gravel in size, shape, and color.

PART 3. EXECUTION

3.1. PREPARATION

A. Protection: Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

B. Layout: Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Owner reserves the right to adjust plant material locations to meet field conditions. Do not plant closer than 24 inches to a building wall or other similar structure. Provide on-site locations for excavated rock, soil, and vegetation.

C. Erosion Control: Provide erosion control and seeding with native plant species to protect slopes.

D. Soil Preparation: Apply pH adjuster and soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site.

E. Fertilizer Application Rates: Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site or as recommended by the nursery.

F. Root Control Barrier: Install geotextile fabric in the soil in a horizontal application. Use appropriate holding device to assure fabric position. A minimum 2 inch soil cover is required over the top edge. A minimum 18 inch extension of fabric beyond the structure area to be protected is required to prevent root growth from growing around fabric edges.

3.2. PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. Protect existing adjacent turf before excavations are made. Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Depth of plant pit excavation shall be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph entitled "Plant Installation." Do not install trees within 10 feet of any utility lines or building walls unless coordinated with the Contract Officer.

3.3. PLANT INSTALLATION

A. Individual Plant Pit Excavation: Excavate pits at least twice as large in diameter as the size of ball or container to depth shown.

B. Plant Beds with Multiple Plants: Excavate plant beds continuously throughout entire bed as outlined to depth shown.

C. Handling and Setting: Move plant materials only by supporting the root ball or container. Set plants on hand compacted layer of prepared backfill soil mixture 6 inches thick and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, 1 to 2 inches below depth at which they were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

D. Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas.

E. Balled and Burlapped Stock: Backfill with topsoil to approximately half the depth of ball and then tamp and water. Carefully remove or fold back excess burlap and tying materials from the top a minimum 1/3 depth from the top of the rootball. Tamp and complete backfill, place mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit prior to backfill operations.

F. Bare-Root Stock: Plant so roots are arranged in a natural position. Place roots in water a minimum of 30 minutes prior to planting. Carefully work topsoil among roots. Tamp remainder of backfill, place mulch topdressing and water.

G. Container Grown Stock: Remove from container and prevent damage to plant or root system.

H. Ground Covers and Vines: Plant after placing mulch topdressing. Do not remove plant materials from flats or containers until immediately before planting. Space at intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 6 inches without run off or puddling. Smooth planting areas after planting to provide even, smooth finish. Mulch as indicated.

I. Earth Mounded Watering Basin for Individual Plant Pits: [Form with topsoil around each plant by placing a mound of topsoil around the edge of each plant pit. Watering basins shall be 6 inches deep for trees and 4 inches deep for shrubs. Construct watering basin in a 4 1/2 foot diameter circle around specimen (not planted in a close group) trees and shrubs.

J. Weed Control Fabric Installation: Remove grass and weed vegetation, including roots, from within the area enclosed by edging. Completely cover landscape areas with specified weed control fabric prior to placing mulch or landscape gravel layer. Overlap cut edges 6 inches.

K. Erosion Control Material: Install in accordance with manufacturer's instructions.

L. Placement of Mulch Topdressing: Place specified mulch topdressing on top of weed control fabric covering total landscape area (non-pea gravel areas). Place mulch topdressing to a depth of 3 inches.

M. Installation of Edging: Edging is not proposed on this project.

N. Fertilization: Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth, or apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

O. Watering: Start watering areas planted as required by temperature and wind conditions. Slow deep watering shall be used. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 12 inches without run off or puddling. Watering of other plant material or adjacent areas shall be prevented.

P. Staking and Guying:

1. Staking: Stake plants with the number of stakes indicated complete with double strand of 12 gage guy wire as detailed. Attach guy wire half the tree height but not more than 5 feet high. Drive stakes to a depth of 2 1/2 to 3 feet into the ground outside the plant pit. Do not injure the root ball. Use hose chafer guards where guy wire comes in contact with tree trunk.

2. Guying: Guy plants as indicated. Attach two strands of guying wire or guying cable around the tree trunk at an angle of 45 degrees at approximately 1/2 of the trunk height. Anchor guys to deadmen wood blocks, wood ground stakes, malleable iron anchors, or steel screw anchors. Provide turnbuckles as indicated.

3. Chafing Guards: Use hose chafing guards, as specified where guy wire or cable will contact the plant.

4. Deadmen: Place deadmen minimum 18 inches below ground surface. Place equal distance from tree trunk and around the plant pit.

5. Wood Ground Stakes: Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.

6. Iron Anchors: Drive malleable iron anchors into firm ground outside of plant pit a minimum 30 inches below finish grade. Place equal distance from tree trunk and around the plant pit.

7. Steel Screw Anchors: Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.

8. Flags: Securely fasten flags on each guy wire or cable approximately two-thirds of the distance up from ground level.

Q. Pruning: Prune in accordance with safety requirement of ANSI Z133.1.

1. Trees and Shrubs: Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars shall remain in place. Pruning shall be accomplished by trained and experienced personnel and shall be accordance with ANSI A300.

2. Wound Dressing: Do not apply tree wound dressing to cuts.

3.4. CLEAN UP

Excess and waste material shall be removed from the installed area and shall be disposed offsite.

3.5. ESTABLISHMENT AND MAINTENANCE

Landscape areas shall be maintained by the Contractor and shall be guaranteed for a period of one (1) year. In the event the landscape vegetation fails to establish or if weed breakthrough occurs within this time period, the Contractor shall redo this work to the satisfaction of the Owner.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of storm drainage utilities. This Section includes gravity-flow, non-pressure storm drainage outside the building, with the following components:

1. Piping and Fittings
2. Precast concrete manhole, storm water detention outlet structure
3. Frame/cover for manhole & catch basin, grating cover & trash rack
4. Installation of manhole and stormwater detention outlet structure
5. Capping existing catch basin grate
6. Core-drill existing catch basin and connect it to the proposed storm drain
7. Extend existing culvert and connect it to the manhole
8. Erosion protection at the outlet of the storm drains and emergency spillway

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 03 40 00 | Pre-Cast for Concrete |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 31 03 00 | Off-site Waste Disposal |
| 31 03 00 | Dewatering and Water Control |

## 1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C 1433 | (2008) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers |
| ASTM C-361 | (2011) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe |
| ASTM C 443 | (2005ae1) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C 478 | (2009) Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C 76 | (2010a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |

| | |
|---|---|
| ASTM C 923 | (2008) Standard Specification for Resilient Connectors Btween Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C 94/C 94M | (2009a) Standard Specification for Ready-Mixed Concrete |
| ASTM C 990 | (2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C 1478 | (2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-60005 | (Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole |

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00: “Submittals”:

A. Shop Drawings: Precast concrete structures, Metal items such as frames, covers, and gratings

B. Product Data: Pipeline materials including any special connectors or branches, gaskets, resins, mastic, riprap for outlet protection, flared-end section, erosion control mattings

C. Core-drill Method and Equipment

D. As-Built Drawings: Submit As-Built Drawings signed and sealed by a Professional Surveyor for the storm sewer systems including the final grades of the stormwater detention area showing complete detail with all dimensions, both above and below grade, invert elevations, and other utility crossings.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manhole according to manufacturer's written rigging instructions.

D. Handle drainage inlet according to manufacturer's written rigging instructions.

1.6. PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Engineer's written permission.

1.7. QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage systems.

B. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered.

PART 2. PRODUCTS

2.1. PIPING MATERIALS

A. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), Class IV, Wall B, for gasketed joints.

1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

B. Principal spillway barrels shall meet ASTM C-361, Class IV. The designation C-361 must be stated on the profile through the principal spillway. A certification letter with the test results shall be furnished to the purchaser upon delivery.

2.2. MANHOLE AND CATCH BASIN

A. Junction Box and Storm water Outlet Structure including frame/cover shall be in accordance with the Construction Drawings.

2.3. CONCRETE MATERIALS

A. Concrete
Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements under Section 03 40 00 "Pre-Cast Concrete".

B. Cement Mortar

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

C. Portland Cement
Portland cement shall conform to ASTM C 150/C 150M, Type II or concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking. Air-entraining admixture conforming to ASTM C 260 shall be used with Type V cement.

D. Portland Cement Concrete
Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for

manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psi minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

E. Pre-Cast Reinforced Concrete Structures
Manufactured in accordance with Section 03 40 00 “Pre-Cast for Concrete”, and in accordance with and conforming to ASTM C 1433 and to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure. The first riser shall be monolithic.

2.4. PIPE OUTLETS AND EMERGENCY SPILLWAY

A. Modified Riprap Inflow Protection, Flared-End-Section, Stone, Filter Cloth, and Matting to match size and shape as shown on Construction Drawings.

2.5. SOIL STABILIZATION MATTING

A. Products that meet the MDE standards and specifications and approved by the Owner.

1. Temporary soil stabilization matting shall have a minimum shear stress of 2 $lb/ft^2$ and be acceptable on slopes of 2:1 or flatter, where natural vegetation will provide permanent stabilization. Example Products: North American Green SC150, Synthetic Industries Landlok CS2.

2. Permanent soil stabilization matting shall have a minimum shear stress of 7 $lb/ft^2$ and be acceptable on slopes steeper than 2:1 and in channels, where natural vegetation will not provide long term stabailization. Example Products: North American Green P300 and P550 (vegetated), and Colbond Enkamat 7010 and 7020 (vegetated).

PART 3. EXECUTION

3.1. EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 00 00.

3.2. PIPING APPLICATIONS

A. General: Include soil tight joints, except where watertight or silt tight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following to manufacturer's recommendations.

3.3. INSTALLATION, GENERAL

A. General Locations and Arrangements: Construction Drawings indicate the general location and arrangement of underground drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations

for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where fittings are indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity flow systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

F. Install drainage piping pitched down in direction of flow, at slope and cover indicated.

3.4. PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Concrete Pipe and Fittings: Install according to ACPA "Concrete Pipe Handbook." Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets.

B. All joints and connections must be water tight and shall be approved by the engineer. And Baltimore County Department of Environment Protection and Resource Management (DEPRM) prior to fabrication.

3.5. CONCRETE PLACEMENT

A. Place Pre-Cast concrete as indicated.

3.6. CATCH BASIN & MANHOLE INSTALLATION

A. Construct catch basins to the location indicated.

B. Set frames and grates to elevations indicated.

3.7. IDENTIFICATION

A. Materials and their installation are specified in Section 31 00 00 Excavation, Backfill, and Compaction. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over piping as indicated on the Construction Drawing or 16” above the pipe.

3.8. FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.

2. Place plug in end of incomplete piping at end of day and whenever work stops.

3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visual between structures.
b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

## 3.9. SOIL STABILIZATION MATTING

A. The Contractor shall provide soil stabilization matting on all slopes of 3:1 or steeper per manufacturers instruction.

B. The Contractor shall provide soil stabilization matting on the bottom and side slopes of the proposed swale as specified on the E&SC Plan.

END OF SECTION

# APPENDIX B—100% DESIGN FOR SOIL EXCAVATION – BLOCKS E AND G

# TECHNICAL SPECIFICATIONS

**FOR**

# DESIGN OF SWALE ABANDONMENT AND SUBSURFACE PIPELINE REPLACEMENT, BLOCK G SOUTHWESTERN TCE BIOREMEDIATION AREA

**AND**

# SOIL REMEDIAL EXCAVATION AT BLOCKS E AND G Middle River, Maryland

**FOR:**

## LOCKHEED MARTIN CORPORATION

Prepared by:
Tetra Tech, Inc.

March 2013

**LMC Middle River Complex Design of Swale Abandonment and Subsurface Pipeline Replacement, Block G Southwestern TCE Bioremediation Area and Soil Remedial Excavation at Blocks E and G**

**Specifications Table of Contents**


**DIVISION 01 – GENERAL**

01 01 00 Scope of Work

01 02 00 Contractor Work Plan

01 31 00 Project Meetings & Coordination

01 33 00 Submittals

01 35 10 Environmental Protection

01 41 00 Regulatory Requirements

01 42 00 Abbreviations & Definitions

01 45 00 Quality Control

01 50 00 Temporary Facilities

01 55 00 Traffic Control

**DIVISION 02 – EXISTING CONDITIONS**

02 41 00 Demolition and Deconstruction

**DIVISION 03 - CONCRETE**

03 40 00 Pre-Cast Concrete

**DIVISION 31 - EARTHWORK**

31 00 00 Excavation, Backfill, and Compaction

31 00 01 Excavation Support and Protection

31 02 00 Off-site Waste Disposal

31 03 00 Dewatering and Water Control

31 05 19 Geotextiles

31 11 00 General Site Preparation (Clearing and Grubbing)

**DIVISION 32 - EXTERIOR IMPROVEMENTS**


32 11 23 Aggregate and/or Graded-Crushed Aggregate For Roadways

32 12 17 Hot Mix Bituminous Pavement

32 92 19 Seeding, Soil Supplements, and Mulching

32 93 00 Exterior Plants and Landscaping


**DIVISION 33 - UTILITIES**


33 40 00 Storm Drainage Utilities

# PART 1. GENERAL

## 1.1 SCOPE OF WORK

A. The Contractor shall provide all services and materials necessary for the installation of the Block G Swale, Design of Swale Abandonment, Subsurface Pipeline Replacement, and Soil Remedial Excavation at Blocks E and G, located at Southwestern TCE Bioremediation Area, Middle River, Maryland as shown in the Technical Drawings.

1. List of Technical Drawings, Block G Swale Replacement

| | | |
|---|---|---|
| a. | G-1 | Cover Sheet |
| b. | G-2 | Notes and Legend |
| c. | C-1 | Existing & Demolition Site Plan |
| d. | C-2 | Site Layout Plan |
| e. | C-3 | Site Grading Plan and Profile |
| f. | C-4 | Storm Water Management Details |
| g. | C-5 & 6 | Erosion and Sediment Control Plans |
| h. | C-7 & 8 | Erosion and Sediment Control Details |
| i. | C-9 | Seeding Specifications |

2. List of Technical Drawings, Soil Remedial Excavation at Blocks E and G

| | | |
|---|---|---|
| a. | G-1 | Cover Sheet |
| b. | G-2 | Notes and Legend |
| c. | C-1 | Existing Conditions Plan – Block E |
| d. | C-2 | Existing Conditions Plan – Block G |
| e. | C-3 | Excavation Plan – Block E |
| f. | C-4 | Excavation Plan – Block G |
| g. | C-5 | Site Restoration Plan – Block E |
| h. | C-6 | Site Restoration Plan – Block G |
| i. | C-7 | Erosion and Sediment Control Plan – Block E |
| j. | C-8 | Erosion and Sediment Control Plan – Block G |
| k. | C-9 | Details I |
| l. | C-10 | Details II |
| m. | C-11 | Seeding Specifications |

B. A Scope of Work is provided as Attachment A of this Section, and is provided to create a uniform Schedule of Values and Measurement of Payment. The Scope is broken down into the following structure:

Section 1: Mobilization and Demobilization
Section 2: Site Preparation and Temporary Facilities
Section 3: Site Work and Restoration

C. The work shall be complete and include furnishing, as applicable or required, all Contractor's safety devices, labor, tool, materials, supplies, and services; and performing all operations necessary for or incidental to a complete project in conformance with the attached Basis of Design Report, Technical Drawings, and Technical Specifications.

D. The Contractor shall furnish all labor, materials, equipment and incidentals to install the above listed systems and equipment, including the piping, wiring, and instrumentation interconnections between all specified components and auxiliary equipment.

E. Contractor shall be responsible for the field erection of materials oversized for shipment.

F. Contractor will provide one (1) year warranty for parts and workmanship, or as specified in the individual part warranties, whichever is greater.

1.2 REFERENCE SPECIFICATIONS

This section refers to all technical specification divisions.

1.3 SUBMITTALS

The Contractor shall submit the following to the Owner for review, comment, and approval prior to pre-construction conference in accordance with Section 01 33 00, “Submittals”:

A. Contractor’s markup drawings.

B. Product information for any proposed additions or changes per the Contractors markup drawings showing all important details, layout of components, materials of construction and dimensions.

SECTION 01 01 00

ATTACHMENT "A" – SCOPE OF WORK

Section 1: Mobilization and Demobilization

Mobilization and Demobilization consists of the following construction components:

1. Provide and Execute, the Contractor Work Plan, including Project Close-out.

2. Execute the Health and Safety Plan including quality control, spill control, health and safety, traffic control, and site security.

3. Provide permits, bonds, warranties, fees, insurance, and other similar expenses required by the contract.

4. Mobilization and Demobilization of all equipment, tools, materials, supplies, temporary facilities and utilities, and personnel required to perform the work.

5. Compliance with all regulatory requirements.

6. Pre-construction and construction period planning, management, scheduling, submittals, reporting, project closeout, administration and documentation.

7. Close out the project per the Contractor Work Plan, Health and Safety Plan, and Division 1 Specifications, including permits, and record drawings

8. All other requirements and miscellaneous items not included in other pay items.

Section 2: Site Preparation and Temporary Facilities

Site Preparation and Temporary Facilities consist of the following construction components:

1. Execute the Erosion and Sedimentation Control Plan, and provide and execute a Dewatering Plan.

2. Stake-out limits of construction locations and other important features such as proposed swale centerline, storm sewer pipe and outlet structure locations, and excavation limits.

3. Post project and safety signs, tree protection fencing, flagging, and other access restrictions.

4. Layout and construct the construction laydown area including stabilized construction entrance.

5. Set up the contractor's office (trailer with power and telephone connections if necessary).

6. Abandon/cap existing domestic water line as shown on the Technical Drawings.

7. Remove concrete foundation area as shown on the Technical Drawings.

Section 3: Site Work and Restoration

The Site Work and Restoration consist of the following components:

1. Furnish all earthwork for the proposed Block G swale excavation and site re-grading, as shown in the Technical Drawings and as described in the design report and technical specifications. This includes modifying the existing stormwater systems to be disturbed and constructing the new stormwater system.

2. Furnish all earthwork for the proposed soil remedial excavation at Blocks E and G, as shown in the Technical Drawings and as described in the technical specifications. This includes the excavation and direct loading of contaminated materials for offsite disposal. Areas to be used as trenches for the in-situ bioremediation groundwater remedy system will be excavated to widths larger than what is necessary for the remedy system and backfilled with material appropriate for the type of piping that will be used in the system.

3. Furnish all proposed exterior improvements such as seeding and sodding (topsoil) and landscaping per the technical drawings and specifications.

4. Repair or replace asphalt, fence, grass, trees, decorative planting, or other permanent site features that were disrupted during construction to visual acceptance or otherwise working condition. Resurface disturbed concrete surfaces in Block E and G with crushed stone as shown in the Technical Drawings and as described in the technical specifications.

5. Remove all remaining erosion and sediment control, dewatering, and temporary features once the site is stabilized.

6. Close out Erosion and Sediment Control Plan and Dewatering Plan as part of Project Closeout.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

The contractor shall provide a Work Plan (WP) a minimum of 10 days prior to the issuance of the Notice to Proceed. The WP shall identify project personnel and organization, equipment, material, instructions, records, forms, construction procedures, and schedule to be used and followed in performing the work in compliance with the Project Manual of this project.

1.2. RELATED SECTIONS

01 33 00 Submittals

1.3. CONTENTS OF THE WORK PLAN

The WP shall outline the overall construction sequencing and procedures to be followed during the site work activities. The plan shall contain a thorough and concise summary of how the work will be accomplished and shall include at a minimum:

A. Contractor's technical approach including work sequence, major milestones, health and safety, and general work procedures.

B. Construction Project Organization Chart showing lines of authority and responsibility. Number of personnel to be utilized on the job should be indicated in appropriate organizational elements. If significant changes in the organization are expected to occur during the life of the project or phases of construction, these should be discussed. Necessary substitutions, due to change of employment status and other unforeseen circumstances, must be submitted in writing for approval by the Owner prior to conducting work.

C. Names, qualifications, and work experience of all contractor supervisors, health and safety personnel, and employees with quality control responsibilities. If the personnel identified in the WP are not available at the start of the project, the Contractor shall submit, prior to mobilization, the names and qualifications of substitute personnel, with equal or more extensive experience, to the Owner Field Representative for approval.

D. Equipment to be utilized for the site activities.

E. Discussion of regulatory requirements applicable to the project and how compliance will be assured. Personnel training requirements should be listed and compliance demonstrated.

F. Proof of Contractors' permits required to successfully complete this Contract.

G. Procedures for scheduling and managing submittals. The schedule should identify the work tasks and completion date, and show the critical path to completion. The schedule should be prepared using Microsoft Project, or approved equivalent, and will be updated and submitted to the Owner every two weeks.

H. Provide names of personnel trained in spill control and list dedicated equipment to be provided on-site.

I. A description of provisions for controlling erosion, diverting surface run-off from excavations, and dewatering including pumping, if necessary.

J. Reporting procedures, including proposed reporting format.

K. Identification of proposed waste disposal facilities that are approved by the Owner.

L. An Air Monitoring Plan, containing at minimum:

a. A list of the air quality parameters to be sampled and the methods to be used for sampling. At minimum, the sampling should include Real Time Dust, Particulate Matter, Lead, Polyaromatic Hydrocarbons, and Mercury Vapor;
b. Copies of the Standard Operation Procedures, equipment list, equipment manuals, and forms to be used for the monitoring;
c. The proposed monitoring locations, including a map showing the locations;
d. The duration and frequency of monitoring;
e. Methodology for compensating for meteorological conditions; and
f. The Quality Assurance/Quality Control methodology to be used.

M. A Health and Safety Plan (HASP), meeting at minimum the requirement of the Occupational Safety and Health Administration requirements for the type of work to be performed and the requirements of the Owner. At minimum, the HASP must include:

a. An emergency action plan, which includes the procedures for response to an accident, the location of the nearest emergency facilities, and emergency numbers;
b. A list of personal protective equipment to be used for each task;
c. A site history;
d. A description of the scope of work to be performed;
e. Task specific hazards and safe work practices associated with these tasks;
f. A list of potential chemical hazards, and the appropriate controls;
g. A monitoring plan, as needed, for the hazards;
h. A site control plan;
i. A spill containment plan;
j. A list of the site specific training and medical monitoring requirements, including the information for every individual working on-site; and
k. All other pertinent information as required by federal, state, local, and Owner requirements.

1.4. NOTIFICATION OF CHANGE

After submittal of the WP, the contractor shall notify the Owner in writing, on a prescribed form, of any proposed change. At a minimum, the Contractor shall state the date and time of the submission of the form, the detailed description of the proposed change, the technical merit of the proposed change, the methods to implement the proposed change, the impact of the proposed change on other units or operations, the cost and schedule to implement the proposed change, and the person(s) of the Contractor and/or its subcontractor(s) who have proposed the change and will be responsible to implement the change.

1.5. SUBMITTALS

The Contractor shall submit the following to the Owner for approval in accordance with Section 01 33 00, “Submittals”:

A. Work plan, including Health and Safety Plan and Air Monitoring Plan.

B. Copies of Daily Log pages.

1.6. PROJECT ORGANIZATION

A. Site Manager

1. The Contractor shall designate a Site Manager, who shall be responsible for overall management of the WP and have the authority to act on behalf of the Contractor.

2. The Site Manager for this Contract shall be an individual experienced in hazardous materials remediation whose responsibility is to insure compliance with the Contract plans and specifications.

3. The Site Manager shall be on-site whenever work is in progress.

B. Personnel

1. A staff shall be maintained under the direction of the Site Manager to perform all project activities.

2. The personnel shall be fully qualified, by experience and technical training, to perform their assigned responsibilities and shall be hired directly by and work for the Contractor and its subcontractors.

1.7. CONTROL

The WP is the means by which the Contractor and the Owner are assured that the construction complies with the requirements of the Technical Drawings and Technical Specifications. The plan shall be adequate to cover all construction operations.

1.8. DOCUMENTATION

A. The Contractor shall maintain a daily log of work activities, including the work of suppliers and subcontractors. This log shall be in an acceptable form and indicate a description of trades working on the project, the number of personnel working, the weather conditions and delays encountered, and acknowledgement of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, the log shall include factual evidence that required activities have been performed, including, but not limited to, the following:

1. Type, number, and progress of activities.

2. All documentation and submittals that are required for the current activities.

3. Nature of defects, causes for rejection, etc.

4. Proposed remedial action.

5. Corrective actions taken.

6. Any proposed change(s) that are outstanding.

7. Schedule of current activities and upcoming activities within the next week.

B. The Log shall cover both conforming and defective or deficient features, and shall include a statement that supplies and materials incorporated in the work comply with the Contract. Legible copies of the log shall be furnished daily to the Owner's Representative. The Contractor shall keep records of the pre-final and final inspections, including a "punch list" of items which do not conform to the approved plans and specifications. For each item on this list, the Contractor shall document corrective actions taken.

1.9. NOTIFICATION OF NON-COMPLIANCE

The Owner will provide written notification to the Contractor of any non-compliance with the foregoing requirements. After receipt of such notice, the contractor shall immediately take corrective action. If the contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. GENERAL

The Contractor shall perform all work related activities in compliance with the WP.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Contractor is responsible for coordinating and communicating project activities with the Owner, and all lower tier subcontractors or other parties, including utility companies, as designated by the Owner.

This Section covers the requirements for the Pre-Construction Conference, Pre-Work Conference, and progress meetings. Also provided is a suggested agenda for the progress meetings.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 02 00 | Contractor Work Plan |
| 01 33 00 | Submittals |
| 01 45 00 | Quality Control |

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Sample Daily Progress Summary.

B. Sample Weekly Site Safety Summary.

C. Summary of Contractor’s Quality Control Plan.

D. Agenda for Progress Meetings.

E. Meeting Minutes from the Progress Meetings.

# PART 2. PRODUCTS

## 2.1. GENERAL

A. The choice of quantity and type of labor, materials, and construction equipment shall be at the discretion of the Contractor, but must be available in the quality and quantity to perform the work as specified in the Contract and schedule.

B. The Contractor shall furnish equipment which will be efficient and appropriate to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the project schedule. If at any time such equipment appears to the Owner to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Owner may order the Contractor to increase the efficiency, change the character, or increase the equipment, and the Contractor shall conform to such order. Failure by the Owner to give such an order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

## PART 3. EXECUTION

### 3.1. GENERAL PROCEDURES

A. Prior to beginning work the Contractor shall meet with the Owner and arrange the schedule for the project. Once the project is started, it shall be carried to completion without delay.

B. Phasing of work shall be clearly established and verified with the Owner prior to commencing work in any area. No cutting or removal work shall begin until authorized by the Owner.

C. Any utility service interruptions or outages required by the Contractor in performing the work shall be prearranged and shall occur only during those scheduled times.

### 3.2. PRE-CONSTRUCTION CONFERENCE

A. The Contractor shall meet with the Owner after the Award of Contract, but prior to the Notice to Proceed, to review and discuss submittal, safety, payrolls, labor relations, environmental protection, progress schedules, payment, and procurement of materials. The principle features of work shall also be reviewed and any questions regarding the contract and the work site will be addressed.

B. After this meeting but prior to the Pre-work Conference, the Contractor shall submit the Work Plan (WP) and Health and Safety Plan (HASP) to the Owner for review. The Contractor will also submit samples of the daily progress summary and the weekly site safety summary, and a brief summary of the Contractor's Quality Control Plan for review by the Owner prior to the Pre-work conference. The Contractor shall submit all required submittals to the Owner within ten (10) working days after the Pre-construction Conference.

C. The contractor must coordinate site work with the Owner, including, but not limited to, work hours, access, traffic controls, and security. Initial planning for the coordination should be discussed prior to the Pre-work Conference.

### 3.3. PRE-WORK CONFERENCE

A. After the Notice to Proceed has been issued and just prior to the mobilization to the site and commencement of work, the Contractor shall meet with the Owner on-site, ready to begin work. Attendance by the Contractor's superintendent, quality control personnel, safety personnel, and any major subcontractor's job superintendents will be required.

B. The purpose of the meeting is to define the Contractor's Quality Control Plan, to thoroughly review the WP, and to develop a mutual understanding of the specific requirements established by the contract. The specifics of the Contractor's HASP will be discussed so that the emergency and safety requirements are understood by all of those directly related to the site work. The schedule of work, particularly for the initial start-up period, will also be discussed. Questions concerning the administrative requirements outlined during the Pre-construction Conference or any other aspect of the project may also be addressed.

### 3.4. PROGRESS MEETINGS

A. The Contractor shall schedule progress meetings at a minimum of once per week. The Contractor will administer the progress meetings by preparing the agenda, preparing and distributing the minutes, and presiding at all meetings.

B. In attendance shall be the Contractor's Superintendent, Quality Control Supervisor, and Safety and Emergency Response Coordinator; any Subcontractors or Suppliers, as appropriate to the agenda; and others as appropriate.

C. Suggested agenda for the progress meeting(s) include, but are not limited to:

1. Review of work progress since the previous meeting.
2. Field observations, problems, and conflicts.
3. Problems which impede the project schedule and proposed corrective actions.
4. Review of off-site delivery schedule.
5. Corrective measures and procedures to regain projected schedule.
6. Updates to the project schedule.
7. Progress intended for the subsequent two weeks work period
8. Coordination of schedules.
9. Review submittal schedule.
10. Maintenance of quality and safety standards.
11. Pending changes and substitutions.
12. Review proposal changes for effect on project schedule and on completion date.
13. Any other applicable business.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Contractor shall provide timely four (4) sets, unless otherwise directed, of the submittals required by this Section for review, comment, and approval, as required or deemed necessary by the Owner.

## 1.2. RELATED SECTIONS

Related sections are listed in the attached Submittal Table.

## 1.3. SUMMARY OF SUBMITTALS

The submittals which the Contractor is required to provide include, but are not limited to, those summarized on the Submittal Table. The submission dates represent the minimum number of working days for prior to, and maximum number of working days for after, the referenced bench mark dates.

## 1.4. SHOP DRAWINGS, MANUFACTURER'S PRODUCT DATA, AND SAMPLES

A. Shop Drawings

1. Engineering data covering all equipment and fabricated materials that will become a permanent part of the work under this Contract shall be submitted for review. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation drawings, scheduled information, setting diagrams, actual shop-work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection, and test reports including performance curves and certifications, manufacturer's certificates, as applicable to the work.

2. To aid in expediting the project, shop drawings submitted by the Contractor's Subcontractors (i.e., Supplier, Manufacturer, etc.) for review shall be sent directly to both the Contractor and the Owner for preliminary checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.

3. The Contractor shall check all of his Subcontractors' shop drawings regarding measurements, size of members, materials, and details to satisfy themselves that they conform to the intent of the Technical Drawings and Technical Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the Subcontractor for correction before final submission to the Owner.

4. Each final submittal shall have affixed to it the following Certification Statement, signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data and I have checked and coordinated each item with other applicable reviewed shop drawings and all Contract requirements."

5. All deviations from the Technical Drawings or Technical Specifications shall be identified on each submittal and will be tabulated in the Contractor's letter of transmittal. Such submittal shall, as pertinent to the deviations, indicate essential details for all changes proposed by the Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

6. Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

7. Submittals shall be sequentially numbered, with re-submittals of the same or supplementary information numbered with the original submittal number and a "-Revision 1" for the second submittal, "-Revision 2" for the third submittal, and so forth.

B. Manufacturer’s Product Data

1. Manufacturer’s Product Data, as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliances and applicability, roughing in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

2. Manufacturer’s product data shall also include, if requested by the Owner, items of disposable clothing, safety equipment, breathing apparatus, communication devices, items of equipment to be used on the site, and any other items which are required for the safety and health of all personnel on the site. This information shall be submitted to the Owner's Site Representative to verify that the requirements for materials have been met. This information shall be required for, at a minimum, the concrete mix, crushed stone, excavation backfill material, seed mixture, gratings, and concrete manholes.

C. Samples

Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, and units of work to be used by the Owner for independent inspection and testing, as applicable to the work.

D. Submission Requirements

1. Coordination of Submittal Items

Prepare and transmit each submittal within the time specified in the individual work sections of the Specifications, so that the installation will not be delayed by

processing times including revision and re-submittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery, and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the work.

2. Number of Submittals Required

   a. Shop drawings: Submit four (4) copies.
   b. Manufacturer's Product Data: Submit four (4) copies.
   c. Samples: Submit four (4) pieces or the number stated in the respective Specification Sections or as directed by the Owner.
   d. All other submittals: Submit four (4) copies or pieces, unless stated elsewhere in the Technical Specification or as directed by the Owner.

3. All submittals, regardless of origin, shall have the following identification data, as applicable, contained thereon or permanently adhered thereto:

   a. Date of submission and dates of any previous submissions.
   b. Project Name and Contract Number.
   c. Contractor's name and address.
   d. Supplier's name and address.
   e. Manufacturer's name and address.
   f. Submittal or re-submittal number.
   g. Title or identification of submittal.
   h. References to applicable Section and part of the Technical Specification paragraphs or to applicable Technical Drawings.
   i. Contractor's Certification Statement.
   j. Deviations from Contract Documents, to be adequately stated.

E. Resubmission Requirements

Make any corrections or changes in the submittals required by the Owner and resubmit until approved.

F. Review of Shop Drawings, Manufacturer's Product Data, and Samples.

1. After review by the Owner, shop drawings, manufacturer's product data, and samples will be returned to the Contractor denoted with the following classifications:

   a. Approved.
   b. Approved except as noted. Re-submittal not necessary.
   c. Approved except as noted. Re-submittal necessary.
   d. Disapproved. Re-submittal necessary.
   e. Receipt acknowledged.
   f. Submittal not required.

2. Re-submittals will indicate any changes that have been made in addition to those requested by the Owner.

3. No portion of the work requiring a shop drawing, manufacturer's product data, or sample shall be commenced nor shall any material be fabricated or installed prior to review of that shop drawing, manufacturer's product data, or sample by the Owner

and the submittal returned to the Contractor denoted "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT NECESSARY". The Owner will not be responsible for any expense or delay due to Contractor's corrections or remedies required to accomplish conformity.

4. Any need for more than one re-submission, or other delay in obtaining Owner's review of submittals, will not entitle Contractor to a schedule extension.

5. It may be expected that the Owner will review and return submittals to the Contractor within seven (7) working days of their receipt by Owner.

G. Distribution

Distribute reproduction of shop drawings, manufacturer's product data, and samples returned to the Contractor marked "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT REQUIRED," where required, to the job site file and elsewhere as directed by the Owner.

1.5. CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall photographically record progress of construction on a biweekly basis and provide 3-1/2 inch x 5-inch glossy photographs and negatives.

B. Each photographic print shall have attached to the backing a label, approximately 4 inches wide by 2 inches high containing thereon in typed lettering:

1. Project name and Contract number.
2. Contractor's name.
3. Photographer's name.
4. Photographer's numbered identification of exposure.
5. Date and time of exposure.
6. Orientation of view.
7. Short description of view.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. GENERAL

The Contractor shall timely present all submittals in accordance with this Section.

| SUBMITTAL TABLE | | | |
|---|---|---|---|
| **SECTION** | **TITLE** | **LIST OF SUBMITTAL** | **SUBMISSION DATE** |
| 01 01 00 | Scope of Work | • Contractor's Markup Drawings<br>• Product information | • Prior to pre-work conference |
| 01 02 00 | Contractor Work Plan | • Contractor Work Plan<br>• Health and Safety Plan<br>• Air Monitoring Plan | • A minimum of 10 days prior to the issuance of the Notice to Proceed |
| 01 31 00 | Project Meetings & Coordination | • Sample Daily Progress Summary<br>• Sample Weekly Site Safety Summary<br>• Summary of Contractor's Quality Control Plan<br>• Agenda for Progress Meetings<br>• Meeting Minutes from the Progress Meetings | • Prior to the pre-work conference<br><br><br>• Weekly |
| 01 35 10 | Environmental Protection | • Erosion and Sediment Control Plan Modifications<br>• Spill Report<br>• Spill Control Plan | • Prior to pre-work conference<br>• Immediately upon the occurrence<br>• Prior to pre-work conference |
| 01 41 00 | Regulatory Requirements | • Grading Permit & Notifications<br>• Erosion and Sediment Control Permit | • Prior to pre-work conference |
| 01 45 00 | Quality Control | • Quality Control Plan<br>• Quality Control Project Summary Report | • Prior to pre-work conference<br>• Within 30 days of the final compliance inspection |
| 01 50 00 | Temporary Facilities | • Proposed temporary facilities information | • Prior to pre-work conference |
| 02 41 00 | Demolition & Deconstruction | • Preconstruction Submittals:<br>1. Existing Conditions Records & Survey Results<br>2. Certificates & Notification to Federal, State, Regional, & Local authorities, and the Owner<br>• Closeout Submittals; Receipts | • 10 days prior to commencement of work<br><br><br><br>• Within 30 days after the final compliance inspection |
| 03 40 00 | Pre-Cast Concrete | • Pre-cast Concrete Units: Shop Drawings, Design Details of Steel Reinforcement Size and Placement, Supporting Design Calculations, Manufacturer's Certificate<br>• Product Data including embedded items: trash rack, frame and cover, etc.<br>• Design Data and Test Reports | • Prior to pre-work conference<br><br><br><br>• At the time of delivery |

| | | | |
|---|---|---|---|
| 31 00 00 | Excavation, Backfill, & Compaction | • Product Data<br>• Laboratory Test Data<br>• Field Density Test Results | • At time of delivery<br><br>• Daily |
| 31 00 01 | Excavation, Support, & Protection | • Shop Drawings | • Prior to pre-work conference |
| 31 02 00 | Off-site Waste Disposal | • Name, Qualifications, and State Identification Numbers of the Proposed Off-site Waste Transportation<br>• Name, Location, Qualifications, and State Identification Number of the Proposed Off-site Disposal Facility.<br>• Shipment Manifests<br>• Certificate of Disposal<br><br>• Sampling and Analysis Plan | • Prior to pre-work conference<br><br><br><br>• Prior to any shipment of waste leaving the site<br>• Upon receiving receipt from off-site disposal facility<br>• Prior to pre-work conference |
| 31 03 00 | Dewatering & Water Control | • Dewatering Plan<br>• Field QC Reports and Photographs | • Prior to pre-work conference<br>• Weekly |
| 31 05 19 | Geotextiles | • Product Data Sheet | • Prior to pre-work conference |
| 32 11 23 | Aggregate &/or Graded-Crushed Aggregate for Roadways | • Product Data<br>• Test Reports | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 12 17 | Hot Mix Bituminous Pavement | • Product Data<br>• Laboratory Test Data | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 92 19 | Seeding, Soil Supplements, & Mulching | • Product Data<br>• Laboratory Test Data | • Prior to pre-work conference<br>• At time of delivery to site |
| 32 93 00 | Exterior Plants & Landscaping | • Product Data | • At time of delivery to site |

| | | | |
|---|---|---|---|
| 33 40 00 | Storm Drainage Utilities | • Shop Drawings<br>• Product Data<br>• Core-drill Method and Equipment<br>• As-built drawings | • Prior to pre-work conference<br><br>• Within 30 days of final compliance inspection |

END OF SECTION

# PART 1. GENERAL

## 1.1 SCOPE OF WORK

A. This Section describes the work required by the Contractor for the protection of the environment throughout the course of the project, except for those measures specifically set forth in other sections of these Specifications. Compliance with the provisions of this section by lower-tier subcontractors will be the responsibility of the Contractor. Items to be considered under this section are air, water, and land resources and shall include noise, equipment fuel management, land resource management, and management of other chemicals.

B. This section also details the requirements the Contractor and lower-tier contractors must follow regarding spill control procedures to be followed during completion of this project.

## 1.2 RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |

## 1.3 DEFINITIONS

Environmental protection shall be defined as the retention of the environment in its natural state, to the greatest extent possible, during the project implementation, and the enhancement of the natural appearance in its final condition.

## 1.4 SUBMITTALS

A. Should the Erosion and Sediment Control Plan (E&SCP) require a modification due to field conditions, the Contractor shall submit two copies of the proposed modifications to the E&SCP to the Owner for approval in accordance with Section 01 33 00, “Submittals”.

B. Submit a spill report to the Owner immediately after the occurrence of such spill in accordance with Section 01 33 00, “Submittals”.

C. A spill control plan shall be submitted under this section with the Site-Specific Health and Safety Plan.

# PART 2. PRODUCTS

The Contractor shall provide all labor, equipment, and materials necessary for environmental protection that could arise as a result of Contractor activities or conditions during the course of this project.

## PART 3. EXECUTION

### 3.1 GENERAL

The Contractor shall be responsible for complying with all applicable federal, state, and local laws concerning the prevention, abatement, and control of all environmental pollution arising from the project activities in accordance with Section 01 41 00, “Regulatory Requirements”.

### 3.2 PROTECTION OF LAND RESOURCES

A. The Contractor shall confine project activities to work areas designated by the Owner and/or construction oversight firm, and, at all times, perform work in a manner that minimizes the interference with or the disturbance to fish, wildlife, and vegetation.

B. The Contractor shall implement measures to prevent lubricants, chemicals, and fuels from entering natural land features.

### 3.3 BURNING

Under no circumstances shall the burning of debris or waste materials be conducted at the site.

### 3.4 SPILL CONTROL

A. Contractor shall ensure that all tanks containing hazardous materials which are required to complete the activities presented herein are located on-site such that any spill would be confined/contained.

B. The Contractor shall follow appropriate federal, state, and local regulations applicable and/or relevant to spill control in accordance with Section 01 41 00, “Regulatory Requirements”.

C. The Contractor shall immediately report all hazardous materials spills to the Owner.

D. The Contractor shall be responsible for the timely cleanup of all hazardous materials spills and affected media, including the provision of all labor, equipment, and materials necessary for the cleanup. Cleanup of affected areas shall be subject to approval by the Owner.

### 3.5 TEMPORARY CONTROLS

A. All construction machinery and vehicles shall be equipped with practical sound-muffling devices and operated in a manner to cause the least noise, consistent with efficient performance of work. In addition, in order to minimize noise disturbances, the operation of machinery and large vehicles shall be confined to the hours of 8:00 a.m. to 7:00 p.m. Monday through Friday.

B. The Contractor shall maintain all excavations, stockpiles, access roads, waste areas, and all other areas free from dust to such a degree as to avoid causing a hazard or nuisance. Earth surfaces subject to dusting may be kept moist with water or dust may be controlled by other measures, if approved by Owner. Dusty materials in piles or in transit shall be covered to prevent blowing. The Contractor will maintain a mobile water tank complete with spray bar and pump on-site, if dust control is to be performed by water sprinkling.

C. The Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

D. Erosion and Sediment Control

1. The Contractor shall use the Erosion and Sediment Control measures specified on the technical drawings as the E&SCP, and shall specify additional applicable erosion and sediment control measures and Best Management Practices (BMPs) in accordance with the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control (MDE, 2011) The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations.

2. The Contractor shall obtain an approval of the Erosion and Sediment Control Plan and a Grading Permit through Baltimore County if required.

3. The Contractor shall use the Erosion and Sediment Control measures to control adverse effects from erosion and sedimentation during construction activities.

4. The Contractor shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. The Contractor shall design, construct, and maintain, as a minimum, the erosion control BMPs specified in the E&SCP. Protective erosion control measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations that will disturb the natural protection.

5. The Contractor shall construct or install temporary and permanent erosion and sediment control, as indicated on the drawings. BMPs may include, but not be limited to, vegetation cover, slope stabilization, silt fences, construction of terraces, interceptor channels, inlet and outfall protection, and diversion channels.

6. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and to maintain natural vegetation to the greatest extent possible. Any temporary measures shall be removed after the area has been stabilized.

3.6 NOTIFICATION OF NON-COMPLIANCE

Failure of the Owner to notify the Contractor of non-compliance does not relieve the Contractor of responsibility of compliance with the aforementioned federal, state, or local laws or regulations. In the event the Owner issues such a notice, the Contractor shall immediately inform the Owner of the proposed corrective action(s) and take such action(s) as may be appropriate. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost because of any such stop orders shall be made the subject of a claim for extension of time, or for excess costs or damages by the Contractor.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Contractor shall comply with all applicable federal, state, and local laws, ordinances, rules and regulations. The Contractor shall comply with all authorities having jurisdiction over the work. The list of regulations provided in this specification does not necessarily include all regulations which may be applicable to site activities and off-site transportation and disposal. All necessary permits or certificates of inspection shall be paid for and obtained by the Contractor.

## 1.2. REFERENCES

The following references are part of this specification to the extent referenced. These publications shall be the latest edition and are referred in the text by the basic designation only:

FEDERAL LAWS

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation and Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 94-469 | Toxic Substance Control Act (TSCA) of 1976, as amended |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 40 CFR 260 | Hazardous Waste Management Systems, General |
| 40 CFR 261 | Identification and Listing of Hazardous Wastes |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Wastes |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Wastes |
| 40 CFR 264 | Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 265 | Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 270 | Hazardous Waste Permits Program |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |
| 49 CFR 171 | General Information, Regulations, and Definitions |

| | |
|---|---|
| 49 CFR 172 | Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans |
| 49 CFR 173 | Shippers—General Requirements for Shipments and Packagings |
| 49 CFR 177 | Carriage by Public Highway |
| 49 CFR 178 | Specifications for Packagings |
| 49 CFR 180 | Continuing Qualification and Maintenance of Packagings |

STATE OF MARYLAND LAWS

Annotated Code of Maryland, Environmental (Consolidated)
Annotated Code of Maryland, Health (Consolidated)

STATE OF MARYLAND REGULATIONS

| | |
|---|---|
| Title 09 | Department of Labor, Licensing, and Regulation |
| Title 10 | Department of Health and Mental Hygiene |
| Title 26 | Department of the Environment |

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1 FEDERAL REGULATIONS

A. Conduct all site work in accordance with PL 91-596 and 29 CFR 1910.120, including hazardous waste cleanup or chemical spills.

B. Identify all hazardous wastes in accordance with all applicable Federal regulations, including PL 94-850/98-616 and 40 CFR 261.

C. Manage all hazardous wastes in accordance with all applicable Federal regulations, including PL 94-850/98-616, 40 CFR 260, and 40 CFR 262.

D. Transport all hazardous wastes in accordance with all applicable Federal regulations, including PL94-850/98-616, 40 CFR 263, 40 CFR 761, 49 CFR 171 through 49 CFR 173, 49 CFR 177, 49 CFR 178, and 49 CFR 180.

E. Dispose of all hazardous wastes at off-site facilities which are in compliance with all applicable Federal regulations, including PL 94-850/98-616, 40 CFR 264, 40 CFR 265, 40 CFR 270, and 40 CFR 761.

3.2 STATE REGULATIONS

A. All Contractor activities within the State of Maryland boundaries shall be in compliance with Maryland State labor laws.

B. Transportation and disposal of non-hazardous wastes must comply with the Maryland State Regulations.

C. Transportation of wastes through states other than Maryland shall be in compliance with all applicable requirements of those states.

D. Hazardous waste treatment and disposal facilities shall be in compliance with all requirements of the state in which they are operated.

3.3 LOCAL REQUIREMENTS

Ascertain and comply with all applicable county and municipal ordinances, codes, rules and regulations, and obtain all required permits including public health requirements, and seasonal load limits which may be imposed to cover transportation on certain roads. It is required to obtain a Grading Permit from Baltimore County, and Contractor shall adhere to the requirements of the permit.

END OF SECTION

PART 1. GENERAL

1.1. ABBREVIATIONS

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| ACPA | American Concrete Pipe Association |
| AFBMA | Anti-Friction Bearing Manufactures Association |
| AI | Asphalt Institute |
| ANSI | American National Standards Institute |
| ARAR | Applicable or Relevant and Appropriate Requirements |
| ASSE/SAFE | American Society of Safety Engineers |
| ASTM | ASTM International |
| AWPA | American Wood Protection Association |
| AWS | American Welding Society |
| BMP | Best Management Practices |
| cfm | Cubic feet per minute |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CRSI | Concrete Reinforcing Steel Institute |
| CSA | CSA Standards |
| DOT | Department of Transportation |
| E&SCP | Erosion and Sediment Control Plan |
| EPA | United States Environmental Protection Agency |
| F | Fahrenheit |
| gpd | gallons per day |
| gpm | gallons per minute |
| HASP | Health and Safety Plan |
| HMA | hot mix asphalt |
| HVAC | Heating, Ventilating, Air Conditioning |
| JMF | job mix formula |
| LMC | Lockheed Martin Corporation |
| MCL | Maximum Contaminant Level |
| MD SHA | Maryland State Highway Administration |
| MDE | Maryland Department of the Environment |
| MDTA | Maryland Transportation Authority |
| mg/kg | milligrams per kilogram |
| MRC | Middle River Complex |
| MSMT | Maryland Standard Method of Test |
| MVA | Motor Vehicle Administration |
| NCP | National Contingency Plan |
| NFPA | National Fire Protection Association |
| NIOSH | National Institute of Occupational Safety and Health |
| NPCA | National Precast Concrete Association |
| NPDES | National Pollution Discharge Elimination System |
| ODS | Operational Data Store |
| OSHA | Occupational Safety and Health Administration |
| PCA | Portland Cement Association |
| PCB | polychlorinated biphenyl |
| PPE | Personal Protective Equipment |
| psi | Pounds per Square Inch |
| psig | Pounds per Square Inch Gauge |
| QA | Quality Assurance |

| | |
|---|---|
| QC | Quality Control |
| QCP | Quality Control Plan |
| RAP | reclaimed asphalt pavement |
| RCRA | Resource Conservation and Recovery Act of 1976, as amended |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SHA | State Highway Administration |
| SSPC | Steel Structure Painting Council |
| TSCA | Toxic Substances Control Act of 1976, as amended |
| TSDF | Treatment, Storage, and Disposal Facility |
| TSP | Total Suspended Particulates |
| TSR | Tensile Strength Ratio |
| USDA | U.S. Department Of Agriculture |
| USDH | United States Department of Health and Human Services |
| USDOT | United States Department of Transportation |
| USEPA | United States Environmental Protection Agency |
| WP | Work Plan |

1.2. DEFINITIONS

A. Completion of Work – Completion of all required on-site activities.

B. Construction Documents – Documents pertaining to the completion of the project, including Technical Drawings and Specifications.

C. Contractor – The entity entering into the Contract with Owner to perform the work described in the Contract Documents.

D. Decontamination Area – Areas constructed by the Contractor, Materials, equipment, and personnel shall receive decontamination or cleaning in these areas.

E. Decontamination (equipment) – A thorough rinsing of the equipment with a high-pressure steam sprayer to remove all surface contamination.

F. Decontamination (personnel) – This encompasses the procedure for performing proper decontamination. This item is detailed in the HASP.

G. Design Engineer – The engineer preparing the Technical Drawings and Technical Specifications.

H. Hazardous Waste – A material that has been sampled, analyzed, and meets the RCRA definition of a hazardous waste.

I. Managing Contractor – The entity who is the Owner's representative for the design and construction of the project.

J. Manufacturer – The entity actually supplying any equipment or material component for one or more of the items of the project.

K. Manufacturer's Representative – Person designated by the manufacturer to coordinate the supply and installation of equipment.

L. Non-Hazardous Waste – A material which has been sampled, analyzed, and exceeds the Owner Type B cleanup criteria, but does not satisfy the RCRA definition of hazardous waste.

M. Owner – Lockheed Martin Corporation, who will be represented by its Design Engineer and its Managing Contractor.

N. Product – Materials, systems, and equipment.

O. Project Manager – Lockheed Martin Corporation technical lead.

P. Project Manual – The compilation of documents which govern the work to be performed which includes instructions to Offerors, Contract Forms, Contract Conditions, Technical Specifications, and Technical Drawings.

Q. Provide – To furnish and install in place.

R. Shop Drawings – Equipment specific drawings prepared by Manufacturer and showing all necessary equipment fabrication data.

S. Site – Block G, Lockheed Martin Middle River Complex as shown in the Construction Documents.

T. Site Manager – Contractor's Field Representative who has the overall responsibility to manage and execute the work in accordance with the Project Manual and subsequent amendments.

U. Supplier – The entity actually supplying one or more equipment items.

V. Support Plans – Documents required for the start of work as outlined in the Technical Specifications including, but not limited to, the WP, QCP, and HASP.

W. Technical Drawings – These drawings prepared by the Engineer showing the design of the remedial soil excavation, swale relocation and construction of the project.

X. Technical Specifications – Specifications prepared by the Design Engineer for the Contractor.

Y. Treatment, Storage, and Disposal Facility – A licensed Type I, II, or III treatment, storage, and disposal facility

Z. Work – All engineering, labor equipment, and material required to design, procure, and install a complete storm sewer system and grading as specified herein.

AA. Work Area – The area in which the Contractor can work and perform construction activities. The Contractor shall not go outside of this area without prior approval of Owner.

1.3. NOTE

Due to the nature of the work and the type of equipment required, it is possible and acceptable, that the same entity be at once Contractor, Supplier, and Manufacturer or any combination thereof.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION – NOT APPLICABLE

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This section describes the minimum requirements the Contractor shall address and abide by with respect to quality control.

## 1.2. RELATED SECTIONS

A. 01 33 00 Submittals

B. Division 1 Sections for project management and coordination.

C. All other Division Sections for specific test and inspection requirements.

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Quality Control Plan

Submit a Quality Control Plan detailing the quality control organization and procedures to be used during the project. The Quality Control Plan should be prepared for general construction only.

B. Quality Control Project Summary Report

Submit a Quality Control Project Summary Report that will summarize the overall quality of the data obtained and the work completed during the project. This report shall be submitted within 30 days after the final compliance inspection.

# PART 2. PRODUCTS – NOT APPLICABLE

# PART 3. EXECUTION

## 3.1 QUALITY CONTROL PROCEDURES

Through quality control (QC) procedures, the Contractor assures the Owner that the Contractor and all lower-tier contractors comply with the requirements of the specifications presented herein. The controls shall be adequate to cover all contract operations. The quality of all work shall be the responsibility of the Contractor. Sufficient inspections and tests of all items of work, including that of lower-tier contractors, shall be performed on a continuing basis to ensure conformance with respect to the quality of work. The Contractor shall furnish qualified personnel, appropriate facilities, instruments and testing devices necessary for the performance of the QC function. The controls shall be adequate to cover all operations both on and off-site, keyed to the proposed work sequence, and correlated by the Contractor's QC personnel.

## 3.2 QUALITY CONTROL RECORDS

The Contractor shall maintain up-to-date records of QC operations, activities, and tests performed. These records shall include the work of suppliers and lower-tier contractors. The records shall cover both conforming and defective or deficient features.

## 3.3 INSPECTIONS

A. After the substantial completion of work, the Contractor, in conjunction with the Owner, shall conduct a completion inspection of the work and develop a list of any items that do not conform to the approved specifications presented herein. Such a list shall include the estimated date by which the deficiencies will be corrected. The substantial completion inspection and any deficiency correction required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment thereof. The Contractor shall keep records of the inspection, including the list of deficiency items. For each item on this list, the Contractor shall document the corrective actions taken.

B. Following corrective action measures, the Contractor, in conjunction with the Owner, shall make a final completion inspection to ascertain that all deficiencies have been corrected.

## 3.4 QUALITY CONTROL PROJECT SUMMARY REPORT

Within 30 days of completion of the final compliance inspection, the Contractor shall submit to the Owner a Contractor Quality Control Project Summary Report. This report will summarize and state the overall quality of data obtained (where applicable) and work completed during the project. The report will certify the acceptability of data and work based on the QA/QC requirements defined in the Contractor quality control plan.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This section describes the provision, layout, installation, maintenance, and removal of all Contractor temporary facilities and utilities necessary to complete the project work tasks.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 02 41 00 | Demolition and Deconstruction |

## 1.3. SUBMITTALS

Submit in accordance with Section 01 33 00, “Submittals”, information on all proposed temporary facilities to be used on-site including, but not limited to, a layout sketch of the laydown area, size of the facility, anticipated duration on-site, and potential impacts of the facility prior to placement of the temporary facility on-site.

## 1.4. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

Code of Federal Regulations (CFR)

| | |
|---|---|
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |

# PART 2. PRODUCTS

The Contractor shall provide all labor, materials, and equipment necessary to provide temporary facilities to the site. Facilities may include, but not be limited to:

A. Field office and support trailer(s).

B. Material staging areas.

C. Sanitary facilities.

D. Rubbish and waste collection.

E. Fire protection and safety equipment.

## 2.1. FIELD OFFICE AND SUPPORT TRAILER(S)

The Contractor shall locate the field office trailer to a location approved by the Owner if necessary.

## 2.2. MATERIAL STAGING AREAS

The Contractor shall construct and maintain material staging areas for raw material at locations

approved by the Owner. The areas shall be designed by the contractor to be as compact as possible, but yet to provide adequate space for intended uses. If the areas are to be used for storing construction materials and no potential of spills, the area(s) shall be well drained. If the stored materials contain hazardous constituents or have potential of spills and will likely cause environmental impacts, the area(s) shall have containment structures with precipitation protection as appropriate. Temporary storage areas for excavated materials that are considered PCB remediation waste per 40 CFR 761.3 shall meet the requirements of 40 CFR 761.65(c)(9).

2.3. SANITARY FACILITIES

At least one portable chemical toilet shall be brought to the site, set up adjacent to the office trailer (or other locations agreed to by the Owner), and regularly maintained by the Contractor.

2.4. RUBBISH AND WASTE COLLECTION

The Contractor shall be responsible for collection of wastes and rubbish generated throughout the site activities, (i.e., trash, used supplies, office waste, etc.). These wastes are not anticipated to be large in volume and may be collected and deposited through the Contractor's normal waste disposal methods. All waste and rubbish generated on-site shall be removed at regular intervals, as needed.

2.5. FIRE PROTECTION AND SAFETY EQUIPMENT

The Contractor shall be responsible for providing and maintaining fire protection and health and safety equipment to the temporary facilities throughout the site activities in accordance with the technical specifications, regulatory requirements from federal, state, and local governments, and/or generally accepted industry practices.

PART 3. EXECUTION

3.1. INSTALLATION AND MAINTENANCE OF FACILITIES

A. The Contractor shall provide all temporary utilities including, but not limited to, electricity, telephone, and sanitary waste removal. The Contractor shall be responsible for all site contractor and lower-tier contractor utility costs.

B. The Contractor shall locate all temporary facilities on-site and properly secure them to withstand all anticipated weather conditions. The Contractor shall maintain all contractor temporary facilities and equipment. Maintenance shall extend beyond the structures to all parking areas and all exterior portions of the support areas. The Contractor shall comply with all applicable federal, state, and local regulations and codes with respect to the construction, maintenance, and removal of temporary facilities.

3.2. SECURITY

It is the responsibility of the Contractor to assure that their equipment, materials, facilities, etc. are properly secured during the course of the project. Neither the Owner nor any of their representatives shall be responsible for loss, theft, or damage to Contractor equipment, materials, or facilities until completion of the project.

A height of 6’ temporary security fencing is recommended wherever the construction site is currently accessible, such as from the adjacent parking lot of North American Electric to the southeast.

## 3.3. REMOVAL OF FACILITIES

The Contractor shall remove all temporary facilities upon completion of the project in accordance with the provisions of this section and Section 02 41 00 Demolition and Deconstruction. All areas occupied by temporary facilities shall be restored to the original contour and condition existing prior to the project. The Contractor shall disconnect and remove all temporary utilities at the completion of work. Contaminated materials and equipment will be decontaminated, subject to the approval of the Owner, and removed from the site.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

This section describes the minimum requirements the Contractor shall address and abide by with respect to traffic control.

1.2. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

PART 2. PRODUCTS

The Contractor shall provide for traffic control as appropriate with flaggers, barricades, flashing lights, and warning signs, both on site and at other appropriate locations, to ensure safety.

PART 3. EXECUTION

The Contractor shall be responsible for proper coordination of traffic control activities with applicable federal, state, and local regulations, including:

A. Acquisition of permits and the submission of temporary traffic control plans to perform work in the right-of-way if required.

B. Coordination of large construction vehicles entering and exiting the property shall take place on suitable roads.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

| | |
|---|---|
| 01 35 10 | Environmental Protection |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |
| 31 00 00 | Excavation, Backfill, and Compaction |

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6 (2006) Safety Requirements for Demolition Operations

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 40 CFR 61 | National Emission Standards for Hazardous Air Pollutants |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |

1.3 PROJECT DESCRIPTION

A. General Requirements

1. Do not begin demolition or deconstruction until authorization is received from the Owner. Remove rubbish and debris from the project site. In the interest of occupational safety and health, perform the work in accordance with this section.

1.4 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the LMC. Repair or replace damaged items as approved by the Owner. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Owner prior to performing such work.

A. Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

B. Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which is indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Owner.

C. Facilities

Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Owner. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.5 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.6 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

A. Preconstruction Submittals

Existing Conditions Photos or Video file

B. Certificates

Demolition and Deconstruction Plan - Prior to the start of the demolition activity, the Contractor must provide a list of the materials and describe methods for the removal and disposal of portions of the concrete foundation (slab) and the existing utility abandonment.

Notifications

C. Closeout Submittals

Receipts

1.7 QUALITY ASSURANCE

Submit timely notification of demolition and deconstruction projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the local air pollution control district/agency and the Owner in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

A. Dust and Debris Control

Prevent the spread of dust and debris and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Vacuum and dust the work area as needed.

1.8 PROTECTION

A. Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Owner prior to beginning such work.

B. Protection of Personnel

Before, during and after the demolition and deconstruction work continuously evaluate the condition of the structure being demolished and deconstructed and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.9 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Owner showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top and invert of storm sewer systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

A. Utilities and Related Equipment

1. Disconnecting Existing Utilities
   Remove existing utilities as indicated and as uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Owner. When utility lines are encountered but are not indicated on the drawings, notify the Owner prior to further work in that area. This work will also include the cutting and capping of any existing utilities, either by the Contractor or the appropriate utility provider.

B. Paving and Slabs

Remove sawcut concrete and asphaltic concrete paving and slabs including aggregate base as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored as directed by the Owner. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense. Temporary storage areas for concrete considered to be PCB remediation waste per 40 CFR 761.3 shall meet the requirements of 40 CFR 761.65(c)(9). Dispose of concrete PCB remediation waste as referenced in Specification 31 02 00 OFF-SITE WASTE DISPOSAL.

## 3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings if necessary.

## 3.3 DISPOSITION OF MATERIAL

A. Title to Materials

All demolition material shall be removed from the site and disposed of in accordance with the specifications.

B. Salvaged Materials and Equipment

There shall be no salvage of demolition materials.

C. Special Instructions

No more than one type of Operational Data Store (ODS) is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

1. Activity name and unit identification code

2. Activity point of contact and phone number

3. Type of ODS and pounds of ODS contained

4. Date of shipment

D. Transportation Guidance

Refer to Section 3.5.

E. Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material as referenced in Specification 31 02 00 OFF-SITE WASTE DISPOSAL.

## 3.4 CLEANUP

Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

## 3.5 DISPOSAL OF REMOVED MATERIALS

A. Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified in the Waste Management Plan.

B. Burning on LMC Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on LMC property.

C. Removal to Spoil Areas on LMC Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on LMC property.

D. Removal from LMC Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from LMC property for legal disposal. Dispose of waste soil as directed.

## 3.6 REUSE OF SALVAGED ITEMS

There shall be no salvage of demolition materials.

END OF SECTION

PART 1. GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 211.2 | (1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete |
| ACI 305R | (2010) Specification for Hot Weather Concreting |
| ACI 306.1 | (1990; R 2002) Standard Specification for Cold Weather Concreting |
| ACI 318 | (2008; Errata 2010; Errata 2010) Building Code Requirements for Structural Concrete and Commentary |

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

| | |
|---|---|
| ACPA 01-102 | (2000) Concrete Pipe Handbook |
| ACPA 01-110 | (1984) Design Manual for Sulfide and Corrosion Prediction and Control |
| ACPA QPC | (2005; Ver 3.0) QCast Plant Certification Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010) Structural Welding Code - Steel |
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A185/A185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |
| ASTM A36/A36M | (2008) Standard Specification for Carbon Structural Steel |
| ASTM A496/A496M | (2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement |
| ASTM A497/A497M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete |

| | |
|---|---|
| ASTM A615/A615M | (2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A706/A706M | (2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A767/A767M | (2009) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement |
| ASTM A775/A775M | (2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A82/A82M | (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A884/A884M | (2006) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement |
| ASTM C 1064/C 1064M | (2008) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete |
| ASTM C 1107/C 1107M | (2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C 1116/C 1116M | (2010a) Standard Specification for Fiber-Reinforced Concrete |
| ASTM C 1244 | (2005ae1) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill |
| ASTM C 138/C 138M | (2010b) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete |
| ASTM C 143/C 143M | (2010) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C 1478 | (2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |
| ASTM C 150/C 150M | (2011) Standard Specification for Portland Cement |
| ASTM C 171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C 173/C 173M | (2010b) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C 192/C 192M | (2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C 309 | (2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |

| | |
|---|---|
| ASTM C 31/C 31M | (2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33/C 33M | (2011) Standard Specification for Concrete Aggregates |
| ASTM C 330 | (2009) Standard Specification for Lightweight Aggregates for Structural Concrete |
| ASTM C 39/C 39M | (2010) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 443 | (2010) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C 494/C 494M | (2010a) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C 595/C 595M | (2010) Standard Specification for Blended Hydraulic Cements |
| ASTM C 618 | (2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C 877 | (2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections |
| ASTM C 891 | (2011) Installation of Underground Precast Concrete Utility Structures |
| ASTM C 920 | (2011) Standard Specification for Elastomeric Joint Sealants |
| ASTM C 923 | (2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C 989 | (2010) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM C 990 | (2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C231/C231M | (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260/C260M | (2010a) Standard Specification for Air-Entraining Admixtures for Concrete |

CSA STANDARDS (CSA)

| | |
|---|---|
| CSA A23.4 | (2009; Update 2010) Precast Concrete - Materials and Construction |

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

| | |
|---|---|
| NPCA QC Manual | (2005; R 2006) Quality Control Manual for Precast Plants |

1.2. SYSTEM DESCRIPTION

Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least 3 years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades.

A. Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318, ASTM, ACPA 01-102, Chapter 7-Design for Sulfide Control. Design shall also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings. Submit drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Owner. These drawings shall demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings. Submit cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

B. Custom-Made Precast Units

Submit design calculations for custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices. Submit drawings furnished by the precast concrete producer for approval by the Owner. Show on these drawings complete design, installation, and construction information in such detail as to enable the Owner to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

C. Proprietary Precast Units

Products manufactured under franchise arrangements shall conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, shall conform to the requirements in this specification. Submit standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

D. Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

E. Concrete Mix Design

1. Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design and proportions for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

2. Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of 4,500 psi.

3. Water-to-Cement Ratio

Furnish concrete, that will be exposed to freezing and thawing, containing entrained air and with water-cement ratios of 0.45 or less. Furnish concrete which will not be exposed to freezing, but which is required to be watertight, with a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. Furnish reinforced concrete exposed to deicer salts, brackish water or seawater with a water-cement ratio of 0.40 or less for corrosion protection.

4. Air Content

The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

| NOMINAL AGGREGATE | MAXIMUM SIZE | AIR CONTENT % | |
|---|---|---|---|
| | | SEVERE EXPOSURE | MODERATE EXPOSURE |
| 10 mm (3/8 inch) | 6.0 to 9.0 | 4.5 to 7.5 | |
| 13 mm (1/2 inch) | 5.5 to 8.5 | 4.0 to 7.0 | |
| 19 mm (3/4 inch) | 4.5 to 7.5 | 3.5 to 6.5 | |
| 25 mm (1.0 inch) | 4.5 to 7.5 | 3.0 to 6.0 | |
| 38 mm (1.5 inch) | 4.5 to 7.0 | 3.0 to 6.0 | |

1.3. SUBMITTALS

All submittals are the responsibility of the precast concrete producer. . Submit the following in accordance with Section 01 33 00 “Submittals”:

A. Pre-cast concrete units shop drawings, design details of steel reinforcement and placement, supporting design calculations, Manufacturer’s certificate.

B. Product Data for materials used in the construction of pre-cast structures, such as standard pre-cast units, proprietary pre-cast units, reinforcing bars, and embedded items (trash rack, frame and cover, etc.)

C. Design data and test reports, indicating the methods used in the design of the structures, the concrete batches used, and the results of quality testing.

1.4. QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual and/or ACPA QPC. Meet requirements written in the subparagraphs below.

A. NPCA and ACPA Plant Certification
The precast concrete producer shall be certified by the National Precast Concrete Association's and/or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

B. Qualifications, Quality Control and Inspection

1. Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

2. Quality Control Procedures

a. Submit quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and/or ACPA QPC. Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

1.) Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C 143/C 143M.
2.) Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064/C 1064M.
3.) Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C 31/C 31M, ASTM C 192/C 192M, ASTM C 39/C 39M.
4.) Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C231/C231M or ASTM C 173/C 173M for normal weight aggregates and ASTM C 173/C 173M for lightweight aggregates.
5.) Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C 138/C 138M.

b. Submit test reports as Follows:

1.) Copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.
2.) Copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete items.
3.) Sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.
4.) Copies of in-plant QA/QC inspection reports, upon the request of the Owner.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Owner for quality and final acceptance.

B. Storage

Store units off the ground or in a manner that will minimize potential damage.

C. Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

PART 2. PRODUCTS

2.1. MATERIALS

Materials shall conform to the following specifications.

A. Cement

Cement shall be portland cement, or portland cement in combination with pozzolan or ground granulated blast furnace slag conforming to appropriate specifications listed below. Restrict usage of cement in concrete that will have surfaces exposed in the completed structure so there is no change in color, source, or type of cement. Furnish cement conforming to ASTM C 150/C 150M, Type I, II, III or V. Furnish blended cements that conform to ASTM C 595/C 595M.

B. Fly Ash and Pozzolans

Fly ash is used as a supplementary cementitious material (SCM) conforming to ASTM C 618, Class [C or F] with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

C. Ground Granulated Blast-Furnace Slag
Ground granulated blast furnace slag is used as a supplementary cementitious material conforming to ASTM C 989, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

D. Water

Furnish water potable or free of deleterious substances in amounts harmful to concrete or embedded metals.

E. Aggregates

Fine and coarse aggregates shall "be tested and evaluated for alkali-aggregate reactivity in accordance with ASTM C 1260. The fine and coarse aggregates shall be evaluated separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing shall have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, the aggregate(s) shall be rejected or additional testing using ASTM C 1260 and ASTM C 1567 shall be performed. The additional testing using ASTM C 1260 and ASTM C 1567 shall be performed using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. GGBF slag shall be used in the range of 40 to 50 percent of the total cementitious material by mass. Class F fly ash shall be used in the range of 25 to 40 percent of the total cementitious material by mass."

1. Selection
Furnish aggregates conforming to ASTM C 33/C 33M. Provide aggregates not containing any substance, which may be deleteriously reactive with the alkalies in the cement.

2. Aggregates for Lightweight Concrete

ASTM C 330

F. Admixtures

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

1. Air-Entraining
ASTM C260/C260M

2. Accelerating, Retarding, Water Reducing Moderate to High

ASTM C 494/C 494M

G. Reinforcement

1. Reinforcing Bars
   a. Deformed Billet-steel: ASTM A615/A615M
   b. Deformed Low-alloy steel: ASTM A706/A706M

2. Reinforcing Wire

   a. Plain Wire: ASTM A82/A82M
   b. Deformed Wire: ASTM A496/A496M

3. Welded Wire Fabric

   a. Plain Wire: ASTM A185/A185M
   b. Deformed Wire: ASTM A497/A497M

4. Epoxy Coated Reinforcement

   a. Reinforcing Bars: ASTM A775/A775M
   b. Wires and Fabric: ASTM A884/A884M

5. Galvanized Reinforcement

   Provide galvanized reinforcement conforming to ASTM A767/A767M.

H. Synthetic Fiber Reinforcement

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inch.

I. Inserts and Embedded Metal

All items embedded in concrete shall be of the type required for the intended task, and meet the following standards.

1. Structural Steel Plates, Angles, etc.: ASTM A36/A36M

2. Hot-dipped Galvanized: ASTM A153/A153M

3. Proprietary Items: In accordance with manufacturers published literature

J. Accessories

Submit proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.

1. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C 443.

2. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C 877.

3. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C 990.

4. Elastomeric Joint Sealants: ASTM C 920

K. Pipe Entry Connectors

Pipe entry connectors shall conform to ASTM C 923 or ASTM C 1478.

L. Grout

Nonshrink Grout shall conform to ASTM C 1107/C 1107M. Cementitious grout shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

## PART 3. EXECUTION

### 3.1. FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual and/or ACPA QPC unless specified otherwise.

A. Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturer's recommendations and do not allow to build up on the form casting surfaces.

B. Reinforcement

Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch. Provide concrete cover not less than 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

C. Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations. Submit product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

D. Synthetic Fiber Reinforced Concrete

Add fiber reinforcement to the concrete mix in accordance with the applicable sections of ASTM C 1116/C 1116M and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.2. CONCRETE

A. Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

B. Concrete Placing

Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

1. Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
b. Free from frost all concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact.
c. Do not use frozen materials or materials containing ice.
d. In cold weather the temperature of concrete at the time of placing shall not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

2. Hot Weather Concreting

Recommendations for hot weather concreting are given in detail in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90 degrees F.

C. Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

1. Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C 171.
b. Cover with burlap or other absorptive material and keep continually moist.

c. Use of a membrane-curing compound applied at a rate not to exceed 200 square ft/gallon, or in accordance with manufacturers' recommendations according to ASTM C 309.

2. Curing with Heat and Moisture
Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

D. Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

1. Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

2. Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted but no major imperfections, honeycombs, or other major defects shall be permitted.

3. Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

E. Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

F. Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

1. Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

2. Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3. Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

G. Shipping Products

Do not ship products until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3. INSTALLATION

A. Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

B. General Requirements

1. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.

2. Lift products by suitable lifting devices at points provided by the precast concrete producer.

3. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with ASTM C 891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.

4. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

C. Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.4. FIELD QUALITY CONTROL

A. Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

a. Vacuum Testing

Prior to backfill vacuum test system according to ASTM C 1244.

b. Water Testing

Perform water testing according to the contract documents and precast concrete producer's recommendations.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This Section covers the requirements for performing the following work, as shown on the Technical Drawings and as specified:

A. Excavating, backfilling, and compacting for structures, piping, utilities, and soil remedial excavation
B. Site grading
C. Restoration of surfaces
D. All other related and incidental work

All work within this section should adhere to the Maryland State Highway Administration (MD SHA) 2008 Standard Specifications for Construction and Materials, as updated, unless specified by the Construction Drawings, Technical Specifications, or geotechnical report, or as directed in the field.

If earthwork measurement and payment items are not specified by LMC, the Contractor shall use MD SHA's 2008 Standard Specifications for Construction and Materials, as updated, as a basis for measurement and payment of earthwork.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 03 40 00 | Pre-cast Concrete |
| 31 02 00 | Off-Site Waste Disposal |
| 31 11 00 | General Site Preparation (Clearing and Grubbing) |
| 32 92 19 | Seeding, Soil Supplements, and Mulching |
| 33 40 00 | Storm Drainage Utilities |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

American Association of State and Highway Transportation Officials

| | |
|---|---|
| AASHTO T 27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 89 | Determining the Liquid Limit of Soils |
| AASHTO T 90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T 180 | Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 422 | Particle-Size Analysis of Soils |
| ASTM D 1556 | Density and Unit Weight of Soil in Place by the Sand Cone Method |
| ASTM D 1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort |
| ASTM D 2922 | Density of Soil and Soil Aggregate in Place by Nuclear Methods |
| ASTM D 4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

Code of Federal Regulations (CFR)

| | |
|---|---|
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Product Data: Name of fill material sources and suppliers.

B. Laboratory Data: Maximum dry density test results (according to ASTM D 1557 or AASTHO T 180) as outlined in paragraph 3.7.A for material used as bedding, embedment, fill, or backfill material.

C. Field density test results (according to ASTM D 1556 or ASTM D 2922) as outlined in paragraph 3.7.B for material used as bedding, embedment, fill, or backfill material.

1.5. DEFINITIONS

A. Select Fill - Sand, gravel and similar material free of clay, loam, organic material and debris containing stones, pebbles or lumps less than two inches in greatest dimension.

B. Unstable material - Debris, topsoil, peat and materials containing peat; and, all wet, soft or loose material that will not remain in position when cut for excavation, or that does not provide sufficient bearing capacity to satisfactorily support structures.

C. Unsuitable material - Excavated material that does not meet Specification requirements for backfilling, to include unstable material.

D. Common Fill - Consists of select fill as defined above or imported sand or other granular material as approved by the Owner.

E. Bedding - Granular material consisting of sand, crushed rock or pea gravel for surrounding pipes and culverts during trench installation.

1.6. PROPERTY PROTECTION AND SAFETY

A. Buildings, poles, roadways, walkways, landscape vegetation, and all other property shall be protected unless their removal is authorized.

B. The Contractor shall contact underground utility locator service to locate and mark all utilities prior to commencing work. If any unknown utilities are encountered during excavation, the Contractor shall immediately notify the Owner. The Contractor shall preserve intact any utilities encountered.

C. The Contractor shall maintain safe passage for local traffic and provide all necessary barricades, warning lights, signs, signals, and flagmen where required.

D. All excavation work shall comply with 29 CFR 1926.650, 1926.651, 1926.652, and 1926.653.

## PART 2. PRODUCTS

### 2.1. MATERIALS

A. All fill material shall be free of contamination. The Contractor shall provide the Owner with the names of all fill sources or suppliers. The Contractor shall provide evidence, satisfactory to the Owner, documenting that the material is free of contamination. A letter provided by the borrow pit owner or operator certifying that the material is natural material not previously excavated from the borrow pit will be considered sufficient

B. The Owner may collect random samples of fill material to verify that it is uncontaminated.

C. Backfill material for structures shall be select fill, and shall meet the guidelines listed in the geotechnical report and the structural portion of the Construction Drawings.

D. Backfill material for soil remedial excavations shall be bedding material for piping that meets the MD SHA Aggregate requirement for the type of piping that will be used in the in-situ bioremediation groundwater remedy system. All aggregate gradations shall be confirmed using ASTM C 136 or AASTHO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90.

E. Bedding material for piping and utilities shall meet the MD SHA Aggregate requirement as stipulated by the type of utility. All aggregate gradations shall be confirmed using ASTM C 136 or AASTHO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90.

F. Backfill material over bedding material for piping and utilities shall be select fill.

G. Geotextile shall be in accordance with Section 31 05 19 “Geotextiles”.

H. Waning tape shall be detectable by bright green color and written in red “Sewer underneath” on it.

### 2.2. MATERIAL TESTING

Fill material beneath bedding material for piping, culverts, and foundations and backfill material for soil remedial excavations shall be tested by the Contractor in accordance with ASTM D 422 and ASTM D 1557.

## PART 3. EXECUTION

### 3.1. CLEARING

Before the removal of topsoil and commencing excavation, the surface areas within the grading limits shall be cleared of all vegetation, rubbish, and other objectionable matter in accordance with Section 31 11 00, “General Site Preparation”. Cleared material shall be properly disposed of off-site in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

3.2. EXCAVATING

A. Excavation shall be performed by any practicable method consistent with maintaining the integrity and protection of the work, workers, and the public.

B. Excavation shall proceed in a manner that minimizes the volume of surface water runoff from precipitation and groundwater infiltration that may collect in the excavation.

C. If dust is generated during excavation of soils, the Contractor shall cease operations immediately until a method of control in accordance with Section 01 35 10, "Environmental Protection", has been approved by the Owner, and dust control measures have been implemented.

D. The Contractor shall be responsible for collecting waters that may accumulate in the excavation.

E. Excavating operations shall include the removal of all materials encountered within the required widths and depths of the excavation, regardless of the nature of the materials, the condition of the materials at the time they are excavated, or the manner in which they are excavated.

F. Excavated materials shall be directly loaded for offsite disposal to the extent practicable.

G. Excavated soil and concrete materials not directly loaded for offsite disposal that are considered PCB remediation waste per 40 CFR 761.3 shall be temporarily stockpiled per the requirements of 40 CFR 761.65(c)(9).

H. Stockpiled material shall not obstruct roads, ditches, or drainage swales.

I. All trash, debris, excess excavated material, and material excavated for the soil remedial excavation shall be disposed offsite in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

J. Unstable material in excavations shall be removed to the extent and depths as required, or as directed by the Owner. The excavation shall be filled to the proper grade with approved select fill. The fill shall be compacted according to the requirements of these Specifications. Whenever the material encountered is in the Contractor's opinion unstable, he shall immediately notify the Owner to make a determination whether the soil is suitable for support. All notifications shall be substantiated in writing by the Contractor.

J. The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12 inches (6 inches per side) to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Contractor shall not over excavate intentionally; however, if over excavation is required, the over excavated volume will be replaced with compacted bedding material.

K. Pipe trenches shall be excavated so that pipes can be laid straight at uniform grade without deflection.

3.3. BACKFILLING AND COMPACTING - GENERAL

A. Unless otherwise directed, excavations shall be backfilled as soon as possible after structures are built or pipes are laid; and the work is inspected, tested as required, and accepted; and when permission to backfill has been given by the Owner. Prior to backfilling, all rubbish, debris, forms and similar materials shall be removed from the excavation or trench. Backfilling shall not be done in freezing weather, with frozen materials, or when in-place materials are frozen.

B. Backfill shall be brought up to adjacent finished grade minus the depth of any required surface finishing (i.e., top soil, asphalt, or gravel). Any excavations improperly backfilled shall be reopened to the depth required for proper compaction, and shall then be refilled and properly compacted with the surface restored to required grade.

C. Each layer of backfill material shall be compacted to the density specified in this Section. Compaction densities shall be the percentage of the maximum dry density obtainable at optimum moisture content, as determined by ASTM D 1557 or AASTHO T 180. Field density tests shall be made in accordance with ASTM D 1556 or D 2922. The moisture content of each layer of backfill shall be controlled as required.

D. Failure of the compacted material to reach the required density is cause for rejection of the work in the affected area(s). Unless the Contractor can rework and compact the material to the required density, the Contractor shall remove the material in the areas affected. Subsequently, the Contractor shall replace the rejected work with material that can be compacted to the required density. Field density tests and rejection of the non-compliant compacted material shall be repeated until test results are accepted by the Owner.

E. Under structures, the material shall be placed in lifts not to exceed 8 inches in thickness and compacted to not less than 95% of maximum dry density (ASTM D 1557 or AASHTO T 180).

F. In soil remedial excavation areas, place backfill material in lifts not exceeding 8 inches in thickness and compact to not less than 90% of maximum dry density according to ASTM D 1557 or AASHTO T 180.

3.4. FILLING, BACKFILLING, AND COMPACTING FOR PIPE TRENCHES

A. Bedding shall be installed on approved subgrades as detailed on the Technical Drawings. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings and bodies of conduits.

B. Place initial backfill material below the pipe and both sides of the pipe. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. The bedding materials shall not be more than 6 inches in layers to the height of pipe spring line.

C. Provide construction fabric around the perimeter of stone bedding and overwrap adjacent edges at least 18 inches. Top edges shall face down grade.

D. Place backfill and fill soil materials over the pipe in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Coordinate backfilling with utilities testing.

E. Compact each layer of backfill soil material at 90 percent under unpaved areas and at 95 percent under paved areas according to ASTM D 1557 or AASHTO T 180.

F. Warning tape shall be located below finished grade as shown on the Drawing.

G. Place appropriate surface material according to the paved or unpaved finished grade as shown on the Drawing.

3.5. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

## 3.6. RESTORATION OF SURFACES

A. Damaged or disturbed surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

B. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

C. The finished soil and gravel surfaces over trenches shall be left slightly mounded.

## 3.7. CONSTRUCTION TESTING

A. Laboratory testing

One laboratory maximum dry density test (ASTM D 1557 or AASTHO T 180) shall be performed for each material to be used as bedding or backfill material.

B. Field testing

Field density tests shall be performed according to ASTM D 1556 or ASTM D 2922.

1. For general filling and backfilling, one test shall be performed for every lift. At minimum, one test shall be performed per lift for each 250 linear feet of trench bedding and backfill material in trench excavation areas. At minimum, one test shall be performed per lift for each 2,500 square feet of backfill material in excavation areas where piping or utilities will not be placed.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish, install, monitor, and maintain excavation support and protection system where required capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads. Prevent surface water from entering excavations by grading, dikes, or other means. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation. Monitor vibrations, settlements, and movements.

## 1.2. RELATED SECTIONS

01 33 00 Submittals
01 50 00 Temporary Facilities
31 00 00 Excavation, Backfill, and Compaction
31 03 00 Dewatering and Water Control

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Shop Drawings: For excavation support and protection system.

## 1.4. QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at the project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

a. Existing utilities and subsurface conditions.
b. Proposed excavations.
c. Proposed equipment.
d. Monitoring of excavation support and protection system.
e. Working area location and stability.
f. Coordination with waterproofing.
g. Abandonment or removal of excavation support and protection system.
h. Environmental Concerns
i. Health and Safety Concerns

## 1.5. PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of utility.

2. Do not proceed with interruption of utility without Owner’s written permission.

B. Project-Site Information: All geotechnical information provided for this Project is for information only. Owner will not be responsible for interpretations or conclusions drawn from the data. Contractor is responsible for making additional test borings and conducting

other exploratory operations necessary for excavation support and protection.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2. PRODUCTS

### 2.1. MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM International (ASTM) A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners may be site-fabricated mechanical interlock or roll-formed corner shape with continuous interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches (100 mm)

E. Tiebacks: Steel bars, ASTM A 722/A 722M.

F. Tiebacks: Steel strand, ASTM A 416/A 416M.

## PART 3. EXECUTION

### 3.1. PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

F. Where required, install systems as defined in 3.2, 3.3, 3.4 and 3.5 this section.

3.2. SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment].

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3. SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4. TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5. BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Owner.

2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6. REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.

2. Fill voids immediately with approved backfill compacted to density specified in Section 31 00 00 “Excavation, Backfill, and Compaction”.

3. Repair or replace, as approved by Owner, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave certain excavation support and protection systems permanently in place, including capping and finishing, as shown on Contract Documents. Support systems shall be left in place if removal would result in risk of damage to adjacent facilities.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

A. The Contractor shall collect, containerize, and temporarily store on site all waste resulting from work at the Site that is not directly loaded for off-site transportation and disposal. This includes, but is not limited to:

1. Excavated contaminated soil

2. Discarded health and safety personal protection equipment (PPE) as applicable

3. General construction debris, waste materials, and refuse

4. Contaminated water due to dewatering activities

B. The Contractor shall provide all labor, material, and equipment necessary to transport and dispose off-site all waste generated by work at the Site in accordance with the results of the waste characterization and with all applicable local, state, and federal regulations.

## 1.2 RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 41 00 | Regulatory Requirements |
| 01 45 00 | Quality Control |
| 31 00 00 | Excavation, Backfill, and Compaction |

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest edition and are referred in the text by the basic designation only.

Code of Federal Regulations (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 40 CFR 260 | Hazardous Waste Management Systems: General |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Waste |
| 40 CFR 264 | Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 265 | Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |
| 49 CFR 171 | General Information, Regulations, and Definitions |
| 49 CFR 172 | Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans |
| 49 CFR 173 | Shippers—General Requirements for Shipments and Packagings |
| 49 CFR 177 | Carriage by Public Highway |
| 49 CFR 178 | Specifications for Packagings |

| | |
|---|---|
| 49 CFR 180 | Continuing Qualification and Maintenance of Packagings |

Federal Laws

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

U.S. Environmental Protection Agency (EPA) Publications

| | |
|---|---|
| SW-846 | Test Methods for Evaluating Solid Wastes Physical/Chemical Methods, July 1982 |

Maryland State Laws

Environment Article §§9-204, 9-252, and 9-314, Annotated Code of Maryland

Maryland State Regulations

| | |
|---|---|
| COMAR 11.07.01 | Transportation of Hazardous Waste; |
| COMAR 26.04.07 | Solid Waste Management; |
| COMAR 26.13 | Disposal of Controlled Hazardous Substances; |
| COMAR 26.14 | Hazardous Substances Response Plan |

1.4 SUBMITTALS

The Contractor shall submit the following to the Owner for approval in accordance with Section 01 33 00, “Submittals”:

A. Name, qualifications, and State identification numbers of the proposed Subcontractor(s) for off-site waste transportation. For transportation of hazardous waste, a written certificate shall be provided that the off-site transportation firm is approved for the waste in accordance with 40 CFR 716 and the applicable sections of 49 CFR 171 through 180. A copy of the EPA and State permits and a 24-hour point of contact shall be included.

B. Name, location, qualifications, and State identification number of the proposed off-site disposal facilities that are approved by the Owner. For disposal of hazardous waste, a written certificate shall be provided that the disposal facility is approved for the waste in accordance with 40 CFR 716. A copy of EPA and State permits and a 24-hour point of contact shall be included.

C. A Shipment Manifest for each shipment of hazardous waste to be transported to the off-site disposal facility in accordance with all applicable Federal, State, and local regulations. The Contractor shall submit the Shipment Manifests to the Owner's Site Representative for signature prior to any shipment of waste leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests and return the signed original to the Contractor. The Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date at which it was received by the facility.

D. A Certificate of Disposal shall be submitted for each shipment of hazardous waste disposed by the off-site disposal facility. Certificates of Disposal shall include the following

information:

1. The identity of the disposal facility by name, address, Owner and State Identification Number.

2. The identity of the waste shipment affected by the Certificate of Disposal including reference to the Shipment Manifest number.

3. A statement certifying the fact of disposal of the identified waste shipment, including the date(s) of disposal and the disposal method used.

E. A signed receipt or manifest from the off-site disposal facility for each shipment of non-hazardous waste. This receipt shall document the nature and weight of waste disposed and the date of disposal.

F. A Sampling and Analysis Plan, containing at minimum:

a. The field sampling approach, which will discuss how sampling locations and quantities will be determined;
b. The sampling methodology to be used, for both confirmatory and waste characterization samples;
c. The laboratory analysis to be performed on the samples, based on sample material and location;
d. The field quality assurance/quality control methods; and
e. Copies of forms to be used during the sampling and a sample data package.

The results of the Sampling and Analysis Plan will be evaluated to further establish stockpiling and disposal needs if materials are determined to be hazardous waste or PCB remediation waste. The Technical Drawings for the Soil Remedial Excavation at Blocks E and G will be amended with specific areas of contamination identified as hazardous waste or as materials with PCB concentrations greater than 50 mg/kg.

## PART 2. PRODUCTS – NOT APPLICABLE

## PART 3. EXECUTION

### 3.1 WASTE CHARACTERIZATION

Waste characterization will be conducted in accordance with a Sampling and Analysis Plan. The characterization of the waste shall also conform to the requirements of the off-site disposal facility.

### 3.2 IDENTIFICATION OF OFF-SITE WASTE DISPOSAL FACILITY

A. Based on the results of the waste characterization, the Contractor shall identify an appropriate method of disposal in accordance with all local, State, and Federal regulations. The method(s) of waste disposal shall be approved by the Owner.

B. The Contractor shall identify one (or more) Owner approved off-site disposal facility and submit the necessary information regarding each facility for Owner approval in accordance with Section 01 33 00, “Submittals”.

## 3.3 WASTE TRANSPORTATION

A. The Contractor shall select one or more waste transportation firms and submit the necessary information regarding each firm for approval by Owner in accordance with Section 01 33 00, “Submittals”.

B. Waste shall be transported to the Owner approved off-site disposal facility in accordance with all applicable local, State, and Federal regulations. In particular, off-site transportation of hazardous waste shall conform to all the applicable requirements of 40 CFR 263 and 49 CFR 171 through 49 CFR 180, and off-site transportation of waste that is characterized as soil with polychlorinated biphenyls (PCBs) concentrations greater than 50 milligrams per kilogram (mg/kg) shall conform to all the applicable requirements of 40 CFR 761.

C. A Shipment Manifest shall be prepared by the Contractor for each shipment of hazardous waste and submitted to the Owner's Site Representative for signature prior to any shipment leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests and return the signed original to the Contractor. The Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date received by the facility.

## 3.4 WASTE DISPOSAL

A. Waste shall be disposed of at the Owner approved off-site disposal facility in accordance with all local, State, and Federal regulations. The Contractor shall ensure that all wastes are accepted at the facility; that the facility is properly permitted to accept the stated wastes; and that the facility provides the stated services. Waste shall be disposed of by the method(s) identified by the Contractor and approved by the Owner.

B. The Contractor shall also ensure that non-hazardous waste disposals are at a facility which complies with state regulations concerning treatment, storage and disposal of non-hazardous solid waste and the facility complies with the local solid waste disposal plan.

C. Hazardous waste shall be disposed of in accordance with all applicable local, State, and Federal regulations including the relevant provisions of 40 CFR 264.

D. Waste that is characterized as soil with PCB concentrations greater than 50 mg/kg shall be disposed of in accordance with all applicable local, State, and Federal regulations including the relevant provisions of 40 CFR 761.

E. The Contractor shall submit to the Owner's Site Representative a signed receipt from the off-site disposal facility for each shipment of non-hazardous waste in accordance with Section 01 33 00, “Submittals”.

F. The Contractor shall submit to the Owner a Certificate of Disposal for each shipment of hazardous waste in accordance with Section 01 33 00, “Submittals”.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

A. Furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Ensure erosion control, stability of excavations and constructed slopes, so that excavation does not flood, and that damage to subgrades and permanent structures is prevented. Prevent surface water from entering excavations by grading, dikes, berms, or other means. Contain surface water and ground water that has entered the excavation area, collect the water in tanks and transport it to the off-site treatment facility. Decontaminate and remove the dewatering system when no longer required for construction.

1.2. RELATED SECTIONS

01 33 00 Submittals
01 41 00 Regulatory Requirements
01 35 10 Environmental Protection
31 00 00 Excavation, Backfill, and Compaction
31 00 01 Excavation Support and Protection

1.3. SUBMITTALS

A. Dewatering Plan

B. Field quality-control reports and photographs

1. Provide documentation that dewatering plan is functioning or provide changes to dewatering plan during construction.

2. Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.4. QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing Maryland State Highway Administration (MD SHA) / Baltimore County notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Pre-installation Conference: Conduct conference at project site.

1. Review methods and procedures related to dewatering including, but not limited to, the following:

a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.

1.) Geotechnical conditions.
2.) Proposed site clearing and excavations.
3.) Existing utilities and subsurface conditions.

4.) Coordination for interruption, shutoff, capping, and continuation of utility services.
5.) Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6.) Coordinate transport system to off-site treatment facility.
7.) Testing and monitoring of dewatering system.
8.) Environmental Concerns
9.) Health and Safety Concerns

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system as needed to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

3.2. INSTALLATION

A. Install dewatering system utilizing wells, well points, sumps or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches (600 mm) below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Water from excavation areas should be assumed to be contaminated and needs to be disposed off-site at the Owner approved water treatment plant. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all labor, equipment and materials, and perform all operations in connection with installation of the geotextiles fabric. Geotextiles shall be installed for reinforcement and separation of gravel roadways, parking areas, foundation drainage, and rock riprap areas and as silt fences.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 11 23 | Aggregates and/or Graded-Crushed Aggregate For Roadways |
| 33 40 00 | Storm Drainage Utilities |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM D 3786 | Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics Diaphragm Bursting Strength Tester Method |
| ASTM D 4355 | Standard Test Method for Determining UV (ultraviolet) Resistance |
| ASTM D 4491 | Standard Test Method for Water Permeability of Geotextiles by Permittivity |
| ASTM D 4533 | Standard Test Method for Determining Trapezoidal Tear. |
| ASTM D 4632 | Standard Test Method for Grab Breaking Load and Elongation of Geotextiles |
| ASTM D 4759 | Determining the Specification Conformance of Geosynthetics. |
| ASTM D 4873 | Identification, Storage, and Handling of Geotextiles |
| ASTM D 4833 | Standard Test Method for Determining Puncture Strengths |

State of Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

Maryland Department of the Environment (MDE)

2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control

## 1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Product Data Sheet for Geotextiles or Filter Fabric

## PART 2. PRODUCTS

### 2.1. GEOTEXTILE FABRIC MATERIAL

The fabrics provided shall be woven or nonwoven geotextile that meets the standards and specifications of MD SHA or MDE for geotextiles (i.e. Grab Strength, Seam Strength, Puncture, Trapezoid Tear, Apparent Opening Size, U.S. Sieve, Permittivity, Ultraviolet Degradation, etc).

A. Geotextiles installed for gravel roadways and parking lots shall meet MD SHA or MDE's requirements for roadway stabilizing fabric.

B. Geotextiles (nonwoven) installed beneath riprap shall meet MD SHA or MDE's requirements for riprap separation fabric.

C. Geotextiles installed as sediment control (silt) fences shall meet MD SHA or MDE's requirements for sediment control fence fabric.

### 2.2. DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

2. Geotextile rolls shall be marked or tagged in accordance with ASTM D 4873 and with the following information:

   a. Manufacturer's name
   b. Production dates
   c. Product identification
   d. Roll number
   e. Roll dimensions

B. Acceptance at the Site

1. Perform inventory and surface inspection for defects and damage of all geotextile rolls upon delivery.

2. Unroll and inspect any geotextile roll that shows signs of damage.

3. Damaged geotextiles shall be rejected upon delivery to the site and shall be replaced with new geotextile at no additional cost to the Contract.

C. Storage and Protection

1. Provide onsite storage area protected from ultraviolet light for geotextile rolls from time of delivery until installed.

2. Store and protect geotextile rolls from dirt, excessive heat and cold, water, ultraviolet light exposure, and other sources of damage in accordance with ASTM D 4873.

3. Preserve the integrity and readability of geotextile roll labels.

D. Handling

No hooks, tongs or other sharp instruments shall be used for handling geotextile. Geotextile shall not be dragged along the ground.

PART 3. EXECUTION

3.1. SURFACE PREPARATION

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction shall be in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

3.2. INSTALLATION

At the time of installation, geosynthetic materials shall be rejected if they have defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, storage, or placement. Visual review of the geosynthetic materials shall be performed during, after installation and prior to placement of any overlying materials.

The geosynthetic materials shall be protected at all times during construction from contamination by surface run-off and any fabric so contaminated shall be removed and replaced with uncontaminated materials.

Any materials damaged by exposure to sunlight, siltation prior to covering, or mechanical damage during installation or during covering, shall be replaced at no additional cost to the contract.

A. Installation

Prior to geotextile deployment, subgrades and surfaces shall be inspected and approved by the Contractor Officer.

1. Geotextile Deployment

Handle geotextiles in a manner to ensure they are not damaged. Comply with the following:

a. Install the geotextile as recommended by the manufacturer.
b. Weigh down geotextile with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material.
c. Prevent damage to underlying layers during placement of geotextile.
d. During geotextile deployment, do not entrap stones or excessive fine material that could cause clogging of drains or filters in or beneath geotextile.
e. Visually examine entire geotextile surface. Ensure no potentially harmful foreign objects are present. Remove foreign objects encountered or replace geotextile.
f. Overlap adjacent edges at least 18 inches. Top edges shall face down grade.
g. All workmanship shall conform to OSHA and all applicable safety regulations.

2. Defects and Repairs

   Repair holes or tears in geotextile as directed by the Owner in accordance with manufacturer's requirements.

B. Interface with Other Products

Ensure the following when placing soil or rock materials on top of a geotextile.

1. Geotextile and underlying lining materials are not damaged.

2. Minimal slippage of geotextile on underlying layers occurs.

3. No excess tensile stresses occur in geotextile.

4. Overlapping of adjacent edges is maintained.

5. Minimum of 6 inches of material is required over any geotextiles before heavy equipment is allowed on the cover material. Small areas that require compaction will be completed with hand-operated compactors.

6. Rock shall not be dropped on fabric from a height of more than 18 inches.

C. Silt Fences

If MD SHA standards are not available, the following specifications may be used:

1. Geotextile filter cloth material shall be pervious sheets of strong rot-proof plastic fabric meeting the requirements of AASHTO M 288 for sediment control fabrics with a geotextile minimum tensile strength of 210 lbs. Fabric shall be a minimum of 24 inches in height.

2. Post spacing: Posts shall be spaced at a maximum of 8 ft apart. Fences in areas of concentrated flows shall be 4 ft apart.

3. Posts shall be driven 12 inches into the ground.

4. Posts: Wood posts shall be nominal 1.5 in. x 1.5 in., made from oak or similar hardwood, and a minimum of 3 ft long.

5. Filter fabric shall be attached to the posts with wire staples or other appropriate fasteners.

6. Preassembled silt fence in general compliance with items 1 through 4 above may be used instead of a field-constructed silt fence with the approval of the Owner.

END OF SECTION

## PART 1. GENERAL

### 1.1. SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to prepare the site for construction. The work includes, but is not limited to implementing the following procedures prior to any intrusive activities.

A. Site Debris Removal

B. Clearing and Grubbing

### 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 35 10 | Environmental Protection |
| 31 02 00 | Off-Site Waste Disposal |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 93 00 | Seeding, Soil Supplements, and Mulching |

## PART 2. PRODUCTS

Fill materials shall conform to the provisions of Section 31 00 00, “Excavation, Backfill, and Compaction”.

## PART 3. EXECUTION

### 3.1. GENERAL

A. Generation of airborne particulate matter shall be controlled at all times using methods approved by the Owner.

B. All work for this project shall be in strict accordance with the Technical Drawings and Technical Specifications. All methods of work for this project shall also comply with Federal, State, and local ordinances, unless otherwise noted in the Technical Drawings and Technical Specifications.

C. The Contractor shall be responsible for limiting all work to the immediate project area. All areas disturbed by the Contractor that are outside the limits of work shall be restored by the Contractor to their original condition at no additional cost to the contract.

D. Maximum protection shall be provided for existing utilities which are to remain in service. Contractor shall provide all temporary service. The Contractor is responsible for locating and protecting all under ground and above ground utilities. The Contractor shall utilize the underground utility locator service and all other techniques required to locate the utilities prior to construction.

E. The Contractor shall thoroughly inspect the Site prior to construction to verify existing Site conditions.

### 3.2. PROTECTION OF EXISTING FEATURES

A. The Contractor shall use all means necessary to protect the existing features that are to remain.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements, to the satisfaction of the Owner.

3.3. CLEARING, GRUBBING, AND WASTE DISPOSAL

A. General

1. Except as otherwise directed, cut, grub, remove, and dispose of all shrubs, roots, and any other material, which may interfere with the work, within the areas defined on the Technical Drawings and as approved by the Owner. In general, clearing and grubbing will be performed at all areas to be excavated and at areas where earth or rock-fill will be placed. Clearing shall extend a maximum of 10 feet outside the limits of all excavations and fill areas except in sensitive wetland areas.

2. Materials removed as a result of clearing and grubbing shall be disposed off-site at a facility approved by the Owner.

3. The Contractor shall backfill and grade all holes resulting from clearing and grubbing. Backfilling and grading shall be performed in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

4. The Contractor shall protect all trees 2 inches in diameter and greater that are not to be removed and are in danger of being damaged. The trees shall be protected by completely encircling with planking or with snow fencing unless otherwise approved by the Owner.

5. In the performance of clearing and grubbing, the Contractor shall preserve and protect all public and private property, existing lawns, trees, plants, and other vegetation that are to remain within or adjacent to the project and shall use every precaution necessary to prevent damage or injury thereto. The Contractor shall repair all injuries to bark, trunk, limbs, and roots of remaining plants using tree surgery methods, tools, and materials which are approved by the Owner in accordance with Section 01 35 10, “Environmental Protection”.

6. The Contractor shall reseed, in accordance with Section 32 92 19, “Seeding, Soil Supplements, and Mulching”, all cleared and grubbed areas which have been disturbed by work on-site.

7. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct, on the part of the Contractor in the execution of the work, such property shall be restored by the Contractor, at his expense, to a condition equal to that existing before such damage or injury was done, or he shall make good such damage or injury in such other manner as may be acceptable to Owner.

8. On-site burning shall not be permitted.

B. Clearing

1. Clearing operations shall consist of the complete removal and disposal of all trees, brush, and vegetation. Trees and other vegetation in areas to be cleared shall be cut within 1-½ inches of the ground surface.

2. Trees and brush may be chipped for reuse during final grading.

C. Grubbing

1. Grubbing shall consist of the removal of all stumps, roots, and buried logs. All tap roots, lateral roots, or other projections over 2 inches in diameter shall be removed to a depth of 3 feet below the natural ground surface. All holes caused by grubbing operations shall be backfilled and graded in accordance with Section 31 00 00, “Excavation, Backfill, and Compaction”.

2. All disturbed cleared and grubbed areas shall be fertilized and seeded immediately upon establishing final grade in accordance with Section 32 92 19 “Seeding, Soil Supplements, and Mulching”. The Contractor shall be responsible for implementing adequate erosion and sedimentation control measures during the course of construction in accordance with Section 01 35 10, “Environmental Protection”.

D. Waste Disposal

All wastes and debris generated by the site preparation activities shall be disposed of off-site in accordance with Section 31 02 00, “Off-Site Waste Disposal”.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of aggregate for access roads, construction laydown area, and for the subgrade of roadways.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 03 40 00 | Pre-Cast Concrete |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 31 05 19 | Geotextiles |
| 32 12 17 | Hot Mix Bituminous Pavement |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

American Association of State and Highway Transportation Officials

| | |
|---|---|
| AASHTO T 27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 89 | Determining the Liquid Limit of Soils |
| AASHTO T 90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T 180 | Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort |
| ASTM D 4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

B. References shall also include those listed within, such as Maryland Standard Method of Test (MSMT), AASHTO, and ASTM references within MD SHA specifications.

## 1.4. SUBMITTALS

Submit for following in accordance with Section 01 33 00, “Submittals”.

A. List of materials to be used, including sources and suppliers

B. Test reports for aggregates and other materials

1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

1.6. Modification of References

B. Where term “Engineer” or “State” is used in MD SHA Standard Specifications, it shall be construed to mean “Owner”.

1.7. DELIVERY, STORAGE, AND HANDLING

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall be handled in a manner that ensures delivery in sound, undamaged condition.

PART 2. PRODUCTS

2.1. FILL

Fill shall be select or common as defined in Section 31 00 00, “Excavation, Backfill, and Compaction”, and soil or gravelly materials free of debris, peat, contamination, or excess moisture. Fill may be imported, excavated from the access road drainage ditches and excess excavation from site grading and construction.

2.2. BEDDING

Bedding material for piping and utilities shall be granular material consisting of the appropriate aggregate for each utility as described in the MD SHA “Standard Specifications for Construction and Materials”. All aggregate gradations shall be confirmed using ASTM C 136 or AASHTO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90

2.3. GEOTEXTILE

Geotextile shall be in accordance with Section 31 05 19, “Geotextiles”.

2.4. ROADWAYS OR WALKWAYS

Subgrade: Materials for subgrade and base course construction shall be in accordance with MD SHA’s “Standard Specifications for Construction and Materials”.

Surface Course: Adhere to Section 32 12 17 “Hot Mix Bituminous Pavement” for asphalt roads.

## PART 3. EXECUTION

### 3.1. PREPARATION

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 “Excavation, Backfill, and Compaction”.

### 3.2. CONSTRUCTION

A. Geotextile: Geotextile shall be in accordance with Section 31 05 19, “Geotextiles”.

B. Subgrade: Place material in lifts not exceeding 8 inches in thickness and compact to no less than 95% of maximum dry density (ASTM D 1557 or AASHTO T 180). Compaction testing should be performed by Contractor as specified in Section 31 00 00 “Excavation, Backfill, and Compaction”, as well as proof roll testing for stability.

C. Surface Courses: Adhere to Section 32 12 17 “Hot Mix Bituminous Pavement” for asphalt roads. Surfacing shall be sloped to prevent adequate drainage.

### 3.3. 3.3. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

### 3.4. RESTORATION OF SURFACES

A. Disturbed vegetated areas shall be revegetated in accordance with Section 32 92 19, “Seeding, Soil Supplements, and Mulching”.

B. Damaged surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

C. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

### 3.5. MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted at the end of the project.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of asphalt surface courses of roadways.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 32 11 23 | Aggregates and/or Graded-Crushed Aggregate for Roadways |

1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

American Association of State and Highway Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M 323 | Standard Specification for Superpave Volumetric Mix Design |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 4867/D 4867M | Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures |

Asphalt Institute (AI)

| | |
|---|---|
| AI MS-02 | Mix Design Methods |

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials (CM)

Maryland Standard Method of Test (MSMT)

| | |
|---|---|
| MSMT 412 | Design Procedure for Hot Mix Asphalt Containing Recycled Asphalt Pavement |

B. References shall also include those listed within, such as MSMT and the AI references within the MD SHA specifications.

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”.

A. Product Data: List of materials and formula to be used, including sources, suppliers, and laboratory

B. Lab Data: Test report for mix formula and materials, including grain size chart

1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

B. Modification of References

Where term “Engineer” or “state” is used in MDSHA Standard Specifications, it shall be construed to mean Owner.

1.6. DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.7. ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the ambient air and surface temperatures are at least 40 degrees Fahrenheit (F) and rising. Place mixtures used as intermediate and base layers when the ambient air and surface temperatures are at least 32 degrees F and place polymer modified surface mixes when the ambient air and surface temperatures are at least 50 degrees F.

1.8. CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory within 12 months of commencing work.

PART 2. PRODUCTS

2.1. AGGREGATES AND MINERAL FILLER

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

A. Coarse Aggregates, Fine Aggregates, and Mineral Filler shall meet MD SHA CM grading requirements based on the selected mix design.

B. Aggregate physical property requirements shall meet the requirements provided by MD SHA CM.

2.2. ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to Viscosity Grade, Performance Grade, and Penetration Grade specified by MD SHA CM for the specified performance grade. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Owner. The supplier is defined as the last source of any modification to the binder.

2.3. MIX DESIGN

The Contractor shall develop the mix design in accordance with MD SHA CM Section 904.04. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a Superpave mix design has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 0.85 (85 percent), the aggregates shall be rejected or the asphalt mixture treated with an approved antistripping agent. The amount of antistripping agent added shall be sufficient to produce a TSR of not less than 0.85 (85 percent). If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. All mix designs must be field verified.

2.4. RECYCLED HOT MIX ASPHALT

Recycled hot mix asphalt (HMA) shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP allowable shall be determined in conformance with MSMT 412 and AASHTO M 323. Crushed glass may not be used in surface mixes.

PART 3. EXECUTION

3.1. PREPARATION

A. The job mix shall be delivered to the site per MD SHA Specifications. The material shall be delivered heated at a uniform temperature to avoid local overheating, and shall be free of moisture.

B. Surface Preparation of Underlying Course: Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter using cleaning methods as necessary. If the time period between the placements of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty, clean between lifts and apply a tack coat.

C. Spraying of Contact Surfaces: Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2. PLACEMENT

Machine spreading; shoveling, raking, and tamping; and hand-spreading (in lieu of machine-spreading) shall conform to MD SHA Standards and Specifications.

3.3. COMPACTION OF MIXTURE

A. Compact the mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot.

B. Before continuing rolling, correct variations by removing or adding materials as necessary.

C. Refer to MD SHA Specifications for additional instructions, ASTM and AASHTO requirements, and restrictions.

3.4. JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.5. FIELD QUALITY CONTROL

A. Contractor (or asphalt subcontractor) is responsible for sampling and approving the source/plant samples per MSMT and MD SHA Specifications. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

B. Contractor (or asphalt subcontractor) is responsible for field verification via coring method per MSMT and MD SHA Specifications. A MD SHA certified technician is required to perform QA/QC testing. Contractor (or asphalt subcontractor) is responsible for sampling and approving field mixture samples per MSMT and MD SHA Specifications.

3.6. PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F.

END OF SECTION

PART 1. GENERAL

1.1. REFERENCES

Furnish all labor, materials, equipment, and incidentals necessary to perform all seeding, and mulching as shown on the Technical Drawings and described in the Technical Specifications. This work shall include, but not be limited to final grading, tilling and cleaning the seed bed; seeding; fertilizing; mulching; specified watering; and maintaining the seeded area through the required mowings. The areas to be seeded and mulched include: areas cleared and grubbed, storage areas, backfill areas, and areas around proposed Block G swale location.

Note: Should the Contractor wish to sod rather than seed, the Contractor shall provide a sodding specification to the Owner for review and approval before sodding.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |

1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 602 (2007) Agricultural Liming Materials

ASTM D 4427 (2007) Peat Samples by Laboratory Testing

ASTM D 4972 (2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications of Construction and Materials

1.4. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 “Submittals”:

A. Product data for seed formula demonstrating testing, purity, and germination.

B. Laboratory testing of on-site or borrowed topsoil with soil amendment recommendations.

PART 2. PRODUCTS

2.1. MATERIALS

A. Seed shall meet the MD SHA requirements for testing, purity, and percent germination.

B. Fertilizer shall be a commercial fertilizer supplied in 50 lb. bag or bulk. Fertilizer supplied in bulk form shall be accompanied with a certification giving the analysis and weight.

C. All soil conditioners shall be horticultural grade.

D. Mulch shall be either small grain straw or for hydro mulching shall be commercially available wood cellulose fiber or wood pulp for use in spray applicators. Mulch shall be free of noxious weeds.

E. Erosion and Sediment (blanket, fabric, netting) shall conform to Section 33 40 00 “Storm Drainage Utilities”.

F. Topsoil is subject to the requirements of the MD SHA 2008 Specifications for Construction and Materials. Topsoil shall be stockpiled separately from other fill materials. All topsoil shall meet the following additional requirements:

1. Contractor to provide required representative samples to an independent testing agency for analysis and recommended treatment, including payment of all costs incurred for testing and analysis.

2. Test reports shall include specific recommendations regarding exact types, time and rates of application of soil additives and fertilizers based upon soil test results and type of material to be planted. Include the following in topsoil analysis:

   a. pH factor
   b. Percent organic matter
   c. Soluble salts
   d. Available nutrients
   e. Percent clay, sand and silt particles

3. Before delivery of imported topsoil, furnish the Owner’s representative with a written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owner(s), analysis of topsoil, depth to be stripped, previously used herbicides, and crops grown during past 2 years.

4. All topsoil shall be screened, natural, fertile agricultural soil capable of sustaining vigorous plant growth, not in frozen or muddy condition. Imported topsoil shall be typical of locality and shall come from a well-drained site free of flooding, not from bogs or marshes. Topsoil is to be free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and foreign matter. Visually or mechanically screen material prior to re-spreading operation.

5. Topsoil: pH range of 6.0 to 7.5, a minimum of 1.5 percent organic material content; free of stones 3/4 inch or larger in any dimension and meeting the following requirements.

   a. Sand Content: 2.000 mm to 0.05 mm, greater than 60%

b. Silt Content: 0.05 mm to 0.005 mm, greater than 30% silt plus clay
c. Clay Content: 0.005 mm and smaller, less than 40%.

6. Screening: No more than 60% of material passing #100 mesh consists of clay as determined by Bouyoucous hydrometer or by decantation method. Mechanically screen topsoil to conform to following gradations:

| | SIEVE DESIGNATIONS | % PASSING |
|---|---|---|
| a. | 3/4" | 100% |
| b. | 1/4" | 97-100% |
| c. | #200 | 20-65% |

These limits may be modified as recommended by the nursery or testing laboratory.

## PART 3. EXECUTION

### 3.1 SEEDING AND MULCHING

A. Seeding

1. Perform seeding as indicated in the Technical Drawings. See the Technical Drawings for acceptable seed mixtures, seeding seasons, application scenarios, application rates, and application methods.

2. Apply seed uniformly with a cyclone seeder, drill, cultipacker seeder or hydroseeder (slurry includes seed and fertilizer) on a firm, moist seedbed. Maximum seeding depth should be ¼ inch on clayey soils and ½ inch on sandy soils, when using other than hydroseeder method of application.

3. Apply seed within twenty four hours after seed bed preparation. Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

4. Seeding must be accomplished in a time frame that allows seed germination prior to October 15.

B. The contractor shall fine grade and remove all sticks, stones, debris, clay lumps, sod clods, and other undesirable materials in the top three inches of soil. The top three inches of soil shall be loosened by raking, discing, or other acceptable means before seeding. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. The Owner shall approve the seed bed prior to seeding.

C. Soil Amendments: Soil amendments shall adhere to the recommendations of the testing lab or nursery. A typical mix for seeding is as follows: apply 800 lbs/1000 sq. yds. of pulverized agricultural limestone, 192 lbs/1000 square yards of 10-20-20 commercial analysis fertilizer and 50 lbs/1000 square yards of 38-0-0 urea form fertilizer.

D. Mulching:

1. Straw shall be un-rotted small grain straw applied at 125-140 lbs/1000 square feet. Mulch materials shall be relatively free of all kinds of weeds. Spread uniformly by hand or mechanically for uniform distribution of hand spread mulch, divide area into approximately 1,000 square yards section and place 125-140 pounds of mulch in each section.

2. Wood cellulose mulch shall be applied via hydro-mulching at a rate of 1,250 pounds per acre.

E. Watering: Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

F. Restoration: Restore to original condition existing turf areas which have been damaged during construction operations at the Contractor's expense.

G. Seeded lawn areas shall be maintained by the Contractor and shall be guaranteed for a period of one (1) year. Maintenance may include aeration, mowing, dethatching, or overseeding, In the event previously seeded areas fail to establish an adequate ground cover, the Contractor shall redo this work to the satisfaction of the Owner.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

Provide soil preparation, fertilizing, tree, shrub, groundcover, and planting, staking and guying, weed control fabric, erosion control material and root control barrier installation and a mulch topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01 33 00 | Submittals |
| 01 35 10 | Environmental Protection |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 32 92 19 | Seeding, Soil Supplements, and Mulching |

1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300 (1995) Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance

ANSI Z133.1 (2006) Arboricultural Operations - Safety Requirements for Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush

ANSI Z60.1 (1996) Nursery Stock

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA P5 (2005) Standard for Waterborne Preservatives

AWPA T1 (2004; R 2005) Use Category System: Processing and Treatment Standard

AWPA U1 (2004; R 2005) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A 580/A 580M (2008) Standard Specification for Stainless Steel Wire

ASTM C 602 (2007) Agricultural Liming Materials

ASTM D 1972 (1997; R 2005) Standard Practice for Generic Marking of Plastic Products

ASTM D 4427 (2007) Peat Samples by Laboratory Testing

ASTM D 4972 (2001; R 2007) pH of Soils

ASTM D 5268 (2007) Topsoil Used for Landscaping Purposes

ASTM D 5539 (1994; R 2008) Seed Starter Mix

ASTM D 5852 (2000; R 2007) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method

ASTM D 6629 (2001; R 2007) Selection of Methods for Estimating Soil Loss by Erosion

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.4. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 “Submittals”:

A. Product data including graphics for trees and shrubs, including botanical names, common names, quality, fungicide and pesticide treatment, and size.

B. Nursery certifications, warranties, and plant care data

C. Product data or samples for other materials (pea gravel, weed control fabric)

1.5. DELIVERY, STORAGE, AND HANDLING

A. The Owner will inspect plant materials at the project site and approve them upon delivery. Plants shall be tagged for size and quality.

B. Branched Plant Delivery: Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

C. Soil Amendment Delivery: Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, gypsum, sulfur, iron, and lime may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates.

D. Plant Labels: Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels shall be legible for a minimum of 60 days after delivery to the planting site.

E. Store and protect plants not planted on the day of arrival at the site as follows:

1. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

2. Heel-in bare root plants.

3. Protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

4. Keep plants in a moist condition until planted by watering with a fine mist spray.

5. Do not store plant material directly on concrete or bituminous surfaces.

F. Root Control Barrier and Weed Control Fabric: Store materials on site in enclosures or under protective covering in dry location. Store under cover out of direct sunlight. Do not store materials directly on ground.

G. Handling: Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem. Remove damaged plants from the site.

H. Time Limitation: Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch shall be a maximum of 24 hours.

1.6. TIME RESTRICTIONS AND PLANTING CONDITIONS

A. Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

B. Plant all plants between March 1 and October 31. All plantings not within the March-October timeframe must first obtain approval from the Owner. Do not plant when ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7. GUARANTEE

All plants shall be guaranteed for at least one year beginning on the date of inspection by the Owner to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period. Transplanted plants require no guarantee.

PART 2. PRODUCTS

2.1. PLANTS

A. Regulations and Varieties: Furnish nursery stock in accordance with ANSI Z60.1, except as otherwise specified or indicated. Each plant or group of planting shall have a "key" number indicated on the nursery certifications of the plant schedule. Plants specified shall be low maintenance varieties, tolerant of site's existing soils and climate. Plants of the same specified size shall be of uniform size and character of growth. Plants shall be chosen with their mature size and growth habit in mind to avoid over-planting and conflict with other plants, structures or underground utility lines. All plants shall comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

B. Shape and Condition: Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

C. Growth of Trunk and Crown: A height to caliper relationship shall be provided in accordance with ANSI Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

D. Deciduous Trees and Shrubs: Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

E. Evergreen Trees and Shrubs: Well developed symmetrical tops with typical spread of branches for each particular species or variety.

F. Ground Covers and Vines: Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section. Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANSI Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

G. Root Ball Size: All box-grown, field potted, field boxed, collected, plantation grown, bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls shall conform to ANSI Z60.1. All wrappings and ties shall be biodegradable. Root growth in container grown plants shall be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

H. Mycorrhizal fungi inoculums: Before shipment, root systems shall contain mycorrhizal fungi inoculum.

2.2. TOPSOIL

A. Refer to Section 32 92 19 “Seeding, Soil Supplements, and Mulching” for topsoil and soil supplement requirements.

B. Planting Soil Mixtures shall be 100% topsoil with plant-specific additives as recommended by the nursery (i.e. peat, lime, clay, vermiculite, etc)

2.3. FERTILIZER

Fertilizer for groundcover, wildflowers and grasses are not permitted for the trees, plants, or shrubs described in this section. Use fertilizer for trees, plants, and shrubs as recommended by the nursery. Synthetic chemical fertilizers are not permitted. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not permitted.

2.4. WEED CONTROL FABRIC

Roll Type Polypropylene or Polyester Mats: Fabric shall be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric shall be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight shall be 5 ounces per square yard with a minimum thickness of 20 mils with a 20 year (minimum) guarantee.

2.5. MULCH

Refer to Section 32 92 19 “Seeding, Soil Supplements, and Mulching” for mulching requirements. Mulch shall be free from noxious weeds, mold, pesticides, or other deleterious materials.

2.6. STAKING AND GUYING MATERIAL

A. Staking Material:

1. Tree Support Stakes: Rough sawn, hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes shall be minimum 2 inches square by 8 feet long, pointed at one end.

2. Ground Stakes: 2 inches square by 3 feet long, pointed at one end

B. Guying Material:

1. Guying Wire: 12 gauge annealed galvanized steel, ASTM A 580/A 580M.

2. Guying Cable: Minimum five-strand, 3/16 inch diameter galvanized steel cable [plastic coated].

3. Hose Chafing Guards: New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

C. Flags: White, 12 inches long, fastened to guying wires or cables.

D. Turnbuckles: Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts shall be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1 1/2 inches, minimum.

E. Deadmen: 4 by 8 inch rectangular or 8 inch diameter by 36 inch long, pine wood material.

F. Metal Anchors, Driven: Malleable iron, arrow shaped, galvanized, sized 3 to 10 inches for tree calipers 2 to 12 inches, respectively.

G. Screw Anchors: Steel, screw type with welded-on 3 inch round helical steel plate, minimum 3/8 inch diameter, 15 inches long.

2.7. ANTIDESICCANTS

Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film shall form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity.

2.8. EROSION CONTROL MATERIALS
Refer to Section 01 35 10 “Environmental Protection” for Erosion and Sediment Practices.

2.9. ROOT CONTROL BARRIER

Flexible and permeable geotextile fabric with permanently attached time-released nodules. Pre-formed barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material. Color to be black or grey.

2.10. WATER
Source of water to be suitable quality for irrigation and shall not contain elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

2.11. MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.12. PESTICIDES

Pesticides and herbicides are not permitted unless approved by the Owner. An Integrated Pest Management Plan shall be submitted if an approval as requested.

2.13. LANDSCAPE GRAVEL

Landscape gravel “pea gravel” shall match the existing on-site landscape gravel in size, shape, and color.

PART 3. EXECUTION

3.1. PREPARATION

A. Protection: Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

B. Layout: Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Owner reserves the right to adjust plant material locations to meet field conditions. Do not plant closer than 24 inches to a building wall or other similar structure. Provide on-site locations for excavated rock, soil, and vegetation.

C. Erosion Control: Provide erosion control and seeding with native plant species to protect slopes.

D. Soil Preparation: Apply pH adjuster and soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site.

E. Fertilizer Application Rates: Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site or as recommended by the nursery.

F. Root Control Barrier: Install geotextile fabric in the soil in a horizontal application. Use appropriate holding device to assure fabric position. A minimum 2 inch soil cover is required over the top edge. A minimum 18 inch extension of fabric beyond the structure area to be protected is required to prevent root growth from growing around fabric edges.

3.2. PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. Protect existing adjacent turf before excavations are made. Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Depth of plant pit excavation shall be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph entitled "Plant Installation." Do not install trees within 10 feet of any utility lines or building walls unless coordinated with the Contract Officer.

3.3. PLANT INSTALLATION

A. Individual Plant Pit Excavation: Excavate pits at least twice as large in diameter as the size of ball or container to depth shown.

B. Plant Beds with Multiple Plants: Excavate plant beds continuously throughout entire bed as outlined to depth shown.

C. Handling and Setting: Move plant materials only by supporting the root ball or container. Set plants on hand compacted layer of prepared backfill soil mixture 6 inches thick and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, 1 to 2 inches below depth at which they were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

D. Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas.

E. Balled and Burlapped Stock: Backfill with topsoil to approximately half the depth of ball and then tamp and water. Carefully remove or fold back excess burlap and tying materials from the top a minimum 1/3 depth from the top of the rootball. Tamp and complete backfill, place mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit prior to backfill operations.

F. Bare-Root Stock: Plant so roots are arranged in a natural position. Place roots in water a minimum of 30 minutes prior to planting. Carefully work topsoil among roots. Tamp remainder of backfill, place mulch topdressing and water.

G. Container Grown Stock: Remove from container and prevent damage to plant or root system.

H. Ground Covers and Vines: Plant after placing mulch topdressing. Do not remove plant materials from flats or containers until immediately before planting. Space at intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 6 inches without run off or puddling. Smooth planting areas after planting to provide even, smooth finish. Mulch as indicated.

I. Earth Mounded Watering Basin for Individual Plant Pits: [Form with topsoil around each plant by placing a mound of topsoil around the edge of each plant pit. Watering basins shall be 6 inches deep for trees and 4 inches deep for shrubs. Construct watering basin in a 4 1/2 foot diameter circle around specimen (not planted in a close group) trees and shrubs.

J. Weed Control Fabric Installation: Remove grass and weed vegetation, including roots, from within the area enclosed by edging. Completely cover landscape areas with specified weed control fabric prior to placing mulch or landscape gravel layer. Overlap cut edges 6 inches.

K. Erosion Control Material: Install in accordance with manufacturer's instructions.

L. Placement of Mulch Topdressing: Place specified mulch topdressing on top of weed control fabric covering total landscape area (non-pea gravel areas). Place mulch topdressing to a depth of 3 inches.

M. Installation of Edging: Edging is not proposed on this project.

N. Fertilization: Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth, or apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

O. Watering: Start watering areas planted as required by temperature and wind conditions. Slow deep watering shall be used. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 12 inches without run off or puddling. Watering of other plant material or adjacent areas shall be prevented.

P. Staking and Guying:

1. Staking: Stake plants with the number of stakes indicated complete with double strand of 12 gage guy wire as detailed. Attach guy wire half the tree height but not more than 5 feet high. Drive stakes to a depth of 2 1/2 to 3 feet into the ground outside the plant pit. Do not injure the root ball. Use hose chafer guards where guy wire comes in contact with tree trunk.

2. Guying: Guy plants as indicated. Attach two strands of guying wire or guying cable around the tree trunk at an angle of 45 degrees at approximately 1/2 of the trunk height. Anchor guys to deadmen wood blocks, wood ground stakes, malleable iron anchors, or steel screw anchors. Provide turnbuckles as indicated.

3. Chafing Guards: Use hose chafing guards, as specified where guy wire or cable will contact the plant.

4. Deadmen: Place deadmen minimum 18 inches below ground surface. Place equal distance from tree trunk and around the plant pit.

5. Wood Ground Stakes: Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.

6. Iron Anchors: Drive malleable iron anchors into firm ground outside of plant pit a minimum 30 inches below finish grade. Place equal distance from tree trunk and around the plant pit.

7. Steel Screw Anchors: Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.

8. Flags: Securely fasten flags on each guy wire or cable approximately two-thirds of the distance up from ground level.

Q. Pruning: Prune in accordance with safety requirement of ANSI Z133.1.

1. Trees and Shrubs: Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars shall remain in place. Pruning shall be accomplished by trained and experienced personnel and shall be accordance with ANSI A300.

2. Wound Dressing: Do not apply tree wound dressing to cuts.

3.4. CLEAN UP

Excess and waste material shall be removed from the installed area and shall be disposed offsite.

3.5. ESTABLISHMENT AND MAINTENANCE

Landscape areas shall be maintained by the Contractor and shall be guaranteed for a period of one (1) year. In the event the landscape vegetation fails to establish or if weed breakthrough occurs within this time period, the Contractor shall redo this work to the satisfaction of the Owner.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of storm drainage utilities. This Section includes gravity-flow, non-pressure storm drainage outside the building, with the following components:

1. Piping and Fittings
2. Precast concrete manhole, storm water detention outlet structure
3. Frame/cover for manhole & catch basin, grating cover & trash rack
4. Installation of manhole and stormwater detention outlet structure
5. Capping existing catch basin grate
6. Core-drill existing catch basin and connect it to the proposed storm drain
7. Extend existing culvert and connect it to the manhole
8. Erosion protection at the outlet of the storm drains and emergency spillway

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 03 40 00 | Pre-Cast for Concrete |
| 31 00 00 | Excavation, Backfill, and Compaction |
| 31 03 00 | Off-site Waste Disposal |
| 31 03 00 | Dewatering and Water Control |

## 1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C 1433 | (2008) Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers |
| ASTM C-361 | (2011) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe |
| ASTM C 443 | (2005ae1) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C 478 | (2009) Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C 76 | (2010a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |

| | |
|---|---|
| ASTM C 923 | (2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C 94/C 94M | (2009a) Standard Specification for Ready-Mixed Concrete |
| ASTM C 990 | (2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C 1478 | (2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |

U.S. GENERAL SERVICES ADMINISTRATION

| | |
|---|---|
| CID A-A-60005 | (Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole |

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00: “Submittals”:

A. Shop Drawings: Precast concrete structures, Metal items such as frames, covers, and gratings

B. Product Data: Pipeline materials including any special connectors or branches, gaskets, resins, mastic, riprap for outlet protection, flared-end section, erosion control mattings

C. Core-drill Method and Equipment

D. As-Built Drawings: Submit As-Built Drawings signed and sealed by a Professional Surveyor for the storm sewer systems including the final grades of the stormwater detention area showing complete detail with all dimensions, both above and below grade, invert elevations, and other utility crossings.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manhole according to manufacturer's written rigging instructions.

D. Handle drainage inlet according to manufacturer's written rigging instructions.

1.6. PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Engineer's written permission.

1.7. QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage systems.

B. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered.

PART 2. PRODUCTS

2.1. PIPING MATERIALS

A. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), Class IV, Wall B, for gasketed joints.

1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

B. Principal spillway barrels shall meet ASTM C-361, Class IV. The designation C-361 must be stated on the profile through the principal spillway. A certification letter with the test results shall be furnished to the purchaser upon delivery.

2.2. MANHOLE AND CATCH BASIN

A. Junction Box and Storm water Outlet Structure including frame/cover shall be in accordance with the Construction Drawings.

2.3. CONCRETE MATERIALS

A. Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements under Section 03 40 00 "Pre-Cast Concrete".

B. Cement Mortar

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

C. Portland Cement

Portland cement shall conform to ASTM C 150/C 150M, Type II or concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking. Air-entraining admixture conforming to ASTM C 260 shall be used with Type V cement.

D. Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psi minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

E. Pre-Cast Reinforced Concrete Structures
Manufactured in accordance with Section 03 40 00 “Pre-Cast for Concrete”, and in accordance with and conforming to ASTM C 1433 and to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure. The first riser shall be monolithic.

2.4. PIPE OUTLETS AND EMERGENCY SPILLWAY

A. Modified Riprap Inflow Protection, Flared-End-Section, Stone, Filter Cloth, and Matting to match size and shape as shown on Construction Drawings.

2.5. SOIL STABILIZATION MATTING

A. Products that meet the MDE standards and specifications and approved by the Owner.

1. Temporary soil stabilization matting shall have a minimum shear stress of 2 $lb/ft^2$ and be acceptable on slopes of 2:1 or flatter, where natural vegetation will provide permanent stabilization. Example Products: North American Green SC150, Synthetic Industries Landlok CS2.

2. Permanent soil stabilization matting shall have a minimum shear stress of 7 $lb/ft^2$ and be acceptable on slopes steeper than 2:1 and in channels, where natural vegetation will not provide long term stabilization. Example Products: North American Green P300 and P550 (vegetated), and Colbond Enkamat 7010 and 7020 (vegetated).

PART 3. EXECUTION

3.1. EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 00 00.

3.2. PIPING APPLICATIONS

A. General: Include soil tight joints, except where watertight or silt tight joints are indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following to manufacturer's recommendations.

3.3. INSTALLATION, GENERAL

A. General Locations and Arrangements: Construction Drawings indicate the general location and arrangement of underground drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where fittings are indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity flow systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

F. Install drainage piping pitched down in direction of flow, at slope and cover indicated.

3.4. PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Concrete Pipe and Fittings: Install according to ACPA "Concrete Pipe Handbook." Use the following seals:

1. Round Pipe and Fittings: ASTM C 443 (ASTM C 443M), rubber gaskets.

B. All joints and connections must be water tight and shall be approved by the engineer. And Baltimore County Department of Environment Protection and Resource Management (DEPRM) prior to fabrication.

3.5. CONCRETE PLACEMENT

A. Place Pre-Cast concrete as indicated.

3.6. CATCH BASIN & MANHOLE INSTALLATION

A. Construct catch basins to the location indicated.

B. Set frames and grates to elevations indicated.

3.7. IDENTIFICATION

A. Materials and their installation are specified in Section 31 00 00 Excavation, Backfill, and Compaction. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over piping as indicated on the Construction Drawing or 16” above the pipe.

3.8. FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.

2. Place plug in end of incomplete piping at end of day and whenever work stops.

3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visual between structures.
b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

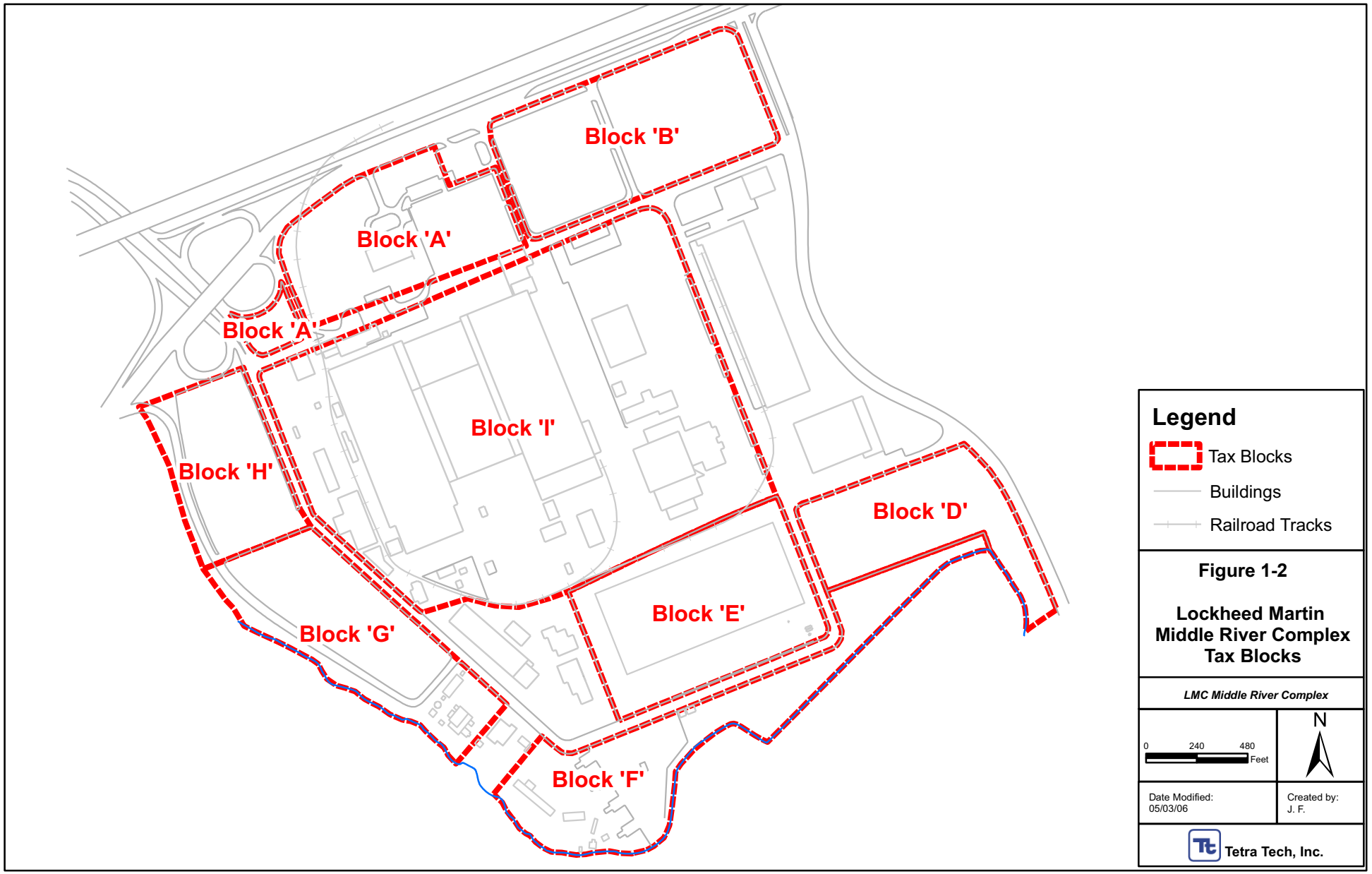
3.9. SOIL STABILIZATION MATTING

1. The Contractor shall provide soil stabilization matting on all slopes of 3:1 or steeper per manufacturers instruction.

2. The Contractor shall provide soil stabilization matting on the bottom and side slopes of the proposed swale as specified on the Erosion and Sediment Control Plan.

END OF SECTION

# APPENDIX C—FIGURES FROM THE GROUNDWATER RESPONSE ACTION PLAN

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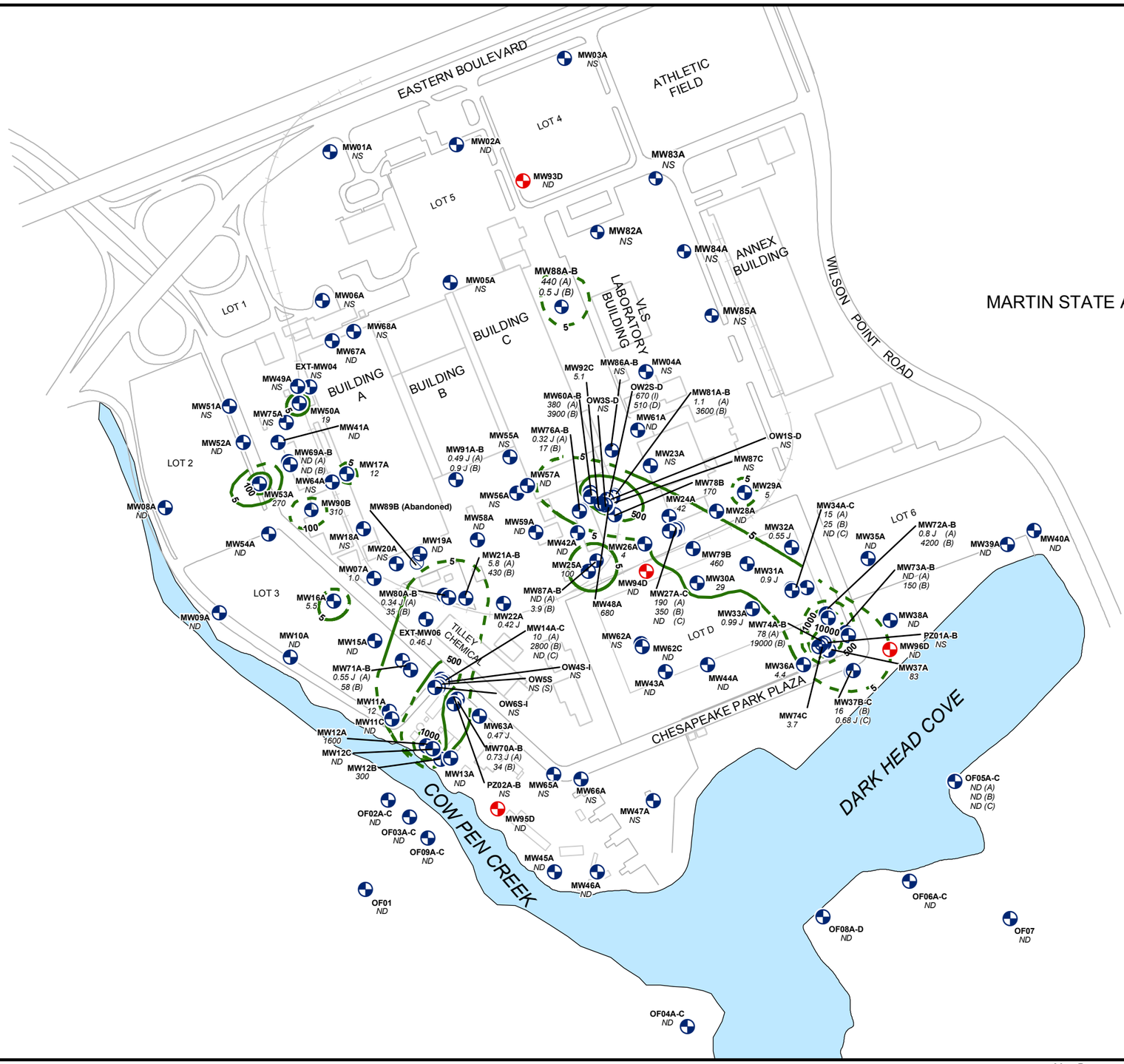


MARTIN STATE AIRPORT

**FIGURE 2-2**

**DISTRIBUTION OF TCE IN GROUNDWATER, MAY- JUNE 2010**

**LEGEND**

- GROUNDWATER MONITORING WELL
- DEEP GROUNDWATER MONITORING WELL
- ABANDONED WELL
- SURFACE WATER
- TCE ISOCONCENTRATION (UG/L)
- INFERRED

*13* MAXIMUM CONCENTRATION IN WELL (UG/L)

UG/L MICROGRAMS PER LITER

ND NOT DETECTED

NS NOT SAMPLED

Groundwater standard is 5 ug/l

***Lockheed Martin Middle River Complex***
***Middle River, Maryland***

0 150 300 600 Feet

N

DATE MODIFIED: 9/2/10

CREATED BY: MP

TETRA TECH

Map Document: (K:\GProject\middle_river\Maps\Middle River TCE Distribution in GW_June 2010.mxd)
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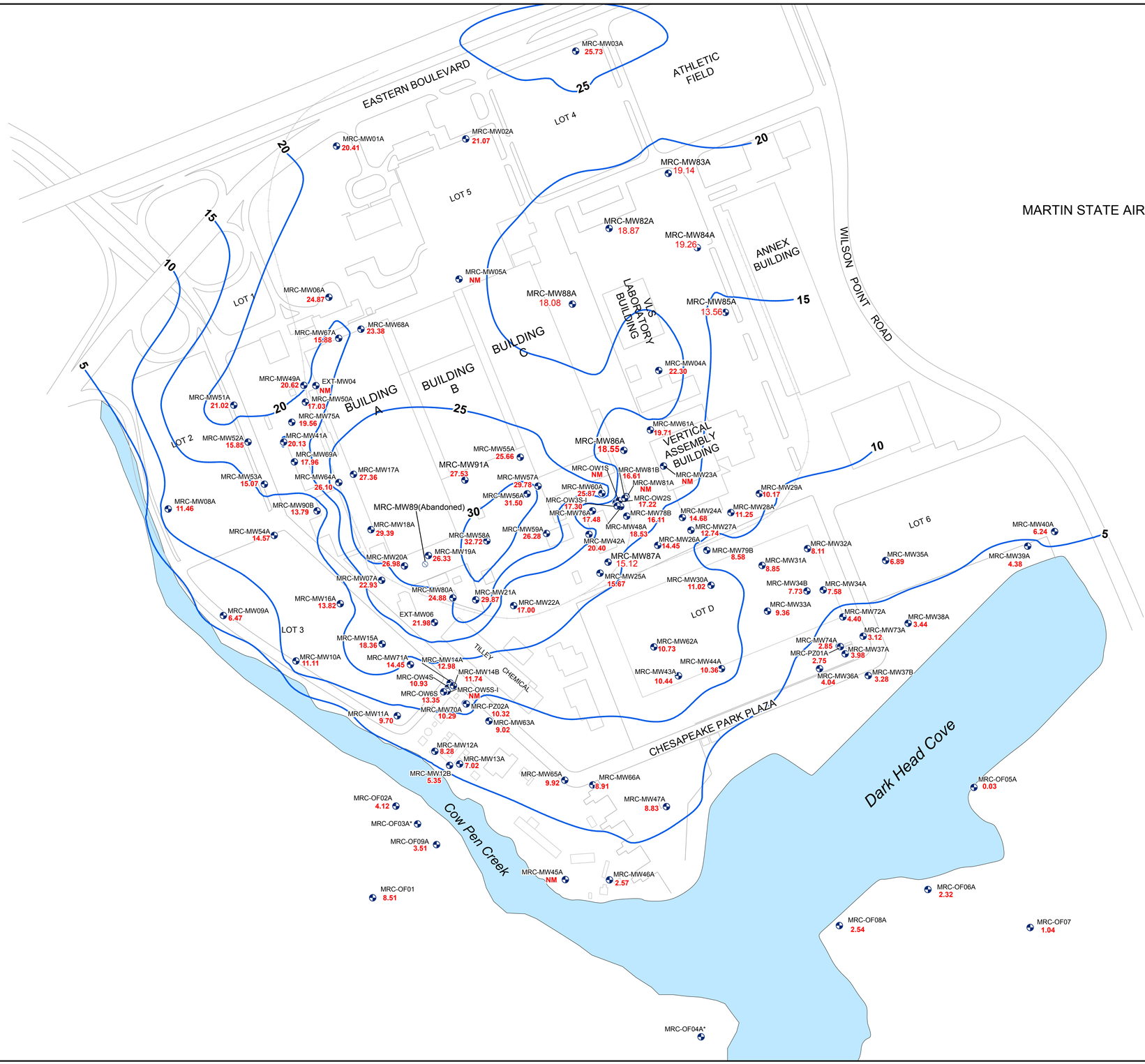


**FIGURE 2-11**

**GROUNDWATER CONTOURS OF THE UPPER SURFICIAL AQUIFER, JUNE 2010**

## Legend

- GROUNDWATER MONITORING WELL
- ABANDONED WELL
- SURFACE WATER
- GROUNDWATER CONTOUR CONTOUR INTERVAL = 5 FEET
- INFERRED
- 15.23 GROUNDWATER ELEVATION FEET, MEAN SEA LEVEL
- NM NOT MEASURED

Elevation for this well is not consistent with previous measurements or surrounding wells and appears to be from insufficient recharge to the well casing.

***Lockheed Martin Middle River Complex***
***Middle River, Maryland***

0 225 450 Feet

N

DATE MODIFIED: 9/14/10

CREATED BY: MP

TETRA TECH

Map Document: (K:\GProject\middle_river\Maps\Middle River GW Contours of Upper Surfacial Aquifer June2010.mxd)
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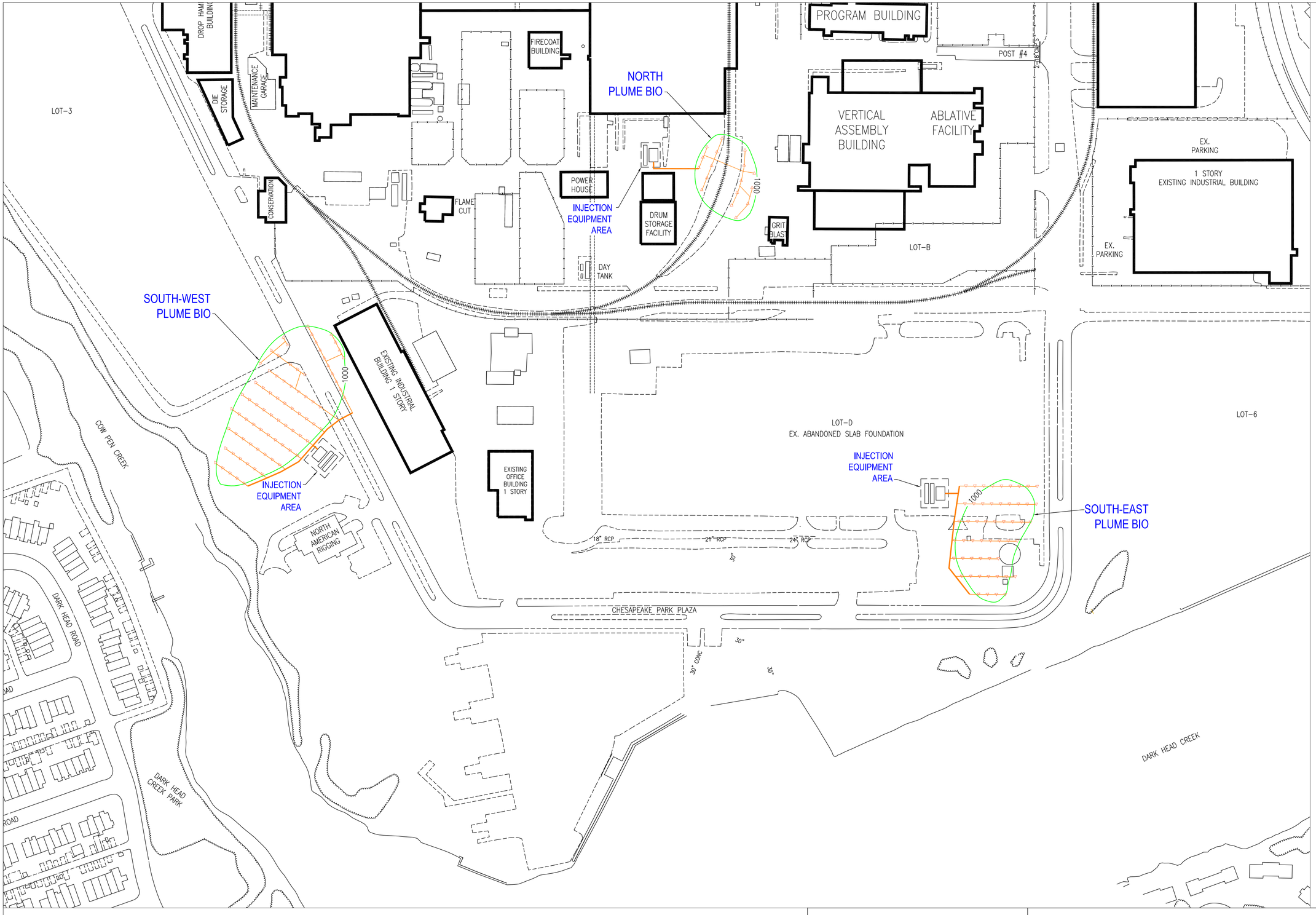



## LEGEND

- PROPERTY LINE
- PROPOSED PIPING ROUTE
- AMENDMENTS INJECTION WELL
- PIPING TO INJECTION WELLS

BASE MAP: BASED ON DRAWING PREPARED BY TAI CONSULTING ENGINEERS, INC.

TOPOGRAPHY: TOPOGRAPHY WITHIN AREA OF DISTURBANCE FROM FIELD RUN SURVEY CONDUCTED BY DMW, INC. IN JUNE 1999 FLOATED TO STATE GRID.

HORIZONTAL INFORMATION OUTSIDE OF LIMIT OF DISTURBANCE FROM BALTIMORE COUINTY OFFICE OF INFORMATION TECHNOLOGY GIS SERVICES UNIT. DATE OF CAPTURE: MARCH 1995

EXISTING UTILITIES: FIELD INFORMATION OBTAINED FROM DMW FIELD RUN SURVEY AND LOCKHEED MARTIN ENTITLED "EXHIBIT #6 EXISTING UTILITIES PLAN."

BOUNDARY LINES: BOUNDARY INFORMATION TAKEN FROM RECORDED PLAT E.H.K., JR. 51 FOLIO 43 "1ST AMENDED CHESAPEAKE PARK RE-SUBDIVISION" PREPARED BY MARYLAND SURVEYING AND ENGINEERING CO., INC. 4/24/84. BOUNDARY HAS BEEN ORIENTED TO THE BALTIMORE COUNTY METROPOLITAN DISTRICT GRID, BUT SHOULD NOT BE CONSIDERED A BOUNDARY SURVEY.

SCALE

0' 125' 250' 500'

TETRA TECH

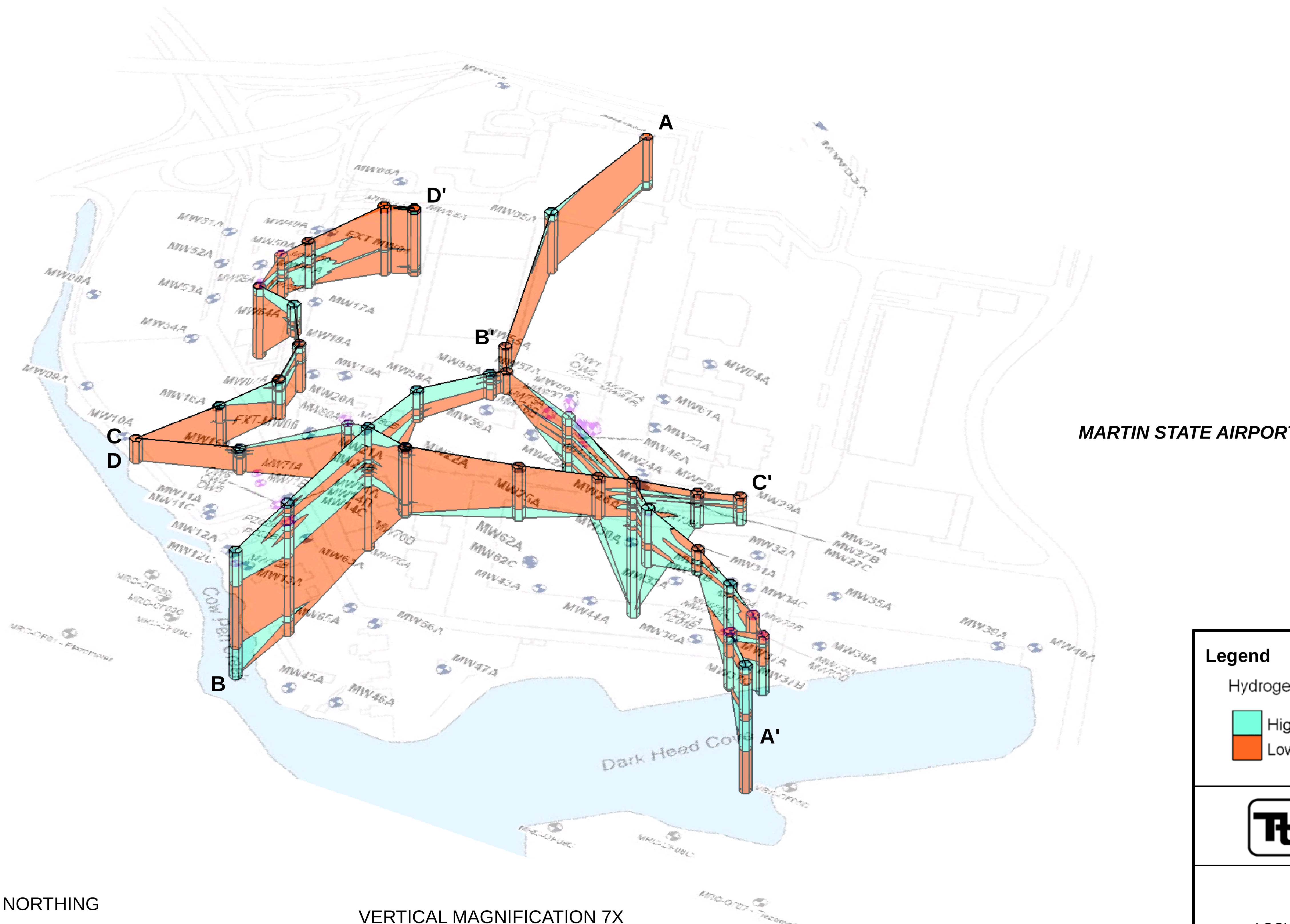
IN-SITU BIOREMEDIATION IN HIGH CONCENTRATION AREAS, ICs
ALTERNATIVE 3

LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 01-04-11 |
| PROJECT NO.: | |
| DESIGNED BY: | BD |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

FIGURE 6-10

P:\GIS\MIDDLE_RIVER\MAPDOCS\MXD\FENCE.MXD 06/19/08 JEE




NORTHING

EASTING

VERTICAL MAGNIFICATION 7X

**Legend**

Hydrogeologic Unit

- High Permeability (>= 1ft/d)
- Low Permeability (< 0.01 ft/d)

**Tetra Tech NUS, Inc.**

FENCE DIAGRAM
LOCKHEED MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| FILE | SCALE | |
|---|---|---|
| FENCE.MXD | AS NOTED | |
| FIGURE NUMBER | REV | DATE |
| FIGURE NO. | 0 | ________ |

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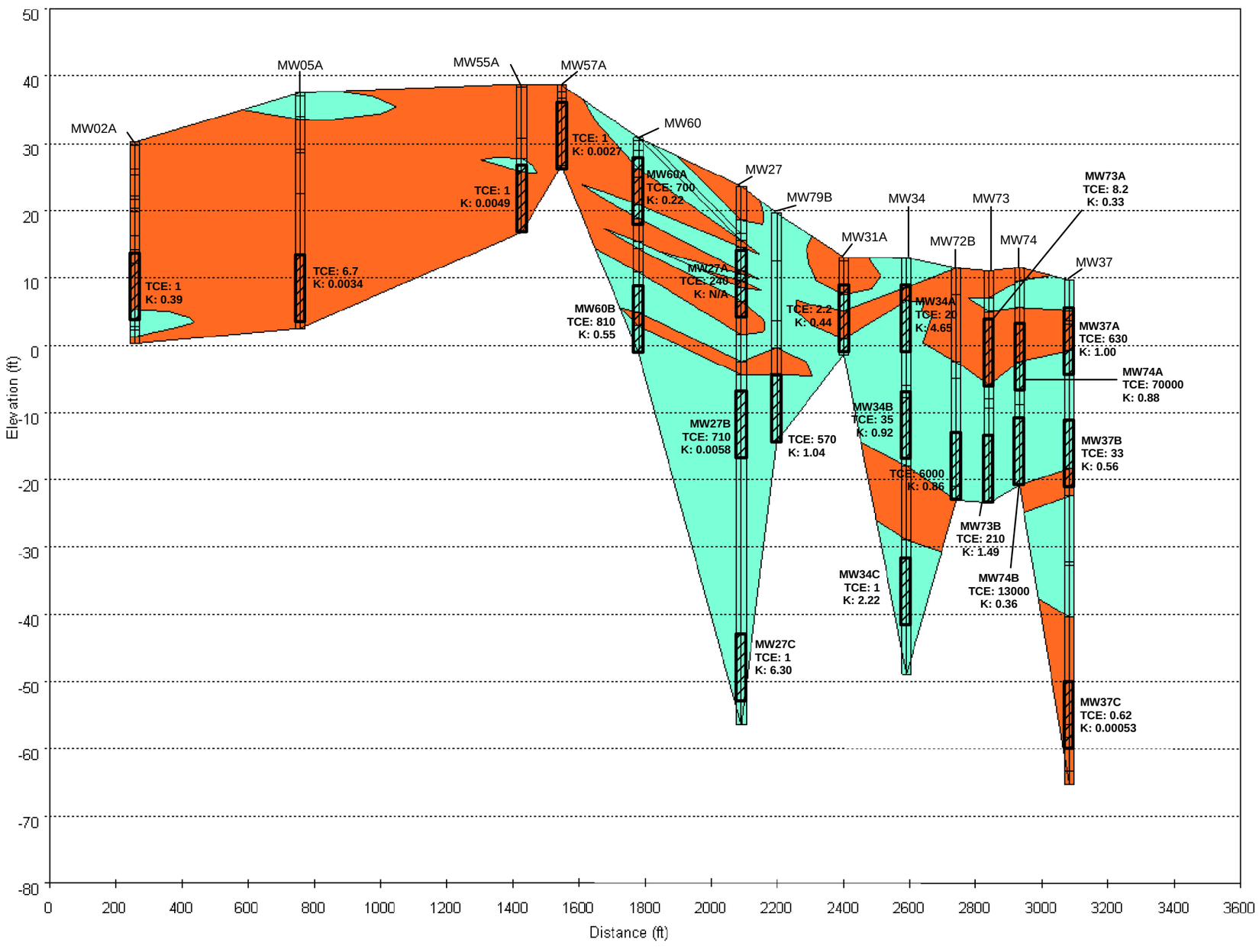
A'




## Legend

- Well Screen
- TCE Trichloroethene Concentrations (ug/L)
- K Hydraulic Conductivity (ft/day)

Hydrogeologic Unit

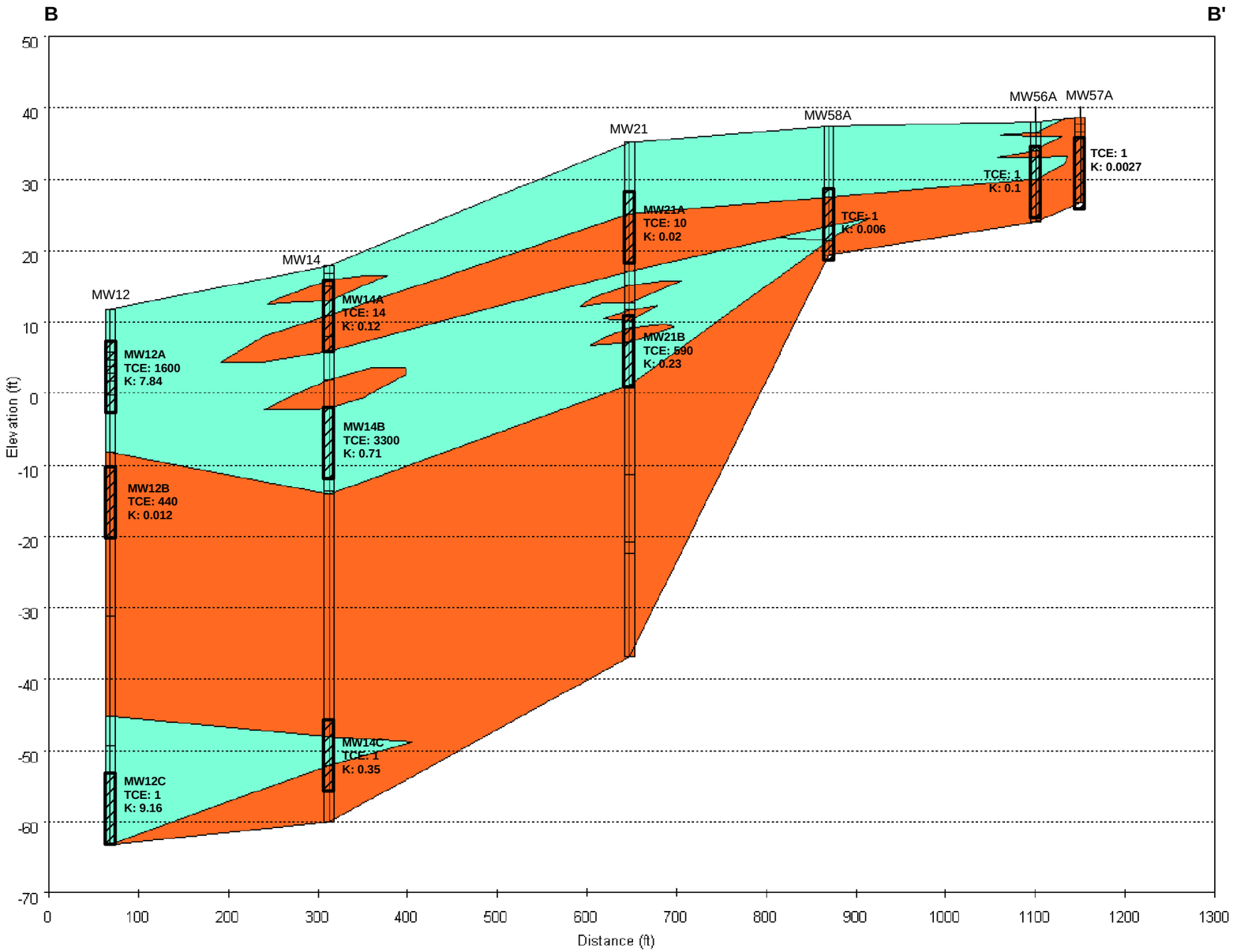
- High Permeability (>= 1ft/d)
- Low Permeability (< 0.01 ft/d)

**Tetra Tech NUS, Inc.**

GEOLOGIC CROSS-SECTION A-A'
LOCKHEED MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| FILE | SCALE |
|---|---|
| CROSS_SECTION_AA.MXD | AS NOTED |
| FIGURE NUMBER | REV / DATE |
| FIGURE NO. | 0 / _____ |

P:\GIS\MIDDLE_RIVER\MAPDOCS\MXD\CROSS_SECTION_BB.MXD 06/19/08 JEE




**Legend**

- Well Screen
- **TCE** Trichloroethene Concentrations (ug/L)
- **K** Hydraulic Conductivity (ft/day)

Hydrogeologic Unit

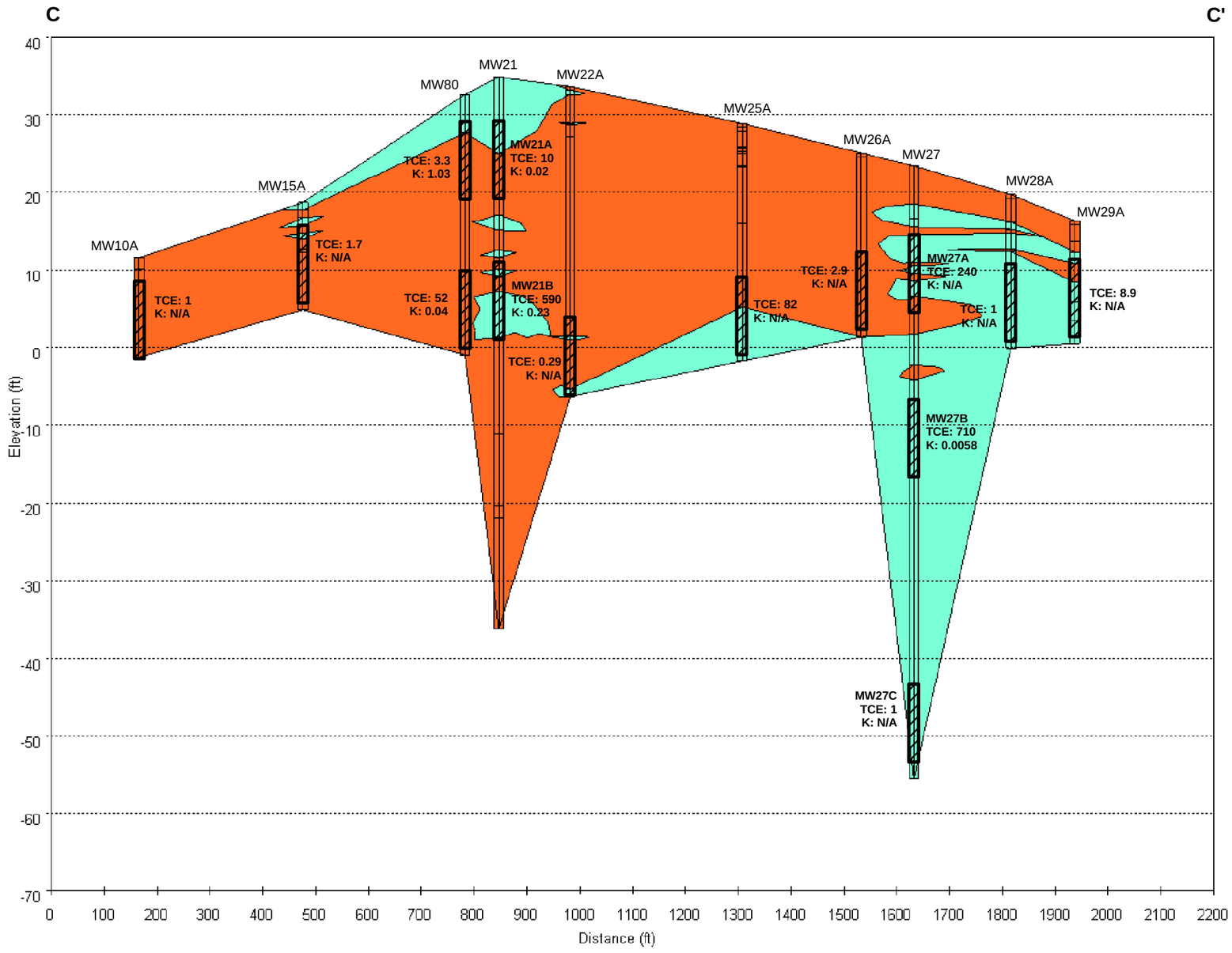
- High Permeability (>= 1ft/d)
- Low Permeability (< 0.01 ft/d)

**Tetra Tech NUS, Inc.**

GEOLOGIC CROSS-SECTION B-B'
LOCKHEED MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| FILE | SCALE |
|---|---|
| CROSS_SECTION_BB.MXD | AS NOTED |
| FIGURE NUMBER | REV / DATE |
| FIGURE NO. | 0 / |

P:\GIS\MIDDLE_RIVER\MAPDOCS\MXD\CROSS_SECTION_CC.MXD 06/19/08 JEE




**Legend**

Well Screen

**TCE** Trichloroethene Concentrations (ug/L)
**K** Hydraulic Conductivity (ft/day)

Hydrogeologic Unit

High Permeability (>= 1ft/d)
Low Permeability (< 0.01 ft/d)

**Tetra Tech NUS, Inc.**

GEOLOGIC CROSS-SECTION C-C'
LOCKHEED MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| FILE | SCALE |
|---|---|
| CROSS_SECTION_CC.MXD | AS NOTED |
| FIGURE NUMBER | REV / DATE |
| FIGURE NO. | 0 / _____ |

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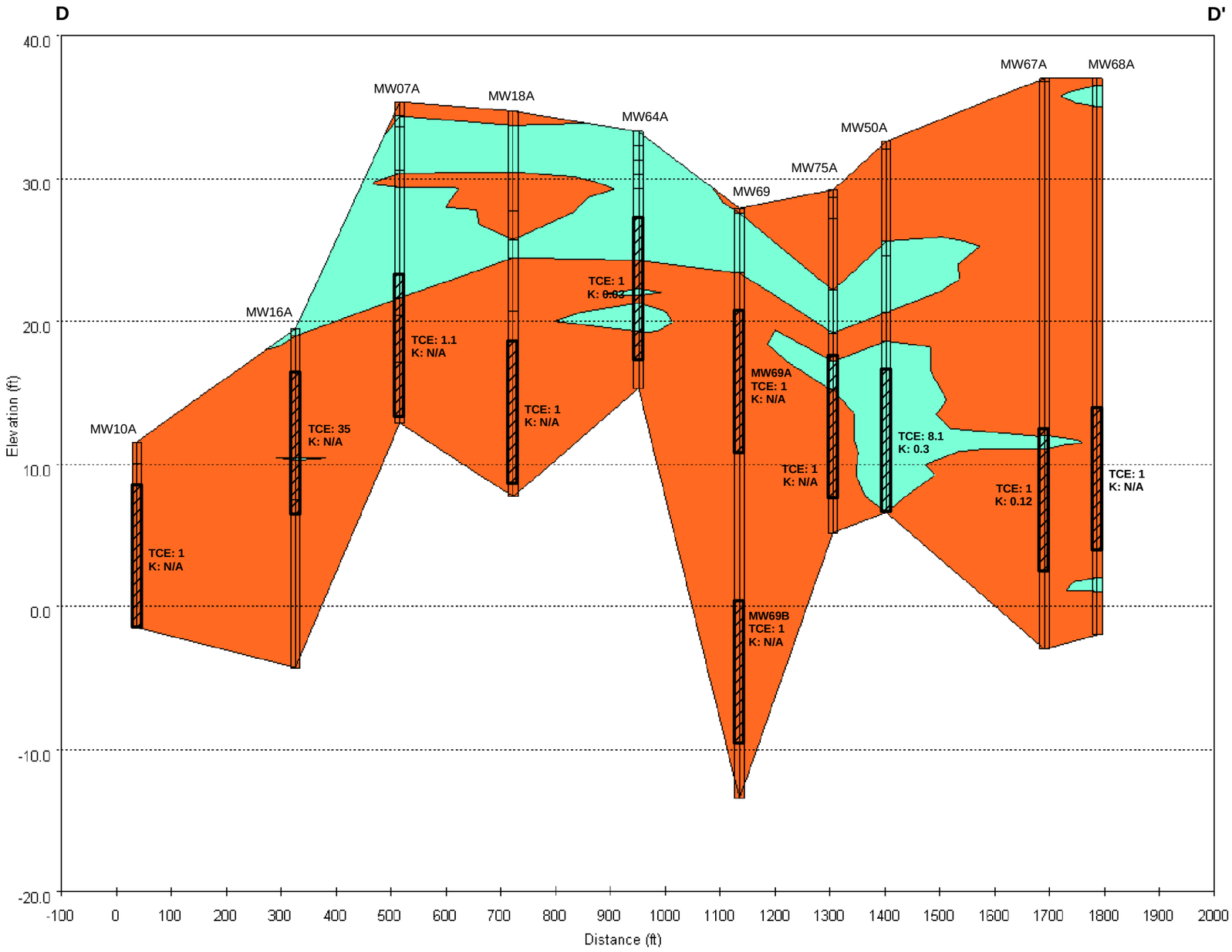



## Legend

- Well Screen
- **TCE** Trichloroethene Concentrations (ug/L)
- **K** Hydraulic Conductivity (ft/day)

Hydrogeologic Unit

- High Permeability (>= 1ft/d)
- Low Permeability (< 0.01 ft/d)

**Tetra Tech NUS, Inc.**

GEOLOGIC CROSS-SECTION D-D'
LOCKHEED MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

| FILE | SCALE |
|---|---|
| CROSS_SECTION_DD.MXD | AS NOTED |
| FIGURE NUMBER: FIGURE NO. | REV: 0 / DATE: |

**Table 2-4**

**Groundwater Depths and Elevations - June 2010**
**Lockheed Martin Middle River Complex, Middle River, Maryland**


| Well ID | Elevation Top of Well Casing-2010 Feet (NGVD 1988) | Elevation Ground-2010 Feet (NGVD 1988) | Screen Depth Top Feet (bgs) | Screen Depth Midpoint (1) Feet (bgs) | Screen Depth Bottom Feet (Below Grade) | Screen Elevation Top Feet (NGVD 1988) | Screen Elevation Midpoint Feet (NGVD 1988) | Screen Elevation Bottom Feet (NGVD 1988) | Depth to Groundwater 6/30/2010 Feet Top of Casing | Groundwater Elevation 6/30/2010 Feet (NGVD 1988) |
|---|---|---|---|---|---|---|---|---|---|---|
| MRC-MW01A | 33.63 | 33.76 | 18 | 23 | 28 | 15.63 | 10.63 | 5.63 | 14.98 | 18.65 |
| MRC-MW02A | 28.35 | 28.99 | 17 | 22 | 27 | 11.35 | 6.35 | 1.35 | 9.10 | 19.25 |
| MRC-MW03A | 28.17 | 28.61 | 4 | 9 | 14 | 24.17 | 19.17 | 14.17 | 4.24 | 23.93 |
| MRC-MW04A | 24.26 | 24.42 | 4 | 9 | 14 | 20.26 | 15.26 | 10.26 | 3.80 | 20.46 |
| MRC-EXT-MW04 | 34.22 | 32.66 | -- | -- | -- | NA | NA | NA | DRY | NA |
| MRC-MW05A | 35.15 | 35.49 | 24 | 29 | 34 | 11.15 | 6.15 | 1.15 | NM | NA |
| MRC-MW06A | 31.82 | 32.07 | 23 | 28 | 33 | 8.82 | 3.82 | -1.18 | 8.74 | 23.08 |
| MRC-EXT-MW06 | 31.63 | 29.58 | -- | -- | -- | NA | NA | NA | 11.41 | 20.22 |
| MRC-MW07A | 33.39 | 33.70 | 12 | 17 | 22 | 21.39 | 16.39 | 11.39 | 12.14 | 21.25 |
| MRC-MW08A | 9.70 | 9.87 | 3 | 8 | 13 | 6.70 | 1.70 | -3.30 | 0.00 | 9.70 |
| MRC-MW09A | 8.26 | 7.72 | 4 | 9 | 14 | 4.26 | -0.74 | -5.74 | 2.90 | 5.36 |
| MRC-MW10A | 9.52 | 9.64 | 3 | 8 | 13 | 6.52 | 1.52 | -3.48 | 0.20 | 9.32 |
| MRC-MW11A | 11.90 | 12.21 | 3 | 8 | 13 | 8.90 | 3.90 | -1.10 | 3.79 | 8.11 |
| MRC-MW11C | 11.45 | 13.41 | 63 | 68 | 73 | -51.55 | -56.55 | -61.55 | 2.21 | 9.24 |
| MRC-MW12A | 9.29 | 9.67 | 4 | 9 | 14 | 5.29 | 0.29 | -4.71 | 2.55 | 6.74 |
| MRC-MW12B | 9.56 | 9.87 | 20 | 25 | 30 | -10.44 | -15.44 | -20.44 | 3.99 | 5.57 |
| MRC-MW12C | 9.83 | 9.98 | 65 | 70 | 75 | -55.17 | -60.17 | -65.17 | 0.60 | 9.23 |
| MRC-MW13A | 10.31 | 10.37 | 4 | 9 | 14 | 6.31 | 1.31 | -3.69 | 4.77 | 5.54 |
| MRC-MW14A | 16.67 | 16.86 | 3 | 8.55 | 13 | 13.67 | 8.12 | 3.67 | 5.39 | 11.28 |
| MRC-MW14B | 15.88 | 16.06 | 20 | 25 | 30 | -4.12 | -9.12 | -14.12 | 5.76 | 10.12 |
| MRC-MW14C | 15.88 | 16.02 | 65 | 70 | 75 | -49.12 | -54.12 | -59.12 | 6.61 | 9.27 |
| MRC-MW15A | 16.80 | 17.01 | 3 | 8 | 13 | 13.80 | 8.80 | 3.80 | 0.00 | 16.80 |
| MRC-MW16A | 18.89 | 19.42 | 3 | 10.33 | 13 | 15.89 | 8.56 | 5.89 | 5.07 | 13.82 |
| MRC-MW17A | 32.59 | 33.06 | 9 | 14 | 19 | 23.59 | 18.59 | 13.59 | 7.09 | 25.50 |
| MRC-MW18A | 32.46 | 32.88 | 16 | 21.3 | 26 | 16.46 | 11.16 | 6.46 | 4.86 | 27.60 |
| MRC-MW19A | 36.36 | 36.90 | 8 | 13 | 18 | 28.36 | 23.36 | 18.36 | 11.86 | 24.50 |
| MRC-MW20A | 36.18 | 36.45 | 15 | 20 | 25 | 21.18 | 16.18 | 11.18 | 11.02 | 25.16 |
| MRC-MW21A | 32.70 | 33.09 | 6 | 11 | 16 | 26.70 | 21.70 | 16.70 | 4.97 | 27.73 |
| MRC-MW21B | 32.91 | 33.15 | 24 | 29 | 34 | 8.91 | 3.91 | -1.09 | 11.23 | 21.68 |
| MRC-MW22A | 31.58 | 32.05 | 30 | 35 | 40 | 1.58 | -3.42 | -8.42 | 16.46 | 15.12 |
| MRC-MW22B | 31.04 | 31.24 | 27 | 32 | 37 | 4.04 | -0.96 | -5.96 | 0.00 | 31.04 |
| MRC-MW23A | 25.37 | 25.64 | 12 | 17 | 22 | 13.37 | 8.37 | 3.37 | NA | NA |
| MRC-MW24A | 20.77 | 21.31 | 10 | 15 | 20 | 10.77 | 5.77 | 0.77 | 7.92 | 12.85 |
| MRC-MW25A | 26.71 | 27.23 | 20 | 25 | 30 | 6.71 | 1.71 | -3.29 | 12.81 | 13.90 |
| MRC-MW26A | 22.90 | 23.40 | 13 | 18 | 23 | 9.90 | 4.90 | -0.10 | 10.19 | 12.71 |
| MRC-MW27A | 20.76 | 21.07 | 8.5 | 14 | 19 | 12.26 | 6.76 | 2.26 | 9.81 | 10.95 |
| MRC-MW27B | 20.90 | 21.24 | 40 | 45 | 50 | -19.10 | -24.10 | -29.10 | 23.65 | -2.75 |
| MRC-MW27C | 21.35 | 21.62 | 68 | 73 | 78 | -46.65 | -51.65 | -56.65 | 13.67 | 7.68 |
| MRC-MW28A | 17.45 | 17.83 | 9 | 14 | 19 | 8.45 | 3.45 | -1.55 | 7.94 | 9.51 |
| MRC-MW29A | 13.97 | 14.36 | 5 | 10 | 15 | 8.97 | 3.97 | -1.04 | 5.60 | 8.37 |
| MRC-MW30A | 11.14 | 11.28 | 4 | 9 | 14 | 7.14 | 2.14 | -2.87 | 1.77 | 9.37 |
| MRC-MW31A | 11.00 | 11.12 | 4 | 9 | 14 | 7.00 | 2.00 | -3.00 | 3.85 | 7.15 |
| MRC-MW32A | 11.01 | 11.23 | 4 | 9 | 14 | 7.01 | 2.01 | -2.99 | 4.58 | 6.43 |
| MRC-MW33A | 11.08 | 11.19 | 4 | 9 | 14 | 7.08 | 2.08 | -2.92 | 3.39 | 7.69 |
| MRC-MW34A | 10.88 | 11.13 | 4 | 9 | 14 | 6.88 | 1.88 | -3.12 | 5.04 | 5.84 |
| MRC-MW34B | 10.84 | 11.20 | 20 | 25 | 30 | -9.16 | -14.16 | -19.16 | 4.92 | 5.92 |
| MRC-MW34C | 10.80 | 11.21 | 45 | 50 | 55 | -34.20 | -39.20 | -44.20 | 4.21 | 6.59 |
| MRC-MW35A | 8.39 | 8.87 | 3 | 8 | 13 | 5.39 | 0.39 | -4.61 | 3.25 | 5.14 |

**Table 2-4**

**Groundwater Depths and Elevations - June 2010**
**Lockheed Martin Middle River Complex, Middle River, Maryland**


| Well ID | Elevation Top of Well Casing-2010 Feet (NGVD 1988) | Elevation Ground-2010 Feet (NGVD 1988) | Screen Depth Top Feet (bgs) | Screen Depth Midpoint (1) Feet (bgs) | Screen Depth Bottom Feet (Below Grade) | Screen Elevation Top Feet (NGVD 1988) | Screen Elevation Midpoint Feet (NGVD 1988) | Screen Elevation Bottom Feet (NGVD 1988) | Depth to Groundwater 6/30/2010 Feet Top of Casing | Groundwater Elevation 6/30/2010 Feet (NGVD 1988) |
|---|---|---|---|---|---|---|---|---|---|---|
| MRC-MW36A | 9.72 | 10.15 | 8.5 | 13.5 | 18.5 | 1.22 | -3.78 | -8.78 | 7.42 | 2.30 |
| MRC-MW37A | 10.50 | 10.79 | 7 | 12.05 | 17 | 3.50 | -1.55 | -6.50 | 8.25 | 2.25 |
| MRC-MW37B | 7.36 | 7.64 | 24 | 29 | 34 | -16.64 | -21.64 | -26.64 | 5.97 | 1.39 |
| MRC-MW37C | 7.45 | 7.58 | 60 | 65 | 70 | -52.55 | -57.55 | -62.55 | 6.04 | 1.41 |
| MRC-MW38A | 8.07 | 8.13 | 4 | 9.6 | 14 | 4.07 | -1.53 | -5.93 | 6.26 | 1.81 |
| MRC-MW38B | 8.18 | 8.13 | 21 | 23.5 | 26 | -12.82 | -15.32 | -17.82 | NA | NA |
| MRC-MW39A | 4.78 | 4.88 | 4 | 9 | 14 | 0.78 | -4.22 | -9.22 | 2.22 | 2.56 |
| MRC-MW40A | 4.50 | 4.74 | 5 | 10 | 15 | -0.50 | -5.50 | -10.50 | 0.00 | 4.50 |
| MRC-MW41A | 27.52 | 27.82 | 6 | 12.7 | 16 | 21.52 | 14.87 | 11.52 | 9.06 | 18.46 |
| MRC-MW42A | 28.21 | 28.48 | 9 | 15.2 | 19 | 19.21 | 13.04 | 9.21 | 9.60 | 18.61 |
| MRC-MW43A | 11.01 | 11.34 | 3.5 | 8.5 | 13.5 | 7.51 | 2.51 | -2.49 | 2.34 | 8.67 |
| MRC-MW44A | 10.64 | 11.11 | 3 | 8 | 13 | 7.64 | 2.64 | -2.36 | 2.04 | 8.60 |
| MRC-MW45A | 4.64 | 5.15 | 3 | 9.72 | 13 | 1.64 | -5.08 | -8.36 | 12.89 | -8.25 |
| MRC-MW46A | 6.40 | 6.54 | 3 | 8.8 | 13 | 3.40 | -2.40 | -6.60 | 5.41 | 0.99 |
| MRC-MW47A | 10.75 | 10.86 | 5 | 10 | 15 | 5.75 | 0.75 | -4.25 | 3.47 | 7.28 |
| MRC-MW48A | 24.76 | 25.09 | 11 | 16 | 21 | 13.76 | 8.76 | 3.76 | 8.01 | 16.75 |
| MRC-MW49A | 31.47 | 31.47 | 12 | 17 | 22 | 19.47 | 14.47 | 9.47 | 12.43 | 19.04 |
| MRC-MW50A | 30.15 | 30.72 | 16 | 21 | 26 | 14.15 | 9.15 | 4.15 | 14.89 | 15.26 |
| MRC-MW51A | 21.88 | 22.09 | 3 | 8 | 13 | 18.88 | 13.88 | 8.88 | 2.60 | 19.28 |
| MRC-MW52A | 20.32 | 20.55 | 3 | 8 | 13 | 17.32 | 12.32 | 7.32 | 6.19 | 14.13 |
| MRC-MW53A | 18.59 | 18.79 | 3 | 8 | 13 | 15.59 | 10.59 | 5.59 | 5.17 | 13.42 |
| MRC-MW53B | 18.41 | 18.74 | 39 | 44 | 49 | -20.59 | -25.59 | -30.59 |  | NA |
| MRC-MW54A | 17.05 | 17.14 | 7 | 12 | 17 | 10.05 | 5.05 | 0.05 | 4.06 | 12.99 |
| MRC-MW55A | 38.35 | 38.70 | 12 | 17 | 22 | 26.35 | 21.35 | 16.35 | 12.69 | 25.66 |
| MRC-MW56A | 35.94 | 36.18 | 2.5 | 7.5 | 12.5 | 33.44 | 28.44 | 23.44 | 6.18 | 29.76 |
| MRC-MW57A | 36.49 | 36.96 | 2 | 7 | 12 | 34.49 | 29.49 | 24.49 | 8.46 | 28.03 |
| MRC-MW58A | 35.03 | 35.55 | 8 | 13 | 18 | 27.03 | 22.03 | 17.03 | 4.06 | 30.97 |
| MRC-MW59A | 34.11 | 34.47 | 2 | 7 | 12 | 32.11 | 27.11 | 22.11 | 9.63 | 24.48 |
| MRC-MW60A | 31.26 | 31.63 | 12 | 17 | 22 | 19.26 | 14.26 | 9.26 | 13.95 | 17.31 |
| MRC-MW60B | 30.06 | 30.82 | 22 | 27 | 32 | 8.06 | 3.06 | -1.94 | 12.66 | 17.40 |
| MRC-MW61A | 24.16 | 26.05 | 4 | 9 | 14 | 20.16 | 15.16 | 10.16 | 6.11 | 18.05 |
| MRC-MW62A | 10.62 | 11.27 | 3 | 8 | 13 | 7.62 | 2.62 | -2.38 | 1.66 | 8.96 |
| MRC-MW62C | 10.89 | 11.17 | 55 | 60 | 65 | -44.12 | -49.12 | -54.12 | 3.46 | 7.43 |
| MRC-MW63A | 16.20 | 16.40 | 4 | 9 | 14 | 12.20 | 7.20 | 2.20 | 8.72 | 7.48 |
| MRC-MW64A | 30.88 | 31.40 | 6 | 11 | 16 | 24.88 | 19.88 | 14.88 | 6.75 | 24.13 |
| MRC-MW65A | 14.76 | 14.99 | 8 | 13 | 18 | 6.76 | 1.76 | -3.24 | 6.50 | 8.26 |
| MRC-MW66A | 14.99 | 15.10 | 9 | 14 | 19 | 5.99 | 0.99 | -4.01 | 7.74 | 7.25 |
| MRC-MW67A | 36.67 | 36.92 | 22 | 30 | 37 | 14.67 | 7.17 | -0.33 | 20.82 | 15.85 |
| MRC-MW68A | 36.28 | 37.04 | 18 | 28 | 38 | 18.28 | 8.28 | -1.72 | 12.91 | 23.37 |
| MRC-MW69A | 27.63 | 27.92 | 7 | 12 | 17 | 20.63 | 15.63 | 10.63 | 9.57 | 18.06 |
| MRC-MW69B | 27.85 | 27.90 | 25 | 33 | 40 | 2.85 | -4.65 | -12.15 | 12.48 | 15.37 |
| MRC-MW70A | 14.69 | 14.95 | 4 | 9 | 14 | 10.69 | 5.69 | 0.69 | 4.18 | 10.51 |
| MRC-MW70B | 14.44 | 14.63 | 20 | 25 | 30 | -5.56 | -10.56 | -15.56 | 4.71 | 9.73 |
| MRC-MW71A | 16.90 | 17.29 | 4 | 9 | 14 | 12.90 | 7.90 | 2.90 | 2.20 | 14.70 |
| MRC-MW71B | 16.94 | 17.13 | 20 | 25 | 30 | -3.06 | -8.06 | -13.06 | 5.22 | 11.72 |
| MRC-MW72A | 11.12 | 11.45 | 4 | 9 | 14 | 7.12 | 2.12 | -2.88 | 6.80 | 4.32 |
| MRC-MW72B | 10.79 | 10.95 | 25 | 30 | 35 | -14.21 | -19.21 | -24.21 | 6.92 | 3.87 |
| MRC-MW73A | 10.46 | 10.74 | 7 | 12 | 17 | 3.46 | -1.55 | -6.55 | 7.39 | 3.07 |

**Table 2-4**

**Groundwater Depths and Elevations - June 2010**
**Lockheed Martin Middle River Complex, Middle River, Maryland**


| Well ID | Elevation Top of Well Casing-2010 Feet (NGVD 1988) | Elevation Ground-2010 Feet (NGVD 1988) | Screen Depth Top Feet (bgs) | Screen Depth Midpoint (1) Feet (bgs) | Screen Depth Bottom Feet (Below Grade) | Screen Elevation Top Feet (NGVD 1988) | Screen Elevation Midpoint Feet (NGVD 1988) | Screen Elevation Bottom Feet (NGVD 1988) | Depth to Groundwater 6/30/2010 Feet Top of Casing | Groundwater Elevation 6/30/2010 Feet (NGVD 1988) |
|---|---|---|---|---|---|---|---|---|---|---|
| MRC-MW73B | 10.28 | 10.44 | 24 | 29 | 34 | -13.73 | -18.73 | -23.73 | 7.66 | 2.62 |
| MRC-MW74A | 11.18 | 11.69 | 8 | 13 | 18 | 3.18 | -1.83 | -6.83 | 8.19 | 2.99 |
| MRC-MW74B | 10.88 | 11.15 | 22 | 27 | 32 | -11.12 | -16.12 | -21.12 | 8.40 | 2.48 |
| MRC-MW74C | 11.05 | 11.41 | 45 | 50 | 55 | -33.45 | -38.45 | -43.45 | 8.78 | 2.27 |
| MRC-MW75A | 29.00 | 29.37 | 11.5 | 16.5 | 21.5 | 17.50 | 12.50 | 7.50 | 9.10 | 19.90 |
| MRC-MW76A | 28.42 | 28.70 | 9 | 14 | 19 | 19.42 | 14.42 | 9.42 | 10.79 | 17.63 |
| MRC-MW76B | 28.24 | 28.97 | 24 | 29 | 34 | 4.24 | -0.76 | -5.76 | 10.49 | 17.75 |
| MRC-MW77A | 23.06 | 23.87 | 7 | 12 | 17 | 16.06 | 11.06 | 6.06 | NA | NA |
| MRC-MW78B | 24.30 | 24.60 | 24 | 29 | 34 | 0.30 | -4.70 | -9.70 | 8.11 | 16.19 |
| MRC-MW79B | 19.14 | 19.65 | 27 | 32 | 37 | -7.86 | -12.86 | -17.86 | 10.49 | 8.65 |
| MRC-MW80A | 32.82 | 33.23 | 4 | 9 | 14 | 28.82 | 23.82 | 18.82 | 7.82 | 25.00 |
| MRC-MW80B | 32.66 | 32.90 | 23 | 28 | 33 | 9.66 | 4.66 | -0.34 | 12.17 | 20.49 |
| MRC-MW81A | 27.34 | 27.56 | 9 | 13.5 | 18 | 18.34 | 13.84 | 9.34 | NA | NA |
| MRC-MW81B | 25.96 | 27.00 | 22 | 27 | 32 | 3.96 | -1.04 | -6.04 | 9.29 | 16.67 |
| MRC-MW82A | 23.88 | 24.16 | 20 | 25 | 30 | 3.88 | -1.12 | -6.12 | 5.20 | 18.68 |
| MRC-MW83A | 20.14 | 20.42 | 24 | 29 | 34 | -3.86 | -8.86 | -13.86 | 1.19 | 18.95 |
| MRC-MW84A | 20.20 | 20.69 | 20 | 25 | 30 | 0.20 | -4.80 | -9.80 | 1.45 | 18.75 |
| MRC-MW85A | 18.66 | 19.06 | 30 | 35 | 40 | -11.35 | -16.35 | -21.35 | 5.33 | 13.33 |
| MRC-MW86A | 23.62 | 24.18 | 6 | 11 | 16 | 17.62 | 12.62 | 7.62 | 5.14 | 18.48 |
| MRC-MW86B | 23.72 | 24.18 | 24.5 | 29.5 | 34.5 | -0.78 | -5.78 | -10.78 | 5.10 | 18.62 |
| MRC-MW87A | 26.64 | 27.06 | 6 | 11 | 16 | 20.64 | 15.64 | 10.64 | 11.66 | 14.98 |
| MRC-MW87B | 26.72 | 27.06 | 24.5 | 29.5 | 34.5 | 2.22 | -2.78 | -7.78 | 12.01 | 14.71 |
| MRC-MW88A | 24.47 | 24.78 | 10 | 20 | 30 | 14.47 | 4.47 | -5.54 | 6.20 | 18.27 |
| MRC-MW88B | 24.40 | 24.68 | 48 | 53 | 58 | -23.61 | -28.61 | -33.61 | 6.32 | 18.08 |
| MRC-MW90B | 21.67 | 21.88 | 30 | 35 | 40 | -8.33 | -13.33 | -18.33 | 7.71 | 13.96 |
| MRC-MW91A | 36.85 | 36.75 | 10 | 15 | 20 | 26.85 | 21.85 | 16.85 | 9.32 | 27.53 |
| MRC-MW91B | 36.54 | 36.75 | 60 | 65 | 70 | -23.46 | -28.46 | -33.46 | 19.60 | 16.94 |
| MRC-MW91C | 36.21 | 36.75 | 60 | 65 | 70 | -23.79 | -28.79 | -33.79 | NA | NA |
| MRC-MW92C | 25.31 | 25.87 | 64.5 | 69.5 | 74.5 | -39.19 | -44.19 | -49.19 | 25.43 | -0.12 |
| MRC-MW93A | 32.05 | 32.29 | 4 | 9 | 14 | 28.05 | 23.05 | 18.05 | NA | NA |
| MRC-MW93B | 31.97 | 32.29 | 65 | 70 | 75 | -33.03 | -38.03 | -43.03 | NA | NA |
| MRC-MW93D | 25.06 | 25.26 | 179 | 184 | 189 | -153.94 | -158.94 | -163.94 | 9.80 | 15.26 |
| MRC-MW94B | 25.28 | 25.29 | 41.5 | 46.5 | 51.5 | -16.22 | -21.22 | -26.22 | NA | NA |
| MRC-MW94D | 23.01 | 23.12 | 186 | 191 | 196 | -162.99 | -167.99 | -172.99 | 11.82 | 11.19 |
| MRC-MW95B | 24.04 | 24.31 | 45 | 50 | 55 | -20.96 | -25.96 | -30.96 | NA | NA |
| MRC-MW95D | 9.99 | 10.02 | 204 | 209 | 214 | -194.01 | -199.01 | -204.01 | 1.82 | 8.17 |
| MRC-MW96D | 6.44 | 6.35 | 179 | 184 | 189 | -172.56 | -177.56 | -182.56 | 0.00 | 6.44 |

MRC-MW23A - buried and cannot be located in the field.
NA - Not available.
NGVD = National Geodetic Vertical Datum.

# APPENDIX D—CALUCLATIONS

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Injection Lines Pressure Losses | | CHECKED BY: C. Pike | DATE: 5/3/2012 |

## References

ref 1 Practical hydraulics handbook By Barbara A. Hauser

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions |
|---|---|---|---|---|---|
| $q$ | volume flow | | 0.5 | gal per minute | Twice design value |
| $d_h$ | Inside pipe diameter | | 0.671 | inches | 3/4" PEX |
| $c$ | Hazen-Williams roughness constant | | 140 | | ref 1 |
| $L$ | longest injection line length (southwest TCE area) | | 350 | feet | Figure C-3 |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| $f$ | friction head loss in feet of water per 100 feet of pipe (fth20/100 ft pipe) | | 0.2 | feet | $f = 0.2083\ (100/c)^{1.852}\ q^{1.852} / d_h^{4.8655}$ |
| $\Delta h_f$ | total friction head loss in feet of water | | 0.8 | feet | $\Delta h_f = F * L / 100$ |
| $\Delta P_f$ | total friction head loss in psi | | 0.3 | psi | $\Delta h_{required} = \Delta h_f / 2.31$ feet/psi |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Materials and Waste Volumes Calculation For Southeast TCE Area (following pre-remediation soil exccavation) | | CHECKED BY: C. Pike | DATE: 5/3/2013 |

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions | |
|---|---|---|---|---|---|---|
| *L* | total trench length | | 0 | feet | | |
| *Lc* | trench length in areas with concrete | | 0 | feet | | |
| *W* | average trench width | | 0 | feet | | |
| *Td* | average trench depth | | 0 | feet | | |
| *P* | concrete thickness | | 0 | feet | | |
| *S* | sand bedding thickness | | 0 | feet | | |
| *ES* | excess soil to be disposed thickness | | 0 | feet | | |
| *BD* | injection well/monitoring borehole radius | | 0.42 | feet | Drawing C-5, C6 | |
| *WD* | average injection/monitoring well depth | | 35 | feet | Drawing C-5, C6 | |
| *Fc* | excavated to undisturbed soil volume ratio | | | | assumed (conservatively) | |
| *N* | number of injection wells | | 28 | feet | Drawing C-2 | |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| *DCV* | drill cuttings volume for disposal | | 20 | cubic yards | $DCV=N * Fc * WD\ (ft) * 3.14 * BD^2\ (ft^2) / 27\ yd^3 / ft^3$ |
| *PV* | concrete for disposal | | 0 | cubic yards | *PV=Fc* *Lc(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *SV* | sand bedding volume | | 0 | cubic yards | *SV=* L(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *ESV* | excess soil to be disposed volume | | 0 | cubic yards | *PV=Fc* *L(ft)*WD (ft)*ES (ft) / 27 yd3 / ft3 |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Materials and Waste Volumes Calculation For Southwest TCE Area (following swale relocation and soil removal) | | CHECKED BY: C. Pike | DATE: 5/3/2013 |

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions | |
|---|---|---|---|---|---|---|
| *L* | total trench length outside of pre-remediation excavation | | 270 | feet | Drawing C-3 | |
| *Lc* | trench length in areas with asphalt | | 50 | feet | Drawing C-3 | |
| *W* | average trench width | | 2 | feet | Drawing C-8 | |
| *Td* | average trench depth | | 3 | feet | Drawing C-8 | |
| *P* | asphalt pavement thickness | | 0.5 | feet | Drawing C-8 | |
| *S* | sand bedding thickness | | 0.75 | feet | Drawing C-8 | |
| *ES* | excess soil to be disposed thickness | | 0.75 | feet | assumed the same as sand bedding | |
| *BD* | injection well/monitoring borehole radius | | 0.42 | feet | Drawing C-5, C6 | |
| *WD* | average injection/monitoring well depth | | 35 | feet | Drawing C-5, C6 | |
| *Fc* | excavated to undisturbed soil volume ratio | | 2 | | assumed (conservatively) | |
| *N* | number of injection wells | | 39 | feet | Drawing C-3 | |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| *DCV* | drill cuttings volume for disposal | | 28 | cubic yards | $DCV = N * Fc * WD\ (ft) * 3.14 * BD^2\ (ft^2) / 27\ yd^3 / ft^3$ |
| *PV* | asphalt pavement for disposal | | 4 | cubic yards | *PV=Fc* *Lc(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *SV* | sand bedding volume | | 15 | cubic yards | *SV=* L(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *ESV* | excess soil to be disposed volume | | 30 | cubic yards | *PV=Fc* *L(ft)*WD (ft)*ES (ft) / 27 yd3 / ft3 |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Materials and Waste Volumes Calculation For North TCE Area | | CHECKED BY: C. Pike | DATE: 5/3/2013 |

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions | |
|---|---|---|---|---|---|---|
| *L* | total trench length | | 300 | feet | Drawing C-4 | |
| *Lc* | trench length in areas with asphalt | | 300 | feet | Drawing C-4 | |
| *W* | average trench width | | 2 | feet | Drawing C-9 | |
| *Td* | average trench depth | | 3 | feet | Drawing C-9 | |
| *P* | asphalt pavement thickness | | 0.5 | feet | Drawing C-9 | |
| *S* | sand bedding thickness | | 0.75 | feet | Drawing C-9 | |
| *ES* | excess soil to be disposed thickness | | 0.75 | feet | assumed the same as sand bedding | |
| *BD* | injection well borehole radius | | 0.42 | feet | Drawing C-5, C-6 | |
| *WD* | average injection/monitoring well depth | | 35 | feet | Drawing C-5, C-6 | |
| *Fc* | excavated to undisturbed soil volume ratio | | 2 | | assumed (conservatively) | |
| *N* | number of injection/monitoring wells | | 11 | feet | Drawing C-4 | |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| *DCV* | drill cuttings volume for disposal | | 8 | cubic yards | $DCV = N * Fc * WD\ (ft) * 3.14 * BD^2\ (ft^2) / 27\ yd^3 / ft^3$ |
| *PV* | asphalt pavement for disposal | | 22 | cubic yards | *PV=Fc* *Lc(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *SV* | sand bedding volume | | 17 | cubic yards | *SV=* L(ft)*WD (ft)*P (ft) / 27 yd3 / ft3 |
| *ESV* | excess soil to be disposed volume | | 33 | cubic yards | *PV=Fc* *L(ft)*WD (ft)*ES (ft) / 27 yd3 / ft3 |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: Stonebreaker | PAGE: 1 of 1 |
| SUBJECT: Electrical Loads Calculation For Southeast/North TCE Area | | CHECKED BY: B.Dynkin | DATE: 4/27/2012 |

## Lighting Loads:

Ref. NEC, 2011, Article 220.12

| Equip. # | Description | | Length (ft) | Width (ft) | Area ($ft^2$) | Occupancy Unit Load (VA / $ft^2$) | | Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lighting | | 28 | 8 | 224 | 1.00 | | 0.22 | 1.0 | 0.22 |
| | | | | | | | | 0.00 | 1.0 | 0.00 |
| | | | | | | | Subtotal | 0.22 | | 0.22 |

## Non-Lighting Loads:

Ref. NEC, 2011, Article 220.14 (A) thru (L)

| Recpt. Type | Qty. | VA (each) | | Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|---|---|---|---|
| Duplx. | 6 | 180 | | 1.08 | 1.0 | 1.08 |
| Quad. | 0 | 360 | | 0 | 1.0 | 0.00 |
| | | | | | Receptacle Total | 1.08 |
| | | | | | Up to 1st 10 KVA @ 100% | 0.72 |
| | | | | | Overage | 0.36 |
| | | | | | Overage @ 50% | 0.18 |
| | | | | | Subtotal | 0.90 |

**Specific Loads and Motors:**

| Equip. # | Description | Volts | Amps | Phase | | Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|---|---|---|---|---|---|
| MV-1 | Potable Water Line MOV | 120 | 0.05 | 1 | | 0.01 | 0.5 | 0.00 |
| VP-1 | Vacuum Pump (1/3 HP) | 120 | 7.20 | 1 | | 0.86 | 1.0 | 0.86 |
| MP-1 | Metering Pump (29W) | 120 | 0.30 | 1 | | 0.04 | 0.5 | 0.02 |
| MP-2 | Metering Pump (29W) | 120 | 0.30 | 1 | | 0.04 | 0.5 | 0.02 |
| MX-2 | Mixer (1/4 HP) | 120 | 5.80 | 1 | | 0.70 | 0.2 | 0.14 |
| AC-1 | Electric Heater (2 KW) | 240 | 8.33 | 1 | | 2.00 | 0.6 | 1.20 |
| | | | | | | | | |
| | Electric Heat Trace, Approx 20' at | 120 | 1.33 | 1 | | 0.16 | 0.4 | 0.06 |
| | 8 Watts/foot | | | | | | | |
| | | | | | | | | |
| CP-1SE | PLC Control Panel: | 120 | 15.33 | 1 | | 1.84 | 1.0 | 1.84 |
| | 24VDC Pwr. Supply for AI Cards | | 2.00 | | | | | |
| | 110V Pwr. Supply for DIs | | 4.80 | | | | | |
| | 110V Pwr. Supply for DOs | | 3.20 | | | | | |
| | 110V Backplane Pwr. Supply | | 5.00 | | | | | |
| | Control Panel Light | | 0.33 | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | Subtotal | 5.64 | | 4.15 |
| | | | | | Total KVA | 7 | | 5 |
| | | | | | Amps @ 120V | 56 | | 44 |
| | | | | | Amps at 125% | 70 | | 55 |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: Stonebreaker | PAGE: 1 of 1 |
| SUBJECT: Electrical Loads Calculation For Southwest TCE Area | | CHECKED BY: B.Dynkin | DATE: 4/27/2012 |

## Lighting Loads:

Ref. NEC, 2011, Article 220.12

| Equip. # | Description | | Length (ft) | Width (ft) | Area ($ft^2$) | Occupancy Unit Load (VA / $ft^2$) | | Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lighting | | 28 | 8 | 224 | 1.00 | | 0.22 | 1.0 | 0.22 |
| | | | | | | | | 0.00 | 1.0 | 0.00 |
| | | | | | | | Subtotal | 0.22 | | 0.22 |

## Non-Lighting Loads:

Ref. NEC, 2011, Article 220.14 (A) thru (L)

| Recpt. Type | Qty. | VA (each) | | Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|---|---|---|---|
| Duplx. | 6 | 180 | | 1.08 | 1.0 | 1.08 |
| Quad. | 0 | 360 | | 0 | 1.0 | 0.00 |
| | | | | | Receptacle Total | 1.08 |
| | | | | | Up to 1st 10 KVA @ 100% | 0.72 |
| | | | | | Overage | 0.36 |
| | | | | | Overage @ 50% | 0.18 |
| | | | | | Subtotal | 0.90 |

## Specific Loads and Motors:

| Connected Load (KVA) | Demand Factor | Demand in KVA |
|---|---|---|

| Equip. # | Description | Volts | Amps | Phase | | | | |
|---|---|---|---|---|---|---|---|---|
| MV-1 | Potable Water Line MOV | 120 | 0.05 | 1 | | 0.01 | 0.5 | 0.00 |
| BP-1 | Booster Pump (1 HP) | 230 | 4.20 | 3 | | 1.67 | 0.1 | 0.17 |
| VP-1 | Vacuum Pump (1/3 HP) | 120 | 7.20 | 1 | | 0.86 | 1.0 | 0.86 |
| MP-1 | Metering Pump (29W) | 120 | 0.30 | 1 | | 0.04 | 0.5 | 0.02 |
| MP-2 | Metering Pump (29W) | 120 | 0.30 | 1 | | 0.04 | 0.5 | 0.02 |
| MX-2 | Mixer (1/4 HP) | 120 | 5.80 | 1 | | 0.70 | 0.5 | 0.35 |
| | | | | | | | | |
| F-1 | Exhaust Fan (1/4 HP) | 120 | 5.80 | 1 | | 0.70 | 0.6 | 0.42 |
| HTR-1 | Electric Heater (2 KW) | 240 | 8.33 | 1 | | 2.00 | 0.6 | 1.20 |
| | | | | | | | | |
| | Electric Heat Trace, Approx 20' at | 120 | 1.33 | 1 | | 0.16 | 0.4 | 0.06 |
| | 8 Watts/foot | | | | | | | |
| | | | | | | | | |
| CP-1SW | PLC Control Panel: | 120 | 16.93 | 1 | | 2.03 | 1.0 | 2.03 |
| | 24VDC Pwr. Supply for AI Cards | | 2.00 | | | | | |
| | 110V Pwr. Supply for DIs | | 4.80 | | | | | |
| | 110V Pwr. Supply for DOs | | 4.80 | | | | | |
| | 110V Backplane Pwr. Supply | | 5.00 | | | | | |
| | Control Panel Light | | 0.33 | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | Subtotal | 8.20 | | 5.13 |
| | | | | | Total KVA | 9 | | 6 |
| | | | | | Amps @ 120V | 78 | | 52 |
| | | | | | Amps at 125% | 97 | | 65 |

# Tetra Tech NUS

| | | | |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Heat Balance Calculations for Air Conditioning | | CHECKED BY: C. Pike | DATE: 5/3/2013 |

## References

ref 1 HVAC Equations, Data, and Rules of Thumb By Arthur A. Bell

## BASIS & ASSUMPTIONS

| Notation | Description | Value | Unit | Reference/Assumptions |
|---|---|---|---|---|
| *L* | equipment container external length | 40 | feet | as selected |
| *h* | equipment container external height | 9 | feet | as selected |
| *w* | equipment container external height | 8 | feet | as selected |
| *Tair* | maximum outside temperature | 110 | deg F | assumed |
| *Tint* | maximum acceptable interior temperature | 80 | deg F | assumed |
| *Rins* | R-value of insulation | 12 | $ft^2 \cdot °F \cdot hour/Btu$ | 2 inches of rigid polyurethane panel (aged) |
| *Rply* | R-value of plywood | 1 | $ft^2 \cdot °F \cdot hour/Btu$ | 3/4 inch of plywood |

## Calculations

| Notation | Description | Value | Unit | Equation (ref 1) |
|---|---|---|---|---|
| *A* | total area | 1504.0 | square feet | *A = 2*(L*h+L*w+h*w)* |
| *U* | overall heat transfer coefficient | 0.08 | BTU/(hour °F $ft^2$) | *U=1/(Rins+Rply)* |
| *ΔT* | Temperture difference | 30 | deg F | *ΔT = Tair - Tint* |
| *H* | Required AC input | 3471 | BTU/hour | H = U * A * ΔT |
| $H_{actual}$ | Selected AC capacity | 8700 | BTU/hour | |
| *SF* | Safety sizing factor | 2.5 | | $H_{actual}/H$ |

Note: it is assumed for calculations that roof, walls, and floor are the same heat conductance. Usually roof is assumed to be 15%

# Tetra Tech NUS

| | | | |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Heat Balance Calculations for Heating | | CHECKED BY: C. Pike | DATE: 5/3/2013 |

## References

ref 1 HVAC Equations, Data, and Rules of Thumb By Arthur A. Bell

## BASIS & ASSUMPTIONS

| Notation | Description | Value | Unit | Reference/Assumptions |
|---|---|---|---|---|
| *L* | equipment container external length | 40 | feet | as selected |
| *h* | equipment container external height | 9 | feet | as selected |
| *w* | equipment container external height | 8 | feet | as selected |
| *Tair* | minimum outside temperature | 0 | deg F | assumed |
| *Tint* | mimimum interior temperature | 40 | deg F | assumed |
| *Rins* | R-value of insulation | 12 | ft²·°F·hour/Btu | 2 inches of rigid polyurethane panel (aged) |
| *Rply* | R-value of plywood | 0.63 | ft²·°F·hour/Btu | 1/2 inch of plywood |

## Calculations

| Notation | Description | Value | Unit | Equation (ref 1) |
|---|---|---|---|---|
| *A* | total area | 1504.0 | square feet | *A = 2*(L*h+L*w+h*w)* |
| *U* | overall heat transfer coefficient | 0.08 | BTU/(hour °F ft²) | *U=1/(Rins+Rply)* |
| *ΔT* | Temperture difference | 40 | deg F | *ΔT = Tint -Tair* |
| *H* | Required heat input | 4763 | BTU/hour | H = U * A * ΔT |
| $H_{actual}$ | Selected heat pump capacity | 8700 | BTU/hour | |
| *SF* | Safety sizing factor | 1.8 | | $H_{actual}/H$ |

Note: it is assumed for calculations that roof, walls, and floor are the same heat conductance. Usually roof is assumed to be 15% more conductive. Therefore, roof insulaiton thickness will be increased (at least 15%) to balance this effect.

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Wind Loading Calculations | | CHECKED BY: C. Pike | DATE: 5/5/2012 |

## References

ref 1 Wind Load of Structures By J.D. Holmes

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions |
|---|---|---|---|---|---|
| *L* | container length | | 40 | feet | Drawing M-9 |
| *b* | container width | | 8 | feet | Drawing M-9 |
| *H* | container height | | 9 | feet | Drawing M-9 |
| *M1* | empty container weight | | 8663 | feet | Appendix F |
| *M2* | minimum load | | 4000 | feet | Conservatively estimated |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| *M* | total container weight | | 12663.0 | feet | *M = M1 + M2* |
| *V* | critical wind speed (overturning) | ref 1 | 97 | mph | $V = \{M*b/(0.033*L)\}^2/H$ |

| **Tetra Tech NUS** | | | *STANDARD CALCULATION SHEET* |
|---|---|---|---|
| CLIENT- LMC (LMC Middle River) | | BY: B. Dynkin | PAGE: 1 of 1 |
| SUBJECT: Total System Pressure Losses | | CHECKED BY: C. Pike | DATE: 5/5/2012 |

## References

ref 1 Practical hydraulics handbook By Barbara A. Hauser

## BASIS & ASSUMPTIONS

| Notation | Description | | Value | Unit | Reference/Assumptions |
|---|---|---|---|---|---|
| $q$ | injection flow per well | | 0.25 | gal per minute | Design value |
| $n$ | Number of wells in operation | | 6 | | Design value for SW area |
| $k$ | Flow multiplier | | 1.5 | | Assumed Conservative |
| $d_h$ | Inside piping diameter | | 1.029 | inches | SCH 80 PVC |
| $c$ | Hazen-Williams roughness constant | | 140 | | ref 1 |
| $\Delta h$ | difference in elevation bewteen GWTP and injection area | | -5 | feet | site map |
| $\Delta P_{ft}$ | Mechanical flow totalizer pressure loss at max flow | | | | |
| $\Delta P_f$ | total injeciotn tubing friction head loss | | 0.3 | psi | *Injection Lines Pressure Losses* |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| $L$ | total internal piping length | | 100 | feet | Figure M-3 (conservatively) |
| $\Delta P_{wellhead}$ | required available wellhead pressure | | 10 | psi | Maxium conservative value |

## Calculations

| Notation | Description | | Value | Unit | Equation |
|---|---|---|---|---|---|
| Q | total system flow | | 2.25 | gal per minute | $Q = q * n * k$ |
| $f$ | friction head loss in feet of water per 100 feet of pipe (fth20/100 ft pipe) | | 0.4 | feet | $f = 0.2083\ (100/c)^{1.852}\ q^{1.852} / d_h^{4.8655}$ |
| $\Delta P_{pipe}$ | total internal piping friction head loss in psi | | 0.2 | psi | $\Delta P_{pipe} = f * L / 100/2.31$ feet/psi |
| $\Delta P_{FT}$ | Mechanical flow totalizer pressure loss at total system flow flow (Q) | | 1.0 | psi | *Appendix F (flow vs pressure curve for FT-1)* |
| $\Delta P_{GAC}$ | GAC vessel pressure loss at total system flow flow (Q) | | 0.2 | psi | *Appendix F (flow vs pressure curve for GAC-1)* |
| $\Delta P_{MC}$ | Membrane contactor pressure loss at total system flow flow (Q) | | 0.2 | psi | *Appendix F (flow vs pressure curve for MC-1)* |
| $\Delta P_V$ | Injection manifold metering valve pressure drop | | 2.0 | psi | *Value assumed for flow balancing* |
| $\Delta P_{misc}$ | Miscellaneous equipment pressure losses (filter, fittings, etc.) | | 0.9 | psi | *Assumed (conservatively) as ΔPf x 5* |
| $\Delta P_{total}$ | total system pressure losses | | 4.9 | psi | $\Delta P_{total} = \Delta P_f + \Delta P_{pipe} + \Delta P_{FT} + \Delta P_{GAC} + \Delta P_{MC} + \Delta P_V + \Delta P_{misc}$ |
| $P_{available}$ | total available discharge pressure in feet of water | | 75 | psig | typical water main pressure |

# APPENDIX E—SPECIFICATIONS

# TECHNICAL SPECIFICATIONS

# FOR

# GROUNDWATER REMEDIATION SYSTEM
# Lockheed Martin Middle River Complex
# 2323 Eastern Boulevard
# Middle River, Maryland

**FOR:**

## LOCKHEED MARTIN CORPORATION

Prepared by:
Tetra Tech, Inc.

April 2013

**Technical Specifications for Groundwater Remediation System**
**LMC Middle River Complex**
**2323 Eastern Boulevard, Middle River, Maryland**
**DRAFT Specifications Table of Contents (January 2013)**


**DIVISION 01 – GENERAL**

| | |
|---|---|
| 01010 | Scope of Work |
| 01090 | Abbreviations & Definitions |
| 01210 | Project Meetings & Coordination |
| 01300 | Submittals |
| 01400 | Quality Control |
| 01500 | Temporary Facilities |
| 01600 | Sustainable Design Requirements |
| 01720 | Regulatory Requirements |
| 01730 | Environmental Requirements |
| 01810 | Traffic Control |

**DIVISION 02 – CONSTRUCTION**

| | |
|---|---|
| 02300 | Trenching, Backfill, and Compaction |
| 02400 | Injection and Monitoring Wells |
| 02450 | Aggregate and/or Graded-Crushed Aggregate For Roadways |
| 02451 | Hot Mix Bituminous Pavement |
| 02600 | Off-site Waste Disposal |
| 02900 | Seeding, Soil Supplements, and Mulching |

**DIVISION 07 – THERMAL AND PROTECTION**

| | |
|---|---|
| 07210 | Building Insulation |

**DIVISION 9 - FINISHES**

| | |
|---|---|
| 09900 | Paints and Coatings |

**DIVISION 10 - SPECIALITIES**

| | |
|---|---|
| 10520 | Portable Fire and Safety Equipment |

**DIVISION 11 - EQUIPMENT**

| | |
|---|---|
| 11010 | Chemical Feed Pumps |
| 11020 | Carbon Adsorbers |
| 11030 | Membrane Contactors |
| 11040 | Storage Tanks |
| 11050 | Bag Filters |
| 11060 | Vacuum Pumps |
| 11070 | Mechanical Flow Meters |
| 11080 | Electronic Flow Meters |
| 11090 | Backflow Preventers |

**DIVISION 13 – SPECIAL CONSTRUCTION**

| | |
|---|---|
| 13120 | Standard Shipping Containers |

**DIVISION 15 – MECHANICAL**

| | |
|---|---|
| 15100 | Underground Piping |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |
| 15730 | Air-Conditioning Equipment |
| 15950 | Pressure Testing |

**DIVISION 16 – ELECTRICAL**

| | |
|---|---|
| 16100 | Common Work Results for Electrical |
| 16110 | Low-Voltage Electrical Power Conductors and Cables |
| 16120 | Low Voltage Instrumentation Cables |
| 16130 | Grounding and Bonding for Electrical Systems |

| | |
|---|---|
| 16140 | Hangers and Supports for Electrical Systems |
| 16150 | Cable Trays for Electrical Systems |
| 16160 | Underground Conduits for Electrical Systems |
| 16170 | Identification for Electrical Systems |
| 16180 | Low Voltage Transformers |
| 16190 | Enclosed Switches and Circuit Breakers |
| 16200 | Surge Protective Devices |
| 16210 | Interior Lighting |
| 16220 | I & C General Provisions, Testing and Training |
| 16230 | Liquid Pressure Process Measurement Devices |
| 16240 | Flow Process Measurement Devices |
| 16250 | Electrical-Operated Primary Control Valves |
| 16260 | Solenoid Primary Control Valves |
| 16270 | PLC and HMI Hardware and Software |
| 16280 | UPS Systems (Single Phase) |
| 16290 | Process Control Software Inputs / Outputs Lists |

PART 1. GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall provide all services and materials necessary for the installation, testing, start-up and operation of the Groundwater Remediation System located at Middle River, Maryland as shown in the Technical Drawings.

1. List of Technical Drawings

| | |
|---|---|
| T-1 | Title Sheet |
| C-1 | Existing Conditions Plan |
| C-2 | Southeast TCE Area Remedy Layout |
| C-3 | Southwest TCE Area Remedy Layout |
| C-4 | North TCE Area Remedy Layout |
| C-5 | Typical Injection Well (no conduit) |
| C-6 | Typical Injection Well (with conduit) |
| C-7 | Southeast TCE Area Construction Details |
| C-8 | Southwest TCE Area Construction Details |
| C-9 | North TCE Area Construction Details |
| M-1 | General Process Flow Diagram |
| M-2 | Process & Instrumentation Diagram |
| M-3 | Equipment Container General Arrangement |
| M-4 | Oxygen Removal Contactor Detail |
| M-5 | Injection Manifold Details |
| M-6 | GAC Treatment Details |
| M-7 | Lines Entrance Internal View Details |
| M-8 | Lines Entrance External View Details |
| M-9 | Container Construction Details |
| M-10 | Container Anchoring Details |
| E-1 | Electrical Symbols Legend |
| E-2 | Southeast TCE Area Electrical Site Plan (2 sheets) |
| E-3 | Southwest TCE Area Electrical Site Plan (2 sheets) |
| E-4 | North TCE Area Electrical Site Plan (2 sheets) |
| E-5 | Service Connection Details |
| E-6 | Electrical Equipment and Conduits (2 sheets) |
| E-7 | Internal Wiring Diagram (2 sheets) |
| E-8 | Single Line Electrical Diagram (2 sheets) |
| E-9 | Control Panel Layout |
| E-10 | Control System Bill of Materials |
| E-11 | Control System Architecture |
| E-12 | HMI Screen Layout |

B. The work shall be complete and include furnishing, as applicable or required, all Performing Contractor's safety devices, labor, tool, materials, supplies, and services; and performing all operations necessary for or incidental to a complete project in conformance with the attached Basis of Design Report, Technical Drawings, and Technical Specifications.

C. Sequence of work shall be as described in Design Report.

D. The Performing Contractor shall furnish all labor, materials, equipment and incidentals to

install the above listed systems and equipment, including the piping, wiring, and instrumentation interconnections between all specified components and auxiliary equipment.

E. Performing Contractor shall be responsible for the field erection of materials oversized for shipment.

F. Performing Contractor will provide one (1) year warranty for parts and workmanship, or as specified in the individual part warranties, whichever is greater.

1.2 REFERENCE SPECIFICATIONS

This section refers to all technical specification divisions.

1.3 SUBMITTALS

The Performing Contractor shall submit the following to the Owner for review, comment, and approval prior to pre-construction conference in accordance with Section 01 33 00, “Submittals”:

A. Performing Contractor’s markup drawings.

B. Product information for any proposed additions or changes per the Contractors markup drawings showing all important details, layout of components, materials of construction and dimensions.

**ATTACHMENT "A" – SCOPE OF WORK**

Section 1: Mobilization and Demobilization

Mobilization and Demobilization consists of the following construction components:

1. Provide and Execute, the Contractor Work Plan, including Project Close-out.

2. Execute the Health and Safety Plan including quality control, spill control, health and safety, traffic control, and site security.

3. Provide permits, bonds, warranties, fees, insurance, and other similar expenses required by the contract.

4. Mobilization and Demobilization of all equipment, tools, materials, supplies, temporary facilities and utilities, and personnel required to perform the work.

5. Compliance with all regulatory requirements.

6. Pre-construction and construction period planning, management, scheduling, submittals, reporting, project closeout, administration and documentation.

7. Close out the project per the Contractor Work Plan, Health and Safety Plan, and Division 1 Specifications, including permits, and record drawings

8. All other requirements and miscellaneous items not included in other pay items.

Section 2: Site Preparation and Temporary Facilities

Site Preparation and Temporary Facilities consist of the following construction components:

1. Execute the Erosion and Sedimentation Control Plan, and provide and execute a Dewatering Plan.

2. Stake-out limits of construction locations and other important features such as proposed trench centerline, road crossings and excavation limits.

3. Post project and safety signs, tree protection fencing, flagging, and other access restrictions.

4. Layout and construct the construction laydown area.

Section 3: Previous Work and Work Sequence

1. Previous work (covered in a separate design package) consists of swale relocation and pre-remedial soil excavation.

2. Pre-remedial soil excavation will utilize clean sand as a backfill for excavated areas. The majority of the underground utilities for the groundwater remedy will be installed in trenches excavated in the clean sand backfill.

3. Trenches in several areas will be excavated through native soils: all trenching in North TCE area; trenches on Tilley property (north of Chesapeake Park Plaza Road; Chesapeake Park Plaza road crossing; shallow trench for electrical conduit north-west of Southwest TCE area (Block G).

4. General work sequence shall be as follows:

    a. Swale relocation and pre-remedy soil excavation
    b. Injection wells installation
    c. Underground utilities trench and piping installation
    d. Equipment modules hook-up.

Section 4: Site Work and Restoration

The Site Work and Restoration consist of the following components:

1. Furnish equipment trailers as required.

2. Furnish all injection and monitoring wells in Southeast, Southwest and North TCE areas as shown in the Technical Drawings and as described in the design report and technical specifications.

3. Furnish and install underground injection lines in Southeast, Southwest and North TCE areas as shown in the Technical Drawings and as described in the design report and technical specifications.

4. Furnish and install electrical and potable water utilities in Southeast, Southwest and North TCE areas as shown in the Technical Drawings and as described in the design report and technical specifications.

5. Furnish all proposed exterior improvements such as seeding and sodding (topsoil) and landscaping per the technical drawings and specifications.

6. Repair or replace asphalt, fence, grass, trees, decorative planting, or other permanent site features that were disrupted during construction to visual acceptance or otherwise working condition. Resurface disturbed concrete surfaces in Southeast and Southwest TCE areas with crushed stone as shown in the Technical Drawings and as described in the technical specifications.

7. Perform remediation equipment start-up as described in the design report.

8. Perform tracer testing in Southeast, Southwest and North TCE areas as described in the design report

9. Operate the groundwater remediation systems in Southeast, Southwest and North TCE areas as described in the design report.

10. Close out the project.

**ATTACHMENT "B" – KEY PROCESS EQUIPMENT LIST**

| P&ID Symbol | Descriptioin | | Sizes/Capacities/Models | | | Total Quantity |
|---|---|---|---|---|---|---|
| | | Mahufacturer | Southwest TCE area | Southeast TCE area | North TCE area | |
| GAC-1 | Liquid-phase carbon vessel, polyglass construction, 150 psig maxium working pressure | Siemens, PG series | model PG200, 200 lbs of carbon, 10 gpm max flow | model PG200, 200 lbs of carbon, 10 gpm max flow | Container from southeast will be used | 2 |
| MC-1 | Oxygen removal membrane contactor | Liqui-Cell extra flow series | model 4 x 28 extra-flow, 30 gpm max | model 4 x 28 extra-flow, 30 gpm max | Container from southeast will be used | 2 |
| VP-1 | Vacuum pump, twin cylinder rocking piston type, staged. 29"Hg max vacuum, 1/3 hp, 115VAC, 2.6 CFM open flow | GAST | model 72R547-V116-D303X | model 72R547-V116-D303X | Container from southeast will be used | 2 |
| MP-1 and MP2 | Substrate and pH buffer metering pump, 115VAC, analog 4-20 mA speed control input, PVC head and fittings | LMI series, solenoid diaphragm | Model B92-1-498SI; 2.5 gph, 100 psi max | Model B92-1-498SI; 2.5 gph, 100 psi max | Container from southeast will be used | 4 |
| PF-1 | Bag filter housing for #4 filter bags (304SS material, 150 psi pressure rating, 1-inch FNPT side connections, 5"D x 24"L); #4 bag cartridge, 5 micron rating | Rosedale | Housing 6-18-1P-2-150-S-B-PB; Cartridge model PL-R2-PEMF-3-P4 | Housing 6-18-1P-2-150-S-B-PB; Cartridge model PL-R2-PEMF-3-P4 | Container from southeast will be used | 2 |
| SV-101 to 110 | Solenoid valve, 150 psi max pressure, 3/8"FNPT, 115VAC, 10.1 watts, normally closed | ASCO Valve | 8210G093 | 8210G093 | Container from southeast will be used | 20 |
| PS-101 to 110 | Adjustable pressure switch (0.8 to 28 psig), 5 A @ 250 VAC, 3 A @ 28 VDC, 1/8" MNP process connection | Dwyer | APS-150 | APS-150 | Container from southeast will be used | 20 |
| MV-1 | Electrically-actuated ball valve with spring return, normally closed, 1/2" FNPT, 115VAC, 200 psi max, 0.05 amp, limit switches for open and closed position | Johnson Controls | VG1241BL+943BUB | VG1241BL+943BUB | Container from southeast will be used | 2 |
| FMT-1 | Padle-type electronic flow sensor, transmitter with totalizer function (0.3 to 20 fps or 0.25 to 15 gpm for 1/2" sch 80); 1/2-inch PVC sch 80 fitting, field-mounted transmitter | Georg Fischer Signet Model 2536, Field mounted 8550-type transmitter | Sensor: 3-8512-P0 Transmitter: 3-8550-1 Fitting: MPV8T005F Adapter kit: 3-8051 | Sensor: 3-8512-P0 Transmitter: 3-8550-1 Fitting: MPV8T005F Adapter kit: 3-8051 | Container from southeast will be used | 2 |
| FT-1 and FT-101 to FT-110 | Bronze multi-jet water meter, ½" union couplings, 145 psi max, 0.125 to 13 gpm range | Dwyer | WM-A-C-01 | WM-A-C-01 | Container from southeast will be used | 22 |
| V-101 to V-110 | Metering needle valve, ¼" FNPT, brass, 0.125" orifice, 20 turns to open | Hoke Valve | 2300 Series Model 2331F4B | 2300 Series Model 2331F4B | Container from southeast will be used | 20 |
| PR-1 | Series 252A pressure regulator, bronze, ½" MNPT, 300 psi max, 12 gpm maximum flow, outlet pressure 3 to 15 psi | Watts | Series 252A, Spring #145 | Series 252A, Spring #145 | Container from southeast will be used | 2 |
| BFP-1 | Series 007 Double Check Valve Assembly, includes two shut-off valves and strainer, bronze, 1/2" MNPT, 175 psi max, 12 gpm maximum flow | Watts | 007-QT-S | 007-QT-S | Container from southeast will be used | 2 |
| AC-1 | Through the Wall Air Conditioner with 8,700 BTU Heat Pump and 3,900 BTU Backup Electric Heat, 115 VAC | Amana | PBH092E12AX | PBH092E12AX | Container from southeast will be used | 2 |
| PT-1 | Pressure transmitter (0 to 30 psig), 316SS body, current and voltage output, 1/4" MNP process connection | Dwyer | 626-08-GH-P1-E5-S1 | 626-08-GH-P1-E5-S1 | Container from southeast will be used | 2 |
| VS-1 | Adjustable vacuum switch (2.7 to 28.4 "Hg), 5 A @ 250 VAC, 3 A @ 28 VDC, 1/8" MNP process connection | Dwyer | AVS-150 | AVS-150 | Container from southeast will be used | 2 |
| DPS-1 | Adjustable differential pressure switch (7 to 13 psi), AC: 3 VA, 0.25A @ 120 VAC; 5 VA, 0.25A @ 175 VDC, 1/4" MNP process connection | Dwyer | A4-1 | A4-1 | Container from southeast will be used | 2 |
| LSHH-1 | Secondary containment level switch, Buna-N float, brass stem and slosh guard, electrical rating 20 VA, 25' PVC cable, NC | Gem Sensors | Series L750, #149350 | Series L750, #149350 | Container from southeast will be used | 2 |
| LSHH-2 | Redundant secondary containment level switch, electro-optical, polysulfone body, 1/4" NPT mounting and 3/8" conduit | Gem Sensors | Series ELS –1100, #143585 | Series ELS –1100, #143585 | Container from southeast will be used | 2 |
| Fire extinguisher | 10-lb, with wall bracket, rechargeable | ULINE | S-9874 | S-9874 | Container from southeast will be used | 2 |
| Eye wash station | Gravity-fed, 9-gallons capacity, certified by CSA to meet the ANSI Z358.1 Standard. | HAWS | 7501 | 7501 | Container from southeast will be used | 2 |

END OF SECTION

PART 1. GENERAL

1.1. ABBREVIATIONS

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| ACPA | American Concrete Pipe Association |
| AFBMA | Anti-Friction Bearing Manufactures Association |
| AI | Asphalt Institute |
| ANSI | American National Standards Institute |
| ARAR | Applicable or Relevant and Appropriate Requirements |
| ASSE/SAFE | American Society of Safety Engineers |
| ASTM | ASTM International |
| AWPA | American Wood Protection Association |
| AWS | American Welding Society |
| BMP | Best Management Practices |
| cfm | Cubic feet per minute |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CRSI | Concrete Reinforcing Steel Institute |
| CSA | CSA Standards |
| DOT | Department of Transportation |
| E&SCP | Erosion and Sediment Control Plan |
| EPA | United States Environmental Protection Agency |
| F | Fahrenheit |
| gpd | gallons per day |
| gpm | gallons per minute |
| HASP | Health and Safety Plan |
| HMA | hot mix asphalt |
| HVAC | Heating, Ventilating, Air Conditioning |
| JMF | job mix formula |
| LMC | Lockheed Martin Corporation |
| MCL | Maximum Contaminant Level |
| MD SHA | Maryland State Highway Administration |
| MDE | Maryland Department of the Environment |
| MDTA | Maryland Transportation Authority |
| mg/kg | milligrams per kilogram |
| MRC | Middle River Complex |
| MSMT | Maryland Standard Method of Test |
| MVA | Motor Vehicle Administration |
| NCP | National Contingency Plan |
| NFPA | National Fire Protection Association |
| NIOSH | National Institute of Occupational Safety and Health |
| NPCA | National Precast Concrete Association |
| NPDES | National Pollution Discharge Elimination System |
| ODS | Operational Data Store |
| OSHA | Occupational Safety and Health Administration |
| PCA | Portland Cement Association |
| PCB | polychlorinated biphenyl |
| PPE | Personal Protective Equipment |
| psi | Pounds per Square Inch |
| psig | Pounds per Square Inch Gauge |
| QA | Quality Assurance |
| QC | Quality Control |

| | |
|---|---|
| QCP | Quality Control Plan |
| RAP | reclaimed asphalt pavement |
| RCRA | Resource Conservation and Recovery Act of 1976, as amended |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SHA | State Highway Administration |
| SSPC | Steel Structure Painting Council |
| TSCA | Toxic Substances Control Act of 1976, as amended |
| TSDF | Treatment, Storage, and Disposal Facility |
| TSP | Total Suspended Particulates |
| TSR | Tensile Strength Ratio |
| USDA | U.S. Department Of Agriculture |
| USDH | United States Department of Health and Human Services |
| USDOT | United States Department of Transportation |
| USEPA | United States Environmental Protection Agency |
| WP | Work Plan |

1.2. DEFINITIONS

A. Completion of Work – Completion of all required on-site activities.

B. Construction Documents – Documents pertaining to the completion of the project, including Technical Drawings and Specifications.

C. Performing Contractor – The entity entering into the Contract with Owner to perform the work described in the Contract Documents.

D. Decontamination Area – Areas constructed by the Contractor, Materials, equipment, and personnel shall receive decontamination or cleaning in these areas.

E. Decontamination (equipment) – A thorough rinsing of the equipment with a high-pressure steam sprayer to remove all surface contamination.

F. Decontamination (personnel) – This encompasses the procedure for performing proper decontamination. This item is detailed in the HASP.

G. Design Engineer – The engineer preparing the Technical Drawings and Technical Specifications.

H. Hazardous Waste – A material that has been sampled, analyzed, and meets the RCRA definition of a hazardous waste.

I. Managing Contractor – The entity who is the Owner's representative for the design and construction of the project.

J. Manufacturer – The entity actually supplying any equipment or material component for one or more of the items of the project.

K. Manufacturer's Representative – Person designated by the manufacturer to coordinate the supply and installation of equipment.

L. Non-Hazardous Waste – A material which has been sampled, analyzed, and exceeds the Owner Type B cleanup criteria, but does not satisfy the RCRA definition of hazardous waste.

M. Owner – Lockheed Martin Corporation, who will be represented by its Design Engineer and its Managing Contractor.

N. Product – Materials, systems, and equipment.

O. Project Manager – Lockheed Martin Corporation technical lead.

P. Project Manual – The compilation of documents which govern the work to be performed which includes instructions to Offerors, Contract Forms, Contract Conditions, Technical Specifications, and Technical Drawings.

Q. Provide – To furnish and install in place.

R. Shop Drawings – Equipment specific drawings prepared by Manufacturer and showing all necessary equipment fabrication data.

S. Site – Lockheed Martin Middle River Complex as shown in the Construction Documents.

T. Site Manager – Contractor's Field Representative who has the overall responsibility to manage and execute the work in accordance with the Project Manual and subsequent amendments.

U. Supplier – The entity actually supplying one or more equipment items.

V. Support Plans – Documents required for the start of work as outlined in the Technical Specifications including, but not limited to, the WP, QCP, and HASP.

W. Technical Drawings – These drawings prepared by the Engineer showing the design of the remedial soil excavation, swale relocation, and groundwater remediation components of the project.

X. Technical Specifications – Specifications prepared by the Design Engineer.

Y. Treatment, Storage, and Disposal Facility – A licensed Type I, II, or III treatment, storage, and disposal facility

Z. Work – All engineering, labor equipment, and material required to design, procure, and install a complete storm sewer system and grading as specified herein.

AA. Work Area – The area in which the Contractor can work and perform construction activities. The Contractor shall not go outside of this area without prior approval of Owner.

1.3. NOTE

Due to the nature of the work and the type of equipment required, it is possible and acceptable, that the same entity be at once Contractor, Supplier, and Manufacturer or any combination thereof.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION – NOT APPLICABLE

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

The Performing Contractor is responsible for coordinating and communicating project activities with the Owner, and all lower tier subcontractors or other parties, including utility companies, as designated by the Owner.

This Section covers the requirements for the Pre-Construction Conference, Pre-Work Conference, and progress meetings. Also provided is a suggested agenda for the progress meetings.

## 1.2. RELATED SECTIONS

01200 Contractor Work Plan
01300 Submittals
01400 Quality Requirements

## 1.3. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”:

A. Weekly Site Safety Summary.

B. Summary of Contractor’s Quality Control Plan.

C. Agenda for Progress Meetings.

D. Meeting Minutes from the Progress Meetings.

# PART 2. PRODUCTS

## 2.1. GENERAL

A. The choice of quantity and type of labor, materials, and construction equipment shall be at the discretion of the Performing Contractor, but must be available in the quality and quantity to perform the work as specified in the Contract and schedule.

B. The Performing Contractor shall furnish equipment which will be efficient and appropriate to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the project schedule. If at any time such equipment appears to the Owner to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Owner may order the Performing Contractor to increase the efficiency, change the character, or increase the equipment, and the Contractor shall conform to such order. Failure by the Owner to give such an order shall in no way relieve the Performing Contractor of his obligations to secure the quality of the work and rate of progress required.

PART 3. EXECUTION

3.1. GENERAL PROCEDURES

A. Prior to beginning work, the Performing Contractor shall meet with the Owner and arrange the schedule for the project. Once the project is started, it shall be carried to completion without delay.

B. Phasing of work shall be clearly established and verified with the Owner prior to commencing work in any area. No cutting or removal work shall begin until authorized by the Owner.

C. Any utility service interruptions or outages required by the Contractor in performing the work shall be prearranged and shall occur only during those scheduled times.

3.2. PRE-CONSTRUCTION CONFERENCE

A. The Performing Contractor shall meet with the Owner after the Award of Contract, but prior to the Notice to Proceed, to review and discuss submittal, safety, payrolls, labor relations, environmental protection, progress schedules, payment, and procurement of materials. The principle features of work shall also be reviewed and any questions regarding the contract and the work site will be addressed.

B. After this meeting but prior to the Pre-work Conference, the Performing Contractor shall submit the Work Plan (WP) and Health and Safety Plan (HASP) to the Owner for review. The Contractor will also submit samples of the daily progress summary and the weekly site safety summary, and a brief summary of the Contractor's Quality Control Plan for review by the Owner prior to the Pre-work conference. The Contractor shall submit all required submittals to the Owner within ten (10) working days after the Pre-construction Conference.

C. The contractor must coordinate site work with the Owner, including, but not limited to, work hours, access, traffic controls, and security. Initial planning for the coordination should be discussed prior to the Pre-work Conference.

3.3. PRE-WORK CONFERENCE

A. After the Notice to Proceed has been issued and just prior to the mobilization to the site and commencement of work, the Contractor shall meet with the Owner on-site, ready to begin work. Attendance by the Contractor's superintendent, quality control personnel, safety personnel, and any major subcontractor's job superintendents will be required.

B. The purpose of the meeting is to define the Performing Contractor's Quality Control Plan, to thoroughly review the WP, and to develop a mutual understanding of the specific requirements established by the contract. The specifics of the Contractor's HASP will be discussed so that the emergency and safety requirements are understood by all of those directly related to the site work. The schedule of work, particularly for the initial start-up period, will also be discussed. Questions concerning the administrative requirements outlined during the Pre-construction Conference or any other aspect of the project may also be addressed.

3.4. PROGRESS MEETINGS

A. The Performing Contractor shall schedule progress meetings at a minimum of once per week. The Performing Contractor will administer the progress meetings by preparing the

agenda, preparing and distributing the minutes, and presiding at all meetings.

B. In attendance shall be the Performing Contractor's Project Manager, Design Engineer, any Subcontractors or Suppliers, as appropriate to the agenda; and others as appropriate. This meeting can take place by teleconference.

C. Suggested agenda for the progress meeting(s) include, but are not limited to:

1. Review of work progress since the previous meeting.
2. Field observations, problems, and conflicts.
3. Problems which impede the project schedule and proposed corrective actions.
4. Review of off-site delivery schedule.
5. Corrective measures and procedures to regain projected schedule.
6. Updates to the project schedule.
7. Progress intended for the subsequent two weeks work period
8. Coordination of schedules.
9. Review submittal schedule.
10. Maintenance of quality and safety standards.
11. Pending changes and substitutions.
12. Review proposal changes for effect on project schedule and on completion date.
13. Any other applicable business.

END OF SECTION

PART 1. END OF GENERAL

1.1. SCOPE OF WORK

The Performing Contractor shall provide timely four (4) sets, unless otherwise directed, of the submittals required by this Section for review, comment, and approval, as required or deemed necessary by the Owner.

1.2. RELATED SECTIONS

Related sections are listed in the attached Submittal Table.

1.3. SUMMARY OF SUBMITTALS

The submittals which the Performing Contractor is required to provide include, but are not limited to, those summarized on the Submittal Table. The submission dates represent the minimum number of working days for prior to, and maximum number of working days for after, the referenced bench mark dates.

1.4. SHOP DRAWINGS, MANUFACTURER'S PRODUCT DATA, AND SAMPLES

A. Shop Drawings

1. Engineering data covering all equipment and fabricated materials that will become a permanent part of the work under this Contract shall be submitted for review. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation drawings, scheduled information, setting diagrams, actual shop-work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection, and test reports including performance curves and certifications, manufacturer's certificates, as applicable to the work.

2. To aid in expediting the project, shop drawings submitted by the Performing Contractor's Subcontractors (i.e., Supplier, Manufacturer, etc.) for review shall be sent directly to both the Performing Contractor and the Owner for preliminary checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.

3. The Performing Contractor shall check all of his Subcontractors' shop drawings regarding measurements, size of members, materials, and details to satisfy themselves that they conform to the intent of the Technical Drawings and Technical Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the Subcontractor for correction before final submission to the Owner.

4. All deviations from the Technical Drawings or Technical Specifications shall be identified on each submittal and will be tabulated in the Contractor's letter of transmittal. Such submittal shall, as pertinent to the deviations, indicate essential details for all changes proposed by the Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

5. Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

B. Manufacturer's Product Data

1. Manufacturer's Product Data, as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliances and applicability, roughing in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

2. Manufacturer's product data shall also include, if requested by the Owner, items of disposable clothing, safety equipment, breathing apparatus, communication devices, items of equipment to be used on the site, and any other items which are required for the safety and health of all personnel on the site. This information shall be submitted to the Owner's Site Representative to verify that the requirements for materials have been met. This information shall be required for, at a minimum, the concrete mix, crushed stone, excavation backfill material, seed mixture, gratings, and concrete manholes.

C. Samples

Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, and units of work to be used by the Owner for independent inspection and testing, as applicable to the work.

D. Submission Requirements

1. Coordination of Submittal Items

Prepare and transmit each submittal within the time specified in the individual work sections of the Specifications, so that the installation will not be delayed by processing times including revision and re-submittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery, and similar sequenced activities. No extension of time will be authorized because of the Performing Contractor's failure to transmit submittals sufficiently in advance of the work.

2. Number of Submittals Required

a. Shop drawings: Submit four (4) copies.
b. Manufacturer's Product Data: Submit four (4) copies.
c. Samples: Submit four (4) pieces or the number stated in the respective Specification Sections or as directed by the Owner.
d. All other submittals: Submit four (4) copies or pieces, unless stated elsewhere in the Technical Specification or as directed by the Owner.

3. All submittals, regardless of origin, shall have the following identification data, as applicable, contained thereon or permanently adhered thereto:

   a. Date of submission and dates of any previous submissions.
   b. Project Name and Contract Number.
   c. Contractor's name and address.
   d. Supplier's name and address.
   e. Manufacturer's name and address.
   f. Title or identification of submittal.
   g. References to applicable Section and part of the Technical Specification paragraphs or to applicable Technical Drawings.
   h. Deviations from Contract Documents, to be adequately stated.

E. Resubmission Requirements

Make any corrections or changes in the submittals required by the Owner and resubmit until approved.

F. Review of Shop Drawings, Manufacturer’s Product Data, and Samples.

1. After review by the Owner, shop drawings, manufacturer’s product data, and samples will be returned to the Performing Contractor denoted with the following classifications:

   a. Approved.
   b. Approved except as noted. Re-submittal not necessary.
   c. Approved except as noted. Re-submittal necessary.
   d. Disapproved. Re-submittal necessary.
   e. Receipt acknowledged.
   f. Submittal not required.

2. Re-submittals will indicate any changes that have been made in addition to those requested by the Owner.

3. No portion of the work requiring a shop drawing, manufacturer’s product data, or sample shall be commenced nor shall any material be fabricated or installed prior to review of that shop drawing, manufacturer’s product data, or sample by the Owner and the submittal returned to the Contractor denoted "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT NECESSARY". The Owner will not be responsible for any expense or delay due to Contractor's corrections or remedies required to accomplish conformity.

4. Any need for more than one re-submission, or other delay in obtaining Owner's review of submittals, will not entitle Contractor to a schedule extension.

5. It may be expected that the Owner will review and return submittals to the Contractor within seven (7) working days of their receipt by Owner.

G. Distribution

Distribute reproduction of shop drawings, manufacturer’s product data, and samples returned to the Contractor marked "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT REQUIRED," where required, to the job site file and elsewhere as directed by the Owner.

1.5. CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall photographically record progress of construction on a biweekly basis and provide photographs in electronic form.

B. Each photograph shall have a description containing the following:

1. Project name and Contract number.
2. Contractor's name.
3. Photographer's name.
4. Date and time.
5. Orientation of view.
6. Short description of view.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1. GENERAL

The Performing Contractor shall timely present all submittals in accordance with this Section.

**SUBMITTAL TABLE**

| SECTION | TITLE | LIST OF SUBMITTAL | SUBMISSION DATE |
|---|---|---|---|
| 01010 | Scope of Work | • Technical Drawings<br>• Product information | • Prior to pre-work conference |
| 01200 | Contractor Work Plan | • Contractor Work Plan<br>• Health and Safety Plan | • Prior to pre-work conference |
| 01210 | Project Meetings & Coordination | • Sample Weekly Site Safety Summary<br>• Agenda for Progress Meetings<br>• Meeting Minutes from the Progress Meetings | • Prior to the pre-work conference<br>• Weekly |
| 01400 | Quality Control | • Quality Control Plan<br>• Quality Control Project Summary Report | • Prior to pre-work conference<br>• Within 30 days of the final compliance inspection |
| 01500 | Temporary Facilities | • Proposed temporary facilities information | • Prior to pre-work conference |
| 01720 | Regulatory Requirements | • Erosion and Sediment Control Permit | • Prior to pre-work conference |
| 01730 | Environmental Protection | • Erosion and Sediment Control Plan Modifications<br>• Spill Report<br>• Spill Control Plan | • Prior to pre-work conference<br>• Immediately upon the occurrence<br>• Prior to pre-work conference |

| | | | |
|---|---|---|---|
| 02300 | Trenching, Backfill, & Compaction | • Product Data<br>• Laboratory Test Data<br>• Field Density Test Results | • At time of delivery<br>• Daily |
| 02400 | Injection and Monitoring Wells | • Product Data | • Prior to pre-work conference |
| 02600 | Off-site Waste Disposal | • Name, Qualifications, and State Identification Numbers of the Proposed Off-site Waste Transportation<br>• Name, Location, Qualifications, and State Identification Number of the Proposed Off-site Disposal Facility.<br>• Shipment Manifests<br>• Certificate of Disposal | • Prior to pre-work conference<br>• Prior to any shipment of waste leaving the site<br>• Upon receiving receipt from off-site disposal facility<br>• Upon receiving receipt from off-site disposal facility |
| 02450 | Aggregate &/or Graded-Crushed Aggregate for Roadways | • Product Data<br>• Test Reports | • At time of delivery to site |
| 02451 | Hot Mix Bituminous Pavement | • Product Data<br>• Laboratory Test Data | • At time of delivery to site |
| 02900 | Seeding, Soil Supplements, & Mulching | • Product Data<br>• Laboratory Test Data | • At time of delivery to site |
| 11010 to 11090; 15100 to15730 | Equipment; Piping | • Product Data<br>• Product drawings, catalog information<br>• Test data<br>• Certifications | • Prior to shipment |
| 13120 | Shipping Containers | • Product Data<br>• Drawings, catalog information<br>• Certifications | • Prior to shipment |
| 13121 | Shipping Containers Modifications | • Shop drawings | • Prior to shipment |
| 15950 | Pressure Testing | • Test notifications<br>• Test reports | • At least 5 days prior each test<br>• No later than 5 days after each test |
| Division 16 | Electrical | • Shop Drawings<br>• Product Data<br>• Test reports<br>• Certifications | • Prior to shipment |

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

This section describes the minimum requirements the Performing Contractor shall address and abide by with respect to quality control.

1.2. RELATED SECTIONS

A. 01300 Submittals

B. Division 1 Sections for project management and coordination.

C. All other Division Sections for specific test and inspection requirements.

1.3. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”:

A. Quality Control Plan

Submit a Quality Control Plan detailing the quality control organization and procedures to be used during the project. The Quality Control Plan should be prepared for general construction only.

B. Quality Control Project Summary Report

Submit a Quality Control Project Summary Report that will summarize the overall quality of the data obtained and the work completed during the project. This report shall be submitted within 30 days after the final compliance inspection.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1 QUALITY CONTROL PROCEDURES

Through quality control (QC) procedures, the Performing Contractor assures the Owner that the Performing Contractor and all lower-tier contractors comply with the requirements of the specifications presented herein. The controls shall be adequate to cover all contract operations. The quality of all work shall be the responsibility of the Performing Contractor. Sufficient inspections and tests of all items of work, including that of lower-tier contractors, shall be performed on a continuing basis to ensure conformance with respect to the quality of work. The Performing Contractor shall furnish qualified personnel, appropriate facilities, instruments and testing devices necessary for the performance of the QC function. The controls shall be adequate to cover all operations both on and off-site, keyed to the proposed work sequence, and correlated by the Performing Contractor's QC personnel.

3.2 QUALITY CONTROL RECORDS

The Performing Contractor shall maintain up-to-date records of QC operations, activities, and tests performed. These records shall include the work of suppliers and lower-tier contractors. The records shall cover both conforming and defective or deficient features.

3.3 INSPECTIONS

A. After the substantial completion of work, the Performing Contractor, in conjunction with the Owner, shall conduct a completion inspection of the work and develop a list of any items that do not conform to the approved specifications presented herein. Such a list shall include the estimated date by which the deficiencies will be corrected. The substantial completion inspection and any deficiency correction required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment thereof. The Performing Contractor shall keep records of the inspection, including the list of deficiency items. For each item on this list, the Contractor shall document the corrective actions taken.

B. Following corrective action measures, the Performing Contractor, in conjunction with the Owner, shall make a final completion inspection to ascertain that all deficiencies have been corrected.

3.4 QUALITY CONTROL PROJECT SUMMARY REPORT

Within 30 days of completion of the final compliance inspection, the Performing Contractor shall submit to the Owner a Contractor Quality Control Project Summary Report. This report will summarize and state the overall quality of data obtained (where applicable) and work completed during the project. The report will certify the acceptability of data and work based on the QA/QC requirements defined in the Performing Contractor quality control plan.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

This section describes the provision, layout, installation, maintenance, and removal of all Contractor temporary facilities and utilities necessary to complete the project work tasks.

1.2. RELATED SECTIONS

01300 Submittals

1.3. SUBMITTALS

Submit in accordance with Section 01300, “Submittals”, information on all proposed temporary facilities to be used on-site including, but not limited to, a layout sketch of the laydown area, size of the facility, anticipated duration on-site, and potential impacts of the facility prior to placement of the temporary facility on-site.

PART 2. PRODUCTS

The Contractor shall provide all labor, materials, and equipment necessary to provide temporary facilities to the site. Erosion and sediment control facilities (E&SC) facilities shall be maintained and removed at the completion of work. E&SC facilities (specified in pre-remedy soil excavation and swale relocation design package) are installed and removed as part of the preceding soil excavation and swale relocation work. Facilities may include, but not be limited to:

A. E&SC facilities

B. Material staging areas

C. Sanitary facilities.

D. Rubbish and waste collection.

E. Fire protection and safety equipment.

2.1. FIELD OFFICE AND SUPPORT TRAILER(S)

If required, the Performing Contractor shall locate the field office trailer in a location approved by the Owner if necessary.

2.2. MATERIAL STAGING AREAS

If required, the Performing Contractor shall construct and maintain material staging areas for raw material at locations approved by the Owner. The areas shall be designed by the contractor to be as compact as possible, but yet to provide adequate space for intended uses. If the areas are to be used for storing construction materials and no potential of spills, the area(s) shall be well drained. If the stored materials contain hazardous constituents or have potential of spills and will likely cause environmental impacts, the area(s) shall have containment structures with precipitation protection as appropriate.

2.3. RUBBISH AND WASTE COLLECTION

The Performing Contractor shall be responsible for collection of wastes and rubbish generated throughout the site activities, (i.e., trash, used supplies, office waste, etc.). These wastes are not anticipated to be large in volume and may be collected and deposited through the Contractor's normal waste disposal methods. All waste and rubbish generated on-site shall be removed at regular intervals, as needed.

2.4. FIRE PROTECTION AND SAFETY EQUIPMENT

The Performing Contractor shall be responsible for providing and maintaining fire protection and health and safety equipment to the temporary facilities throughout the site activities in accordance with the technical specifications, regulatory requirements from federal, state, and local governments, and/or generally accepted industry practices.

PART 3. EXECUTION

3.1. INSTALLATION AND MAINTENANCE OF FACILITIES

A. The Contractor shall provide all temporary utilities including, but not limited to, electricity and sanitary waste removal. The Performing Contractor shall be responsible for all site contractor and lower-tier contractor utility costs.

B. The Performing Contractor shall locate all temporary facilities on-site and properly secure them to withstand all anticipated weather conditions. The Performing Contractor shall maintain all contractor temporary facilities and equipment. Maintenance shall extend beyond the structures to all parking areas and all exterior portions of the support areas. The Performing Contractor shall comply with all applicable federal, state, and local regulations and codes with respect to the construction, maintenance, and removal of temporary facilities.

3.2. SECURITY

It is the responsibility of the Performing Contractor to assure that their equipment, materials, facilities, etc. are properly secured during the course of the project. Neither the Owner nor any of their representatives shall be responsible for loss, theft, or damage to Performing Contractor equipment, materials, or facilities until completion of the project.

3.3. REMOVAL OF FACILITIES

The Performing Contractor shall remove all temporary facilities upon completion of the project. All areas occupied by temporary facilities shall be restored to the original contour and condition existing prior to the project. The Performing Contractor shall disconnect and remove all temporary utilities at the completion of work. Contaminated materials and equipment will be decontaminated, subject to the approval of the Owner, and removed from the site.

END OF SECTION

PART 1. GENERAL

1.1 SUMMARY

This Section describes general requirements and procedures to maximize the resource efficiency in this project in accordance with the Owner's Goin' Green program, the Performing Contractor's corporate program, and industry standards.

1.2 OBJECTIVES

A. To maximize resource efficiency and reduce the environmental impacts of construction and operation, the Performing Contractor during the construction phase of this project shall implement the following procedures:

1. Select products that minimize consumption of energy, water and non-renewable resources, while minimizing the amounts of pollution resulting from the production and employment of the groundwater remediation system components. It is the intent of this project to conform with EPA's Five Guiding Principles on environmentally preferable purchasing. The five principles are:

a. Include environmental considerations as part of the normal purchasing process.

b. Emphasize pollution prevention early in the purchasing process.

c. Examine multiple environmental attributes throughout a product's or service's life cycle.

d. Compare relevant environmental impacts when selecting products and services.

e. Collect and base purchasing decisions on accurate and meaningful information about environmental performance.

2. Control sources for potential Indoor Air Quality (IAQ) pollutants by controlled selection of materials and processes used in project construction in order to attain superior IAQ.

3. Products and processes that achieve the above objectives to the extent currently possible and practical have been selected and included in these Construction Documents. The Performing Contractor is responsible to maintain and support these objectives in developing means and methods for performing the work proposing product substitutions and/or changes to specified processes.

4. Use practices that reduce construction debris and particulates during construction and operational activities.

1.3 RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 01400 | Quality Control |
| 01720 | Regulatory Requirements |
| 01730 | Environmental Requirements |

| | |
|---|---|
| Division 2 | Construction |
| Division 11 | Equipment |
| 15200 | Process Piping |

1.4 DEFINITIONS

A. Construction and Demolition Waste: Includes solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair and demolition operations. A construction waste management plan is to be provided by the Contractor as defined in Section 01 74 19.

C. Recycled Content Materials: Products that contain pre-consumer or post-consumer materials as all or part of their feedstock

D. Post-Consumer Recycled Content: The percentage by weight of constituent materials that have been recovered or otherwise diverted from the solid-waste stream after consumer use

E. Pre-Consumer Recycled Content: Materials that have been recovered or otherwise diverted from the solid-waste stream during the manufacturing process. Pre-consumer content must be material that would not have otherwise entered the waste stream as per Section 5 of the FTC Act, Part 260 “Guidelines for the Use of Environmental Marketing Claims”:

F. Salvaged or Reused Materials: Materials extracted from existing buildings in order to be reused in other buildings without being manufactured

G. Sealant: Any material that fills and seals gaps between other materials

H. Volatile Organic Compounds (VOCs): Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. Compounds that have negligible photochemical reactivity, listed in EPA 40 CFR 51.100(s), are also excluded from this regulatory definition.

1.5 QUALITY ASSURANCE

A. Preconstruction Meeting: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner, and all Subcontractors to discuss the Sustainable Design Requirements. The purpose of this meeting is to develop a mutual understanding of the Project’s Sustainable Design Requirements and coordination of the Contractor’s management of these requirements with the Owner.

B. Construction Job Conferences: The status of compliance with the Sustainable Design Requirements of these specifications will be an agenda item at job meetings conducted during the course of work at the site.

PART 2 - PRODUCTS

2.1 PRODUCT ENVIRONMENTAL REQUIREMENTS

A. Site Clearing: Topsoil shall be provided by the Contractor from on-site material which has been stockpiled for reuse. Off-site borrow should only be used when on-site sources are exhausted. Chip and/or compost on site all vegetated material identified for removal. Do

not burn rubbish, organic matter, etc. or any material on the site. Dispose of legally in accordance with Specifications Sections 02600.

B. Herbicides and Pest Control: Herbicides shall not be permitted, and pest control measures shall utilize EPA-registered biopesticides only.

C. Elimination of CFCs AND HCFCs:

1. Ozone Protection and Greenhouse Gas Reduction: Base building cooling equipment shall contain no refrigerants other than the following: HCFC-123, HFC-134a, HFC-245fa, HFC-407c, or HFC 410a.

2. Fire suppression systems may not contain ozone-depleting substances such as halon 1301 and 1211.

3. Extruded polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation shall not be manufactured with hydrochlorofluorocarbon (HCFC) blowing agents.

D. Appliances and Equipment: All materials and equipment being installed that falls under the Energy Star or FEMP programs must be Energy Star or FEMP-rated. Eligible equipment includes refrigerators, motors, laundry equipment, office equipment and more. Refer to each program's website for a complete list.

E. Salvaged or Reused materials: There shall be no substitutions for specified salvaged and reused materials and products.

1. Salvaged materials: Use of salvaged materials reduces impacts of disposal and manufacturing of replacements.

F. Recycled Content of Materials:

1. The Contractor shall make all attempts to maximize the procurement of materials with recycled content.

a. Post-consumer recycled content value of a material shall be determined by dividing the weight of post-consumer recycled content by the total weight of the material and multiplying by the cost of the material.

b. Do not include mechanical and electrical components in the calculations.

c. Do not include labor and delivery costs in the calculations.

d. Recycled content of materials shall be defined according to the Federal Trade Commission's "Guide for the Use of Environmental Marketing Claims," 16 CFR 260.7 (e).

e. The materials in the following list must contain the minimum recycled content indicated:

| **Category** | **Minimum Recycled Content** |
|---|---|

| | |
|---|---|
| Compost/mulch | 100% post-consumer |
| Asphaltic Concrete Paving | 25% post-consumer |
| Cast-in-Place Concrete | 6% pre-consumer |
| Rigid Insulation | 20% pre-consumer |
| Batt insulation | 30% combined |

PART 2 - EXECUTION

The Performing Contractor will complete an environmental life cycle analysis of the system described in this Draft 60% design using SiteWise$^{TM}$, with support from Tetra Tech's GSRx tool. This process will be used to identify activities/materials that contribute significantly to the overall environmental footprint of the remedy. These activities and materials will then be further evaluated to determine if modifying the design to reduce the footprint of the remedy can be accomplished without compromising performance. Changes to the design will only be made with the Owner's consent.

PART 1. GENERAL

1.1. SCOPE OF WORK

The Performing Contractor shall comply with all applicable federal, state, and local laws, ordinances, rules and regulations. The Performing Contractor shall comply with all authorities having jurisdiction over the work. The list of regulations provided in this specification does not necessarily include all regulations which may be applicable to site activities and off-site transportation and disposal. All necessary permits or certificates of inspection shall be paid for and obtained by the Performing Contractor.

1.2. REFERENCES

The following references are part of this specification to the extent referenced. These publications shall be the latest edition and are referred in the text by the basic designation only:

FEDERAL LAWS

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation and Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 94-469 | Toxic Substance Control Act (TSCA) of 1976, as amended |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 40 CFR 260 | Hazardous Waste Management Systems, General |
| 40 CFR 261 | Identification and Listing of Hazardous Wastes |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Wastes |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Wastes |
| 40 CFR 264 | Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 265 | Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 270 | Hazardous Waste Permits Program |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |
| 49 CFR 171 | General Information, Regulations, and Definitions |

| | |
|---|---|
| 49 CFR 172 | Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans |
| 49 CFR 173 | Shippers—General Requirements for Shipments and Packagings |
| 49 CFR 174 | Carriage by Rail |
| 49 CFR 175 | Carriage by Aircraft |
| 49 CFR 176 | Carriage by Vessel |
| 49 CFR 177 | Carriage by Public Highway |
| 49 CFR 178 | Specifications for Packagings |
| 49 CFR 179 | Specifications for Tank Cars |
| 49 CFR 180 | Continuing Qualification and Maintenance of Packagings |

STATE OF MARYLAND LAWS

Annotated Code of Maryland, Environmental (Consolidated)
Annotated Code of Maryland, Health (Consolidated)

STATE OF MARYLAND REGULATIONS

| | |
|---|---|
| Title 09 | Department of Labor, Licensing, and Regulation |
| Title 10 | Department of Health and Mental Hygiene |
| Title 26 | Department of the Environment |

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1 FEDERAL REGULATIONS

A. Conduct all site work in accordance with PL 91-596 and 29 CFR 1910.120, including hazardous waste cleanup or chemical spills.

B. Identify all hazardous wastes in accordance with all applicable Federal regulations, including PL 94-850/98-616 and 40 CFR 261.

C. Manage all hazardous wastes in accordance with all applicable Federal regulations, including PL 94-850/98-616, 40 CFR 260, and 40 CFR 262.

D. Transport all hazardous wastes in accordance with all applicable Federal regulations,

including PL94-850/98-616, 40 CFR 263, 40 CFR 761, and 49 CFR 171 through 49 CFR 180.

E. Dispose of all hazardous wastes at off-site facilities which are in compliance with all applicable Federal regulations, including PL 94-850/98-616, 40 CFR 264, 40 CFR 265, 40 CFR 270, and 40 CFR 761.

3.2 STATE REGULATIONS

A. All Contractor activities within the State of Maryland boundaries shall be in compliance with Maryland State labor laws.

B. Transportation and disposal of non-hazardous wastes must comply with the Maryland State Regulations.

C. Transportation of wastes through states other than Maryland shall be in compliance with all applicable requirements of those states.

D. Hazardous waste treatment and disposal facilities shall be in compliance with all requirements of the state in which they are operated.

3.3 LOCAL REQUIREMENTS

Ascertain and comply with all applicable county and municipal ordinances, codes, rules and regulations, and obtain all required permits including public health requirements, and seasonal load limits which may be imposed to cover transportation on certain roads. It is required to obtain a Grading Permit from Baltimore County, and Contractor shall adhere to the requirements of the permit.

END OF SECTION

# PART 1. GENERAL

## 1.1 SCOPE OF WORK

A. This Section describes the work required by the Performing Contractor for the protection of the environment throughout the course of the project, except for those measures specifically set forth in other sections of these Specifications. Compliance with the provisions of this section by lower-tier subcontractors will be the responsibility of the Performing Contractor. Items to be considered under this section are air, water, and land resources and shall include noise, equipment fuel management, land resource management, and management of other chemicals.

B. This section also details the requirements the Performing Contractor and lower-tier contractors must follow regarding spill control procedures to be followed during completion of this project.

## 1.2 RELATED SECTIONS

01300 Submittals
01720 Regulatory Requirements
01400 Quality Control

## 1.3 DEFINITIONS

Environmental protection shall be defined as the retention of the environment in its natural state, to the greatest extent possible, during the project implementation, and the enhancement of the natural appearance in its final condition.

## 1.4 SUBMITTALS

A. Should the Erosion and Sediment Control Plan (E&SCP) require a modification due to field conditions, the Performing Contractor shall submit two copies of the proposed modifications to the E&SCP to the Owner for approval in accordance with Section 01300, “Submittals”.ls”.

B. A spill control plan shall be submitted under this section with the Site-Specific Health and Safety Plan.

# PART 2. PRODUCTS

The Performing Contractor shall provide all labor, equipment, and materials necessary for environmental protection that could arise as a result of Performing Contractor activities or conditions during the course of this project.

# PART 3. EXECUTION

## 3.1 GENERAL

The Performing Contractor shall be responsible for complying with all applicable federal, state, and local laws concerning the prevention, abatement, and control of all environmental pollution arising from the project activities in accordance with Section 017200, “Regulatory Requirements”.

## 3.2 PROTECTION OF LAND RESOURCES

A. The Performing Contractor shall confine project activities to work areas designated by the Owner and/or construction oversight firm, and, at all times, perform work in a manner that minimizes the interference with or the disturbance to fish, wildlife, and vegetation.

B. The Performing Contractor shall implement measures to prevent lubricants, chemicals, and fuels from entering natural land features.

3.3 BURNING

Under no circumstances shall the burning of debris or waste materials be conducted at the site.

3.4 SPILL CONTROL

A. The Performing Contractor shall ensure that all tanks containing hazardous materials which are required to complete the activities presented herein are located on-site such that any spill would be confined/contained.

B. The Performing Contractor shall follow appropriate federal, state, and local regulations applicable and/or relevant to spill control in accordance with Section 01 41 00, “Regulatory Requirements”.

C. The Performing Contractor shall immediately report all hazardous materials spills to the Owner.

D. The Performing Contractor shall be responsible for the timely cleanup of all hazardous materials spills and affected media, including the provision of all labor, equipment, and materials necessary for the cleanup. Cleanup of affected areas shall be subject to approval by the Owner.

3.5 TEMPORARY CONTROLS

A. All construction machinery and vehicles shall be equipped with practical sound-muffling devices and operated in a manner to cause the least noise, consistent with efficient performance of work. In addition, in order to minimize noise disturbances, the operation of machinery and large vehicles shall be confined to the hours of 8:00 a.m. to 7:00 p.m. Monday through Friday.

B. The Performing Contractor shall maintain all excavations, stockpiles, access roads, waste areas, and all other areas free from dust to such a degree as to avoid causing a hazard or nuisance. Earth surfaces subject to dusting may be kept moist with water or dust may be controlled by other measures, if approved by Owner. Dusty materials in piles or in transit shall be covered to prevent blowing. The Contractor will maintain a mobile water tank complete with spray bar and pump on-site, if dust control is to be performed by water sprinkling.

C. The Performing Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

D. Erosion and Sediment Control

1. The Performing Contractor shall use the Erosion and Sediment Control measures specified on the technical drawings as the E&SCP, and shall specify additional

applicable erosion and sediment control measures and Best Management Practices (BMPs) in accordance with the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control (MDE, 2011) The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations.

2. The Performing Contractor shall obtain an approval of the Erosion and Sediment Control Plan and a Grading Permit through Baltimore County if required.

3. The Performing Contractor shall use the Erosion and Sediment Control measures to control adverse effects from erosion and sedimentation during construction activities.

4. The Performing Contractor shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. The Performing Contractor shall design, construct, and maintain, as a minimum, the erosion control BMPs specified in the E&SCP. Protective erosion control measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations that will disturb the natural protection.

5. The Performing Contractor shall construct or install temporary and permanent erosion and sediment control, as indicated on the drawings. BMPs may include, but not be limited to, vegetation cover, slope stabilization, silt fences, construction of terraces, interceptor channels, inlet and outfall protection, and diversion channels.

6. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and to maintain natural vegetation to the greatest extent possible. Any temporary measures shall be removed after the area has been stabilized.

7. It is not anticipated to encounter any PCB-contaminated soils during trenching as those shall be removed during Pre-Remedial Soil Excavation phase of work. In case if accidental or unforeseen encounter with PCB-contaminated soil the contractor shall follow the relevant procedures described in Pre-Remedial Soil Excavation Design specifications and drawings.

## 3.6 NOTIFICATION OF NON-COMPLIANCE

Failure of the Owner to notify the Performing Contractor of non-compliance does not relieve the Performing Contractor of responsibility of compliance with the aforementioned federal, state, or local laws or regulations. In the event the Owner issues such a notice, the Contractor shall immediately inform the Owner of the proposed corrective action(s) and take such action(s) as may be appropriate. If the Performing Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost because of any such stop orders shall be made the subject of a claim for extension of time, or for excess costs or damages by the Performing Contractor.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

This section describes the minimum requirements the Performing Contractor shall address and abide by with respect to traffic control.

1.2. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

PART 2. PRODUCTS

The Performing Contractor shall provide for traffic control as appropriate with flaggers, barricades, flashing lights, and warning signs, both on site and at other appropriate locations, to ensure safety.

PART 3. EXECUTION

The Performing Contractor shall be responsible for proper coordination of traffic control activities with applicable federal, state, and local regulations, including:

A. Acquisition of permits and the submission of temporary traffic control plans to perform work in the right-of-way if required.

B. Coordination of large construction vehicles entering and exiting the property shall take place on suitable roads.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This Section covers the requirements for performing the following work, as shown on the Technical Drawings and as specified:

A. Excavating, backfilling, and compacting of trench for underground utilities
B. Site grading
C. Restoration of surfaces
D. All other related and incidental work

All work within this section should adhere to the Maryland State Highway Administration (MD SHA) 2008 Standard Specifications for Construction and Materials, as updated, unless specified by the Construction Drawings, Technical Specifications, or geotechnical report, or as directed in the field.

If earthwork measurement and payment items are not specified by LMC, the Performing Contractor shall use MD SHA's 2008 Standard Specifications for Construction and Materials, as updated, as a basis for measurement and payment of earthwork.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 017300 | Environmental Requirements |
| 02600 | Off-Site Waste Disposal |
| 02900 | Seeding, Soil Supplements, and Mulching |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

American Association of State and Highway Transportation Officials

| | |
|---|---|
| AASHTO T 27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 89 | Determining the Liquid Limit of Soils |
| AASHTO T 90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T 180 | Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 422 | Particle-Size Analysis of Soils |
| ASTM D 1556 | Density and Unit Weight of Soil in Place by the Sand Cone Method |
| ASTM D 1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort |
| ASTM D 2922 | Density of Soil and Soil Aggregate in Place by Nuclear Methods |
| ASTM D 4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

Code of Federal Regulations (CFR)

29 CFR 1926.360, .651, .652, and .653

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

1.4. SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittals”:

A. Product Data: Name of fill material sources and suppliers.

B. Laboratory Data: Maximum dry density test results (according to ASTM D 1557 or AASTHO T 180) as outlined in paragraph 3.7.A for material used as bedding, embedment, fill, or backfill material.

C. Field density test results (according to ASTM D 1556 or ASTM D 2922) as outlined in paragraph 3.7.B for material used as bedding, embedment, fill, or backfill material.

1.5. DEFINITIONS

A. Select Fill - Sand, gravel and similar material free of clay, loam, organic material and debris containing stones, pebbles or lumps less than two inches in greatest dimension.

B. Unstable material - Debris, topsoil, peat and materials containing peat; and, all wet, soft or loose material that will not remain in position when cut for excavation, or that does not provide sufficient bearing capacity to satisfactorily support structures.

C. Unsuitable material - Excavated material that does not meet Specification requirements for backfilling, to include unstable material.

D. Common Fill - Consists of select fill as defined above or imported sand or other granular material as approved by the Owner.

E. Bedding - Granular material consisting of sand, crushed rock or pea gravel for surrounding pipes and culverts during trench installation.

1.6. PROPERTY PROTECTION AND SAFETY

A. Buildings, poles, roadways, walkways, landscape vegetation, and all other property shall be protected unless their removal is authorized.

B. The Performing Contractor shall contact underground utility locator service to locate and mark all utilities prior to commencing work. If any unknown utilities are encountered during excavation, the Contractor shall immediately notify the Owner. The Performing Contractor shall preserve intact any utilities encountered.

C. The Performing Contractor shall maintain safe passage for local traffic and provide all necessary barricades, warning lights, signs, signals, and flagmen where required.

D. All excavation work shall comply with 29 CFR 1926.650, 1926.651, 1926.652, and 1926.653.

## PART 2. PRODUCTS

### 2.1. MATERIALS

A. All fill material shall be free of contamination. The Performing Contractor shall provide the Owner with the names of all fill sources or suppliers. The Performing Contractor shall provide evidence, satisfactory to the Owner, documenting that the material is free of contamination. A letter provided by the borrow pit owner or operator certifying that the material is natural material not previously excavated from the borrow pit will be considered sufficient

B. The Owner may collect random samples of fill material to verify that it is uncontaminated.

C. Backfill material for trenching shall be sand bedding material for piping that meets the MD SHA Aggregate requirement for the type of piping that is used in the groundwater remediation system. All aggregate gradations shall be confirmed using ASTM C 136 or AASTHO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90.

D. Bedding material for piping and utilities shall meet the MD SHA Aggregate requirement as stipulated by the type of utility. All aggregate gradations shall be confirmed using ASTM C 136 or AASTHO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90.

E. Backfill material over bedding material for piping and utilities shall be select fill.

F. Warning tape shall be detectable by blue color for injection lines and for potable water lines and written “Water underneath” on it.

G. Warning tape shall be detectable by red color for electrical conduit lines and written “Electrical underneath” on it.

### 2.2. MATERIAL TESTING

Fill material beneath bedding material for piping and backfill material for trenches shall be tested by the in accordance with ASTM D 422 and ASTM D 1557.

## PART 3. EXECUTION

### 3.1. TRENCHING

A. Excavation of trenches shall be performed by any practicable method consistent with maintaining the integrity and protection of the work, workers, and the public.

B. Excavation shall proceed in a manner that minimizes the volume of surface water runoff from precipitation and groundwater infiltration that may collect in the excavation.

C. Excavating operations shall include the removal of all materials encountered within the required widths and depths of the trench, regardless of the nature of the materials, the condition of the materials at the time they are excavated, or the manner in which they are excavated. The Performing Contractor shall notify the LMC Representative before excavating any materials that cannot be removed with earthmoving equipment used at the site for trenching such as concrete and asphalt.

D. Trench for electrical conduit (approximately 1200 feet long) will be installed north-west of the Southwest TCE area (Block G). This trench is outside of the known impacted area of soil and/or groundwater contamination. Excavated soil will be placed along the trench and immediately used as a backfill.

E. Stockpiled material shall not obstruct roads, ditches, or drainage swales.

F. All trash, debris, and excess excavated material shall be disposed offsite in accordance with Section 02600, “Off-Site Waste Disposal”.

G. Unstable material in trenches shall be removed to the extent and depths as required, or as directed by the Owner. The excavation shall be filled to the proper grade with approved select fill. The fill shall be compacted according to the requirements of these Specifications.

H. The width of trenches shall be as indicated in Technical Drawings.

I. If suspected contaminated soil or materials are encountered the Performing Contractor shall cease operations and notify the Owner for further instructions.

J. It is not anticipated to encounter any PCB-contaminated soils during trenching as those shall be removed during Pre-Remedial Soil Excavation phase of work. In case if accidental or unforeseen encounter with PCB-contaminated soil the contractor shall follow the relevant procedures described in Pre-Remedial Soil Excavation Design specifications and drawings.

3.2. BACKFILLING AND COMPACTING - GENERAL

A. Unless otherwise directed, trenches shall be backfilled as soon as possible after pipes are laid; and the work is inspected and tested as required. Prior to backfilling, all rubbish, debris, forms and similar materials shall be removed from the excavation or trench. Backfilling shall not be done in freezing weather, with frozen materials, or when in-place materials are frozen.

B. Backfill shall be brought up to adjacent finished grade minus the depth of any required surface finishing (i.e., top soil, asphalt, or gravel). Any excavations improperly backfilled shall be reopened to the depth required for proper compaction, and shall then be refilled and properly compacted with the surface restored to required grade.

C. Each layer of backfill material shall be compacted to the density specified in this Section. Compaction densities shall be the percentage of the maximum dry density obtainable at optimum moisture content, as determined by ASTM D 1557 or AASTHO T 180. Field density tests shall be made in accordance with ASTM D 1556 or D 2922. The moisture content of each layer of backfill shall be controlled as required.

D. Failure of the compacted material to reach the required density is cause for rejection of the work in the affected area(s). Unless the Performing Contractor can rework and compact the material to the required density, the Performing Contractor shall remove the material in the areas affected. Subsequently, the Performing Contractor shall replace the rejected work with material that can be compacted to the required density. Field density tests and rejection of the non-compliant compacted material shall be repeated until test results are accepted by the Owner.

E. Place backfill material in lifts not exceeding 8 inches in thickness and compact to not less than 90% of maximum dry density according to ASTM D 1557 or AASHTO T 180.

3.3. FILLING, BACKFILLING, AND COMPACTING FOR PIPE TRENCHES

A. Bedding shall be installed on approved subgrades as detailed on the Technical Drawings. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings and bodies of conduits.

B. Place initial backfill material below the pipe and both sides of the pipe. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. The bedding materials shall not be more than 6 inches in layers to the height of pipe spring line.

C. Place backfill materials over the pipe in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Coordinate backfilling with utilities testing.

D. Compact each layer of backfill soil material at 90 percent under unpaved areas and at 95 percent under paved areas according to ASTM D 1557 or AASHTO T 180.

E. Warning tape shall be located below finished grade as shown on the Technical Drawings.

F. Place appropriate surface material according to the paved or unpaved finished grade as shown on the Technical Drawings.

3.4. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

3.5. RESTORATION OF SURFACES

A. Damaged or disturbed surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

B. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

C. The finished surfaces over trenches shall be left slightly mounded.

3.6. CONSTRUCTION TESTING

A. Laboratory testing

One laboratory maximum dry density test (ASTM D 1557 or AASTHO T 180) shall be performed for each material to be used as bedding or backfill material.

B. Field testing

Field density tests shall be performed according to ASTM D 1556 or ASTM D 2922.

1. For general filling and backfilling, one test shall be performed for every lift. At minimum, one test shall be performed per lift for each 250 linear feet of trench bedding and backfill material in trench excavation areas.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

This Section covers the requirements for performing the following work, as indicated in the Design Report, the Technical Drawings and as specified:

A. Installation of 71 injection wells, including wellhead boxes and concrete collars, in Southeast, Southwest, and North TCE areas as indicated on Technical Drawings.

B. Installation of 9 performance monitoring wells, including wellhead boxes and concrete collars, in Southeast, Southwest, and North TCE areas as indicated on Technical Drawings.

C. Well development.

D. Waste Disposal.

E. All other related and incidental work.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 017300 | Environmental Requirements |
| 02600 | Off-Site Waste Disposal |

## 1.3. REFERENCES

The following publications form a part of this specification for guidance to the extent referenced. These publications shall be the latest edition and are referred to in the text by their basic designation only.

1. American Society for Testing of Materials (ASTM)

2. American Water Works Association (AWWA)

3. American Petroleum Institute (API)

## 1.4. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”:

A. Supplier's information (wells screen, casing, filter sand).

B. Product data.

## 1.5. DEFINITIONS

A. "Annular-space: annulus" means the space between a casing and a riser or between the riser and the borehole.

B. "Aquifer" means a water-bearing formation.

C. "Borehole" means an open or cased subsurface hole created by drilling.

D. "Casing" means the pipe installed to maintain the integrity of the borehole. The term casing is used in this chapter only in reference to protective casing; the definition is included to distinguish the term from riser.

E. “Injection well” means any cased excavation or opening into the ground made by digging, boring, drilling, driving, jetting, or other methods for the purpose of distribution of an injected fluid into the aquifer.

F. "Monitoring well" means any cased excavation or opening into the ground made by digging, boring, drilling, driving, jetting, or other methods for the purpose of determining the physical, chemical, biological, or radiological properties of groundwater.

PART 2. PRODUCTS

2.1. WELL SCREEN AND CASING

A. Well screen and casing shall be: four inches in diameter for injection wells and two inches in diameter for monitoring wells; National Science Foundation-certified polyvinyl chloride (PVC) Schedule 80 pipe, flush-thread, screw joint (no glue or solvents); polytetrafluorethylene (PTFE, such as Teflon) tape or O-rings in the joints; no collar couplings.

B. Well screen and casing shall be cleaned and packaged at the place of manufacture; the packaging shall include a PVC wrapping on each section of casing to keep it from being contaminated prior to installation. The casing shall be free of ink, labels, or other markings.

C. The screen shall be compatible with the casing and should generally be of the same material. The screen shall not involve the use of any glues or solvents for construction.

D. Well screen size shall be 0.01 inch slot size.

E. Field-cut slots are not permitted for well screen. Filter cloth shall not be used.

2.3 FILTER PACK

A. The filter pack, shall consist of prepackaged, inert, clean silica sand or glass beads.

B. Open stockpile sources of sand or gravel are not permitted.

C. The filter pack usually has a 30% finer grain size that is about four to ten times larger than the 30% finer grain size of the water-bearing zone; the filter pack should have a uniformity coefficient less than 2.5.

2.4 ANNULAR SEAL, GROUT

A. The annular seal should be composed of coarse-grain sodium bentonite, coarse-grit sodium bentonite, or bentonite grout.

B. The cement/bentonite grout shall be placed on top of the annular seal and extend to 3 feet below grade.

C. The cement/bentonite grout shall consist of a commercial bentonite grout or a cement-bentonite mixture.

D. Drilling spoil, cuttings, or other native materials are not permitted for use.

E. Quick-setting cements are not permitted for use.

2.5 WELL BOX

A. Well boxes shall be sufficient size to allow for injection wells plumbing, conduit, and other equipment.

B. Injection well boxes shall be round, with cast iron body ring, galvanized steel skirt, and cast-iron cover.

C. Injection well boxes shall be 18 inches internal diameter by approximately 20 inches total height including skirt and body ring.

D. Monitoring well boxes shall be 12 inches in diameter by approximately 12 inches total height including skirt and body ring.

E. All well boxes shall be H-20 traffic rated.

F. All well boxes shall be water-resistant to prevent surface water contamination. The gaskets shall O-ring type, neoprene.

G. Covers shall be cast iron, with at least two recessed stainless steel bolts.

A. “DO NOT FILL” Graphic Warning Statement shall be permanently cast into cover with black equilateral triangle inset into a white background in accordance with API Recommended Practices 1615.

2.6 CONCRETE PAD

A. Each well box shall be encased with structural-type concrete pad to the top of the ground surface to form a pad at the surface.

B. This formed surface pad shall be at least six inches thick and not less than four (preferably six) feet square or five (preferably six) feet in diameter for injection wells and 4 feet square for monitoring wells.

C. The pad shall contain sufficient reinforcing steel to ensure its structural integrity in the event that soil support is lost.

D. The top of the pad shall slope away from the well bore to the edges to prevent ponding of water around the casing or collar.

## PART 3. EXECUTION

### 3.1. DRILLING

A. Wells must be drilled by Roto-Sonic methods by a Maryland-licensed driller who is qualified to drill and install monitoring wells.

B. The installation and development shall be supervised by a professional geoscientist or engineer who is familiar with the geology of the area.

C. Drilling techniques used for boring shall take into account the materials to be drilled, depth to groundwater, total depth of the hole, adequate soil sampling, and other such factors that affect the selection of the drilling method.

D. If any fluids are necessary in drilling or installation, then clean, treated city water shall be used; other fluids must be approved in writing by the Owner before use.

E. A log of the boring shall be made by or under the supervision of a geoscientist or engineer who is familiar with the geology of the area.

### 3.2. WELL SCREEN

A. The screen shall be compatible with the casing and should generally be of the same material. The screen shall not involve the use of any glues or solvents for construction.

B. Selection of the size of the screen opening should be done by a person experienced with such work and shall include consideration of the distribution of particle sizes both in the water-bearing zone and in the filter pack surrounding the screen. The screen opening shall not be larger than the smallest fraction of the filter pack.

### 3.3 FILTER PACK

A. The filter pack shall be placed between the screen and the well bore.

B. The filter pack shall extend one foot above the top of the screen.

C. The filter pack should be placed with a tremie pipe to ensure that the material completely surrounds the screen and casing without bridging.

### 3.4 ANNULAR SEAL, GROUTS

A. The annular seal shall be placed on top of the filter pack and shall be five feet thick.

B. The seal should be composed of coarse-grain sodium bentonite, coarse-grit sodium bentonite, or bentonite grout.

C. The cement/bentonite grout shall be placed on top of the annular seal and extend to 2 to 3 feet below grade.

D. The cement/bentonite grout shall consist of a commercial bentonite grout or a cement-bentonite mixture.

E. Drilling spoil, cuttings, or other native materials are not permitted for use.

3.5 CONCRETE PAD

A. Each well box shall be encased with structural-type concrete pad to the top of the ground surface to form a pad at the surface.

B. This formed surface pad shall be at least six inches thick and not less than four (preferably six) feet square or five (preferably six) feet in diameter.

C. The pad shall contain sufficient reinforcing steel to ensure its structural integrity in the event that soil support is lost.

D. The top of the pad shall slope away from the well bore to the edges to prevent ponding of water around the casing or collar.

3.6 WELL DEVELOPMENT

A. Following well installation, each injection and monitoring well shall be developed to remove fines from the well filter pack and casing and to ensure a hydraulic connection between the well and the geologic formation.

B. Well development shall be performed as soon as possible following installation, after at least 24 hours have elapsed following well construction (to allow the grout to set up).

C. Wells shall be developed by gentle surging and air lifting to remove fines and sediment from the sand pack and well screen. Development shall begin at the bottom of the well screen, work up incrementally to the top of the screened interval, and then back down to the bottom of the well.

D. Development shall be considered complete when the monitored water quality parameters stabilize in accordance with the information provided in the Design Report, or when a minimum of three saturated well casing volumes have been removed, or when the well is purged dry.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of aggregate for access roads, construction laydown area, and for the subgrade of roadways.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 02300 | Trenching, Backfill, and Compaction |
| 02451 | Hot Mix Bituminous Pavement |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

American Association of State and Highway Transportation Officials

| | |
|---|---|
| AASHTO T 27 | Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 89 | Determining the Liquid Limit of Soils |
| AASHTO T 90 | Determining the Plastic Limit and Plasticity Index of Soils |
| AASHTO T 180 | Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort |
| ASTM D 4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

B. References shall also include those listed within, such as Maryland Standard Method of Test (MSMT), AASHTO, and ASTM references within MD SHA specifications.

## 1.4. SUBMITTALS

Submit for following in accordance with Section 01300, “Submittals”.

A. List of materials to be used, including sources and suppliers

B. Test reports for aggregates and other materials

## 1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

1.6. Modification of References

B. Where term “Engineer” or “State” is used in MD SHA Standard Specifications, it shall be construed to mean “Owner”.

1.7. DELIVERY, STORAGE, AND HANDLING

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall be handled in a manner that ensures delivery in sound, undamaged condition.

## PART 2. PRODUCTS

2.1. FILL

Fill shall be select or common as defined in Section 02300, “Trenching, Backfill, and Compaction”, and soil or gravelly materials free of debris, peat, contamination, or excess moisture. Fill may be imported, excavated from the access road drainage ditches and excess excavation from site grading and construction.

2.2. BEDDING

Bedding material shall be granular material consisting of the appropriate aggregate for each utility as described in the MD SHA “Standard Specifications for Construction and Materials”. All aggregate gradations shall be confirmed using ASTM C 136 or AASHTO T 27; liquid limit, plastic limit, and plasticity index values shall be confirmed using ASTM D 4318 or AASHTO T 89 and AASHTO T 90

2.3. ROADWAYS OR WALKWAYS

Subgrade: Materials for subgrade and base course construction shall be in accordance with MD SHA’s “Standard Specifications for Construction and Materials”.

Surface Course: Adhere to Section 02451 “Hot Mix Bituminous Pavement” for asphalt roads.

## PART 3. EXECUTION

3.1. PREPARATION

Excavation and filling to establish elevation of subgrade is specified in Section 02300 “Trenching, Backfill, and Compaction”.

3.2. CONSTRUCTION

A. Subgrade: Place material in lifts not exceeding 8 inches in thickness and compact to no less than 95% of maximum dry density (ASTM D 1557 or AASHTO T 180). Compaction testing should be performed by Contractor as specified in Section 31 00 00 “Excavation, Backfill, and Compaction”, as well as proof roll testing for stability.

B. Surface Courses: Adhere to Section 32 12 17 “Hot Mix Bituminous Pavement” for asphalt roads. Surfacing shall be sloped to prevent adequate drainage.

3.3. 3.3. SITE GRADING

Areas to be graded shall be made reasonably smooth, compacted and free of irregular surface changes. Unless otherwise specified, the degree of finish shall be that ordinarily obtainable from motor grader operations.

3.4. RESTORATION OF SURFACES

A. Disturbed vegetated areas shall be re-vegetated in accordance with Section 02900, “Seeding, Soil Supplements, and Mulching”.

B. Damaged surfaces shall be restored to a condition that equals or exceeds the surface condition prior to construction.

C. Finished surfaces shall be thoroughly rolled and shall match adjacent surfaces as nearly as practicable.

3.5. MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted at the end of the project.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor for construction of asphalt surface courses of roadways.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 02450 | Aggregates and/or Graded-Crushed Aggregate for Roadways |

1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

American Association of State and Highway Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M 323 | Standard Specification for Superpave Volumetric Mix Design |

ASTM International (ASTM)

| | |
|---|---|
| ASTM C 136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 4867/D 4867M | Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures |

Asphalt Institute (AI)

| | |
|---|---|
| AI MS-02 | Mix Design Methods |

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications for Construction and Materials

Maryland Standard Method of Test (MSMT)

| | |
|---|---|
| MSMT 412 | Design Procedure for Hot Mix Asphalt Containing Recycled Asphalt Pavement |

B. References shall also include those listed within, such as MSMT and the AI references within the MD SHA specifications.

1.4. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”.

A. Product Data: List of materials and formula to be used, including sources, suppliers, and laboratory

B. Lab Data: Test report for mix formula and materials, including grain size chart

1.5. QUALITY ASSURANCE

A. Standards and Specifications

Provide testing, work, and materials in accordance with applicable requirements of MD SHA Standard Specifications. Paragraphs entitled “Quantity and Payment”, “Method of Measurement”, and “Basis of Payment” shall not apply unless otherwise directed.

B. Modification of References

Where term “Engineer” or “state” is used in MDSHA Standard Specifications, it shall be construed to mean Owner.

1.6. DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.7. ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the ambient air and surface temperatures are at least 40 degrees Fahrenheit (F) and rising. Place mixtures used as intermediate and base layers when the ambient air and surface temperatures are at least 32 degrees F and place polymer modified surface mixes when the ambient air and surface temperatures are at least 50 degrees F.

1.8. CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory within 12 months of commencing work.

PART 2. PRODUCTS

2.1. AGGREGATES AND MINERAL FILLER

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

A. Coarse Aggregates, Fine Aggregates, and Mineral Filler shall meet MD SHA grading requirements based on the selected mix design.

B. Aggregate physical property requirements shall meet the requirements provided by MD SHA.

2.2. ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to Viscosity Grade, Performance Grade, and Penetration Grade specified by MD SHA for the specified performance grade. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Owner. The supplier is defined as the last source of any modification to the binder.

2.3. MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a Superpave mix design has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. All mix designs must be field verified.

2.4. RECYCLED HOT MIX ASPHALT

Recycled hot mix asphalt (HMA) shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP allowable shall be determined in conformance with MSMT 412 and AASHTO M 323. Crushed glass may not be used in surface mixes.

PART 3. EXECUTION

3.1. PREPARATION

A. The job mix shall be delivered to the site per MD SHA Specifications. The material shall be delivered heated at a uniform temperature to avoid local overheating, and shall be free of moisture.

B. Surface Preparation of Underlying Course: Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter using cleaning methods as necessary. If the time period between the placements of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty, clean between lifts and apply a tack coat.

C. Spraying of Contact Surfaces: Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2. PLACEMENT

Machine spreading; shoveling, raking, and tamping; and hand-spreading (in lieu of machine-spreading) shall conform to MD SHA Standards and Specifications.

3.3. COMPACTION OF MIXTURE

A. Compact the mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot.

B. Before continuing rolling, correct variations by removing or adding materials as necessary.

C. Refer to MD SHA Specifications for additional instructions, ASTM and AASHTO requirements, and restrictions.

3.4. JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.5. FIELD QUALITY CONTROL

A. Contractor (or asphalt subcontractor) is responsible for sampling and approving the source/plant samples per MSMT and MD SHA Specifications. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

B. Contractor (or asphalt subcontractor) is responsible for field verification via coring method per MSMT and MD SHA Specifications. A MD SHA certified technician is required to perform QA/QC testing. Contractor (or asphalt subcontractor) is responsible for sampling and approving field mixture samples per MSMT and MD SHA Specifications.

3.6. PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

A. The Performing Contractor shall collect, containerize, and temporarily store on site all waste resulting from work at the Site that is not directly loaded for off-site transportation and disposal. This includes, but is not limited to:

1. Surplus excavated non-contaminated soil
2. Excavated contaminated soil
3. Well drilling cuttings
4. Well development water
5. Discarded health and safety personal protection equipment (PPE) as applicable
6. General construction debris, waste materials, and refuse
7. Contaminated water due to dewatering activities

B. The Contractor shall provide all labor, material, and equipment necessary to transport and dispose off-site all waste generated by work at the Site in accordance with the results of the waste characterization and with all applicable local, state, and federal regulations.

## 1.2 RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 01720 | Regulatory Requirements |
| 01400 | Quality Control |
| 023 00 | Trenching, Backfill, and Compaction |

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest edition and are referred in the text by the basic designation only.

Code of Federal Regulations (CFR)

| | |
|---|---|
| 29 CFR 1910.120 | Hazardous Waste Operations and Emergency Response |
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 40 CFR 260 | Hazardous Waste Management Systems: General |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Waste |
| 40 CFR 264 | Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 265 | Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions |
| 49 CFR 171 | General Information, Regulations, and Definitions |
| 49 CFR 172 | Hazardous Materials Table, Special Provisions, Hazardous |

| | |
|---|---|
| | Materials Communications, Emergency Response Information, Training Requirements, and Security Plans |
| 49 CFR 173 | Shippers—General Requirements for Shipments and Packagings |
| 49 CFR 174 | Carriage by Rail |
| 49 CFR 175 | Carriage by Aircraft |
| 49 CFR 176 | Carriage by Vessel |
| 49 CFR 177 | Carriage by Public Highway |
| 49 CFR 178 | Specifications for Packagings |
| 49 CFR 179 | Specifications for Tank Cars |
| 49 CFR 180 | Continuing Qualification and Maintenance of Packagings |

Federal Laws

| | |
|---|---|
| PL 94-850/98-616 | Resource Conservation Recovery Act (RCRA) of 1976 as amended 1984 |
| PL 91-596 | Occupational Safety and Health Act (OSHA) of 1970 |

U.S. Environmental Protection Agency (EPA) Publications

| | |
|---|---|
| SW-846 | Test Methods for Evaluating Solid Wastes Physical/Chemical Methods, July 1982 |

Maryland State Laws

Environment Article §§9-204, 9-252, and 9-314, Annotated Code of Maryland

Maryland State Regulations

| | |
|---|---|
| COMAR 11.07.01 | Transportation of Hazardous Waste; |
| COMAR 26.04.07 | Solid Waste Management; |
| COMAR 26.13 | Disposal of Controlled Hazardous Substances; |
| COMAR 26.14 | Hazardous Substances Response Plan |

1.4 SUBMITTALS

The Contractor shall submit the following to the Owner for approval in accordance with Section 01300, “Submittals”:

A. Name, qualifications, and State identification numbers of the proposed Subcontractor(s) for off-site waste transportation. For transportation of hazardous waste, a written certificate shall be provided that the off-site transportation firm is approved for the waste in accordance with 40 CFR 716 and 49 CFR 171 through 180. A copy of the EPA and State permits and a 24-hour point of contact shall be included.

B. Name, location, qualifications, and State identification number of the proposed off-site disposal facilities that are approved by the Owner. For disposal of hazardous waste, a written certificate shall be provided that the disposal facility is approved for the waste in accordance with 40 CFR 716. A copy of EPA and State permits and a 24-hour point of contact shall be included.

C. A Shipment Manifest for each shipment of hazardous waste to be transported to the off-site disposal facility in accordance with all applicable Federal, State, and local regulations. The Contractor shall submit the Shipment Manifests to the Owner's Site Representative

for signature prior to any shipment of waste leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests and return the signed original to the Contractor. The Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date at which it was received by the facility.

D. A Certificate of Disposal shall be submitted for each shipment of hazardous waste disposed by the off-site disposal facility. Certificates of Disposal shall include the following information:

1. The identity of the disposal facility by name, address, Owner and State Identification Number.

2. The identity of the waste shipment affected by the Certificate of Disposal including reference to the Shipment Manifest number.

3. A statement certifying the fact of disposal of the identified waste shipment, including the date(s) of disposal and the disposal method used.

E. A signed receipt or manifest from the off-site disposal facility for each shipment of non-hazardous waste. This receipt shall document the nature and weight of waste disposed and the date of disposal.

F. A Sampling and Analysis Plan, containing at minimum:

a. The field sampling approach, which will discuss how sampling locations and quantities will be determined;
b. The sampling methodology to be used, for both confirmatory and waste characterization samples;
c. The laboratory analysis to be performed on the samples, based on sample material and location;
d. The field quality assurance/quality control methods; and
e. Copies of forms to be used during the sampling and a sample data package.

## PART 2. PRODUCTS – NOT APPLICABLE

## PART 3. EXECUTION

### 3.1 WASTE CHARACTERIZATION

Waste characterization will be conducted in accordance with a Sampling and Analysis Plan. The characterization of the waste shall also conform to the requirements of the off-site disposal facility.

### 3.2 IDENTIFICATION OF OFF-SITE WASTE DISPOSAL FACILITY

A. Based on the results of the waste characterization, the Performing Contractor shall identify an appropriate method of disposal in accordance with all local, State, and Federal regulations. The method(s) of waste disposal shall be approved by the Owner.

B. The Performing Contractor shall identify one (or more) Owner approved off-site disposal

facility and submit the necessary information regarding each facility for Owner approval in accordance with Section 01 33 00, “Submittals”.

3.3 WASTE TRANSPORTATION

A. The Performing Contractor shall select one or more waste transportation firms and submit the necessary information regarding each firm for approval by Owner in accordance with Section 01300, “Submittals”.

B. Waste shall be transported to the Owner approved off-site disposal facility in accordance with all applicable local, State, and Federal regulations. In particular, off-site transportation of hazardous waste shall conform to all the applicable requirements of 40 CFR 263 and 49 CFR 171 through 49 CFR 180, and off-site transportation of waste that is characterized as soil with polychlorinated biphenyls (PCBs) concentrations greater than 50 milligrams per kilogram (mg/kg) shall conform to all the applicable requirements of 40 CFR 761.

C. A Shipment Manifest shall be prepared by the Performing Contractor for each shipment of hazardous waste and submitted to the Owner's Site Representative for signature prior to any shipment leaving the Site. Owner's Site Representative shall retain a copy of the Shipment Manifests and return the signed original to the Performing Contractor. The Performing Contractor shall also submit a copy of the Shipment Manifests signed by the off-site disposal facility. Shipment Manifests signed by the off-site disposal facility shall indicate the weight of the waste shipment and the date received by the facility.

3.4 WASTE DISPOSAL

A. Waste shall be disposed of at the Owner approved off-site disposal facility in accordance with all local, State, and Federal regulations. The Performing Contractor shall ensure that all wastes are accepted at the facility; that the facility is properly permitted to accept the stated wastes; and that the facility provides the stated services. Waste shall be disposed of by the method(s) identified by the Performing Contractor and approved by the Owner.

B. The Performing Contractor shall also ensure that non-hazardous waste disposals are at a facility which complies with state regulations concerning treatment, storage and disposal of non-hazardous solid waste and the facility complies with the local solid waste disposal plan.

C. Hazardous waste shall be disposed of in accordance with all applicable local, State, and Federal regulations including the relevant provisions of 40 CFR 264.

D. Waste that is characterized as soil with PCB concentrations greater than 50 mg/kg shall be disposed of in accordance with all applicable local, State, and Federal regulations including the relevant provisions of 40 CFR 761.

E. The Performing Contractor shall submit to the Owner's Site Representative a signed receipt from the off-site disposal facility for each shipment of non-hazardous waste in accordance with Section 01 33 00, “Submittals”.

F. The Performing Contractor shall submit to the Owner a Certificate of Disposal for each shipment of hazardous waste in accordance with Section 01300, “Submittals”.

END OF SECTION

# PART 1. GENERAL

## 1.1. REFERENCES

Furnish all labor, materials, equipment, and incidentals necessary to perform all seeding, and mulching as shown on the Technical Drawings and described in the Technical Specifications. This work shall include, but not be limited to final grading, tilling and cleaning the seed bed; seeding; fertilizing; mulching; specified watering; and maintaining the seeded area through the required mowings. The areas to be seeded and mulched include: areas cleared and grubbed, storage areas, backfill areas, and areas around proposed Block G swale location.

Note: Should the Contractor wish to sod rather than seed, the Contractor shall provide a sodding specification to the Owner for review and approval before sodding.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 01730 | Environmental Requirements |
| 02300 | Trenching, Backfill, and Compaction |

## 1.3. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 602 (2007) Agricultural Liming Materials

ASTM D 4427 (2007) Peat Samples by Laboratory Testing

ASTM D 4972 (2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

Maryland State Highway Administration (MD SHA)

2008 Standard Specifications of Construction and Materials

## 1.4. SUBMITTALS

The following shall be submitted in accordance with Section 01300 “Submittals”:

A. Product data for seed formula demonstrating testing, purity, and germination.

B. Laboratory testing of on-site or borrowed topsoil with soil amendment recommendations.

PART 2. PRODUCTS

2.1. MATERIALS

A. Seed shall meet the MD SHA requirements for testing, purity, and percent germination:

B. Fertilizer shall be a commercial fertilizer supplied in 50 lb. bag or bulk. Fertilizer supplied in bulk form shall be accompanied with a certification giving the analysis and weight.

C. All soil conditioners shall be horticultural grade.

D. Mulch shall be either small grain straw or for hydro mulching shall be commercially available wood cellulose fiber or wood pulp for use in spray applicators. Mulch shall be free of noxious weeds.

E. On-Site Topsoil: Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Topsoil Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 “Excavation, Backfill, and Compaction”.

F. Off-Site Topsoil: Conform to requirements specified in paragraph entitled "Topsoil Composition." Additional topsoil shall be furnished by the Contractor.

G. Erosion and Sediment (blanket, fabric, netting) shall conform to Section 33 40 00 “Storm Drainage Utilities”.

H. Topsoil is subject to the requirements of the MD SHA 2008 Specifications for Construction and Materials. Topsoil shall be stockpiled separately from common fill. All topsoil shall meet the following additional requirements:

1. Contractor to provide required representative samples to an independent testing agency for analysis and recommended treatment, including payment of all costs incurred for testing and analysis.

2. Test reports shall include specific recommendations regarding exact types, time and rates of application of soil additives and fertilizers based upon soil test results and type of material to be planted. Include the following in topsoil analysis:

   a. pH factor
   b. Percent organic matter
   c. Soluble salts
   d. Available nutrients
   e. Percent clay, sand and silt particles

3. Before delivery of imported topsoil, furnish the Owner’s representative with a written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owner(s), analysis of topsoil, depth to be stripped, previously used herbicides, and crops grown during past 2 years.

4. All topsoil shall be screened, natural, fertile agricultural soil capable of sustaining vigorous plant growth, not in frozen or muddy condition. Imported topsoil shall be typical of locality and shall come from a well-drained site free of flooding, not from bogs or marshes. Topsoil is to be free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and

foreign matter. Visually or mechanically screen material prior to re-spreading operation.

5. Topsoil: pH range of 6.0 to 7.5, a minimum of 1.5 percent organic material content; free of stones 3/4 inch or larger in any dimension and meeting the following requirements.

   a. Sand Content: 2.000 mm to 0.05 mm, greater than 60%
   b. Silt Content: 0.05 mm to 0.005 mm, greater than 30% silt plus clay
   c. Clay Content: 0.005 mm and smaller, less than 40%.

6. Screening: No more than 60% of material passing #100 mesh consists of clay as determined by Bouyoucous hydrometer or by decantation method. Mechanically screen topsoil to conform to following gradations:

| | SIEVE DESIGNATIONS | % PASSING |
|---|---|---|
| a. | 3/4" | 100% |
| b. | 1/4" | 97-100% |
| c. | #200 | 20-65% |

These limits may be modified as recommended by the nursery or testing laboratory.

## PART 3. EXECUTION

### 3.1 SEEDING AND MULCHING

A. Seeding

1. Perform seeding as indicated in the Construction Drawings. See the Construction Drawings for acceptable seed mixtures, seeding seasons, application scenarios, application rates, and application methods.

2. Apply seed uniformly with a cyclone seeder, drill, cultipacker seeder or hydroseeder (slurry includes seed and fertilizer) on a firm, moist seedbed. Maximum seeding depth should be ¼ inch on clayey soils and ½ inch on sandy soils, when using other than hydroseeder method of application.

3. Apply seed within twenty four hours after seed bed preparation. Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

4. Seeding must be accomplished in a time frame that allows seed germination prior to October 15.

B. The contractor shall fine grade and remove all sticks, stones, debris, clay lumps, sod clods, and other undesirable materials in the top three inches of soil. The top three inches of soil shall be loosened by raking, discing, or other acceptable means before seeding. Protect finished topsoil areas from damage by vehicular or pedestrian traffic. The Owner shall approve the seed bed prior to seeding.

C. Soil Amendments: Soil amendments shall adhere to the recommendations of the testing lab or nursery. A typical mix for seeding is as follows: apply 800 lbs/1000 sq. yds. of pulverized agricultural limestone, 192 lbs/1000 square yards of 10-20-20 commercial analysis fertilizer and 50 lbs/1000 square yards of 38-0-0 urea form fertilizer.

D. Mulching:

1. Straw shall be un-rotted small grain straw applied at 125-140 lbs/1000 square feet. Mulch materials shall be relatively free of all kinds of weeds. Spread uniformly by hand or mechanically for uniform distribution of hand spread mulch, divide area into approximately 1,000 square yards section and place 125-140 pounds of mulch in each section.

2. Wood cellulose mulch shall be applied via hydro-mulching at a rate of 1,250 pounds per acre.

E. Watering: Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

F. Restoration: Restore to original condition existing turf areas which have been damaged during construction operations at the Contractor's expense.

G. Seeded lawn areas shall be maintained by the Contractor and shall be guaranteed for a period of one (1) year. Maintenance may include aeration, mowing, dethatching, or overseeding, In the event previously seeded areas fail to establish an adequate ground cover, the Contractor shall redo this work to the satisfaction of the Owner.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install insulation for modified shipping containers to be used as equipment enclosures for groundwater remediation system.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 13120 | Shipping Containers |
| 13121 | Shipping Containers Modifications |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

1. ASTM International (ASTM): C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

## 1.4. DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry at all times. Protect against weather, condensation, and damage.

# PART 2. PRODUCTS

## 2.1. BATT INSULATION AND FASTENERS

A. Fiberglass or Mineral Wool Batts: ASTM C665, Type **ID,** Class B, with 0.5 perm rating, reflective aluminum foil vapor retarder membrane laminated to one side with R-13 value (2 inches thickness) and as indicated on Technical Drawings.

1. Manufacturers:

a. CertainTeed Corp.

b. Owens-Coming Fiberglas Corp.

c. Johns Manville.

B. Fasteners: As recommended by insulation manufacturer.

C. Tape: As recommended by insulation manufacturer.

PART 3. EXECUTION

3.1. BATT INSULATION

A. Install in accordance with manufacturer's instructions and as specified below:

1. Install batt insulation in widths required by framing spacing with vapor retarder facing warm side.

2. Fit tightly to ensure continuous seal. Tape overlapping flanges of vapor retarder when necessary, using tape as recommended by insulation manufacturer.

3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.

4. Protect installed insulation from tears and other damage until covered with finish material.

5. Remove and replace damaged material.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

A. Furnish all material, equipment, supplies, and labor required to prepare surfaces and apply paints and coatings for modified shipping containers as specified within this Section, unless otherwise indicated on the Drawings.

## 1.2. RELATED SECTIONS

13120 Shipping Containers

13121 Shipping Containers Modifications

## 1.3. REFERENCES

A. ASTM D 16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products.

B. SSPC-SP 1 - Solvent Cleaning.

C. SSPC-SP 2 - Hand Tool Cleaning.

D. SSPC-SP 3 - Power Tool Cleaning.

## 1.4. DEFINITIONS

A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.

B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

## 1.5 ENVIRONMENTAL REQUIREMENTS

A. Weather:

1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer’s instructions.

2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.

3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer’s instructions.

4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.

5. Wind: Do not spray coatings if wind velocity is above manufacturer’s limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants:

1. Schedule coating work to avoid excessive dust and airborne contaminants.

2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Tnemec Company Incorporated or approved equal.

B. Benjamin Moore or approved equal.

C. Sherwin Williams or approved equal.

2.2 COATING SYSTEMS FOR TANKS, PIPE, AND EQUIPMENT

A. Exterior Exposed:

1. System Type: Epoxy/urethane.
2. Surface Preparation: SSPC-SP 6.
3. Primer: Series 66 Hi-Build Epoxoline: DFT 3.0 to 5.0 mils.
4. Intermediate Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.
5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 5.0 mils.
6. Total DFT: 7.0 to 13.0 mils.
7. As selected by Owner from manufacturer's standard colors.

B. Immersion:

1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 10.
3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

C. Below Grade:

1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 10.
3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar: DFT 14.0 to 20.0 mils.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

D. Marginally Prepared Surfaces (Maintenance, Non-Immersion):

1. System Type: Epoxy.

2. Surface Preparation: In accordance with manufacturer's instructions.

3. Primer: Series 135 Chembuild: DFT 4.0 to 6.0 mils.

4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 4.0 to 6.0 mils.

5. Total DFT: 8.0 to 12.0 mils.

6. Finish Color: As selected by Owner from manufacturer's standard colors.

2.3 COATING SYSTEMS FOR INTERIOR WALLS, DOORS, AND FRAMES

A. Exterior Exposed:

1. System Type: Epoxy/urethane.

2. Surface Preparation: Clean and dry.

3. Primer: Factory primed.

4. Intermediate Coat: Series 27 Typoxy: DFT 2.0 to 3.0 mils.

5. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.

6. Total DFT: 4.0 to 6.0 mils.

7. Finish Color: as selected by Owner from manufacturer's standard colors.

2.4 COATING SYSTEMS FOR PVC

A. Exterior Exposed:

1. System Type: Epoxy/urethane.

2. Surface Preparation: Scarify.

3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.

4. Finish Coat: Series 73 Endura-Shield: DFT 2.0 to 3.0 mils.

5. Total DFT: 4.0 to 6.0 mils.

6. Finish Color: as selected by Owner from manufacturer's standard colors.

B. Interior Exposed:

1. System Type: Epoxy.

2. Surface Preparation: Scarify.

3. Primer: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.

4. Finish Coat: Series 66 Hi-Build Epoxoline: DFT 2.0 to 3.0 mils.

5. Total DFT: 4.0 to 6.0 mils.

6. Finish Color: as selected by Owner from manufacturer's standard colors.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

### 3.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage duringsurface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

### 3.3 SURFACE PREPARATION

A. Ensure surfaces are dry.

B. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter

C. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill, scale, rust, paint, oxides, corrosion products, and other foreign matter.

D. Interior or Immersion Surfaces, Severe Exposure: Remove visible oil, grease, dirt, dust, mill, scale, rust, paint, oxides, corrosion products, and other foreign matter.

E. Marginally Prepared Surfaces (Maintenance): Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with manufacturer’s instructions.

### 3.4 APPLICATION

A. Apply coatings in accordance with manufacturer's instructions.

B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer’s instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer’s instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

END OF SECTION

# PART 1. GENERAL

## 1.1. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

1. National Fire Protection Association (NFPA): No. 10, Standard for Portable Fire Extinguishers.

2. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.

## 1.2. SUBMITTALS

A. Action Submittals: Manufacturer's product data for each item including sizes, ratings, UL listings, or other certifications, and mounting information.

# PART 2. PRODUCTS

## 2.1. PORTABLE FIRE EXTINGUISHERS

A. General:

1. Conform to NFPA 10 for fire extinguishers.

2. Furnish fire extinguishers and cabinets from one manufacturer. Each equipment container shall be supplied with one (1) fire extinguisher.

3. All Extinguishers: UL listed, charged and ready for service.

B. Multipurpose Hand Extinguisher

1. Tri-class dry chemical extinguishing agent.

2. Pressurized, red enameled steel shell cylinder.

3. Activated by top squeeze handle.

4. Agent propelled through hose or opening at top of unit.

*5.* For use on A, B, and C class fires.

6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.

## 2.2 EYE-WASH STATION

A. General:

1. Wall-mounted, gravity-fed eye wash station shall be supplied for each equipment container.

2. Minimum volume shall be 5 gallons.

B. Manufacturers:

1. Honeywell, Bradley, Guardian, Haws or approved equal.

2.3 FIRST-AID CABINETS AND SUPPLIES

A. Manufacturers:

1. Afassco, Inc.

2. Johnson & Johnson.

3. Zee Medical Products Co., Inc.

B. Cases:

1. Enameled metal or break-resistant plastic.

2. Carrying handles.

3. Made to hang on wall.

C. Supplies: Quantities to serve 5 people.

2.3 ACCESSORIES

A. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Interior: Rust-resistant.

2. Exterior: Stainless steel.

B. Brackets: For all hand extinguishers furnish heavy-duty brackets with clip-together strap for wall mounting.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install where indicated or directed and following manufacturer's recommendations.

B. Plumb and level equipment.

C. Rigidly attach cabinets and brackets to structure.

D. provide adequate backing for mounting surfaces

3.2 PORTABLE FIRE EXTINGUISHERS, EYE WASH STATIONS, AND CABINETS

A. Provide at locations shown or as directed by Engineer.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

3.3 FIRST-AID CABINETS

A. Provide at locations shown or as directed by Engineer.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the chemical metering pumps, associated motors, controllers and related accessories.

B. The equipment shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 02300 | Trenching, Backfill, and Compaction |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |
| Division 16 | Electrical |

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on all chemical feed pumps.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the equipment.

2. Data on the characteristics and performance of the pumps

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

## 1.4 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 2.5 gph (maximum rating);

2. Discharge Pressure: 100 psig (maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

## 1.4 QUALITY ASSURANCE

A. The pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on all mechanical components of the pump.

B. Pumps shall be as similar as practical with respect to spare parts to minimize spare parts inventory.

C. All work under this specification shall be the responsibility of the Contractor.

D. Each pump shall include Operating and Maintenance manual

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. LMI Pumps, Inc. or approved equal

B. Pump model shall be the same for all applications: LMI Pumps, B92-1-498SI. Alternative model can only be used if approved by Engineer.

C. Spare parts for liquid end shall be provided (2 replacement kits).

2.2 CONSTRUCTION

A. Chemical metering pumps shall be positive displacement, Liquifram™ type pumps that are UL and CUL approved. Output volume shall be adjustable while pumps are in operation from zero to maximum capacity of 2.5 GPH (9.5 liters per hour).

B. The power supply shall be 115VAC, 60Hz, single phase.

C. Chemical metering pumps shall be capable, without a hydraulically backed diaphragm, of injecting solutions against pressures up 100 psig (6.9 bar)

D. Metering pumps shall have a clear liquid crystal display. Control shall be selectable between internal and external pulsing by means of a tactile keypad. Internal stroke frequency shall be adjustable from 1 stroke per hour to 100 strokes per minute. Pressure capacity shall be keypad adjustable to reduce noise, vibration and wear.

E. Metering pump shall be capable of dividing or multiplying pulse inputs from 1 to 999 or responding directly or inversely to a 4-20mA input signal.

F. The pump drive shall be totally enclosed with no exposed moving parts. Solid state electronic pulser shall be fully encapsulated and supplied with quick connect terminals at least 3/16" (4.75 mm) wide. Electronics shall be housed in chemical resistant enclosure at the rear of the pump for maximum protection against chemical spillage. Electrical power consumption shall not exceed 29 watts per hour under full speed and maximum pressure conditions. Pump weight shall not exceed 15 lbs (6.9 kg).

G. To eliminate need for pressure relief valve, the pump shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by not more than 35%.

H. Chemical metering pump housing shall be of chemically resistant PVC. Chemical metering pump check valves shall be ball type, with ceramic balls. Valve seat and seal ring shall be renewable by replacing the combination seat-seal ring or cartridge valve assembly. Pump head shall be of PVC material capable of resisting the pumped chemical. Fittings and connections at pump head shall be PVC.

2.1 CONTROL

A. Stroke length control shall be manually adjusted between 0% and 100% with a stroke adjustment knob on the pump face control. The LCD shall digitally display stroke length setting in 1% increments in the full range between 0% and 100%.

B. Stroke frequency control shall be manually adjusted by touch keypads, with the set stroke rate displayed on the LCD. The metering pump shall be capable of receiving a pulse input via optional external control cable such that 1 pulse gives 1 pump stroke rate. The pump shall be capable of remote ON-OFF operation through a control cable.

C. The pump shall accept an analog signal such that stroke frequency is proportional to 4-20mA.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

B. Contractor shall supply shielded signal wiring for wiring of the required remote input and output to the connectors.

3.2 FIELD QUALITY CONTROL

A. After the pumps have been completely installed, conduct such tests as are necessary to indicate that pump efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water and auxiliary equipment required to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.

C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the activated carbon adsorber vessels used for residual chlorine removal from potable water.

B. Equipment number for the vessel shall be assigned as "GAC-1"

C. The equipment shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

D. Process piping will be provided by others, as shown in the Drawings.

E. Supplier standard designs are desired.

F. It is hereby understood that the Supplier agrees to furnish any apparatus, appliances, or material not herein specifically mentioned or included, but which is necessary to complete and test every portion of the apparatus and equipment specified in a substantial manner and in compliance with the requirements written and implied in this request for quotation document without extra cost to the Owner.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |

## 1.3. REFERENCES

A. Design, materials, and workmanship of the vessel shall be in accordance with the requirements of all local, state, and federal regulations. The standards, codes, and regulations listed here contain information and requirements that apply to the work specified herein and are mandatory for this Project. Applicable standards, codes, and regulations may include, but are not limited to, the latest edition of the following:

1. American Society of Mechanical Engineers (ASME).

   a. B16.5, Pipe Flanges and Flanged Fittings NPS 112 through NFS 24

   b. RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment

   c. D3299, Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

   d. D4097, Specification for Contact-Molded Glass-Fiber-Reinforced

2. Boiler and Pressure Vessel Code, Section X: Fiberglass Reinforced Plastic Pressure Vessels.

3. National Fire Protection Association (NFPA) Code 30 Flammable and Combustible Liquids Code.

1.4. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on carbon adsorption vessel.

B. Product Data shall include at least the following:

1. Descriptive literature, catalog information, and specifications for the equipment provided.

2. Design Drawings of carbon vessel showing: dimensions of vessels and complete assembly, including actual dimensions and clearance requirements.

3. Net weight and operating weight of carbon adsorbers and complete system, including skid and supports.

4. Carbon weight and volume contained in each adsorber.

5. Specification sheet for GAC including type, Iodine number (minimum), ash percentage (maximum), mesh size, and other salient characteristics.

6. Certification of factory hydrostatic pressure test reports.

1.4 QUALITY ASSURANCE

A. The carbon vessels covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such equipment. The carbon vessels furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 WARRANTY

A. All equipment, coatings, valves, and controls are warranted for 12 months against defects in design, manufacture, workmanship, or materials. Any part proving defective shall be replaced or repaired within this period at the expense of the Supplier.

B. The supplied equipment shall not have any breakage, damage, defects, or deterioration (other than those due to the negligence of parties other than the Supplier or to the imposition on the equipment of extraordinary working conditions or to normal wear and tear) within the guarantee period referred to above. The Supplier shall make good promptly any defective equipment at Supplier's entire expense including the expense of all necessary labor, supervision, traveling, replacement parts and transportation.

C. The vessel design operating life is 10 years minimum.

D. The vessel is designed for indoor installation.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Siemens Water Technologies or approved equal

2.2 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 35 gpm (maximum rating); 1 gpm (average);

2. Influent Pressure: 150 psig (maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

4. Influent Source: potable water.

2.3 EQUIPMENT DESCRIPTION

A. Carbon adsorber vessels shall be constructed using fiberglass reinforced resin and polyethylene lining.

B. Internal fittings shall be polypropylene.

C. Carbon adsorbers shall have top inlet and bottom outlet connections. The connections shall be 3” female National Pipe.

D. Carbon adsorbers overall dimensions shall be 30” diameter by 89” overall height. Bottom outlet clearance shall be 10”.

E. Carbon adsorbers shall have a maximum pressure rating of 150 psig and a temperature limit of 140ºF.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings.

B. Pressure test the carbon adsorbers along with the connecting piping per Section 15950. There shall be no visible leaks in the carbon adsorbers, valves, or joints of the interconnecting piping.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This specification covers design, materials, installation, and testing of membrane contactor for dissolved oxygen removal from potable water.

B. In this application, the Membrane Contactor makes it possible to transfer dissolved oxygen from an aqueous stream without dispersion. The membrane contactors contain thousands of Celgard® microporous polypropylene hollow fibers knitted into an array that is wound around a distribution tube. The hollow fibers are arranged in a uniform open packing, allowing greater flow capacity and utilization of the total membrane surface area. Because the hollow fiber membrane is hydrophobic, the aqueous stream will not penetrate the pores.

C. The gas/liquid interface is immobilized at the pore by applying a higher pressure to the aqueous stream relative to the gas stream. TheMembrane Contactor provides a constant interfacial area for transfer over the entire operating range of flow rates.

A. Separation principle differs substantially from other membrane separations such as filtration and gas separation. With Membrane Contactors, there is no convective flow through the pores as occurs in other membrane separations. Instead, the membrane acts as an inert support that brings the liquid and gas phases in direct contact without dispersion. The mass transfer between the two phases is governed entirely by the pressure of the gas phase. Because of the Celgard hollow fibers and the contactor geometry, the surface area per unit volume is an order of magnitude higher than traditional technologies such as packed columns, forced draft deaerators and vacuum towers. This high level of surface area to volume leads to a dramatic reduction in contactor/system size for a given level of performance.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |
| Division 16 | Electrical |

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on membrane contactor.

B. Product Data shall include at least the following:

1. Descriptive literature, catalog information, and specifications for the equipment provided.

2. Design Drawings of membrane contactor including actual dimensions and clearance requirements.

3. Submit manufacturer's instruction manual covering membrane contactor operation and maintenance.

1.3 QUALITY ASSURANCE

A. The membrane contactors covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such equipment. The membrane contactors furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

PART 2. PRODUCTS

2.1. MANUFACTURERS

Manufacturer shall be Liqui-Cell of Membrana-Charlotte.

2.2 HOUSING

A. Fabricate the membrane contactor housing of polypropylene.

B. The contactor design shall use a radial liquid flowpath around a central baffle. Liquid shall flow on the outside (shellside) of the hollow fibers.

C. Connections shall be 3/4 inch female pipe thread on shellside (liquid inlet/outlet) and 3/4 inch female pipe thread on lumenside (gas/vacuum).

D. Housing shall be equipped with side-clamps on both sides of the housing for cleaning.

E. Design housing to meet the hydraulic conditions listed in the section on "Service Conditions."

F. Membrane contactor shall be extra-flow type with membrane surface area of approximately 215 square feet.

G. Membrane potting material shall be polyethylene.

2.3 HOLLOW MEMBRANE

A. Membrane type shall be X-40 as more suitable for oxygen transfer.

B. Fiber material shall microporous polypropylene.

C. Fiber nominal outside diameter (OD) shall be 300 microns.

D. Fiber nominal inside diameter (ID) shall be 200 microns.

E. Fiber porosity shall be 25%.

F. Fiber pore sieze shall be 0.03 microns

G. Some of the appropriate materials include polyester, polypropylene, nylon.

2.4 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 30 gpm (maximum rating); 1 gpm (average);

2. Influent Pressure: 105 psig at 86 deg F(maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

4. Influent Source: potable water pre-treated with granular activated carbon.

PART 3. EXECUTION

3.1 INSTALLATION

A. Attach membrane contactor to wall using piping supports as shown on Design Drawings.

B. Provide reducers as necessary.

C. Vacuum connections between the membrane contactor and vacuum pump shall be copper tubing with brass compression fittings.

D. Do not operate the membrane contactor until all process piping has been thoroughly cleaned and connecting pipelines have been thoroughly flushed.

E. Do not operate the membrane contactor until the upstream filter bag is tested and its operational performance is confirmed.

3.2 FIELD TEST

A. Operate the membrane contactors under design conditions for 2 hours. Correct any deviations from normal operation such as excessive vibration, noise or other abnormal operation. Verify that the pressure and flow rate are within 5% of the values shown on the certified rating.

B. Pressure test the membrane contactors along with the connecting piping per Section 15950. There shall be no visible leaks in the membrane contactors, valves, or joints of the interconnecting piping.

END OF SECTION

PART 1. GENERAL

1.1. DESCRIPTION

A. This specification covers upright, cylindrical, flat and/or cone bottom tanks molded in one-piece seamless construction by rotational molding. The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship, and appearance.

B. One tank shall be provided for each of the equipment containers.

C. This specification does not cover the design of vessels intended for use at pressures above or below atmospheric conditions. It is also not for vessels intended for use with liquids heated above their flash points, temperatures above 140 degrees Fahrenheit for Type I materials, or temperatures above 130 degrees Fahrenheit for Type II materials (see section 4.1 for material classifications).

1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 02300 | Trenching, Backfill, and Compaction |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |

1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on carbon adsorption vessel.

B. Product Data shall include at least the following:

1. Descriptive literature, catalog information, and specifications for the equipment provided.

2. Design Drawings of storage tank showing: dimensions of tank and complete assembly, including actual dimensions and clearance requirements.

1.3 REFERENCES

A. ASTM (American Society for Testing and Materials) Standards:

D618 Conditioning Plastics and Electrical Insulating Materials for Testing
D638 Tensile Properties of Plastics
D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D883 Definitions of Terms Relating to Plastics
D1505 Density of Plastics by the Density-Gradient Technique
D1525 Test Method for Vicat Softening Temperature of Plastics
D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
D1998 Standard Specification for Polyethylene Upright Storage Tanks
D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as

Determined by Solvent Extraction
D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
D3892 Practice for Packaging/Packing of Plastics
F412 Definitions of Terms Relating to Plastic Piping Systems

B. ARM (Association of Rotational Molders) Standards:

Low Temperature Impact Resistance (Falling Dart Test Procedure)

C. ANSI Standards:

B-16.5 Pipe Flanges and Flanged Fittings

D. OSHA Standards:

29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

E. UBC CODE:

Uniform Building Code 1997 Edition

1.4 CHEMICAL COMPATIBILITY

A. Chemical compatibility shall be according to the following chemical resistance guides:

Pruett, Kenneth M., "Chemical Resistance Guide for Elastomers", Compass Publications.
Pruett, Kenneth M., "Compass Corrosion Guide II", Compass Publications.

B. These references shall be considered as general guidelines only. In many cases, combinations of these chemicals are used in such a way that only the customer (by testing molded product samples) can make a determination in regards to acceptability.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Poly processing Company, Snyder-Crown Industries, Inc., or approved equal

2.2 SERVICE CONDITIONS

A. Operating Parameters:

1. Volume: 350 gallons;
2. Liquid stored: 6% maximum sodium bicarbonate solution;
3. Stored solution specific gravity: <1.05
4. Temperature Range: 33 degrees F to 85 degrees F.

2.3 MATERIALS

A. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Tanks shall be made from crosslinked polyethylene resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.

B. All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer. Pigments may be added at the purchaser's request, but shall not exceed 0.25% (dry blended) of the total weight.

C. Mechanical Properties of tank material:

| PROPERTY | ASTM | VALUE |
|---|---|---|
| Density (Resin) | D1505 | 0.938-0.946 g/cc |
| Tensile (Yield Stress 2"/min) | D638 | 3000 PSI |
| Elongation at Break (2"/min.) | D638 | >300% |
| ESCR (100% Igepal, Cond. A, F50) | D1693 | >1000 hours |
| ESCR (10% Igepal, Cond. A, F50) | D1693 | >1000 hours |
| Vicat Softening Degrees F. Temperature | D1525 | 250 |
| Flexural Modulus | D790 | 100,000 PSI |

PART 3. EXECUTION

3.1 DESIGN REQUIREMENTS

A. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick.

$$T = P \times O.D./2\,SD = 0.433 \times S.G. \times H \times O.D./2\,SD$$

T = wall thickness
SD = hydrostatic design stress, PSI
P = pressure (.433 x S.G. x H), PSI
H = fluid head, ft.
S.G. = specific gravity, g/cm^3
O.D. = outside diameter, in.

B. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees Fahrenheit for Type I and Type II materials. In accordance with the formula in 6.1, the tank shall have a stratiform (tapered wall thickness) wall.

C. The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.

D. The standard design specific gravity shall be 1.5 or 1.9.

E. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. Flat areas shall be provided to allow locating large fittings on the cylinder straight shell.

F. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2000 or more gallons of capacity shall be designed to provide a minimum of 1300 square inches of flat area for fitting locations.

G The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head.

3.2 DIMENSIONS AND TOLERANCES

A. All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

B. The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

C. The tolerance for fitting placements shall be +/- 0.5 in. in elevation and 2 degrees radial at ambient temperature.

3.2 TANK FITTINGS

A. Fittings - Threaded Bulkhead. Threaded bulkhead fittings can be used for below-liquid installation. Fittings must be placed away from tank knuckle radius and flange lines. The maximum allowable size for bulkhead fittings placed on a curved sidewall section of tanks 48 in. to 142 in. in diameter is 2 inch size. Tank wall thickness must be considered for bulkhead fitting placement. The maximum wall thickness for each fitting size is shown below.

| **Fitting Size** | **Maximum Wall Thickness** |
|---|---|
| 1/2 in. | 0.750 in. |
| 3/4 in. | 0.875 in. |
| 1 in. | 0.875 in. |
| 1 1/4 in. | 0.875 in. |
| 1 1/2 in. | 0.875 in. |

B. The bulkhead fittings shall be constructed of PVC, PP, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton®, or other specified material.

END OF SECTION

PART 1. GENERAL

1.1. DESCRIPTION

A. This specification covers design, materials, installation, and testing of the bag filter housing, filter bags, and appurtenances.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |

1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on carbon adsorption vessel.

B. Product Data shall include at least the following:

1. Descriptive literature, catalog information, and specifications for the equipment provided.

2. Design Drawings of bag filter housing including actual dimensions and clearance requirements.

3. Submit manufacturer's instruction manual covering cartridge changing and housing

PART 2. MATERIALS

2.1. MANUFACTURERS

Manufacturers shall be Eaton, Rosedale, Filtra Systems or approved equal.

2.2 HOUSING

A. Fabricate the filter cartridge housing, support legs and eyebolts for cover closure of Type 304 stainless steel. After fabrication, the vessel shall be glass bead blast finished

B. Cover closure shall use swing bolts with eye nuts or other appropriate closure for service conditions. Inlet and outlet shall be 1 inch female pipe thread.

C. Housing shall be of height (length) sufficient to contain the filter bags as specified in the "Service Conditions."

D. Housing shall have one bottom threaded drain connection and two threaded connections for pressure gauge attachment.

E. Design housing to meet the hydraulic conditions listed in the section on "Service Conditions."

2.3 FILTER BAGS

A. Bags with 5 micron rating shall be used.

B. Bags shall be #4 size (4 inch diameter by 14 inches length).

C. Filter bags with metal ring fabricated from Type 304 stainless steel shall be used.

D. Materials appropriate for “Service Conditions” shall be used.

E. Some of the appropriate materials include polyester, polypropylene, nylon.

2.4 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 100 gpm (maximum rating); 1 gpm (average);

2. Influent Pressure: 150 psig (maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

4. Influent Source: potable water.

PART 3. EXECUTION

3.1 INSTALLATION

A. Set filter in place, plumb, level, and securely anchored. Provide reducers as necessary.

B. Do not install filter bags until housing has been thoroughly cleaned and connecting pipelines have been thoroughly flushed.

C. Flush the filter bags a minimum of three times before placing the units in service.

3.2 FIELD TEST

A. Operate the filters under design conditions for 2 hours. Correct any deviations from normal operation such as excessive vibration, noise or other abnormal operation. Verify that the pressure and flow rate are within 5% of the values shown on the certified rating.

B. Pressure test the filters along with the connecting piping per Section 15950. There shall be no visible leaks in the filters, valves, or joints of the interconnecting piping.

END OF SECTION

PART 1. GENERAL

1.1. DESCRIPTION

A. This section of the specification describes the vacuum pump, associated motors, controllers and related accessories.

B. The equipment shall be installed as indicated on the Design Drawings, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |
| Division 16 | Electrical |

Division 16: Electrical

1.3. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on all vacuum pumps.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the equipment.

2. Data on the characteristics and performance of the pumps

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

1.4 QUALITY ASSURANCE

A. The vacuum pumps covered by this Section are intended to be standard pumping equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on all mechanical components of the pump.

B. Pumps shall be as similar as practical with respect to spare parts to minimize spare parts inventory.

C. All work under this specification shall be the responsibility of the Contractor.

D. Each pump shall include Operating and Maintenance manual.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. GAST Manufacturing, Inc. or approved equal

2.2 CONSTRUCTION

A. Vacuum pumps shall be oilless Rocking Piston type in twin-cylinder configuration for high vacuum service with continuous service rating.

B. The power supply shall be 115VAC,60Hz, single phase.

C. The vacuum pump motor power rating shall be 1/3 of horse power (0.25 kilowatt) with 5.3 amps full current.

D. Vacuum pump free air flow shall be 3.5 cubic feet per minute and a maximum vacuum of 29 inches of mercury.

E. Vacuum pumps shall have aluminum die casting body with treatment for corrosion protection, rugged motor shell construction, rubber feet.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install the vacuum pumps in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

B. The pumps are to be installed on the vacuum side of dissolved oxygen conactors in each equipment container as indicated on Technical Drawings.

3.2 FIELD QUALITY CONTROL

A. After the vacuum pumps have been completely installed, conduct such tests as are necessary to indicate that pumps efficiency and discharge conform to the Specifications. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water and auxiliary equipment required to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified.

C. Any component parts which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the cold water multi-jet meters.

B. Meters furnished shall be new and complete units conforming in all details to AWWA Standard C708 for Cold Water Multi-Jet Type Meters and current amendments thereto, subject to the following supplementary requirements except where in conflict with these specifications.

C. These meters shall be installed at the potable water inlet and on each branch of the injection manifold as indicated on Technical Drawings.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on all water meters.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs.

2. Data on the characteristics and performance of the meters.

3. Manufacturer's test data.

## 1.4 QUALITY ASSURANCE

A. The water meters covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such water meters. The meters furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

## 2.4 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 13 gpm (maximum rating); 1 gpm (average);

2. Influent Pressure: 140 psig (maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

4. Influent Source: potable water.

1.5 MAINTENANCE

A. Meters shall be as similar as practical with respect to spare parts to minimize spare parts inventory.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each meter shall include Operating and Maintenance manual.

1.6 WARRANTY

A. Meters shall be guaranteed against defects in material and workmanship for a period of one (1) year from the date of installation. Meters shall meet or exceed AWWA Standards C708.

B. Visual read registers shall be warranted to remain functional and watertight for a minimum period of ten (10) years.

C. Bidder may submit additional information on third party testing that substantiates claims for meter durability beyond the formal warranty periods.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Dwyer Instruments, Badger Inc., Siemens Inc., or approved equal

2.2 CONSTRUCTION

2.2.1 Registers

A. Register shall be magnetically driven, permanently rolled sealed type and mechanically disconnected from the measuring components. (The term “sealed” shall mean moisture and dust-proof.) All gearing shall be enclosed in the sealed register unit.

B. Register shall be standard straight reading (Odometer Type).

C. All same size meters furnished under this and future contracts shall have identical change registers.

D. All registers of like-size meters shall be interchangeable with each other without loss of accuracy.

E. Registers shall be furnished with either internal or external tamper-proof protection locking devices.

F. Register lid may be manufactured of brass or high density plastic.

2.2.2 Housing

A. Meter housings including the register box shall be made of a copper alloy containing not less than 85% copper and be Certified by NSF to NSF/ANSI Standard 61.

B. Housing connection shall be spuds having external straight threads conforming to ANSI 82.1. Meters shall be shipped with plastic end caps over meter threads.

C. The manufacturer's meter/serial number shall be stamped on the outer main case. The first two numbers in the serial number shall identify the year the meter was manufactured. The remaining numbers shall identify the unique number for a particular meter. No meter shall have the same number as another meter manufactured by the same manufacturer.

2.2.3 Measuring Chambers

A. Measuring chambers shall be separate units of copper alloy, containing not less than 85% copper but no lead, or shall be separate units of approved suitable synthetic polymer material, inert in potable water.

B. Meters shall have a strainer with an effective straining area of at least double that of the main housing inlet.

C. Meters shall be manufactured with sufficient quality control as to permit successful interchangeability of registers and measuring chambers without loss of accuracy.

D. The multi-jet element and measuring chamber shall be of the dry-register type with water flow directed across the multi-vaned rotor proportional to the quantity of water passing through the chamber.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install the water meters in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

B. Install the water meters in a horizontal orientation with the face clearly visible.

C. Pressure test the water meters along with the connecting piping per Section 15950. There shall be no visible leaks in the water meters, valves, or joints of the interconnecting piping.

END OF SECTION

PART 1. GENERAL

1.1. DESCRIPTION

A. This section of the specification describes the insertion-style paddlewheel type flow sensors, transmitters, and associated fittings.

1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |
| 15210 | Process Valves and Instrumentation |
| Division 16 | Electrical |

1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on all electronic flow meters.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs.

2. Data on the characteristics and performance of the electronic flow meters.

3. Manufacturer's test data.

1.4 SERVICE CONDITIONS

A. Operating Parameters:

1. Flow Rate: 20 gpm (maximum rating); 1 gpm (average);

2. Influent Pressure: 150 psig (maximum rating); 5 psig (average);

3. Temperature Range: 33 degrees F to 85 degrees F.

4. Influent Source: potable water.

1.5 QUALITY ASSURANCE

A. The water meters covered by this Section are intended to be standard equipment, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such electronic flow meters. The electronic flow meters furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant

equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.6 MAINTENANCE

A. Electronic flow meters shall be as similar as practical with respect to spare parts to minimize spare parts inventory.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each meter shall include Operating and Maintenance manual.

1.7 WARRANTY

A. Electronic flow meters shall be guaranteed against defects in material and workmanship for a period of one (1) year from the date of installation.

B. Electronic flow meters shall be manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management Meters shall meet or exceed AWWA Standards C708.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Georg Fisher Signet LLC or approved equal

2.2 CONSTRUCTION

2.2.1 Sensors

A. Sensor shall be capable of sensing flow in either direction (bi-directional).

B. The paddlewheel insertion flow sensor shall generate an electrical signal proportional flow velocity from a range of 0.3-20 feet per second.

C. The sensor shall be inserted at the correct depth and there shall be a fully developed flow profile. Linearity of the output signal shall be ±1% of full range, with a repeatability of ±0.5% of full range.

D. The sensor shall not create a pressure drop of >1 psi at any flow rate.

E. Two optional sensor lengths shall allow the flow sensor to install into a flow installation fitting. Optional sensor lengths will allow insertion in pipes from 0.5 to 8 inches.

F. The sensor body materials shall be glass-filled polypropylene (black) or, PVDF (natural).

G. The electrometric seals shall be FPM-Viton® (standard) with optional EPDM or FFPM-Kalrez®.

H. Rotor pins shall be Titanium (standard for PP), Hastelloy-C or PVDF (standard for PVDF), with optional ceramic, Tantalum, or stainless steel.

I. Rotor material shall be black PVDF (standard for PP) or natural PVDF (standard for PVDF) with optional Tefzel® with or without Fluoraloy G ® sleeve.

J. Sensor shall have integral mount electronics capable of 4-20 mA or, Digital (S3L) or, flow switch, or pump pulser output.

K. The flow sensor shall be a Georg Fischer Signet model 2536 or equal.

2.2.2 Mounting Fittings

A. Installation fitting specifically designed for the flow sensor shall be used

B. Installation fitting shall be tee-type manufactured from PVC SCH 80.

C. The installation fittings size shall be ½ inches nominal pipe size.

D. The installation fittings shall have threaded union ends with solvent cement socket connections.

2.2.3 Transmitters

A. Transmitters shall be able to convert the signal from frequency and digital (S3L) flow sensors into a 4 to 20 mA signal for long distance transmission.

B. Transmitters shall be compatible with Signet flow sensors with frequency outputs.

C Transmitters shall have one input, 2 or 4 wire, 4 to 20 mA and open collector for Hi, Lo, Pulse, and Frequency configuration.

D. Transmitters power supply shall be 12 to 24 VDC, regulated.

E. Transmitters shall have alphanumeric LCD display with sealed 4-key silicon rubber.

F. Transmitters enclosure shall be NEMA 4X/IP65 classification.

G. Transmitter enclosure shall be manufactured of PBT resin and be capable of a field mount.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install the electronic flow meters in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

B. Install the electronic flow meters in a horizontal orientation.

C. Pressure test the electronic flow meters along with the connecting piping per Section 15950. There shall be no visible leaks in the electronic flow meters, valves, or joints of the interconnecting piping.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install backflow preventers for groundwater remediation system potable water service connections.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 13120 | Shipping Containers |
| 15200 | Process Piping |

## 1.3. SUBMITTALS

A. Submit the following in accordance with Section 01300, “Submittals”.

B. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following:

C. Submit manufacturer's certificate of compliance with AWWA C510 for backflow preventers. Submit manufacturer's certificate of compliance with NSF 61.

D. Submit manufacturer's catalog data and descriptive literature. Submit dimensional drawings. Call out materials of construction by ASTM reference and grade.

E. Submit manufacturer’s catalog information and installation instructions.

# PART 2. PRODUCTS

## 2.1. BACKFLOW PREVENTERS

A. Backflow preventers shall be of the double-check valve reduced pressure type, complying with AWWA C510. Provide two independently operating check valves, two shutoff valves, and test cocks so that a test of each check valve can be made.

B. Backflow preventers shall have bronze cast body and bronze (ASTM B61 or B62) check valves. Check valves shall be of the poppet type and have replaceable seats.

C. Shutoff valves shall be ball valves.

D. Backflow preventer assembly shall include a strainer.

E. Backflow preventers shall meet the following standards: ASSE 1015, AWWA C510, IAPMO PS31, CSA B64.5

F. Backflow preventers shall meet the following approvals: ASSE, AWWA, IAPMO, CSA, UPS.

G. Maximum pressure rating: 175 psig

H. Temperature range: 33ºF – 180ºF.

I. Backflow preventer assembly shall be Watts model 007-QT-S or approved equal, size ½”.

## PART 3. EXECUTION

### 3.1. GENERAL INSTALLATION

A. Install the equipment as indicated on Technical Drawings and in this specification.

B. Install in accordance with manufacturer's instructions, unless otherwise shown or specified.

C. Use Teflon tape with all threaded connections to achieve leak-proof joints.

### 3.2 PRESSURE TESTING

A. Perform pressure testing along with the connecting piping in accordance with Section 15950.

### 3.3 PIPE HANGERS

A. Provide pipe hangers and supports as detailed in the drawings.

B. Install backflow preventers without springing, forcing, or stressing the assembly or any adjacent connecting valves or equipment.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

A. These specifications are for a typical 40’x8’x9’6” ISO type steel dry cargo container “High Cube”.

B. Shipping containers shall be used as remediation equipment enclosures for this project.

C. Containers shall be modified as described in Design Basis Report and on technical Drawings.

D. Some of the modifications and additions include elements such as wall and ceiling insulation, plywood internal walls, personnel entrance door, secondary containment system, HVAC and lighting.

E. This specification describes un-modified shipping containers. Refer to Design Basis Report (Appendix F) for detailed technical specifications of the standard containers to be used.

F. Shipping containers shall have the following external dimensions: length: 40 feet; width: 8 feet; height: 9.5 feet.

1.2. RELATED SECTIONS

01300 Submittals

1.3. REFERENCES

1. International Maritime Organization (IMO)

2. International Convention for Safe Containers (CSC) 1972-2007 and in ccordance with CSC Article IV(2)

3. U.S. Steel technical data sheet, 2002

4. Universal Building Code

5. Cronos Leasing Company

6. China International Maritime Containers (Group) CIMC

1.4. DELIVERY, STORAGE, AND HANDLING

A. Protect from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Lift, full or empty, at the top corner fittings vertically by means of spreaders fitted with hooks, shackles or twistlocks

C. Lift, full or empty, at the bottom corner fittings using slings with appropriate terminal fittings at slings angle of thirty ( 30° ) degrees to horizontal.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Reputable manufacturers must be in container manufacturing business for at least 5 years. Only containers built to standards described in this specification are acceptable.

2.2. DIMENSIONS AND RATINGS

A. OVERALL DIMENSIONS

| | External Dimensions | Internal Dimensions |
|---|---|---|
| Length | 12,192 mm | 12,032 mm |
| Width | 2,438 mm | 2,352 mm |
| Height | 2,896 mm | 2,698 mm |

B. DOOR OPENING

| | |
|---|---|
| Width | 2,340 mm |
| Height | 2,585 mm |

C. RATING

| | |
|---|---|
| Inside Volume | 76.4 cu.m. |
| Maximum Gross Weight | 30,480 kg |
| Maximum Payload | 26,640 kg |
| Empty Weight | 3,840 kg |

2.3. CONSTRUCTION

2.2.1 GENERAL

A. The container will be constructed with steel frames, fully vertically corrugated steel side and end walls, die-stamped corrugated steel roof, wooden flooring, corrugated double hinged doors and ISO corner fittings at eight corners. All steelworks will be built up by means of automatic and semi-automatic CO2 gas arc welding.

B. Corner Fittings. Corner fittings will be designed in accordance with ISO/1161 standard, and manufactured at the workshops approved by the classification society.

C. Base Frame. The base frame will be composed of two (2) bottom side rails, a number of crossmembers and a gooseneck tunnel, which are welded together as a sub-assembly.

D. Front End. The front end will be composed of corrugated end wall and front end frame, which are welded together as a sub-assembly.

E. Rear End. Rear end is composed of Rear End Frame which consists of one door sill, two corner posts, one rear header with header plate and four corner fittings, which are welded together as a sub-assembly, and Door Systems with locking devices.

F. Roof. The roof will be constructed by several die-stamp corrugated steel sheets with a certain upwards camber at the center of each trough and corrugation, these sheets are butt jointed together to form one panel by automatic welding.

G. Floor. The floor consists of ¾-inc plywood. The plywood shall be treated with wood

preservative. The plywood boards are longitudinally laid on the crossmember with a pre-blasted painted and free floating flat steel at the center, two angle steel along both side rails. The plywood boards are tightly secured to each crossmember with countersunk self-tapping electro-zinc plated steel screws. These heads of the floor screws are countersunk below the level of the upper surface of the floor by 1.5 mm to 2.5 mm.

H. Vents. One vent is supplied on each side wall at the right-hand end when facing the side from outside of container, fixed by three aluminum huck bolts, the silicone sealant is to be applied on the edges except the bottom side of the ventilator, after the completion of paint.

2.2.2 MATERIALS

The main materials used in construction are as follows or approved equivalent:

| | | |
|---|---|---|
| A. | All structural steel | Corten A. |
| B. | Door gasket | EPDM |
| C. | Floor | Plywood |
| D. | Miscellaneous Hardware | Stainless Steel |

PART 3. EXECUTION

3.1. PRESERVATION

A. All the steel surface prior to forming or after will be degreased and shot blasted to Swedish Standard SA 2.5 to obtain the surface roughness at 25 to 35 microns which can result in the removement of all the rust, dirt, mill scale and all other foreign materials.

B. Locking rod assemblies, which are welded with gear cams, bars holder and handle hinges, are hot dipping galvanized (Thickness : 75 microns).

C. All fasteners such as bolts/nuts, washers, self-tapping screws, which are not mentioned in this Spec. will be electro zinc plated to 13 Microns.

D. Hinges and cam-keepers will be electro zinc plated to 13 Microns.

E. Sealant for joints. Each perimeter of the floor, all the overlapped joints of inside, all the holes for bolts and nuts and all the places where may leak water will be sealed to give prevention against water entry. Sealant Materials:

1. Chloroprene (Cargo contact area)

2. Butyl (Hidden parts)

3.2. COATING

A. All the steel surface will be coated with primer paint immediately after shot-blasting.

B. All the weld joints will be shot-blasted to remove all the welding fluxes, spatters, burnt primer coatings caused by welding heat, and other foreign materials, and followed with the secondary paint operation immediately.

3.3 TESTING AND INSPECTION

A. Proto-type container to be manufactured in accordance with this specification and shall be tested according to procedures described in the ISO 1496/1 and the Classification Society's requirements. The containers will be fabricated & tested in advance of the mass production.

F. Every container in mass production shall be manufactured under effective quality control procedures to meet the specified standards. One in every 100 of containers shall be tested for following items:

1. Stacking test

2. Lifting from top corner fitting test

3. Lifting from bottom corner fitting test

4. Floor test.

C. After completion, all the containers shall be subject to dimension check, door operation check, light leakage test & production type weather-proofness test.The containers shall be inspected by the surveyor of Classification Society and identified by the appropriate society seal.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install underground piping for the groundwater remediation system as indicated on the Technical Drawings, in the Design Report, and in this specification.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 02300 | Trenching, Backfill, and Compaction |
| 02400 | Injection and Monitoring Wells |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

1. ASTM F876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

2. AWWA C904-06 - Crosslinked Polyethylene (PEX) Pressure Pipe, 1/2 In.(12 mm) Through 3 In. (76 mm), for Water Service.

1. ANSI/AWWA C901-08 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm) for Water Service.

2. ANSI/AWWA C906-07 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission,

3. ASTM D1785, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

4. ASTM D2466, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.

5. ASTM D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.

6. ASTM D2855, Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.

7. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.

## 1.4. DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and equipment in shipping containers with labeling in place.

B. Store piping in a safe place, dry, enclosed, under cover, in a well-ventilated area.

C. Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

PART 2. PRODUCTS

2.1. POLYETHYLENE TUBING FOR INJECTION WELLS CONNECTIONS

A. Tubing shall be high-density crosslinked polyethylene known as PEX- tubing.

B. Tubing shall be copper tube size dimension (CTS), SDR9 wall thickness and shall meet the respective requirements of ASTM F876 and F877.

A. Tubing shall be supplied in continuous length coils of sufficient length to allow continuous length piping runs (i.e., no joints) between the remediation system enclosure and the injection wells.

B. Tubing shall be rated for continuous operation of 160 psi gauge pressure at 73°F temperature.

C. The minimum bend radius for cold bending of the tubing shall be not less than eight (8) times the outside diameter.

D. All fittings used with crosslinked polyethylene (PEX) tubing shall be of the cold-expansion compression-sleeve design.

E. Compression-sleeve fittings shall be manufactured of brass and shall be supplied by the piping manufacturer as part of a proven cataloged system.

F. PEX tubing size shall be as indicated below:

| | Trade size | Actual External Diameter | Actual Internal Diameter | Wall Thickness |
|---|---|---|---|---|
| Tubing between injection wells and remediation equipment | 3/4” | 0.875” | 0.671” | 0.088” |

2.2. PIPING FOR POTABLE WATER CONECTIONS

A. The following piping is acceptable:

1. HDPE SDR 11 pipe and butt fusion fittings suitable for domestic water distribution lines.

2. PEX-type tubing and mechanical fittings suitable for domestic water distribution lines.

B. Type of piping for potable water connections (PEX tubing or HDPE pipe) shall be at the discretion of the Performing Contractor.

C. Selected piping shall be rated for 160 psi gauge maximum pressure at 73ºF temperature.

D. Piping for potable water connections shall be 1” nominal size with the following actual dimensions:

| Service | Trade size | Actual External Diameter | Actual Internal Diameter | Wall Thickness |
|---|---|---|---|---|
| HDPE pipe | 1” | 1.315” | 1.051” | 0.120” |
| PEX tubing | 1” | 1.125” | 0.863” | 0.1318” |

C. Piping shall be supplied in continuous length coils of sufficient length to allow continuous length piping runs (i.e., no joints) between the remediation system enclosure and the potable water sources.

D. Fittings used with HDPE pipe shall be joined by butt fusion method.

E. Fittings used with crosslinked polyethylene (PEX) tubing shall be of the cold-expansion compression-sleeve design.

F. Compression-sleeve fittings shall be manufactured of brass and shall be supplied by the piping manufacturer as part of a proven cataloged system.

A.

PART 3. EXECUTION

3.1. EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.2. INSTALLATION

A. Install the piping as indicated on Technical Drawings and in the Design Report.

B. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

C. Remove foreign objects prior to assembly and installation.

D. Tubing between injection wells and remediation equipment enclosures shall be installed in a single piece without joints.

E. Piping between potable water connections and remediation equipment enclosures shall be installed in a single piece without joints.

F. Surround the piping by sand bedding. Use at least 2 inches of sand bedding under piping. Backfill and compact the sand bedding as indicated in Section 02300 Trenching, Backfill, and Compaction.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install process piping inside the remediation equipment enclosures as indicated on Technical Drawings, in Design Report and in this specification.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 13129 | Standard Shipping Containers |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

1. ANSI B1.1. Unified Inch Screw Threads
2. ANSI B1.20.1. Pipe Threads, General Purpose (Inch)
3. ASME B31.3. Power Piping
4. ASME B16.15. Standard for Cast Bronze Threaded Fittings, 125 and 250 lb
5. ASTM B62. Standard Specification for Composition Bronze or Ounce Metal Castings.
6. ASTM B 43. Seamless Red Brass Pipe, Standard Sizes
7. ASTM B75. Specification for Seamless Copper Tube.
8. ASTM B687 Standard Specification for Brass and Chromium-Plated Pipe Nipples
9. ANSI A12.18.1 Finished and Rough Brass Plumbing Fixtures.

10. ASTM D2466, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.

11. ASTM D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.

12. ASTM D2855, Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.

13. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.

1.4. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”:

A. Shop drawings.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and equipment in shipping containers with labeling in place.

B. Store piping in a safe place, dry, enclosed, under cover, in a well-ventilated area.

C. Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

PART 2. PRODUCTS

2.1. PIPING

A. Size: as specified on Technical Drawings and in Design Report

B. Diameters shown: nominal size

2.2. JOINTS

A. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

B. Socket: PVC solvent cement

2.3. PVC PIPING

A. Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

B. Fittings shall be Schedule 80 and shall conform to ASTM D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

C. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D1784.

D. Union connections to other metal piping materials shall comply with MSS SP-107. The fitting end for connection to PVC pipe shall be a female socket. Provide wrought or cast copper tailpieces for connection to copper piping and tubing. Provide Type 316 stainless steel tailpieces for connection to steel piping.

E. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to valves and equipment.

F. Solvent cement for socket joints shall comply with ASTM D2564 and F656.

2.4. BRASS PIPE, NIPPLES AND FITTINGS

A. Threaded nipples, brass pipe and fittings shall conform to ASTM B 43, regular wall thickness. Threads shall conform to ANSI B1.20.1.

B. Brass pipe and fittings shall be designed to withstand the working pressures shown on the plans or to a design working pressure of 125 psi, whichever is greater.

C. Pipe and fittings shall meet the following specifications:

1. Fittings: ASTM B16.15 dimensional specifications

2. Fittings material: ASTM B-62 standards

3. Nipples: ASTM B-687 standards

4. Red Brass Nipples: ASTM B43 specifications

5. All threads: ASME/ANSI B1.20.1 standards

D. Cast fittings materials: Copper Alloy C84400 which consists of 81% copper, 7% lead, 3% tin, and 9% zinc per ASTM Specification B584.

E. Brass nipples materials: Seamless Red Brass Pipe (Copper Alloy 230).

F. Seamless Pipe Size: WW-P-460 Pipe Fittings: Brass and Bronze (Threaded); WW-U-516 Unions, Brass, and Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections.

2.5. PIPE SUPPORTS

A. Pipe supports shall use steel strut channel system.

B. Strut channel for pipe support shall be slotted galvanized steel, 1 5/8” width. Channel height can be selected to match desired pipe position.

C. Piping shall be secured to strut channel using strut-mounted pipe clamps of appropriate size for pipe.

D. Pipe clamps shall be zinc-plated steel, 400 lbs minimum work load.

2.6. PIPE SCHEDULE

Piping Schedule

| P&ID Legend | Service | Size (in) | Installation (see Note 1) | Material (see Note 2) | Test pressure (psig) (see Note 3) |
|---|---|---|---|---|---|
| VAC | Vacuum lines | 1/4 | INT | COPPER | NA |
| PWR | Incoming potable water | 1 | BUR | PEX | NA |
| IMF | Injection manifold | 1 | INT | BRASS | 60 |
| MCI | Membrane contactor influent | 1 | INT | PVC SCH 80 | 60 |
| GBP | GAC by-pass | 1 | INT | PVC SCH 80 | 60 |
| GCI | GAC influent | 1 | INT | PVC SCH 80 | 60 |
| GCE | GAC effluent | 1 | INT | PVC SCH 80 | 60 |
| CBP | Membrane contactor by-pass | 3/4 | INT | PVC SCH 80 | 60 |
| EIT | Exterior Injection | 3/4 | BUR | PEX | NA |
| MTR | Metering line | 1/2 | INT | PVC SCH 80 | 60 |
| EMF | Entrance manifold | 1/2 | INT | BRASS | 60 |
| IIT | Interior Injection | 1/2 | INT | LDPE | 60 |
| SUB | Substrate injection | 3/8 | INT | LDPE | 60 |
| BUF | Buffering agent injection | 3/8 | INT | LDPE | 60 |
| ITB | Instrumentation | 1/4 | INT | LDPE | 60 |

Notes

1) INT - Interior exposed
   BUR - Underground

2) PVC SCH 80 - Polyvinyl Chloride Schedule 80 pressure pipe
   Brass - brass schedule 40 pressure pipe
   PEX - cross-linked polyethylene tubing
   COPPER - copper tubing (flexible)
   LDPE - low density polyethylene tubing (flexible)

3) Hydrostatic pressure testing

PART 3. EXECUTION

3.1. EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.2. GENERAL INSTALLATION

A. Install the piping as indicated on the Technical Drawings and in the Design Report.

B. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

C. Remove foreign objects prior to assembly and installation.

3.3 PRESSURE TESTING

A. Perform pressure testing for all process piping in accordance with Section 15950.

3.4 INSTALLING UNIONS

A. Provide unions as follows:

1. Where shown in the drawings.

2. 6 to 12 inches downstream of valves unless valves have union ends..

3. Every 40 feet in straight pipe runs.

3.5 PIPE HANGERS

A. Provide pipe hangers and supports as detailed in the drawings.

B. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

C. Strut channel for piping support shall be attached to walls and ceiling using stainless steel wood screws.

D. Wooden screw size shall be at least #10 (0.19 inches).

3.6 THREADED PIPE JOINTS

A. All screw joints shall be made with taper threads, properly cut.

B. Joints shall be made tight with Teflon-based compound appropriate to the medium, material, and temperature range of the system.

C. Compound shall be applied to the pipe threads only and not to fittings.

D. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs.

E. Before installing pipe that has been cut and threaded, lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

3.7 PVC PIPING

A. Do not install PVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water.

B. Store fittings indoors in their original cartons.

C. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements that have exceeded the shelf life marked on the storage container.

D. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section of pipe.

E. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.

3.7.1 SOLVENT-WELDED JOINTS

A. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

B. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

C. Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

D. The pipe and fitting socket shall have an interference fit. Perform a dry fit test at each joint before applying solvent cement. The pipe shall enter the fitting socket between one third and two-thirds of the full socket depth when assembled by hand.

E. Make up solvent-welded joints per ASTM D2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire joint perimeter.

F. Allow at least eight hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

G. Acceptance criteria for solvent-welded joints shall be as follows:

1. Unfilled Areas in Joint: None permitted.

2. Unbonded Areas in Joint: None permitted.

3. Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50%.

3.7.2 ASSEMBLING THREADED JOINTS

A. Cut threaded ends on PVC to the dimensions of ASTM F1498. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe hold-down methods, saw cutting blade size, and saw cutting speed. Gauges, gauge tolerances, and gauging procedures shall comply with ASTM F1498, Sections 7 and 8. Perform field gauging on every field-cut threaded connection.

B. Pipe or tubing cutters shall be specifically designed for use on PVC pipe. Use cutters manufactured by Reed Manufacturing Company, Ridge Tool Company, or equal.

C. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to avoid scratching the pipe.

D. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.

E. Apply Teflon® thread compound or Teflon® tape lubricant to threads before screwing on the fitting.

F. Assemble threaded flanges and fittings per ASTM F1498, Sections 4, 7, and 8. Do not tighten threaded connections more than two turns past finger tightness for both internal and external threads.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install process valves and instrumentation inside the remediation equipment enclosures as indicated on the Technical Drawings, in the Design Report, and in this specification.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| Division 11 | Equipment |
| 15200 | Process Piping |

## 1.3. REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications shall be the latest editions and are referred to within the text by the basic designation only.

1. ASTM B1.20.1.
2. ASME B31.3. Power Piping
3. ASME B16.15. Standard for Cast Bronze Threaded Fittings, 125 and 250 lb
4. ASTM B62. Standard Specification for Composition Bronze or Ounce Metal Castings.
5. ASTM B75. Specification for Seamless Copper Tube.
6. ASTM D1785, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
7. ASTM D2466, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
8. ASTM D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
9. ASTM D2855, Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.
10. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.

## 1.4. SUBMITTALS

Submit the following in accordance with Section 01300, “Submittals”:

A. Product data

B. Shop drawings.

C. Catalog information.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Deliver and store in containers with labeling in place.

B. Store piping in a safe place, dry, enclosed, under cover, in a well-ventilated area.

C. Piping and instrumentation shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

PART 2. PRODUCTS

2.1. PROCESS VALVES

A. Size and locations: as specified on the Technical Drawings and in the Design Report.

B. Process valves sizes shall be 1", ¾", ½", and ¼" size.

C. Plastic valves shall not be used.

D. Manual valves sizes 1" and ¾" shall be as following:

1. Ball valve with quick-connection union end, UL, C-UL, CSA and CSA-US certified,

2. Bronze body, chrome-plated brass ball, PTFE seats and seals.

3. Female pipe thread connections.

4. Maximum pressure for water, oil, and inert gas: 600 psig at 100ºF.

5. Temperature range: -20º to +450ºF.

6. Vacuum rating: 29" Hg.

E. Manual valves sizes ½" and ¼" shall be as following:

1. Ball valve type, UL, C-UL, CSA and CSA-US certified,

2. Brass body, chrome-plated brass ball, fluoroelastomer seal.

3. Female pipe thread connections.

4. Maximum pressure for water, oil, and inert gas: 600 psig at 100ºF.

5. Temperature range: -50º to +400ºF.

6. Vacuum rating: 29.9" Hg.

F. Flow control needle valves:

1. Bar stock metering valves, globe pattern.

2. Brass body, 8" solid stem, 0.125" orifice.

3. ¼" female pipe thread connections.

4. Maximum pressure for water, oil, and inert gas: 3000 psig at 200ºF.

5. Temperature range: -40º to +200ºF.

2.2. PRESSURE AND VACUUM GAUGES

A. Gauges.

B. Non-liquid filled type.

C. Accuracy: ASME B40.100, Grade B, ±3-2-3%

D. Painted steel case, polycarbonate window

E. Bourbon tube C-shape bronze.

F. 2” diameter dial size

G. ¼” MNPT brass connection

2.3. TUBING

A. Polyethylene (LLDPE) and copper tubing shall be used in sizes indicated on Technical Drawings.

B. Flexible tubing (e.g. clear PVC tubing) with low pressure rating is not allowed.

C. Tubing shall have a pressure rating of at least 150 psi at 70 degrees.

D. LLDPE tubing shall be semi-clear, white (no color)M D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

2.4. COMPRESSION FITTINGS

A. Compression fittings shall be used in sizes and locations as indicated on Technical Drawings.

B. Compression fittings shall brass, consisting of a body, nut, and sleeve (ferrule).

C. Fittings shall be supplied by the manufacturer as part of a proven cataloged system. Example manufacturers: Parker, Swagelock.

D. Fittings shall provide no flow restrictions when connected.

E. Ferrules shall be brass if used for copper tubing connections and plastic if used for plastic tubing connections.

F. Minimum pressure rating for compression fittings shall be 400 psig at 73ºF.

2.5. QUICK-DISCONNECT FITTINGS

A. Quick-disconnect fittings shall be used in sizes and locations as indicated on Technical Drawings.

B. Quick-disconnect fitting shall be brass, consisting of a coupling and a plug.

C. Coupling shall be a sleeve-lock type with a zinc-plated steel sleeve and a Buna-N (nitrile) seal.

D. Coupling shall have and a single spring-actuated shut-off valve to seal off a line when a coupling is disconnected from a plug.

E. Fittings shall be supplied by the manufacturer as part of a proven cataloged system. Example manufacturers: Parker, Hansen.

F. Couplings shall have female pipe threads (FNPT); plugs shall have male pipe threads (MNPT).

G. Minimum pressure rating for quick-connection fittings shall be 200 psig at 73ºF.

2.6. VALVES SCHEDULE

| P&ID Designation | Service | Size (in) | Type[1] | Material[2] | Pressure Rating[3] (psig) | Temperature of pressure rating ($^{o}$F) | Temperature range ($^{o}$F) | Manufacturer[4] |
|---|---|---|---|---|---|---|---|---|
| V-1 | GAC influent | 1 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-2 | GAC effluent | 1 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-3 | GAC by-pass | 1 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-4 | Membrane contactor influent | 1 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-5 | Membrane contactor influent | 3/4 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-6 | Metering line | 3/4 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-7 | Membrane contactor by-pass | 3/4 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| V-8 | Injection manifold | 1 | Manual ball valve, union end, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| MV-1[5] | Incoming potable water | 1/2 | Actuated ball valve, FNPT | Bronze body, PTFE seat and packing | 600 | 100 | -20 to +450 | Ap, Cr, Wt or AE |
| PR-1[5] | Entrance manifold | 1/2 | Pressure regulator, FNPT | Bronze body, SS seat, disk, strainer, laminated diaphragm | 300 | 100 | max +400 | Wt or AE |
| CV-1 | Entrance manifold | 1/2 | Ball-cone spring check valve, FNPT, 0.5 psi cracking pressure | Bronze body, PTFE seat, SS spring | 400 | 100 | -20 to +350 | Ap, Cr, Wt or AE |
| CV-2 | Injection manifold | 1 | Ball-cone spring check valve, FNPT, 0.5 psi cracking pressure | Bronze body, PTFE seat, SS spring | 400 | 100 | -20 to +350 | Ap, Cr, Wt or AE |
| Instrumentation valves[6] | Varies | 1/4 | Manual ball valve, t-handle, FNPTxMNPT | Brass body, PTFE seat and packing | 600 | 100 | -50 to +400 | Ap, Cr, Wt or AE |

[1]FNPT - National Pipe Thread female end; MNPT - National Pipe Thread male end

[2]PTFE - Polytetrafluoroethylene

[3]For water, oil, and inert gas

[4]Ap - Apollo; Cr - Crane; Wt - Watts, AE - approved equal

[5]Model number selected, cut sheet included (Basis of Design Report)

[6]Instrumentation valves include sampling ports, gauge and switches access ports, injection ports, injection wellheads vents

## 2.7. GAUGES SCHEDULE

| P&ID Designation | Service | Range | Dial size (inches) | Grade and Accuracy | Connection[1] | Description | Temperature range ($^{o}$F) | Manufacturer |
|---|---|---|---|---|---|---|---|---|
| PG-1 | PR-1 inlet | 0 to 160 psig | 4 | ±1.5% Accuracy full scale ASME B40.1 Grade A | 1/4" MNPT bottom | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| PG-2 | PR-1 outlet | 0 to 30 psig | 4 | ±1.5% Accuracy full scale ASME B40.1 Grade A | 1/4" MNPT bottom | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| PG-3 | PF-1 inlet | 0 to 30 psig | 2.5 | ±2.5% Accuracy full scale ASME B40.1 Grade B | 1/4" MNPT center back | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| PG-4 | PF-1 outlet | 0 to 30 psig | 2.5 | ±2.5% Accuracy full scale ASME B40.1 Grade B | 1/4" MNPT center back | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| PG-5 | Injection manifold | 0 to 30 psig | 4 | ±1.5% Accuracy full scale ASME B40.1 Grade A | 1/4" MNPT bottom | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| PG-101 to 110 | Injection manifold | 30"Hg vacuum to 15 psig | 1.5 | ±2.5% Accuracy full scale ASME B40.1 Grade B | 1/4" MNPT center back | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| NA | Injection well heads | 30"Hg vacuum to 15 psig | 1.5 | ±2.5% Accuracy full scale ASME B40.1 Grade B | 1/4" MNPT center back | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |
| VG-1 | PF-1 outlet | 0 to 30 psig | 2.5 | ±2.5% Accuracy full scale ASME B40.1 Grade B | 1/4" MNPT center back | Stainless steel case, maximum indicating pointer | 0 to +140 | Noshok or approved equal |

[1]FNPT - National Pipe Thread female end; MNPT - National Pipe Thread male end

## PART 3. EXECUTION

### 3.1. EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and service.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

### 3.2. GENERAL INSTALLATION

A. Install the equipment as indicated on the Technical Drawings and in the Design Report.

B. Join valves, instruments and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

C. Remove foreign objects prior to assembly and installation.

D. Use Teflon tape with all threaded connections to achieve leek-proof joints.

### 3.3 PRESSURE TESTING

A. Perform pressure testing for all process valves and instruments in accordance with Section 15950.

### 3.4 PIPE HANGERS

A. Provide pipe hangers and supports as detailed in the drawings.

B. Install valves and instrumentation without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

END OF SECTION

# PART 1. GENERAL

## 1.1. SCOPE OF WORK

Furnish all material, equipment, supplies, and labor to install air conditioning unit for modified shipping containers to be used as equipment enclosures for groundwater remediation system.

## 1.2. RELATED SECTIONS

| | |
|---|---|
| 01300 | Submittals |
| 13120 | Shipping Containers |

## 1.3. REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Air-conditioning and Refrigeration Institute (ARI): 2101240, Unitary Air- Conditioning and Air-Source Heat Pump Equipment.

2. American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE): 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings. Manufactured Housing.

## 1.4. SUBMITTALS

A. Action Submittals: Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

B. Informational Submittals:

1. Recommended procedures for protection and handling of equipment and materials prior to installation.

2. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

3. Operation and Maintenance Data.

# PART 2. PRODUCTS

## 2.1. THROUGH-WALL AIR CONDITINER/HEAT PUMP (AC-1)

A. Air conditioner unit shall be through-the-wall type, able to function as heat pump, equipped with back-up heating coil.

B. Manufacturer and model: Amana PBH092E12AX or approved equal.

C. Characteristics:

1. Requirements: high efficiency, EER 9 minimum rating, energy start rated, adjustable thermostat.

2. Models shall be available either for 115 VAC or 230 VAC.

3. Circuit breaker size: 15 amps.

D. Suggested model performance data:

| | | |
|---|---|---|
| 1. | Cooling capacity: | 8700 BTUH |
| 2. | Heat pump heating capacity: | 8500 BTUH |
| 3. | Cooling amps: | 8.8 |
| 4. | Heating pump amps: | 7.7 |
| 5. | Cooling watts: | 960 |
| 6. | Heating pump watts: | 860 |
| 7. | Back-up electric heater capacity: | 3900 BTUH |
| 8. | Heater amps: | 11 |
| 9. | Heater watts: | 1120 |
| 10. | Air flow: | 265 CFM |

PART 3. EXECUTION

3.1. THROUGH-WALL AIR CONDITINER/HEAT PUMP (AC-1)

1. Install in accordance with manufacturer's instructions, in locations indicated on technical Drawings, and as specified below.

2. The wall sleeve must be installed before the air conditioner chassis can be set in place.

3. The wall opening must be the correct size. See manufacturer’s installation instructions for minimum wall opening size and clearances.

4. Do not use extension cords with unit.

END OF SECTION

PART 1. GENERAL

1.1. SCOPE OF WORK

A. Furnish all material, equipment, supplies, and labor to perform pressure testing for the groundwater remediation system as indicated in Design Report and in this specification.

B. The requirement to pressure test underground injection lines between the equipment trailers and the wellheads shall be waived if continuous length piping runs (i.e., no joints) are used between the remediation system enclosure and the wellhead.

1.2. RELATED SECTIONS

01300 Submittals

02300 Trenching, Backfill, and Compaction

Division 11 Equipment

15200 Process Piping

15210 Process Valves and Instrumentation

1.3. SUBMITTALS

A. Informational Submittals:

1. Testing Notifications: Submit prior to testing and include at least the information that follows.

a. Testing dates.

b. Piping systems and section(s) to be tested.

c. Test type.

d. Method of isolation.

e. Test Report.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.01 PREPARATION

A. Notify Performing Contractor 5 days in advance of testing. Perform testing in presence of Performing Contractor.

B. Pressure Piping:

1. Install temporary thrust restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

3. New Piping Connected to Existing Piping:

a. Isolate new piping with end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

4. Test Pressure: As indicated on Piping Schedule.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

3.02 HYDROSTATIC TEST

A. Fluid: Clean potable water of such quality to prevent corrosion of materials in piping system.

B. Internal Process Piping and Equipment:

1. Perform testing as described in Design Report.

2. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

3. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to allow for piping expansion and to conduct examinations for leakage. Examine joints and connections for leakage.

4. Correct visible leakage and retest as specified.

5. Empty process piping and equipment of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during filling.

3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for 2 hours minimum.

5. Correct leakage and retest as specified.

3.03 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.

2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

   a. Leaks (type, location).

   b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Performing Contractor and any subcontractors performing the test to represent that test has been satisfactorily completed.

END OF SECTION

PART 1 GENERAL

1.1 WORK INCLUDED

A. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical service for each proposed Injection Equipment Container and spare set of electrical conduits (if required), that meets all local, state, and federal requirements and complies with the NEC.

B. A Single Phase, 120/240VAC, underground electrical service will be supplied from an existing power source, as shown on the Drawings, to the Injection Equipment Container. The Contractor shall assume there is sufficient power supply available and space in the existing Distribution Panel at these locations to supply a 60 Amp, 120/240VAC, Single Phase service to the Injection Equipment Container and house the two-pole 60 Amp breaker, respectively. The CONTRACTOR will be responsible for installing an appropriately sized conduit through the existing building wall, with fitting (i.e. troughs, LB) on the exterior wall of the building, from where the remaining of the electrical conduit will be installed underground. The underground service trench will be at least 24-inches deep, to allow for a minimum 2-inch sand bed above and below the properly sized Sch 40 PVC Electrical conduit, therefore maintaining a minimum depth of 18-inches to the top of the electrical conduit. The electrical trench will be backfilled to 12-inches below grade, then two rows of red caution tape will be installed, prior to trenching being backfill to match existing grade. Electrical conduit junction boxes, 18” (diameter) shall be installed every 300 feet and/or if the numbers of bends in the conduit run are more than 360 degrees, to allow for the proper installation of the conductors and ground wires. The conductors shall be sized with a maximum voltage drop of 3% and an appropriately sized ground. The following are the specifics to each electrical service:

1) Southwest – The electrical service will be supplied from approximately 1200 ft from the Injection Equipment Container, three #4 AWG THHN conductors and grounder, will be installed in a 1-inch diameter Sch 40 Electrical Conduit. The electrical pull boxes will be installed at a minimum as shown on the Drawings.

2) Southeast – The electrical service will be supplied from approximately 200 ft from the Injection Equipment Container, three #4 AWG THHN conductors and grounder, will be installed in a 1-inch diameter Sch 40 Electrical Conduit. One electrical pull boxes will be installed at a minimum, to keep the number of bends below 360 degrees, as shown on the Drawings.

3) North – The electrical service will be supplied from approximately 50 ft from the Injection Equipment Container, three #4 AWG THHN conductors and grounder, will be installed in a 1-inch diameter Sch 40 Electrical Conduit.

C. Spare 2-inch diameter Sch 40 Electrical conduits will be installed from the Southwest and Southeast Injection Equipment Containers, as shown on the Drawings, which may be used for future purposes. Electrical conduit junction boxes, 18” (diameter) will be installed

adjacent to the injection wells, as shown on the Drawings, with 2-inch diameter Sch 40 PVC Electrical Conduits run between them. The Electrical Conduits will extend through the pull box well approximately 2-3-inches and depending upon the location of the pull box, conduits may be installed through one or more sides on the electrical pull box, as shown on the Drawings. The 2-inch Sch 40 Electrical Conduit will stub up and be capped next to the Injection Equipment Container, as shown on the Drawing(s).

1.2 RELATED DOCUMENTS, DRAWINGS & SECTION SPECIFICATIONS

A. General provisions of Contract apply to this and the other sections of Division 16.

B. Divison Reference:

| | |
|---|---|
| Division 1 | General Requirements |
| Division 2 | Site Construction |
| Division 7 | Thermal and Protection |
| Division 9 | Finishes |
| Division 10 | Specialties |
| Division 11 | Equipment |
| Division 13 | Special Construction |
| Division 15 | Mechanical |
| Division 16 | Electrical |

C . The following is a list of Electrical Drawings:

| | |
|---|---|
| E-1 | ELECTRICAL SYMBOLS LEGEND |
| E-2 | SOUTHEAST TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-3 | SOUTHWEST TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-4 | NORTH TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-5 | SERVICE CONNECTION DETAILS |
| E-6 | ELECTRICAL EQUIPMENT AND CONDUITS (2 SHEETS) |
| E-7 | INTERNAL WIRING DIAGRAM (2 SHEETS) |
| E-8 | SINGLE LINE ELECTRICAL DIAGRAM (2 SHEETS) |
| E-9 | CONTROL PANEL LAYOUT |
| E-10 | CONTROL SYSTEM BILL OF MATERIALS |
| E-11 | CONTROL SYSTEM ARCHITECTURE |
| E-12 | HMI SCREEN LAYOUT |

D . The following is a full list of the Section 16 Specifications

16100 - Common Work Results for Electrical

16110 - Low-Voltage Electrical Power Conductors and Cables

16120 – Low Voltage Instrumentation Cables

16130 - Grounding and Bonding for Electrical Systems

16140 - Hangers and Supports for Electrical Systems

16150 - Cable Trays for Electrical Systems

16160 - Underground Conduits for Electrical Systems

16170 - Identification for Electrical Systems

16180 - Low Voltage Transformers

16190 - Enclosed Switches and Circuit Breakers

16200 – Surge Protective Devices

16210 - Interior Lighting

16220 - I & C General Provisions, Testing and Training

16230 - Liquid Pressure Process Measurement Devices

16240 - Flow Process Measurement Devices

16250 - Electrical-Operated Primary Control Valves

16260 - Solenoid Primary Control Valves

16270 - PLC and HMI Hardware and Software

16280 - UPS Systems (Single Phase)

16290 - Process Control Software Inputs / Outputs Lists

## 1.3 REFERENCES

A. Middle River, State of Maryland and National Electrical Codes

B. National Electrical Code (NFPA 70), 2011 Edition

C. Life Safety Code 10

D. PLEASE NOTE: Individual Section 16 Specifications may note reference codes applicable to the items or service to be supplied as described in the specific Section.

## 1.4 COORDINATION WITH OTHER TRADES

A. Contractor shall coordinate the installation and location of all fixtures, outlets, equipment, and devices with other trades to avoid conflicts.

1.5 QUALITY CONTROL

A. Prior to submitting a bid, Contractor shall visit the site and determine existing conditions at the site and all existing structures to become familiar with existing conditions and electrical systems, which may, in any manner, affect the work required under this Contract.

B. The Contractor shall carry out any work involving shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the Engineer. Contractor shall do such work when directed by the Engineer.

C. After award of the Contract, the Contractor shall confer with the Engineer to verify, at each stage of construction activity, the location(s) of existing Engineer and utility facilities. Contractor shall protect all existing underground utilities during construction except as noted on the drawings. The Contractor shall pay for all required repairs for damage inflicted during construction without increase in Contract cost.

D. Responsibility: The Contractor shall be responsible for completing the systems in accordance with the intent of these Contract Documents:

1. Coordination of the details of the facility equipment and construction for all Specification divisions which affect the work covered under Division 16, Electrical.
2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good trade practice to provide complete, functioning systems.

E. Departures from the Contract Documents: The Contractor shall submit to the Engineer, in writing, details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. No such departures shall be authorized without the written review of the Engineer.

F. Substitution of Materials and Equipment: In accordance with provisions elsewhere in these Contract Documents, manufacturers' names and catalog numbers stated herein are intended to indicate the type, function and quality of equipment or materials desired. Unless substitution is specifically forbidden in writing, proposed alternatives may be submitted for review.

1.6 SUBMITTALS

A. Submit in accordance with Section 01300, "Submittals."

B. Additional copies may be required by individual sections of these Specifications.

C. List of Proposed Materials: The Contractor shall submit a complete list of the proposed manufacturers for each of the items listed in these electrical specifications. Additional submittal data, sufficient to determine equality, shall be required if the Contractor proposes to substitute another manufacturer's equipment. The Engineer's opinion shall be the final authority in the decision to accept or reject substitutions.

1.7 RECORD DOCUMENTS

A. Prepare record (close-out) documents in accordance with the requirements in Division 1 Section "SUBMITTALS."

1.8 OPERATION & MAINTENANCE MANUALS

A. Prepare operation and maintenance manuals in accordance with Section 01 33 00 "Submittals" In addition, include the following information for major equipment items:

1) Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2) Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and any specific summer / winter operating instructions.

3) Maintenance procedures for routine preventative maintenance and troubleshooting; dis-assembly, repair, and re-assembly; aligning and adjusting instructions; servicing instructions and lubrication charts and schedules.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 PRODUCTS

2.1 REFERENCE TO DRAWINGS

A. Reference shall be made to Drawing Schedules, Details, Notes and Specifications for: Manufacturer, model, catalog number, size, capacity, performance, ratings and installation of equipment and material.

2.2 CHOICE OF MATERIALS AND EQUIPMENT

A. In submitting substitutions, bidders should note the following minimum considerations:

1) capacities shown are absolute minimum and must be equaled or exceeded

2) physical size limitations for space allotted,

3) structural properties,

4) noise level,

5) interchangeability,

6) compatibility with other materials and assemblies,

7) similar items shall be same manufacturer and style wherever possible, and;

8) electrical hazardous area classification of equipment shall not be downgraded under any circumstances.

B. All materials and equipment, for which a UL, ANSI, or a NEMA Standard is established, shall be so approved, and will be labeled or stamped as such.

2.3 SUBMITTALS DURING CONSTRUCTION

A. Certified arrangement drawings, outline dimensions and weights for all major (engineered) equipment.

B. Functional description or logic diagrams for all control systems furnished under Division 16, Electrical, and not listed above.

C. Characteristic curves for all protective devices.

D. Interconnection elementary diagrams for each of the following conductor types:

1. Service conductors, feeder conductors and any branch circuit conductors which have a connection point between the branch circuit over-current protection or motor starter, and the utilization equipment.

PART 3 EXECUTION

3.1 ROUGH-INS

A. Contractor shall verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.2 ELECTRICAL INSTALLATIONS

A. The Contractor shall be responsible for all electrical power, control and instrumentation wiring and connections to all equipment requiring electrical power. This responsibility applies to all equipment supplied by the Contractor, as well as all equipment supplied under this and other Divisions, and/or by the Engineer.

B. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building and well installation components.
2. Verify all dimensions by field measurements and record on contract drawings.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

6. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
10. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

## 3.3 SITE CONSTRUCTION

A. Refer to Division 2 for Site Construction Requirements

## 3.4 RECORD AND AS-BUILT DRAWINGS

A. Contractor shall maintain at the job site, a set of Contract Documents kept current by indicating thereon, all changes, revisions and substitutions between work as specified and as installed.

B. Contractor shall furnish Engineer with one complete set of reproducible drawings, and one complete, clean sets of Specifications, showing installed locations, size, catalog numbers, etc., of all work and material as taken from record documents.

## 3.5 EQUIPMENT OPERATION

A. This Division is responsible for: (1) proper motor rotation, (2) observing that lubrication has been properly performed, (3) that motors operate within nameplate limits, and (4) adjustment or circuit breaker and motor controller trip settings.

## 3.6 IDENTIFICATION

A. Contractor shall identify all major items of equipment, including: controls, panel-boards, switches, contactors, motor starters and enclosures, junction boxes and metering with permanent nameplates, with verbiage approved by the Engineer and per Section 16170 - Identification for Electrical Systems.

3.7 ELECTRICAL TESTING AND

STARTUP A. General:

1. Prior to energizing any equipment, the Contractor shall thoroughly vacuum clean the equipment with an industrial type vacuum cleaner. Any sheet metal parts shall be thoroughly cleaned with degreaser to remove any oil deposited during fabrication or installation. The outside of all electrical equipment shall be cleaned and touched up with vendor-supplied touch-up paint, in order to leave the equipment in an “as-purchased” condition.
2. During startup of new equipment, the Contractor shall provide sufficient manpower to aid with the startup of the electrical equipment, to remove any faults, and to make any necessary adjustment for proper operation of electrical equipment
3. All testing equipment shall be furnished by the Contractor.
4. All failures under tests due to defective material or poor workmanship shall be corrected by the Contractor, at no expense to the Engineer or the Engineer.
5. The Contractor shall not, under any circumstances, energize any electrical equipment covered by these Specifications, without first obtaining the permission of the Engineer.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section..

B. The materials shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all NEC, NFPA, OSHA, state, local, and federal codes and regulations.

## 1.2 RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3 REFERENCES

A. American Society of Testing Material (ASTM): D2301-10; D2304-10; D3005-10

B. National Electrical Manufacturers Association (NEMA): WC 70-09

C. National Fire Protection Association (NFPA):70-11 -National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL)

## 1.4 QUALITY ASSURANCE

A. The power conductors and cables described by this section are intended to be standard electrical construction trade materials. All testing shall be in compliance with specifications 16 10 00 - Common Work Results for Electrical.

## 1.5 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals” information on Low Voltage Electrical Power Conductors and Cables

B. Product Data shall include the following:

1. Electrical ratings and insulation type for each conductor and cable.
2. Splicing materials and pulling lubricant

PART 2. PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.

B. All conductors shall be copper.

C. Single Conductor and Cable:

1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
2. No. 8 AWG and larger: Stranded.
3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN-THWN and XHHW-2.

D. Color Code:

1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: Color-coded using one of the following methods:
   a. Solid color insulation or solid color coating.
   b. Stripes, bands, or hash marks of color specified.
   c. Color using 19 mm (0.75 inches) wide tape.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Conductors shall be color-coded as follows:

| 208/120 V | Phase | 480/277 V |
|---|---|---|
| Black | A | Brown |
| Red | B | Orange |
| Blue | C | Yellow |
| White | Neutral | Gray * |
| * or white with colored (other than green) tracer. | | |

2.2 SPLICES

A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:

1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.

2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be //zinc-plated//cadmium-plated// steel.

D. Above Ground Splices for 250 kcmil and Larger:
1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

E. Underground Splices for No. 10 AWG and Smaller:
1. Solderless, screw-on, reusable pressure cable type, with integral insulation. Listed for wet locations, and approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

F. Underground Splices for No. 8 AWG and Larger:
1. Mechanical type, of high conductivity and corrosion-resistant material. Listed for wet locations, and approved for copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.//

G. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

## 2.3 CONNECTORS AND TERMINATIONS

A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be //zinc-plated//cadmium-plated// steel.

2.4 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.
B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.
B. Shall not be used on conductors for isolated power systems.

PART 3. EXECUTION

3.1 GENERAL

A. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.
B. Install all conductors in raceway systems.
C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.
E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.
H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
I. Conductor and Cable Pulling:
    1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.

2. Use nonmetallic pull ropes.
3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All conductors in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

J. No more than three branch circuits shall be installed in any one conduit.

K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 INSTALLATION IN MANHOLES

A. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 SPLICE AND TERMINATION INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.

3.4 CONDUCTOR IDENTIFICATION

A. Refer to 16 17 00 Identification for Electrical Systems

3.5 CONTROL WIRING INSTALLATION

A. Unless otherwise specified in specification 16 12 00 Control Voltage Electrical Power Cables, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.

B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.6 CONTROL WIRING IDENTIFICATION

A. Refer to 16 17 00 Identification for Electrical Systems

3.7 DIRECT BURIAL CABLE INSTALLATION

A. Tops of the cables:

1. Below the finished grade: Minimum 600 mm (24 inches) unless greater depth is shown.

2. Below road and other pavement surfaces: In conduit as specified, minimum 760 mm (30 inches) unless greater depth is shown.
3. Do not install cables under railroad tracks.

B. Work with extreme care near existing ducts, conduits, cables, and other utilities to prevent any damage.

C. Provide horizontal slack in the cables for contraction during cold weather.

D. Install the cables in continuous lengths. Splices within cable runs shall not be accepted.

## 3.8 ACCEPTANCE CHECKS AND TESTS - FIELD QUALITY CONTROL

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests: Inspect physical condition.
2. Electrical tests:
   a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
   b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
   c. Perform phase rotation test on all three-phase circuits if applicable.

END OF SECTION

# PART 1 GENERAL

## 1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation cable.
   2. Types of cable include the following:
      a. Shielded instrument cable.
      b. Ethernet Category 5 cable.

B. Related Sections:
   1. Section 11080 – Electronic Flow-meters.
   2. Section 16230 – Liquid Pressure Process Measurement Devices
   3. Section 16240 – Flow Process Measurement Devices
   4. Section 16270 – PLC and HMI Hardware & Software
   5. Section 16170 - Identification for Electrical Systems.

## 1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 1581, Electrical Wires, Cables and Flexible Cords.
   2. UL 13, Power-Limited Circuit Cables.
   3. UL VW-1, Vertical Wire Flame Test.

## 1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power- Limited Circuits.
   2. NEC Article 727, Instrumentation Tray Cable.
   3. Tests by Independent Testing Agencies: Cable shall bear UL Label.

## 1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for instrumentation cable proposed.

# PART 2 PRODUCTS

## 2.1 SHIELDED INSTRUMENT CABLE

A. Single Shielded Pair Instrument Cable:

   1 Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pair with overall shield, stranded tinned No. 18 AWG copper drain wire and overall PVC jacket. Rated for 600 volts minimum and conforming to UL 1581.

   2. Manufacturers: Provide products of one of the following:
      a. Belden Company
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.

d. Or equal.

B. Cable Terminals:
   1. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.
   2. Manufacturers: Provide products of one of the following:
      a. Burndy Insulug.
      b. Or equal.

2.2 ETHERNET CATEGORY 5 CABLE:

A. Category 5 Shielded Twisted Pair solid cable with PVC jacket and shielded 8P8C modular connectors. Factory terminated cable is required.

B. Meet the following requirements:
   1. Wiring Type: Category 5, ANSI/EIA/TIA 568B
   2. Impedance: 100 + 15 Ohms
   3. Conductor Gauge: 24 AWG
   4. Cable construction: 4 pair, PVC jacket, solid or stranded conductors.
   5. Connectors: 8P8C, shielded
   6. Frequency: Up to 250 MHz
   7. Shield: Copper braid, covering all pairs and connectors. Shield connected to external drain wire.

C. Manufacturers: Provide products of one of the following:
   1. Belden Company.
   2. Or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Install cable complete with proper terminations at both ends.
   2. Install in conduit separate from power cables, unless specified otherwise.
   3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
   4. Identify conductors in accordance with Section 161700, Electrical Identification.
   5. Install and terminate Supplier-furnished cable in accordance with Supplier equipment requirements and cable manufacturer's recommendations.
   6. Install in conformance with the National Electrical Code, and Laws and Regulations.

3.2 FIELD QUALITY CONTROL

A. Site Testing:
   1. Test shielded instrumentation cable shields with an ohmmeter for continuity along full length of cable, and for shield continuity to ground.
   2. Connect shielded instrumentation cables to calibrated 4 to 20 mA DC signal transmitter and receiver. Test at four and twenty milliamp transmitter settings.
   3. Replace with new cable the full length of cable that fails a test.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems and equipment.

## 1.2 RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.2. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on Grounding and Bonding of Electrical Systems.

a. Shop Drawings:

i. Listing of grounding connector types identifying where each will be used.

ii. Layouts of each structure’s ground grid.

iii. Test point construction details.

b. Product Data:

i. Manufacturer’s technical information for grounding materials proposed for use.

c. Testing Plan:

i. Ground resistance test procedure.

d. Field Quality Control:

i. Results of ground resistance tests at each test point.

1.4 QUALITY ASSURANCE

A. Comply with UL 467 for grounding and bonding materials and equipment.

B. Comply with the National Electrical Code, (NEC) NEC Article 250, Grounding and Bonding.

1.5 REFERENCES

A. UL 467, Grounding and Bonding Equipment.

B. National Electrical Code, (NEC) NEC Article 250, Grounding and Bonding.

C. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.

PART 2. PRODUCTS

2.1. MATERIALS

A. Bare Ground Cable:

a. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG

B. Ground Rods:

a. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.

C. Grounding Connectors:

a. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.

PART 3. EXECUTION

3.1. INSPECTION

A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 EQUIPMENT GROUNDING

A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.

C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.

D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings

E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.

F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold- down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.

G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.

H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.

I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.3 FIELD QUALITY CONTROL

A. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER and OWNER will witness the testing.

B. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive installing additional ground rods to increase their effectiveness.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish, and install the necessary hangers and supports for the electrical systems.

## 1.2 RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on Hangers and Supports for Electrical Systems.

a. Product Data:

i. Manufacturer’s technical information for each type of product specified.

## 1.4 QUALITY ASSURANCE

A. Electrical Component Standards: Components and installation shall comply with NFPA 70. Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

## 1.5 REFERENCES

A. National Fire Protection Association (NFPA), NFPA 70.

B. Underwriters Laboratories (UL).

## PART 2. PRODUCTS

### 2.1. COATINGS

Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Product for use outdoors shall be hot-dip galvanized.

### 2.2. MATERIALS

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

a. Expansion Anchors: Carbon steel wedge or sleeve type.

b. Toggle Bolts: All steel springhead type.

B. U-Channel Systems: 16-gage steel channels, with 9/16-inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

C. Conduit Sealing Bushings: Factory-fabricated assembly consisting of threaded body and insulating wedging plugs for non-armored electrical cables in conduits subject to exposure to water and/or oil penetration at conduit joints. Provide plugs with number and size of conductor gripping holes as required to suit installation. Construct body of malleable iron casting with hot-dipped galvanized finish. Support systems shall be capable of carrying the weight of the box and its contents.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts and flat end lock washers. Provide steel channel supports with 9/16-inch diameter holes at a maximum of 8 inches on center, in at least one surface. Fittings and accessories to mate and match with channels and to be form same manufacturer.

## PART 3. EXECUTION

### 3.1. INSTALLTION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NFPA 70.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish, and install the necessary cable trays for the electrical cabling systems.

## 1.2 RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3 REFERENCES

A. NEC Article 318 – Cable Tray

B. NEMA Publication VE-1

## 1.4 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals” information on Cable Trays for Electrical Systems

B. Product Data shall include the following:

1. Manufacturer’s technical information for each type of cable tray required.

## 1.5 QUALITY ASSURANCE

A. The cable trays described in this section are designed to protect electrical wiring in applications where dirt, dust, oil and water are not serious problems.

B. All cable tray components shall comply with NEMA Standard VE-1.

## 1.6 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

## PART 2. PRODUCTS

### 2.1. MANUFACTURERS

A. Square D

B. Cablofil

C. Weigmann

D. Or Approved Equal

### 2.2 CONSTRUCTION

A. Install cable trays where shown in accordance with the manufacturer's written instructions, NEC NEMA Standard VE-1 and with recognized industry practices to ensure that the cable trays comply with the specified requirements and serve the intended purpose to support wire cables.

B. Remove burrs and sharp edges and avoid contact with cable insulation using manufacturer recommended finishing accessories.

C. Rigidly anchor the cable tray to the structure and at each directional change.

D. Electrically ground cable trays to ensure continuous electrical conductivity.

END OF SECTION

# PART 1 GENERAL

## 1.1. GENERAL

A. The Contractor shall furnish all conduit and conduit fittings to complete the installation of all electrically operated equipment as specified herein, in other Divisions of these specifications and as required. All conduit shall be electrical metallic tubing except conduit installed above or below grade which shall be PVC, and flexible conduit which shall be liquid tight metal flexible type. All above grade exposed conduit shall be schedule 80 PVC and all below grade shall be schedule 40 PVC.

B. The Contractor shall furnish all trenching and backfill work for all underground conduit. The Contract drawings indicate the general location of conduits both exposed and concealed: however, the Contractor shall install these conduits and appurtenances in such a manner as to avoid all interferences. The Contractor may not combine conduits not shown combined on the Contract drawings without specific written approval from the Engineer.

## 1.2. RELATED SECTIONS

15 00 0 Mechanical

16 00 0 Electrical

## 1.3 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on Underground Conduit for Electrical Systems.

1. As-built Drawings:

a) Construction / Elevational Data

b) Layouts of each structure’s ground grid.

c) Test / access point construction details.

PART 2 PRODUCTS

2.1 CONDUIT

A. All interior conduit shall be electrical metallic tubing (EMT). All connections shall be made with approved compression type fittings. Screw type fittings shall not be permitted.

C. Electric feed exposed conduits installed above grade shall be schedule 80 PVC and below grade conduits shall be schedule 40 PVC. All connections shall be made with approved conduit fittings and shall be bonded with approved adhesive compound to form a rigid watertight connection.

D. Liquid tight metal flexible conduit shall bear the UL label as approved for ground conducting. 3/8" conduit shall not be permitted. Length of liquid tight metal flexible conduit shall be not less than 9" but not more than 24". The minimum size conduit permitted is 1/2 inch. Conduit sized shall be installed as specified on the Contract Drawings.

PART 3 EXECUTION

3.1 INSTALLATION - CONDUIT

A. Where liquid-tight metal flexible (LQT) conduit is used, only short lengths not to exceed 24" shall be installed. These lengths shall be provided with appropriate connectors which will provide an excellent electrical connection between equipment and the rigid conduit for the flow of ground current. LQT conduit shall be installed in such a manner that it does not rub on any surface.

B. Each piece of conduit installed shall be free from blisters and other defects. Each piece installed shall be cut square and taper reamed. Conduit connections shall be screwed tight with only incomplete threads exposed. All conduit joints shall be made with standard couplings and the ends of the conduit shall butt tightly into the couplings. In exposed work only, where standard couplings cannot be used, only union type couplings are permitted. Junction and pull device boxes with hubs, etc., shall not be made loose to facilitate positioning. If the connection cannot be made tight then union fitting shall be used.

C. PVC conduit shall be cleaned and welded using approved solvents and adhesives and shall be made water tight.

D. The equivalent number of 90 degree bends in a single conduit run shall be limited to four (4)
   i. and the radius of bending shall comply with N.E.C. requirements.

E. Factory bent elbows or field bent elbows with approved tools may be used. Heating of metal conduit to facilitate bending is prohibited. Bending of PVC conduit shall be done with an approved heat bender designed for this purpose.

F. All exposed conduit shall be installed, either parallel or perpendicular to structural members, unless impractical, and shall be grouped wherever possible. Conduit shall be attached to structural components with approved supports spaced a maximum of ten (10) ft. apart and shall form a neat rigid installation. Conduit supports from walls, floors or ceilings shall be installed with at least a 1/4 inch clearance from the surface to prevent the accumulation of dirt and moisture behind the conduit.

G. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and pull wire and cable. Before wire or cable is pulled, insulated bushings shall be installed at each end of the conduit.

K. Conduit buried underground shall be a minimum of 24 inches below grade. Metallic "Electrical Buried" warning tape shall be installed at a minimum of 12 inches below grade. Trenching and back filling shall be provided by the Contractor in accordance with other applicable Divisions of these Specifications.

L. Where nipples are used between fittings and electrical equipment, they shall be so installed that no threads are exposed.

M. Conduit containing intrinsically safe circuits shall be labeled in accordance with NEC 504-80.

3.2 INSTALLATION – CONDUIT FITTINGS

3.3

A. Conduit penetrating block walls shall be sealed using a non-shrink grout. Conduit penetrating concrete walls below grade shall enter through core drilled holes with conduit sealing bushings installed. The conduit sealing bushings shall be installed on both sides of the wall and shall be O-Z/Gendey CSMC both sides of the structure. Sealing fitting consisting of linked segments are not acceptable. For conduit penetrations above grade in concrete walls, a CSMC sealing bushing shall be installed outside the wall with no bushing required inside.

B. Cast fittings shall be copper free aluminum or other corrosion resistant metal. Cast fittings shall be provided with heavy threaded hubs to fit the conduit required. Covers shall be of the same material as the fittings to which they are attached and shall be screwed on with stainless steel screws and rubber or neoprene gaskets between the covers and fittings.

END OF SECTION

# IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.1 DESCPTION

A. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

### 1.2 RELATED SECTIONS

A. Section 16110 – Low Voltage Electrical Power Conductors and Cables
B. Section 16120 – Control Voltage Electrical Power Cables
C. Section 16270 – PLC and HMI Hardware and Software

### 1.3 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on Identification for Electrical Systems.

B. Product Data shall include at least the following:

1. Descriptive literature of the labeling materials.
2. Conduit and wire identification numbering system and equipment signage.

### 1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
1. NEC Article 110, Requirements for Electrical Installation.
2. NEC Article 210, Branch Circuits.
3. NEC Article 215, Feeders.
4. NEC Article 700, Emergency Systems.
5. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
6. NFPA 70E, Electrical Safety in the Workplace.

## PART 2 PRODUCTS

### 2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplates:
a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
b. Size: As required.
c. Letter Size: Minimum 3/16 in.

2. Legend Plates:
   a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
   b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:
1. Low-Voltage Safety Signs:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-86060 by Brady.
      2) Or equal.
   b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, “DANGER – 480 VOLTS”.
2. Low-Voltage Markers:
   a. Products and Manufacturers: Provide one of the following:
      1) CV442xx by Brady.
      2) Or equal.
   b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, “120 VOLTS”, “208 VOLTS”, “120/208 VOLTS”, or “240 VOLTS” as required.

C. Arc-flash Safety Signs:
1. Products and Manufacturers: Provide one of the following:
   a. Brady.
   b. Or equal.
2. Warning signs shall be adhesive-backed polyester.
3. Warning signs shall read, “Warning – Arc Flash and Shock Hazard. Appropriate PPE Required. Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.

D. Voltage System Identification Directories:
1. General:
   a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
   b. Directories shall identify all voltage systems within building or structure.
   c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

E. Conduit Labels:
1. Products and Manufacturers: Provide one of the following:
   a. B-915-xxxxx by Brady.
   b. Or equal.
2. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit for conduit up through five-inch diameter, or pre-molded to conform to circumference of conduit six-inch diameter and larger.

3. Attach strap-on style for six-inch diameter conduit with stainless steel springs.
4. Shall be blank for use with custom printed labels.
5. Custom Labels:
   a. Shall have black lettering on yellow background.
   b. Shall not contain abbreviations in legend.
   c. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.

F. Wire Identification:
1. Heat Shrinkable Wire and Cable Labeling System:
   a. Products and Manufacturers: Provide one of the following:
      1) B-341 PS-xxx-2W by Brady.
      2) Or equal.
   b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
2. Wrap-Around Wire and Cable Labeling System:
   a. Products and Manufacturers: Provide one of the following:
      1) THT-XX-427 by Brady.
      2) Or equal.
   b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

G. Detectable Underground Warning Tape:
1. Products and Manufacturers: Provide one of the following:
   a. Indentoline by Brady.
   b. Or equal.
2. Material: Polyethylene or polyester with detectable metal core and polyester underlaminate.
3. Width: Two inches.
4. Color and Labeling: Yellow or red with permanently imprinted black letters: “CAUTION – Buried Electric Line”, repeated continuously over full length of tape.

H. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
2. Wire and Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) TLS2200 by Brady.
      2) Or equal.
   b. Desktop, Products and Manufacturers: Provide one of the following:
      1) 200M by Brady.
      2) Or equal.
3. Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) Handimark by Brady.
      2) Labelizer PLUS by Brady.
      3) Or equal.

## 2.2 FABRICATION

A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.

B. Engraved Identification Devices (Nameplates and Legend Plates):

1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
5. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
6. Push Buttons:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Provide red buttons for stop function.
   d. Provide black buttons for other functions.
7. Pilot Lights:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

| Color | Legend |
|---|---|
| Green | Running, Open |
| Red | Stopped, Closed |
| Amber | Alarm |
| Blue | Power |
| White | Status |

7. Selector Switches:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment..
8. Panel Mounted Instruments:
   a. Provide nameplates for identification of function.
9. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
   a. Provide nameplates for identification.
   b. Interior items requiring nameplates include:
      1) Terminal blocks and strips.
      2) Bus bars.
      3) Relays.
   c. Circuit Breaker Directory:

1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.

10. Re-label existing equipment whose designation changed.

C. Safety Signs and Voltage Markers:
1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
a. Install rigid safety signs.
b. Clean surfaces before applying pressure-sensitive signs and markers.
2. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
a. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.
b. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
c. Do not label cable trays that contain only instrument signal cables.
3. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

E. Arc-flash Safety Signs:
1. Provide arc-flash safety signs as required by NEC Article 110.
2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain 480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

F. Conduit Labels:
1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.
3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
4. Conduit labels shall indicate the following information:
a. Contract Number: Alphanumeric, three or four digits, as applicable.
b. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
5. Provide conduit labels at the following locations:
a. Where each conduit enters and exits walls, ceilings, floors, or slabs.
b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
c. At maximum intervals of 50 feet along length of conduit.

G. Wire and Cable Identification:
1. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
2. Do not provide labels for the following:
a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
3. Wire and Cable Identification System:
a. Wire and cable labels shall be imprinted with an identifying designator.
b. Field Wiring shall reflect actual designations used in the Work and shall be documented in record documents.

c. Cabinet, Console, Panel, and Enclosure Wiring, Internal: shall have designators as specified on the Process and Instrumentation Diagram.

H. Terminal Strip Labeling:
1. Label panel side of terminal to match panel wire number.
2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

END OF SECTION

1.1. DESCRIPTION

A. This section of the specification describes low voltage transformers and related installation practices.

B. The equipment shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

1.2. RELATED SECTIONS

15 Mechanical

16 Electrical

**1.3.** SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on all chemical feed pumps.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the equipment.

2. Data on the characteristics and performance of the low voltage transformer

3. Manufacturer's wiring diagrams including necessary field connections.

1.4 QUALITY ASSURANCE

A. The transformer(s) covered by this Section are intended to be standard manufacturer equipment.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on all mechanical components of the pump.

B. Each transformer shall be provided with Operating and Maintenance Instructions.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Transformers shall be as manufactured by Square D, General Electric, Cutler-Hammer, or approved equal.

2.2 EQUIPMENT REQUIREMENTS

A. Single-phase and three-phase general purpose dry type transformers shall be equal to Hevi-Duty Electrical Class 1100 and Class 1200 respectively, be of the two-winding type, self-cooled, with ratings (KVA) as indicated on the drawings. Transformers shall be built in accordance with applicable NEMA, ANSI, IEEE, OSHA, UL standards, and regulations on listings.

B. Transformers shall contain copper windings. Aluminum not allowed.

C. Transformers with single phase ratings through 10 KVA shall have a voltage ratio of 240/480 volts primary-120/240 volts secondary with a maximum temperature rise of 115 degrees C at full load rating for the non-ventilated type, suitable for indoor or outdoor use.

D. Transformers with three phase ratings through 9 KVA shall have a voltage ratio as indicated on drawings. Provide four 2-1/2% full capacity voltage adjusting taps, 2 above and 2 below primary rated voltage; Maximum full load temperature rise to be 115 degrees C; for the non-ventilated, HARDSHELL, encapsulated type, suitable for indoor or outdoor use.

E. Units configured single or three phase transformers rated above 9 KVA to be insulated with UL listed Class 220 rated materials; and have a maximum average full load temperature rise of 150 degrees C.

F. Transformers to have voltage ratios as indicated on drawings. Transformers between 10 KVA and 300 KVA to be provided with six (6) 2-1/2% full capacity taps--two above and four below primary rated voltage.

G. Transformer core to be of low loss type, high quality, grain oriented steel. Core clamping members shall cover a minimum of 90% of the top and bottom core yoke laminations; and vertical framing members shall be contained within the insulated coil form, to minimize external flux path.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide flexible conduit to and from transformer.

B. Install transformers in accordance with manufacturers' recommendations.

C. Provide trapeze type hangers for transformers supported from the structure or mount

on the floor as shown on the drawings.

D. Ground secondary neutral of all transformers to grounding conductor in primary feeder and to building steel or other approved electrode using grounding electrode conductor sized in accordance with NEC. Ground transformer enclosure with bonding jumper.

E. Provide both primary and secondary protection by use of fuses or circuit breakers as shown on drawings.

END OF SECTION

# PART 1 GENERAL

## 1.1 DESCRIPTION

A. This section of the specifications describes the enclosed switches and molded case circuit breakers as specified herein and as indicated or scheduled on the Drawings, as follows:

1) Thermal magnetic molded case circuit breakers.

2) Electronic trip molded case circuit breakers.

## 1.2 RELATED SECTIONS

A. 15 Mechanical

B. 16 Electrical

## 1.3 REFERENCES

A. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."

B. NFPA 70, "National Electrical Code" – hereinafter NEC.

C. UL 489, "Standard for Molded-Case Circuit Breakers and Circuit-Breaker Enclosures."

D. UL 508, "Standard for Industrial Control Equipment" (copyrighted by UL, ANSI approved).

E. UL 1053, "Standard for Ground Fault Sensing and Relaying Equipment."

## 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of molded case circuit breakers of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.

B. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing molded case circuit breakers similar in type and scope to that required for this Project.

C. Regulatory Requirements:

1. Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
2. Electrical Components, Devices, and Accessories: Electrical components, devices, and accessories shall be listed and labeled as defined in NEC, Article 100, by an inspecting and testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on enclosed switches and molded case circuit breakers.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the equipment.

2. Data on the characteristics and performance of the low voltage transformer

3. Manufacturer's wiring diagrams including necessary field connections.

1.6 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on all enclosed switches and circuit breakers.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Enclosed Switches and Circuit Breakers shall be as manufactured by

1) Square D

2) Allen-Bradley

3) or approved substitute.

B. General Characteristics

1) Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.
2) Circuit breakers shall have an over center, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
3) The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings.
4) The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
5) Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.
6) Circuit breakers shall be factory-sealed with a hologram quality mark and shall have date code on face of circuit breaker.

C. Accessories

1) Circuit breakers shall be equipped with UL-listed electrical accessories as noted on the Drawings or schedules or they may be field-installable.
2) The addition of auxiliaries shall not increase the volume of the circuit breaker.
3) The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Preparation and installation shall be in accordance with reviewed product data, final drawings, and manufacturer's written recommendations. Install molded case circuit breakers in accordance with the NEC and applicable local codes.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section describes the materials and installation requirements for Surge Protective Devices (SPDs) Transient Voltage Surge Suppressors (TVSS), historically referred to as Transient Voltage Surge Suppressors (TVSS)as shown on the drawings and herein specified.

B. Surge Protective Devices are to be installed at circuit breaker panels as shown on the drawings.

## 1.2 RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3 REFRENCES

A. IEEE C62.41 and C62.45

B. National Electrical Manufacturers Association (NEMA LS1)

C. National Fire Protection Association (NFPA 70)

D. Underwriters' Laboratories (UL 1449 and 1283)

## 1.4 SUBMITTALS

A. Submit in accordance with Section 01 30 0, “Submittals”, information on Transient Voltage Surge Suppression for Electrical Systems.

1) Product Data Sheets
2) Installation and Operating Instructions.
3) UL 1449 Edition 2 Listing Certificate.
4) UL 1449 Edition 2 Suppressed Voltage Ratings.

## PART 2. PRODUCTS

### 2.1. MANUFACTURERS

A. Manufacturers shall be ISO9000 certified.

B. Manufacturers shall have been engaged in the design and manufacturing of such devices for at least ten (10) years.

C. Suggested Manufacturers

1) SQUARE D

2) ERICO, Inc.

3) OR EQUAL

## PART 3. EXECUTION

### 3.1. INSTALLATION

A. Install TVSS (SPD) as indicated on Drawings, and in full accordance with manufacturer's written instructions and comply with all applicable codes

B. Units shall be installed with minimal connection lead length within interior of Circuit Breaker Panel using selected manufacturer's accessory / hardware devices.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting fixtures and controls.

B. The equipment shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

C. The installation shall coordinate with piping, ductwork, equipment and egress points clear of interferences.

## 1.2 RELATED SECTIONS

15 Mechanical

16 00 Electrical

## 1.3 REFERENCES

A. Standards referenced in this Section are:
1. UL 844, Electric Lighting Fixtures for Use in Hazardous Locations.
2. UL 935, Fluorescent-Lamp Ballasts.

## 1.4 QUALITY ASSURANCE

A. Regulatory Requirements
1. NEC Article 410, Luminaires (Lighting Fixtures), Lampholders, and Lamps.

## 1.5 SUBMITTALS

A. Submit the following:
1. Shop Drawings:
a. Manufacturer’s technical information for lighting controls proposed.
b. Wiring diagrams.
2. Product Data:
a. Manufacturer’s catalog cuts and technical information for lighting fixtures proposed.
b. Fixture construction details.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fixtures shall be complete with supports, ballasts, lamps, and incidentals, as required.

B. Lamps:
1. Fluorescent: Fluorescent lamps shall be toxic characteristic leaching procedure (TCLP) compliant for low mercury content. Linear fluorescent lamps shall be T8, energy efficient, extended life type. Compact fluorescent lamps shall be long life, energy efficient type.
2. High Pressure Sodium: Shall be TCLP compliant for low mercury content. Lamps shall be clear with high efficacy and lumen maintenance.
3. Metal Halide: Shall be designed for low mercury content and be TCLP compliant when available. Lamps shall be clear pulse start type with high efficacy and lumen maintenance.
4. Incandescent: Inside frosted.
5. Spare: Ten percent spare lamps of each type and wattage.

C. Ballasts:
1. Fluorescent: UL 935 listed, high power factor, energy efficient type, equipped with thermal protectors (Type “P” ballast), compatible with lamps installed. All indoor two- lamp fluorescent ballasts shall be electronic type with a total harmonic distortion of less than 20 percent. Ballast factor shall be 0.85 minimum with a total of less than 61 watts input. Cold weather type ballast shall be provided where noted in the Fixture Schedule.
2. High Intensity Discharge: UL 1029 listed, high power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
3. Ballasts sound level shall be 30 decibels or less, sound rating “A”.
4. Ballasts shall be Edison Testing Laboratories (ETL) listed and Certified Ballast Manufacturer Association, CMB certified.
5. For fixtures utilizing double-ended lamps, provide fixture disconnecting means within the fixture.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision where necessary to clear conflicts and obstructions.

B. Surface Mounted Fixtures: Attach to appropriate outlet box. Attach to surface using fasteners and sealing washers when mounting fixture in damp or wet locations.

D. Boxes and Fixtures:
1. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers, or Unistrut.

2. Do not install boxes with open conduit holes.
3. Cable each circuit and identify with tag.

E. Mounting Heights: Mounting heights or elevations are to bottom of fixture or to centerline of device.

F. Re-lamp all existing fluorescent fixtures with new lamps prior to completing work.

G. Mount fixtures so that sufficient access is provided for ready and safe maintenance.

J. Install fixtures in conformance with manufacturer recommendations

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the liquid pressure process measurement devices, associated controllers and related accessories.

B. The devices shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

C. Refer to Section 01010 Attachment “B” – Key Process Equipment List for the parts numbers and models.

## 1.2. RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on the liquid pressure process measurement devices.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the devices.

2. Data on the characteristics and performance of the devices.

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

## 1.4 QUALITY ASSURANCE

A. The devices covered by this Section is intended to be standard liquid pressure measurement devices, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such devices. The

devices furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that devices which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each device shall include Operating and Maintenance manual (if applicable).

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Dwyer Instrument or approved equal

2.2 CONSTRUCTION

A. MEMBRANE VACUUM SWITCH (VS-1)

1. Differential Pressure Switch, model series 1950, with an adjustable operating range of 4 – 20 IWC and a minimum and maximum deadband of 0.40 and 0.60 respectively, and is CE and UL, CUL, CSA, and FM approved.

2. The power supply 120V.

3. Mounted in a vertical position with 1/8” FNPT process connections.

B. DIFFERENTIAL PRESURE SWITCH (DPS-1)

1. Differential Pressure Switch, model series 1950, with an adjustable operating range of 4 – 20 IWC and a minimum and maximum deadband of 0.40 and 0.60 respectively, and is CE and UL, CUL, CSA, and FM approved.

2. The power supply 120V.

3. Mounted in a vertical position with 1/8" FNPT process connections.

C. PRESSURE SWITCH (PS-101 through PS-110)

1. Diaphragm Pressure Switch, model number CS-10, with adjustable operating range of 1-10 psig and a fixed dead-band value of 0.4 psig, and is CE and UL and CUL approved.

2. The power supply 120V.

3. Mounted with a ¼" FNPT fitting in any position.

2.1 CONTROL

A. The device shall be used to monitor the operating pressure, breaking the 120VAC circuit, if the operating pressure is above the adjustable set point of the device.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. After the devices and process connections (if applicable) are completely installed, adjust the operating pressures settings on each device, and conduct such tests as are necessary to indicate that devices function as required by the Specifications. Field tests shall be performed on all devices furnished under this Section. Supply all electric power, labor, process piping (as necessary) required to complete the field tests.

B. If the device performance does not meet the Specifications, corrective measures shall be taken, or the device shall be removed and replaced with devices which satisfy the operating parameters specified.

C. Any devices which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the flow process measurement devices, associated controllers and related accessories.

B. The devices shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

C. Refer to Section 01010 Attachment “B” – Key Process Equipment List for the parts numbers and models.

## 1.2. RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on the flow process measurement devices.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the flow process measurement devices.

2. Data on the characteristics and performance of the flow process measurement devices.

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

## 1.4 QUALITY ASSURANCE

A. The devices covered by this Section is intended to be standard flow process measurement devices, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such devices. The devices furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that devices which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each device shall include Operating and Maintenance manual (if applicable).

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. GF Signet LLC or approved equal

2.2 CONSTRUCTION

A. FLOW METER TRANSMITTER (FMT-1) – PADDLEWHEEL ASSEMBLY

1. FMT-1 Flow Senor Signet Paddlewheel, model number 3-8512-PO, with a Panel Mount Signet 9900 Transmitter (see 2.2 B below), model number 3-9900-1P, which are manufactured under ISO 9001 and 14001 and FM and CE approved.

2. The power supply is 24VDC.

3. Mounted with in a ½" PVC Sch 80 Pipe, Signet model number MPV8T005 in a horizontal position.

4. Installation requires (5) pipe diameter lengths upstream and (2) pipe diameter lengths downstream.

B. FLOW METER TRANSMITTER (FMT-1) – TRANSMITTER ASSEMBLY

1. FMT-1 Panel Mount Signet 9900 Transmitter, model number 3-9900-1P, manufactured under ISO 9001 and 14001 and FM and CE approved.

2. Power supply 24VDC.

3. Signal Output – 4-20milliamps.

4. Display mounted locally.

2.1 CONTROL

A. The device shall be used to monitor the total process flow rate, by taking the 4-20 mA signal generated by the paddlewheel and converting the signal to a flow rate (gpm), display at the control panel. The device shall have a flow totalizing function (total accumulated gallons dispayed).

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. After the devices and process connections (if applicable) are completely installed, conduct such tests as are necessary to indicate that devices function as required by the Specifications. Field tests shall be performed on all devices furnished under this Section. Supply all electric power, labor, process piping (as necessary) required to complete the field tests.

B. If the device performance does not meet the Specifications, corrective measures shall be taken, or the device shall be removed and replaced with devices which satisfy the operating parameters specified.

C. Any devices which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the electrical-operated primary control valves, associated controllers and related accessories.

B. The device shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

C. Refer to Section 01010 Attachment “B” – Key Process Equipment List for the parts numbers and models.

## 1.2. RELATED SECTIONS

15 00 00 Mechanical

16 00 00 Electrical

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01 33 00, “Submittals”, information on the electrical-operated primary control valves.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the electrical-operated primary control valves.

2. Data on the characteristics and performance of the electrical-operated primary control valves.

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

## 1.4 QUALITY ASSURANCE

A. The devices covered by this Section is intended to be standard electrical-operated primary control valves, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such devices. The devices furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that devices which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each device shall include Operating and Maintenance manual (if applicable).

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Johnson Controls, Inc. or approved equal

2.2 CONSTRUCTION

A. MOTOR IZED VALVE (MV-1)

1. VG1000 Series Two-Way, Plated Brass Trim, NPT End Connections Ball Valve with Spring Return Electric Actuator with End Switch, model number VG1241BL+943BUB, normally closed with end switches and a close off rating of 200 psig.

2. Power supply 120V.

3. Mounted with a ¾" FNPT fitting in any position.

2.1 CONTROL

A. The device shall be used to control water feed to the injection system, MV-1 will be de-energized by the PLC due to a General Alarm condition or during power outages, therefore stopping the water feed to the injection system.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. After the devices and process connections (if applicable) are completely installed such tests as are necessary to indicate that devices function as required by the Specifications. Field tests shall be performed on all devices furnished under this Section. Supply all electric power, labor, process piping (as necessary) required to complete the field tests.

B. If the device performance does not meet the Specifications, corrective measures shall be taken, or the device shall be removed and replaced with devices which satisfy the operating parameters specified.

C. Any devices which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1. GENERAL

## 1.1. DESCRIPTION

A. This section of the specification describes the solenoid primary control valves, associated controllers and related accessories.

B. The device shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

C. Refer to Section 01010 Attachment “B” – Key Process Equipment List for the parts numbers and models.

## 1.2. RELATED SECTIONS

15 Mechanical

16 Electrical

## 1.3. SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”, information on the solenoid primary control valves.

B. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the solenoid valve.

2. Data on the characteristics and performance of the solenoid valve.

3. Manufacturer's wiring diagrams for instrumentation and control system, including necessary field connections (if required).

## 1.4 QUALITY ASSURANCE

A. The devices covered by this Section is intended to be standard solenoid primary control valves, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such devices. The devices

furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that devices which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.5 MAINTENANCE

A. The manufacturer shall provide a minimum 1 year warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each device shall include Operating and Maintenance manual (if applicable).

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. ASCO or approved equal

2.2 CONSTRUCTION

A. SOLENOID VALVES (SV-101 THROUGH SV-110)

1. Pilot Operated General Service Solenoid Valves, catalog number 8210G94, normally closed, with an operating pressure differential of 150 psi for air and water, and is CSA certified and meets CE directives.

2. Power supply 120V.

3. Mounted with a ½" FNPT fitting in any position.

2.1 CONTROL

A. The device shall be used to control injection of fluids to an individual injection point, the PLC will energize the solenoid valve when fluids can be injected (i.e. no alarm conditions are present), while the solenoid valve will be de-energized by the PLC due to an alarm conditions or during power outages and therefore stop the injection of fluids.

PART 3. EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. After the devices and process connections (if applicable) are completely installed such tests as are necessary to indicate that devices function as required by the Specifications. Field tests shall be performed on all devices furnished under this Section. Supply all electric power, labor, process piping (as necessary) required to complete the field tests.

B. If the device performance does not meet the Specifications, corrective measures shall be taken, or the device shall be removed and replaced with devices which satisfy the operating parameters specified.

C. Any devices which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

# PART 1 GENERAL

## 1.1 DESCRIPTION

A. This scope of work is to manufacture, install, wire, test and start-up the control panels for two remediation equipment trailers to be deployed at the MRC site. The control panels shall be UL-508A listed. Each control panel shall be based on a programmable logic controller (PLC), a local Human Machine Interface (HMI) and a cellular gateway (cellular transmission) to enable remote parameter monitoring and direct control over the process by authorized users.

B. The Control System consists of a Main Process PLC and local HMI housed in a control panel and monitored by an operator located in a remote location. The PLC will control the injection process via hardwired I/O to instrument devices located in each injection trailer. The local HMI will display the process information, trend process variables, and display process alarms. Alarm notification will be handled by the local HMI and sent via an internet connection in the form of an email or text message. Each equipment trailer control system will communicate through its own internet connection via the cellular device located in each trailer which will have unique IP addresses, thus two data packages are required from the selected cellular carrier. The local HMI will be the main interface with the control system for the operator when at the injection trailer. A laptop will be used by the operator at the site for making changes to the control system. Alarms and historical trending data will be downloaded to a flash drive by the operator for later use.

C. This specification, including all attachments, establishes the minimum requirements for the design, components, fabrication, programming, testing and delivery of the Equipment.

## 1.2 RELATED SECTIONS

A. 15 Mechanical

B. 16 Electrical

C. 16290 Process Control Software Inputs / Outputs List

D. Electrical Drawings

1) E-8 SINGLE LINE ELECTRCIAL DIAGRAM
2) E-9 CONTROL SYSTEM ARCHITECHTURE
3) E-10 CONTROL PANEL LAYOUT (control panel internal and external views)

## 1.3 REFERENCES

A. NFPA 70, "National Electrical Code" – hereinafter NEC

B. NEC 409, “Industrial Machines”.

C. UL 508, "Standard for Industrial Control Equipment"

D. Various codes, standards, or other documents that are mentioned by short-form name elsewhere in the drawings or specification are fully identified below.

1) ANSI - American National Standards Institute
2) EPA - Environmental Protection Agency
3) FM - Factory Mutual
4) IEC - International Electrotechnical Commission
5) IEEE - Institute of Electrical and Electronic Engineer and/or its representatives
6) ISA - International Society of Automation
7) NEC - National Electric Code
8) NEMA - National Electrical Manufacturers' Association
9) NFPA - National Fire Protection Association
10) NIST - National Institute of Standards and Technology
11) OSHA - Occupational Safety and Health Administration
12) UL - Underwriters Laboratory

## 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of Control Panels for (10) or more years.

B. Control Panel Manufacturer Services must include at a minimum:

1) UL® 508A Certification
2) Product Design & Development
3) Industrial & Electronic Controls
4) Process Control Systems
5) QC Testing
6) CAD Drawing Preparation
7) In-House Engineering Support

C. Factory Tests

1) The Contractor shall perform all factory tests necessary to insure that the material and workmanship are of the required quality and that the equipment furnished will perform as specified and guaranteed. The Engineer and/or its representatives reserve the right to witness all factory tests. The Contractor shall notify the Engineer and/or its representative at least two (2) weeks in advance of the tests.
2) The Contractor shall perform his standard factory testing on the control panels which progressively check the assembly, programming and wiring systems.
3) The Contractor shall confirm all assembly, programming and wiring has been accomplished in accordance with drawings and documents approved by the Engineer and/or its representative. The Contractor shall test each circuit and each piece of control panel mounted electrical equipment prior to shipment of the control panel.
4) The Contractor shall as a minimum perform the following factory tests on each control panel and control panel wiring system:

a. Dimensional check of the control panels and inspection of the control panels for compliance with approved drawings.
b. Point to point wiring continuity check to confirm all wiring has been installed in accordance with the drawings.
c. A complete operational check of the program and all control panel mounted equipment shall be performed by the Contractor.
d. The Contractor shall prepare detailed procedures for all factory testing and submit it to the Engineer and/or its representative for review and approval prior to testing. Factory test reports, including certified complete and signed off copies of the Contractor's factory test procedures shall be prepared by the Contractor, made available for inspection at the factory acceptance test, and then copies

D. Factory Acceptance Testing

1) After the completion of all factory testing, the Contractor shall conduct a Factory Acceptance Test (FAT) to be witnessed by the Engineer and/or its representative. The FAT shall entail a visual inspection of the control panels, power up of the control panels, functional check of control panel mounted components, and a complete point to point checkout.

2) The FAT of the control panels shall be a part of a full “wet” system testing as described in Section 3.8.8. of the Design Report.

3) The Contractor shall provide the Engineer and/or its representative a minimum of 2 weeks advance notice for final scheduling the FAT.

4) The Contractor shall provide copies of the proposed HMI screens for review by the Engineer and/or its representative for review and approval prior to testing.

5) The Contractor shall prepare a FAT Test Report upon completion of the FAT which shall document the test, including procedural steps signed off by the FAT attendees' representatives and an itemized list of all open action items resulting from the FAT.

6) Upon the Contractor's certification of completion of all FAT open action items and the Engineer and/or its representative's confirmatory re-inspection (if required), the Engineer and/or its representative shall release the Contractor for shipment of the control panels.

## 1.5 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”.

B. The list below provides a list of documents that identifies the drawings and data which must be supplied by the Contractor to complete the contract requirements.

1) Engineering, Documentation, Configuration, Fabrication Schedule

2) Product Data including descriptive literature and manufacturer’s cut sheets

3) Control Panel Layout and Wiring Drawings, including Complete Bill Of Materials

4) Copies of HMI Screens

5) As-Built Control Panel Layout, Bill Of Materials and Operation & Maintenance Manual

C. A single compact disc copy, AutoCAD version 2006 of the Contractor's approved drawings shall be submitted to the Engineer and/or its representative. Contractor shall confirm compliance with this requirement in his bid or advise as to why this requirement cannot be met.

D. Two hard copies and one electronic copy of the final operation and maintenance manual are to be provided upon delivery.

1.6 MAINTENANCE / WARRANTY

A. The Contractor shall guarantee that the assembled and tested control panels furnished are mechanically and electrically complete, free of defects, and constructed of new materials designed for the service intended.

B. The Contractor shall also guarantee that the control panels will meet the requirements set forth in this specification and, furthermore, that the control panels will be free from defective parts for one (1) year from startup date.

PART 2 PRODUCTS

A. Control Panel Enclosure

1) All controls will be housed within a UL listed, NEMA 12 enclosure as manufactured by Hoffman or approved equal,

2) In addition to the attached panel drawings, must include at a minimum:

a) Programmable Logic Controller (PLC)
b) Color Human Machine Interface (HMI)
c) DC power supply (if needed)
d) Side Mounted Emergency Stop Button
e) Heating and Cooling, as required

B. Major Control Components

1) Specifications for the major panel components are described in this section. All other minor components (motor starters, overloads, terminal blocks, etc) will be based upon approval of contractor recommended devices.

2) As manufactured by:

a. Square D
b. Allen Bradley
c. Approved equal

C. Programmable Logic Controller (PLC)

1) The system will be controlled by a DIN mountable programmable logic controller (PLC) with sufficient input/out modules for all field connections.

2) The PLC will be an Allen Bradley CompactLogix I/O or approved equivalent.

D. Human Machine Interface (HMI)

1) The system operation and status will be accessible via a Human Machine Interface (HMI).

2) The HMI will be a C-more EA7-T12C, or approved equivalent.

E. Cellular Gateway – with Static IP Address

1) Remote communication with the HMI will be via ethernet gateway wireless static IP.

2) The Cellular Gateway be an AirLink™ Raven XE as manufactured by Sierra Wireless or approved equivalent

F. Uninterruptable Power Supply (UPS)

1) The panel will have an uninterruptable power supply (UPS) capable of maintaining the system controls for a period of time following any loss of primary power.

2) Refer to specification 16 28 00

G. Computer Hardware & Software Components

1) Required computer hardware shall include:

a. One (1) Dell laptop, Windows 7 w/Microsoft Office, 4GB Ram, 250 GB Hard Drive. or approved equivalent
b. 2GB Sandisk Cruzer USB Memory device. or approved equivalent
c. Rockwell Automation RSLogix Programming Cable or approved equivalent
d. Automation Direct Item Code USB-CBL-AB15 – USB 2.0, Type A-B Connector Cable, 15 feet. or approved equivalent

2) Required software shall include:

a. Rockwell Automation RSLogix Standard Edition or approved equivalent
b. Automation Direct Item Code EA-PGMSW – C-More touch panel programming software or approved equivalent

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Panel Construction shall be in accordance with reviewed product data, engineer approved final drawings, and control panel contractor's manufacturing procedures

B. Refer to specification 16170 Identification for Electrical Systems for labeling requirements.

C. Refer to specification 16110 Low-Voltage Electrical Power Conductors and Cables; 16120 Control-Voltage Electrical Power Cables for further construction requirements.

### 3.2 TESTING

A. Refer to Quality Assurance Sections 1.4 C & 1.4 D for details regarding final system testing.

END OF SECTION

# PART 1 GENERAL

## 1.1 DESCRIPTION

A. The CONTRACTOR shall furnish a complete Uninterruptible Power Supply system, as specified herein, and hereafter referred to as the "UPS", to provide continuous, regulated AC power to critical loads (i.e. PLC) under normal and abnormal conditions, including loss of the utility AC power.

B. The device shall be installed as indicated on the plans, as recommended by the supplier, and in compliance with all OSHA, state, local, and federal codes and regulations.

## 1.2 RELATED SECTIONS

A. 15 Mechanical

B. 16 Electrical

## 1.3 REFERENCES

A. NEMA Standards Publication “PE-1 2003, Uninterruptible Power Systems (UPS) – Specification and Performance Verification”

B. NFPA 70, "National Electrical Code" – hereinafter NEC.

C. UL 1778, "Uninterruptible Power Systems (UPS)”

## 1.4 SUBMITTALS

A. Submit in accordance with Section 01330, “Submittals”, information on the UPS system.

B. Provide Run-time (minutes) versus Load (watts) calculations based on the PLC, HMI, and Critical Control Device load summary.

C. Product Data shall include at least the following:

1. Descriptive literature, bulletins, and/or catalogs of the UPS system.

2. Data on the characteristics and performance of the UPS system.

3. Manufacturer's wiring diagrams.

1.5 QUALITY ASSURANCE

A. The devices covered by this Section is intended to be standard UPS System, as modified by this Section, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such devices. The devices furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein.

B. In the event that devices which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the Owner and be as approved by the Performing Contractor.

1.6 MAINTENANCE

A. The manufacturer shall provide a minimum 3 years repair or replace (excluding battery) and 2 year for battery warranty from time of shipment against defects in materials and workmanship on the device.

B. All work under this specification shall be the responsibility of the Contractor.

C. Each device shall include Operating and Maintenance manual.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. UPS Devices shall be as manufactured by:

1) APC

2) Or Approved Equal

2.2 CONSTRUCTION

A. UPS SYSTEM (SINGLE PHASE)

1. APC Smart-UPS 1500VA, part number SMT1500, with a 1000 watts/1500VA output power, sine wave, with (8) NEMA5-15R output connections and is cUL Listed, Energy Start (USA) rated, and UL 1778a certified.

2. Dry contact I/O SmartSlot Card with USB Cable to provide UPS functional status outputs for PLC real-time monitoring including battery load, battery status, etc. – APC part number AP9613.

3. Power supply 120V with a NEMA 5-15P input connection and replacement battery (model number RBC7).

4. Suitable for installation indoors with ambient temperatures from 0 - 40$^{o}$ C. (32 - 104$^{o}$ F.) and relative humidity from 0 - 95%.

2.3 CONTROL

A. The device shall be used to supply back up power to the PLC to allow for Operator Notification process to accrue in case of power interruption and/or failure.

1. Rating 7 minute battery (full load) ; 26 minute battery life (half load)

2. Calculations to be provided based on operating VA of Control Components connected to the UPS Device.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations in the locations shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. After the devices and process connections (if applicable) are completely installed such tests as are necessary to indicate that devices function as required by the Specifications. Field tests shall be performed on all devices furnished under this Section. Supply all electric power, labor, process piping (as necessary) required to complete the field tests.

B. If the device performance does not meet the Specifications, corrective measures shall be taken, or the device shall be removed and replaced with devices which satisfy the operating parameters specified.

C. Any devices which are damaged as a result of testing or which fail to meet the requirements of these Specifications shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

A. The Control System consists of a Main Process PLC and local HMI housed in a control panel and monitored by an operator located in a remote location. The PLC will control the injection process via hardwired I/O to instrument devices located in each injection trailer. This specification details the PLC Process Control Inputs and Outputs.

1.2 RELATED SECTIONS

A. 15 Mechanical

B. 16 Electrical

C. 16270 PLC and HMI Hardware and Software

1.3 REFERENCES

A. NFPA 70, "National Electrical Code" – hereinafter NEC

B. NEC 409, “Industrial Machines”.

C. UL 508, "Standard for Industrial Control Equipment"

1.4 QUALITY ASSURANCE

A. The PLC Process Control Inputs and Outputs will be tested as an integrated system.

B. Factory Tests

1) The Contractor shall perform all factory tests necessary to insure that the material and workmanship are of the required quality and that the equipment furnished will perform as specified and guaranteed. The Engineer and/or its representatives reserve the right to witness all factory tests. The Contractor shall notify the Engineer and/or its representative at least two (2) weeks in advance of the tests.
2) The Contractor shall perform his standard factory testing on the control panels which progressively check the assembly, programming and wiring systems.
3) The Contractor shall confirm all assembly, programming and wiring has been accomplished in accordance with drawings and documents approved by the Engineer and/or its representative. The Contractor shall test each circuit and each piece of control panel mounted electrical equipment prior to shipment of the control panel.
4) The Contractor shall as a minimum perform the following factory tests on each control panel and control panel wiring system:
    a. Dimensional check of the control panels and inspection of the control panels for compliance with approved drawings.

b. Point to point wiring continuity check to confirm all wiring has been installed in accordance with the drawings.
c. A complete operational check of the program and all control panel mounted equipment shall be performed by the Contractor.
d. The Contractor shall prepare detailed procedures for all factory testing and submit it to the Engineer and/or its representative for review and approval prior to testing. Factory test reports, including certified complete and signed off copies of the Contractor's factory test procedures shall be prepared by the Contractor, made available for inspection at the factory acceptance test, and then copies

C. Factory Acceptance Testing

1) After the completion of all factory testing, the Contractor shall conduct a Factory Acceptance Test (FAT) to be witnessed by the Engineer and/or its representative. The FAT shall entail a visual inspection of the control panels, power up of the control panels, functional check of control panel mounted components, and a complete point to point checkout.
2) The Contractor shall provide the Engineer and/or its representative a minimum of 2 weeks advance notice for final scheduling the FAT.
3) The Contractor shall provide copies of the proposed HMI screens for review by the Engineer and/or its representative for review and approval prior to testing.
4) The Contractor shall prepare a FAT Test Report upon completion of the FAT which shall document the test, including procedural steps signed off by the FAT attendees' representatives and an itemized list of all open action items resulting from the FAT.
5) Upon the Contractor's certification of completion of all FAT open action items and the Engineer and/or its representative's confirmatory re-inspection (if required), the Engineer and/or its representative shall release the Contractor for shipment of the control panels.

## 1.5 SUBMITTALS

A. Submit in accordance with Section 01300, “Submittals”

B. Submit PLC Inputs / Outputs Listing to Engineer for approval and programming.

# PART 2 PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

A. The Control Panel Contractor as selected in specification 16270

PART 3 EXECUTION

3.1 INSTALLATION

A. PLC Input List - PRELIMINARY

| PLC Input | | | |
|---|---|---|---|
| Type | Device P&ID Symbol | Source device | Function |
| Analog signal | PT-1 | Pressure Transmitter | High and low pressure set points. |
| Discrete signal | LSHH-1 | Secondary containment level switch | Relay contact opens when liquid is sensed. |
| Discrete signal | LSHH-2 | Secondary containment level switch - redundant | Relay contact opens when liquid is sensed. |
| Discrete signal | DPS-1 | Differential pressure switch | Relay contact opens when high differential pressure set-point exceeds (>5 psi differential pressure) |
| Discrete signal | VS-1 | Vacuum switch | Relay contact opens when low-vacuum set-point exceeds (<20 inches of mercury vacuum) |
| Discrete signal | PS-101 to 110 | Individual line pressure switch | Relay contact opens when pressure set-point exceeded (1 psig for southeast area, 2 psig for southwest area, and 8 psig for north area |
| Analog signal | FM-1 | Flow meter | 4–20 mA analog signal proportional to flow |
| Discrete signal | HTS-1 | Temperature switch (high) | Relay contact opens when high-temperature set-point exceeds (>100$^{o}$F) |
| Discrete signal | LTS-1 | Temperature switch (low) | Relay contact opens when low-temperature set-point exceeds (<35$^{o}$F) |

| | | | |
|---|---|---|---|
| Discrete signal | CS-1 | Current sensor | Relay contact opens when power lost |
| Discrete Signal | CS-2 | Current sensor to UPS | Relay contact opens when power to control panel is lost |

B. PLC Output List - PRELIMINARY

| PLC Output | | |
|---|---|---|
| Type | Logic | Function |
| General alarm | When 4–20 mA analog signal from PT-1 exceeds high- pressure set- point (>30 psi)switch to alarm status until cleared by operator | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |
| General alarm | When 4–20 mA analog signal from PT-1 declines below low-pressure alarm set-point (<5 psi), switch to alarm status until cleared by operator | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |
| General alarm | When LSHH-1 opens, switch to alarm status until cleared by operator. | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |
| General alarm | When LSHH-1 opens, switch to alarm status until cleared by operator. | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |
| General alarm | When DPS-1 opens, switch to alarm status until cleared by operator. | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |
| General alarm | When VS-1 opens, switch to alarm status until cleared by operator. | De-energize MV-1, MP-1, MP-2, SV-101 to SV-110, notify operator |

| | | |
|---|---|---|
| Notify the remote operator | When PS-101 to 110 opens, close associated solenoid valve SV-101 to 110 until cleared by operator. | De-energize individual SV-101 to 110 |
| Notification alarm | When HTS-1 opens, switch to alarm status until cleared by operator. | Notify operator |
| Notification alarm | When LTS-1 opens, switch to alarm status until cleared by operator. | Notify operator |
| Notification alarm | When CS-1 opens, switch to alarm status until cleared by operator. | Notify operator |
| Notification alarm | When CS-2 opens, switch to alarm status until cleared by operator | Notify operator |

END OF SECTION

# APPENDIX F—EQUIPMENT AND MATERIALS VENDOR INFORMATION

# GRANULAR ACTIVATED CARBON VESSEL

# PG Series Polyglass Adsorbers

## PG180, PG500, PG750, PG1100, PG1400, PG2200, PG5000

### Applications

Siemens Water Technologies offers a full line of polyglass liquid phase adsorbers engineered to remove contaminants from high pressure liquid streams while providing maximum corrosion resistance. These adsorbers are manufactured with fiberglass reinforced resin and an inner polyethylene liner. The PG series adsorbers can be utilized by industrial, municipal, or commercial users in a variety of applications.

- Decolorization
- Product Purification
- Process Water Filtration
- Groundwater Remediation
- Wastewater Treatment
- Drinking Water Treatment

### Installation, Startup and Operation

Siemens Water Technologies can provide a total service package that includes utilizing OSHA trained personnel providing on-site carbon changeouts, packaging and transportation of spent carbon for recycling at our reactivation facilities.

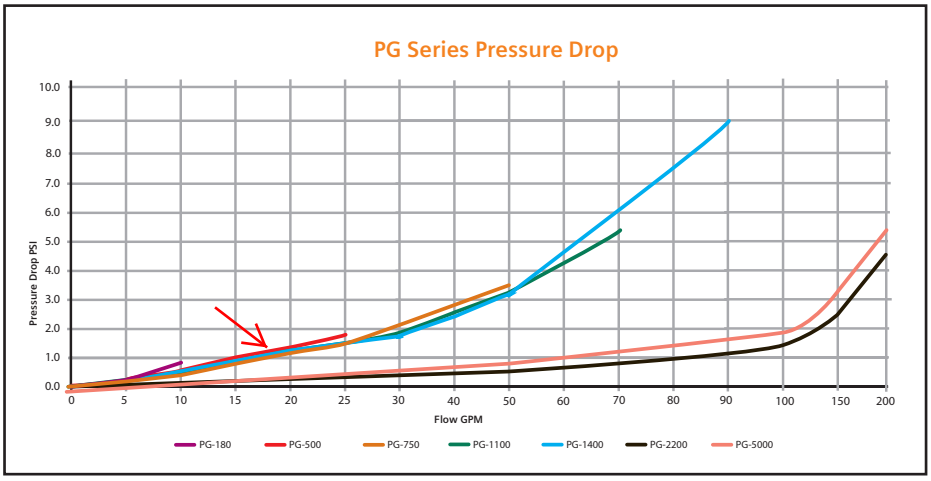
At the time of purchase or rental of the adsorbers, arrangements should be made for the reactivation of the spent carbon. Siemens Water Technologies will provide instructions and assistance on how to obtain acceptance of the spent carbon at our reactivation facilities. Spent carbon cannot be accepted for reactivation until the acceptance process is completed.

### Benefits & Design Features

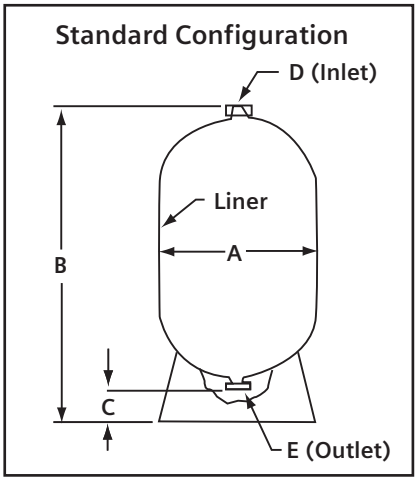
- Durable, Fiberglass Reinforced Resin construction – provides strength for high pressure applications and protection from corrosive environments
- Polyethylene liner and Polypropylene Internal Fittings – provides excellent internal protection against corrosive liquids
- Optional Transport Frame provided for easy transport and installation
- Optional Carbon Fill and Discharge piping (Schedule 80 PVC) provided for slurry carbon transfer
- Available for Purchase or Rental
- Approved for the transport of hazardous spent carbon (when supplied with optional Transport Frame)
- Maximum working pressure of 100 psig (689 kPa) for model PG5000, and maximum working pressure of 150 psig (1034 kPa) for all other models
- Temperature Limit of 140°F (60 C)

| Dimensions and Capacities | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Adsorber | A inches | B inches | C inches | D inches | E inches | Max. Flow (GPM) | Approximate Carbon Fill (lbs.) | Empty Shipping Weight (lbs.)(See NOTE) | Est. Operating Weight (lbs.) |
| PG180 | 24 | 60 | 12 | 3 | 3 | 10 | 180 | 100 | 460 |
| PG500 | 30 | 89 | 10 | 3 | 3 | 35 | 500 | 211 | 1211 |
| PG750 | 36 | 91 | 11 | 3 | 3 | 50 | 750 | 285 | 1785 |
| PG1100 | 42 | 89 | 11 | 3 | 3 | 65 | 1100 | 400 | 2600 |
| PG1400 | 48 | 93 | 11 | 3 | 3 | 90 | 1400 | 494 | 3294 |
| PG2200 | 63 | 109 | 27 | 3 | 3 | 175 | 2200 | 950 | 5350 |
| PG5000 | 63 | 169 | 27 | 3 | 3 | 200 | 5000 | 1398 | 11398 |

***Note:*** *PG adsorbers without Transport Frame must ship empty of carbon. If Transport Frame is included, units may ship filled with carbon. Approximate weight of units with Transport Frame are 350 lbs. higher than empty shipping weights shown above.*
***Note:*** *Standard vessels are furnished with FNPT inlet and outlet fittings. Other optional fittings can be provided as required.*




*Pressure drop in psi through vessel filled with 8x30 carbon*




Safety Note: Wet activated carbon readily adsorbs atmospheric oxygen. Dangerously low oxygen levels may exist in closed vessels or poorly ventilated storage areas. Workers should follow all applicable state and federal safety guidelines for entering oxygen depleted areas.

Siemens makes no warranties as to completeness of information. Users are responsible for evaluating individual product suitability for specific applications. Siemens assumes no liability whatsoever for any special, indirect or consequential damages arising from the sale, resale or misuse of its products. All information presented herein is believed reliable and in accordance with accepted engineering practice.

Siemens
Water Technologies
866.613.5620 phone

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WS-PGdr-DS-0910
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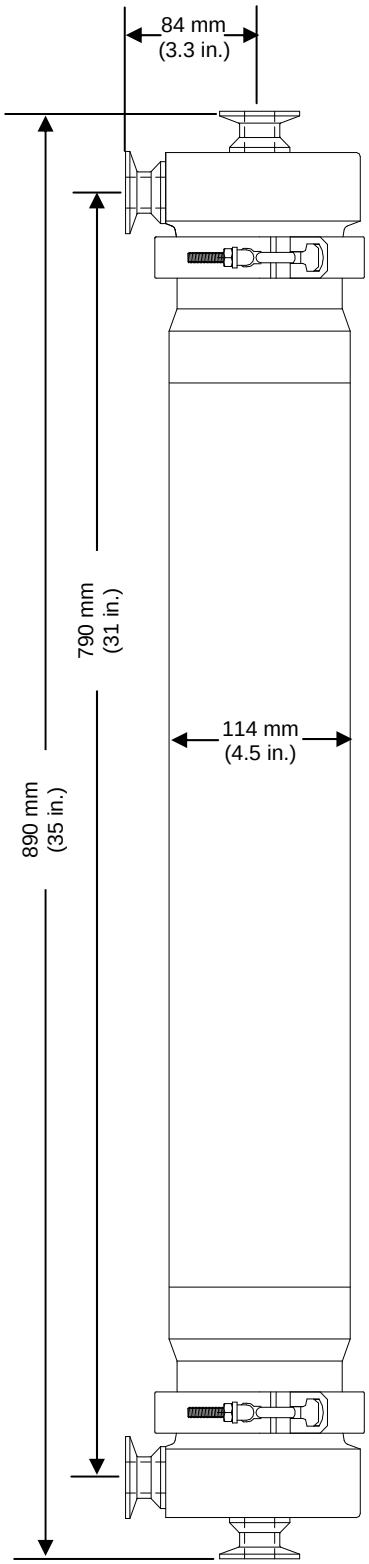
The information provided in this literature contains merely general descriptions or characteristics of performance which in actual case of use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of the contract.

# HOLLOW MEMBRANE CONTACTOR

# 4 x 28 EXTRA-FLOW PRODUCT DATA SHEET




## Cartridge Characteristics

| | | |
|---|---|---|
| **Cartridge Configuration** | Extra-Flow with Center Baffle | |
| **Liquid Flow Guidelines** | 1 – 6.8 $m^3$/hr (4.4 – 30 gpm) | |
| **Membrane** | **X50** | **X40** |
| | Recommended for $CO_2$ removal from water | Recommended for all other gas transfer applications |
| Porosity | ~40% | ~25% |
| OD / ID | 300 / 220 micron | 300 / 200 micron |
| **Membrane / Potting Material** | Polypropylene / Polyethylene | |
| **Typical Membrane Surface Area** | 20 $m^2$ (215 $ft^2$) | |
| **Maximum Shellside Working Temperature/Pressure of fiber*** *[Using 50 mm vacuum on Lumenside. Add 1.05 kg/$cm^2$ (15 psig) when vacuum is not used.]* | 50°C, 7.4 kg/$cm^2$ or 7.3 bar<br>70°C, 2.1 kg/$cm^2$ or 2.0 bar<br>(122°F, 105 psig)<br>(158°F, 30 psig) | |
| **Priming Volume** | Shellside<br>Lumenside X50<br>Lumenside X40 | 4.2 liters (1.1 gal.)<br>1.3 liters (0.35 gal.)<br>1.1 liters (0.29 gal.) |

## Housing Characteristics

| **Material** | **Polypropylene** | **PP Lined FRP** | **316L SS** |
|---|---|---|---|
| **Flange Connection** | | | |
| Shellside (Liquid Inlet/ Outlet) | • 1 inch Sanitary<br>• ¾ inch NPT Female<br>• 1 inch George Fisher<br>• Rc ¾ per JIS B0203 | | • 1 inch Sanitary |
| Lumenside (gas/vacuum) | • 1 inch 90° Sanitary<br>• ¾ inch 90° NPT Female<br>• Rc ¾ per JIS B0203 | | • 1 inch Sanitary |
| **Maximum Shellside Working Temp/ Pressure of Vessel** | 30°C, 7.4 kg/$cm^2$ or 7.3 bar<br>40°C, 4.9 kg/$cm^2$ or 4.8 bar<br>(86°F, 105 psig)<br>(104°F, 70 psig) | 50°C, 8.4 kg/$cm^2$ or 8.3 bar<br>70°C, 3.2 kg/$cm^2$ or 3.1 bar<br>(122°F, 120 psig)<br>(158°F, 45 psig) | 70°C, 10.5 kg/$cm^2$ or 10.3 bar<br>(158°F, 150 psig) |

## Seal Options

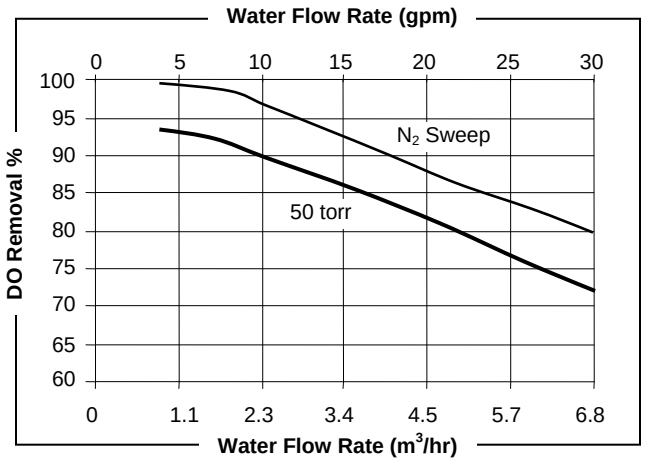
| **Material** | **Applications** |
|---|---|
| Viton | General Purpose |
| K-UPW | Ultra Pure Water |
| K-EXT | Chemical Extraction |
| Buna-N | Beverage |

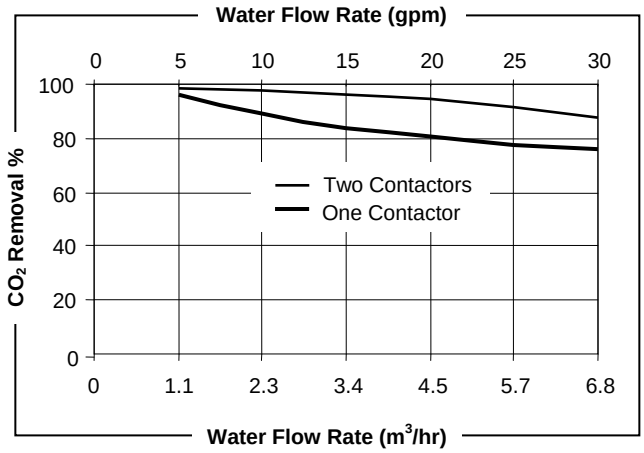
| **Weight** | **PP** | **PP Lined FRP** | **316L SS** |
|---|---|---|---|
| Dry (cartridge and housing) | 4.1 kg (9 lbs) | 4.8 kg (10.6 lbs) | 6.4 kg (14 lbs) |
| Liquid Full (shellside) | Additional 2.7 kg (6 lbs) | | |
| Cartridge only – dry | X50: 0.99 kg (2.2 lbs)<br>X40: 1.2 kg (2.7 lbs) | | |
| Shipping Weight | Additional 0.9 kg (2 lbs) | | |

***Note:*** *All dimensions are nominal values for the Polypropylene vessel. Dimensions for other housings are at www.liqui-cel.com*

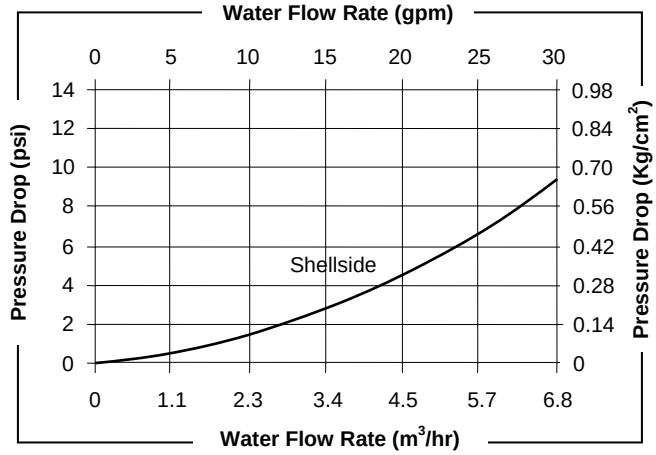
Liqui-Cel®
MEMBRANE CONTACTORS

# 4 x 28 EXTRA-FLOW PRODUCT DATA SHEET




Test Conditions: Air Vacuum Combo. 150 torr at 25 °C




| Cartridge Specifications | | |
|---|---|---|
| **Characteristics** | **Test Conditions** | **Specifications** |
| | | **X50 and X40** |
| Performance $0_2$ Removal | Shellside water flow: 27 gpm, 20°C (68°F). Lumenside $N_2$ Flow: 1 $ft^3$/min, 1.0 atm at 20°C | 78% minimum |
| Pressure Drop | Shellside water flow: 27 gpm, 20°C (68°F) | 7.7 psi maximum |

Curves represent nominal values, generated using water 20-25$^0$ C. Characteristics may change under different operating conditions.

*All components of the Liqui-Cel® Extra Flow Membrane Contactor, when used in accordance with recommendations given in our product literature for treatment of processing water, alcoholic and non-alcoholic beverages, and aqueous, acid and non-acid food products at and below ambient temperatures, are in compliance with all relevant FDA regulations as specified in Title 21 of the Code of Federal Regulations.*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**www.liqui-cel.com**

# VACUUM PUMP

# 71R/72R Series Twin Cylinder Vacuum Pump

## MODEL 71R645/71R655
**28” HG MAX. VACUUM, 4.5 CFM OPEN FLOW (60HZ)**

## MODEL 72R547/72R555 STAGED
**29” HG MAX. VACUUM, 2.6 CFM OPEN FLOW (60HZ)**

## MODEL 72R645/72R655
**28” HG MAX. VACUUM, 5.5 CFM OPEN FLOW (60HZ)**

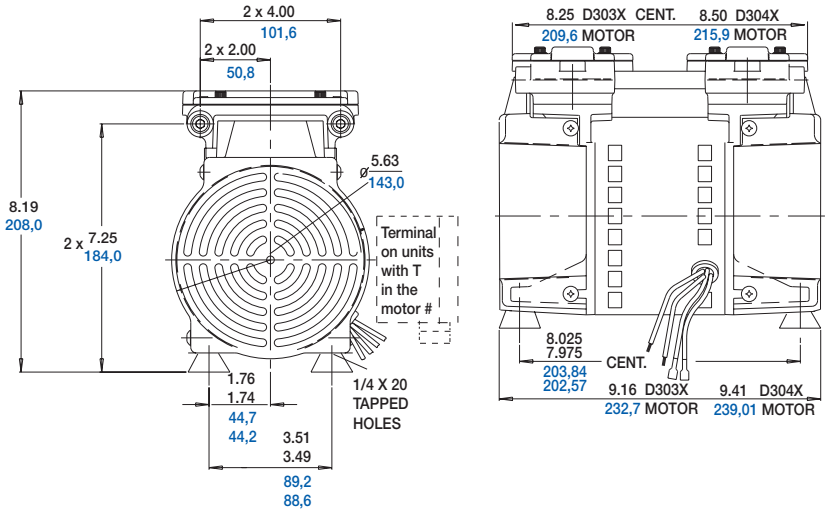
### PRODUCT FEATURES

- Oilless operation
- All wetted aluminum parts treated for corrosion protection from moisture
- Rugged motor shell construction

### INCLUDES

- Dry-cell capacitor AT250 (D303X Motors, AT251 (D304X Motor) - not pictured, shipped unattached
- Rubber feet (4) AF713A

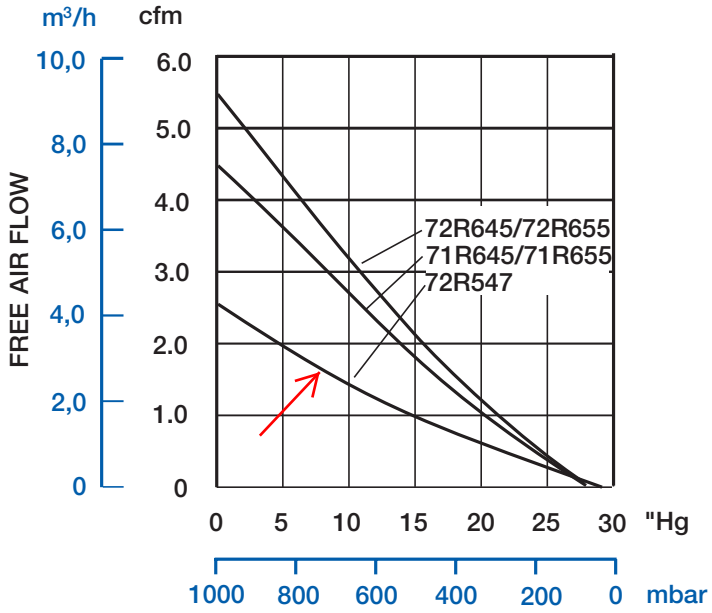
Product Dimensions (Inches, mm)



| Model Number | Motor | Motor Type | Parallel/ Staged | RPM 60 Hz | RPM 50 Hz | HP | kW | Wt. lbs. | Wt. kg |
|---|---|---|---|---|---|---|---|---|---|
| •71R645-V114-D303X | 115-60-1 | PSC (4 pole) | **Parallel** | 1650 | -- | 1/3 | 0,25 | 15.6 | 7,09 |
| •71R655-V114-D304X | 220-240-50-1 | PSC (4 pole) | **Parallel** | -- | 1425 | 1/3 | 0,25 | 16.0 | 7,27 |
| •72R547-V116-D303X | 115-60-1 | PSC (4 pole) | **Staged** | 1650 | -- | 1/3 | 0,25 | 15.6 | 7,09 |
| •72R645-V114-D303X | 115-60-1 | PSC (4 pole) | **Parallel** | 1650 | -- | 1/3 | 0,25 | 15.6 | 7,09 |
| •72R655-V114-D304X | 220-240-50-1 | PSC (4 pole) | **Parallel** | -- | 1425 | 1/3 | 0,25 | 16.0 | 7,27 |

•Units shipped with capacitor - unattached

Product Performance (U.S./Imperial, Metric)



# PARTICULATE FILTERS

# Model 6 Basket Strainer and Bag Filters

Strainers or Bag Filters:
Your Choice!

Model 6 strainer/filter housings are made in 3 sizes and 3 pressure ratings, and can serve as basket strainers (for particle retention down to 74 micron size) or as bag filters (for particle retention down to 1 micron size). In all cases, covers are easily removed without special tools, and the basket or bag is easily cleaned or replaced.

## Features

- Low pressure drops
- Permanently piped housings
- Covers are O-ring sealed
- Carbon steel, or stainless steel (304 or 316) construction for housings
- All housings are electropolished to resist adhesion of dirt and scale
- Easy to clean!
- Adjustable-height legs, standard
- O-ring seals: Buna N, EPR, Viton®, Teflon®
- ASME code stamp available
- Three pressure ratings: 150, 210 or 300 psi
- Duplex units are available
- Can provide 3.4 square feet of basket or bag surface area without need for ASME code construction
- Three basket depths: 12, 18, or 30 inches (nominal)
- Special alloys

## Options

- Sanitary construction
- Different outlet connections
- Higher pressure ratings
- Extra-length legs
- Heat jacketing
- Liquid displacers for easier servicing

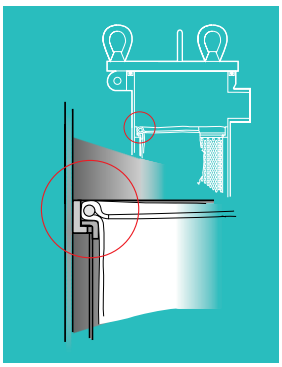
Covers are secured by three eyenut assemblies. One of them acts as a hinge, when the cover is opened.

## Choosing a Basket Strainer or Bag Filter

Choose between straining (removing particles down to 74 micron size) or filtering a fluid (removing particles down to 1 micron). This will direct you to the correct basket when ordering.

## Operation

Unfiltered liquid enters the housing above the bag or basket and passes down through them. Solids are contained inside the bag or basket, where they are easily and completely removed when the unit is serviced.



Fluid bypass around the basket is prevented because the outside diameter of the filter bag seals against the housing inside diameter.

A single cover gasket is used to seal the opening, and covers can be installed and removed without tools.

## Pressure Drop Data

Basket strainers and bag filters are usually selected so that the pressure drop does not exceed 2 psi, when they are clean. Higher pressure drops may be tolerated, when contaminant loading is low. Bag change should occur at 15psid.

The pressure drop data is accurate for all housings with strainer or bag filter baskets. When bag filters are added, total pressure drop becomes the sum of the pressure drop as determined by the steps below, plus the pressure drop through the bag as defined in Rosedale Filter Bag section.

### Follow these easy steps:

1. Using the desired pipe size and approximate flow rate, determine the basic pressure drop from the appropriate graph.
2. Multiply the pressure drop obtained in step 1 by the viscosity correction factor found in the accompanying table. This is the adjusted (clean) pressure drop for all baskets, without bag filters.
3. Add the pressure drop for the bag filter.

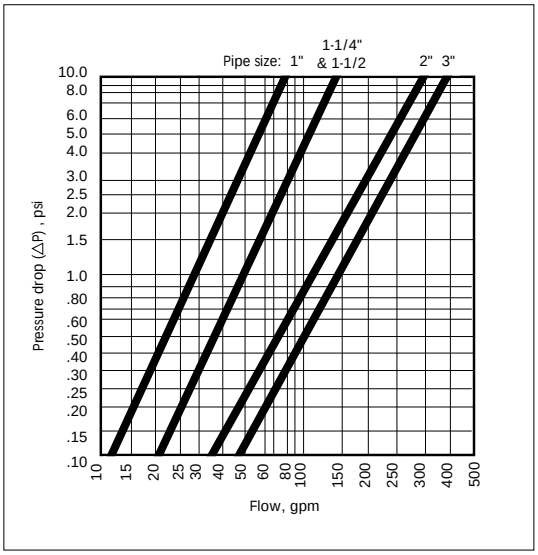
**Note:** Filter bags are specified separately. See page 134.

| | Viscosity, cps | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 ($H_2O$) | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | 2000 |
| All unlined baskets | .65 | .85 | 1.00 | 1.10 | 1.20 | 1.40 | 1.50 | 1.60 | 1.80 |
| 40-mesh lined | .73 | .95 | 1.20 | 1.40 | 1.50 | 1.80 | 1.90 | 2.00 | 2.30 |
| 60-mesh lined | .77 | 1.00 | 1.30 | 1.60 | 1.70 | 2.10 | 2.20 | 2.30 | 2.80 |
| 80-mesh lined | .93 | 1.20 | 1.50 | 1.90 | 2.10 | 2.40 | 2.60 | 2.80 | 3.50 |
| 100-mesh lined | 1.00 | 1.30 | 1.60 | 2.20 | 2.40 | 2.70 | 3.00 | 3.30 | 4.40 |
| 200-mesh lined | 1.30 | 1.70 | 2.10 | 3.00 | 3.40 | 3.80 | 4.40 | 5.00 | 6.80 |

## Basket Data

| Depth Nominal (inches) | Diameter (inches) | Surface Area (sq. ft.) | Volume (cu. in.) | Bag Size No. |
|---|---|---|---|---|
| 12 | 5 | 1.3 | 235 | 7 |
| 18 | 5 | 2.0 | 350 | 8 |
| 30 | 5 | 3.4 | 630 | 9 |

## Model 6–For flow rates to 100 gpm*



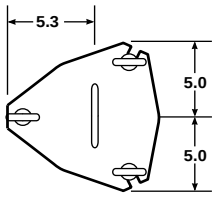

*Based on housing only. Fluid viscosity, bag filter used, and expected dirt loading should be considered when sizing a filter.

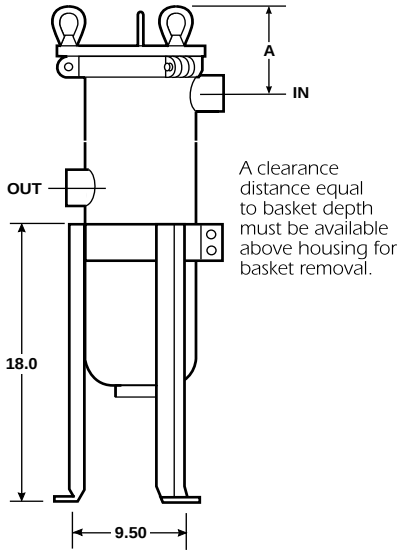
Eyenut covers with bag filter and basket or basket strainer.

## Dimensions (IN)

### Cover Types

**EYENUT COVER**



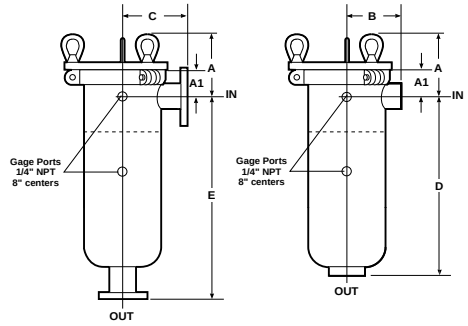

A clearance distance equal to basket depth must be available above housing for basket removal.

(3) 9/16 diameter holes on 9.50 diameter Bolt Circle

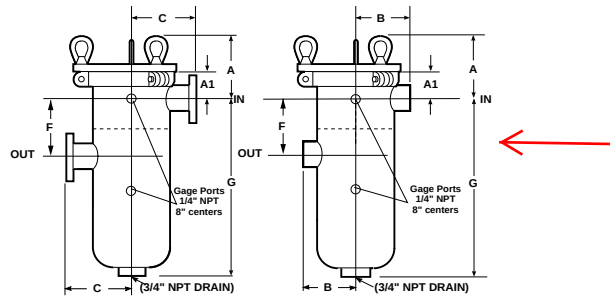
### Outlet Styles

Flanged (150 lb. ANSI) Threaded (NPT)

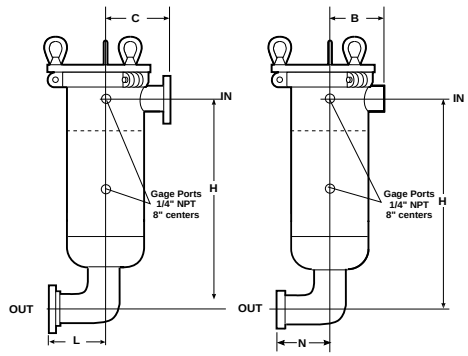
**STYLE 1**




**STYLE 2**




**STYLE 3**




(Style 1 with customer's elbow)

## Dimensions (IN)

| Model | Pipe Size | A | A1 | B | C | D | E | F | G | H | L | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-12 | 1 | 7.6 | 3.9 | 4.3 | 6.0 | 17.6 | 16.6 | 4.3 | 17.4 | 18.1 | 5.0 | 2.5 |
| | 1-1/4 | 7.6 | 3.9 | 4.3 | 6.0 | 17.6 | 16.6 | 4.7 | 17.4 | 18.4 | 5.0 | 2.9 |
| | 1-1/2 | 7.6 | 3.9 | 4.3 | 6.0 | 17.6 | 16.6 | 4.7 | 17.4 | 18.8 | 5.0 | 3.3 |
| | 2 | 7.6 | 3.9 | 4.3 | 6.0 | 16.6 | 16.6 | 6.6 | 16.5 | 18.6 | 5.0 | 4.0 |
| | 3 | 7.9 | 4.1 | 4.3 | 6.0 | 17.0 | 17.5 | 6.6 | 17.0 | 20.5 | 7.3 | 6.1 |
| 6-18 | 1 | 7.6 | 3.9 | 4.3 | 6.0 | 22.8 | 24.3 | 4.3 | 22.7 | 23.3 | 5.0 | 2.5 |
| | 1-1/4 | 7.6 | 3.9 | 4.3 | 6.0 | 22.8 | 24.3 | 4.7 | 22.7 | 23.7 | 5.0 | 2.9 |
| | 1-1/2 | 7.6 | 3.9 | 4.3 | 6.0 | 22.8 | 24.3 | 4.7 | 22.7 | 24.0 | 5.0 | 3.3 |
| | 2 | 7.6 | 3.9 | 4.3 | 6.0 | 21.8 | 24.3 | 6.6 | 21.8 | 23.8 | 5.0 | 4.0 |
| | 3 | 7.9 | 4.1 | 4.3 | 6.0 | 23.0 | 25.1 | 6.6 | 22.5 | 26.0 | 7.3 | 6.1 |
| 6-30 | 1 | 6.3 | 2.5 | 4.3 | 6.0 | 32.8 | 34.3 | 4.3 | 32.7 | 33.3 | 5.0 | 2.5 |
| | 1-1/4 | 6.3 | 2.5 | 4.3 | 6.0 | 32.8 | 34.3 | 4.7 | 32.7 | 33.7 | 5.0 | 2.9 |
| | 1-1/2 | 6.3 | 2.5 | 4.3 | 6.0 | 32.8 | 34.3 | 4.7 | 32.7 | 34.0 | 5.0 | 3.3 |
| | 2 | 7.1 | 3.4 | 4.3 | 6.0 | 31.8 | 34.3 | 6.6 | 31.8 | 33.8 | 5.0 | 4.0 |
| | 3 | 7.1 | 3.4 | 4.3 | 6.0 | 33.0 | 35.1 | 6.6 | 32.5 | 36.0 | 7.3 | 6.1 |

Dimensions are reference only and should not be used for hard plumbing. Consult factory for certified drawings.

| Material | Carbon Steel | 304 Stainless Steel | 304L Stainless Steel | 316 Stainless Steel | 316L Stainless Steel |
|---|---|---|---|---|---|
| Temperature | Class 150 ANSI, B16.5 Flanges | | | | |
| 400°F@150 PSI | ■ | ■ | ■ | ■ | ■ |
| 325°F@210 PSI | ■ | | | ■ | |
| 275°F@210 PSI | | ■ | | | |
| 155°F@210 PSI | | | ■ | | ■ |
| | Class 300 ANSI, B16.5 Flanges | | | | |
| 400°F@300 PSI | ■ | ■ | ■ | ■ | ■ |

# How To Order

Build an ordering code as shown in the example

**Example:** Housing: **6 - 30 - 3P - 1 - 300 - C** Options: **- B - S - M 200 – D - C**

**MODEL NO.**
6 = **6**

**HOUSING SIZE**
12 inch = **12**
18 inch = **18**
30 inch = **30**

**PIPE SIZE, NPT and FLANGED[1]**
3/4-in. female NPT = **3/4P**
1-in. female NPT = **1P**
1-1/4-in. female NPT = **1-1/4P**
1-1/2-in. female NPT = **1-1/2P**
2-in. female NPT = **2P**
3-in. female NPT = **3P**
3/4-in. 150 class ANSI flange = **3/4F**
1-in. 150 class ANSI flange = **1F**
1-1/4-in. 150 class ANSI flange = **1-1/4F**
1-1/2-in. 150 class ANSI flange = **1-1/2F**
2-in. 150 class ANSI flange = **2F**
3-in. 150 class ANSI flange = **3F**

**OUTLET STYLE**
Bottom = **1**
Side = **2**
Bottom elbow = **3**

**PRESSURE RATING[2]**
150 psi (flanged or NPT) = **150**
210 psi (flanged or NPT) = **210**
300 psi (flanged or NPT) = **300**

**HOUSING MATERIAL**
Carbon steel = **C**
304 stainless steel = **S**
316 stainless steel = **S316**

**ASME CODE STAMP**
**C** = Code
**NSF** = NSF 61 listed

**DISPLACER**
**D** = Displacer

**BASKET, MEDIA SIZE**
**No symbol if type B basket was selected**
Perforation diameters (for type P baskets)1/4, 3/16, 9/64, 3/32, 1/16

Mesh sizes (for type M and BM baskets)20, 30, 40, 50, 60, 70, 80, 100, 150, 200

**BASKET TYPE**
**PB** = Filter bag basket, 9/64 perforations[3]
**P** = Strainer basket, perforated metal
**BM** = Filter bag basket, perforated, mesh lined[3]
**M** = Strainer basket, perforated, mesh lined
**HWM** = Filter bag basket, heavy wire mesh[3]

**BASKET SEAL**
**N** = No seal (never on Models 4 & 6 bag-type baskets)
**S** = Seal required (always on Model 8 bag-type baskets)

**COVER SEAL**
**B** = Buna N
**E** = Ethylene Propylene
**V** = Viton® Fluoroelastomer
**TEV** = Teflon® Encapsulated Viton®
**TSW** = Teflon® (solid white)

1. Flanges provided with the housing match the pressure rating of the vessel. Housings rated 150 psi have 150 class flanges. Housings rated 300 psi have 300 class flanges. ANSI B16.5 Pressure-Temperature rating tables determine flange class for ASME code housings. Consult factory.
2. Higher pressure ratings available. Consult factory.
3. Filter bags are specified separately. See page 134.
4. 150 psi unit has 150 class flanges. 300 psi unit has 300 class flanges. 210 psi unit available only in NPT.

# PL Series Bag-Sized Cartridges

Absolute-rated units provide up to 12 times more dirt-holding capacity

Rosedale has combined the best features of filter bags and cartridges into one single unit. Like bags, these bag-sized pleated cartridges are easy to handle and trap contaminant inside, preventing "WASH OFF" when removing spent or dirty cartridges. Like cartridge elements, they provide larger surface areas and greater dirt-holding capacities than standard bags. They are the ideal solution when frequent servicing of filters is a problem.

## Construction

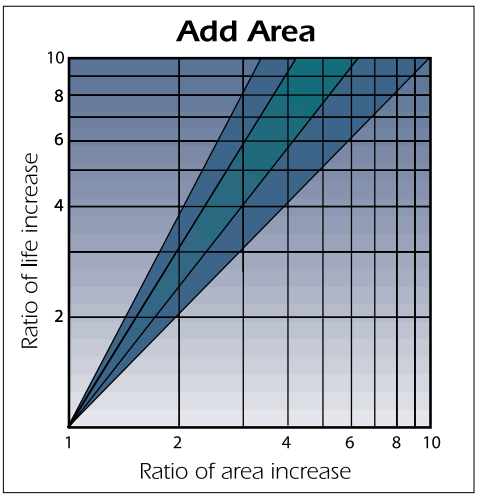
Rosedale bag-sized pleated cartridges are unique. Twenty-five* square feet of high efficiency material is sandwiched between two flow-enhancing, coarse-mesh screens, and then pleated in a supported construction. This supported pleat construction ensures flow cannot be pinched off. It also greatly strengthens the overall integrity of the element. The seams in these units are ultrasonically welded, not sewn, to prevent leakage or contamination bypass. The top sealing ring and cartridge bottom, made of solid molded polypropylene, are sonically welded to the pleated cylinder.

## Features

- Eleven micron retention ratings from 1 to 110 at 95% efficiency, are available
- Three different top sealing ring designs - one to fit your needs
- Available in standard bag sizes 1 and 2, to fit housings 8-15 and 8-30
- Low pressure drop

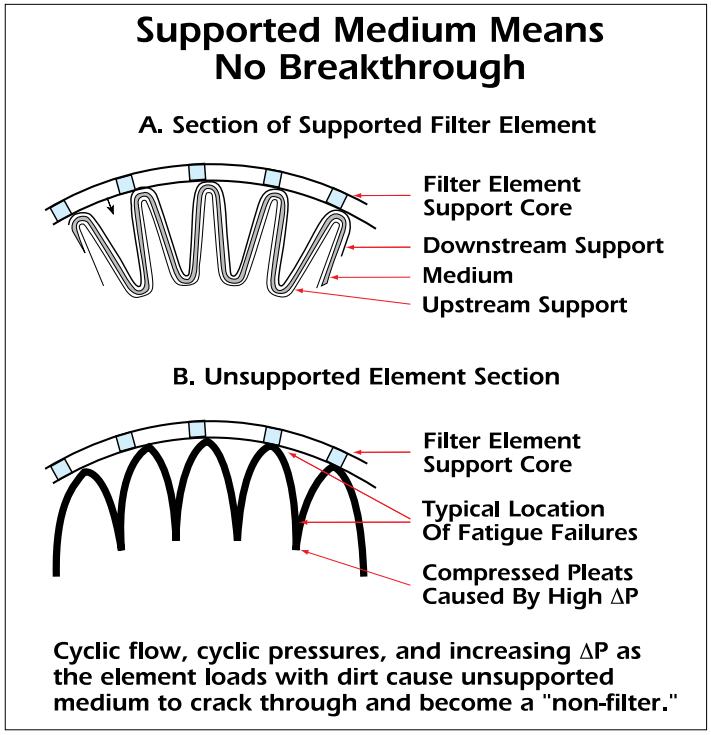
*For Size 2 cartridge, Size 1 cartridge has 13 square feet of material.

R1 Design - Flared
RPO Rosedale Top (standard)



## Materials

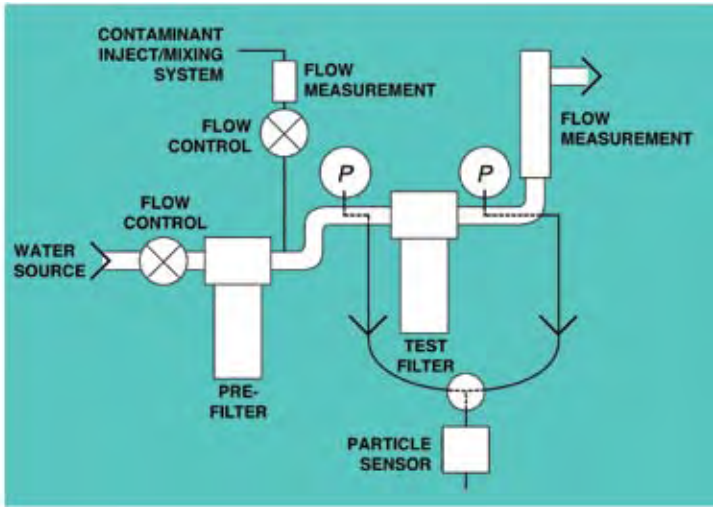
These elements use our unique high-efficiency microfiber material. Polyester or polypropylene microfibers and standard fibers are variably calendered to produce a single layer of our high-efficiency microfiber felt. This unique construction provides filtration to 1 micron at 95% efficiency. A real rating for the real world, consistently giving the same level or performance from batch to batch.




## Greater Capacity Means Longer Life

### FILTRATION LEVEL

These elements have been tested using the Single-Pass Efficiency Test (see diagram) using water and AC Fine Test Dust. Water is passed through an initial pre-filter (at 0.45 µ), after which contaminant is injected into the water line. An automatic particle counter analyzes the number of particles per milliliter greater than a selected size, before the water enters the filter. The water then passes through the test filter, and the effluent is analyzed for the number of those same-size particles. The number of particles removed provides the efficiency rating. For example, if after the single pass, 95 percent of the particles are removed, then the filter is 95 percent efficient at the specified micron rating.




Schematic showing single-pass efficiency test

### FILTRATION EFFICIENCY

Using the single pass efficiency test, we've determined the following efficiency ratings for our pleated cartridges. Real ratings are consistently accurate and reliable, time and time again.

**MICROFIBER GRADES**

| Model Number | PL-PEMF-1.0 PL-POMF-1.0 | PL-PEMF-3.0 PL-POMF-3.0 | PL-PEMF-8.0 PL-POMF-8.0 | PL-PEMF-19.0 PL-POMF-19.0 |
|---|---|---|---|---|
| **EFFICIENCY** | **MICRON RATING** | | | |
| 95% | **1** | **3.0** | **8.0** | **19.0** |
| 99% | **2** | **5.0** | **19.0** | **25.0** |

**RECOMMENDED MAXIMUM FLOW RATE (GPM / ELEMENT) AT 1.0 PSID**

| Element Size | Model Number PL-PEMF 1-19 PL-POMF 1-19 | PL-PE 35-110 PL-PO 35-110 | Viscosity |
|---|---|---|---|
| P1 | 50 GPM | 75 GPM | 1 CST |
| P2 | 100 GPM | 150 GPM | 1 CST |

**STANDARD FIBER GRADES**

| Model Number | PL-PE-35.0 PL-PO-35.0 | PL-PE-48.0 PL-PO-48.0 | PL-PE-55.0 PL-PO-55.0 | PL-PE-65.0 PL-PO-65.0 | PL-PE-70.0 PL-PO-70.0 | PL-PE-90.0 PL-PO-90.0 | PL-PE-110.0 PL-PO-110.0 |
|---|---|---|---|---|---|---|---|
| **EFFICIENCY** | **MICRON RATING** | | | | | | |
| 95% | **35.0** | **48.0** | **55.0** | **65.0** | **70.0** | **90.0** | **110.0** |

If fluids with viscosities greater than 1 CST are used, use the following correction factor to arrive at the recommended maximum flow rate. Divide the flow determined above by the correction factor obtained below.
If your viscosity is not listed, choose the next highest viscosity from the chart and use that correction factor.

| Fluid Viscosity SSU | CPS | Correction Factor |
|---|---|---|
| 80 | 15 | 1.2 |
| 160 | 35 | 2 |
| 240 | 55 | 3 |
| 320 | 70 | 4 |
| 400 | 90 | 5 |
| 480 | 110 | 6 |
| 560 | 130 | 7 |
| 640 | 150 | 8 |
| 720 | 180 | 9 |
| 800 | 260 | 10 |

For example, to filter a fluid having a viscosity of 55 cps using a PL-PEMF P2 element the equation is as follows:

$$\text{Corrected Flow Rate} = \frac{\text{Max Flow Rate}}{\text{Correction Factor}} = \frac{100}{3} = 33 \text{ GPM}$$

# How To Order

Build an ordering code as shown in the example

**Example: PL - R1 - PEMF - 1 - P1**

**BAG-SIZED PLEATED CARTRIDGE = PL**

**TOP SEALING RING DESIGN**
- Flared Polypropylene (P1 - P2) = **R1**
- Solid Polypropylene (P3 - P9) = **R2**

**HIGH EFFICIENCY MATERIAL**
- High-Efficiency Microfiber Polyester = **PEMF**
- High-Efficiency Microfiber Polypropylene = **POMF**
- High-Efficiency Standard Polyester = **PE**
- High-Efficiency Standard Polypropylene = **PO**

**BAG SIZE**

| Symbol | Dia. | x | Length |
|---|---|---|---|
| **P1** = | 7-1/16 | x | 11-1/8 |
| **P2** = | 7-1/16 | x | 24 |
| **P3** = | 4-1/8 | x | 5-1/16 |
| **P4** = | 4-1/8 | x | 11-1/16 |
| **P7** = | 5-5/8 | x | 10-3/4 |
| **P8** = | 5-5/8 | x | 16-1/8 |
| **P9** = | 5-5/8 | x | 26-3/4 |

**MICRON RATING**
(95% efficiency)

Microfiber Only- PEMF and POMF:
- **1** = 1.0 Micron
- **3** = 3.0 Micron
- **8** = 8.0 Micron
- **19** = 19.0 Micron

Standard Felt Only- PE and PO:
- **35** = 35.0 Micron
- **48** = 48.0 Micron
- **55** = 55.0 Micron
- **65** = 65.0 Micron
- **70** = 70.0 Micron
- **90** = 90.0 Micron
- **110** = 110.0 Micron

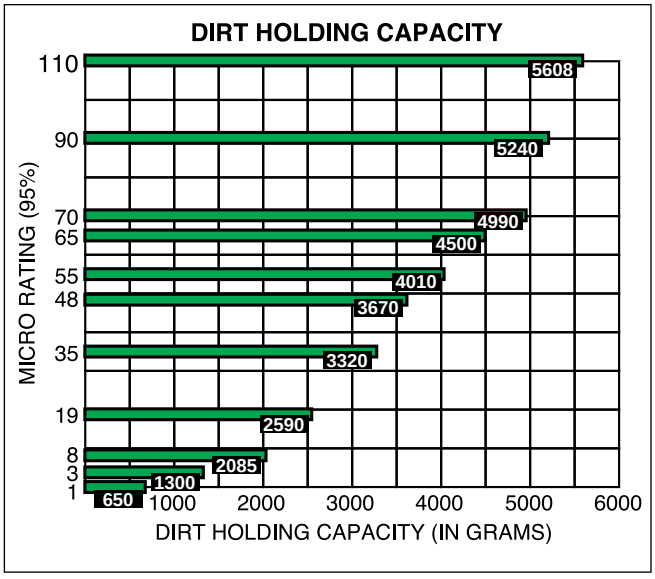
## CHEMICAL COMPATIBILITIES

EXCELLENT GOOD

| | Bag Materials (Fiber) | |
|---|---|---|
| | Polyester | Polypropylene |
| Organic Solvents | ■ | ■ |
| Animal Vegetable & Petro Oils | ■ | ■ |
| Micro-organisms | ■ | ■ |
| Alkalies | ■ | ■ |
| Organic Acids | ■ | ■ |
| Oxidizing Agents | ■ | ■ |
| Mineral Acids | ■ | ■ |

Temperature Limitations, 225°F.

**Note:** For more complete information on chemical compatibilities, refer to our web site.



# PEX TUBING INFORMATION

www.alliedpipesystems.com

# Material Specification Sheet
## Non-Barrier Cross-linked Polyethylene (PEX)

**SCOPE:**
This material specification designates the requirements for Allied PEX cross-linked polyethylene (PEX) tubing for use in hot and cold water distribution tubing. All Allied tubing is copper tube size dimension (CTS), SDR9 wall thickness and meets the respective requirements of ASTM F876 and F877.

**MATERIAL:**
All Allied tubing is manufactured from a cross-linkable high density polyethylene produced by grafting organo-silanes onto a polyethylene base. A catalyst (accelerator) added to the cross-linkable polyethylene during extrusion initiates the cross-linking process. Cross-linking is completed with hot water or steam. Allied tubing is available in white or pigmented red or blue for easy identification of hot and cold lines.

**MARKING AND CERTIFICATION:**
All Allied tubing is marked with the name Allied as the manufacturer, nominal size, design pressure and temperature ratings, relevant ASTM standards numbers, manufacturing date and production code and NSFpw stamp including third party certification by NSF International for meeting and exceeding performance and toxicological standards.

**RECOMMENDED USES:**
Allied tubing is intended and recommended for use in hot and cold potable water distribution systems and hydronic radiant heating systems. Design temperature and pressure ratings for Allied PEX is 160 psi @ 73° F and 100 psi @ 180° F. Allied tubing can also be used in "continuously re-circulating" plumbing systems at temperatures of up to 140° F while still maintaining excellent chlorine resistance. For information on the suitability for other hot and cold water applications not listed here, consult with your Allied Piping Systems representative.

**HANDLING AND INSTALLATION:**
Allied cross-linked polyethylene tubing is tough yet flexible. However, it is softer than metals and may be damaged by abrasion or by objects with a cutting edge. Use of these materials in hot and cold water distribution systems must be in accordance with good plumbing practices, applicable code requirements, and current installation practices available from Allied. Allied is manufactured to meet written national standards. Contact an Allied representative or the applicable code enforcement bureau for information about approvals for specific applications.

| **Property** | **ASTM** | **Typical Values** | |
|---|---|---|---|
| | **Test Method** | **English Units** | **SI Units** |
| Density | D 792 | - | 0.946 g/cc |
| Melt Index 1 (190° C/2.16kg) | D 1238 | - | 0.7 g/10min |
| Flexural Modulus 2 | D 790 | 120,000 psi | 830 MPa |
| Tensile Strength<br>@ Yield (2 in/min) | D 638 | 2,900 psi | 20 MPa |
| Coefficient of Linear Thermal Expansion<br>@ 68° F | D 696 | 8 x $10^{-5}$/°F | 15 x $10^{-5}$/°C |
| Hydrostatic Design Basis<br>@ 73° F (23° C)<br>@ 180° F (82° C) | <br>D 2837<br>D 2837 | <br>1250 PSI<br>800 PSI | <br>8.6 MPa<br>5.5 MPa |
| Vicat Softening Point | D 1525 | 255° F | 124° C |
| Thermal Conductivity | C 177 | 2.4 BTU/(hr)($ft^2$)(°F/in) | 3.5 x $10^{-3}$ Watts/($cm^2$)(°C/cm) |

1. Before Crosslinking 2. 73° F

**SDR9 PEX TUBING**
ASTM F876/F877/CTS-OD SDR9
NOTE: Dimensions are in English units. Tolerances are ASTM requirements.

| Part Number | Tubing Size | O.D | Wall Thickness | Nom. I.D. | Weight Per Foot | Volume (Gal.) Per 100 Foot |
|---|---|---|---|---|---|---|
| | 1/4" | 0.375 ± .002 | 0.065 ± .002 | 0.250 | .0261 | .25 |
| | 3/8" | 0.500 ± .002 | 0.075 ± .002 | 0.350 | .0413 | .50 |
| | 1/2" | 0.625 ± .002 | 0.075 ± .002 | 0.475 | .0535 | .92 |
| | 5/8" | 0.750 ± .002 | 0.088 ± .002 | 0.574 | .0752 | 1.34 |
| | 3/4" | 0.875 ± .002 | 0.102 ± .002 | 0.671 | .1023 | 1.82 |
| | 1" | 1.125 ± .003 | 0.132 ± .002 | 0.863 | .1689 | 3.04 |
| | 1 1/4 " | 1.375 ± .003 | 0.161 ± .003 | 1.053 | .2523 | 4.52 |
| | 1 1/2 " | 1.625 ± .004 | 0.191 ± .004 | 1.243 | .3536 | 6.30 |
| | 2 " | 2.125 ± .004 | 0.248 ± .004 | 1.629 | .6010 | 10.83 |

* Indicates Oxygen Barrier Allied PEX tubing pat numbers

**PRESSURE DROP TABLE**
Expressed per/foot

| | 3/8" | 3/8" | ½" | ½" | 5/8" | 5/8" | ¾" | ¾" | 1" | 1" |
|---|---|---|---|---|---|---|---|---|---|---|
| | PSI | Head Loss | PSI | Head Loss | PSI | Head Loss | PSI | Head Loss | PSI | Head Loss |
| .1 | .001 | .002 | | | | | | | | |
| .2 | .004 | .008 | .001 | .002 | | | | | | |
| .3 | .008 | .017 | .002 | .004 | .001 | .002 | | | | |
| .4 | .013 | .030 | .003 | .007 | .001 | .002 | | | | |
| .5 | .020 | .045 | .004 | .010 | .002 | .004 | | | | |
| .6 | .027 | .063 | .006 | .014 | .003 | .006 | .001 | .003 | | |
| .7 | .036 | .084 | .008 | .019 | .003 | .008 | .002 | .004 | | |
| .8 | .047 | .108 | .011 | .024 | .004 | .010 | .002 | .005 | | |
| .9 | .058 | .134 | .013 | .030 | .005 | .012 | .002 | .006 | | |
| 1 | .070 | .1626 | .016 | .037 | .007 | .015 | .003 | .007 | .001 | .002 |
| 1.5 | | | .034 | .078 | .014 | .032 | .006 | .015 | .002 | .004 |
| 2 | | | .058 | .133 | .024 | .055 | .011 | .025 | .003 | .007 |
| 2.5 | | | .087 | .201 | .036 | .083 | .016 | .037 | .005 | .011 |
| 3 | | | | | .050 | .116 | .023 | .052 | .007 | .015 |
| 3.5 | | | | | .067 | .154 | .030 | .070 | .009 | .021 |
| 4 | | | | | .085 | .197 | .039 | .089 | .011 | .026 |
| 5 | | | | | .129 | .298 | .059 | .135 | .017 | .040 |
| 6 | | | | | .181 | .417 | .082 | .189 | .024 | .056 |
| 7 | | | | | | | .109 | .252 | .032 | .075 |
| 8 | | | | | | | .140 | .322 | .041 | .095 |
| 9 | | | | | | | .174 | .401 | .051 | .118 |
| 10 | | | | | | | .211 | .487 | .062 | .143 |
| 11 | | | | | | | .252 | .581 | .074 | .171 |
| 12 | | | | | | | .296 | .683 | .087 | .201 |
| 13 | | | | | | | .343 | .792 | .101 | .233 |

* Indicates 8fps maximum velocity required by some plumbing codes.
NOTE: Maximum flow for each size based on 12 FPS velocity. PSI x 2.307 = head loss.

**EXAMPLE**: To calculate the pressure drop of a ½" line, 40 ft long, with a 3 gpm flow rate, calculate 122 psi x 40 ft = 4.9 psi pressure drop. Most plumbing codes require 8 psi residual pressure at the fixture. Refer to your local code requirements.

**VOLUME/100FT**

| Tubing Size | Gallons |
|---|---|
| 3/8” | .50 |
| 1/2” | .92 |
| 5/8” | 1.33 |
| 3/4” | 1.84 |
| 1” | 3.04 |

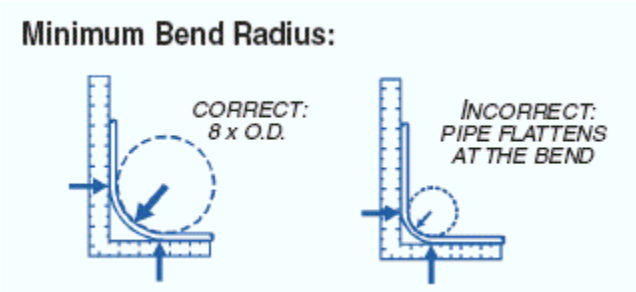
**QUALITY ASSURANCE:**
When the product is marked with the ASTM F876/F877 designation, it affirms that the product was manufactured, inspected, sampled and tested in accordance with these specifications and has been found to meet specified requirements.

**LISTINGS:**
NSF-pw – tested for health effects to ANSI/NSF standard 61 and performance to ANSI/NSF standard 14.

IAPMO – approved for UPS, listed to ASTM F876/F877

ICBO ER # 5287 – listed for plumbing and hydronic heating applications

Intertek Testing Services (Warmock Hersey) – certification to CSA B137.5 (Canadian Standards Association)




Changes in direction may e made bending PEX tubing. The minimum bend radius is 8 times the outside diameter. When bending against the coil direction, the minimum bend radius is 24 times the O.D. No special tools necessary.

Minimum Burst Pressure (PSI)
Per ASTM F876/F877

| Size | 74 degree F (23 C) | 180 degree F (82 C) |
|---|---|---|
| 1/4” | 870 | 390 |
| 3/8” | 620 | 275 |
| 1/2” | 480 | 215 |
| 5/8” | 475 | 210 |
| 3/4” | 475 | 210 |
| 1” | 475 | 210 |
| 1 1/4” | 475 | 210 |
| 1 1/2" | 475 | 210 |
| 2” | 475 | 210 |

Allied reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Allied products previously or subsequently sold.

**USA**: P. O. BOX 443, Lyons, IL 60543
www.alliedpipesystems.com

# HDPE PIPE MATERIAL INFORMATION

# HDPE (High Density Polyethylene) Pipe

HDPE pipe is a primary alternative to PVC (polyvinyl chloride) pipe for all piping applications and is rapidly gaining market share for potable water, sewer, conduit and ducting, DWV (drain, waste and vent,) agriculture, and ground drainage uses. Used since the 1950's, HDPE has demonstrated its effectiveness through its durability, leak-free performance, corrosion resistance, and ductility. Its greater resilience and flexibility make it less susceptible than PVC to surges, damage from digging, and shifting soils during earthquakes.

HDPE is also preferable to PVC as it is chlorine-free, requires fewer additives in its manufacture, and has a much higher recycling rate than PVC. Commonly referred to as vinyl, PVC is a common plastic used in a wide variety of products such as piping, flooring, wallpaper, window frames, siding, office equipment, children's toys, and catheters. About 50% of all PVC is used for piping applications. The worst plastic from an environmental and human health perspective, PVC introduces myriad hazards throughout its lifecycle. The manufacturing of PVC creates dioxin, the most potent carcinogen known, as well as ethylene dichloride and vinyl chloride. These toxins can cause severe health problems including cancer, endocrine disruption, neurological damage, birth defects, and reproductive and immune system damage.

To learn more about the issues with PVC, see www.buildinggreen.com/features/pvc/pvc.cfm.

## *PRODUCT COMPARISONS*

| **HDPE Pipe** | **PVC Pipe** |
|---|---|
| Chlorine-free | Contains chlorine |
| No dioxin produced in manufacture | Dioxin produced in manufacture |
| High abrasion and chemical resistance | Moderate abrasion and chemical resistance |
| Less susceptible to surge shocks | More susceptible to surge shocks |
| Seamless joint connections | Joint seams can leak |
| Flexible | Rigid |

For a general comparison of various piping materials, see the following EPA factsheet: www.epa.gov/owmitnet/mtb/pipe_construction.pdf.

## *LEED CREDITS*

Using this material potentially contributes to obtaining these credits in the US Green Building Council's LEED certification program:

### Materials & Resources

MR Credit 4.1 Recycled Content

MR Credit 4.2 Recycled Content

LEED stands for Leadership in Energy and Environmental Design. To find out more about it, visit www.leedbuilding.org

## *ENVIRONMENTAL ATTRIBUTES*

### Energy Performance

Using recycled HDPE pipe saves energy in the manufacturing process, using less energy than the creation of virgin plastic. Recycling plastic saves significant energy over the creation of new plastic.

### Resource Impacts

HDPE pipe has a service life of 100 years and can then theoretically be recycled. Recycled HDPE has minimal impact on the environment since it keeps material out of the waste stream. An estimated 12% of the U.S. solid waste stream is plastic, and 19% of that is HDPE. The resin can be more easily recycled than almost any other plastic. While most recycled plastic markets are specifically tailored to post-consumer bottles, a pipe manufacturer or large end user should be able to find a recycling facility that will accept their HDPE pipe.

Recycling post-consumer PVC is difficult because of its wide range of additives and formulations. It also complicates the recycling of other plastics.

### Health Considerations

Although PVC is more resistant to combustion, it smolders at a lower temperature than HDPE and releases toxic hydrochloric gases before combustion. Dioxin is an unavoidable byproduct of PVC manufacture and is a bioaccumulative toxin, building up in fat tissues of living things, and becoming more concentrated as it moves up the food chain. Americans are exposed to high levels of dioxin, enough for a calculated risk of cancer greater than 1 in 1,000 - thousands of times greater than the usual standard for acceptable risk.

PVC pipe generally requires toxic solvent glues to join sections, whereas HDPE pipe sections are simply melted together. PVC also requires the addition of toxic heavy metal stabilizer organotins (carbon and metal compounds), which have problems with leaching.

For a comprehensive summary on the health and environmental impacts of PVC, read a briefing paper from the Healthy Building Network at:
www.healthybuilding.net/pvc/ThorntonPVCSummary.html

## *FUNCTIONAL CONSIDERATIONS*

### Cost

Material prices are comparable to PVC. However, material costs may not be the determining factor in pipe selection. Contractors who have never used HDPE may be resistant to working with an unfamiliar material. HDPE is gaining market share and acceptance through its demonstrated effectiveness in the field. For example, a study conducted by engineers with the Oklahoma Water District found that HDPE would cost less than PVC when considering projected leaks, breaks, joint failure, and associated water lost over a 15-year period. Also, trenchless installations can dramatically reduce both cost and environmental impact of some underground pipe projects.

### Installation

Because HDPE pipe can be delivered in longer lengths, thus requiring a smaller number of joints, it has better leak resistance than PVC pipe. Also, butt fusion joint welding provides stronger,

tighter, more leak proof joints than the bell and spigot or solvent glue joints used for PVC. The longer lengths of HDPE can require that longer trenches are open at one time, although its length and flexibility may allow trenchless installations.

Fusion welding requires a fusion machine for larger diameter pipe, which could be problematic in tight spaces. A handheld device can be used for smaller diameter pipes. Mechanical couplings are available for HDPE, though these couplings are sometimes made of PVC.

Because HDPE has a higher coefficient of thermal expansion than other pipe plastics, above-ground applications will warrant extra care in anchor and support design if the pipe will be subject to significant temperature swings.

### Maintenance

HDPE is very durable and should require little maintenance if used in appropriate applications and installed correctly.

## *RESOURCES*

### Suppliers and Installers

**Action Sales**
(Vanguard products rep)
15650 Vineyard Blvd Ste. A
Morgan Hill, CA 95037
(408) 779-6773

**Advanced Drainage Systems**
(drainage pipe)
4640 Trueman Boulevard
Hilliard, OH 43026
(800) 821-6710
www.ads-pipe.com

**AllBay Plumbing Supply Inc.**
(Vanguard products)
2815 E 10th St
Oakland, CA 94601
(510) 533-5060

**ARNCO Corp.**
(conduit, duct, water supply)
860 Garden St
Elyria, OH 44035
(800) 321-7914
www.arncocorp.com

**Cagwin & Dorward**
(HDPE irrigation installation)
Novato, CA
(707) 545-3134

**Ewing Irrigation**
(irrigation pipe)
1735 Rogers Ave.
San Jose, CA 95112
(408) 436-8848
www.ewing1.com

**Ewing Irrigation**
(irrigation pipe)
550 Irwin Street
San Rafael, CA 94901
(415) 457-9530
www.ewing1.com

**Ferguson Enterprises, Inc.**
(Performance Pipe products)
Sacramento, CA
(916) 388-2333

**Hancor Inc.**
(EcoFirst, 50% recycled content drainage pipe)
Findley, OH
(888) FOR PIPE
www.hancor.com

**ISCO Industries**
5610 Doolittle Ave.
Shafter, CA 93263

**Crumpler Plastic Pipe, Inc.**
(drainage pipe)
Roseboro, NC 28382
(800) 334-5071
www.cpp-pipe.com

**Endot Industries, Inc.**
(water supply, duct)
60 Green Pond Road
Rockaway, NJ 07866
(800) 44-ENDOT (443-6368)
www.endot.com

**Ewing Irrigation**
(irrigation pipe)
62 South Buchanan Circle
Pacheco, CA 94553
(925) 687-3220
www.ewing1.com

**Ewing Irrigation**
(irrigation pipe)
6640 Sierra Lane
Dublin, CA 94568
(925) 828-5618
www.ewing1.com

**Ewing Irrigation**
(irrigation pipe)
43055 Osgood Road Ste. A
Fremont, CA 94539
(510) 490-9444
www.ewing1.com

**Ewing Irrigation**
(irrigation pipe)
1618 Jerrold Avenue
San Francisco, CA 94124
(415) 695-9530
www.ewing1.com

**Ewing Irrigation**
(irrigation pipe)
2462 Polvorosa Avenue
San Leandro, CA 94577
(510) 357-9530
www.ewing1.com

(800) 345-ISCO
www.isco-pipe.com

**Maskel-Robbins**
3135 Diablo Avenue
Hayward, CA 94545
(800) 638-4373
Rep: Don Wescott, (510) 612-5844

**Netafim USA**
(irrigation pipe)
5470 E. Home Ave
Fresno, CA 93727
(888) 638-2346
www.netafim-usa.com

**Performance Pipe (Chevron Phillips Chemical Company)**
5085 West Park Blvd. Suite 500
P.O. Box 269006
Plano, TX 75026
(800) 527-0662
http://www.cpchem.com/

**P&F Distributing**
(Performance Pipe products)
511 Tunnel Ave.
Brisbane, CA 94005
(415) 467-4630

**Vanguard Piping Systems, Inc.**
901 N. Vanguard St.
McPherson, KS
(800) 775-5039
www.vanguardpipe.com

**Wis. Plastic Drain Tile**
(100% recycled content drainage pipe)
Jefferson, WI
(800) 362-6642
www.draintile.com

**Wyatt Irrigation Supply Inc.**
(irrigation pipe)
747 Yolanda Ave.
Santa Rosa, CA 95404
(707) 578-3747
www.wyattsupply.com

## *Disclaimer*

**The above information is provided for general education and informational purposes only and does not constitute an endorsement, approval or recommendation of any kind. The actual suitability and applicability of this information for a given use depends upon a host of considerations. These include laws and regulations applicable to the intended use of the information, specific attributes of that use or project, and the specifications for any product associated with this information. Build It Green disclaims all warranties, express or implied, and strongly encourages the reader to consult with a construction professional and/or product supplier before applying any of this information to a specific use or purpose.**

# METERING PUMP

# Data Sheet

## Series B
## Electronic Metering Pumps

## Configuration

**Model** **B92 1 - 392SI**

**Control & Output Code**

**Manual Control**
Speed (stroking frequency) and stroke length manually adjustable

| | | | | |
|---|---|---|---|---|
| B11 | 1.6 GPH | (6.1 l/h) | 150 psi | (10.30 Bar) |
| B12 | 2.5 GPH | (9.5 l/h) | 100 psi | (6.90 Bar) |
| B13 | 4.5 GPH | (17.0 l/h) | 50 psi | (3.50 Bar) |
| B14 | 7.0 GPH | (26.5 l/h) | 30 psi | (2.07 Bar) |

**Instrument Responsive / Manual Control**
Manual adjustment features of Series B1 plus switch conversion to external control for automatic systems.

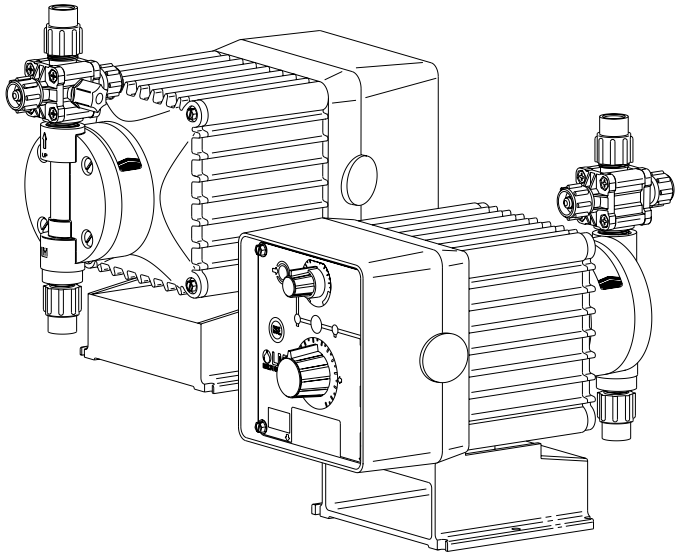
| | | | | |
|---|---|---|---|---|
| B71 | 1.6 GPH | (6.1 l/h) | 150 psi | (10.30 Bar) |
| B72 | 2.5 GPH | (9.5 l/h) | 100 psi | (6.90 Bar) |
| B73 | 4.5 GPH | (17.0 l/h) | 50 psi | (3.50 Bar) |
| B74 | 7.0 GPH | (26.5 l/h) | 30 psi | (2.07 Bar) |
| B91 | 1.6 GPH | (6.1 l/h) | 150 psi | (10.30 Bar) |
| B92 | 2.5 GPH | (9.5 l/h) | 100 psi | (6.90 Bar) |
| B93 | 4.5 GPH | (17.0 l/h) | 50 psi | (3.50 Bar) |
| B94 | 7.0 GPH | (26.5 l/h) | 30 psi | (2.07 Bar) |

**Voltage Code**

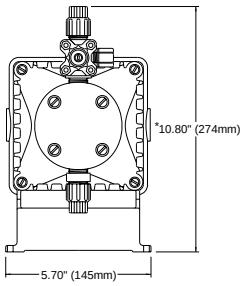
| | | |
|---|---|---|
| 1 | --------- | 120 VAC, US Plug |
| 2 | --------- | 240 VAC, US Plug |
| 3 | --------- | 220-240 VAC, DIN Plug |
| 5 | -------- | 240-250 VAC, UK Plug |
| 6 | -------- | 240-250 VAC, AUST/NZ Plug |
| 7 | -------- | 220-240 VAC, SWISS Plug |

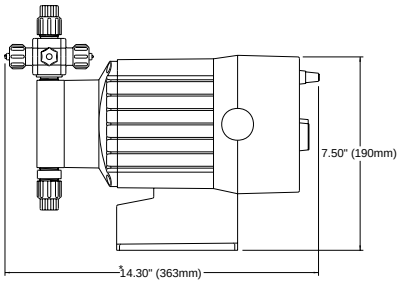
**Liquid End**

See next page for complete Liquid End specifications and selection.

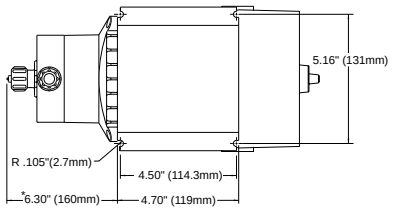


## Dimensions




*DIMENSIONS SHOWN ARE MAXIMUM FOR LARGEST LIQUID END AVAILABLE. THESE DIMENSIONS VARY DEPENDING ON THE LIQUID END SELECTED.




## Specifications

| Series | Strokes Per Minute (Adjustable) Min | Max | Stroke Length (Adjustable) Recommended Minimum | Average Input Power @ Max Speed | Shipping Weight |
|---|---|---|---|---|---|
| B11, B71, B91†<br>B12, B72, B92†<br>B13, B73, B93†<br>B14, B74, B94† | 1 | 100 | 10% | 29 watts | 15 lbs (6.9 kg) |

† Series B9 pumps may be programmed for strokes per hour for lower outputs.


LMI MILTON ROY

8 Post Office Square
Acton, MA 01720 USA
TOLL FREE: (800) 564-1097
TEL: (978) 263-9800
FAX: (978) 264-9172
http://www.lmipumps.com



Replaces same of Rev. G 2/98
1417. H 4/02

# Configuration Data & Materials of Construction

| Drive Assembly | Liquid End No. | Size Code | Materials of Construction | | | | Accessory | Tubing & Connections | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Head & Fittings | Balls | Liquifram™ | Check Valve | | Discharge | Suction |
| | 498SI† | 0.9 | PVC / PVC | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B92 ■ - | 490SI† | 0.9 | Acrylic / PVC | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B91 ■ - | 490FI | 0.9 | Acrylic / PVDF | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B72 ■ - | 398SI† | 0.9 | PVC / PVC | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B71 ■ - | 393SI† | 0.9 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / PTFE | 4FV | PE .375" O.D. | |
| B12 ■ - | 392SI† | 0.9 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B11 ■ - | 85HV | 0.9 | Polypropylene | 316 S.S. | Fluorofilm™ | PTFE | | PE .5" O.D. | Vinyl .938" O.D. |
| | 86HV | 0.9 | Acrylic / PP | 316 S.S. | Fluorofilm™ | Hypalon® | | PE .5" O.D. | Vinyl .938" O.D |
| | 89 | 0.9 | UHMW PE | Ceramic | Hypalon® | Hypalon® | | PE .5" O.D. | Vinyl .500" O.D. |
| | 95S** | 0.9 | Polypropylene | Ceramic | Fluorofilm™ | PTFE | 4FV | PE .375" O.D. | |
| | 297 | 0.9 | 316 S.S. | 316 S.S. | Fluorofilm™ | 316 S.S. | | Pipe 1/4" NPT M | |
| | 468SI† | 1.8 | PVC / PVC | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| | 460SI† | 1.8 | Acrylic / PVC | Ceramic | Fluorofilm™ | PVC / Polyprel® | 4FV | PE .375" O.D. | |
| | 460FI | 1.8 | Acrylic / PVDF | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| | 368SI† | 1.8 | PVC / PVC | Ceramic | Fluorofilm™ | PVC / Polyprel® | 4FV | PE .375" O.D. | |
| | 363SI† | 1.8 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / PTFE | 4FV | PE .375" O.D. | |
| B93 ■ - | 362SI† | 1.8 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .375" O.D. | |
| B73 ■ - | 75HV | 1.8 | Polypropylene | 316 S.S. | Fluorofilm™ | PTFE | | PE .5" O.D. | Vinyl .938" O.D. |
| B13 ■ - | 75S** | 1.8 | Polypropylene | Ceramic | Fluorofilm™ | PTFE | 4FV | PE .5" O.D. | |
| | 76HV | 1.8 | Acrylic / PP | 316 S.S. | Fluorofilm™ | Hypalon® | | PE .5" O.D. | Vinyl .938" O.D. |
| | 79 | 1.8 | UHMW PE | Ceramic | Hypalon® | Hypalon® | | PE .5" O.D. | Vinyl .500" O.D. |
| | 277 | 1.8 | 316 S.S. | 316 S.S. | Fluorofilm™ | 316 S.S. | | Pipe 1/4" NPT M | |
| | 418SI† | 3.0 | PVC / PVC | Ceramic | Fluorofilm™ | PVC / Polyprel® | 4FV | PE .5" O.D. | |
| | 410SI† | 3.0 | Acrylic / PVC | Ceramic | Fluorofilm™ | PVC / Polyprel® | 4FV | PE .5" O.D. | |
| | 410FI | 3.0 | Acrylic / PVDF | .375 PTFE | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .5" O.D. | |
| | 318SI† | 3.0 | PVC / PVC | Ceramic | Fluorofilm™ | PVC / Polyprel® | 4FV | PE .5" O.D. | |
| B94 ■ - | 312SI† | 3.0 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / Polyprel® | 4FV | PE .5" O.D. | |
| B74 ■ - | 313SI† | 3.0 | PVDF / PVDF | Ceramic | Fluorofilm™ | PVDF / PTFE | 4FV | PE .5" O.D. | |
| B14 ■ - | 15S** | 3.0 | Polypropylene | Ceramic | Fluorofilm™ | PTFE | 4FV | PE .5" O.D. | |
| | 217 | 3.0 | 316 S.S. | 316 S.S. | Fluorofilm™ | 316 S.S. | | Pipe 1/4" NPT M | |

■ See front page for voltage code specifications.

** These Liquid Ends are available without a 4FV.

† To specify ¼" NPT male, change 'I' to 'P'. To specify black, UV resistant tubing, change 'I' to 'U'. To specify Bleed 4FV, change 'S' to 'B'. To specify 3FV, change 'S' to'T'.

3FV Indicates that the pump is equipped with an LMI Three Function Valve (pressure relief, priming aid, line drain).

4FV Indicates that the pump is equipped with an LMI Four Function Valve. This diaphragm type anti-syphon/pressure relief valve is installed on the pump head. It provides anti-syphon protection and aids in priming, even under pressure.

Fluorofilm™ is a copolymer of PTFE and PFA.
Polyprel® is an elastomeric PTFE copolymer.

Polyprel is a registered trademark of Liquid Metronics Incorporated. Fluorofilm is a trademark of Liquid Metronics Incorporated. Hypalon is a registered trademark of E. I. du Pont de Nemours & Co., Inc.

# Output Information

| Series | Gallons per Hour* Min | Max | Liters per Hour* Min | Max | mL/cc per Minute* Min | Max | mL/cc per Stroke Min | Max | Maximum Injection Pressure |
|---|---|---|---|---|---|---|---|---|---|
| B11, B71, B91† | 0.002 | 1.6 | 0.006 | 6.1 | 0.10 | 101 | 0.10 | 1.01 | 150 psi (10.30 Bar) |
| B12, B72, B92† | 0.003 | 2.5 | 0.009 | 9.5 | 0.16 | 158 | 0.16 | 1.58 | 100 psi (6.90 Bar) |
| B13, B73, B93† | 0.005 | 4.5 | 0.017 | 17.0 | 0.28 | 284 | 0.28 | 2.84 | 50 psi (3.50 Bar) |
| B14, B74, B94† | 0.007 | 7.0 | 0.027 | 26.5 | 0.44 | 442 | 0.44 | 4.42 | 30 psi (2.07 Bar) |

*Minimum output is based on one (1) stroke per minute and 10% stroke setting, minimum output can be reduced further in external mode.

†Series B9 pumps may be programmed for strokes per hour for lower outputs.

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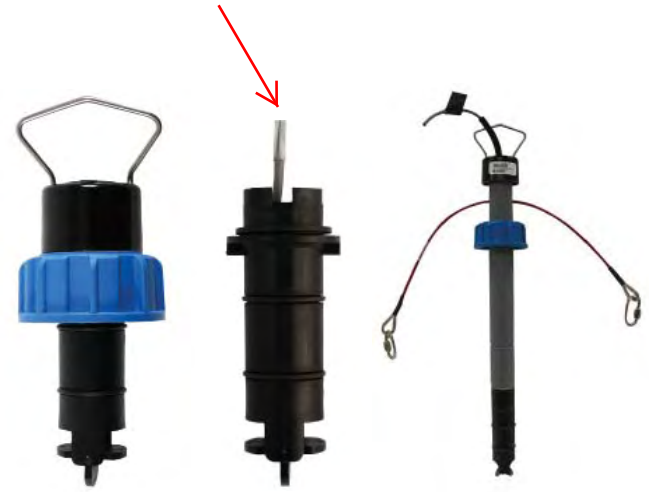
# DIGITAL FLOMETER-TOTALIZER

# Signet 2536 Rotor-X Paddlewheel Flow Sensors



Standard Sensor (with blue cap) | Integral Sensor | Wet-Tap Sensor

Simple to install with time-honored reliable performance, Signet 2536 Rotor-X Paddlewheel Flow Sensors are highly repeatable, rugged sensors that offer exceptional value with little or no maintenance. The Model 2536 has a process-ready open collector signal with a wide dynamic flow range of 0.1 to 6 m/s (0.3 to 20 ft/s). The sensor measures liquid flow rates in full pipes and can be used in low pressure systems.

The Signet 2536 sensors are offered in a variety of materials for a wide range of pipe sizes and insertion configurations. The many material choices including PP and PVDF make this model highly versatile and chemically compatible to many liquid process solutions. Sensors can be installed in DN15 to DN900 (½ to 36 in.) pipes using Signet's comprehensive line of custom fittings. These custom fittings, which include tees, saddles, and weldolets, seat the sensor to the proper insertion depth into the process flow. The sensors are also offered in configurations for wet-tap installation requirements.

## Features

- **Operating range 0.1 to 6 m/s (0.3 to 20 ft/s)**
- **Wide turndown ratio of 66:1**
- **Open-collector output**
- **Highly repeatable output**
- **Simple, economical design**
- **Installs into pipe sizes DN15 to DN900 (½ to 36 in.)**
- **High resolution and noise immunity**
- **Test certificate included for -X0, -X1**
- **Chemically resistant materials**

## Applications

- **Pure Water Production**
- **Filtration Systems**
- **Chemical Production**
- **Liquid Delivery Systems**
- **Pump Protection**
- **Scrubber/Gas Stacks**
- **Gravity Feed Lines**
- **Not suitable for gases**

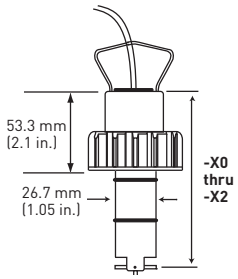
# Specifications

| | | | |
|---|---|---|---|
| **General** | | | |
| Operating Range | | 0.1 to 6 m/s | 0.3 to 20 ft/s |
| Pipe Size Range | | DN15 to DN900 | ½ to 36 in. |
| Linearity | | ±1% of max. range @ 25 °C (77 °F) | |
| Repeatability | | ±0.5% of max. range @ 25 °C (77 °F) | |
| Min. Reynolds Number Required | | 4500 | |
| **Wetted Materials** | | | |
| Sensor Body | | Glass-filled PP (black) or PVDF (natural) | |
| O-rings | | FPM (std) optional EPR (EPDM) or FFPM | |
| Rotor Pin | | Titanium, Hastelloy-C or PVDF; optional Ceramic, Tantalum or Stainless Steel | |
| Rotor | | Black PVDF or Natural PVDF; optional Tefzel®, with or w/o Fluoroloy G® sleeve for rotor pin | |
| **Electrical** | | | |
| Frequency | | 49 Hz per m/s nominal | 15 Hz per ft/s nominal |
| Supply Voltage | | 5 to 24 VDC ±10%, regulated | |
| Supply Current | | <1.5 mA @ 3.3 to 6 VDC | <20 mA @ 6 to 24 VDC |
| Output Type | | Open collector, sinking 10 mA max. | |
| Cable Type | | 2-conductor twisted pair with shield, 22 AWG | |
| Cable Length | | 7.6 m (25 ft) can be extended up to 305 m (1000 ft) maximum | |
| **Max. Temperature/Pressure Rating - Standard and Integral Sensor** | | | |
| | PP | 12.5 bar @ 20 °C | 180 psi @ 68 °F |
| | | 1.7 bar @ 85 °C | 25 psi @185°F |
| | PVDF | 14 bar @ 20 °C | 200 psi @ 68 °F |
| | | 1.7 bar @ 85 °C | 25 psi @ 185 °F |
| Operating Temperature | | | |
| | PP | -18 °C to 85 °C | 0 °F to 185 °F |
| | PVDF | -18 °C to 85 °C | 0 °F to 185 °F |
| **Max. Temperature/Pressure Rating - Wet-Tap Sensor** | | | |
| | PP | 7 bar @ 20 °C | 100 psi @ 68 °F |
| | | 1.4 bar @ 66 °C | 20 psi @ 150 °F |
| Operating Temperature | | -18 °C to 66 °C | 0 °F to 150 °F |
| Max. Wet-Tap Sensor Removal Rating | | 1.7 bar @ 22 °C | 25 psi @ 72 °F |
| **Shipping Weight** | | | |
| | 3-2536-X0 | 0.454 kg | 1.00 lb |
| | 3-2536-X1 | 0.476 kg | 1.05 lb |
| | 3-2536-X2 | 0.680 kg | 1.50 lb |
| | 3-2536-X3 | 0.780 kg | 1.72 lb |
| | 3-2536-X4 | 0.800 kg | 1.76 lb |
| | 3-2536-X5 | 0.880 kg | 1.94 lb |
| | 3-8512-X0 | 0.35 kg | 0.77 lb |
| | 3-8512-X1 | 0.37 kg | 0.81 lb |
| **Standards and Approvals** | | | |
| | CE | | |
| | RoHS compliant, China RoHS | | |
| | Manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management | | |

See Temperature and Pressure Graphs for more information

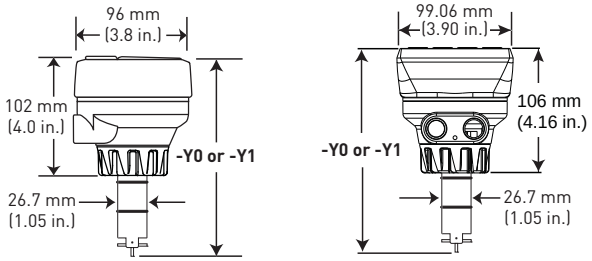
# Dimensions

**Standard Mount**



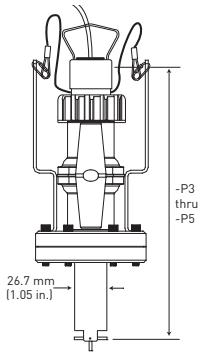

| Pipe range | |
|---|---|
| **0.5 to 4 in.** | -X0 = 104 mm (4.1 in.) |
| **5 to 8 in.** | -X1 = 137 mm (5.4 in.) |
| **10 in. and up** | -X2 = 213 mm (8.4 in.) |

**Integral Mount**
(shown with Transmitter sold separately)




| Pipe range | |
|---|---|
| **0.5 to 4 in.** | -Y0 = 152 mm (6.0 in.) |
| **5 to 8 in.** | -Y1 = 185 mm (7.3 in.) |

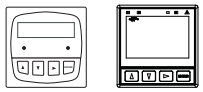
**Wet-Tap Mount Sensor with 3519 Wet-Tap Valve**
(See 3519 product page for more information).

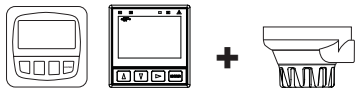



| Pipe range | |
|---|---|
| **0.5 to 4 in.** | -P3 = 297 mm (11.7 in.) |
| **5 to 8 in.** | -P4 = 333 mm (13.1 in.) |
| **10 in. and up** | -P5 = 409 mm (16.1 in.) |

System Overview

| Panel Mount | Field Mount - Pipe, Tank, Wall | Integral Mount |
|---|---|---|
| Signet Instruments<br>5075 5090 5500 5600<br>8550 8900 9900 | Signet Instruments<br>8550 9900<br>with 3-8050 Universal Mount Kit | Signet Instruments<br>8550 9900<br>with 3-8051 Universal Mount Kit |

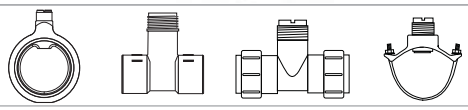




**Signet 2536 Standard or Wet-Tap Flow Sensor**

**Signet 2536 Integral Mount Flow Sensor**

Signet Fittings



All sold separately

For overview of Wet-Tap System, see 3519 product page

## Application Tips

- Use the Conduit Adapter Kit to protect the cable-to-sensor connection when used in outdoor environments. See Accessories section for more information.
- Use a sleeved rotor in abrasive liquids to reduce wear.
- Sensor plug can be used to plug installation fitting after extraction of sensor from pipe.
- For liquids containing ferrous particles, use Signet Magmeters.
- For systems with components of more than one material, the maximum temperature/pressure specification must always be referenced to the component with the lowest rating.

# BACKFLOW PREVENTER

**For Non-Health Hazard Applications**

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

Approval _____ Representative _____

# Series 007
## Double Check Valve Assemblies

### Sizes: ½" – 3" (15 – 80mm)

Series 007 Double Check Valve Assemblies shall be installed at referenced cross-connections to prevent the backflow of polluted water into the potable water supply. Only those cross-connections identified by local inspection authorities as non-health hazard shall be allowed the use of an approved double check valve assembly.

Check with local authority having jurisdiction regarding vertical orientation, frequency of testing or other installation requirements.

The valve shall meet the requirements of ASSE Std. 1015 and AWWA Std. C510. Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.

### Features

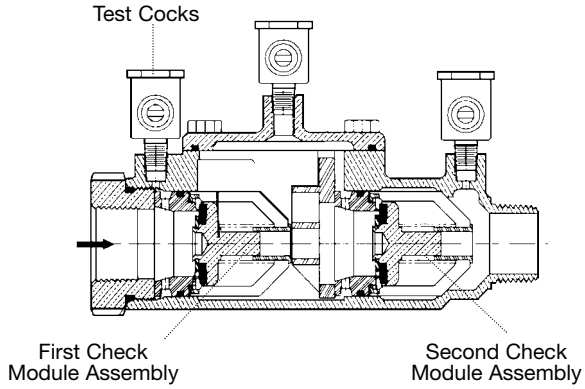
- Ease of maintenance — only one cover
- Top entry
- Replaceable seats and seat discs
- Modular construction
- Compact design
- Cast bronze body construction — ½" – 2" (15 – 50mm)
- Fused epoxy coated cast iron body — 2½" – 3" (65 – 80mm)
- Top mounted ball valve test cocks
- Low pressure drop
- No special tools required for servicing
- ½" – 1" (15 – 25mm) have tee handles

### Specifications

A Double Check Valve Assembly shall be installed at each noted location. The assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module seats and seat discs shall be replaceable. Service of all internal components shall be through a single bronze or stainless steel access cover secured with stainless steel bolts. The assembly shall also include two resilient seated isolation valves; four top mounted, resilient seated test cocks. The assembly shall meet the requirements of ASSE Std. 1015 and AWWA Std. C510. Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. Assembly shall be a Watts Series 007.

**¾" (20mm) 007M3QT**

**2" (50mm) 007M1QT HC**




The 007 Series features a modular design concept which facilitates complete maintenance and assembly by retaining the spring load.

**Now Available**
**WattsBox Insulated Enclosures.**
For more information, send for literature ES-WB.

***IMPORTANT:*** *INQUIRE WITH GOVERNING AUTHORITIES FOR LOCAL INSTALLATION REQUIREMENTS*

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

## Pressure — Temperature

**½" – 2" (15 – 50mm)**

Temperature Range: 33°F – 180°F (0.5°C – 82°C).

Maximum Working Pressure: 175psi (12.1 bar).

**2½" – 3" (65 – 80mm)**

Temperature Range: 33°F – 110°F (0.5°C – 43°C) continuous, 140°F (60°C) intermittent.

Maximum Working Pressure: 175psi (12.1 bar).

## Standards

ASSE Std. 1015, AWWA Std. C510

IAPMO PS31, CSA B64.5

## Approvals

† ASSE, AWWA, IAPMO, CSA, UPC

▲ Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.

• Models LF and S are not listed.

◆ UL Classified (LF models only) ¾" – 2" (20 – 50mm) (except 007M3LF)

◆ UL Classified with OSY gate valves (2½" and 3" horizontal only.)

* Horizontal and vertical "flow up" approval on all sizes

Suffix:

S - bronze strainer

LF - without shutoff valves

LH - locking handle ball valves (open position)

SH - stainless steel ball valve handles

HC - 2½" inlet/outlet fire hydrant fittings (2" valve)

Prefix:

U - Union connections

**2½" – 3" (65 – 80mm)**

Suffix:

NRS - non-rising stem resilient seated gate valves

OSY - UL/FM outside stem and yoke resilient seated gate valves

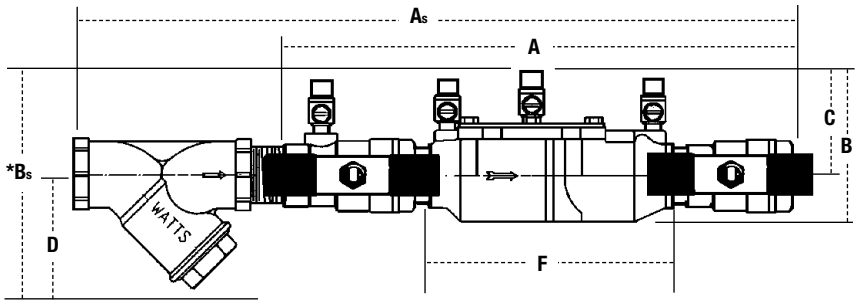
LF - without shutoff valves

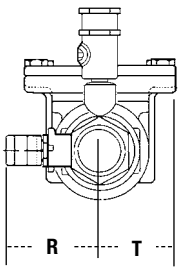
QT-FDA - FDA epoxy coated quarter-turn ball valves

## Dimensions – Weights

## Models

**Sizes: ½" – 2" (15 – 50mm)**



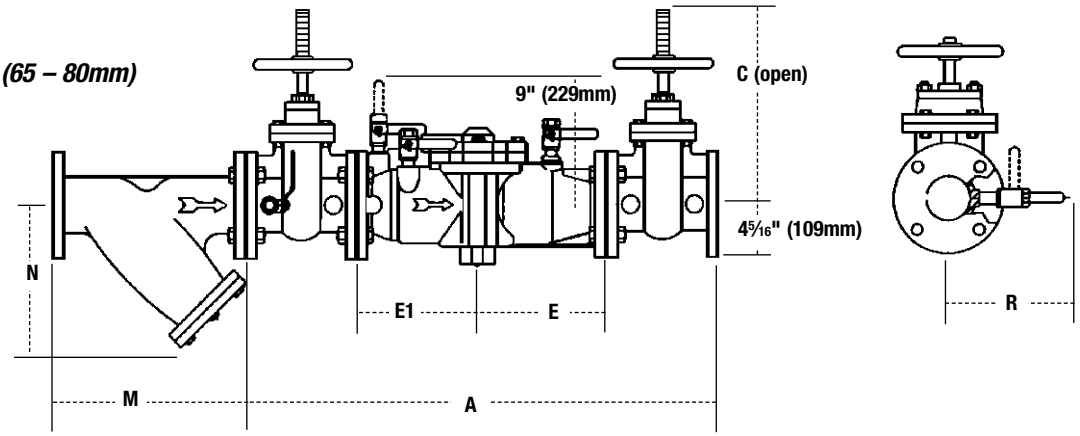

***Subscript 'S' = strainer model**

**Suffix HC — Fire Hydrant Fittings dimension "A" = 23½" (594mm)**

| MODEL | SIZE (DN) | | DIMENSIONS | | | | | | | | | | | | | | | | WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | | B | | C | | D | | F | | G | | R | | T | | | |
| | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | lbs. | kgs. |
| †▲007QT | ½ | 15 | 10 | 254 | 4 5/8 | 117 | 2 7/16 | 62 | — | — | 5 | 127 | 3 3/8 | 85 | 2 5/16 | 59 | 2 1/16 | 52 | 4.5 | 2 |
| †▲007M3QT | ¾ | 20 | 11 1/8 | 282 | 4 | 102 | 3 1/8 | 79 | — | — | 6 3/16 | 157 | 3 7/16 | 87 | 2 1/8 | 54 | 1 5/16 | 33 | 5 | 2.3 |
| †▲007M1QT | 1 | 25 | 13 1/4 | 337 | 5 1/8 | 130 | 4 | 102 | — | — | 7 1/2 | 191 | 3 3/8 | 85 | 1 11/16 | 43 | 1 11/16 | 43 | 12 | 5.4 |
| †▲007M2QT | 1 1/4 | 32 | 16 3/8 | 416 | 5 | 127 | 3 5/16 | 84 | — | — | 9 1/2 | 241 | 5 | 127 | 3 | 76 | 2 | 50 | 15 | 6.8 |
| †▲007M2QT | 1 1/2 | 40 | 16 3/4 | 425 | 4 7/8 | 124 | 3 1/2 | 89 | — | — | 9 3/4 | 248 | 5 13/16 | 148 | 3 1/8 | 79 | 2 11/16 | 68 | 15.9 | 7.2 |
| †▲007M1QT | 2 | 50 | 19 1/2 | 495 | 6 1/4 | 159 | 4 | 102 | — | — | 13 3/8 | 340 | 6 1/8 | 156 | 3 7/16 | 87 | 2 11/16 | 68 | 25.7 | 11.7 |
| • 007QT-S | ½ | 15 | 13 | 330 | 6 | 152 | 2 7/16 | 62 | 3 | 76 | 5 | 127 | 3 3/8 | 85 | 2 5/16 | 59 | 2 1/16 | 52 | 5.5 | 2.5 |
| • 007M3QT-S | ¾ | 20 | 14 1/2 | 368 | 6 1/8 | 156 | 3 1/8 | 79 | 3 | 76 | 6 3/16 | 157 | 3 7/16 | 87 | 2 1/8 | 54 | 1 5/16 | 33 | 6.7 | 3.1 |
| • 007M1QT-S | 1 | 25 | 17 15/16 | 157 | 7 3/4 | 197 | 4 | 102 | 3 1/4 | 83 | 7 1/2 | 191 | 3 3/8 | 85 | 1 11/16 | 43 | 1 11/16 | 43 | 14 | 6.4 |
| • 007M2QT-S | 1 1/4 | 32 | 21 1/2 | 546 | 7 1/16 | 179 | 3 5/16 | 84 | 3 1/2 | 83 | 9 1/2 | 241 | 5 | 127 | 3 | 76 | 2 | 50 | 19 | 8.6 |
| • 007M2QT-S | 1 1/2 | 40 | 25 1/16 | 637 | 7 1/16 | 179 | 3 1/2 | 89 | 3 3/4 | 95 | 9 3/4 | 248 | 5 13/16 | 148 | 3 1/8 | 79 | 2 11/16 | 68 | 19.6 | 8.9 |
| • 007M1QT-S | 2 | 50 | 27 1/4 | 692 | 8 3/4 | 222 | 4 | 102 | 4 | 102 | 13 3/8 | 340 | 6 1/8 | 156 | 3 7/16 | 87 | 2 11/16 | 68 | 33.5 | 15.2 |

## Dimensions – Weights

***Sizes: 2½" – 3" (65 – 80mm)***



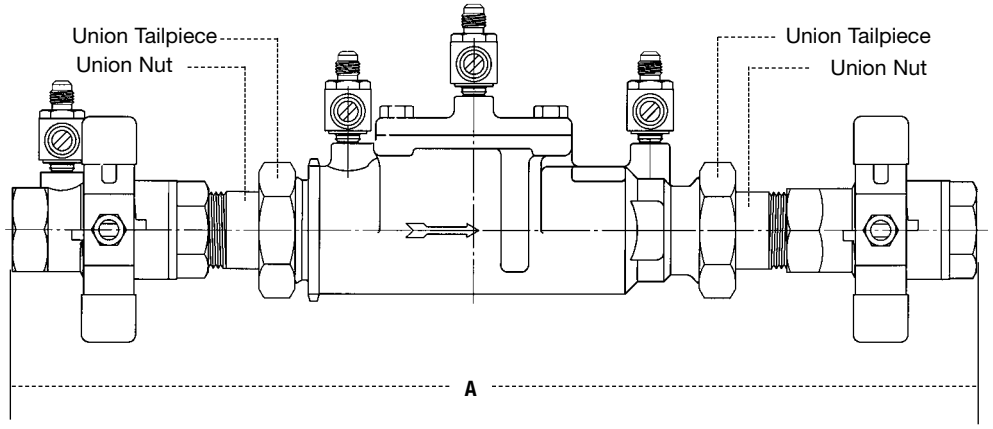

| | MODEL | SIZE (DN) | | DIMENSIONS | | | | | | | | WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | | C | | E, E1 | | R | | | |
| | | *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *lbs.* | *kgs.* |
| | 007QT-FDA | 2½ | 65 | 33⅛ | 841 | 6⅜ | 162 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 155 | 70 |
| ▲ | 007-NRS | 2½ | 65 | 33⅛ | 841 | 9⅜ | 238 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 155 | 70 |
| ▲◆ | 007-OSY | 2½ | 65 | 33⅛ | 841 | 16⅜ | 416 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 158 | 72 |
| | 007-QT-FDA | 3 | 80 | 34⅛ | 867 | 6⅜ | 162 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 155 | 70 |
| ▲◆ | 007-NRS | 3 | 80 | 34⅛ | 867 | 10¼ | 260 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 185 | 84 |
| ▲ | 007-OSY | 3 | 80 | 34⅛ | 867 | 18⅞ | 479 | 9¹⁄₁₆ | 230 | 8¾ | 222 | 185 | 84 |

**Strainer Dimensions**

| SIZE | | | | | | WEIGHT | |
|---|---|---|---|---|---|---|---|
| | | M | | N | | | |
| *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *lbs.* | *kgs.* |
| 2½ | 65 | 10 | 254 | 6½ | 165 | 28 | 13 |
| 3* | 80 | 10⅛ | 267 | 7 | 178 | 34 | 15 |

*S Models only

***1" U007M1QT***




**Sizes: ½" – 2" (15 – 50mm)**

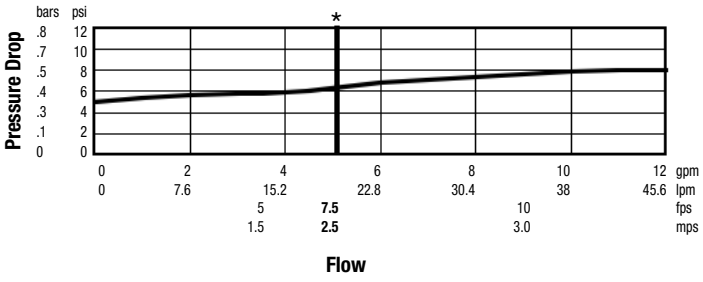
| MODEL | SIZE (DN) | | DIMENSIONS | |
|---|---|---|---|---|
| | | | A | |
| | *in.* | *mm* | *in.* | *mm* |
| U007QT | ½ | 15 | 12¹³⁄₁₆ | 326 |
| U007M2QT | ¾ | 20 | 13¹³⁄₁₆ | 350 |
| U007M2QT | 1 | 25 | 16⅝ | 422 |
| U007M2QT | 1¼ | 32 | 20¾ | 527 |
| U007M2QT | 1½ | 40 | 21½ | 546 |
| U007M1QT | 2 | 50 | 24½ | 622 |

# Capacity

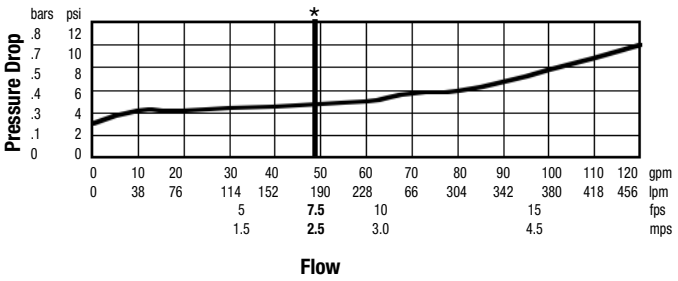
**As complied from documented Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California lab tests.**

* Typical maximum system flow rate (7.5 feet/sec., 2.3 meters/sec.)
** UL rated flow

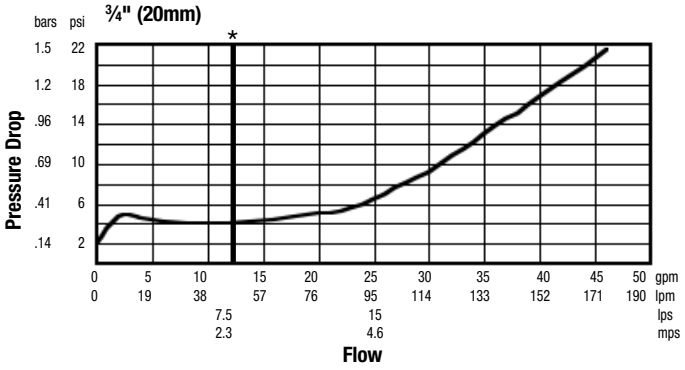
### ½" (15mm)



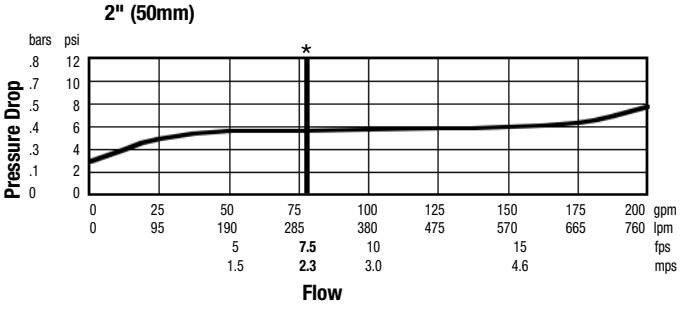

### 1½" (40mm)



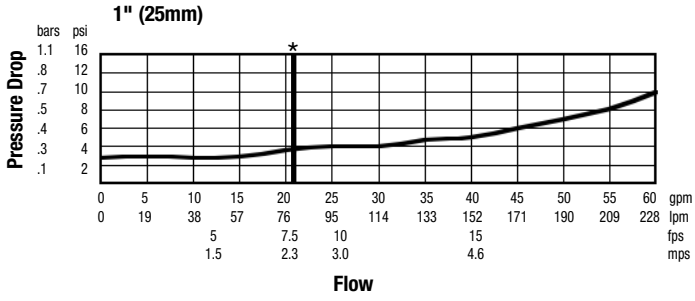

### ¾" (20mm)



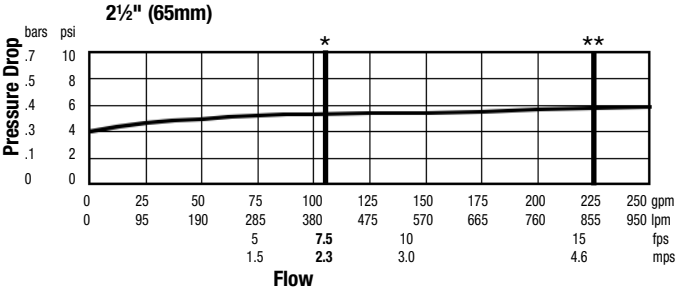

### 2" (50mm)



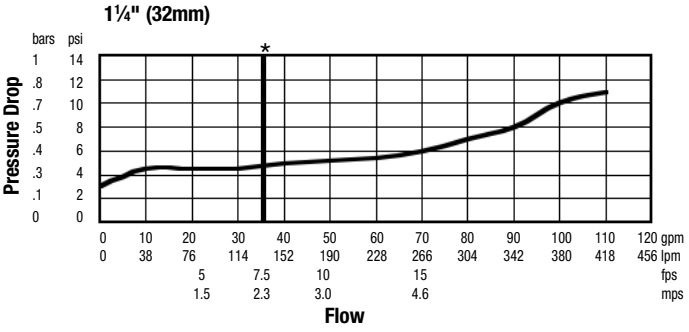

### 1" (25mm)



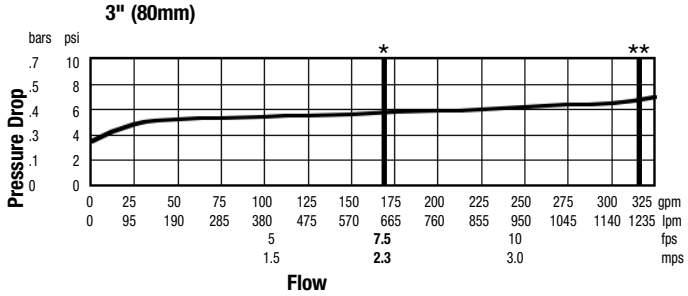

### 2½" (65mm)




### 1¼" (32mm)




### 3" (80mm)







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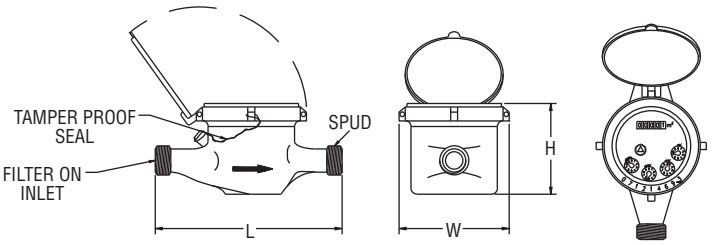
# MECHANICAL FLOW-TOTALIZER

# Series WM Multi-Jet Water Meters

## Specifications - Installation and Operating Instructions




| Size | Spud NPSM [BSPP] | Length "L" | Width "W" | Height "H" | Weight lb [kg] |
|---|---|---|---|---|---|
| 5/8" [15 mm] | 3/4" [3/4'] | 7-1/2" [190 mm] | 3-15/16" [99 mm] | 4-3/16" [106 mm] | 3.53 [1.6] |
| 5/8" x 3/4" | 1" | 7-1/2" | 3-15/16" | 4-3/16" | 3.75 |
| 3/4" [20 mm] | 1" [1'] | 7-1/2" [190 mm] | 3-15/16" [99 mm] | 4-3/16" [106 mm] | 3.75 [1.7] |
| 1" [25 mm] | 1-1/4" [1-1/4'] | 10-1/4" [260 mm] | 4-1/16" [103 mm] | 4-1/2" [114 mm] | 5.73 [2.6] |
| 1-1/4" [32 mm] | 1-1/2" [1-1/2'] | 10-1/4" [260 mm] | 4-1/8" [104 mm] | 4-5/8" [117 mm] | 6.17 [2.8] |
| 1-1/2" [40 mm] | 2" [2'] | 11-13/16" [300 mm] | 4-7/8" [124 mm] | 5-13/16" [147 mm] | 11.25 [5.1] |
| 2" [50 mm] | 2-1/2" [2-1/2'] | 11-13/16" [300 mm] | 4-15/16" [125 mm] | 6-3/4" [172 mm] | 18.74 [8.5] |

**The Series WM Multi-Jet Water Meters** are ideal for commercial and industrial applications. The multi-jet design allows simplicity and accuracy with wide flow ranges, even in low flow applications. The magnetically driven, hermetically sealed register will not leak or fog and is completely separated from the water. These water meters are designed for long service life and maintenance-free operation.

### INSTALLATION INSTRUCTIONS

1. Thoroughly flush the service line upstream of the meter to remove dirt and debris.

2. Remove meter spud thread protectors.

NOTE: To protect the meter spud threads, store the meter with thread protectors in place.

3. Set the meter in the line. Install the meter in a horizontal plane, with the register upright, in a location accessible for reading, service and inspection. Arrows on the side of the meter and above the outlet spud indicate the direction of flow.

4. For accurate measurement, the tap height should be higher than the meter.

5. Do not overtighten connections; tighten only as required to seal. Do not use pipe sealant tape on meter threads.

6. With upstream shutoff valve only:
Open shutoff valve slowly, to remove air from the meter and service line. Open a faucet slowly to allow entrapped air to escape. Close the faucet.

With both upstream and downstream shutoff valves installed:
To test the installation for leaks: Close the outlet (downstream) shutoff valve. Open the inlet (upstream) shutoff slowly until meter is full of water. Open the outlet (downstream) valve slowly until air is out of meter and service line. Open a faucet slowly to allow entrapped air to escape. Close the faucet.

### SPECIFICATIONS

**Service:** Water.
**Flow Range:** See model chart.
**Wetted Materials:** Body: brass, nylon, acetal; Couplings: brass; Measuring Chamber: Fluorocarbon (FKM), polyethylene, high impact polystyrene, ABS plastic.
**Accuracy:** Transitional Flow: ±5%, Nominal Flow: ±2% (See instruction manual).
**Temperature Limit:** 104°F (40°C).
**Pressure Limit:** 145 psi (10 bar).
**Pressure Drop:** See pressure loss chart.
**Totalizing Display Maximum:** 9,999,999 counts.
**Mounting Orientation:** Horizontal.
**Weight:** See dimension chart.

### FLOW RATES

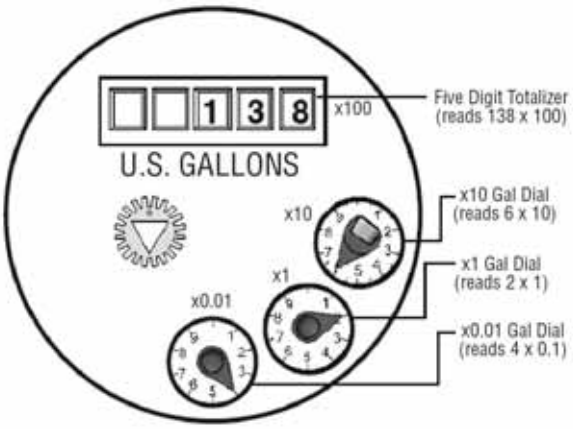
| Size | Coupling Size | Transitional Flow (GPM) | Nominal Flow (GPM) | Max Flow (GPM) |
|---|---|---|---|---|
| 5/8" | 1/2" NPT | 0.125 | 0.5-13 | 13 |
| 5/8" x 3/4" | 3/4" NPT | 0.125 | 1-20 | 20 |
| 3/4" | 3/4" NPT | 0.25 | 1-22 | 22 |
| 1" | 1" NPT | 0.375 | 1.25-30 | 30 |
| 1-1/2" | 1-1/2" NPT | 1.0 | 3-88 | 88 |
| 2" | 2" NPT | 1.25 | 5-132 | 132 |

| Size | Coupling Size | Transitional Flow (L/h) | Nominal Flow ($m^3$/h) | Max Flow ($m^3$/h) |
|---|---|---|---|---|
| 15 mm | 1/2" BSPT | 30 | 0.12-3.0 | 3 |
| 20 mm | 3/4" BSPT | 50 | 0.2-5.0 | 5 |
| 25 mm | 1" BSPT | 70 | 0.28-5 | 7 |
| 32 mm | 1-1/4" BSPT | 120 | 0.48-12 | 12 |
| 40 mm | 1-1/2" BSPT | 200 | 0.8-20 | 20 |
| 50 mm | 2" BSPT | 300 | 1.2-30 | 30 |

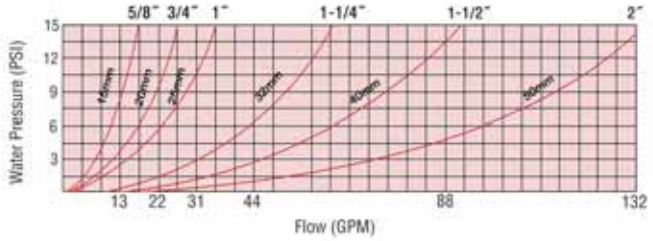
**DWYER INSTRUMENTS, INC.**
**P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.**
**Phone: 219/879-8000**
**Fax: 219/872-9057**
**www.dwyer-inst.com**
**e-mail: info@dwyer-inst.com**

**METER READING**

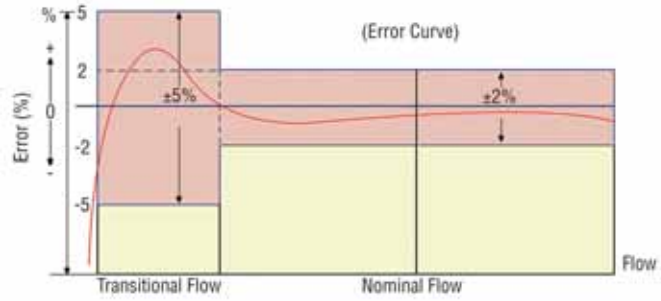
Reading Your Meter. The total Flow that has passed through your meter is read by starting at the top of the register with the Five-Digit Totalizer, and then reading clockwise around the small dials. In the example below, the Five-Digit Totalizer reads 13,800 (138 x 100), and the dial reads 60 (6 x 10), 2 (2 x 1), and .4 (4 x .01) respectively. The Total Flow is 13,862.4 gallons.




**PRESSURE LOSS**




**ACCURACY CHART**




**INSTALLATION**

Horizontal installation only.

**MAINTENANCE**

Preventative maintenance consists of periodic inspections and cleaning procedures. The procedures should be preformed at regular intervals and any defects discovered should be corrected before further operation of the meter.

Visually inspect the meter for missing hardware, broken resister glass, or other signs of wear or deterioration. Verify proper flow rate and pressure for meter. A loss in pressure, with the resulting flow rate decrease, may indicate the meter screen is clogged and requires cleaning.

Clean the strainer yearly, or as required, depending on water condition. Pull out the strainer or backflush the meter to loosen trapped particulates.

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**Phone: 219/879-8000**
**Fax: 219/872-9057**

**www.dwyer-inst.com**
**e-mail: info@dwyer-inst.com**

# ACTUATED VALVE

# *VG1000 Series Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Spring Return Electric Actuators with Switches (Continued)*

**Two-Way – Spring Return Valve Closed – Normally Closed with End Switches**

| Fluid Temperatures: 23 to 203°F (-5 to 95°C) | | | | AC 24 V | | | AC 85–264 V (VA9203) AC 120 V (VA9208) |
|---|---|---|---|---|---|---|---|
| **Valve** | **Size, in.** | **Cv** | **Closeoff psig** | **Floating** | **DC 0 to 10 V Proportional** | **On/Off** | **On/Off** |
| | | | | **Spring Return Closed — Valve Normally Closed — Actuators with One Switch** | | | |
| | | | | **VA9203-AGB-2Z** | **VA9203-GGB-2Z** | **VA9203-BGB-2** | **VA9203-BUB-2** |
| **VG1241AD** | 1/2 | 1.2[1] | 200 | VG1241AD+943AGB | VG1241AD+943GGB | VG1241AD+943BGB | VG1241AD+943BUB |
| **VG1241AE** | | 1.9[1] | | VG1241AE+943AGB | VG1241AE+943GGB | VG1241AE+943BGB | VG1241AE+943BUB |
| **VG1241AF** | | 2.9[1] | | VG1241AF+943AGB | VG1241AF+943GGB | VG1241AF+943BGB | VG1241AF+943BUB |
| **VG1241AG** | | 4.7[1] | | VG1241AG+943AGB | VG1241AG+943GGB | VG1241AG+943BGB | VG1241AG+943BUB |
| **VG1241AL** | | 7.4[1] | | VG1241AL+943AGB | VG1241AL+943GGB | VG1241AL+943BGB | VG1241AL+943BUB |
| **VG1241AN** | | 11.7 | | VG1241AN+943AGB | VG1241AN+943GGB | VG1241AN+943BGB | VG1241AN+943BUB |
| **VG1241BG** | 3/4 | 4.7[1] | 200 | VG1241BG+943AGB | VG1241BG+943GGB | VG1241BG+943BGB | VG1241BG+943BUB |
| **VG1241BL** | | 7.4[1] | | VG1241BL+943AGB | VG1241BL+943GGB | VG1241BL+943BGB | VG1241BL+943BUB |
| **VG1241BN** | | 11.7 | | VG1241BN+943AGB | VG1241BN+943GGB | VG1241BN+943BGB | VG1241BN+943BUB |
| **VG1241CL** | 1 | 7.4[1] | 200 | VG1241CL+943AGB | VG1241CL+943GGB | VG1241CL+943BGB | VG1241CL+943BUB |
| **VG1241CN** | | 11.7[1] | | VG1241CN+943AGB | VG1241CN+943GGB | VG1241CN+943BGB | VG1241CN+943BUB |
| **VG1241CP** | | 18.7 | | VG1241CP+943AGB | VG1241CP+943GGB | VG1241CP+943BGB | VG1241CP+943BUB |
| **Valve** | **Size, in.** | **Cv** | **Closeoff psig** | **Spring Return Closed — Valve Normally Closed — Actuators with Two Switches** | | | |
| | | | | **VA9208-AGC-3** | **VA9208-GGC-3** | **VA9208-BGC-3** | **VA9208-BAC-3** |
| **VG1241DN** | 1-1/4 | 11.7[1] | 200 | VG1241DN+958AGC | VG1241DN+958GGC | VG1241DN+958BGB | VG1241DN+958BAB |
| **VG1241DP** | | 18.7[1] | | VG1241DP+958AGC | VG1241DP+958GGC | VG1241DP+958BGB | VG1241DP+958BAB |
| **VG1241DR** | | 29.2 | | VG1241DR+958AGC | VG1241DR+958GGC | VG1241DR+958BGB | VG1241DR+958BAB |
| **VG1241EP** | 1-1/2 | 18.7[1] | 200 | VG1241EP+958AGC | VG1241EP+958GGC | VG1241EP+958BGB | VG1241EP+958BAB |
| **VG1241ER** | | 29.2[1] | | VG1241ER+958AGC | VG1241ER+958GGC | VG1241ER+958BGB | VG1241ER+958BAB |
| **VG1241ES** | | 46.8 | | VG1241ES+958AGC | VG1241ES+958GGC | VG1241ES+958BGB | VG1241ES+958BAB |
| **VG1241FR** | 2 | 29.2[1] | 200 | VG1241FR+958AGC | VG1241FR+958GGC | VG1241FR+958BGC | VG1241FR+958BAC |
| **VG1241FS** | | 46.8[1] | | VG1241FS+958AGC | VG1241FS+958GGC | VG1241FS+958BGC | VG1241FS+958BAC |
| **VG1241FT** | | 73.7 | | VG1241FT+958AGC | VG1241FT+958GGC | VG1241FT+958BGC | VG1241FT+958BAC |

1. Cv has a characterizing disk.

The performance specifications are nominal and conform to acceptable industry standards. For applications at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products. © 2011 Johnson Controls, Inc.

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Issued July 6, 2011

# VG1000 Series Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Spring Return Electric Actuators with Switches

## Description

VG1000 Series Ball Valves are designed to regulate the flow of hot or chilled water and, for some models, low pressure steam in response to the demand of a controller in Heating, Ventilating, and Air Conditioning (HVAC) systems. Available in sizes 1/2 through 2 in. (DN15 through DN50), this family of two- and three-way forged brass valves is factory or field mounted to Johnson Controls® VA9104, M9106, M9109, and M9100 Series Non-Spring Return and VA9203 and VA9208 Series Spring Return Electric Actuators for on/off, floating, or proportional control.

Refer to the *VG1000 Series Forged Brass Ball Valves Product Bulletin (LIT-977132)* for important product application information.

## Features

- forged brass body — provides 580 psig static pressure rating
- graphite-reinforced Polytetrafluoroethylene (PTFE) seats — include 15% graphite-reinforced ball seals, providing better wear resistance
- 500:1 rangeability — provides accurate control under all load conditions
- maintenance-free design — performs without failure in excess of 200,000 full stroke cycles in iron-oxide contaminated water

## Repair Information

If the VG1000 Series Ball Valve fails to operate within its specifications, replace the unit. For a replacement valve, contact the nearest Johnson Controls representative.

**VG1000 Series Two-Way, Spring Return, Plated Brass Ball and Stem Ball Valve Assemblies with End Switches**

## Selection Charts

**Two-Way – Spring Return Valve Open – Normally Open with Switches**

| Fluid Temperatures: 23 to 203°F (-5 to 95°C) | | | | AC 24 V | | | AC 85–264 V (VA9203) AC 120 V (VA9208) |
|---|---|---|---|---|---|---|---|
| Valve | Size, in. | Cv | Closeoff psig | Floating | DC 0 to 10 V Proportional | On/Off | On/Off |
| | | | | Spring Return Open — Valve Normally Open — Actuators with One Switch | | | |
| | | | | VA9203-AGB-2Z | VA9203-GGB-2Z | VA9203-BGB-2 | VA9203-BUB-2 |
| VG1241AD | 1/2 | 1.2[1] | 200 | VG1241AD+923AGB | VG1241AD+923GGB | VG1241AD+923BGB | VG1241AD+923BUB |
| VG1241AE | | 1.9[1] | | VG1241AE+923AGB | VG1241AE+923GGB | VG1241AE+923BGB | VG1241AE+923BUB |
| VG1241AF | | 2.9[1] | | VG1241AF+923AGB | VG1241AF+923GGB | VG1241AF+923BGB | VG1241AF+923BUB |
| VG1241AG | | 4.7[1] | | VG1241AG+923AGB | VG1241AG+923GGB | VG1241AG+923BGB | VG1241AG+923BUB |
| VG1241AL | | 7.4[1] | | VG1241AL+923AGB | VG1241AL+923GGB | VG1241AL+923BGB | VG1241AL+923BUB |
| VG1241AN | | 11.7 | | VG1241AN+923AGB | VG1241AN+923GGB | VG1241AN+923BGB | VG1241AN+923BUB |
| VG1241BG | 3/4 | 4.7[1] | 200 | VG1241BG+923AGB | VG1241BG+923GGB | VG1241BG+923BGB | VG1241BG+923BUB |
| VG1241BL | | 7.4[1] | | VG1241BL+923AGB | VG1241BL+923GGB | VG1241BL+923BGB | VG1241BL+923BUB |
| VG1241BN | | 11.7 | | VG1241BN+923AGB | VG1241BN+923GGB | VG1241BN+923BGB | VG1241BN+923BUB |
| VG1241CL | 1 | 7.4[1] | 200 | VG1241CL+923AGB | VG1241CL+923GGB | VG1241CL+923BGB | VG1241CL+923BUB |
| VG1241CN | | 11.7[1] | | VG1241CN+923AGB | VG1241CN+923GGB | VG1241CN+923BGB | VG1241CN+923BUB |
| VG1241CP | | 18.7 | | VG1241CP+923AGB | VG1241CP+923GGB | VG1241CP+923BGB | VG1241CP+923BUB |
| Valve | Size, in. | Cv | Closeoff psig | Spring Return Open — Valve Normally Open — Actuators with Two Switches | | | |
| | | | | VA9208-AGC-3 | VA9208-GGC-3 | VA9208-BGC-3 | VA9208-BAC-3 |
| VG1241DN | 1-1/4 | 11.7[1] | 200 | VG1241DN+938AGC | VG1241DN+938GGC | VG1241DN+938BGB | VG1241DN+938BAB |
| VG1241DP | | 18.7[1] | | VG1241DP+938AGC | VG1241DP+938GGC | VG1241DP+938BGB | VG1241DP+938BAB |
| VG1241DR | | 29.2 | | VG1241DR+938AGC | VG1241DR+938GGC | VG1241DR+938BGB | VG1241DR+938BAB |
| VG1241EP | 1-1/2 | 18.7[1] | 200 | VG1241EP+938AGC | VG1241EP+938GGC | VG1241EP+938BGB | VG1241EP+938BAB |
| VG1241ER | | 29.2[1] | | VG1241ER+938AGC | VG1241ER+938GGC | VG1241ER+938BGB | VG1241ER+938BAB |
| VG1241ES | | 46.8 | | VG1241ES+938AGC | VG1241ES+938GGC | VG1241ES+938BGB | VG1241ES+938BAB |
| VG1241FR | 2 | 29.2[1] | 200 | VG1241FR+938AGC | VG1241FR+938GGC | VG1241FR+938BGC | VG1241FR+938BAC |
| VG1241FS | | 46.8[1] | | VG1241FS+938AGC | VG1241FS+938GGC | VG1241FS+938BGC | VG1241FS+938BAC |
| VG1241FT | | 73.7 | | VG1241FT+938AGC | VG1241FT+938GGC | VG1241FT+938BGC | VG1241FT+938BAC |

1. Cv has a characterizing disk.

The performance specifications are nominal and conform to acceptable industry standards. For applications at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products. © 2011 Johnson Controls, Inc.

# *VG1000 Series Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Spring Return Electric Actuators with Switches (Continued)*

## Technical Specifications

| VG1000 Series Two-Way, Plated Brass Trim Ball Valves with Spring Return Electric Actuators with Switches | | |
|---|---|---|
| **Service**[1] | | Hot Water, Chilled Water, 50/50 Glycol Solutions, and 15 psig (103 kPa) Saturated Steam for HVAC Systems |
| **Fluid Temperature Limits** | **Water** | 23 to 203°F (-5 to 95°C) |
| | **Steam** | Not Rated for Steam Service |
| **Valve Body Pressure Rating** | **Water** | 580 psig (3,999 kPa) (PN40) |
| | **Steam** | Not Rated for Steam Service |
| **Maximum Closeoff Pressure** | | 200 psig (1,378 kPa) |
| **Maximum Recommended Operating Pressure Drop** | | 50 psi Maximum Differential Pressure for Valves with Characterized Flow Control Disk and 30 psi Maximum for Quiet Service Ball Valves |
| **Flow Characteristics** | **Two-Way** | Equal Percentage |
| **Rangeability**[2] | | Greater than 500:1 |
| **Minimum Ambient Operating Temperature** | **-22°F (-30°C)** | VA9203 Series Spring Return Actuators |
| | **-40°F (-40°C)** | VA9208 Series Spring Return Actuators |
| **Maximum Ambient Operating Temperature**[3] **(Limited by the Actuator and Linkage)** | **Direct Mount** | 140°F (60°C): VA9208 Series Spring Return Actuators |
| **Leakage** | | 0.01% of Maximum Flow per ANSI/FCI 70-2, Class 4 |
| **End Connections** | | National Pipe Thread (NPT) |
| **Materials** | **Body** | Forged Brass |
| | **Ball** | Chrome Plated Brass |
| | **Blowout-Proof Stem** | Nickel Plated Brass |
| | **Seats** | Graphite-Reinforced PTFE with Ethylene Propylene Diene Monomer (EPDM) O-Ring Backing |
| | **Stem Seals** | EPDM Double O-Rings |
| | **Characterizing Disk** | Amodel® AS-1145HS Polyphthalamide Resin |

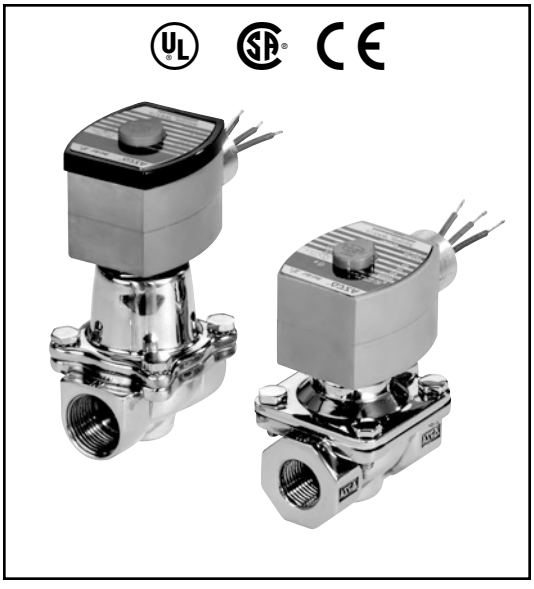
1. Proper water treatment is recommended; refer to the VDI 2035 Standard.
2. Rangeability is defined as the ratio of maximum controllable flow to minimum controllable flow.
3. In steam applications, install the valve with the stem horizontal to the piping and wrap the valve and piping with insulation.

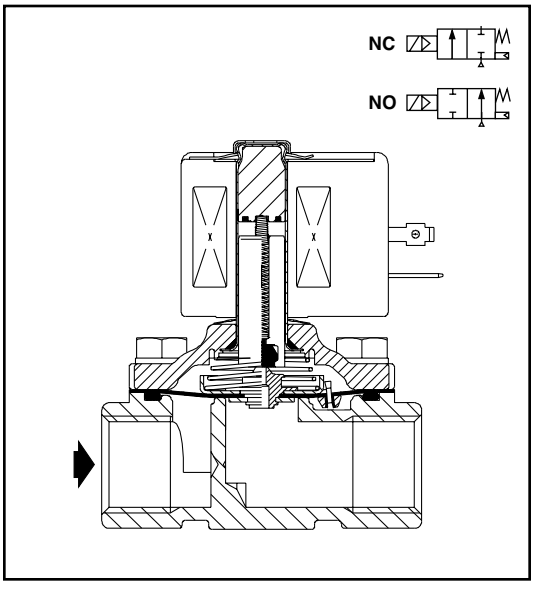
The performance specifications are nominal and conform to acceptable industry standards. For applications at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products. © 2011 Johnson Controls, Inc. 

# SOLENOID VALVE

## Features

- Wide range of pressure ratings, sizes, and resilient materials provide long service life and low internal leakage
- High Flow Valves for liquid, corrosive, and air/inert gas service
- Industrial applications include:
  - Car wash
  - Laundry equipment
  - Air compressors
  - Industrial water control
  - Pumps






## Construction

| Valve Parts in Contact with Fluids | | |
|---|---|---|
| **Body** | Brass | 304 Stainless Steel |
| **Seals and Discs** | NBR or PTFE | |
| **Disc-Holder** | PA | |
| **Core Tube** | 305 Stainless Steel | |
| **Core and Plugnut** | 430F Stainless Steel | |
| **Springs** | 302 Stainless Steel | |
| **Shading Coil** | Copper | Silver |

## Electrical

| Standard Coil and Class of Insulation | Watt Rating and Power Consumption | | | | Spare Coil Part Number | | | |
|---|---|---|---|---|---|---|---|---|
| | | AC | | | General Purpose | | Explosionproof | |
| | DC Watts | Watts | VA Holding | VA Inrush | AC | DC | AC | DC |
| F | - | 6.1 | 16 | 40 | 238210 | - | 238214 | - |
| F | 11.6 | 10.1 | 25 | 70 | 238610 | 238710 | 238614 | 238714 |
| F | 16.8 | 16.1 | 35 | 180 | 272610 | 97617 | 272614 | 97617 |
| F | - | 17.1 | 40 | 93 | 238610 | - | 238614 | - |
| F | - | 20 | 43 | 240 | 99257 | - | 99257 | - |
| F | - | 20.1 | 48 | 240 | 272610 | - | 272614 | - |
| H | 30.6 | - | - | - | - | 74073 | - | 74073 |
| H | 40.6 | - | - | - | - | 238910 | - | 238914 |

**Standard Voltages:** 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering.
Other voltages available when required.

## Solenoid Enclosures

**Standard:** RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X; RedHat - Type I.

**Optional:** RedHat II - Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9; Red-Hat - Explosionproof and Watertight, Types 3, 4, 4X, 7, and 9.

(To order, add prefix "EF" to catalog number, except Catalog Numbers 8210B057, 8210B058, and 8210B059, which are not available with Explosionproof enclosures.)
*See Optional Features Section for other available options.*

## Nominal Ambient Temp. Ranges

RedHat II/
RedHat AC: 32˚F to 125˚F (0˚C to 52˚C)

RedHat II DC: 32˚F to 104˚F (0˚C to 40˚C)
RedHat DC: 32˚F to 77˚F (0˚C to 25˚C)
(104˚F/40˚C occasionally)

8210G227 AC: 32˚F to 130˚F (0˚C to 54˚C)
DC: 32˚F to 90˚F (0˚C to 32˚C)

*Refer to Engineering Section for details.*

## Approvals

UL listed as indicated. CSA certified.
RedHat II meets applicable CE directives.
*Refer to Engineering Section for details.*

# 2/2 SERIES 8210

ASCO®

## Specifications (English units)

| Pipe Size (ins.) | Orifice Size (ins.) | Cv Flow Factor | Operating Pressure Differential (psi) | | | | | | | Max. Fluid Temp. ˚F | | Brass Body | | | Stainless Steel Body | | | Watt Rating/ Class of Coil Insulation ⑦ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Max. AC | | | Max. DC | | | | | | | | | | | | |
| | | | Min. | Air-Inert Gas | Water | Light Oil @ 300 SSU | Air-Inert Gas | Water | Light Oil @ 300 SSU | AC | DC | Catalog Number | Const. Ref. ④ | UL ⑤ Listing | Catalog Number | Const. Ref. ④ | UL ⑤ Listing | AC | DC |
| **NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating** | | | | | | | | | | | | | | | | | | | |
| 3/8 | 3/8 | 1.5 | ① | 150 | 125 | - | 40 | 40 | - | 180 | 150 | 8210G073 ③ | 1P | ● | 8210G036 ③ | 1P | ● | 6.1/F | 11.6/F |
| 3/8 | 5/8 | 3 | 0 | 150 | 150 | - | 40 | 40 | - | 180 | 150 | 8210G093 | 5D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 3/8 | 5/8 | 3 | 5 | 200 | 150 | 135 | 125 | 100 | 100 | 180 | 150 | 8210G001 | 6D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/8 | 5/8 | 3 | 5 | 300 | 300 | 300 | - | - | - | 175 | - | 8210G006 | 5D | ❍ | - | - | - | 17.1/F | - |
| 1/2 | 7/16 | 2.2 | ① | 150 | 125 | - | 40 | 40 | - | 180 | 150 | 8210G015 ③ | 2P | ● | 8210G037 ③ | 2P | ● | 6.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 0 | 150 | 150 | - | 40 | 40 | - | 180 | 150 | 8210G094 | 5D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 0 | 150 | 150 | 125 | 40 | 40 | - | 175 | 150 | - | - | - | 8210G087 | 7D | ● | 17.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 5 | 200 | 150 | 135 | 125 | 100 | 100 | 180 | 150 | 8210G002 | 6D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 5 | 300 | 300 | 300 | - | - | - | 175 | - | 8210G007 | 5D | ❍ | - | - | - | 17.1/F | - |
| 1/2 | 3/4 | 4 | 5 | - | 300 | - | - | 300 | - | 130 | 90 | 8210G227 | 5D | ❍ † | - | - | - | 17.1/F | 40.6/H |
| 3/4 | 5/8 | 4.5 | 0 | 150 | 150 | 125 | 40 | 40 | - | 175 | 150 | - | - | - | 8210G088 | 7D | ● | 17.1/F | 11.6/F |
| 3/4 | 3/4 | 5 | 5 | 125 | 125 | 125 | 100 | 90 | 75 | 180 | 150 | 8210G009 | 9D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/4 | 3/4 | 5 | 0 | 150 | 150 | - | 40 | 40 | - | 180 | 150 | 8210G095 | 8D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 3/4 | 6.5 | 5 | 250 | 150 | 100 | 125 | 125 | 125 | 180 | 150 | 8210G003 | 11D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/4 | 3/4 | 6 | 0 | - | - | - | 200 | 180 | 180 | - | 77 | 8210B026 ② ‡ | 10P | - | - | - | - | - | 30.6/H |
| 3/4 | 3/4 | 6 | 0 | 350 | 300 | 200 | - | - | - | 200 | - | 8210G026 ② ‡ | 40P | ● | - | - | - | 16.1F | - |
| 1 | 1 | 13 | 0 | - | - | - | 100 | 100 | 80 | - | 77 | 8210B054 ‡ | 31D | - | 8210D089 | 15D | - | - | 30.6/H |
| 1 | 1 | 13 | 0 | 150 | 125 | 125 | - | - | - | 180 | - | 8210G054 | 41D | ● | 8210G089 | 45D | ● | 16.1/F | - |
| 1 | 1 | 13 | 5 | 150 | 150 | 100 | 125 | 125 | 125 | 180 | 150 | 8210G004 | 12D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1 | 1 | 13.5 | 0 | 300 | 225 | 115 | - | - | - | 200 | - | 8210G027 ‡ | 42P | ● | - | - | - | 20.1/F | - |
| 1 | 1 | 13.5 | 10 | 300 | 300 | 300 | - | - | - | 175 | - | 8210G078 ② | 13P | - | - | - | - | 17.1/F | - |
| 1 1/4 | 1 1/8 | 15 | 0 | - | - | - | 100 | 100 | 80 | - | 77 | 8210B055 ‡ | 32D | - | - | - | - | - | 30.6/H |
| 1 1/4 | 1 1/8 | 15 | 0 | 150 | 125 | 125 | - | - | - | 180 | - | 8210G055 | 43D | ● | - | - | - | 16.1/F | - |
| 1 1/4 | 1 1/8 | 15 | 5 | 150 | 150 | 100 | 125 | 125 | 125 | 180 | 150 | 8210G008 | 16D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1 1/2 | 1 1/4 | 22.5 | 0 | - | - | - | 100 | 100 | 80 | - | 77 | 8210B056 ‡ | 33D | - | - | - | - | - | 30.6/H |
| 1 1/2 | 1 1/4 | 22.5 | 0 | 150 | 125 | 125 | - | - | - | 180 | - | 8210G056 | 44D | ● | - | - | - | 16.1/F | - |
| 1 1/2 | 1 1/4 | 22.5 | 5 | 150 | 150 | 100 | 125 | 125 | 125 | 180 | 150 | 8210G022 | 18D | ● | - | - | - | 6.1/F | 11.6/F |
| 2 | 1 3/4 | 43 | 5 | 150 | 125 | 90 | 50 | 50 | 50 | 180 | 150 | 8210G100 | 20P | ● | - | - | - | 6.1/F | 11.6/F |
| 2 1/2 | 1 3/4 | 45 | 5 | 150 | 125 | 90 | 50 | 50 | 50 | 180 | 150 | 8210G101 | 21P | ● | - | - | - | 6.1/F | 11.6/F |
| **NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)** | | | | | | | | | | | | | | | | | | | |
| 3/8 | 5/8 | 3 | 0 | 150 | 150 | 125 | 125 | 125 | 80 | 180 | 150 | 8210G033 | 23D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/8 | 5/8 | 3 | 5 | 250 | 200 | 200 | 250 | 200 | 200 | 180 | 180 | 8210G011 ⑧ ⑨ | 39D | ● | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 0 | 150 | 150 | 125 | 125 | 125 | 80 | 180 | 150 | 8210G034 | 23D | ● | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 5/8 | 3 | 0 | 150 | 150 | 100 | 125 | 125 | 80 | 180 | 150 | - | - | - | 8210G030 | 37D | ● | 10.1/F | 11.6/F |
| 1/2 | 5/8 | 4 | 5 | 250 | 200 | 200 | 250 | 200 | 200 | 180 | 180 | 8210G012 ⑧ ⑨ | 39D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 3/4 | 5.5 | 0 | 150 | 150 | 125 | 125 | 125 | 80 | 180 | 150 | 8210G035 | 25D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 5/8 | 3 | 0 | 150 | 150 | 100 | 125 | 125 | 80 | 180 | 150 | - | - | - | 8210G038 | 38D | ● | 10.1/F | 11.6/F |
| 3/4 | 3/4 | 6.5 | 5 | - | - | - | 250 | 200 | 200 | - | 180 | 8210C013 | 24D | ● | - | - | - | - | 16.8/F |
| 3/4 | 3/4 | 6.5 | 5 | 250 | 200 | 200 | - | - | - | 180 | - | 8210G013 | 46D | ● | - | - | - | 16.1/F | - |
| 1 | 1 | 13 | 0 | 125 | 125 | 125 | - | - | - | 180 | - | 8210B057 ⑥ ⑩ | 34D | ● | - | - | - | 20/F | - |
| 1 | 1 | 13 | 5 | - | - | - | 125 | 125 | 125 | - | 180 | 8210D014 | 26D | ● | - | - | - | - | 16.8/F |
| 1 | 1 | 13 | 5 | 150 | 150 | 125 | - | - | - | 180 | - | 8210G014 | 47D | ● | - | - | - | 16.1/F | - |
| 1 1/4 | 1 1/8 | 15 | 0 | 125 | 125 | 125 | - | - | - | 180 | - | 8210B058 ⑥ ⑩ | 35D | ● | - | - | - | 20/F | - |
| 1 1/4 | 1 1/8 | 15 | 5 | - | - | - | 125 | 125 | 125 | - | 180 | 8210D018 | 28D | ● | - | - | - | - | 16.8/F |
| 1 1/4 | 1 1/8 | 15 | 5 | 150 | 150 | 125 | - | - | - | 180 | - | 8210G018 | 48D | ● | - | - | - | 16.1/F | - |
| 1 1/2 | 1 1/4 | 22.5 | 0 | 125 | 125 | 125 | - | - | - | 180 | - | 8210B059 ⑥ ⑩ | 36D | ● | - | - | - | 20/F | - |
| 1 1/2 | 1 1/4 | 22.5 | 5 | - | - | - | 125 | 125 | 125 | - | 180 | 8210D032 | 29D | ● | - | - | - | - | 16.8/F |
| 1 1/2 | 1 1/4 | 22.5 | 5 | 150 | 150 | 125 | - | - | - | 180 | - | 8210G032 | 49D | ● | - | - | - | 16.1/F | - |
| 2 | 1 3/4 | 43 | 5 | - | - | - | 125 | 125 | 125 | - | 150 | 8210 103 | 30P | ● | - | - | - | - | 16.8/F |
| 2 | 1 3/4 | 43 | 5 | 125 | 125 | 125 | - | - | - | 180 | - | 8210G103 | 50P | ● | - | - | - | 16.1/F | - |
| 2 1/2 | 1 3/4 | 45 | 5 | - | - | - | 125 | 125 | 125 | - | 150 | 8210 104 | 27P | ● | - | - | - | - | 16.8/F |
| 2 1/2 | 1 3/4 | 45 | 5 | 125 | 125 | 125 | - | - | - | 180 | - | 8210G104 | 51P | ● | - | | | 16.1/F | - |

① 5 psi on Air; 1 psi on Water.
② Valve provided with PTFE main disc.
③ Valve includes Ultem (G.E. trademark) piston.
④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve.
*Refer to Engineering Section (Approvals) for details.*

⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
‡ Must have solenoid mounted vertical and upright.

† UL listed for fire protection systems per UL429A.

## Specifications (Metric units)

| Pipe Size (ins.) | Orifice Size (mm) | Kv Flow Factor (m3/h) | Operating Pressure Differential (bar) Min. | Max. AC Air-Inert Gas | Max. AC Water | Max. AC Light Oil @ 300 SSU | Max. DC Air-Inert Gas | Max. DC Water | Max. DC Light Oil @ 300 SSU | Max. Fluid Temp. ˚C AC | Max. Fluid Temp. ˚C DC | Brass Body Catalog Number | Brass Body Const. Ref. ④ | Brass Body UL ⑤ Listing | Stainless Steel Body Catalog Number | Stainless Steel Body Const. Ref. ④ | Stainless Steel Body UL ⑤ Listing | Watt Rating/ Class of Coil Insulation ⑦ AC | Watt Rating/ Class of Coil Insulation ⑦ DC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating** | | | | | | | | | | | | | | | | | | | |
| 3/8 | 10 | 1.3 | ① | 10 | 9 | - | 3 | 3 | - | 82 | 65 | 8210G073 ③ | 1P | ● | 8210G036 ③ | 1P | ● | 6.1/F | 11.6/F |
| 3/8 | 16 | 2.6 | 0 | 10 | 10 | - | 3 | 3 | - | 82 | 65 | 8210G093 | 5D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 3/8 | 16 | 2.6 | 0.3 | 14 | 10 | 9 | 9 | 7 | 7 | 82 | 65 | 8210G001 | 6D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/8 | 16 | 2.6 | 0.3 | 21 | 21 | 21 | - | - | - | 79 | - | 8210G006 | 5D | ❍ | - | - | - | 17.1/F | - |
| 1/2 | 11 | 1.9 | ① | 10 | 9 | - | 3 | 3 | - | 82 | 65 | 8210G015 ③ | 2P | ● | 8210G037 ③ | 2P | ● | 6.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0 | 10 | 10 | - | 3 | 3 | - | 82 | 65 | 8210G094 | 5D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0 | 10 | 10 | 9 | 3 | 3 | - | 79 | 65 | - | - | - | 8210G087 | 7D | ● | 17.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0.3 | 14 | 10 | 9 | 9 | 7 | 7 | 82 | 65 | 8210G002 | 6D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0.3 | 21 | 21 | 21 | - | - | - | 79 | - | 8210G007 | 5D | ❍ | - | - | - | 17.1/F | - |
| 1/2 | 19 | 3.4 | 0.3 | - | 21 | - | - | 21 | - | 54 | 32 | 8210G227 | 5D | ❍ † | - | - | - | 17.1/F | 40.6H |
| 3/4 | 16 | 3.9 | 0 | 10 | 10 | 9 | 3 | 3 | - | 79 | 65 | - | - | - | 8210G088 | 7D | ● | 17.1/F | 11.6/F |
| 3/4 | 19 | 4.3 | 0.3 | 9 | 9 | 9 | 7 | 6 | 5 | 82 | 65 | 8210G009 | 9D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/4 | 19 | 4.3 | 0 | 10 | 10 | - | 3 | 3 | - | 82 | 65 | 8210G095 | 8D | ❍ | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 19 | 5.6 | 0.3 | 17 | 10 | 7 | 9 | 9 | 9 | 82 | 65 | 8210G003 | 11D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 3/4 | 19 | 5.1 | 0 | - | - | - | 14 | 12 | 12 | - | 25 | 8210B026 ② ‡ | 10P | - | - | - | - | - | 30.6/H |
| 3/4 | 19 | 5.1 | 0 | 24 | 21 | 14 | - | - | - | 93 | - | 8210G026 ② ‡ | 40P | ● | - | - | - | 16.1F | - |
| 1 | 25 | 11 | 0 | - | - | - | 7 | 7 | 6 | - | 25 | 8210B054 ‡ | 31D | - | 8210D089 | 15D | - | - | 30.6/H |
| 1 | 25 | 11 | 0 | 10 | 9 | 9 | - | - | - | 82 | - | 8210G054 | 41D | ● | 8210G089 | 45D | ● | 16.1/F | - |
| 1 | 25 | 11 | 0.3 | 10 | 10 | 7 | 9 | 9 | 9 | 82 | 65 | 8210G004 | 12D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1 | 25 | 11.5 | 0 | 21 | 16 | 8 | - | - | - | 93 | - | 8210G027 ‡ | 42P | ● | - | - | - | 20.1/F | - |
| 1 | 25 | 11.5 | 0.7 | 21 | 21 | 21 | - | - | - | 79 | - | 8210G078 ② | 13P | - | - | - | - | 17.1/F | - |
| 1 1/4 | 29 | 13 | 0 | - | - | - | 7 | 7 | 6 | - | 25 | 8210B055 ‡ | 32D | - | - | - | - | - | 30.6/H |
| 1 1/4 | 29 | 13 | 0 | 10 | 9 | 9 | - | - | - | 82 | - | 8210G055 | 43D | ● | - | - | - | 16.1/F | - |
| 1 1/4 | 29 | 13 | 0.3 | 10 | 10 | 7 | 9 | 9 | 9 | 82 | 65 | 8210G008 | 16D | ❍ | - | - | - | 6.1/F | 11.6/F |
| 1 1/2 | 32 | 19.5 | 0 | - | - | - | 7 | 7 | 6 | - | 25 | 8210B056 ‡ | 33D | - | - | - | - | - | 30.6/H |
| 1 1/2 | 32 | 19.5 | 0 | 10 | 9 | 9 | - | - | - | 82 | - | 8210G056 | 44D | ● | - | - | - | 16.1/F | - |
| 1 1/2 | 32 | 19.5 | 0.3 | 10 | 10 | 7 | 9 | 9 | 9 | 82 | 65 | 8210G022 | 18D | ● | - | - | - | 6.1/F | 11.6/F |
| 2 | 44 | 37 | 0.3 | 10 | 9 | 6 | 3 | 3 | 3 | 82 | 65 | 8210G100 | 20P | ● | - | - | - | 6.1/F | 11.6/F |
| 2 1/2 | 44 | 39 | 0.3 | 10 | 9 | 6 | 3 | 3 | 3 | 82 | 65 | 8210G101 | 21P | ● | - | - | - | 6.1/F | 11.6/F |
| **NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)** | | | | | | | | | | | | | | | | | | | |
| 3/8 | 16 | 2.6 | 0.0 | 10 | 10 | 9 | 9 | 9 | 6 | 82 | 65 | 8210G033 | 23D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/8 | 16 | 2.6 | 0.3 | 17 | 14 | 14 | 17 | 14 | 14 | 82 | 82 | 8210G011 ⑧ ⑨ | 39D | ● | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0 | 10 | 10 | 9 | 9 | 9 | 6 | 82 | 65 | 8210G034 | 23D | ● | - | - | - | 10.1/F | 11.6/F |
| 1/2 | 16 | 2.6 | 0 | 10 | 10 | 7 | 9 | 9 | 6 | 82 | 65 | - | - | - | 8210G030 | 37D | ● | 10.1/F | 11.6/F |
| 1/2 | 16 | 3.4 | 0.3 | 17 | 14 | 14 | 17 | 14 | 14 | 82 | 82 | 8210G012 ⑧ ⑨ | 39D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 19 | 4.7 | 0 | 10 | 10 | 9 | 9 | 9 | 6 | 82 | 65 | 8210G035 | 25D | ● | - | - | - | 10.1/F | 11.6/F |
| 3/4 | 16 | 2.6 | 0 | 10 | 10 | 7 | 9 | 9 | 6 | 82 | 65 | - | - | - | 8210G038 | 38D | ● | 10.1/F | 11.6/F |
| 3/4 | 19 | 5.6 | 0.3 | - | - | - | 17 | 14 | 14 | - | 82 | 8210C013 | 24D | ● | - | - | - | - | 16.8/F |
| 3/4 | 19 | 5.6 | 0.3 | 17 | 14 | 14 | - | - | - | 82 | - | 8210G013 | 46D | ● | - | - | - | 16.1/F | - |
| 1 | 25 | 11 | 0 | 9 | 9 | 9 | - | - | - | 82 | - | 8210B057 ⑥ ⑩ | 34D | ● | - | - | - | 20/F | - |
| 1 | 25 | 11 | 0.3 | - | - | - | 9 | 9 | 9 | - | 82 | 8210D014 | 26D | ● | - | - | - | - | 16.8/F |
| 1 | 25 | 11 | 0.3 | 10 | 10 | 9 | - | - | - | 82 | - | 8210G014 | 47D | ● | - | - | - | 16.1/F | - |
| 1 1/4 | 29 | 13 | 0 | 9 | 9 | 9 | - | - | - | 82 | - | 8210B058 ⑥ ⑩ | 35D | ● | - | - | - | 20/F | - |
| 1 1/4 | 29 | 13 | 0.3 | - | - | - | 9 | 9 | 9 | - | 82 | 8210D018 | 28D | ● | - | - | - | - | 16.8/F |
| 1 1/4 | 29 | 13 | 0.3 | 10 | 10 | 9 | - | - | - | 82 | - | 8210G018 | 48D | ● | - | - | - | 16.1/F | - |
| 1 1/2 | 32 | 19.5 | 0 | 9 | 9 | 9 | - | - | - | 82 | - | 8210B059 ⑥ ⑩ | 36D | ● | - | - | - | 20/F | - |
| 1 1/2 | 32 | 19.5 | 0.3 | - | - | - | 9 | 9 | 9 | - | 82 | 8210D032 | 29D | ● | - | - | - | - | 16.8/F |
| 1 1/2 | 32 | 19.5 | 0.3 | 10 | 10 | 9 | - | - | - | 82 | - | 8210G032 | 49D | ● | - | - | - | 16.1/F | - |
| 2 | 44 | 37 | 0.3 | - | - | - | 9 | 9 | 9 | - | 65 | 8210 103 | 30P | ● | - | - | - | - | 16.8/F |
| 2 | 44 | 37 | 0.3 | 9 | 9 | 9 | - | - | - | 82 | - | 8210G103 | 50P | ● | - | - | - | 16.1/F | - |
| 2 1/2 | 44 | 39 | 0.3 | - | - | - | 9 | 9 | 9 | - | 65 | 8210 104 | 27P | ● | - | - | - | - | 16.8/F |
| 2 1/2 | 44 | 39 | 0.3 | 9 | 9 | 9 | - | - | - | 82 | - | 8210G104 | 51P | ● | - | - | - | 16.1/F | - |

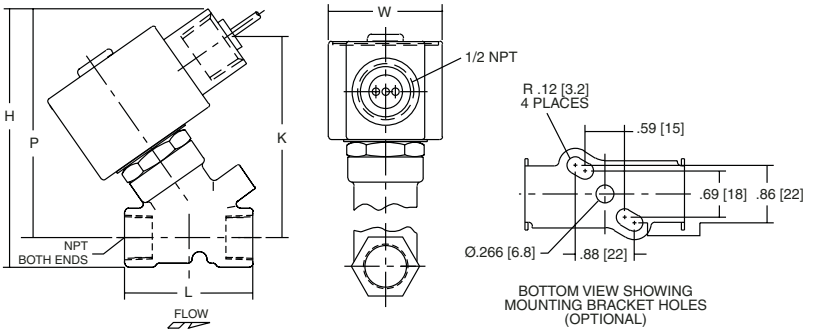
① 0.3 bar on Air; 0.0 bar on Water.
② Valve provided with PTFE main disc.
③ Valve includes ULtem (G.E. trademark) piston.
④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve.
*Refer to Engineering Section (Approvals) for details.*
⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
‡ Must have solenoid mounted vertical and upright.
† UL listed for fire protection systems per UL429A.

## Dimensions: inches (mm)

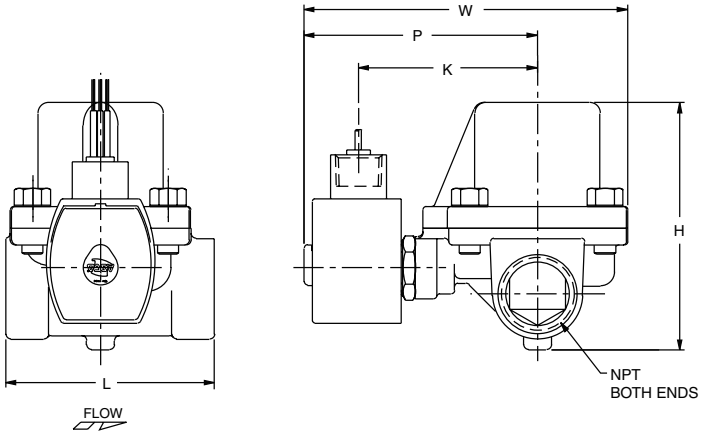
| Const. Ref. | | H | K | L | P | W |
|---|---|---|---|---|---|---|
| 1* | ins. | 3.85 | 3.00 | 1.91 | 3.41 | 1.69 |
| | mm | 98 | 76 | 49 | 87 | 43 |
| 2* | ins. | 4.17 | 3.25 | 2.28 | 3.63 | 1.69 |
| | mm | 106 | 83 | 58 | 92 | 43 |
| 5 | ins. | 3.84 | 2.31 | 2.75 | 3.28 | 2.28 |
| | mm | 98 | 59 | 70 | 83 | 58 |
| 6* | ins. | 3.38 | 1.94 | 2.75 | 2.80 | 2.28 |
| | mm | 86 | 49 | 70 | 71 | 58 |
| 7 | ins. | 4.19 | 2.50 | 2.81 | 3.47 | 2.39 |
| | mm | 106 | 64 | 71 | 88 | 61 |
| 8 | ins. | 4.13 | 2.47 | 2.81 | 3.44 | 2.29 |
| | mm | 105 | 63 | 71 | 87 | 58 |
| 9* | ins. | 3.66 | 2.10 | 2.81 | 2.96 | 2.28 |
| | mm | 93 | 53 | 71 | 75 | 58 |
| 10* | ins. | 5.25 | X | 2.81 | 4.59 | 2.31 |
| | mm | 133 | X | 71 | 117 | 59 |
| 11* | ins. | 4.16 | 2.66 | 3.84 | 3.52 | 2.75 |
| | mm | 106 | 68 | 98 | 89 | 70 |
| 12 | ins. | 5.64 | 3.15 | 3.75 | 4.01 | 3.36 |
| | mm | 143 | 80 | 95 | 102 | 85 |
| 13 | ins. | 4.44 | 3.22 | 3.75 | 4.19 | 5.81 |
| | mm | 113 | 82 | 95 | 106 | 147 |
| 15* | ins. | 5.34 | X | 3.75 | 4.47 | 3.84 |
| | mm | 136 | X | 95 | 114 | 98 |
| 16 | ins. | 5.64 | 3.15 | 3.66 | 4.01 | 3.56 |
| | mm | 143 | 80 | 93 | 102 | 90 |
| 18 | ins. | 6.11 | 3.30 | 4.38 | 4.16 | 3.92 |
| | mm | 155 | 84 | 111 | 106 | 100 |
| 20* | ins. | 7.33 | 3.71 | 5.06 | 4.57 | 4.87 |
| | mm | 186 | 94 | 129 | 116 | 124 |
| 21* | ins. | 7.33 | 3.71 | 5.50 | 4.57 | 4.87 |
| | mm | 186 | 94 | 140 | 116 | 124 |
| 23 | ins. | 4.35 | 2.65 | 2.75 | 3.79 | 2.28 |
| | mm | 110 | 67 | 70 | 96 | 58 |
| 24 | ins. | 5.06 | X | 3.78 | 4.44 | 2.75 |
| | mm | 129 | X | 96 | 113 | 70 |
| 25 | ins. | 4.64 | 2.81 | 2.81 | 3.94 | 2.28 |
| | mm | 118 | 71 | 71 | 100 | 58 |
| 26 | ins. | 6.53 | X | 3.75 | 4.91 | 3.19 |
| | mm | 166 | X | 95 | 125 | 81 |
| 27 | ins. | 8.22 | X | 5.50 | 5.47 | 4.87 |
| | mm | 209 | X | 140 | 139 | 124 |
| 28 | ins. | 6.53 | X | 3.66 | 4.91 | 3.19 |
| | mm | 166 | X | 93 | 125 | 81 |
| 29 | ins. | 7.03 | X | 4.38 | 5.06 | 4.40 |
| | mm | 179 | X | 111 | 129 | 112 |

* DC dimensions slightly larger.
**IMPORTANT:** Valves may be mounted in any position, except as noted in specifications table.

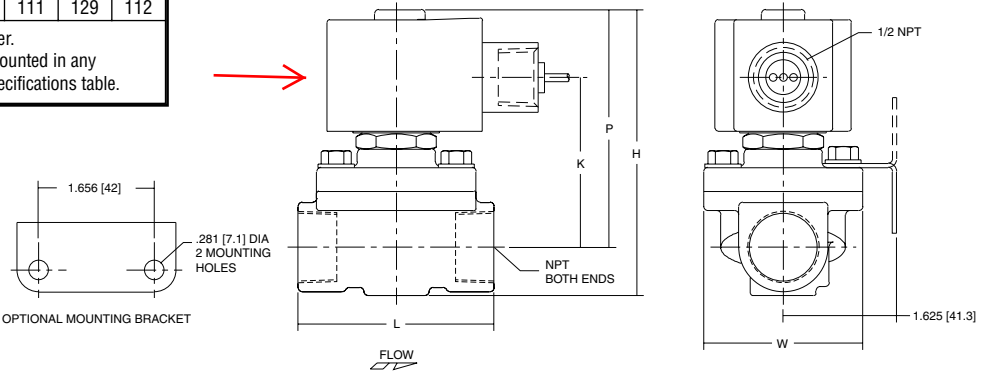
### Const. Ref. 1, 2




### Const. Ref. 13




### Const. Ref. 5-9, 11, 20, 21, 23 , 25, 37,38

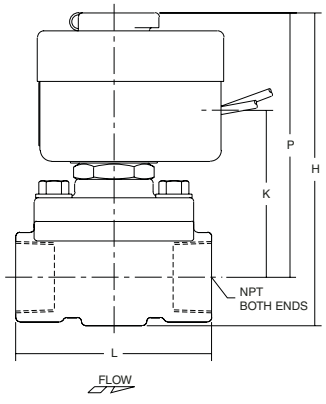


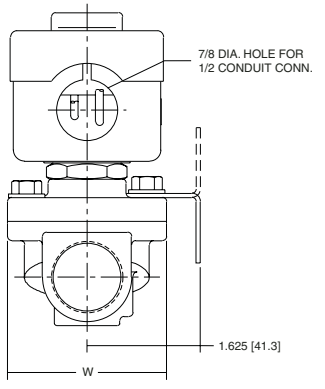
## Dimensions: inches (mm)

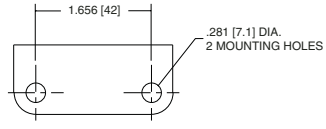
| Const. Ref. | | H | K | L | P | W |
|---|---|---|---|---|---|---|
| 30 | ins. | 8.22 | X | 5.06 | 5.47 | 4.87 |
| | mm | 209 | X | 129 | 139 | 124 |
| 31 | ins. | 5.25 | X | 3.75 | 4.44 | 3.25 |
| | mm | 133 | X | 95 | 113 | 83 |
| 32 | ins. | 5.69 | X | 3.66 | 4.69 | 3.25 |
| | mm | 145 | X | 93 | 119 | 83 |
| 33 | ins. | 6.06 | X | 4.38 | 4.94 | 3.91 |
| | mm | 154 | X | 111 | 125 | 99 |
| 34 | ins. | 6.91 | X | 3.75 | 6.09 | 3.25 |
| | mm | 176 | X | 95 | 155 | 83 |
| 35 | ins. | 7.34 | X | 3.66 | 6.34 | 3.25 |
| | mm | 186 | X | 93 | 161 | 83 |
| 36 | ins. | 7.66 | X | 4.38 | 6.56 | 3.91 |
| | mm | 1.95 | X | 111 | 167 | 99 |
| 37 | ins. | 4.61 | 2.75 | 2.81 | 3.89 | 2.39 |
| | mm | 117 | 70 | 71 | 99 | 61 |
| 38 | ins. | 4.61 | 2.75 | 2.81 | 3.89 | 2.39 |
| | mm | 117 | 70 | 71 | 99 | 61 |
| 39 | ins. | 5.42 | 2.31 | 2.75 | 4.86 | 3.80 |
| | mm | 138 | 59 | 70 | 123 | 97 |
| 40 | ins. | 5.20 | 3.29 | 2.81 | 4.50 | 2.28 |
| | mm | 132 | 83 | 71 | 114 | 58 |
| 41 | ins. | 5.13 | 3.10 | 3.75 | 4.32 | 3.25 |
| | mm | 130 | 79 | 95 | 110 | 83 |
| 42 | ins. | 6.43 | 4.40 | 3.93 | 5.62 | 3.25 |
| | mm | 163 | 112 | 100 | 143 | 83 |
| 43 | ins. | 5.57 | 3.35 | 3.66 | 4.57 | 3.25 |
| | mm | 142 | 85 | 93 | 116 | 83 |
| 44 | ins. | 5.90 | 3.57 | 4.38 | 4.79 | 3.91 |
| | mm | 150 | 91 | 111 | 122 | 99 |
| 45 | ins. | 5.26 | 3.17 | 3.75 | 4.38 | 3.84 |
| | mm | 134 | 81 | 95 | 111 | 98 |
| 46 | ins. | 4.95 | 3.10 | 3.84 | 4.31 | 2.75 |
| | mm | 126 | 79 | 98 | 110 | 70 |
| 47 | ins. | 6.43 | 3.59 | 3.75 | 4.81 | 3.52 |
| | mm | 163 | 91 | 95 | 122 | 90 |
| 48 | ins. | 6.43 | 3.59 | 3.66 | 4.81 | 3.73 |
| | mm | 163 | 91 | 93 | 122 | 95 |
| 49 | ins. | 6.91 | 3.75 | 4.38 | 4.96 | 4.40 |
| | mm | 176 | 95 | 111 | 126 | 112 |
| 50 | ins. | 8.13 | 4.15 | 5.06 | 5.37 | 4.87 |
| | mm | 207 | 105 | 129 | 136 | 124 |
| 51 | ins. | 8.13 | 4.15 | 5.50 | 5.37 | 5.18 |
| | mm | 207 | 105 | 140 | 136 | 132 |

**IMPORTANT:** Valves may be mounted in any position, except as noted in specifications table.

### Const. Ref. 10, 15, 24, 26-36

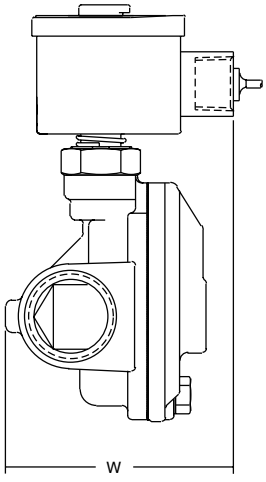


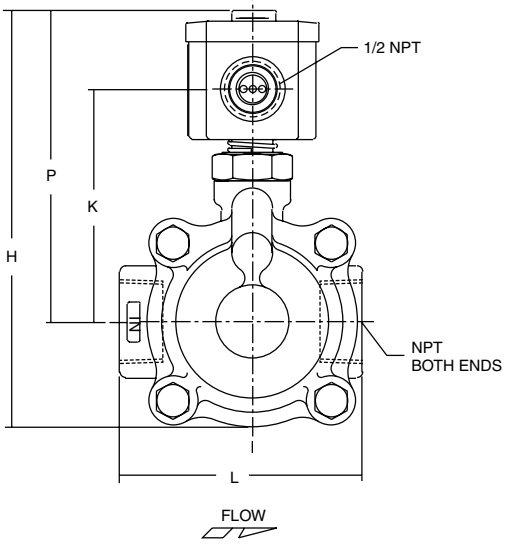




OPTIONAL MOUNTING BRACKET

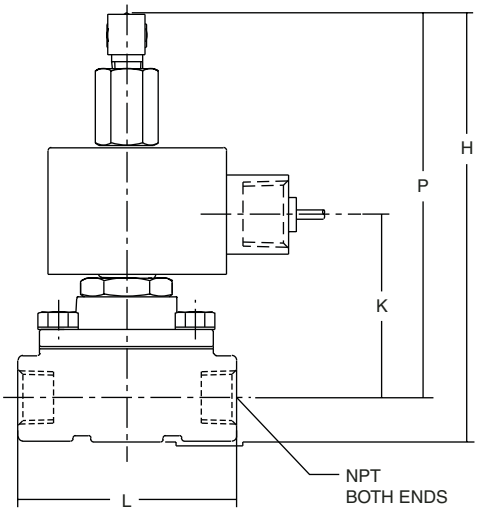
### Const. Ref. 12, 16, 18

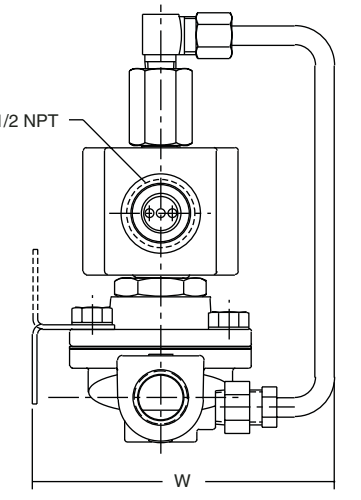


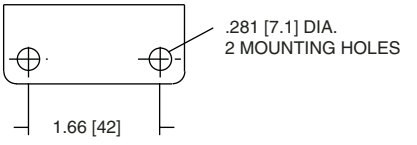



## Dimensions: inches (mm)

### Const. Ref. 39




SHOWING MOUNTING
BRACKET ONLY

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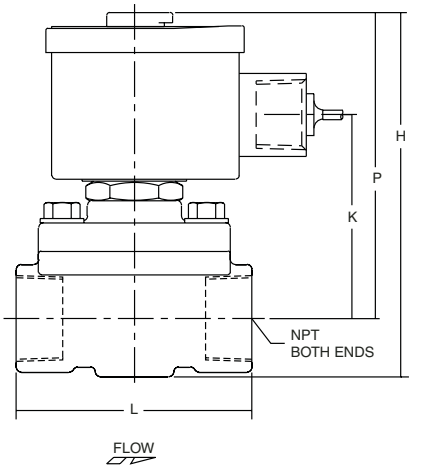
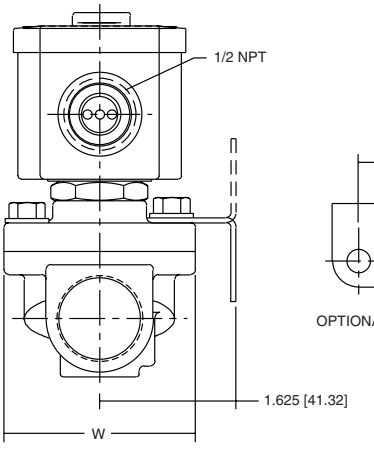
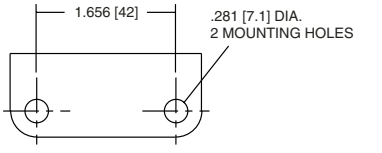



OPTIONAL MOUNTING BRACKET

# PRESSURE REGULATOR

## *For Steam, Liquid or Air Applications*

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

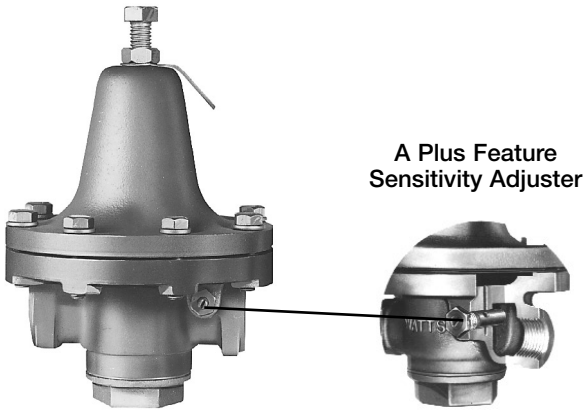
Approval _____ Representative _____

# Series 252A

## Process Steam Pressure Regulators

### Sizes ½" – ¾" (15 - 20mm)

Series 252A Process Steam Pressure Regulators are designed to offer highly sensitive response to reduced pressure changes and maintain fullest possible volume without appreciable reduced pressure drop. These regulators are ideal for use on applications such as oil lines, testing fixtures, autoclaves, steam tables, steam irons, single radiators, vulcanizers, sterilizers and process lines. The series 252A features a sensitivity adjuster to eliminate any vibrating condition that may arise from critical flow requirements.




**Series 252A**

### Features

- Bronze body construction
- Serviceable in line
- Standard sensitivity adjuster

### Models

252A – Bronze body for pressures up to 300psi (21 bars)

252AT – Tight seating for dead end and liquid service. Utilizes Teflon® valve disc, maximum operating temperatures are 300°F (204°C) at 300psi (21 bars) and 400°F (204°C) at 200psi (14 bars)

For information on ½" – 1" stainless steel construction, see literature ES-152SS.

### Specifications

Valve shall be manufactured out of bronze and have a maximum working pressure of up to 300psi. Valve shall feature a sensitivity adjuster to eliminate vibrating conditions. Valves shall be serviceable in line and have stainless steel trim and strainer. Valve shall be a Watts Regulator Company Series 252A.

### Materials

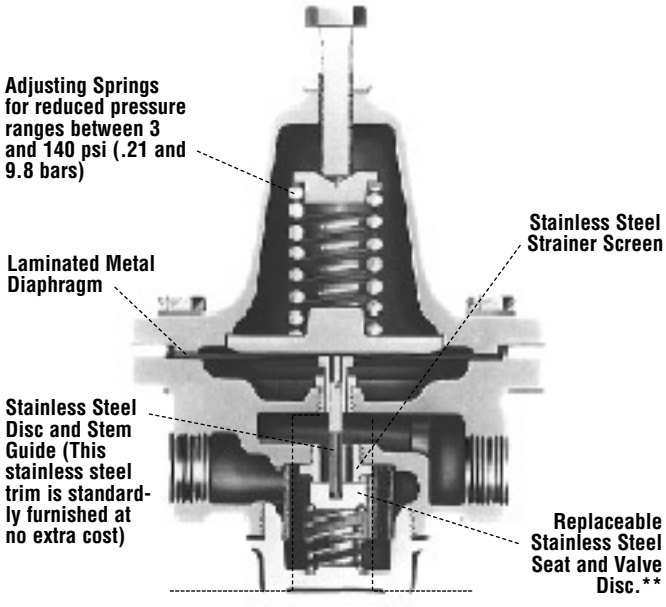
| | |
|---|---|
| Body: | Bronze |
| Trim: | Stainless Steel |
| Strainer: | Stainless Steel |
| Diaphragm: | Laminated Metal |
| Seat: | Replaceable Stainless Steel |
| Disc: | Replaceable Stainless Steel |

### Pressure – Temperature

**252A** Maximum Working Pressure: 300psi (21 bars)

**252AT –** Maximum Temperature: 300°F (149°C)
Maximum Working Pressure: 300psi (21 bars), and
Maximum Temperature: 400°F (204°C)
Maximum Working Pressure: 200psi (14 bars)

### Basic Design Feature




** When utilizing a Teflon® valve disc in the 252AT, the maximum operating temperatures are 300°F at 300psi (149°C at 21 bars) and 400°F at 200psi (204°C at 14 bars).

Teflon® is a registered tradename of E.I. duPont deNemours Co., Inc.

WATTS® REGULATOR

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

## Quick Reference Capacity Chart For Average Conditions

| | | | From psi | From bar | From psi | From bar | From psi | From bar | From psi | From bar | From psi | From bar | From psi | From bar | From psi | From bar | From psi | From bar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Initial Pressure** | | | 50 | 3.52 | 75 | 5.27 | 100 | 7.03 | 125 | 8.79 | 150 | 10.55 | 175 | 12.3 | 200 | 14.06 | 225 | 15.82 | 250 | 17.58 |
| | | | Up To | | Up To | | Up To | | Up To | | Up To | | Up To | | Up To | | Up To | | Up To | |
| **Reduced Pressure** | | | 20 | 1.41 | 35 | 2.46 | 50 | 3.52 | 60 | 4.22 | 70 | 4.92 | 80 | 5.62 | 90 | 6.33 | 100 | 7.03 | 125 | 8.79 |
| | **in.** | **mm** | ***Maximum Capacities in Lbs. of Steam Per Hour** | | | | | | | | | | | | | | | | | |
| 252A | ½" | 15 | 80 | | 111 | | 143 | | 175 | | 205 | | 237 | | 270 | | 299 | | 332 | |
| 252A | ¾" | 20 | 285 | | 394 | | 506 | | 620 | | 726 | | 841 | | 956 | | 1060 | | 1178 | |

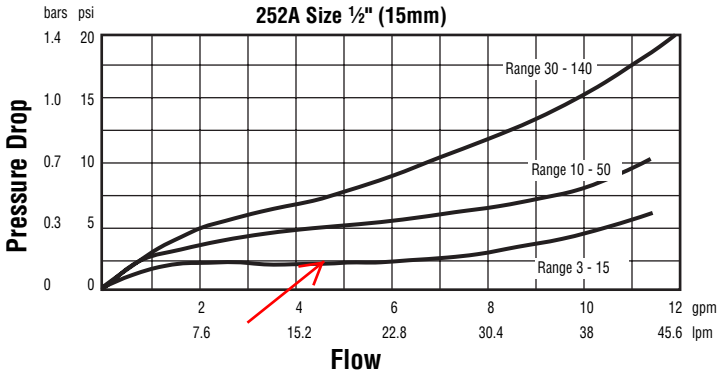
*1 Lb. Steam Equals 970 BTU Per Hour

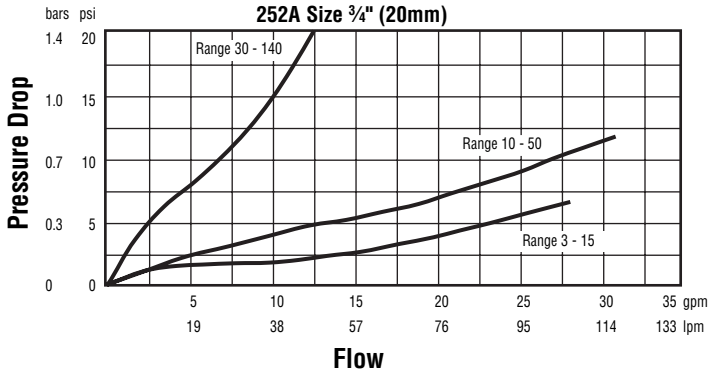
## Series 252A
## Adjusting Spring Range Chart

| SIZE | | *ADJUSTABLE RANGES | | SPRING AND MODEL NO. |
|---|---|---|---|---|
| *in.* | *mm* | *psi* | *bars* | |
| ½ | 15 | 3 – 15 | .21 – 1.05 | 145 |
| ½ | 15 | 10 – 50 | .70 – 3.51 | 146 |
| ½ | 15 | 30 – 140 | 2.11 – 9.84 | 141 |
| ¾ | 20 | 3 – 15 | .21 – 1.05 | 145 |
| ¾ | 20 | 10 – 50 | .70 – 3.51 | 146 |
| ¾ | 20 | 30 – 140 | 2.11 – 9.84 | 141 |

*The minimum reduced pressure ranges shown are recommended only when very sensitive regulation service is needed for specific requirements. However, all valves may be adjusted below the working range minimums shown for lower regulation or complete shut off.

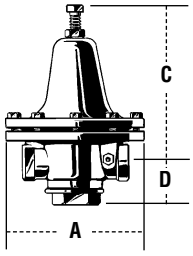
## Capacity




## Dimensions — Weights

| SIZE (DN) | | DIMENSIONS | | | | | | WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | | C | | D | | | |
| *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *in.* | *mm* | *lbs.* | *kg.* |
| ½ | 15 | 6 | 152 | 7 | 178 | $1\frac{15}{16}$ | 49 | 11 | 4.99 |
| ¾ | 20 | 6 | 152 | 7 | 178 | $1\frac{15}{16}$ | 49 | 11 | 4.99 |





**USA:** 815 Chestnut St., No. Andover, MA 01845-6098; www.wattsreg.com
**Canada:** 5435 North Service Rd., Burlington, ONT. L7L 5H7; www.wattscanada.ca

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# PRESSURE TRANSMITTERS, PRESSURE SWITCHES, LEVEL SWITCHES

Series 626 & 628

# Industrial Pressure Transmitter

## Complete Offering of Ranges, Connections and Outputs

General Purpose Housing (-GH)

General Purpose Housing (-GH) with DIN C

626 with LED Display (CH housing only)

Conduit Housing (-CH)

***Please see our website for dimensional drawings.**

**The Series 626 Pressure Transmitters** possess a highly precise 0.25% full scale accuracy piezo-resistive sensor contained in a compact, rugged, NEMA 4X (IP66) stainless steel general purpose housing or cast aluminum conduit housing.

**The Series 628 Pressure Transmitters** are ideal for OEMs with 1% full scale accuracy sensors. The transmitter is also available in the general purpose stainless steel housing and the cast aluminum conduit housing.
The corrosion resistant 316L stainless steel wetted parts allow the Series 626 and 628 transmitters to measure the pressure in a multitude of processes from hydraulic oils to chemicals. The Series 626 and 628 are available in ranges of vacuum, compound to 5000 psi with a variety of optional outputs, process connections and electrical terminations to allow you to select the right transmitter for your application.

### APPLICATIONS

- Compressors
- Pumping systems
- Irrigation equipment
- Hydraulic
- Industrial process monitoring

### FEATURES

- Metal conduit housing option
- Robust 316 SS oil filled sensor
- Compact design

### SPECIFICATIONS

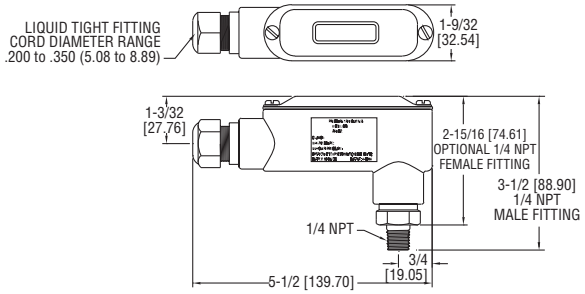
**Service:** Compatible gases and liquids.
**Wetted Materials:** Type 316L SS.
**Accuracy:**
626: 0.25% F.S.;
: 0.20% RSS;
628: 1.0% F.S.;
: 0.5% RSS;
626 Absolute Ranges: 0.5% F.S.;
: 0.30% RSS.
(Includes linearity, hysteresis, and repeatability.)
**Temperature Limit:** 0 to 200°F (-18 to 93°C).
**Compensated Temperature Range:** 0 to 175°F (-18 to 79°C).
**Thermal Effect:** ±0.02% FS/°F (includes zero and span).
**Pressure Limits:** See table.
**Power Requirements:** 10-30 VDC (for 4-20 mA, 0-5, 1-5, 1-6 VDC outputs); 13-30 VDC (for 0-10, 2-10 VDC outputs); 5 VDC ±0.5 VDC (for 0.5-4.5 VDC ratio-metric output).
**Output Signal:** 4-20 mA, 0-5 VDC,1-5 VDC, 0-10 VDC, or 0.5-4.5 VDC.
**Response Time:** 50 ms.
**Loop Resistance:** 0-1000 Ohms max. R max = 50 (Vps-10) Ohms (4-20 mA output), 5K Ohms (0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output).
**Stability:** 1.0% FS/year (Typ.).
**Current Consumption:** 38 mA maximum (for 4-20 mA output); 10 mA maximum (for 0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output); 140 mA maximum (for all 626/628/629-CH with optional LED).
**Electrical Connections:** Conduit Housing (-CH): terminal block, 1/2″ female NPT conduit; General Purpose Housing (-GH): cable DIN EN 175801-803-C.
**Process Connection:** 1/4″ male or female NPT and BSPT.
**Enclosure Rating:** NEMA 4X (IP66).
**Mounting Orientation:** Mount in any position.
**Weight:** 10 oz (283 g).
**Agency Approvals:** CE.

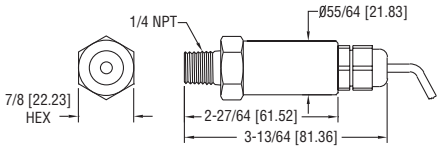
# Series 626 & 628 Pressure Transmitters

## Specifications - Installation and Operating Instructions

-CH Conduit Housing

-GH General Purpose Housing




**The Series 626 and 628 Pressure Transmitters** converts a single positive pressure into a standard 4-20 mA output signal. The Series 626 and 628 can be used to accurately measure compatible gases and liquids; Series 626 full scale accuracy is 0.25%; Series 628 full scale accuracy is 1.0% (see specifications). Designed for industrial environments with a NEMA 4X (IP66) housing, this transmitter resists most effects of shock and vibration.

**CAUTION:** Do not exceed specified supply voltage ratings. Permanent damage not covered by warranty will result. This device is not designed for 120 or 240 volt AC operation. Use only on 13 to 30 VDC.

| Pressure Ranges | | |
|---|---|---|
| **Pressure Range** | **Maximum Pressure** | **Over Pressure** |
| 0-15 psia | 30 psia | 45 psia |
| 15-0 psia | 30 psia | 45 psia |
| 0-30 psia | 60 psia | 90 psia |
| 0-50 psia | 100 psia | 150 psia |
| 0-100 psia | 200 psia | 300 psia |
| 0-200 psia | 400 psia | 600 psia |
| 0-300 psia | 600 psia | 900 psia |
| 0-5 psig | 10 psig | 50 psig |
| 0-15 psig | 30 psig | 150 psig |
| 0-30 psig | 60 psig | 300 psig |
| 0-50 psig | 100 psig | 300 psig |
| 0-100 psig | 200 psig | 500 psig |
| 0-150 psig | 300 psig | 750 psig |
| 0-200 psig | 400 psig | 1000 psig |
| 0-300 psig | 600 psig | 1500 psig |
| 0-500 psig | 1000 psig | 2500 psig |
| 0-1000 psig | 2000 psig | 5000 psig |
| 0-1500 psig | 3000 psig | 5000 psig |
| 0-2000 psig | 4000 psig | 5000 psig |
| 0-3000 psig | 6000 psig | 7500 psig |
| 0-5000 psig | 7500 psig | 10000 psig |
| 0-8000 psig | 10000 psig | 12000 psig |

**SPECIFICATIONS**

**Service:** Compatible gases and liquids.
**Wetted Materials:** Type 316 SS.
**Accuracy:**
626: 0.25% FS;
: 0.20% RSS;
628: 1.0% FS;
: 0.5% RSS;
626 absolute ranges: 0.5% FS;
: 0.35% RSS.
(Includes linearity, hysteresis, and repeatability).
**Temperature Limit:** 0 to 200°F (-18 to 93°C).
**Compensation Temperature Range:** 0 to 175° (-18 to 79°C).
**Thermal Effect:** 626: ±0.02% FS/°F. 628: ±0.04% FS/°F (includes zero and span).
**Pressure Limits:** See table.
**Power Requirements:** 10-30 VDC (for 4-20 mA, 0-5, 1-5, 1-6 VDC outpus); 13-30 VDC (for 0-10, 2-10 VDC outputs); 5 VDC ±0.5 VDC (for 0.5-4.5 VDC ratio-metric output).
**Output Signal:** 4-20 mA, 0-5 VDC,1-5 VDC, 0-10 VDC, or 0.5-4.5 VDC.
**Response Time:** 50 msec.
**Loop Resistance:** 0-1000 Ohms max. R max = 50 (Vps-10) Ohms (4-20 mA output), 5K Ohms (0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output).
**Current Consumption:** 38 mA maximum (for 4-20 mA output); 10 mA maximum (for 0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output); 140 mA maxumum (for all 626/628/629-CH with optional LED).
**Electrical Connections:** Conduit Housing (-CH): terminal block, 1/2″ female NPT conduit; General Purpose Housing (-GH): cable DIN EN 175801-803-C.
**Process Connection:** 1/4″ male or female NPT and BSPT.
**Enclosure Rating:** NEMA 4X (IP66).
**Mounting Orientation:** Mount in any position.
**Weight:** 10 oz (283 g).
**Agency Approvals:** CE.

**INSTALLATION**

**1. Location:** Select a location where the temperature of the transmitter will be between 0 and 175°F (-18 to 79°C). Distance from the receiver is limited only by total loop resistance. The tubing or piping supplying pressure to the unit can be practically any length required but long lengths will increase response time slightly.

**2. Position:** The transmitter is not position sensitive. However all standard models are originally calibrated with the unit in a position with the pressure connection downward. Although they can be used at other angles, for best accuracy it is recommended that units be installed in the position calibrated at the factory.

**3. Pressure Connection:** Use a small amount of plumber's tape or other suitable sealants to prevent leaks. Be sure the pressure passage inside the port is not blocked.

**4. Electrical Connections**

**Wire Length** -The maximum length of wire connecting the transmitter and receiver is a function of wire size and receiver resistance. Wiring should not contribute more than 10% of the receiver resistance to total loop resistance. For extremely long runs (over 1000 feet), choose receivers with higher resistance to minimize the size and cost of connecting leads. Where wiring length is under 100 feet, wire as small as 22 AWG can be used.

**DWYER INSTRUMENTS, INC.**
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Phone: 219/879-8000 www.dwyer-inst.com
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**CURRENT (4-20 mA) OUTPUT OPERATION**

An external power supply delivering 10-30 VDC with minimum current capability of 40 mA DC (per transmitter) is required to power the control loop. See Fig. A for connection of the power supply, transmitter and receiver. The range of appropriate receiver load resistance ($R_L$) for the DC power supply voltage available is expressed by the formula:

$$R_L \text{ Max} = \frac{Vps - 10}{20 \text{ mA DC}}$$

Shielded cable is recommended for control loop wiring.

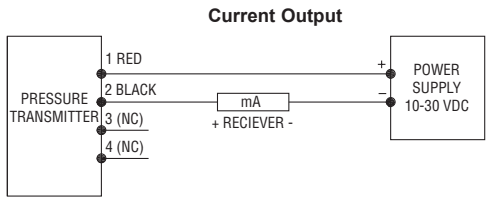



**Fig. A: Current output connection**

**Conduit Housing with 4-20 mA Output (-CH)** Electrical connections to the pressure transmitters are made to the terminal block located inside the housing. Remove the screws and lift off the cover. Wire as shown in Fig. A, B or C. Use Fig. A for current output connection. Use Fig. B for current output with optional LED display. Use Fig. C for current output with optional LED display using two power supplies.

If ordering optional pre-wired cable, black wire is negative (-) and red wire is positive (+).

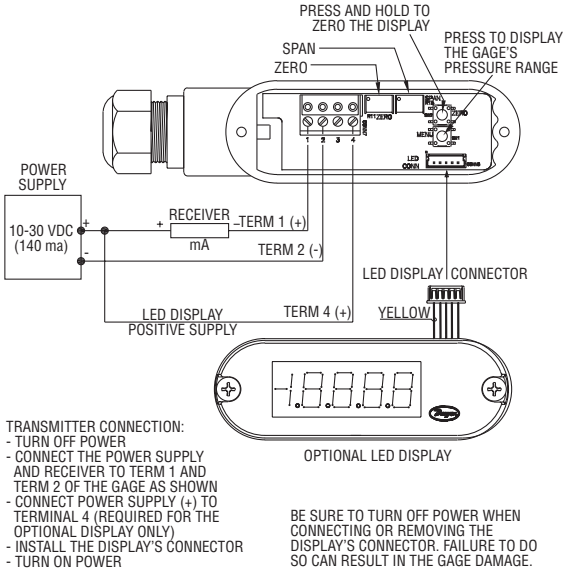



**Fig. B: Current output with optional LED display connection**

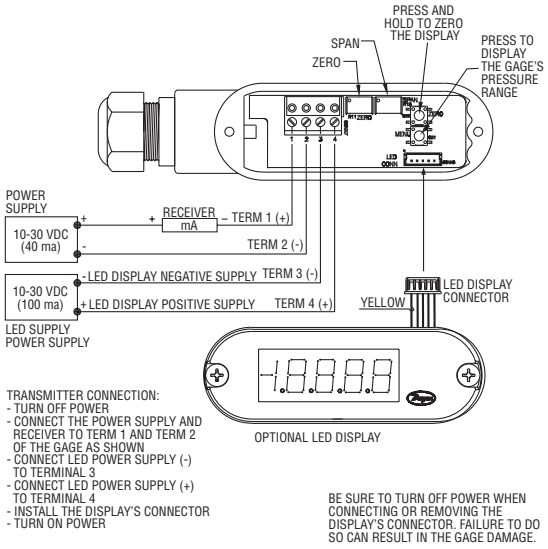



**Fig. C: Current output with optional LED display using two power supplies**

**Heirschman DIN Connector with 4-20 mA** When using cable version of -GH General Purpose Housing, black wire is negative (-) and red wire is positive (+). When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. D. For optional 4-pin M-12 connector, wire to pins as shown in Fig. E.

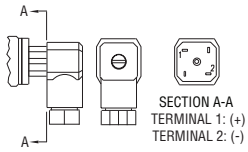



**Fig. D**

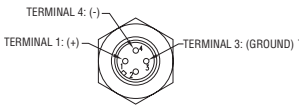



**Fig. E**

**VOLTAGE (0-5, 1-5, 0-10, 1-6 or 2-10 VDC) OUTPUT OPERATION**
(Other outputs contact the factory) See Fig. F for connection of the power supply, transmitter and receiver.

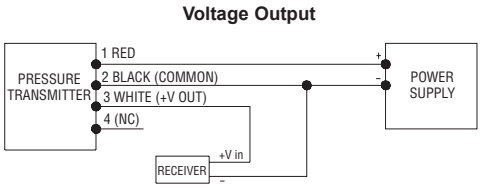



**Fig. F: Voltage output connection**

**Conduit Housing (-CH)** Electrical connections to the pressure transmitters are made to the terminal block located inside the housing. Remove the screws and lift off the cover. Wire as shown in Fig. F or Fig. G. Use Fig. F for voltage output connection. Use Fig. G for voltage output with optional LED display connection. If ordering optional pre-wired cable, black wire is negative (-), red wire is positive (+) and white wire is +Vout.

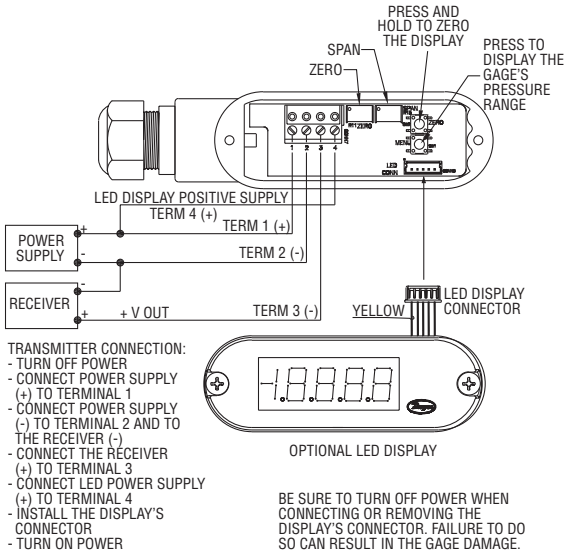



**Fig. G: Voltage output with optional LED display connection**

**Heirschman DIN Connector with Voltage Output** When using cable version of -GH General Purpose Housing, black wire is negative (-), red wire is positive (+) and white wire is output. When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. H. For optional 4-pin M-12 connector, wire to pins as shown in Fig. I. If utilizing optional A-164 cable for M-12 connection, brown wire corresponds to pin #1, white #2, blue #3, and black #4.

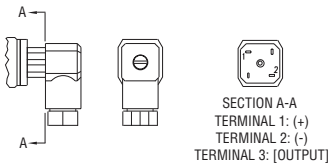



**Fig. H**

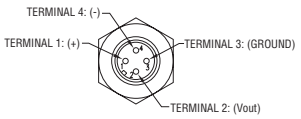



**Fig. I**

**RATIOMETRIC (0.5-4.5 VDC) OUTPUT OPERATION**
(Other outputs contact the factory) See Fig. J for connection of the power supply, transmitter and receiver.

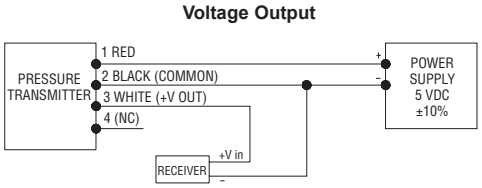



**Fig. J: Voltage output connection**

**General Purpose Housing with Ratiometric Output** When using cable version of -GH General Purpose Housing, black wire is negative (-), red wire is positive (+) and white wire is output. When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. K. For optional 4-pin M-12 connector, wire to pins as shown in Fig. L. If utilizing optional A-164 cable for M-12 connection, brown wire corresponds to pin #1, white #2, blue #3, and black #4.

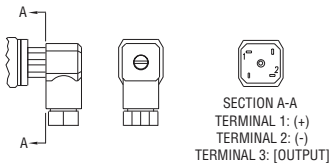



**Fig. K**

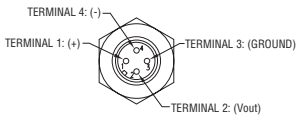



**Fig. L**

**MAINTENANCE**
After final installation of the pressure transmitter and its companion receiver, no routine maintenance is required. A periodic check of system calibration is suggested. The Series 626 and 628 transmitters are not field repairable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

**Pressure Limits**

| Range Number | Pressure Range | Maximum Pressure (psig) | Over Pressure (psig) | Range Number | Pressure Range (psig) | Maximum Pressure (psig) | Over Pressure (psig) |
|---|---|---|---|---|---|---|---|
| 00 | 0-15 psia | 30 | 45 | 12 | 0-200 | 400 | 1000 |
| 30 | 15-0 psia | 30 | 45 | 13 | 0-300 | 600 | 1500 |
| 06 | 0-5 psig | 10 | 50 | 14 | 0-500 | 1000 | 2500 |
| 07 | 0-15 psig | 30 | 150 | 15 | 0-1000 | 2000 | 5000 |
| 08 | 0-30 psig | 60 | 300 | 16 | 0-1500 | 3000 | 5000 |
| 09 | 0-50 psig | 100 | 300 | 18 | 0-3000 | 6000 | 7500 |
| 10 | 0-100 psig | 200 | 500 | 19 | 0-5000 | 7500 | 10000 |
| 11 | 0-150 | 300 | 750 | 26 | 0-8000 | 10000 | 12000 |

**Ordering Chart**

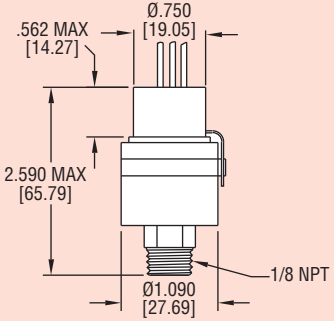
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Accuracy** | 626 | | | | | | | 0.25% Full-Scale Accuracy |
| | 628 | | | | | | | 1.0% Full-Scale Accuracy |
| **Range** | | -00 | | | | | | 0-15 psia |
| | | -01 | | | | | | 0-30 psia |
| | | -02 | | | | | | 0-50 psia |
| | | -03 | | | | | | 0-100 psia |
| | | -04 | | | | | | 0-200 psia |
| | | -05 | | | | | | 0-300 psia |
| | | -06 | | | | | | 0-5 psi |
| | | -07 | | | | | | 0-15 psi |
| | → | -08 | | | | | | 0-30 psi |
| | | -09 | | | | | | 0-50 psi |
| | | -10 | | | | | | 0-100 psi |
| | | -11 | | | | | | 0-150 psi |
| | | -12 | | | | | | 0-200 psi |
| | | -13 | | | | | | 0-300 psi |
| | | -14 | | | | | | 0-500 psi |
| | | -22 | | | | | | 0-600 psi |
| | | -15 | | | | | | 0-1000 psi |
| | | -16 | | | | | | 0-1500 psi |
| | | -18 | | | | | | 0-3000 psi |
| | | -19 | | | | | | 0-5000 psi |
| | | -26 | | | | | | 0-8000 psi |
| | | -67 | | | | | | 0-0.5 bar |
| | | -71 | | | | | | 0-2.5 bar |
| | | -75 | | | | | | 0-10 bar |
| | | -81 | | | | | | 0-40 bar |
| **Housing** | | | -CH | | | | | Conduit Housing |
| | → | | -GH | | | | | General Purpose Housing |
| **Process Connection** | | → | | -P1 | | | | 1/4″ male NPT |
| | | | | -P2 | | | | 1/4″ female NPT |
| | | | | -P3 | | | | 1/4″ male BSPT |
| | | | | -P5 | | | | 1/4″ female SAE with Refrigerant Valve Depressor ① |
| | | | | -P9 | | | | 1/2″ male NPT ① |
| **Electrical Connection** | | | | | -E1 | | | Cable Gland with 3' of Prewired Cable |
| | | | | | -E3 | | | Cable Gland with 9' of Prewired Cable |
| | | | | | -E4 | | | DIN EN 175801-803-L ① |
| | | | → | | -E5 | | | 1/2″ female NPT Conduit ② |
| | | | | | -E6 | | | M-12 4 Pin Connector |
| **Signal Output** | | | | → | | -S1 | | 4-20 mA |
| | | | | | | -S2 | | 1-5 VDC |
| | | | | | | -S4 | | 0-5 VDC |
| | | | | | | -S5 | | 0-10 VDC |
| | | | | | | -S7 | | 0.5-4.5 VDC ① |
| **Options** | | | | | | | -AT | Aluminum Tag |
| | | | | | | | -NIST | NIST Traceable Certificate |
| | | | | | | | -LED | Bright Red LED display ②③ |

① Available with -GH Housing only
② Available with -CH Housing only
③ LED option is not NEMA 4X (IP66)
④ Power Requirement: 5 VDC ±10%

Series APS/ AVS

# Adjustable Pressure Switch

## Vacuum and Pressure Ranges, 5 A Switch, Compact Size




**Miniature Series APS/AVS Adjustable Switches** offer reliable switching for pressure/vacuum alarm, shutdown or control. The units are readily adjustable throughout their range using the locking adjusting ring and indicating pointer. The body is constructed of stainless steel for durability in harsh environments. Switches include 12″ (30 cm) wire leads sealed with epoxy for additional protection.

**SPECIFICATIONS**

**Service:** Compatible liquids or gases.
**Wetted Materials:** Capsule: 17-7 PH SS; Fitting: 303 SS.
**Temperature Limits:** -65 to 225°F (-54 to 107°C), a set point change of up to 2% when used below -10°F (-23°C) or above 125°F (52°C).
**Pressure/Vacuum Limits:** 150% of range.
**Switch Type:** SPDT snap action.
**Electrical Ratings:** 5 A @ 250 VAC, 3 A @ 28 VDC.
**Electrical Connections:** 3-wire, 20 AWG insulated with PVC, 12″ (30 cm) length.
**Process Connection:** 1/8″ male NPT.
**Setpoint:** Field adjustable.
**Cycling:** Not to exceed 20 CPM.
**Sensor Element:** Capsule.
**Weight:** 3 oz (85 g).
**Agency Approval:** UR.

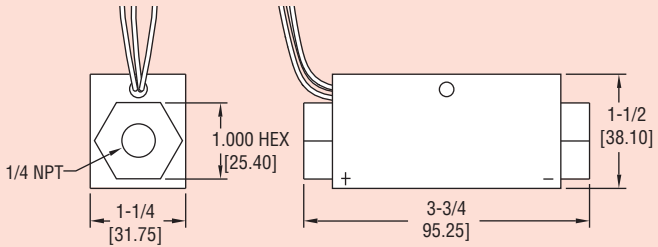
| Model | Set Point Range psi (bar) | | Repeatability psi (bar) | Deadband psi (bar) |
|---|---|---|---|---|
| | Increasing | Decreasing | | |
| **APS-150** | 0.8-28.5(.06-2.0) | 1.6-30.0(.11-2.1) | ±0.6(.04) | 0.8-1.3(.06-.09) |
| **APS-250** | 2.0-48.0(.14-3.3) | 3.0-50.0(.21-3.5) | ±1.0(0.7) | 1-1.7(.07-.12) |
| **APS-350** | 3.0-96.5(.21-6.7) | 4.5-100(.31-6.9) | ±2.0(.14) | 1.6-4(.11-.28) |
| **APS-450** | 7.5-242(.52-16.7) | 9.7-250(.67-17.2) | ±5.0(.35) | 2.5-9(.17-.62) |
| **APS-550** | 15.0-485(1.0-33.4) | 20.0-500(1.4-34.5) | ±10.0(.69) | 5-22(.35-1.5) |

| Model | Set Point Range ″Hg (cm Hg) Vac | | Repeatability ″Hg (cm Hg) | Deadband ″Hg (cm Hg) |
|---|---|---|---|---|
| | Increasing | Decreasing | | |
| **AVS-150** | 1.6-27.1(4.1-68.6) | 2.7-28.2(6.9-71.6) | ±1.2(3.1) | 1.3-2.7(3.3-6.9) |
| **AVS-250** | 4.0-24.8(10.2-63.0) | 5.1-28.2(13.0-71.6) | ±2.0(5.1) | 1.5-3.2(3.8-8.1) |
| **AVS-350** | 6.0-21.5(15.2-54.6) | 8.4-28.2(21.3-71.6) | ±4.0(10.2) | 2.6-7.3(6.6-18.5) |

Series A4

# Differential Pressure Switch

## Adjustable Set Point, High Overpressure




**Rugged Series A4** Differential Pressure Switch offers field adjustments and can handle system pressures up to 6000 psig. Piston design allows mounting in any orientation. The switch is capable of carrying moderate shock and vibratory loads.

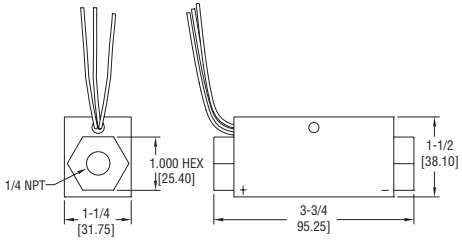
| Model | Repeatability psi (bar) | Set Point psid (bar) | |
|---|---|---|---|
| | | Increasing | Decreasing |
| **A4-1** | ±2 (.14) | 7-13 (.48-.89) | 2-7 (.14-.48) |
| **A4-2** | ±4 (.28) | 13-25 (.89-1.7) | 5-16 (.34-1.1) |
| **A4-3** | ±8 (.55) | 25-45 (1.7-3.1) | 10-21 (.68-1.5) |
| **A4-4** | ±16 (1.1) | 35-160 (2.4-11.0) | 20-80 (1.4-5.5) |
| **A4-5** | ±32 (2.2) | 120-250 (8.3-17.2) | 35-120 (2.4-8.3) |

**SPECIFICATIONS**

**Service:** Compatible gases.
**Wetted Materials:** Body, piston, and fittings: anodized aluminum; spring: steel.
**Temperature Limits:** -65 to 225°F (-54 to 107°C).
**Pressure Limits:** 2000 psid (138 bar), 6000 psig (413 bar).
**Repeatability:** See table.
**Switch Type:** SPDT.
**Electrical Rating:** AC: 3 VA, 0.25A @ 120 VAC; DC: 5 VA, 0.25A @ 175 VDC.
**Electrical Connection:** 24 AWG X 12″ (30.5 cm) wire leads.
**Process Connection:** 1/4″ female NPT.
**Mounting Orientation:** Any.
**Set Point Adjustment:** See table.
**Weight:** 8.5 oz (241 g).
**Agency Approvals:** CE.

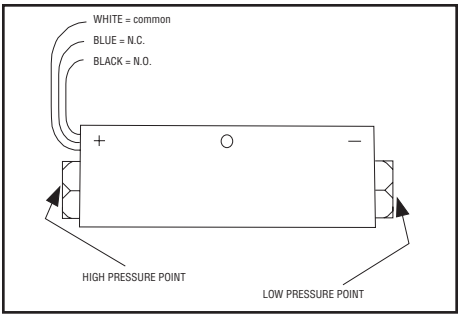
# Series A4 Differential Pressure Switch

## Specifications – Operating Instructions




**Rugged** Series A4 Differential Pressure Switch offers field adjustments and can handle system pressures up to 6000 psig. Piston design allows mounting in any orientation. The switch is capable of carrying moderate shock and vibratory loads.

### Wiring




### Set Point Adjustments

Loosen set screw located in switch body immediately above label. Push wires into body to increase differential pressure. Pull wires away from body to decrease differential pressure. Then tighten set screw. Entire adjustable range may be covered by moving wires approximately 3/16 inch each side of mean.

## SPECIFICATIONS

**Service:** Compatible gases.
**Wetted Materials:** Body, piston, and fittings: anodized Aluminum;. spring: steel.
**Temperature Limits:** -65 to 225°F (-54 to 107°C).
**Pressure Limits:** 2000 psid (138 bar).
**Repeatability:** See table.
**Switch Type:** SPDT.
**Electrical Rating:** AC: 3 VA, 0.25A @ 120 VAC; 5 VA, 0.25A @ 175 VDC.
**Electrical Connection:** 24 AWG X 12″ (30.5 cm) wire leads.
**Process Connection:** 1/4″ female NPT.
**Mounting Orientation:** Any.
**Set Point Adjustment:** See table.
**Weight:** 8.5 oz (241 grams).
**Agency Approvals:** CE.

### Maintenance/Repair

After final installation of the Series A4 Differential Pressure Switch, no routine maintenance is required. A periodic check of the system calibration is recommended. These devices are not field repairable and should be returned to the factory if recalibration or other service is required. After first obtaining a Returned Goods Authorization (RGA) number, send the material, freight prepaid, to the following address. Please include a clear description of the problem plus any application information available.

Dwyer Instruments
Attn: Repair Department
102 Highway 212
Michigan City, IN 46360

**DWYER INSTRUMENTS, INC.**
**P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361,U.S.A.**

**Phone: 219/879-8000** **www.dwyer-inst.com**
**Fax: 219/872-9057** **e-mail: info@dwyer-inst.com**
**Lit-By Fax: 888/891-4963**

# Specialty Switches – Continued

### Portable Level Switch — Integral Mounting Magnet

Precisely monitors liquid level and is ideal for controlling filling operations and preventing overflows. Permanent magnet attaches unit securely to steel tank wall at exact level required.

### LS-750 Series — Weighted for Suspension Cable

With a compact-sized float, slosh shield and weighted collar, the LS-750 provides liquid level detection for a wide variety of applications. Suspend in stand pipes or sumps for leak detection duty, or drop into wells for ground-water monitoring. Supplied with 25 feet of waperproof cable.

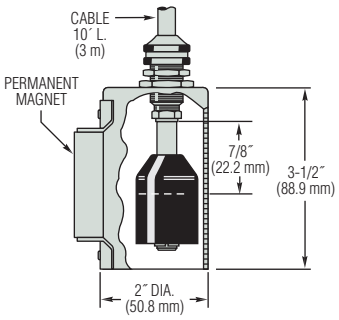
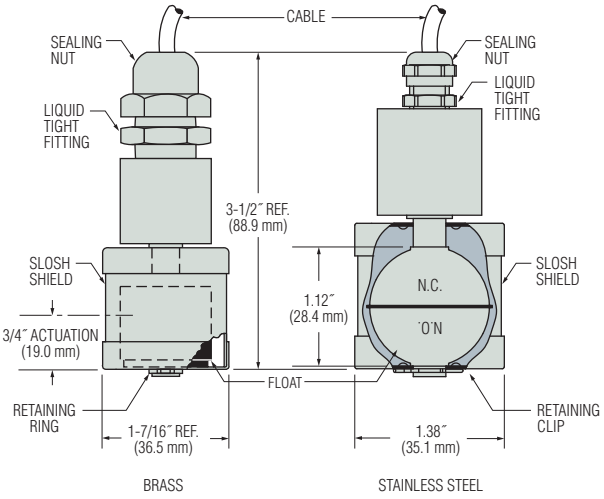
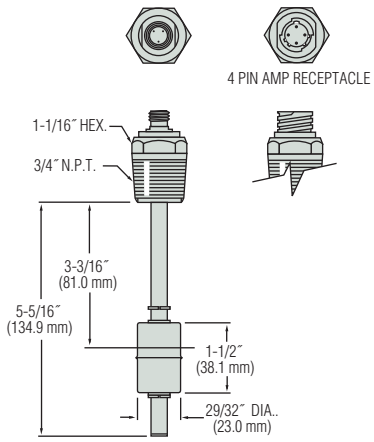
U.L. Recognized— File No. E-45168. CSA Listed-File No. LR-30200.

### LS-700F Series

Overfill Protection for Refrigerant Tanks.The LS-700F enables safe compliance with EPA directives to recover refrigerants. These units are designed to fit standard 30# and 50# D.O.T. approved refrigerant tanks. They provide 80% full shutoff capability when used as an integral part of a recovery system.

U.L. Recognized— File No. SA8857. CSA Listed-File No. LR-30200-31.

## Dimensions

| Portable Level Switch | LS-750 | LS-700F |
|---|---|---|
|   |   |   |
| SJO, 18/2 10´L., Neoprene | 22 AWG, 2-Wire Cable | 3- or 4-Pin, Quick-Connect Receptacle |

†$L_1$ = Switch actuation level. In liquid with specific gravity of 1.0, switch actuation is approximately half the distance from end of stem to mounting, or at the halfway point of float travel.

## How To Order — Select Part Number based on specifications required.

| Series | Material | | | Min. Liquid Sp. Gr. | Operating Temperature | Pressure PSI, Max. | Switch* | Electrical Termination Option | Part Number |
|---|---|---|---|---|---|---|---|---|---|
| | Stem and Mounting | Float | Other Wetted | | | | | | |
| Portable | Brass | Buna N | Aluminum, 316 S.S. | .85 | Oil: -40°F to +230°F (-40°C to +110°C) Water: to 180°F (82°C) | 10 | SPST, 20 VA N.O., Dry | — | **15208** ⚡ |
| LS-750 | Brass | Buna N | Nylon, PVC, Beryllium Copper | .45 | | 150 | SPST, 20 VA N.C., Dry | PVC Cable Jacket | **149350** ⚡ |
| | 316 S.S.** | 316 S.S. | PVDF, Viton® | .65 | -40°F to 212°F (-40°C to +100°C) | 375 | SPST, 10 VA N.C., Dry | Teflon® Cable Jacket | **197433** |
| LS-700F | Brass | 304 S.S. | — | .98 | -40°F to +221°F (-40°C to +105°C) | 400 | SPST, 20 VA N.C., Dry | 3-Pin | **128500** ⚡ |
| | | | | | | | | 4-Pin | **144900** ⚡ |

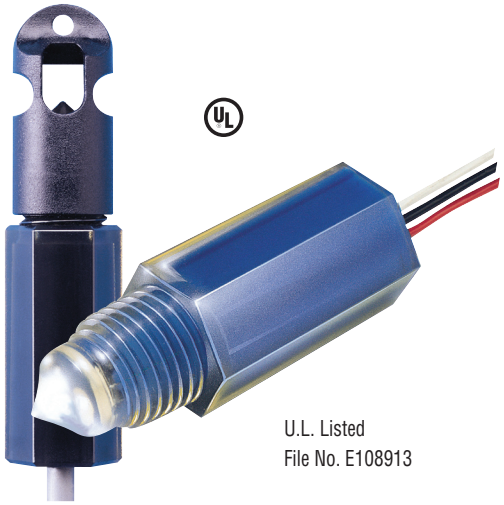
*See "Electrical Data" on Page X-5 for more information.

⚡ – Stock Items.

** Stainless steel is generally recognized as safe (GRAS) with FDA for food contact regulations.

# General Purpose ELS –1100 Series Satisfies Most Applications

These polysulfone units are both compact and economical. They feature a variety of mountings, power requirements and electrical terminations to make it easy to find a perfect match for your application.



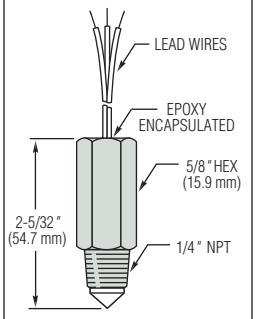
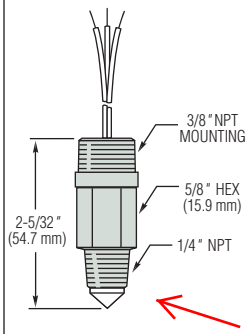
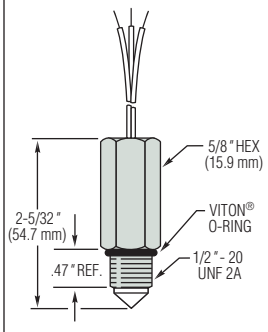
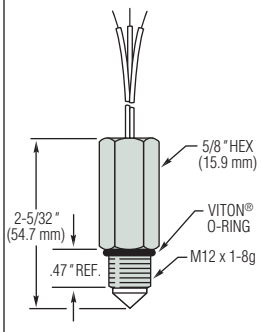
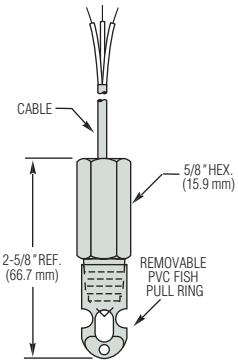
U.L. Listed
File No. E108913

## Specifications

| | |
|---|---|
| **Materials** | |
| **Housing and Prism** | Polysulfone or Nylon |
| **Operating Pressure** | 0 to 150 PSI, Maximum |
| **Operating Temperature*** | 0°F to 176°F (-17.8°C +80°C) |
| **Current Consumption** | 18 mA, Approximately |
| **Output†** | TTL/CMOS Compatible. Open Collector Output May Sink 40 mA UP TO 30 VDC. |
| **Repeatability** | ±1 mm |
| **EMI Susceptability** | Meets (MIL-STD-461B Part 2 Modified) Specification of 10 V/M for Frequency Range 30 to 1000 MHz (Except 609 MHz = 9 V/M and 679 MHz = 7.5 V/M). |

* These switches are not for use in freezing liquid or steam/high condensation environments. Contact Gems for alternative solutions.

## Dimensions

| | 1/4˝ NPT Mounting | 1/4˝ NPT Mounting with 3/8˝ Conduit | 1/2˝ Straight Thread Mounting with O-Ring | M12x1-8g Straight Thread with O-Ring | "Fish" Pull Ring |
|---|---|---|---|---|---|
| |   |   |   |   |   |
| **Electrical Termination** | Lead Wires, 22 AWG, PVC Jacketed, 12˝ to 14˝ Extended | | | | 25˝ Cable, 22 AWG, PVC Jacketed |

## How To Order

Specify Part Number based on Mounting Type, Input Power and Output Condition required.

| Input Power | Probe Condition at Current SInk | Mounting Type | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1/4˝ NPT | 1/4˝ NPT & 3/8˝ Conduit | | 1/2˝ Straight Thread | M12x1-8g Straight Thread | "Fish" Pull Ring |
| | | Polysulfone | Polysulfone | Nylon | Polysulfone | Polysulfone | Polysulfone |
| 5 VDC | Wet | **138167** ⚡ | **144225** | **175631** | **144235** | **166541** | — |
| 10-28 VDC | Wet | **142700** ⚡ | **143585** ⚡ | **157750** | **143580** | **169555** | **143577** |
| | Dry | **143570** ⚡ | **143590** | **175632** | **143575** | **169556** | **148973** |

⚡ – Stock Items.

### Intrinsically-Safe Versions

GEMS ELS-1100 Switches may be rendered intrinsically-safe for Class I, Division 1, Group C & D when used with appropriate GEMS Zener Barriers. Call Gems Sensors for special ELS-1100-IS (intrinsically-safe) part numbers and Installation Bulletins 148745 and 148744, File No. E44570.

**Extended Power and Switching Capabilities of 12 VDC Models with Gems.**

Converts TTL output signal to 5 Amp relay output. Available as open circuit board or mounted in a NEMA 4X enclosure (pictured). See Page A-31.

# METERING VALVE

**HOKE**

405 Centura Court, PO Box 4866

Spartanburg, SC 29303

**Phone:** 864.574.7966 • **Fax:** 864.587.5608

**E-Mail:** sales@hoke.com • **Web site:**www.hoke.com

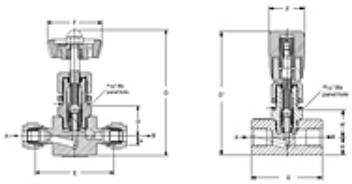
# Item # 2331F4B, 2300 Series

QUOTE

Bar Stock Metering Valves

**Typical Applications**

- Metering liquids and gases on analytical equipment
- Laboratory sampling
- Gas chromatography, analyzers
- Flow meters and gauges



## SPECIFICATIONS

| | |
|---|---|
| End Connections | 1/4" NPT Female |
| Flow Pattern | Globe |
| Body Material | Brass |
| Max Operating Pressure | 3000 psig up to 200° F (207 bar at 93° C) |
| Operating Temperature Range | -40 to +200 ºF<br>-40 to +93 ºC |
| Cv | 0.30 in |
| Stem | 8° STEM Solid |
| Orifice | 0.125 in<br>3.17 mm |

| | |
|---|---|
| D | 3.59 in<br>91 mm |
| D1 | 3.88 in<br>98 mm |
| E | 2 in<br>51 mm |
| F | 1.41 in<br>36 mm |
| F1 | 1 in<br>25 mm |
| H | .50 in<br>12.7 mm |
| H1 | 3/4 in<br>19 mm |
| Panel Hole | 0.64 in<br>16 mm |
| Panel Thickness | 0.13 in<br>3 mm |
| Features &Benefits | • 20 turn stem displacement for fine metering<br>• Optional micrometer vernier handle provides visual control and repeatable stem settings.<br>• 2 orifice sizes 0.062” (1.59mm) and 0.125” (3.17mm) are available with standard 8° stem<br>• Spring loaded stem in all 316 stainless steel valves prevents galling and enlargement of the orifice.<br>• For ultra fine metering, a 1° spring loaded stem design is available for all valves with 0.062” (1.59mm) orifice. See flow curves for details.<br>• Panel mounting is standard on all valves<br>• Bonnet lock prevents accidental disengagement of bonnet. |
| CADPartID | 102411 |

# SUBSTRATE VENDOR INFORMATION

JRW BIOREMEDIATION LLC

# LACTOIL™
## SOY MICROEMULSION

**Description**

LactOil™ soy microemulsion is a stable, self-emulsifying, blended substrate for the remediation of chlorinated solvents, metals and perchlorates. LactOil™ is designed to combine the hydrogen donor properties of readily soluble carbon substrates with enhanced longevity of emulsified vegetable oil products. LactOil™'s true microemulsion formulation provides extended in situ product stability. LactOil™ is delivered as a concentrated, water-in-oil reverse microemulsion with a high organic content and low viscosity. LactOil™ contains fermentable lactate in place of water providing a total of 80% fermentable material in the raw product.

LactOil™ self emulsifies in water over a wide range of concentrations with minimal mixing or shear force. Particle size studies show that the dilute LactOil™ soy microemulsion is predominantly less than 1.0 micron. Studies show LactOil™ soy microemulsion to have a Zeta potential of about -68 mV at neutral pH thereby increasing the product's stability when compared with standard emulsified oil products.

**Typical Properties**

| | LactOil™ |
|---|---|
| Appearance | Clear Brown Liquid |
| Viscosity, cP at 70°F | 25 |
| Specific Gravity (20ºC) | 0.986 |
| pH | Buffered to 6.5 |
| Moisture, % wt/wt | 20 |
| Product Stability | up to 1 year |

**Applications**

Lower concentrations are ideal for the remediation of dissolved phase contaminants over large areas. Higher concentrations of LactOil™ are ideal for barrier applications in slower moving aquifers or for the treatment of DNAPL.

**Packaging**

450 lb. drums.

**Storage**

Store unopened at room temperature.

This information is presented by JRW Bioremediation, LLC for your consideration in the belief that it is reliable and accurate, however, no representation or warranty either expressed or implied is made as to the truth, accuracy, reliability, completeness or currentness of the data, information or opinions contained herein, or as to their suitability for any purpose, condition or application. Nothing contained herein shall be construed as a recommendation to use JRW Bioremediation, LLC products in conflict with restrictions set forth in existing governmental and/or other regulations or in patents. **JRW BIOREMEDIATION, LLC, ITS LICENSORS, AND ITS SUPPLIERS, TO THE FULLEST EXTENT PERMITTED BY LAW, DISCLAIM ALL WARRANTIES, EITHER EXPRESSED OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT OF THIRD PARTIES' RIGHTS, AND FITNESS FOR PARTICULAR PURPOSE.** JRW Bioremediation, LLC warrants its products only to the extent set forth in an executed sales agreement of purchase order by and between JRW Bioremediation, LLC and its customers and nothing contained in this information shall be construed to provide any warranties in addition to the warranties set forth in such sales agreement or purchase order.

# AIR CONDITIONER

Heating & Air Conditioning Amana®

# TECHNICAL MANUAL

# PBC/PBE/PBH
# Through-The-Wall R-410A
# Air Conditioners & Heat Pumps

- All safety information must be followed

  See Installation instructions for more safety precautions.
- Refer to the appropriate Parts Catalog for part number information.
- Models listed on page 3.

This manual is to be used by qualified, professionally trained HVAC technicians only. Goodman does not assume any responsibility for property damage or personal injury due to improper service procedures or services performed by an unqualified person.

RT4271001
May 2010

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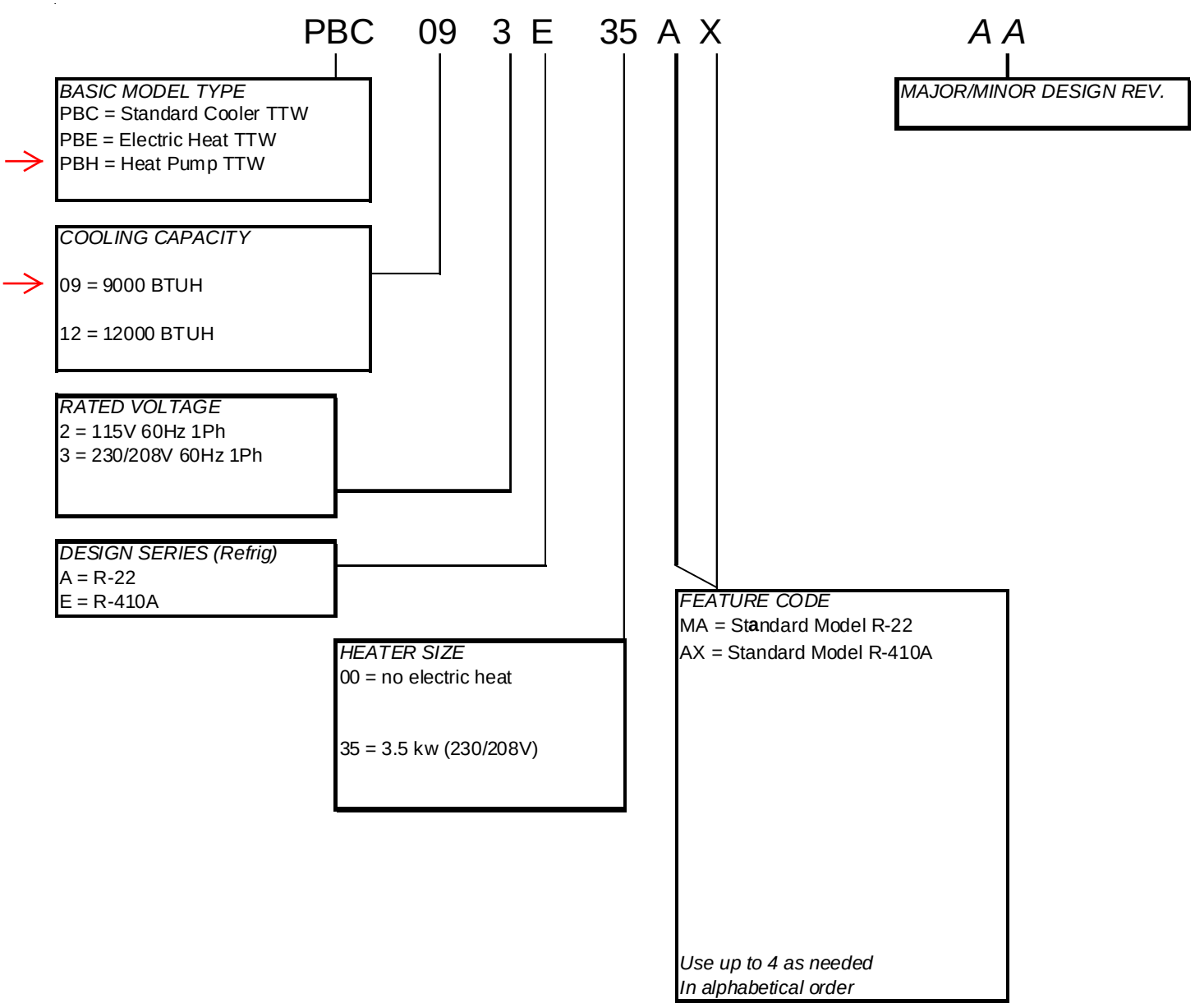
# PRODUCT IDENTIFICATION

The model number is used for positive identification of component parts used in manufacturing. Please use this number when requesting service or parts information.




**WARNING**

**HIGH VOLTAGE!**

**Disconnect ALL power before servicing or installing this unit. Multiple power sources may be present. Failure to do so may cause property damage, personal injury or death.**

**WARNING** **Goodman will not be responsible for any injury or property damage arising from improper service or service procedures. If you install or perform service on this unit, you assume responsibility for any personal injury or property damage which may result. Many jurisdictions require a license to install or service heating and air conditioning equipment.**

**WARNING** **ONLY individuals meeting (at a minimum) the requirements of an "Entry Level Technician" as specified by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) may use this information. Attempting to install or repair this unit without such background may result in product damage, personal injury, or death.**

# PRODUCT IDENTIFICATION

The model number is used for positive identification of component parts used in manufacturing. Please use this number when requesting service or parts information.

PBC092E00AX
PBC122E00AX

PBC093E00AX
PBC123E00AX

PBE093E35AX
PBE123E35AX

PBH092E12AX
PBH093E35AX
PBH113E35AX

**WARNING**

**HIGH VOLTAGE!**
**DISCONNECT ALL POWER BEFORE SERVICING OR INSTALLING THIS UNIT. MULTIPLE POWER SOURCES MAY BE PRESENT. FAILURE TO DO SO MAY CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.**

**To avoid death, personal injury or property damage due to electrical shock:**

- Observe all local codes and ordinances.
- Disconnect electrical power to unit before servicing.
- Ground appliance properly.
- Check with a qualified electrician if you are not sure this appliance is properly grounded.
- DO NOT ground to gas line.
- DO NOT ground to cold water pipe if pipe is interrupted by plastic, non-metallic gaskets, or other insulating (non-conducting) materials.
- DO NOT modify plug on power cord. If plug does not fit electrical outlet, have proper outlet installed by qualified electrician.
- DO NOT have a fuse in the neutral or ground circuit. A fuse in the neutral or ground circuit could result in an electrical shock.
- DO NOT use an extension cord with this appliance.
- DO NOT use an adapter plug with this appliance.
- DO NOT pinch power cord.
- DO NOT REMOVE warning tag from power cord.

**WARNING**

**HIGH TEMPERATURE STRESS HAZARD**
**This room air conditioner is not meant to provide unattended cooling or life support for persons or animals that are unable to react to failure of the product.**

**The failure of an unattended air conditioner may result in extreme heat in the conditioned space causing overheating or death of persons or animals.**

**Precautions must be taken to ward off or guard against such an occurrence.**

**WARNING**

**The United States Environmental Protection Agency ("EPA") has issued various regulations regarding the introduction and disposal of refrigerants introduced into this unit. Failure to follow these regulations may harm the environment and can lead to the imposition of substantial fines. These regulations may vary by jurisdiction. Should questions arise, contact your local EPA office.**

**WARNING**

**Do not connect or use any device that is not design certified by Goodman for use with this unit. Serious property damage, personal injury, reduced unit performance and/or hazardous conditions may result from the use of such non-approved devices.**

**WARNING**

**To prevent the risk of property damage, personal injury, or death, do not store combustible materials or use gasoline or other flammable liquids or vapors in the vicinity of this appliance.**

# PRODUCT DESIGN

PBC, PBE and PBH through-the-wall room air conditioners are designed for window installations in residential applications and are available in 9,000 through 18,000 BTUH sizes. They are designed for 208/230/115 volt single phase applications.

The provided filter must be installed and under no circumstances should the unit be operated without the filter in place.

***Location and Clearances***

Be sure electrical service is adequate for chosen model of air conditioner or heat pump. Complete electrical rating for unit is found on serial plate located behind front grille. Electrical outlet must be close enough to unit for power cord to reach without strain.

Air conditioner should be the only appliance on individual circuit.

For personal safety and to avoid possible damage to appliance or home, observe all safety instructions.

**NOTES:**

1. Mechanical experience is required to install the air conditioner or heat pump.
2. Installation can take from 1 to 3 hours, depending on installer's knowledge and skill.
3. If you encounter problems during installation, call our consumer information line toll-free at 1-877-376-0214 (U.S. and Canada only). If your problem cannot be resolved by phone, contact an authorized Amana® brand servicer. *Contact and service will be at your expense.*

# SPECIFICATIONS

# PBH***E00AX

| MODEL | PBH092E12AX | PBH093E35AX | PBH113E35AX |
|---|---|---|---|
| Cooling (BTU's) | 9000 | 9000<br>8700 | 11500<br>11100 |
| @ EER | 9.4 | 9.4 | 9.4 |
| Cooling Watts | 960 | 960 - 930 | 1220 - 1180 |
| Cooling Amps | 8.8 | 4.5 - 4.8 | 5.7 - 6.2 |
| Electric Heat | 3900 | 11000 - 9000 | 11000 - 9000 |
| Electric Heat Watts | 1150 | 3500 - 2900 | 3500 - 2900 |
| Electric Heat Amps | 11 | 15 / 14 | 15 / 14 |
| Heatpump (BTU's) | 8500 | 8500<br>8200 | 11000<br>10700 |
| @ C.O.P. | 2.9 | 2.9 | 2.7 |
| Heatpump Watts | 860 | 860 - 830 | 1195 - 1160 |
| Heatpump Amps | 7.7 | 4.0 - 4.2 | 5.2 - 5.6 |
| Fan Watts Indoor | 64 Indoor | 64 Indoor | 64 Indoor |
| Fan Watts Outdoor | 123 Outdoor | 123 Outdoor | 123 Outdoor |
| Voltage | 115 | 230 -208 | 230 -208 |
| Plug Type | Parallel | Perpendicular | Perpendicular |
| Power Cord Rating | 15 amp | 20amp | 20amp |
| Power Cord Type | LCDI | LCDI | LCDI |
| Power Cord length | 8 feet | 6 feet | 6 feet |
| Dehumidification: pints / hr. | 41 oz./hr | 41 oz./hr | 55 oz./hr |
| Fan Speeds | | | |
| CFM cooling : High-Low | 265/- | 265/- | 265/- |
| Fan Only Speed | 3 Speed | 3 Speed | 3 Speed |
| Controls | | | |
| Thermostat temp. range | 64° - 86° | 64° - 86° | 64° - 86° |
| Outercase : insulation panels | PBWS01A | PBWS01A | PBWS01A |
| Condensate Drain Spout | Yes on Outercase | Yes on Outercase | Yes on Outercase |
| Thermostatic Drain Valve | Yes | Yes | Yes |
| Adjustable changeover thermostat | Yes | Yes | Yes |
| Chassis Size | 26" | 26" | 26" |
| Chassis Heighth | 15.625" | 15.625" | 15.625" |
| Chassis Width | 26" | 26" | 26" |
| Chassis Depth | 16.875" | 16.875" | 16.875" |

## PBH "E" MODEL 115V

| MODEL | ID WB ENT | ID DB ENT | TOTAL BTUH | SEN BTUH 85 | SHR | TOTAL BTUH | SEN BTUH 95 | SHR | TOTAL BTUH | SEN BTUH 105 | SHR | TOTAL BTUH | SEN BTUH 115 | SHR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | OUTDOOR TEMP | | | | | | | | |
| PBH092 | 61 | 75 | 8490 | 6320 | 74 | 8040 | 6100 | 76 | 7550 | 5860 | 78 | 7055 | 5620 | 80 |
| | | 80 | 8425 | 7375 | 88 | 7985 | 7145 | 89 | 7515 | 6905 | 92 | 7010 | 6990 | 100 |
| | | 85 | 8485 | 8485 | 100 | 8120 | 8120 | 100 | 7725 | 7725 | 100 | 7305 | 7305 | 100 |
| | 67 | 75 | 9620 | 5105 | 53 | 9160 | 4975 | 54 | 8560 | 4700 | 55 | 7985 | 4600 | 58 |
| | | 80 | 9505 | 6090 | 64 | 9000 | 5860 | 65 | 8450 | 5685 | 67 | 7875 | 5370 | 68 |
| | | 85 | 9345 | 7285 | 78 | 8910 | 7145 | 80 | 8295 | 6870 | 83 | 7720 | 6600 | 85 |
| | 73 | 75 | 10810 | 3875 | 36 | 10250 | 3665 | 36 | 9650 | 3445 | 36 | 9035 | 3220 | 36 |
| | | 80 | 10680 | 4905 | 46 | 10120 | 4695 | 46 | 9515 | 4475 | 47 | 8890 | 4250 | 48 |
| | | 85 | 10545 | 5930 | 56 | 9975 | 5720 | 57 | 9365 | 5500 | 59 | 8735 | 5275 | 60 |

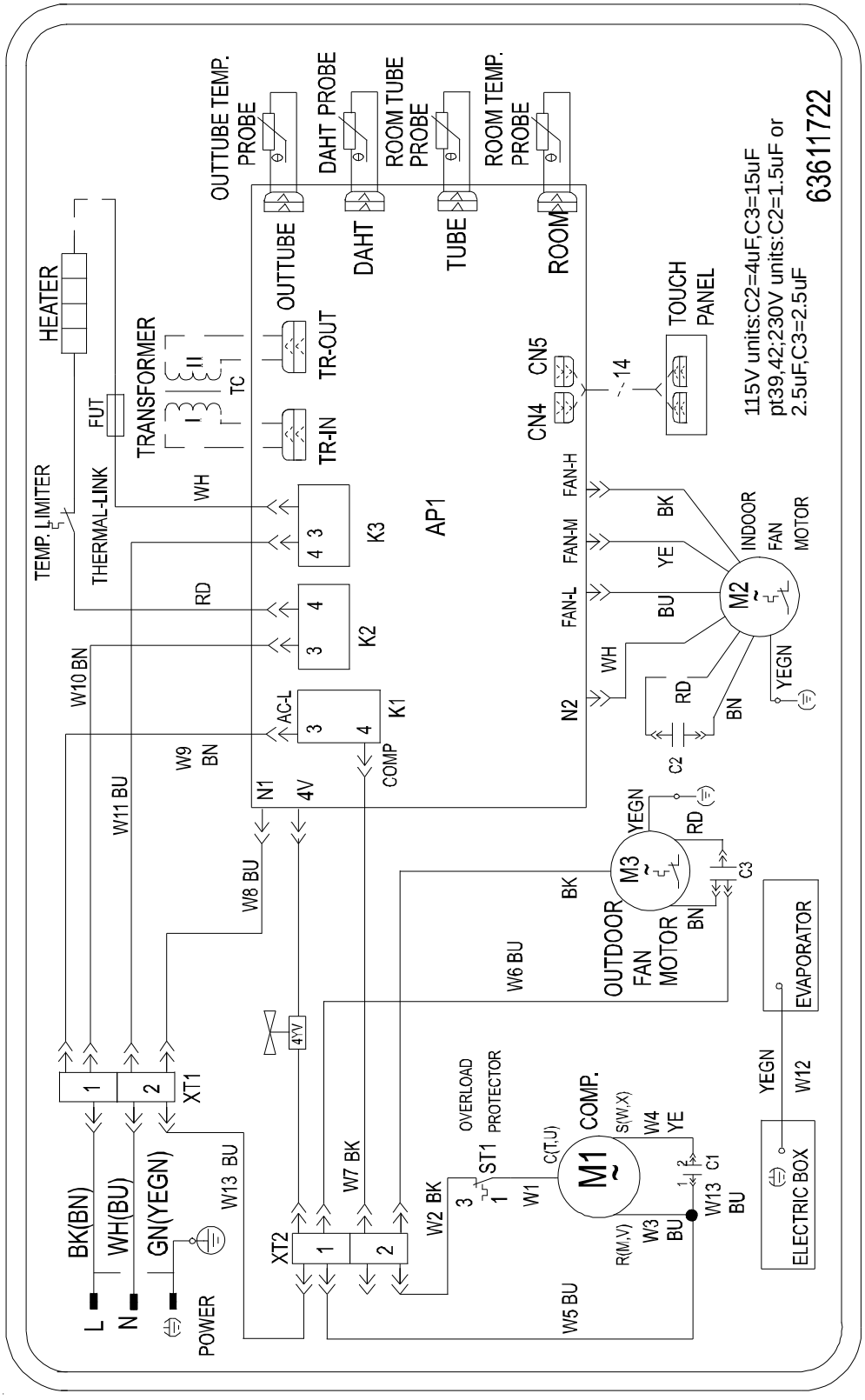
# PBH "E" MODEL 230V

**OUTDOOR TEMP**

| MODEL | ID WB ENT | ID DB ENT | TOTAL BTUH | SEN BTUH 85 | SHR | TOTAL BTUH | SEN BTUH 95 | SHR | TOTAL BTUH | SEN BTUH 105 | SHR | TOTAL BTUH | SEN BTUH 115 | SHR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PBH093 | 61 | 75 | 8490 | 6320 | 74 | 8040 | 6100 | 76 | 7550 | 5860 | 78 | 7055 | 5620 | 80 |
| | | 80 | 8425 | 7375 | 88 | 7985 | 7145 | 89 | 7515 | 6905 | 92 | 7010 | 6990 | 100 |
| | | 85 | 8485 | 8485 | 100 | 8120 | 8120 | 100 | 7725 | 7725 | 100 | 7305 | 7305 | 100 |
| | 67 | 75 | 9620 | 5105 | 53 | 9160 | 4975 | 54 | 8560 | 4700 | 55 | 7985 | 4600 | 58 |
| | | 80 | 9505 | 6090 | 64 | 9000 | 5860 | 65 | 8450 | 5685 | 67 | 7875 | 5370 | 68 |
| | | 85 | 9345 | 7285 | 78 | 8910 | 7145 | 80 | 8295 | 6870 | 83 | 7720 | 6600 | 85 |
| | 73 | 75 | 10810 | 3875 | 36 | 10250 | 3665 | 36 | 9650 | 3445 | 36 | 9035 | 3220 | 36 |
| | | 80 | 10680 | 4905 | 46 | 10120 | 4695 | 46 | 9515 | 4475 | 47 | 8890 | 4250 | 48 |
| | | 85 | 10545 | 5930 | 56 | 9975 | 5720 | 57 | 9365 | 5500 | 59 | 8735 | 5275 | 60 |
| PBH123 | 61 | 75 | 10890 | 8450 | 78 | 10265 | 8155 | 79 | 9560 | 7830 | 82 | 8720 | 7450 | 85 |
| | | 80 | 10850 | 9880 | 91 | 10230 | 9575 | 94 | 9500 | 9225 | 97 | 8825 | 8825 | 100 |
| | | 85 | 11120 | 11120 | 100 | 10605 | 10605 | 100 | 9970 | 9970 | 100 | 9300 | 9300 | 100 |
| | 67 | 75 | 12335 | 6720 | 54 | 11790 | 6490 | 55 | 10940 | 6140 | 56 | 10100 | 5800 | 57 |
| | | 80 | 12200 | 8080 | 66 | 11500 | 7785 | 68 | 10745 | 7480 | 70 | 9870 | 7160 | 73 |
| | | 85 | 12000 | 9500 | 79 | 11405 | 9255 | 81 | 10545 | 8930 | 85 | 9660 | 8600 | 89 |
| | 73 | 75 | 13930 | 4945 | 35 | 13170 | 4660 | 35 | 12400 | 4380 | 35 | 11525 | 4070 | 35 |
| | | 80 | 13760 | 6345 | 46 | 12995 | 6065 | 47 | 12210 | 5780 | 47 | 11240 | 5440 | 48 |
| | | 85 | 13580 | 7750 | 57 | 12830 | 7575 | 58 | 11950 | 7190 | 60 | 10975 | 6820 | 62 |

**WARNING**

**HIGH VOLTAGE!**
**DISCONNECT ALL POWER BEFORE SERVICING OR INSTALLING THIS UNIT. MULTIPLE POWER SOURCES MAY BE PRESENT. FAILURE TO DO SO MAY CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.**



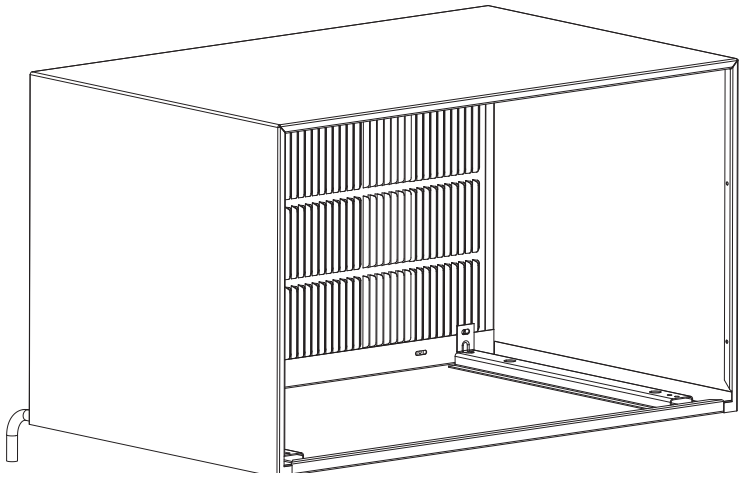

Wiring is subject to change, always refer to the wiring diagram on the unit for the most up-to-date wiring.

# TROUBLESHOOTING

| CODE | | STATUS | CORRECTIVE ACTION |
|---|---|---|---|
| 1 | F1 | Outdoor ambient thermostat not registering on the board. | Replace or re-connect the thermostat |
| 2 | F2 | Outdoor ambient thermostat not registering on the board. | Replace or re-connect the thermostat |
| 3 | F4 | Outdoor coil thermostat not registering on the board | Replace or re-connect the thermostat |
| 4 | FJ | Indoor discharge thermostat not registering on the board | Replace or re-connect the thermostat |

# PBWS01A Wall Sleeve

# Installation Instructions



## General Information

The wall sleeve must be installed before the air conditioner chassis can be set in place. Read the instructions thoroughly before proceeding.

### Table of Contents


**General Information ..... 1**
**Preinstallation Considerations ..... 2**
**Wall Sleeve Installation ..... 3**
**Condensate Drain Kit ..... 3**


**⚠ RECOGNIZE THIS SYMBOL AS A SAFETY PRECAUTION.**

## ATTENTION INSTALLING PERSONNEL

As a professional installer you have an obligation to know the product better than the customer. This includes all safety precautions and related items.

Prior to actual installation, thoroughly familiarize yourself with this Instruction Manual. Pay special attention to all safety warnings. Often during installation or repair, it is possible to place yourself in a position which is more hazardous than when the unit is in operation.

Remember, it is your responsibility to install the product safely and to know it well enough to be able to instruct a customer in its safe use.

Safety is a matter of common sense...a matter of thinking before acting. Most dealers have a list of specific good safety practices...follow them.

The precautions listed in this Installation Manual are intended as supplemental to existing practices. However, if there is a direct conflict between existing practices and the content of this manual, the precautions listed here take precedence.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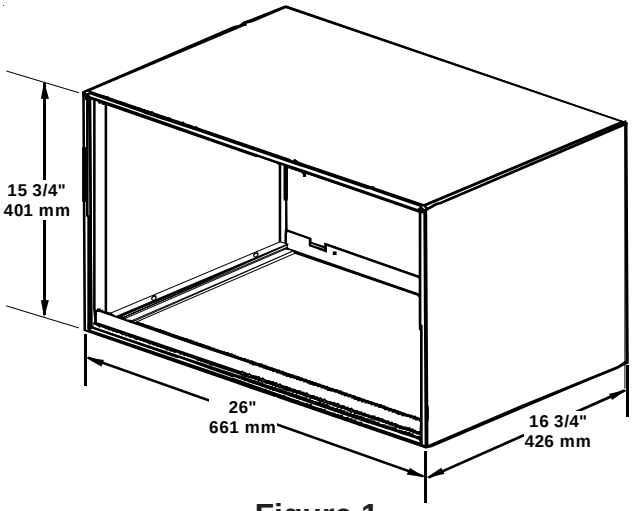


**Figure 1**
**Wall Sleeve Dimensions**

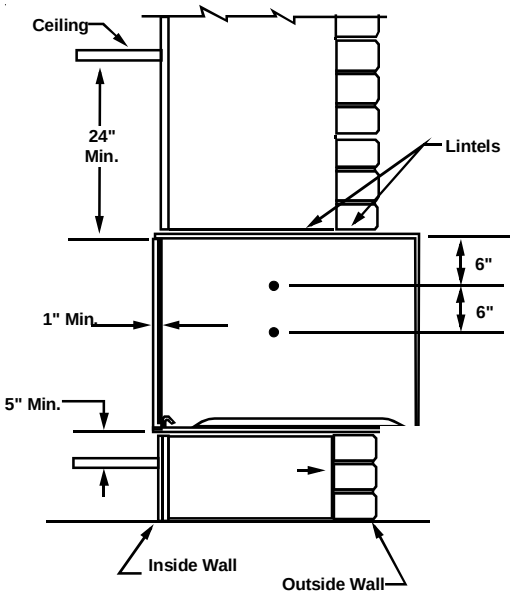


**Figure 2**
**Minimum Unit Clearances**

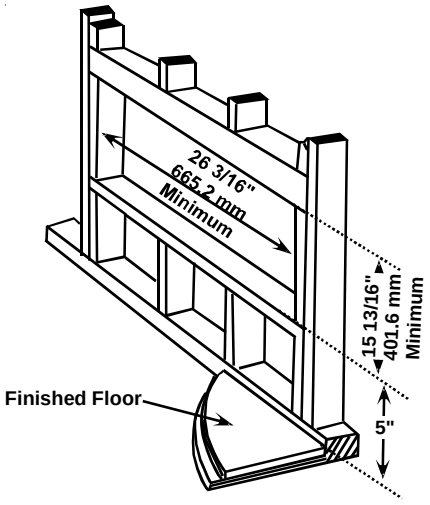


**Figure 3**
**Minimum Wall Opening Dimensions**

## Preinstallation Considerations

Before proceeding with the sleeve installation, ensure the following guidelines for locating the wall opening and sleeve are met:

- The wall opening must be the correct size. See Figure 1 for wall sleeve dimensions and Figure 3 for minimum wall opening size.
- The wall sleeve must be installed with a 5" minimum clearance to the floor and 1 1/2" to adjacent walls. See Figure 2 for minimum projections of the sleeve into and out of the room.
- If installed in a concrete or masonry wall, a lintel must be provided in the wall opening for support. **Do not use the wall sleeve as a lintel.** If the wall is less than 8" thick or of hollow construction, an alternate means of support for the sleeve must be provided. See Figure 4 for a typical lintel construction.

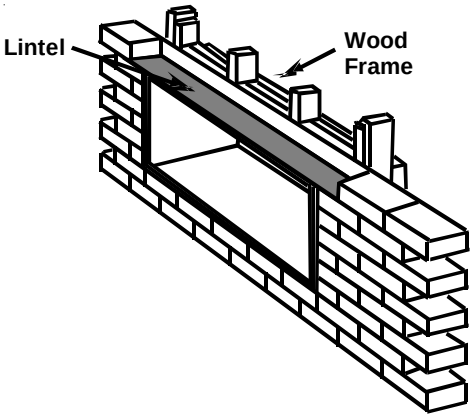


**Figure 4**
**Framing with Lintel**

- When installed in the opening, the wall sleeve must be level from side to side and sloped one quarter bubble front to back. DO NOT SLOPE THE WALL SLEEVE TOWARD THE ROOM. See Figure 5.

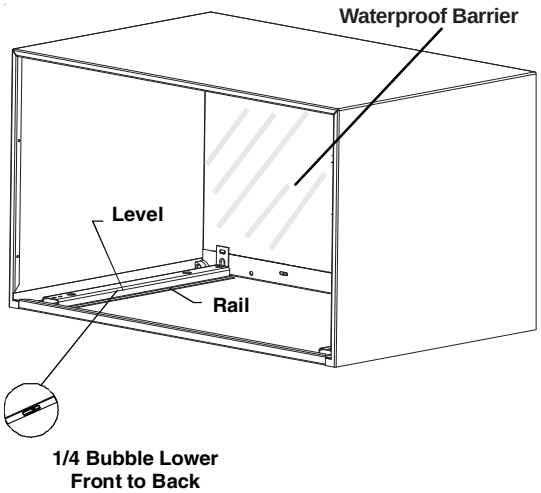


**Figure 5**
**Sleeve Installation**

Waterproof barrier should remain in place until the unit is installed. An accessory metal front panel, PBWMFC, is also available, but must be purchased separately.

- Attach the sleeve using four #12x2" wood screws (for wood constructed buildings) or four #12x2" masonry screws (for cement or brick constructed buildings) (Figure 6). Make sure the wall construction is adequate to support the unit.

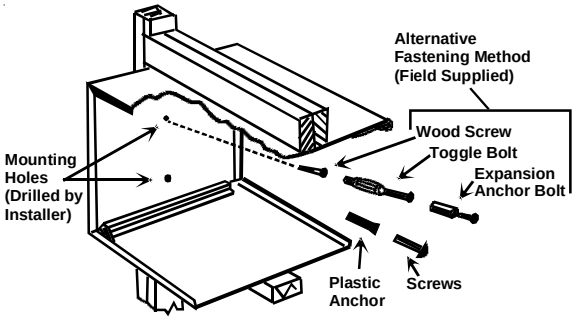


**Figure 6**
**Attaching Wall Sleeve to Opening**

- Provide adequate sealing and insulation around the sleeve after it is installed. See Figure 7 for one example of construction.

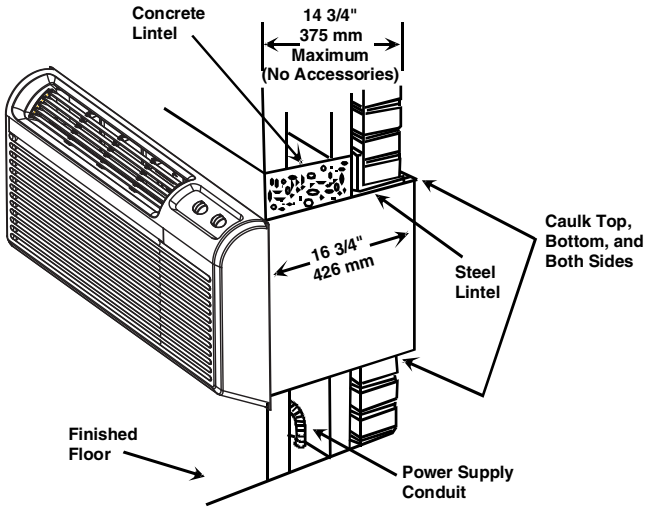


**Figure 7**
**Block and Brick Veneer Installation**

- Do not use extension cords with the unit.

## Wall Sleeve Installation

After the wall opening is checked and approved for strength, location, size, and clearances, install the wall sleeve as follows:

1. Remove the outside enclosure panel from the wall sleeve.
2. Slide the wall sleeve into the wall opening. Do not distort the cabinet shape to fit the wall opening; the unit chassis must fit snugly and uniformly into the wall sleeve.
3. Locate the sleeve within the range of minimum projections, as shown in Figure 2, so both sides are at least the minimum projection from the wall.
4. Check the level of the wall sleeve. For proper drainage, the sleeve should be level from side to side and one-quarter bubble front to back (outside).
5. Drill two holes in both sides of the wall sleeve so mounting screws can be secured to wall supports. See Figure 6 for location of screw holes. DO NOT DRILL THROUGH BOTTOM OF SLEEVE.
6. Check the level of the wall sleeve and adjust if necessary.
7. Caulk or seal around the outside of the entire sleeve.
8. If the unit chassis is not to be installed immediately, replace the enclosure panel on the outside opening of the sleeve to limit weather damage to the building interior.
9. Recycle or dispose of packaging materials according to local codes.

## Condensate Drain Kit

An outdoor condensate drain kit (Figure 8) is available on all models. An accessory drain kit, DK900D, is available for internal drain applications and must be purchased separately. The drain kit must be installed before installing the wall sleeve in the wall. See the drain kit for actual installation instructions.

| Kit Ordering Number | Description |
|---|---|
| DK900D | Internal Condensate Drain Kit |

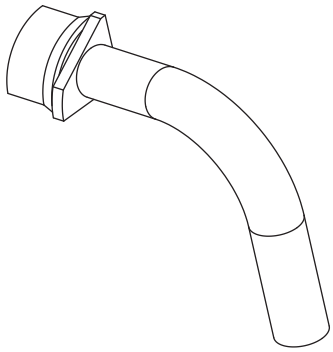

**Figure 8**
**Condensate Drain Kit**

# HELICAL ANCHORS VENDOR INFORMATION

# VCH/372/584/: /32'I/'"Uswctg'Uj ch/3/314\$'Ngcf 'Ugevkqp'y kj 'Fqwdrg'G{ g'I w{ 'Cf cr vgt

| Rtqf wev'Ur gekHecvkqpu | |
|---|---|
| Anchor Style | Square Shaft (150) Anchor |
| Component | Lead Section with Guy Adapter |
| Number of Helices | 2 |
| Helix Diameter | 8" (203mm) - 10" (254mm) |
| Length | 36" (914mm) |
| Flight Thickness | 3/8" (9.5mm) |
| Rod Tensile Strength | 70,000 lbs (311.4 kN) |
| Torque Rating | 7,000 lbs (9,492 N-M) |
| Eyenut Style | Double Eye |
| Adapter Length | 17" (431 mm) |
| Coating | Hot-Dip Galvanized |
| Standard Package | 25 |
| Standard Package Unit | Each |
| Min Order Qty | 1 |
| Weight/ Ea | 66.5 lbs |

**Pqvgu**

1-1/2" Square Shaft Lead 3'(914mm) with 8" (203mm) & 10" (254mm) Helices with Double Eye Guy Adaptor

# BAG LIFTER VENDOR INFORMATION

# LIFT-O-FLEX® By RONI

**Platform**
**200HD Series-Maximum Weight 200-lbs**
**250HD Series-Maximum Weight 250-lbs**

The **LIFT-*N*-GO II™** HD (Heavy Duty) Series lifter is an enhanced lifter for increased capacity over the standard Lift-N-Go™ Series. Both Series are available to meet your material handling needs. The **LIFT-*N*-GO II™** continues the tradition of providing for increased economical, safe, efficient, and ergonomic material handling solutions to assist you with your production needs.

The **LIFT-*N*-GO II™** has a lift capacity of either 90Kg (200-lbs or 115Kg (250-lbs) and provides for improved and expanded flexibility with a wider base and longer legs along with an improved electronic power pack to better fill your ergonomic lifting requirements.

A UHMW load platform (~20" wide x ~17 ¼" deep) is provided for product handling or other selections are available to fit you product-handling needs

**Features and Benefits:**

- Anodized Aluminum Profiles-
  - Lift Masts
- Steel (Powder Coated Paint-Optional SS)
  - Welded Base
  - Handlebar-height Adjustable
  - Power Pack Cover
- Standard swivel casters
- Standard length lift masts
- Foot operated kick brakes on rear casters
- Lift mast slip clutch on the down movement provides for safe load handling
- Current limiting (no limit switches) provide for load limiting and stops
- Totally enclosed lift mast w/ball screw for smooth up and down DC powered movement
- Electronic power pack utilizes quick exchange features allowing for multi-shift operation
- Detachable remote controller
  - Provides the operator with control over load handling functions.
- Handlebar is adjustable by the operators to achieve ergonomic operation
- Highly maneuverable, light-weight (approximately 90-lbs) and easy to operate.

**LIFT-*N*-GO II™ HD Series Ergonomic Lifter**

**Document No. 80078**
**Rev. 09/11**

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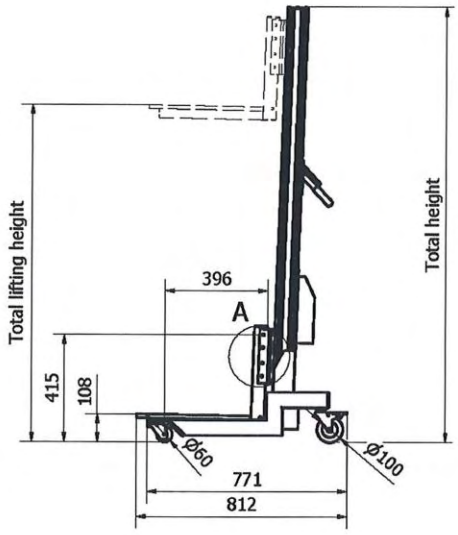


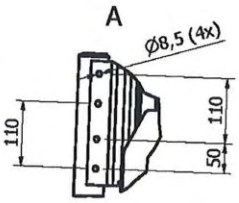


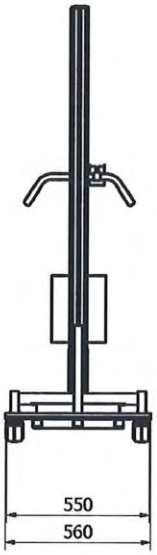


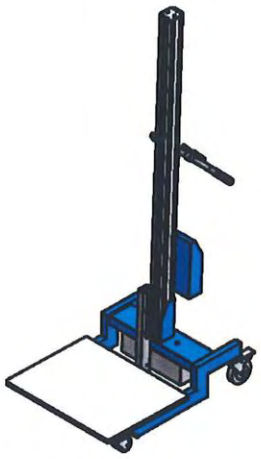

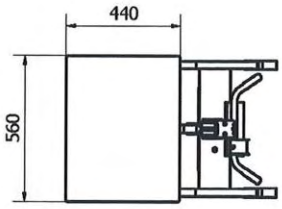


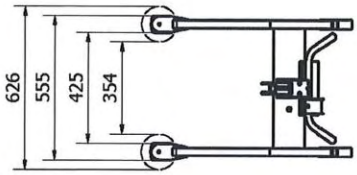


| **Technical Specifications 200 HD/250 HD Series:** | | | | |
|---|---|---|---|---|
| **Lift Stroke** | **Total Height** | **Total Lift Height Floor to top of Platform** | **Series** | **Series** |
| 1192mm (47”) | 1678mm (66”) | 1442mm (51.2”) | 200 HD Series | 250 HD Series |
| 1550mm (56.7”) | 1928mm (76”) | 1692mm (60.9”) | 200 HD Series | 250 HD Series |
| 1800mm (66.6”) | 2178mm (85.8”) | 1942mm (70.8”) | 200 HD Series | 250 HD Series |
| 2000mm (74.4”) | 2378mm (93.7”) | 2192mm (78.6”) | | 250 HD Series |
| 2300mm (86.2”) | 2678mm (105.5“) | 2192mm (90.4”) | | 250 HD Series |

| | |
|---|---|
| Minimum Lift Height Standard | 158mm (6.2”), 108mm (4.25”) |
| Lift Speed 200HD Series | 90mm/sec (3.5”/sec) |
| Lift Speed 250HD Series | 79mm/sec (3.1”/sec) |
| Length (w/o Platform) | 771mm (30.35”) |
| Load Platform (Depth x Width) | 440mm (17.3”) x 560mm (20”) |
| Wheel Diameter (Front/Back) | 60mm (2.3”)/100mm (3.9”) |
| Maximum Load 200 HD Series | 90Kg (200-lbs) |
| Maximum Load 250 HD Series | 115Kg (250-lbs) |
| Lifter Weight w/o End-Effector | 40Kg (90-lbs) |
| Battery Voltage | 24V |
| Battery Capacity | 7.2 AHr |
| Lifter Finish | Powder Coated Paint/Anodized or Stainless Steel/Anodized |

The load platform can if needed, be mounted 110mm (4.3”) higher on the mast yoke. If mounted this way, the platform top when lowered would be higher that the standard mounting height.

**Consult RonI, Inc for other Lift-O-Flex® Solutions**

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# STANDARD SHIPPING CONTAINERS

# GreenCube
# Approval Report

ISBU & Shipping Container
Construction Approval Data

Building Inspectors
Mortgage Companies
Insurance Underwriters

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# GreenCube Approval Report

Version 4.0

**All information in the GreenCube Approval Report is an accurate digest of specifications, requirements, and certifications for all ISBU modules and ISO steel dry cargo Shipping Containers sizes 10', 20', 40', 45' and 53', both GP and HC types.**

**Prepared in accordance with:**
International Organization for Standardization (ISO)
ISO- 1CC type steel dry containers
International Maritime Organization (IMO)
International Convention for Safe Containers (CSC) 1972-2007
and in accordance with CSC Article IV(2)

These specifications and commentary cover design, construction, materials, testing, inspections of ISO standard shipping containers and ISBU modules. All information is in accordance with the requirements of ISO- 1CC type steel dry freight containers by all certified global manufacturers.

These Specifications are for information purposes and for use only by ISBU Association members and their associates for the development and construction of their projects.

Any structural modifications of these containers should be certified by a structural engineer to meet appropriate safety standards and building codes.

All information is certified to be accurate according to ISO/IMO/CSC requirements, articles and revisions current to April 2009.

## Quick Reference Guide

### Who will benefit from this report?

Construction professionals:
-Architects, structural engineers, civil engineers, home designers, building contractors, sub-contractors, welders, real estate developers and real estate agents.

Government agencies:
-EPA, LEEDS, DOE, State, County, and City engineers, planners, zoning, building departments, inspectors, FEMA and other disaster relief agencies.

Finance and Insurance:
-Mortgage companies, banks, private lenders, appraisers, warranty providers, insurance underwriters and their agents.

Educational Institutions:
-Universities, colleges, technical colleges, extended learning, faculty, and students.

### What is an ISBU?

ISBU is universal short term for Inter-modal Steel Building Unit (ISBU)

An ISBU is an ISO- 1CC type Corten steel container manufactured for, or converted for use for either some type building construction purpose or for a storage unit. They come in varying lengths and heights and can be used for either transportation, storage, or building construction.

### Why is ISBU construction or ISBU integration a preferred structure?

The reasons for the growing interest and use of an ISBU for single unit or multi-unit construction are too numerous to mention.

In 2007, 2008 and 2009 the ISBU has become a very legitimate, viable construction and storage technology and not just a trend or fad. Their uses are now widely accepted by the professional designers, contractors, environmentalists and governments.

The low cost of construction has now become a secondary issue.

Whether the use of ISBU construction or ISBU integrated construction will remain economical is no longer the main issue to its demand and acceptance.

The greatest reasons ISBU construction has become so popular with consumers, professionals and government is much simpler and basic than the cost factor:

- 100% Recyclable
- Exceptional Strength and Durability
- Exceptional Safety; tornado, hurricane, flood, and earthquake
- Exceptional Longevity and Sustainability

The economics and overall cost factor of ISBU construction and storage are now becoming a side benefit and not the principle feature.

## ● Certifications: Local and International

### Certification Types

Why are certifications important? We will discuss this because Building Inspectors and architects continue to ask for “strength certifications” before approving the use of ISBU for construction use and often for storage use.

Just because you see a shipping container it **does not** mean it still meets the strength or safety standards listed below.

A vast number of our members are reporting they buy ISBU shipping containers only to find the Building Inspector and/or architect will not allow them for use in construction.

Who wants to build a structure using materials that cannot be certified for their project?

Here are some commonly used, referred to, and requested certifications.

### *SIR Certification (New. See page 38)

SIR is the new certification specifically created for ISBU container projects.

### CSC Certified

CSC is short for ICSC (International Convention for Safe Containers)

CSC Certification is generally meant as the initial Certification from the factory engineer. When the container is certified at the factory it receives a CSC Plate (see below).

Re-certification can also be done by the ACEP or IICL 5 method. (see below). When these methods are used it is sometimes called CSC re-certification, meaning it again meets CSC standards.

### “Cargo Worthy” Certification

Please note there is a difference between:
- Cargo Worthy
- Cargo Worthy Certification

All new containers are “Cargo Worthy”, however many used containers are not and this needs to be clearly understood.

If a container is old or has been damaged, it may be not considered “Cargo Worthy”. That means it can only be used for storage and cannot be used for shipping or transit because it is too week and not stackable.

In the past 12 months we have many ISBA members who have purchased containers only to find they could only be delivered by a private trucker, but not shipped commercially or sent to another location by ship. The reason for this is that they do not have the “cargo worthy” certification and therefore may also they may have a problem getting them approved by the Building Inspector in your local area.

We must state that the term “Cargo Worthy” does not necessarily mean it meets the original strength standards or can be used for all types shipping, stacking and transport operations. Many assume that is what it means but even within the shipping trade and among container dealers there is some confusion.

Things are quite loose in this area. It can be deemed “Cargo Worthy” by a dealer, depot or shipper, yet **not** meet the original strength specifications.

Therefore it’s important to be “Cargo Worthy” if it needs to be shipped to its destination; however this may not be completely acceptable certification for a Building Inspector.

If you are buying ISBU for construction, stacking, etc., and they need the original strength and standards for permits, you must get it certified in some way. A “Cargo Worthy Certification” may be one solution an Inspector may accept.

Usually when an ISBU cannot be certified it will only be used for storage or for parts. (Also see topic: Depots vs., Dealers. Buyer Beware)

NOTE: When a damaged container is repaired it must always be re-inspected before it can be used for transportation. However, the re-inspection **is not** necessarily the same as having it re-certified. This is quite different. Quite often these well-used or frequently damaged units are sold to eliminate the needed repairs and cost of a true re-certification.

## IICL 5 Inspection

This is a standard created by the federation of the container leasing companies (IICL) who’s members represent about 90% of all container leasing companies which own approximately 50% of all shipping containers globally.

Their inspection program is known industry wide however is seldom used by container dealers, Building Inspectors and architects due to the fact the IICL is more of a tracking of repairs rather than the direct testing of it's present strength and condition. Additionally, the inspection costs and unnecessary data seem to make it prohibitive.

## ACEP

ACEP (Approved Continuous Examination Programs)

This is generally a thorough examination of all container parts. The only reason this inspection and certification sticker is often rejected by a Building Inspector is because the ACEP examination can be certified by the owner or one of his employees and is not necessarily performed by an independent third party inspector.

Although the ACEP is usually quite accurate some Building Inspectors and architects will not accept this inspection due to above mentioned reasons.

## ASIS

The ASIS or “as is” simply means it is sold “as is” with no warranty. This does not mean it is a bad container; it also does not mean it's an old container. It simply means it is no longer in use in the transport system and will be used as an ISBU, therefore does not need the CSC plate attached.

This makes sense to container shipping companies and container dealers, how ever most Building Inspectors and architects see this as an admission of possible damage or lower quality containers. It may not be easy to change this mind set unless the container has an additional “third party” strength inspection and certification.

***New!***

## CIN Code

CIN (Container Identification Number)

There is a code stamped by the factory on the inside corner of every shipping container. Few architects, inspectors, and building contractors are aware of this permanent code.

- The number is unique with every container. Meaning it is a different number on every shipping container built.
- It cannot be removed and is permanently stamped into the steel corner inside.
- Like the CSC Plate, the CIN code is an accurate reference to the original manufacturer, engineers, place and date of manufacture.

This code is ideal for the use as an industry standard for recording, registering and certifying ISBU. We were surprised to learn there is presently no formal name for this code. Since it is similar to a VIN code on an automobile the ISBU Association has suggested to name and reference to it as: CIN (Container Identification Number)

We are hopeful to see this CIN used in certification and Building Permits since the CSC Plates are generally removed by either the dealer or the building contractor.

ISBU Association is presently working with an organization to create a strong government backed certification using the CIN and CSC guidelines which could be a relevant, easy to interpret ISBU inspection and certification.

(See the SIR section on page 38 for more information on CIN)

---

## Certification Ratings

The below ratings are feedback from our ISBA members, trade interviews and readers in general.

| | |
|---|---|
| *CIN based Certification | ▲ ▲ ▲ ▲ ▲ (where available) |
| CSC Certification | ▲ ▲ ▲ ▲ |
| Cargo Worthy Certification | ▲ ▲ ▲ |
| ACET Certification | ▲ ▲ |
| IILC 5 Certification | ▲ ▲ |

The above rating analysis is based upon relevance for containers (ISBU) used specifically in building construction and storage and not for containers used in the transportation industry. The transportation industry has inspection requirements which are often not relevant to storage or construction ISBU.

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***Important-** See Updates: SIR Certification, page 38

**How important is the CSC ID Plate?** (Also see SIR page 38)
Presently, the principle reason a CSC ID Plate is so important is mainly due to the lack of any other organized ID system.

Secondly, Building Inspectors and architects are looking for some source of ID and certification and are somewhat mis-guided in their search believing the only ID reference to a container after manufacturing is the CSC Plate. (see CID)

We have only stressed this as an ID form since there is little knowledge of any other organized form of ID and strength certification. In 1993 the CSC revised the laws making the ID Plate a necessary part of ISO container certification for transport purposes. This is not entirely relevant for use on ISBU modules.

Check with your local Inspectors before buying ISBU to see what they require.

**What to look for:**

CSC ID Plate: Revised standards in 1993 by CSC.
Transport seal combined with CSC Certification.

CSC ID Plate: Not combined with Transport seal.

The CSC ID Plate is the certification from the factory engineer. The CSC ID Plate is also the evidence of the containers age and manufacturer. (see CID)

It is generally accepted that you should not purchase ISO shipping containers without the CSC ID Plate and without a strength and safety certification. We hope this concept can soon be changed to include a more relevant inspection and ID certification based on the CID code.

## Depots vs., Dealers. Buyer Beware

There is some controversy in the ISBU and shipping container industry regarding the quality of containers purchased from “container depots”. Many container dealers promote the fact they have better quality containers than a Depot can offer. This is not necessarily correct.

To better address this we must define what a “container depot” is.

A shipping container “depot” is a repair yard, shop and storage facility for the shipping and leasing companies. A Depot is usually where containers are maintained and repaired and Depots are generally very efficient at what they do.

A Depot does not manufacture containers, they are not fleet operators; …they are only a storage facility for all types containers and a repair Depot for damaged or aging shipping containers.

Do they sell containers and ISBU? Yes… but a depot’s reputation is typically of one who sells the “vintage” models that are older, used and abused models that the shipping companies and lease operators will no longer use due to damage or physical appearance. However, they can, and do sell newer containers also which they buy from the shipping and leasing companies just like any other container dealer. So although they do repairs, obtain older or damaged containers, they can obtain and sell newer containers of any quality and grade just like a normal dealer.

Are Depot containers “cargo worthy” containers? They offer many qualities.

Because of their lower cost of acquiring older or well used units they are also able to sell these units wholesale to other dealers who can resell them in other regions of the country.

Understanding all this, good and bad containers can come from anywhere and since you don’t know where your containers history or where they are actually coming from we again strongly suggest “Buyer Beware”. Here is a check list that can be used no matter who your dealer is:

1) Physically check the condition of the container before buying, just as you would an automobile. Check inside, outside, top, and especially the bottom.
2) Always obtain Cargo Worthy or other credible certifications.
3) Always be certain the CSC ID Plate is intact if your Building inspector requires it.
4) Always buy from a reputable dealer, distributor or agent for shipping companies, leasing companies, and fleet operators.
5) If you buy ASIS be certain to have a valid certification of strength and CID for the Building Inspector or architect.

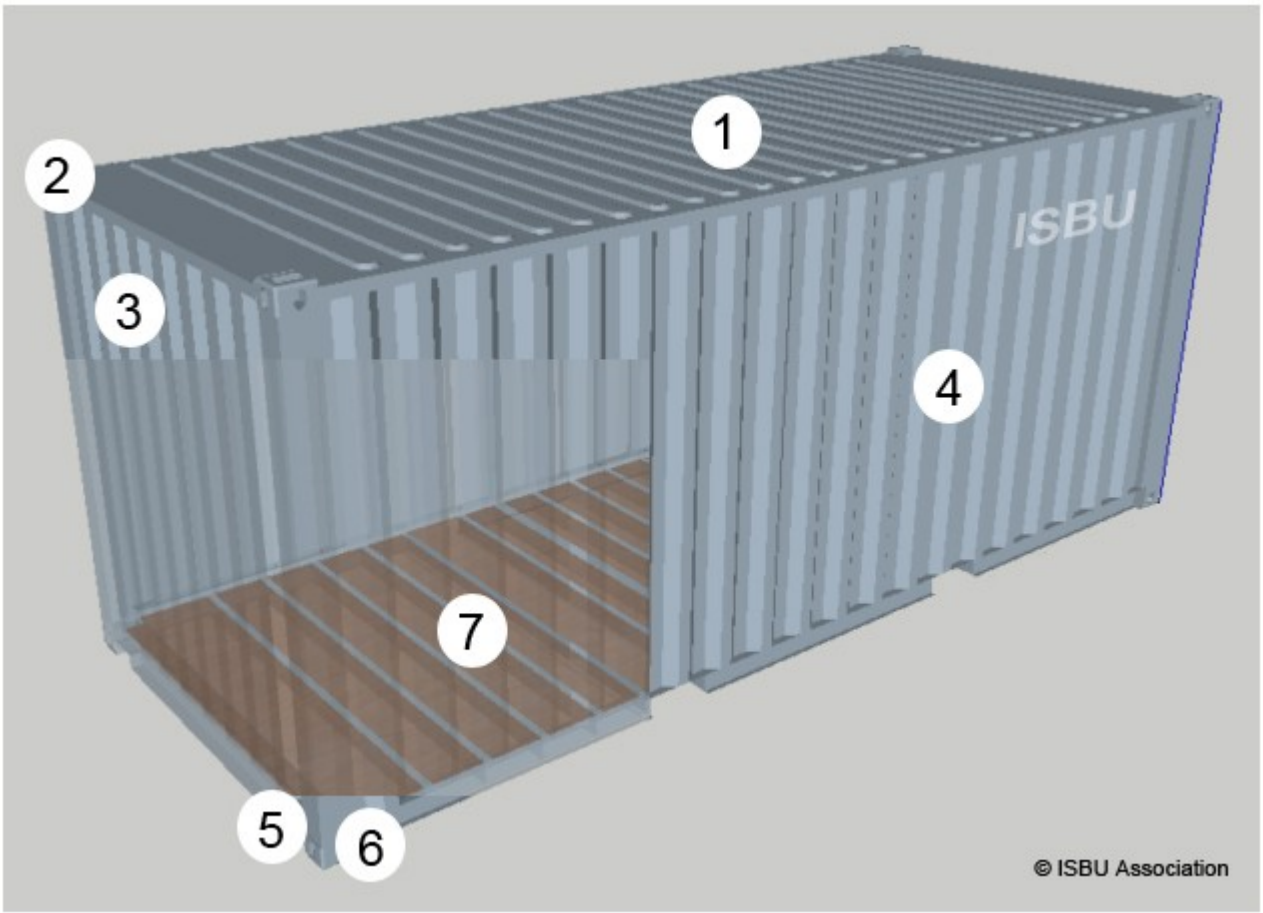
## ● Building Code Comparisons

### Does a standard ISBU meet or exceed IBC or UBC construction standards?

The standard ISO, IMO, and CSC specifications exceed IBC and UBC strength codes in every requirement as a base structural unit:

- Strength loads: top, bottom, side, and end.
- Seismic: earthquake and tremors
- Wind: top and side forces, including tornado and hurricane forces.
- Fire: side, top and bottom.

| TYPE | ISBU (container) CERTIFICATION | UBC (Building Code) REQUIREMENTS | ISBU (times stronger) PERFORMANCE |
|---|---|---|---|
| 1) Roof, uniform load, center | 300 psf | 20 psf | 15.0 x |
| 2) Roof, stacking, axial | 53,000/per post | 500/per post | 106.0 x |
| 3) End walls, lateral | 366 psf | 20 psf | 18.3 x |
| 4) Side walls, lateral | 234 psf | 20 psf | 11.7 x |
| 5) Racking/shear load “A” | 16,800 lb. | 680 lb. | 24.7 x |
| 6) Racking/shear load “B” | 33,600 lb. | 1,600 lb. | 21.0 x |
| 7) Flooring, uniform load | 101 psf | 40 psf | 2.5 x |




(See expanded certifications and specifications for details)

* IBC (International Building Code)
* UBC (Universal Building Code)

## Corten Steel vs., Mild Steel

ISO shipping containers are made using a special steel named “Corten steel”. This product is quite different than the common “mild steel” used in most building construction.

U.S. Steel is the original inventor and manufacturer of Corten steel.

Corten steel has at least three very unique properties compared to mild steel
1) 40% stronger than mild steel
2) Superior bonding properties with paints and coatings
3) Anti-corrosive blend of metals

The rusting or corrosion on the surface of un-painted Corten steel is very slow, loosing only 1.0 mm of surface per 100 years. 1.5 mm in highly corrosive environments.

For this reason, Corten steel is used on bridges, freeways, cargo ships and the favorite of artists for use on outdoor steel art and architecture. It oxidizes, but does not corrode, that is a very significant difference.

The longevity rating for Corten steel on these structures is 100 - 120 years un-painted. When coated with epoxy paints and maintained, these surfaces are near eternal.

TEST: Corten steel used on shipping containers is virtually undamaged (Cronos)

Many independent studies have been done on shipping containers and the Corten steel used in the container construction. One such study was made by the Cronos Leasing company. The results of a study performed by a UK university concluded that Corten A steel was 75% stronger than mild steel. Their strength test was conducted using a hydraulic ram equivalent of over 20 tons per square inch.

An ISBU or shipping container meet and exceeds all U.S. and International building codes for use as a construction unit base. It is the epitome of sustainability and recyclable and its reputation is well known for durability and longevity.

## ● Modification Issues

### Minor Modifications

How much strength does an ISBU loose if modified? Virtually none.

This depends on how much modification it incurs. If modified properly it does not loose any significant strength with minor modifications.

Since an ISBU is simply a base module for a structure, then all modification should comply with standard building codes. For example the cutting and adding of doors and windows then become building code standard with the standard and proper framing.

Unless the basic unit (s) becomes highly modified such as the removal of entire walls, roof, etc., the basic ISBU module will retain its entire structural integrity.

Adding window, doors and even a stairway through the roof will not jeopardize its ability to meet or exceed normal building code standards.

Combining multiple ISBU modules to create larger homes, office or storage will generally increase the total unit strength and stability since the modules become a fully welded multi-unit structure attached to each other.

- The combining of multiple ISBU does not diminish its individual or total unit strength.
- Modifications such as windows, doors and stairways will be done according to code.

### Major Modifications

As with any structure, major modifications to an ISBU or a multi-ISBU complex will require certain supports then be re-certification by a structural engineer. This is a common procedure with any building structure.

Such things as removing entire walls are easily re-supported by vertical steel supports every 13.3’ or horizontal steel beams “I beams” supporting the opened side wall roof.

A qualified architect or structural engineer can easily create construction plans with these structural modifications which will be approved by the Building Inspector.

It needs to be noted: The ISBU is simply the ultra-strong cube which can be modified and added upon with standard building materials.

Except for Emergency housing or Mobile storage units, ISBU modules are not meant to replace normal housing codes, insulations or inner construction. An ISBU is simply a very strong, recyclable, and long life infrastructure to easily combine with multiple ISBU, add inner walls, insulation, plumbing, ceilings, and sit on standard foundations according to standard building codes.

## ● Usage Types

### Permanent Construction

These are homes, offices, apartments, garages, work shops, classrooms, student housing, medical facilities and agricultural structures which are meant to be permanent and not meant to be moved.

They will be placed on foundations and comply fully with local building codes.

Due to their ISBU infrastructures these buildings will be the safest and most durable buildings in the community and can have an exterior which will be of standard design using stucco, siding, brick, or any combination of recyclable materials.

### Temporary Construction

These are emergency shelters, disaster relief, homes, offices, apartments, garages, work shops, classrooms, student housing, medical facilities, guard shacks, and agricultural structures which are meant to only be temporary until the permanent structures are completed.

Due to their ISBU infrastructures these buildings will be the safest and most durable buildings in the community and can have an exterior which will be of standard design using stucco, siding, brick, or any combination of recyclable materials.

### Permanent Storage

These will consist of permanent structures at a residences, offices, schools, agricultural areas, or shopping centers which are meant to be permanent, attractive and not meant to be moved.

Due to their ISBU infrastructures these buildings will be the safest and most durable buildings in the community and can have an exterior which will be of standard design using stucco, siding, brick, or any combination of recyclable materials.

### Mobile Storage

Mobile storage units serve an important need on the property of businesses, residences, schools, government, and in agricultural areas. Consisting either of the smaller 4’, 5’, 8’ and 10’ ISBU or the more common 20’ and 40’ ISBU.

In some areas it is often easier to get a Permit to place cheap, unsafe mobile units on these properties rather than the stronger, safer ISBU storage units.

If aesthetics are an issue these units can be painted or façades added to better adapt to the surroundings or zoning covenants. These are not fire hazards as many mobile units and much safer and less likely to decompose in the neighborhoods of work yards.

Due to their ISBU infrastructures these buildings will be the safest and most durable buildings in the community and can have an exterior which will be of standard design using stucco, siding, brick, or any combination of recyclable materials.

## ● Home Owner

### Is This Right For Me?

Until you've actually been in a properly built ISBU home, classroom or other ISBU building structure you cannot comprehend the absolute warmth and silence.

An ISBU structure has so many benefits and strengths over conventional construction it is difficult to comprehend their intrigue and value.

You should not go into your project because it's possibly a cheaper alternative. The true features of ISBU construction are in the safety, strength, longevity, sustainability, speed, and flexibility of construction.

Plan your project properly as you would any home and comply with every filing and request of your City-County building inspector. You want it right; they want it right.

### Design Options

It's obvious to say there are some limitations to your design, but not many.

We fully recommend you choose most any standard home design and adjust your "cubes" to fit the floor plan, …a few feet here, a couple there and you will see it's not that difficult to have a normal home with strength and sustainability.

The exterior is not complicated either. The steel infrastructure is an excellent frame for either siding, rich stucco, brick, wood, or any combination.

If you are happy with your present home and simply want a durable and safe add-on then ISBU integration is quite simple and affordable.

**NOTE:** Do not begin any construction without a Building Permit. This is always the wrong approach. Be patient with you local Building Department and Bank. They have no reason to decline your project but the need to understand this new technology and be confident it meets code.

When a person has professional architectural plans and a Building Permit, we see little resistance to obtaining the construction loans and home insurance. Most lenders and insurance underwriters are only concerned the home is built according to local building codes.

## ● Construction Professionals

### Designer
In creating your designs the main caution is to understand where the main supports and frame are then design the home or other building project as normal.

Review the section, “Building Code Comparisons” and note where the main structural points are. Removing an entire ISBU roof/ceiling is acceptable if needed to design a vaulted 16’ ceiling. Also remember an ISBU design can include both horizontal and vertical ISBU’s connected for unique designs.

### Architect
If you are also the designer architect please read the above “Designer” comments. To understand your limitations you may want to consult with a structural engineer to assist you in know more about the structural design limitations as you connect other ISBU or attempt any radical modifications.

### Structural Engineer
The need for a structural engineer seems to be one of the weakest points in the rapid development of ISBU construction and technology.

Our organization sees many projects on hold due to the lack of qualified local structural engineers. Due to the infancy of this construction concept Building Inspectors are often going a bit overboard are requesting very basic things certified.

Although much of that information is now in our “Approval Report”, this ISBU technology is creating quite a demand for qualified structural engineers in each State and Province.

### Building Contractor
If you know building construction then you know how to build ISBU homes, offices and other ISBU structures. There is little difference in anything else you already know or do. The only thing that is different is that your super structure is a combination of steel boxes, which, in fact, may actually make the entire project easier for you.

The biggest concern we hear is in regard to cutting and modifying the ISBU. In fact, the use of a Plasma cutter is even easier than attempting to cut holes and modify walls in plywood, sheet rock or concrete. Once the basic holes are made it becomes a standard construction project.

## ● Government Zoning/Planning Commissions

### The Myths & The Facts

There are many myths regarding “shipping container homes” and their construction.

To say these myths and type casting are common would not be correct. In fact very few government agencies promote these un-educated beliefs and concepts.

**Here are the top four myths:**

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**MYTH:** Shipping containers are hot ovens and not fit for human habitation.

**FACT:** Any non-insulated structure can become hot and unsuitable for human habitation in the summer months. A shipping container is as responsive to insulation as any other structure or material. When constructed according to Building codes all homes become safe and habitable.

---

**MYTH:** Shipping container housing only attracts “ghetto type” lifestyles.

**FACT:** Any housing or building material can become a ghetto unless properly managed. Here in the United States we have “ghetto” in every major American city, yet none of the homes are built from shipping containers.

A ghetto is not the material, it’s the people and the governmental management.

---

**MYTH:** Shipping containers should not be used for housing because they quickly become old and rusty housing.

**FACT:** Inasmuch as shipping containers are constructed with Corten steel, then coated with epoxy paint, it is near impossible for them to corrode as some believe. Any scratched, dented and untreated metal will oxidize and in time corrode.

A shipping container home constructed according to building codes will be the most maintenance free structure you could put in a community.

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**MYTH:** Shipping containers cannot meet conventional housing standards or building codes and therefore should not be considered for use in construction.

**FACT:** As proven by the actual tests and certifications a shipping container, when used as housing infrastructures or storage units greatly exceed all government standards.

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Due to the actual facts, ISBU construction is being endorsed by governments, universities and largest corporations globally.

## ● Building Inspectors

### Approvals, Permits, Inspections

The ISBU Association is fortunate to be making much progress with ISBU related Building Permits and approvals.

In virtually every situation we've encountered the city-county Inspectors and agencies have been very cooperative and interested to see this technology go forward.

The most negative situations were created by home owners who did not follow procedures and government regulation in applying for their Building Permits properly.

The main comments we continue to hear from Building Inspectors are:

- Some people are not really interested in building according to code.
- We're very intrigued with this type construction we just don't have access to the proper information.
- You are presenting this to us much differently than the applicant has.
- The architectural drawings were not done properly.
- You need more engineers in our State who know this stuff.

**NOTE:** If you are a Building Inspector or valid employee of a government agency with questions or comments regarding ISBU construction please contact us at:

approvals@isbu-info.org

Please contact us using your government email address for our verification.

## ● Lending Institutions

### Banks, Mortgage Companies and other lending institutions

In speaking with officers six major bank and mortgage companies in the United States we have been met with very positive interest and very little negative.

Generally they only need verification that the local government agency is in approval of the construction and that it is being built according to code.

**NOTE:** If you are a legitimate Lender or valid employee of a Lending agency with questions or comments regarding ISBU construction please contact us at:

approvals@isbu-info.org

Please contact us using your corporate email address for our verification.

## ● Insurance Underwriters

### Warranty Companies, Insurance Agents

Insurance underwriters have been the least problem to date since they generally accept the knowledge and expertise of the Building Inspector and/or Lender.

If the Bank will finance the project then it is obvious they have already done their research on the project and the Insurance company has little concern.

**NOTE:** If you are a legitimate Lender or valid employee of a Lending agency with questions or comments regarding ISBU construction please contact us at:

approvals@isbu-info.org

Please contact us using your corporate email address for our verification.

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Dear Reader,

We have been very involved in working directly with municipalities, lending institutions, and insurance underwriters in behalf or our Members since May 2007.

This is very time consuming, however every project and geographic location can have a different need or concern regarding ISBU construction projects.

We are very committed in learning what the agencies need in order to be comfortable with approving these ISBU building construction projects including ISBU storage units.

Please contact us with your experiences so we can update our reports and know how to better assist these agencies.

Additionally, since our first publication we have been contacted by an agency that can possibly provide the most widely accepted “certifications” which would be very acceptable to inspectors, banks and architects. We are very interested since they also agree with the CIN code concept in their certifications. They have a target date of February 20 to submit the full details of the certification program to us. We expect this will become the most widely accepted program for ISBU construction and storage units.

(UPDATE) New CIN based SIR Certification was approved and implemented March 2009.

Regards,

Barry Naef
Managing Director
ISBU Association

Reference and Documentation:

# ISO Shipping Container Technical Specifications

## ISO General Sizes: Dry Cargo Steel Container

(10', 20' 40', 45' GP/HC models)

# ISBU Association (ISBA)

Specification: ISBA-01.25.09-ISOGEN

Prepared in accordance to:
International Maritime Organization (IMO)
International Convention for Safe Containers (CSC) 1972-2007
and in accordance with CSC Article IV(2)

Current compilation: April 2009

These specifications cover design, construction, materials, testing, inspections of ISO standard shipping containers and ISBU modules. These specifications are in accordance with the requirements of I.S.O. 1CC type steel dry freight containers by all certified global manufacturers.

These Specifications are for information purposes and for use only by ISBU Association members for the development and construction of their projects.

All information is certified to be accurate according to IMO/CSC articles and revisions current to April 2009.

## CONTENTS


| | | |
|---|---|---|
| 1. | GENERAL | 21 |
| 2. | APPROVALS AND CERTIFICATES | 21 |
| 3. | HANDLING | 22 |
| 4. | TRANSPORTATION | 22 |
| 5. | DIMENSIONS AND RATINGS | 23 |
| 6. | GENERAL CONSTRUCTION | 24 |
| 7. | PRESERVATION | 30 |
| 8. | MARKINGS | 31 |
| 9. | TESTING AND INSPECTION | 32 |
| 10. | DOCUMENTS SUBMISSION | 34 |
| 11. | GUARANTEE | 34 |
| 12. | MATERIALS | 35 |
| 13. | ISBA ASSOCIATION SUMMARY | 37 |
| 14. | UPDATES | 38 |
| 15. | SIR CERTIFICATIONS | 39 |
| 16. | CIN CODE | 40 |

## 1. General

### 1.1 Operational Environment (IMO/ISO Requirements)

The container will be designed and constructed for the transportation of general cargo on sea (above or under deck) and on land (road or rail) throughout the world, and will be suitable for the environmental conditions imposed by those modes of transport. All materials used in the construction will be able to withstand extreme temperature ranging from -40°C (-40°F) to 70°C (158°F) without effect on the container's strength and watertight properties.

### 1.2 Standards , Regulations and Rules

#### 1.2.1 Standards and Regulations

Containers shall comply with following in their latest editions:

1) I.S.O./TC-104
   668- Series 1 freight containers - Classification, external dimensions and ratings
   6346- Coding, identification and marking for freight containers
   1161- Specification of corner fittings for series 1 freight containers
   1496-1- Specification and testing of series 1 freight containers.

   Part 1: General cargo containers for general purposes
   830- Freight containers – Terminology.
   3874- Freight containers – Handling and securing

2) The International Union of Railway (UIC) code 592 OR.
3) The Customs Convention on the International Transport of Goods (T.I.R.).
4) The International Convention for Safe Containers (CSC).
5) Transportation Cargo Containers and Unit Loads Quarantine Aspects and Procedures by Commonwealth of Australia Department of Health. (T.C.T.)

**1.2.2** To satisfy the requirements of Rules of classification society.

## 2. Approval and Certificates

### 2.1 Classification Certificate

All the containers shall be certified for design type and individually inspected by Classification Society.

### 2.2 Production Certificate

The Production Certificate of series containers to be issued by the Classification Society. The Society's seal shall be provided.

### 2.3 T.C.T Certificate

Certificate of timber treatment to the requirement of Australia Department of Health which is currently the International standard.

**2.4 Customs Certificate ( T.I.R. )**
Customs' Approval and Certificate to be issued by the Customs.
**2.5 U.I.C. Registration**
All the containers will be registered & comply with the International Union of Railways.

**2.6 C.S.C. Certificate**
All the containers will be certified and comply with the requirements of the International Convention for Safe Containers.

## 3. Handling
The container will be constructed to be capable of being handled without any permanent deformation which will render it unsuitable for use or any other abnormality during the following conditions:

1) Lifting, full or empty, at the top corner fittings vertically by means of spreaders fitted with hooks, shackles or twistlocks.
2) Lifting, full or empty, at the bottom corner fittings using slings with appropriate terminal fittings at slings angle of forty-five ( 45° ) degree to horizontal.
3) Lifting, full or empty, at two fork pocket by fork lift truck.

## 4. Transportation
The container shall be constructed to be suitable for transportation for following modes without any permanent deformation which will render the container unsuitable to use or any abnormality.

**4.1 Marine:**
**- In the ship cell guides:**
Seven (7) high stacked based on Max. gross weight of 30,480 kg.
**- On the deck:**
Four (4) high stacked and secured by suitable vertical and diagonal wire lashings.

**4.2 Road - On flat bed or skeletal chassis:**
Secured by twistlocks or the equivalent at the four bottom corner fittings.

**4.3 Rail - On the flat cars or special container car:**
Secured by twistlocks or the equivalent at the four bottom corner fittings.

## 5 . Dimensions and Ratings

### 5.1 Dimension

Note: See specific ISO shipping container specifications & dimensions.

No part of the container will protrude out beyond the external dimensions mentioned above.
Maximum allowable differences between two diagonals on any one of the following surfaces are as follows:

### 5.2 Door Opening

Note: See specific ISO shipping container specifications & dimensions.

### 5.3 Fork Pocket

Note: See specific ISO shipping container specifications & dimensions.

### 5.4 Inside Cubic Capacity

Note: See specific ISO shipping container specifications & dimensions.

### 5.5 Rating

Note: See specific ISO shipping container specifications & dimensions.

### 5.6 Corner Protrusions

1) The upper faces of the top corner fittings will protrude above the highest level of the roof construction except corner plate by 6 mm.

2) For the containers under empty condition the lower faces of the cross members in their bases including their end transverse members shall be on a plane located at least 17 mm above the lower faces of the bottom corner fittings.

3) The outer side faces of the corner fittings will protrude from the outside faces of the corner post by minimum 3 mm. The outer side faces of the corner fittings will protrude from the outside faces of the side walls by nominal 7 mm and from the outside faces of the front end wall by 7.4 mm.

4) For the containers under the condition such as the load equal to 1.8R - T is uniformly distributed over the floor, no part of the container base will deflect by more than 6 mm below the lower faces of the bottom corner fittings.

## 6. Construction

### 6.1 General

The container will be constructed with steel frames, fully vertically corrugated steel side and end walls, die-stamped corrugated steel roof, wooden flooring, corrugated double hinged doors and ISO corner fittings at eight corners. All steelworks will be built up by means of automatic and semi-automatic CO2 gas arc welding. All exterior welding including that on base structure will be continuous to give perfect watertight properties, Interior welds will be intermittent with a minimum bead length of 25 mm for every 200 mm. All the welds, even spots, will have penetration without undercutting or porosity.

### 6.2 Corner Fittings

Corner fittings will be designed in accordance with ISO/1161 standard, and manufactured at the workshops approved by the classification society.

### 6.3 Base Frame

The base frame will be composed of two (2) bottom side rails, a number of cross members and a pair of fork pockets, which are welded together as a sub-assembly.

#### 6.3.1 Bottom Side Rail

Each bottom side rail is built of a steel pressing made in one piece. The bottom flange face outwards so as to be easily repaired and hard to corrode.

Note: See specific ISO shipping container specifications & dimensions.

#### 6.3.2 Crossmember

The crossmembers are composed of a number of small pressed channel section and some large one with three 4.0 mm thick webs located beneath each board joint of the plywood, which are placed at certain center distance.

Shape: " C " section
Small: 122 x 45 x 45 x 4.0 mm, Quantity: - -
Large: 122 x 75 x 45 x 4.0 mm, Quantity: - -

#### 6.3.3 Fork Pocket

One pair of fork pockets will be provided in accordance with ISO requirements for loaded handling. Each fork pocket is constructed with two adjacent crossmembers, a top plate and two bottom end plates. A angle stiffener plate will be welded to each opening of fork pocket.

| | |
|---|---|
| Top plate: | 3.0 mm Thick |
| Bottom plate: | 6.0 mm Thick |

#### 6.3.4 Reinforcement

Reinforcement plates will be welded at two ends of bottom side rail.

Dimension: 200 x 153 x 4.0 mm

### 6.4 Front End

The front end will be composed of corrugated end wall and front end frame, which are welded together as a sub-assembly.

### 6.4.1 Front End Wall

The front end wall is composed of steel sheet fully vertically corrugated into trapezium section, butt joint together to form one panel by means of automatic welding.

Thickness: 2.0 mm
Corrugation dimension- Outer face: 110 mm Depth: 45.6 mm
Interface: 104 mm Slope: 18 mm

### 6.4.2 Front End Frame

The front end frame will be composed of one front sill, two corner posts, one front header and four corner castings.

### 6.4.2.1 Front Sill

The front sill is made of a special “C” section steel pressed with vertical webs as the stiffener.

Front sill: 4.0 mm thick
Web: 4.0 mm thick Quantity: - -

### 6.4.2.2 Corner Post

Each corner post is made of a 6 mm thick section steel pressing to ensure the suitable strength, light-weight and easy maintenance.

### 6.4.2.3 Front Header

The front header is constructed with steel square tube lower part and steel plate upper part. The upper part is extended inwards of the container certain distance with full width from front part of top corner fittings.

Lower rail: 60 x 60 x 3.0 mm RHS
Upper part: 3.0 mm thick

### 6.5 Rear End

Rear end is composed of Rear End Frame which consists of one door sill, two corner posts, one rear header with header plate and four corner fittings, which are welded together as a sub-assembly, and Door Systems with locking devices.

### 6.5.1 Door Sill

The door sill is built of special channel section steel pressing with internal ribs as stiffeners at the back of each cam keeper. The upper face has a slope for better drainage and the highest part is on the same level to the upper face of the wooden floor.

Door sill: 4.5 mm thick Slope
Stiffener ribs: 4.0 mm thick 1:10 approx. Quantity: - -

### 6.5.2 Corner Post

Each corner post is constructed from an inner part of channel shaped hot-rolled section steel and an outer part of steel pressing, welded together to form a hollow section to ensure the door opening and suitable strength against the stacking and racking force. Four (4) sets of hinge pin lugs are welded to each outer part of the corner post.

| | |
|---|---|
| Inner part: | 113 x 40 x 12 mm |
| Outer part: | 4.5 mm thick |

### 6.5.3 Door Header

The door header is constructed from a lower part of a " U " shaped steel pressing with internal stiffener ribs at the location of the back of cam keeper and an upper part of steel pressing rear header plate, they are welded together to form a box section to provide a high rigidity.

| | | |
|---|---|---|
| Rear header: | 4.0 mm thick | |
| Header plate: | 3.0 mm thick | |
| Rib: | 4.0 mm thick | Quantity: - - |

### 6.5.4 Door Systems

Doors will consist of two door leaves, each leaf with two locking devices, four hinges and pins, seal gaskets and the door holders. The doors will be installed by hinge pins to the rear end frame and capable of swinging about 270 degrees.

### 6.5.4.1 Door Leaves

Each leaf consists of door panel, steel door frame which consists of horizontal ( upper & lower ) and vertical ( inner & outer ) members. They are welded together to form the rectangular door leaves. The door are so arranged that the left leaf can not be opened without displacement of the right leaf.

Door panel: With 3 corrugations

| | |
|---|---|
| Depth: | 40.0 mm |
| Interface: | 106.0 mm |
| Slope: | 22.0 mm |
| Panel thickness: | 2.0 mm |

Note: See specific ISO shipping container specifications & dimensions.

### 6.5.4.2 Hinges and Pins

Four forged hinges, providing with bushed hole, are welded to each door leaf. Each door is installed by hinge pins, washers and bushing.

| | |
|---|---|
| Washer- | Material: Stainless steel, Location: Under the bottom of hinge |
| Bushing- | Self-lubricating synthetic |
| Pin- | Material: Stainless steel |

### 6.5.4.3 Locking Devices

Two locking bars are of steel tube with handles, anti-racking rings and cam ends, and fixed to each door leaf with bolts / nuts and six huck bolts at TIR locations, by top and bottom bearing brackets and bar guide brackets. The bars are suspended in bearing brackets with bush of self-lubricating synthetic material.

Cam-keepers are welded to the door header and sill.
a) Locking device type: 2566MN Type, made in China.
b) Locking bars treatment : Hot-Dipped galvanized (75 Microns)
c) Cam keeper treatment : Electro zinc plated (13 Microns)

### 6.5.4.4 Door Holder and Receptacle

A door holder per door, made of mixed nylon rope, is tied to the center side locking rod & the receptacle ( door hook ) is welded to each bottom side rail to remain the door at the open position.

### 6.5.4.5 Seal Gaskets

The black door seal gaskets are of "J-C" type EPDM rubber. They are attached to the door frame with stainless steel rivets and retainer strips. The gasket is set with adhesive sealant on the back.

### 6.5.4.6 Shim

The E.P.D.M shim will be placed over the holes on the door for fastener ( except under large bearing brackets ).

## 6.6 Side Wall Assembly

### 6.6.1 Top Side Rails

Each top side rail is used a square steel pipe.

Rail: 60 x 60 x 3.0 mm RHS

### 6.6.2 Side Walls

Each side wall will be composed of a number of sheets for the intermediate (inner) parts and outer panels at each end of side wall, fully vertically corrugated into trapezium section, butt welded together to form one panel by automatic welding.

| | | |
|---|---|---|
| Inner panel: | 1.6 mm thick, | Quantity: - - |
| Outer panel: | 2.0 mm thick, | Quantity: - - |

**Trapezium:**

| | |
|---|---|
| Outer face: | 72 mm |
| Slope: | 68 mm |
| Inner face: | 72 mm |
| Depth: | 36 mm |
| Pitch: | 278 mm |

## 6.7 Roof

The roof will be constructed by several die-stamp corrugated steel sheets with a certain upwards camber at the center of each trough and corrugation, these sheets are butt jointed together to form one panel by automatic welding.

| | | |
|---|---|---|
| Corrugation Shape: | Depth: | 20.0 mm |
| | Pitch: | 209.0 mm |
| | Inner face: | 91.0 mm |
| | Slope: | 13.5 mm |
| | Camber upwards: | 5.0 mm |
| Panel thickness: | 20 mm | |
| Sheet Quantity: | (depending on container length) | |

### 6.7.1 Roof reinforcement plate

Four 3.0 mm thick. reinforcement plates shall be mounted around the four corner fittings.

## 6.8 Floor

### 6.8.1 The Floor Boards

The floor consists of plywood. The plywood is treated with wood preservative containing "Phoxim" or equivalent according to the Commonwealth Department of Health, Australia (International standard).

| | |
|---|---|
| Plywood thickness: | 28 mm |
| Plywood moisture content: | Less than 14% |
| Plywood ply number: | 19 plies |
| Plywood material: | Apitong/Hardwood |

### 6.8.2 Arrangement and Fixing

The plywood boards are longitudinally laid on the Crossmember with a pre-blasted painted and free floating flat steel at the center, and two angle steel along both side rails. The plywood boards are tightly secured to each crossmember with countersunk self-tapping electro-zinc plated steel screws. These heads of the floor screws are countersunk below the level of the upper surface of the floor by 1.5 mm to 2.5 mm.

Screws:

M8 x 45 x Φ16 (head), Electro zinc plated
Screws, quantity:

6 Pcs/end row, 4 Pcs/other
Flat bar: 50 x 4.0 mm, primed and painted
"L" section: 3.0 mm Thick.

## 6.9 Special Features

### 6.9.1 Customs Seal Provision

Customs seal provisions are made on each locking handle and retainer in accordance with TIR requirements.

### 6.9.2 Lashing rings

1) Lashing rings are welded to each bottom and top side rail at corresponding recessed area of side wall.
   Lashing ring Qty./ Each bottom or top side rail: (depending on container length)

2) Lashing rods are welded on each rear & front corner post slot.
   Lashing rods Qty. / Each front corner post : (depending on container length)
   Lashing rods Qty. / Each rear corner post : (depending on container length)

3) Capabilities of pull load of every lashing point are as following:
   Lashing rings on the side rails: 1,500 kg/each
   Lashing rods on the corner posts: 1,500 kg/each

4) Treatment of lashing ring / bar: Electro zinc plated

### 6.9.3 Sill Cut-Outs

200 x 75 x 9 mm channel section steel recesses are provided in each ends of rear and front sills adjacent to the bottom fitting to prevent damage due to any twistlock misalignment.

### 6.9.4 Ventilators

One ventilator with E.P.D.M seal gasket is supplied on each side wall at the right-hand end when facing the outside of container, fixed by aluminum huck bolts, the seal is to be applied on the edges except the bottom side of the ventilator, after the completion of the painting process.

Quantity: 1 / each side panel
Material: ABS Labyrinth Type.

## 7. Preservation

### 7.1 Surface Preparation of the Steelwork

1) All the steel surface prior to forming or after will be de-greased and shot blasted to Swedish Standard SA 2.5 to obtain the surface roughness at 25 to 35 microns which can result in the removal of all the rust, dirt, mill scale and all other foreign materials.
2) Locking rod assemblies, which are welded with gear cams, bars holder and handle hinges, are hot dipping galvanized (Thickness: 75 microns).
3) All fasteners such as bolts/nuts, washers, self-tapping screws, which are not mentioned in this Spec. will be electro zinc plated to 13 Microns, unless specified otherwise.
4) Hinges and cam keepers will be electro zinc plated to 13 Microns.
5) Sealant
   Apply to each perimeter of the floor, all the overlapped joints of inside, all the holes for bolts and nuts and all the places where water may leak and be sealed to prevent against water entry.

   Sealant Materials:
   Chloroprene (Cargo contact areas)
   Butyl (Hidden parts and other areas)

### 7.2 Coating

#### 7.2.1 Prior to Assembly

All the steel surfaces will be coated with primer paint immediately after shot-blasting .

#### 7.2.2 After Assembly

All the weld joints will be shot-blasted to remove all the welding fluxes, spatters, burnt primer coatings caused by welding heat, and other foreign materials, and followed with the secondary paint operation immediately.

**7.2.3** All the surface of the assembled container will have coating system as follows:

| **Process** | **Paint Name** | **DFT ( μ )** |
|---|---|---|
| Exterior Surface | Epoxy zinc rich primer | 30 |
| Epoxy primer | Chlorinated rubber or Acrylic topcoat | 40 |
| Color: BS 445 | | 40 |
| **Total:** | | **110** |
| | | |
| Interior Surface | Epoxy zinc rich primer | 40 |
| Pure epoxy | | 30 |
| **Total:** | | **70** |
| | | |
| Underside Epoxy zinc rich primer | | 30 |
| Bitumen | | 200 |
| **Total:** | | **230** |

NOTE: Flooring is not generally coated with epoxy zinc primer or any epoxy topcoat.

## 8. Markings

### 8.1 Lettering

The markings will be designed decal and arranged according to buyer's requirement. The markings consist of the following contents:

1) Owner's emblems ..... according to owner's design.
2) Owner's code , serial number and check digit ( outside & inside )
3) Size and type code ( outside )
4) Weight details ( on door )
5) Other marking: According to owner's requirements.

### 8.2 Consolidate Plate

8.2.1 The containers will bear marking plate in accordance with the requirements of the Classification Authorities and owner such as mentioned in section 2 in this specification. The plate will be permanently riveted to the specified position by rivets and sealant.

| | |
|---|---|
| Plate material: | Stainless steel |
| Plate treatment: | Chemically etched & enameled |
| Rivets material: | Stainless steel |
| Plate thickness: | 0.8 mm |

### 8.2.2 Contents of the plate: (rev. 2007)

1) Owner’s plate ( name and address ) .
2) Maker’s plate ( name and address ) .
3) CSC approval No.
4) Customs approval No.
5) Wood treatment .

The engraved letters on this plate are as following :
IM: Immunization
XXXX : The name of preservative.
XXXX : The time of immunization.
6) Date of manufacture (year-engraved, month-stamped)
7) Owner’s serial number (stamped)
8) Owner’s model number.

## 9. Testing and Inspection

### 9.1 Prototype-type Container

Prototype-type container to be manufactured in accordance with this specification and shall be tested according to procedures described in the ISO 1496/1 and the Classification Society's requirements. The containers will be fabricated & tested in advance of the mass production.

### 9.2 Container in Mass Production (Testing procedure)

**9.2.1** Every container in mass production shall be manufactured under effective Quality Control procedures to meet the specified standards. One in every 100 of containers shall be tested for following items:

a) Stacking test
b) Lifting from top corner fitting test
c) Lifting from bottom corner fitting test
d) Floor test.

After completion, ALL the containers shall be subject to dimension check, door operation check, light leakage test & production type weather-proofing test. The containers shall be inspected by the surveyor of Classification Society and identified by the appropriate society seal.

**9.2.2** Each assembled corner post structure will have a tension test with 15,240 kgs. after the welding in the construction line.

(See testing table below)

## 9.3 General Testing Criteria:

| Test Number | Test Load | Method |
|---|---|---|
| a. Stacking | Internal Load:<br>1.8R-T Testing load:86,400kg/post | Hydraulic cylinder load to corner post through top corner fittings.<br>Time duration : 5 mins . |
| b. Lifting from Top Corner Fittings | Internal Load: 2R-T | Lifting vertically from top corner fittings.<br>Time duration : 5 mins . |
| c. Lifting from Bottom Corner Fittings | Internal Load: 2R-T | Lifting from bottom corner fitting 45° Deg. To horizontal.<br>Time duration : 5 mins . |
| d. Lifting from Fork Pocket | Internal Load: 6R-T | Lifted by horizontal bars.<br>Bar length : 1828 mm,<br>Bar width : 200 mm,<br>Time duration : 5 mins . |
| e. Restraint (Longitudinal) | Testing Load: 2R(R/side)<br>Internal Load: R-T | Hydraulic cylinder load applied to bottom side rails in compression & then tension .<br>Time duration : 5 mins . |
| f. Floor Strength | Truck Load: 7,260 kg | Special truck is used.<br>Total contact area: 284 sq cm,<br>Wheel width: 180 mm,<br>Wheel center distance: 760 mm |
| g. Wall Strength (Front & Door) | Test Load: 0.4 P | Compressed air bag is used.<br>Time duration : 5 mins. |
| h. Side Wall Strength | Test Load: 0.6 P | Compressed air bag is used.<br>Time duration : 5 mins. |
| i. Roof Strength | Test Load: 300 kg | Applied area will be the weakest place of 600 x 300 mm longitudinal & transverse.<br>Time duration : 5 mins . |
| j. Rigidity (Transverse) | Test Force: 15,240 kg<br>(150 kn) | Hydraulic cylinder will be applied to front top end rail & door header through top corner fittings, each time pulling & pushing.<br>Time duration : 5 mins . |
| k. Rigidity (Longitudinal) | Test Force: 7,620 kg<br>(75 kn) | Hydraulic cylinder load will applied to side top rail through top corner fittings.<br>Time duration : 5 mins . |
| l. Weather proofing | Nozzle:<br>Pressure: | 12.5 mm (inside dia.)<br>100 kpa (1 kg/sq.cm) | Distance: 1.5 m<br>Speed: 100 mm/Sec. |

Note: R - Maximum gross weight T - Tare weight P - Maximum payload

### 9.4 Inspection

**9.4.1** Materials and Component Parts Inspection
All the materials and components will be inspected by Quality Control Dept. to make sure that the most suitable and qualified components being used for the containers and to meet this specification.

**9.4.2** Production Line Inspection
Every container will be manufactured under effective Quality Control procedures, and every production line of the factory will be inspected and controlled by the Quality Control Dept. to meet this specification.

## 10. Documents Submission

### 10.1 When Contracting

The manufacturer shall submit the specification with following drawing (3 sets):

General arrangement
Base assembly
Rear end assembly
Marking arrangement
Side wall assembly
Front end assembly
Roof assembly

### 10.2 When delivery

The appointed manufacturer shall prepare all the documents needed two weeks before the date of delivery and submit them to the owner.

## 11. Guarantee

The guarantee period will commence at the day of delivery and the delivery is not later than three (3) months after the containers are accepted by the owner.

### 11.1 Paint Guarantee

The paint system applied to the container surface shall be guaranteed against corrosion and/or paint failure for a period of five (5) years. The guarantee shall be applied to all kinds of faults / failures affecting more than 10 % of any given part of the container, and partial or total repainting shall be assured for the container(s) at the manufacturer's expense. Normal wear/tear, or corrosion caused by acid, alkaline solution or result from damages by abrasion impact or accident are excluded. Corrosion is defined as the rusting exceeding RE3 (European scale of degree of rusting).

### 11.2 Other Guarantees

All containers shall be guaranteed against any defects or omissions in construction, poor workmanship, or defective materials for a period of one (1) years. Any damages caused by mis-handling, mis-securing, mis-loading, impact and other natures of accident are excluded. The self-adhesive film decal shall have a guaranteed life of seven (7) years minimum.

## 12. Materials

The main materials used in construction are as follows or approved equivalent:

| Location | Materials |
|---|---|
| **Front End Assembly:** | |
| Front corner post | Corten A |
| Front sill | Corten A |
| Front panel | Corten A |
| Front header cap | Corten A |
| Front rail | Corten A |
| **Base Assembly:** | |
| Bottom side rail | Corten A |
| Crossmember | Corten A |
| Fork pocket assembly | Corten A |
| Floor center rail | Corten A |
| Floor support angle | Corten A |
| Cover plate Corten A | |
| **Rear End Assembly:** | |
| Rear corner post (outer) | Corten A |
| Rear corner post (inner) | SM50YA (or SS50) |
| Rear header cap | Corten A |
| Door header lower | Corten A |
| Door sill | Corten A |
| Door panel frame | Corten A |
| Door panel | Corten A |
| Door hinge | S25C, Electro zinc plated |
| Door hinge pin | Stainless steel |
| Locking device | BE 2566MN Type, made in China |
| Locking cam keeper | S20C, Electro zinc plated |
| Locking cam | S20C, HDG |
| Locking rod | STKR41, HDG |
| Door gasket | E.P.D.M |
| Gasket retainer | Stainless steel |
| Washer | Stainless steel |
| Rivet | Stainless steel |
| Shim | EPDM |
| Corner fitting | SCW49 |

**Side Wall Assembly:**

| | |
|---|---|
| Side panel | Corten A |
| Top side rail | Corten A |
| Lashing bar, lashing ring | SS41, Electro zinc plated |
| Ventilator | A.B.S |

**Roof:**

| | |
|---|---|
| Roof corner gusset | Corten A |
| Roof panel | Corten A |

**Floor:**

| | |
|---|---|
| Floor board | Apitong / Hardwood plywood |
| Floor screws | Electro zinc plated |

## Material Strengths:

| Material | Yield point (Kg/sq.mm) | Tensile strength (Kg/sq.mm) |
|---|---|---|
| SS41 | 25 | 41 |
| JIS SCW49 | 28 | 49 |
| SS50 | 29 | 50 |
| S20C | 25 | 42 |
| S25C | 28 | 46 |
| SM50YA | 37 | 50 |
| Corten A | 35 | 49 |
| SM50A | 33 | 50 |

---

References and documentations include:

International Maritime Organization (IMO)
International Convention for Safe Containers (CSC) 1972-2007 and in accordance with CSC Article IV(2)
U.S. Steel technical data sheet, 2002
Universal Building Code
Cronos Leasing Company
China International Maritime Containers (Group) CIMC
Bank of America, Wells Fargo, Countrywide Financial, CitiMortgage
State Farm Insurance, St. Paul's Travelers Companies
SIR Certification: International Inspections, Inc.

## 13. Summary: ISBU Usage

An ISO Shipping Container is understood to have two (2) principle uses:

1) Transportation purposes
2) Storage and building construction (ISBU)

Please consider the following notes:

• Do not purchase an ISBU without the CSC Identification Plate attached or one with CIN included in the certification.

The CSC should be left intact and/or documented for city/county building inspectors. Without the CSC plate or CIN certification you could have serious problems.

Architects should require the CSC ID Plate to be intact for their Building Code certifications, or use Certifications based on CIN codes.

• The container should have a current strength certification from the dealer.

• The strengths listed above in the International specifications code are pertaining to "non-modified" ISBU. The cutting and modifying can alter the strength in certain areas and will need to be re-certified by a structural engineer if much cutting and modifications are done.

• Please note that there are two roof strength tests. Although every area of the roof far exceeds the strength required by any Building Code, the corners have the greatest strength to support weight. The inner and main roof areas support less weight than the corner posts.

• The information listed above is the "basic" International Code for ISO shipping containers and all brands should meet these minimum requirements even with door or top modifications.

The metals and parts are accurately listed, however for further strength or properties of these parts you should consult a metal or part engineering database.

• Flooring is always a concern when purchasing a used ISBU.

Since the usage of the shipping container was unknown it is recommended the wood portion of the flooring be replaced prior to construction. Not only is the cost nominal, this is often a valid concern of the local Building Inspector.

The exception can be for use as a mobile storage unit. The resurfacing and sealing of the wood flooring is safe and acceptable.

## 14. UPDATES:
## SIR Certification: Structural Integrity Report

Soon after we published our first edition of the “Getting Approved Report” we began getting feedback and interest from many agencies, corporations, and organizations. The main topic for the ISBU Association was “how can we standardize container inspections and certifications to better address the gaps between the shipping container trade, container dealers, and the inspectors including government, architects and structural engineers”.

After negotiating the needs and possible solutions, numerous conversations and meetings were held between certain organizations, trade professionals and governmental agencies to formulate a simple, solid inspection, report and certificate that building inspectors, architects, engineers, lenders, and insurance underwriters can have ultimate confidence in.

After several weeks of discussions and final approvals we are pleased to announce the creation of the Structural Integrity Report (SIR) and it's immediate implementation by International Equipment Inspections, Inc., with a credible, well known, well trained and respected national inspection network.

**Key Points:**
- Structural Integrity
- Safety
- CIN Code based
- Environmental Security (toxic residues)

Our sincere thanks to Mr. John Stangel who's strong international shipping trade experience and professional background was able to organize and mediate the rapid formation of the new certification program. He and others pushed our concept through with organizations, governmental agencies and legal entities to bring this to fruition in record time, ...weeks, not months or years.

Please work with IEI directly if you have further questions and comments. The ISBU Association were only involved in the conception and have no involvement in the administration and implementation of the SIR Certification.

Please read the following summary. We will have more detail in weeks and months to come. This much needed standardization is a very solid and effective beginning which can immediately assist all consumers and professionals who use ISBU for storage and construction purposes.

## SIR Certification-

International Equipment Inspections, Inc (IEI) is pleased to announce that it can offer to individuals, builders and corporations a **S.I.R.** Structural Integrity Report on any containers that might be purchased for purposes of building shelters.

The report encompasses a visual inspection by a qualified inspector with knowledge of the CSC (Container Safety Convention) criteria, the Institute of International Container Lessors guide to equipment inspections (IICL-5), the Department of Defense Guide to Container Inspection for Commercial and Military Intermodal Containers and its guide to Convention for Safe Container (CSC) Re-inspection of modular causeway systems, ISOPAK Components.

The report provides city inspectors, developers, banks, architects and any interested parties with a guide line of what constitutes a structurally sound and safe ISO container in regards to the CSC requirement under a re-inspection of its structural integrity.

The report is a record of the containers condition at the time of the inspection and that the units purchased are free from any structural deficiencies in any primary structural components as per CSC and IICL guidelines. While containers might have structural deficiencies not affecting their use in static domestic storage; units to be used in a shelter configuration may rely on the structural integrity of primary components. The value to the local inspectors and builders is knowing for certain that the containers they received have been inspected to the structural integrity of its intended marine capacity.

While the stresses, racking, and pressures on containers in their marine capacity would normally be much greater then the loads associated in shelter configuration, knowing that the components have not been compromised is important to the professions using the components in their projects.

The inspection goes further to highlight any visible and transferable toxins, hazards or residues in the containers; allowing for rejections of units prior to purchases. There is no known method available to inspectors to ensure that toxins, at some point in time during the containers maritime use, had come in contact with any hazardous materials. Under all circumstances it would be I.E.I's position that container floors should be taken out of any units considered for a shelter project. What can be verified is that there are no transferable residues or odors in containers at the time of the inspections/purchases of containers for shelter use.

Local inspectors may not be familiar with ISO containers. ISO containers are built for enormous stress and pressures and their viability as a component with-in the construction industry is slowing being recognized. The ISBA is working hard to promote information in regards to containers and there usefulness outside of the shipping world. There is still a need for a qualified inspector to check unit conditions for the benefits of: architects, engineers, designers, builders and local inspectors.

It is important to know that when containers are used, the primary components at the time of the inspection meet the marine industries most stringent conditions; the Container Safety Convention Regulations, better known as (CSC).

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Summary written by John C. Stangel, a co-author of the SIR

John C. Stangel is a graduate of the University of Wisconsin. He resided and worked in Europe since 1979, returning to the States in 1997. While inEurope, he worked for various companies within the international shipping industry including Maersk and AP Moller group. His last position was Vice President for Unicon International, responsible for Europe the Middle East and Africa. In 1996 he developed the first web based auction site for trading of shipping containers, which was later sold to Transamerica's container leasing division.

In November 2000 he left Transamerica and together with Maersk Inc. he organized Container-it, Inc., a wholesale container equipment trading company based in Georgia and serving North America and the Caribbean.

## SIR / CIN Summary-

The Structural Integrity Report (SIR) is a standardized combination of established reports and inspections and offers a specific three part inspection to specifically address issues related to ISBU containers that will be used for storage, shelter or other construction:

1) Structural integrity (strength)
2) Environmental safety (toxins and containments)
3) Verifiable identification system (container ID)

Due to the fact that recycled shipping containers generally have the CSC plates removed by the shipping companies and container equipment leasing companies, the SIR utilizes the CIN code stamped inside the container to create a more positive and verifiable ID if required for ownership and modular construction.

CIN- Container Identification Number
SIR- Structural Integrity Report

**CIN-**
The CIN is an alphanumeric code stamped into the right, inside corner post of every ISO container that is manufactured. The code is stamped into the steel corner after the container passes inspection at the factory. The code identifies the date, factory, engineering information, and unique code for each container.

The same CIN code is then painted in larger numbers on the inside and outside of the container for easy identification during its global transit and repairs over the next few years of it's transit life.

Even after the container is sold, retired, recycled, re-painted or re-conditioned, the CIN code will always remain stamped on the inside of the container and can become visible even when covered by multiple coats of paint.

**SIR-**

The SIR inpector is quite experienced with various container industry inspections including CSC, Cargo Worthy, ACET, IILC 5, etc. The experienced SIR inspector uses the criteria listed on page 39 to determine the status of the ISBU container then issues a certified SIR which includes the CIN code listed inside the container.

The SIR provides the buyers, contractors, building inspectors, architects and engineers with “one” standardized inspection that is very specific for the non-transit use as ISBU's as construction and storage modules.

**NOTE:** The SIR certification means it compies with the original strength standards when originally manufactured. This strength will remain with stacking and even with simple cutting and modifications for doors and windows. However, ...the removal of entire sides or roofing would need to be properly reinforced, then re-certified by a structural engineer. These calculations and recertification is not a complicated procedure.

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The SIR certification is ultimately a U.S. government backed certification administered by International Equipment Inspections, Inc.

For inspections, inspector opportunites, or information regarding the international use of the SIR in your country you may contact Mr. Marvin Johnson at I.E.I., Inc.  Mr. Johnson is also the CEO of Intermodal Support Services, Inc.

Email: mjohnson@sircertifications.org

## UPGRADE- 12 Month Updates

If you did not purchase the Approval Report Plus, you may wish to do so now.

[ UPGRADE HERE ]

The Approval Report is an ongoing report containing Approval and Approval related information; new certifications processes, guidelines, contacts, lender and insurance underwriter comments, government agency comments, etc.

When you upgrade you receive 12 month access to the Approval Report update section which you can check periodically for additional information and version changes.

---

The $8 Upgrade fee will pro-rate according to your original Approval Report purchase.

Example: If you buy the Upgrade a month after you originally purchased the Report your Upgrade will allow you access for 11 more months.

# APPENDIX G—PLC INPUT AND OUTPUT LIST

# PLC INPUT/OUTPUT LIST

| NO. | TAG | DESCRIPTION | NOTES | ALARM COUNT |
|---|---|---|---|---|
| **DC INPUT 1** | | AB: 1769-IQ32 | | |
| 1 | RESET | RESET BUTTON ON PANEL DOOR | | |
| 2 | VS-1 | LOW VACUUM (VACUUM PUMP FAILURE) | | A1 |
| 3 | DPS-1 | HIGH DIFFERENTIAL PRESSURE | | A2 |
| 4 | PS-101 | INJECTION WELL1 HIGH PRESSURE | | A3 |
| 5 | PS-102 | INJECTION WELL2 HIGH PRESSURE | | A4 |
| 6 | PS-103 | INJECTION WELL3 HIGH PRESSURE | | A5 |
| 7 | PS-104 | INJECTION WELL4 HIGH PRESSURE | | A6 |
| 8 | PS-105 | INJECTION WELL5 HIGH PRESSURE | | A7 |
| 9 | PS-106 | INJECTION WELL6 HIGH PRESSURE | | A8 |
| 10 | PS-107 | INJECTION WELL7 HIGH PRESSURE | | A9 |
| 11 | PS-108 | INJECTION WELL8 HIGH PRESSURE | | A10 |
| 12 | PS-109 | INJECTION WELL9 HIGH PRESSURE | | A11 |
| 13 | PS-110 | INJECTION WELL10 HIGH PRESSURE | | A12 |
| 14 | LSHH-1 | SEC. CONTAINMENT SWITCH (FLOOR) | | A13 |
| 15 | LSHH-2 | SEC. CONTAINMENT SWITCH (FLOOR) BACKUP | | A14 |
| 16 | HTS | ENCLOSURE HIGH TEMPERATURE | | A15 |
| 17 | LTS | ENCLOSURE LOW TEMPERATURE | | A16 |
| 18 | CS-1 | POWER LOSS (UPS ACTIVE) | | A17 |
| 19 | CS-2 | VDC POWER SUPPLY FAILURE | | A18 |
| 20 | ESTOP | EMERGENCY STOP ACTIVE | | A19 |
| 21 | LSO-1 | WATER INLET VALVE OPEN LIM. SW. | FAIL TO OPEN | A20 |
| 22 | LSC-1 | WATER INLET VALVE CLOSED LIM. SW. | FAIL TO CLOSE | A21 |
| 23 | | SPARE | | |
| 24 | | SPARE | | |
| 25 | | SPARE | | |
| 26 | | SPARE | | |
| 27 | | SPARE | | |
| 28 | | SPARE | | |
| 29 | | SPARE | | |
| 30 | | SPARE | | |
| 31 | | SPARE | | |
| 32 | | SPARE | | |
| **DC INPUT 2** | | AB: 1769-IQ32 | | |
| 1-32 | TBD | ALL (32) INPUTS ARE SPARE | | |
| | | | | |
| **RELAY OUTPUT 1** | | AB: 1769-OW16 | | |
| 1 | MV-1 | INLET WATER VALVE | | |
| 2 | VP-1 | VACUUM PUMP | | |
| 3 | MP-1 | METERING PUMP (SUBSTRATE) | | |
| 4 | MP-2 | METERING PUMP (SODIUM BICARBONATE) | | |
| 5 | SV-101 | INJECTION WELL1 SOLENOID VALVE | | |
| 6 | SV-102 | INJECTION WELL2 SOLENOID VALVE | | |

| | | |
|---|---|---|
| 7 | SV-103 | INJECTION WELL3 SOLENOID VALVE |
| 8 | SV-104 | INJECTION WELL4 SOLENOID VALVE |
| 9 | SV-105 | INJECTION WELL5 SOLENOID VALVE |
| 10 | SV-106 | INJECTION WELL6 SOLENOID VALVE |
| 11 | SV-107 | INJECTION WELL7 SOLENOID VALVE |
| 12 | SV-108 | INJECTION WELL8 SOLENOID VALVE |
| 13 | SV-109 | INJECTION WELL9 SOLENOID VALVE |
| 14 | SV-110 | INJECTION WELL10 SOLENOID VALVE |
| 15 | | SPARE |
| 16 | | SPARE |

**RELAY OUTPUT 2** AB: 1769-OW16

| | | |
|---|---|---|
| 1 | ALARM | COMMON ALARM LIGHT (ON PANEL) |
| 2-15 | SPARE | REMAINING (15) OUTPUTS ARE SPARE |

**ANALOG INPUT** AB: 1769-IF8

| | | | | |
|---|---|---|---|---|
| 1 | FMT-1 | WATER FLOW | HIGH AND LOW | A22,A23 |
| 2 | PT-1 | WATER PRESSURE | HIGH AND LOW | A24,A25 |
| 3-8 | SPARE | REMAINING (6) INPUTS ARE SPARE | | |

**ANALOG OUTPUT** AB: 1769-OF4CI

| | | | |
|---|---|---|---|
| 1 | MP-1 | METERING PUMP SPEED | RE-TRANSMIT OUTPUT FROM FMT-1[1] |
| 2 | MP-2 | METERING PUMP SPEED | RE-TRANSMIT OUTPUT FROM FMT-1[1] |
| 3 | | SPARE | |
| 4 | | SPARE | |

| | |
|---|---|
| SWITCH IN HAND | A26 |
| ALL SOL. VALVES CLOSED | A27 |

27 POSSIBLE ALARM CONDITIONS

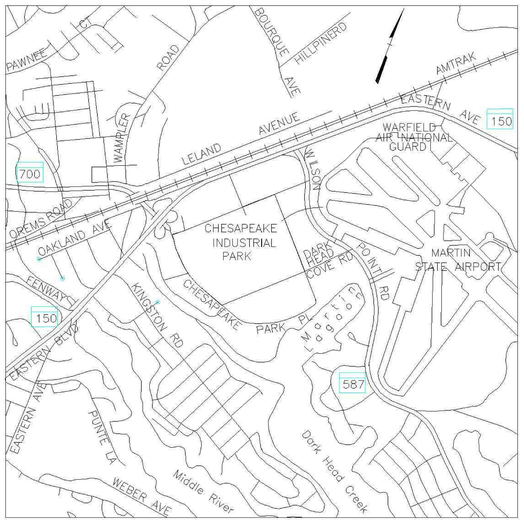
[1]Scaing for MP-1 and MP-2 is performed locally at the metering pump panel.

# 100% DESIGN DRAWINGS

# 100% DESIGN DRAWINGS

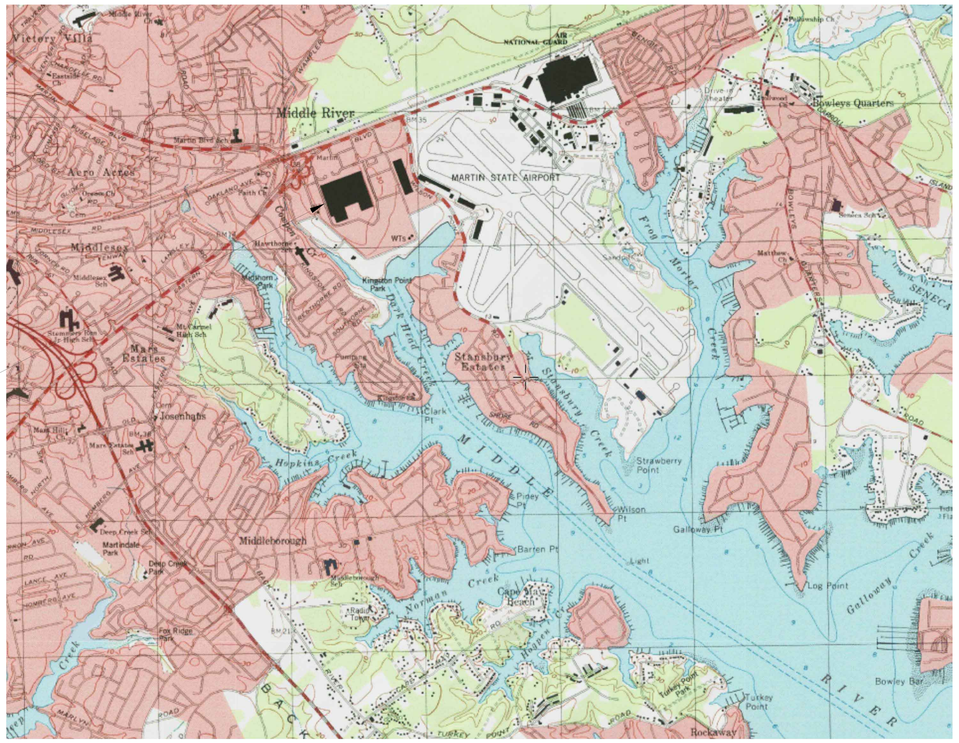
| | |
|---|---|
| T-1 | Title Sheet |
| C-1 | Existing Conditions Plan |
| C-2 | Southeast TCE Area Remedy Layout |
| C-3 | Southwest TCE Area Remedy Layout |
| C-4 | North TCE Area Remedy Layout |
| C-5 | Typical Injection Well (No Conduit) |
| C-6 | Typical Injection Well (With Conduit) |
| C-7 | Southeast TCE Area Trench Construction Details |
| C-8 | Southwest TCE Area Trench Construction Details |
| C-9 | North TCE Area Trench Construction Details |
| E-1 | Electrical Symbols Legend |
| E-2 | Southeast TCE Area Electrical Site Plan (2 sheets) |
| E-3 | Southwest TCE Area Electrical Site Plan (2 sheets) |
| E-4 | North TCE Area Electrical Site Plan (2 sheets) |
| E-5 | Service Connection Details |
| E-6 | Electrical Equipment and Conduits (2 sheets) |
| E-7 | Internal Wiring Diagram (2 sheets) |
| E-8 | Single Line Electrical Diagram (2 sheets) |
| E-9 | Control Panel Layout |
| E-10 | Control System Bill of Materials |
| E-11 | Control System Architecture |
| E-12 | HMI Screen Layout |
| M-1 | General Process Flow Diagram |
| M-2 | Process and Instrumentation Diagram |
| M-3 | Equipment Container General Arrangement |
| M-4 | Oxygen Removal Contactor Side View Detail |
| M-5 | Injection Manifold Details |
| M-6 | GAC Treatment Details |
| M-7 | Lines Entrance Internal View Details |
| M-8 | Lines Entrance External View Details |
| M-9 | Container Construction Details |
| M-10 | Container Anchoring Details |

# GROUNDWATER REMEDIATION DESIGN DRAWINGS
# 100% COMPLETION SUBMITTAL
# LOCKHEED MARTIN MIDDLE RIVER COMPLEX
# 2323 EASTERN BOULEVARD, MIDDLE RIVER MARYLAND




SITE VICINITY MAP

| ID # | DRAWING TITLE |
|---|---|
| T-1 | TITLE SHEET |
| C-1 | EXISTING CONDITIONS PLAN |
| C-2 | SOUTHEAST TCE AREA REMEDY LAYOUT |
| C-3 | SOUTHWEST TCE AREA REMEDY LAYOUT |
| C-4 | NORTH TCE AREA REMEDY LAYOUT |
| C-5 | TYPICAL INJECTION WELL (NO CONDUIT) |
| C-6 | TYPICAL INJECTION WELL (WITH CONDUIT) |
| C-7 | SOUTHEAST TCE AREA CONSTRUCTION DETAILS |
| C-8 | SOUTHWEST TCE AREA CONSTRUCTION DETAILS |
| C-9 | NORTH TCE AREA CONSTRUCTION DETAILS |
| M-1 | GENERAL PROCESS FLOW DIAGRAM |
| M-2 | PROCESS & INSTRUMENTATION DIAGRAM |
| M-3 | EQUIPMENT CONTAINER GENERAL ARRANGEMENT |
| M-4 | OXYGEN REMOVAL CONTACTOR DETAIL |
| M-5 | INJECTION MANIFOLD DETAILS |
| M-6 | GAC TREATMENT DETAILS |
| M-7 | LINES ENTRANCE INTERNAL VIEW DETAILS |
| M-8 | LINES ENTRANCE EXTERNAL VIEW DETAILS |
| M-9 | CONTAINER CONSTRUCTION DETAILS |
| M-10 | CONTAINER ANCHORING DETAILS |
| E-1 | ELECTRICAL SYMBOLS LEGEND |
| E-2 | SOUTHEAST TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-3 | SOUTHWEST TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-4 | NORTH TCE AREA ELECTRICAL SITE PLAN (2 SHEETS) |
| E-5 | SERVICE CONNECTION DETAILS |
| E-6 | ELECTRICAL EQUIPMENT AND CONDUITS (2 SHEETS) |
| E-7 | INTERIOR WIRING DIAGRAM (2 SHEETS) |
| E-8 | SINGLE LINE ELECTRICAL DIAGRAM (2 SHEETS) |
| E-9 | CONTROL PANEL LAYOUT |
| E-10 | CONTROL SYSTEM BILL OF MATERIALS |
| E-11 | CONTROL SYSTEM ARCHITECTURE |
| E-12 | HMI SCREEN LAYOUT |




SITE AREA TOPOGRAPHIC MAP

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — PETER A. KUHT — NO. 20883 — PROFESSIONAL ENGINEER

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

TITLE PAGE
100% GROUNDWATER REMEDIAL DESIGN – FINAL

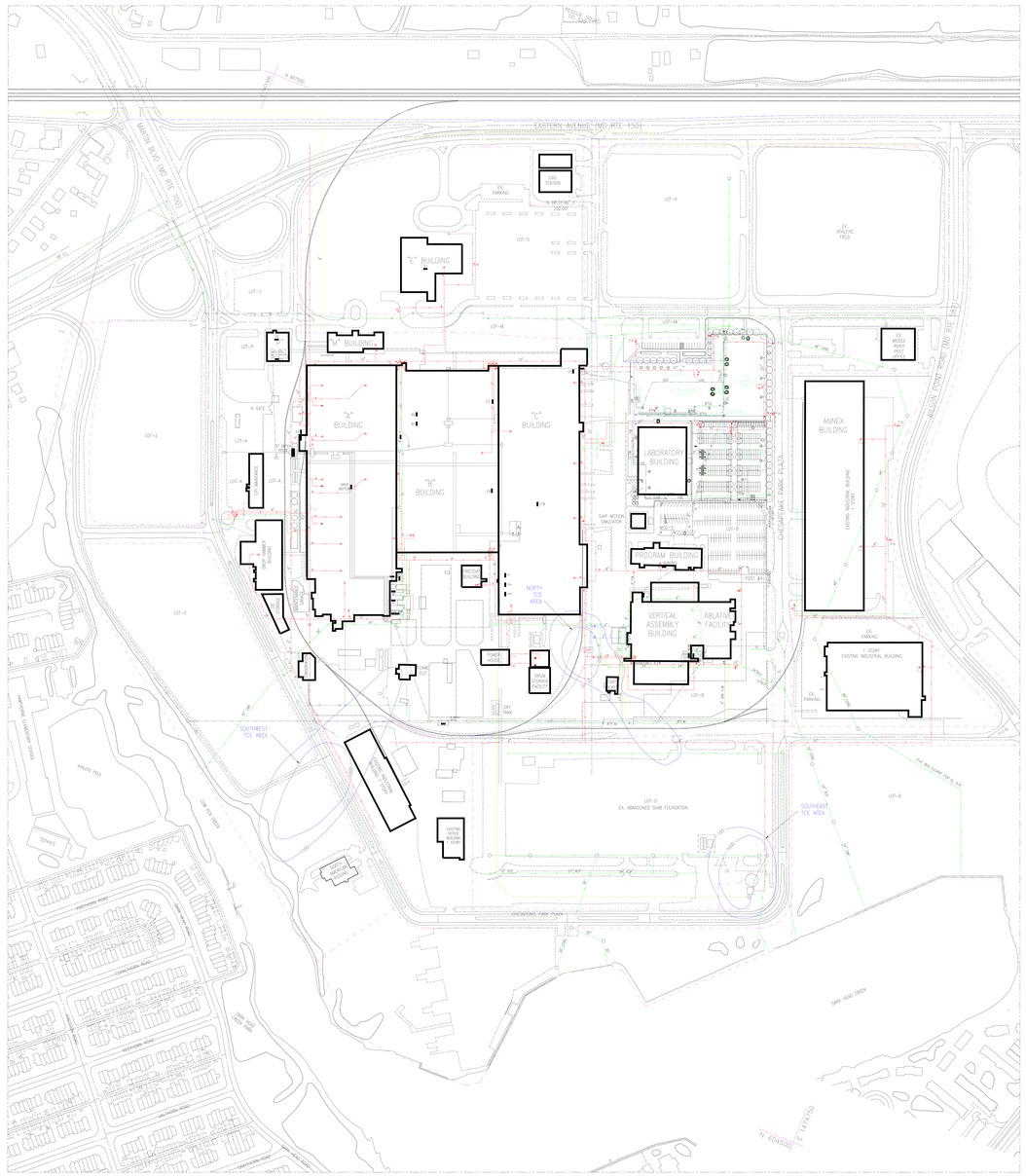
LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 6/3/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH D |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

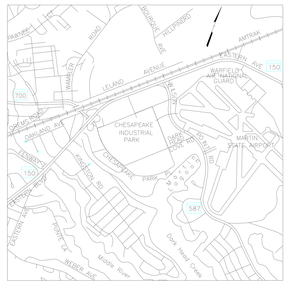
COPYRIGHT TETRA TECH INC.

**DRAWING T-1**

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\STAMPED 100% DRAWINGS\90% T-1_STAMPED.DWG DWM 6/3/13




0 125 250 500 feet




VICINITY MAP
SCALE: 1"=2000'

## SITE DATA

1. OWNER:
   LMC PROPERTIES INC.
   100 SOUTH CHARLES STREET
   BALTIMORE, MD 21201-2725
   PROPERTY ADDRESS:
   2323 EASTERN BOULEVARD, MIDDLE RIVER, MD
2. ZONING: MH-IM, MAP NE I-3, I-4
3. NET TRACT AREA: CHESAPEAKE PARK PLAZA BLOCK I, 66,484 AC. GROSS TRACT AREA: 70.595 AC. +/-
4. TAX ACCOUNT NO. 04-15-1900014060 MAP 90 GRID 18 PARCEL 964 BLOCK I DEED REFERENCE: LIBER 4953 FOLIO 235 PLAT REFERENCE: 51/43
5. CENSUS TRACT: 4516
6. WATERSHED: 108 MIDDLE RIVER SUBWATERSHED: 134 DARKHEAD CREEK
7. SUBSEWERSHED: 82
8. NO PORTION OF THIS SITE IS LOCATED WITHIN A DESIGNATED AREA OF CRITICAL PARKING REQUIRED: 77,000 S.F. @ 3.3/1000 S.F. = 254 P.S. PARKING PROVIDED = 256 P.S.
9. THIS SITE WAS GRANTED AN A-7 LIMITED EXEMPTION OF THE DEVELOPMENT PROCESS ON 12-21-98. REFERENCE DRC #122184.
10. THIS SITE WAS GRANTED A B-9 LIMITED EXEMPTION OF THE DEVELOPMENT PROCESS ON 5-10-99, DRC #051099.
11. WAIVER TO THE BALTIMORE COUNTY STORMWATER MANAGMENT REGULATIONS GRANTED.
12. AVERAGE DAILY TRIPS (ADT) 77,000 S.F. @ 14/1000 S.F. OF G.F.A. = 1079 ADT's 15. BUILDING ELEVATIONS WILL BE SUBMITTED TO THE OFFICE OF PLANNING PRIOR TO ISSUANCE OF BUILDING PERMITS.

**REFERENCE PLANS & DATA:**

1. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — DAVID W. MARTIN — No. 25926 — REGISTERED PROFESSIONAL ENGINEER

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

EXISTING CONDITIONS PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH D |
| DRAWN BY: | DWM |
| CHECKED BY: | BD |

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**DRAWING C-1**

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\90% EXISTING CONDITIONS C-1.DWG DWM 5/31/13

NOTE 2: APPROXIMATELY 275 LINEAR FEET OF TRENCH IS THROUGH CONCRETE SURFACES

IL-4
10.48

IWE-1 IWE-2 IWE-3 IWE-4 IWE-5 IWE-6

7.5'

SEMW-1I
SEMW-2I
SEMW-3I

40'x8' INJECTION EQUIPMENT MODULE

NOTE 3: APPROXIMATELY 2,000 SQUARE FEET OF CONCRETE SURFACE TO BE REMOVED

CONCRETE (FORMER D-BUILDING BASEMENT)

GATE DOOR OPENING

FIRE WATER LINE

HISTORICAL FIRE PUMP LOCATION

CONCRETE

CONCRETE

UG COMMUNICATION LINE

IWE-7 IWE-8 IWE-9 IWE-10 IWE-11 IWE-12

SET1

FIRE WATER LINE (ABANDONED)

MH-10 (IL-3)
7.79
INV. 5.20

MH-9

MW-72B

BROMIDE SAMPLING LOCATION

NOTE 4: UNDERGROUND UTILITIES TRENCH WIDTH IS 7.5 FEET

MH-8
9.83
INV. 5.48

BLOCK

HISTORICAL CONNECTION

HISTORIC WATER LINES

SET2

IWE-13 IWE-14 IWE-15 IWE-16 IWE-17

7.5'

CONCRETE BLOCK

GRASS AREA

IL-20
11.05
(FILLED W/ DEBRIS)

NOTE 1: EXISTING INJECTION PILOT TEST MONITORING POINTS MPE-1I AND MPE2I/S ARE UTILIZED AS MONITORING WELLS SEMW-4I AND SEMW-5S/I

APPROXIMATE 1000 UG/L TCE CONTOUR

SEMW-4I

IW-E

SEMW-5S/I

500,000-GALLON WATER TANK ABOVE-GROUND

FIRE WATER LINE

UG ELECTRIC LINE

FORMER 500-GAL UST

MW-74A

IWE-18 IWE-19 IWE-20 SET3 IWE-21

PUMP HOUSE

6" DOMESTIC WATER LINE

MW-74B

UG ELECTRIC LINE

CONNECTION TO EXISTING POTABLE WATER AND POWER INSIDE PUMP HOUSE

SHED

CONCRETE BLOCK

LOCATION OF FORMER 500,000 GALLON ABOVE-GROUND FUEL TANK

7.5'

IWE-22 IWE-23 IWE-24

HISTORIC 2" DIESEL FUEL LINE

UG ELECTRIC LINE

SEMW-6I

UG COMMUNICATION LINE

IL-2
6.85
INV. 3.92

IL-1
7.45
INV. 2.75

6" DOMESTIC WATER LINE

UG COMMUNICATION LINE

UG COMMUNICATION LINE

ROAD CURB

20" CMP

IL-25
9.21
INV. 1.56

## LEGEND

- PROPERTY LINE W/ MONUMENTS
- TREELINE
- BUILDING - MAJOR

EXISTING UTILITIES

- WATER LINE W/ VALVE & HYDRANT
- GAS LINE W/ METER & VALVE
- UNDERGROUND ELECTRIC
- ABOVE-GROUND ELECTRIC W/ POLE
- COMMUNICATIONS W/ BOX
- STORM PIPE W/ INLET & MANHOLE
- HISTORICAL FLOOR DRAIN W/ CLEANOUT
- SANITARY LINE W/ MANHOLE
- FORCE MAIN
- CHAIN LINK FENCE W/ GATE
- UNKNOWN UTILITIES- GEOPHYSICAL SURVEY
- HISTORICAL UTILITIES OR STRUCTURES (LINETYPES VARY)

REMEDIAL SYSTEM FEATURES

- 4" INJECTION WELL
- 4" INJECTION WELL (WITH CONTINGENCY CONDUIT)
- CONDUIT JUNCTION BOX
- SEMW-5I/S: 2" PERFORMANCE MONITORING WELL I - INTERMEDIATE DEPTH S - SHALLOW DEPTH
- EXISTING MONITORING WELL
- PILOT TEST INJECTION WELL
- CONCRETE SURFACES
- INJECTION PIPING BUNDLE
- 2" PVC CONTINGENCY ELECTRICAL CONDUIT
- 1" PVC ELECTRICAL CONDUIT
- 1" HDPE POTABLE WATER LINE
- EXTENT OF TRENCH AND EXCAVATED SOIL

GRAPHIC SCALE

0' 25' 50'

**REFERENCE PLANS & DATA:**

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — THERESA A. RUDY — NO. 21622 — REGISTERED PROFESSIONAL ENGINEER — 6/3/13

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHEAST TCE AREA REMEDY LAYOUT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | DWM |
| CHECKED BY: | BD |

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**DRAWING C-2**

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\90% SE LAYOUT.DWG DWM 5/31/13

**REFERENCE PLANS & DATA:**

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH
www.tetratech.com

STATE OF MARYLAND PETER A. RICH NO. 20066 REGISTERED PROFESSIONAL ENGINEER 6/3/13

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SOUTHWEST TCE AREA REMEDY LAYOUT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | DWM |
| CHECKED BY: | BD |

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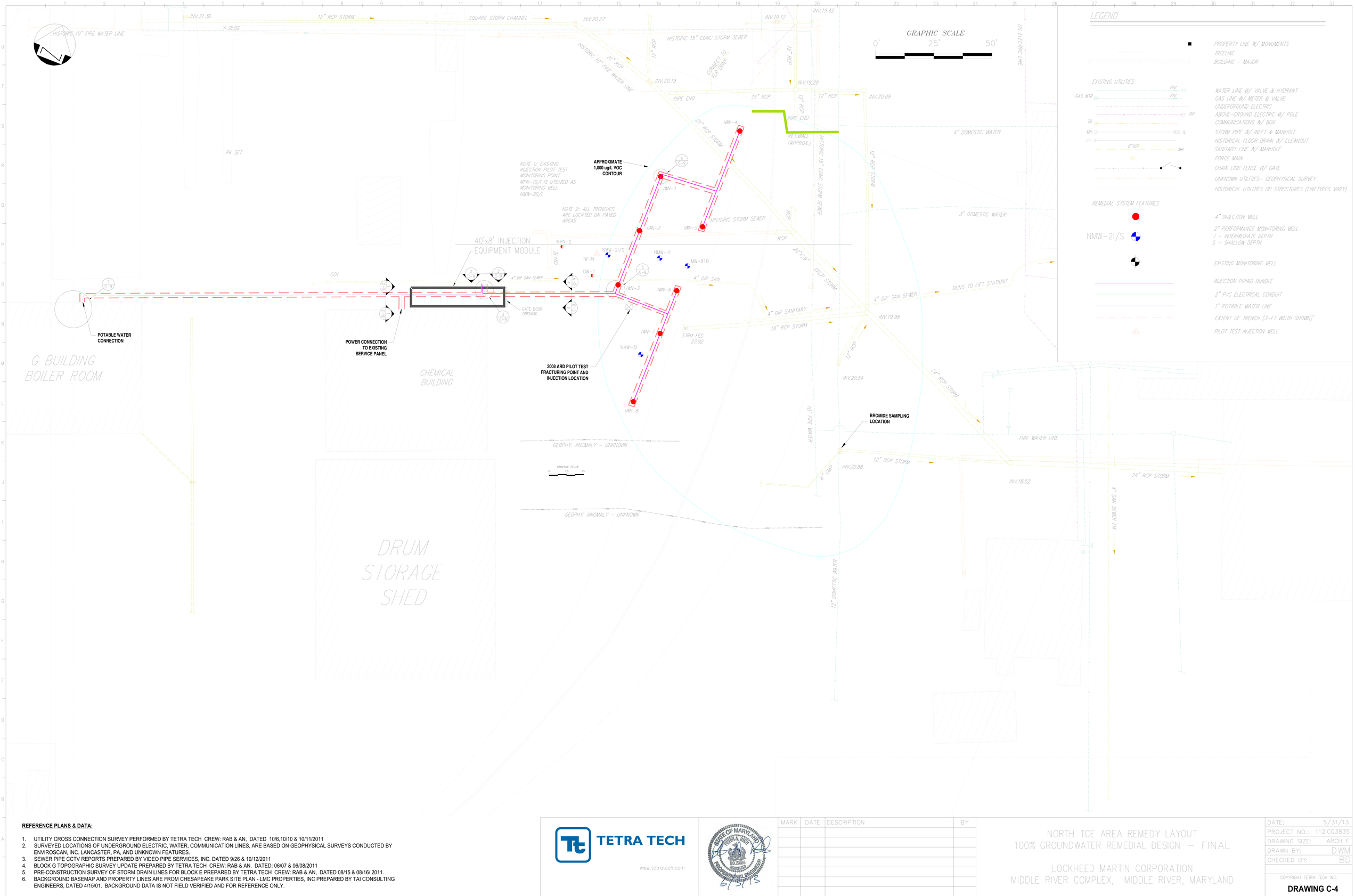
**DRAWING C-3**




**REFERENCE PLANS & DATA:**

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH

www.tetratech.com

STATE OF MARYLAND — BRIAN D. DYNKIN — No. 21066 — REGISTERED PROFESSIONAL ENGINEER

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|---|---|---|---|
| | | | |

NORTH TCE AREA REMEDY LAYOUT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | DWM |
| CHECKED BY: | BD |

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**DRAWING C-4**

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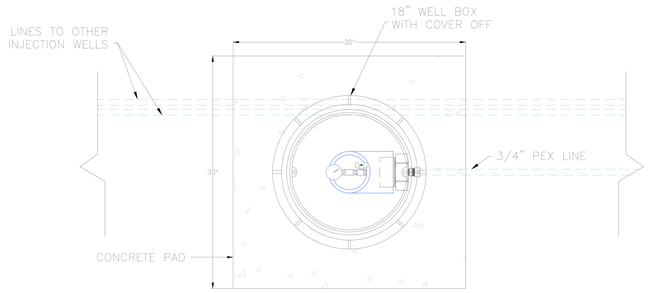
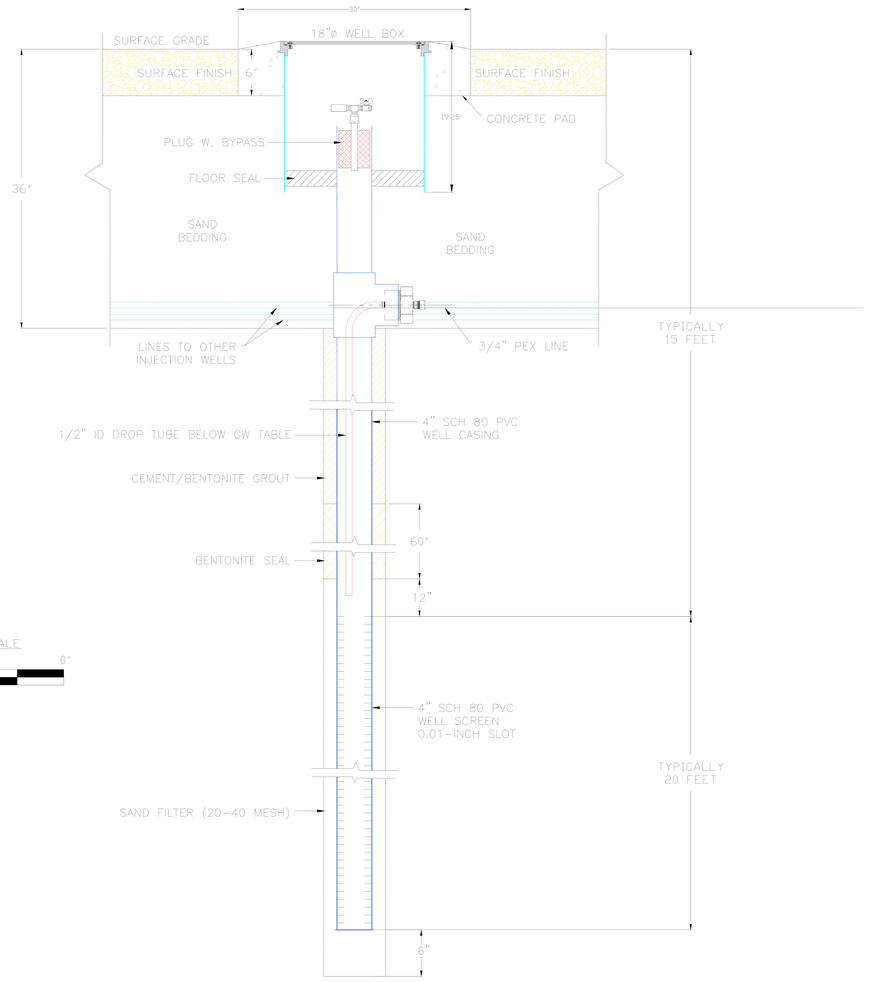



**INJECTION WELL PLAN VIEW (TYPICAL)**




**INJECTION WELL SIDE VIEW (TYPICAL)**

NOTES:

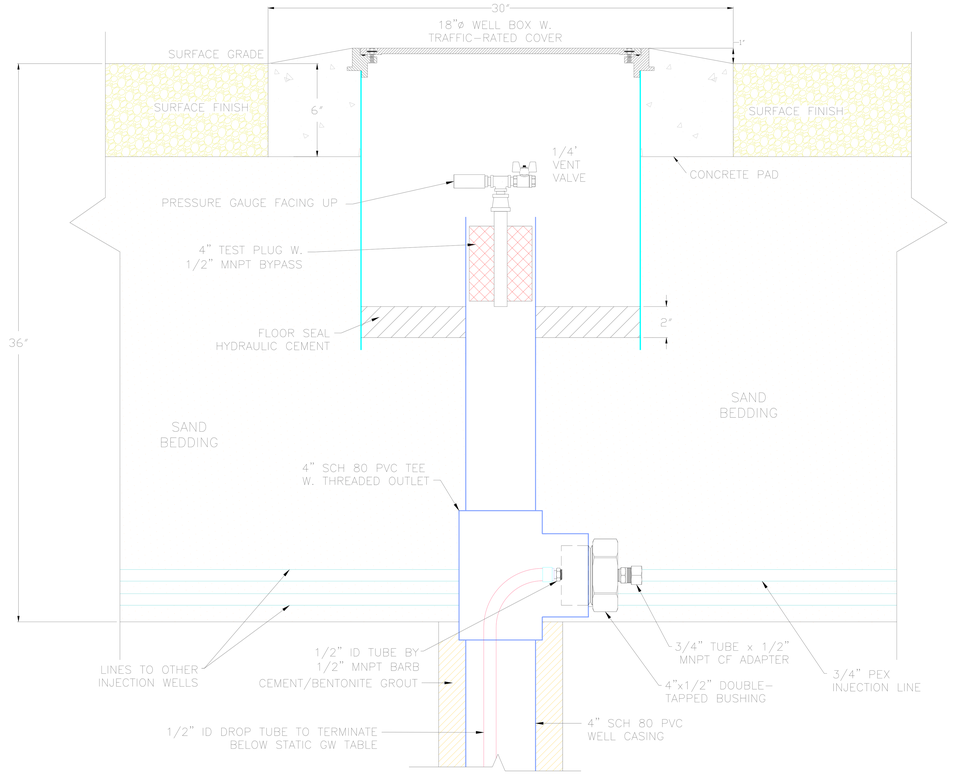
1. TRENCH WIDTH VARIES IN DIFFERENT AREAS. TYPICAL TRENCH WIDTHS ARE 7.5 FEET IN SOUTHWEST AND SOUTHEAST TCE AREAS AND 2 FEET IN NORTH TCE AREA. REFER TO DRAWINGS C-2, C-3, C-4, C-7, C-8, C-9 FOR TRENCH WIDTH DETAILS.

2. INJECTION LINES AND PIPES IN THE TRENCH ARE SHOWN FOR ILLUSTRATION ONLY. REFER TO DRAWINGS C-2, C-3, C-4, C-7, C-8, C-9 FOR PIPING ARRANGEMENT IN TRENCHES.

3. TYPICAL INJECTION WELL FOR NO TRAFFIC AREAS AND WITHOUT CONTINGENCY POWER CONNECTIONS IS SHOWN ON THIS DRAWING.

4. SURFACE FINISH:
a) CRUSHED STONE IN CONCRETE AREAS TO MATCH CONCRETE THICKNESS;
b) MINIMUM 6" OF TOP SOIL AND RE-SEED IN LAWN AREAS;
c) ASPHALT PAVEMENT IN PAVED AREAS TO MATCH EXISTING SURFACE.

5. TRENCHES IN SOUTHEAST AND SOUTHWEST TCE AREAS SHALL BE 7.5 FEET IN WIDTH IN SAND BACKFILL INSTALLED BY PRE-REMEDIAL SOIL EXCAVATION WORK. TRENCHES IN NORTH TCE AREA VARY BETWEEN 1.5 AND 2.5 FEET IN WIDTH EXCAVATED IN EXISTING SOILS AND SHALL BE BACKFILLED WITH SAND BACKFILL.




**INJECTION WELLHEAD SIDE VIEW DETAIL (TYPICAL)**

DRAWING SCALE
0" 6" 0"

TETRA TECH
www.tetratech.com

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|---|---|---|---|
| | | | |

TYPICAL INJECTION WELL (NO CONDUIT)
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH D |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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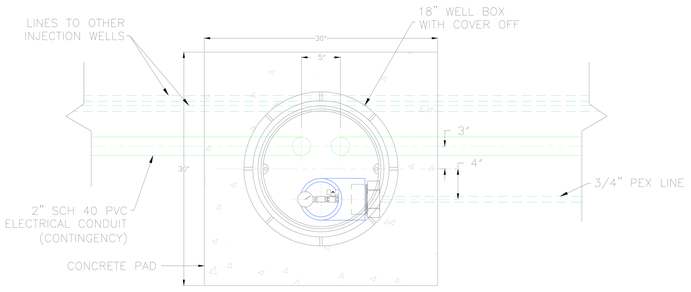
DRAWING C-5

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\90% INJECTION WELL.DWG DWM 5/31/13




**INJECTION WELL PLAN VIEW (TYPICAL)**

NOTES:

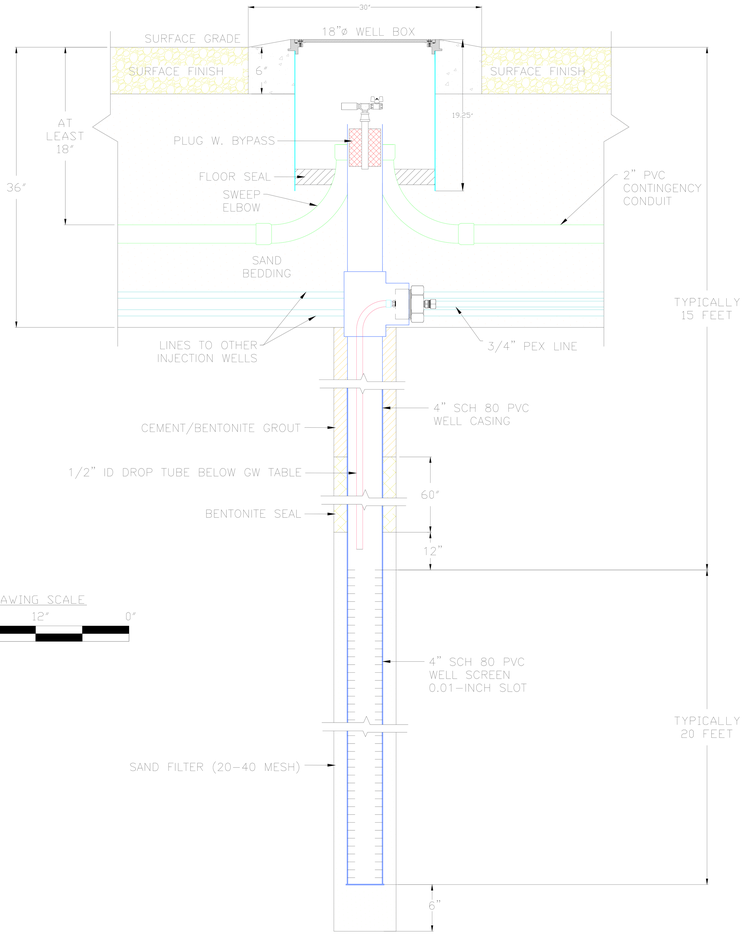
1. TRENCH WIDTH VARIES IN DIFFERENT AREAS. TYPICAL TRENCH WIDTHS ARE 7.5 FEET IN SOUTHWEST AND SOUTHEAST TCE AREAS AND 2 FEET IN NORTH TCE AREA. REFER TO DRAWINGS C-2, C-3, C-4, C-7, C-8, C-9 FOR TRENCH WIDTH DETAILS.

2. INJECTION LINES AND PIPES IN THE TRENCH ARE SHOWN FOR ILLUSTRATION ONLY. REFER TO DRAWINGS C-2, C-3, C-4, C-7, C-8, C-9 FOR PIPING ARRANGEMENT IN TRENCHES.

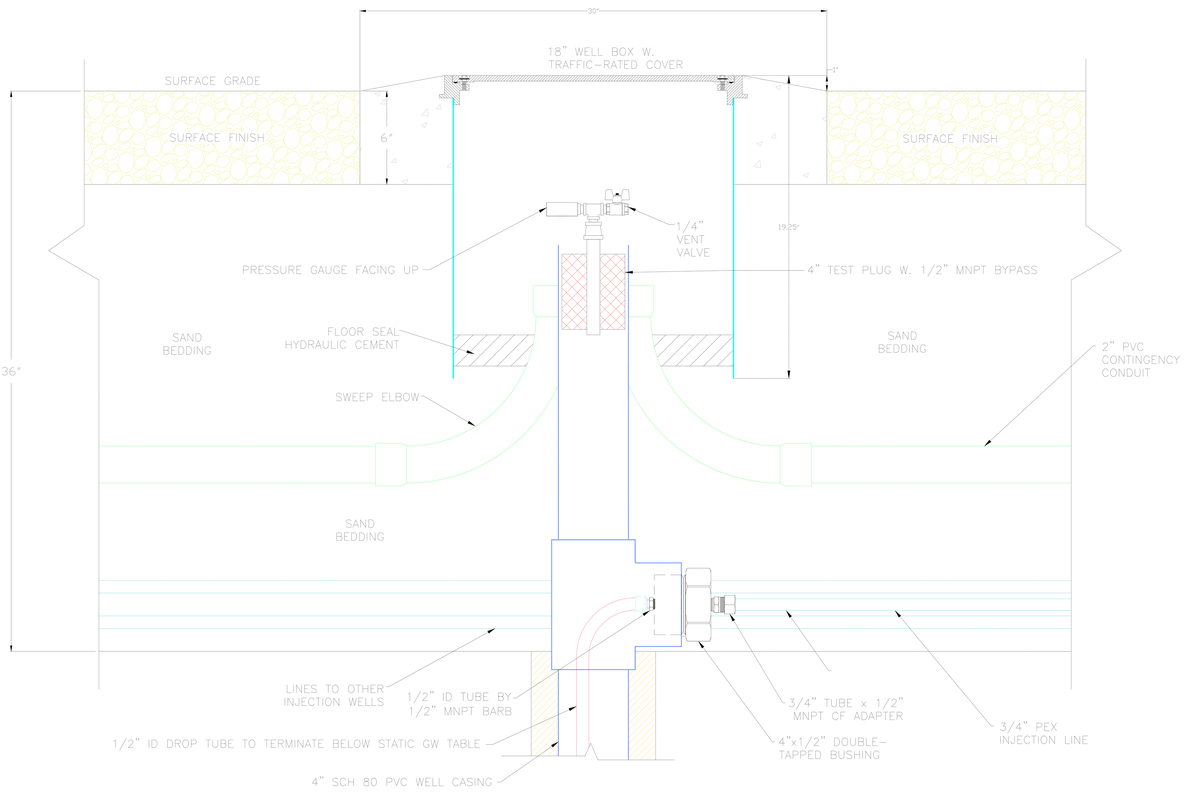
3. TYPICAL INJECTION WELL FOR TRAFFIC AREAS AND WITH CONTINGENCY POWER CONNECTIONS IS SHOWN ON THIS DRAWING.

4. SURFACE FINISH:
a) CRUSHED STONE IN CONCRETE AREAS TO MATCH CONCRETE THICKNESS;
b) MINIMUM 6" OF TOP SOIL AND RE-SEED IN LAWN AREAS;
c) ASPHALT PAVEMENT IN PAVED AREAS TO MATCH EXISTING SURFACE.

5. TRENCHES IN SOUTHEAST AND SOUTHWEST TCE AREAS SHALL BE 7.5 FEET IN WIDTH IN SAND BACKFILL INSTALLED BY PRE-REMEDIAL SOIL EXCAVATION WORK. TRENCHES IN NORTH TCE AREA VARY BETWEEN 1.5 AND 2.5 FEET IN WIDTH EXCAVATED IN EXISTING SOILS AND SHALL BE BACKFILLED WITH SAND BACKFILL.




**INJECTION WELL SIDE VIEW (TYPICAL)**




**INJECTION WELLHEAD SIDE VIEW DETAIL (TYPICAL)**

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — STEPHEN A. TIBBETS — NO. 20080 — REGISTERED PROFESSIONAL ENGINEER — 6/15/13

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TYPICAL INJECTION WELL (WITH CONDUIT)
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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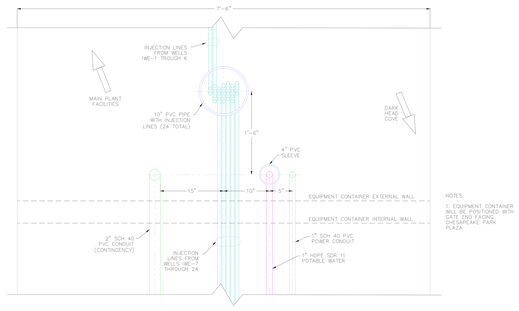
DRAWING C-6

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\90% INJECTION WELL.DWG DWM 5/31/13




1 C-2 UTILITIES STUB-OUT PLAN

GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN SOUTHEAST AREA:

1. 3" DETECTABLE RED WARNING TAPE WITH ALUMINUM BACKING SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.

2. 3" DETECTABLE BLUE WARNING TAPE WITH ALUMINUM BACKING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.

3. 3" DETECTABLE BLUE WARNING TAPE WITH ALUMINUM BACKING TAPE SHALL BE PLACED ON EACH SIDE OF EXCAVATION DURING PRE-REMEDIATION SOIL EXCAVATION ACTIVITIES.

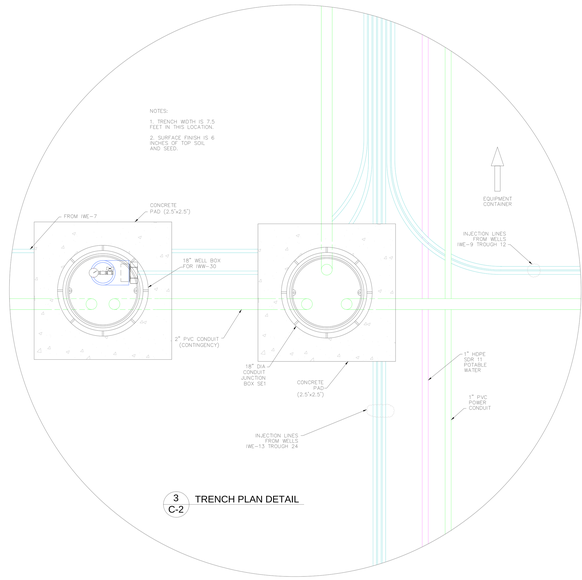
4. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.

5. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.

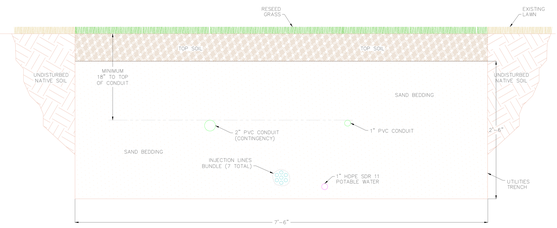
6. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.

7. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL

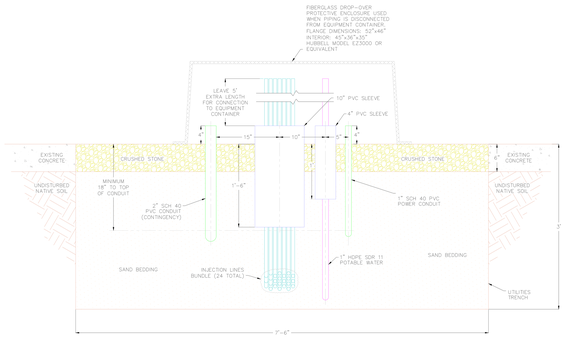
8. CONDUIT JUNCTION BOXES (SE1, SE2, SE3) ARE THE SAME TYPE AS 18"ø MANHOLES USED FOR INJECTION WELLS.



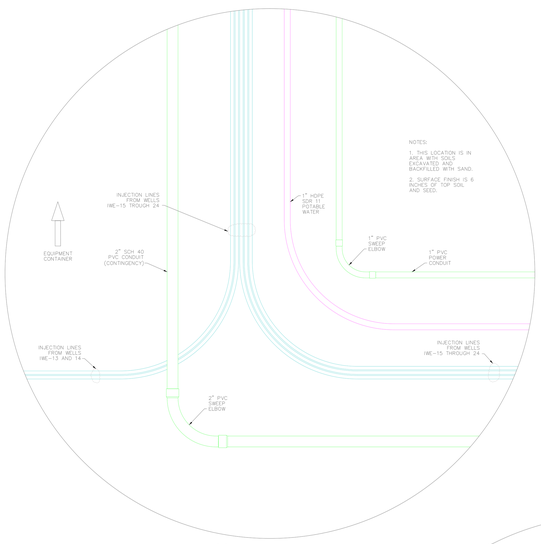

3 C-2 TRENCH PLAN DETAIL



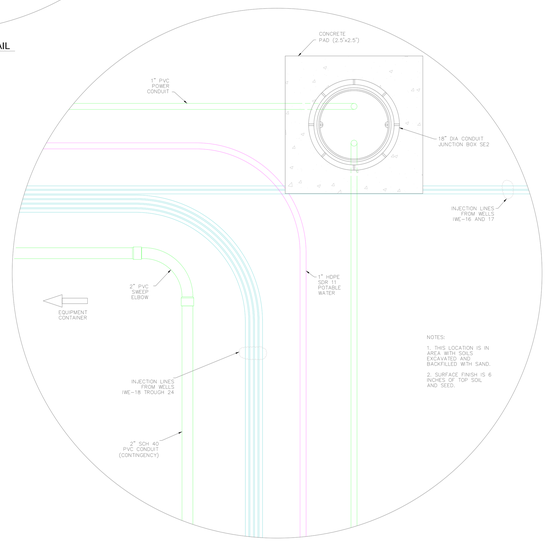

6 C-2 TRENCH SECTION DETAIL



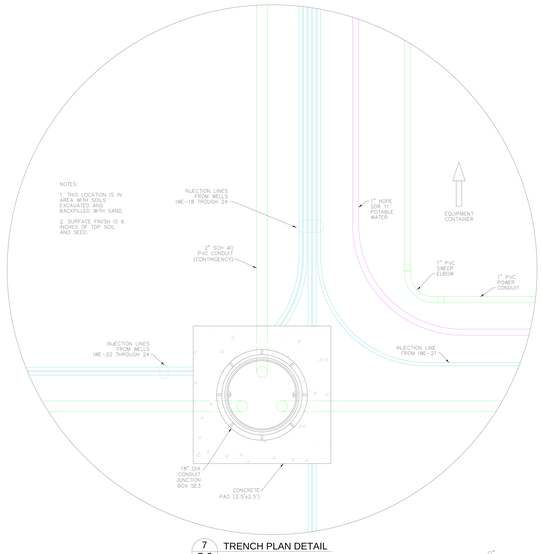

2 C-2 TRENCH SECTION DETAIL




4 C-2 TRENCH PLAN DETAIL

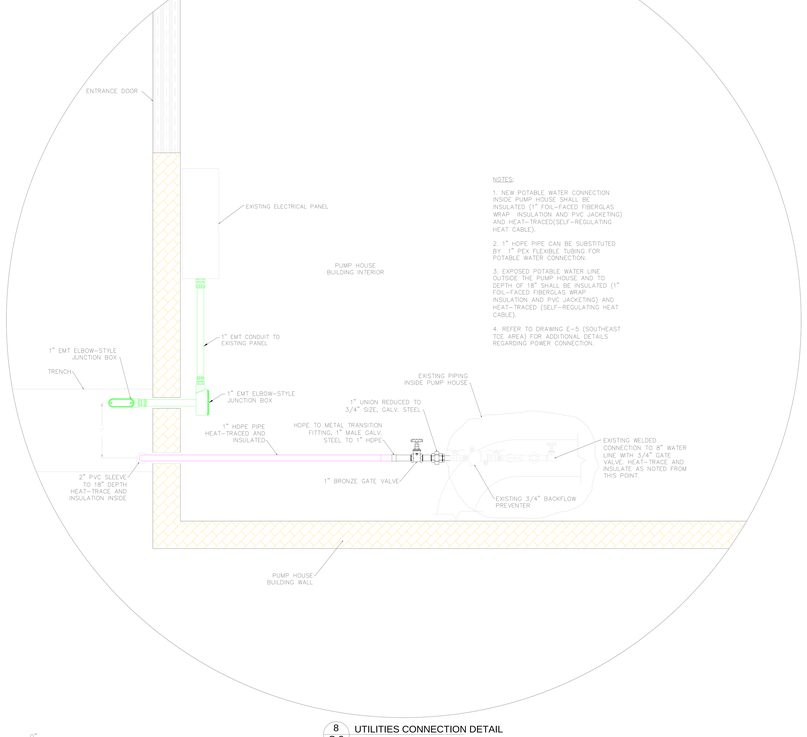



5 C-2 TRENCH PLAN DETAIL




7 C-2 TRENCH PLAN DETAIL

DRAWING SCALE
0" 12" 24" 12" 0"




8 C-2 UTILITIES CONNECTION DETAIL

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — ANGELA R. PERRY — No. 22665 — REGISTERED PROFESSIONAL ENGINEER

| MARK | DATE | DESCRIPTION | BY |
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SOUTHEAST TCE AREA CONSTRUCTION DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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**DRAWING C-7**

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GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN SOUTHWEST AREA:

1. 3" DETECTABLE RED WARNING TAPE WITH ALUMINUM BACKING SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.

2. 3" DETECTABLE BLUE WARNING TAPE WITH ALUMINUM BACKING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.

3. 3" DETECTABLE BLUE WARNING TAPE WITH ALUMINUM BACKING TAPE SHALL BE PLACED ON EACH SIDE OF EXCAVATION DURING PRE-REMEDIATION SOIL EXCAVATION ACTIVITIES.

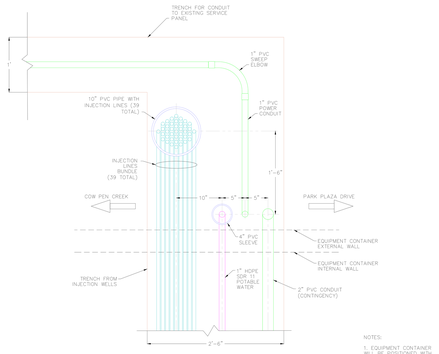
4. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.

5. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.

6. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.

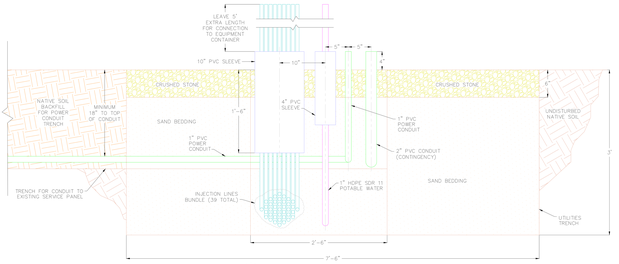
7. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL EXCEPT FOR ELECTRICAL CONDUIT TRENCH FROM EQUIPMENT CONTAINER TO POWER SOURCE.

8. CONDUIT JUNCTION BOXES (SE1, SE2, SE3) ARE THE SAME TYPE AS 18"ø MANHOLES USED FOR INJECTION WELLS..

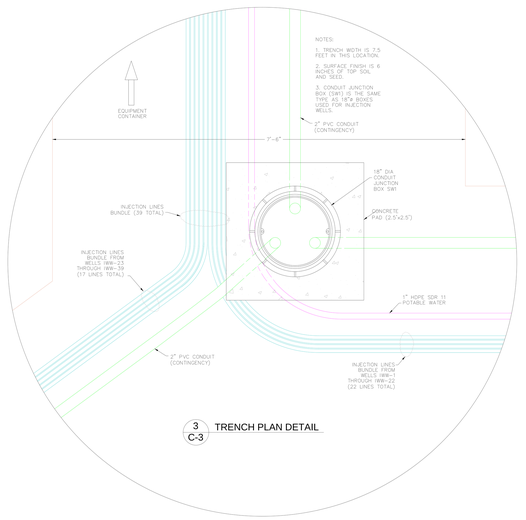



NOTES:
1. EQUIPMENT CONTAINER WILL BE POSITIONED WITH GATE END FACING CHESAPEAKE PARK PLAZA.
2. NATIVE SOIL BACKFILL TO BE USED FOR TRENCHING FROM SERVICE TRENCH TO EXISTING SERVICE PANEL.

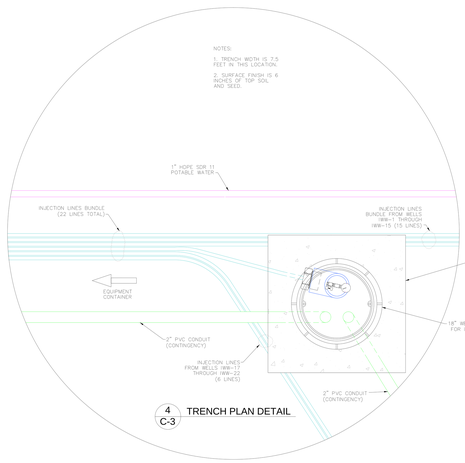
1 C-3 UTILITIES STUB-OUT PLAN



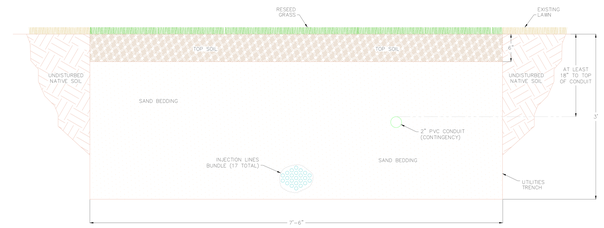

2 C-3 TRENCH SECTION DETAIL



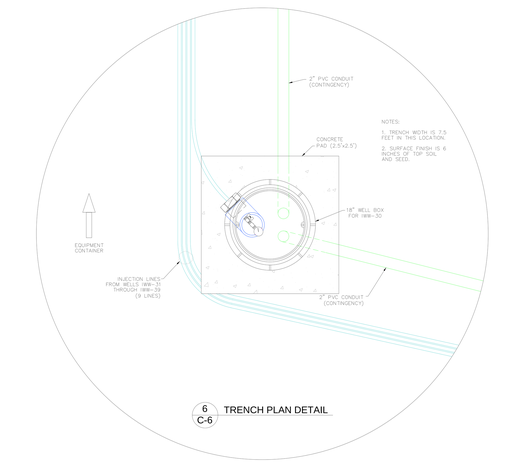

3 C-3 TRENCH PLAN DETAIL



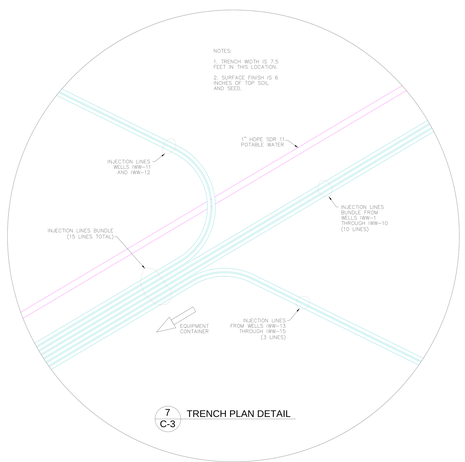

4 C-3 TRENCH PLAN DETAIL



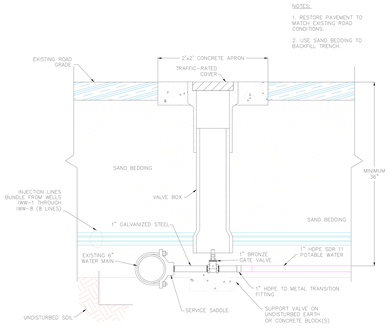

5 C-3 TRENCH SECTION DETAIL



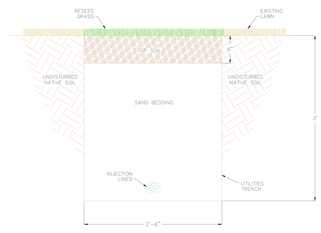

6 C-6 TRENCH PLAN DETAIL



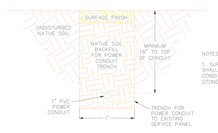

7 C-3 TRENCH PLAN DETAIL




8 C-3 WATER TIE-IN DETAIL




9 C-3 TRENCH SECTION DETAIL




10 C-3 TRENCH SECTION DETAIL

DRAWING SCALE

0" 6" 12" 24" 36" 48"

TETRA TECH
www.tetratech.com

STATE OF MARYLAND — 34A — 10/1/2005 — REGISTERED PROFESSIONAL ENGINEER — 67315

| MARK | DATE | DESCRIPTION | BY |
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SOUTHWEST TCE AREA CONSTRUCTION DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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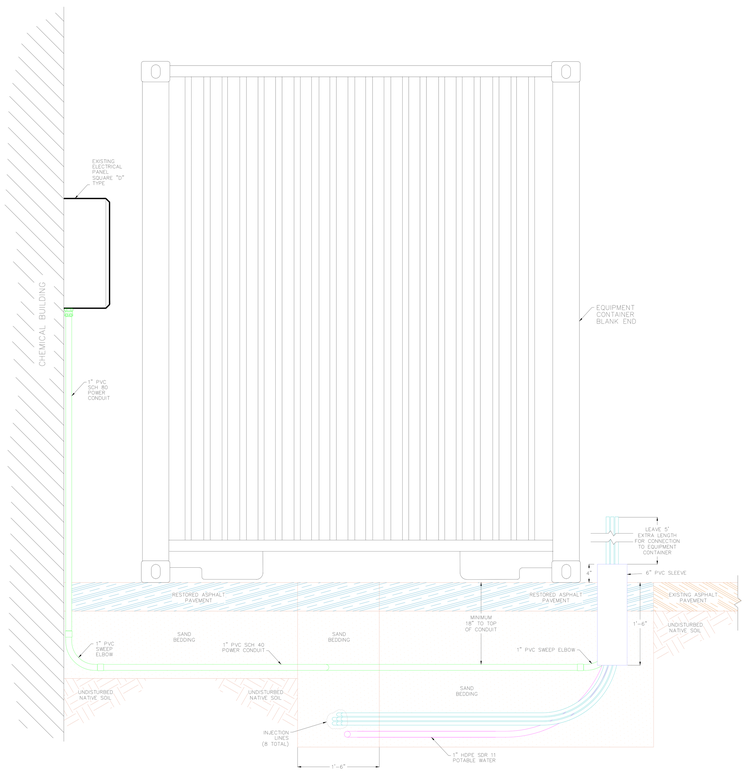
**DRAWING C-8**

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\90% TRENCH DETAILS.DWG DWM 5/31/13




1 C-4 TRENCH SECTION DETAIL

GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN NORTH AREA:

1. 3" DETECTABLE RED WARNING TAPE WITH ALUMINUM BACKING SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.

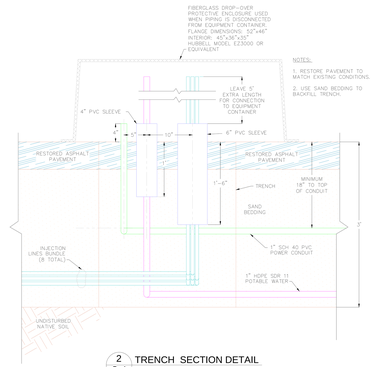
2. 3" DETECTABLE BLUE WARNING TAPE WITH ALUMINUM BACKING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.

3. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.

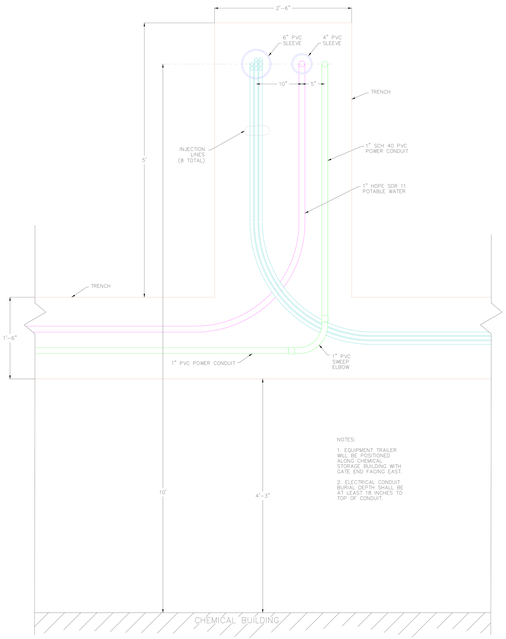
4. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.

5. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.

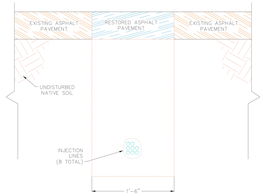
6. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL.



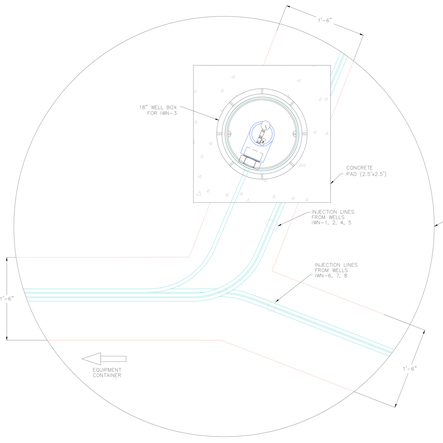

2 C-4 TRENCH SECTION DETAIL




3 C-4 UTILITIES STUB-OUT PLAN

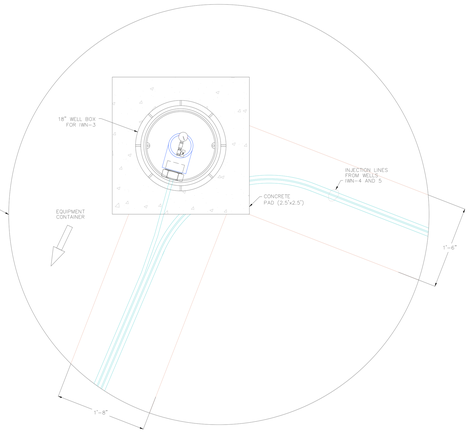



4 C-2 TRENCH SECTION DETAIL




5 C-4 TRENCH PLAN DETAIL

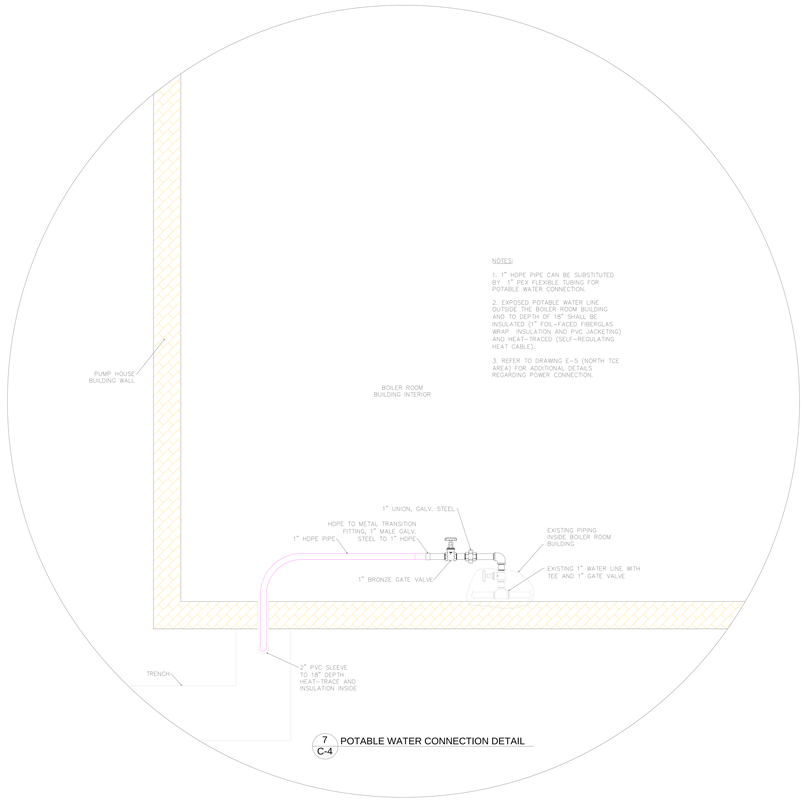
NOTES:
1. TRENCH WIDTH IS 1.5 FEET IN THIS LOCATION.
2. RESTORE ASPHALT PAVEMENT TO MATCH EXISTING CONDITIONS.
3. USE SAND BEDDING TO BACKFILL TRENCH.




6 C-4 TRENCH PLAN DETAIL

DRAWING SCALE

0" 12" 24" 12" 0"




7 C-4 POTABLE WATER CONNECTION DETAIL

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www.tetratech.com

STATE OF MARYLAND — DEBRA K. KIRBY — NO. 22662 — REGISTERED PROFESSIONAL ENGINEER — 6/31/13

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NORTH TCE AREA CONSTRUCTION DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DRAWING SIZE: | ARCH E |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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**DRAWING C-9**

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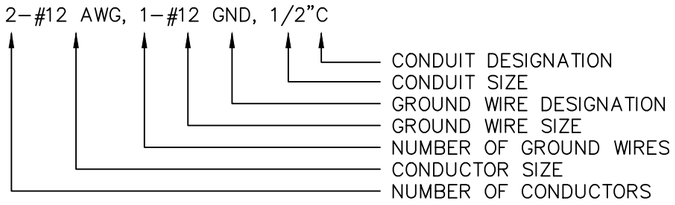
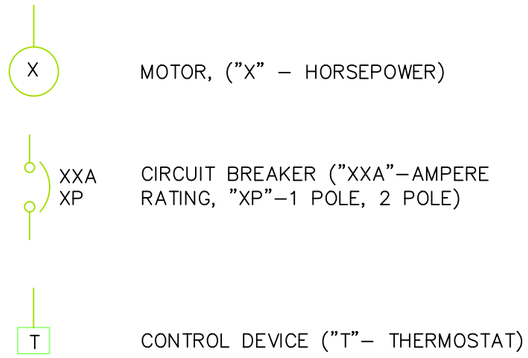
## CONDUCTOR – CONDUIT DESIGNATION




## SYMBOL LEGEND




## ABBREVIATIONS

AC – AIR CONDITIONER
AWG – AMERICAN WIRE GAUGE
CM – CELLULAR MODEM
CP – CONTROL PANEL
DPS – DIFFERENTIAL PRESSURE SWITCH
EMT – ELECTRICAL METALLIC TUBING
FMT – FLOW METER/TOTALIZER
GB – GROUND BUSS
GND – GROUND
LQT – LIQUID TIGHT FLEXIBLE CONDUIT
MV – MOTORIZED VALVE
MP – METERING PUMP
MX – MIXING PUMP
NEMA – NATIONAL ELECTRIC MANUFACTURERS ASSOCIATION
OIT – OPERATOR INTERFACE TERMINAL
PDP – POWER DISTRIBUTION PANEL
PLC – PROGRAMMABLE LOGIC CONTROLLER
PS – POWER SUPPLY
PT – PRESSURE TRANSMITTER
PVC – POLYVINYL CHLORIDE
SCH – CONDUIT SCHEDULE SIZE
SV – SOLENOID VALVE
TS – TERMINAL STRIP
TSP – TERMINAL STRIP POWER
UPS – UNINTERRUPTIBLE POWER SUPPLY
VP – VACUUM PUMP
VS – VACUUM SWITCH

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|---|---|---|---|
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ELECTRICAL SYMBOLS LEGEND
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH A |
| DRAWN BY: | RJD |
| CHECKED BY: | RB |

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**E-1**

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-1 SYMBOL LEGEND 90 PCT.DWG DWM 5/31/13

NOTE 2: APPROXIMATELY 275 LINEAR FEET OF TRENCH IS THROUGH CONCRETE SURFACES

NOTE 3: APPROXIMATELY 2,000 SQUARE FEET OF CONCRETE SURFACE TO BE REMOVED

NOTE 4: UNDERGROUND UTILITES TRENCH WIDTH IS 7.5 FEET

NOTE 1: EXISTING INJECTION PILOT TEST MONITORING POINTS MPE-1I AND MPE2I/S ARE UTILIZED AS MONITORING WELLS SEMW-4I AND SEMW-5S/I

IWE-1 IWE-2 IWE-3 IWE-4 IWE-5 IWE-6 IWE-7 IWE-8 IWE-9 IWE-10 IWE-11 IWE-12 IWE-13 IWE-14 IWE-15 IWE-16 IWE-17 IWE-18 IWE-19 IWE-20 IWE-21 IWE-22 IWE-23 IWE-24

7.5'

SEMW-1I SEMW-2I SEMW-3I SEMW-4I SEMW-5S/I SEMW-6I

IW-E

SE-1 SE-2 SE-3

MW-72B MW-74A MW-74B

IL-4 10.48

IL-20 11.05 (FILLED W/ DEBRIS)

MH-8 9.83 INV. 5.48

MH-9

MH-10 (IL-3) 9.78 INV. 5.20

IL-25 9.21 INV. 1.56

IL-2 6.85 INV. 3.92

IL-1 7.45 INV. 2.75

40'x8' INJECTION EQUIPMENT MODULE

GATE DOOR OPENING

CONCRETE (FORMER D-BUILDING BASEMENT)

CONCRETE

CONCRETE BLOCK

HISTORICAL CONNECTION

HISTORICAL FIRE PUMP LOCATION

ALL TRENCH SOUTH OF THIS POINT IS THROUGH CONCRETE SURFACES

FIRE WATER LINE

FIRE WATER LINE (ABANDONED)

HISTORIC WATER LINE

6" DOMESTIC WATER LINE

UG COMMUNICATION LINE

UG ELECTRIC LINE

BROMIDE SAMPLING LOCATION

GRASS AREA

APPROXIMATE 1000 UG/L TCE CONTOUR

FORMER 500-GAL UST

500,000-GALLON WATER TANK ABOVE-GROUND

PUMP HOUSE

SHED

CONNECTION TO EXISTING POTABLE WATER AND POWER INSIDE PUMP HOUSE

LOCATION OF FORMER 500,000 GALLON ABOVE-GROUND FUEL TANK

HISTORIC 2" DIESEL FUEL LINE

PINK-UNKNOWN

6' CHAIN-LINK FENCE

## LEGEND

- PROPERTY LINE W/ MONUMENTS
- TREELINE
- BUILDING – MAJOR

EXISTING UTILITIES

- WATER LINE W/ VALVE & HYDRANT
- GAS LINE W/ METER & VALVE
- UNDERGROUND ELECTRIC
- ABOVE-GROUND ELECTRIC W/ POLE
- COMMUNICATIONS W/ BOX
- STORM PIPE W/ INLET & MANHOLE
- HISTORICAL FLOOR DRAIN W/ CLEANOUT
- SANITARY LINE W/ MANHOLE
- FORCE MAIN
- CHAIN LINK FENCE W/ GATE
- UNKNOWN UTILITIES- GEOPHYSICAL SURVEY
- HISTORICAL UTILITIES OR STRUCTURES (LINETYPES VARY)

REMEDIAL SYSTEM FEATURES

- 4" INJECTION WELL
- 4" INJECTION WELL (WITH CONTINGENCY CONDUIT)
- CONDUIT JUNCTION BOX
- SEMW-5I/S — 2" PERFORMANCE MONITORING WELL I – INTERMEDIATE DEPTH S – SHALLOW DEPTH
- EXISTING MONITORING WELL
- PILOT TEST INJECTION WELL
- CONCRETE SURFACES
- INJECTION PIPING BUNDLE
- 2" PVC CONTINGENCY ELECTRICAL CONDUIT
- 1" PVC ELECTRICAL CONDUIT
- 1" HDPE POTABLE WATER LINE
- EXTENT OF TRENCH AND EXCAVATED SOIL

GRAPHIC SCALE

0' 25' 50'

REFERENCE PLANS & DATA:

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH
www.tetratech.com

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SOUTHEAST TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | DWM |
| CHECKED BY: | BD |

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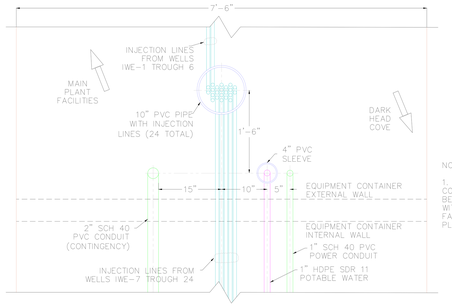
E-2 SHEET 1 OF 2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-2 SOUTHEAST TCE AREA ELECTRICAL SITE PLAN S 1 OF 2.DWG DWM 5/31/13

GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN SOUTHEAST AREA:

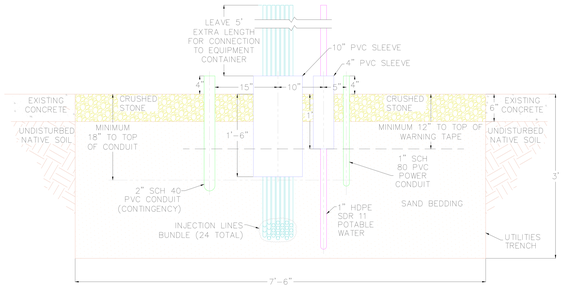
1. RED WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.
2. BLUE WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.
3. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.
4. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.
5. ALL ABOVEGROUND ELECTRICAL CONDUIT SHALL BE SCH 80 PVC PIPE, GRAY.
6. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.
7. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL.



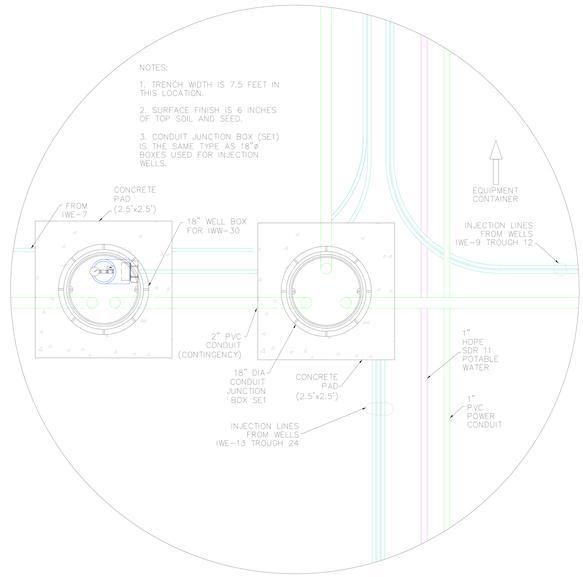

NOTES:

1. EQUIPMENT CONTAINER WILL BE POSITIONED WITH GATE END FACING PARK PLAZA DRIVE.

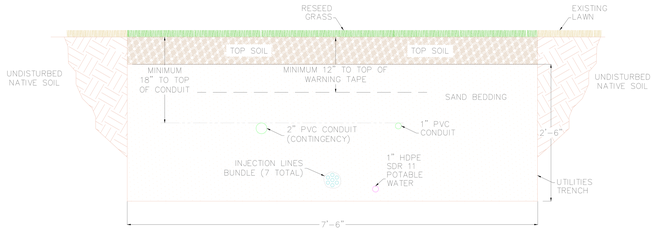
1 E-2 UTILITIES STUB-OUT PLAN



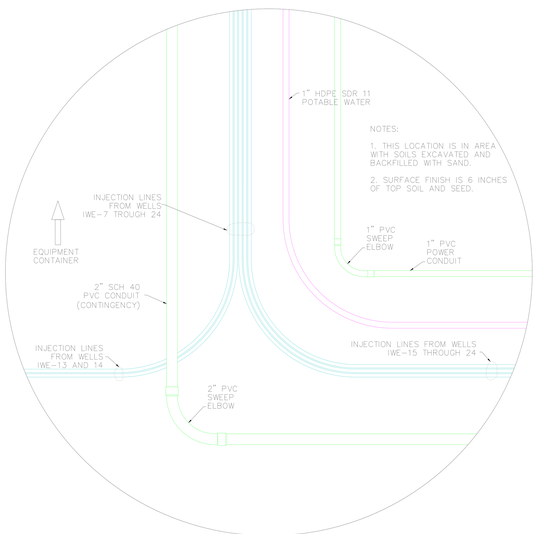

2 E-2 TRENCH SECTION DETAIL



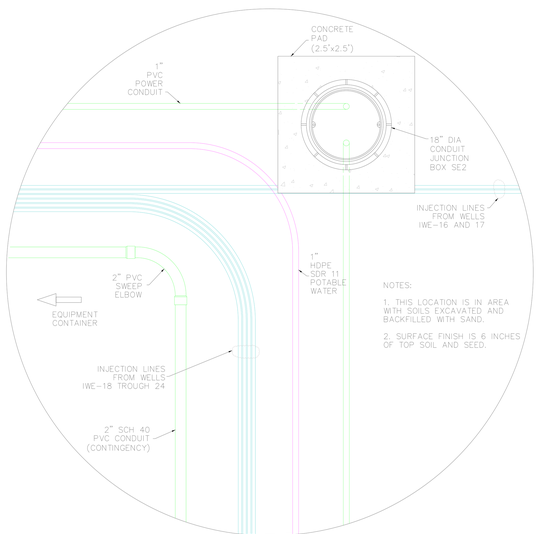

3 E-2 TRENCH PLAN DETAIL



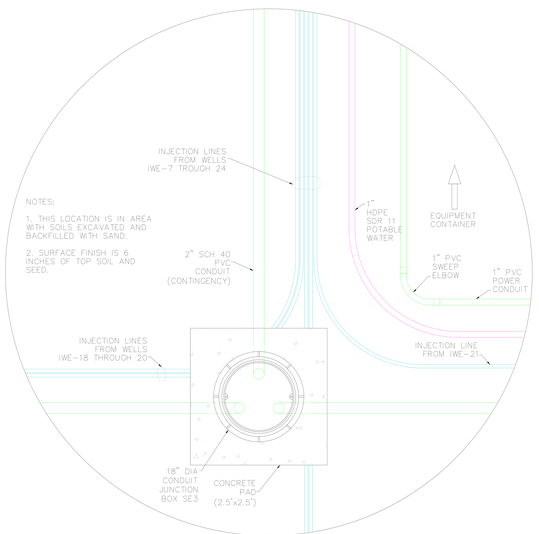

6 E-2 TRENCH SECTION DETAIL




4 E-2 TRENCH PLAN DETAIL




5 E-2 TRENCH PLAN DETAIL




7 E-2 TRENCH PLAN DETAIL

DRAWING SCALE

0" 12" 24" 12" 0"

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|---|---|---|---|
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SOUTHEAST TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | BD |
| CHECKED BY: | CP |

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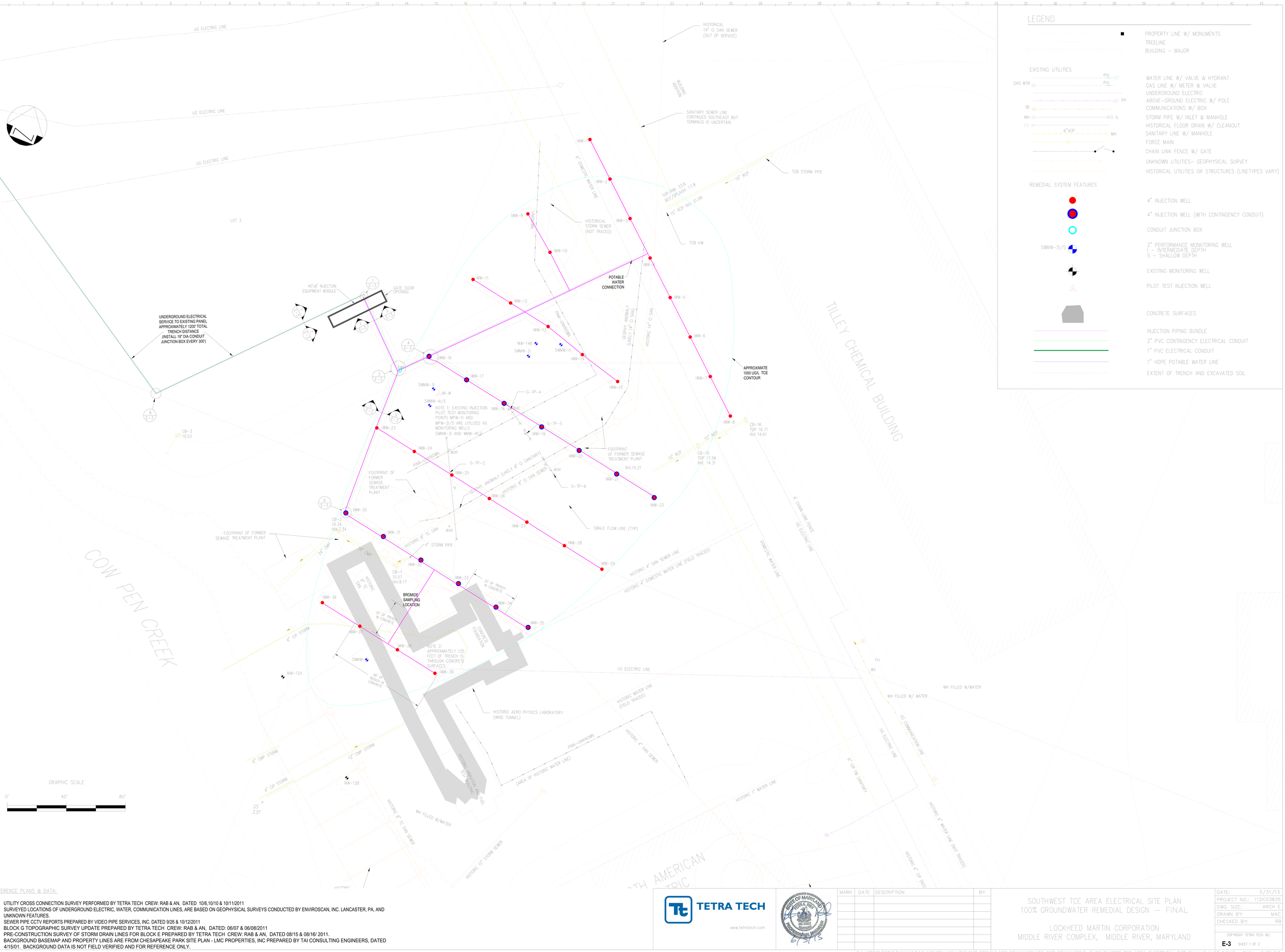
E-2 SHEET 2 OF 2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-2-3-4 ELECTRICAL SITE PLAN SHEET 2 OF 2.DWG DWM 5/31/13




REFERENCE PLANS & DATA:

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
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6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

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SOUTHWEST TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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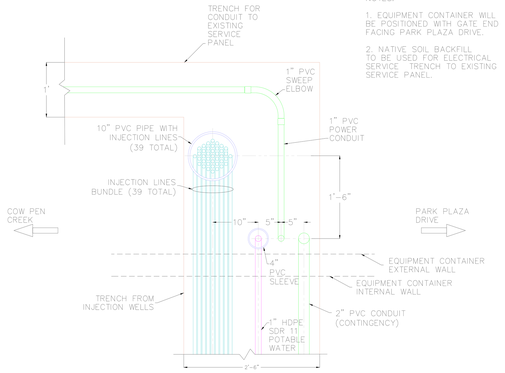
E-3 SHEET 1 OF 2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-3 SOUTHWEST TCE AREA ELECTRICAL SITE PLAN S 1 OF 2.DWG DWM 5/31/13




1 E-3 UTILITIES STUB-OUT PLAN

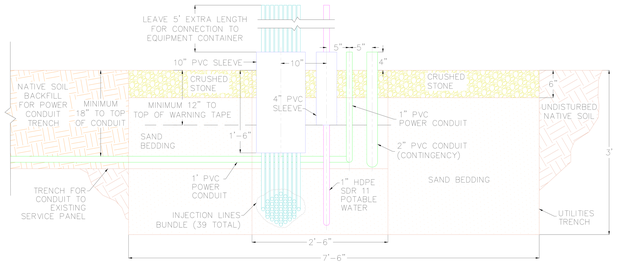
NOTES:

1. EQUIPMENT CONTAINER WILL BE POSITIONED WITH GATE END FACING PARK PLAZA DRIVE.

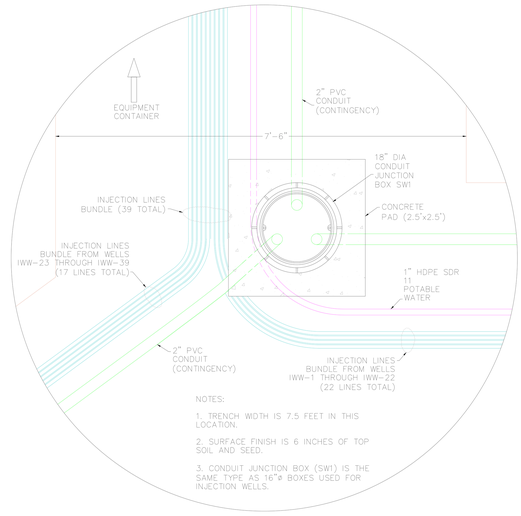
2. NATIVE SOIL BACKFILL TO BE USED FOR ELECTRICAL SERVICE TRENCH TO EXISTING SERVICE PANEL.

GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN SOUTHWEST AREA:

1. RED WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.
2. BLUE WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.
3. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.
4. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.
5. ALL ABOVEGROUND ELECTRICAL CONDUIT SHALL BE SCH 80 PVC PIPE, GRAY.
6. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.
7. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL EXCEPT FOR TRENCH TO EXISTING ELECTRICAL PANEL (AS NOTED).




2 E-3 TRENCH SECTION DETAIL




NOTES:

1. TRENCH WIDTH IS 7.5 FEET IN THIS LOCATION.

2. SURFACE FINISH IS 6 INCHES OF TOP SOIL AND SEED.

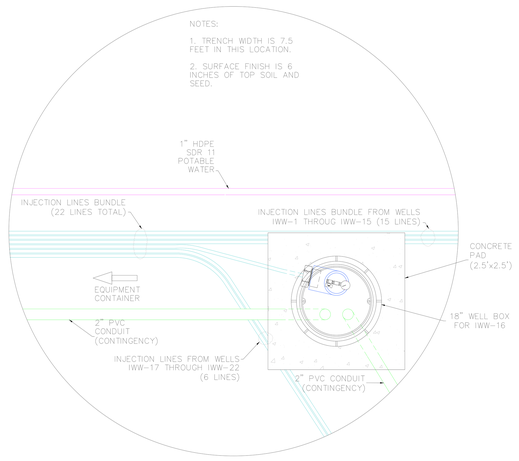
3. CONDUIT JUNCTION BOX (SW1) IS THE SAME TYPE AS 16"ø BOXES USED FOR INJECTION WELLS.

3 E-3 TRENCH PLAN DETAIL

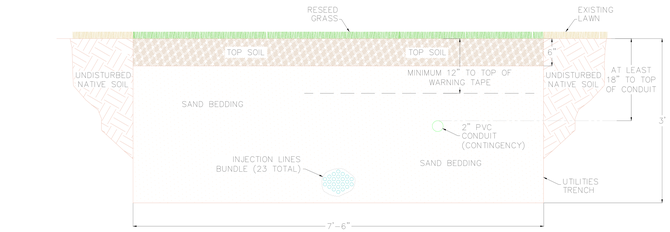
NOTES:

1. TRENCH WIDTH IS 7.5 FEET IN THIS LOCATION.

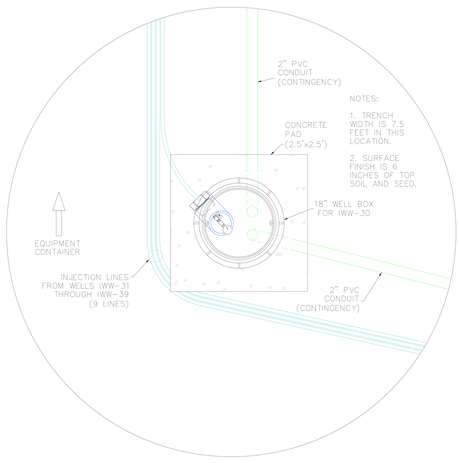
2. SURFACE FINISH IS 6 INCHES OF TOP SOIL AND SEED.




4 E-3 TRENCH PLAN DETAIL




5 E-3 TRENCH SECTION DETAIL




NOTES:

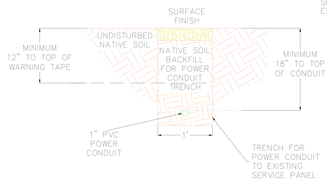
1. TRENCH WIDTH IS 7.5 FEET IN THIS LOCATION.

2. SURFACE FINISH IS 6 INCHES OF TOP SOIL AND SEED.

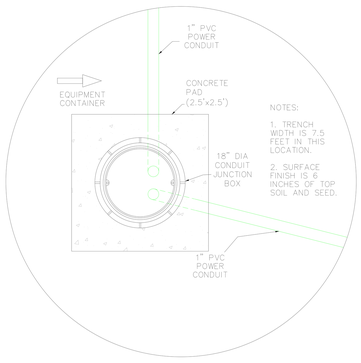
6 E-3 TRENCH PLAN DETAIL

NOTES:

1. SURFACE FINISH SHALL MATCH EXISTING CONDITIONS.




7 E-3 TRENCH SECTION DETAIL




NOTES:

1. TRENCH WIDTH IS 7.5 FEET IN THIS LOCATION.

2. SURFACE FINISH IS 6 INCHES OF TOP SOIL AND SEED.

8 E-3 TRENCH PLAN DETAIL

DRAWING SCALE

0" 12" 24" 12" 0"

TETRA TECH

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHWEST TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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E-3 SHEET 2 OF 2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-2-3-4 ELECTRICAL SITE PLAN SHEET 2 OF 2.DWG DWM 5/31/13

HISTORIC 15" CONC STORM SEWER

HISTORIC 10" FIRE WATER LINE

21" RCP

12" RCP

CONNECT TO FLR DRNS?

INV.20.19

INV.19.29

PIPE END

15" RCP

12" RCP

12" RCP

PIPE END

21" RCP STORM

IWN-4

RET.WALL (APPROX.)

HISTORIC 15" CONC STORM SEWER

NOTE 1: EXISTING INJECTION PILOT TEST MONITORING POINT MPN-1S/I IS UTILIZED AS MONITORING WELL NMW-2S/I

APPROXIMATE 1,000 ug/L VOC CONTOUR

IWN-1

NOTE 2: ALL TRENCHES ARE LOCATED ON PAVED AREAS

IWN-2

IWN-5

HISTORIC STORM SEWER

RCP

RCP

MPN-2

40'x8' INJECTION EQUIPMENT MODULE

NMW-2I/S

NMW-1I

MW-81B

IW-N

GRATE

OW-1

CO1

4" DIP SAN SEWER

4" DIP SAN

IWN-3

IWN-6

20"x28" ERCP STORM

RUNS TO LIFT STATION?

4" DIP SAN SEWER

4" DIP SANITARY

INV.19.98

18" RCP STORM

IWN-7

STRM FES 23.92

NMW-3I

12" RCP

CB-10A 22.24 INV.20.54

24" RCP STORM

GATE DOOR OPENING

POWER CONNECTION TO EXISTING SERVICE PANEL

2008 ARD PILOT TEST FRACTURING POINT AND INJECTION LOCATION

CHEMICAL BUILDING

IWN-8

GRAPHIC SCALE

0' 7.5' 15'

10" FIRE WATER

BROMIDE SAMPLING LOCATION

PK FND.110

UKWN UKWN UKWN UKWN

PINK-UNKNOWN

## LEGEND

- PROPERTY LINE W/ MONUMENTS
- TREELINE
- BUILDING – MAJOR

EXISTING UTILITIES

- WATER LINE W/ VALVE & HYDRANT
- GAS LINE W/ METER & VALVE
- UNDERGROUND ELECTRIC
- ABOVE-GROUND ELECTRIC W/ POLE
- COMMUNICATIONS W/ BOX
- STORM PIPE W/ INLET & MANHOLE
- HISTORICAL FLOOR DRAIN W/ CLEANOUT
- SANITARY LINE W/ MANHOLE
- FORCE MAIN
- CHAIN LINK FENCE W/ GATE
- UNKNOWN UTILITIES– GEOPHYSICAL SURVEY
- HISTORICAL UTILITIES OR STRUCTURES (LINETYPES VARY)

REMEDIAL SYSTEM FEATURES

- 4" INJECTION WELL
- 2" PERFORMANCE MONIITORING WELL
  I – INTERMEDIATE DEPTH
  S – SHALLOW DEPTH
- EXISTING MONITORING WELL
- INJECTION PIPING BUNDLE
- 2" PVC ELECTRICAL CONDUIT
- 1" POTABLE WATER LINE
- EXTENT OF TRENCH (3-FT WIDTH SHOWN)*
- PILOT TEST INJECTION WELL

REFERENCE PLANS & DATA:

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH

www.tetratech.com

STATE OF MARYLAND – RENEE A. RIGBY – NO. 21663 – REGISTERED PROFESSIONAL ENGINEER – 6/5/13

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

NORTH TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH D |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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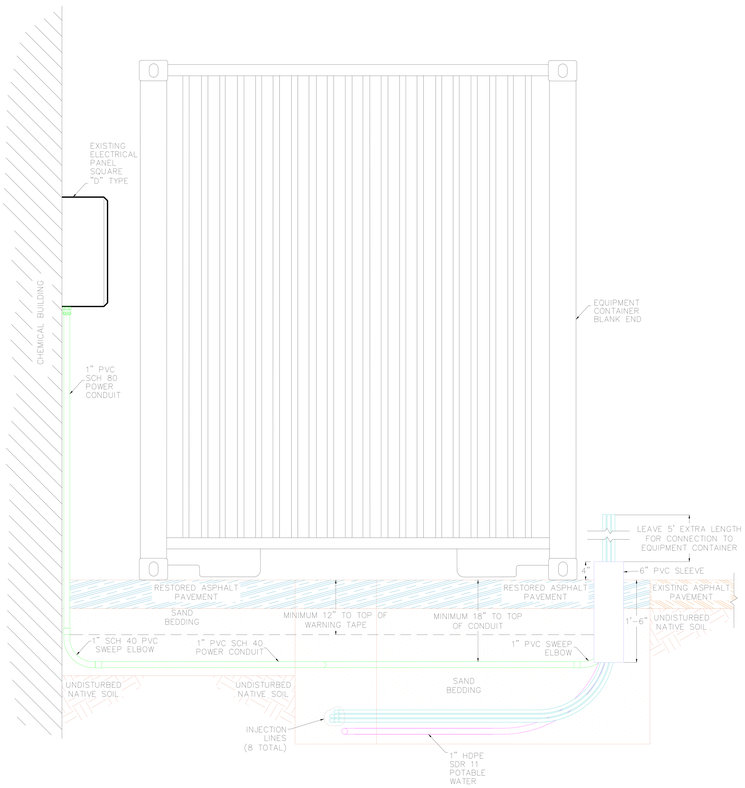
NOTES:

1. EQUIPMENT TRAILER WILL BE POSITIONED ALONG CHEMICAL STORAGE BUILDING WITH GATE END FACING EAST.

2. PVC SCH 80 CONDUIT SHALL BE USED FOR EXPOSED PORTION FOR CONNECTION TO EXISTING PANEL ON CHEMICAL BUILDING WALL.

3. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.

4. RESTORE PAVEMENT TO MATCH EXISTING CONDITIONS.

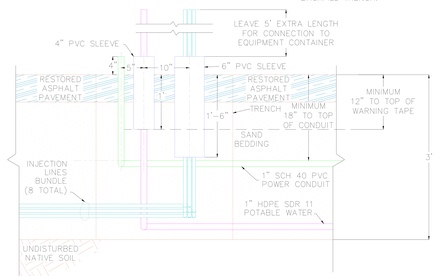



1 E-4 TRENCH SECTION DETAIL

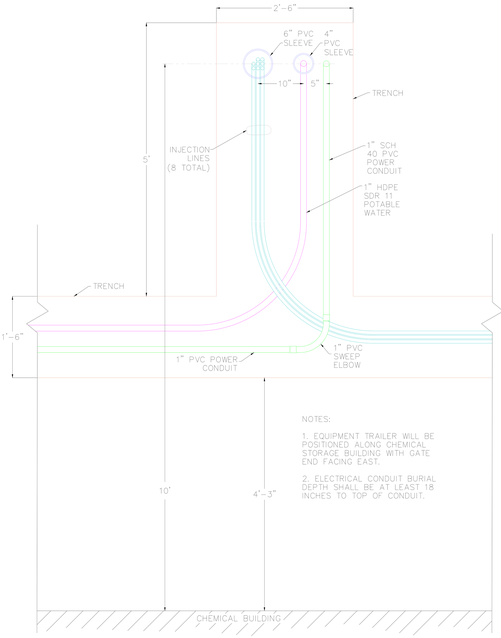
NOTES:

1. RESTORE PAVEMENT TO MATCH EXISTING CONDITIONS.

2. USE SAND BEDDING TO BACKFILL TRENCH.




2 E-4 TRENCH SECTION DETAIL




3 C-4 UTILITIES STUB-OUT PLAN

NOTES:

1. EQUIPMENT TRAILER WILL BE POSITIONED ALONG CHEMICAL STORAGE BUILDING WITH GATE END FACING EAST.

2. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.

GENERAL NOTES FOR UNDERGROUND UTILITY TRENCHES IN NORTH AREA:

1. RED WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND ELECTRICAL CONDUIT.
2. BLUE WARNING TAPE SHALL BE PLACED IN ALL TRENCHES WITH UNDERGROUND POTABLE WATER LINES AND INJECTION LINES.
3. WARNING TAPE SHALL BE PLACED IN TRENCHES AT 12 INCHES DEPTH.
4. ALL UNDERGROUND ELECTRICAL CONDUIT SHALL BE SCH 40 PVC PIPE, GRAY, WITH BELLED END.
5. ALL ABOVEGROUND ELECTRICAL CONDUIT SHALL BE SCH 80 PVC PIPE, GRAY.
6. ELECTRICAL CONDUIT BURIAL DEPTH SHALL BE AT LEAST 18 INCHES TO TOP OF CONDUIT.
7. SAND BEDDING SHALL BE USED FOR TRENCH BACKFILL.

DRAWING SCALE

0" 12" 24" 12" 0"

TETRA TECH
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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

NORTH TCE AREA ELECTRICAL SITE PLAN
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/16/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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E-4 SHEET 2 OF 2

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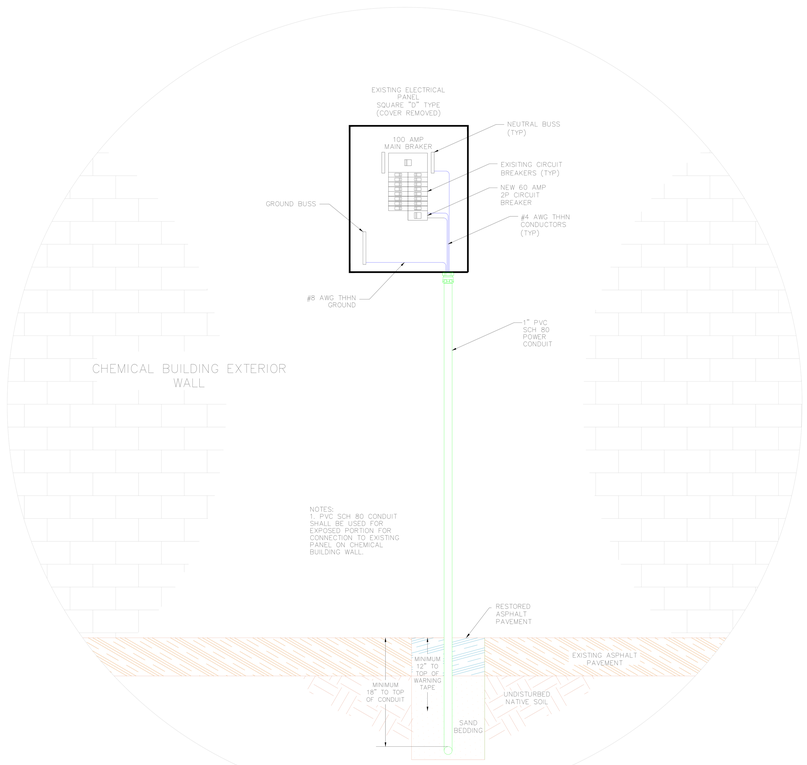
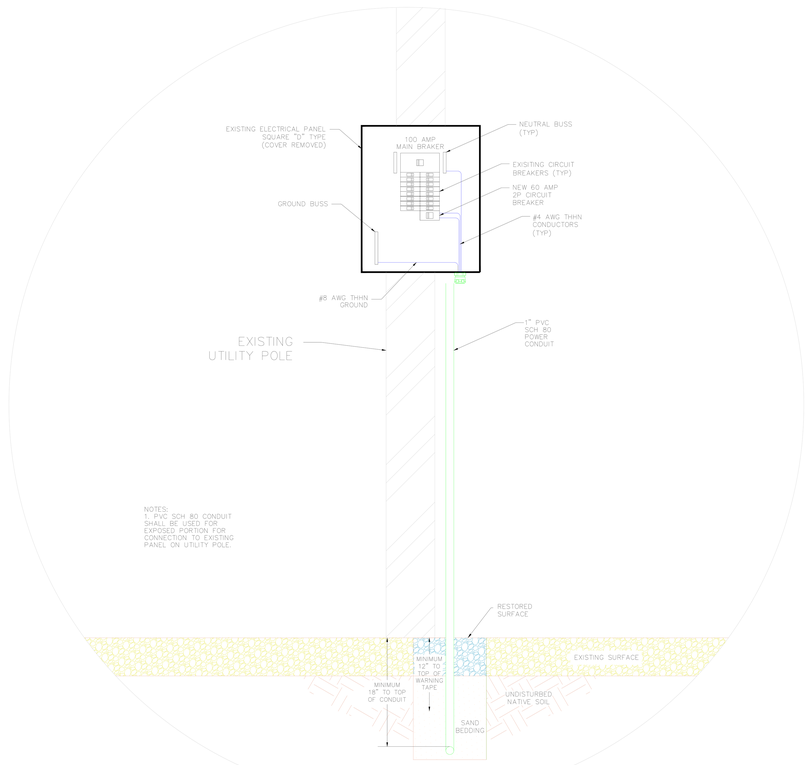
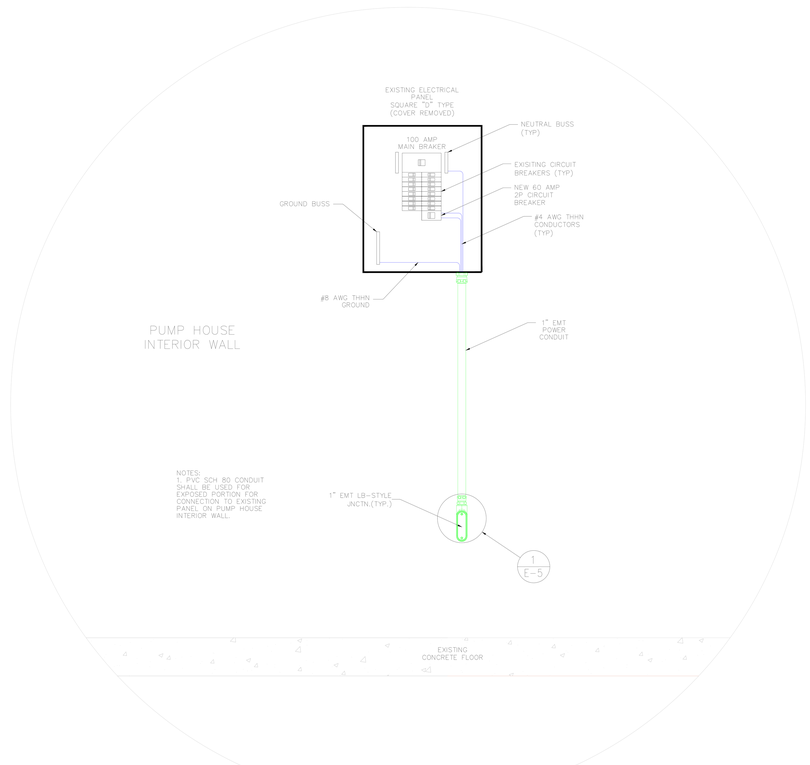
## NORTH TCE AREA

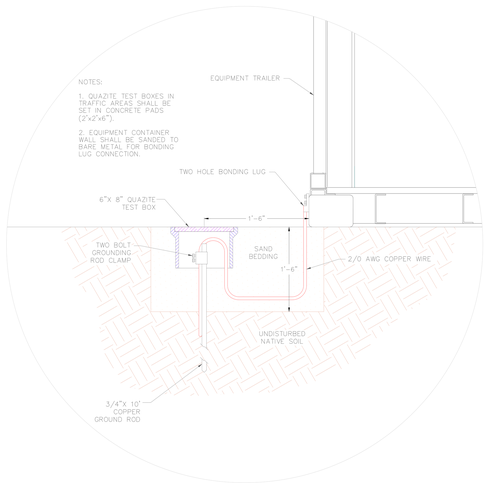



## SOUTHWEST TCE AREA




## SOUTHEAST TCE AREA



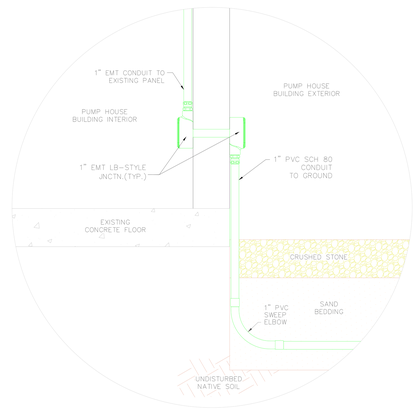




TYPICAL GROUNDING DETAIL

2
E-6

DRAWING SCALE

0" 12" 24" 12" 0"




LB JUNCTION DETAIL – ROTATED 90° FOR CLARITY

1
E-5

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www.tetratech.com

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SERVICE CONNECTIONS DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112C03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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E-5

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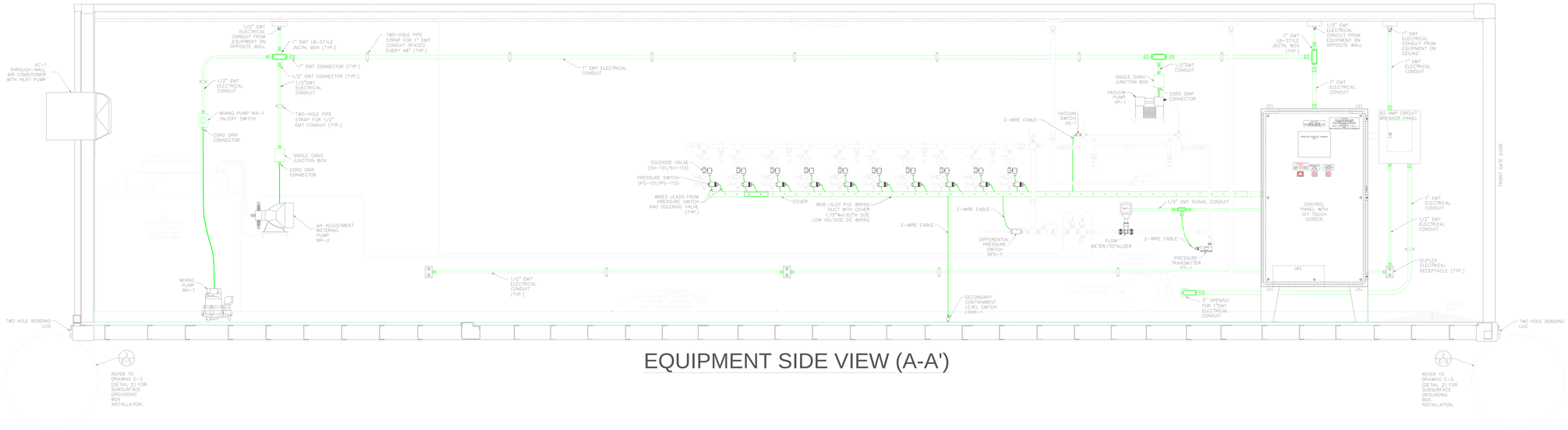
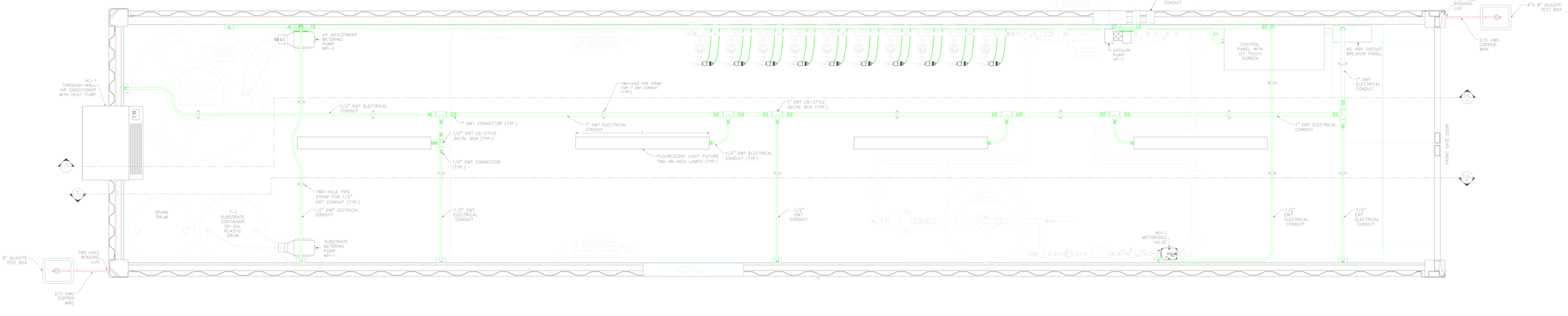
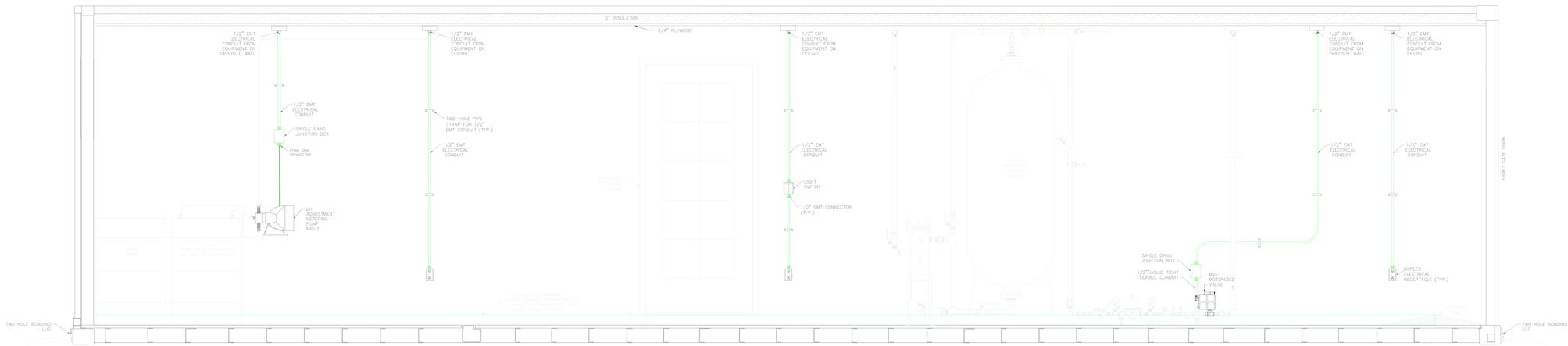



# EQUIPMENT SIDE VIEW (A-A')




# GENERAL EQUIPMENT PLAN VIEW




# EQUIPMENT SIDE VIEW (B-B')

DRAWING SCALE

0" 12" 24" 12" 0"

TETRA TECH

www.tetratech.com

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHEAST / NORTH
ELECTRICAL EQUIPMENT AND CONDUITS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112C03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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E-6 SHEET 1 OF 2

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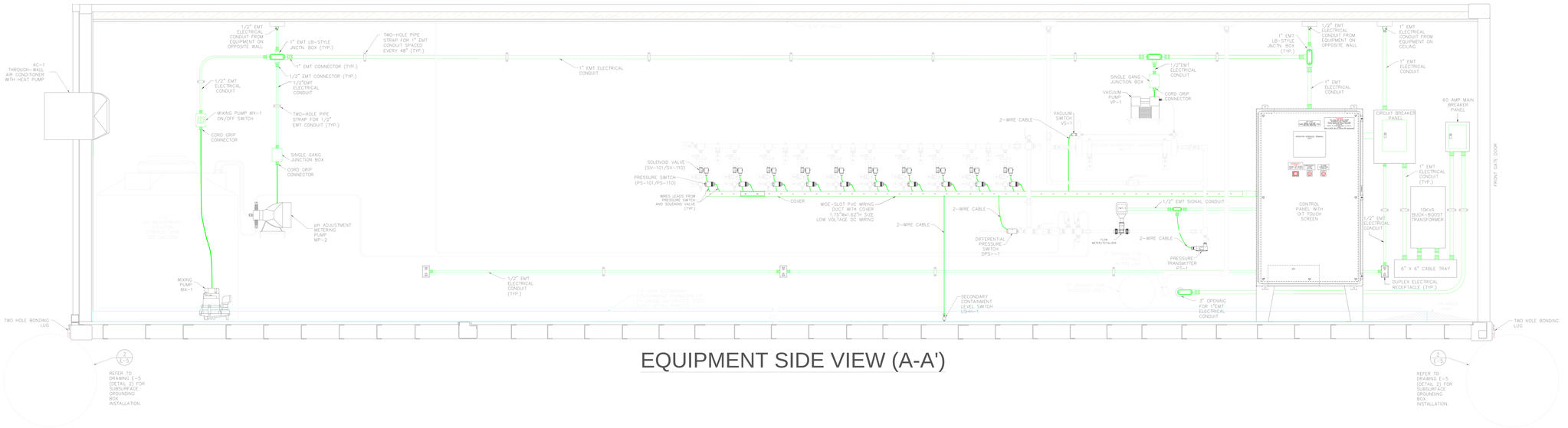
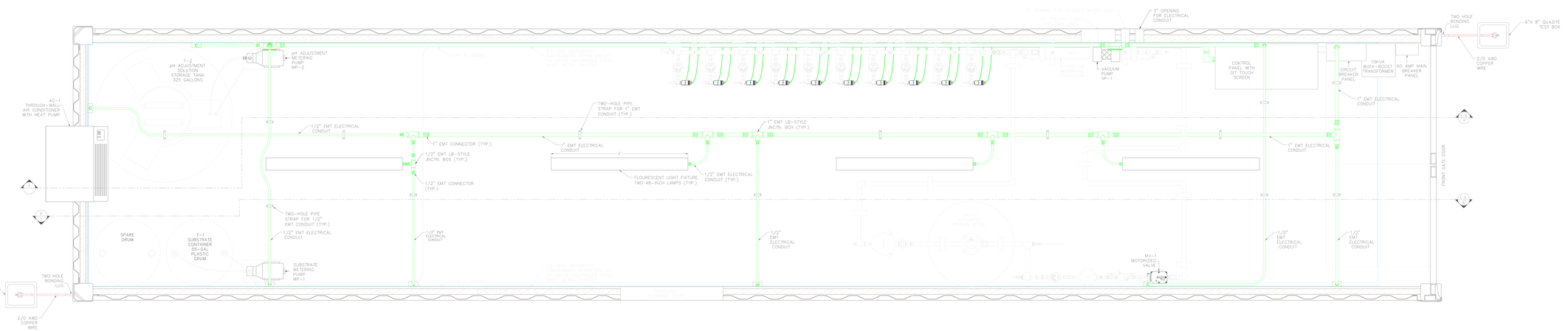



## EQUIPMENT SIDE VIEW (A-A')




## GENERAL EQUIPMENT PLAN VIEW

## EQUIPMENT SIDE VIEW (B-B')

DRAWING SCALE

0" 12" 24" 12" 0"

TETRA TECH
www.tetratech.com

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHWEST ELECTRICAL EQUIPMENT AND CONDUITS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112/C03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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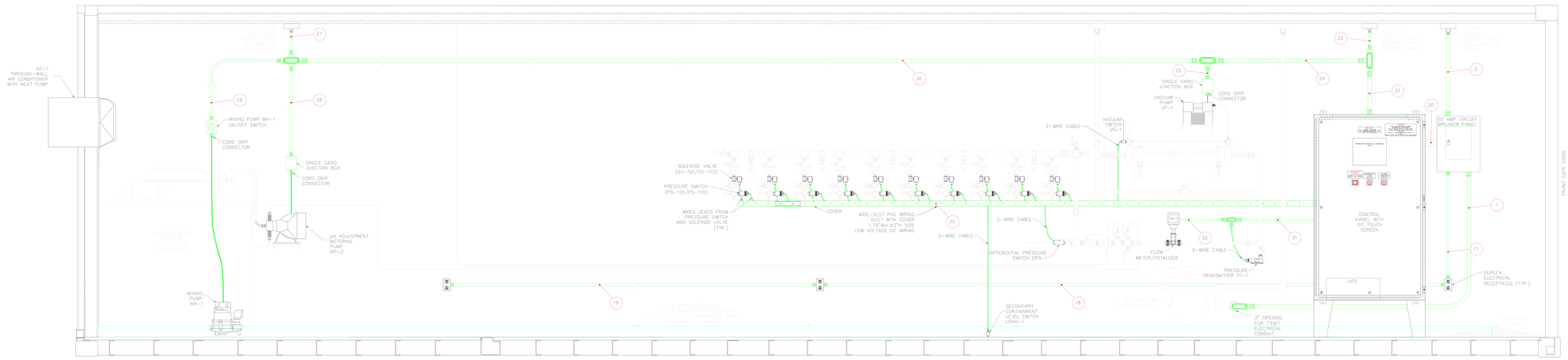
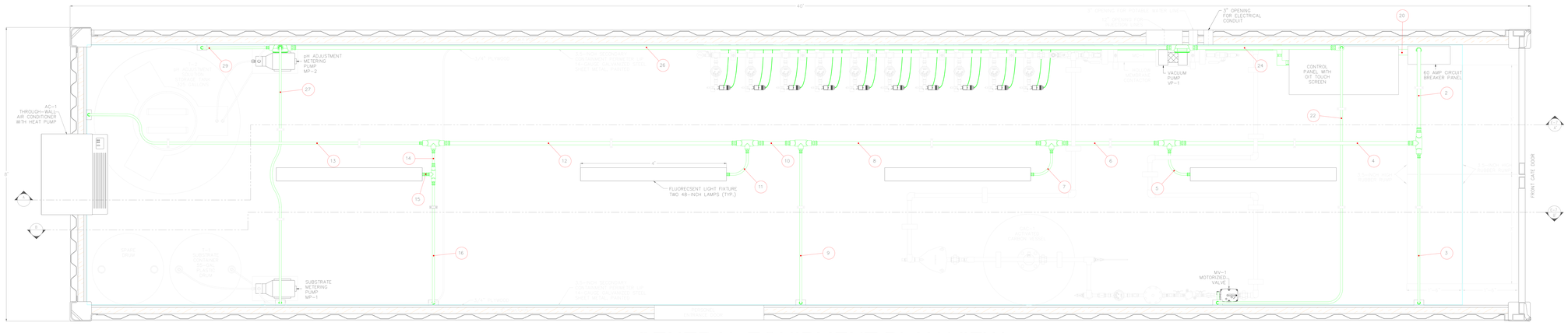
E-6 SHEET 2 OF 2

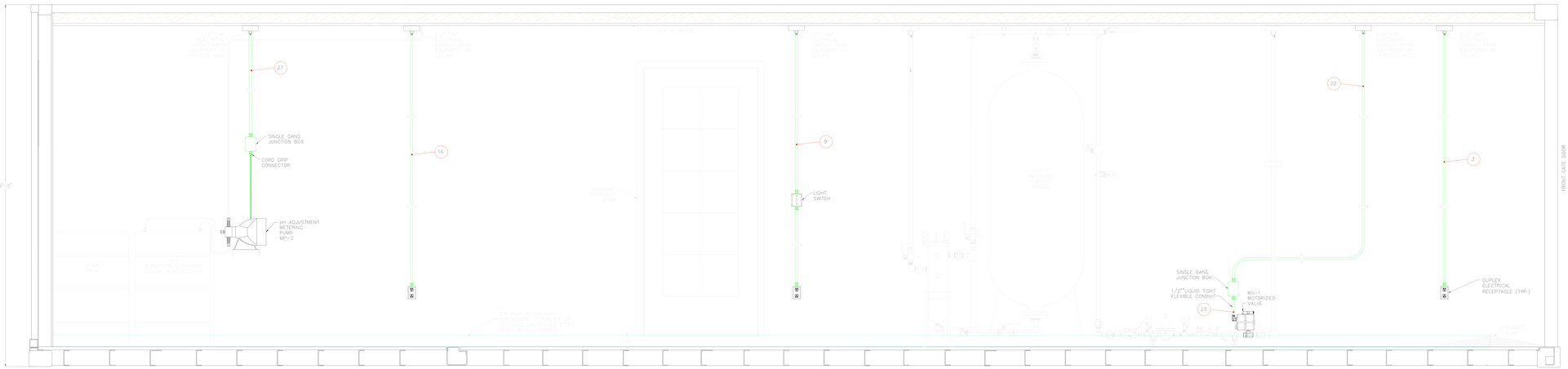
C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-6 ELECTRICAL EQUIPMENT AND CONDUITS.DWG DWM 5/31/13




# EQUIPMENT SIDE VIEW (A-A')




# GENERAL EQUIPMENT PLAN VIEW




# EQUIPMENT SIDE VIEW (B-B')

## CABLE AND RACEWAY LEGEND

| CODE | NUMBER AND SIZE OF CONDUCTORS | SIZE OF RACEWAY | TYPE OF RACEWAY | TYPE OF INSULATION | REMARKS |
|---|---|---|---|---|---|
| 1 | (3)#4, (1)#8G | 1" | EMT | THHN | SERVICE ENTRANCE CONDUCTORS (L1, L2, N, GND) |
| 2 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 3 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 4 | (5)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 5 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 6 | (7)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 7 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 8 | (7)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 9 | (4)#12 (1)#12G | 1/2" | EMT | THHN | INTERIOR LIGHTS & DUPLEX ELECTRICAL RECEPTICAL |
| 10 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 11 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 12 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 13 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL (HVAC UNIT) |
| 14 | (4)#12 (1)#12G | 1/2" | EMT | THHN | INTERIOR LIGHTS & DUPLEX ELECTRICAL RECEPTICAL |
| 15 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 16 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 17 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |

## CABLE AND RACEWAY LEGEND ( CONTINUED )

| CODE | NUMBER AND SIZE OF CONDUCTORS | SIZE OF RACEWAY | TYPE OF RACEWAY | TYPE OF INSULATION | REMARKS |
|---|---|---|---|---|---|
| 18 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 19 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 20 | (12)#12 (1)#10G | 2" | EMT | THHN | EQUIPMENT CONDUCTORS FROM 60 AMP MAIN PANEL |
| 21 | (10)#12 (2)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 22 | (2)#12 (1)#12G | 1/2" | EMT | THHN | POTABLE WATER SUPPLY MOV (MV-1) |
| 23 | (2)#12 (1)#12G | 1/2" | LGT | THHN | POTABLE WATER SUPPLY MOV (MV-1) |
| 24 | (8)#12 (1)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 25 | (2)#12 (1)#12G | 1/2" | EMT | THHN | VACUUM PUMP (VP-1) |
| 26 | (6)#12 (1)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 27 | (2)#12 (1)#12G | 1/2" | EMT | THHN | METERING PUMP (MP-1) |
| 28 | (2)#12 (1)#12G | 1/2" | EMT | THHN | METERING PUMP (MP-2) |
| 29 | (2)#12 (1)#12G | 1/2" | EMT | THHN | MIXING PUMP (MX-1) |
| 30 | (20)#14 (1)#14G | -- | -- | THHN | PVC WIRING DUCT WITH COVER – LOW VOLTAGE DC SOLENOID VALVES, PRESS, LEVEL & VAC. SWITCHES |
| 31 | (2) 1 PR. #22 | 1/2" | EMT | PVC | PRESSURE TRANS. (PT-1) & FLOW TRANS. (FMT-1) |
| 32 | (1) 1 PR. #22 | 1/2" | EMT | PVC | FLOW TRANS. (FMT-1) |

DRAWING SCALE

0" 12" 24" 36" 48"

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHEAST / NORTH INTERNAL WIRING DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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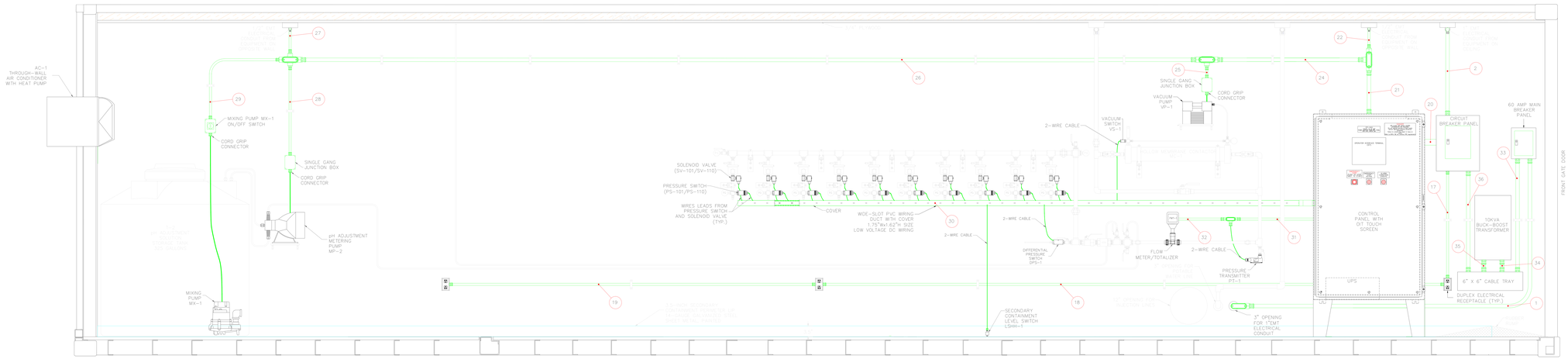
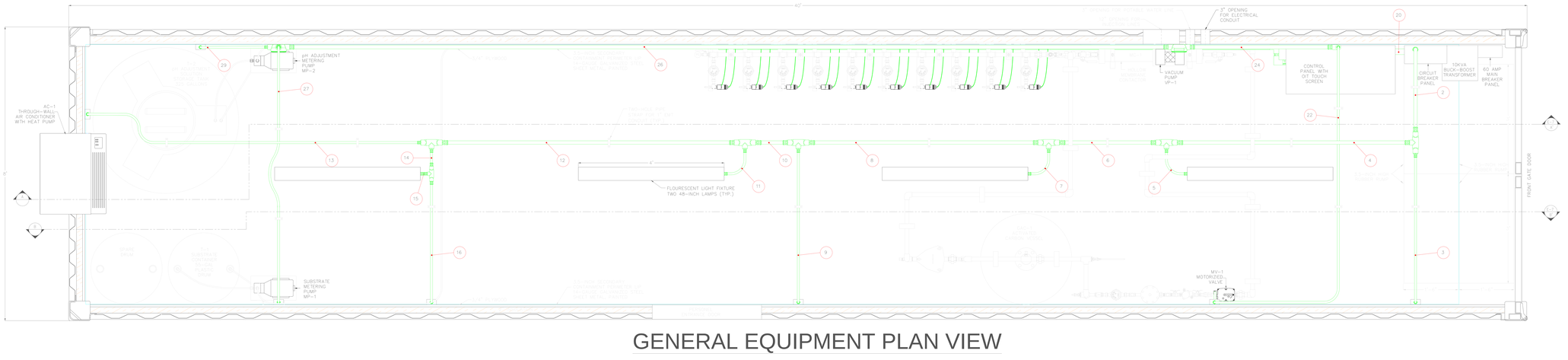
E-7 SHEET 1 OF 2

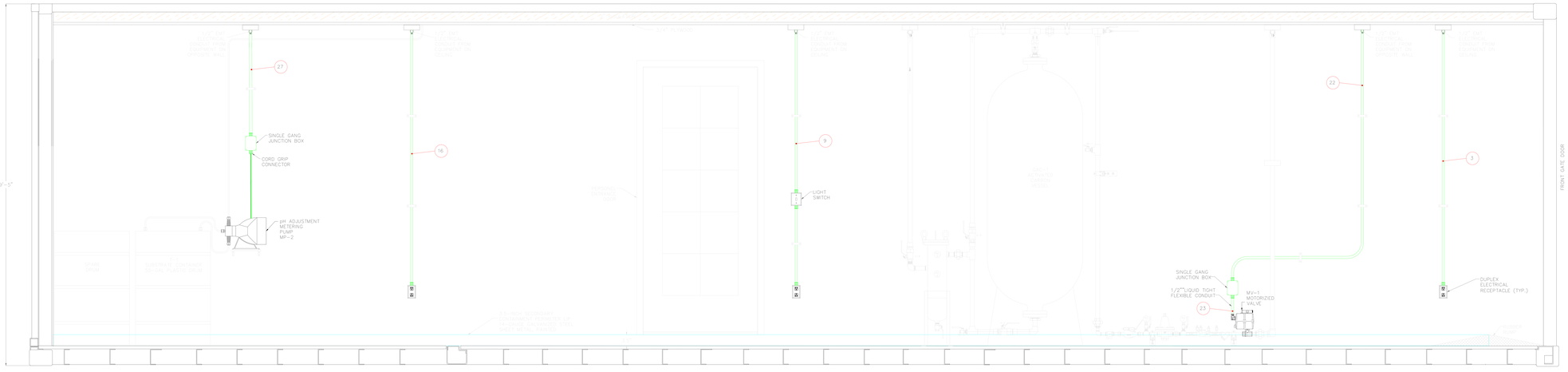
C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-7 INTERIOR WIRING DIAGRAM.DWG DWM 5/31/13




# EQUIPMENT SIDE VIEW (A-A')




# GENERAL EQUIPMENT PLAN VIEW




# EQUIPMENT SIDE VIEW (B-B')

## CABLE AND RACEWAY LEGEND

| CODE | NUMBER AND SIZE OF CONDUCTORS | SIZE OF RACEWAY | TYPE OF RACEWAY | TYPE OF INSULATION | REMARKS |
|---|---|---|---|---|---|
| 1 | (3)#4, (1)#8G | 1" | EMT | THHN | SERVICE ENTRANCE CONDUCTORS (L1, L2, N, GND) |
| 2 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 3 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 4 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 5 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 6 | (7)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 7 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 8 | (7)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 9 | (4)#12 (1)#12G | 1/2" | EMT | THHN | INTERIOR LIGHTS & DUPLEX ELECTRICAL RECEPTICAL |
| 10 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 11 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 12 | (6)#12 (1)#12G | 1" | EMT | THHN | UTILITY CONDUCTORS FROM 60A MAIN PANEL |
| 13 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL (HVAC UNIT) |
| 14 | (4)#12 (1)#12G | 1/2" | EMT | THHN | INTERIOR LIGHTS & DUPLEX ELECTRICAL RECEPTICAL |
| 15 | (2)#12 (1)#12G | 1/2" | EMT | THHN | ENCLOSURE INTERIOR LIGHTS |
| 16 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 17 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 18 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |
| 19 | (2)#12 (1)#12G | 1/2" | EMT | THHN | DUPLEX ELECTRICAL RECEPTICAL |

## CABLE AND RACEWAY LEGEND ( CONTINUED )

| CODE | NUMBER AND SIZE OF CONDUCTORS | SIZE OF RACEWAY | TYPE OF RACEWAY | TYPE OF INSULATION | REMARKS |
|---|---|---|---|---|---|
| 20 | (12)#12 (1)#10G | 2" | EMT | THHN | EQUIPMENT CONDUCTORS FROM 60 AMP MAIN PANEL |
| 21 | (10)#12 (2)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 22 | (2)#12 (1)#12G | 1/2" | EMT | THHN | POTABLE WATER SUPPLY MOV (MV-1) |
| 23 | (2)#12 (1)#12G | 1/2" | LOT | THHN | POTABLE WATER SUPPLY MOV (MV-1) |
| 24 | (8)#12 (1)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 25 | (2)#12 (1)#12G | 1/2" | EMT | THHN | VACUUM PUMP (VP-1) |
| 26 | (6)#12 (1)#12G | 1" | EMT | THHN | EQUIPMENT CONDUCTORS FROM PLC CONTROL PANEL |
| 27 | (2)#12 (1)#12G | 1/2" | EMT | THHN | METERING PUMP (MP-1) |
| 28 | (2)#12 (1)#12G | 1/2" | EMT | THHN | METERING PUMP (MP-2) |
| 29 | (2)#12 (1)#12G | 1/2" | EMT | THHN | MIXING PUMP (MX-1) |
| 30 | (2)#14 (1)#14G | --- | --- | THHN | PVC WIRING DUCT WITH COVER – LOW VOLTAGE DC SOLENOID VALVES, PRESS., LEVEL & VAC. SWITCHES |
| 31 | (2) 1 PR. #22 | 1/2" | EMT | PVC | PRESSURE TRANS. (PT-1) & FLOW TRANS. (FMT-1) |
| 32 | (1) 1 PR. #22 | 1/2" | EMT | PVC | FLOW TRANS. (FMT-1) |
| 33 | (3)#4, (1)#8G | 1" | EMT | THHN | WIRE WAY CONDUCTORS (L1, L2, N, GND) |
| 34 | (3)#4, (1)#8G | 1" | EMT | THHN | TRANSFORMER CONDUCTORS (L1, L2, N, GND) |
| 35 | (3)#4, (1)#8G | 1" | EMT | THHN | TRANSFORMER CONDUCTORS (L1, L2, N, GND) |
| 36 | (3)#4, (1)#8G | 1" | EMT | THHN | WIRE WAY CONDUCTORS (L1, L2, N, GND) |

DRAWING SCALE
0" 12" 24" 12" 0"

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHWEST INTERIOR WIRING DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 1/17/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH E |
| DRAWN BY: | MAC |
| CHECKED BY: | RB |

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E-7 SHEET 2 OF 2

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240/120V, 1 PH, 60A POWER SUPPLY,
SOUTHEAST FROM POWER PANEL INSIDE PUMP HOUSE
(ALTERNATE "NORTH" – POWER PANEL ON EXTERNAL
WALL OF CHEMICAL STORAGE BUILDING)

3–#4 AWG, 1–#8 GND, 1"C.

## PDP–1SE/1N

125A, 120/240V, 1 PHASE, 3 WIRE, 60 HZ, 65KA SHORT–CIRCUIT, NEMA 1, PANELBOARD W/CONVERTABLE MAIN LUG (20 CIRCUITS)

MAIN
L1
L2
60A
2P
N

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20A 2P | 15A 1P | 20A 1P | 20A 1P | 20A 1P | 20A 1P | 15A 1P | 20A 1P | 15A 1P | 15A 1P | 20A 1P |
| 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C | 2–#12 AWG, 1–#12 GND, 1/2"C |
| SPD SURGE PROTECTIVE DEVICE (36kA) | ENCLOSURE INTERIOR LIGHTS | GENERAL AREA RECEPTACLES (QTY 3) | GENERAL AREA RECEPTACLES (QTY 3) | CP–1SE/1N PLC CONTROL PANEL (16A) | H: 5600 BTU<br>C: 9200 BTU<br>T<br>HVAC–1 HEAT/COOL UNIT (14A) | M<br>MV–1 POTABLE WATER SUPPLY MOV (6W) | 1/3<br>VP–1 VACUUM PUMP (7.2A) | 1/25<br>MP–1 METERING PUMP (0.3A) | 1/25<br>MP–2 METERING PUMP (0.3A) | 1/4<br>MX–2 TANK T–2 MIXER (5.8A) |

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STATE OF MARYLAND — DEBRA A. PIKEY — NO. 21605 — REGISTERED PROFESSIONAL ENGINEER

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHEAST / NORTH TCE AREA ELECTRICAL
SINGLE LINE DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH B |
| DRAWN BY: | DWM |
| CHECKED BY: | RB |

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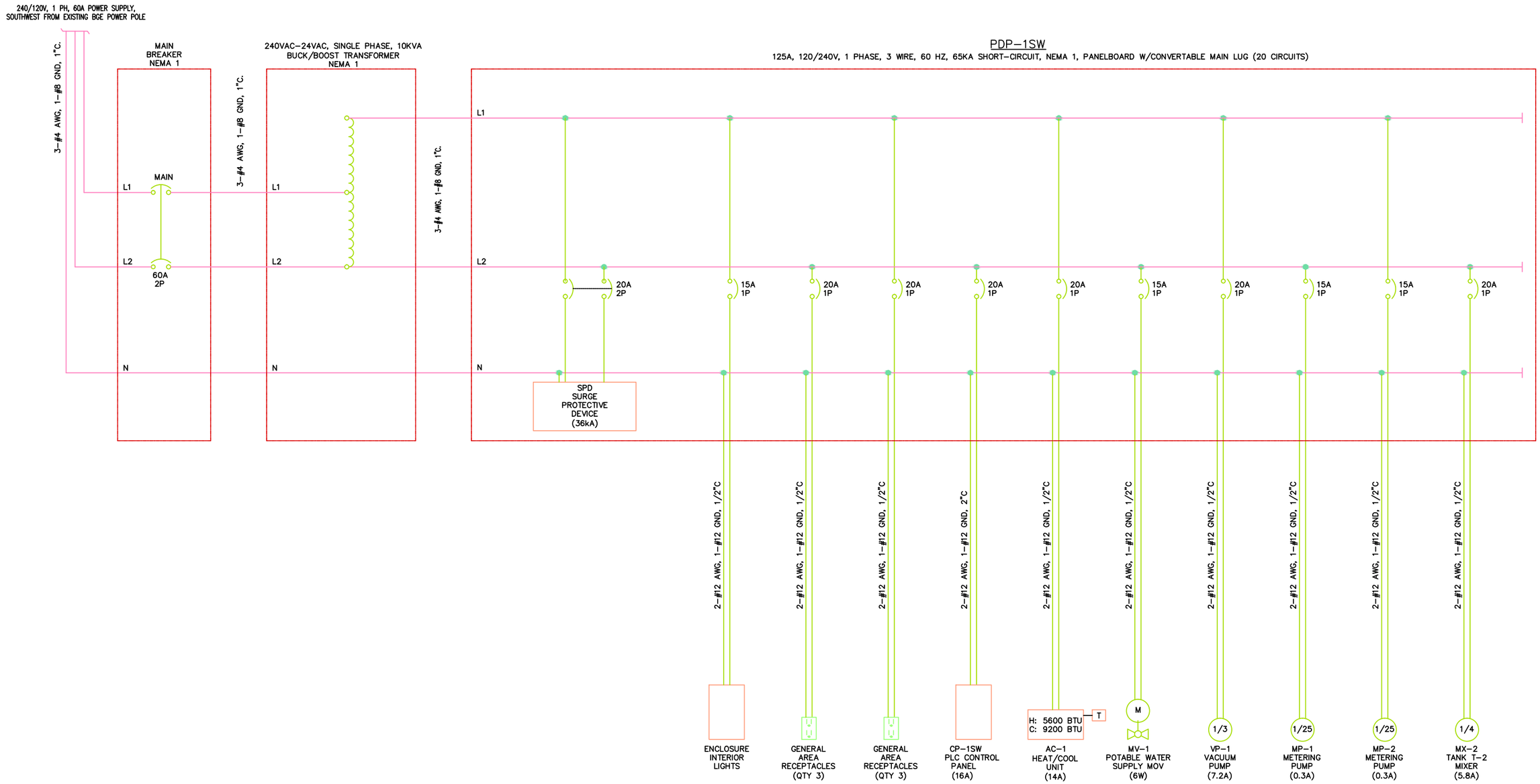
C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-8 SINGLE LINE ELECTRICAL DIAGRAMS.DWG DWM 5/31/13




TETRA TECH

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STATE OF MARYLAND
PETER A. RICH
NO. 20069
REGISTERED PROFESSIONAL ENGINEER
6/31/13

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

SOUTHWEST TCE AREA ELECTRICAL SINGLE LINE DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH B |
| DRAWN BY: | DWM |
| CHECKED BY: | RB |

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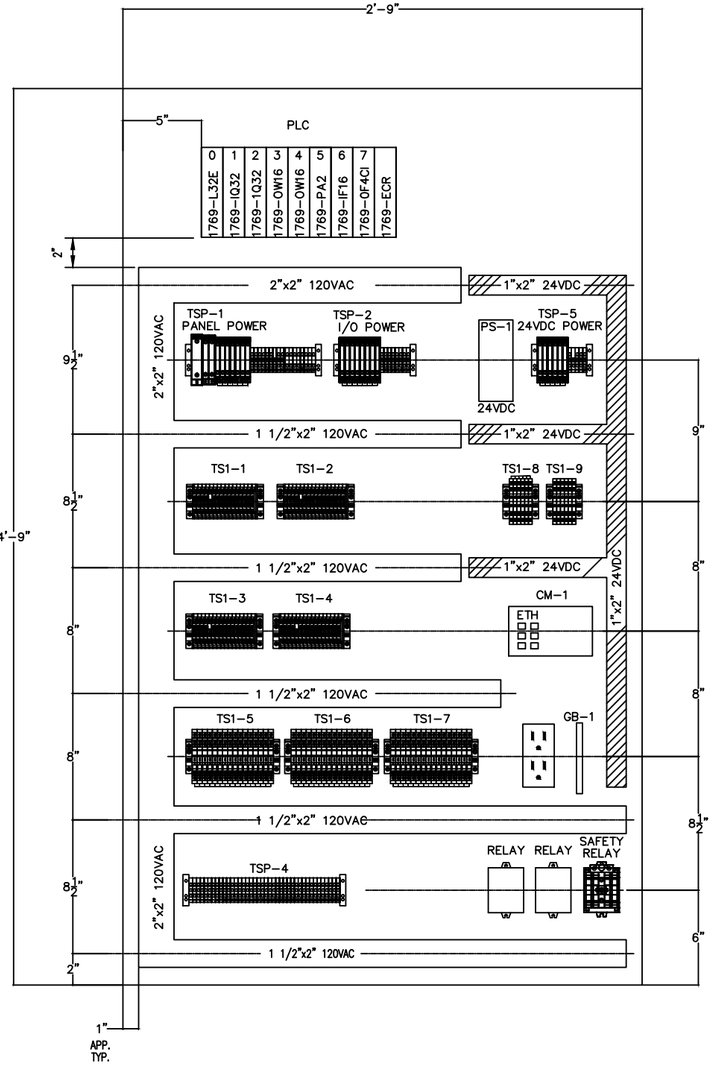
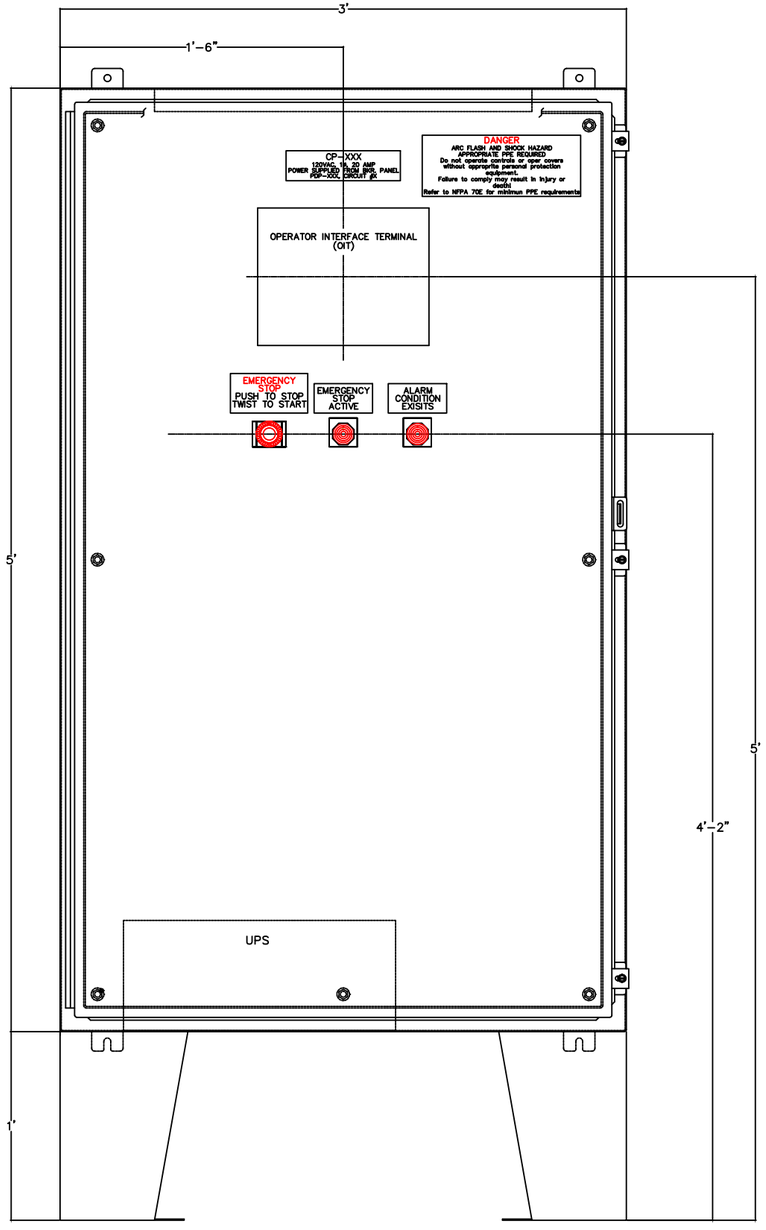
E-8 SHEET 2 OF 2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-8 SINGLE LINE ELECTRICAL DIAGRAMS.DWG DWM 5/31/13




SUBPANEL ARRANGEMENT
SCALE: 1 1/2" = 1'-0"




FRONT VIEW – ENCLOSURE
SCALE: 1 1/2" = 1'-0"

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| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

CONTROL PANEL LAYOUT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
| DATE: | 5/31/13 |
| PROJECT NO.: | 112IC03835 |
| DWG. SIZE: | ARCH B |
| DRAWN BY: | RJD |
| CHECKED BY: | RB |

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E-9

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\90% DESIGN\90% DRAWINGS\NES 90% DRAWINGS\E-9 & 10 CONTROL PANEL.DWG DWM 5/31/13

## SOUTHEAST/NORTH BILL OF MATERIALS

| ITEM NO. | QUAN. | TAG | MANUFACTURER MODEL | DESCRIPTION |
|---|---|---|---|---|
| 1 | 1 | CP–XXX | HOFFMAN A603629LP | 60" x 36" x 20" NEMA 12 ENCLOSURE<br>SINGLE DOOR |
| 2 | 2 | – | HOFFMAN A60P36 | 57" x 33" SUBPANEL |
| 3 | 3 | – | HOFFMAN AFK1220 | FLOOR STAND KIT<br>2 STANDS PER KIT |
| 4 | 2 | – | HOFFMAN XPV–32 | VENT KIT |
| 5 | 4 | – | HOFFMAN A–LFSWD | DOOR ACTIVATED SWITCH |
| 6 | 5 | – | – | 2'–0" FLUORESCENT STRIP LIGHT<br>(1) LAMP (W/LAMP SHIELD), 40 WATT |
| 7 | – | PLC | ALLEN–BRADLEY COMPACT LOGIX SERIES I/O | COMPACT LOGIX PLC CONSISTING OF:<br>(1) 1769–ECR END CAP RIGHT<br>(1) 1769–PA2 PWR SUPPLY<br>(1) 1769–L32E PROCESSOR<br>(2) 1769–IQ32 24VDC INPUT MODULE<br>(2) 1769–OW16 RELAY CONTACT OUTPUT MODULES<br>(1) 1769–IF6 ISOLATED ANALOG INPUT MODULE<br>(1) 1769–OF4CI ISOLATED ANALOG OUTPUT MODULE<br>(1) 1769–CRL3 EXPANSION CABLE |
| 8 | 1 | OIT | C–MORE EA7–T12C | 12 INCH COLOR TFT<br>TOUCH PANEL W/BUILT IN ETHERNET |
| 9 | 1 | – | C–MORE USB–CBL–AB15 | USB 2.0, TYPE A–B CONNECTOR CABLE,<br>15 FT. LENGTH |
| 10 | 1 | – | SANDISK SDCZ4–2048–A10 | 2GB SANDISK CRUZER USB MEMORY DEVICE |
| 11 | 1 | GB–1 | SQUARE D PK9GTA | GROUNDING BLOCK |
| 12 | 1 | – | PHOENIX CONTACT 5600461 | DUPLEX RECEPTACLE – 15A |
| 13 | 1 | PS–1 | PHOENIX CONTACT 2938581 | QUINT SERIES 24VDC POWER SUPPLY<br>5 AMP |
| 14 | 1 | – | SQUARE D ZB5AS54 | EMERGENCY STOP PUSHBUTTON, MUSHROOM HEAD<br>TWIST TO UNLOCK, TYPE 4/4X/13, 22 mm |
| 15 | 2 | – | SQUARE D ZB5AVG4/ZB5AV043 | PILOT LIGHT RED, LED<br>TYPE 4/4X/13, 22 mm |
| 16 | 2 | – | SQUARE D ZBZ33 | STANDARD NAMEPLATE LEGEND MOUNTING BRACKET<br>LEDGEND – AS REQUIRED |
| 17 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 2"x2"<br>W/COVER (WHITE = 120VAC) |
| 18 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 1 1/2"x2"<br>W/COVER (WHITE = 120VAC) |
| 19 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 1"x2"<br>W/COVER (GRAY = 24VDC) |
| 20 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 10.3 x 38mm (TSP–1, 20 A MAIN)<br>BUSSMAN LP–CC SERIES, LOW PEAK, TIME DELAY |
| 21 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 6.3 x 32mm (TSP–1, 10 A FUSE F01, F02)<br>BUSSMAN MDL SERIES, TIME DELAY, GLASS TUBE |
| 22 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 5x20mm (GENERAL PURPOSE)<br>BUSSMAN GMA SERIES, FAST ACTING, GLASS TUBE |
| 23 | 1 | UPS | APC SMT 1500 | APC SMART UPS 120VAC/1500VA<br>USE "RBC7" REPLACEMENT BATTERY CARTRIDGES |
| 24 | 1 | – | SIERRA | CELLULAR MODEM PACKAGE CONSISTING OF:<br>V2221E–VA VERIZON CELLULAR MODEM<br>100–170–1015 MODEM BRACKET<br>301125 3dBi Pmni N MAG MOUNT ANTENNA W/15 FT. PIGTAIL |
| 25 | 1 | – | DELL | LAPTOP, WINDOWS 7 W/ MICROSOFT OFFICE,<br>4GB RAM, 250GB HARD DRIVE |
| 26 | 1 | – | ROCKWELL AUTOMATION 9324–RLD300ENE | RSLOGIX 5000 STANDARD EDITION<br>(NODE LOCKED) PROGRAMMING SOFTWARE |
| 27 | 1 | – | ROCKWELL AUTOMATION 1756–CP3 | LOGIX 5000 PROGRAMMING CABLE |
| 28 | 1 | – | C–MORE EA–PGMSW | TOUCH PANEL PROGRAMMING SOFTWARE |

## SOUTHWEST BILL OF MATERIALS

| ITEM NO. | QUAN. | TAG | MANUFACTURER MODEL | DESCRIPTION |
|---|---|---|---|---|
| 1 | 1 | CP–XXX | HOFFMAN A603629LP | 60" x 36" x 20" NEMA 12 ENCLOSURE<br>SINGLE DOOR |
| 2 | 2 | – | HOFFMAN A60P36 | 57" x 33" SUBPANEL |
| 3 | 3 | – | HOFFMAN AFK1220 | FLOOR STAND KIT<br>2 STANDS PER KIT |
| 4 | 2 | – | HOFFMAN XPV–32 | VENT KIT |
| 5 | 4 | – | HOFFMAN A–LFSWD | DOOR ACTIVATED SWITCH |
| 6 | 5 | – | – | 2'–0" FLUORESCENT STRIP LIGHT<br>(1) LAMP (W/LAMP SHIELD), 40 WATT |
| 7 | – | PLC | ALLEN–BRADLEY COMPACT LOGIX SERIES I/O | COMPACT LOGIX PLC CONSISTING OF:<br>(1) 1769–ECR END CAP RIGHT<br>(1) 1769–PA2 PWR SUPPLY<br>(1) 1769–L32E PROCESSOR<br>(2) 1769–IQ32 24VDC INPUT MODULE<br>(2) 1769–OW16 RELAY CONTACT OUTPUT MODULES<br>(1) 1769–IF6 ISOLATED ANALOG INPUT MODULE<br>(1) 1769–OF4CI ISOLATED ANALOG OUTPUT MODULE<br>(1) 1769–CRL3 EXPANSION CABLE |
| 8 | 1 | OIT | C–MORE EA7–T12C | 12 INCH COLOR TFT<br>TOUCH PANEL W/BUILT IN ETHERNET |
| 9 | 1 | – | C–MORE USB–CBL–AB15 | USB 2.0, TYPE A–B CONNECTOR CABLE,<br>15 FT. LENGTH |
| 10 | 1 | – | SANDISK SDCZ4–2048–A10 | 2GB SANDISK CRUZER USB MEMORY DEVICE |
| 11 | 1 | GB–1 | SQUARE D PK9GTA | GROUNDING BLOCK |
| 12 | 1 | – | PHOENIX CONTACT 5600461 | DUPLEX RECEPTACLE – 15A |
| 13 | 1 | PS–1 | PHOENIX CONTACT 2938581 | QUINT SERIES 24VDC POWER SUPPLY<br>5 AMP |
| 14 | 1 | – | SQUARE D ZB5AS54 | EMERGENCY STOP PUSHBUTTON, MUSHROOM HEAD<br>TWIST TO UNLOCK, TYPE 4/4X/13, 22 mm |
| 15 | 2 | – | SQUARE D ZB5AVG4/ZB5AV043 | PILOT LIGHT RED, LED<br>TYPE 4/4X/13, 22 mm |
| 16 | 2 | – | SQUARE D ZBZ33 | STANDARD NAMEPLATE LEGEND MOUNTING BRACKET<br>LEDGEND – AS REQUIRED |
| 17 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 2"x2"<br>W/COVER (WHITE = 120VAC) |
| 18 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 1 1/2"x2"<br>W/COVER (WHITE = 120VAC) |
| 19 | AS REQ'D | – | PANDUIT OR EQUIVALENT | SLOTTED DUCT – 1"x2"<br>W/COVER (GRAY = 24VDC) |
| 20 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 10.3 x 38mm (TSP–1, 20 A MAIN)<br>BUSSMAN LP–CC SERIES, LOW PEAK, TIME DELAY |
| 21 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 6.3 x 32mm (TSP–1, 10 A FUSE F01, F02)<br>BUSSMAN MDL SERIES, TIME DELAY, GLASS TUBE |
| 22 | AS REQ'D | – | BUSSMAN OR EQUIVALENT | FUSE, 5x20mm (GENERAL PURPOSE)<br>BUSSMAN GMA SERIES, FAST ACTING, GLASS TUBE |
| 23 | 1 | UPS | APC SMT 1500 | APC SMART UPS 120VAC/1500VA<br>USE "RBC7" REPLACEMENT BATTERY CARTRIDGES |
| 24 | 1 | – | SIERRA | CELLULAR MODEM PACKAGE CONSISTING OF:<br>V2221E–VA VERIZON CELLULAR MODEM<br>100–170–1015 MODEM BRACKET<br>301125 3dBi Pmni N MAG MOUNT ANTENNA W/15 FT. PIGTAIL |

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STATE OF MARYLAND — ROBERT A. RIVET — NO. 20695 — REGISTERED PROFESSIONAL ENGINEER

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CONTROL SYSTEM BILL OF MATERIALS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
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| DWG. SIZE: | ARCH B |
| DRAWN BY: | RJD |
| CHECKED BY: | RB |

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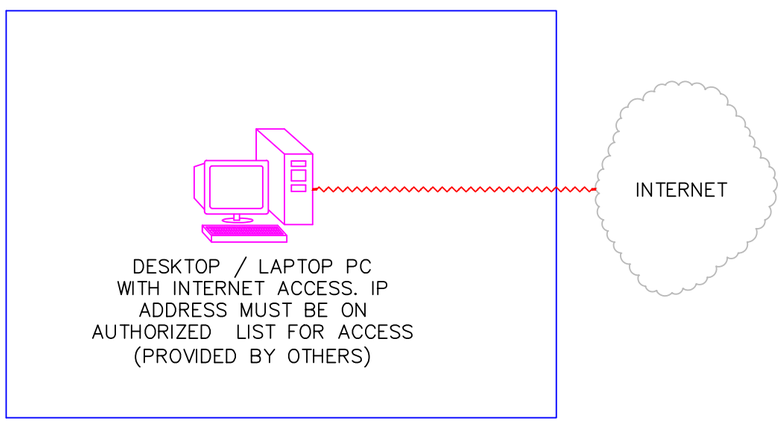
NOTES:

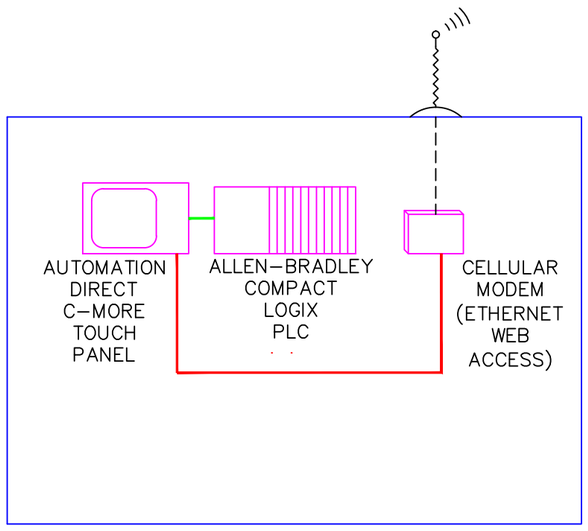
1. SITE SOFTWARE IS ACCESSED THROUGH THE AUTOMATION DIRECT C–MORE TOUCH SCREEN OVER THE WEB VIA A SECURE STATIC IP ADDRESS, USER ID AND PASSWORD.

2. SITE SOFTWARE RESIDES ON C–MORE TOUCH SCREEN PANEL,

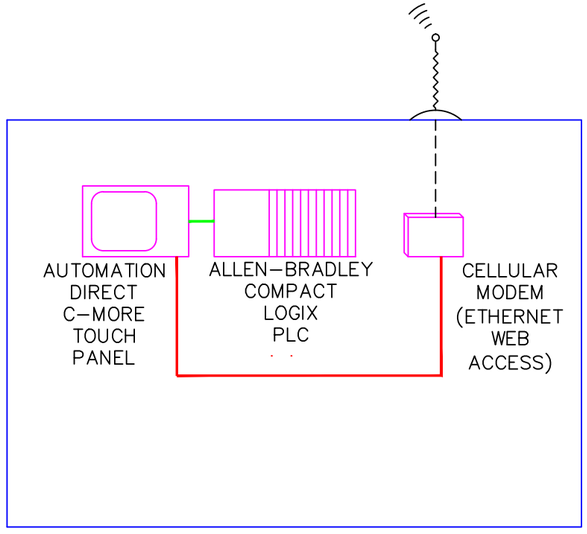
3. TWO LEVELS OF SECURITY ACCESS WILL ALLOW REMOTE CONTROL AND DATA ACQUISITION OR VISUAL OPERATIONAL STATUS ONLY.

REMOTE OFFICE




SOUTHEAST/NORTH TCE AREA




SOUTHWEST TCE AREA

LEGEND:

- ETHERNET
- SERIAL RS232
- CELLULAR TRANSMISSION
- INTERNET CONNECTION

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STATE OF MARYLAND PETER A. RICH NO. 20656 REGISTERED PROFESSIONAL ENGINEER 6/31/13

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# CONTROL SYSTEM ARCHITECTURE
## 100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**E-11**

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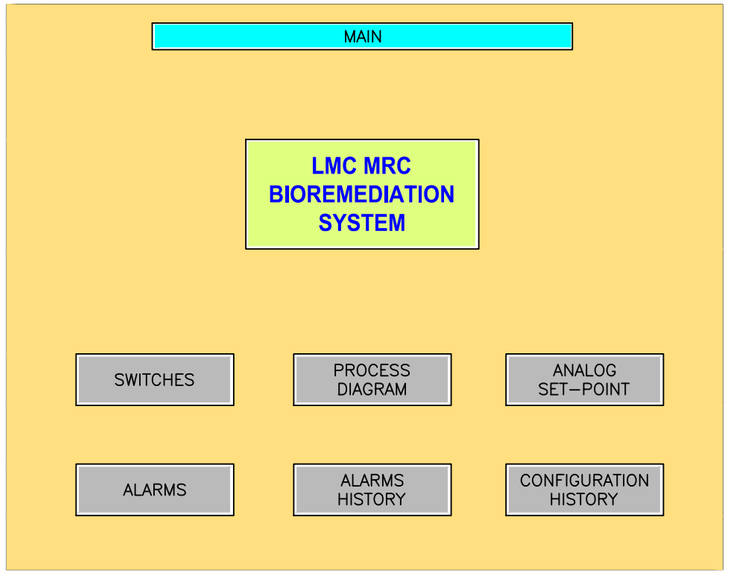


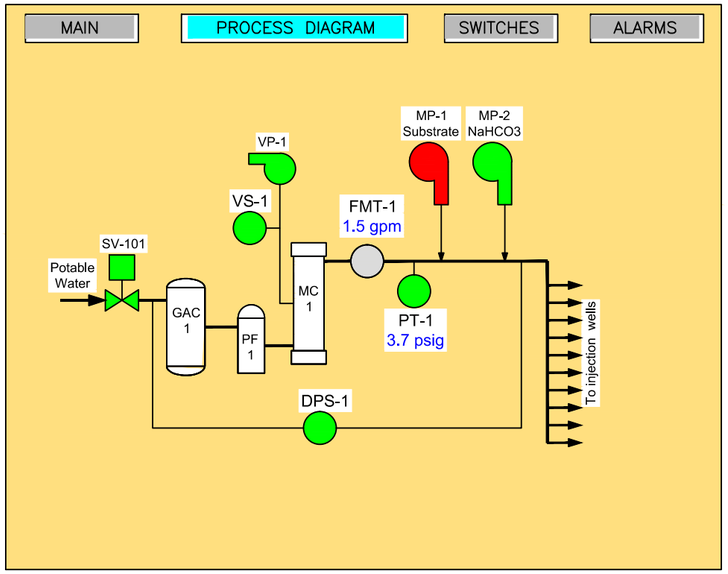


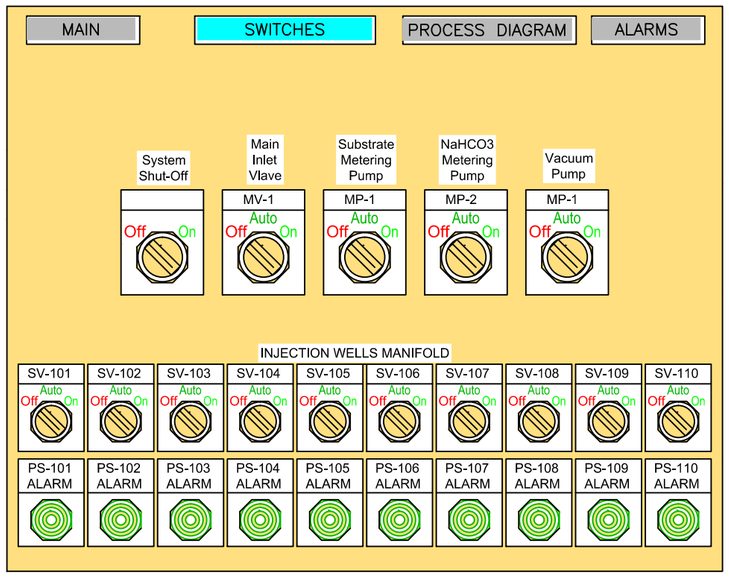


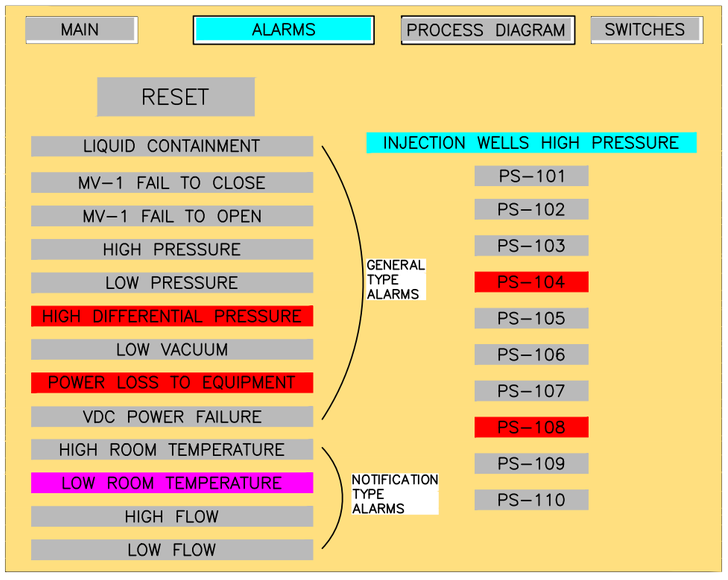


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HMI SCREEN LAYOUT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

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DRAWING E-12

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ENCLOSED EQUIPMENT TRAILER

SUBSTRATE CONTAINER 55-GAL DRUM

VARY SPEED IN PROPORTION TO FLOW IN INJECTION MANIFOLD TO MAINTAIN CONSTANT SUBSTRATE CONCENTRATION. TURN PUMP OFF AT ZERO FLOW.

SUBSTRATE METERING PUMP

pH BUFFER 330-GAL POLY TANK

VARY SPEED IN PROPORTION TO FLOW IN INJECTION MANIFOLD TO MAINTAIN CONSTANT BUFFER CONCENTRATION. TURN PUMP OFF AT ZERO FLOW.

MIXING PUMP WITH SIDE OUTLET

pH BUFFER METERING PUMP

PRESSURE TRANSMITTER

PT

FLOW SENSOR WITH TOTALIZER

FMT

MECHANICAL FLOW TOTALIZER

FT

DIFFERENTIAL PRESSURE SWITCH

DPS

MOTORIZED VALVE (CLOSE IN CASE OF ALARM OR LOSS OF POWER)

DOUBLE-CHECK VALVE BACKFLOW PREVENTER ASSEMBLY

STRAINER

POTABLE WATER LINE

200 LBS GRANULAR ACTIVATED CARBON COLUMN FOR RESIDUAL CHLORINE REMOVAL

FIBERGLASS, 150 PSI MAX PRESSURE

HOLLOW MEMBRANE DISSOLVED-OXYGEN REMOVAL CONTACTOR 30 GPM MAX FLOW

VS VACUUM SWITCH

VACUUM PUMP (¼ HP)

PARTICULATE FILTER 5 MICRONS

1-INCH INJECTION MANIFOLD (10 BRANCHES)

MT

PS

FLOW-CONTROL NEEDLE VALVE

MECHANICAL FLOW TOTALIZER

SOLENOID VALVE

CLOSE SOLENOID VALVE IF HIGH PRESSURE SET-POINT EXCEEDED. REMOTE ON/OFF CONTROL

PRESSURE SWITCH

TRANSITION TO 3/8" ID FLEX TUBING

TRANSITION TO 3/4" PEX TUBING

NOTE:
DIFFERENT COMBINATIONS OF INJECTION WELLS ARE PERIODICALLY CONNECTED TO MANIFOLD

INDIVIDUAL LINES TO INJECTION WELLS
39 WELLS IN SOUTHWEST TCE AREA
24 WELLS IN SOUTHEAST TCE AREA
8 WELLS IN NORTH TCE AREA

3/4" LDPE PEX TUBING UNDERGROUND (TYPICAL)

WELL BOX

WELLHEAD VENT VALVE

WELLHEAD PRESSURE GAUGE

4" SCH 80 PVC TEE

1/2" ID FLEXIBLE DROP TUBE

4" PVC SCH 80

4" SCH 80 PVC INJECTION WELL (TYPICAL)

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GENERAL PROCESS FLOW DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**FIGURE M-1**

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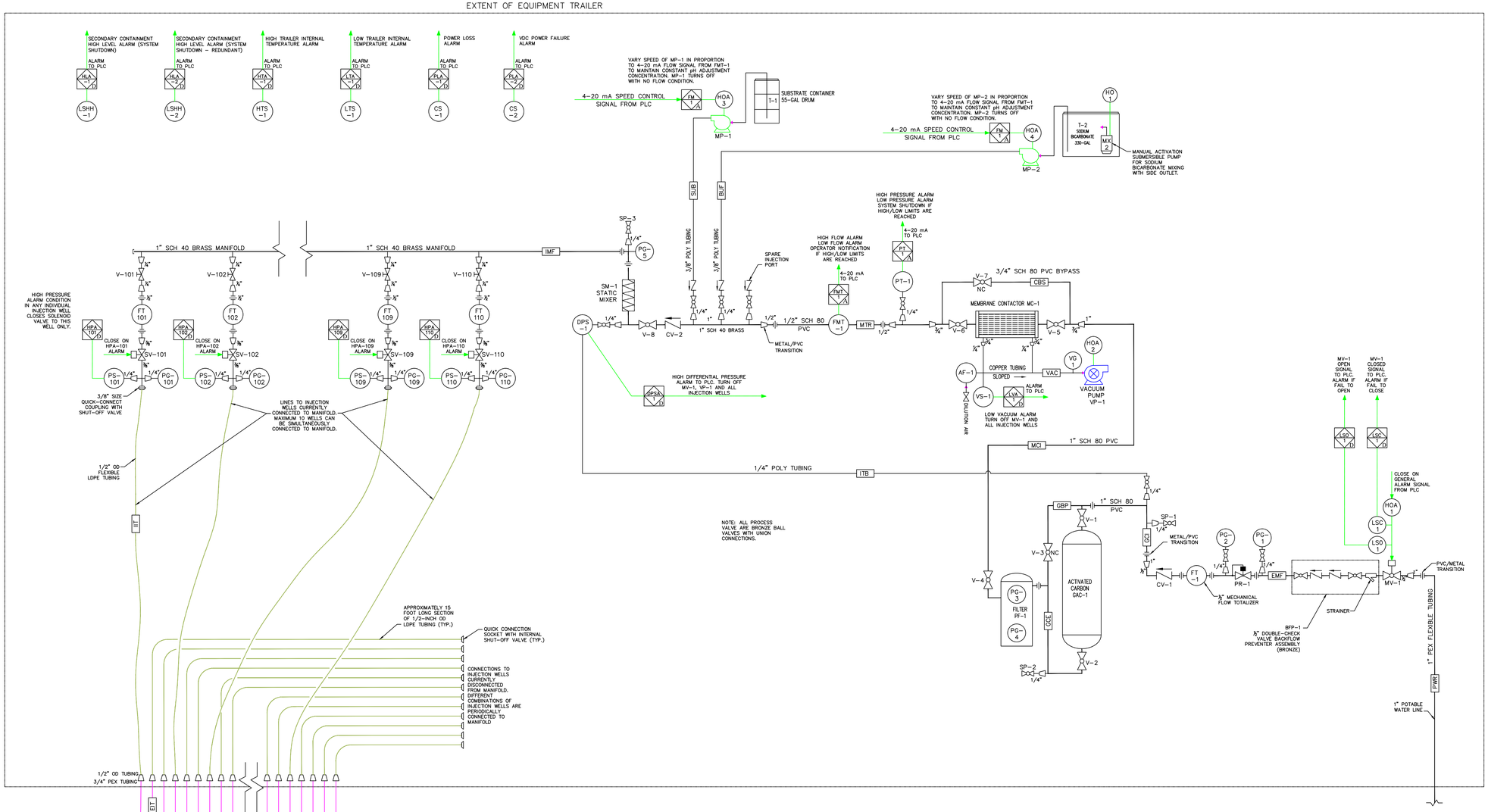
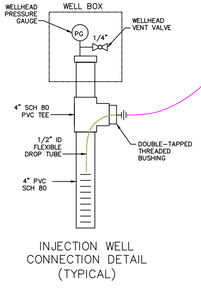
EXTENT OF EQUIPMENT TRAILER




NOTE: ALL PROCESS VALVE ARE BRONZE BALL VALVES WITH UNION CONNECTIONS.

**GENERAL ALARMS**

| CONDITION | DEVICE | PLC INPUT TYPE | ACTION TYPE | ACTION DESCRIPTION |
|---|---|---|---|---|
| LIQUID IN SECONDARY CONTAINMENT | LSHH–1, LSHH–2 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN LIQUID SENSED: DE–ENERGIZE MV–1, SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| HIGH PRESSURE | PT–1 | ANALOG SIGNAL | GENERAL ALARM (LATCHING) | WHEN > 30 psig: DE–ENERGIZE MV–1, SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| LOW PRESSURE | PT–1 | ANALOG SIGNAL | GENERAL ALARM (LATCHING) | WHEN < 5 psig: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| HIGH DIFFERENTIAL PRESSURE | DPS–1 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN > 10 psig: DE–ENERGIZE MV–1, SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| LOW VACUUM | VS–1 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN < 20"Hg: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| MV–1 FAILS TO OPEN | LSO–1 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN TRIGERED: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| MV–1 FAILS TO CLOSE | LSC–1 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN TRIGERED: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| LOSS OF POWER | CS–1 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN TRIGERED: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| VDC POWER SUPPLY FAILURE | CS–2 | DISCRETE SIGNAL | GENERAL ALARM (LATCHING) | WHEN TRIGERED: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| | | | | |
| HIGH FLOW | FMT–1 | ANALOG SIGNAL | NOTIFICATION ALARM | WHEN FLOW INCREASES > 15% IN < 1 MINUTE: SEND OPERATOR NOTIFICATION |
| LOW PRESSURE | PT–1 | ANALOG SIGNAL | GENERAL ALARM (LATCHING) | WHEN < 5 psig: DE–ENERGIZE MV–1,SV–101 to SV–110, MP–1, MP–2, VP–1. SEND OPERATOR NOTIFICATION |
| **NOTIFICATION ALARMS** | | | | |
| INDIVIDUAL INJECTION WELL HIGH PRESSURE | PS–101 TO PS–110 | DISCRETE SIGNAL | LOCAL ALARM (LATCHING) | WHEN SET–POINT EXCEEDED ( (1 PSIG FOR SE AREA, 2 PSIG SW AREA, 8 PSIG FOR NORTH AREA): DE–ENERGIZE INDIVIDUAL SOLENOID VALVE (PS–101 TO PS–110). SEND OPERATOR NOTIFICATION. |
| HIGH FLOW | FMT–1 | ANALOG SIGNAL | NOTIFICATION ALARM (LATCHING) | WHEN FLOW INCREASES > 15% IN < 1 MINUTE: SEND OPERATOR NOTIFICATION |
| LOW FLOW | FMT–1 | ANALOG SIGNAL | NOTIFICATION ALARM (LATCHING) | WHEN FLOW DECREASES > 15% IN < 1 MINUTE: SEND OPERATOR NOTIFICATION |
| HIGH EQUIPMENT ENCLOSURE TEMPERATURE | HTS–1 | DISCRETE SIGNAL | NOTIFICATION ALARM (LATCHING) | WHEN > 80°F: SEND OPERATOR NOTIFICATION |
| LOW EQUIPMENT ENCLOSURE TEMPERATURE | HTS–1 | DISCRETE SIGNAL | NOTIFICATION ALARM (LATCHING) | WHEN < 40°F: SEND OPERATOR NOTIFICATION |
| **PID LOOPS** | | | | |
| SUBSTRATE METERING PUMP CONTROL SIGNAL | MP–1 | ANALOG SIGNAL FROM FMT–1 | CONTROL SIGNAL | SIGNAL TO LOCAL PUMP CONTROL. ADJUST SPEED IN PROPORTION TO FLOW. SCALING FACTOR ENTERED BY OPERATOR. |
| BUFFER METERING PUMP CONTROL SIGNAL | MP–2 | ANALOG SIGNAL FROM FMT–1 | CONTROL SIGNAL | SIGNAL TO LOCAL PUMP CONTROL. ADJUST SPEED IN PROPORTION TO FLOW. SCALING FACTOR ENTERED BY OPERATOR. |




INJECTION WELL CONNECTION DETAIL (TYPICAL)

## LEGEND

- FIELD MOUNTED INSTRUMENT
- PLC FUNCTION (ANALOG)
- PLC FUNCTION (DISCRETE)
- PUMP AND MOTOR
- BLOWER/VACUUM PUMP
- PIPE SIZE CHANGE
- PROCESS BALL VALVE
- CHECK VALVE
- MOTORIZED BALL VALVE
- SOLENOID VALVE
- PRESSURE REGULATING VALVE
- FLOW CONTROL NEEDLE VALVE
- IMF SERVICE DESIGNATION LABEL
- UNION/COMPRESSION FITTING
- PACKAGED EQUIPMENT
- ELECTRICAL CONNECTION
- MAIN PIPING
- SECONDARY PIPING
- FLEXIBLE PIPE

## ABBREVIATIONS

| | |
|---|---|
| AF | AIR FLOW METER |
| CV | CHECK VALVE |
| PR | PRESSURE REGULATOR |
| DPS | DIFFERENTIAL PRESSURE SWITCH |
| DPSA | DIFFERENTIAL PRESSURE ALARM |
| FMT | FLOW METER/TOTALIZER |
| GAC | GRANULAR ACTIVATED CARBON |
| HO | HAND OFF SELECTOR SWITCH |
| HOA | HAND OFF AUTO SELECTOR SWITCH |
| HPA | HIGH PRESSURE ALARM |
| IW | INJECTION WELL |
| LSO | LIMIT SWITCH VALVE OPEN |
| LVS | LIMIT SWITCH VALVE CLOSED |
| LVA | LOW VACUUM ALARM |
| MC | HOLLOW MEMBRANE CARTRIDGE |
| MP | METERING PUMP |
| PF | PARTICULATE FILTER |
| PG | PRESSURE GAUGE |
| PS | PRESSURE SWITCH |
| PT | PRESSURE TRANSMITTER |
| PVC | POLYVINYL CHLORIDE |
| SV | SOLENOID VALVE |
| V | VALVE |
| FT | MECHANICAL FLOW TOTALIZER |

## SERVICE DESIGNATION

| | |
|---|---|
| IMF | INJECTION MANIFOLD |
| SUB | SUBSTRATE |
| BUF | BUFFERING AGENT |
| MTR | METERING LINE |
| CBP | MEMBRANE CONTACTOR BY–PASS |
| VAC | VACUUM LINES |
| MCI | MEMBRANE CONTACTOR INFLUENT |
| GBP | GAC BY–PASS |
| GCI | GAC INFLUENT |
| GCE | GAC EFFLUENT |
| EMF | ENTRANCE MANIFOLD |
| PWR | INCOMING POTABLE WATER |
| ITB | INSTRUMENTATION TUBING |
| IIT | INTERIOR INJECTION TUBING |
| EIT | EXTERIOR INJECTION TUBING |

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STATE OF MARYLAND — DEBRA A. RICH — NO. 21663 — REGISTERED PROFESSIONAL ENGINEER — 6/7/13

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PROCESS AND INSTRUMENTATION DIAGRAM
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-2**

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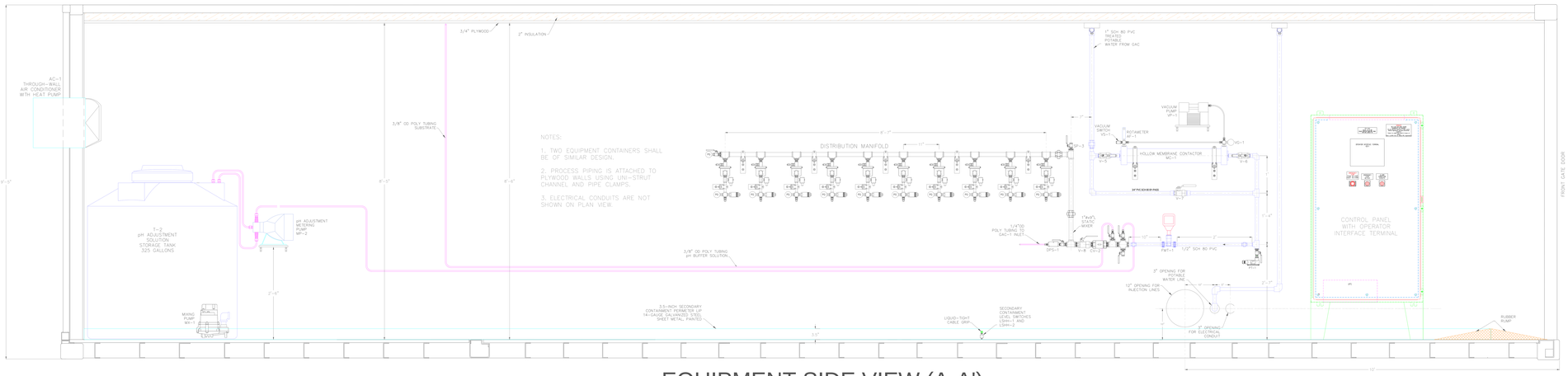
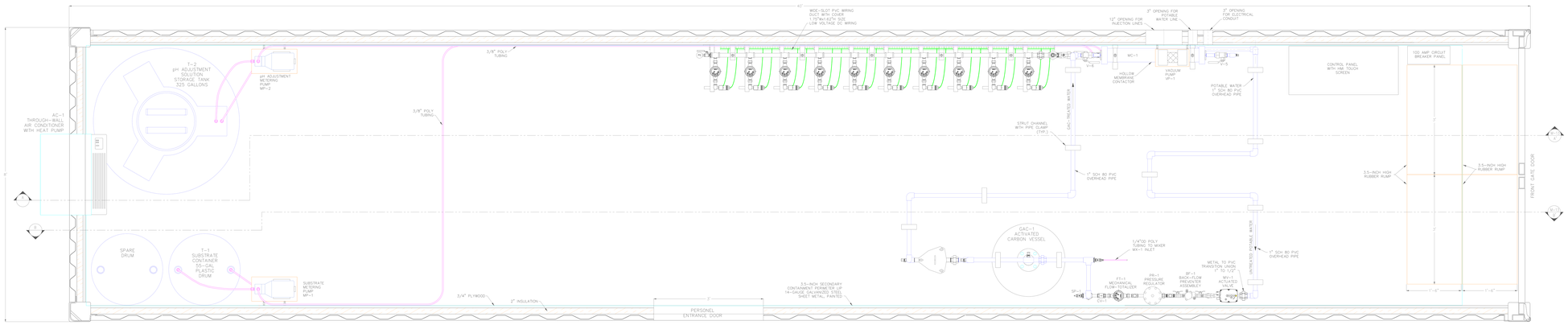
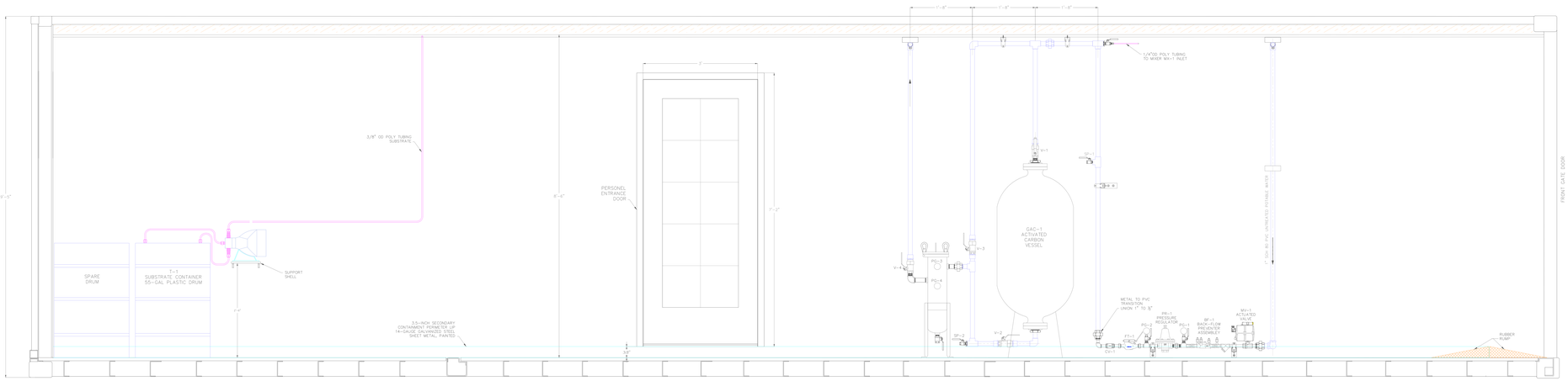



EQUIPMENT SIDE VIEW (A-A')




GENERAL EQUIPMENT PLAN VIEW




EQUIPMENT SIDE VIEW (B-B')

DRAWING SCALE

0" 12" 24" 3' 6"

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EQUIPMENT CONTAINER GENERAL ARRANGEMENT
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-3**

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NOTES:

1. ALL METAL CONNECTIONS ARE NATIONAL PIPE THREAD. ALL PVC CONNECTIONS ARE SOCKET CEMENTED JOINTS.

2. THREAD JOINTS DESIGNATION
MNPT – MALE NATIONAL PIPE THREAD.
FNPT – FEMALE NATIONAL PIPE THREAD.

1" SCH 80 PVC TREATED POTABLE WATER FROM GAC
2" INSULATION
3/4" PLYWOOD
1" ELECTRICAL CONDUIT
1" ELECTRICAL CONDUIT FROM EQUIPMENT ON OPPOSITE WALL
1" EMT ELECTRICAL CONDUIT FROM EQUIPMENT ON CEILING
1" EMT ELECTRICAL CONDUIT
SCH 80 PVC UNTREATED POTABLE WATER
1/4" COPPER TUBING
VP-1 VACUUM PUMP
7"
VS-1 VACUUM SWITCH
AF-1 ROTAMETER
VG-1 VACUUM GAUGE
1" SCH 80 PVC 90° ELBOW (TYP.)
SP-3
HOLLOW MEMBRANE CONTACTOR MC-1
V-5
V-6
STRUT CHANNEL WITH PIPE CLAMP
1" SCH 80 PVC TEE (TYP.)
1'
3/4" SCH 80 PVC BYPASS
1" MNPT TO FEMALE SOCKET ADAPTER SCH 80 PVC (TYP.)
V-7
PG
1" TO 1/4" BUSHING
1"ø x 9"L STATIC MIXER
METAL | PVC
1'-4"
1/4"OD POLY TUBING TO GAC-1 INLET
10"
2'
DPS-1 DIFFERENTIAL PRESSURE SWITCH
V-8
FLOW METER FMT-1
1/2" SCH 80 PVC
1/2" SCH 80 PVC ONE-SIDE THREADED NIPPLE
PT-1
3/4" TO 1/4" BUSHING
CV-2 1" FNPT CHECK VALVE
1" CROSS, BRASS
1" TO 1/2" REDUCING BUSHING
3" OPENING FOR POTABLE WATER LINE
10"
5"
2'-7"
12" OPENING FOR INJECTION LINES
10"
3" OPENING FOR ELECTRICAL CONDUIT
LIQUID-TIGHT CABLE GRIP SECONDARY CONTAINMENT LEVEL SWITCHES (LSHH-1 AND REDUNDANT LSHH-2)
CP-XXX
DANGER
OPERATOR INTERFACE TERMINAL (OIT)
EMERGENCY STOP PUSH TO STOP TWIST TO START
EMERGENCY STOP ACTIVE
ALARM CONDITION EXISTS
CONTROL PANEL WITH TOUCH SCREEN HMI
UPS
60 AMP CIRCUIT BREAKER PANEL
1/2" EMT ELECTRICAL CONDUIT
DUPLEX ELECTRICAL RECEPTACLE (TYP.)
FRONT GATE DOOR
10'

DRAWING SCALE
0" 12" 0"

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OXYGEN REMOVAL CONTACTOR SIDE VIEW DETAIL
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-4**

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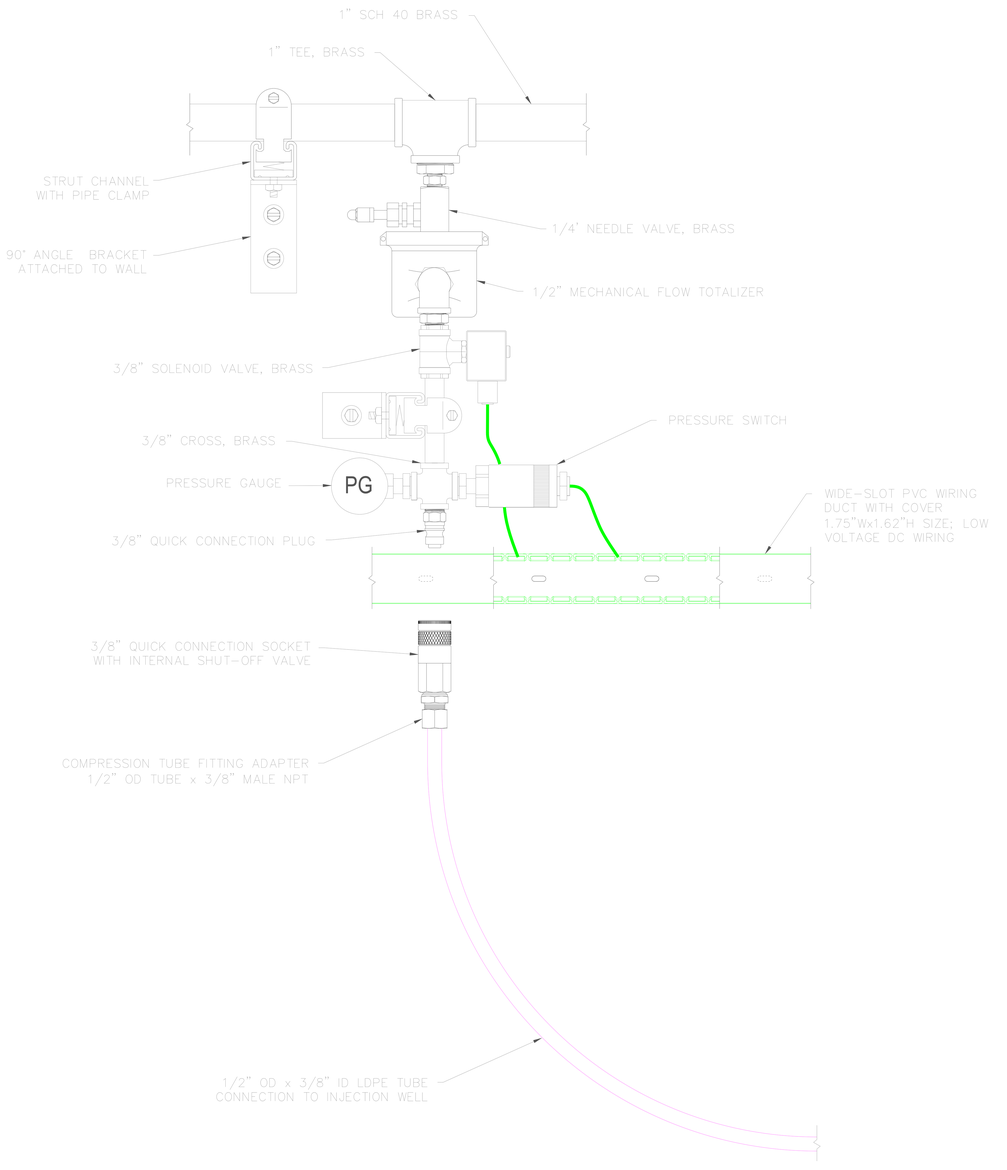
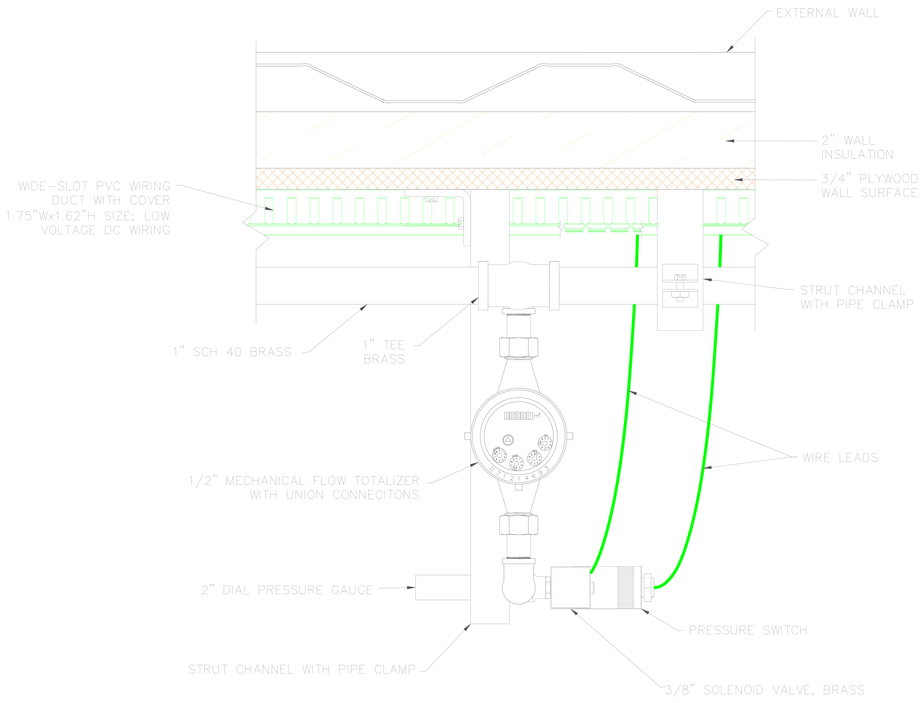



INJECTION MANIFOLD DETAIL SIDE VIEW




INJECTION MANIFOLD DETAIL TOP VIEW

NOTES:

1. ALL THREADED CONNECTIONS ARE NATIONAL PIPE THREAD (NPT).

DRAWING SCALE

0" 3" 6" 3" 0"

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|---|---|---|---|
| | | | |

INJECTION MANIFOLD DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
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**DRAWING M-5**

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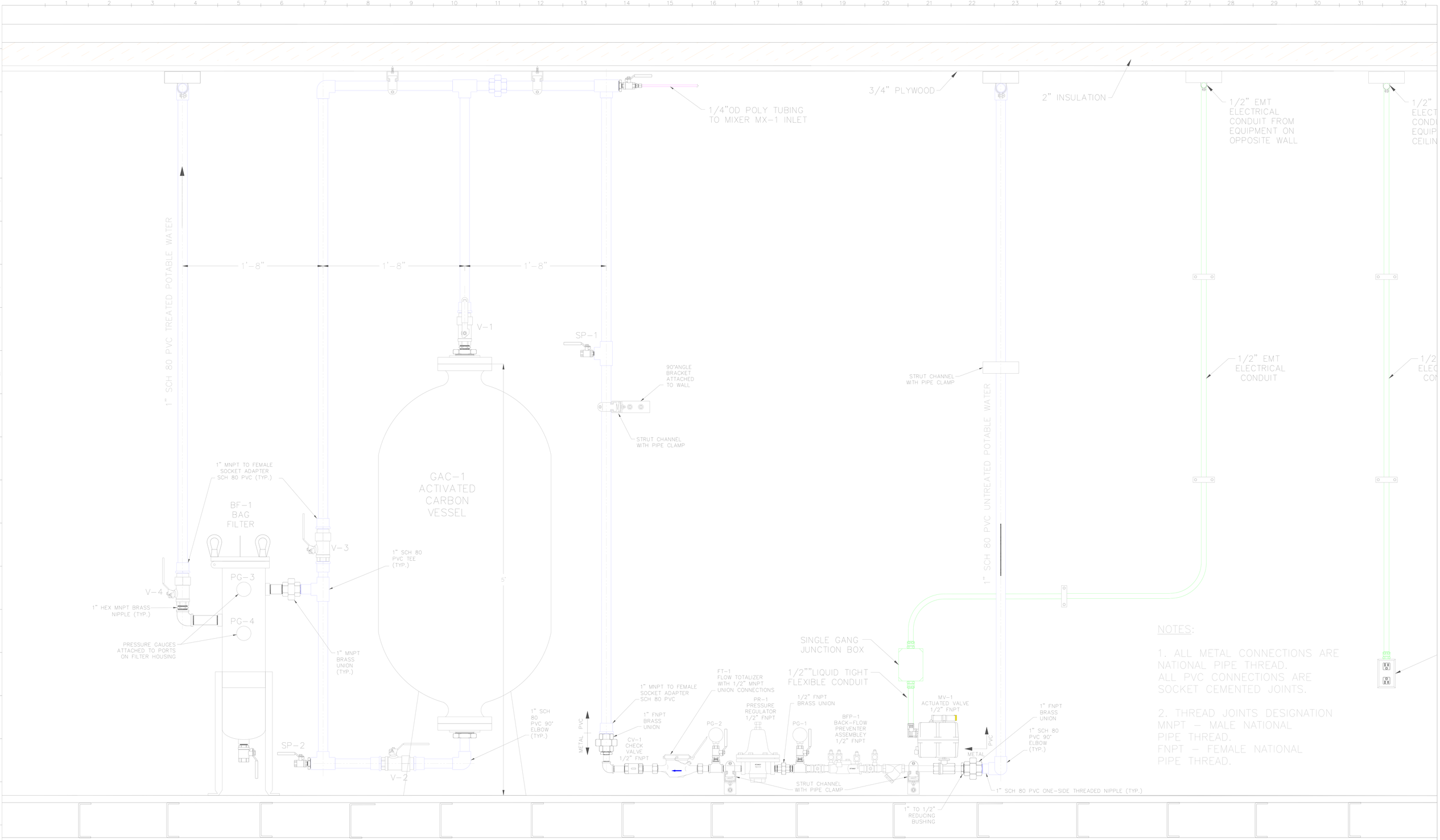


NOTES:

1. ALL METAL CONNECTIONS ARE NATIONAL PIPE THREAD. ALL PVC CONNECTIONS ARE SOCKET CEMENTED JOINTS.

2. THREAD JOINTS DESIGNATION
MNPT – MALE NATIONAL PIPE THREAD.
FNPT – FEMALE NATIONAL PIPE THREAD.

DRAWING SCALE

0" 12" 0"

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GAC TREATMENT DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-6**

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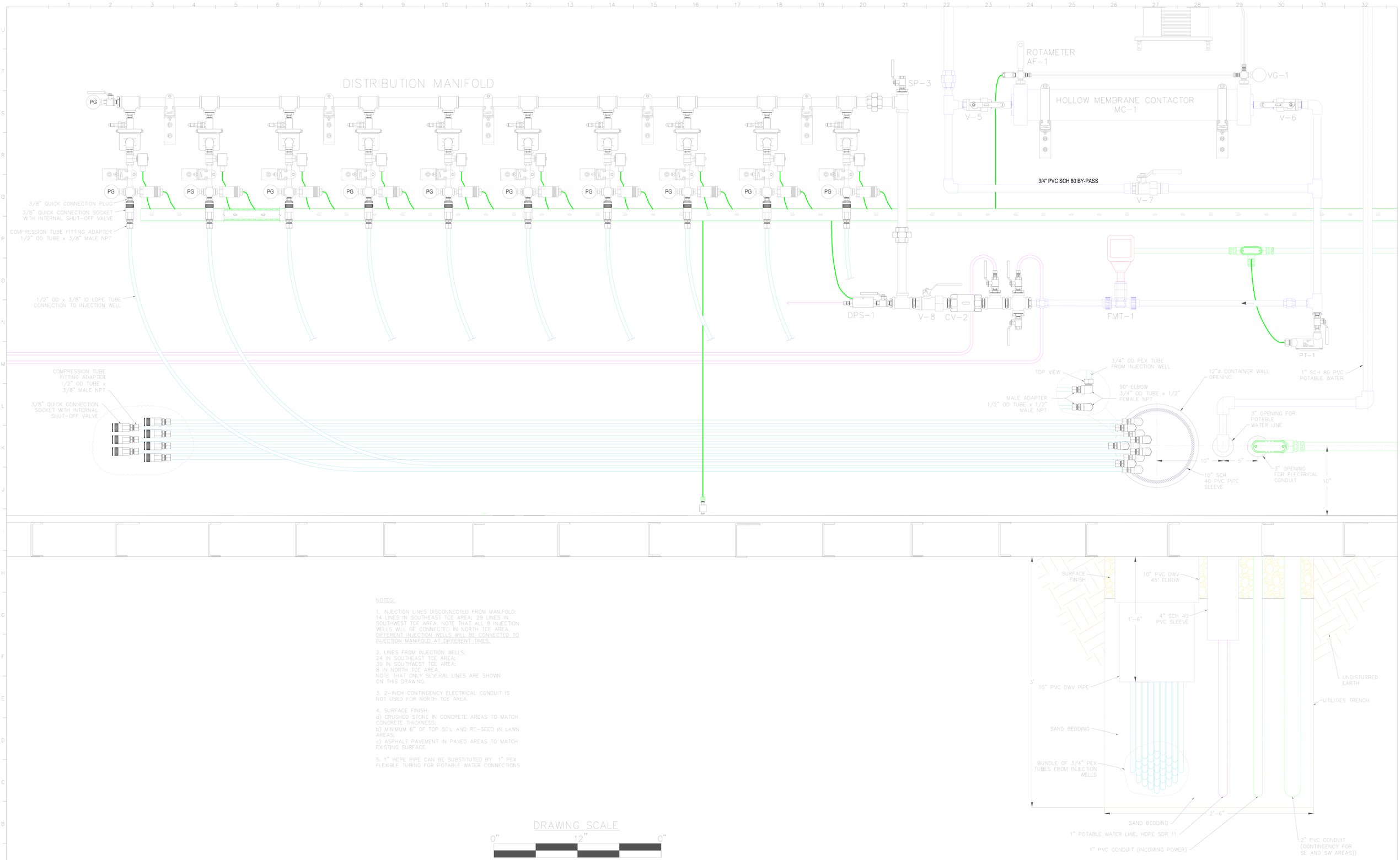


NOTES:

1. INJECTION LINES DISCONNECTED FROM MANIFOLD:
14 LINES IN SOUTHEAST TCE AREA; 29 LINES IN SOUTHWEST TCE AREA. NOTE THAT ALL 8 INJECTION WELLS WILL BE CONNECTED IN NORTH TCE AREA.
DIFFERENT INJECTION WELLS WILL BE CONNECTED TO INJECTION MANIFOLD AT DIFFERENT TIMES.

2. LINES FROM INJECTION WELLS:
24 IN SOUTHEAST TCE AREA;
39 IN SOUTHWEST TCE AREA;
8 IN NORTH TCE AREA.
NOTE THAT ONLY SEVERAL LINES ARE SHOWN ON THIS DRAWING.

3. 2-INCH CONTINGENCY ELECTRICAL CONDUIT IS NOT USED FOR NORTH TCE AREA.

4. SURFACE FINISH:
a) CRUSHED STONE IN CONCRETE AREAS TO MATCH CONCRETE THICKNESS;
b) MINIMUM 6" OF TOP SOIL AND RE-SEED IN LAWN AREAS;
c) ASPHALT PAVEMENT IN PAVED AREAS TO MATCH EXISTING SURFACE.

5. 1" HDPE PIPE CAN BE SUBSTITUTED BY 1" PEX FLEXIBLE TUBING FOR POTABLE WATER CONNECTIONS

DRAWING SCALE

0" 12" 0"

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LINES ENTRANCE INTERNAL VIEW DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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DRAWING M-7

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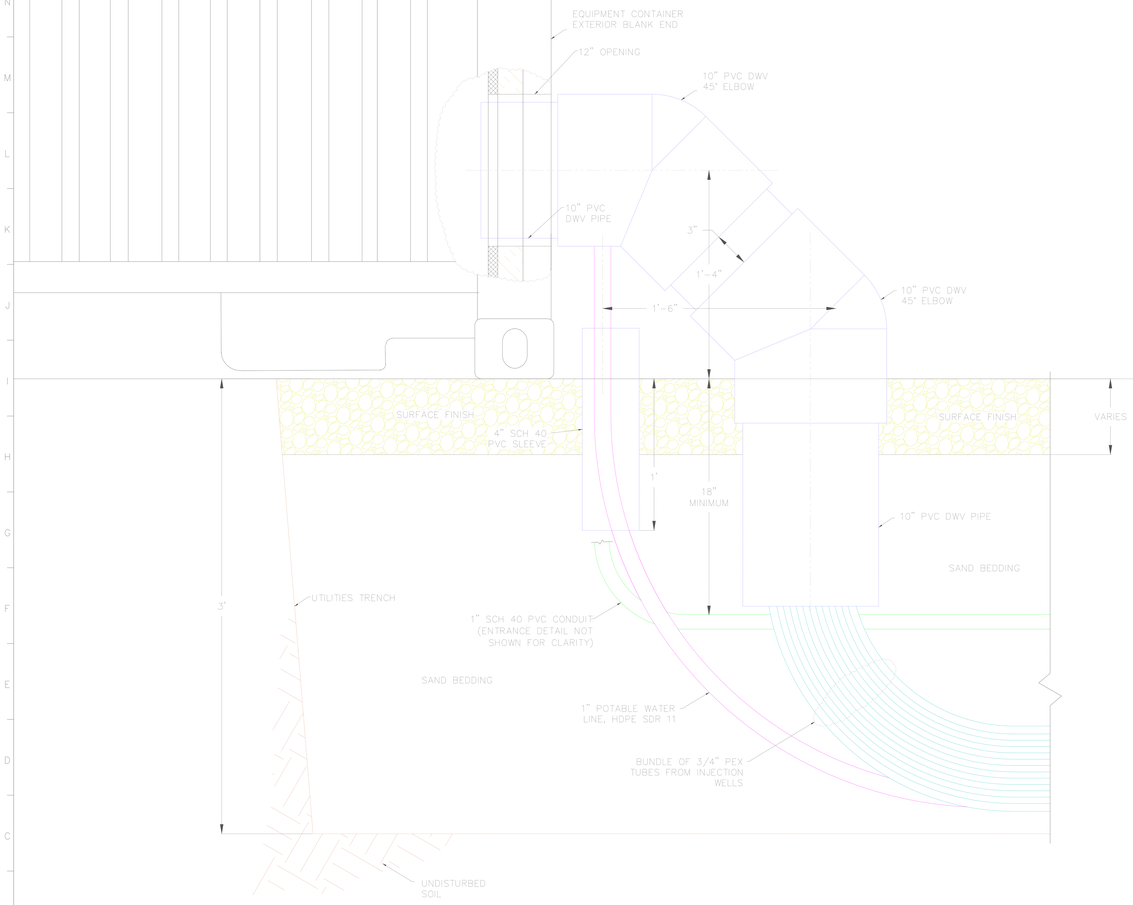
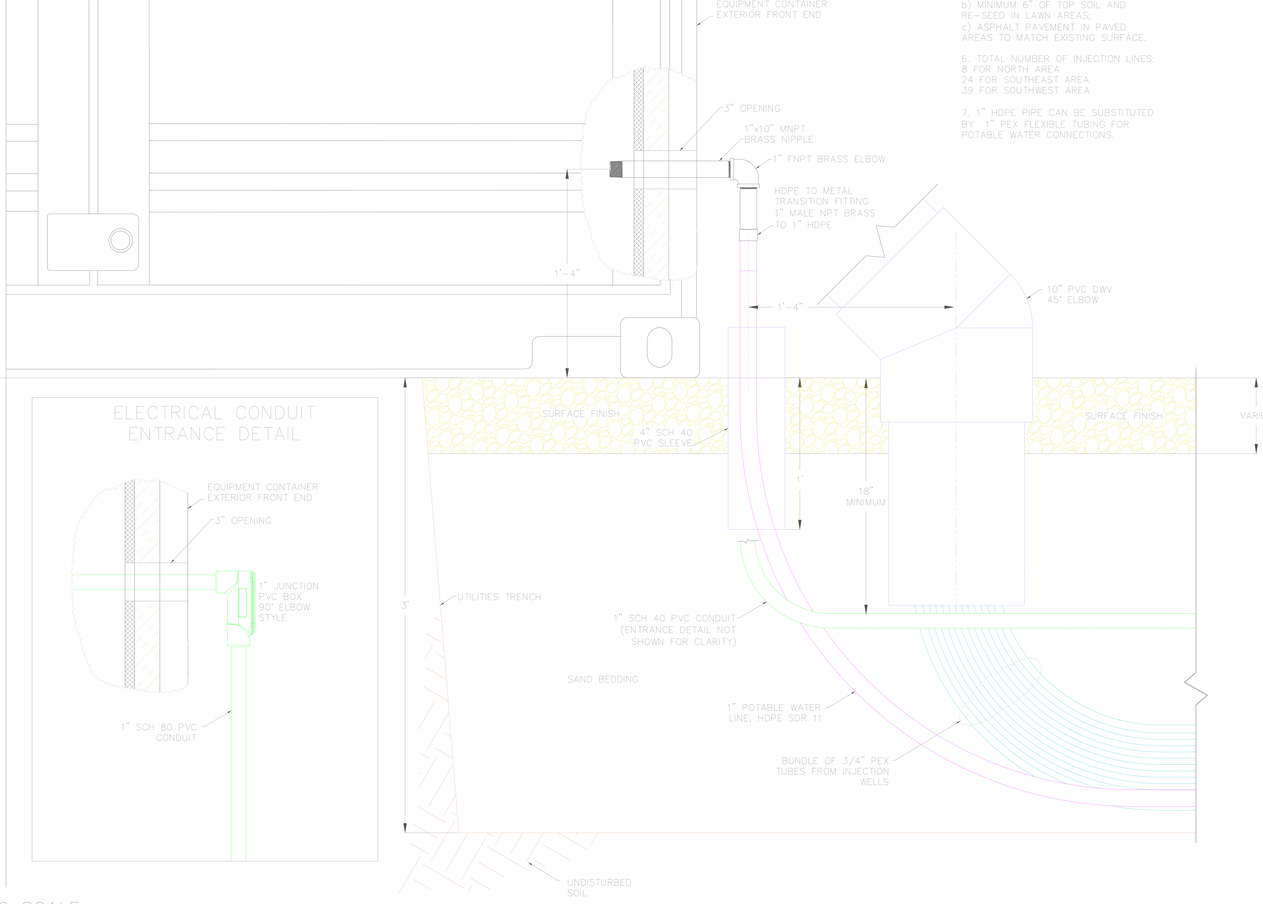
# UTILITIES ENTRANCE CONTAINER BACK VIEW




# UTILITIES ENTRANCE CONTAINER FRONT VIEW




## ELECTRICAL CONDUIT ENTRANCE DETAIL




NOTES:

1. UNDERGROUND LINES ARE SHOWN FOR ILLUSTRATION ONLY. REFER TO TRENCH CONSTRUCTION DETAILS ON DRAWINGS C-2, C-3, AND C-4.

2. EXPOSED 10" PVC PIPE SHALL BE INSULATED (1" FOIL-FACED FIBERGLAS WRAP INSULATION AND PVC JACKETING).

3. EXPOSED 1" POTABLE WATER PIPE SHALL BE INSULATED (1" FOIL-FACED FIBERGLAS WRAP INSULATION AND PVC JACKETING) AND HEAT-TRACED (SELF-REGULATING HEAT CABLE).

4. ELECTRICAL CONDUIT AND INJECTION LINES ENTRANCE NOT SHOWN FOR CLARITY.

5. SURFACE FINISH:
a) CRUSHED STONE IN CONCRETE AREAS TO MATCH CONCRETE THICKNESS;
b) MINIMUM 6" OF TOP SOIL AND RE-SEED IN LAWN AREAS;
c) ASPHALT PAVEMENT IN PAVED AREAS TO MATCH EXISTING SURFACE.

6. TOTAL NUMBER OF INJECTION LINES:
8 FOR NORTH AREA
24 FOR SOUTHEAST AREA
39 FOR SOUTHWEST AREA

7. 1" HDPE PIPE CAN BE SUBSTITUTED BY 1" PEX FLEXIBLE TUBING FOR POTABLE WATER CONNECTIONS.

DRAWING SCALE

0" 12" 0"

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LINES ENTRANCE EXTERNAL VIEW DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-8**

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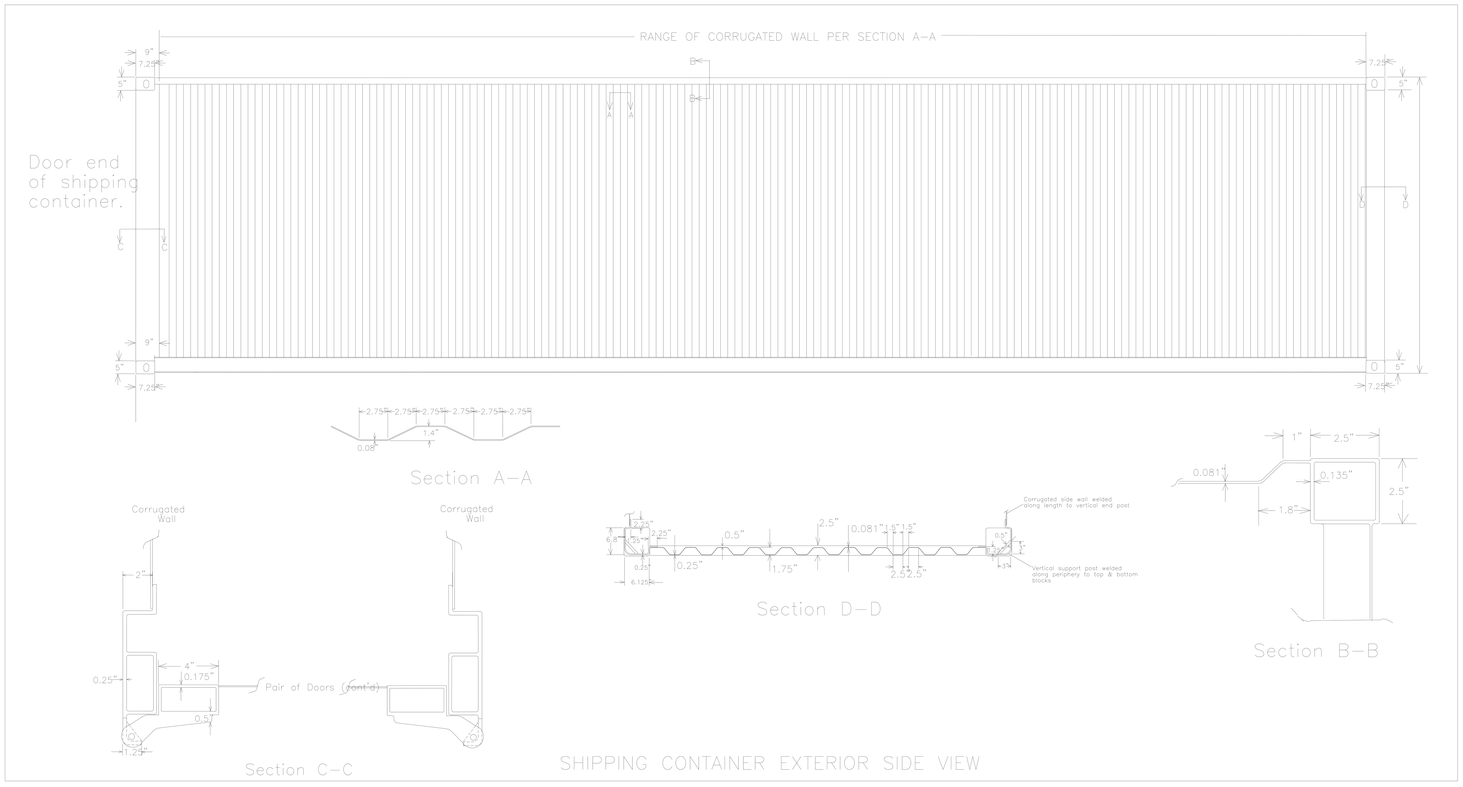
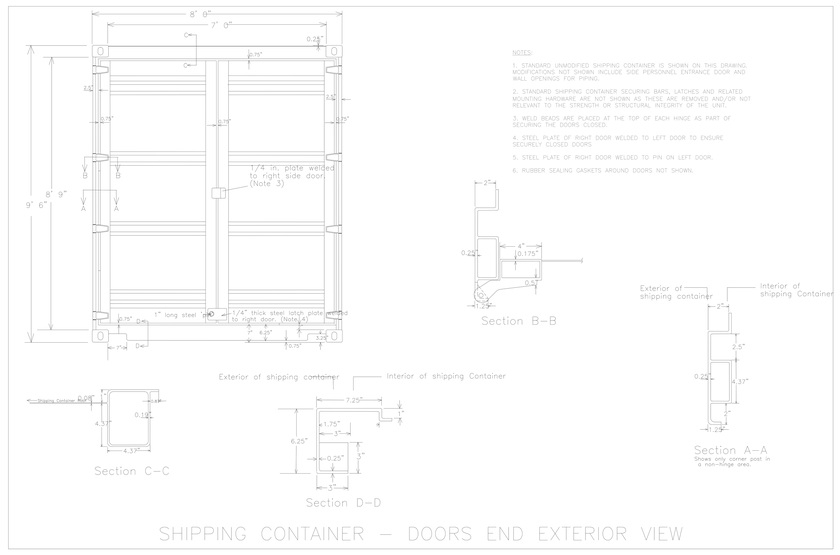
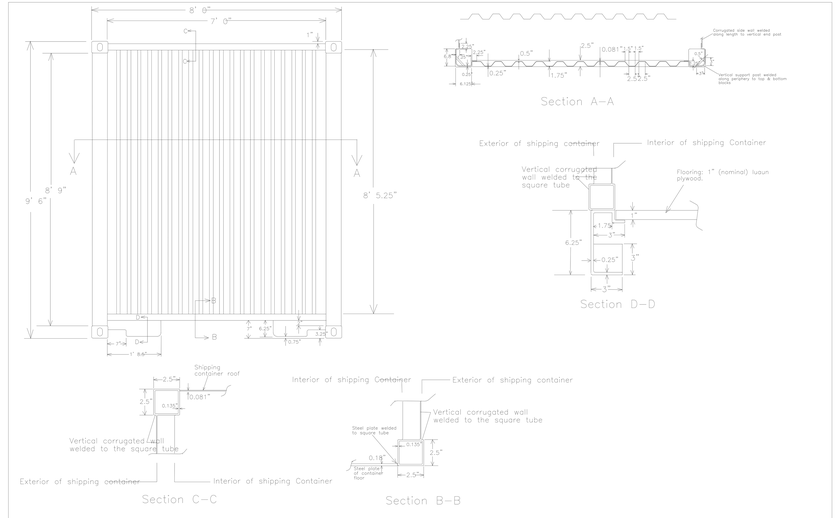



NOTES:

1. STANDARD UNMODIFIED SHIPPING CONTAINER IS SHOWN ON THIS DRAWING. MODIFICATIONS NOT SHOWN INCLUDE SIDE PERSONNEL ENTRANCE DOOR AND WALL OPENINGS FOR PIPING.
2. STANDARD SHIPPING CONTAINER SECURING BARS, LATCHES AND RELATED MOUNTING HARDWARE ARE NOT SHOWN AS THESE ARE REMOVED AND/OR NOT RELEVANT TO THE STRENGTH OR STRUCTURAL INTEGRITY OF THE UNIT.
3. WELD BEADS ARE PLACED AT THE TOP OF EACH HINGE AS PART OF SECURING THE DOORS CLOSED.
4. STEEL PLATE OF RIGHT DOOR WELDED TO LEFT DOOR TO ENSURE SECURELY CLOSED DOORS
5. STEEL PLATE OF RIGHT DOOR WELDED TO PIN ON LEFT DOOR.
6. RUBBER SEALING GASKETS AROUND DOORS NOT SHOWN.




DRAWING SCALE

0" 24" 48" 24" 0"

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CONTAINER CONSTRUCTION DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

| | |
|---|---|
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**DRAWING M-9**

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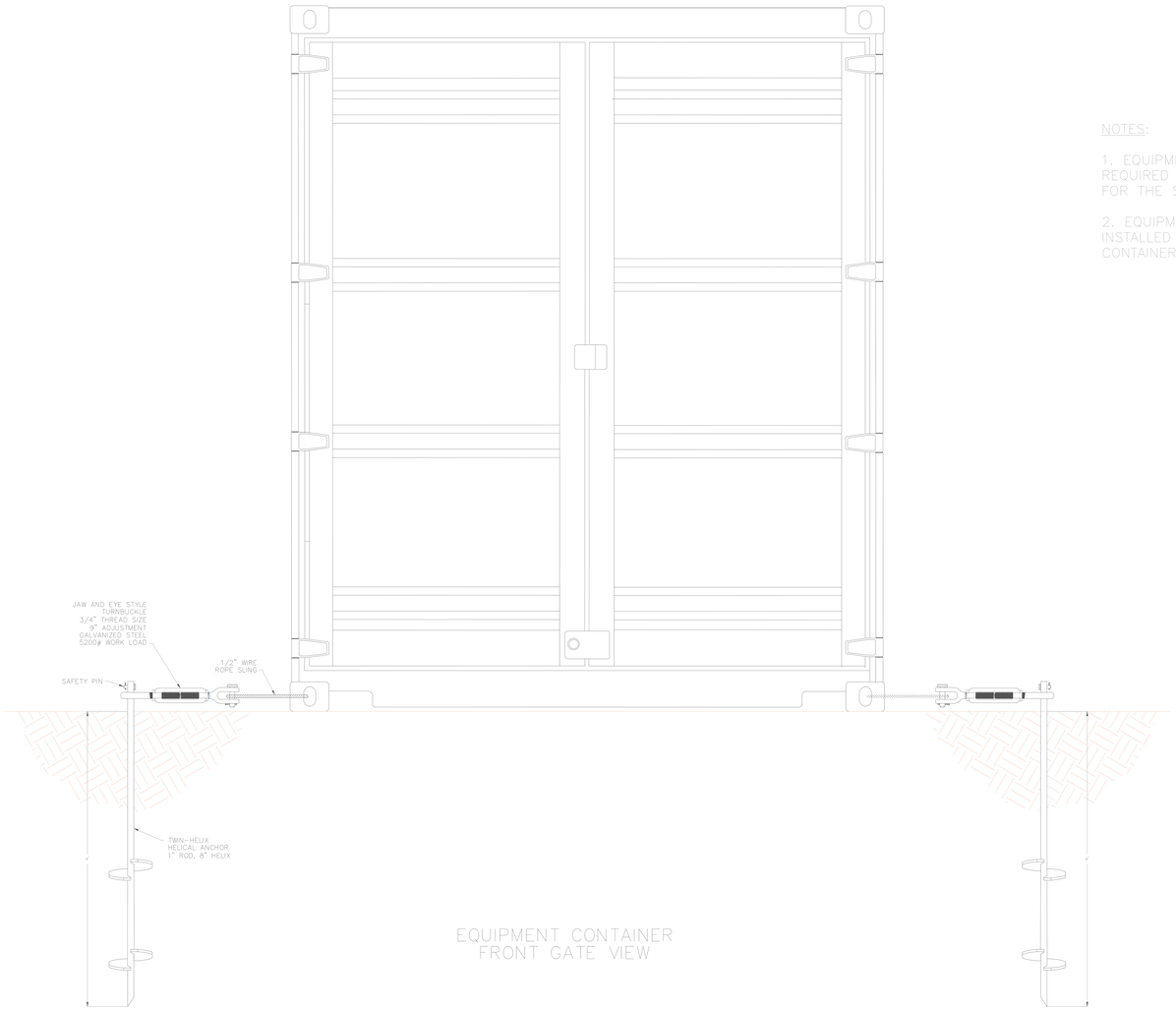
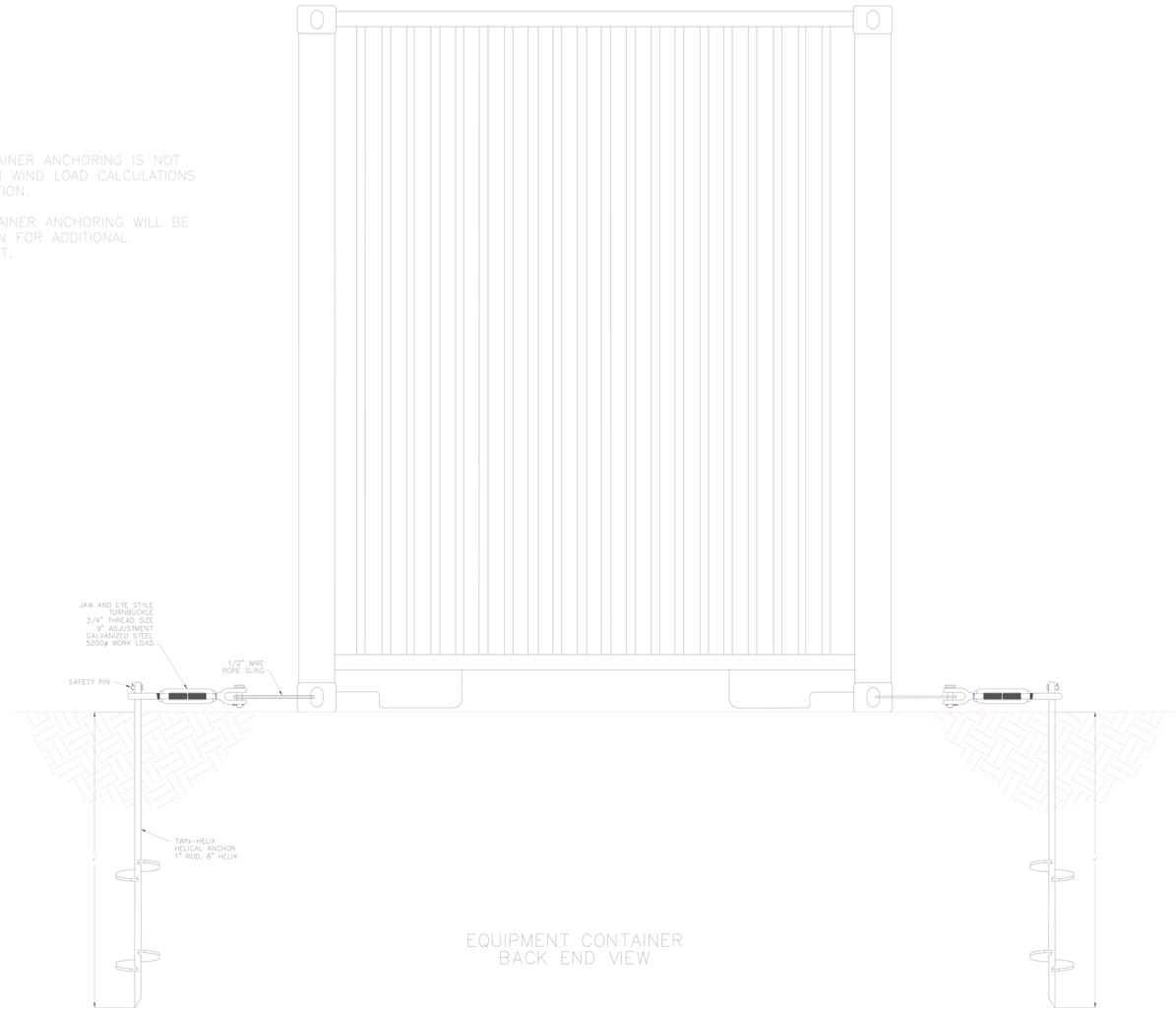



EQUIPMENT CONTAINER
FRONT GATE VIEW

NOTES:

1. EQUIPMENT CONTAINER ANCHORING IS NOT REQUIRED BASED ON WIND LOAD CALCULATIONS FOR THE SITE LOCATION.

2. EQUIPMENT CONTAINER ANCHORING WILL BE INSTALLED AS SHOWN FOR ADDITIONAL CONTAINER RESTRAINT.




EQUIPMENT CONTAINER
BACK END VIEW

DRAWING SCALE

0" 12" 24" 12" 0"

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CONTAINER ANCHORING DETAILS
100% GROUNDWATER REMEDIAL DESIGN – FINAL

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

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**DRAWING M-10**

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