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March 28, 2016

VIA PRIVATE CARRIER

Mr. James R. Carroll
Program Administrator
Land Restoration Program
Land Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

Subject: Transmittal of the Bulkhead and Storm-Drain Assessment, Blocks D and F,
Lockheed Martin Middle River Complex,
2323 Eastern Boulevard
Middle River, Maryland

Dear Mr. Carroll:

For your information, please find enclosed two hard copies with CD of the above-referenced document. This report summarizing the results of an August 2015 inspection and evaluation of the bulkhead and related storm drains at Tax Blocks D and F at the Lockheed Martin Middle River Complex in Baltimore County, Middle River, Maryland.

Please let me know if you have any questions. My office phone is (301) 548-2227.

Sincerely,

Lynnette Drake
Remediation Analyst, Environmental Remediation

Enclosures:

cc: (via email without enclosure)
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Bulkhead and Storm-Drain Assessment, Blocks D and F, Lockheed Martin Middle River Complex 2323 Eastern Boulevard Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

March 2016

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Regional Manager

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ACRONYMS

ASCE	American Society of Civil Engineers
CCTV	closed-circuit television
CMP	corrugated-metal pipe
EESH	energy, environment, safety, and health
EM	electromagnetic
FS	feasibility study
GIS	geographic information system
GPR	ground-penetrating radar
GPS	global positioning system
HASP	health and safety plan
IEI	Infrastructure Engineers, Inc.
LMCPI	LMC Properties, Inc.
Lockheed Martin	Lockheed Martin Corporation
MRC	Middle River Complex
MSA	Martin State Airport
PPE	personal protective equipment
RCP	reinforced-concrete pipe
Tetra Tech	Tetra Tech, Inc.
VLS	vertical-launch systems

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Section 1
Introduction

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this report summarizing the results of an August 2015 inspection and evaluation of the bulkhead and related storm drains at Tax Blocks D and F at the Lockheed Martin Middle River Complex (MRC) in Baltimore County, Middle River, Maryland (Figure 1[1]). This report describes the methodology used in this investigation, including bulkhead engineering inspections (aboveground and underwater), a geophysical survey of drainage lines, locating buried manhole frames and covers, and video surveying of drainage pipes. Figure 2 depicts the MRC waterfront tax blocks in July 2015.

1.1 BACKGROUND

Tetra Tech performed prior surveys and evaluations of the bulkhead in 2012 (Tetra Tech, 2012a) and 2013 (Tetra Tech, 2014a), respectively. These studies identified deteriorated bulkhead components and soil erosion near the bulkhead, but the extent of degradation and urgency of repairs were not determined. Previous studies of Middle River Complex storm drains indicate that existing and abandoned storm-drain lines at the Middle River Complex that have historical and/or current outlets through the bulkhead are possible sources of contaminated sediment resulting from historical industrial discharges. Evidence suggests the existence of collapsed pipes (sinkholes) along storm-drain lines 007, 009, and 00X, three stormwater conveyance lines with outfall pipes in Block D. The associated outfalls (OF), OF-007 and OF-009, were previously mapped and well documented, while the latter unnamed storm-drain line (designated as line "00X" and outfall "OF-00X") was identified during prior visual reconnaissance activities and was not consistently depicted in records reviewed. Prior to completing the subject study, the condition and contents of these pipes were unknown. This work is intended to address remaining data gaps and determine if additional measures will be required to protect Dark Head Cove from further contamination.

[1]All figures appear after Section 5, "References."

This investigation includes the following components:

- an engineering inspection of the above-water and underwater portions of the constructed reinforced shoreline and the bulkhead shoreline along the Middle River Complex, where Blocks D and F meet Dark Head Cove
- a geophysical survey of subsurface utilities to locate three storm-drainpipes in Block D (i.e., lines 007, 009, and 00X) with possible past and/or present discharges to Dark Head Cove (e.g., Outfalls 007 and 009)
- locating up to two buried manholes in Block D along storm drain lines 007, 009, and 00X, and raising them to grade
- video surveying of three storm-drain lines in this area, where accessible
- reporting results

This follow-on bulkhead study further assesses the deterioration of bulkhead structural components and the localized drainage properties and factors contributing to soil erosion at the bulkhead. A feasibility study (FS) [Tetra Tech, 2013] and 60% remedial design (Tetra Tech, 2015a) have been prepared to address the cleanup of contaminated sediments in Dark Head Cove. The results of this study will be used to assess whether existing and/or damaged drainage conduits carry impacted sediment or runoff to Dark Head Cove, and to evaluate the need to repair the bulkhead to prevent soil loss (through the bulkhead) before planned dredging of adjacent sediments begins. This study's findings will be used to plan and implement the sediment remediation project.

1.2 OBJECTIVES

This assessment aims to:

- evaluate underwater observations and the engineer's inspection documentation of bulkhead structural components, including ultrasound measurement of sheet-pile thickness
- draw conclusions regarding the need to repair deteriorated bulkhead components and stabilize eroded areas along the bulkhead, to prevent further erosion of backfill and further bulkhead degradation
- locate and inspect manholes and access points along storm drain lines 007, 009, and 00X, and complete a video survey of these lines

- assess the condition and degree of sedimentation in storm drain lines 007, 009, and 00X, and use these results to support planned cleanup of possibly contaminated sediments that will be completed as part of the future sediment remedy

As stated above, sediment remediation for Dark Head Cove includes the area adjacent to the bulkhead, and is under design by Lockheed Martin Corporation. The findings from this study will be used to plan measures intended to eliminate future sediment migration into the cove. Results from this study will also guide additional design considerations that may be incorporated into the sediment remediation design and the procurement of dredging construction.

1.3 REPORT ORGANIZATION

This report is organized as follows:

Section 1—Introduction: Presents the project background and objectives.

Section 2—Bulkhead Inspection: Describes the methodology used to inspect the bulkhead and summarizes data generated from the inspections.

Section 3—Storm Drain Assessment: Discusses the field methods used to locate and assess storm drains and manholes, and summarizes the observations made.

Section 4—Conclusions: Summarizes the investigation results and recommends proposed structural repairs.

Section 5—References: Lists the references used to compile this report.

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Section 2
Bulkhead Inspection

This section describes the approach and methodology used for the field tasks described below that assessed the structural condition of the waterfront bulkhead along Blocks D and F. A separate investigation of the storm drainpipes connected to the bulkhead was also performed. It is summarized in Section 3. Figure 3 shows the bulkhead inspection area.

2.1 MOBILIZATION/DEMOBILIZATION

Before mobilizing for the field activities, appropriate Tetra Tech, Inc. (Tetra Tech) personnel became familiar with the site-specific health and safety plan (HASP) and the emergency response plan. Tetra Tech conducted mandatory health and safety tailgate meetings before each day's field events. The Tetra Tech site health and safety officer documented the topics covered and personnel in attendance.

Before mobilization, Tetra Tech notified tenants at Middle River Complex (MRC) about the bulkhead inspection and Block D storm-drain work at an LMC Properties, Inc. (LMCPI) bi-weekly meeting. LMCPI approved the work and schedule, and was notified before mobilization. Local tide charts were used to determine appropriate low-tide periods to target to perform bulkhead inspection tasks. Site access, utility clearance, notifications/approvals, and documentation were done in accordance with the Lockheed Martin Corporation (Lockheed Martin) *Remediation Contractor's ESH Handbook*, Revision 2, May 1, 2014 (Lockheed Martin, 2014).

The bulkhead inspection marine-engineer subcontractor, Infrastructure Engineers, Inc. (IEI), prepared a dive plan after consulting information about the construction and features of the bulkhead and the water depth adjacent to the bulkhead. Past bulkhead assessment reports were provided to IEI to support the dive plan. The dive plan was reviewed and approved by Tetra Tech's health and safety coordinator for MRC. A copy of the subcontractor's approved dive plan is included as Attachment A.

2.2 INSPECTION METHODOLOGY

An inspection and professional evaluation of the bulkhead structural components, including underwater structure, was performed on July 27–28, 2015 by IEI, with oversight by Tetra Tech. The inspection of the aboveground portion was completed over the entire length of bulkhead, from the Block D Panhandle to the southern end of Block F. This area includes the concrete bulkhead, riprap-reinforced shoreline, and the wooden bulkhead west of the tarmac ramp. Underwater inspection of the bulkhead was conducted for the steel and concrete-capped bulkhead only from Blocks D to F, and the small section of wooden bulkhead at Block F. The bulkhead inspection assessed the following:

- the structural integrity and degree of deterioration of the existing concrete bulkhead structure
- sheet-pile thickness (an indication of deterioration) at the bulkhead
- whether sediment dredging up to four feet deep could be performed adjacent to the bulkhead without compromising the structure, or what measures are needed to allow dredging
- whether stabilization of existing eroded sinkholes via backfilling will prevent soil migration from upland sources, and whether it can be conducted without compromising the structural integrity of the bulkhead
- the urgency of needed structural repairs, replacements, and/or upgrades to the bulkhead to maintain its current structural purpose

The underwater inspection was done by a certified and experienced diver trained in marine structural assessments. The underwater inspection included underwater photographs, an ultrasonic survey of the bulkhead surface, and measurement of sheet pile thickness. The water line (routine-level) inspection was simultaneously completed by a licensed structural engineer during the underwater inspection. The underwater inspection conformed to a Level I investigation per American Society of Civil Engineers (ASCE) *Underwater Investigations Standard Practice Manual, ASCE Manuals and Reports on Engineering Practice No. 101* (ASCE, 2001). The Level I base-level inspection was supplemented with ASCE Level II methods (e.g., removing marine growth to facilitate visual or tactile inspection), as necessary.

An ultrasonic survey was performed over the portion of the bulkhead constructed with steel sheet piles and tiebacks, to measure the thickness of sheet-pile components. Approximately 10% of the

exposed sheet pile surface was surveyed to obtain ultrasonic measurements per Level III inspection requirements (ASCE, 2001). A Cygnus DIVE™ ultrasonic measuring instrument equipped with a data-logging kit was used to collect and store data in real time. The Cygnus DIVE™ instrument was operated in a single-echo five-megahertz (MHz) frequency, achieving an accuracy of ±0.004 inches. The manufacturer's specifications for the Cygnus DIVE™ instrument are in Attachment B. Measurements of sheet pile thickness were also made by hand, as needed (e.g., in areas of delaminated or deteriorated concrete bumpers). Holes in sheet pile, including those visible underwater, were documented and photographed.

The subcontractor's bulkhead inspection report (see Attachment C) includes photographs, a summary of thickness measurements, and maps showing inspected bulkhead sections on geographic information system (GIS)-based maps. The subcontractor report includes recommendations (but not specifications) for repairs. All features identified during the inspection were located using a global positioning system (GPS) device with sub-meter accuracy, and were identified on the baseline map developed during the previous bulkhead evaluation report (Tetra Tech, 2014b).

2.3 UNDERWATER SURVEY

Two Virginia-registered professional engineer-divers performed the underwater survey on July 27–28, 2015. The survey included the entire concrete and steel sheet-pile bulkhead, beginning at the Block D panhandle (linear wall "Section A" in Attachment C), continuing westerly across Blocks D and F, and ending at the southwestern end of the steel sheet-pile bulkhead, near the southern edge of the concrete tarmac area in Block F (linear wall "Section H" in Appendix B). The engineer-diver also performed a separate visual and tactile inspection of the wooden section of bulkhead ("timber section" or "timber seawall" in Attachment C) that is west of the tarmac ramp.

Linear-wall Sections A–C and F–H of the concrete-reinforced steel bulkhead were in poor condition below the water line. "Poor" condition is defined as meeting two or more of the following conditions, based on the divers' observations:

- severe deterioration of steel sheet piling throughout the reinforced concrete sections of the seawall, with knife-edging and up to 100% section loss

- moderate to severe deterioration of concrete deck in the reinforced concrete sections, including exposed reinforcement, with up to 100% section loss and failed deck slabs
- significant erosion- and backfill-material loss behind the seawall structure in sheet pile areas with deterioration
- severe deterioration of vertical and horizontal breast-wall timbers in the timber section of seawall, with up to 100% section loss and broken or missing boards

Table 2-1 provides a summary of 54 thickness measurements of the steel sheet-pile wall at approximately 30-foot linear intervals. Complete section loss (i.e., places where the steel sheet-pile corrosion formed a perforation) was observed in all six wall sections (i.e., linear sections A, B, C, F, G, and H). These badly deteriorated areas had either 100% section loss or knife-edging and perforations over 50–75% of the exposed surface area. Perforations and knife-edging were noted at the wooden/timber-pile seawall at Block F.

The concrete cantilever vertical supports and concrete grade-beams supporting the concrete walking deck in areas of steel sheet pile were in fair condition (minor cracks or concrete degradation). The concrete cap is the primary structural support for the remaining degraded components, due to the poor condition of the sheet piles and the walking deck. Damage to the concrete cantilever supports or caps would likely hasten complete structural failure of the steel sheet pile bulkhead sections and decks. Table C-1 in Appendix C contains detailed descriptions and observations of inspected bulkhead components.

2.4 ABOVEGROUND INSPECTION

A marine structural engineer performed an aboveground inspection of the bulkhead on July 27, 2015. This inspection included the concrete deck walking surface, the concrete cap, the riprap shoreline, and the bulkhead-associated embankment (e.g., soil retained behind the bulkhead). The aboveground inspection included all three types of bulkhead or reinforced shoreline (e.g., steel sheet pile, riprap, and timber) along Blocks D and F. The condition of the steel sheet-pile bulkhead and the timber-pile section of seawall were characterized as poor, consistent with the underwater inspection findings. Aboveground and underwater timber bumper-piles and underlying steel or wood piles were severely deteriorated, as described in Section 2.3.

The concrete cap is in fair condition, as are the concrete and riprap sections of reinforced shoreline (linear Sections D and E). The inspection subcontractor defined “fair” as having little to moderate deterioration and settlement, with minor longitudinal cracks (up to two inches wide) in the concrete overlay, but no evidence of major shift or collapse of the underlying riprap. The aboveground inspection noted a significant area of soil erosion, approximately 15-feet by 15-feet by up to four-feet deep, on the shoreline behind Section D.

Table 2-1

Ultrasonic Thickness Measurements
Bulkhead Diver Inspection
July 27-28, 2015
Middle River Complex, Middle River, Maryland

Meas. No.	Wall Section	Station (00 + No. of ft.)	Water Depth (ft)	Location Category	Thickness (in)[1]	Net Loss (in)[2]
1	A	00	0.5	FH	NA	--
2	A	20	4.9	CB	0.175	-0.325
3	A	30	6.1	CB	0.185	-0.315
4	A	60	5.5	CB	0	-0.5
5	A	90	4.5	CB	0	-0.5
6	A	120	2.7	FH	NA	--
7	B	00	2.7	FH	NA	--
8	B	30	3.5	FH	0	-0.5
9	B	60	8	CB	0.135	-0.365
10	B	90	7.5	CB	0.195	-0.305
11	B	120	7.5	CB	0.18	-0.32
12	B	150	6.5	CB	0.19	-0.31
13	B	180	5	CB	0.32	-0.18
14	B	210	4	CB	0.325	-0.175
15	B	230	3	CB	0.175	-0.325
16	C	00	3	CB	0.175	-0.325
17	C	30	3	CB	0.14	-0.36
18	C	60	3.1	FH	0	-0.5
19	C	90	3	FH	0	-0.5
20	C	120	4	FH	0	-0.5
21	C	150	4	FH	0	-0.5
22	C	180	4.2	FH	0	-0.5
23	C	210	5	CB	0.19	-0.31
24	C	240	4.5	CB	0.24	-0.26
25	C	270	5.5	CB	0.2	-0.3
26	C	300	4	CB	0.19	-0.31
27	C	330	4	CB	0.2	-0.3
28	C	355	3.5	FH	NA	--
29	F	0	8.5	CB	0.18	-0.32
30	F	30	8.5	CB	0.19	-0.31
31	F	60	9.5	CB	0.19	-0.31
32	F	90	7.7	CB	0.17	-0.33
33	F	120	7	CB	0.19	-0.31
34	F	150	6.5	CB	0.18	-0.32
35	F	180	2.5	FH	NA	--
36	F	192	0	FH	NA	--
37	G	0	8	CB	0.175	-0.325

Table 2-1

Ultrasonic Thickness Measurements
Bulkhead Diver Inspection
July 27-28, 2015
Middle River Complex, Middle River, Maryland

Meas. No.	Wall Section	Station (00 + No. of ft.)	Water Depth (ft)	Location Category	Thickness (in)[1]	Net Loss (in)[2]
38	G	30	8.5	CB	0.185	-0.315
39	G	60	9	CB	0.175	-0.325
40	G	90	8.5	CB	0.18	-0.32
41	G	120	8	CB	0.14	-0.36
42	G	150	8.5	CB	0.46	-0.04
43	G	165	8.5	CB	0.18	-0.32
44	H	-70	10	CB	0	-0.5
45	H	0	5	CB	0.22	-0.28
46	H	30	6.5	CB	0	-0.5
47	H	50	6.5	CB	0.44	-0.06
48	H	90	8.3	CB	0.175	-0.325
49	H	130	5.5	CB	0.18	-0.32
50	H	170	6.1	CB	0.175	-0.325
51	H	210	8.9	CB	0.175	-0.325
52	H	250	9	CB	0.19	-0.31
53	H	290	8.5	CB	0.19	-0.31
54	H	310	8	CB	0.175	-0.325

CB - Channel Bottom
FH - Full Height
NA - Not analyzed; no underwater exposure.
" -- " - not available.

1. Measured using Cygnus Ultrasonic underwater thickness gauge, or by hand. Thickness of "0" indicates perforation in steel, gauge not needed.
2. Represents the decrease in thickness of steel from it original thickness of 0.5 in. Assumes an original steel thickness of 0.5 in. in steel sheetpile. (Delta of -0.5 indicates complete section loss.)

Section 3
Manhole and Storm-Drain Assessment

The storm drain assessment included a geophysical survey to locate all possible utilities and manholes in Block D and a video survey of three storm-drain lines in this area, where accessible. Figure 4 illustrates the locations of the geophysical survey and storm-drain video survey. The storm drain assessment focused on three storm-drainpipes in Block D (i.e., lines 007, 009, and 00X) that discharge to Dark Head Cove. The drainpipes were video-scoped to assess their condition and the degree of sedimentation in the storm-drain lines. This information will support the planned cleanup of (possibly) contaminated sediments from the interior of these storm drains during the future sediment remedy.

3.1 MOBILIZATION

This section describes the mobilization activities for field tasks performed to assess Block D storm drains. Before starting field activities, the proposed work areas were cleared for subsurface utilities. In addition to calling in a Maryland "Miss Utility" ticket, a private utility-locating service was used to mark on the ground surface any underground utilities and anomalies identified. Before fieldwork began, a utility and underground structure location survey was performed to locate and mark any subsurface obstructions, such as buried foundations and slabs, piping, direct-bury cables, and other buried conduits and structures. The most current project plans and utility maps were used to complete the utility clearance. Community representatives were notified of mobilization both in writing and during an LMC Properties, Inc. (LMCPI) bi-weekly meeting, as described in Section 2.1.

3.1.1 Records Review

Available storm drain plans and historical maps were reviewed before fieldwork began. Historical site plans were studied to obtain locations, pipe diameters, and construction materials

used for storm drain lines 007, 009, and 00X (see Figure 4). Information concerning the layout and construction of the drains is described below:

- Storm drain 007 consists of a five-foot by five-foot concrete box-culvert that enters Block D near the northern midpoint of the former parking lot (after passing below Dark Head Cove Road), and proceeds southeasterly through Block D. This line has one bend near the approximate midpoint of the pipe within Block D, then continues south-southeasterly, and discharges through Outfall 007. The outfall is in a section of reinforced concrete and steel sheet-pile bulkhead, adjacent to a narrow grass strip along the shoreline at Block D. The portion of the storm drain 007 system targeted for inspection was from the manhole at Dark Head Cove Road to Outfall 007, about 700 linear feet. The Outfall 007 system drains runoff from the northeastern corner of Building C, the Annex Building, and Johnson & Towers, Inc. The Outfall 007 system also drains areas north of the Middle River Complex (MRC) and north of Eastern Boulevard.

- Storm drain 009 consists of a 24-inch-diameter reinforced-concrete pipe that enters Block D near its northwestern corner (after passing below Dark Head Cove Road) and proceeds on a straight southeasterly course through Block D. This line includes two manholes in Block D. It discharges through Outfall 009, in a section of reinforced-concrete bulkhead near the shoreline midpoint at Block D. The portion of the Outfall 009 system targeted for inspection was from catch basin IL-26 (shown on Figure 4) to the Outfall 009, about 900 feet in length. The Outfall 009 storm drain system drains the southern and southeastern portions of Building C, the vertical-launch systems (VLS) area, and a portion of Chesapeake Park Plaza east of the VLS.

- Storm drain 00X consists of two 24-inch-diameter corrugated-metal pipes that traverse the southeastern corner of Block D, near the Block D Panhandle. Storm drain 00X originates on the east side of Wilson Point Road and continues from Martin State Airport (MSA) Outfall MPT009 on a straight line below the road to a catch basin at the boundary of Block D. It then continues southwesterly to a junction box/manhole at the southern end of the parking lot. This storm-drain line was identified during prior visual reconnaissance activities. OF-00X had no apparent name or label in historical plans and maps reviewed; thus for the purposes of this report it has been designated with the "00X" suffix.

  A 36-inch-diameter corrugated-metal pipe (CMP) from the junction box/manhole leads toward an outfall at the concrete bulkhead adjoining portions of Block D and the Block D Panhandle. The 00X storm drain line beginning at the eastern side of Wilson Point Road is approximately 340 feet long. The land area and soil near this outfall show evidence of severe subsidence and erosion, and the last 15 feet of pipe appears to be missing.

  The Outfall 00X system is not included in the storm-drain-line clean-out plan for the remedial design and sediment remedy. However, repair of the eroded portions of this drain line is part of the MRC Block D soil remedy (Tetra Tech, 2014). The Outfall 00X system appears to drain a portion of the MSA Main Terminal and a portion of Wilson Point Road adjacent to MSA.

3.1.2 Geophysical Survey

A geophysical survey along portions of storm drain lines 007 and 009 was completed in conjunction with the Block D utility clearance. A geophysical survey grid was set up on a parallel axis with each storm drain line (007, 009, and 00X), extending along the entire length of the storm drain through Block D, as shown in Figure 4. Each grid unit is 15-feet wide in both directions off each pipe's estimated centerline, for a total grid-unit width of 30 feet. The geophysical-survey firm Enviroscan, Inc. (Enviroscan) completed the geophysical survey. The geophysical survey entailed various electromagnetic (EM) and magnetic methods, including a TW-6 EM instrument, RadioDetection CAT and Genny system, and a RadioDetection RD8000 digital cable- and pipe-locator to trace the drainpipes while searching for contrasting electromagnetic signatures indicative of manholes or manhole covers. A magnetometer and a GSSI SIR 4000 ground-penetrating radar (GPR) were used to confirm suspected buried magnetic and ferromagnetic objects, where present (e.g., manhole covers).

All features identified during the geophysical survey were located using a survey-grade global positioning system (GPS) device with ±0.1 foot horizontal and vertical accuracy, and these features were referenced to the baseline map. The storm-drain lines in Block D and any related manhole structures were marked on the ground surface with paint. Pipe and manhole (storm drain 009 only) locations were documented using GPS and referenced to the Block D baseline map. Attachment D contains the geophysical survey report provided by Enviroscan.

3.2 LOCATING MANHOLES

Attempts were made to excavate geophysical anomalies exhibiting signatures similar to manholes. Excavation entailed hand digging where depths were less than two feet below grade. Excavation at one geophysical anomaly location along drain line 007 did not reveal a manhole; however, a four-foot long broken metal rod was found below approximately two feet of soil at this location. The excavation was backfilled and compacted at the surface. At the "dogleg" bend in drain line 007 (see Figure 4), in the northeastern portion of Block D, hand excavation was performed in an attempt to locate a possible junction box to access the drain line at this dogleg. However, excavation revealed a five-foot culvert box that did not have a manway or a point of entry, so the excavation was backfilled. The top and partial sides of the exposed culvert box appear to be in good condition.

3.3 STORM-SEWER VIDEO SURVEYING

Once the access locations of manhole and storm drains had been confirmed, video inspections of storm-drain lines were attempted/conducted using mobile closed-circuit television (CCTV). Training, health and safety requirements, and personal protective equipment (PPE) were maintained in accordance with the work plan (Tetra Tech, 2015b). The storm drain CCTV assessment was done on August 31, 2015 by a video inspection technician and supporting crew using CCTV mobile video cameras. The crew carried out CCTV inspection in the conduit for storm drain line 007 and in manholes (only) for storm drain lines 009 and 00X.

Attempts to advance the mobile video camera at the outfall and at three manhole access points in storm-drain line 009 failed because the pipe was completely flooded, even at low tide. Therefore, no linear CCTV footage was obtained. The water in the storm drain 009 pipe was highly turbid. In storm drain 00X, the mobile video camera could not be advanced from the upstream junction box (JB-2) at Wilson Point Road or from the concrete junction box/manhole (JB-1) in Block D. The pipes at JB-2 were partially filled with sediment and were completely flooded with water during low tide. JB-1 was also completely flooded with turbid water at low tide, so those pipes could not be filmed.

Sediment or debris obstructing manholes inlets/outlets was not flushed out or removed, but was photographed and documented. Conditions in manholes that prevented access to storm drain lines for video scoping (e.g., mud or water) were noted as a limitation and discussed in the subcontractor's report. Brief CCTV videos and photographs of access points (e.g., manholes, junction box, or discharge outfalls) for Outfalls 009 and 00X are in Attachment G.

On October 13–14, 2015, storm drain lines 009 and 00X were dewatered to the extent possible to facilitate CCTV filming. Approximately 500 feet of storm drain line 009 were filmed, but thick mud prevented the camera from filming several upstream sections; the water depth in the pipe exceeded the top of the camera from 167–208 feet downstream of manhole MH-11 (some distance measurements may not be accurate due to the camera's wheels spinning in the pipe sediment and debris). The interior of JB-1 (storm drain line 00X) and the first few feet of its two 24-inch CMPs were also filmed, but the camera could not proceed upstream due to thick sediment, debris, and collapsed pipe. The camera could only proceed downstream a few feet in the 36-inch-diameter CMP.

Outfall 009 was observed and photographed during a very low tide on October 21, 2015. The low creek water level exposed Outfall 009 at the bulkhead face and in the eroded area behind the outfall and the bulkhead face. Preliminary observations from the October CCTV and Outfall 009 inspection are presented below; however, reports of the pipe condition are not available at this time. That information will be included in the bulkhead geotechnical and storm drain data report that is being developed to document additional tasks recently conducted for the bulkhead design.

3.3.1 CCTV Approach and Scope

The CCTV inspection was intended to assess the condition of the pipe, inlet and outlet locations, and system connectivity, identify intermediate connections, determine the presence/absence of infiltration and/or accumulated sediment, and inspect and document areas of sinkholes, pipe corrosion/holes, adjacent erosion, and suspected pipe collapse. Video inspection was attempted or begun at the farthest upstream portions of each drainage system segment (as shown in Figure 4) and would then proceed downstream.

The CCTV inspection of storm drain 007 was performed as follows:

- The internal television inspection used a color CCTV with a pan and tilt head. The camera was moved through the line in either direction at a uniform rate, no more than 30 feet per minute, stopping when necessary to ensure proper documentation of the pipe/conduit's condition and of the service connections.
- At all service connections or obstructions within the pipe, camera movement was halted and the pan and tilt camera head was rotated to completely inspect the visible portion of the sewer service-connection or defect.
- The CCTV camera inspected stretches of pipe in which two-thirds or more of the pipe was visible. All work near the discharge end was done at low tide to minimize the amount of water in the discharge pipes.
- Measurements to locate defects used a calibrated meter on the camera with a digital readout on the video monitor. Measurement was accurate to 0.1 per 100 feet of inspected pipe.

The mobile CCTV truck was positioned at the upstream structure, and a robotic crawler camera equipped with a multi-angle lens and video was inserted into the drainage pipe to inspect the downstream structure. During the video inspection, onscreen information was viewed and interpreted by the crew, including date, upstream structure number, downstream structure number, and a continuous-footage readout to track the camera's location. In turn, computer-

generated television inspection reports were created using *Flexidata* software for each scoped segment of pipe. Onscreen data and observations were also entered into a *Windows*®-based computer database. All photos and video clips of the defects and observations were saved in this database.

Printed logs from the CCTV inspection document drainpipe features in relation to adjacent manholes. Other observations, such as obstructions, degree of sedimentation, pipe connections, and scale and corrosion, were recorded in the inspection logs. Logs and reports were provided to Tetra Tech in both printed and electronic format. The printed logs for the August CCTV inspection are in Attachment F. Video footage from each length or section of inspected pipe is included on the digital versatile disk (DVD) in Attachment G.

3.3.2 CCTV Findings

A summary of CCTV inspection results for each storm-drain system follows:

Storm drain 009—

- A 24-inch-diameter reinforced-concrete pipe (RCP) was observed between IL-26 and MH-12, MH-12 and MH-11, and approximately 200 feet downstream of MH-11.
- The filmed portion of RCP appears to be in good condition.
- A paved-over manhole was found 155.17 feet downstream (southeast) of IL-26.
- A concrete pipe-tap break-in was observed approximately three feet south of the Block D fence. Water was flowing from the tap break-in into the storm drain 009 pipe.
- RCP was present from MH-11 to film termination at 208 feet. This is approximately 40 feet southeast of a possible RCP/CMP junction (indicated by the ground surface geophysical survey). However, the 208-foot distance might be imprecise, due to wheel spinning during interrupted progress along the last portion of the footage.
- The October 15, 2015 field inspection of Outfall 009 found evidence of a former 24-inch CMP on the bulkhead (vertical) face. A small piece of the CMP remains on the top surface (in the 11–1 o'clock positions) of the outfall opening in the bulkhead face. Pipe is not present from the bulkhead face to 5.85 feet landward. The current pipe end is 5.85 feet landward of the bulkhead face and appears to be CMP. Accumulation of debris at the pipe end allows water to pond upstream of the current pipe end. The area behind the bulkhead face to the end of the pipe end is eroded and contains concrete blocks and other debris.

Storm drain 00X—

- Two 24-inch-diameter CMPs lead from JB-2 (Wilson Point Road) to JB-1 (Block D manhole), and one 36-inch CMP from JB-1 channels flow downstream.

- A small hole or possible tap break-in was observed on top of the 36-inch downstream pipe, approximately 8.3 feet downstream of JB-1.

- One 24-inch CMP is partially collapsed several feet upstream of the junction box.

- Sediment and/or debris are in pipes at JB-2 (Wilson Point Road), several feet upstream of JB-1 (Block D manhole), and downstream of JB-1 (Block D manhole).

Storm drain 007—

- Somewhat more favorable conditions for CCTV inspection were encountered at the two access points for storm drain line 007 (e.g., OF-007 and CB-2). Inspection of the upstream catch basin (CB-2) at Dark Head Cove Road found the entry point accessible and debris free. Therefore, CCTV efforts produced video footage from CB-2 nearly to JB-2, stopping 0.5 foot short of the entire 90-foot length due to cobbles encountered at the junction box at the dogleg bend. Large cobbles were also observed from the inlet on the southern side of Dark Head Cove Road to the inlet on the northern shoulder of Dark Head Cove Road (near the Johnson & Tower property). The section of pipe between CB-2 and JB-2 contained about 1.5 feet of stormwater, and CCTV was completed only for sections above the water line because the water was turbid.

  The CCTV inspection showed that CB-2 was in good condition, with some exposed rebar at some locations. The entire storm drain line was surveyed by CCTV, from JB-2 to OF-007 (591.2 linear feet). This section of pipe contained very little debris or sediment and was in good condition, with some exposed rebar and very little debris or sedimentation. Printed summaries of the electronic logs entered in the CCTV database by the subcontractor while on site are in Attachment E. The subcontractor-prepared CCTV summary reports for each access point or section of surveyed pipe are in Attachment F, and the video footage and photographs are in Attachment G.

3.4 DEMOBILIZATION

All disturbed areas were restored to approximately pre-existing grades upon the completion of field activities. The cover and surrounding ground surface at manholes used for CCTV were restored. Repairs consisted of grading and planting grass seed to return the surface to its original or better condition.

All CCTV equipment was cleaned before arriving on-site and before leaving the site. CCTV equipment was cleaned between pipe segments to remove sediment and debris. Cleaning involved using phosphate-free soap (Alconox™/Liquinox™-type detergent) and rinsing with water. Decontamination (wash) fluids were contained as investigation-derived wastes in drums to

be disposed of off-site at an LMC-approved disposal facility in accordance with the approved work plan (Tetra Tech, 2015b).

Section 4
Conclusions

The engineering bulkhead-inspection completed on July 27–28, 2015 consisted of underwater and land-based inspection of accessible bulkhead structural components. Underwater photographs were taken to document the condition of structural bulkhead components, and ultrasound measurements of sheet pile thickness were obtained. Results from the bulkhead inspection indicate that many sections of steel sheet-pile show full section-loss for 50% or more of the area exposed (i.e., steel is corroded, leaving openings through which sediment from behind the sheet pile can pass).

The concrete front-bumper piles are also severely degraded in many areas. Above-water degradation is often evident in the same areas where voids occur in steel sheet pile. This erosion and loss of soil backfill from behind the structure will be addressed as part of future sediment remedial actions planned for Dark Head Cove in approximately 2016.

The concrete cantilever supports and cap that underlie the concrete deck were in fair condition (minor cracks or concrete degradation) throughout the steel and concrete bulkhead at Blocks D and F. The poor condition of the associated steel sheet piles and concrete deck means that these concrete cap/support beams are the primary structural supports for the degraded bulkhead components. Damage to the concrete cantilever supports or caps would likely hasten complete structural failure of the steel sheet-pile bulkhead sections and decks. Excessive loading or damage should be prevented until the bulkhead can be repaired or replaced. The concrete cap should be monitored for settlement and/or movement. The wooden and timber-pile bulkhead at Block G is also in poor condition, with perforations and knife-edging over the entire length of the structure. An expedited plan to repair eroded areas and replace the bulkhead has been developed by the Lockheed Martin team, and is currently being incorporated into the sediment remedial design, with planned construction in 2016.

Closed-circuit television video inspections of storm drainpipes were completed on August 31, 2015 and October 13–14, 2015 to assess the interior of pipes that discharge to Dark

Head Cove via bulkhead outfall structures. Storm drain lines discharging to Outfalls 009 and 00X were flooded at low tide on August 31, 2015, so conditions were not favorable to complete a mobile video inspection. They were subsequently dewatered on October 13–14, 2015 to facilitate filming their interiors. A field inspection was conducted at Outfall 009 on October 21, 2015 when a very low tide exposed the outfall, the eroded area behind it, and the current outfall pipe behind the bulkhead face.

Two 24-inch-diameter corrugated-metal pipes (CMP) running from JB-2 (Wilson Point Road) to JB-1 (Block D manhole), and one 36-inch corrugated-metal pipe running from JB-1 to the downstream outfall, channel stormwater to storm drain 00X. All pipes contained sediment and/or debris at JB-2 (Wilson Point Road), several feet upstream of JB-1 (Block D manhole), and downstream of JB-1 (Block D manhole). At storm drain 009, a 24-inch-diameter reinforced-concrete pipe (RCP) is between IL-26 and MH-12, MH-12 and MH-11, and approximately 200 feet downstream of MH-11.

The portion of the reinforced-concrete pipe that was filmed appears to be in good condition. Reinforced-concrete pipe runs from MH-11 to the termination of filming at 208 feet. This is approximately 40 feet southeast of a possible junction of reinforced-concrete pipe and corrugated-metal pipe that was indicated by the ground surface geophysical survey. However, the 208-foot distance might be inaccurate, due to the camera's wheels spinning during interrupted progress along the last portion of the footage.

The October 15, 2015 field inspection of Outfall 009 indicates a 24-inch corrugated-metal pipe was formerly in place at the bulkhead (vertical) face. That pipe is currently absent from the bulkhead face to 5.85 feet landward of the bulkhead face. The end of the current pipe is 5.85 feet landward of the bulkhead face, and appears to be corrugated-metal pipe. The area behind the bulkhead face to the end of the pipe is eroded and contains concrete blocks and other debris. Two linear segments (approximately 680 linear feet) of five-foot concrete culvert-box pipe leading to Outfall 007 were accessible and free of major obstructions. Video footage shows that the culvert-box pipe for drain line 007 is in fair condition, with some exposed rebar, and no major defects.

Section 5
References

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FIGURES

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2013 ESRI and its data suppliers).

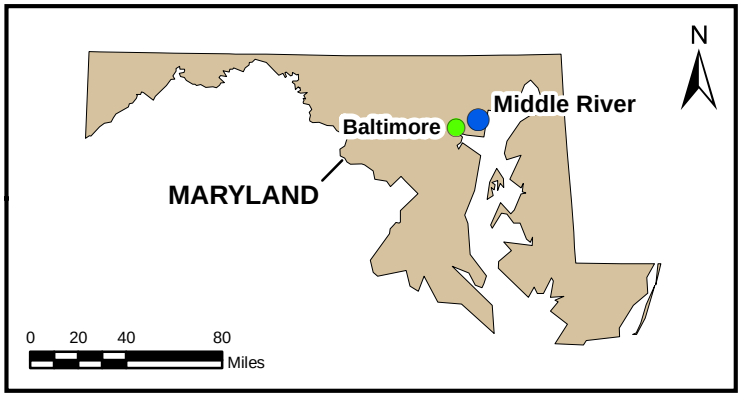


FIGURE 1

MIDDLE RIVER COMPLEX LOCATION MAP

Lockheed Martin, Martin State Airport
Middle River, Maryland

DATE MODIFIED:	CREATED BY:
07/09/15	JEE

TETRA TECH

Map Document: (P:\GIS\Middle_River\MapDocs\MXD\mrc_sitemap_jun2014.mxd)
07/09/15 -- JEE

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2013 ESRI and its data suppliers).

BUILDING A
BUILDING B
BUILDING C
VLS BUILDING
JOHNSON AND TOWERS
Chesapeake Park Plz
Dark Head Cove Rd
Wilson Point Rd
800
612
Martin Blvd
BLOCK 'D'
BLOCK 'D' PANHANDLE
PARKING LOT NO. 3
BLOCK 'G'
FORMER BUILDING D
BLOCK 'E'
TILLEY CHEMICAL COMPANY
Glenn Martin Lagoon Rd
WATERFRONT LOT
DARK HEAD COVE
BLOCK 'F'
COW PENS CREEK
Kingston Rd
Firethorn Rd
Corelthorn Rd
2199
2200
300
400
330
916

FIGURE 2

MIDDLE RIVER COMPLEX WATERFRONT TAX BLOCKS, JULY 2015

LEGEND

- TAX BLOCK
- RAILROAD TRACKS
- CURB LINE

Lockheed Martin Middle River Complex
Middle River, Maryland

0 125 250 Feet

N

DATE MODIFIED: 07/09/15

CREATED BY: JEE

TETRA TECH

Map Document: (P:\GIS\Middle_River\MapDocs\MXD\mrc_waterfront_tax_blocks_jul2015_aerial.mxd)
07/09/15 -- JEE

FIGURE 3

BULKHEAD INSPECTION AREA
MIDDLE RIVER COMPLEX

LEGEND

- STORMWATER OUTFALL LOCATION (UPDATED APRIL 2015)

SHORELINE MATERIAL AND BULKHEAD INSPECTION AREA

- CONCRETE BULKHEAD
- RIPRAP
- WOOD
- TAX BLOCK

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2013 ESRI and its data suppliers).

Lockheed Martin Middle River Complex
Middle River, Maryland

0 80 160 Feet

N

DATE MODIFIED: 10/05/15

CREATED BY: JEE

TETRA TECH

Map Document: (P:\GIS\Middle_River\MapDocs\MXD\dhc_bulkhead_inspection_jul2015.mxd)
10/05/15 -- JEE

FIGURE 4

GEOPHYSICAL SURVEY AND STORM DRAIN VIDEO SURVEY LOCATIONS MIDDLE RIVER COMPLEX

LEGEND

- STORMWATER OUTFALL LOCATION
- MANHOLE
- CATCH BASIN (GRATED INLET)
- STORM DRAIN PIPE
- GEOPHYSICAL SURVEY AND STORM DRAIN VIDEO LOCATION
- MSA MARTIN STATE AIRPORT

SHORELINE MATERIAL AND BULKHEAD INSPECTION AREA

- CONCRETE BULKHEAD
- RIPRAP
- TAX BLOCK

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2013 ESRI and its data suppliers).

Lockheed Martin Middle River Complex
Middle River, Maryland

0 60 120 Feet

N

DATE MODIFIED: 10/26/15

CREATED BY: JEE

TETRA TECH

Map Document: (P:\GIS\Middle_River\MapDocs\MXD\block_d_storm_line_inspection_jul2015.mxd)
10/26/15 -- JEE

ATTACHMENT A—BULKHEAD INSPECTOR'S DIVE PLAN

DIVE PLAN

TETRA TECH

Lockheed Martin Middle River Complex

Table of Contents

Dive Operations Plan

This dive operations plan is an overview of work to be performed, dive modes and equipment, site access, anticipated conditions, and personnel information as required by ADCI Consensus Standards

As specified in the Tetra Tech, Inc. Scientific Diving Program (Document Control Number 2-15, Revision 10/1/2008), this document will serve to satisfy the following criteria:

- Description of project objectives and proposed field activities (including approximate number and location of proposed dives)
- Assignments and responsibilities of the dive team members
- Divers qualifications including the type of certifications, training and medical documentation for each dive team member
- Diving mode to be employed
- Estimated depths and bottom times anticipated
- Decompression status and repetitive dive plans if required.
- Hazard risk analysis for each proposed activity
- Safety procedures and checklists
- Equipment procedures (including equipment and boats to be employed)
- Emergency plan to include the following: name telephone number and relationship of person to be contacted for each diver in the event of an emergency, nearest operational recompression chamber, nearest accessible hospital and available means of transport.
- Any hazardous conditions anticipated

a) Contractor Name

Infrastructure Engineers Inc.

b) Contract Information

Contract # 1116753

c) Submission Date

7/27/2015

d) Contact Information

Diving Officer Preparing Dive Plan:

Brett Frazer
bfrazer@go-iei.com
804-456-2033

Additional Field Contact:

James Lightfoot
jlightfoot@go-iei.com
804-417-6472

e) Dive Team Members and Duties

Team Member	Assigned Role	Certifications
Brett Frazer, PE	Supervisor/Team Leader/Diver	ADCI Surface-Supplied Air Diver CPR/First aid/AED/O2 Provider
James Lightfoot, EIT	Team Leader/Diver	ADCI Surface-Supplied Air Diver CPR/First aid/AED/O2 Provider
Matt Ratliff	Diver/Tender	ADCI Entry Level Tender / Diver CPR/First aid/AED/O2 Provider
Patrick Pieczynski	Diver/Tender	ADCI Entry Level Tender / Diver CPR/First aid/AED/O2 Provider

Refer to Appendix D for copies of relevant certifications, medical documentation and cards.

f) List of Diving Equipment to be used

Commercial SCUBA:
AGA Diving Masks
OTS wireless communication system
Spare Air bailout system
Dive fins
Dry suit or Wet suit
Gloves
Dive boots
Emergency Oxygen
First Aid Kit
Time keeping device
Dive flag
Dive Knife
Cygnus ultrasonic gauge

g) Access

Diving operations will be staged from the shore or a 14' boat as necessary. Commercial SCUBA will be used with a standby diver.

h) Description

This Dive Safety Plan covers the full visual bulkhead inspection of approximately 1,350 feet of metal and timber bulkhead at the Lockheed Martin Facility in Middle River, MD. Photographic documentation and ultrasonic survey of at least 20% of the metal sheet pile will also be performed as part of the dives.

Brett Frazer will be the dive supervisor and designated person in charge of the dive from the topside station. He will be responsible for repetitive dive designation and completion of dive logs. James Lightfoot, Matt Ratliff, and Patrick Pieczynski will serve as diver, standby diver and tender respectively depending on the daily assignment.

The dive will end once underwater inspection is complete or the limits of the navy no-decompression tables are approached.

i) Date, Time, Duration, and Location of Operations

Dates: July 27th – July 29th

Times: Between the hours of 08:00 and 17:00
(During Slack Tides or when current allows) - Refer to schedule for high and low tide.

Location: Lockheed Martin Middle River Complex
2323 Eastern Blvd, Middle River, MD 21220

Duration: Dive duration will be in accordance with the Navy no Decompression dive tables

j) Dive Mode

After carful review of the dive location, site hazards, depth, and difficulty of the dive, it has been determined to perform this dive using Commercial SCUBA without a recompression chamber on site. Operations shall conform to ADCI Consensus Standards.

a) The dive will be less than 100 ft
b) The dives will be within the limits of no decompression.
c) There will be no pressure differential.

k) Work to be Performed

Divers will perform visual and tactile inspection of the substructure for all of the bulkhead components specified in the Scope of Work located in the water to determine overall structural integrity. Extent and location of defects will be recorded. Divers will use hand tools to perform a level ll cleaning of the substructure and perform ultrasonic survey of at least 20% of the applicable substructure. Underwater cameras will be used as necessary to aid in documentation of underwater deficiencies.

l) Anticipated Conditions

Underwater visibility: 1 - 3 ft
Water Temperature: 70-80 deg
Surface Temperature: 75-90 deg
Current: Minor/Tidal (Diving operations will be scheduled around low / slack tides)

m) Dive Profile

Anticipated maximum depth: 10ft
Maximum bottom time per Navy dive tables: Unlimited

n) Topside Support

Topside support will be the use of a tender/standby diver and the dive supervisor. OTS wireless communications will be used to monitor divers' progress and bottom time. No additional topside support will be used.

o) Means of Communication

Mobile phones and an OTS wireless communication system will be on site. The following project related personnel will be contacted prior to commencing diving operations.

Project Manager

Peter Maldini
PMaldini@go-iei.com
443-702-6256

Tetra Tech Contact

Amy McGivney
Amy.McGivney@tetratech.com
(301) 528-3018

Contract # 1116753

If for any reason the dive plan is altered in mission, depth, personnel, or equipment the DDC will be contacted in order to review and accept the alteration prior to actual operation.

Activity Hazard Analysis (AHA)

This AHA represents our best efforts to anticipate and mitigate or prevent the adverse effects of equipment failure, extreme weather/environmental conditions, or other hazardous/unexpected situations as required by the ADCI Consensus Standards

POTENTIAL HAZARD	MEANS OF PREVENTION	ACTION
Drowning	Divers are experienced, use and assurance of properly working equipment	CPR, get medical help immediately
Lost Diver/Loss of consciousness	A pre-dive meeting will determine exit/entrance procedures and locations. Wireless communications will be used when possible. Since the dive is in within the limits of No-D the lost diver will surface immediately.	Determine last know location, mobilize back up diver and start search patterns.
Boat Traffic	Notify divers via wireless communications, Display dive flag.	Get medical help if diver is injured.
Injured diver	Divers are trained and in good physical condition.	Remove injured diver from the water and get medical help. A stand-by diver will be deployed to help if necessary.
Decompression Sickness	Follow Navy decompression tables.	Administer Oxygen, Get medical help, Start on chamber treatment as soon as possible.
Hypoxia	Make sure cylinders have been tested.	Breath fresh air and administer oxygen immediately.
Air Embolism	Experienced divers, good physical condition.	Get medical help, chamber treatment as soon as possible.
Squeeze	Trained divers.	Get medical help. (depending on severity and squeeze type)
Hypothermia	Dress appropriately	Get diver warm, medical assistance may be necessary.
Carbon monoxide/ dioxide	Ensure tanks provide adequate air supply.	Get medical help, breath fresh air.
Diver tether entanglement	Never tether with a line that cannot be cut	If the diver cannot easily free himself, he will cut the line and immediately return to the surface.
Communication loss	Ensure proper equipment and maintenance.	Diver to immediately return to surface.
Main Air Supply loss	Ensure proper equipment and maintenance. Closely monitor air pressure gauge.	Switch to alternate/backup air source and surface immediately.

Special Hazards (AHA)

- On Site Assessment – The site will be examined for hazards, existing conditions, and entrance/exit strategies prior to commencement of work. The team leaders on site have prior experience with coastal facilities and conditions.

Potential hazards

- Water depths will be shallow (est. less than 10ft). This will decrease the risk to the divers. However, careful attention to dive times and diver comfort will be closely monitored through wireless communications. All divers will have time pieces. (low risk)

- Water conditions will be good. There will be minimal current with incoming and outgoing tides (The dives will be scheduled around a predicted high and low tides), and diver visibility is estimated to be less than 3 ft. (moderate risk)

- Water temperatures are assumed to be approximately 80 degrees, based upon NOAA station data for Baltimore, MD. Surface temperature is estimated to be between 75 and 85 degrees. Divers will wear wetsuits and / or coveralls as conditions allow. (low risk)

- Marine life/Obstructions are not expected. Any concerns or potential hazards will be addressed in the pre-dive briefing. (low risk)

- Altitude – Divers are not diving deep, however, flights will be a minimum of 24 hours after dive completion. (low risk)

- Office Contact information

  Infrastructure Engineers Inc.
  1-888-451-6822
  Dial 0 for the operator

- Risk assessment code = **12** (SUM of risk value scores from following page)

Low Risk = 0 to 12
Caution = 13 to 25
High Risk = 26 to 35

*High risk operations assigned a value of 20-35 require approval by David R. Reser and an extensive dive plan. When two or more areas are assigned a risk factor of 5, the overall rating is high risk.

Planning	**Risk Value**		**SCORE 2**
	Preparatory Time		
Contract Type	Optimum	Adequate	Minimal
Emergency (last minute)	3	4	5
New Contract	**2**	3	4
Ongoing Contract or Repeat	1	2	3
Organization and Equipment	**Risk Value**		**SCORE 1**
	Equipment Available		
Project Organization	Internal Equip	Leased Equipment	Another Company's
Working for Contractor	2	3	4
Subconsultant	**1**	2	3
Prime	1	2	3
Physical Requirements of Divers	**Risk Value**		**SCORE 1**
	Employee Preparation		
Environment	Optimum	Adequate	Minimal
Non-acclimated	3	4	5
Partially Acclimated	2	3	4
Acclimated	**1**	2	3
Team Members	**Risk Value**		**SCORE 2**
	Diver Experience		
Task	Very Experienced	Moderate Experience	Minimal Experience
Complex	3	4	5
Routine	**2**	3	4
Simple	1	2	3
Weather	**Risk Value**		**SCORE 1**
Water	**Rain and Weather**		
Temperature °F	Clear	Drizzle or High Humidity	Rain/ Snow/Ice/Dust
<45° or >86°	3	4	5
45° - 65°	2	3	4
66°-85°	**1**	2	3
Waterway	**Risk Value**		**SCORE 3**
	Current		
Type Visibility	No Current	Moderate Current	Fast Current
Zero Visibility	4	5	6
1 ft visibility	**3**	4	5
3 ft visibility	2	3	4
6 ft visibility	1	2	3
Project Duration	**Risk Value**		**SCORE 2**
	Team Experience Together		
Duration in Weeks	Much	Some	Little
2	**3**	4	5
1	1	**2**	3

Emergency Management Plan:

a) Divers Alert Network (DAN)

Contact Information
(919) 684-9111 (24hr emergency line)
(919) 684-2948 (non-emergency, 8:30am-5:00pm EST Mon-Fri.)

b) Medical Facilities

Location and phone numbers for nearest hospital & recompression chamber (directions attached).

Johns Hopkins Bayview Medical Center (medical)
4940 Eastern Ave
Baltimore, MD 21224
Main Line: (410) 550-7900

R. Adams Cowley Shock Trauma Center
University of Maryland Medical Center
Hyperbaric Medicine Department (recompression chamber)
22 S. Greene St
Baltimore, MD 21201
Direct Line: (410) 328-6152
Main Line: (410) 328-9284

c) Emergency Victim Transport Plan:

-Notify local medical/EMT personnel. Secure emergency transportation to Hospital.
- Emergency # 911

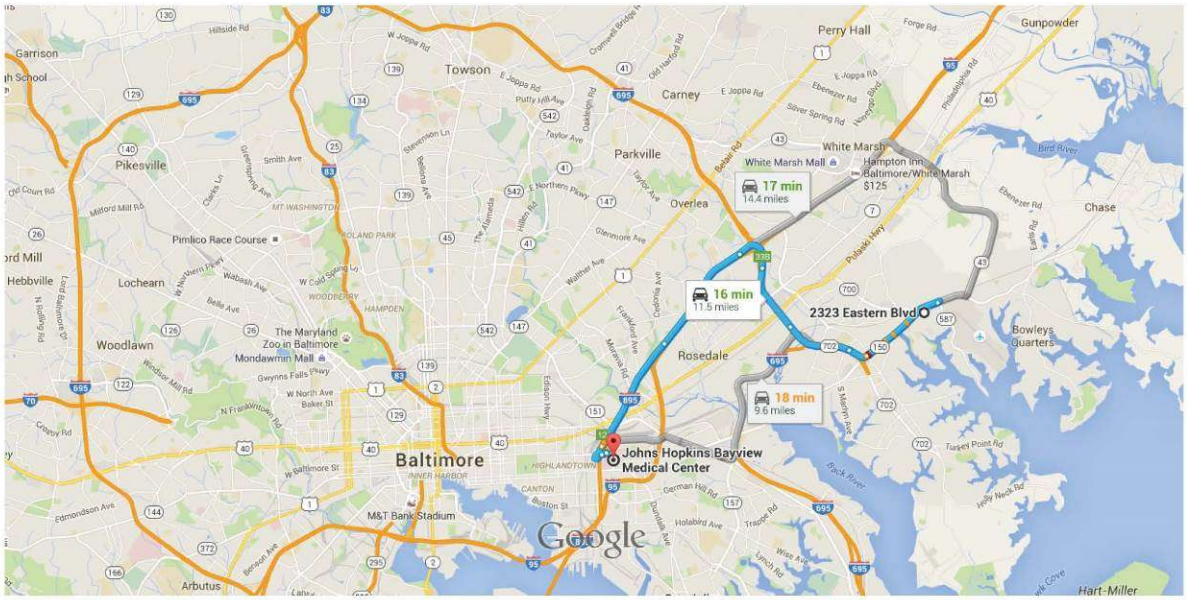
d) Diver Rescue Procedures

The dive supervisor will secure the dive site and direct the second diver to assist in securing the injured diver to the bank. The standby diver will be deployed to aid in getting the injured diver out of the water. Emergency response will be immediately notified and directed where to meet. CPR and First Aid will be administered until emergency response officials arrive at the scene.

Appendix A: Directions to Nearest Medical Facility

Johns Hopkins Bayview Medical Center (medical)
4940 Eastern Ave
Baltimore, MD 21224
Main Line: (410) 550-7900

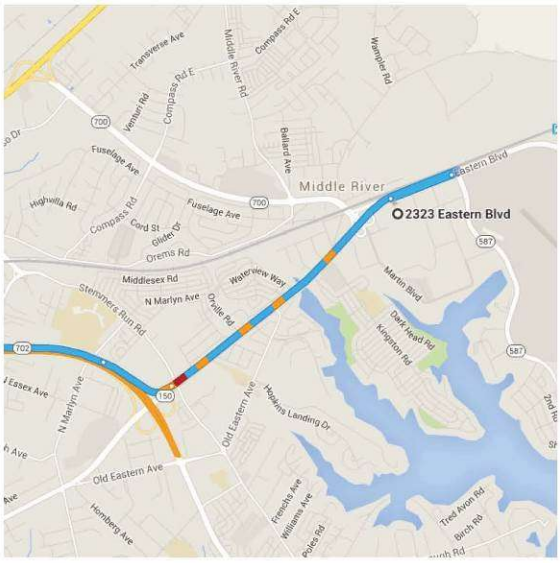
Google 2323 Eastern Blvd, Middle River, MD 21220 to Johns Hopkins Bayview Medical Center — Drive 11.5 miles, 16 min



○ 2323 Eastern Blvd
Middle River, MD 21220

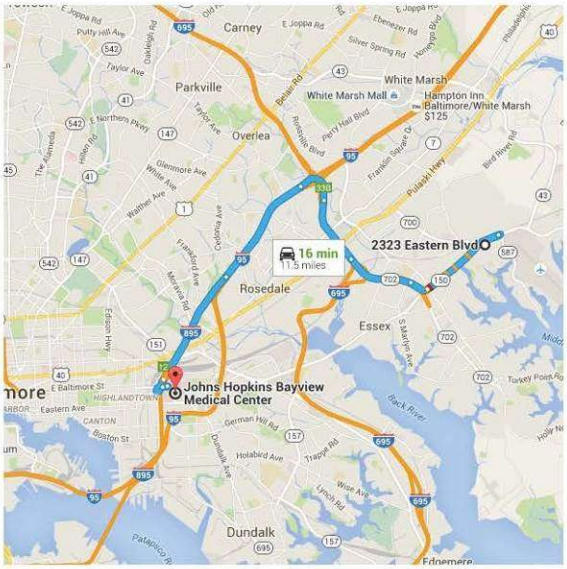
Get on MD-702 N in Essex — 2.6 mi / 5 min

1. Head northeast on Eastern Blvd toward Chesapeake Park Dr — 0.3 mi
2. Make a U-turn — 1.9 mi
3. Use the right 2 lanes to take the Maryland 702 N ramp to Interstate 695 N — 0.4 mi



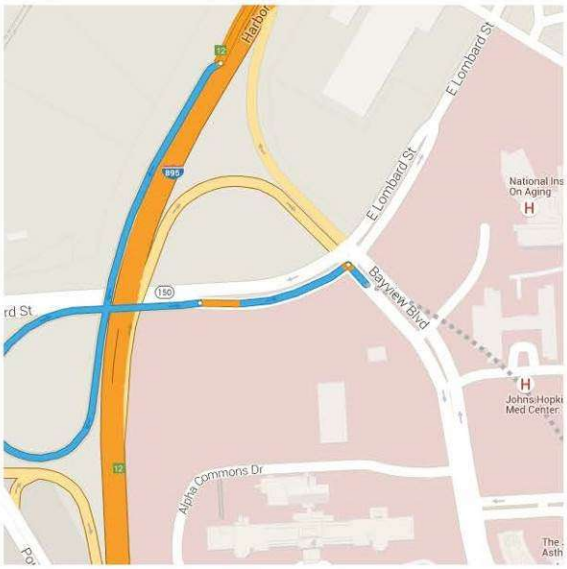
Take I-95 S and I-895 S to E Lombard St in Baltimore. Take exit 12 from I-895 S — 8.8 mi / 9 min

4. Merge onto MD-702 N
1.3 mi
5. Merge onto I-695 N
1.4 mi
6. Use the right 2 lanes to take exit 33B for Interstate 95 S
0.9 mi
7. Merge onto I-95 S
2.4 mi
8. Keep right at the fork to continue on I-895 S, follow signs for Baltimore Harbor Tunnel Thruway/Annapolis
2.4 mi
9. Take exit 12 to merge onto E Lombard St
0.5 mi



Continue on E Lombard St. Drive to Bayview Blvd
0.1 mi / 27 s

10. Merge onto E Lombard St
0.1 mi
11. Turn right onto Bayview Blvd
85 ft



Johns Hopkins Bayview Medical Center
4940 Eastern Avenue, Baltimore, MD 21224

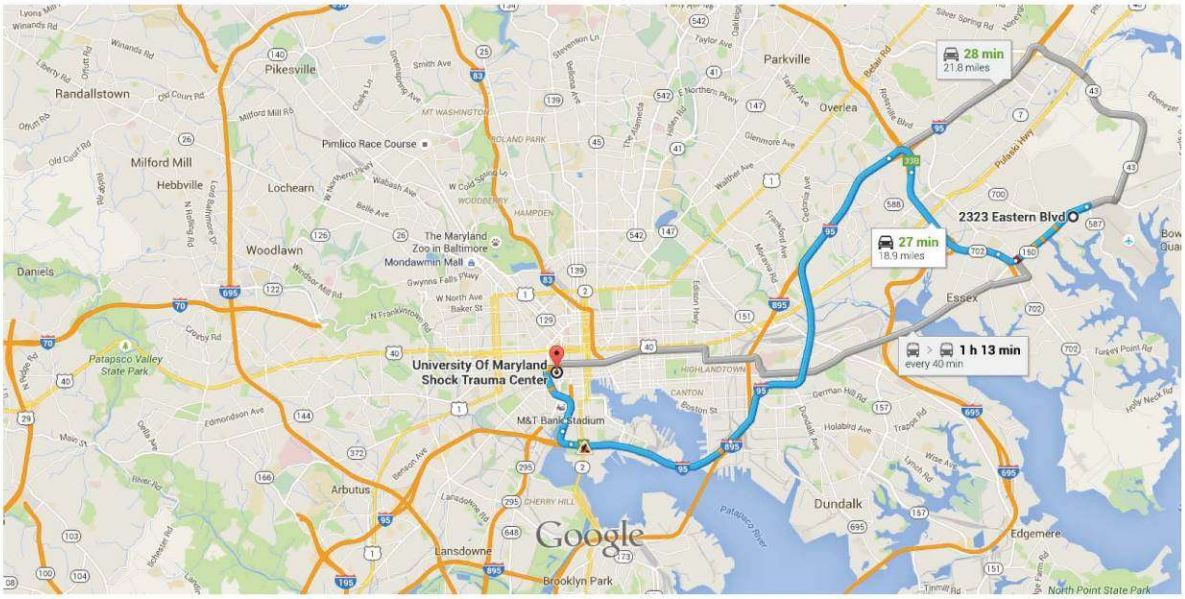
These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Map data ©2015 Google 2 mi

Appendix B: Directions to Nearest Recompression Chamber

R. Adams Cowley Shock Trauma Center
University of Maryland Medical Center
Hyperbaric Medicine Department (recompression chamber)
22 S. Greene St
Baltimore, MD 21201
Direct Line: (410) 328-6152
Main Line: (410) 328-9284

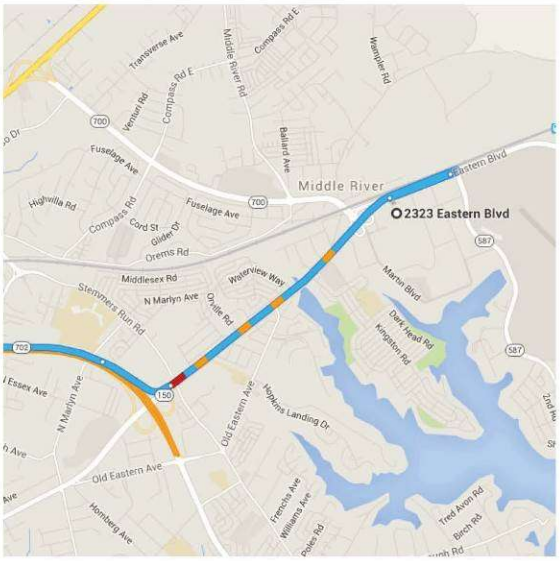
Google 2323 Eastern Blvd, Middle River, MD 21220 to University Of Maryland Shock Trauma Center — Drive 18.9 miles, 27 min



○ 2323 Eastern Blvd
Middle River, MD 21220

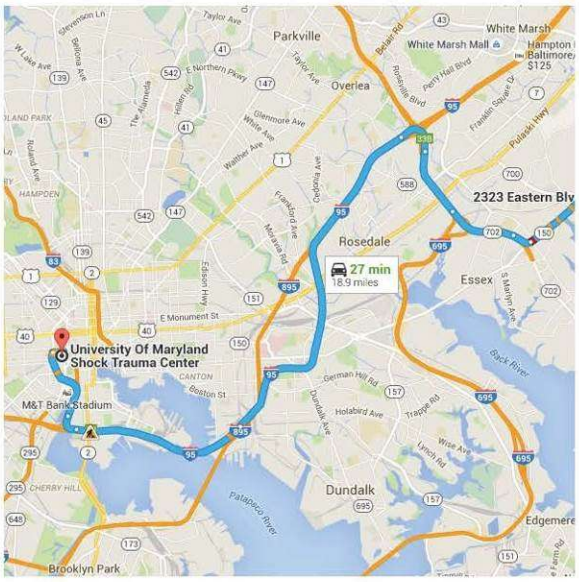
Get on MD-702 N in Essex
2.6 mi / 5 min

1. Head northeast on Eastern Blvd toward Chesapeake Park Dr
0.3 mi
2. Make a U-turn
1.9 mi
3. Use the right 2 lanes to take the Maryland 702 N ramp to Interstate 695 N
0.4 mi



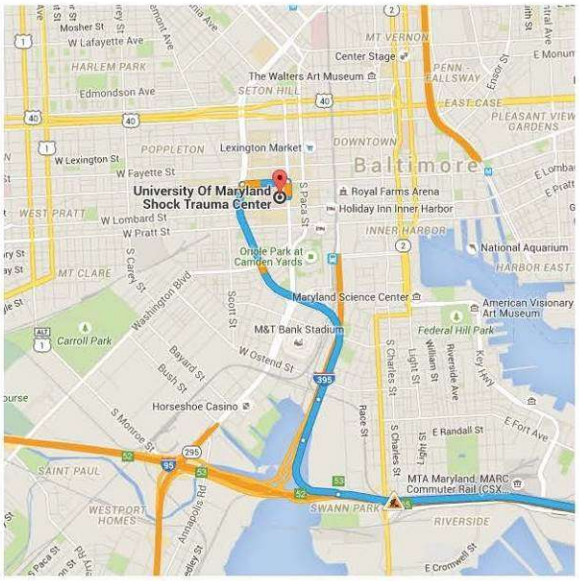
Take I-95 S to S Martin Luther King Jr Blvd in Baltimore
14.7 mi / 16 min

4. Merge onto MD-702 N — 1.3 mi
5. Merge onto I-695 N — 1.4 mi
6. Use the right 2 lanes to take exit 33B for Interstate 95 S — 0.9 mi
7. Merge onto I-95 S
   ⚠ Partial toll road — 7.1 mi
8. Keep left to stay on I-95 S
   ⚠ Partial toll road — 3.4 mi
9. Take exit 53 for I-395 N toward Downtown/Inner Harbor — 0.4 mi
10. Continue onto I-395 N — 0.2 mi



Continue on S Martin Luther King Jr Blvd.
Drive to S Greene St — 1.6 mi / 5 min

11. Use the right 2 lanes to turn slightly right onto S Martin Luther King Jr Blvd (signs for M.L. King. Jr.Blvd) — 1.3 mi
12. Turn right onto W Baltimore St — 0.2 mi
13. Turn right at the 3rd cross street onto S Greene St
    ⓘ Destination will be on the right — 371 ft



University Of Maryland Shock Trauma Center

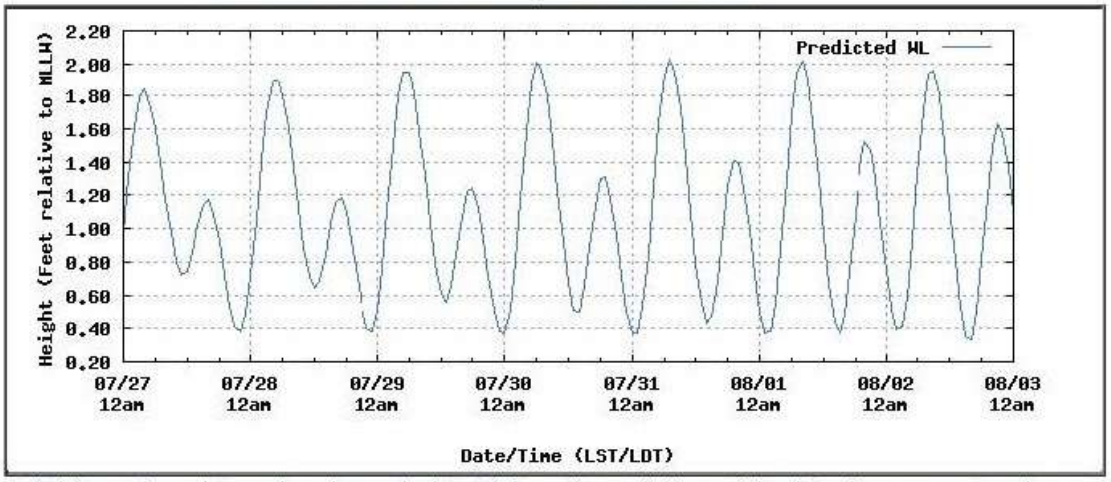
22 South Greene Street, Baltimore, MD 21201

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Map data ©2015 Google 2 mi

Appendix C: Tidal Data

NOAA/NOS/CO-OPS
Weekly Tide Prediction for BALTIMORE,MD
StationId 8574680
From: 2015/07/27 - 2015/08/02
Units: Feet Time Zone: LST/LDT Datum: MLLW



Disclaimer: These data are based upon the latest information available as of the date of your request, and may differ from the published tide tables.

High/Low Tide Predictions

Station Name: BALTIMORE,MD
Parameter: Weekly
Product: Tide Prediction
Start Date & Time: 2015/07/27 12:00AM
End Date & Time: 2015/08/02 11:59PM

Source: NOAA/NOS/CO-OPS
Prediction Type: Harmonic
Datum: MLLW
Height Units: Feet
Time Zone: LST/LDT

Date	Day	Time	Hgt	Time	Hgt	Time	Hgt	Time	Hgt
2015/07/27	Mon	03:50 AM	1.84 H	11:17 AM	0.72 L	03:45 PM	1.18 H	09:43 PM	0.38 L
2015/07/28	Tue	04:39 AM	1.91 H	12:07 PM	0.63 L	04:44 PM	1.2 H	10:38 PM	0.37 L
2015/07/29	Wed	05:27 AM	1.97 H	12:52 PM	0.56 L	05:40 PM	1.25 H	11:34 PM	0.36 L
2015/07/30	Thu	06:15 AM	2.01 H	01:34 PM	0.49 L	06:34 PM	1.33 H		
2015/07/31	Fri	12:31 AM	0.35 L	07:03 AM	2.03 H	02:15 PM	0.42 L	07:26 PM	1.42 H
2015/08/01	Sat	01:28 AM	0.35 L	07:50 AM	2.02 H	02:55 PM	0.37 L	08:19 PM	1.53 H
2015/08/02	Sun	02:26 AM	0.38 L	08:37 AM	1.98 H	03:35 PM	0.32 L	09:12 PM	1.63 H

Appendix D: Commercial SCUBA Checklist and Dive Log Example

INFRASTRUCTURE ENGINEERS, INC.
consulting engineers | commercial divers

SCUBA DIVE STATION CHECKLIST

PREPARING THE DIVE STATION	CHECK
Verify that a recompression chamber is present for dives of more than 80 fsw.	
Verify dive flags and other signals are displayed correctly.	
Ensure that all personnel concerned, or in the vicinity, are informed of diving operations.	
Determine that all valves, switches, controls, and equipment components affecting diving operation are tagged-out to prevent accidental shut-down or activation.	
Assemble all members of the diving team and support personnel for a predive briefing and conduct brief.	
Assemble and lay out all dive equipment, both primary equipment and standby spares for diver (or standby diver), including all accessory equipment and tools, air supplies (primary and secondary).	
Insure all air certificates are current.	
PREPARING THE PROPER SAFETY EQUIPMENT	
Verify the required dive gear checkist is completed.	
Verify oxygen tank experation date.	
Verify secondary airsource is fully charged.	
ACTIVATE THE AIR SUPPLY	
Compressors	
Verify that there is a properly functioning pressure gauge on the air receiver and that the compressor is meeting its delivery requirements.(If HP compressor is on board to fill tanks while diving.)	
Cylinders	
Gauge all cylinders for proper pressure.	
Verify availability and suitability of reserve cylinders.	
Check all manifolds and valves for operation.	
Activate and check air sytem for leaks.	
FOR ALL SUPPLY SYSTEMS, DOUBLE CHECK **"DO NOT TOUCH"** TAGS (TAG OUTS).	
DIVING HOSES	
Check hoses for damage and blow out hoses.	
TEST EQUIPMENT WITH ACTIVATED AIR SUPPLY	
Hook up all air hoses to helmets, masks and chamber.	
Verify flow to Aga or scuba regulator is sufficent to sustain proper breathing.	
Check all exhaust and non-return valves.	
Hook up and test all communications.(If applicable)	
Check air flow from both primary and back-up supplies to chamber (if chamber used).	
RECOMPRESSION CHAMBER CHECKOUT IF NEEDED (PREDIVE ONLY)	
Check that chamber is completely free and clear of all combustible materials.	
Check primary and back-up air supply to chamber and all pressure gauges.	
Check that chamber is free of all odors or other "contaminants".	
Hook up and test all communications.	
Check air flow from both primary and back-up supplies to chamber.	
FINAL PREPARATIONS	
Verify that all necessary records, log, and timesheets are on the diving station.	
Check that appropriate decompression tables are readily at hand.	
Place the dressing bench in position (if used), reasonably close to the diving ladder or stage, to minimize diver travel.	
Notes:	
Supervisor/DPIC Signature Date	

FORM FSCD101-SSA

Z:\600\OPERATIONS\FORMS\FORMS-CHECKLISTS\scuba dive station checklist.xls

INFRASTRUCTURE ENGINEERS, INC.
consulting engineers | commercial divers
2121 Old Hickory Tree Road
St. Cloud, Florida 34772
Phone: (407) 957-1660

Date
Job Number: *
Diver Last Name:
Diver First Name:
Tender Last Name:

Divers Dress:
Type Hat:
Diving Mode:
Structure Number/ Name:

Waterway Name:
Water Type:
Description of Work:
State:
EGS Pressure:

(LS) Left Surface:
Depth:
(LB) Left Bottom:

(RB) Reach Bottom:
(TBT)Total Bottom Time:

Table and Schedule Used:
(RS) Reach Surface:
(SI) Surface Interval Since Previous Dive:

Time to First Stop:
Total Decompression Tim
Rept Dive Designation for Current Dive:

Descent	Ascent	Stops	Decompress Time Water	Decompress Time Chamber	Record Times Reach and Depart Each Stop Water	Record Times Reach and Depart Each Stop Chamber
		10			L R	
		20			L R	
		30			L R	
		40			L R	
		50			L R	
		60 70 80				
		90 100				

Water Temp:
Air Temp:
Weather:

Bottom Material:
Current:
Water Visibility:

Dive Platform:

Comments:

USL H Shore Nay Minutes
Maritime Boat Nay Minutes:
State ACT Non Nay Minutes:

Supervisor Last Name:

ATTACHMENT B—ULTRASONIC INSTRUMENT SPECIFICATIONS

Cygnus DIVE Underwater Gauge

Wrist-Mountable Underwater Thickness Gauge

Options

Topside Repeater with Video Overlay

Allows real-time thickness measurements and calibration settings to be overlaid on the dive monitor screen. Also supplied with a hand held repeater unit.

- Measurements superimposed on to a composite PAL or NTSC video signal
- Overlay can be re-positioned anywhere on the screen
- Measurements and locations recorded on the survey video.

Surface Repeater

The Cygnus DIVE can be connected to a laptop on the surface running CygLink software. This can then be used to log readings and control gauge settings, for example the velocity of sound. Reports and graphical analysis can then be produced and saved.

Data Logging

Up to 5,000 measurements and A-Scans can be stored. The "Auto-Log" feature saves each stable measurement meaning the diver doesn't have to press a button every time a readings needs to be logged. Supplied with CygLink version 4 software.

HelmetView™

Developed by Cygnus for divers in black or limited visibility water. The small remote OLED display is mounted just in front of the lens on the diver's helmet. With adjustable brightness, the thickness measurement is clearly visible to the diver. When auto-log is being used, the HelmetView™ display will indicate when the reading is logged.

Media

Watch the Cygnus Instruments underwater thickness gauge video on how Cygnus DIVE works.

Features

- 300 m depth rated
- Wrist-mountable, giving the diver a free hand
- A-Scan (selectable)
- Data logging - stores 5000 measurements and A-Scans
- "Auto-Log" - no log button to press
- AMOLED display, easy viewing from all angles for diver and camera
- Multiple Echo, error- checked measurements through coatings up to 20 mm thick
- Single-Echo - for use on extreme corrosion, anchor chain links and some plastics
- MSI™ Measurement Stability Indicator - exclusive to Cygnus, confirms a stable reading in single echo mode
- HelmetView™ - optional remote display.

Product Enquiry: Cygnus DIVE Underwater Gauge

Kit Content

Cygnus DIVE gauge, 2 rechargeable batteries, fast charger, Multiple Echo (through coating) probe (2.25 MHz 13 mm), user manual, spare membranes, membrane key, test block and surface and membrane couplant.

Applications

- Maintenance and safety checks on bridges
- Metal thickness / wear checks on jetties, dock gates, piers and piling systems.
- Metal thickness and corrosion checks on offshore structures and ships
- Safety corrosion monitoring of pipelines and storage vessels
- Ships classification surveys.

Download brochures

Rela

Specification

Display	2.8" quarter VGA colour AMOLED (320 x 240 pixels) Large clear thickness measurement (15 mm high numbers), viewable from all angles A-Scan display with automatic X axis Battery level, signal strength, probe type, velocity Measurement mode and units indication
Battery	Single 3.6V Li-ion 8.2 W battery 11 hours continuous measurement Low battery warning 'alert' message
Measurement Modes	Multiple echo (three back-wall echoes) using Single Crystal (zero-degree) probes automatically ignores surface coatings and measures only metal thickness Single echo (first back-wall echo) using Twin Crystal probes
Deep Coat	In Multiple Echo mode, allows measurement to be made through thicker coatings of suitable materials of up to 20 mm thick
Accuracy	±0.1 mm (±0.004") or 0.1% of thickness measurement, whichever is greatest, when calibrated in accordance with Cygnus Instruments calibration procedure
Probes	Single Crystal probes: 2.25 MHz 13 mm (standard) S2C 2.25 MHz 19 mm S2D 3.5 MHz 13 mm S3C 5.0 MHz 6 mm S5C Twin Crystal probes: 2.0 MHz 13 mm x2 (for some plastics e.g. outfall pipes) T2C 5.0 MHz 8 mm x2 (standard) T5B
Probe Cables	Double outer jacket in tough PU. Coloured yellow for easy locations underwater. Coiled for ease of use. Fischer S105 series connectors.
Measurement Ranges	Multiple Echo (through coatings) with Single Crystal probes: 2.25 MHz = 3.0 to 250 mm 3.5 MHz = 2.0 to 150 mm 5.0 MHz = 1.0 to 50 mm Single Echo with Twin Crystal probes: 5.0 MHz = 1.5 to 50 mm in steel 2.0 MHz = 2.5 to 150 mm in steel
Measurement Resolution	Multiple Echo with Single Crystal probes - 0.1 mm or 0.05 mm Single Echo with Twin Crystal probes - 0.1 mm or 0.01 mm
Measurement Units	mm or inches
Probe Zero	Fully automatic probe zeroing for all probes types
V-Path Correction	Automatic V-Path correction for all Twin Crystal probes
Velocity Range	2000 to 9000 m/s in 1 m/s setps
Pulser	Twin channel 70 V spike pulser
Receiver / Amplifier	10 MHz bandwidth, 120 dB range, automatic TCG 60 MHz measurement time-base
Data Logging	One-handed automatic logging of stable measurements. Capacity for up to 5000 points including 640 point A-Scan data.
Data Output	RS-485 single pair, half duplex for surface connection
Computer Software	CygLink v4 allows remote logging and viewing of A-Scan graphs. Survey and report generation to PDF file. Graphic analysis of data and statistical calculations. Designed for Windows 7 and Windows 8.

ATTACHMENT C—BULKHEAD-INSPECTION SUBCONTRACTOR'S REPORT

Underwater Inspection Report

TETRA TECH

Prepared for Tetra Tech, Inc.

Lockheed Martin Middle River Complex

Seawall – Dark Head Cove/Cowpen Creek near Middle River

Middle River, Maryland
July 27 – 28, 2015

Developed by:

INFRASTRUCTURE ENGINEERS, INC.
consulting engineers | commercial divers

Job No. 15117MD00.00

This Underwater Inspection Report was Developed for:

Lockheed Martin Middle River Complex

-

Seawall bordering Dark Head Cove/Cowpen Creek

in

Middle River, Maryland

Infrastructure Engineers • 8000 Jumpers Hole Road • Pasadena, MD 21122

2015 UNDERWATER INSPECTION REPORT EXECUTIVE SUMMARY

Inspection Date: July 27 – 28, 2015

Condition Summary:

- The structure's reinforced concrete sections are in **Poor** condition.
- The structure's timber section is in **Poor** condition.
- The structure's concrete stabilized riprap sections are in **Fair** condition.

Significant Conditions Observed:

- Severe deterioration of steel sheet piling throughout the reinforced concrete sections of the seawall, with knife-edging and up to 100% section loss.
- Moderate to severe deterioration of concrete deck in the reinforced concrete sections, including exposed reinforcement with up to 100% section loss and failed deck slabs.
- Severe deterioration of vertical and horizontal breastwall timbers in the timber section of seawall, with up to 100% section loss and broken / missing boards.
- Significant erosion and backfill material loss behind the seawall structure in areas of steel sheet pile deterioration.

Repair Recommendations:

- Design and install new shoreline protection structure in the form of sheet piling or engineered riprap slope.

1.0 INTRODUCTION

1.1 Purpose and Scope

The Lockheed Martin Middle River complex features a Seawall bordering Dark Head Cove near Middle River, located in Middle River, Maryland. On July 27 – 28, 2015 Infrastructure Engineers, Inc. performed a special underwater investigation at the structure to evaluate the condition of all substructure units (SSUs) located in the water. This report includes a general description of the structure and the method of investigation, as well as a detailed description of the conditions noted. In addition, this report contains an assessment of the evaluated structure components and presents recommendations for structural repairs.

The scope of the investigation included a visual and tactile inspection of all accessible SSUs located in the water from the high water mark to the channel bottom, as well as ultrasonic thickness measurements of the steel sheet pile at regular intervals. A visual inspection of the accessible above water components of the structure was also completed. Depth soundings were also taken along the structure to assist in dredging and scour identification and documentation.

1.2 General Description of the Structure

The report cover photograph shows an overall aerial view of seawall structures bordering Dark Head Cove and Cowpen Creek, and Photograph 1 in Appendix B shows the same photograph with labeled sections and approximate limits of those sections. Photographs 2 through 6 in Appendix B show additional views of seawall sections.

The seawall structures consists of eight main sections along Dark Head Cove, with a separate timber section located west of the main structure bordering Cowpen Creek. The sections are labeled from East to West. Sections “A” through “C” and “F” through “H” each consist of a reinforced concrete bulkhead, with wooden fender piles,

sitting above a steel sheet pile wall, and Sections "D" and "E" consist of a concrete reinforced riprap slope. Refer to Figures 1, 2 and 3 in Appendix A for detail drawings of SSUs. Sections "A" through "C" and "F" through "H" consist of a continuous steel sheet pile wall with a reinforced concrete bulkhead cap with tapered cantilever supports, at 15' intervals, which support the walking surface. Additionally, a tie-back system connects to the cap and steel sheet pile wall. Historical drawings, date the structures construction around the mid 1940's. In addition the historical drawings detail the tip elevation of the sheet pile at 35' below mean low water and the tip of the steel sheet pile being driven into hard clay. The separate timber section of seawall bordering Cowpen Creek consists of rectangular cross-section timbers driven vertically into the channel, with horizontal timber bracing. No reference drawings were provide for the timber section of the seawall therefore construction date and details of construction were not available. Refer to Photograph 7 in Appendix B for a view of a typical segment of reinforced concrete seawall, and Photograph 8 for a view of a typical segment of timber seawall.

The report's labeling convention designates the seawall sections based on drawings provided by Tetra Tech, Inc. annotated to show stationing for defect locations. The stationing for a given section typically proceeds from south to north and west to east, as applicable. Refer to Figure 1, 2 and 3 in Appendix A for annotated plan sketches of the structures.

1.3 Method of Investigation

A dive team, led by a Virginia-registered professional engineer-diver, conducted the underwater inspection. The inspection team accessed the site from shore.

The underwater investigation generally consisted of a Level I "swim-by" visual inspection over 100 percent of the accessible SSUs surfaces from the high water mark to the channel bottom. Divers performed a Level II visual/tactile inspection on at least 20 percent of the SSUs, which included cleaning marine growth at the waterline, mid-depth, and channel bottom to facilitate an evaluation of the underlying surfaces. Where

applicable, divers measured the remaining thickness of the steel sheet piling at regular intervals, with an underwater ultrasonic thickness measurement gauge, in the areas of the most significant observed deterioration. Refer to Table A-1 in Appendix A for thickness measurements of the steel sheet piling. Inspectors paid particular attention to any observed areas of excessive deterioration or apparent distress while noting the condition of any previous repairs that were evident.

The inspection team also assessed the waterway and streambed conditions in the structure vicinity, noting the type of channel bottom material, as well as the location and extent of any observed scour, riprap, or debris. Depth soundings were taken along the structure fascia using a sounding line.

2.0 INSPECTION FINDINGS

At the time of inspection, soundings indicate that the maximum water depth was 10.0 ft. Dark Head Cove and Cowpen Creek are tidally influenced and did not present significant flow velocity during the inspection. Refer to Table A-1 in Appendix A for a listing of the sounding measurements relative to the waterline at low tide.

The banks along Dark Head Cove and Cowpen Creek in the structure's vicinity are in poor condition. The embankment in the vicinity of the structure is actively eroding at locations throughout the structure where the steel sheet piling has significant deterioration, allowing runoff and tidal action to displace fill material into the channel. The signs of active erosion are less severe in the sections "D" and "E" where the structure consists of concrete stabilized riprap, however there are several areas of settlement and erosion noted along these sections. The channel bottom in the structure's vicinity primarily consists of sand, silt and broken shell, based on information provided by Tetra Tech Inc, this layer of sand, silt and broken shell is approximately 4' in depth with a hard clay layer below.

All of the inspected seawall sections were located in water at the time of inspection. Reinforced concrete sections "A" through "C" and "F" through "H" are in

Poor condition due to steel sheet pile deterioration and the deterioration of the concrete walking surface. The concrete bulkhead show no movement in the horizontal or vertical direction. These sections have a band of severe deterioration, knife-edging and up to 100% section loss in the steel sheet piling throughout, this deterioration is typically concentrated in a 1 ft. to 2ft. high band at the top of the sheet pilings, where the sheet pile connects to the reinforced concrete cap. Refer to Appendix A, Table A-1 for ultrasonic thickness measurements. Due to the age and condition of the steel sheet pile the original thickness could not be determined, but based on measurements taken the original thickness would be assumed to be ½". Refer to Photographs 9 through 11 in Appendix B for underwater sheet pile photographs. There is active backfill loss up to full width x 5 ft. deep beneath the concrete deck (walking surface) sections occurring at these locations of 100% section loss due to runoff and tidal action, causing areas of erosion in the embankment behind the seawall. Refer to Photograph 12 and 13 in Appendix B. The concrete walking surface typically exhibits moderate deterioration throughout the seawall sections in the form of spalling up to 1 in. deep and map cracking up to 1/16 in. wide throughout. Refer to Photograph 14 in Appendix B. There are several locations in section "H" where the concrete walking surface has failed entirely, with exposed rebar and up to 100% section loss. Refer to Photograph 15 in Appendix B. A steel ramp/overlay is present adjacent to section "H" and is undermined up to 10ft. underneath. The horizontal and vertical timber fender sections are in fair condition and typically exhibit checking up to 1/4in. wide and weathering up to 1 in. deep throughout, with more significant decay or failure in several locations. Refer to Photograph 16 in Appendix B. Section "G" contains the exit of an outfall pipe approximately 3ft. diameter with severe deterioration and 100% section loss to the edges and interior of the pipe. Refer to Photograph 17 in Appendix B. Refer to Table C-1 in Appendix C for a complete list of defects and locations in the inspected sections.

Concrete stabilized riprap sections "D" and "E" are in **Fair** condition, and typically exhibit longitudinal cracking up to 2in. wide, with minor settlement of the outboard edge of the concrete. Refer to Photograph 18 in Appendix B. There is an area of

embankment erosion behind section "D" measuring 15ft. long x 15ft. wide x up to 4ft. deep. Refer to Table C-1 in Appendix C for a complete list of defects and locations in the inspected sections.

The separate timber section of seawall located along Cowpen Creek is in **Poor** condition, and typically exhibits severe deterioration, decay and 100% section loss to the vertical and horizontal timbers for the full length of the section, with associated embankment erosion and fill loss. The deterioration is concentrated in a band in the tidal zone, from the high water line extending down 1 1/2ft. Refer to Photograph 19 in Appendix B. The vertical timbers are broken off at nine locations, with associated backfill loss. Refer to Photograph 20 in Appendix B. Vegetation is growing between and behind the timber wall at various locations. Refer to Photograph 21 in Appendix B. Refer to Table 1 in Appendix C for a complete list of defects and locations in the inspected sections.

3.0 EVALUATION AND ASSESSMENT

Overall, the submerged components of the reinforced concrete sections and timber section are in **Poor** condition, and the concrete stabilized riprap sections of the seawall are in **Fair** condition.

The reinforced concrete sections "A" through "C" and "F" through "H" show signs of severe deterioration of the steel sheet piling throughout and intermittent areas of moderate to severe deterioration and failure of the concrete walking surface. These areas are contributing to erosion of backfill beneath the structure and the adjacent embankment through runoff and tidal action. Similarly, deterioration in the drainage outfall pipes which exit the seawall sections is contributing to further backfill loss and erosion. The reinforced concrete cap above the steel sheet pile wall appears structurally sound, and does not show signs of major deterioration, settlement or failure due to the deterioration of the concrete deck and/or steel sheet piling. Based on a review of the historical design drawings the reinforcement in the reinforced concrete cap is acting like

a grade beam spanning sections of deteriorated steel sheet pile. The maximum unsupported length of the reinforced concrete cap should be evaluated further to determine the risk of failure of the cap due to further loss of sheet pile.

The severe deterioration and decay throughout the timber section of the seawall has contributed to erosion and backfill loss adjacent to the structure. These areas are contributing to erosion of backfill beneath the structure and the adjacent embankment through runoff and tidal action.

4.0 RECOMMENDATIONS

The severe deterioration of the steel sheet piling in the reinforced concrete sections and the deterioration of the timber section with the associated areas of backfill loss and erosion negatively affect the stability of the shoreline and embankment in the vicinity of the structure. The reinforced concrete cap structure of sections “A” through “C” and “F” through “H” are in satisfactory condition, and as stated above are acting like a grade beam spanning areas of steel sheet pile deterioration. The reinforced concrete cap structure should be monitored for any settlement and/or movement caused by further loss of the steel sheet pile structure below.

Based on information, provided by Tetra Tech Inc., obtained during prior shoreline modification, the steel sheet pile wall is anchored in dense clay substrate beneath an intermediate silt layer. Because this silt layer is not providing structural support, removal of this silt through dredging should have no impact on the overall structure.

It is recommended that the seawall be repaired or replaced, including the design and installation of steel sheet piling to repair and/or replace the existing steel sheet piling, repair or replacement of deteriorated drainage outfall pipes, and the addition of replacement fill material in areas of erosion behind and beneath the structure. These efforts would address the root cause of the embankment erosion / backfill loss and facilitate future dredging or construction activity in the vicinity of the structure.

The deterioration of the timber section with the associated areas of backfill loss and erosion negatively affect the stability of the shoreline and embankment in the vicinity of the structure. The nature and extent of the deterioration to the timber section is not conducive to repair of the existing structure. It is therefore recommended that the structure be replaced with a suitable structure (timber or steel sheet pile or rock rip rap) to stabilize and protect the shoreline.

Respectfully submitted,

INFRASTRUCTURE ENGINEERS, INC.

Peter Maldini, P.E.

Table A - 1

Depth Soundings and Steel Sheet Pile Ultrasonic Section Measurements

Wall Section	Station (feet)	Soudings (feet)	Location of Sample (worst area of deterioration)	Remaining Sheet Pile Section (inches)
A	+00	0.5	FH	No exposure
A	+20	4.9	CB	0.175
A	+30	6.1	CB	0.185
A	+60	5.5	CB	0.000
A	+90	4.5	CB	0.000
A	+120	2.7	FH	No exposure
B	+00	2.7	FH	No exposure
B	+30	3.5	FH	0.000
B	+60	8.0	CB	0.135
B	+90	7.5	CB	0.195
B	+120	7.5	CB	0.180
B	+150	6.5	CB	0.190
B	+180	5.0	CB	0.320
B	+210	4.0	CB	0.325
B	+230	3.0	CB	0.175
C	+00	3.0	CB	0.175
C	+30	3.0	CB	0.140
C	+60	3.1	FH	0.000
C	+90	3.0	FH	0.000
C	+120	4.0	FH	0.000
C	+150	4.0	FH	0.000
C	+180	4.2	FH	0.000
C	+210	5.0	CB	0.190
C	+240	4.5	CB	0.240
C	+270	5.5	CB	0.200
C	+300	4.0	CB	0.190
C	+330	4.0	CB	0.200
C	+355	3.5	FH	No exposure
F	+00	8.5	CB	0.180
F	+30	8.5	CB	0.190
F	+60	9.5	CB	0.190

F	+90	7.7	CB	0.170
F	+120	7.0	CB	0.190
F	+150	6.5	CB	0.180
F	+180	2.5	FH	No exposure
F	+192	0.0	FH	No exposure
G	+00	8.0	CB	0.175
G	+30	8.5	CB	0.185
G	+60	9.0	CB	0.175
G	+90	8.5	CB	0.180
G	+120	8.0	CB	0.140
G	+150	8.5	CB	0.460
G	+165	8.5	CB	0.180
H	-70	10.0	CB	0.000
H	+00	5.0	CB	0.220
H	+30	6.5	CB	0.000
H	+50	6.5	CB	0.440
H	+90	8.3	CB	0.175
H	+130	5.5	CB	0.180
H	+170	6.1	CB	0.175
H	+210	8.9	CB	0.175
H	+250	9.0	CB	0.190
H	+290	8.5	CB	0.190
H	+310	8.0	CB	0.175

Key: CB = Channel Bottom, FH = Full Exposed Height

Note: “No Exposure” is used to describe a sample location where there is no exposed sheet pile in the vicinity due to channel bottom elevation. A remaining section of “0.000” indicates an area where there are perforations or 100% section loss of the steel, and no significant section remains intact.

Figure 1: Seawall Detail
Sections "A", "B" and "C"

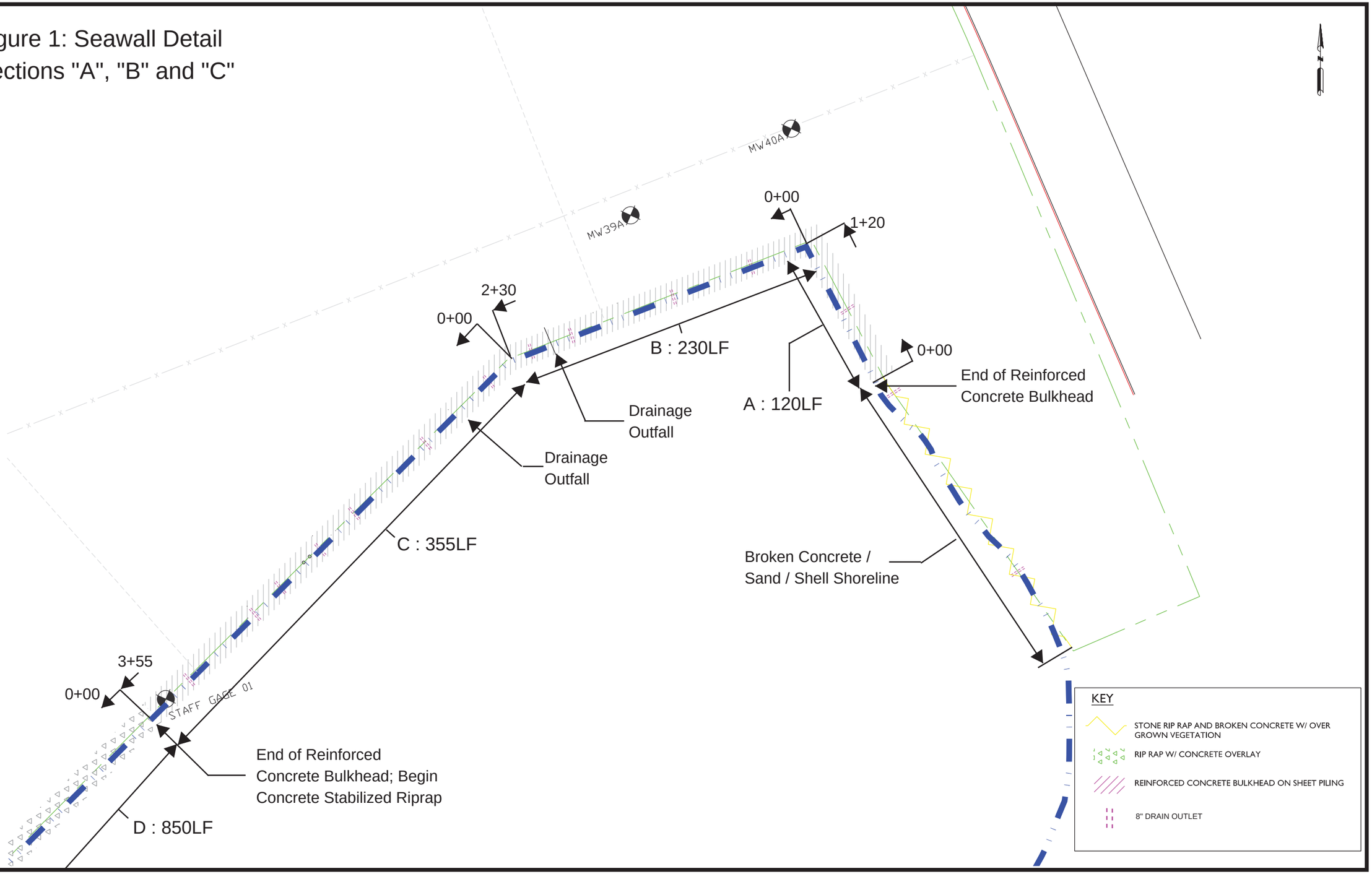


Figure 2: Seawall Detail
Sections "D" and "E"

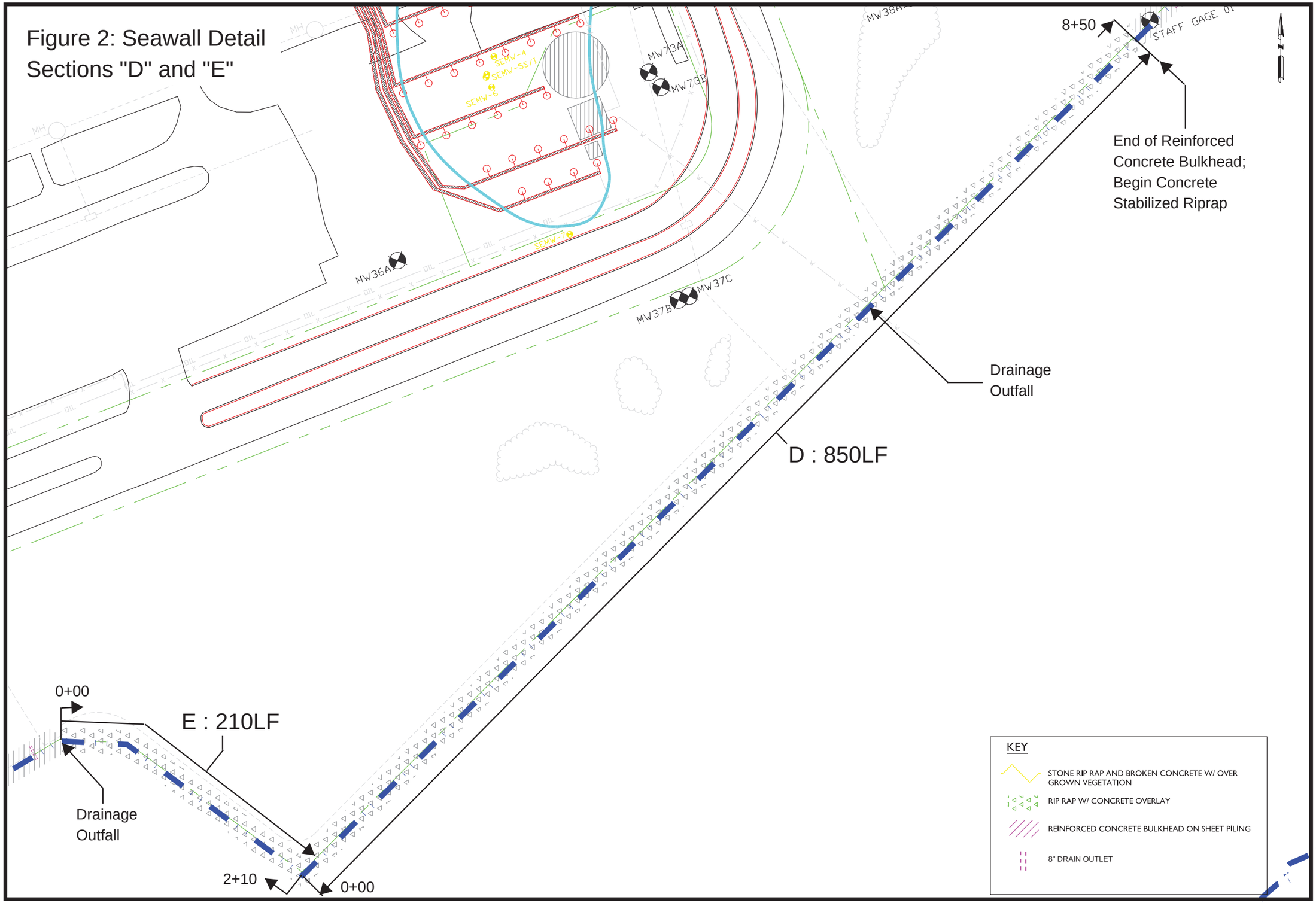
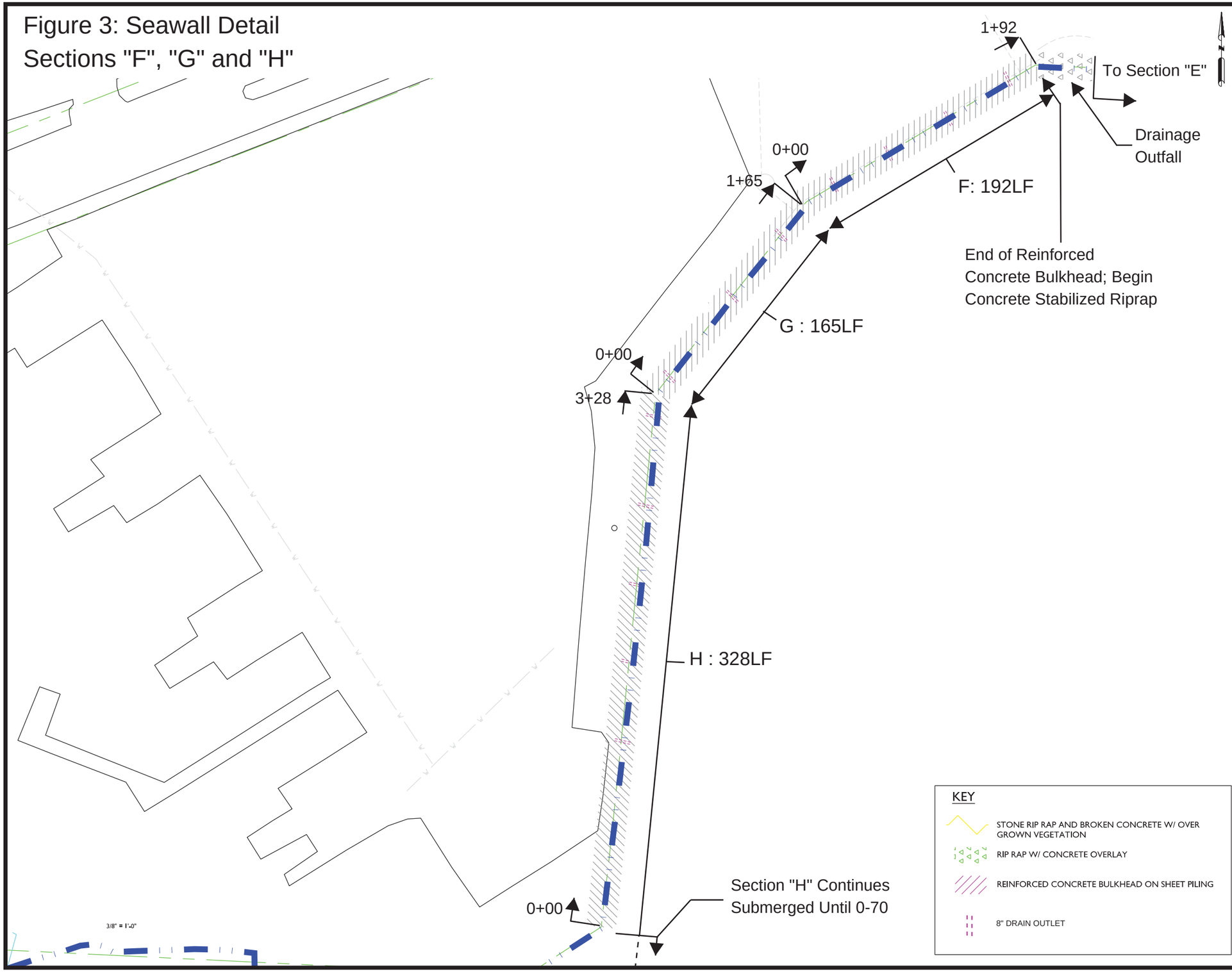
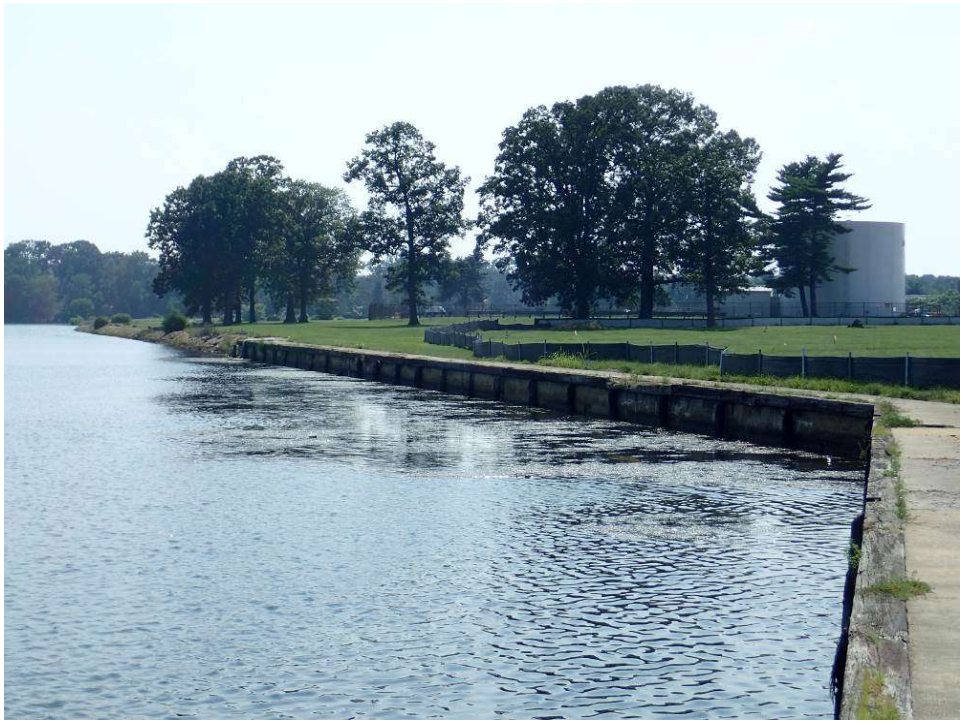


Figure 3: Seawall Detail
Sections "F", "G" and "H"



Photograph 1. Facility overview showing section labels.

Photograph 2. Seawall Sections "E", "F", "G" and "H", looking northeast.

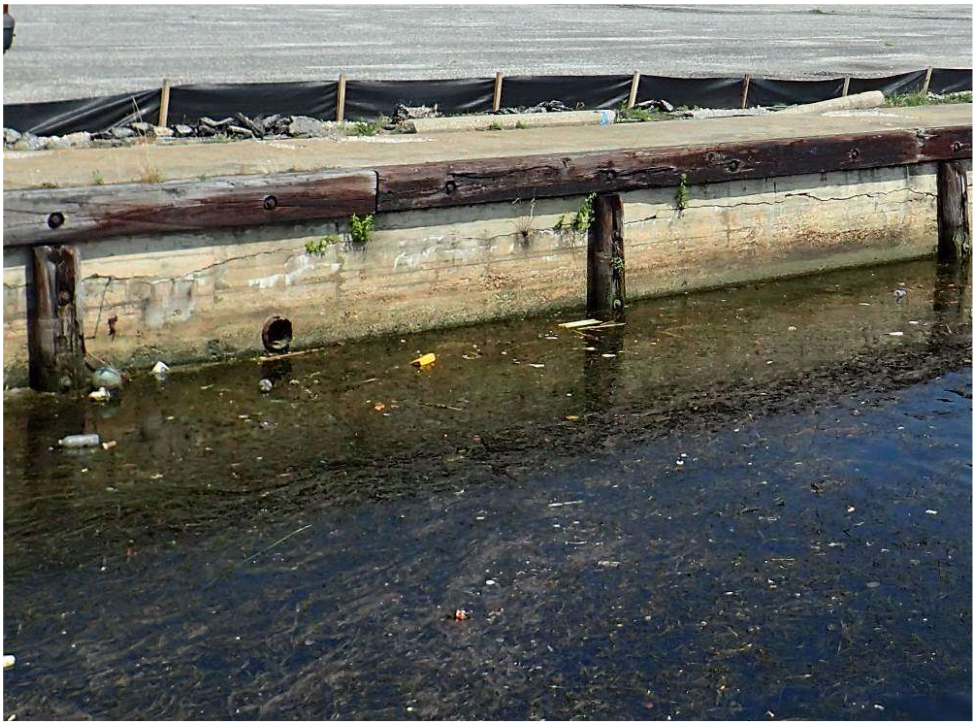


Photograph 3. Seawall Sections "B", "C" and "D", looking southwest.

Photograph 4. Seawall Sections "A" and "B" (foreground), looking northwest.

Photograph 5. Seawall Section "H", looking west.

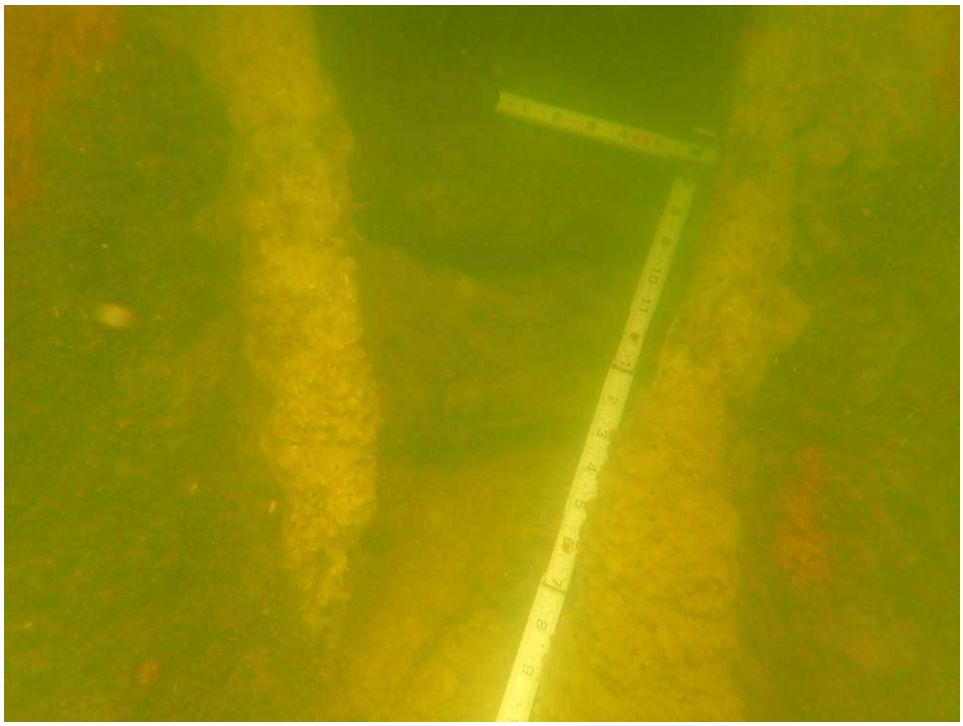
Photograph 6. Separate timber wall located west of Section "H", looking north



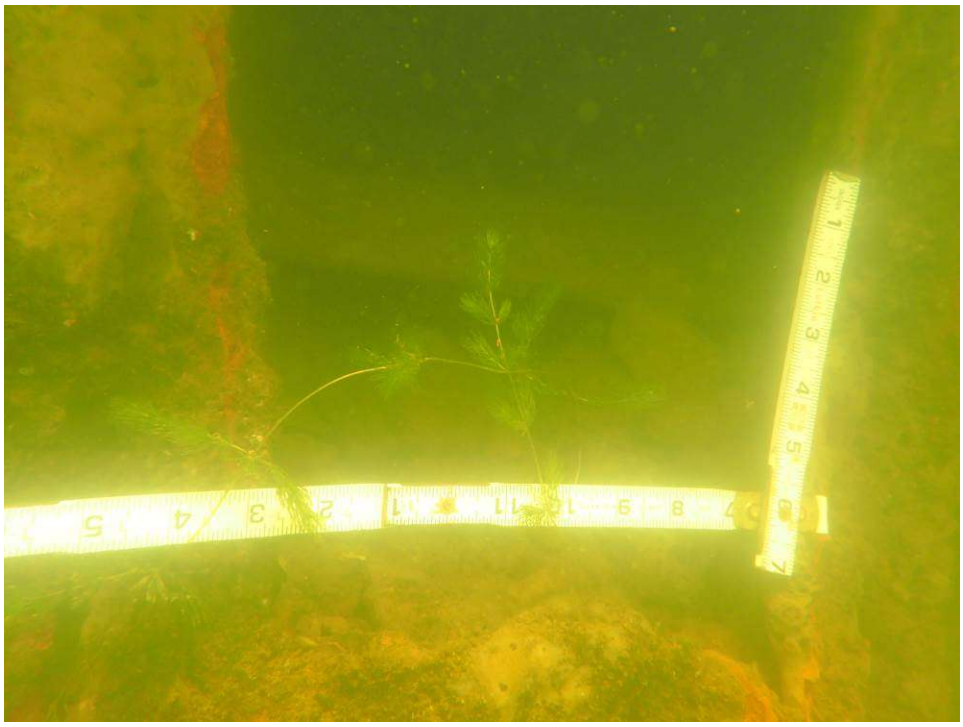
Photograph 7. View of typical seawall segment above the waterline.

Photograph 8. Typical timber seawall detail at waterline.

Photograph 9. Typical severe deterioration of steel sheet piling.



Photograph 10. Typical severe deterioration of steel sheet piling.



Photograph 11. Typical severe deterioration of steel sheet piling.

Photograph 12. Section "H", typical embankment erosion behind seawall.

Photograph 13. Typical fill loss beneath concrete deck, showing area of 100% section loss in steel sheet pile at lower right.

Photograph 14. Typical deterioration of concrete deck, showing spalling and exposed reinforcement.

Photograph 15. Section "H", failed area of concrete deck with backfill loss and vegetation growth.

Photograph 16. Severe deterioration of timber fender at edge of concrete deck.

Photograph 17. Outfall pipe with areas of 100% section loss.

Photograph 18. Longitudinal cracking in upper concrete of stabilized riprap slope.

Photograph 19. Decay and 100% section loss of breastwall timbers in tidal zone.

Photograph 20. Broken vertical timbers at waterline with associated fill loss.

Photograph 21. Backfill loss and vegetation behind broken breastwall timbers.

Appendix C: Table C - 1

Defects

Wall Section	Location	Member	Defect	Dimensions	Quantity	Notes
Wall A	GEN	Timber Fender	Checking	Up to 1/4"W	120LF (full length)	
Wall A	GEN	Timber Fender	Weathering	Up to 1"D	120LF (full length)	
Wall A	GEN	Conc. Cap	Spalling	Up to 1"D	30LF total	
Wall A	GEN	Conc. Deck	Spalling	Up to 1"D	210SF total	
Wall A	GEN	Embankment	Erosion / Fill Loss	Up to 5' vert. x 7' wide	120LF (full length)	Entire length is intermittently undermined; tapers from maximum depth at inboard side of cap up to edge of embankment behind deck.
Wall A	STA+04'	Conc. Cap	Spall	5.5'L x 19"W x 9"D	12SF	Spall in bottom of concrete cap/curtain wall
Wall A	STA+00' to 120'	Conc. Cap	Cracking	120'L x 1/8" to 1"W	120LF	Meandering full length horizontal crack in outboard face of concrete cap/wall with efflorescence; The deck concrete appears to be separating from the cap
Wall A	STA+00' to 120'	Sheet Pile	Deterioration	Top 3' of pile x full length	120LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 50%-75% of surface area described.
Wall A	STA+60	Conc. Deck	Spall	14'L x 3.5'W x Full Depth	56SF	
Wall B	GEN	Timber Fender	Checking	Up to 1/4"W	230LF (full length)	
Wall B	GEN	Timber Fender	Weathering	Up to 1"D	230LF (full length)	
Wall B	GEN	Conc. Cap	Spalling	Up to 1"D	20LF total	
Wall B	GEN	Conc. Deck	Spalling	Up to 1"D	140SF total	

Wall B	STA+00' to 130'	Sheet Pile	Deterioration	Top 3' of pile x full length	130LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 50%-75% of surface area described.
Wall B	STA+00'	Embankment	Erosion / Fill Loss	35'L x up to 20'W x 5'D		
Wall B	STA+35'	Embankment	Erosion / Fill Loss	80'L x up to 7'W x 4'D		Intermittently undermined throughout.
Wall B	STA+115'	Embankment	Erosion / Fill Loss	30'L x up to 8'W x 5'D		
Wall B	STA+130' to 230'	Sheet Pile	Deterioration	Top 1' of pile x full length	100LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 30% of surface area described.
Wall B	STA+150'	Embankment	Erosion / Fill Loss	1'L x 1' W x 1'D	10SF	Ten areas of this size are present in the vicinity
Wall B	STA+200'	Conc. Deck	Spall w/ER	2'L x 4'W x 0.5'D	8SF	Located at storm drain; steel has surface corrosion
Wall B	STA+200'	Embankment	Erosion / Fill Loss	4'L x 2'W x 2'D		
Wall C	GEN	Timber Fender	Checking	Up to 1/4"W	355LF (full length)	
Wall C	GEN	Timber Fender	Weathering	Up to 1"D	355LF (full length)	
Wall C	GEN	Conc. Cap	Spalling	Up to 1"D	50LF total	
Wall C	GEN	Conc. Deck	Spalling	Up to 1"D	350SF total	
Wall C	STA+00' to 205'	Sheet Pile	Deterioration	2'H (full height) of pile x full length	205LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 75% of surface area described.
Wall C	STA+205' to 275'	Sheet Pile	Deterioration	Top 6" of pile x full length	70LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 25% of surface area described.

Wall C	STA+275' to 355'	Sheet Pile	Deterioration	2'H (full height) of pile x full length	80LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 30% of surface area described.
Wall C	STA+00'	Embankment	Erosion / Fill Loss	70'L x 1'W x 1'D		
Wall C	STA+70'	Embankment	Erosion / Fill Loss	80'L x up to 7'W x 4'D		
Wall C	STA+190'	Embankment	Erosion / Fill Loss	20'L x up to 6'W x 4'D		
Wall C	STA+220'	Embankment	Erosion / Fill Loss	55'L x up to 7'W x 4'D		
Wall C	STA+255'	Conc. Deck	Spall w/ER	3'L x 3.5'W x Full Depth	12SF	Steel has surface corrosion
Wall C	STA+295'	Embankment	Erosion / Fill Loss	15'L x up to 7'W x 5'D		
Wall C	STA+320'	Embankment	Erosion / Fill Loss	30'L x up to 10'W x 5'D		
Slope D	STA+00'	Conc. Stabilized Riprap	Cracking / Settlement	70'L	70LF	Longitudinal cracking up to 2"W with minor settlement of outboard edge of concrete stabilized riprap
Slope D	STA+70'	Conc. Stabilized Riprap	Cracking / Settlement	230'L	230LF	
Slope D	STA+330'	Conc. Stabilized Riprap	Erosion	15'L x 15'W x up to 4'D		Erosion hole behind concrete stabilized riprap slope with area of undermining and settlement
Slope D	STA+345'	Conc. Stabilized Riprap	Cracking / Settlement	260'L	260LF	
Slope D	STA+605'	Conc. Stabilized Riprap	Cracking / Settlement	150'L	150LF	
Slope E	STA+105'	Conc. Stabilized Riprap	Cracking	10'L x 6"W	10LF	Transverse crack
Wall F	GEN	Timber Fender	Checking	Up to 1/4"W	187LF (full length)	
Wall F	GEN	Timber Fender	Weathering	Up to 1"D	187LF (full length)	

Wall F	GEN	Conc. Deck	Spalling / Deterioration	Up to 1"D	131SF	10% of total deck area affected; no exposed reinforcement; vegetation growing up through gaps
Wall F	GEN	Conc. Deck	Cracking	Up to 1/16"W		Random throughout deck
Wall F	STA+00' to 195'	Sheet Pile	Deterioration	Top 4' of pile x full length	192LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 50%-75% of surface area described.
Wall F	STA+01'	Conc. Deck	Spall	10"L x 10" W x Full Depth	1SF	Exposed reinforcing bars have surface corrosion and no section loss
Wall F	STA+00' to 09'	Embankment	Erosion / Fill Loss	9'L x 13"W x 2'D		
Wall F	STA+27'	Embankment	Erosion / Fill Loss	1'dia. x 1.5'D		
Wall F	STA+86' to 92'	Embankment	Erosion / Fill Loss	6'L x 14"W x 14"D		
Wall F	STA+102' to 109'	Embankment	Erosion / Fill Loss	5'L x 13"W x 15"D		
Wall F	STA+123' to 134'	Embankment	Erosion / Fill Loss	11'L x 18"W x 28"D		
Wall F	STA+186' to 192'	Embankment	Erosion / Fill Loss	6'L x 2'W x 2'D		
Wall G	GEN	Timber Fender	Checking	Up to 1/4"W	165LF (full length)	
Wall G	GEN	Timber Fender	Weathering	Up to 1"D	165LF (full length)	
Wall G	GEN	Conc. Deck	Spalling / Deterioration	Up to 1"D	174SF	15% of total deck area affected; no exposed reinforcement
Wall G	GEN	Conc. Deck	Cracking	Up to 1/16"W		Random throughout deck
Wall G	STA+00' to 165'	Sheet Pile	Deterioration	Top 4' of pile x full length	165LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 50%-75% of surface area described.
Wall G	STA+57'	Conc. Deck	Hardware	NA		Displaced cleat block leaning on inboard side of deck
Wall G	STA+84'	Conc. Deck	Hardware	NA		Displaced cleat block leaning on inboard side of deck

Wall G	STA+00 to 154'	Embankment	Erosion / Backfill Loss	Up to 4.5'W x 3.5'D		Typically 3'W x 3'D
Wall G	STA+152'	Embankment	Fill Loss	NA		Large 3' dia. outfall pipe is deteriorated on edges with riprap and backfill material spilling out.
Wall H	GEN	Timber Fender	Checking	Up to 1/4"W	328LF (full length)	
Wall H	GEN	Timber Fender	Weathering	Up to 1"D	328LF (full length)	Several failed timbers and fender piles along full length of deck
Wall H	STA+30' to 130'	Sheet Pile	Deterioration	Top 4' of pile x full length	130LF	Band of severe deterioration, 100% section loss, knife edging and perforations over 50%-75% of surface area.
Wall H	STA+130' to 160'	Sheet Pile	Deterioration	Top 2' of pile x full length	30LF	
Wall H	STA+160' to 210'	Sheet Pile	Deterioration	Top 4' of pile x full length	50LF	
Wall H	STA+210' to 310'	Sheet Pile	Deterioration	Top 1.5' x full length	100LF	
Wall H	STA+30'	Conc. Deck	Spall / Failure	12'L x 7'W x Full Depth	84SF	Deck has failed and collapsed; Exposed rebar has widespread 100% loss of section
Wall H	STA+30'	Embankment	Erosion / Fill Loss	12'L x up to 7'W x 2'D		Beneath failed deck
Wall H	STA+42'	Conc. Deck	Spalling	18'L x 8"W x 7"D	18SF	Exposed reinforcement has up to 50% loss of section
Wall H	STA+60'	Conc. Deck	Spall / Failure	12'L x 3'W x Full Depth	84SF	Deck has failed and collapsed; Exposed rebar has widespread 100% loss of section
Wall H	STA+60'	Embankment	Erosion / Fill Loss	12'L x up to 7'W x 4'D		Beneath failed deck; vegetation growing up through concrete; undermining extends up to 10' beneath adjacent deck
Wall H	STA+72'	Conc. Deck	Spalling	6'L x 1'W x up to 2"D	6SF	
Wall H	STA+78'	Conc. Deck	Offset	6" Vertical	15LF	Deck is offset up to 6" vertical from adjacent ramp; possible evidence of settlement

Wall H	STA+101' to 328'	Embankment	Erosion/Fill Loss	65'L x up to 7'W x 5'D		Typically 4'W x 4'D
Wall H	STA+101' to 166'	Conc. Deck	Spalling / Deterioration	65'L x 1'W x up to 3"D	65SF	Exposed reinforcement with up to 50% loss of section
Wall H	STA+166' to 190'	Embankment	Erosion / Fill Loss	24'L x 12'W x up to 6'D		Steel ramp to concrete deck is undercut by erosion/fill loss
Wall H	STA+199'	Conc. Deck	Spall	9"L x 22"W x Full Depth	2SF	Adjacent to old patch
Wall H	STA+215'	Conc. Deck	Hardware	NA		Displaced cleat block leaning on inboard side of deck
Wall H	STA+240' to 288'	Conc. Deck	Cut	1.5'L x 1.5'W x Full Depth	4SF	Hole has been cut in adjacent abandoned foundation and convered with scrap wood; area beneath deck has fill loss up to 5' deep
Wall H	STA+290'	Conc. Deck	Hardware	NA		Displaced cleat block leaning on inboard side of deck
Timber Wall	GEN	Retaining Wall	Decay	Full Length		
Timber Wall	GEN	Retaining Wall	Erosion / Fill Loss	Intermittent / Full Length		
Timber Wall	GEN	Retaining Wall	Deterioration	Full Length		
Timber Wall	GEN	Retaining Wall	Vegetation	Intermittent		
Timber Wall	GEN	Retaining Wall	Damage	Several points (see notes)	27LF (approx.)	Upper half of vertical timbers broken off, allowing fill material to spill through; Areas at STA+40, +44, +75, +115, +125, +145, +160, +161, +163
Timber Wall	STA+40'	Embankment	Erosion / Fill Loss	8'L x 3'W x 2.5' D		These five (5) areas have large perforations and deteriorations at the waterline allowing fill material to spill through
Timber Wall	STA+60'	Embankment	Erosion / Fill Loss	6'L x 2'W x 1.5'D		
Timber Wall	STA+75'	Embankment	Erosion / Fill Loss	6'L x 1.5'W x 1.5'D		
Timber Wall	STA+90'	Embankment	Erosion / Fill Loss	7'L x 1.5W x 2'D		
Timber Wall	STA+120'	Embankment	Erosion / Fill Loss	20'L x 2'W x 1.5'D		

ATTACHMENT D—GEOPHYSICAL SURVEY REPORT

Final Report
Geophysical Survey
Utility/Structure (Manhole, Catch Basin) Clearance
Middle River Complex
Middle River, MD
Enviroscan Reference Number 061531

Prepared For: Tetra Tech NUS, Inc.
Prepared By: Enviroscan, Inc.
August 18, 2015

1051 Columbia Avenue ● Lancaster, PA 17603 ● 717.396.8922 ● Fax 717.396.8746 ● email@enviroscan.com ● www.enviroscan.com

August 18, 2015

Mr. Fred Kolberg
Tetra Tech NUS, Inc.
20251 Century Blvd
Suite 200
Germantown, MD 20874

RE: Geophysical Survey
Utility/Structure (Manhole, Catch Basin) Clearance
Middle River Complex
Middle River, MD
Enviroscan Reference Number 061531

Dear Mr. Kolberg:

Pursuant to our proposal written on June 19, 2015, Enviroscan, Inc. conducted a subsurface utility survey at the above-referenced site on August 10 and 12, 2015. The purpose of the survey was to detect concrete manholes (with steel covers) and catch basins (with steel grates) or other anomalies beneath the ground surface along 1500 lineal feet of three storm drain lines. The project site was a combination of asphalt, concrete, and grass ground cover, with three recently excavated pits within the survey area.

Methods

Locations of identified underground utilities were surveyed using a Topcon global positioning system (GPS) back pack unit, with differential corrections to produce differential GPS (DGPS) position. At each data point, the DGPS was collected using State Plane (feet) NAD 83 (North American Datum 1983). The utility survey was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology, including:

- a Radiodetection RD8000 Multi-Frequency pipe and cable tracer;
- a Radiodetection C.A.T. and Genny pipe and cable locator/tracer;
- a Fisher TW-6 electromagnetic (EM) pipe and cable locator/tracer;
- a GSSI SIR-4000 and GSSI UtilityScan DF ground penetrating radar (GPR) system.

The principles of these techniques are detailed below.

RD8000

Utility tracing was conducted using a Radiodetection RD8000 digital cable and pipe tracer. The transmitter can be directly (conductively) coupled to exposed portions of a metallic pipe, cable, or wire or indirectly (inductively) to a subsurface metallic utility of known location/orientation. The transmitter remains stationary and energizes the metallic utility at a frequency selected by the operator (512 Hz, 8 kHz, 33 kHz, or 65 kHz), which is received at the ground surface by the digital locator. When the transmitter is directly coupled to the metallic utility, the digital receiver can also calculate the depth of the utility to an accuracy of ±10% of the actual depth of the utility. Please note that the close proximity to bends in the traced line, or poor signal strength, can result in erroneous depth estimations.

C.A.T. and Genny

The survey areas were also scanned with a Radiodetection C.A.T. and Genny pipe and cable locator and tracer. In Power mode, the C.A.T. detects the 50 to 60 Hertz (Hz) electromagnetic field generated by live power cables and other metallic utilities to which a live line is grounded. In Radio mode, the C.A.T. detects buried conductors (cables or metallic pipes) as they conduct and re-transmit commercial broadcast radio energy. In Genny mode, the C.A.T. detects signal generated by the Genny transmitter. The Genny transmitter can be coupled directly (conductively) to exposed portions of a metallic pipe, cable or wire, or indirectly (inductively) to a subsurface metallic utility with known location and orientation.

TW-6

In order to detect unknown utilities, Enviroscan employed a Fisher TW-6 pipe and cable locator and tracer. In pipe and cable search mode, the TW-6 is essentially a deep-sensing metal detector that detects any highly electrically conductive materials (e.g. metals) by creating an electromagnetic field with a transmitting coil. A receiving coil at a fixed separation from the transmitter measures the field strength. As the instrument is swept along the ground surface, subsurface metallic bodies distort the transmitted field. The change in field strength/orientation is sensed by the receiver, setting off an audible alarm and/or causing deflection of an analog meter. The TW-6 can nominally detect a 2-inch metal pipe to a depth of 8 feet and a 10-inch metal pipe to a depth of 14 feet.

In pipe and cable tracing mode, the TW-6 transmitter can be coupled directly (conductively) to exposed portions of a metallic pipe, cable, or wire or indirectly (inductively) to a subsurface metallic utility with known location and orientation. The transmitter remains stationary and energizes, or excites, the metallic utility to be traced with an 81.92-kilohertz signal that can be traced at the ground surface using the mobile TW-6 receiver wand or probe.

GPR

GPR systems produce cross-sectional images of subsurface features and layers by continuously emitting pulses of radar-frequency energy from a scanning antenna as it is towed along a survey profile. The radar pulses are reflected by interfaces between materials with differing dielectric properties. The reflections return to the antenna and are displayed on a video monitor as a continuous cross section in real time. Since the electrical properties of metal are distinctly different from soil and backfill materials, metallic pipes and other structures commonly produce dramatic and characteristic reflections. Fiberglass, plastic, concrete and terra-cotta pipes and structures also produce recognizable, but less dramatic, reflections. Scanning was performed using a GSSI SIR-4000 with an internal hard drive and a color display, and a 400 MegaHertz (MHz) antenna or transducer. The GPR penetration depth for this site was approximately 5 feet below land surface (bls).

Results Summary

The survey area, located within the G Block of the Middle River Complex, was scanned using the methods described above. Suspected targets were marked on the ground using semi-permanent marking paint in accordance with APWA uniform color code.

The eastern and the central storm utilities were able to be identified with the TW-6 and GPR. The western storm utility was only able to be located for a short distance - from the outfall towards the southern-most manhole. This portion of the utility is depicted in Figure 1 with a cyan dashed line. Beyond this point, the utility was not able to be located with the methods listed above. Therefore, its location was estimated using three manhole covers and an outfall, and is shown on Figure 1 as a green dashed line. This location is assumed accurate, as long as the pipe is straight from manhole to manhole.

Only one area, depicted with a magenta box in Figure 1, was observed as an anomaly. During the GPR portion of the survey, a rise in elevation coupled with a thick GPR banding signature was observed over the central storm utility. This rise in elevation of the pipe could indicate a possible manhole “neck.” The thick banding signature is typical of metal which could be caused by a manhole cover. In addition, it is recommended that the bend in the central storm utility be investigated to discover how the bend was put into the pipe. This utility was approximately 4 to 6 feet in width, so a pre-formed angled section is possible but highly suspect.

The eastern storm utility was traced from a catch basin near Wilson Point Road to a rectangular vault, and then towards the water. This pipe could not be traced to its outfall; a large area of earth had either been removed or eroded away, exposing the pipe and causing it to deteriorate. A small pool of water at the base of this pit and the outfall was observed.

Limitations

The above-referenced geophysical survey was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology. Enviroscan does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen site-specific conditions. However, we make every effort to identify and notify the client of such limitations or conditions. In particular, please note the following specific limitations and recommendations:

- Enviroscan's field markings - a line with an arrow on either end and a dot on either side of the line - should be given a clearance of approximately +/-24 inches for single lines. In contrast, since electromagnetic tracing of duct banks provides only a centerline, banks may extend for 2 to 3 feet beyond the marked trace.

- The completion of this survey does not relieve any party of applicable legal obligations to notify the appropriate One-Call center prior to digging or drilling.

As always, we appreciate this opportunity to have worked with you again. If you have any questions, please do not hesitate to contact me.

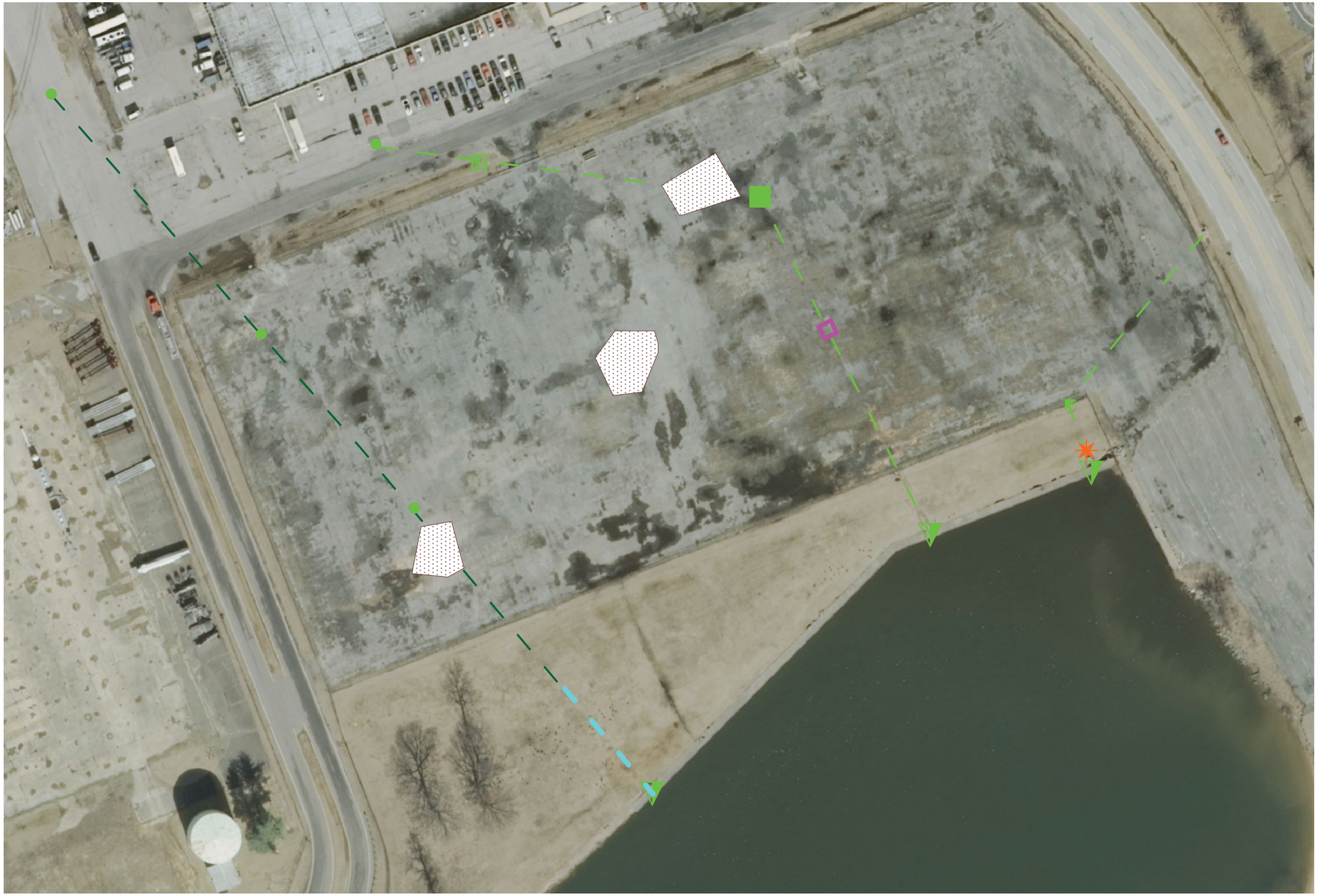
Sincerely,
Enviroscan, Inc.

John L. Mullen
Project Manager

Technical Review By:
Enviroscan, Inc.

Felicia Kegel Bechtel, M.Sc., P.G.
President

enc.: Figure 1: Geophysical Utility Survey Results



N

MAP LEGEND

- Storm Sewer (Reinforced Concrete)
- Visually Identified Storm Sewer
- Storm Sewer (Metallic)
- Storm Sewer Manhole
- Storm Sewer Grate
- Storm Sewer Vault
- Storm Sewer Outfall
- Exposed Pipe
- Approximate Location of Bend in Pipe
- GPR Anomaly
- Open Excavation Pits

Scale (feet)

0 50 100

Note: The information depicted on this drawing represents survey results on the date surveyed and can only be considered to be indicative of the general conditions existing on the survey date.

Coordinates in Maryland State Plane (feet) NAD-83 Datum.

Figure composed using aerial image from the USGS WMS server, field notes and DGPS survey by Enviroscan, Inc. personnel.

Prepared by: **Enviroscan, Inc.** 1051 Columbia Ave. Lancaster PA 17603 717-396-8922 www.enviroscan.com	Title: **Geophysical Survey Utility Survey Results**	Project Location: **D Block Survey Area Middle River Complex Middle River, MD**	Figure **1**
		Project Number 061531 / Revision/Issue 08/13/2015	
		Original Scale 1"= 100' / Survey Ending Date 08/12/2015 / Drawn by: JLM / Approved by: FKB	

ATTACHMENT E—STORM-DRAIN INSPECTION DATA

ATTACHMENT E

SUMMARY of STORM-DRAIN INSPECTIONS PERFORMED-BLOCKS D and F

Lockheed Martin Middle River Complex

Middle River, Maryland

Downstream MH	Direction	Material	Height	Length Surveyed	Video_Name	Comment
MH-12	Downstream	Reinforced concrete pipe	24	3.1	1_IL-26_MH-12.mpg	No inspection completed. Surcharge
MH-11	Downstream	Reinforced concrete pipe	24	0	1_MH-12_MH-11.mpg	No inspection completed. Surcharge
009	Downstream	Reinforced concrete pipe	24	3	1_MH-11_009.mpg	no inspection completed. Surcharge
00X	Downstream	Corrugated metal pipe	36	3	1_JB_1_00X.mpg	no inspection completed. Surcharge
JB 2	Upstream	Reinforced concrete pipe	60	89.5	1_CB_2_JB_2.mpg	Large pieces of debris.
007	Downstream	Reinforced concrete pipe	60	620	1_JB_2_007.mpg	High water level; camera underwater for long periods of time

Attachment E

SUMMARY of DEFECTS IDENTIFIED during STORM-DRAIN INSPECTION DATA- BLOCKS D and F

Lockheed Martin Middle River Complex

Middle River, Maryland

Inspection ID	Upstream MH	Downstream MH	Condition ID	Distance	PACP Code	Remarks
1	IL-26	MH-12	1	0	AMH	USMH BEGIN
1	IL-26	MH-12	2	0	MGP	
1	IL-26	MH-12	3	0.1	MWL	
1	IL-26	MH-12	4	0.1	MCU	PIPE FULL OF WATER
1	IL-26	MH-12	5	3.1	MSA	CANT SEE PIPE FULL OF WATER
2	MH-11	009	6	0	AMH	USMH BEGIN
2	MH-11	009	7	0	MGP	
2	MH-11	009	8	0	MWL	
2	MH-11	009	9	3	MSA	PIPE FULL OF WATER CANT SEE
3	JB 1	00X	10	0	AJB	USJB BEGIN
3	JB 1	00X	11	0	MWL	
3	JB 1	00X	12	3	MCU	PIPE FULL OF WATER
3	JB 1	00X	13	3	MGP	DROP OFF AT START OF PIPE
3	JB 1	00X	14	3	MSA	CANT SEE ANYTHING WATER TOO HIGH
4	CB 2	JB 2	15	0	AJB	DSJB BEGIN
4	CB 2	JB 2	16	0	MGP	
4	CB 2	JB 2	17	0	MWL	
	CB 2	JB 2	18	10.4	MGP	ROCKS IN LINE
4	CB 2	JB 2	19	54.7	SAVZ	
4	CB 2	JB 2	20	89.5	MSA	CANT MAKE IT TO MH BECAUSE OF ROCKS
5	JB 2	007	21	0	AMH	USJB BEGIN
5	JB 2	007	22	0	MWL	
5	JB 2	007	23	236.2	SRVZ	
5	JB 2	007	24	261	lL	
5	JB 2	007	25	265.8	SRVZ	
5	JB 2	007	26	325.5	SRVZ	
5	JB 2	007	27	335.2	SRIZ	
5	JB 2	007	28	360.5	MCU	
5	JB 2	007	29	410.3	SRVZ	
5	JB 2	007	30	436.7	SRVZ	
5	JB 2	007	31	491.5	SRVZ	
5	JB 2	007	32	511.9	SAVZ	
5	JB 2	007	33	554.5	SRVZ	
5	JB 2	007	34	591.2	SRVZ	
5	JB 2	007	35	620	ADP	DSDP END

ATTACHMENT F—STORM-DRAIN-INSPECTION SUBCONTRACTORS' REPORTS

HYDROSTRUCTURES®

4717 Washington Blvd. Suite A
Arbutus, MD 21227
Tel: 410-242-3247

Inspection Report / Inspection: i1

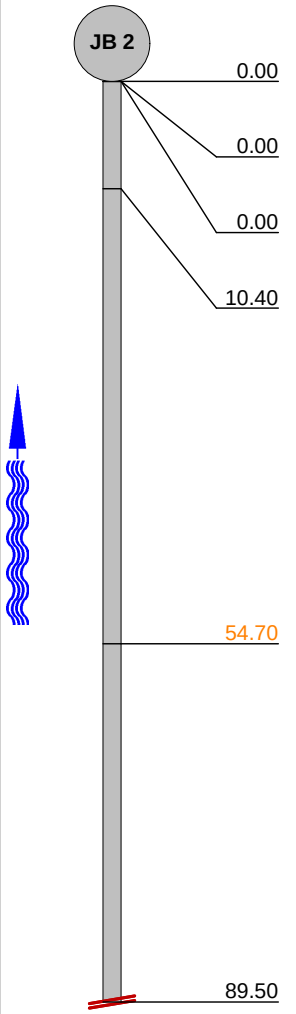
Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 007-1**	**4**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Dark Head Cove Rd**	Use of Sewer	**Stormwater**	Upstream MH	**CB 2**
City	**Middle River**	Drainage Area		Dowstream MH	**JB 2**
Loc. details		Flow Control		Dir. of Survey	**Upstream**
Location Code	**Light Highway**	Length surveyed	**89.50 ft**	Section Length	**90.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**60 inch**
Year Rehabilitated		Material	**Reinforced Concrete Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:224 Position	Observation	Photo	Grade
0.00	Junction Box, REMARK: DSJB BEGIN	4_1A	
0.00	General Photograph	4_2A	
0.00	Water Level, 25% of cross sectional area	4_3A	
10.40	General Photograph	4_4A	
54.70	Surface Aggregate Visible Unknown, at 09 o'clock, within 8 inches: NO	4_5A	S 3
89.50	Survey Abandoned, REMARK: CANT MAKE IT TO MH BECAUSE OF ROCKS	4_6A	



QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
3100	**0000**	**3**	**0**	**3**	**3**	**4**	**3**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**4**

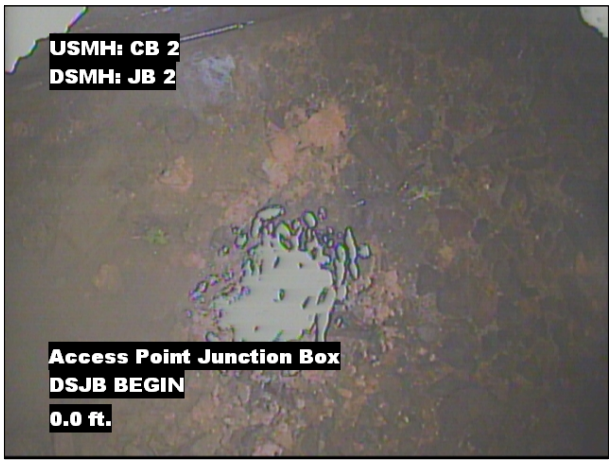

Photo: CB_2_JB_2_AJB_0.0.jpg, VCR No.: 1
0FT, Junction Box, REMARK: DSJB BEGIN

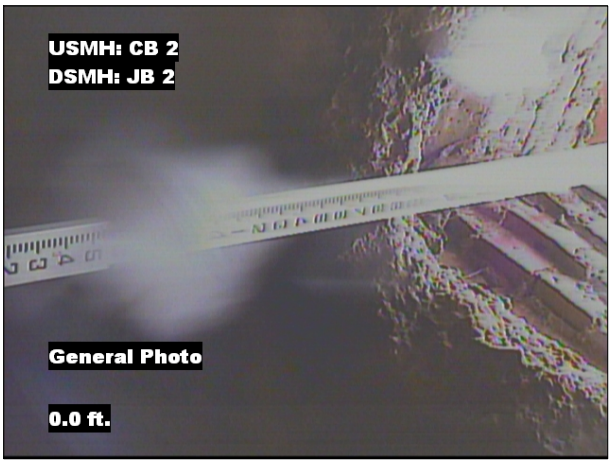

Photo: CB_2_JB_2_MGP_0.0.jpg, VCR No.: 1
0FT, General Photograph

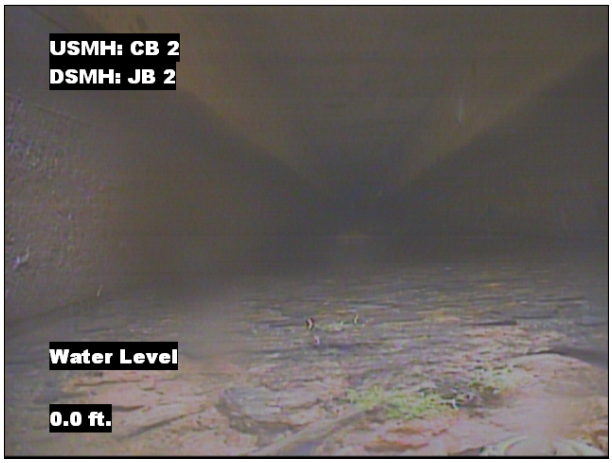

Photo: CB_2_JB_2_MWL_0.0.jpg, VCR No.: 1
0FT, Water Level, 25% of cross sectional area

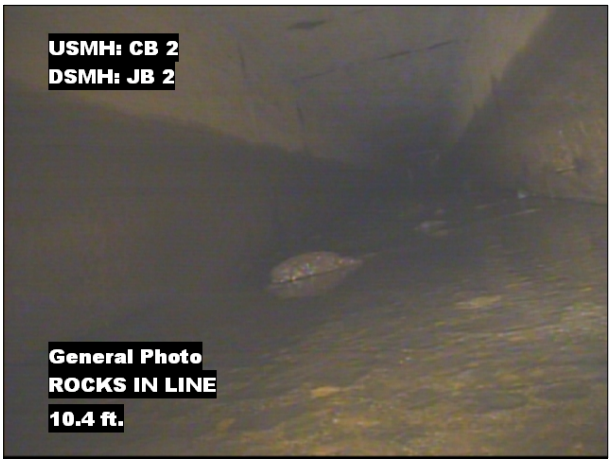

Photo: CB_2_JB_2_MGP_10.4.jpg, VCR No.: 1
10.4FT, General Photograph

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**4**

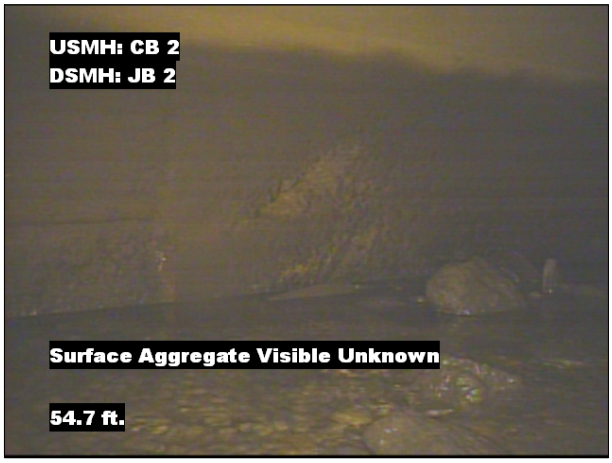

Photo: CB_2_JB_2_SAVZ_54.7.jpg, VCR No.: 1
54.7FT, Surface Aggregate Visible Unknown, at 09 o'clock, within 8 inches: NO

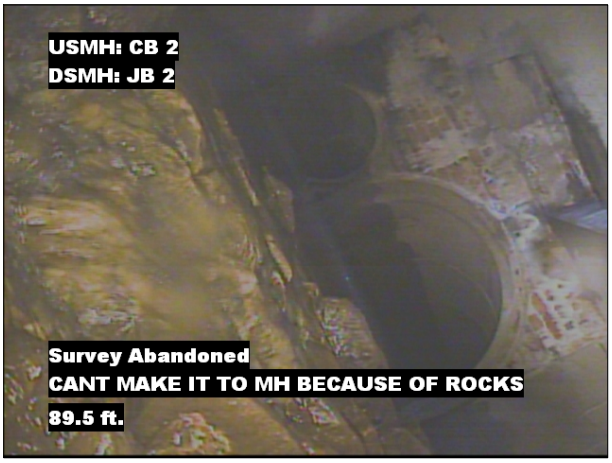

Photo: CB_2_JB_2_MSA_89.5.jpg, VCR No.: 1
89.5FT, Survey Abandoned, REMARK: CANT MAKE IT TO MH BECAUSE OF ROCKS

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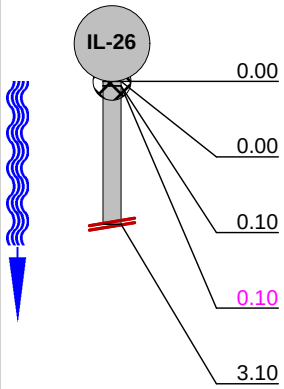
Inspection Report / Inspection: i1

Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 009-1**	**1**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Martin Blvd**	Use of Sewer	**Stormwater**	Upstream MH	**IL-26**
City	**Middle River**	Drainage Area		Dowstream MH	**MH-12**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Parking Lot**	Length surveyed	**3.10 ft**	Section Length	**5.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**24 inch**
Year Rehabilitated		Material	**Reinforced Concrete Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:50	Position	Observation	Photo	Grade
	0.00	Manhole	1_1A	
	0.00	General Photograph	1_2A	
	0.10	Water Level, 100% of cross sectional area	1_3A	
	0.10	Camera Underwater	1_4A	M 4
	3.10	Survey Abandoned, REMARK: CANT SEE PIPE FULL OF WATER	1_5A	

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**4100**	**0**	**4**	**4**	**4.4**	**4**	**4**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Martin Blvd**			**1**

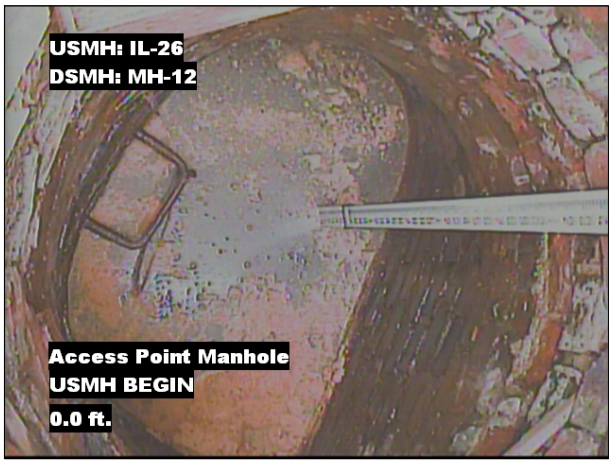

Photo: IL-26_MH-12_AMH_0.0.jpg, VCR No.: 1
0FT, Manhole

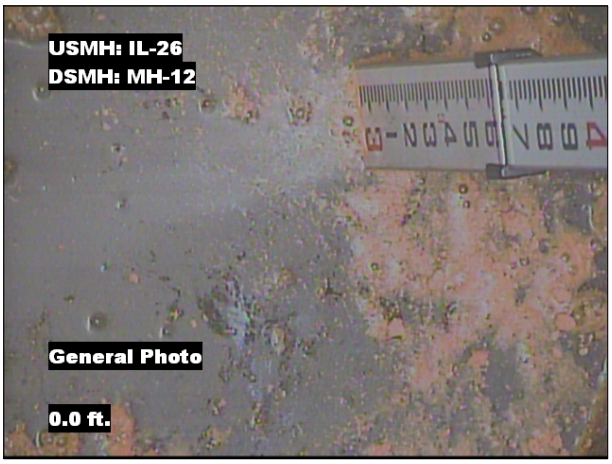

Photo: IL-26_MH-12_MGP_0.0.jpg, VCR No.: 1
0FT, General Photograph

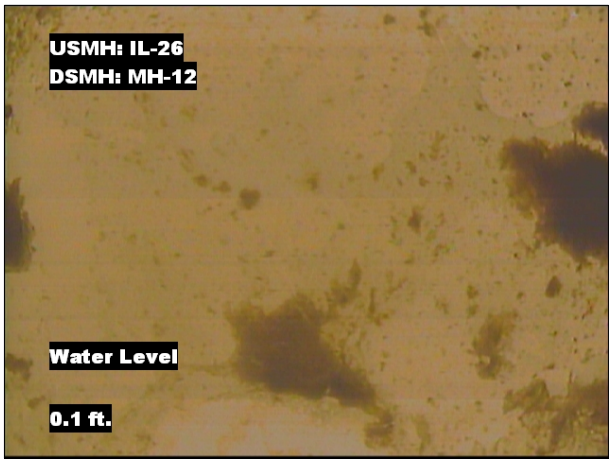

Photo: IL-26_MH-12_MWL_0.1.jpg, VCR No.: 1
0.1FT, Water Level, 100% of cross sectional area

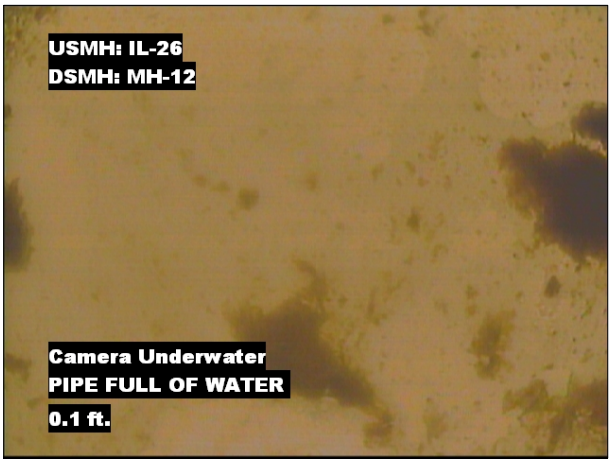

Photo: IL-26_MH-12_MCU_0.1.jpg, VCR No.: 1
0.1FT, Camera Underwater

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Martin Blvd**			**1**

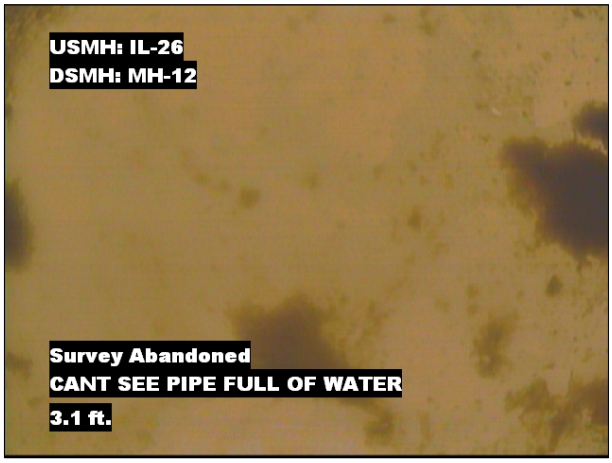

Photo: IL-26_MH-12_MSA_3.1.jpg, VCR No.: 1
3.1FT, Survey Abandoned, REMARK: CANT SEE PIPE FULL
OF
WATER

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Inspection Report / Inspection: i1

Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 00X-1**	**3**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Wilson Point Rd**	Use of Sewer	**Stormwater**	Upstream MH	**JB 1**
City	**Middle River**	Drainage Area		Dowstream MH	**00X**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Parking Lot**	Length surveyed	**3.00 ft**	Section Length	**5.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**36 inch**
Year Rehabilitated		Material	**Corrugated Metal Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:50	Position	Observation	Photo	Grade
JB 1	0.00	Junction Box, REMARK: USJB BEGIN	3_1A	
	0.00	Water Level, 100% of cross sectional area	3_2A	
	3.00	Camera Underwater	3_3A	M 4
	3.00	General Photograph	3_4A	
	3.00	Survey Abandoned, REMARK: CANT SEE NOTHING WATER TO HIGH	3_5A	

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**4100**	**0**	**4**	**4**	**0**	**4**	**4**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Wilson Point Rd**			**3**

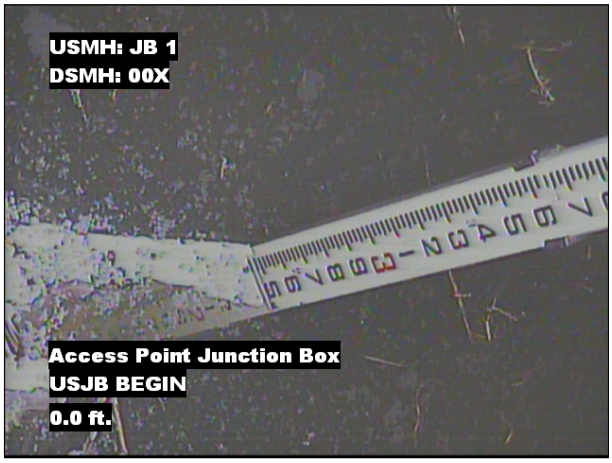

Photo: JB_1_00X_AJB_0.0.jpg, VCR No.: 1
0FT, Junction Box, REMARK: USJB BEGIN

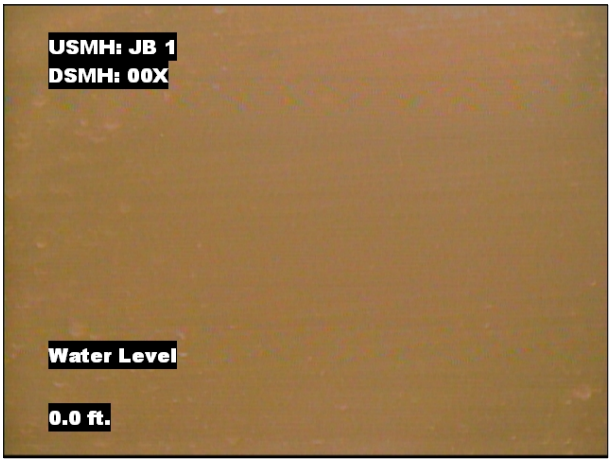

Photo: JB_1_00X_MWL_0.0.jpg, VCR No.: 1
0FT, Water Level, 100% of cross sectional area

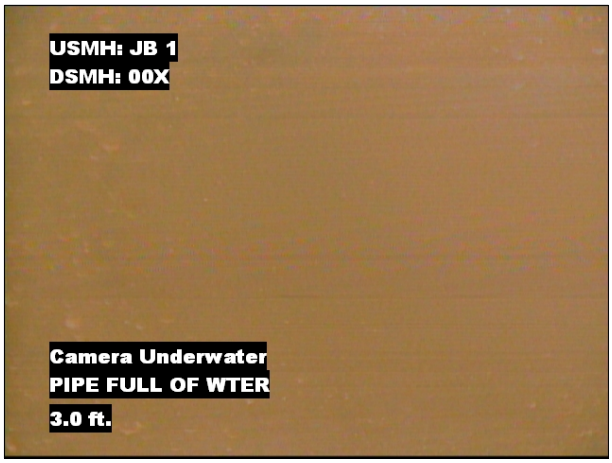

Photo: JB_1_00X_MCU_3.0.jpg, VCR No.: 1
3FT, Camera Underwater

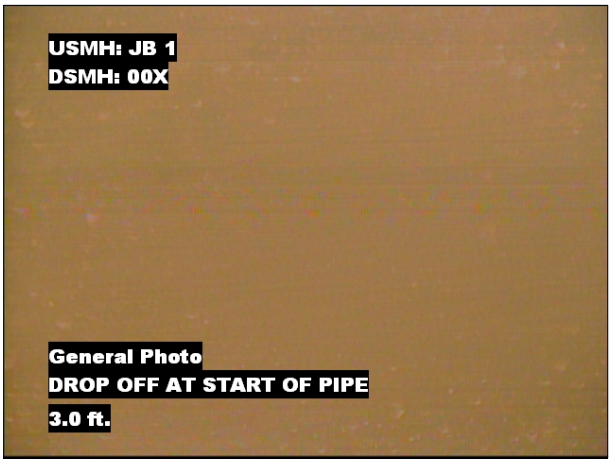

Photo: JB_1_00X_MGP_3.0.jpg, VCR No.: 1
3FT, General Photograph

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Wilson Point Rd**			**3**

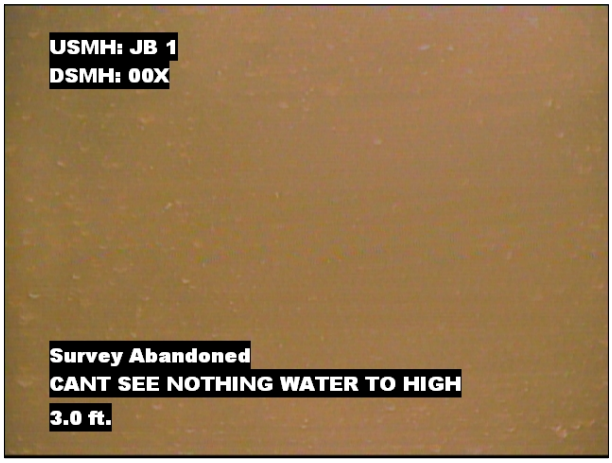

Photo: JB_1_00X_MSA_3.0.jpg, VCR No.: 1
3FT, Survey Abandoned, REMARK: CANT SEE NOTHING WATER TO HIGH

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Inspection Report / Inspection: i1

Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 007-2**	**5**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Dark Head Cove Rd**	Use of Sewer	**Stormwater**	Upstream MH	**JB 2**
City	**Middle River**	Drainage Area		Dowstream MH	**007**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Light Highway**	Length surveyed	**620.00 ft**	Section Length	**620.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**60 inch**
Year Rehabilitated		Material	**Reinforced Concrete Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:1494 Position	Observation	Photo	Grade
0.00	Manhole	5_1A	
0.00	Water Level, 30% of cross sectional area	5_2A	
236.20	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_3A	S 5
261.00	Alignment Left, 45%	5_4A	
265.80	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_5A	S 5
325.50	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_6A	S 5
335.20	Surface Roughness Increased Unknown, at 12 o'clock, within 8 inches: NO	5_7A	S 1
360.50	Camera Underwater	5_8A	M 4
410.30	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_9A	S 5
436.70	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_10A	S 5
491.50	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_11A	S 5
511.90	Surface Aggregate Visible Unknown, at 12 o'clock, within 8 inches: NO	5_12A	S 3
554.50	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_13A	S 5
591.20	Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO	5_14A	S 5

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Inspection Report / Inspection: i1

Date :	Job number :	Weather : **Dry**	Operator : **Jason_McNeill**	Counter : **5**	Section name :
Present :	Vehicle :	Camera :	Preset :	Cleaned : **No Pre-Cleaning**	Rate :

1:1494	Position	Observation	Photo	Rate
	620.00	Discharge Point	5_15A	

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
5831	**4100**	**44**	**4**	**48**	**4.4**	**4**	**4.36**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**5**

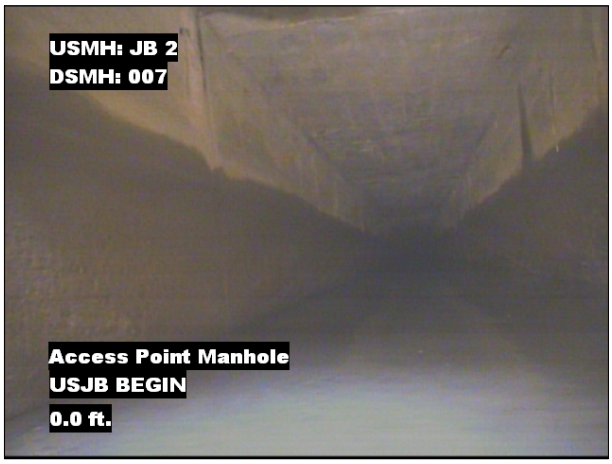

Photo: JB_2_007_AMH_0.0.jpg, VCR No.: 1
0FT, Manhole

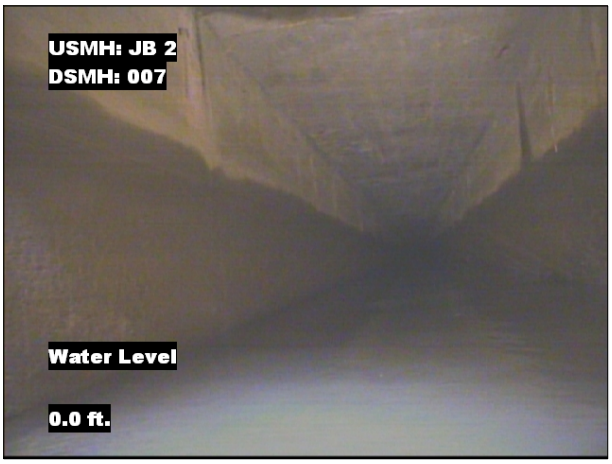

Photo: JB_2_007_MWL_0.0.jpg, VCR No.: 1
0FT, Water Level, 30% of cross sectional area

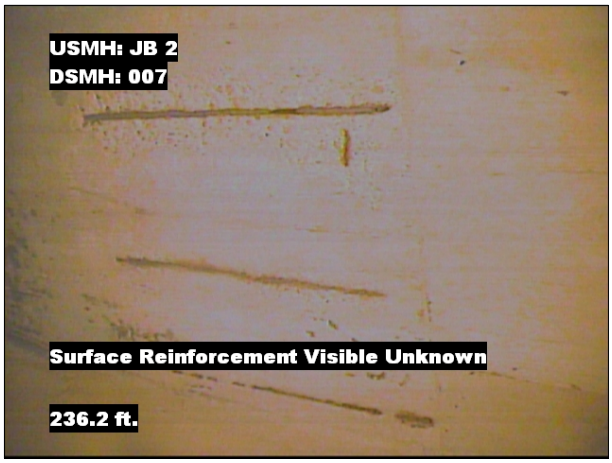

Photo: JB_2_007_SRVZ_236.2.jpg, VCR No.: 1
236.2FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

Photo: JB_2_007_IL_261.0.jpg, VCR No.: 1
261FT, Alignment Left, 45%

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**5**

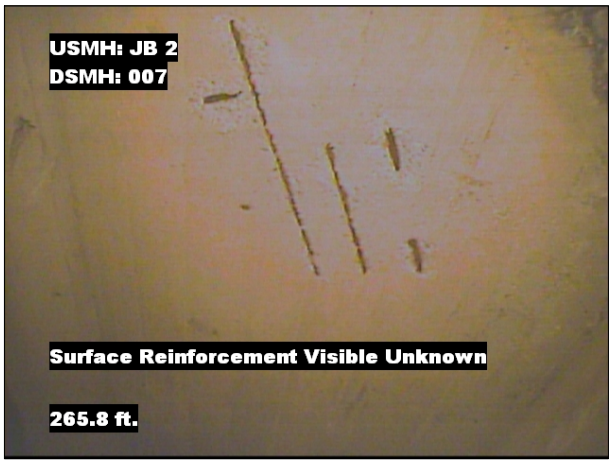

Photo: JB_2_007_SRVZ_265.8.jpg, VCR No.: 1
265.8FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

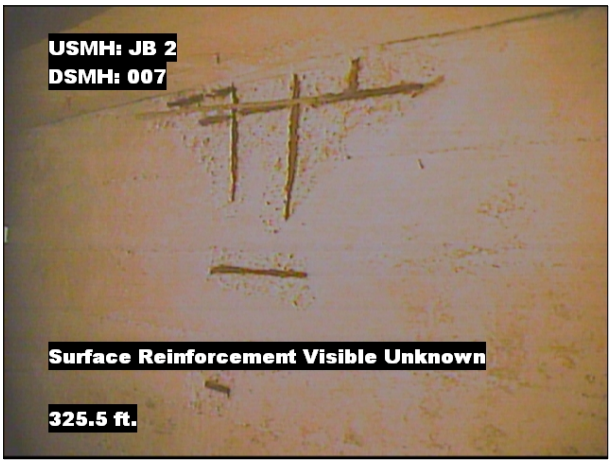

Photo: JB_2_007_SRVZ_325.5.jpg, VCR No.: 1
325.5FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

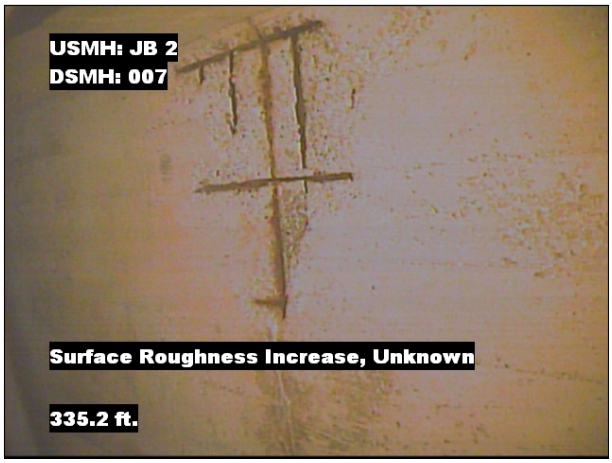

Photo: JB_2_007_SRIZ_335.2.jpg, VCR No.: 1
335.2FT, Surface Roughness Increased Unknown, at 12 o'clock, within 8 inches: NO

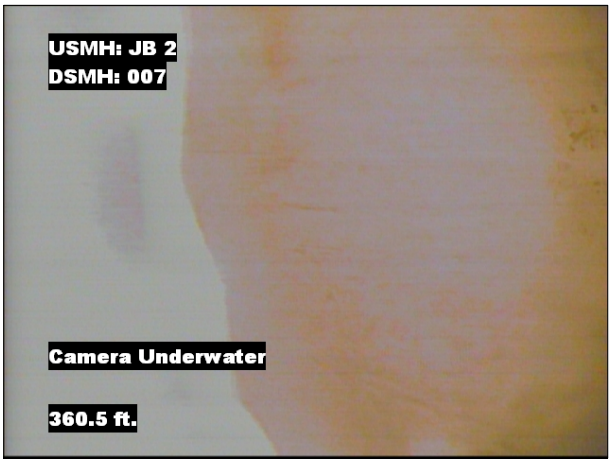

Photo: JB_2_007_MCU_360.5.jpg, VCR No.: 1
360.5FT, Camera Underwater

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**5**

Photo: JB_2_007_SRVZ_410.3.jpg, VCR No.: 1
410.3FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

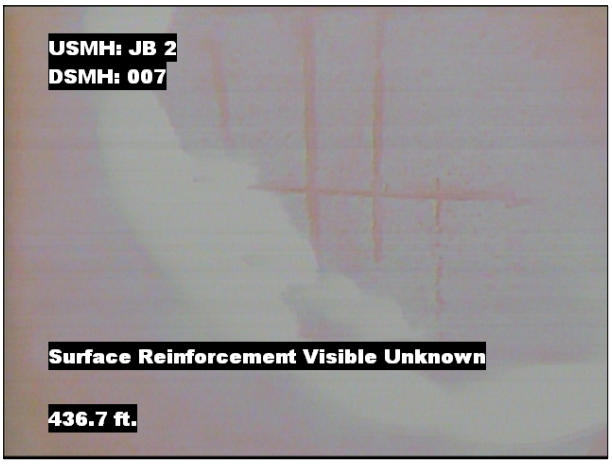

Photo: JB_2_007_SRVZ_436.7.jpg, VCR No.: 1
436.7FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

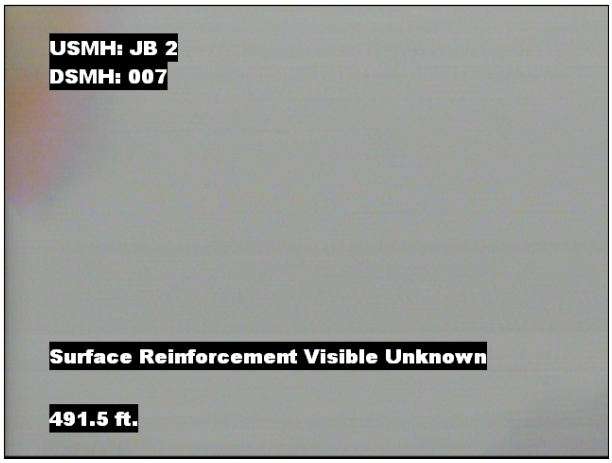

Photo: JB_2_007_SRVZ_491.5.jpg, VCR No.: 1
491.5FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

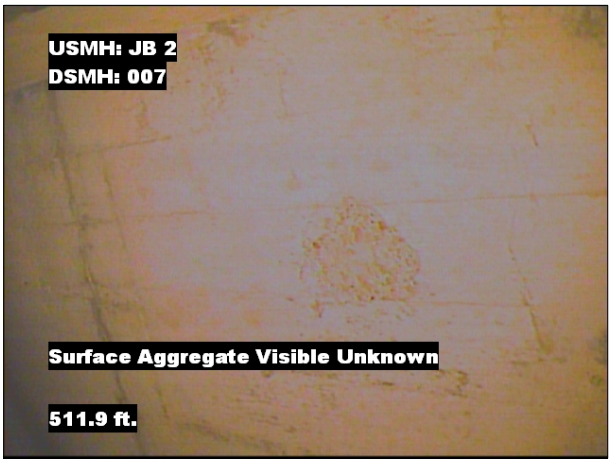

Photo: JB_2_007_SAVZ_511.9.jpg, VCR No.: 1
511.9FT, Surface Aggregate Visible Unknown, at 12 o'clock, within 8 inches: NO

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City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Dark Head Cove Rd**			**5**

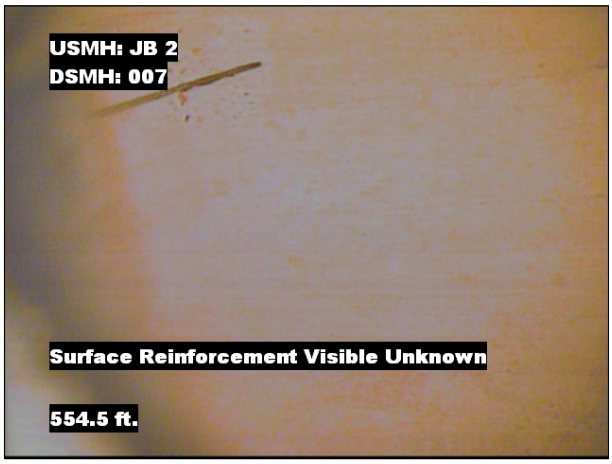

Photo: JB_2_007_SRVZ_554.5.jpg, VCR No.: 1
554.5FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

Photo: JB_2_007_SRVZ_591.2.jpg, VCR No.: 1
591.2FT, Surface Reinforcement Visible Unknown, at 12 o'clock, within 8 inches: NO

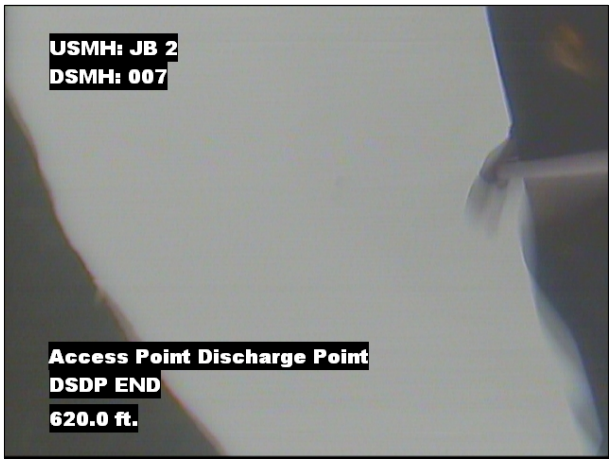

Photo: JB_2_007_ADP_620.0.jpg, VCR No.: 1
620FT, Discharge Point

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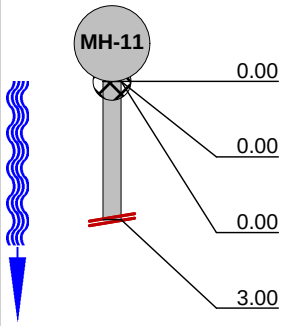
Inspection Report / Inspection: i1

Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 009-3**	**2**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Martin Blvd**	Use of Sewer	**Stormwater**	Upstream MH	**MH-11**
City	**Middle River**	Drainage Area		Dowstream MH	**009**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Parking Lot**	Length surveyed	**3.00 ft**	Section Length	**5.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**24 inch**
Year Rehabilitated		Material	**Reinforced Concrete Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:50	Position	Observation	Photo	Grade
	0.00	Manhole	2_1A	
	0.00	General Photograph	2_2A	
	0.00	Water Level, 100% of cross sectional area	2_3A	
	3.00	Survey Abandoned, REMARK: PIPE FULL OF WATER CANT SEE	2_4A	

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**0**	**4**	**4**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Martin Blvd**			**2**

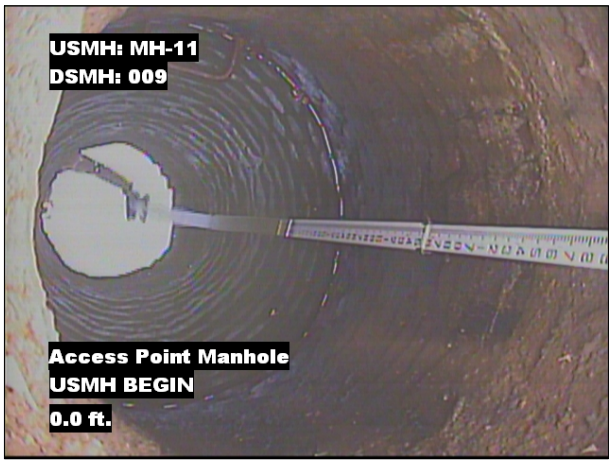

Photo: MH-11_009_AMH_0.0.jpg, VCR No.: 1
0FT, Manhole

Photo: MH-11_009_MGP_0.0.jpg, VCR No.: 1
0FT, General Photograph

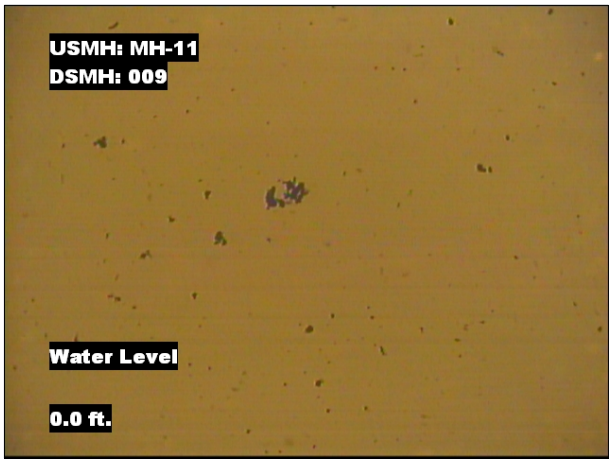

Photo: MH-11_009_MWL_0.0.jpg, VCR No.: 1
0FT, Water Level, 100% of cross sectional area

Photo: MH-11_009_MSA_3.0.jpg, VCR No.: 1
3FT, Survey Abandoned, REMARK: PIPE FULL OF WATER CANT SEE

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Inspection Report / Inspection: i1

Date	Order Number	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
8/31/2015	**1117459**	**Dry**	**Jason_McNeill**	**Storm Drain 009-2**	**6**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-1206-4200	**Tetra Tech Inc**	**Lockheed Martin**		**No Pre-Cleaning**	

Street123	**Martin Blvd**	Use of Sewer	**Stormwater**	Upstream MH	**MH-12**
City	**Middle River**	Drainage Area		Dowstream MH	**MH-11**
Loc. details		Flow Control		Dir. of Survey	**Downstream**
Location Code	**Parking Lot**	Length surveyed	**0.00 ft**	Section Length	**5.00 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**24 inch**
Year Rehabilitated		Material	**Reinforced Concrete Pipe**
Tape / Media No.	**1**	Lining Method	

Add. Information :

1:50	Position	Observation	Photo	Grade
MH-12	0.00	Manhole	6_1A	
	0.00	Water Level, 100% of cross sectional area		
	0.10	Survey Abandoned, REMARK: Surcharge Manhole		

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	**0000**	**0**	**0**	**0**	**3**	**4**	**3**

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Inspection photos / Inspection: i1

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Middle River	**Martin Blvd**			**6**

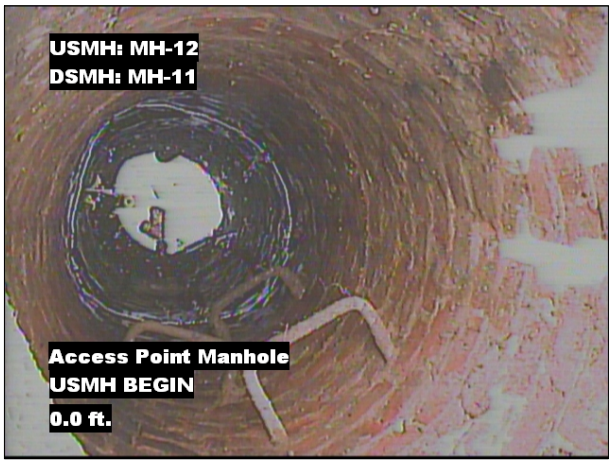

Photo: MH-12_MH-11_AMH_0.0.jpg, VCR No.: 1
0FT, Manhole

ATTACHMENT G—STORM-DRAIN CCTV-VIDEO FILES AND PHOTOGRAPHS

(ON DVD ONLY)

Attachment G in on a seperate DVD due to size.