Lockheed Martin Corporation
1600 Tallevast Road, Sarasota, Fl 34243
Telephone 240-687-1813

Electronically Transmitted

October 29, 2018

Ms. Simone Core, P.E.
Remediation Engineer
Florida Department of Environmental Protection
Permitting and Waste Cleanup
13051 N. Telecom Parkway
Temple Terrace, FL 33637-0926

Re: 2018 Remedial Action Status Report
Lockheed Martin Tallevast Site
FDEP Site No. COM_169624/Project No. 238148
Tallevast, Manatee County, Florida

Dear Ms. Core:

Please find enclosed one copy of the 2018 Remedial Action Status Report (RASR) for the referenced site. Per your request, this RASR is being distributed to you in electronic form only. This RASR covers the period of performance from September 1, 2017 through August 31, 2018 and provides a comprehensive summary of system operation and maintenance for the groundwater treatment system. This report also summarizes other Site-related programs that include persulfate pilot study monitoring, groundwater level monitoring, effectiveness monitoring, private well monitoring and wetlands monitoring. If you have any questions, please contact me at 240-687-1813, or paul.e.calligan@lmco.com.

Sincerely,

Paul E. Calligan, P.G.
Project Manager, Environmental Remediation
Lockheed Martin Corporation

cc: Ms. MaryEllen Fugate, SWFWMD (email)
Mr. Derek Matory, EPA (hard copy)
Mr. Randy Merchant, FDOH (CD)
Mr. Robert Brown, Manatee County (hard copy and CD)
Mr. Andre Rachmaninoff, Manatee County (hard copy and CD)
Mr. Tom Larkin, Manatee County, (CD)
Mr. Michael DiPinto, Manatee County (CD)
Mrs. Laura Ward (hard copy and CD)
Mrs. Wanda Washington (hard copy and CD)
Mr. Rob Powell, Ramboll (CD)
Mr. Kent Bontrager, SMAA (CD)

REMEDIAL ACTION STATUS REPORT SEPTEMBER 2017 THROUGH AUGUST 2018 - TALLEVAST SITE, FLORIDA

Prepared for:
Lockheed Martin Corporation

Prepared by:
AECOM Technical Services, Inc

October 2018

Approved by:
Lockheed Martin, Inc.

Revision: 0

Lewis J. Davies, P.E., C.B.C
Project Director

Michael D. McCoy, P.G.
Project Manager

Darrin Johnson
Operations Manager

CERTIFICATION

This Remedial Action Status Report for the Remedial Action Plan Addendum Groundwater Recovery and Treatment System at the Lockheed Martin Tallevast Site located at 1600 Tallevast Road, Sarasota, Florida documents the time period of September 1, 2017 through August 31, 2018. This report has been prepared for Lockheed Martin Corporation under the direction of a State of Florida Registered Professional Engineer. The work and professional opinions rendered in this report were developed in accordance with Section 471 Florida Statutes, the governing state and federal regulations, and commonly accepted protocols and procedures. If conditions are discovered that differ from those described, the undersigned should be notified.

This item has been digitally signed and sealed by:

Perdicaris, Jason

Digitally signed by Perdicaris, Jason
DN: cn=Perdicaris, Jason, ou=USORL3
Date: 2018.10.29 14:20:49 -04'00'

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Jason Perdicaris, P.E.
Florida Professional Engineer
License No. 66506
Engineering Business No. 8115
Date: 10/29/2018

Printed copies of this document are not considered signed and sealed. The signature must be verified on the electronic document.

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
ABC	American Beryllium Company
AECOM	AECOM Technical Services, Inc.
AF	Arcadia Formation
AOP	advanced oxidation process
COC	chemical(s) of concern
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	cis-1,2-dichloroethene
1,4-D	1,4-dioxane
DID	District Identification
F.A.C.	Florida Administrative Code
Facility	The "Facility" is defined as the property of approximately 5 acres located at 1600 Tallevast Road
FDEP	Florida Department of Environmental Protection
FIT	flow indicator transmitter
GAC	granular activated carbon
GCTL	groundwater cleanup target level
GRTS	Groundwater Recovery and Treatment System
ID	isotope dilution
Lockheed Martin	Lockheed Martin Corporation
LPGAC	liquid phase granular activated carbon
LSAS	Lower Shallow Aquifer System
LTWLM	long-term water level monitoring
MCUO	Manatee County Utility Operations
msl	mean sea level
µg/L	micrograms per liter
MW	monitoring well

OMM	operation, maintenance, and monitoring
PCE	tetrachloroethene
PLC	programmable logic controller
POTW	publicly owned treatment works
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RAPA	Remedial Action Plan Addendum
RASR	Remedial Action Status Report
RC	Infiltration Gallery
RO	reverse osmosis
RW	reference wetland
S&P	Salt & Pepper
SIM	selective ion monitoring
Site	The “Site” consists of both the Tallevast Facility and the surrounding area groundwater that is impacted by chemicals of concern
SOP	standard operating procedure
SU	standard units
SWFWMD	Southwest Florida Water Management District
TCE	trichloroethene
TDS	total dissolved solids
TestAmerica	TestAmerica Laboratories, Inc.
TPOC	Temporary Point of Compliance
TW	target wetland
USAS	Upper Surficial Aquifer System
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
WMP	Wetlands Monitoring Plan
WUP	Water Use Permit

SECTION 1
INTRODUCTION

Lockheed Martin Corporation (Lockheed Martin) is pleased to present this annual Remedial Action Status Report (RASR) to the Florida Department of Environmental Protection (FDEP). This document provides a comprehensive summary of the remediation and monitoring activities for FDEP Site No. 169624 as described below.

1.1 GENERAL

This RASR describes operation, maintenance, and monitoring (OMM) activities for the Remedial Action Plan Addendum (RAPA; ARCADIS, 2009a) Groundwater Recovery and Treatment System (GRTS), at the Lockheed Martin Tallevast Site (also known as the Former American Beryllium Company [ABC] Site) (the Site) located in Tallevast, Manatee County, Florida. The Site consists of both the Facility (also referred to as the “on-Facility” portion of the Site) and the surrounding area (referred to as the “off-Facility” portion of the Site) where groundwater is impacted by chemical(s) of concern (COC). Refer to Figure 1-1 a Site Location Map. This RASR documents the reporting period from September 1, 2017 through August 31, 2018.

This report was prepared in accordance with and contains the applicable items required in Rule 62.780.700(12), Florida Administrative Code (F.A.C.) for a RASR. The activities, analyses, and results described in this report demonstrate fulfillment of Lockheed Martin commitments and achievement of FDEP requirements. The RASR also provides permit compliance status for Southwest Florida Water Management District (SWFWMD) Water Use Permit (WUP) number 20020198.000 and Manatee County Discharge Permit #IW-0025S. Manatee County Utility Operations (MCUO) will continue receiving annual reports concurrent with FDEP reporting requirements. Also included in this RASR are results of the biennial Persulfate Pilot Study Monitoring, the Wetlands Monitoring, and the Long-Term Water Level Monitoring (LTWLM) programs.

1.2 OBJECTIVES

The GRTS Remedial Action Objectives (RAOs) provided in the RAPA are as follows:

- Reduce the potential for human exposure to COC in groundwater.
- Hydraulically control groundwater containing COC in concentrations greater than the groundwater cleanup target levels (GCTLs) as listed in Chapter 62-777, F.A.C.
- Actively extract and treat the groundwater plume until concentrations are below GCTLs.
- Reduce the potential for exposure to COC present in soil at the Facility.
- Minimize community and natural resource disturbance.

This RASR provides descriptions and results demonstrating achievement of the RAOs.

1.3 REPORT ORGANIZATION

This report is organized into seven sections as described below.

Section	Description
1 – Introduction	Presents the purpose and objectives of remedial actions and the organization of this report.
2 – Background	Summarizes the regulatory and physical settings, Site hydrology, geology and hydrogeology, and history of Facility operations.
3 – Groundwater Recovery and Treatment System (GRTS) Description	Provides a summarized description of the GRTS.
4 – System Operation, Maintenance, and Monitoring (OMM) Activities	Describes OMM, LTWLM, Persulfate Pilot Study Monitoring, and Wetlands Monitoring activities.
5 – System Operation, Maintenance, and Monitoring Results	Describes the OMM, LTWLM, Wetlands Monitoring, and Persulfate Pilot Study Monitoring results.
6 – Summary and Conclusions	Summarizes data and analyses presented in this report and recommendations for changes to system operations and monitoring.
7 – References	Lists the references used to support and prepare this report.

SECTION 2
BACKGROUND

This section of the RASR provides an overview of the Facility location, regulatory setting, Facility description, and historical operations. A more detailed description of the GRTS can be found in the first Lockheed Martin Tallevast Site RASR (AECOM Technical Services, Inc. [AECOM], 2014) submitted to the FDEP on October 28, 2014.

2.1 FACILITY LOCATION

The Facility is an approximate 5-acre property located at 1600 Tallevast Road, between the cities of Sarasota and Bradenton, in southwestern Manatee County, Florida. Land use in the area consists of single-family residential homes, churches, light commercial and industrial development, and heavy manufacturing. The location of the Facility is shown on Figure 1-1.

2.2 REGULATORY SETTING

The RAPA was developed in accordance with the Consent Order for the Site entered into by Lockheed Martin and the FDEP. The File Number for the Consent Order is 04-1328 with an effective date of July 28, 2004, as amended by Consent Order No. 08-2254 with an effective date of October 13, 2008. The Consent Order requires Lockheed Martin to perform assessment and remediation activities at the Site.

Lockheed Martin submitted the RAPA to the FDEP on July 14, 2009. The FDEP issued a Remedial Action Plan (RAP) Approval Order on November 5, 2010. Construction of the full-scale groundwater remedy provided in the RAPA began in March 2011. A challenge to the RAP Approval Order was heard by an Administrative Law Judge, who recommended in an October 6, 2011 filing that FDEP issue a final order approving the RAPA. The final order from FDEP was received on January 4, 2012, and construction of the GRTS was completed April 2013. The startup of the GRTS occurred on November 18, 2013. The activities described within this RASR have been conducted in accordance with the Consent Order.

2.3 FACILITY DESCRIPTION

This section provides the physical setting of the Site and describes Site hydrologic, geologic, and hydrogeological conditions.

2.3.1 Physical Setting

The Facility is bounded by Tallevast Road to the north; 17th Street Court East to the east; a nine-hole golf course and driving range to the south; and an abandoned industrial property to the west, as shown on Figure 2-1. The treatment building is located in the north-central portion of the Facility property as shown on Figure 2-2. Two concrete driveways provide entry to the Facility from the north off of Tallevast Road. The treatment building is located within a concrete parking area to the east, a concrete driveway to the south, and impermeable asphalt with a permeable artificial turf overlay to the north and to the west. A stormwater retention pond is located west of the treatment building. A map showing Site monitoring well, extraction well, stilling well, private well, and staff gauge locations is presented as Figure 2-3.

2.3.2 Site Hydrology

A number of small surface water bodies are located within and near the Site. Several shallow swales convey surface runoff to streets and stormwater channels. In addition, several wetlands are present within and near the Site according to the Florida Department of Transportation Florida Land Use, Cover, and Forms Classification System. Surface water on the western portion of the Facility flows west toward improved drainage features around the Sarasota-Bradenton Airport, which drain into Sarasota Bay. Surface water on the easternmost portion of the Site flows southeast toward the Pearce Canal.

2.3.3 Site Geology and Hydrogeology

In January 1995, the SWFWMD published a report titled ROMP TR-7 Oneco Monitor Well Site, Manatee County, Florida (SWFWMD, 1995), which describes the drilling and testing of a well completed to a reported depth of 1,715 feet below ground surface at a location approximately 2.5 miles north of the Facility in southwestern Manatee County. The nomenclature used in that SWFWMD report to describe subsurface sediments is typically used to describe consolidated carbonate formations in the region and therefore is used for this Site. Local hydrogeologic units and water-bearing zones beneath the Site are detailed on Figure 2-4.

2.4 FACILITY OPERATION

The following sections summarize the history of Facility operations and RAPA implementation.

2.4.1 History of Facility Operations

From 1962 until 1996, the Facility was owned by Loral Corporation and operated by ABC as an ultra-precision machine parts manufacturing plant in which metals were milled, lathed, and drilled into various components. Some of the components were finished by electroplating, anodizing, and ultrasonic cleaning. Chemicals used and wastes generated at the Facility included oils, fuels, solvents, acids, and metals. Lockheed Martin acquired ownership of the former ABC facility through its 1996 acquisition of Loral Corporation, the parent company of ABC. Historical plant operations were discontinued in late 1996. Lockheed Martin sold the property in 2000 and re-purchased it in June 2009 to prepare it for remedial actions.

2.4.2 History of RAPA System Implementation

Construction of the GRTS building began in January of 2012, and Manatee County issued a Temporary Certificate of Occupancy on February 1, 2013. Construction reached substantial completion on April 19, 2013, and Manatee County issued the final Certificate of Occupancy on August 21, 2013 when the Facility civil improvements were completed.

Startup and testing activities began in February 2013 and concluded on November 18, 2013, the date of official GRTS startup. As-built Drawings, which included the soil control plan at the completion of Site civil activities, were submitted to the FDEP on November 14, 2013. The Site is currently in the OMM phase of remedial activities.

SECTION 3
GROUNDWATER RECOVERY AND TREATMENT SYSTEM DESCRIPTION

This section presents a summarized process description of the Tallevast GRTS.

3.1 TREATMENT BUILDING SUMMARY

The GRTS equipment is housed inside a 14,200 square foot reinforced concrete building. The Treatment System General Arrangement Plan, shown as Figure 3-1, provides the location of GRTS equipment in the process area. The treatment building is designed to contain more than the entire volume of water in the treatment plant stored in the piping, tanks, and process equipment. The treatment building includes treatment equipment, chemical containment rooms, operator offices, restroom facilities, a break room, a sample preparation room, and a parts storage room.

3.2 EXTRACTION WELL AND PUMP SUMMARY

The GRTS includes 77 vertical groundwater extraction wells, four horizontal extraction wells, three infiltration galleries, and five injection wells. A submersible pump and pressure transducer are located in each extraction well. The GRTS extracts groundwater from 33 on-Facility vertical wells, 44 off-Facility vertical wells, and four off-Facility horizontal wells. Most of the treated water is currently discharged to the publicly owned treatment works (POTW), but GRTS-treated water is also discharged to the infiltration galleries and injection wells. Contaminated groundwater is extracted from the upper four water-bearing zones underlying the Site. The primary operational objectives of the GRTS are: (a) to provide hydraulic containment and capture of the COC plume and (b) to ultimately achieve COC concentrations that are less than GCTLs in groundwater beneath the Site - two of the Site RAOs.

3.3 CONVEYANCE PIPING AND FIELD UTILITIES

Groundwater from horizontal and vertical extraction wells is transported in the underground conveyance piping network to the treatment plant. Each well vault contains a flow meter, pressure transducer, sample port, check valve, Y strainer, and isolation ball valve. On-Facility extraction wells are individually piped to the treatment building. Conveyance piping for the on-Facility and off-Facility extraction wells is combined once inside the treatment building. Conveyance carrier piping is enclosed in secondary containment (i.e., containment piping, manhole structures, etc.) until it reaches the interior of the treatment building. Manifold piping inside of specific cleanout manholes and extraction well vaults is constructed to provide leak detection in the capture and conveyance system using permanent dual containment termination fittings and capacitance sensors capable of detecting water. Once the capacitance sensors detect water, the operator is alerted and the extraction well network is automatically disabled.

Five on-Facility injection wells are contained inside pre-cast concrete vaults. Each vault contains a level sensor, drop pipe, and air release valve. The flow rate to each well is controlled via flow control valves, and flow is totalized using a single flow meter inside the process area. Injection wells are supplied treated water from a single pump which feeds from the recharge tank inside the process area.

3.4 TREATMENT PLANT PROCESS OPERATION SUMMARY

Refer to Figure 3-2 for a treatment process diagram. Extracted groundwater is pumped to the Treatment System where pre-treatment equipment is used to adjust the pH of the groundwater, oxidize metals, and remove solids using settling tanks, media filters, and ultrafilters. Removed solids and metals are pumped to a solids thickening tank for further settling. The concentrated solids are dewatered using a filter press before being loaded into 55-gallon drums and transported as non-hazardous waste to a licensed and permitted landfill. Advanced oxidation process (AOP) units and liquid phase granular activated carbon (LPGAC) vessels are used to provide treatment of contaminants. Groundwater COC at the Site include 1,4-dioxane (1,4-D), tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), and vinyl chloride (VC). After AOP treatment some 1,1-DCA remains, and that is removed using LPGAC.

Water that has been treated through the settling tanks, filters, AOP units, and activated carbon processes meets the POTW discharge standards. In addition to discharge to the POTW, treated water can be used for the following: 1) backwash supply water for the media filters and LPGAC vessels; 2) further process treatment through softeners and reverse osmosis (RO) systems to meet

GCTLs and Florida Surface Water Quality Criteria for application to the infiltration galleries or injection wells; and 3) non-potable process water used for equipment wash-down, Facility irrigation, and miscellaneous non-potable uses. The on-Facility injection wells recharge the Upper Surficial Aquifer System (USAS) via five passive injection wells that focus flushing of areas with the highest historical COC concentrations. The three off-Facility infiltration galleries are used as needed to maintain established wetland hydroperiod water levels to minimize wetland health impacts due to drawdown effects of the groundwater extraction system.

A compressed air system operates the pneumatic equipment, including double-diaphragm pneumatic pumps and the pneumatic valves. Compressed air is also used to assist in metals oxidation in the primary pretreatment tanks. Displaced air from the pre-AOP holding tank, backwash surge tank, and solids thickening tank vent systems are routed to the vapor phase granular activated carbon (GAC) vessels located in the process area loading dock for passive treatment of volatile organic compounds (VOCs).

Various instruments are used to monitor key process variables (primarily flow rate, water level, line pressures, pH and temperature). Redundant alarms, switches, and control logic are used to automate the GRTS and prevent system failures such as accidental overfilling of tanks. A programmable logic controller (PLC) provides control and communications between systems, equipment, and instrumentation. The treatment building includes an operations room where operators monitor and control the GRTS.

SECTION 4
SYSTEM OPERATION, MAINTENANCE, AND MONITORING ACTIVITIES

This section describes activities conducted as part of system OMM. The data and conclusions resulting from these activities are detailed in Sections 5 and 6 of this document.

4.1 SYSTEM OPERATION

The GRTS operated continuously from September 1, 2017 through August 31, 2018, with the exception of planned downtime for required maintenance activities and a limited number of unplanned shutdowns. The extraction wells were in operation during the reporting period, with the exception of extraction well EW-5002 (refer to Section 5.4.1).

An OMM log describing key GRTS operations, maintenance activities, and downtime events during this period of performance is presented in Table 1. Treatment plant shift daily logs document the key GRTS readings and are presented in Appendix A. System runtime is discussed in Section 5.1, and system runtime is presented in Table 2. Monthly extraction well volumes since startup are presented in Table 3.

Startup of the on-Facility injection wells occurred October 4, 2016 and continued throughout the 2018 reporting period. Discharge to infiltration gallery RC-7002 began on July 9, 2014 and continued throughout the reporting period. Discharge to RC-7001 and RC-7003 was initiated on July 5, 2017. Refer to Figure 2-1 and Figure 2-2 for the locations of infiltration galleries and injection wells, respectively. The use of treated effluent to the Facility irrigation system used for the maintenance of landscaping was initiated April 17, 2017. Additional details that include volumes of water discharge are provided in Section 5.2.

4.2 WATER TREATMENT PROCESS AND COMPLIANCE MONITORING

The following sections describe water treatment process sampling and laboratory analyses. Data that demonstrate RAPA and regulatory permit compliance are also provided. Water treatment and compliance sampling were conducted in accordance with FDEP Standard Operating Procedures (SOPs) FS 2000 *General Aqueous Sampling*, revision date March 1, 2014 (FDEP, 2014a) and FC 1000 *Cleaning/Decontamination Procedures*, revision date March 1, 2014 (FDEP, 2014b). Table 4 summarizes the monitoring schedule as originally specified in RAPA Table 12-1.

4.2.1 Compliance Sampling

Treatment System POTW effluent compliance samples were collected in accordance with the RAPA and the requirements of Manatee County Discharge Permit #IW-0025S. The Manatee County Discharge Permit, located in Appendix B, was renewed in late 2015 with an effective date of November 9, 2015. The current permit expires November 8, 2018. Effluent compliance sampling dates and analytical results are presented in Table 5. The analytical results of this sampling are described in Section 5.2. The calibration sheet from March 28, 2018, for discharge flow indicator transmitter (FIT) 500 is presented in Appendix C.

TestAmerica Laboratories, Inc. (TestAmerica) located in Tampa, Florida analyzed compliance samples using United States Environmental Protection Agency (USEPA) Method 8260B for VOCs and USEPA Method 8260C with heated purge and selective ion monitoring isotope dilution (SIM/ID) for 1,4-D. Effluent samples were also analyzed for the 12 metals (aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, nickel, zinc, sodium, and molybdenum) specified in the MCUO Discharge Permit by USEPA Method 6010B. Temperature and pH are continuously monitored using treatment system instrumentation.

4.2.2 GRTS Performance Monitoring Sampling

Performance samples were collected from the RO system effluent on October 9, 2017 to document the water quality during discharge to infiltration galleries and injection wells. TestAmerica in Tampa, Florida analyzed these samples using USEPA Method 8260B for VOCs and USEPA Method 8260C with heated purge, and SIM/ID for 1,4-D. Samples were also analyzed for the RO system effluent 10 metals (aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, zinc, and sodium) by USEPA Method 6020A, total dissolved solids (TDS) by Standard Method 2540C, and chloride and sulfate by USEPA Method 300.0, as specified in Table 6, to confirm that RO permeate met the lower of either GCTL or surface water quality criteria for discharge to infiltration galleries and adherence to GCTL for discharge to injection wells.

To evaluate critical process performance parameters and carbon breakthrough, performance samples are collected at the combined plant influent, AOP feed, AOP effluent, and the primary and secondary carbon vessel discharge points. These samples were analyzed using USEPA Method 8260B for VOCs and USEPA Method 8260C with heated purge, and SIM/ID for 1,4-D. Refer to Table 7 for the process monitoring analytical results. Refer to Table 8 for the combined influent analytical results. Section 5.2 includes a discussion of the analytical results.

4.2.3 SWFWMD Water Use Permit Compliance

The SWFWMD issued General WUP No. 20 020198.000, which limits the volume of groundwater extracted at the Site, on November 18, 2011. The current permit, which is provided in Appendix D, expires on November 18, 2021 and is to be renewed one year prior to the date of expiration. As prescribed in the permit, Lockheed Martin is permitted to extract a total of 410,600 gallons daily from the network of extraction wells. Table 3 presents monthly extraction well volumes pumped. Table 9 summarizes cumulative groundwater volumes extracted, treated, and discharged. Section 5.1 summarizes the monthly influent flow totals plus the daily maximum and average flows. Permit special conditions require monthly reporting of meter readings at three compliance points (District Identification numbers DID-95, DID-96, and DID-97). DID-95 and DID-97 correspond to the GRTS influent (FIT-100) and discharge to the POTW (FIT-500), respectively. The discharge total for the infiltration galleries (RC-7001, RC-7002, and RC-7003), the injection wells (RC-6001, RC-6002, RC-6003, RC-6004, RC-6005), and treated effluent used for Facility irrigation is calculated (DID-95 minus DID-97) and submitted under DID-96. Summarized in Table 9a below are the dates that monthly WUP compliance point flow totals were submitted to the SWFWMD online e-Permitting website service portal. Appendix C contains flow meter calibration sheets for the extraction wells, combined influent, POTW effluent, combined injection well flow meters, and infiltration gallery flow meters.

Table 9a – Southwest Florida Water Management District (SWFWMD) E-Permitting Submittal Dates	
Month	**SWFWMD E-Permitting Submittal Date**
September 2017	October 2, 2017
October 2017	November 2, 2017
November 2017	December 1, 2017
December 2017	January 4, 2018
January 2018	February 8, 2018
February 2018	March 1, 2018
March 2018	April 2, 2018
April 2018	May 2, 2018
May 2018	June 1, 2018
June 2018	July 2, 2018
July 2018	August 1, 2018
August 2018	September 1, 2018

4.3 WATER LEVEL AND WETLANDS MONITORING

Groundwater level monitoring provides a means for confirming hydraulic capture of the COC plume, optimizing the extraction system, and providing adequate protection of groundwater supply resources. The following sections describe the water level gauging events performed in February 2018 and August 2018.

4.3.1 Semi-Annual Gauging Event

During the semi-annual groundwater gauging event, field personnel collected water levels from a total of 185 monitoring locations. These locations included monitoring wells, staff gauges, stilling wells, and piezometers, as identified in Table 10 and shown on Figure 2-3. The monitoring wells gauged during this event were opened and vented on February 19, 2018 and water levels were allowed to equilibrate for up to 24 hours. Field personnel gauged monitoring wells on February 20, 2018 while under GRTS pumping conditions.

4.3.2 Annual Effectiveness Monitoring Gauging Event

Sampling personnel collected water level data during the annual event from 298 monitoring points, including monitoring wells, piezometers, staff gauges, and stilling wells, as identified in Table 11 and shown on Figure 2-3. Field personnel opened monitoring wells on August 6, 2018, and water levels were allowed to vent and equilibrate for up to 24 hours. Monitoring wells were gauged on August 7, 2018 while under GRTS pumping conditions. Groundwater elevation and potentiometric contour maps were developed using data collected from the USAS, Lower Shallow Aquifer System (LSAS), Arcadia Formation (AF) Gravels, Salt and Pepper (S&P) Sands, and Lower AF Sands Aquifer. These data are presented on Figures 4-1 through 4-5, respectively. Capture boundaries shown on these figures are estimated using data from monitoring wells, stilling wells, and piezometers, and by applying professional judgment including consideration of information from extraction wells. The water level information and capture boundaries are discussed in Section 5.3.2.

4.3.3 Long-Term Water Level Monitoring Program

The LTWLM program at the Site began in 2008 and has provided data to identify specific off-Site groundwater pumping stresses that were further investigated and evaluated using desktop and numerical modeling techniques and integrated into the conceptual site model. The LTWLM program data have also been used to characterize hydraulic interrelationships and gradients between geologic units on-Facility and off-Facility, allow evaluation of potential regional groundwater trends, and monitor the effects of groundwater extraction. The LTWLM program includes ongoing data collection and analysis, maintenance, and reporting of the LTWLM network of transducers installed in wells at the Site. The LTWLM transducer download events were conducted September 18 through 19, 2017, December 11 through 12, 2017, March 12 through 13, 2018, and June 5 through 7, 2018. The annual *Long-Term Water Level Monitoring Report* (Tetra Tech, Inc., 2018) is provided in Appendix E.

4.3.4 Wetlands Monitoring Program

In accordance with the July 2009 *Wetlands Monitoring Plan* (WMP; ARCADIS, 2009b) the semi-annual wetland manual water-level monitoring event was conducted on December 11, 2017 and the annual wetlands assessment was conducted on May 30 through 31, 2018. Wetland telemetry monitoring systems continued to provide real-time collection and reporting of water levels at each of the reference wetlands (RWs) and target wetlands (TWs). Results of monitoring activities are provided in the approved *Wetlands Monitoring Report June 2017 through June 2018* (AECOM, 2018: referenced herein as the Annual Wetlands Monitoring Report) in Appendix F.

4.4 GROUNDWATER QUALITY MONITORING

Groundwater quality monitoring was conducted in accordance with FDEP SOP *FS 2200 Groundwater Sampling*, revision date March 1, 2014 (FDEP, 2014c), and *FC 1000 Cleaning/Decontamination Procedures* (FDEP, 2014b). Completed groundwater sampling logs for the groundwater sampling events are included in Appendix G. Equipment used for field measurements was calibrated each morning before the start of purging and sampling and a calibration check was conducted each afternoon following completion of the day's activities. Field personnel sampled monitoring and private wells as part of the effectiveness monitoring events and extraction wells as part of the GRTS performance monitoring program.

Groundwater samples were placed into insulated coolers and maintained at temperatures between 2 and 6 degrees Celsius (°C), (4°C±2°C). The coolers were sealed and the contained samples were delivered to TestAmerica in Tampa, Florida for laboratory analysis. The coolers and samples were delivered to the laboratory under chain-of-custody procedures found in the USEPA's *Quality Assurance Handbook Volume II*, Section 8 (USEPA, 2008). Laboratory analytical reports and associated chain-of-custody forms are included in Appendix H. Data Validation Reports are presented in Appendix I. There were no laboratory analytical quality control issues that adversely affected data usability, as documented in the Data Validation Reports.

The groundwater purged during monitoring well sampling was stored in containers within secondary containment trays. Purged water was manually transferred to the GRTS for treatment.

The following sections provide more detail on the performance and effectiveness sampling events.

4.4.1 Semi-Annual Extraction Well Monitoring

Field personnel conducted groundwater sampling at 77 vertical extraction wells and four horizontal extraction wells on February 22 and 23, 2018 and August 8 through 9, 2018. Groundwater pumped from 30 on-Facility extraction wells was collected from the sample ports located on each dedicated line inside the treatment building. Groundwater samples from three of the on-Facility extraction wells, 44 of the off-Facility vertical extraction wells and the four off-Facility horizontal extraction wells were collected utilizing dedicated sample ports located inside their respective well vaults. TestAmerica analyzed the samples using USEPA Method 8260B for VOCs and USEPA Method 8260C SIM/ID with heated purge for 1,4-D. Section 5.4.1 includes a discussion of the analytical results provided in Table 12.

4.4.2 Semi-Annual Effectiveness Monitoring

Field personnel conducted groundwater sampling at 55 monitoring wells identified on Table 13 from February 21 through 28, 2018. Monitoring well MW-101 was added to the semi-annual effectiveness monitoring schedule, as discussed in the Response to Comments 2016 Remedial Action Status Report (AECOM, 2016). The FDEP requested that monitoring well MW-101 be sampled semi-annually until a downward trend is observed with at least a 95% confidence factor using the *Mann-Kendall* statistical method (Mann-Kendall, 2003). TestAmerica analyzed the samples using USEPA Method 8260B for VOCs and USEPA Method 8260C SIM/ID with heated purge for 1,4-D. Sections 5.4.2 and 5.4.4 provide the extent and trends of the COC using the analytical results from Table 14.

4.4.3 Biennial Persulfate Compliance Monitoring

On August 28, 2018, biennial persulfate compliance monitoring sampling was conducted at six monitoring wells detailed in Table 11. Monitoring well samples were analyzed for one or more of the following parameters; USEPA Method SM 2540C for TDS, USEPA Method 6010B for aluminum, iron, and/or manganese, or USEPA Method 300.0 for sulfate. Monitoring wells and/or parameters have been eliminated from persulfate compliance monitoring as concentrations have decreased below baseline or GCTLs for two or more consecutive events.

Section 5.4.3 includes a discussion of the analytical results provided in Table 15. The next persulfate compliance monitoring event will take place in August 2020.

4.4.4 Annual Effectiveness and Private Well Monitoring

As part of the annual effectiveness monitoring, on August 7, 2018, total depths were measured in the accessible monitoring wells in the annual sampling program. These measurements were used to determine if monitoring wells require redevelopment to provide continued function. The monitoring well network did not require redevelopment to address siltation during this reporting period.

Annual effectiveness sampling was conducted at 148 monitoring wells, three private wells, and six piezometers between August 8 and August 31, 2018, in accordance with the RAPA and detailed in Table 13. TestAmerica analyzed the samples using USEPA Method 8260B for VOCs and USEPA Method 8260C SIM/ID with heated purge for 1,4-D. The analytical data from the August 2018 annual sampling event are summarized in Table 14. The analytical data from sampling from the private monitoring wells are summarized in Table 16. Section 5.4.4 includes a discussion of the analytical results from this sampling event.

SECTION 5
SYSTEM OPERATION, MAINTENANCE, AND MONITORING RESULTS

This section provides results from system operation, treatment and compliance, water level, effectiveness, persulfate, and wetlands monitoring. The section also includes a summary of waste management activities.

5.1 SYSTEM OPERATION

The total volume of groundwater pumped from the extraction system for the reporting period from September 1, 2017 to August 31, 2018 was approximately 80,053,200 gallons, resulting in a total of 379,502,100 gallons of groundwater extracted and treated since initial system startup in November 2013. A cumulative monthly summary of groundwater volumes that were extracted, treated and discharged is presented in Table 9. The GRTS was operational for 96.7% of the reporting period. The GRTS was able to process groundwater for 8,476.6 hours, with 240.6 hours of planned downtime and 42.6 hours of unplanned downtime. GRTS runtime is presented in Table 2.

Table 16a below presents monthly influent flow totals, plus the daily maximum and average flows, as recorded automatically by the PLC and archived in the reporting software database. The flow rates during the reporting period were in compliance with the WUP pumping volume allowance of 410,600 gallons daily (annual average) from the extraction network.

Table 16a – SWFWMD Influent Flow Totals			
SWFWMD - District Identifications (DID)	**DID 95**	**DID 95**	**DID 95**
Month	**Maximum Daily Influent Flow in Gallons**	**Average Daily Influent Flow in Gallons**	**Monthly Total Influent Flow in Gallons**
September 2017	260,300	175,600	5,268,400
October 2017	271,700	251,400	7,792,500
November 2017	227,100	226,500	7,089,300
December 2017	257,700	230,900	7,158,600
January 2018	183,800	156,300	5,872,300
February 2018	232,900	199,600	5,587,700
March 2018	241,500	230,500	7,145,100
April 2018	233,300	227,000	6,809,400
May 2018	235,300	220,600	6,839,300
June 2018	236,800	206,400	6,193,500
July 2018	244,300	228,000	7,069,100
August 2018	240,300	233,200	7,228,000

Table 3 presents monthly flow volumes for individual extraction wells, as recorded automatically by the PLC. Facility personnel operate and maintain the GRTS safely and effectively 24 hours per day, 7 days per week.

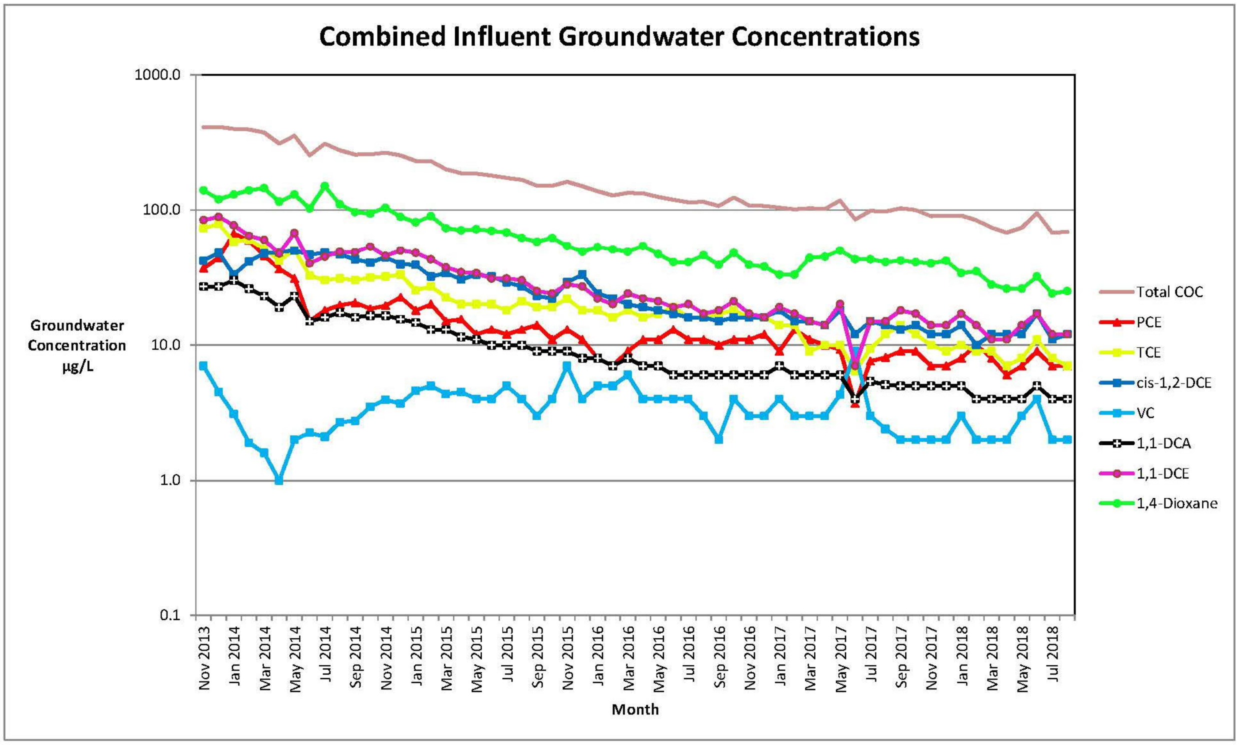
5.2 TREATMENT PROCESS AND COMPLIANCE MONITORING RESULTS

System process monitoring samples collected upstream and downstream of the AOP units and downstream of the primary and secondary GAC vessels demonstrate that the AOP and GAC process units are effectively treating groundwater to meet limits in the Manatee County Discharge Permit and Table 6. The monthly average GRTS combined influent COC concentrations listed in Section 3.4 are presented in Table 16b below.

Table 16b – Average Monthly Plant Influent Total Chemicals of Concern (COC) Concentration	
Month	**Influent Total COC Average Concentrations (micrograms per liter [µg/L])**
September 2017	102
October 2017	100
November 2017	88
December 2017	91
January 2018	90
February 2018	83
March 2018	72
April 2018	68
May 2018	73
June 2018	94
July 2018	68
August 2018	68

The historical combined influent groundwater concentrations for individual and total COC from November 2013 to July 2018 are presented on Figure 5 below. The concentrations on this figure are presented in logarithmic scale.

Figure 5 - Combined Influent Groundwater Concentrations



The individual and total COC concentrations have maintained a downward trend since the start of RAP operation; the exception is the concentration of VC, which has remained fairly consistent at low values since an initial drop in March 2014 and subsequent rebound. The continuing presence of VC is to be expected, as it is generated through the conversion of the higher order chlorinated compounds associated with trichloroethene (TCE) to ethene during anaerobic reduction, which results in overall plume mass reduction. VC may also be reduced aerobically. In this case, where the concentration of VC is declining at a slower rate than other COC, it appears that the rate of generation is just slightly slower than the rate of degradation and removal by the GRTS system.

System-combined influent samples were collected approximately twice per month as part of process monitoring. Samples were collected quarterly from the POTW effluent in accordance with the RAPA. To verify carbon breakthrough and media replacement schedules and to verify compliance with discharge permit requirements, process samples were collected upstream and downstream of the AOP units and at the primary and secondary carbon vessel discharge sample ports. Table 7 provides the GRTS process monitoring analytical results. These process sampling results also allow operators to track the effectiveness of the AOP units in removing COC.

The permit requirements prescribed in the Manatee County Discharge Permit #IW-0025S were met. Refer to Appendix B for a copy of Manatee County Discharge Permit #IW-0025S. Appendix B also includes the required Manatee County Industrial Pretreatment Program Certification Statement. There were no laboratory analytical quality control issues that adversely affected data usability, as documented in the Data Validation Reports. Analytical results for the POTW effluent samples indicate that COC and metals concentrations in the treated effluent were below limits set forth in the discharge permit noted above, and treatment efficiencies for VOC and 1,4-D removal were 100% and 100%, respectively, averaged over the reporting period.

Table 16c below presents the Discharge Permit limits and recorded values for pH, temperature, and daily discharge flow, as recorded by the GRTS PLC using discharge instrumentation.

Table 16c - Manatee County Discharge Permit Compliance Limits

Monitored Parameter	Discharge Permit Limits	Publicly Owned Treatment Works (POTW) Discharge Recorded Values
pH Range	5 to 11.5 standard units (SU)	5.36 to 10.84 SU
Maximum Temperature	104 Degrees Fahrenheit	102.1 Degrees Fahrenheit
Maximum Daily POTW Effluent Flow	432,000 Gallons	248,800 Gallons
Average Daily POTW Effluent Flow	Report Only	213,900 Gallons

Presented below in Table 16d are the detailed monthly pH range and maximum recorded temperatures recorded by the GRTS PLC using discharge instrumentation, and demonstrate compliance with the Discharge Permit.

Table 16d - Manatee County Discharge Permit Compliance			
Reporting Period	**Minimum POTW Discharge pH**	**Maximum POTW Discharge pH**	**Maximum POTW Discharge Temp (º Fahrenheit)**
September 2017	6.03	7.87	102.1
October 2017	6.14	7.36	98.5
November 2017	6.08	7.34	94.3
December 2017	5.74	7.53	94.7
January 2018	6.11	9.04	96.1
February 2018	6.12	7.47	99.4
March 2018	5.96	7.27	90.9
April 2018	5.36	10.84	92.0
May 2018	6.15	10.51	91.8
June 2018	6.10	9.21	93.3
July 2018	5.97	10.1	93.6
August 2018	6.31	9.73	95.4

The total volume of treated groundwater discharged to the POTW is recorded automatically by the PLC. These data, including maximum and average daily flows and water reuse conveyed to the infiltration galleries, injection wells, and the facility irrigation system, are archived in the reporting software database and are presented below in Table 16e.

Table 16e – SWFWMD Effluent Flow Totals				
SWFWMD DID	**DID 97**	**DID 97**	**DID 97**	**DID 96***
Month	**Maximum Daily POTW Effluent Flow in Gallons**	**Average Daily POTW Effluent Flow in Gallons**	**Monthly Total POTW Effluent Flow in Gallons**	**Monthly Total Water Reuse in Gallons**
September 2017	248,800	167,100	5,013,200	255,200**
October 2017	233,000	213,900	6,630,200	1,162,300
November 2017	230,100	183,500	5,503,900	1,494,200
December 2017	196,900	169,700	5,260,600	1,898,000

Table 16e – SWFWMD Effluent Flow Totals				
SWFWMD DID	**DID 97**	**DID 97**	**DID 97**	**DID 96***
Month	**Maximum Daily POTW Effluent Flow in Gallons**	**Average Daily POTW Effluent Flow in Gallons**	**Monthly Total POTW Effluent Flow in Gallons**	**Monthly Total Water Reuse in Gallons**
January 2018	181,200	134,400	4,164,900	1,707,400
February 2018	168,900	137,100	3,839,800	1,747,900
March 2018	167,400	152,500	4,726,000	2,419,100
April 2018	190,300	154,800	4,644,400	2,165,000
May 2018	212,000	168,800	4,985,000	1,854,300
June 2018	201,000	153,300	4,600,200	1,593,300
July 2018	214,800	188,900	5,854,700	1,214,400
August 2018	217,800	179,100	5,550,900	1,677,100

*Water reuse calculated using Plant influent total flow minus POTW effluent total flow

** Low reuse total due to impacts from Hurricane Irma

Table 9 provides additional information on volumes of groundwater extracted, treated and discharged via the POTW or through reuse/injection. The difference between the recorded values of the combined influent and the POTW effluent flow totals is due primarily to discharge to the three infiltration galleries, on-Facility injection wells, and on-Facility irrigation usage of treated effluent. The potable water used for general treatment plant cleaning, filter press cleaning, and carbon change-out also contributes to the difference in recorded flow totals. Potable water used for these activities flows to the plant sump and is treated by the GRTS and subsequently discharged. This additional water volume is reflected in the POTW effluent flow total, but not in the combined influent flow total, because the potable water collected in the plant sump is not routed through the combined influent flow meter (FIT-100).

Samples collected from the RO system effluent confirmed that discharge to infiltration galleries and injection wells met both the GCTL and surface water quality criteria, as specified in RAPA Table 10-3 and shown on Table 6. Discharge of RO system effluent to infiltration gallery RC-7002, located adjacent to target wetland TW-6 on the agricultural area to the east-southeast of the Facility, began on July 9, 2014 and continued throughout this reporting period. Discharge to infiltration galleries RC-7001 and RC-7003 was initiated on July 5, 2017 and continued to the end of this reporting period. As shown on Table 9, a total of 16,562,900 gallons of RO system effluent was discharged to the three infiltration galleries during the reporting period. Approximately 1,674,900 gallons of RO treated water was discharged to on-Facility injection wells RC-6001 through RC-6005 during the reporting period. About 23% of the influent groundwater was treated and discharged to the infiltration galleries and on-Facility injection wells. In addition, approximately 981,500 gallons of RO-treated water was utilized for irrigation of on-Facility green areas during the reporting period.

5.3 GROUNDWATER LEVEL MONITORING RESULTS

The results of groundwater level monitoring are presented in Table 10. Groundwater water level elevation contour maps for the USAS, and potentiometric surface contour maps for the LSAS, Arcadia Formation (AF) Gravels, S&P Sands, and Lower AF Sands, based on the annual water level event, are provided as Figures 4-1 through 4-5, respectively.

Groundwater elevation data from some monitoring wells were not contoured. Typically, this is due to monitoring wells screened in combined hydrogeologic units being presented on a single figure. Data plotted on a particular figure, but not used in contouring, are noted on the maps by an asterisk (*). Groundwater elevations measured at extraction wells were also not used in contouring; however, based on professional judgment the localized effects of extraction wells and infiltration galleries were considered when contouring. Vertical hydraulic gradients for the August 2018 monitoring event were calculated between each water-bearing adjacent unit and were generally consistent with the August 2017 data. Gradients between vertically adjacent units were estimated by dividing the difference in the groundwater elevations between the two units by the distance between the bottoms of the screens for the wells in each of the units (Section 5.3.2).

5.3.1 Semi-Annual Gauging Event

All of the vertical and horizontal extraction wells, except for EW-5002, were operating during the semi-annual gauging event, as discussed in Section 4.1. The results of the semi-annual gauging event are presented in Table 10.

5.3.2 Annual Gauging Event

All of the vertical and horizontal extraction wells, except for EW-5002, were operational at the Site during the annual gauging event. EW-3004 was not pumping during the gauging event due to normal cycling when drawdown exceeds operational set points.

The results of the August 2018 gauging event are presented in Table 10 and on Figures 4-1 through 4-5. Capture zones were approximated based on potentiometric contours and professional judgment. The similarity of the capture zones and water levels to prior years helps illustrate the consistent containment of the COC plume. Monitoring has consistently shown the Lower AF is not well-connected to the overlying units and is unaffected by GRTS operation. In general, vertical gradients were downward from the USAS and LSAS toward the AF Gravels and upward from the Lower AF and S&P Sands toward the AF Gravels, which is consistent with the design of the GRTS. The elevation data from August 2017 and August 2018 and vertical gradient information are provided in Table 16f, below.

Table 16f – 2018 Average Water Elevations and Aquifer Vertical Gradients

Aquifer Zone	Average Water Elevation 2018 (ft above msl)	Average Water Elevation 2017 (ft above msl)	Change in Water Elevation from 2017	Average Vertical Gradient (ft/foot)
USAS	21.81	21.98	-0.17	-0.87
LSAS	10.94	10.62	0.32	-0.15
AF Gravels	3.22	4.16	-0.94	-
S&P Sands	7.16	7.54	-0.38	+0.04
Lower AF	12.83	12.07	0.76	+0.06

msl = mean sea level
ft/foot = feet per foot
Negative number indicates downward vertical gradient
Positive number indicates upward vertical gradient

5.3.3 Long-Term Water Level Monitoring

The long-term water level monitoring program facilitates detailed tracking of the hydraulic and hydrologic relationships within and between water-bearing zones over time. In general, the results from the annual *Long-Term Water Level Monitoring Report* (Tetra Tech, Inc., 2018) provided in Appendix E confirm the horizontal and vertical gradient data presented above. In addition, the continuous monitoring of wells near the edges of the Site provided information on the extent of GRTS effects for each water-bearing zone, demonstrating that RAOs are being met.

5.4 GROUNDWATER QUALITY MONITORING RESULTS

The applicable FDEP cleanup criteria for Site COC are listed below.

COC	Groundwater Cleanup Target Level (GCTL) (µg/L) (62-777 F.A.C.)
1,4-D	3.2
TCE	3
PCE	3
cis-1,2-DCE	70
1,1-DCE	7
1,1-DCA	70
VC	1

5.4.1 Extraction Well Monitoring

Groundwater quality data for vertical and horizontal extraction wells are provided in Table 12. The data from the August 2018 sampling event indicate that COC concentrations in the USAS and LSAS extraction wells have generally declined since November 2013. In the AF Gravels, laboratory analytical data indicate generally stable to decreasing COC concentrations since November 2013. Two extraction wells are screened in the S&P Sands (EW-5001 and EW-5002). The data from the August 2018 sampling event indicate that COC concentrations in the S&P Sands extraction wells generally increased from 2013 to 2016, but have been generally stable to decreasing since February 2016. As discussed in Section 4.1 and in the Response to Comments 2016 Remedial Action Status Report (AECOM, 2016), Lockheed Martin decided to continue to keep extraction well EW-5002 off given the stable to decreasing COC trends observed at that well since the August 2016 extraction well sampling event and the extensive capture zone present in the S&P Sands. Extraction well EW-5002 is operated periodically to maintain well function and for groundwater sampling events.

5.4.2 Semi-Annual Effectiveness Monitoring

The results from semi-annual groundwater sampling conducted in February 2018 are presented in Table 14. This table also includes historical data dating to 2009. Further discussion of COC concentrations that includes consideration of the semi-annual groundwater sampling data is presented in Section 5.4.4.

5.4.3 Biennial Persulfate Compliance Monitoring

Groundwater samples from the biennial sampling event were collected and analyzed for the persulfate pilot study parameters, as described in Section 4.4.3. Analytical results indicate that the concentrations of aluminum, sulfate, manganese, iron or TDS exceeded either their GCTLs or baseline value in the monitoring wells sampled. A reduction in the number of analytes detected above baseline or GCTLs since the baseline sampling event in March 2008 is observed in both the USAS and LSAS monitoring wells. The results from sampling are presented in Table 15. The next biennial event is scheduled for August 2020.

5.4.4 Monitoring Well and Private Well Annual Effectiveness Monitoring

Groundwater monitoring events are also conducted on an annual basis to monitor current COC concentrations and provide a basis for comparison of the progress of ongoing active remediation and natural degradation occurring at the Site. The results of the annual effectiveness monitoring event at Site monitoring wells and private wells are provided in Table 14. Figures 5-1 through 5-39 present 1,4-D, TCE, PCE, cis-1,2-DCE, 1,1-DCE, 1,1-DCA and VC groundwater concentrations and interpreted isoconcentration lines in the USAS, LSAS, AF Gravels, S&P Sands and Lower AF Sands. Observed historical variations in concentration and plume morphology in the various aquifers from August 2017 and August 2018 are discussed in Sections 5.4.4.1 through 5.4.4.5 below.

The following information is provided to aid the discussion of the annual sampling results:

- Analytical results indicate an overall decline in average COC concentrations in the monitoring wells in the USAS, LSAS, AF Gravels and S&P Sands since August 2017, indicating continued reduction of in-situ COC mass. Consistent with previous sampling events, no COC were detected in the Lower AF Sands. Appendix J includes charts of

COC concentration versus time for a group of selected monitoring wells and relevant COC. The horizontal distributions of COC within aquifer zones in August 2018 are generally consistent with the distributions during August 2017.

- Average concentrations for each COC for the USAS, LSAS, AF Gravels and S&P Sands, calculated using the laboratory analytical data from the August 2017 and August 2018 sampling events, are summarized in Tables 16g, 16h, 16i, and 16j in the sections below. To avoid skewing results due to varying detection limits and in order to ease calculations in the tables, non-detect concentrations were set to zero.

5.4.4.1 COC Distribution in the USAS

The concentrations of 1,4-D, TCE, PCE, cis-1,2-DCE, 1,1-DCE, 1,1-DCA and VC in the monitoring wells and private wells within the USAS are shown on Figures 5-1 through 5-7, respectively. Average concentrations for each COC, calculated using the laboratory analytical data from the August 2014 through August 2018 annual sampling events, are summarized below in Table 16g. Results indicate that average COC concentrations have decreased overall since the 2014 sampling event. The average concentration of cis-1,2-DCE slightly increased from the 2017 sampling event; this increase was associated with reductive dechlorination and evident in monitoring wells MW-27 and MW-28, where increases were 8.4 µg/L and 1.1 µg/L, respectively.

Table 16g - Average COC Concentrations in the Upper Surficial Aquifer System (USAS) in 2014 through 2018

COC	August 2014 (µg/L)	August 2015 (µg/L)	August 2016 (µg/L)	August 2017 (µg/L)	August 2018 (µg/L)
1,4-D	15.6	10.7	5.4	5.8	4.0
TCE	6.6	4.9	3.1	2.6	2.2
PCE	20.8	19.1	11.0	4.6	1.3
cis-1,2-DCE	1.2	0.7	0.5	0.5	0.6
1,1-DCE	4.1	3.3	1.6	1.6	1.1

Table 16g - Average COC Concentrations in the Upper Surficial Aquifer System (USAS) in 2014 through 2018					
COC	**August 2014 (µg/L)**	**August 2015 (µg/L)**	**August 2016 (µg/L)**	**August 2017 (µg/L)**	**August 2018 (µg/L)**
1,1-DCA	2.5	2.3	1.2	1.2	0.8
VC	0.0	0.0	0.0	0.0	0.0

The composite COC distribution in the USAS is presented on Figure 5-8, along with the estimated USAS capture zone. The area of COC concentrations exceeding GCTLs in the USAS during August 2018 was 44 acres, compared to 58 acres in August 2017. Appendix J includes charts of COC concentration versus time for a group of selected USAS monitoring wells (MW-27, MW-35, MW-63, MW-67, MW-114 and MW-254).

5.4.4.2 COC Distribution in the LSAS

The concentrations of 1,4-D, TCE, PCE, cis-1,2-DCE, 1,1-DCE, 1,1-DCA and VC concentrations in the monitoring wells and private wells within the LSAS are shown on Figures 5-9 through 5-15, respectively. Average concentrations for each COC using the laboratory analytical data from the August 2014 through August 2018 annual sampling events are summarized below in Table 16h. Average concentrations for individual COC have an overall decrease since 2014, with the exception of the average VC concentration, which increased in 2018 and was primarily attributed to the detection in MW-85 at 1.9 µg/L.

Table 16h - Average COC Concentrations in the Lower Shallow Aquifer System (LSAS) in 2014 through 2018					
COC	**August 2014 (µg/L)**	**August 2015 (µg/L)**	**August 2016 (µg/L)**	**August 2017 (µg/L)**	**August 2018 (µg/L)**
1,4-D	50.7	32.4	29.6	19.0	12.5
TCE	176.03	161.6	95.9	86.6	50.0
PCE	4.13	7.4	5.1	3.5	3.4
cis-1,2-DCE	26.72	15.0	15.2	20.0	18.2
1,1-DCE	14.79	10.5	10.1	5.5	4.4

Table 16h - Average COC Concentrations in the Lower Shallow Aquifer System (LSAS) in 2014 through 2018					
COC	August 2014 (µg/L)	August 2015 (µg/L)	August 2016 (µg/L)	August 2017 (µg/L)	August 2018 (µg/L)
1,1-DCA	8.03	7.4	5.8	3.8	2.5
VC	0.04	0.0	0.1	0	0.1

The composite COC distribution is presented on Figure 5-16 along with the estimated LSAS capture zone. The area in which COC concentrations exceeded GCTLs in the LSAS in August 2018 was 76 acres in size, compared to 88 acres in August 2017. Application of the *Mann-Kendall* statistical method (Mann-Kendall, 2003) to the 1,4-D data at well MW-101 (see Section 4.4.2) resulted in an increasing trend at that well with a 95.5% confidence factor. However, analytical results since August 2017 indicate COC concentrations in MW-101 have decreased or are stable and the monitoring well remains within GRTS capture. Appendix J includes charts of COC Concentration versus Time for a group of selected LSAS monitoring wells (MW-41, MW-77, MW-81, MW-86R, MW-87, MW-98, MW-101 and PZ-LSAS-4).

5.4.4.3 COC Distribution in the AF Gravels

The concentrations of 1,4-D, TCE, PCE, cis-1,2-DCE, 1,1-DCE, 1,1-DCA and VC in the monitoring wells and private wells within the in the Upper AF Gravels are shown on Figures 5-17 through 5-23, respectively. Average concentrations for each COC using the laboratory analytical data from the August 2014 through August 2018 annual sampling events are summarized below in Table 16i. These data indicate that average total COC concentrations in the AF Gravels have an overall decrease since the 2014 sampling event.

Table 16i - Average COC Concentrations in the Arcadia Formation Gravels (AF Gravels) in 2014 through 2018					
COC	August 2014 (µg/L)	August 2015 (µg/L)	August 2016 (µg/L)	August 2017 (µg/L)	August 2018 (µg/L)
1,4-D	22.48	28.4	22.7	25.4	12.8
TCE	35.0	15.7	6.8	6.0	1.3
PCE	0.0	0.0	0.0	0.0	0.0
cis-1,2-DCE	117.78	146.5	88.1	70.1	40.4

Table 16i - Average COC Concentrations in the Arcadia Formation Gravels (AF Gravels) in 2014 through 2018					
COC	**August 2014 (µg/L)**	**August 2015 (µg/L)**	**August 2016 (µg/L)**	**August 2017 (µg/L)**	**August 2018 (µg/L)**
1,1-DCE	13.80	14.6	12.6	10.1	5.8
1,1-DCA	3.28	3.9	3.1	3.1	1.6
VC	12.42	16.0	18.0	14.9	6.3

The composite COC distribution is presented on Figure 5-24 along with the estimated AF Gravels capture zone. The area of COC concentrations exceeding GCTLs in the AF Gravels identified in August 2018 is 58 acres in size, compared to 67 acres in August 2017. Appendix J includes charts of COC Concentration versus Time for a group of selected AF Gravels monitoring wells (IWI-1, MW-127, MW-129, MW-130, MW-134 and MW-253).

5.4.4.4 COC Distribution in the S&P Sands

The concentrations of 1,4-D, TCE, PCE, cis-1,2-DCE, 1,1-DCE, 1,1-DCA and VC in monitoring wells in the S&P Sands in August 2018 are shown on Figures 5-25 through 5-31, respectively. Average concentrations for each COC using the laboratory analytical data from the August 2014 through August 2018 annual sampling events are summarized in Table 16j, below. These results indicate an increase in average concentrations for 1,4-D, TCE, cis-1,2-DCE, and 1,1-DCE from 2014 to 2016 and an overall decline in average concentrations for TCE, 1,1-DCE and 1,4-D from 2016 to 2018. Biotic or abiotic processes appeared to be occurring based on the increased presence of daughter products (cis-1,2-DCE, 1,1-DCE and VC) associated with reductive dechlorination of chlorinated solvents. The increase in average 1,4-D, cis-1,2-DCE, 1-1-DCE and VC concentrations since 2017 is primarily attributed to the increase in the concentrations of COC in IWI-2, in which those concentrations have fluctuated historically.

Table 16j - Average COC Concentrations in the S&P Sands in 2014 through 2018					
COC	**August 2014 (µg/L)**	**August 2015 (µg/L)**	**August 2016 (µg/L)**	**August 2017 (µg/L)**	**August 2018 (µg/L)**
1,4-D	0.2	3.4	5.4	3.7	4.5
TCE	0.4	1.5	2.3	1.2	1.0

Table 16j - Average COC Concentrations in the S&P Sands in 2014 through 2018					
COC	August 2014 (µg/L)	August 2015 (µg/L)	August 2016 (µg/L)	August 2017 (µg/L)	August 2018 (µg/L)
PCE	0.3	0.0	0.0	0.0	0.0
cis-1,2-DCE	0.3	1.9	3.5	1.6	4.0
1,1-DCE	0.1	0.4	1.3	0.3	1.0
1,1-DCA	0.0	0.8	0.4	0.5	0.4
VC	0.2	0.1	0.1	0.1	0.2

The composite COC distribution is presented on Figure 5-32 along with the estimated S&P Sands capture zone. The area of COC concentrations exceeding GCTLs in the S&P Sands identified in August 2018 is two acres in size, compared to three acres in August 2017. Concentrations of COC in MW-21, IWI-2 and MW-128 have historically fluctuated. Appendix J includes charts of COC Concentration versus Time for a group of selected S&P Sands monitoring wells (MW-21, IWI-2 and MW-128).

5.4.4.5 COC Distribution in the Lower AF Sands

No COC were detected at concentrations greater than their respective GCTLs in monitoring wells screened within the Lower AF Sands, as shown on Figures 5-33 through 5-39. These results are consistent with historical data.

5.4.4.6 Temporary Point of Compliance

The comprehensive August 2018 overall GCTL boundary is presented on Figure 5-40. This overall boundary was derived from integrating the composite COC concentration maps from each unit impacted by COC above GCTLs and is used to define the proposed 2018 Temporary Point of Compliance (TPOC). The changes in groundwater COC concentrations and distributions discussed in Section 5.4.4 did not necessitate additional TPOC notifications, per Rule 62-780.220, F.A.C. The estimated area of the August 2018 GCTL boundary was 120 acres in size, as compared to 132 acres for the August 2017 boundary. This difference reflected a decrease in area of approximately 9%.

5.4.4.7 Additional Volatile Organic Compounds

Data from laboratory analyses were reviewed to determine if concentrations of additional compounds, other than the seven COC discussed in the preceding sections of this report, were detected or exceeded GCTL limits in groundwater samples. Concentrations of additional volatile compounds were either not detected or detected below their respective GCTLs.

5.5 CHEMICAL OF CONCERN MASS REMOVAL

The mass of COC (PCE, TCE, cis-1,2-DCE, VC, 1,4-D, 1,1-DCA, and 1,1-DCE) removed during this one-year reporting period is estimated to be approximately 55 pounds, based on the average combined influent COC concentrations and combining the volumes of extraction for each month. The mass is calculated using the average of two (if available) groundwater combined influent sample results per month, as presented in Table 8, and the monthly combined influent flow totals, which were presented in Section 5.1. The results of these calculations are shown in Table 17. Mass removal rates in 2018 averaged approximately 4.6 pounds per month compared to 5.3 pounds per month during the 2017 reporting period. The reduction in the mass removal rate is attributed to the overall decrease in COC concentrations due to contaminant removal by the GRTS and natural processes.

5.6 WETLANDS MONITORING PROGRAM

The May 2018 annual wetlands monitoring event was the fifth conducted during RAPA operations. The RWs and TWs exhibited normal water level fluctuations in response to the normal seasonal rainfall distribution for the region. The Wetlands Monitoring Report was submitted to the FDEP and the SWFWMD on August 23, 2018. FDEP approved the report on September 10, 2018. The wetland telemetry system continued to operate well, eliminating the previous need for frequent wetlands visits, and also allowed quick access to water level instrumentation status to determine changes in functionality requiring attention. Data provided by the telemetry system is used for monitoring and adjusting groundwater extraction and recharge in the vicinity of TW-6.

5.7 WASTE MANAGEMENT

Approximately 68,000 pounds of non-hazardous dewatered filter cake solids were removed and transported to the Clark Environmental disposal facility in Mulberry, Florida during the reporting period. Solids are removed through primary settling tanks, ultra-filters, and media filter backwashing, and subsequently pumped to the solids thickening tank, settled, and then dewatered through the operation of the filter press. Transportation and disposal of the dewatered solids is contracted through Southern Waste Services, Inc. Appendix K includes the waste characterization laboratory analytical results of the dewatered solids and disposal facility waste acceptance letters. Appendix L includes the dewatered solids non-hazardous waste manifests.

The GAC system primarily provides a polishing step for the removal of 1,1-DCA. The GAC becomes saturated with organic compounds and requires periodic replacement. During each GAC replacement event, approximately 10,000 pounds of non-hazardous spent carbon is removed, stored in lined and covered dumpsters, and transported to a landfill for disposal. Carbon change-out events were conducted in September 2017, December 2017, February 2018, and June 2018. During these events, Adler Tank removed and transported approximately 50,000 pounds (dry weight) of spent carbon to the Waste Management landfill in Okeechobee, Florida for disposal. Appendix K includes the spent carbon waste characterization laboratory analytical results and landfill waste acceptance letters. Appendix L includes the spent carbon non-hazardous waste manifests.

The filter cake material and waste GAC are disposed at Lockheed Martin-approved, permitted and licensed facilities in accordance with applicable environmental laws and regulations.

SECTION 6
SUMMARY AND CONCLUSIONS

Lockheed Martin constructed and has operated the GRTS at the Site per the following orders and guidance:

- Consent Order No. 04-1328
- Consent Order No. 08-22542009 (as amended)
- 2009 RAPA
- 2012 FDEP RAPA Approval Order
- Approved OMM Manual
- Approved recommendations in previous RASRs

The reporting period for this document documents operation from September 1, 2017 through August 31, 2018. The GRTS is meeting the RAOs described in Section 1.2. The following sections provide conclusions for the reported data during this operational reporting period by OMM activity in the appropriate context for further interpretation, and also provide recommendations for each activity.

6.1 PROCESS PERFORMANCE AND COMPLIANCE MONITORING

Based on the data presented in this report, Lockheed Martin has the following conclusions and recommendations for the GRTS:

- A total of approximately 80,053,200 gallons of groundwater was successfully extracted, treated, and discharged, bringing the total cumulative volume of groundwater extracted and treated since initial startup in November 2013 to approximately 379,502,100 gallons.

- The GRTS run time was 96.7%.

- The GRTS was successful in meeting the MCUO Discharge Permit criteria.

- The conditions of the SWFWMD WUP for extraction volumes and monthly reporting were achieved.

- The RO effluent concentrations discharged to the infiltration galleries and on-Facility injection wells met discharge criteria, defined as the lower of either the GCTL or Surface Water Quality Standards for constituents summarized in Table 6.

- The GRTS removed approximately 55 pounds of COC mass.

- Approximately 68,000 pounds of non-hazardous dewatered filter cake solids and 50,000 pounds (dry weight) of non-hazardous spent GAC were removed and transported for disposal to approved facilities.

Lockheed Martin will continue to operate the GRTS through the next operational reporting period. The operation will include the following actions:

- Meet the established RAOs.

- Extract groundwater for treatment and discharge per the Consent Orders, the 2009 RAPA, the 2012 FDEP RAPA Approval Order, and the approved OMM Manual.

- Continue scheduled compliance sampling.

- Discharge to infiltration galleries as needed to maintain water levels in wetland areas.

- Discharge to on-Facility injection wells to perform flushing in the USAS.

- Use treated effluent water for on-site irrigation.

- Meet MCUO discharge permit and WUP requirements.

6.2 GROUNDWATER LEVEL MONITORING

Based on the data presented in this report, Lockheed Martin provides the following conclusions for the groundwater level monitoring program:

- Groundwater level monitoring indicated the GRTS system continued to maintain adequate hydraulic control of the Site COC in the USAS, LSAS, AF Gravels, and S&P Sands as discussed in Sections 5.3.2 and 5.4.

- By design, the GRTS system did not influence the Lower AF Sands.

- The LTWLM program continued to monitor the effects of the GRTS system and off-Site pumping influences and generally confirmed the description of hydraulic gradients detailed in Section 5.3.2.

Based on the data presented above, Lockheed Martin recommends continuing the current water level monitoring program, as described in Table 18, and the LTWLM program.

6.3 EXTRACTION WELL SAMPLING

Based on the data presented in this report, Lockheed Martin provides the following summary of the extraction well sampling program:

- The GRTS system continued to extract and treat the groundwater COC plume. Generally, the COC concentrations in the groundwater extracted from the USAS, LSAS and AF Gravels have been stable to decreasing, as indicated by the results discussed in Section 5.4.1. The COC concentrations in S&P Sands extraction wells have been generally stable to decreasing since February 2016.

- EW-2103 flow rates were regulated to maintain TW-6 water levels.

- Groundwater in the S&P Sands with COC concentrations in excess of GCTLs was well within the S&P capture zone. Therefore, EW-5002 remained off during the period of performance, with the exception of periodic operation to maintain well function.

Lockheed Martin recommends continuing semi-annual extraction well sampling aligned with the effectiveness monitoring to occur in February and August 2019. Future operation of extraction well EW-5002 will continue to be evaluated in an effort to achieve RAOs.

6.4 EFFECTIVENESS MONITORING

Based on the data presented in Section 5.4.4, Lockheed Martin provides the following conclusions for the effectiveness monitoring program:

- Analytical results indicated average COC concentrations have been decreasing in the USAS, LSAS, and AF Gravels groundwater since August 2014 and these concentrations indicated a reduction of in-situ COC mass. An exception was the slight increase in average concentrations of daughter products in the S&P Sands (cis-1,2-DCE, 1,1-DCE and VC), but average concentrations of 1,4-D and TCE have declined since August 2016. Analytical data indicated that reductive dechlorination of chlorinated solvents appeared to be occurring based on the observation of increased daughter products. These natural attenuation processes have been aiding in the removal of contaminant mass in addition to the physical removal of contaminants associated with the GRTS.

- The 2018 data indicated an overall TPOC GCTL boundary reduction from 132 acres in 2017 to 120 acres in 2018.

Based on recent and historical groundwater sampling data, Lockheed Martin recommends the following for the effectiveness monitoring program:

- Continue with the semi-annual and annual sampling scheduled to occur in February 2019 and August 2019, respectively as shown on Figure 6.1 and Table 19.

- Continue to sample LSAS monitoring well MW-101 semi-annually until COC downward trends are observed with at least a 95% confidence factor, as determined using the *Mann-Kendall* statistical method (Mann-Kendall, 2003).

- Change the frequency of sampling to biennial for the following monitoring wells: MW-116, MW-117, MW-118, MW-119, MW-120, MW-175, MW-176, MW-178, and MW-221. These wells will be sampled again in August 2020.

- Eliminate the monitoring wells in Table 19a below from the annual effectiveness monitoring program as shown on Figure 6.1 and Table 19.

Table 19a – Monitoring Wells Recommended to be Removed from Annual Effectiveness Monitoring			
Well ID	**Aquifer Zone**	**Reasoning**	**Monitoring Wells that Define COC Plumes**
MW-126	USAS	No detections for at least 9 years.	MW-100, MW-74, and MW-75
MW-141	USAS	No detections for at least 9 years.	MW-146, MW-62, and MW-26
MW-162	USAS	No detections for at least 9 years.	MW-89, MW-110R, MW-62, and MW-26
MW-156	USAS	No detections for at least 9 years.	MW-146, EW-2037, and MW-107
MW-219	USAS	Either no detections or below GCTLs for at least 9 years.	MW-100, MW-74, and MW-75
MW-200	AF Gravels	No detections for at least 9 years.	MW-249 and MW-185R
MW-231	AF Gravels	No detections for at least 9 years.	7561/7571 15TH ST E, MW-239, and MW-16
MW-34	S&P Sands	Either no detections or below GCTLs for at least 9 years.	MW-57 and MW-4

6.5 BIENNIAL PERSULFATE MONITORING

Lockheed Martin provides the following conclusion for the biennial persulfate monitoring program:

- Analytical results indicated that groundwater concentrations of one or more target parameters remained above GCTLs or baseline concentrations for one or more sampling events; therefore, none of the wells qualified for removal from the persulfate monitoring program.

Lockheed Martin recommends continuing the biennial persulfate monitoring program.

6.6 WETLANDS MONITORING

The following conclusions are from the 2018 Annual Wetlands Monitoring Report:

- Groundwater elevations at TW-6 during the 2018 monitoring event were consistent with those observed during the 2017 monitoring event. In 2018, RC-7002 successfully augmented groundwater recharge and effectively buffered TW-6 from declines which were attributable to operation of the GRTS system.

- Wetland vegetation observed in the RWs and TWs during the 2018 monitoring event remained similar to that recorded during the 2017 reporting period.

Lockheed Martin recommends the following for the wetlands monitoring program:

- Continue to address potential GRTS system impacts to TWs by appropriately adjusting flow rates at extraction wells and through the operation of infiltration galleries.

- Continue annual WMP monitoring and reporting in 2019 during GRTS operation.

- Submit a Wetlands Monitoring Report and comparative analysis with local climate and previously collected data to the SWFWMD by September 1, 2019.

Re-evaluate the monitoring plan with the FDEP and SWFWMD after five years of system operation and the 2019 annual monitoring event to determine whether it needs to continue or be modified, as described in the RAPA and the approved 2018 Wetlands Monitoring Report.

SECTION 7
REFERENCES

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