Imagine the result

Lockheed Martin Corporation

Remedial Action Plan Addendum

Lockheed Martin Tallevast Site

Tallevast, Florida

July 14, 2009

R625-EDC-001213-0

Remedial Action Plan

and to eliminate conduits through which contaminants might seep into an uncontaminated part of the aquifer system. An important parallel effort investigated the potential for soil vapor intrusion impacts from both soil and groundwater. This study confirmed that vapor intrusion exposure was not a concern either on the facility or in the community.

To more effectively manage the cleanup and communicate with the Tallevast community, Lockheed Martin leased the entire facility in July 2007 and in June 2009, purchased it back from BECSD, LLC.

Remedial Action Plan Addendum

The comprehensive remedial actions detailed in this *RAP Addendum* were developed through a systematic process grounded in an appropriate balancing of state, community, and corporate interests. This development included the following:

- Establishment of objectives
- Determination of remedial system requirements from analytical and test data
- Evaluation of remedial alternatives
- Selection and justification of remedial approach and plan implementation

All of these steps were informed by open communication with the community and its experts, environmentalt9remedia6 0 TD2l90.1(4(ed in pn)0re)-5.2()0rT.5 TD0 T5(ant)-5.5(parallel e)-5.4(ffo

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Remedial Objectives

Lockheed Martin has established objectives for both soil and groundwater at the site.

Soil

The *RAP Addendum* proposes a single objective for soil:

- Reduce the potential for exposure to COCs present in soil at the Facility

This will be accomplished with institutional and engineering controls that prohibit certain uses of the property and protect the health and safety of on-site workers and the surrounding community with barriers that prevent direct exposure.

Groundwater

The *RAP Addendum* proposes the following objectives for groundwater at the site:

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

As described in this plan, these will be accomplished via active remedial measures.

With these objectives in mind, Lockheed Martin established design criteria for the remedial measures proposed. A key element in the establishment of design criteria was the development of a detailed, three-dimensional groundwater model to enable reasonable prediction of groundwater movement and its effects on the contaminant plume. From this it was possible to evaluate the effectiveness of the remediation system and estimate cleanup timeframes from a variety of perspectives and under various assumed circumstances.

- Regular inspections and testing of fail-safes
- Continuous manned operations

Also provided are sampling and analysis activities to confirm system A

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[illegible] No other warranty is implied or intended.

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Date

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ARCADIS

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Acronyms, Abbreviations, and Units of Measurement

ABC	American Beryllium Company
AF	Arcadia Formation
AF Gravels	Upper AF Gravels Unit in the Intermediate Aquifer System
AOP	advanced oxidation process
APT	Applied Process Technology, Inc.
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BBL	Blasland, Bouck & Lee, Inc.
bgs	below ground surface
CAP	Corrective Action Plan
CDM	Camp Dresser & McKee
CEB	chemically enhance backwash

F.A.C.	Florida Administrative Code
Facility	Lockheed Martin Tallevast Facility
Floridan	Upper Floridan Aquifer
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FID	flame-ionization detector
FLUCFCS	Florida Land Use, Cover, and Forms, Classification System
FOCUS	Family Oriented Community, United, Strong
Forum LLC	Forum
FRP	fiberglass reinforced plastic
ft	feet
ft^2	square feet
ft^3	cubic feet
ft bgs	feet below ground surface
ft/day	feet per day
ft^3/day	cubic feet per day
ft/ft	feet per foot

IDW	investigation derived waste
IRA	Interim Remedial Action
IRAP	*Interim Remedial Action Plan*
IRM	Interim Remedial Measure
ISCO	*in situ* chemical oxidation
ISR	interim source removal
ITRC	Interstate Technology Regional Council
IUD	industrial user discharge
J&E	Johnson & Ettinger
K	vertical hydraulic conductivity
K_d	soil/groundwater partitioning coefficient
K_v	vertical hydraulic conductivity
kW	kilowatt
lbs	pounds
lbs/day	pounds per day
L/kg	liters per kilogram
Lockheed Martin	Lockheed Martin Corporation
Lower AF Sands System	Lower AF Sands unit within the Intermediate Aquifer
LPGAC	liquid phase granular activated carbon
Lpm	liters per minute
Lpm/Kw	liters per minute per kilowatt
LSAS	Lower Shallow Aquifer System
LTG	leachability-to-groundwater
MCC	motor control center
MCHD	Manatee County Health Department
MCUO	Manatee County Utility Operations Department Office of Industrial Compliance
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µS	microSiemens
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mi^2	square miles
MIP	membrane interface probe
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NAM	natural attenuation monitoring
NFA	no further action

MNA	monitored natural attenuation
msl	mean sea level
NAPL	non-aqueous phase liquid
NOD	Natural Oxidant Demand
MIP	membrane interface probe
O_3	ozone
O&M	operation and maintenance
OMM	operation, maintenance, and monitoring
ORR	operational readiness review
PAH	polycyclic aromatic hydrocarbons
PCE	tetrachloroethene
PCR	polymerase chain
PES	polyethersulfone
Photo-Cat	photocatalytic
PID	photo-ionization detector
ppb	parts per billion
ppm	parts per million
PPE	personal protective equipment
psi	pounds per square inch
POTW	publicly owned treatment works
PLC	programmable logic controller
PRF	Peace River Formation
Purifics	Purifics ES, Inc.
PVC	polyvinyl chloride
PVP	polyvinylpyrrolidone
Q	flow rate
QA/QC	quality assurance/quality control
RAO	Remedial Action Objective
RAP	*Remedial Action Plan*
RAWP	*Remedial Action Work Plan*
RCA	Root Cause Analysis
RCRA	Resource Conservation and Recovery Act
RDE	Residential Direct Exposure
RO	reverse osmosis
ROI	radius of influence
rpm	revolutions per minute
RW	reference wetland
S&P Sands	Salt & Pepper Sands in the Intermediate Aquifer System
SAPA	*Site Assessment Plan Addendum*
SARA	*Site Assessment Report Addendum*

WAP	wetlands assessment procedure
WMP	wetlands monitoring plan
WPI	Wire Pro, Inc.

Appendices

The previous investigations and development of this *RAP Addendum* were conducted pursuant to the requirements detailed in Consent Order No. 04-1328 executed by and between Lockheed Martin and FDEP, effective July

This *RAP Addendum* presents a summary assessment of the Facility, an assessment of Site geology and hydrogeology, characterization of the nature and extent of soil and groundwater impacts, an evaluation of remedial technologies, and details of the selected remedial measures to address impacts to soil on the Facility and to groundwater Site-wide.

1.1 Remedial Action Objectives

Specific remedial action objectives (RAOs) for both soil and groundwater were developed to focus remedy selection. Remedies satisfying the RAOs while minimizing impacts to the community were given preference. The RAOs are described below for both media.

Soil

The RAO for soil is:

- Reduce the potential for exposure to COCs present in soil at the Facility

The soil COCs and their respective cleanup target levels (CTLs) are listed here:

Soil Contaminants of Concern	Residential Soil Cleanup Target Level (µg/kg)	Industrial Soil Cleanup Target Level (µg/kg)	Leachability Based on Groundwater Criteria Soil Cleanup Target Level (µg/kg)
Arsenic	2,100	12,000	*
Beryllium	120,000	1,400,000	63,000
Chromium	210,000	470,000	38,000
Copper	150,000	89,000,000	*
PAH **	100	700	***
Tetrachloroethene (PCE)	8,800	18,000	30
Total Petroleum Hydrocarbons	460,000	2,700,000	340,000

Notes:

1) G-II Aquifer— Class of groundwater designated by the Florida Department of Environmental Protection as potable water use, groundwater in aquifers that have a total dissolved solids content of less than 10,000 milligrams pe

2.1 Site Location and Land Use

The Facility is located at 1600 Tallevast Road, between the cities of Sarasota and Bradenton, in southwestern Manatee County, Florida. Land use in the area is predominantly single-family residential homes, churches, light commercial and industrial development, and heavy manufacturing. A large percentage of the ground cover in the area includes grass fields, a golf course, and residential landscaping. The Facility is located in the northwest quarter of Section 31, Township 35 South, Range 18 East, as shown on the Bradenton, Florida United States Geological Survey (USGS) 7½-minute quadrangle (Figure 1-1).

2.2 Physical Setting

The Facility encompasses an area slightly larger than five acres and is zoned various times by ABC, Spindrift, and Wellcraft) adjoining the Facility to the west, a CITGO gas station approximately 500 feet northwest of the Facility, and a north-south trending spur of the Seminole Gulf Railroad that intersects Tallevast Road approximately 200 feet east of the Facility. Aside from these features, surrounding properties are primarily single-family residences. Several small churches and the Tallevast Community Center are also nearby.

2.3 Topographic Setting

The Facility sits on a gently sloping plain known as the Gulf Coastal Lowlands at an elevation of approximately 30 feet above mean sea level (msl). The Facility is approximately 1.5 miles east (inland) of Sarasota Bay and approximately six miles from the Gulf of Mexico. The land surface close to the Facility has very little relief and slopes gently in a radial pattern away from the Facility (see Figure 1-1). The land surface declines from approximately 30 feet above msl at the Facility to 25 feet above msl to the west near the intersection of Tallevast Road and 15th Street East. Farther west, land surface elevations decrease to approximately 15 feet above msl just north of the Sarasota-Bradenton International Airport. Elevation contours show a very gentle slope from approximately 30 feet above msl at the Facility to 25 feet above msl approximately 2,000 feet north, northeast, southeast, and southwest of the Facility.

2.4 Regional and Site Hydrology

The Site is located in the Sarasota Bay watershed within Florida’s Southern Coastal Watershed. The Southern Coastal Watershed includes numerous estuaries, wetlands, and small coastal streams that are tidally influenced over much of their length, and a few longer stream/canal systems with predominantly freshwater habitats (SWFWMD, 2002). The Sarasota Bay watershed drains more than 200 square miles within Manatee, Sarasota, and Charlotte Counties (Kish, et. al, 2008). In the area of the Site, the Braden River southeast (0.75 mile) and east (one mile) of Tallevast. A topographical high runs north-south through the Facility. Surface water on the western portion of the Facility flows west toward the Bowlees Creek and the improved drainage features around the Bradenton-Sarasota airport, both of which drain to Sarasota Bay. Surface water on the easternmost portion of the Facility flows toward the Pearce Canal. The Pearce Canal drains both south into the Sarasota Bay watershed and north into the Braden River watershed (DelCharco and Lewelling, 1997). The drainage divide along the Pearce Canal is located about one mile north of the Manatee/Sarasota County line, which is approximately where the canal crosses US 301, approximately one mile southeast of the Facility (Tampa Bay Regional Planning Council, 1986).

A number of small surface water bodies lie within a half-mile radius of the Facility, as shown on Figure 1-1. Several shallow swales also convey surface runoff to the street and stormwater channels. In addition, a number of wetlands have been identified by the Florida Department of Transportation Florida Land Use, Cover, and Forms, Classification System (FLUCFCS) near the Site. These wetlands are shown in Figure 2-1.

2.5 Regional Geology and Hydrogeology

In January 1995, the Southwest Florida Water Management District (SWFWMD) published a report entitled *ROMP TR-7 Oneco Monitor Well Site, Manatee County, Florida*, which describes the drilling and testing of a well completed to a reported depth of 1,715 feet (ft) below ground surface (bgs) at a location approximately 2.5 miles north of the Facility in southwestern Manatee County (SWFWMD, 1995). The nomenclature used in the 1995 SWFWMD report to describe subsurface sediments is typically used to describe consolidated carbonate formations in the Site area and is therefore used for this Site.

The regional geology consists of three main lithostratigraphic units, which are further subdivided into hydrogeologic units and water-bearing zones for monitoring purposes. Figure 2-2, below, illustrates the generalized geologic cross-section. Figure 2-3 provides a detailed stratigraphic column. From the surface downward, the geologic units underlying southern Manatee County

The main geologic units listed above are further subdivided into the local hydrogeologic units and water-bearing zones listed below. More detailed descriptions are presented on Figure 2-3.

- Surficial Aquifer System (SAS) — the unconfined surficial aquifer overlying is usually identified in drilling logs as “wet.” Hereafter, the term AF Gravels is only used to refer to the Upper AF Gravels.

- o Clay/Sand Zone 2 a subunit of the AF, consisting primarily of low permeability carbonate mudstones.
- o

Based on Site assessment data collected through August 2005, *SARA 2* recommended that a *RAP* be prepared for the Site to address COC exceedances in the USAS, LSAS, and IAS. In an October 5, 2005 letter, FDEP directed Lockheed Martin to augment the *SARA 2* with specific additional activities and information, and to submit *SARA 3*.

3.1.3 *Site Assessment Report Addendum 3* (April 2006)

In response to comments from FDEP, FOCUS, and other stakeholders, Lockheed Martin completed comprehensive Site assessment activities, which were presented in the *SARA 3* (BBL, 2006a). *SARA 3* was submitted to FDEP on April 26, 2006 and summarized additional Site assessment data collected between approximately August 2005 and April 2006. Specific elements of the *SARA 3* assessment and field activities included well drilling, logging, installation, development, surveying, sampling, surface geophysical investigations, hydraulic conductivity testing, both on-facility and off-facility soil sampling, and assessment of potential receptors and exposure pathways. FDEP approved *SARA 3* on September 25, 2006, thus indicating that Site charactep7wJ-7(t)-5.5(nion)was stbpl1(es)0(e)-5.5(r. ur..2-5.6(t)0.3(e)2(t)0.3mati)--341.1ipttebpl all COCs above GCTLs in all transmissive zones beneath the Site was identified as approximately 1,200 feet north, 2,800 feet east, 1,600 feet south, and 800 feet west of the Facility. The vertical extent of COCs above GCTLs in Site groundwater was limited to approximately 200 ft bgs within the uppermost four water-bearing zones.

- Groundwater in the Lower AF Sands and the Floridan did not contain Site COCs above GCTLs.
- The most frequently detected COC in Site groundwater samples was 1,4-dioxane, which also had the largest areal distribution in Site groundwater.
- Nonaqueous phase liquid (NAPL) has never been observed directly in any soil or groundwater samples collected during Site assessments. However, NAPL could potentially exist within the former Facility boundaries in a limited portion of the USAS near the southeast corner of Building 5.

3.1.3.2 Soil Assessment

The *SARA 3* soil assessment included an evaluation of Site-related COCs, historical soil management practices, Facility chemical usage, and previous and recent Site investigations. This information was considered in conjunction with the results of soil sampling conducted in residential areas in the Tallevast community, as well as soil sampling conducted at representative reference/background locations. In a letter dated September 25, 2006, FDEP concluded that no further action is warranted for off-facility soils, and on-facility soils can be addressed using engineering and/or institutional controls, in accordance with Chapter 62-780, F.A.C. The *SARA 3* soil assessment reached the following conclusions regarding the nature and extent of soil contamination at the Facility:

- Beryllium, copper, and chromium are the soil COCs at the Facility.
- Chromium and beryllium were detected at levels exceeding respective leachability-to-groundwater (LTG) Soil Cleanup Target Levels (SCTLs). Subsequent leachability testing using United States Environmental Protection Agency (USEPA) Methods 1312 and 6010B for beryllium indicated that the soil was not leachable. Copper was retained as a COC for Facility soils because the concentration in one location exceeded the residential direct exposure (RDE) SCTL of

- Groundwater extraction occurs at undetermined locations near the Site. This may influence groundwater levels and associated hydraulic gradients.
- The direction of the vertical hydraulic gradient between the USAS and the LSAS, and between the LSAS and the AF Gravels, was downward throughout the monitoring period at the locations monitored.
- The direction of the vertical gradient between the S&P Sands and the AF Gravels was upward throughout the monitoring period at the locations monitored.

3.1.3.4 Fate and Transport

The *SARA 3* document reviewed the naturally occurring fate and transport processes governing COC migration in Site groundwater, including advection, dilution, dispersion, adsorption and retardation, *in situ* biodegradation, and molecular diffusion. All of these processes are present to some extent in Site groundwater, and their combined effect on COC migration rates and directions is to attenuate COC concentrations over time and distance. Evidence also indicated that biotic and abiotic degradation of chlorinated volatile organic compounds (CVOCs) in Site groundwater is occurring via reductive dechlorination processes. Evidence of reductive dechlorination occurring in portions of all monitored zones includes the presence of CVOC daughter products (cis-1,2-DCE, 1,1-DCE, 1,1-DCA, ethene, and ethane) and the presence of reducing geochemical conditions (i.e., iron reducing, sulfate reducing, and methanogenic). Overall, the *SARA 3* data demonstrate that natural attenuation processes are occurring for CVOCs in the Site's transmissive zones.

3.1.3.5 Potential Receptors and Exposure Pathways

Potential receptors and exposure pathways were evaluated during development of *the SARA 3*, including consideration of potential human and ecological receptors, as summarized below.

Human receptors — Given the mixed industrial/commercial/residential nature of land use near the Site, potential human receptors include workers and residents. These receptor groups may be exposed to site-specific COCs present in groundwater, soil, sediment, air, fish, and produce. Exposure

Closure Report summarizes the wells closed in March 2009.

The results of these tests indicate that hydraulically developed five-inch diameter wells with a minimum of five feet of screen could produce 3–5

This technology is a continuous, in-line, at-pressure AOP to destroy waterborne VOCs and 1,4-dioxane. A 2.5-gallon sample of extracted water obtained during the pumping tests (described above) was used in bench-scale tests of ozone and peroxide oxidation using the HiPOx process. This process uses ozone (O_3) and hydrogen peroxide (H_2O_2) chemistry in a uniquely designed oxidation reactor. Reactants are injected directly into the water stream in precisely controlled ratios and locations, generating hydroxyl radicals, which are powerful oxidizers. These hydroxyl radicals attack the bonds in the organic molecules, progressively oxidizing those compounds and any resulting intermediate byproducts until the basic atoms ultimately recombine into benign end products of carbon dioxide (CO_2), water, and salts.

To confirm efficacy and to design a full-scale system for a particular application, a bench-scale reactor was used to validate HiPOx performance. Having been proven effective in treating the Site COCs, the HiPOx data were then used to model the design and performance of a full-scale system. A test report prepared by APT, including analytical data from Accutest Laboratories, was presented in the *IRAP* (BBL, 2005a).

3.2.4 Interim Remedial Action System Installation and Operation

As described in the *IRAP* (BBL, 2006b), remediation of groundwater at the Site began with the installation of the IRA groundwater extraction and treatment system. System construction began on July 24, 2006, with initial system start-up and testing on August 23, 2006. Additional construction and start-up testing continued until October 2, 2006.

3.2.4.1 Overview of the 2006 Interim Remedial Action Groundwater Extraction and Treatment System

The location of the 2006 IRA groundwater extraction and treatment system is shown on the Facility site plan (Figure 1-3). Except for the influent tank, treatment equipment was housed inside the treatment system building. The AOP is a photo-catalytic ultraviolet (UV) light VOC-destruction system operating at a flow rate of approximately 20–25 gpm and capable of operating up to a maximum flow rate of 75 gpm. Per the *IRAP*, groundwater was initially extracted from six on-facility extraction wells: three screened in the USAS (EW-103, EW-105, and EW-109) and three screened in the LSAS (EW-104, EW-106, and EW-110).

On February 4, 2008, four additional extraction wells were brought online, two in the USAS (EW-101 and EW-107) and two in the LSAS (EW-102 and

Pollutant Storage Tank Permit	# 06061730
Non-Structural Fence Permit	# 06061731

All permits were reviewed and approved in the following Departments of Manatee County: Permitting, Zoning, Infrastructure, Health, Environmental

Interim Source Removal (ISR) Report (ARCADIS, 2008k) submitted to FDEP, soil and groundwater samples were collected at 30 locations to delineate the lateral and vertical extent of resultant impacts. From August 8 to September 3, 2008, 104 soil and 140 groundwater samples were collected to be analyzed for VOCs and 1,4-dioxane. As described in the *ISR Report*, a soil remedy was not required based on the soil analytical results. The groundwater results indicated that Site related COCs were present in the shallowest groundwater in the immediate vicinity of the release and within Facility boundaries.

- Used lockable valves
- Installed two aerators in parallel so one can be removed for cleaning while the system remains operable
- Used a centrifugal pump capable of producing a recirculation flow rate of 15 gpm at an estimated 101 feet of total dynamic head (TDH) with the pump shutoff head at approximately 140 feet TDH or 60 psi
- Replaced the metal curb at the north roll-up door with concrete curbing for improved containment within the building
- Improvements to the building, equipment, and electrical system surge suppression and grounding network

Additional Improvements

- Replaced the existing 10-well influent manifold made of Schedule 80 PVC and included flexible hose connections between the buried influent piping and the PVC manifold. This manifold was reconstructed using Schedule 40 welded stainless steel piping, valves, and braided and stainless steel flexible fittings to be consistent with the other new piping in the treatment Facility.
- Replaced the influent flow meters during reconstruction of the influent manifold. The replacement flow meters are constructed with stainless steel bodies, were sized for the anticipated flows from the recovery wells, and are powered by a 24 volt power supply.
- Replaced the existing pressure gauges (local, manual readout only) on the influent manifold with pressure indicating transmitters that provide both local pressure readings and transmit that information to the PLC.
- Installed dedicated drain lines from select process equipment to the building sump, to facilitate equipment maintenance.

As these modifications were being deployed, they were documented by means

Three groundwater monitoring events were conducted between October 2006 and February 2007 to support the development of the RAP submitted in May 2007. These events are summarized below. Results and evaluation were provided in the May 2007 *RAP*.

- *October 2006* — F.A.C. Chapter 62-780 requires collection of groundwater data no more than 270 days before submittal of a *RAP*. In advance of the May 2007 *RAP* submission, groundwater levels were measured and samples collected for analysis from 102 monitoring wells during October 2006. The samples were analyzed for VOCs (including 1,4-dioxane) using USEPA Method 8260. 1,4-dioxane was also analyzed using Method USEPA 8270.
- *December 2006* — Subsequent to the October 2006 groundwater sampling effort, FDEP approved USEPA Method 8260 to analyze 1,4-dioxane in groundwater using heated purge and isotope dilution. Thus, monitoring wells and available private wells were re-sampled for all COCs, and 1,4-dioxane was analyzed for using Method 8260. Water levels were also measured during this monitoring event. The COC distribution maps associated with this event were provided in Appendix D of the August 2008 *RAP*.
- *February 2007* — On February 20, 2007, depth to groundwater was measured in all monitoring wells and samples were collected from three monitoring wells installed between December 2006 and February 2007. The potentiometric surface maps associated with this measurement event were provided in Appendix D of the August 2008 *RAP*.

Three groundwater monitoring events were conducted between December 2007 and February 2008 to support development of the revised *RAP* submitted in August 2008.

- *December 2007*— In November 2007, the IRA system was shut down to prepare for aquifer testing as described in Section 4.3. After groundwater levels in each zone had stabilized following the shutdown, a comprehensive water level measurement event was conducted in December 2007. The potentiometric surface maps associated with this measurement event were presented in the 2008 *Groundwater*

Monitoring Report (GWMR) (ARCADIS, 2008f), and were included in the August 2008 *RAP*.

- *January 2008* — A comprehensive water level measurement event was conducted in January 2008, after the aquifer testing described in Section 4.3. The potentiometric surface maps associated with this measurement event were presented in the 2008 *GWMR*, and were included in the August 2008 *RAP*.
- *January–February 2008* — A comprehensive groundwater sampling event was conducted following the January 2008 water level measurement event to provide analytical results within 270 days of submittal of the revised *RAP*, as required by rule. COC distribution maps associated with this sampling event were presented in the 2008 *GWMR*, and were included in the August 2008 *RAP*. Historical monitoring and extraction well analytical results are presented in Tables B-3 through B -5 of Appendix B of this *RAP Addendum*. Historical groundwater elevations are presented in Table B-6 of Appendix B. Laboratory analytical data for the 2006 and 2007 sampling events were provided in Appendix E of the August 2008 *RAP*. Laboratory analytical data for the 2008 sampling event were provided in the 2008 GWMR.

One groundwater monitoring event was conducted following submittal of the August 2008 *RAP* to support development of this *RAP Addendum*. This event was comprised of the following five activities:

- *March/April 2009 Annual Sampling* — A comprehensive groundwater sampling event was conducted in conjunction with obtaining water level measurements to provide analytical results not more than 270 days prior to submittal of this *RAP Addendum*, as required by rule. The COC distribution maps and potentiometric surface maps associated with this sampling event are presented and discussed below in Section 5 of this *RAP Addendum* and are also in the 2009 *GWMR*, included here as Appendix C. Historical analytical results and groundwater elevations are presented in Tables B-3 through B-6 of Appendix B of this *RAP Addendum*. Laboratory analytical data for the 2009 sampling event are also provided in Appendix C.
- *March/April 2009 IRAP Sampling* — Quarterly monitoring of the 44 IRA wells (including the 10 extraction wells) is required by the *OMM Manual*

(ARCADIS, 2006, revised 2009). The IRA well sampling was conducted as an element of the annual event. Results for the IRA wells were reported in the *IRA Monitoring Report* (ARCADIS 2009c) submitted on May 26, 2009 and are included in Tables B-3, B-4, and B-5 of Appendix B. Lab data packages are included in Appendix C.

- *March/April 2009 Blended Water RAP Design Data Sampling* — Groundwater samples were collected from a series of 16 monitoring wells and analyzed for additional design parameters, to help estimate the influent properties of this blended groundwater to the RAP treatment system. Total and dissolved iron and manganese were measured in 148 monitoring wells using USEPA Method 6010B. Field testing for total iron using Hach kits was conducted on an additional 30 monitoring wells. Analytical results for the blended water parameters and the total/dissolved iron and manganese are summarized in Tables B-7 and B-8 of Appendix B, respectively. Laboratory data packages are included in Appendix C.
- *March/|April 2009 In situ Chemical Oxidation (ISCO)-Underground Injection Control (UIC) Sampling* — The April 2008 ISCO pilot study requires ongoing monitoring of metals to comply with UIC

4.2.1.1 2006-2007 Monitoring Well Installation Event

(potential influence) during the aquifer testing program conducted in the AF Gravels on-facility (see Section 4.3 below). Well MW-254 (USAS) was installed in the parking lot south of Building 5 to evaluate the relative level of COC concentrations in groundwater near borings, to provide qualitative information about elevated chlorinated COCs (see Section 4.2.3, below). The monitoring well construction information is summarized in Table 3-1. The boring logs were provided in Appendix F of the August 2008 *RAP*. Information in the boring logs confirms the depth and nature of the geology identified in previous investigations. These wells were sampled and gauged as part of the 2009 *GWMR* activities. The results of historic groundwater sampling and gauging are summarized in Appendix B, Tables B-3, B-4, B-5, and B-6. The potentiometric surface and COC distribution maps including data collected from these wells, are provided in Section 5.

4.2.1.3 Piezometer Installation

Seven piezometers were installed as part of Lockheed Martin's Proposed Pumping Test Scope of Work dated November 16, 2007 (Lockheed Martin, 2007b). They were installed in the LSAS to provide additional information on LSAS water levels during the aquifer testing program being conducted in the AF Gravels on the Facility (see Section 4.3). The piezometers were designated PZ-LSAS-1 through PZ-LSAS-7. The monitoring well construction information is summarized in Table 3-1. The boring logs are provided in Appendix F of the August 2008 *RAP*. The boring log information confirms the depth and nature of the USAS, the Hard Streak, and the LSAS as ide o(he)-izw8.83-. 5.4(5 log)ideidg(epe-0.004eed)-4(-7.1(ed)4c-0

GT-S-10. Soil samples were retrieved at various depths shown in Table 4-1 and analyzed for the following:

- Total organic carbon (TOC) by USEPA Method 9060 corrected for carbonate carbon (inorganic carbon) either by direct measurement (American Society for Testing and Materials [ASTM] D513 Method B) and mathematical subtraction or removal by acidification (USEPA Lloyd Kahn Method)
- VOCs, including the full VOC list, by 8260B and 1,4-dioxane by 8260C selective ion monitoring (SIM), heated purge, isotope dilution
- Vertical hydraulic conductivity (K_v) by ASTM D 5084 (Flexible Wall Permeameter)
- Soil adsorption (soil/groundwater partitioning coefficient [K_d]) of TCE and 1,4-dioxane using batch-type procedures outlined in technical resource document: EPA-530/SW-87/006-F (see Section 4.4.2)
- Porosity by ASTM D 854
- Bulk density by ASTM D 2937
- Particle size distribution by ASTM D 422/4464
- Moisture content by ASTM D 2216

Depending on lithology type, degree of consolidation, and sub-surface drilling conditions, the following methods were used for collection of subsurface samples:

- Unlined 2-inch diameter split-spoon sampling
- Lexan-lined 2-inch and 3-inch diameter split-spoon sampling
- Brass sleeve-lined 3-inch diameter split-spoon sampling
- Dual-tube split-barrel HQ-wireline coring (Layne-Christensen model)
- Triple-tube split-barrel HQ-wireline coring (Boart Longyear model)

Hollow-stem augers were used to advance boreholes within the surficial aquifer units and into the upper portion of the Venice Clay unit. The HQ-wireline and spin casing were used to advance the boreholes through the Venice Clay and underlying units. Upon termination of the borings at their total depths, each borehole was grouted using a tremie pipe to introduce grout from the bottom of the boring to land surface to seal the borehole and prevent possible cross contamination in the aquifer system. Materials that were retrieved via coring were archived in labeled wooden core boxes located at the Facility.

The geologic logs of the soil borings were provided in Appendix F of the

- Flame-Ionization Detector (FID), which responds to organic molecules
- Photo-Ionization Detector (PID), which responds to molecules containing double carbon bonds

The information from these devices is captured in digital format and translated into graphical output, facilitating interpretation of soil types and the presence of compounds of interest. MIP data are only qualitative, and simply indicate the presence or absence of the COCs. One-hundred-thirteen MIP borings were advanced on the Facility, 31 were advanced on the property directly east of the Facility, and 17 were advanced on the next property east (Figure 4-2). In addition, single MIP borings were advanced adjacent to MW-74 and in the road right-of-way on 17th Street East, south of the Facility. Confirmation borings logged for soil lithology were advanced at three on-facility MIP locations. The borehole logs were provided in Appendix F of the August 2008 *RAP*.

To confirm soil lithology in select locations, cone penetrometer borings were advanced as described in Appendix G of the August 2008 *RAP*. Approxima3(-o2acm t3(200)-4-o2acm(a3(-(5g(0.0
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Area A — Facility

Several conclusions regarding the relative distribution of VOCs at the Facility resulted from the MIP investigation (see Figure 4-3):

(1) Compared to other responses across the Facility, ECD response data indicate elevated levels of VOCs in the southeastern parking area, an area to the north that previously included several sumps, and along an alley separating Buildings 1 and 2 from Buildings 3, 4 and 5.

(2) Soil conductivity data suggest that elevated levels of VOCs appear to be associated with an interbedded zone at depth and distributed vertically. Soil conductivity data at the Facility indicate that the USAS consists of sands and silty sands to approximately 20 ft bgs, but that soils from approximately 20 ft bgs to the Hard Streak are interbedded with silty clay and clay. This interbedded zone overlying the Hard Streak has lower hydraulic conductivity than upper portions of the USAS. In most locations, significant ECD response (and by inference, VOC concentrations) was associated with this interbedded zone.

(3) Four locations (MIP-39, 41, 42, 43 and 44) along a sewer line in the alleyway between Buildings 1 and 2, and Buildings 3, 4 and 5 exhibited a maximum ECD response above the interbedded zone.

Discrete groundwater sampling confirms that the areas listed above have the highest concentrations of COCs. COCs detected at concentrations greater than GCTLs in the discrete groundwater sampling included 1,1,1-TCA, 1,1-DCE, cis-1,2-DCE, TCE, 1,1-DCA, PCE, and 1,4-dioxane.

Area B — Southeast of the Facility

Area B was chosen for evaluation based on historical groundwater monitoring data. MIP data regarding distribution of VOCs at Area B off-facility locations support the following conclusions:

(1) The same pattern of higher response in the interbedded zone observed in Area A (at the Facility) was also observed in Area B. However, in Area B the higher response tended to be in the upper

portion of the interbedded zone rather than in the lower portion (as was observed in Area A).

(2) In contrast to the ECD response observed at the Facility, the ECD response in Area B did not exceed the detector maximum in any location.

(3) FID and PID response profiles do not coincide with ECD response profiles. FID and PID responses were observed in the interval between 10 and 20 ft bgs, which is shallower than the interval where ECD response occurred.

COC concentrations based on confirmatory groundwater sampling in Area B differ from those recorded in Area A (the Facility):

(1) Total VOC concentrations detected in groundwater samples collected from Area B were more than an order of magnitude lower than concentrations detected in Area A.

(2) In Area B groundwater samples, 1,4-dioxane was detected at higher concentrations than in Area A. In Area B, the 1,4-dioxane concentrations were detected at similar levels to the VOC concentrations.

Area C — South of the Facility

Area C locations were chosen for evaluation based on historical groundwater

on-facility well EW-UAFG-1), and two wells in the S&P Sands unit (off-facility wells MW-44 and MW-165).

After the specific capacity tests were completed, groundwater samples from the discharge line of the pump assembly were collected at test wells MW-27, MW-44, MW-67, MW-74, MW-82, MW-93, and MW-131. These post-test groundwater samples were analyzed for VOCs by USEPA Method 8260 and for 1,4-dioxane by USEPA Method 8270. A groundwater sample was not collected at test well MW-165 because it did not produce enough groundwater to perform a sustained four-hour specific capacity test. Appendix H of the August 2008 *RAP* presents a graphical and tabulated summary of the specific capacity test data and analysis.

4.3.2 Slug Testing and Pump Testing - Winter 2007-2008

Between November 2007 and January 2008, aquifer testing was performed to gather additional hydraulic information in support of RAP development. This

- Slug testing
- Specific capacity testing
- 24-hour aquifer pumping tests
- Seven-day aquifer pumping test

4.3.2.2 Arcadia Formation Gravels Aquifer Testing

The AF Gravels aquifer testing evaluated five different wells located on the Facility screened in the AF Gravels zone. During each test, transducers were installed in the pumped well and in 51 additional monitoring and stilling wells at and near the Facility. A detailed description of aquifer testing methods and data was included in Appendix H of the August 2008 *RAP*. GeoTrans analyzed the

- *24-Hour Pumping Tests* — A series of 24-hour pump tests assessed hydraulic response to extended pumping in the AF Gravels. Wells IWI-1, MW-127, and MW-134 were pumped separately for 24 hours, and then allowed to recover for at least 24 hours before beginning extraction at the next well. Pumping rates ranged from 2.0 to 2.5 gpm. The 24-hour pumping tests produced observable responses in all the monitored AF Gravels wells, as well as in many of the monitored LSAS wells. This indicates that groundwater extraction in one hydraulic zone can produce a response in another zone of the Hawthorn, even though they are separated by significant confining layers. Observed drawdown for each test is tabulated in Appendix H, Table H-5 of the August 2008 *RAP*.
- *Seven-Day Pumping Test* — A seven-day pump test likewise assessed hydraulic response to long-term pumping in the AF Gravels. Well

feet from the extraction wells. This approximately triples the radius of influence as compared to the previous effect of IRA system operation.

- _LSAS_ — Data from pressure transducers suggest that the IRA system's observable zone of influence in the LSAS extends beyond the monitored wells to the north, west, and east. This represents a radius greater than 700 feet. In addition, drawdown at the farthest monitoring points was more than double the amount of recovery observed after the IRA system shutdown.
- _AF Gravels_ — With the addition of the new IRA system wells, the AF Gravels experienced drawdown due to IRA system operation. The radius of influence in the AF Gravels is estimated between 200 to 300 feet from the center of LSAS pumping, indicating that extraction in the LSAS influences the gradient between units to a larger extent than previously estimated.

2008 *GWMR* Figures 3-2A to 3-2C, included in Appendix H of the August 2008 *RAP*, present the November 2007 IRA system shutdown recovery data, and Appendix H of the August 2008 *RAP*, Figures H-8 to H-9 presents the February 2008 IRA system start-up drawdown data.

4.3.2.4 Value of Hydraulic-Stress Changes to Model Calibration and Verification

The groundwater hydraulic response data collected from December 2007 through April 2008 provides a strong foundation for improving the calibration of the groundwater flow model (discussed more fully in Section 9), including testing the model against several significant changes in hydraulic stresses due to sudden, programmed changes, either from extraction well pumping (discussed above) or injection well recharge (discussed in Section 4.4.3 below). The following activities induced measurable water level responses across all of the aquifer units where remediation efforts are focused.

- _LSAS and USAS tracer tests_— In these tests, solutions were injected at rates sufficiently high to cause substantial water level changes in these two units and adjacent layers. Transient water level data from these tests were used to refine estimated values for the horizontal and vertical hydraulic conductivities of the USAS, LSAS, and AF Gravels units, as well as the vertical hydraulic conductivities of the Hard Streak and the Venice Clay or Clay/Sand Zone 1 confining units. In addition, the groundwater quality data from these tests provides the primary basis for estimating the mobile porosity of the contaminated aquifer units.

- _IRA system pumping changes._ These changes provided several sets of hydraulic--stress data. The changes included full system shut--down for running the AF Gravels pumping test, re-start following the test, and subsequent on/off cycling of selected IRA extraction wells during the LSAS and USAS tracer tests. Analyses of water level responses to these pumping changes helped improve estimates of the vertical hydraulic conductivity of the lower permeability clay zone within the LSAS and of the Venice Clay or Clay/Sand Zone 1 confining unit, and for the horizontal hydraulic conductivity of the shallower and deeper portions of the LSAS. In particular, the observed higher yields of EW-108 and significant water level responses in nearby monitoring wells during the on/off pumping cycle provides the basis for estimates of horizontal hydraulic conductivity for the deeper portion of the LSAS.

These hydraulic stress-change periods serve as the foundation for verifying the accuracy of the groundwater flow model for simulating remediation pumping effectiveness, and for representing the seepage through confining units with sufficient accuracy for predictive modeling purposes. Thus, the data from these hydraulic changes were used to confirm the ability of the model to simulate stressed pumping conditions in the USAS, LSAS, and AF Gravels geologic units at the Facility, as described in more detail in the Modeling Report (Appendix D), and as summarized in Section 9 below.

4.4 Bench- and Field-Scale Testing

As part of the *RAP* preparation, several field- and bench-scale studies were conducted with the goal of directly testing the effectiveness of remedial options and to characterize certain site-specific aquifer properties that would influence the effectiveness of remedial options. These studies included the following:

- *In situ* biostimulation and bioaugmentation treatability study
- Bench-scale natural-oxidant-demand (NOD) testing
- Partitioning-coefficient testing

- *In situ* chemical oxidation bench-scale treatability study
- *In situ* pilot studies, including tracer injection tests and chemical oxidation pilot tests

4.4.1 *In situ* Biostimulation and Bioaugmentation Treatability Study

Preliminary treatability testing was conducted in October 2005 to determine the potential effectiveness of biostimulation (i.e., the addition of a biodegradable substrate to act as an electron donor in the reductive dechlorination process) and biostimulation/bioaugmentation (i.e., the addition of a specific microbial consortium known to facilitate complete reductive dechlorination). Specific deoxyribonucleic acid (DNA) analyses were performed to assess the potential presence of *Dehalococcoides ethanogenes,* a microorganism known to facilitate reductive dechlorination. The preliminary treatability testing included a bench-scale microcosm assessment and analysis of groundwater samples from monitoring wells MW-37, MW-39, IWI-1, and IWI-2 for key biogeochemical parameters. A detailed description of these tests and their results was included in Appendix I of the August 2008 *RAP*.

In-well microcosms were constructed using select amendments, including biodegradable substrate and/or an engineered consortium of dehalorespiring bacteria. Groundwater sampling associated with biotreatability testing included the analysis of field parameters (i.e., pH, temperature, specific electrical conductivity, dissolved oxygen, turbidity, and oxidation reduction potential), analysis for chlorinated VOCs, dissolved light hydrocarbon gases (i.e., ethene, ethane, and methane), and anions (i.e., nitrate, nitrite, sulfate, phosphate, chloride, lactate, and bromide), and DNA analyses using the polymerase chain reaction (PCR) method. *In situ* testing was done using down-hole, retrievable microcosms, including one or more of the following components: (1) diffusive groundwater sampler, (2) degradable substrate, and/or (3) dehalorespiring microbial consortium.

These bench and field tests found that:

- DNA expression of indigenous Dehalococcoides sp. was not detected in ambient groundwater samples; however, in situ testing revealed detectable levels of Dehalococcoides sp. in one control microcosm where no additional amendments were provided, and in two microcosms containing only electron donor amendment, which

4.4.2 Bench-Scale Testing

The following bench-scale tests were completed to assess remedial alternatives and to provide information on solute transport model parameters: NOD testing, soil/groundwater partitioning coefficient (K_d) testing, and *in situ* chemical oxidation treatability studies.

4.4.2.1 Bench-Scale Natural Oxidant Demand Testing

Bench-scale NOD testing evaluated the oxidant demand of the aquifer materials. ARCADIS carried out the tests using soil and groundwater samples collected from the Facility. Sodium persulfate served as the oxidant. Test methodology and results were included in Appendix J of the August 2008 *RAP*. Results of the NOD testing are summarized as follows:

- Following seven days of chemical oxidation treatments, the NOD values were between 29 and 40 grams of sodium persulfate per kilogram of saturated soil (g/kg). A typical NOD value is approximately 1 g/kg.
- The high NOD exerted by Site soils from the USAS and LSAS is likely associated with a relatively high concentration of naturally occurring organic material, typically associated with shallow soils in Florida and reduced mineralogy.
- Reduced divalent metals (e.g., ferrous iron) are naturally present in the USAS, providing a certain level of persulfate activation.

4.4.2.2 Partitioning Coefficient Testing

The ARCADIS Treatability Laboratory performed a batch-type soil adsorption treatability study to determine the site-specific range in soil/groundwater partitioning coefficient (K_d) for TCE using 12 soil samples collected over a range of depths (13 to 154 ft bgs) and locations (GT-D-1, GT-D-2, GT-D-3, GT-D-5, and GT-D-6). Sample locations are shown on Figure 4-2. The soil samples represent multiple hydraulic units, including the LSAS, USAS, AF Gravels, and S&P Sands, and were selected as samples of minimally impacted soil. The K_d study was based on USEPA’s “Batch-Type Procedures for Estimating Soil Adsorption of Chemicals,” (EPA.530-SW-87-006-F). ARCADIS also referred to “Natural Attenuation of Chlorinated Volatile Organic

Compounds in a Freshwater Tidal Wetland, Aberdeen Proving Ground, Maryland," (USGS Water Resources Investigations Report 97-4171, page 27).

Soil samples were air-dried and screened using a 2-millimeter diameter sieve size. Various soil to water ratios were established for each soil sample, including 1:4, 1:6, 1:7, 1:8, and 1:10. The K_d vessels were filled with deionized water spiked with a target concentration of 2 mg/L TCE, then agitated for 48 hours. After agitation, the samples were analyzed to determine aqueous TCE concentration. Multiple samples of TCE-spiked water without soil were subjected to the same treatments to establish baseline TCE concentrations and to serve as volatilization controls.

After completing these analyses, an average K_d was calculated for each soil sample using the laboratory results for each soil to water ratio. The average K_d values for each aquifer were as follows:

USAS:	0.97 liters per kilogram (L/kg)
LSAS:	1.00 L/kg
AF Gravels:	1.04 L/kg
S&P Sands:	1.48 L/kg

These data suggest that Site soils possess relatively limited capacity to adsorb TCE. A detailed report on this treatability study was included in the August 2008 *RAP* as Appendix K.

Several parameters were defined and loaded into numerical models to simulate groundwater flow and solute fate and transport (see Appendix D, "Groundwater Modeling Report," below, and the summary in Section 9 of this *RAP Addendum*). These parameters include fraction of organic carbon (foc), partitioning coefficient (K_{oc}), soil/groundwater partitioning coefficient (K_d), effective porosity, bulk density, retardation coefficient, and dispersivity. Values for these parameters were then used in the contaminant mass, fate, and transport modeling simulations presented in Table 16 of Appendix D. As noted in that table, a number of these parameters and variables (e.g., foc, total porosity, and bulk density) were measured in samples collected at the deep geotechnical borings completed in late 2007 (ARCADIS, 2008b).

Data from these borings augmented results from the batch test, providing improved indicators of TCE sorption in the field. The bench tests primarily enhanced the exposed surface area of the soil and sediment grains, in contrast to the more limited exposure of these grains under *in situ* conditions. For example, sediment grains in the sandy USAS are tightly packed, whereas more heterogeneous arrangements, packing, and semi-consolidation of sediments is typical of the IAS units (LSAS, AF Gravels, and S&P Sands, as well as confining units, such as the Hard Streak, Venice Clay, and Clay/Sand Zones 1, 2, and 3). Based on the field collected and laboratory tested samples from the geotechnical borings, the following distribution coefficients for TCE were used in the groundwater models described in Appendix D:

USAS:	0.69 L/Kg
Hard Streak & LSAS:	0.22 L/Kg
Venice Clay:	0.85 L/Kg
Clay/Sand Zone 1:	0.50 L/Kg
AF Gravels:	0.14 L/Kg
Clay/Sand Zone 2:	0.32 L/Kg
S&P Sands:	0.36 L/Kg
Clay/Sand Zone 3:	0.31 L/Kg

4.4.2.3 In Situ *Chemical Oxidation Bench-Scale Treatability Study*

Camp Dresser & McKee (CDM) performed an *in situ* chemical oxidation bench-scale treatability study to evaluate the efficacy of *in situ* chemical oxidation using sodium persulfate to treat 1,4-dioxane and chlorinated compounds found at the Site. CDM conducted the bench-scale study in two separate phases:

- Phase I — Chemistry, Persulfate Activation, and Metals Test
- Phase II — Optimal Oxidant Dosage Evaluation

Soil samples for the treatability study were collected from different locations near the Site. Phase I has been completed and is discussed in Appendix L ("*In Situ* Chemical Oxidation Bench-Scale Treatability Study Report") of the August

2008 *RAP*. Bench-testing data generated June 1, 2008 is also included in this report. Results of the Phase I study indicate the following:

- Naturally-activated persulfate effectively oxidizes chlorinated compounds and 1,4-dioxane. This natural-activation method was

- USAS tracer testing wells: one injection well (IW-1) and 30 monitoring wells designated with the prefix “T-.”
- USAS chemical oxidation pilot testing wells: one injection well (IW-2) and 20 monitoring wells designated with the prefix “CO-.”
- LSAS tracer testing wells: one injection well (TL-INJ) and six monitoring wells designated with the prefix “TL-.”

Installation of the oxidation and tracer-test wells confirmed the presence of the Hard Streak and USAS interbedded-zone immediately above the Hard Streak, as well as confirming the nature and thickness of the LSAS in this tight grid of well points. The details of the installation, sampling, specific locations, and use of these wells are provided in Appendix L of the August 2008 *RAP*. Monitoring well construction information is summarized in Table 3-1, and the boring logs are provided in Appendix L of the August 2008 *RAP*.

4.4.3.2 Tracer Tests

The tracer testing methodology involved injection by gravity drainage of water augmented with fluorescein dye and bromide into the tracer testing injection wells. The injection locations were IW-1 in the USAS, and TL-INJ in the LSAS. The tracer injection dates were:

- USAS tracer test: March 24–27, 2008
- LSAS tracer test: March 31–April 2, 2008

The tracer study concluded that (1) the sustainable rate of injection into the USAS is approximately 1.4 gpm at 4 psi; (2) Mobile porosity of the USAS ranges between 0.14 and 0.47, with an average of 0.28; and (3) groundwater velocity estimates based on preliminary tracer breakthrough data are approximately 0.32 foot/day for the USAS and 4.2 feet/day for the LSAS under pumping conditions. These estimates were based on information available at the time of testing. The tracer injection study shows that oxidant injection is possible in both the USAS and LSAS. Tracer injections into the LSAS required the operation of nearby extraction wells to allow for injection without increasing pressures, which would risk fracturing the formation. Further, preferential flow within the LSAS makes it difficult to ensure that an oxidant can reliably be placed in contact with the contaminants to ensure effective treatment.

control have been finalized, they will be submitted to FDEP in a separate report.

4.5.8 Field Identification of Nearby Pumping Influences and Pond Characterization

The influence of water supply well pumping on the groundwater flow system is a concern for the RAP design because several permitted and operating supply wells lie within the area of the Site and that of the larger groundwater model. Small to moderate pumping rates in the confined units of the IAS (specifically the LSAS, AF Gravels, and S&P Sands) have been observed to create moderate to large cones of depression. Therefore, characterization of supply well pumping in the Site and model area remains an important aspect of plume remediation. This characterization effort includes identification and closure of wells within the Site area, identification and characterization of supply wells beyond the Site that may influence the RAP design, collection of water level data at strategic monitoring locations, and groundwater flow modeling that accounts for the effects of supply well pumping and helps confirm the characterization information.

Preliminary analysis of these transducer data indicates previously unidentified groundwater extraction influences in the northwest and southwest portions of the Site that warrant further investigation. A door-to-door search in the northwest quadrant revealed only wells that are used minimally or infrequently. Transducer data from the southwest area shows the characteristic on/off cycling of a single supply well (PW-127). The data point to a nearby well that is used to replenish the decorative pond (TL-1) along 15th St. E. As appropriate, the effects of water supply well pumping are included in the groundwater modeling described in Section 9. Additional wells identified during this well search have been added to Figure 3-1 and Table 3-1. Attempts to close specific wells that may affect remediation efforts are ongoing.

To enhance modeling accuracy, Site personnel surveyed the condition and water level of all stormwater and decorative ponds within a three-quarter mile

USAS groundwater elevations, where appropriate, since the surface water bodies are believed to act as recharge and discharge points to the USAS. Groundwater elevations ranged from 10.94 to 24.55 ft msl in March and April 2009. The USAS potentiometric surface during these measurement events showed a groundwater high beneath the Facility and extending onto the golf course. The horizontal component of groundwater flow was, therefore, radial, away from the Facility with a gradient ranging from 0.003 to 0.007 feet per foot (ft/ft). The average vertical downward gradient from the USAS to the lower LSAS at the Facility and across the monitored area was 0.3 ft/ft. Some features of the USAS potentiometric surface are:

- A groundwater high beneath the southern portion of the Facility and the northeastern portion of the golf course which is likely due to increased recharge at the golf course.
- A localized groundwater high beneath Pond TW-6 (Stilling Well 3) may be due to the pond collecting surface water drainage and thus acting as a recharge feature.
- Potentiometric lows near some ponds and the Tallevast Roaetus-5.6(one4w.6(d c5.6(oae)ge8n5t1(tusac)-

lower portion). Hydraulic heads in the upper portion of the LSAS range from 21.83 to 23.64 ft msl as measured during the March 2009 monitoring event. Limited data points are available in the uppermost LSAS. The available data indicate that the general flow direction during the March 2009 measurement event was toward the north across the Site, with a slight groundwater depression near the corner of Building 5. The wells in this zone are screened just below the Hard Streak (which forms the interface between the USAS and LSAS), and the downward gradient from the USAS to the uppermost portion of the LSAS was approximately 0.20 ft/ft as measured from MW-38 to PZ-LSAS-2.

5.1.3 Lower Portion of the Lower Shallow Aquifer System Potentiometric Surface

Figure 5-3 shows the potentiometric surface of the lower portion of the LSAS in March/April 2009. The hydraulic heads in the lower portion of the LSAS ranged from 4.28 to 22.09 ft msl in March/April 2009. The highest head was on the golf course at well MW-87. The lowest contoured hydraulic head was at well MW-246, located in the northwest corner of the contoured area. The horizontal component of groundwater flow was again radial, away from the Facility. The horizontal gradient ranged from approximately 0.003 to 0.007 ft/ft, depending on direction. The average vertical gradient was approximately 0.1 ft/ft downward to the AF Gravels.

Some features of the lower portion of the LSAS potentiometric surface include:

- A groundwater high beneath the golf course likely due to increased recharge. This is also an indication of hydraulic connection between the USAS and the LSAS in this area.
- A groundwater high west of pond TW-6 that may be due to increased recharge from the pond itself.
- A groundwater low in the southwest corner of the map area that appears to be due to groundwater extraction from a private well in the area, used to maintain water levels in a decorative pond (TL-1).

11.72 ft msl in March/April 2009. The lowest head was at well MW-221, located in the southwest corner of the contoured area (southeast of the airport). The highest head occurred at the Facility and at well MW-232 located north of the Facility. Here, too, the horizontal component of groundwater flow was radial, away from the Facility. The horizontal gradient ranged from approximately 0.004 to 0.007 ft/ft, with the strongest gradients toward the southwest. Horizontal gradients were shallower towards the east and south. At the Facility, the vertical gradient was downward from the AF Gravels to the S&P Sands throughout most of the mapped area, ranging approximately 0.01 to 0.1 ft/ft. However, the vertical gradients are upward from the S&P Sands to the AF Gravels in the extreme western and eastern portions of the contoured area away from the Facility. The main features of the AF Gravels' potentiometric surface include:

- A groundwater high beneath the Facility and north of the Facility, with horizontal radial flow, away from these areas.
- An apparent cone of depression in the southwest contoured area. The cone of depression appears to be due to groundwater extraction from a private well (PW-127, see Figure 3-1) in the area, used to maintain water levels in a decorative pond (TL-1).
- Groundwater elevations in the northwest portion of the Site are lower than the northeast and southeast portions which may be due to water supply pumping.

5.1.5 Salt & Pepper Sands Potentiometric Surface

Figure 5-5 shows the potentiometric surface of the S&P Sands as measured in March/April 2009. The hydraulic heads in the S&P Sands ranged from -1.92 (April event) to 9.51 ft msl (March event). The lowest heads were consistently in the southwest corner of the contoured area, and the highest heads were in the eastern portion of the contoured area. The horizontal component of

Lower AF Sands to the S&P Sands, at -0.01 ft/ft. The main features of the S&P Sands potentiometric surface are:

- A groundwater low, southwest of the Facility, apparently due to groundwater extraction from a private well (PW-127, Figure 3-1) in the area to maintain water levels in a decorative pond (TL-1).
- A groundwater high, east of the Facility. Previous reports and the potentiometric-surface map indicate that the Facility and immediate vicinity are located in or west of a regional recharge area between discharge boundaries (ARCADIS BBL 2007c, GeoTrans 2008a).

5.1.6 Lower Arcadia Formation Sands Potentiometric Surface

Figure 5-6 shows the Lower AF Sands potentiometric surface as measured in March/April 2009. Groundwater elevations in the Lower AF Sands ranged from

5.1.8 Summary

The March/April 2009 sampling event was conducted during a period of significant drought conditions, exacerbating the already occurring dry season. This resulted in decreased water elevations in all of the monitored geologic layers and many of the surface water features. Regional groundwater extraction for water supply purposes from the AF Gravels, S&P Sands, and the Floridan also decreased groundwater elevations. As a result, decreased water levels were observed in these aquifer zones between the January/February

5.2 Horizontal and Vertical Distribution of Contaminants of Concern

Testing of subsurface conditions to date shows that the uppermost four water-bearing zones (USAS, LSAS, AF Gravels, and S&P Sands) contain COCs above GCTLs (resulting in a vertical extent of approximately 200 ft bgs or less). Figures 5-8A through 5-14C illustrate the distribution of each COC in each groundwater hydrostratigraphic zone. All figures were plotted using the contouring interval of the GCTL, 10×GCTL, 100×GCTL, and 1000×GCTL, as appropriate. The distribution of COCs is also fully described in the 2009 *GWMR* (included in Appendix C below). Analytical data from the March/April 2009 sampling event are presented in Tables 2-3 and 2-4 in Appendix C**.**

5.2.1 Contaminants of Concern Distribution in the Upper Surficial Aquifer System

The distribution of each COC in the USAS is shown on Figures 5-8A through F. In addition, Figure 5-8G superimposes the extent of COC concentrations above GCTL in the USAS. Representation of the 1,4-dioxane GCTL boundary extended further to the northeast of the Facility in 2009 as compared to 2008. This change is based on detections of this constituent in MW-62 and MW-65, as well as the removal of MW-14S, MW-16S, and MW-17S from contouring to create a more conservative contour. Representation of the 1,4-dioxane and 1,1-DCE GCTL boundaries south of the Facility are smaller in 2009 as compared to 2008. This change is primarily based on reduced detections of 1,1-DCE in MW-25 and of 1,4-dioxane detections in MW-75. Appendix C includes a more detailed description of these conditions.

5.2.2 Contaminants of Concern Distribution in the Lower Shallow Aquifer System

The distribution of each COC in the LSAS is shown on Figures 5-9A through F.
In addition, Figure 5-9G superimposes .0093 TOF5.0097 Ts.3(e85.3(097 Tsn(.0093 o97 Tsf.0093 (COC)0.9cion)4
L05.3(ns th)-5.2(e(LSA.t)-4.8 Onle)-5.8yTOF5.2(slFig)-5.2ht vagte GCT L oe

above GCTL in the AF Gravels. In the northeast and southeast portions of the Site, the 1,4-dioxane GCTL boundary line contours in 2009 show reductions in the surface area affected by this constituent as compared to 2008 results. A non-detect result at MW-248 in 2009 (above GCTL in 2008) was the primary reason for changing the boundary representation in the southeast. The change in the representation of the disconnected 1,4-dioxane plume boundary to the northeast is based on a non-detect result for the private well located at 2411 Tallevast Road (above GCTL in 2008). A reduction in the representation of the TCE GCTL boundary was made to the northeast due to a decrease in the TCE concentration detected at MW-135. TCE concentrations in MW-134 and EW-UAFG-1 (on the Facility) have increased. Appendix C offers a more detailed description of these conditions.

5.2.4 Contaminants of Concern Distribution in the Salt & Pepper Sands and Clay/Sand Zone 3 & 4

The distribution of each COC in the S&P Sands is shown on Figures 5-11A through F. Figure 5-11G superimposes the extent of COC concentrations above GCTL in the S&P Sands. For this unit, the representation of the 1,4-dioxane GCTL boundary changed due to a decrease in concentration at

observed subsurface conditions and thus enable the 3-dimensional computer model to better reflect groundwater flow and contaminant fate and transport near the Site.

6.1 Site Geology

The updated Site geologic understanding is described in Section 2.5, and additional detail is provided in the *Groundwater Modeling Report* presented as Appendix D. Figure 2-2, provided below, illustrates the Site's generalized geologic cross-section.

Figure 2-2. Conceptual Geological Cross-Section

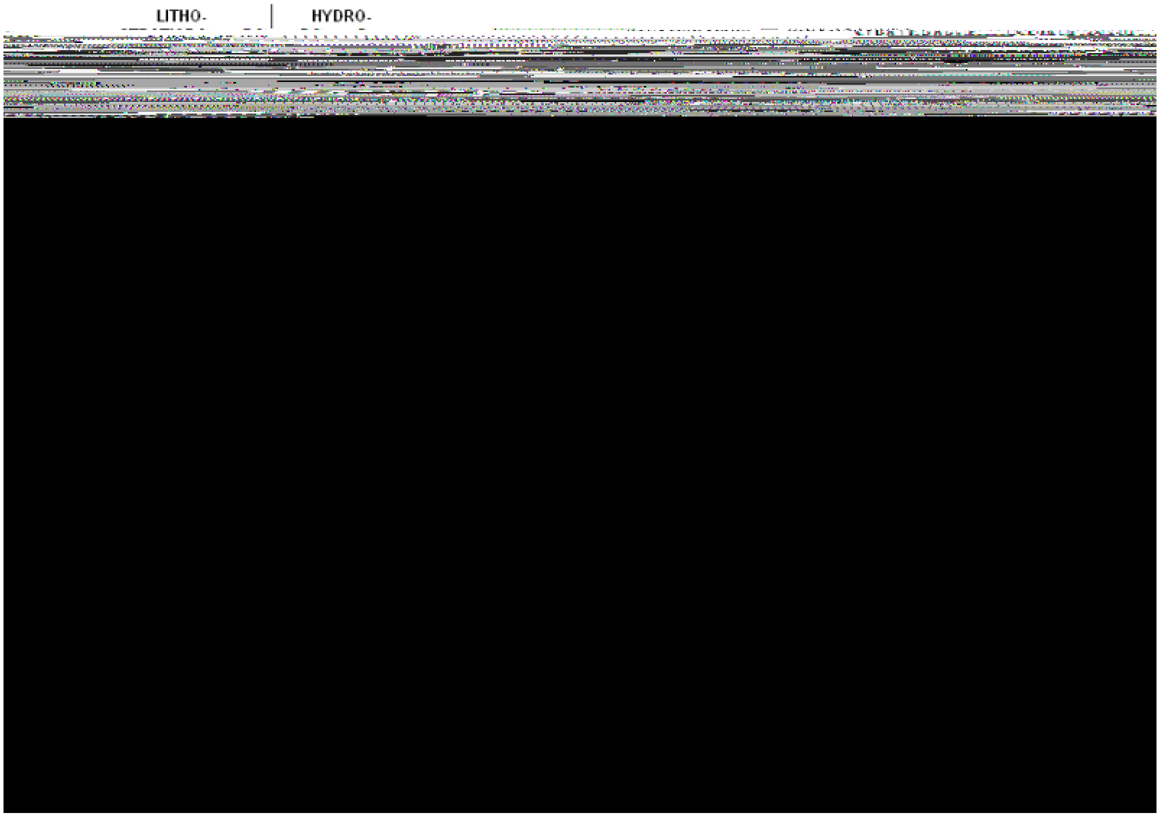

Figure 2-3 provides a detailed stratigraphic column. Summarized below are several recent updates to investigators' geologic understanding of the setting that will specifically affect the assessment and selection of a remedial alternative:

- The bottom portion (approximately the 5-foot interval above the Hard Streak) of the USAS is more clayey and finely laminated than the

LSAS is hydraulically confined. In addition, the middle portion of the LSAS acts as a confining, low permeability zone that causes the upper portion of the LSAS to respond differently than the lower portion. Although each of these low-permeability units represents an impediment to groundwater flow, particularly vertical groundwater flow, hydraulic testing of the various units indicates slight and variable hydraulic connectivity across these units.

Vertical hydraulic gradients are generally downward until the AF Gravels are

Degradation is another significant fate process for some of the COCs at the site, TCE in particular. This factor represents biological and chemical processes that decrease the mass of dissolved constituents including biodegradation, photolysis, oxidation-reduction, and hydrolysis. Chlorinated solvents typically degrade in anaerobic conditions, which are generally present at the Site, and the presence of daughter products such as cis-1,2-DCE, 1,1-DCE, and 1,1-DCA indicate that degradation is occurring. In addition, the biostimulation and bioaugmentation treatability study, described in Section 4.4.1, indicated that bacteria responsible for biodegrading chlorinated solvents have been detected in Site groundwater. Of the two primary COCs, TCE and 1,4-dioxane, TCE is subject to degradation and is included in the predictive assessment. Because 1,4-dioxane degrades slowly, and its degradation rate is not well understood, degradation of 1,4-dioxane was not considered a significant process.

For the simulations presented in this report, TCE was assigned a two year half-life. This value was selected based on prior experience at similar sites and literature-reported investigations. Note that in the conceptual fate and transport model, and its subsequent incorporation into the numerical model (see Section 9.3), the TCE half-life only applies to the *dissolved* phase of TCE. Degradation of TCE in the sorbed phase is assumed not to occur. Consequently, the effective half-life is equal to the half-life in the dissolved phase (2.0 yrs) times the retardation coefficient. The resulting effective half-life values for each of the contaminated aquifer layers are as follows:

- *USAS*: 11.6 years
- *LSAS*: 4.6 years
- *AF Gravels*: 3.2 years
- *S&P Sands*: 5.8 years

Numerical fate and transport modeling facilitated the further assessment of Site COCs in groundwater and evaluation of the effects of both physical and chemical processes on proposed remediation efforts. A discussion of the groundwater model and the results of this evaluation are presented in Section 9.

6.4 Distribution of the Contaminants of Concern

Potential historical COC source areas at the Facility include:

- A 1,000-gallon above ground storage tank used for solvent storage near the southeast corner of Building 1
- An area on the east and northeast side of former Building 5 where five sumps were located, and
- A hazardous material storage area in the southeast corner of former Building 5

the area of COC migration in the overlying, more permeable USAS, LSAS and AF Gravels. The lack of COCs detected in samples collected from the Clay/Sand Zones 1 & 2 suggests that COC migration through these confining units is through anthropogenic features (well bore holes) or discrete natural pathways. Groundwater sample results from permeable units below the Clay/Sand Zones 3 & 4 indicate that COCs have not migrated below these confining units, as no samples from these units were above GCTLs. This may be due to the low number of private wells that have been completed through the Clay/Sand Zones 3 & 4, as well as the consistency and thickness of these confining units.

7. Identification of General Response Actions and Remedial Technologies and Process Options

Applicable soil and groundwater standards, the extent of exceedances of those standards, and general response actions, remedial technologies or process options capable of addressing those exceedances are presented below.

7.1 Soil and Groundwater Cleanup Standards

In accordance with Chapter 62.780, F.A.C, the cleanup standards for soil are the default residential, commercial/industrial standards; the LTG SCTLs and groundwater cleanup standards are the default GCTLs (as referenced in Chapter 62.777, F.A.C.).

7.2 Extent of Soil Exceeding Cleanup Standards

The extent of soil that will be addressed by this *RAP* is limited to the Facility, as discussed in the *SARA 3* (BBL, 2006a). Soil samples collected on-facility that exceed the default residential, commercial/industrial, or LTG SCTLs are summarized in Table 7-1 and shown on Figures 7-1 through 7-7. The following is a summary of the COCs exceeding the default SCTLs in soil samples collecte-0.009gs or arexex(BBL, March 2006a)-5.61 Tc5.3627 0 TD-0.0085 Tc15.36

7.4 General Response Actions

General Response Actions (GRAs) are broad remediation approaches capable of achieving the Site RAOs. Some response actions are sufficiently broad to meet the remedial objectives alone, but usually combinations of response actions are required to address varied site conditions and meet all the remediation objectives. The identification of GRAs involved a focused review of available literature, including the following documents:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (USEPA, 1988)
- *Treatment Technologies* (USEPA, 1991)
- *Remediation Technologies Screening Matrix and Reference Guide, Version 3* (Federal Remedial Technologies Roundtable, 1997)
- *Technical and Regulatory Guidance for* In Situ *Chemical Oxidation of Contaminated Soil and Groundwater* (Interstate Technology Regulatory Council [ITRC], 2005)
- *Treatment Technologies for 1,4-Dioxane: Fundamentals and Field Applications* (USEPA, 2006)

These documents, along with remedial technology vendor information, applicable regulatory requirements, and other available information, were reviewed to identify the GRAs and their remedial technologies or process options that are potentially applicable for addressing COCs in soil and groundwater and the RAOs. General response actions and their remedial technologies and process options were also selected to address on-facility groundwater containing COCs at the highest concentrations (hot spots). The GRAs and their remedial technologies and process options are listed below by media (soil, Site-wide groundwater, and groundwater hot spots):

SOIL

- No further action (NFA)
- Institutional controls
- Engineering controls
- Monitoring

GROUNDWATER –– Hot spots

- *In situ* treatment
    - Enhanced biological degradation (EBD)
    - In situ chemical oxidation (ISCO)
    - Electrical resistive heating (ERH)
- Groundwater recovery
    - Focused groundwater extraction and injection wells
    - Dual-phase extraction (DPE)
- Removal
    - Excavation

7.5 Description of the GRAs, Remedial Technologies and Process Options

A description of potentially applicable remediation technologies and process options is provided here:

SOIL

No Further Action - No further action (NFA) without controls, Risk Management Options I, as specified in Rule 62-780.680(1), F.A.C., is not an acceptable remedial option for the soils identified in Section 7.2 because Site conditions do not meet the criteria specified in the rule. However, NFA with institutional and engineering controls, Risk Management Options Level II as defined in Rule 62-780.680 (2), F.A.C., may be an acceptable remedial option to address the extent of soils identified in Section 7.2. This option was proposed in the *SARA 3* and the previous *RAPs*. In accordance with this rule, the remedial option is acceptable provided that institutional and engineering controls protect human health, public safety, and the environment and they are agreed to by the current real-property owner(s) that will be affected by them. Other conditions that must be met (i.e., demonstrated to FDEP) for this to be an acceptable remedial process option include:

1. No free product is present and no fire or explosive hazard exists as

2. COC concentrations in soil do not exceed the default commercial/industrial SCTLs, as specified in Rule 62-780.680(2)(b)1a. F.A.C.

3. If an engineering control preventing human exposure (for example, permanent cover material or a minimum of two feet of soil) is implemented, the COC concentrations in the soil below the permanent cover may exceed the direct exposure SCTLs, as specified in Rule 62-780.680(2)(b)1b. F.A.C.

4. Direct leachability testing results can demonstrate that leachate concentrations do not exceed the GCTLs, as specified in Rule 62-780.680(2)(b)2b. F.A.C.

5. If an engineering control that prevents infiltration (for example, permanent impermeable cover material) is implemented, concentrations of COCs in the soil below the impermeable cover may exceed the LTG SCTLs, as specified in Rule 62-780.680(2)(b)2c. F.A.C.

4 2 6. Previous Site assessments, remedial action inp-mTvimap0m F.ous rifie-sv07(ple)-5i1trverneS5.5(ncsuou

conservation easement. Each of these documents must be properly recorded with the appropriate county's land records to help ensure proper notice and effectiveness of the control. As indicated above, institutional controls are necessary to meet the requirements under Risk Management Option II Lockheed Martin has provided FDEP draft terms of a restrictive covenant as a potential remedy to address Facility soils containing COCs above the default residential SCTL.

Engineering Controls— Engineering controls, such as impermeable barriers (i.e., caps), slurry walls, or other controls are designed to limit access and exposure to contamination, or are designed to eliminate further contaminant migration. Where an engineering control is necessary, institutional controls may need to be imposed to ensure that engineering controls are properly monitored and maintained, and that the FDEP has access to inspect the engineering controls. As indicated above, engineering controls are necessary to meet the requirements under Risk Management Option II. Existing asphalt pavement or building slabs, as well as new pavement or building slabs, are considered to prevent exposure to or infiltration of the remaining soil that is above the default commercial/industrial or LTG SCTLs, respectively. A soil cap has not been considered because it would require removing the soil that

not degrade or else has a very long half-life, and the existing Site data do not dioxide, water, and chlorides. Several different reagents are effective at treating the Site CVOCs and 1,4-dioxane, including Fenton's reagent (peroxide and iron), peroxide plus ozone, and activated persulfate. The formation of the hydroxyl radical from peroxide using either iron, ozone, or the persulfate radical is necessary to oxidize 1,4-dioxane. Before submitting the *RAP* in 2008, persulfate was selected for bench and pilot scale testing. Fenton's reagent and peroxide plus ozone were not selected because far more of the oxidant is consumed by the natural soil oxygen demand (i.e. carbonates) than activated persulfate. Accordingly, activated persulfate is much less likely to dissolve the large amount of carbonate present in the Hard Streak or clays.

As presented in Section 4.4, the results from the bench and pilot scale tests with activated persulfate indicate that it effectively treated the COCs in the subsurface and achieved an effective injection radius of approximately 7.5 ft. Test results also indicate that multiple injections would be required to reduce concentrations below GCTLs. The pilot study revealed that injection of persulfate temporarily mobilized naturally occurring metals (arsenic and chromium) in the formation. The mobilization of these metals was not observed beyond the zone of injection. Based on the pilot scale test, treatment of the entire plume in the USAS wide would require a total activated persulfate injection volume well in excess of a million gallons. Adequate precautions must be taken when handling, mixing, and transporting powerful oxidants. This remedial technology is considered further in Section 8.

<u>Electrical Resistive Heating (ERH)</u>— ERH enhances the removal of COCs in the subsurface by heating the subsurface sufficiently to volatilize the compounds and recover them with a vacuum extraction system. Although this technology is effective at removing CVOCs, it is less effective at removing 1,4-dioxane, because a large percentage of the mass is removed via the vapor stream. Thionuoionue4-5. ((e)-5hmedi)5va ((e)-ii)-6 etr7(ea e)live Heat.2787 TD-0.0101 Tc0 Tw006 Tw[(subsurfac

Extraction Trenches— Shallow extraction trenches are relatively easy to install and may be more effective at groundwater removal than vertical wells because they are capable of connecting more transmissive channels and zones within a heterogeneous aquifer. A Dewind - trenching machine is being considered as the method for constructing extraction trenches in the USAS. The trenching machine can install a trench, extraction pipeline, and backfill in one operation and should be capable of reaching the bottom of the USAS in most areas without extensive benching (i.e., excavation to place trenching equipment before excavating the trench). One excavation is relatively quick (up to 200 feet per day (ft/day)), reducing construction time compared to other trenching technologies. An approximately 50-ft-wide unobstructed path is necessary to dig an extraction trench.

Trench construction into the LSAS could not be practically done with a one pass trencher because the Hard Streak would slow down the cutting, significant benching would be required to reach the LSAS, and it would be very difficult to ensure that the finished LSAS trench is adequately isolated from USAS. Driving sheet-piling is a more conventional method for installing a deep trench and ensuring its isolation from shallower zones; however, the Hard Streak would resist sheet-pile driving or make installation of other isolation walls difficult and time consuming, and produce a large volume of construction waste. As a result, extraction trenches are only considered for use in the USAS and not in any of the deeper water bearing zones.

Extraction trenches may be preferable in areas where large continuous lobes of relatively higher COC concentrations are encountered, such as the southwest and southeast portions of the USAS plume. The extraction trenches can reduce the number of wells necessary for hydraulic capture and mass removal, thereby reducing the number of associated extraction appurtenances such as pumps and pump controls. Accordingly, the same benefits offered by extraction trenches can also be disadvantages, because trenches offer less operational control of the groundwater extraction system over the life of the rates at each well can be individually controlled to optimize capture and control drawdown. Wells can be shut off as more distant areas of the plume with low COC concentrations are cleaned up. Extraction wells also require less space and produce less construction waste to install than extraction trenches.

Dual Phase Extraction— DPE, also known as multi-phase extraction, uses a high vacuum system to remove both contaminated groundwater and soil vapor. Fluid/vapor extraction systems depress the water table so that water flows faster to the extraction well. Although DPE dewaters the aquifer, volatile contaminants can also be removed by extracting the soil vapor. Once above ground, the extracted vapors and groundwater are treated. This technology is difficult to implement because it requires a large volume of groundwater to be removed to subject the source of USAS contamination to vapor extraction. Most contamination in the USAS exists below 20 feet or more of clean or relatively uncontaminated groundwater. Once the clean layer of groundwater is removed, CVOCs will migrate to the shallow soil zone, thus increasing the

Liquid Phase Granular Activated Carbon (LPGAC)— Liquid phase granular activated carbon adsorbs relatively small quantities of soluble organics and some inorganic compounds. Adsorption occurs when molecules adhere to the

be carefully handled and managed. ISCO may also mobilize metals that may

  - Vapor phase granular activated carbon (VPGAC)
- Groundwater discharge
  - Discharge of untreated groundwater to publicly owned treatment works (POTW)
  - Recharge galleries and extraction wells (retained for remedial scenarios, not evaluated in Section 8)

GROUNDWATER— Hot Spots

- *In situ* treatment
  - Enhanced biological degradation (EBD)
  - *In situ* chemical oxidation (ISCO)
  - Electric resistive heating (ERH)
- Groundwater recovery
  - Focused groundwater extraction and injection wells
  - Dual-phase extraction (DPE)
- Removal
  - Excavation

8. Selection of Preferred Remedial Alternative

In accordance with the criteria provided in Rule 62-780.700 F.A.C., potentially applicable GRAs, remediation technologies, and process options were evaluated on the basis of feasibility, implementability, long-term human health and environmental effects, short-term human health and environmental effects, operability, maintainability, reliability, cleanup time, and cost effectiveness. A historical practice in Florida and referenced against published guidance from the USEPA.

These characteristic criteria components were structured so that true/false logic can be applied when the speciff e0 /TT2 re7873gic e0t5.2(specica)-5.2(n b32-6.6(hara)75.1(c)-1.1.6(f)-1ishe

Characteristic Components by Criterion

The following are the interpretations applied to each of the evaluation criteria listed in Rule 62-780.700*(3)(d)2.a. through g., F.A.C.* These are structured as statements against which applicable technology attributes can be assessed using “true/false” logic. Since relatively few environmental remediation measures can be asserted effective in an absolute sense, evaluating them entails making relative comparisons among the spectrum of technologies

- Does not require access to numerous parcels of private property
- Does not cause significant disruption of community or locale
- Does not require extraordinary measures to sustain

Long-Term Human Health and Environmental Effects

Characteristic components of this criterion are:

- Direct human exposure pathways are precluded
- Post-remediation residual contamination is below harmful levels, or isolated
-

Cleanup Time

The component characteristics of the relative time to achieve cleanup are:

- Limited basis for third parties to delay start up
- Lengthy interruption of operation unlikely
- Reasonable confidence that cleanup times can be predicted
- Does not cause conditions that would require lengthy post remediation monitoring
- No major unknowns that, if encountered, could cause indefinite delay

Cost Effectiveness

The characteristic components of cost effectiveness are:

- The ratio of capital cost to mass of contaminant ultimately removed (or sequestered) in dollars per pound ($/lb) is less than the statistical median of the cost effectiveness ratios of the technologies considered
- The ratio of life-cycle operating cost to mass of contaminant ultimately removed (or sequestered) in $/lb is less than the statistical median of the cost effectiveness ratios of the technologies considered
- The ratio of life-cycle maintenance cost to mass of contaminant ultimately removed (or sequestered) in $/lb is less than the statistical median of the cost effectiveness ratios of the technologies considered
-

Weighting Factors

These evaluation criteria were given weighting factors that reflect the level of emphasis in selecting a preferred alternative. Long-term and short-term human health and environmental effects were given the greatest emphasis and weighted at 5; time to achieve cleanup and feasibility were assigned a weighting factor of 4; all remaining criteria were assigned a weighting factor of 3.

8.2 Discussion of Ranking Considerations

SOIL

No Further Action (NFA)

No further action without controls as a process option for soil has a low composite score (ranking) because it does not remove mass or reduce migration of COCs nor do conditions on the Facility currently exist that are protective of human health or the environment. Since current conditions on the Facility do not meet the criteria set forth in Rule 62-780.680(1), F.A.C., it would short-term risk to implement. As indicated in Section 7, if excavation on Facility was implemented to address soil above default residential SCTLs most of the surface soil on Facility would have to be removed. As a result, excavation is not retained as the major element of any remedial strategy for soil on the Facility. However, some soil excavation is contemplated to install groundwater recovery and treatment systems and a soil management plan would be implemented to minimize potential short-term risk as a result there of.

GROUNDWATER – Site-wide

No Further Action (NFA)

The proposed active groundwater remedial alternative is intended to

Liquid Phase Granular Activated Carbon (LPGAC) – LPGAC scores higher as an auxiliary treatment technology than it does as a primary system. It is effective for removal of VOCs, of limited value in removing 1,4 dioxane, and ineffective in removing dissolved metals. It poses no hazard to human health or the environment, it is easy to construct, easy to operate and maintain, is very reliable and cost effective.

Advanced Oxidation Process (AOP) –This technology obtained a high composite score because it is very effective at reducing the COCs in groundwater to below GCTLs, it is simple to operate, easy to maintain, has demonstrated a high degree of reliability, poses the least threat to human health and the environment, and is cost effective. Further, this technology reduces contamination by permanently destroying most of the COC mass in the groundwater.

Groundwater Disposal

Discharge to POTW— This technology scores high for disposal of treated water but low for disposal of contaminated groundwater.

Groundwater Hot Spots

In Situ Treatment

Enhanced biological degradation (EBD), *in situ* chemical oxidation (ISCO), and electrical resistive heating (ERH) are more feasible for hot spot treatment than the site-plume because they require much less infrastructure, chemical/energy and are less intrusive. In small areas of high concentrations of COCs, *in situ* methods are sometimes preferred, however, all of the same criteria must be considered. Generally, *in situ* methods do not by themselves arrest the spread of contaminants and can produce adverse collateral impacts (e.g. mobilization of metals) thereby reducing their feasibility, may exacerbate short term human health and environmental effects, can be difficult to control and maintain, are not always reliable, and aren’t necessarily the most cost effective approach. Furthermore, there have been instances in which the subsurface formation is affected in a way that makes subsequent efforts to remove or treat groundwater more difficult.

technology, because it does not effectively remove 1,4-dioxane and because it would transfer the COCs to the air phase, where they would require additional treatment before discharge to the atmosphere. The specific elements of preferred groundwater remedy are described further in Section 8.3.2.

8.3.1 Soils Retained Alternative

FDEP approved the *SARA 3* (BBL, 2006a) in a September 25, 2006 letter, in which the agency acknowledged that Lockheed Martin would address on-facility soil through a combination of engineering and institutional controls, in accordance with Rule 62-780.680(2) F.A.C. Institutional controls include a “Declaration of Restrictive Covenant” for the Facility prohibiting certain uses of the property and requiring appropriate soil management disposal practices to protect the health and safety of on-facility workers. Fencing around the Facility and existing or new buildings or pavement constitute the engineering control. FDEP concluded in its approval letter that no further action is required for soil beyond the former ABC Facility property. Lockheed Martin understands that a final “Site Rehabilitation Completion Order” (SRCO) for the Site will not be issued until all impacted media achieve media cleanup goals.

8.3.2 Groundwater Retained Alternative

The remedial technologies identified for groundwater include:

- Hydraulic containment of groundwater in the upper four water-bearing zones containing COCs at concentrations greater than GCTLs, using extraction wells and trenches
- Treatment of extracted groundwater using AOP, with GAC polishing
- Discharge of treated groundwater to the POTW and recharge galleries
- Groundwater recharge using infiltration galleries around wetlands, where groundwater withdrawal from the USAS may impact such areas
- Focused pumping and injection of treated groundwater in on-facility areas of highest COC concentrations in the USAS

Focused flushing in the USAS will also produce the beneficial effect of promoting flushing in the LSAS. Injecting treated water into the USAS will

layout of the groundwater technologies was based in part on information generated from the three-dimensional groundwater model and evaluating existing IRA treatment data. Development of the groundwater model and its use in the development of the preferred alternative are discussed in Section 9 and Appendix D.

9. Groundwater Modeling

GeoTrans, Inc. (GeoTrans) developed, calibrated, and used a three-dimensional computer model of groundwater flow, complemented by solute transport modeling, to simulate the recommended groundwater remedial alternative, support the design of the alternative, and estimate remediation time frames. *MODFLOW-2000* (Harbaugh, et al, 2000a and 2000b) was used to simulate groundwater flow and *MT3DMS* V 5.2 (Zheng C., 2006) was used to simulate solute transport. Groundwater flow and s11.6l(Hf)0.2(gc7aGd)-5.4(T*[.uswat)-5.wa1(e)0 information.2na-

observed in wells screened at different depths in the LSAS. The remaining permeable zones (AF Gravels, S&P Sands, and Lower AF Sands) are each represented by a single model layer. The Venice Clay is simulated using two layers to facilitate the solute transport modeling. All other less permeable units are represented by a single model layer.

The groundwater flow model was subjected to a several step calibration and confirmation or validation process:

1) The model was initially calibrated in steady-state mode using groundwater elevation data collected on December 28, 2006. Overall calibration statistics indicated that the residual standard deviation was less than 10 percent of the observed range in target hydraulic head values.

2) Next, the groundwater flow model was calibrated in transient mode to drawdown observed during the seven-day aquifer pumping test conducted in January 2008 at well EW-UAFG-1 (see Section 4.3.2.2). Again, the overall residual standard deviation was less than 10 percent of the observed range in target drawdown values.

3) The model was subjected to additional qualitative checks using tracer testing and IRA system performance data obtained in spring 2008.

4) A sensitivity analysis was performed to further improve the model calibration statistics. No significant improvement was achieved through the parameter perturbations applied.

5) The final groundwater flow model was successfully checked against March/April 2009 groundwater elevation data, and off-facility water supply pumping influences were included, improving the model’s fit to measured data and confirming that it can accurately simulate this additional new data set.

The groundwater flow model was therefore considered adequately calibrated and verified to meet its objectives. Details of model calibration and validation, including tables and plots of the residuals, a description of the sensitivity analysis procedure, and summaries of the qualitative and quantitative validation checks are provided in Appendix D.

GTCL of the composite plume. Particle-tracking analyses were also performed to verify the success of each hydraulic containment scenario.

Figure 2-1 presents wetlands and ponds in the Site area. Three wetlands/ponds could be affected by the drawdown in the USAS. To mitigate impact to surface water bodies and wetlands, simulations were run with strategically placed injection trenches or wells which would recharge treated groundwater back into the USAS, to prevent dewatering near ponds, drainage ditches, wetlands, and other strategic locations (see Appendix G for details of how the potential for dewatering will be evaluated). Since the ponds on the golf course are manmade, the assumption was made that these could be lined if necessary. In contrast, it was assumed that the three wetland/pond locations indicated on Figure 9-5 would be artificially recharged via infiltration trenches to maintain their water level hydroperiods.

The recommended groundwater management alternative, consisting of groundwater extraction and recharge, is summarized in the tables below. The scenario includes extraction in all four targeted aquifers, limited on-facility re-injection for enhanced flushing in the USAS, and recharge of groundwater near the three locations indicated on Figure 9-5. Approximately 200 gpm will be extracted at full system operation. Approximately 10 gpm will be reinjected at the Facility, and 48 gpm will be recharged at the pond/wetland areas during system operation.

Table 9-1: Proposed Remedial Action Alternative Extraction and Recharge System

Extraction Wells and Trenches

Unit	Number of extraction wells/Trenches	Extraction Rate (gpm)

Injection Wells

Unit	Number of injection wells	Injection Rate (gpm)

running (see Section 9.4 below for more information on this simulation), and a subsequent period with the full RAP system operational. The groundwater flow model- simulated the anticipated IRA system pumping for the initial 3-year period, using recently measured average rates as the presumed operational values. The solute transport model simulated that same 3-year period, with the COC concentrations from the end of this simulation used as the initial concentrations for full RAP system implementation simulation.

The groundwater flow model was then used to simulate the hydraulic responses of the groundwater flow system to the full RAP system, including focused flushing with injection-extraction in on-facility “hot spot” areas and control of wetland-pond water levels through groundwater recharge of treated effluent. Progressive shut-down of extraction wells and trenches was simulated, in 5-year increments, to help reduce the time to reach GCTLs by avoiding creation of stagnation points. The flow fields simulated in the flow model were used by the solute transport model for predicting the rate of plume capture and mass extraction.

three units, GCTLs are predicted to be achieved in 39 years or less. Modeling observations include:

- Significant portions of the contaminant mass are predicted to be removed within the first five years of extraction.
- Focused flushing within the most impacted groundwater area on-facility produce adequate “hot spot” remediation.
- Shutting off select wells and collection trenches as the cleanup proceeds decreases the time to reach GCTLs in comparison to running all extraction wells and trenches for the full duration.

As shown in Table 21B of Appendix D, the model simulation for the proposed recovery and treatment system predicts that approximately 67 percent of the TCE and 53 percent of the 1,4-dioxan.2732549nou1l(TCEc0.0002 Tw6393 -1 0 eatmenLsm-6.w62x..4536 0 T1,4-)6.5.5(fi)-t

Figures 9-7 through 9-16, indicate that only in two units do the predicted 2012 GCTL boundaries extend beyond the 2009 boundaries: 1,4-dioxane in the USAS (Figure 9-7), and 1,4-dioxane and TCE in the upper portion of the LSAS (Figures 9-9 and 9-10). As these three figures show, the 2012 predicted GCTL extents still fall well within the groundwater recovery system's predicted capture zones. Of these three predicted 2012 extents, only 1,4-dioxane in the upper portion of the LSAS (Figure 9-9) may extend beyond the existing most downgradient monitoring well (MW-105) currently proposed for annual sampling (see Section 13). Past sampling events have indicated that no COCs have been detected in MW-105. If detectable concentrations of COCs are ultimately found in MW-105, remedial action monitoring well(s) and location(s) can be proposed during the annual reporting event, to install monitoring well(s) further downgradient, if necessary.

9.5 Groundwater Modeling Future Use

The selected remedial strategy involves groundwater extraction focused along the areas with higher COC concentrations, to minimize the time needed to reach GCTLs, while continuously maintaining containment. The model will be used particularly during implementation and operation of the RAP system, to evaluate remediation progress and further improve the extraction strategy as the area of groundwater above GCTLs decreases.

10. Remedial Action Design

An overview of the selected remedial alternative was presented in Section 8 and evaluated with respect to FDEP criteria. For soils, "No Further Action with Controls" is the selected remedial alternative. For groundwater, the existing IRA groundwater recovery, treatment, and discharge system will be replaced with an expanded system that will include 77 extraction wells and four trenches to recover impacted groundwater throughout the Site. The groundwater treatment system incorporates the following elements:

- A more robust pretreatment approach to remove metals, including oxidation, metals precipitation, media filtration, and membrane filtration
- Advanced oxidation to destroy organic contaminants
- Granular activated carbon adsorption polishing to remove organics

to the existing building or paving footprint will be done with the concurrence of FDEP. Draft terms of the restrictive covenant will likely be as follows:

a) Generally, there shall be no agricultural use of the Facility, including forestry, fishing, and mining; no hotels or lodging; no recreational uses, including amusement parks, parks, camps, museums, zoos, or gardens; no residential uses; and no educational uses, such as elementary and secondary schools, or day care services.

b) Excavation is not prohibited within the Facility, provided that any contaminated soils that are excavated are removed and properly disposed of pursuant to Chapter 62-780, F.A.C. (or subsequent Site cleanup criteria rule(s)) and in accordance with the soil management plan described in Section 11. Reasonable construction methods and techniques shall be employed to minimize risk of exposure. Nothing herein shall limit or conflict with any other legal requirements regarding construction methods and techniques that must be followed to minimize risk of exposure while working on the Facility.

c) Engineering controls currently in place or planned to minimize infiltration in soil areas containing COCs at concentrations greater than industrial/commercial use or leachability criteria must be restored if they are disturbed.

d) To monitor the restrictions contained herein, FDEP or its respective successors and assigns shall have access to the Facility at reasonable times and with reasonable notice to the owner.

10.2 Groundwater Remedial Action

The proposed remedial action plan would replace the existing IRA groundwater recovery, treatment, and discharge systems for the Site with an expanded system. The design criteria/details of the new system are provided in this section and are shown in drawings as described below:

Figure 10-2	Extraction Well and Extraction Trench Locations— an overall Site plan showing the extraction network.

Figure 10-30	General Arrangement Plan— orientation of major process equipment in the treatment system.
Figure 10-31	Proposed Treatment Building, East-West Section— major equipment and Building features including typical foundations.
Figure 10-32	Proposed Treatment Building, North-South Section— major equipment and Building features including typical foundations.

10.2.1 Extraction System Design

The proposed extraction and recharge system consists of:

- Four extraction trenches and 37 extraction wells installed in the USAS, to the top of the Hard Streak. Of the 37 wells, five will replace existing USAS extraction wells that will be subsequently abandoned.
- Twenty-seven LSAS extraction wells. Of the 27 wells, five will replace existing LSAS extraction wells that will be subsequently abandoned.
- Eleven AF Gravels extraction wells, including an existing AF Gravels extraction well on-facility.
- Two S&P Sands extraction wells.
- Five on-facility injection points installed in the USAS, to recharge treated groundwater and flush the USAS source area.
- Three off-facility recharge galleries installed in the USAS near potentially affected wetlands, where treated groundwater can be recharged to sustain the hydroperiods of those wetlands.

The proposed extraction network is shown on Figure 10-2. Greater detail is depicted on Figures 10-3 and 10-4, which include general utility trench routing. Typical utility trench sections, extraction well and trench details, injection well and recharge gallery details, extraction system vault details, and recharge system vault details are shown on Figures 10-5 through 10-10.

Upper Surficial Aquifer System

Groundwater extraction will be achieved using a combination of vertical wells and horizontal trenches. A Dewind-type trenching machine will be used to construct the trenches because it can rapidly excavate trenches to the required dimensions, thereby minimizing short-term exposures and construction disruptions. The five existing IRA USAS extraction wells will be properly abandoned by a Florida-licensed driller. New extraction wells will be installed near the location of the respective abandoned extraction well, using the well construction proposed in this *RAP*. This will allow the existing system to be used as long as possible while construction of the full-scale RAP system is completed. Additionally, the proposed extraction-well construction described in Section 10.2.1.2 below offers a number benefits over the existing extraction well design, including:

- Stainless-steel continuous wire-wrapped screens to provide better connectivity to the aquifer formation than the slotted well screens now used. Continuous wire-wrapped screens typically have an open area

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within 300 to 400 feet of each other, the VFDs for those wells may be co-located in a single electrical cabinet so that the above-ground equipment may be minimized. Data from the VFD and water level transducer, in addition to flow rate and total volume of groundwater extracted from each extraction well and trench, will be logged at the central control panel located at the treatment facility. Design details are provided below.

Equipment

1. Submersible Well Pumps

USAS Well Pumps	(P-2001 - P-2037)
LSAS Well Pumps	(P-3001— P-3027)
AF Gravels Well Pumps	(P-4001— P-4011)
S&P Sands Well Pumps	(P-5001 and P-5002)
Manufacturer:	Grundfos, or equal
Model:	5S05-13
Type:	Electric Submersible
Quantity:	77
Horsepower:	0.5 – 0.75
Flow Rate:	1.6 gpm @ 175 ft total dynamic head (TDH) to 2.0 gpm @ 200 ft TDH

2. Submersible Well Pumps

USAS Extraction Trenches	(P-2101— P-2104)
Manufacturer:	Grundfos, or equal
Model:	25S15-9
Type:	Electric Submersible
Quantity:	4
Horsepower:	1.5
Flow Rate:	20 gpm @ 185 ft TDH

10.2.1.5 Transmission System Construction

Groundwater from extraction wells and trenches will be conveyed to the treatment facility within sub-grade dual-containment piping. All such dual-containment piping from will be made of HDPE pipe. Carrier piping will have a minimum 160 psi pressure-rating (SDR-11) and the containment piping will have a minimum 100 psi pressure-rating (SDR-17). All pipe and fitting joints will be butt-welded. The containment and carrier piping will be pressure-tested before the system is commissioned. Groundwater conveyance system routing from the extraction wells and trenches to the treatment system is depicted on Figure 10-3 for the off-facility extraction wells and trenches, and on Figure 10-4 for the on-facility extraction wells.

10.2.1.6 Utilities Trench Installation

Utility trenches between the treatment facility and the extraction wells, trenches, recharge galleries, remote electrical control panels are depicted on Figure 10-3. Utility trenches between the treatment facility and the on-facility extraction wells are depicted on Figure 10-4. These trenches will contain some or all of the following utility conduits:

1. Dual containment piping to convey groundwater to the treatment building
2. Single-wall piping to convey treated water to discharge to the POTW, on-facility injection wells, and off-facility recharge galleries
3. Electrical power (230V 3 phase)
4. Electrical control (24VDC)
5. Optical fiber communication

Generally, process water lines (dual-containment piping) will be installed below electrical and optical fiber conduits. The top of the dual-containment piping will typically be installed at least two feet below ground surface, while the top of electrical power, controls, and communication conduits will all be installed at least 18 inches below ground surface. A magnetic marking tape will be installed above the conduits, and the trench will be backfilled to the surface. Above-grade trench surfaces will be restored with original cover upon completion.

10.2.1.7 Influent Concentrations

The remediation system’s estimated combined influent concentrations are based on groundwater analytical results obtained during the March 2009 monitoring well sampling event. Calculation of the “flow-weighted” influent concentration was performed as follows:

1) Sixteen existing monitoring wells distributed across the area of the

1,1-DCA	40
PCE	40
cis-1,2-DCE	30
1,1-DCE	90
Total Iron	9,200
Total Aluminum	180

Based on these analytical results, the key constituents to be removed by the treatment system design were identified as TCE, 1,4-dioxane, 1,1-DCA, iron, and aluminum. TCE and 1,4-dioxane were identified as the key constituents

- A robust pretreatment approach to removing metals, including oxidation, metals precipitation, media filtration, and membrane filtration
- Advanced oxidation to destroy organic contaminants
- Granular activated carbon adsorption polishing to remove residual organics
- Discharge of treated groundwater to the POTW, on-facility injection wells, and off-facility recharge galleries
- [

10.2.2.1 Pretreatment Metals Removal

The metals removal pretreatment system for the RAP system will consist of a multi-phase process to remove aluminum, iron, and other metals. The system will consist of pH adjustment, oxidation, gravity settling, primary multimedia filtration, and secondary ultra-filtration. This pretreatment system is expected to consistently reduce concentrations of metals below both the GCTLs and the IUD permit levels. Iron concentrations are expected to consistently remain below 0.3 mg/L, which will increase the performance of the AOP (used to destroy VOCs and semivolatile organic compounds (SVOCs)). Operating the AOP with iron concentrations at these low levels will reduce the potential for iron to precipitate and will allow the AOP to operate at close to neutral pH.

10.2.2.1.1 Aluminum Oxidation and Settling

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to the PLC. The pH of the water will be adjusted to approximately 8.5 S.U., to specifically target the oxidation of iron.

Equipment

1. Sodium Hydroxide Metering Pump (P-700B)

Manufacturer:	Grundfos, or equal
Model:	DME 12-6 A-PP/E/C-F-21RRB
Type:	Diaphragm
Quantity:	1
Flow Rate:	0.0032gph— 3.17gph @ 85 psi

2. Solids Contact Tank (T-120)

Manufacturer:	Belding Tank, or equal
Model:	C-CKV
Type:	Vertical Cone Bottom
Storage Capacity:	3,390 gallons
Materials of Construction:	Fiberglass Reinforced Plastic
Mixer:	28-inch diameter, dual paddle
Quantity:	1

3. Secondary Settling Tank Splitter Box (T-130)

Manufacturer:	Plasti-Fab, Inc., or equal
Model:	custom
Type:	Dual Weir
Storage Capacity:	270 gallons (minimum)
Materials of Construction (Basin):	Fiberglass Reinforced Plastic
Materials of Construction (Gates):	316L Stainless Steel
Quantity:	1

4. Secondary Settling Tanks	(T-140A and T-140B)
Manufacturer:	Belding Tank, or equal
Model:	C-CKV
Type:	Vertical Cone Bottom
Storage Capacity:	7,470 gallons (minimum)
Materials of Construction:	Fiberglass Reinforced Plastic
Quantity:	2

10.2.2.1.3 Aeration System

A continuous recirculation and inline aeration system will increase the dissolved oxygen content of the process water in the aluminum and iron oxidation and settling systems. Increasing dissolved oxygen in the process water will oxidize aluminum and iron. As mentioned previously, oxidation of aluminum and iron will occur in separate treatment processes, at specific pH levels to target efficient oxidation of the desired metals.

The aeration system will consist of two end-suction centrifugal pumps and two inline aerators. During normal operations, one pump and two aerators will be used and the second4.5( )5xiconrl5 c( )l1(i)-0.1(i5.5(coiecon)-5 st.5(and)-5-busl)-5..dne pu mps d(e)(pste)u)-5(m)-

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Equipment

1. In-Line Aerator (A-150A and A-150B)

Manufacturer:	Purifics
Model:	P7A-802
Type:	Inline Ceramic-Membrane
Air-Flow Rate:	1.75 cubic feet per minute (cfm) (maximum)
Water-Flow Rate:	26.4 gpm (maximum)
Quantity:	3 (2 installed, 1 spare)

2. Aerator Recirculation Pump (P-150A and P-150B)

Manufacturer:	Goulds Pump, or equal
Model:	1ST1G5B4F
Type:	End Suction Centrifugal
Quantity:	2
Horsepower:	2
Flow Rate:	30 gpm @ 108ft TDH

10.2.2.2 Filtration System

After passing through the iron oxidation and settling phases of the treatment system, process water will flow via gravity from the secondary settling tanks to the filter feed tank. Three pumps, in parallel, will pump process-water in the filter-feed tank through the filtration system. Each pump will feed a filtration train consisting of a media filter and an ultra-filtration unit. Each filtration train is designed to operate at a maximum flow rate of 100 gpm. During normal operations, when the treatment system flow-rate is approximately 200 gpm, only two of the three filtration trains will be in use; the third will remain in standby. However, during high flow conditions, when the treatment system flow rate is above 200 gpm, all three skids will be used.

The filter feed tank will be made of FRP, with a 3,340-gallon capacity. The tank’s exterior base will be flat; however, the interior tank base will be sloped toward the pump suction, so solids will not accumulate on the tank bottom.

End-suction centrifugal pumps will pump water from the tank through the filtration system. The pumps will use a clean water seal/flush system to reduce solids fouling the pump seal, thereby reducing pump maintenance and increasing pump reliability.

Equipment

1. Filter Feed Tank (T-200)

Manufacturer:	Belding Tank, or equal
Type:	Vertical w/sloped interior base
Model:	C-CFV
Storage Capacity:	3,340 gallons
Materials of Construction:	Fiberglass Reinforced Plastic
Quantity:	1

2. Filter Feed Pumps (P-200A, P-200B and P-200C)

Manufacturer:	Goulds Pumps, or equal
Model:	10SH2L52B0
Type:	End Suction Centrifugal w/ Continuous Clean Water Seal/Flush
Quantity:	3
Horsepower:	10

procedure during high flow conditions (with all three vessels operating) requires a brief reduction in overall treatment flow rate, since one of the filter skids will have to be shut down to permit backwashing.

As previously noted, the filters will use an automatic backwash system that will

Equipment:

1. Media Filters (F-210A, F-210B and F-210C)

Manufacturer:	Yardney, or equal
Model:	MM-5460-3A
Flow Rate:	150 gpm each (maximum)
Maximum Working Pressure:	80 psi
Materials of Construction:	Epoxy-Coated Carbon Steel
Quantity:	3 (vendor supplied skid)

2. Media

Manufacturer:	Layne Christensen Company
Model:	LayneOx
Screen Size:	20 x 40 mesh (US sievp-5.5(v)[9 458Steel

the AOP from the AOP feed tank. The AOP feed system will use three end-suction centrifugal feed pumps; however, only a single pump will be used for pumping. The others will be stand-by pumps. Two of these are sized to operate in the 150 to 300 gpm flow rate range, while the third is sized to operate in the 75 to 150 gpm flow rate range. Typical operations are expected to be within the 150 to 300 gpm range, so two pumps would be available for that system flow rate. Treatment system flow rates below 150 gpm are not expected to be typical, but are likely during plant start-up and in the future when extraction wells are taken off-line as cleanup criteria are achieved; therefore no standby pump for this flow range was provided.

Specific rate constants for COC destruction were developed during IRA system operations and have been shown to be typically lower than those developed during initial AOP pilot testing. The differences in rate constants are thought to result from different groundwater quality observed during the pilot test, compared to groundwater quality typically treated during IRA system operations. Specifically, the concentration of iron in the groundwater influent experienced during most of the IRA system’s operation has been approximately one order of magnitude greater than the iron concentrations seen during the pilot-scale tests. Note too that the IRA AOP system is not being operated to generate contaminant destruction curves; rather, the unit is being operated to maximize contaminant destruction. Calculating rate constants based on the performance of this system will result in conservative rate constants because the calculation is based on a large number of non-detect effluent data for the system. For purposes of the RAP, the rate constants developed during IRA system operations have been used to size the AOP.

The IRAP operational rate constants for TCE, 1,4-dioxane and 1,1-DCA are 17.55, 14.92 and 3.09 liters per minute/kilowatt (Lpm/kW), respectively. Calculations of the rate constants are shown in Table 10-2A. As stated previously, TCE and 1,4-dioxane are used specifically to size the AOP, since TCE concentrations are expected to be the highest experienced at the treatment system and 1,4-dioxane is recalcitrant to other treatment processes. 1,1-DCA will not be used to size the AOP since 1,1-DCA and other chlorinated ethanes have long rates of reaction with most oxidants, including the hydroxyl radicals produced in this AOP. However, calculated 1,1-DCA removal through the AOP is used to determine GAC influent concentrations of 1,1,-DCA.

Concentrations of constituents in the influent expected during full-scale operations are outlined in Section 10.2.1.7. As shown in Table 10-2B, a 365 kilowatt (kW) Photo-Cat unit will be sufficient for the destruction of COCs, based on the estimated flow rate and concentrations for the RAP system. The two existing AOP units will be replaced with three new units. All three photo-cat units will be installed in parallel, with each unit being capable of treating process water at a flow rate of 100 gpm. For the RAP system, the major differences to the AOP units will be the power of the lamps and the hydraulic capacity of the units. The current IRA system uses 75 watt (W) lamps; however, for the RAP system, 190 W lamps will be used. Hydraulically, each unit will be capable of flow rates of at least 100 gpm as compared to 75 gpm used in the IRA design. The final AOP system will be capable of treating 300 gpm of groundwater with a TCE concentration of approximately 840 µg/L and 1,4-dioxane concentrations of approximately 385 µg/L to an effluent concentration of 3 µg/L or less for both compounds. These concentrations are 33 percent and 178 percent greater than the expected initial concentrations of TCE and 1,4-dioxane, respectively. This calculation is provided in Appendix E.

The water temperature increase through the AOP process was evaluated at the average design condition (100 gpm flow rate through each unit) and at a reduced flow rate condition that would produce a greater temperature rise through the unit. The reduced flow condition evaluated assumes that the average design flow rate (200 gpm) was treated using the 3 AOPs resulting in a flow rate of 67 gpm through each unit. Under these two conditions, the anticipated temp gp5(e)0.eatixthe unted6C ese (w0.1(mp u75 Tsm-.TJ787 Ta)-6.9(.7()-6.9(s4( )-5.5(and)]TJ0 -1
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4. Low Flow AOP Feed Pump (P-300C)

Manufacturer:	Goulds Pumps, or equal
Model:	3196 STi 1.5x3-6 (5.625" IMP)
Type:	End Suction Centrifugal
Quantity:	1
Horsepower:	10
Flow Rate:	150 gpm @ 122 ft TDH

5. Sulfuric Acid Metering Pump (P-710A, P-710B) (continuous acidification and catalyst cleaning)

Manufacturer:	Grundfos, or equal
Model:	DME 8-10 A-PV/V/C-F-21RRB
Type:	Diaphragm
Quantity:	2
Flow Rate:	0.002 gph - 1.98 gph @ 145psi

6. Static Mixer (SM-300)

Manufacturer:	Koflo, or equal
Model:	400
Type:	6 Element Low Pressure Loss Flange Mounted Static Mixer
Material of Construction (body):	PVDF Lined 316L Stainless Steel
Material of Construction (mixer):	PVDF
Quantity:	1

7. AOP Effluent Pumps (P-310A, P-310B and P-310C)

Manufacturer:	Goulds Pumps, or equal
Model:	7SH2L52D0
Type:	End Suction Centrifugal
Quantity:	3
Horsepower:	10

Flow Rate:	125 gpm @ 152 ft TDH

10.2.2.4 Granular Activated Carbon Vessels

Two parallel trains of lead-lag GAC units will be used as a polishing step following the AOP. The main function of these units is to remove any residual VOCs (mainly 1,1-DCA) not destroyed in the AOP. Flow from the AOP units will be split equally between the trains. Each train will be sized to fully process half of the treatment plant maximum design flow rate (with an appropriate processing margin). These trains will operate continuously any time the AOP system is operating. The design is configured to allow change-out of beds without shutting down the system by diverting flow around the exhausted bed.

Each train is comprised of three GAC beds in series with piping/valving to enable any of the vessels to operate as the lead bed. Each bed is hydraulically capable of accepting the full flow through the train. Rather than keeping one bed in idle standby while the other two in the train are on-line, the trains are configured so that during normal operation, flow will be directed through all three beds. This minimizes the potential for bacterial growth in the standby bed then to C-A-B then to A-B-C). Valve changes will be automated and initiated by

Manufacturer:	Siemens, or equal
Model:	PV5000
Carbon Capacity:	5,000 pounds (lbs)/each
Carbon Type:	Acid-Washed Coconut
Max. Pressure:	125 psi
Quantity:	6

2. GAC Backwash Pump (P-400A, P-400B)

Manufacturer:	Goulds Pumps, or equal
Model:	8SH2M52E0
Type:	End-Suction Centrifugal
Quantity:	2
Horsepower:	15
Flow Rate:	280 gpm @ 113ft TDH

10.2.2.5 Effluent Tank

Treated groundwater from the liquid phase GAC vessels will be transferred into

Horsepower: 15
Flow Rate: 300 gpm @ 92ft TDH

3. On-Facility Injection Well Feed Pump (P-510)

    Manufacturer: Goulds Pumps, or equal
    Model: 1SVD1E5C0H
    Type: End-Suction Centrifugal
    Quantity: 1
    Horsepower: 1
    Flow Rate: 10 gpm @ 109ft TDH

4. Sodium Hydroxide Metering Pumps (P-700C, P-700D)

    Manufacturer: Grundfos, or equal
    Model: DME 12-6 A-PP/E/C-F-21RRB
    Type: Diaphragm
    Quantity: 2
    Flow Rate: 0.0032 gph— 3.17gph @ 85psi

5. Static Mixer (SM-500)

    Manufacturer: Koflo, or equa
    Model: 275

wetland areas in the vicinity of the groundwater extraction system. Consistent with the design of the other treatment processes, the RO system has been designed to produce treated water at a maximum rate 50 percent greater than the nominal recharge rate predicted by the groundwater model, or approximately 75 gpm.

Using cross-flow filtration, RO can remove (rejecting) 99 percent of the heavy metals in the treated groundwater. In this configuration, pressurized feed water flows across a membrane, with a portion of the feed permeating it. The balance of the feed sweeps parallel to the surface of the membrane and exits the system without being filtered.

To implement RO as a treatment strategy, the feed water to the RO system must first have the hardness (calcium and magnesium) removed. Hard water will quickly foul the RO membranes and require frequent membrane cleaning or replacement. Therefore, the RO system will consist of a twin alternating softener to remove hardness, followed by the RO membrane unit.

The softening system will have two softener vessels, with one vessel in-service and the second one in standby until a preset amount of water (measured in gallons) is processed or when hardness break-through is detected. At that time, the second vessel enters service and the first vessel is regenerated; thus, the flow of soft water is uninterrupted. Automatic regeneration cycles will be controlled by the PLC control system located on the RO skid. Regeneration cycles will occur based on totalized flow, manually initiated by the operator, or by detecting hardness breakthrough. Only one vessel will be regenerated at a time.

Each softener vessel is designed to typically operate at 100 gpm. The design flow rate to the softeners is 25 percent higher than the design permeate flow rate from the RO system. In cross-flow filtration, part of the feed stream does not permeate the medium but retains and increases the amount of ions, organics, and suspended particles, which are rejected by the membrane. This is referred to as the concentrate or reject stream. The design reject flow is 25 gpm; therefore, the total effluent flow from the softeners to the RO unit will be 100 gpm. Each vessel will contain 30 cubic feet (ft^3) of resin. The exchange capacity of the resin will be 24,000 grains/ft^3. The expected hardness of the influent water is 18.5 grain/gallon. The softeners will likely regenerate once every eight hours of operation. The softeners can be set to automatically regenerate based on volume throughput, time interval, or hardness break-through (determined via in-line analysis). The softeners are designed to remove the hardness concentration to 0.01 mg/L or less. Effluent from the softener system will feed the suction side of the high pressure RO pumps.

The RO system design will consist of one single-pass RO system, with a 2×1 array (two membrane housings on the first stage and one housing on the

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Horsepower: 15
Flow Rate: 100 gpm @ 330 ft TDH

4. Reverse Osmosis System (RO-640A/B/C)
Manufacturer: Crown Solutions. or equal
Model: CRO-863-75
Flow Rate: 100 gpm
Array: 2×1
Recovery: 60–75 percent
Membranes: Hydranautics, CPA5
Rejection Rate: 99 percent for heavy metals

Quantity: 1

5. Wetlands Recharge Pump (P-660)
Manufacturer: Goulds Pumps, or equal
Model: 10SH2K52D0
Type: End-Suction Centrifugal
Quantity: 1
Horsepower: 7.5
Flow Rate: 70 gpm @ 174 ft TDH

6. POTW Waste Pump (P-620)
Manufacturer: Goulds Pumps, or equal
Model: 1STH5A4F
Type: EndSuction Centrifugal
Quantity: 1
Horsepower: 3
Flow Rate: 45 gpm @ 106 ft TDH

10.2.2.7 pH Adjustment Systems

Two chemical injection systems will be used for pH adjustment of process water. Sodium hydroxide will be used in three locations as follows:

- Aluminum oxidation and settling system
- Iron oxidation and settling system
- Final pH adjustment of treated water effluent discharge to the POTW and on-site injection wells

Increasing the pH of the process water in the metals oxidation and settling systems will promote oxidation of the desired metals in those systems, and the treated effluent may require pH adjustment to meet discharge requirements.

top of the curbing on three sides of the containment. The only side without the Plexiglas splashguard will be for delivery from the loading dock.

Chemical will be transferred from temporary transfer totes to permanently installed storage totes. Transfer totes will be received at the treatment facility as required and placed on the chemical transfer dock, adjacent to the storage totes and within the chemical containment area. Chemicals will then be transferred from tote to tote using dedicated pumps and piping.

Equipment:

1. Chemical Storage Totes (T-700A, T-700B, T-700C, T-700D, T-710A, and T-710B)

Manufacturer:	Snyder Tanks, or equal
Model:	68445
Capacity:	330 gallons (maximum)
Materials of Construction:	1.9 SPGR HDLPE
Quantity:	6

2. Sodium Hydroxide Pumps (P-700A, P-700B, P-700C,P-700D, and P-700E)

Manufacturer:	Grundfos, or equal
Model:	DME 12-6 A-PP/E/C-F-21RRB
Type:	Diaphragm
Quantity:	5
Flow Rate:	0.0032 gph— 3.17 gph @ 85 psi

3. Sulfuric Acid Metering Pumps (P-710A and P-710B)

Manufacturer:	Grundfos, or equal
Model:	DME 8-10 A-PV/V/C-F-21RRB
Type:	Diaphragm
Quantity:	2
Flow Rate:	0.002 gph - 1.98 gph @ 145psi

10.2.2.8 Secondary Treatment Processes

Secondary treatment processes are those processes that are not specifically used for the treatment of the process water. These include the solids handling system, the seal water system, the compressed air system, and the vapor phase carbon system.

10.2.2.8.1 Solids Handling System

The solids handling system will consist of all equipment used to thicken solids produced from the aluminum and iron oxidation and settling systems as well as backwash effluent from the media filtration and ultra-filtration systems. Solids settled in the primary and secondary settling tanks, T-110A/B and T-140A/B, will be transferred using electric-driven positive displacement pumps, P-110A/B and P-140A/B to the solids thickening tank (T-1700). The solids thickening tank will be constructed of FRP and will have a capacity of 7,470 gallons. The tank is designed to be of adequate size to allow for settling and thickening of solids.

Coagulant aids will be injected into the solids process stream from T-110A/B and T-140A/B, before T-810. The coagulant aids will be used to form a solids floc that will more readily settle in the tank and therefore thicken before further processing. The coagulant aids will be injected using diaphragm chemical metering pumps, P-830A/B. Two pumps are used in the design; however, only one pump will be used for pumping and the second will be in standby. A static mixer will be used to disperse the coagulant aid into the solids process stream.

Solids produced during media filtration and ultra-filtration backwashing will be used for the same purpose as mentioned previously. P-830A/B will be used to inject the coagulant aid into the process stream.

Thickened solids in T-810 will be transfer to a plate and frame style filter press for further thickening and drying. Solids will be transferred from T-810 using two double diaphragm pneumatic pumps (T-810A/B). Two pumps are used in the design; however, only a single pump will be used for pumping while the second is kept in standby. Tank T-810 will use a gravity overflow system that will be transfer clarified water back to the filter feed tank (T-200). The filter press will use a pre-coat system that

2. Filter Press Feed Pumps (P-810A and P-810B)

Manufacturer:	Warren Rupp, or equal
Model:	SA1-A-DV-4-SS

6. Filter Press (FP-820)
Manufacturer: Siemens, or equal
Model: 800mm J-Press
Type: Plate & Frame
Capacity: 20 cu-ft (minimum)
Materials of Construction: Various

Quantity: 1

7. Coagulant Aid Storage Tank (T-830)
Manufacturer: Various
Model: HDPE Drum
Capacity: 55 gallons (minimum)
Materials of Construction: HDPE

Quantity: 1

8. Coagulant Aid Metering Pumps (P-830A, P-830B)
Manufacturer: Grundfos, or equal
Model: DME 8-10 A-PV/V/C-F-21RRB
Type: Diaphragm
Quantity: 2
Flow Rate: 0.002 gph - 1.98 gph @ 145 psi

9. Static Mixer (SM-800)
Manufacturer: Koflo, or equal
Model: 365
Type: 2-inch 6 Element Low Pressure Loss Flange Mounted Static Mixer
Material of Construction (body): 316L Stainless Steel
Material of Construction (mixer): 316L Stainless Steel

Quantity: 1

10. Pre-Coat Tank (T-840)

Manufacturer:	Snyder Tanks, or equal
Model:	586000N-L

Equipment:

1. Air Compressor (AC-900)

Manufacturer:	Atlas Copco, or equal
Model:	SF8 HP
Type:	Oil-less Scroll Compressor
Horsepower:	10
Performance:	24 cfm @ 145psi
Quantity:	1

2. Refrigerated Air Dryer (AD-900)

Manufacturer:	Atlas Copco, or equal
Model:	Integral to Compressor
Quantity:	1

10.2.2.8.4 Vapor Phase Carbon

Vapor phase granular activated carbon (VPGAC) vessels will treat vapors from all non-pressurized vessels containing water not treated through the AOP

10.2.2.9 Treatment System Building and Containment

The groundwater treatment system equipment will be housed in a new, galleries is 75 gpm. Recharge galleries are planned in three locations as shown on Figure 10-3. Flow rate into the galleries is calculated using Darcy's law and is detailed below.

$$Q = KhA$$

Where:

Q = flow rate (cubic feet per day [ft^3/day])

K = vertical hydraulic conductivity (ft/day)

h = head or potential causing flow (ft)

A = cross-sectional area of flow (ft^2)

Hydraulic conductivity used for the calculation was 0.7 ft/day, the same value used by the groundwater model for the upper portion of the USAS aquifer. The head value used for the calculation was 2.5 ft, which assumes water in the trench will be above the effective groundwater table by 2.5 ft. This is a reasonable design value since during wet periods when high water levels are naturally present in the wetlands, no water will likely be sent to the recharge galleries, and during dry periods, 2.5 feet of head differential will be present. Based on the calculation, approximately 1,590 linear feet of gallery (5 ft width)

Table 10-3: Effluent Limitations for MCUO ID Permit #IW 0025S, GCTLs, and Surface Water Quality Criteria

Parameter	Unit	MCUO IUD Permit #IW 0025S Effluent Limitation	GCTL	Surface Water Quality Criteria
pH	SU	5–11.5	--	--
1,4-dioxane	mg/L	Report	0.0032	0.120
TCE	mg/L	0.003	0.003	0.0807
PCE	mg/L	0.003	0.003	0.00885
1,1-DCE	mg/L	0.007	0.007	0.0032
1,1-DCA	mg/L	0.07	0.07	--
cis-1,2-DCE	mg/L	0.07	0.07	--
Vinyl chloride	mg/L	0.001	0.001	0.0024
Metals				
Aluminum	mg/L	Report	0.2	0.013
Arsenic	mg/L	2.51	0.01	0.050

expected emissions have been calculated to be less than the allowable limits of 5.5 and 13.7 pounds a day (lbs/day) for individual and aggregate hazardous air pollutants (HAPs). In fact, if the total expected concentration of TCE (630 µg/L) were to volatilize and the treatment system was operating at the maximum flow rate of 300 gpm, the total mass of TCE volatilized would be approximately 2.3 lb/day, nearly 100 percent below the allowable limit. Regardless, the tank vents will be piped to will send vapor collected from the tanks to VPGAC vessels. Two VPGAC vessels will be used in series for vapor treatment. The exhaust side of the primary vessel will be monitored with a vapor analyzer periodically. The vessels will be replaced at least annually.

10.3 Cleanup Target Levels

Cleanup target levels for COCs in Site groundwater are specified in Chapter 62-777, F.A.C. as follows:

Chemical of Concern	G-II GCTL (µg/L)
PCE	3
TCE	3

TCµg/L) 4dioxanec1G263 Tw[(TC)111471E

10.5.2 TPOC Administrative Requirements

In requesting a TPOC beyond the Facility, Lockheed Martin will comply with the notice requirements of Rule 62-780.220(3) F.A.C. Specifically, Lockheed Martin will provide:

- Actual notice
- Constructive notice
- Copies of notices made

Actual notice will be made in writing and be mailed via “Certified Mail, Return

- Including a statement in the notice indicating the 30-day deadline by

10.6 Cessation Criteria

The groundwater pump and treat system will operate until it can be demonstrated that conditions satisfy the “No Further Action” criteria set forth in Rule 62-780.680, F.A.C. (generally speaking, GCTLs have been achieved). As discussed in Section 10.2.1, the groundwater hydraulic model, in conjunction with the groundwater solute model, were used to evaluate and design an expanded groundwater extraction system that achieves RAOs effectively and efficiently. Though groundwater recovery and treatment systems are known to take a considerable amount of time to achieve cleanup standards, as entropy would suggest, typically longer than the problem has existed, groundwater recovery and treatment is a very effective means of controlling the groundwater plume and reducing COC concentrations. The model simulation of the proposed recovery and treatment system predicts that approximately 50 percent and 64 percent of mass of 1,4-dioxane and TCE, respectively, would be removed within the first five years of extraction system operation, while approximately 66 percent of the 1,4-dioxane and 83 percent of the TCE mass would be removed within 10 years of beginning groundwater extraction operation. The model predicts that the COCs will meet the RAOs in the entire plume (concentrations below the GCTLs) in approximately 48 years. Further, the model simulation indicates a significant number of recovery wells in the proposed recovery system will be shut down much sooner than that, as areas of the plume are reduced below GCTLs. Procedures for shutting down extraction locations are detailed in Section 13.5.

11. RAP Construction

This section outlines the process of RAP construction. A schedule for these activities is presented in Section 14. Waste handling, characterization, and disposal are discussed below in Section 11.3.

11.1 Site Preparation Activities

Site preparation activities are required to be completed prior to construction. The Site preparation will include survey, utility identification, and obtaining access agreements for construction. A full survey of the area described in Figure 10-2 (approximately 250 acres) will be conducted. The survey will include obtaining horizontal and vertical controls of property lines, utilities (e.g., gas, overhead electric, underground electric, telephone, fiber optic, sanitary

- Prepare area for treatment facility building construction, including removing existing concrete slabs or asphalt in new building foundation area to prepare area for concrete placement
- Build treatment facility, including treatment building and equipment installation
- Install and develop extraction and injection wells
- Install extraction trenches
- Install recharge galleries
- Install pipe and electrical conduit trenches from extraction system to treatment facility
- Pressure test piping
- Conduct treatment system shake-down using potable water to confirm operation of each component to establish acceptance to proceed with start-up as describe in Section 12

11.3.1 Waste Material Handing and Characterization

Soils and waste materials that will require handling as part of RAP activities at the Site are expected to include the following:

- Drill cuttings from extraction and injection well installation
- Soil generated from building foundation excavation
- Soil generated from utility trench installation for transmission piping and electrical conduits
- Soil generated from recharge gallery installation
- Soil generated from extraction trench installation which will include dry soils excavated from above the water table (vadose zone) and wet soils excavated from below the water table
- Water from well development, extraction trench installation, and other construction-related activities including stormwater

Soils from 3 to 30 ft bgs excavated from below the water table will be wet and, therefore, handled separately from dry soils. Wet soils will be loaded into a filter box or similar equipment to facilitate dewatering before off-site disposal.

The filter box will consist of a roll-off fitted with floor and sidewall screens covered with a filter cloth to allow gravity migration of water into a collection sump. The collection sump will be fitted with drains to facilitate dewatering. Collected water will be managed along with other construction water as described below.

Following dewatering, stabilizing agents such as granular absorbents or Portland cement may be blended with the wet soils. The purpose of the stabilizing agent is to attain the moisture content requirements of the disposal facility.

Construction Water

Construction water will be generated from a number of sources including water from well development, extraction trench installation, and other construction-related activities including stormwater. Stormwater diversions will be used to minimize the volume of stormwater that runs into excavation areas. However, stormwater that enters active excavation areas that must be removed to continue the excavation activities will be pumped to a temporary storage tank. Similarly, water generated from the extraction trench installations will also be collected in a temporary storage tank. Depending on the volume being generated, water generated from other construction-related activities, including well development, will be collected in DOT-approved 55-gallon drums or temporary storage tanks. Construction water will be managed as hazardous or non-hazardous waste based on waste profiles for the Site.Off-site disposal will be at a licensed disposal facility approved by Lockheed Martin.

11.3.2 Waste Disposal

Asphalt and concrete at the surface will be targeted for off-site recycling at a Lockheed Martin approved facility. A bill-of-lading will be maintained for each container sent off-site for recycling.

Soil, water and other waste removed from areas characterized as non-hazardous will be transported and disposed of off-site by Lockheed Martin approved waste transporters at a Lockheed Martin approved non-hazardous waste disposal facility.

Hazardous waste generation is not anticipated during implementation of this project. In the unlikely event hazardous waste is generated, it will be segregated from non-hazardous waste. The hazardous waste will be transported and disposed of off-site by Lockheed Martin approved waste step of the start-up will be scripted and then positively verified to confirm completion. The start-up activities are described below.

Before start-up, the following representative activities will be completed to confirm that the construction activities are complete and RAP system is ready for operations:

- Prepare a detailed *OMM Manual* including SOPs and DOPs.
- Train operators including classroom review and field testing of SOPs and DOPs to confirm operators are knowledgable on all aspects of the RAP system.
- Check utilities— electrical, controls, communication, and potable water.
- Check and test electrical equipment— transformers, switch gear, control panels, electrical panels, motors and motor control center (MCC).
- Test building controls— ventilation and lighting.
- Test operation of inst

- Notify Manatee County that discharge is ready to begin

Following completion of the activities described above, start-up of the RAP system will begin. Operating personnel will be on-site 24 hours per day, 7 days per week throughout the start-up. The start-up will be sequenced to first confirm operation of the treatment system using extracted groundwater from select wells and then bring on line additional extraction wells plus the extraction trenches, infiltration galleries and injection wells. The general start-up sequence is summarized below.

- The on-site extraction wells will be started one at a time. The treatment system will be started up in recycle mode (no discharge) at a flow rate of about 100 gpm (50 percent of the average design flow rate). The wells will continue to operate until all main process piping is full and process tanks reach their operating levels. The treatment system will continue to be operated in recycle mode and samples will be collected throughout the system to confirm general conformance with design parameters. A sample will also be taken from the effluent tank with the system still in recycle to confirm compliance with the discharge permit limitations.
- Upon receipt of analytical result that confirm design and discharge standards, the treatment system will be configured to discharge treated groundwater. The on-site extraction wells will again be started and the treatment system restarted at about 100 gpm. The extraction wells and trenches located to the southwest of the Site will thene0bc-0.00b t tm t1(th)-5.   u ua lant sysext the-5.6(d

200 gpm to confirm continued conformance with the design parameters and discharge permit limitations.

- Upon receipt of acceptable analytical results, any remaining extraction

Maintenance will be generally involve routine activities, preventive action or equipment repairs. Operating personnel will be trained to complete all three types of maintenance activities, although subcontractor personnel may be used for specific services such as well maintenance or electrical troubleshooting.

One key element of on-going OMM will be a quality assurance/quality control (QA/QC) process to verify that operating and maintenance procedures are being followed and are effective. The process will include a configuration-change-control program to manage and approve/disapprove any design modification or operating change before they oc

redevelopment is completed. Frequency of extraction well maintenance will be determined through operational experience.

12.2.3 Extraction System Line Operation and Maintenance

Precipitated iron may build up within the extraction system pipeline, reducing overall extraction-system flow rate. Increased pressure along the pipeline, reduced overall flow-rate from the extraction wells and high power usage at individual wells can indicate that the pipeline is becoming clogged. To reduce the effect of precipitated iron within the extraction system pipeline, cleanouts will be installed strategically along the extraction system pipeline. When reduced performance of the extraction system pipeline is observed, a high-pressure water jet will be introduced to the pipeline through the cleanouts and used to break-up precipitated iron within the pipeline. After line jetting is completed, water will be pumped through the extraction system by restarting the extraction wells. This will remove the dislodged precipitated iron from the extraction system by entraining it with the overall flow from the extraction system. Water collected from the extraction system after line jetting will be discharged to the primary settling tanks. Waste produced during the line maintenance will contain high levels of iron and will therefore be metered into the treatment stream or characterized and disposed of off-site at a Lockheed Martin approved facility. Frequency of line maintenance will be determined through operational experience.

12.2.4 Splitter Box Operation and Maintenance

The primary and secondary splitter boxes may require adjustment to maintain flows split evenly between the tanks. The splitter box weirs will be inspected monthly for buildup of precipitates and cleaned as necessary.

12.2.5 Settling Tank Operation and Maintenance

The primary and secondary settling tanks have been designed to reduce the likelihood of sediments and precipitated metal solids build-up. To maintain the operability of these tanks the following maintenance item fp5.3(ed)-5.5s t)(p5.3fstrc)-5(na)4.4(5(an)]TJ0 -1.2732 sediment buildup and pumped out as necessary. The frequency of tank cleaning will be determined by operational experience.

12.2.8 Media Filter System Operation and Maintenance

Operational data will be collected from the media filter system daily. Operational data will include influent and effluent pressure of the media vessels, feed water flow rate and backwash flow rate.

Media filters will be monitored for typical number of backwash cycles; a large change from typical operations will denote a potential upstream issue with the metals oxidation and settling system. The effluent from the media filters will be tested weekly with a colorimetric field test kit to verify iron removal to design specifications.

12.2.9 Ultra-Filtration System Operation and Maintenance

Operational data will be collected daily from the Ultra-filtration system. Operational data will include temperature of the feed water, backwash flow rate, volume of water used during a backwash cycle, feed water flow rate, volume of filtrate produced between cleaning cycles, pressure at the top and bottom of the filter, and permeate pressure. This data will be used to calculate Transmembrane Pressure (TMP) of the system. This is the effective pressure for forcing water through the membrane. A clean membrane will have a relatively low TMP, whereas a fouled membrane will have a relatively high TMP, depending on the severity of fouling. When TMP reaches 15-20 psi a chemical cleaning will occur. Furthermore, a temperature compensated specific flux for the membranes will be calculated. This value is used to further determine membrane performance based on a relative temperature. In relation to startup conditions, a significantly high flux rate may indicate chemical degradation of the membrane, whereas a low flux may indicate fouling. When this value reaches 7–9 gsfd/psi, a chemical cleaning is recommended. Finally, the percent recovery will be calculated. All of these values and calculations will provide insight as to system and membrane performance and assist in determining membrane-cleaning frequency. Membrane cleaning will consist of an hourly backwash cycle and a daily chemically enhanced backwash cycle.

12.2.10 Solids Thickening and Dewatering Operation and Maintenance

The coagulant aid feed system will be checked daily to assure its proper operation during solids pumping to the solids thickening tank. Supernatant

12.2.14 Vapor-Phase Granular Activated Carbon Operation and Maintenance

The VPGAC vessels are designed to adsorb VOCs4(f)-1.3601.92VOCss(3601.92VTw[(Tdsor)]6(t)-10.1(e)-5.1(na)

12.2.18 System Alarms and Response

System operation set points for various process parameters will be set by the system operator. The PLC will monitor these parameters and alert the operator of changes in the system operation. The following parameters will be monitored for both “informational” and “process maintenance” conditions:

- High differential pressure across the media filter units
- High differential pressure across the ultra filter units
- High differential pressure across the lead LPGAC vessel
- High differential pressure across the intermediate LPGAC vessel
- High differential pressure across the lag LPGAC vessel

Shutdown alarms are triggered under the following conditions:

- High or low pH to the primary settling tanks T-110A/B
- High or low pH to the solids contact tank T-120
- High or low feed pressure to the media filter units
- High turbidity in the effluent from the ultra filters
- High or low feed pressure to the AOP units
- AOP fault
- High effluent pressure
- Low effluent pressure
- High high-level alarm in tanks T-110A/B, T-120, T-140A/B, T-200, T-300, T-500, T-620, T-660, T-800, T-810 and T-1200
- Low low-level alarm in tanks T-110A/B, T-120, T-140A/B, T-200, T-300, T-500, T-620, T-660, and T-800
-

- Influent fault— No feed water to the AOP
- Effluent fault— Water cannot be discharged from the AOP
- Air pressure— Loss of air pressure to the system
- Acidification fault— Actual pH is outside of specified pH range
- Neutralization fault— Same as for acidification
- TiO2 slurry feed return fault— Insufficient TiO2 slurry return to the influent
- Ballast temperature fault— Temperature switch in the ballast cabinets will fault if there is overheating due to failure of the ballast cooling fan

All alarms and system operation will be accessible via remote telemetry using the treatment system computer and *PCAnywhere* software. The PLC, computer, and *PCAnywhere* software may be used to remotely investigate, correct, reset, and document any alarm conditions that occur. The system will never be controlled remotely. Any process adjustments will be conducted by on-facility personnel. For detailed treatment system alarm procedures involving the primary treatment components including the setting tanks, media and ultra-

To evaluate the operational performance of the treatment system, operational samples will also be collected from the combined influent (T-100 influent), mid-process (before lead GAC vessel) and post-lead GAC vessel at a frequency necessary to optimize the treatment system and monitor its performance. The samples collected post-lead GAC vessel will be used to determine CVOC breakthrough.

Samples will also be collected from operating recovery wells and trenches on the following frequency:

- Weekly for the first month
- Monthly for the next two months
- Quarterly for the next two years
- Semi-annually thereafter.

The extraction well and trench samples will be analyzed for COCs and may include other parameters as necessary to evaluate the operational

Remedial Action Plan Addendum

Lockheed Martin Tallevast Site

Table 12-1 summarizes the schedule for the effectiveness monitoring groundwater recovery system per Rule 62-780.700(3)(g), F.A.C.

In accordance with FDEP meetings on June 26 and July 1, 2008, wetlands and manmade lakes whose water levels may be potentially affected by the drawdown caused by the groundwater extraction system will be monitored for potential changes in hydroperiod and vegetation composition. FDEP has requested that potentially affected wetlands be evaluated using the Wetland Assessment Procedure (WAP) (SFWMD, March 2005).

13.2 Monthly Groundwater Monitoring

Water levels will be measured in the monitoring wells listed in Table 13-2 and shown on Figure 3-2 at least once a month during the first six months after the RAP groundwater pump and treat system is fully operational. The purpose of this portion of the monitoring program is to monitor the development of the groundwater capture zones in the USAS, LSAS, AF Gravels and S&P Sands to verify that the groundwater recovery system is providing hydraulic control site-wide and to monitor the influence groundwater recovery has on deeper units. The data will be used to prepare potentiometric surface contour maps and delineate capture zones in the USAS and LSAS, AF Gravels and S&P Sands. As described in Section 13.7, monthly monitoring reports will be submitted to FDEP showing the results. After six months of monthly monitoring, water levels will be collected quarterly and semi-annually as discussed in Sections 13.3 and 13.4.

13.3 Quarterly Groundwater Monitoring

Groundwater samples will be collected from the monitoring wells listed in Table 13-1 quarterly during the first year after the RAP groundwater pump and treat system is operational. Additionally, during the last quarterly sampling event, groundwater samples will be collected from the annual monitoring wells. The purpose of the groundwater sampling will be to monitor the COC mass removal rates, changes in COC concentrations over time, and the extent of the capture zones. The data will be used to estimate COC mass removal rates, evaluate changes in COC concentrations over time, prepare potentiometric surface contour maps, and delineate capture zones in the USAS and LSAS. As described in Section 13.7, quarterly-monitoring results will be summarized and submitted to FDEP in an annual report. The sampling event conducted during the last quarter will be used to redefine the plume. After one year of quarterly monitoring, groundwater samples and water level measurements will be collected on a semi-annual basis as discussed in Section 13.4.

13.4 Semi-Annual Groundwater Monitoring

After one year of quarterly groundwater sampling, groundwater samples will be collected from monitoring wells semi-annually. Groundwater samples will be collected from the monitoring wells listed in Table 13-1 during the first semi-annual event each year and from all monitoring wells during the last semi-annual event each year.

The purpose of the semi-annual groundwater monitoring program will be to monitor COC mass removal rates, changes in COC concentrations over time during operation of the RAP, and the extent of the capture zones. The data will be used to evaluate changes in COC concentrations over time, prepare potentiometric surface contour maps, and delineate capture zones in the USAS, LSAS, AF Gravels and S&P Sands. The sampling event conducted during the last semi-annual event each year will be used to establish the new limits of the plume. As described in Section 13.7, an annual monitoring report will be submitted to FDEP summarizing the monitoring results.

13.5 Additional Monitoring

13.5.1 Recovery Well/Trench Shut Down Post-Active Remediation Monitoring

This section describes the process for shutting down portions of the groundwater recovery system in areas of the plume where COCs no longer exceed GCTLs. The groundwater solute and transport model simulation of the selected remedy, presented in Appendix D, predicts that COCs in different areas of the plume will be reduced to post-active remediation monitoring plan for that portion of the plume will be implemented similar to the requirements set forth in Rule 62-780.750, F.A.C.

After shutdown, the recovery well/trench and affected monitoring wells will be sampled quarterly for a period of at least one year. The recovery system will be maintained in an inactive but operational status during the period the four quarterly sampling events are conducted. If the results of at least the last two sampling events do not exceed the GCTLs, then the recovery well/trench will remain off. If the results indicate that the action levels are exceeded, then an alternate proposal will be submitted, which may include, but not be limited to, be provided to the FDEP on an annual basis. It is expected that any intended changes in the long term transducer monitoring network will be proposed in the yearly transducer monitoring report, and will be implemented during the quarter

13.6.2 Critical Action Levels for Further Evaluation

Surface water depths and elevations recorded at the staff gauges and piezometer wells in each wetland after operating the groundwater remedy will be compared to baseline conditions recorded prior to remedy implementation. If water level elevations are below 50 percent of the baseline normal pool or seasonal low for three consecutive monitoring periods within a target wetland, but not within the reference wetlands, then FDEP would be contacted to determine if a mitigation plan needs to be implemented.

- water elevation data recorded for current and past five monitoring quarters and baseline data
- photographic data recorded for current and past five monitoring quarters and baseline data
- dominant vegetation species data with indicator status for current and past five monitoring quarters and baseline data
- an evaluation of the critical action levels for hydroperiod and vegetation

13.6.4 Potential Mitigation Measures

If there are impacts to the hydroperiod or vegetation of wetlands or manmade lakes that exceed the critical action levels, then FDEP would be contacted to

a) Water level data collected from all designated wells, piezometers, and staff gauge locations each time monitoring wells and recovery wells are sampled.

b) If encountered, the total volume of free product recovered and the thickness and horizontal extent of free product during the reporting period until free product recovery is completed. As noted in this RAP Addendum and earlier reports, free product has never been encountered and is not expected; however, if it is encountered in the future, details of its presence will be reported.

c) Total volume of groundwater recovered from each recovery well during each month of the operating period for the first year and quarterly thereafter.

d) Concentrations of applicable contaminants based on analyses performed on the effluent from the groundwater treatment system, daily for the first three days with a 24-hour turnaround on analytical results of the samples collected the first two days, weekly for the next three weeks, monthly for the next two months and quarterly

i) Concentrations of recovered vapors from a vacuum extraction system (not applicable to this RAP), and post-treatment air emissions if air treatment is provided, weekly for the first month, monthly for the next two months, and quarterly thereafter; influent and effluent samples will be monitored for contaminants using appropriate analytical methods pursuant to Chapter 62-160, F.A.C.

j) Percentage of system operation time and treatment efficiency for all operating treatment systems including the dates when the Site was visited and whether the system was operating upon arrival at the Site and upon departure from the Site

k) Results of analyses of soil samples taken to verify that the applicable NFA or NAM criteria are met (not applicable to this RAP as NFA or NAM are not being sought as active soil remediation is not being conducted)

- A completed Form 62-780.900(5), summarizing the information from annual remedial action tasks.
- Graphs of groundwater COC concentrations versus time for select monitoring locations.

Further details provided in the annual OMM reports will include:

- Measurements and analytical data will be provided in summary tables
- Groundwater elevation contour maps
- Maps posting groundwater COC analytical results in the USAS, LSAS, AF Gravels and S&P Sands monitoring wells
- Actual capture zones of the RAP will be estimated by contouring groundwater elevation data and determining the location of hydraulic stagnation points, and shown on Site maps
- COC mass removal rates will be estimated and tabulated

Analysis of the data and figures listed above will be provided. Any recommendations to modify the operation of the Facility will also be provided and the recommendations will be based on, but not limited to, the analysis of the data above, if warranted.

14. RAP Implementation Timeline

A timeline of implementation has been developed for the principal milestones necessary to achieve an operational remedy.

Duration After Prior Activity	***Activity***
Start date	RAP approval
3 months	Bidding and contractor selection
3 months	Pre-construction planning and contractor Mobilization (permits, work plans, utility clearances, etc.)
18 months	Construction
2 months	System startup and testing

This schedule results in a total estimated timeframe of 26 months from RAP

Camp Dresser & McKee (CDM). 2008. *Building 4 & 5 Demolition Plan* (March 28).

DelCharco, M. J. and Lewelling, B. R. 1997. *Hydrologic Description of the Braden River Watershed, West-Central Florida: U.S. Geological Survey Open-File Report 96–634*, 30 p.

ENVIRON. 2008. *Air Monitoring Plan for Proposed Demolition Activities, Buildings 4 and 5 (*March 17).

ENVIRON, 2008. *Soil Vapor Asse*ssment.

ENVIRON, 2008. *Draft Ambient Air Monitoring Report*.

Federal Remedial Technologies Roundtable. 1997. *Remediation Technologies Screening Matrix and Reference Guide, Version 3.*

FDEP, 2004.

Harbaugh, A. W., Banta, E. R., Hill M. C., and McDonald, M. G., 2000b. *MODFLOW-2000, the U.S. Geological Survey Modular Groundwater Model—User's Guide to Observation, Sensitivity, and Parameter Estimation Process and Three Post-Processing Programs,* USGS Open-File Report 00-184, 210 p.

Howard, P. H., R. S. Boethling, W. F. Jarvis, W. M. Meylan, E. M. Michalenko. 1991. *Handbook of Environmental Degradation Rates*. Lewis Publishers, Chelsea, Michigan, 725 p.

ITRC, 2005. *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater— Second Edition*. January.

Kish, G. R., Harrison, A. S., and Alderson, Mark. 2008. *Retrospective Review of Watershed Characteristics and a Framework for Future Research in the Sarasota Bay Watershed, Florida: U.S. Geological Survey Open-File Report* 2007-1349. 49 p.

Law Engineering and Environmental Services, Inc., 2000. *Phase I Environmental Site Assessment, December 1999 to January 2000*.

Leeper, D., Kelly, M., Munson, A., and R. Gant, 2001. *A Multi-Parameter Approach for Establishing Minimum Levels for Category 3 Lakes of the Southwest Florida Water Management District*. Prepared by the Ecological Evaluation Section of the Resource Conservation and Development Department, Southwest Florida Water Management District. SWFWMD Guidance Document 04329.

Lockheed Martin Corporation, 2007a. *Proposed Field Activities Scope of Work, Former American Beryllium Company Site*. October 5.

Lockheed Martin Corporation, 2007b. *Proposed Pumping Test Scope of Work, Former American Beryllium Company*. November 16.

McDonald, M. G. and A. W. Harbaugh, 1988. *A Modular, Three-Dimensional, Finite Difference Groundwater Flow Model*, USGS Techniques of Water Resource Investigations (Book 6).

Newell, C. J., H .S. Rifai, J. T. Wilson, J. A. Connor, J. A. Aziz, and M. P. Suarez. 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies*. EPA 540-S-02/500.

Payne, F, Potter, S, and Quinnan, J. 2008. *Remediation Hydraulics*. CRC Press.

Suthersan, S. S. and Payne, F. C., 2005. *In Situ Remediation Engineering*. CRC Press, Boca Raton.

SWFWMD, 1995. *ROMP TR-7 Oneco Monitor Well Site, Manatee County, Florida* (January).

SWFWMD, 2002. *Sarasota Bay Surface Water Improvement and Management*

Tetra Tech, 2005c. *Interim Data Report 2* (April 14).

Tetra Tech, 2005d. *Site Assessment Report Addendum* 2 (August 5).

Tetra Tech, 2005e. *Remedial Action Work Plan* (July).

Tetra Tech, 2005f. *Vapor Intrusion Sampling Report*.

USEPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

USEPA, 1991. *Treatment Technologies.*

USEPA, 2004. Letter from USEPA dated September 24, 2004.

USEPA, 2006. *Treatment Technologies for 14(4)0rd-4(4sio)-5.xoxane:echnm*