PROPOSED PLAN

Remedial Action
Greater Strawberry Point Site at Martin State Airport Middle River, Maryland

March 2019

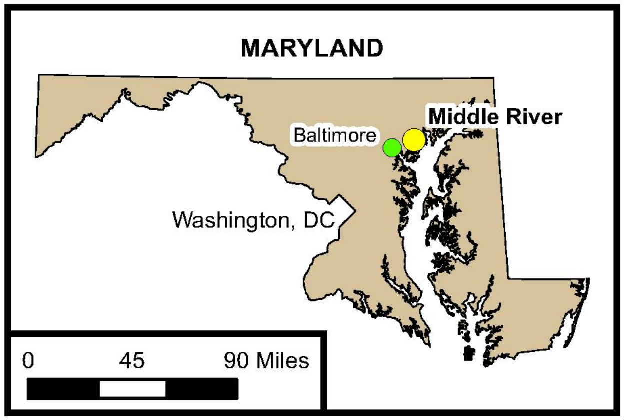
INTRODUCTION

Lockheed Martin Corporation (Lockheed Martin) is seeking public comment on this Proposed Plan for the Greater Strawberry Point (GSP) Site at Martin State Airport (MSA) in Middle River, Maryland. This Proposed Plan includes the preferred alternative for the treatment of contaminated groundwater at the site, and consists of the following:

- Monitored natural attenuation (MNA);
- Land use controls; and
- Five-Year Reviews

The public is invited to provide written comments on the Proposed Plan through April 19, 2019.

This Proposed Plan includes a description of the GSP site and a summary of investigations conducted at the site. This document is based on the *Feasibility Study for Greater Strawberry Point at Martin State Airport, Middle River, Maryland* (Tetra Tech, October 2018). Also included is a discussion of the remedial action objectives (RAOs) for the site, and a summary of the alternatives evaluated for the site cleanup. A detailed description of the preferred alternative is presented at the end of this document.



PURPOSE OF THE PREFERRED ALTERNATIVE

The proposed GSP remedial action will reduce potential human and ecological receptor exposure to contaminants present in site groundwater.

PUBLIC COMMENT PERIOD – THROUGH April 19, 2019

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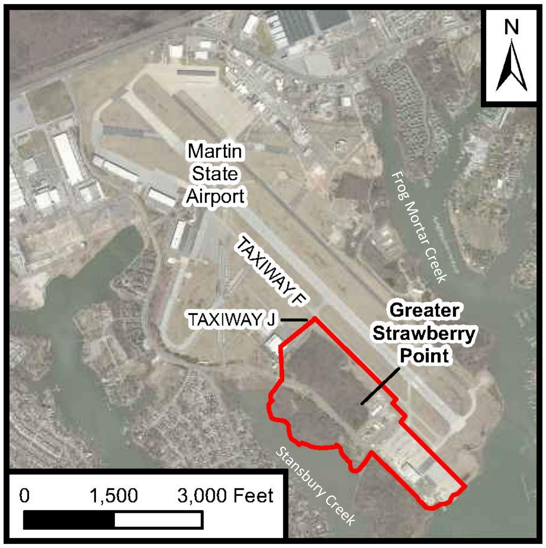
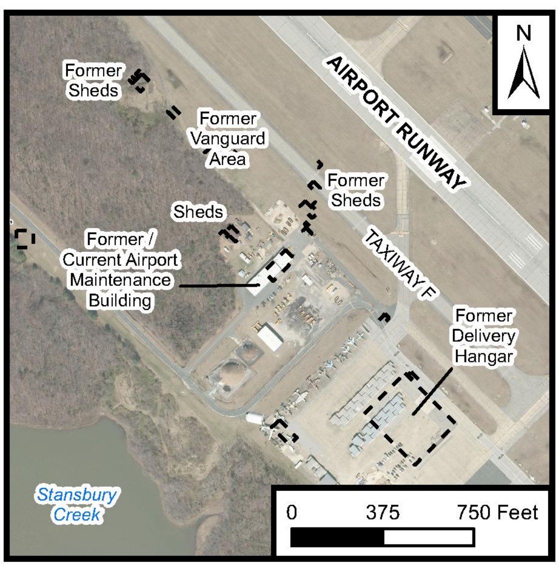


SITE DESCRIPTION

Martin State Airport (MSA) is located at 701 Wilson Point Road in Middle River, Maryland, and is bounded by Frog Mortar Creek to the east and Stansbury Creek to the west. Both creeks join the Chesapeake Bay near the southern end of the airport. The GSP site is on the southwest portion of MSA and is bounded by Stansbury Creek to the south and Taxiway J and the main airport runway to the north. See the figure to the left for a site-wide aerial photograph.

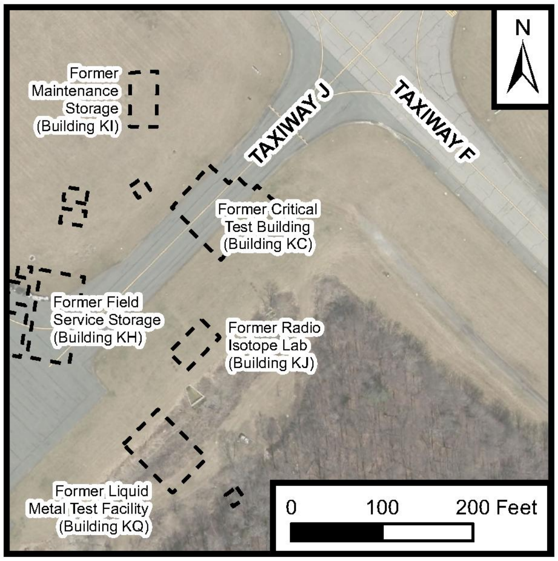
SITE HISTORY

The Martin State Airport property was owned by the Glenn L. Martin Company and Martin Marietta Corporation (both predecessor firms of Lockheed Martin Corporation) from approximately 1929 to 1975. Runways and hangars were built in 1939–1940. The Glenn L. Martin Company consolidated with American Marietta Corporation to form Martin Marietta Corporation in September 1961. Lockheed Corporation and Martin Marietta merged in 1996 to form Lockheed Martin Corporation. In July 1955, the Maryland Air National Guard (MDANG) began leasing a portion of the MSA property from the Glenn L. Martin Company. In September 1975, the State of Maryland purchased the land, including GSP. Maryland Aviation Administration (MAA) currently operates MSA on behalf of the Maryland Department of Transportation (MDOT).



The GSP area is an approximately 100-acre portion of MSA that includes a former seaplane ramp, hangars, a fuel tank farm, a Baltimore County Marine Police station, tarmac, a wooded area, and maintenance buildings. It extends from the southern end of the tarmac (the former seaplane ramp) along Frog Mortar Creek to Taxiway J, and eastward from Stansbury Creek to Taxiway F. The airport runway is northeast of and parallel to Taxiway F. The GSP area excludes the Strawberry Point (SP) wooded area at the southern end of the MSA peninsula (see illustration on page 4).

The United States Navy leased a portion of GSP from the Glenn L. Martin Company/Martin Marietta between December 1943 and December 1963; this leased area was south of the current maintenance building. During its occupancy, the Navy used a large hangar for seaplane maintenance, launching, and recovery operations (former delivery hangar). The former hangar and surrounding GSP area was known as Naval Weapons Industrial Reserve Plant No. 148. The hangar was demolished in 1989. Other areas northwest of the former delivery hangar were used for airport maintenance, missile propulsion research, aircraft engine testing, and other aircraft parts testing. Most of these former buildings, with the exception of the airport maintenance building, were demolished in the 1970s. Some small, older buildings remain around the maintenance area.



From the 1940s to the 1960s, the northern portion of GSP was developed with several facilities related to nuclear and propulsion research. These structures included the critical-test building (Building KC), the radioisotope lab (Building KJ), and the liquid-metal test facility (Building KQ). Several former Glenn L. Martin airport maintenance buildings (e.g., Buildings KH, KI, and several smaller sheds, outlined but not labeled on the adjacent figure) were also located in the northern portion of GSP on the opposite side of a former dirt road near these research buildings; the former dirt road has been replaced by Taxiway J. The former research and maintenance structures that existed in the northern part of GSP in the 1960s were demolished in the early 2000s to make way for a new taxiway and hangar.

SITE HISTORICAL INVESTIGATIONS

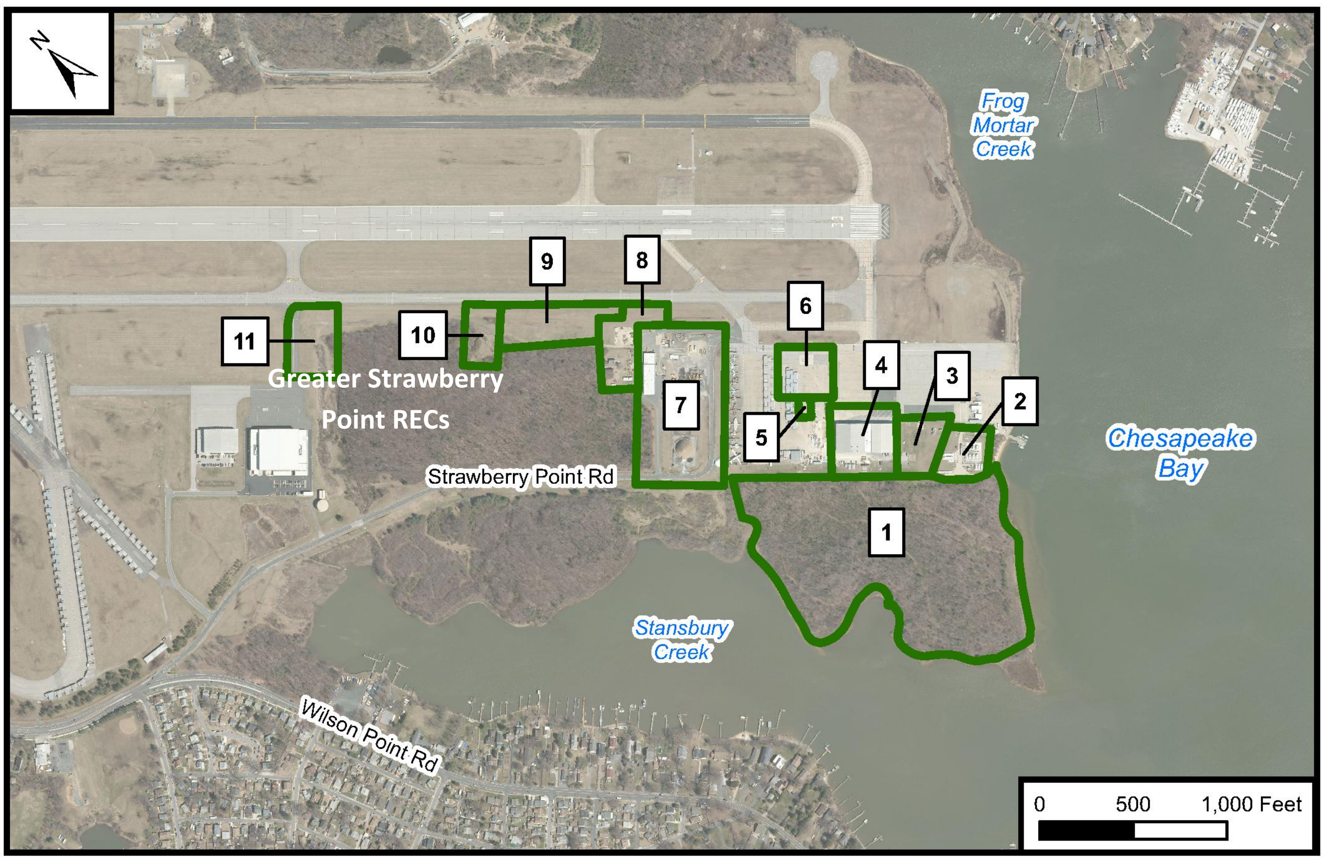
This Proposed Plan is based on the 2018 feasibility study (FS) conducted for the GSP Area at MSA. The *Greater Strawberry Point Area Design Characterization Report, Martin State Airport, 701 Wilson Point Road, Middle River, Maryland (Tetra Tech, March 2017)*, prepared prior to the FS, included summaries of previous historical investigations.

Since 2007, Lockheed Martin has performed more than ten site investigations and/or sampling events to outline the extent of potential environmental contamination at GSP and SP. Early investigations identified 11 areas of potential concern, known as recognized environmental conditions (RECs). The investigation and evaluation of REC #1 in SP was investigated separately from GSP and is not included in the FS or in this Proposed Plan. The 2008 Phase II investigation of REC 1, the wooded southern limit of the SP peninsula, found no evidence of releases and no subsequent investigations were undertaken.

The RECs investigated at GSP from 2007 to 2016 are:

- REC # 2 –fuel storage tank farm
- REC # 3 – former waste water treatment plant
- REC # 4 – former solvent storage area (current Maryland State Police hangar)
- REC # 5 – former electrical transformer pad
- REC # 6 – former delivery hangar (Building ND) and seaplane ramp
- REC # 7 – airport maintenance garage and former propulsion test areas
- REC # 8 – former jet/engine test areas, compressor shed, noise suppression and storage buildings
- REC # 9 – former Vanguard area/hyper-therm test facilities, propellant and acetylene storage sheds
- REC # 10 – former coupon test sheds and block house
- REC # 11 – northern GSP wooded area and former nuclear research facilities, former liquid-metal test facility (Buildings KH, KI, KJ, and KQ)

These areas of concern were identified during a records review of historical site features and operations in the 1940s to 1960s. GSP site investigations from 2007 to 2016 included monitoring well installation, soil and groundwater sampling, test pit excavations, and geophysical surveys. More than 100 groundwater samples were collected from 26 permanent monitoring wells, and from several temporary monitoring wells and temporary groundwater sampling points distributed across RECs #2 through #11. More than 200 soil samples were collected from soil borings and test pits. Surface water and sediment samples were also collected from the stormwater conveyance features that begin in REC #11 near the northernmost portion of GSP and convey stormwater south towards Stansbury Creek. A geophysical survey and gamma surface scan of REC #11 (including the vicinity of former Buildings KC and KJ where radioactive materials were believed to have been handled) were performed in 2015. At that time, exploratory test pits were dug to verify the absence of former building foundations and utilities, and soil samples from these locations were tested for potential releases, including radioactivity. These investigation results show no evidence of environmental impacts related to former radiological research activities in these buildings. The geophysics and test pit results confirmed records indicating that the foundations and utility lines for the former buildings were removed and that there is no evidence of radioactivity associated with the former buildings. There is no evidence of impacts to Stansbury Creek associated with historical site activities, and the creek was not evaluated as part of GSP; no additional investigations are planned.



Soil and groundwater investigations at RECs #2 through #6 were conducted primarily in 2010, while investigations at RECs #7 through #11 were completed in 2011 through 2016. The 2017 design characterization study was conducted to further delineate contaminants that had been identified in the earlier work, and to support the choice of the GSP remedial action in the FS. The FS included an evaluation of the nature and extent of environmental contamination at GSP, a human health risk assessment (HHRA), and an ecological risk assessment (ERA). The contaminants triggering unacceptable risks to human health and ecological receptors were identified in the FS and used to define current environmental conditions and to help choose an appropriate remedial action. A summary of the FS, including the HHRA and ERA, is presented below.

Soil Conditions

Surface Soil: Surface soil analytical results from RECs #2 through #6 were screened (identified for further evaluation) against conservative residential Maryland Department of the Environment (MDE) soil-cleanup standards, or MDE's published Anticipated Typical Concentrations (ATCs) for eastern Maryland soil (e.g., background or naturally occurring concentrations), to identify chemicals of potential concern (COPC) as part of the human health risk assessment (HHRA). Exceedances of MDE residential soil cleanup standards in surface soil include arsenic, chromium, iron, manganese, vanadium, and polycyclic aromatic hydrocarbons (PAHs). In RECs #7 through #10, surface soil chemicals exceeding MDE residential soil cleanup standards are predominantly PAHs, arsenic, and iron. Concentrations of manganese, vanadium, and diesel-range organics (DRO) in surface soil samples also exceed MDE residential soil cleanup standards. Throughout REC #11, surface soil concentrations of DRO, polychlorinated biphenyls (PCB, as Aroclor 1260), and PAHs also exceed MDE residential soil cleanup standards.

Subsurface Soil: Subsurface soil sample results were screened in a similar manner as the surface soil samples to identify COPCs as part of the HHRA. Arsenic, chromium, iron, manganese, nickel, and vanadium exceed MDE residential soil cleanup standards and ATCs in subsurface soil throughout RECs #2 to #4. Subsurface soil concentrations (at various depths) of arsenic, chromium, and vanadium also exceed MDE residential soil cleanup standards and ATCs in RECs #7 through #10, while concentrations of DRO and PAHs, mostly located in shallow REC #10 samples (less than eight feet below ground surface [bgs]), exceed MDE residential soil cleanup standards in an area that was likely disturbed as part of the 1998–2000 airport improvements. In REC #11, DRO exceeds MDE residential soil cleanup standards in five shallow subsurface samples, while Aroclor 1260 and PAH concentrations exceed MDE residential soil cleanup standards in many subsurface soil samples.

Did you know?

Although GSP soil has elevated contaminant levels, the remedial alternatives for GSP focus on **groundwater cleanup,** because current land use at the site is commercial, and future land-use controls will prevent unacceptable exposure to contaminated soil.

Groundwater treatment will focus on RECs #8 and #9. These are the only areas where RAO No. 1 (prevent unacceptable exposure to TCE in groundwater) is not met under current site conditions.

Groundwater Conditions

Extensive groundwater investigations at the GSP site and the results of the HHRA indicate that volatile organic compounds (VOCs), including trichloroethene (TCE), 1,2-dichloroethane (1,2-DCA), and vinyl chloride (VC), are the primary COPCs, because they are detected with maximum concentrations greater than conservative screening levels, such as MDE groundwater cleanup standards, USEPA Regional Screening Levels (RSLs) for tap water, and USEPA Maximum Contaminant Levels (MCLs).

A summary of the nature and extent of the contamination in GSP groundwater follows:

- At RECs #2 through #6, metals and total petroleum hydrocarbons (TPH)-DRO in groundwater are the primary contaminants that exceed MDE groundwater cleanup standards. Other, more volatile petroleum-related compounds such as benzene, toluene, ethylbenzene, and xylenes (BTEX) are generally not detected.

- At RECs #7 through #10, chemicals exceeding MDE groundwater cleanup standards include DRO, naphthalene (REC #8), TCE (RECs #7 through #9), and metals. The highest TCE concentrations (up to 2,600 micrograms per liter [µg/L]) were detected in shallow groundwater on the north boundary of REC #8. TPH concentrations, detected as gasoline-range organics (GRO), exceed the groundwater screening levels in four wells in RECs #7-9. Several unfiltered metals (arsenic, cobalt, lead, thallium, and vanadium) also exceed groundwater screening levels in RECs #7-9. In REC #10, shallow groundwater exceedances consist primarily of cobalt, vanadium, and DRO.

- At REC #11, VOCs (TCE, DCA, and VC) are the primary chemicals exceeding groundwater screening levels. VOC impacts in REC #11 groundwater appear to occur in several small, diffuse plumes over a broad area (more than 700 feet long), without distinct source areas. Naphthalene, DRO, arsenic, cobalt, nickel, thallium, and vanadium also exceed groundwater screening levels in one or more REC #11 wells.

Groundwater flow across the GSP area is generally to the southwest, toward Stansbury Creek. However, radial flow patterns have also been observed during previous MSA studies. A central groundwater-flow divide is present in the uplands area near the airport runway and north of GSP. North and east of this divide, groundwater flows toward Frog Mortar Creek; south of the divide, groundwater flows toward Stansbury Creek. Some of the contaminant plume in RECs #8 and #9 near this divide is being transported to the northeast, toward Frog Mortar Creek. A plume at REC #11 has migrated in a southwesterly direction, toward Stansbury Creek (see Figures on pages 12 and 13 in this plan). Although the plumes migrate towards the creeks with the natural groundwater flow, the plumes themselves do not reach the creeks.

Surface Water and Sediment Conditions

The surface water and sediment present at GSP are limited to the northern area in REC #11 and consist primarily of stormwater detention and conveyance features that were installed during the 1998-2000 airport improvement project. Chemical results for the GSP sediment samples were not carried forward as site-related contaminants of potential concern (COPC) because they are representative of recent airport use (i.e., after the year 2000, when the detention ponds were constructed) and not historical GSP site use impacts (the focus of this Proposed Plan). In addition, per the ERA, all GSP surface water constituents were eliminated as COPC (see below). As noted above, Stansbury Creek was not included in the evaluation of GSP.

Human Health Risk Assessment

The HHRA completed in 2017 was conducted in accordance with the US Environmental Protection Agency (USEPA) and Maryland Department of the Environment (MDE) guidelines. The HHRA used the complete set of GSP sample results to evaluate risk to potential human receptors under current and likely future land uses. Initially, GSP soil and groundwater chemical concentrations were compared to stringent, residential cleanup standards to identify chemicals of potential concern. A cumulative lifetime-excess-cancer-risk greater than 1×10^{-5} (or an excess lifetime cancer risk of one in one-hundred thousand) was used to determine unacceptable cancer risk, and a hazard index greater than 1 was used as the criterion for determining unacceptable noncancer risk. Chemicals that contribute to an unacceptable cancer risk or a hazard index greater than 1 are chemicals of concern (COC) requiring action to mitigate the risk. Site use at GSP is currently commercial/industrial and is expected to remain so in the future. Therefore, the HHRA further evaluated risks to potential receptors most likely to be exposed to impacted environmental media at GSP (i.e., commercial and construction workers). The HHRA concluded that risk associated with commercial- or industrial-receptor exposure to soil is within the acceptable risk range. No COC in GSP soils were identified for current or future commercial, industrial, or construction worker exposures and so no remedial action is warranted for GSP soils for continued commercial/industrial land use.

Commercial and industrial workers are not expected to be exposed to chemicals in groundwater because groundwater is not used as a source of either drinking water or process water, and because industrial workers are not expected to directly contact groundwater in their day-to-day work. For expected receptors (e.g., the construction worker who may have dermal contact with contaminated site media), TCE is the only groundwater COC associated with unacceptable human health risk, limited to RECs #8 and #9. Although the VOC concentrations in REC #11 groundwater exceed groundwater screening levels, they are not associated with unacceptable risk to hypothetical construction-workers exposed to groundwater, and therefore groundwater in this area is not subject to remedial action.

Ecological Risk Assessment

An ERA was conducted in accordance with USEPA guidelines in 2010 as part of remedial investigation activities to evaluate risk due to potential ecological receptors' exposure to surface soil, sediment, and surface water within the GSP RECs. The wooded area in the northern portion of GSP is the only area at the site considered to be a viable ecological habitat, as industrial and airport activities occur in the remainder of the site. Potential ecological risks were identified for PAHs and metals in site surface soil and sediment, but because habitat is of limited extent and concentrations were isolated, remedial actions are not warranted. Stansbury Creek sediment was tested at 12 locations for site contaminants in 2009. No impacts were detected, and no additional action was required for the creek by MDE.

Did you know?

As part of Lockheed Martin's **"Go Green"** program, **sustainability** was a factor when selecting the recommended remedial alternative, and sustainability practices will be included in the design and implementation of the selected remedial action alternative.

Sustainability practices in general are those that consider natural resources, ecology, human health and safety, quality of life, and reduction of the overall environmental "footprint."

REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are cleanup goals established during an FS that are based on investigation data and risk assessments. RAOs assist with the development of remedial alternatives for protection of human health and the environment. At GSP, the following RAOs were developed for the remedial action based on the risks identified in the HHRA:

- RAO No. 1 — Prevent exposure of construction workers to trichloroethene (TCE) in groundwater during construction that could cause unacceptable risk based on a hazard index (HI) greater than 1.
- RAO No. 2 — Prevent human exposure (including via showering, drinking, and irrigation) to groundwater containing COC concentrations greater than groundwater criteria.
- RAO No. 3 — Prevent off site migration of site contaminants to Stansbury Creek, and prevent exceedances of ambient water quality criteria or human health risk-based exposure criteria in Stansbury Creek and Frog Mortar Creek by migration of contaminated groundwater.
- RAO No. 4—Prevent exposures to site soil other than those of construction/industrial workers during activities consistent with typical commercial/industrial use and maintenance.

- RAO No. 5—Prevent exposure of industrial workers and hypothetical residents to volatile organic compounds (VOCs) resulting from vapor intrusion into buildings that could cause unacceptable risk (total cancer-risk greater than 1×10-5 [i.e., a one in 100,000 probability] or a hazard index greater than 1).

Preliminary remediation goals (PRGs) for groundwater in GSP were developed in the FS in consideration of current land use. PRGs were developed to account for current site use exposure scenarios, specifically construction workers encountering groundwater, and are referred to as construction worker PRGs in this Proposed Plan. There were no unacceptable risks for the industrial exposure scenario. A second set of PRGs was also developed based on MDE and USEPA guidance to provide the highest level of protection for human health and the environment (e.g., levels acceptable for drinking water/residential use), and are referred to as residential PRGs in this Proposed Plan.

For the construction worker exposure scenario, the only COC is TCE with a PRG of 320 µg/L. For drinking water/residential use, PRGs consist of MCLs, MDE groundwater cleanup standards, or risk-based levels if there are no MCLs or MDE standards. The COCs listed in Table 1 were identified based on exceedances of the most stringent cleanup standards associated with potential residential exposure.

Table 1

Chemical of Concern	Residential PRG, µg/L	Type
Volatile Organic Compounds (VOCs)		
Trichloroethene	5	MCL
1,2-Dichloroethane	5	MCL
Carbon Tetrachloride	5	MCL
Chloroethane	3.6	MDE Standard
Chloroform	80	MCL
cis-1,2-Dichloroethene	70	MCL
Naphthalene	0.65	MDE Standard
Vinyl Chloride	2	MCL
Bromomethane	0.85	MDE Standard
Metals		
Arsenic	10	MCL
Chromium	100	MCL
Cobalt	6	Risk-Based
Iron	300	MDE Standard
Manganese	50	MDE Standard
Nickel	73	MDE Standard
Thallium	2	MCL
Vanadium	3.7	MDE Standard
Petroleum Hydrocarbons		
TPH-GRO (C06-C10)	47	MDE Standard
TPH-DRO (C10-C32)	47	MDE Standard

SUMMARY OF ALTERNATIVES

Remedial alternatives, or cleanup options, that would meet the RAOs, were identified in the GSP FS, and are summarized below. These alternatives include different combinations of methods or plans to restrict access and/or to contain, remove, or treat contamination, so that human health and the environment are protected. As noted in the next section, Alternative G-2 is the preferred alternative.

- ***Alternative G-1* — No action**

Alternative G-1 was developed and analyzed as a baseline against which the other alternatives can be compared, as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This alternative would not improve existing conditions, and would not reduce the toxicity, volume, or mobility of groundwater COC, other than what would result from natural dispersion, dilution, biodegradation, and other attenuating factors.

- ***Alternative G-2* — Monitored natural attenuation (MNA), land use controls (LUCs), and five-year reviews**.

  Alternative G-2 relies on natural biological and geochemical processes in groundwater to degrade groundwater contaminants and reduce concentrations over time. Chlorinated VOC (cVOC) concentrations, such as that of TCE, would be reduced primarily through biological activity, but would also be reduced by dispersion and dilution with movement through the aquifer and adsorption onto soil particles. Long-term monitoring (i.e., sampling and testing) of groundwater would be performed to confirm decreasing contaminant concentrations and ensure MNA effectiveness. Alternative G-2 is expected to attain residential PRGs for VOCs in 40 years. At least once every five years, a site review would be required to evaluate and report on remedy effectiveness.

- ***Alternative G-3* — *In situ* chemical oxidation, MNA, LUCs, and five-year reviews**.

  Sodium persulfate would be injected into the groundwater at RECs #8 and #9 to facilitate *in situ* chemical oxidation (ISCO). Direct-push technology drilling would be used to inject the substrate at depths of 10 to 30 feet bgs. Multiple injection rounds of sodium persulfate may be required to achieve construction worker PRGs. Only the area with elevated TCE concentrations would be treated; the lower concentrations of contaminants downgradient would be managed by natural attenuation. ISCO will also promote the oxidizing conditions that can facilitate the precipitation and co-precipitation of specific metals (e.g., iron, manganese, and arsenic), thus reducing their mobility. Alternative G-3 is estimated to require 32 years to achieve residential PRGs in groundwater. The MNA, LUC, and five-year review components are the same as that described in Alternative G-2.

- ***Alternative G-4* — *In situ* enhanced bioremediation, MNA, LUCs, and five-year reviews**.

  Alternative G-4 is the same as Alternative G-3, except that, instead of ISCO, the GSP area would be treated with an electron donor to promote anaerobic biological activity. A long-lasting, multicomponent electron donor is proposed because it remains effective on TCE that desorbs from soil over time. The proposed substrate contains a mixture of lactate, polylactate esters, fatty acids, and fatty acid esters that provide electron donor release in the short- and long-term. Similar to Alternative G-3, the substrate would be injected in the groundwater at 10 to 30 feet below ground surface. Alternative G-4 is estimated to require 32 years to attain groundwater residential PRGs. The MNA, LUC, and five-year review components are the same as that described in Alternative G-2.

What are the evaluation criteria used for selection of the alternative?

Threshold Criteria (The selected remedy must satisfy these criteria):

Overall Protection of Human Health and the Environment: determines whether an alternative eliminates, reduces, or controls threats to public health and the environment.

Compliance with Applicable Statutes and Regulations

Balancing Criteria (These criteria are used to weigh the relative merits of the alternatives):

Long-Term Effectiveness and Permanence: considers the ability of an alternative to maintain the degree of certainty that it will prove successful and includes the magnitude of residual risk and the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment: evaluates an alternative's use of treatment to reduce the amount of contamination present, and to reduce the harmful effects of principal contaminants and their ability to move in the environment.

Short-Term Effectiveness: considers the length of time needed to implement an alternative, and the risk the alternative poses to workers, residents, and the environment during implementation.

Implementability: considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services. The selected alternative must include the flexibility to treat additional groundwater if conditions at the site should change.

Sustainability: incorporates the environmental (e.g., resource consumption and waste generation), economic, and social effects of each alternative. The evaluation of sustainability is consistent with Lockheed Martin's 'Go Green' program.

Cost: includes estimated capital and annual operation and maintenance (O&M) costs, as well as a net present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

Modifying Criteria (These criteria are also considered during evaluation, but are only evaluated after the remedy selection):

Governmental Authorities Acceptance of the project will be assessed as the project planning progresses.

Community Acceptance considers whether the local community agrees with the preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

COMPARISON OF GROUNDWATER ALTERNATIVES BY CRITERIA

Alternative	G-1	G-2	G-3	G-4
Threshold Criteria				
Protects human health and the environment	○	●	●	●
Complies with federal and state statutes and regulations	○	●	●	●
Balancing Criteria				
Provides long-term effectiveness and is permanent	○	●	●	●
Reduces mobility, toxicity, and volume of contaminants through treatment	○	⊙	●	●
Provides short-term protection	○	●	●	●
Can be implemented	NA	●	⊙	⊙
Sustainability	●	●	⊙	⊙
Cost ($ in millions)				
• Upfront cost to design and construct the alternative	NA	$0.24 M	$1.4 M	$1.2 M
• Net present worth of maintaining injection wells and future *in situ* injections (if needed), LUCs, and monitoring program associated with the alternative for 40 (G-2) or 32 years (G-3 and G-4)	NA	$1.4 M	$1.1 M	$1.1 M
• **Total cost net present worth**	**NA**	**$1.6 M**	**$2.5 M**	**$2.3 M**
Modifying Criteria				
State environmental protection agency acceptance	To be determined after the public comment period			
Community acceptance	To be determined after the public comment period			

Relative comparison of criteria and each alternative:

● – High, ⊙ – Medium, ○ – Low; NA – not applicable

Cost ($): M – million

SELECTION OF PREFERRED GROUNDWATER ALTERNATIVE

Alternative G-2 (monitored natural attenuation) was selected as the preferred remedial alternative to address groundwater contamination in the GSP area at MSA. This alternative complies with applicable regulations and meets the threshold criteria in that it ensures threats to human health and the environment are controlled. Land use controls (LUCs) preventing site residential uses would prevent unacceptable risk from exposure to soil. LUCs would also prevent residential and industrial groundwater use until residential PRGs can be met through natural attenuation. Groundwater modeling indicates that natural attenuation processes will degrade groundwater contaminants to levels acceptable for residential (drinking water) use in approximately 40 years. A groundwater monitoring program will evaluate the effectiveness of natural attenuation processes and confirm that no COC transport from groundwater to surface water is occurring by sampling new monitoring wells located between the groundwater contamination and Stansbury Creek.

Figure 1. Current Distribution of TCE in the Surficial Aquifer.

Figure 2. Simulated Distribution of TCE after 10 Years.

Alternatives G-3 and G-4 were not selected, primarily because they offer only a marginal reduction in time to achieve residential PRGs, but at significantly greater costs. Alternative G-2 will take only eight years longer (40 years total) to attain remediation goals, as compared to Alternatives G-3 and G-4 (each approximately 32 years). In addition, the total costs of Alternatives G-3 and G-4 are about 45-55% higher over their attainment period, as compared to the 40-year attainment period for Alternative G-2. Alternative G-2 is ranked higher in sustainability, because it has a smaller carbon footprint (i.e., no intrusive activities are associated with MNA, and it has a lower energy demand).

Figures 1 through 4 demonstrate the projected decrease in GSP plume concentrations over 40 years of monitored natural attenuation.

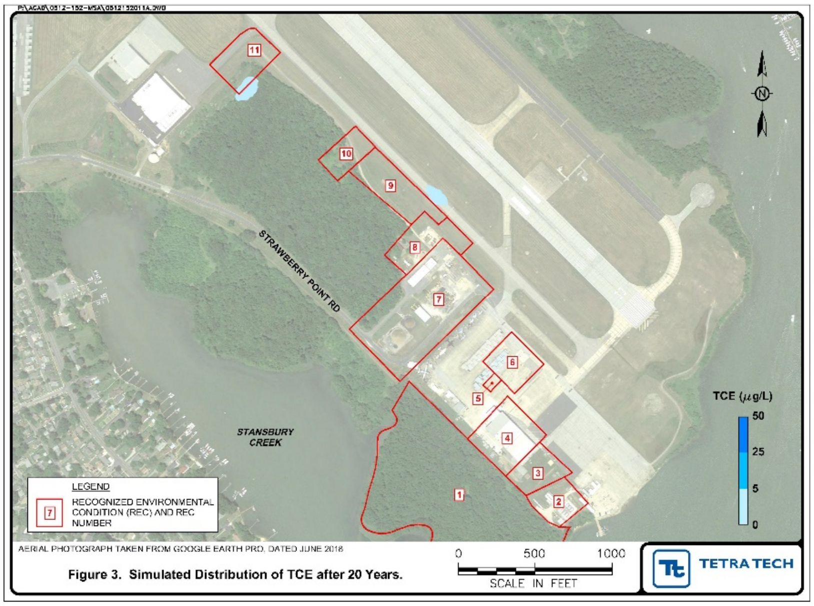


Figure 3. Simulated Distribution of TCE after 20 Years.

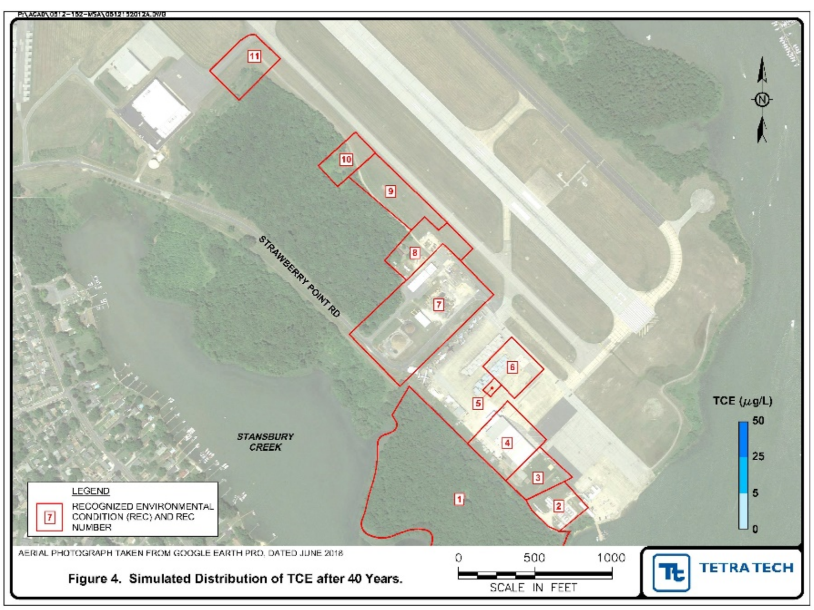


Figure 4. Simulated Distribution of TCE after 40 Years.

Preferred Alternative:

G-2

The following is a more detailed design description of the preferred alternative according to its three major components:

(1) monitored natural attenuation

(2) LUCs

(3) five-year reviews

Detailed design description of the preferred alternative, G-2:

1) ***Monitored Natural Attenuation –*** Naturally-occurring processes within the aquifer will reduce concentrations of chlorinated volatile organic compounds (cVOCs). The cVOC concentrations would be reduced primarily through biological activity, but would also be reduced by dispersion, dilution, and movement through the aquifer, and adsorption onto soil particles. MNA of organic compounds is typically demonstrated through lines of evidence. First, groundwater sampling results must show plume stabilization and/or contaminant-mass reduction. Second, geochemical conditions must be shown to be suitable for biological degradation, such as depletion of electron acceptors and donors, increasing metabolic byproduct concentrations, and increasing daughter-compound concentrations.

As shown below, the volume of groundwater with TCE concentrations greater than the construction worker PRG in the contaminant plume at RECs #8 and #9 is approximately 865,000 gallons. This volume also includes additional COC and other contaminants, such as arsenic, lead, naphthalene, DRO, and GRO. Groundwater modeling indicates that residential

PRGs for VOCs at RECs #8 and #9 would be met by natural attenuation in approximately 40 years. Groundwater modeling also suggests that cVOCs will not migrate from GSP groundwater to surface water. Groundwater monitoring is a component of the MNA remedy. Monitoring would consist of regularly measuring groundwater levels and collecting and analyzing groundwater samples to evaluate changes in contaminant concentrations over time and assess natural attenuation effectiveness.

GSP AREA AND VOLUME OF CONTAMINATED MEDIA REQUIRING TREATMENT

Area	Dimensions (feet)	Area (square feet)	Depth interval (feet below ground surface)	Saturated soil volume (cubic feet)	Groundwater volume (gallons)
RECs #8 and #9	175×110	19,200	10 to 30	385,000	865,000

Wells upgradient of the plume would be sampled, as would wells at the highest concentration locations, wells within the plume, and wells near the downgradient edge of the plume. Wells would be sampled quarterly during the first year to establish baseline conditions. Natural attenuation processes are expected to be slow, so subsequent sampling would be conducted annually until trends can be identified to refine the estimated period to reach residential PRGs. Annual groundwater sampling and analysis reports will be submitted to the regulators. The groundwater monitoring program would be reviewed at least every five years to determine if changes are needed in sampling frequency, laboratory analyses, or wells to be sampled.

A long-term monitoring plan would identify wells to be sampled and define chemicals to be analyzed. Groundwater samples would be collected and analyzed for cVOCs and natural attenuation parameters such as oxidation-reduction potential (ORP), dissolved oxygen, pH, alkalinity, temperature, conductivity, total organic carbon, ferrous and total iron, sulfur compounds (sulfate and sulfide), nitrogen compounds (nitrate and nitrite), orthophosphate, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide).

Because of the presence of TPH in concentrations greater than residential criteria, wells near RECs #8, #10, and #11 would also be routinely sampled and analyzed for TPH. Similarly, because of the metals present above residential criteria, monitoring wells near RECs #4 through #6 would be sampled and analyzed for metals. Additional monitoring wells would be installed downgradient of the locations exhibiting elevated TPH and metals concentrations, if no existing wells are present. A cluster of three wells screened at multiple depths would be installed north of REC #8 to further evaluate the extent of TCE and confirm the groundwater modeling results. Samples from new monitoring wells installed near the shore downgradient of the RECs would be used to confirm the absence of groundwater impacts to surface water. No surface water impacts are expected based on modeling of currently defined plumes. Final selection of monitoring well locations and depths will be made in the design phase of the project, with the concurrence of regulatory agencies.

2) LUCs — Land use controls for groundwater would include limiting land use to industrial purposes and prohibiting surficial aquifer use for drinking water and industrial purposes. LUCs would address soil contamination and prevent residential use of the site, thus preventing unacceptable exposure to elevated contaminant concentrations in soil. Deed restrictions would be required for LUC implementation. Land use controls would be maintained until groundwater contaminant concentrations are below residential PRGs and may need to remain in effect longer to prevent residential exposure to contaminants in site soil.

Vapor intrusion is a potential problem because TCE and other VOCs are present in shallow groundwater. Thus, an additional LUC would be applied to areas overlying shallow groundwater where VOC concentrations pose unacceptable risk for vapor intrusion. This additional LUC would require special construction methods, such as installation of vapor barriers and foundation venting, to prevent unacceptable VOC exposure (via vapor intrusion) to building occupants. There are no vapor intrusion concerns for any existing, occupied buildings in GSP so LUCs would prevent unacceptable exposures associated with vapor intrusion.

3) Five-Year Reviews — At least once every five years, a site review would evaluate the protectiveness of the remedy, review environmental laws and regulations in effect at the time of the review, review MNA effectiveness, verify that LUCs are effective, and provide direction for further action, if deemed necessary. Site reviews would be required because this alternative would allow soil and groundwater contaminants to remain on site at concentrations that are unacceptable for unrestricted use.

COMMUNITY PARTICIPATION INFORMATION

The public is encouraged to participate in the decision-making process for the GSP Site at MSA by reviewing and commenting on this Proposed Plan during the public comment period. You do not have to be a technical expert to comment before the beginning of the cleanup process.

- **Public comment period for the Proposed Plan:**
  through April 19, 2019
- **Location of project documents:**
  https://www.lockheedmartin.com/martinstateairport
- **Send Comments to:**
  Kay Armstrong
  PO Box 2687
  Tybee Island, GA 31328

  Or, by email:
  darrylkay@aol.com
- **Contact information:**
  Meghan Macdonald - (301) 897-6195; meghan.o.macdonald@lmco.com

GLOSSARY

This glossary defines the technical terms used in this Proposed Plan. The definitions in this glossary apply specifically to this Proposed Plan, and may have other meanings when used in different circumstances.

Aquifer — An underground layer of rock, sand, silt, or clay that contains water in sufficient amounts to serve as a source of groundwater for wells and springs.

BTEX - Benzene, toluene, ethylbenzene, and xylenes.

Chemical of concern (COC) — Chemicals that are found at concentrations higher than those considered to be safe, based on prescribed risk calculations and criteria, and must be cleaned up and/or monitored.

Chemical of potential concern (COPC) — Chemicals identified during a remedial investigation (RI) that are at concentrations that may have the potential to harm human health and/or the environment.

Chlorinated volatile organic compounds (cVOCs) — examples include trichloroethene (TCE) and *cis*-1,2-dichloroethene (*cis*-1,2-DCE); see VOCs for additional information.

***cis*-1,2-Dichloroethene (*cis*-1,2-DCE) —** A degradation product of trichloroethene (TCE).

1,2-Dichloroethane — A colorless liquid chemical formerly used as a solvent and more commonly used in the production of vinyl chloride.

Ecological risk assessment (ERA) — A study that evaluates the toxicity of chemicals released to the environment to ecological receptors present, and determines whether (and at what levels) adverse ecological effects are likely from exposure to those chemicals.

Groundwater — Water found beneath the ground surface that fills open spaces between particles such as sand, soil, and gravel, or that fills cracks and fractures in rock.

Hazard Index (HI) — The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. If the value is less than one, then adverse health effects are unlikely to occur.

Human health risk assessment (HHRA) — A study that evaluates the harmful effects and risks from eating, breathing, or touching a chemical (current and future).

***In situ* —** For this project, *in situ* means on-site and below ground.

***In situ* chemical oxidation (ISCO) —** A treatment technology in which chemicals are added to groundwater *in situ* (in place, as opposed to extracted groundwater) to promote the generation of highly reactive hydroxyl radicals that react with COC and degrade them to less harmful components. For example, the injected chemical causes the oxidative cleavage of the carbon to carbon bond (e.g., in cVOCs and TPH), yielding water, carbon dioxide, oxygen, and dilute hydrochloric acid as byproducts.

***In situ* enhanced bioremediation —** A treatment technology in which chemicals and/or nutrients are added to groundwater *in situ* (in place, as opposed to extracted groundwater) to increase the activity of naturally occurring bacteria that consume and degrade organic compounds.

Land use controls (LUCs) — Engineered and non-engineered (administrative) controls formulated and enforced to regulate current and future land use options. Engineered controls include fencing and posting of signs. Non-engineered controls typically consist of administrative restrictions that prohibit residential development and/or groundwater use.

Monitored natural attenuation — Reliance on *in situ* natural processes to achieve site-specific cleanup goals within a time frame that is reasonable compared to other methods. These natural processes include biological degradation, chemical reaction, dispersion, dilution, sorption, and volatilization of contaminants. Groundwater is sampled regularly to verify the progress toward the cleanup goals.

Net present worth — A present worth analysis that evaluates costs over a specific period by discounting all future costs to a common base year. It represents the amount of money that, if invested in the base year and dispersed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. Net present worth considers both capital (construction) and annual (such as maintenance and labor) costs.

Operation and maintenance (O&M) — Activities conducted after a site action has been completed to ensure that the action is effective.

Plume — A body of contaminated groundwater moving away from its source. The movement of contaminants is influenced by such factors as local groundwater flow patterns, aquifer characteristics, and the nature and type of contaminant.

Polychlorinated biphenyl (PCB) — Polychlorinated biphenyls are a class of organic compounds that have a chemical structure with 1 to 10 chlorine atoms attached to a biphenyl, which is a molecule composed of two benzene rings. PCBs were widely used for many applications, especially as dielectric fluids in transformers, capacitors and coolants. Due to PCB's perceived toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979.

Polycyclic aromatic hydrocarbon (PAHs) — A group of carcinogenic compounds primarily derived from the incomplete combustion of materials. PAHs are also present in petroleum products.

Preliminary remediation goals (PRGs) — Contaminant concentration goals for soil, sediment, water, and air, listed by land use option, that are protective of human health and the environment. Customarily used at Superfund, federal facilities, Brownfield, and RCRA sites, PRGs comply with all regulatory requirements. Preliminary remediation goals serve as a target during the initial development, analysis, and selection of cleanup alternatives.

Recognized environmental condition (REC) – The ASTM International standard E1527-13 defines the recognized environmental condition as “the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment.

Remedial action — The construction or implementation phase of the selected remedial alternative at a site cleanup program.

Remedial action objectives (RAOs) — Cleanup objectives that specify contaminants to be cleaned up, the level of cleanup, the area of cleanup, and the time required to achieve cleanup, for the purpose of protecting human health and the environment.

Remediation — The process of correcting and/or cleaning up environmental contamination. Remediation involves reducing, isolating, or removing contamination from an environmental medium (e.g., soil, air, groundwater, surface water), with the goal of preventing people or animal exposures to contamination and reducing impact to the environment.

Trichloroethene (TCE) — A nonflammable, colorless liquid chemical with a slightly sweet odor, commonly used as an industrial solvent and metal degreaser. TCE is also used in household and consumer products such as typewriter correction fluid, paint removers, adhesives, and spot removers.

Vapor intrusion — The movement (migration) of chemical vapors from soil gases found under the ground into overlying buildings, such as through foundation cracks.

Vinyl chloride (VC) — A degradation product of trichloroethene (TCE).

Volatile organic compounds (VOCs) — A group of chemicals (organic compounds) that will vaporize or evaporate at room temperature into the atmosphere. They often have a sharp smell and can come from many products such as office equipment, adhesives, carpeting, upholstery, paints, petroleum products, solvents, and cleaning products.

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