DEPARTMENT OF THE ARMY
HEADQUARTERS, 3D INFANTRY DIVISION (MECHANIZED) AND FORT STEWART
DIRECTORATE OF PUBLIC WORKS
1557 FRANK COCHRAN DRIVE
FORT STEWART, GEORGIA 31314-4928

REPLY TO
ATTENTION OF

NOV 02 1999

AFZP-PWV-E (200-1a)

MEMORANDUM FOR HEADQUARTERS, FORSCOM, DCSPIM, ATTN:
STEPHANIE SIGLER, 1777 HARDEE AVENUE SW.,
FORT MCPHERSON, GA 30330-1062

SUBJECT: Decision Document for Final Remedial Action at the Former Tanker Purging Station (SWMU 26), Fort Stewart, Georgia

1. The attached decision document is provided for your use and convenience in distributing funding for ER,A projects at Fort Stewart. The decision document summarizes the site conditions at the former Tanker Purging Station (SWMU 26) at Fort Stewart which has led the Directorate of Public Works (DPW) Environmental Branch to submit a Corrective Action Plan (CAP) to GA EPD for this site. Implementation of the CAP will begin immediately upon State approval of the report (anticipated in 2d QTR FY00).

2. Mr. Wayne Mandell at the Army Environmental Center has reviewed and approved this decision document, per a telephone conversation with Ms. Melanie Little on September 22, 1999.

3. The point of contact for this memorandum is Ms. Melanie Little or Ms. Tressa Rutland, DPW Environmental Branch, at (405) 364-8461 or (912) 767-7919, respectively.

FOR THE COMMANDER:

Encl

OVIDIO E. PEREZ
COL, EN
Director, Public Works

DOCUMENT 6

DECISION DOCUMENT FOR FINAL REMEDIAL ACTION AT THE FORMER TANKER PURGING STATION (SWMU 26) FORT STEWART, GEORGIA

PURPOSE OF THE FINAL REMEDIAL ACTION

This decision document describes the selected final remedial action for the Former 724th Tanker Purging Station (TPS) (Solid Waste Management Unit [SWMU] 26) at Fort Stewart, Georgia.

The Former 724th TPS was located in the western cantonment area, which is in the southern portion of the Fort Stewart Military Reservation (FSMR). The tanker purging station was an area where tanker trailers that carried diesel, JP-4 jet fuel, and mogas were routinely cleaned. During August 1996 the tanker purging station was dismantled, the underground facilities were removed, and approximately 525 yd^3 of contaminated soil were excavated and replaced with clean backfill.

Potential contamination due to fuel leakage at the site was investigated during a Phase I Resource Conservation Recovery Act Facility Investigation (RFI) for 24 SWMUs at Fort Stewart in 1993. Analytical results from soil sampling conducted at the Former 724th TPS indicated fuel product and solvent contamination in soil. Based on these findings, Georgia Environmental Protection Division (GA EPD) instructed the Fort Stewart Directorate of Public Works (DPW) to conduct a Phase II RFI at the site.

The objectives of the Phase II RFI for the Former 724th TPS, as defined in the Work Plan approved by GA EPD on June 10, 1997 were to:

- Determine the horizontal and vertical extent of contamination.
- Determine whether contaminants present a threat to human health or the environment.
- Determine the need for future action and/or no further action.
- Gather necessary data to support a Corrective Action Plan (CAP), if warranted.

Results of the Phase II RFI chemical analyses indicated that soils, groundwater, surface water, and sediment at the site

contain organic and metal constituents at concentrations greater than their reference background concentrations. The predominant constituents in both soil and groundwater are fuel-related chemicals such as benzene, toluene, ethylbenzene, and total xylene (BTEX) compounds, with secondary contaminants such as acetone, 1,1-dichloroethane, and polyaromatic hydrocarbon (PAH) compounds.

Contamination present in surface and subsurface soils is dominated by BTEX and secondary PAH contaminants. Maximum BTEX concentrations reported in soil include benzene (9420 µg/kg), toluene (27,400 µg/kg), ethylbenzene (27,100 µg/kg), and total xylenes (124,000 µg/kg). BTEX contamination in soil extends to the water table (approximately 6 feet deep) and is greatest immediately north and east of the area where contaminated soils were removed in August 1996. The soil contamination covers an approximate 4500 square foot area (approximately 60 feet by 75 feet).

BTEX contamination in groundwater extends to a depth of approximately 20 feet below the water table, although isolated areas of BTEX were found in groundwater to depths up to 40 feet. Maximum concentrations were found in a water table well at the site (MW-2) and include benzene (8,090 µg/L), toluene (4,200 µg/L), ethylbenzene (2,870 µg/L), and total xylenes (12,100 µg/L). These concentrations exceed the respective Maximum Contaminant Levels (MCLs) for each constituent. The BTEX contamination covers a plume area approximately 100 feet wide by 160 feet long, extending from the former 724th TPS facilities to the north and west. Mill Creek, the nearest downgradient surface water body, is located more than 1,000 feet from the leading edge of the BTEX plume and is therefore not being impacted by the contamination. Biodegradation of the BTEX is likely occurring, as evidenced by the presence of methane, a breakdown product of BTEX degradation.

Limited metal contamination (principally barium, mercury, and silver) is present at the site and in the ditch immediately west of the site. In surface and subsurface soils at the site, maximum concentrations of barium (14.1 mg/kg) and mercury (0.06 mg/kg) were reported. In groundwater at the site, maximum concentrations of arsenic (3.5 µg/L), barium (99.2 µg/L), mercury (0.3 µg/L), and silver (4.1µg/L), were reported, although concentrations in the upgradient well MW-1 were generally higher than those in the downgradient wells and

therefore may not be site-related. In sediments within the ditch, concentrations of barium (29.2 mg/kg), mercury (0.07 mg/kg), and silver (2.6 mg/kg) were reported at levels above reference background criteria for both sediment and soil media. In addition, lead (6.6 mg/kg) was higher than reference background criterion for sediment, but below the criterion for soil and therefore may not be site-related. In surface water, concentrations of cadmium (1.7 µg/L), lead (10.8 µg/L), and mercury (0.18 µg/L) were reported at levels above reference background criteria for both surface water and groundwater. Arsenic (1.8 µg/L) and silver (1.3 µg/L) were higher than reference background for surface water, but below the criteria for groundwater and therefore may not be site-related.

The results of the Phase II RFI and conclusions regarding nature and extent of contamination, fate and transport, human health risk, and ecological risk, indicated that a Corrective Action Plan (CAP) was required to address the soil and groundwater contamination. After evaluation of alternatives, the CAP (currently being reviewed by GA EPD) recommends that the final remedial action consist of Phoster® II enhanced bioremediation and bioventing (see Table 1, Corrective Action Alternatives).

SUMMARY OF SITE RISK

A quantitative risk evaluation has not been completed for the site; however, the analytical results from the Phase I and Phase II RFIs have been reviewed and a qualitative risk evaluation completed. Potential risks to human health and the environment do exist, based on the constituents detected during investigation activities, for both soil and groundwater.

HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment included a Step 1 Risk Evaluation to determine potential human health risks associated with the contaminants. Contaminants of Potential Concern (COPCs) have been identified as those constituents present at concentrations higher than their reference background criteria and higher than their respective EPA Region III risk-based screening criteria.

In surface soil, there are no COPCs for human health, because no constituent exceeded its respective risk-based screening criterion for exposure to a residential receptor. In subsurface

Table 1. Corrective Action Alternatives

Corrective Action	Description	Time to Implement	Cost	Comments
Alternative 1. Monitored Natural Attenuation	The action would require the monitoring of contaminant levels to ensure the reduction of these levels through biodegradation and dispersion	The estimated time to reach the RL of 5 µg/L in groundwater is approximately 20 years.	Approximately $300,700 (installation of 1 monitoring well, annual monitoring of 5 wells during attenuation period, quarterly post-attenuation monitoring for 1 year, and soil verification)	Least expensive, but longest implementation time
Alternative 2. Excavation and Air Sparging	Excavation of soils above 200 µg/kg followed by air sparging of ground-water to the MCL of 5 µg/L	Air sparging treatment at 60 scfm total would require approximately 32 months to reduce the maximum concentration of benzene from 8,090 µg/L to 5 µg/L. Following excavation, natural attenuation of soils <200 µg/kg would reach the 20 µg/kg RL within the groundwater remediation time frame.	Approximately $673,700 (excavation and disposal of soils, installation of 1 monitoring well, monthly monitoring of 5 wells during treatment, treatment with 6 injection wells, post-remediation monitoring for 1 year, and soil verification)	Moderately expensive to implement and moderately short time frame
Alternative 3. Excavation and Enhanced Bioremediation (Pure Oxygen Injection)	Excavation of soils above 200 µg/kg followed by enhanced bioremediation of groundwater to MCL of 5 µg/L	Oxygen injection treatment at 28 scfm total would require approximately 35 months to reduce the maximum concentration of benzene from 8,090 µg/L to 5 µg/L. Following excavation, natural attenuation of soils <200 µg/kg would reach the 20 µg/kg RL within the groundwater remediation time frame.	Approximately $845,600 (excavation and disposal of soils, installation of 1 monitoring well, monthly monitoring of 5 wells during treatment, treatment with 40 injection points, post-remediation monitoring for 1 year, and soil verification)	More costly than Alternative 2 with slightly longer implementation time
Alternative 4. Air Sparging and Monitored Natural Attenuation	Air sparging of groundwater to 50 µg/L followed by natural attenuation of residual contamination in soil and groundwater (no excavation of soil)	Air sparging treatment at 60 scfm total would require approximately 22 months to reduce benzene to 50 µg/L. Natural attenuation would then require approximately 6 years to reach the RL of 5 µg/L. Natural attenuation of soils would reach the 20 µg/kg RL within the groundwater remediation time frame.	Approximately $495,900 (installation of 1 monitoring well, monthly monitoring of 5 wells during treatment, treatment with 6 injection wells, monitored natural attenuation for 6 years, post-remediation monitoring for 1 year, and soil verification)	Less costly than Alternative 2 with twice the length of time needed to implement
Alternative 5. Enhanced Bioremediation and Monitored Natural Attenuation	Enhanced bioremediation of groundwater to 50 µg/L followed by natural attenuation of residual contamination in soil and groundwater (no excavation of soil)	Oxygen injection treatment at 28 scfm total would require approximately 24 months to reduce benzene to 50 µg/L. Natural attenuation would then require approximately 6 years to reach the RL of 5 µg/L. Natural attenuation of soils would reach the 20 µg/kg RL within the groundwater remediation time frame.	$721,700 (installation of 1 monitoring well, monthly monitoring of 5 wells during treatment, treatment with 40 injection points, monitored natural attenuation for 6 years, post-remediation monitoring for 1 year, and soil verification)	Less costly than Alternative 3 with twice the length of time needed to implement
Alternative 6. PHOSter® II Enhanced Bioremediation and Bioventing	Enhanced bioremediation using the PHOSter® II system in groundwater to meet the RL of 5 µg/L, In situ bioventing in soil to meet the RL of 20 µg/kg.	PHOSter® II injection treatment at a total of 12 scfm would require an estimated 4 months to reduce benzene levels to 5 µg/L in groundwater and 20 µg/kg in vadose zone soil. Time to implement is highly uncertain due to limited full-scale implementation of the PHOSter® II technology.	$354,400 (installation of one monitoring well, monthly monitoring of 5 wells during treatment, treatment with 6 injection points in groundwater and a 100-foot-long lateral injection trench in vadose zone soil). Post-remediation monitoring for one year and soil verification.	Lower cost than air sparging or oxygen injection and shortest time to implement; however, much higher uncertainty on system effectiveness and required treatment time

RL = Remedial Level

soil, there are likewise no COPCs as a result of direct exposure; no constituent presents a significant potential risk to receptors. As discussed for fate and transport, acetone, benzene, toluene, ethylbenzene, xylenes, and naphthalene have been identified as contaminants in subsurface soil that may leach into groundwater at concentrations that are unacceptable in terms of groundwater use as a drinking water source.

In groundwater, the initial COPCs are acetone, arsenic, 1,2-dichloroethane, chloroform, chloromethane, and BTEX. These constituents present a potential threat to human health as a result of groundwater use as a source of drinking water. However, the maximum concentration of arsenic (3.5 µg/L) was well below its MCL of 50 µg/L, and was only slightly above its reference background concentration of 3.4 µg/L. Arsenic exceeded background in only a single downgradient well (MW-2) and was reported at an even higher concentration in the site-specific upgradient well (10.1 µg/L at MW-1). Therefore, arsenic in groundwater is not considered a potential threat to human health at the Former 724th TPS.

In addition, use of the surficial groundwater at this site for drinking water is unlikely. Given the shallow depth of the surficial aquifer and the presence of the deeper Principal Artesian aquifer (a common source of drinking water throughout the region), the use of the surficial aquifer is not considered to be a viable exposure scenario. Drinking water screening values were used in the absence of more appropriate values.

In surface water, the maximum concentration of arsenic in the drainage ditch adjacent to the site (1.8 µg/L) exceeded the Water Quality Criteria for protection of human health (0.018 µg/L). However, the screening values are based on the use of the surface waters for drinking water or harvesting food, which are not appropriate for a drainage ditch. Surface water is not used for drinking water at the site and will not be used for drinking water in the future; therefore this is not considered to be a viable exposure scenario. The maximum concentration of arsenic in surface water in the ditch is less than its groundwater reference background criteria (3.4 µg/L), and arsenic concentrations in surface soils and sediments at the site were not elevated above background. Therefore, arsenic in surface water is not considered a potential threat to human health.

In sediment, none of the contaminants are likely to present a potential human health threat to receptors coming into direct contact with them. Methylene chloride was identified as a possible COPC for sediment, as a result of leaching into groundwater at concentrations that are unacceptable based on the use of groundwater as a drinking water source. The maximum concentration of methylene chloride (2.6 µg/kg) in sediment is less than its method detection limit (5 µg/kg) and less than its average concentration in the reference background soil data (6.2 µg/kg). Methylene chloride is a common laboratory contaminant and is therefore not considered related to contaminant releases at the former 724th TPS.

In Mill Creek, the mercury concentration in the surface water sample collected downstream of the site exceeded its respective Water Quality Criteria. However, Mill Creek does not receive contaminated groundwater discharge or direct runoff from the site. Therefore, the source of mercury in Mill Creek is not from the Former 724th TPS.

ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment provided a Phase 1 preliminary risk evaluation for potential terrestrial and aquatic receptors at the site. The Preliminary Risk Evaluation for the Former 724th TPS identified ecological COPCs in surface water, sediment, and groundwater based on a comparison of their maximum site concentrations to their EPA Region IV ecological screening values. Preliminary risk quotients were calculated for ecological COPCs identified in surface soil and surface water based on a comparison of detected concentrations to toxicity reference values (TRVs) for surrogate species representing ecological receptors.

Chromium and lead are present in surface soil at the Former 724th TPS at concentrations that exceed the TRVs for the robin, as do lead and selenium at the upgradient soil sampling location (MW-1). As concluded in the evaluation of contaminant nature and extent, none of these metals are present at concentrations exceeding reference background criteria and therefore none are considered site-related contaminants in surface soils.

There is uncertainty about whether silver, ethylbenzene, benzo(b)flouranthene, and styrene are ecological COPCs in surface soil, because there are no TRVs for these substances;

they are ecological COPCs by default according to GA EPD guidance. However, silver was present at a concentration (0.07 mg/kg) significantly less than its reference background criterion (0.64 mg/kg) and is therefore not site-related. Benzo(b)flouranthene and styrene were not present at the site, but were detected only at MW-5 (adjacent to Mill Creek) at concentrations near their detection limit, and are therefore not site-related. Ethylbenzene was detected at MW-2 and is related to former releases at the site, and is therefore the only ecological COPC in surface soil.

According to EPA Region IV guidance, groundwater is to be treated as surface water in the ecological preliminary risk evaluation. Treating groundwater as surface water is realistic at the Former 724th TPS site because groundwater may discharge to the drainage ditch next to the site during times of high groundwater stage.

Barium, lead, mercury, silver, benzene, and chloromethane are present in groundwater at the Former 724th TPS at concentrations that exceed EPA Region IV ecological screening values (ESVs) for surface water. These chemicals are therefore ecological COPCs for protection of aquatic biota, particularly amphibian species potentially breeding in downgradient surface water bodies. Barium, lead, mercury, and silver are present in groundwater at concentrations greater than their reference background criteria. However, there is some uncertainty about whether they are related to contaminant releases from the site, because they are higher in the upgradient well, MW-1, than in either of the two water table wells near the ditch (MW-2 and MW-3).

Maximum groundwater concentrations of barium, lead, mercury, and benzene do not exceed a published TRV for raccoons potentially ingesting groundwater as surface water; therefore these metals are not of concern for raccoons. There is uncertainty about whether silver or chloromethane are ecological COPCs in groundwater because there are no published TRVs for them, so that they are potentially of concern for raccoons, by default. In addition, silver and chloromethane are higher in the upgradient well and may not be site-related.

In the drainage ditch adjacent to the site, barium, cadmium, lead, mercury, and silver were identified as ecological COPCs in surface water for protection of amphibians breeding in the ditch based on comparison with EPA Region IV ecological screening

values. However, barium, mercury, and silver are present at higher concentrations in groundwater in the upgradient well MW-1 than in surface water in the ditch, and may therefore not be related to contaminant releases from the site. Only cadmium and lead are therefore ecological COPCs in surface water in the ditch.

Barium and silver were identified as ecological COPCs in ditch sediment; but exposure of sediment-dwelling biota to sediment in the drainage ditch was judged to be unlikely. The ditch is an ephemeral surface water body, as shown by the lack of water at SWS-3 at the time of sampling, and is unlikely to support a community of aquatic sediment-dwelling organisms. Exposure of other types of receptors, (e.g., terrestrial animals) to ditch sediment by direct contact and ingestion is likely to be minimal. There are therefore no ecological COPCs in sediment in the ditch.

In Mill Creek, barium, mercury, and silver were identified as ecological COPCs in surface water based on comparison to EPA Region IV ecological screening values. Mercury is the only ecological COPC identified in surface water for protection of terrestrial predators (mink, green heron) in Mill Creek based on comparison to their TRVs. There are no published TRVs for silver, so that there is uncertainty about whether silver is of concern in Mill Creek surface water. In Mill Creek sediment, no ecological COPCs were identified, although there is uncertainty about barium since there are no published ecological screening values for barium, making it a COPC by default. Ecological risks in Mill Creek are not related to the Former 724th TPS for the following reasons:

- As concluded in the fate and transport evaluation, offsite migration of contaminants would be very limited due to retardation and biodegradation, as well as the slow movement of groundwater. Mill Creek is the nearest surface water stream to the Former 724th TPS and is located approximately 1200 feet west of the site. Therefore, migration of contaminants to Mill Creek via groundwater discharge is unlikely and there is no complete pathway from groundwater to ecological receptors in Mill Creek.

- The drainage ditch accepts runoff from the site and the adjacent fuel truck parking area, but is not connected to Mill Creek or its tributaries. Therefore, migration of

contaminants to Mill Creek via surface water runoff is also not likely and there is no complete pathway from the Former 724th TPS to ecological receptors in Mill Creek.

Therefore, based on all the information provided above, and in accordance with various State of Georgia regulations, the former 724th Tanker Purging Station (SWMU 26) must be remediated to the proposed Remedial Levels (RLs) as presented in both the Revised Final Phase II RFI Report (Science Applications International Corporation [SAIC], 1999) and the Final Corrective Action Plan (SAIC, 1999). These RLs, and the maximum observed levels at the site, are presented below:

Table 2. Remedial Levels for Soil and Groundwater, Former 724th Tanker Purging Station, Fort Stewart

Analyte	Soil Remedial Level (µg/kg)	Maximum Observed Level in Soil (µg/kg)	Groundwater Remedial Level (µg/L)	Maximum Observed Level in Groundwater (µg/L)
Arsenic	–	–	–[a]	–
1,1-Dichloroethane	–	–	–[b]	–
1,2-Dichloroethane	–	–	–[b]	–
Acetone	370	1,060	370	1,450
Benzene	20	9,420	5	8,090
Chloroform	–	–	–[a]	–
Chloromethane	–	–	–[b]	–
Ethylbenzene	3,100	27,100	700	2,870
Naphthalene	600	4,160	150[c]	242
Toluene	4,200	27,400	1,000	4,200
Xylenes, total	31,700	124,000	10,000	12,100

– Indicates no remedial action needed for that analyte.
[a] No remedial action is needed for arsenic or chloroform in groundwater since the maximum concentrations for arsenic and chloroform are below their respective maximum contaminant levels (MCLs).
[b] No remedial action is needed for 1,1-dichloroethane, 1,2-dichloroethane, or chloromethane since the maximum concentrations for these analytes during the supplemental groundwater sampling did not exceed their respective MCLs or U.S. Environmental Protection Agency (EPA) Region III risk-based levels.
[c] No MCL exists for naphthalene; the remedial level for naphthalene is based on its EPA Region III risk-based level.

SUMMARY OF CORRECTIVE ACTIONS/TECHNOLOGIES

Based on the previous studies conducted at the site and conclusions regarding nature and extent of contamination, fate and transport, human health risk, and ecological risk, the options presented in Table 3 were evaluated for final remedial action of the identified soil and groundwater contamination.

Table 3. Evaluation of Corrective Actions/Technologies

Action/ Technology	Description	Effectiveness	Implementability	Costs
No Action	The "No Action" alternative provides a baseline against which other actions can be compared. Under the "No Action" alternative, all source units, surface water, and groundwater would be left "as is," without implementing any removal, treatment, or other mitigating actions to reduce existing or potential future exposure.	This alternative would not address remedial response objectives of the site. This alternative does not provide protection of human health or the environment.	There is no implementability involved for this alternative because no action is taken.	There would be no cost associated with the "No Action" alternative
Institutional Controls	Technologies associated with institutional controls will reduce potential hazards by limiting exposure of humans to contaminated soils, surface water, and groundwater. Land use restrictions and institutional control requirements that would be enforced include the following: deed restrictions; zoning controls; and applicable State land use control management systems in effect at the time. Deed restrictions would prohibit any construction at the site that might disturb the soil.	This technology alone would not meet the site objectives (i.e., RLs). Assuming compliance with deed restrictions, this technology should be effective and provide long-term reliability with respect to eliminating human exposure to contaminated media within the boundaries of the site. NOTE-From the Phase II RFI Report, there are no COCs for human health in surface or subsurface soil due to direct contact. In addition, use of surficial groundwater at this site for drinking water is unlikely.	Very few factors limit implementability of the institutional controls. The property is not expected to be developed in the near future and will remain under Federal ownership. This alternative is readily implementable.	Low; to establish deed restrictions, approximately $6,000
Monitored Natural Attenuation	This action would require the monitoring of contaminant levels to ensure that the mass of contamination is being reduced over time. A total of 5 wells would be sampled annually for 20 years and analyzed for BTEX and natural attenuation parameters (e.g., methane).	Natural attenuation of BTEX constituents through biodegradation is known to be occurring at the site and would be effective. However, this action would require approximately 20 years to successfully meet the site objectives (i.e., RLs).	This alternative is readily implementable and would only require the installation of one new monitoring well and monitoring of a total of 5 wells at the site for approximately 20 years.	High; installation of 1 new well and annual sampling/ monitoring of 5 wells are required for approximately 20 years
Excavation	Excavation involves the removal of "hot spots" of soil contamination. The area of benzene soil contamination greater than 200 g/kg would be removed to the depth of the water table (~6 feet). Approximately 10,930 cubic feet (547 tons) of soil would be removed and disposed of at a RCRA landfill.	Excavation has already proven to be effective in reducing the contamination level in soil at the site.	Excavation is a readily implementable alternative since it would only require excavation equipment, an operator, and disposal.	High; $100 to $200 per ton of unsaturated soil excavated and disposed
Air Sparging	Air sparging involves injecting a gas, usually air, under pressure, into the subsurface to volatilize groundwater contaminants and to promote biodegradation by increasing subsurface oxygen concentrations. Volatilized vapors migrate into the vadose zone where they can be extracted via vacuum, generally by a soil vapor extraction system. At this site, since the depth to groundwater is very shallow (~6 feet), a soil vapor extraction system is not necessary.	Technology proven for light petroleum products such as those present at the site. Air sparging has been used to address a broad range of volatile and semivolatile groundwater and soil contaminants including gasoline and other fuels and associated BTEX components.	Equipment readily available. Compressors and other air injection system components would need to be operated for two or more years. Approximately six injection wells would have to be installed. Monitoring and maintenance of the wells would be required.	Moderate; $20 to $50 per ton of saturated soil (EPA 1995)
Enhanced Bioremediation (Pure Oxygen Injection)	Enhanced biodegradation is the enhancement of one aspect of natural attenuation. The activity of naturally occurring microbes is stimulated by injecting 98 percent pure oxygen to enhance in situ biological degradation of organic contaminants. Nutrients or other additives may be used to encourage the natural biodegradation processes.	Technology proven for site contaminants.	Equipment readily available, applicable to small site. Approximately 40 injection points would have to be installed for this alternative. Bioremediation process may require continuous monitoring and maintenance to prevent plugging of injection wells by microbial growth or mineral precipitation.	Moderate; similar to air sparging based on quote from manufacturer
Enhanced Bioremediation (PHOSter® II)	Similar to pure oxygen injection, the PHOSter® II technology enhances natural attenuation through injection of vapor-phase phosphorous, nitrogen, and air. In soils, enhanced bioremediation using air/nutrient injection is referred to as "bioventing."	PHOSter® II is an innovative technology that has been demonstrated at other sites to be effective for fuels and related BTEX components. Technical performance is highly uncertain due to limited full-scale implementation.	Equipment readily available and applicable to small site. Because this technology is innovative and relative new, there is relatively high uncertainty regarding radius of influence and treatment time required. Longer-term operations may require monitoring to prevent plugging of injection wells by microbial growth or mineral precipitation.	Moderate; similar to enhanced bioremediation using pure oxygen injection; costs dependent on required treatment time
Geo-Cleanse	The Geo-Cleanse Process is an aggressive, pressurized injection of concentrated hydrogen peroxide and ferrous iron catalyst (together known as Fenton's reagent) that generates a hydroxyl free radical that acts as the active oxidizing agent. Oxidation of an organic compound by Fenton's reagent is a rapid and exothermic (heat-producing) reaction.	Expected to provide accelerated performance over air sparging. However, multiple applications may be required to achieve RLs. Chemical oxidation would temporarily destroy the natural bioremediation processes observed at the site.	Geo-Cleanse requires that the depth to contamination be greater than 5 feet BGS. Table 5-3 in the Phase II RFI Report presents values in soil exceeding 100 g/kg in the 4- to 6-foot interval.	High; $100 to $200 per ton of saturated soil; cost would be based on bid price and number of reapplications required

BGS = Below ground surface.
BTEX = Benzene, toluene, ethylbenzene, and total xylenes.
COC = Chemical/contaminant of concern.
RCRA = Resource Conservation and Recovery Act.
RFI = RCRA Facility Investigation.
RL = Remedial level

Based on an evaluation of the corrective actions/technologies presented in Table 3, six (6) alternatives were evaluated further in the Corrective Action Plan. Specifically, each of these alternatives are discussed in Table 1 and provide detailed information on the alternative description, estimated time to implement, estimated cost, and comments. These factors were critical in choosing which alternative to propose for site remediation.

Upon review of all the alternatives, Fort Stewart has proposed to GA EPD in the Corrective Action Plan, that ***Alternative #6: (PHOSter® II Enhanced Bioremediation and Bioventing)*** be implemented at the site.

DECLARATION

The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate to this interim remedial action, and is cost-effective. This remedy satisfies the statutory preference for remedies that employ treatment to reduce the mobility of toxic material as a principal element.

Due to the fact that the selected course of action will be implemented in accordance with the Corrective Action Plan, as revised and approved by GA EPD, and all proposed progress reports and confirmatory sampling will be conducted in accordance with the GANTT chart, the five-year review will not apply to this final remedial action.

This decision document was developed by the Directorate of Public Works at Fort Stewart, with support from the U.S. Army Corps of Engineers and SAIC.