ENGINEERING EVALUATION/COST ANALYSIS

REVISION 0

Closure of the East Gypsum Stack and North Ponds

Mississippi Phosphates Corporation Site

Pascagoula, Jackson County, Mississippi

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Executive Summary

The U.S. Environmental Protection Agency Region 4 (EPA) has initiated a program to address environmental contamination associated with the Mississippi Phosphates Corporation (MPC) Site (Site), located in Pascagoula, Jackson County, Mississippi.

As a first step, EPA prepared this Engineering Evaluation/Cost Analysis (EE/CA) to support the selection and implementation of a Non-Time-Critical Removal Action (NTCRA) for closure of the East Gypsum Stack (EGS) and North Ponds at the West Gypsum Stack (WGS).

Mississippi Phosphates Corp. (MPC) produced diammonium phosphate (DAP) fertilizer at the Site from 1958 to 2014. Imported phosphate ore was dissolved in sulfuric acid produced on site to create phosphoric acid. The phosphoric acid was then reacted with ammonia to form DAP. Phosphogypsum was produced as a byproduct of the sulfuric acid dissolution step. This solid was filtered from the phosphoric acid and slurried to disposal areas where it was deposited in large piles known as gypsum stacks. The WGS ceased receiving material in 2002 and was closed by MPC. The EGS served as the disposal area from 2002 until operations ceased in 2014; it has not been closed.

The 350-acre (ac) EGS complex includes the phosphogypsum stack, four ponds that hold contaminated water (Ponds 3, 4, 5, and 6, and the Water Return Ditch WRD) which encloses the stack and collects runoff and leachate from the pile. Together these sources retain up to 585 Mgal of water with a hydrogen ion concentration (pH) less than 3 and elevated concentrations of ammonia, phosphorus, and fluoride. The 30-ac North Ponds at the WGS were constructed initially to provide clarification and aeration of water from the on-site wastewater treatment plant and subsequently to treat water *in situ* with lime slurry. These ponds, which retain an additional 52 Mgal of contaminated water, are mostly filled with lime sludge. In total, more than 700 Mgal of contaminated water are being held on the MPC Site.

Every inch of rain falling on the EGS complex generates approximately 9.1 Mgal of water requiring treatment. Through November 2017, the MPC Site received nearly 107 inches of rainfall in 2017, greatly exceeding the average annual precipitation of 66.3 inches measured at the Site. The volume of water generated by this rainfall exceeded the Site's water treatment capacity, necessitating discharges of partly treated water under EPA's emergency bypass protocol on five occasions to prevent overtopping of dikes and potential uncontrolled releases of contaminated water to the adjacent Grand Bay National Estuarine Research Reserve and Bayou Casotte.

MPC filed for Chapter 11 bankruptcy and ceased operations in October 2014. At this time, two trusts were created from the assets of the firm. The Environmental Trust assumed ownership of about 628 ac, including the EGS, WGS, ponds and ditches associated with those facilities, and the wastewater treatment plant and its outfall. Funding for the Environmental Trust, which continued to operate the water treatment plant, was exhausted in February 2017. Consequently, the EPA Region 4 Removal Program assumed financial responsibility and daily operations at the MPC Site on February 11, 2017. Through November, 2017, the EPA has spent an estimated $12.6M maintaining and treating water at the MPC Site.

The MPC Site was proposed for the National Priorities List (NPL) on August 3, 2017. Final listing, which has been approved by the State of Mississippi, is pending.

Closure of the EGS and its associated ponds and the North Ponds will greatly reduce contact between precipitation and the phosphogypsum solids and stored contaminated water at the Site, thereby reducing the volume of water requiring treatment. Reduction in the storage of contaminated water will reduce potential risks to human and ecological receptors by minimizing the potential for containment dikes to fail or be overtopped. The EPA established an overall site goal of long-term leachate management at the EGS and WGS and developed Removal Action Objectives (RAOs) to support this goal.

The EPA determined that the Removal Action would close the EGS and North Ponds in a phased manner. Phase 1 would close the EGS footprint including Ponds 3 and 4 and the stack side slopes. Phase 2 would close Pond 5 and the North Ponds. Phase 3 would close Pond 6 and the water return ditch at the EGS.

The EPA screened technologies that could be used to permanently reduce risks and identified six Removal Action Alternatives for further evaluation on the basis of effectiveness, implementability, and cost. These were:

1. No Action. Under Alternative 1, no action would be taken to attain the RAOs or overall site goal.

2A. Phase 1 – Partial linear low density polyethylene (LLDPE) Liner Across the EGS. Under Alternative 2A, Ponds 3 and 4 atop the EGS would be closed and graded, a LLDPE liner would be placed across the crest and on the benches of the EGS, side slopes would be covered with compacted clay, and the entirety of the EGS would be covered with a layer of protective soil and vegetated topsoil. Storm water would be collected on the benches and routed to Bayou Casotte.

2B. Phase 1 – Complete LLDPE Liner Across the EGS. Under Alternative 2B, Ponds 3 and 4 atop the EGS would be closed and graded, LLDPE would be placed across the crest, side slopes and benches of the EGS and the entirety of the EGS would be covered with a layer of protective soil and vegetated topsoil. Storm water would be collected on the benches and routed to Bayou Casotte.

3A. Phase 2 – Pond 5 Closure with North Ponds Excavation. Alternative 3A would drain and close Pond 5, grade the area for drainage, and cover the footprint of the pond with LLDPE liner, a protective soil layer, and vegetated topsoil. Lime sludge from the North Ponds would be excavated, transported to Pond 5 and incorporated into the soil cover, and the excavation would be backfilled, graded for drainage and covered with a protective soil layer and vegetated topsoil. Storm water shed from both areas would be routed to Bayou Casotte.

3B. Phase 2 – Pond 5 Closure with North Ponds Capped in Place. Alternative 3B would drain and close Pond 5, grade the area for drainage, and cover the footprint of the pond with LLDPE liner, a protective soil layer, and vegetated topsoil. Lime sludge in the North Ponds would be covered in place with reinforced geotextile, covered with a protective soil layer graded for drainage, and covered with vegetated topsoil. Storm water shed from both areas would be routed to Bayou Casotte.

4. Phase 3 – Pond 6 and Water Return Ditch Closure. Under Alternative 4, Pond 6 and the Water Return Ditch (WRD) at the EGS would be drained and graded to promote drainage. The footprint of the WRD would be covered with LLDPE liner, a protective soil layer, and vegetated

topsoil and the EGS underdrain would be connected to a perimeter collection system that would be connected to the mechanical wastewater treatment plant. The footprint of Pond 6 would be covered with a protective soil layer and vegetated topsoil. Storm water shed from both areas would be routed to Bayou Casotte.

The analyses of each alternative were compared to one another and were used by EPA as the basis for selecting a recommended removal action alternative for each construction phase.

Alternative 1 (No Action) would not take any action to reduce the volume of rain water infiltration into the EGS, prevent contact of precipitation with phosphogypsum solids or contaminated water, or reduce the volume of water requiring treatment. Therefore, exposure risks to contaminants would not be reduced. Because this alternative would not be protective of human health and the environment (HH&E) and would not comply with applicable or relevant and appropriate requirements (ARARs), it was not considered further.

Phase 1 Alternatives 2A (Partial LLDPE Liner) and 2B (Complete LLDPE Liner) would remove the 155 ac footprint of the EGS from the site water balance, thereby reducing the volume of water requiring treatment by an estimated 39%. Both alternatives are technically and administratively implementable and utilize well developed technologies; they would require waiver of the $2M/12-month statutory limit on Removal Actions. Draining and treating water from Ponds 3 and 4 potentially would be accomplished using EPA's emergency bypass protocol which could potentially increase the load of ammonia and phosphorus in Bayou Casotte. Water shed from the capped EGS is expected to meet discharge standards and would be routed to Bayou Casotte without treatment. Both alternatives would significantly increase traffic due to the requirement to haul 541,000 cubic yards (cy) of soil to the Site for use as the protective cover and topsoil layer. Alternative 2B has a slightly lower total cost than Alternative 2A ($31,376,398 vs. $31,769,362). The higher cost of installing a complete LLDPE liner under Alternative 2B is offset by the estimated high cost of sourcing and transporting clay soil that can be compacted to design specifications on the side slopes of the EGS under Alternative 2A.

Phase 2 Alternatives 3A (Pond 5 Closure with North Ponds Excavations) and 3B (Pond 5 Closure with North Ponds Capped In Place) would remove 90 ac from the site water balance, thereby reducing the volume of water requiring treatment by an estimated 23.8% (62.9% when combined with Phase 1). Both alternatives are technically and administratively implementable and utilize well developed technologies; they would require waiver of the $2M/12-month statutory limit on Removal Actions. Draining and treating water from Pond 5 potentially would be accomplished using EPA's emergency bypass protocol which could potentially increase the load of ammonia and phosphorus in Bayou Casotte. Water shed from the capped areas is expected to meet discharge standards and would be routed to Bayou Casotte without treatment. Both alternatives would significantly increase traffic due to the requirement to haul 291,000 cy of soil to the Site for use as the protective cover and topsoil layer. Alternative 3A would additionally require transport of about 728,000 cy of lime sludge from the North Ponds to Pond 5 and an equal amount of soil to backfill the excavated area. Due to the costs associated with excavation and backfill of the North Ponds, Alternative 3B has a significantly lower total cost than Alternative 3A ($18,456,080 vs. $47,011,950).

Phase 3 Alternative 4 (Pond 6 and WRD Closure) would remove the remaining 135 ac of the EGS from the Site water balance, thereby reducing the volume of water requiring treatment by an additional

35.5% (98.4% when combined with Phases 1 and 2). The alternative is technically and administratively implementable and utilizes well developed technologies; it would require waiver of the $2M/12-month statutory limit on Removal Actions. Draining and treating water from Pond 6 and the WRD potentially would be accomplished using EPA's emergency bypass protocol which could potentially increase the load of ammonia and phosphorus in Bayou Casotte. Water shed from the capped areas is expected to meet discharge standards and would be routed to Bayou Casotte without treatment. Both alternatives would significantly increase traffic due to the requirement to haul 400,000 cy of soil to the Site for use as the protective cover and topsoil layer. Alternative 4 has a total cost of $21,770,441.

EPA selected Alternative 2B (Complete LLDPE Liner Across the EGS) as the preferred Removal Action Alternative for Phase 1, Alternative 3B (Pond 5 Closure with North Ponds Capped In Place) as the preferred alternative for Phase 2, and Alternative 4 (Pond 6 and WRD Closure) as the preferred alternative for Phase 3. These alternatives will meet RAOs and achieve EPA's overall long-term goal of leachate management at the Site. They provide the best tradeoff to protect HH&E, will eliminate storage of more than 475 Mgal of contaminated water on site, and will reduce the volume of water requiring treatment by an estimated 98% during an average precipitation year. The total cost to implement the three recommended alternatives is $71,602,918.

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Acronyms and Abbreviations

%	percent
ac	acre
amsl	above mean sea level
AO	Administrative Order
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirements
Black & Veatch	Black & Veatch Special Projects Corporation
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act of 1980
CERCLIS ID	Comprehensive Emergency Response, Compensation, and Liability Information System Identification
CFR	Code of Federal Regulations
COC	contaminant of concern
cy	cubic yard
DAP	diammonium phosphate
DMR	Discharge Monitoring Report
DOJ	Department of Justice
EE/CA	Engineering Evaluation/Cost Analysis
EGS	East Gypsum Stack
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
FS	feasibility study
ft	feet/foot
GCL	geosynthetic clay liner
GRA	general response action
HDPE	high density polyethylene
H:V	horizontal:vertical
HH&E	human health and the environment
HRS	hazard ranking system
in/yr	inches per year
LiDAR	light detection and ranging
LLDPE	linear low density polyethylene
MARIS	Mississippi Automated Resource Information System
MCL	maximum contaminant level
MDEQ	Mississippi Department of Environmental Quality
Mgal	million gallons
Mgal/day	million gallons per day
Mgal/yr	million gallons per year

mg/L	milligrams per liter
mm	millimeter
MPC	Mississippi Phosphates Corporation
MS	Mississippi
N	North
NCP	National Oil and Hazardous Substances Contingency Plan
NERR	National Estuarine Research Reserve
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTCRA	Non-Time Critical Removal Action
O&M	operation and maintenance
pcf	pounds per cubic foot
pCi/g	picoCurie per gram
pH	hydrogen ion concentration
PPE	Personal Protective Equipment
RAO	Removal Action Objective
RCRA	Resource Conservation and Recovery Act
RG	removal action goal
RI	remedial investigation
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act of 1986
Site	Mississippi Phosphates Corporation Site
SPLP	Synthetic Precipitation Leaching Procedure
sq ft	square feet
TCLP	Toxicity Characteristic Leaching Procedure
TMDL	Total Maximum Daily Load
T/M/V	toxicity, mobility, or volume
TRG	Target Remediation Goal
TSS	total suspended solids
URS	URS Corporation
US	United States of America
W	West
WGS	West Gypsum Stack
WRD	Water Return Ditch

1.0 Introduction

This report presents the results of an Engineering Evaluation/Cost Analysis (EE/CA) for the Mississippi Phosphates Corporation (MPC) Site (Comprehensive Emergency Response, Compensation, and Liability Information System Identification [CERCLIS] ID MSD077909133) in Pascagoula, Jackson County, Mississippi. It was prepared for the U.S. Environmental Protection Agency, Region 4 (EPA) under contract EP-S4-09-02, Work Assignment 090-RIFS-B45U. This EE/CA was prepared in accordance with *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* ([Comprehensive Emergency Response, Compensation, and Liability Act of 1980]; EPA, 1993) to support a Non-Time-Critical Removal Action (NTCRA) by EPA. It evaluates engineering alternatives to close the East Gypsum Stack (EGS) and North Ponds facilities at the MPC Site to reduce the volume of contaminated water requiring treatment.

The EPA, under authority of the Comprehensive Emergency Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), has initiated work to remediate contamination at the Mississippi Phosphates Corporation site (Site). The Site is located in Jackson County, Mississippi at 601 Industrial Road, Pascagoula, MS 39851 (Figure 1-1). The Site, which produced diammonium phosphate (DAP) fertilizer, includes an industrial complex consisting of former processing plants and facilities, an active wastewater treatment plant, a diffuser outfall in Bayou Casotte, rail infrastructure, and a deep water dock; two phosphogypsum waste stacks; and numerous ponds and ditches that retain contaminated water. The coordinates of the industrial complex are: 30°20’58.80”N, 88°30’05.25”W; the coordinates of the EGS are: 30°22’26.25”N, 88°29’25.21”W.

The large volume of contaminated water stored on site poses a threat to Bayou Casotte, which borders the Site to the west and to the Grand Bay National Estuarine Research Reserve, which borders the Site to the east.

This EE/CA report addresses closure of the EGS and associated water storage ponds and the North Ponds at the West Gypsum Stack (WGS) in a manner that reduces the volume of contaminated water generated and stored on site.

The report is organized into eight sections. Detailed cost estimate tables are included as an appendix. An overview of the information contained in each section is provided below.

1.0 **Introduction.** Section 1 discusses the regulatory history of the Site, the purpose and scope of the MPC EE/CA, and the study methodology.

2.0 **Site Characterization.** This section discusses the location, setting, and history of the MPC Site; briefly describes previous site investigations; examines the source, nature, and extent of contamination; presents limited analytical data; and assesses potential risks to human health and the environment (HH&E) posed by contaminants at the Site.

3.0 **Removal Action Objectives and Goals.** Section 3 describes the scope and objectives of the removal action, reviews applicable or relevant and appropriate requirements, and presents removal action goals for the Site.

4.0 **Identification and Screening of Technologies.** Section 4 identifies and screens technologies that could be used to meet the removal action objectives.

5.0 **Identification and Evaluation of Removal Action Alternatives.** This section presents a list of removal action alternatives identified for consideration; and evaluates the alternatives on the basis of effectiveness, implementability, and cost.

6.0 **Comparative Analysis of Removal Action Alternatives.** This section compares the alternatives to one another using the CERCLA criteria for remedy selection.

7.0 **Recommended Removal Action Alternative.** Section 7 presents the recommended removal action alternative(s) for the MPC Site.

8.0 **References.** Section 8 lists the references cited in the text.

1.1 REGULATORY HISTORY

MPC filed for Chapter 11 bankruptcy in October 2014 and operations ceased in December 2014 (Tetra Tech, 2017). The EPA Region 4 Removal Program assumed financial responsibility and daily operations at the MPC Site on February 11, 2017. Region 4 prepared a Hazard Ranking System (HRS) package (Tetra Tech, 2017) and the Site was proposed for inclusion on the National Priorities List (NPL) on August 3, 2017. Final listing, which has been approved by the State of Mississippi, is pending.

In September 2017, EPA issued work assignment 090-RIFS-B45U to Black & Veatch Special Projects Corp. (Black & Veatch) to prepare an EE/CA document for the MPC Site in a manner consistent with the regulations specified in the National Oil and Hazardous Substances Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] 300).

Tetra Tech (2017) provides a brief synopsis of the regulatory history of the Site during its operational history; much of the following information is summarized from Tetra Tech. Following investigations by EPA and the Mississippi Department of Environmental Quality (MDEQ) that identified arsenic, cadmium, and lead contamination of surface water and groundwater at the Site in 2005, MPC entered into an Administrative Order on Consent (AOC) under Section 3013(a) of the Resource Conservation and Recovery Act (RCRA). The 2005 AOC required MPC to conduct additional studies to characterize metals contamination in surface water and sediment in Bayou Casotte adjacent to the WGS and down-gradient from Outfall 003, and groundwater surrounding the WGS.

The facility was inspected by EPA and MDEQ as part of a nationwide assessment of phosphate fertilizer facilities in July 2009. At this time, the Agencies found evidence of past sulfuric acid releases to soil and groundwater. Groundwater sampling on the industrial complex measured concentrations of arsenic, cadmium, chromium, and lead in excess of their respective groundwater Maximum Contaminant Levels (MCL). These metals also were noted as being present in the EGS, WGS, and Outfall 003. As a result, EPA and MPC entered into an AOC under Section 7003(a) of RCRA in September 2009. The 2009 AOC required MPC to address issues related to the handling, transport, storage, and disposal of solid wastes on the Site and pertaining to the sulfuric acid plants, DAP plant, and other site areas.

EPA and MPC entered into a second Section 7003(a) RCRA AOC in February 2009 which required MPC to develop and implement a plan to mitigate risks that present an imminent risk to human health or the environment from past handling, transport, storage, and disposal of solid or hazardous wastes at the Site.

From 1989 to 2014, MPC received numerous Administrative Orders (AO) and Notices of Violations (NOV) related to noncompliance with their National Pollutant Discharge Elimination System (NPDES) permit. Violations were noted for exceedances of the permit limits for metals, phosphorus, ammonia-nitrogen, hydrogen ion concentration (pH), and total suspended solids (TSS). Of the 20 outfalls identified in the permit, MPC was required to monitor only diffuser Outfall 003 for copper, lead, nickel, zinc and ammonia-nitrogen.

Several uncontrolled releases of wastewater are known to have occurred from the MPC Site. An estimated 17 million gallons (Mgal) of water was released to Bangs Lake and Grand Bay Estuary, Bayou Casotte, and Tillman Creek in April 2005 when a containment dike at the EGS failed as it was being raised (Weston Solutions, Inc. [Weston], 2007; Department of Justice [DOJ], 2015). The spill of acid water (pH 2.2 to 2.4) resulted in extensive loss of vegetation and wildlife and had a significant negative impact to fisheries in the estuary. In August 2005, storm surge from Hurricane Katrina breached cooling ditches holding contaminated water (EPA, 2007) and caused extensive damage throughout the Site (Weston, 2007). In August 2013, MPC released an estimated 38 Mgal of acidic water to Bayou Casotte killing an estimated 47,000 fish, resulting in closure of the Bayou for an unspecified time and resulting in a criminal violation of the Clean Water Act (DOJ, 2015).

1.2 PURPOSE AND SCOPE OF THE EE/CA

The MPC Site received above average rainfall through the first 10 months of 2017. From January through October 2017, the Site received approximately 109 inches of rainfall, significantly greater than the annual average precipitation of 66.3 inches. Excessive rainfall produced a large volume of contaminated runoff from the EGS and surrounding area that requires treatment. The EPA assumed responsibility for water treatment at the MPC Site on February 11, 2017. From the onset of their involvement through September 30, 2017, EPA treated 583.4 Mgal of water at a cost of $8,871,810 (EPA, 2017e). One inch of rain that falls on the footprint of the EGS (350 acres) generates an estimated 9.1 Mgal of water that requires treatment (EPA, 2017e). This large volume of runoff exceeded available on-site storage capacity necessitating emergency bypasses on at least 4 occasions. Through early October 2017, a total of approximately 173 Mgal of water was bypassed at the Site.

The purpose of this EE/CA is to develop and evaluate engineering alternatives to close the EGS and North Ponds facilities at the MPC Site to reduce the volume of contaminated water requiring treatment. EPA intends to close these facilities in a manner that will prevent precipitation runoff from contacting phosphogypsum solids which will permit storm water runoff to be discharged from the Site without treatment.

The EPA has developed an overall goal for the MPC Site of long term leachate management at the EGS and WGS. This goal would be achieved through a phased approach to closure of the EGS and the North Ponds at the WGS. Once these facilities have been addressed, the EPA intends to complete a site-wide Remedial Investigation (RI) and Feasibility Study (FS) which will encompass the entirety of the MPC property including the industrial complex, EGS, WGS, and water treatment process. The RI/FS process will lead to a final remedy for the MPC Site.

1.3 STUDY METHODOLOGY

This document was prepared in accordance with EPA's Guidance on Conducting NTCRAs Under CERCLA (EPA, 1993). Analytical data were collected by personnel from EPA's Emergency Response and Removal Branch including contractor and subcontractor personnel. A very limited data set is available to support to support the Streamlined Risk Assessment, mostly in the form of analyses of treated water that is released to the environment, and partial analyses of contaminated water which is held on-site in ponds and ditches at the EGS and WGS.

This EE/CA is restricted to closure of the EGS and North Ponds at the WGS to remove these areas where precipitation contacts phosphogypsum or lime sludge solids from the Site water balance. A complete evaluation of potential contamination in these areas and on the industrial complex, as well as an evaluation of options to treat contaminated leachate will be conducted as part of the Site-wide RI/FS. This EE/CA develops and analyzes a limited number of alternatives that can be used to quickly close the EGS and North Ponds facilities and prevent contamination of rainfall runoff. The analysis of alternatives fulfills the requirements of EPA's guidance as described below. EPA's methodology for conducting an EE/CA for interim and final actions includes the following elements (EPA, 1993):

- Developing remedial action objectives (RAOs) that will protect HH&E giving consideration to the nature of the contamination and the problem to be addressed. The RAOs are developed from comparisons to the criteria and standards in applicable or relevant and appropriate requirements (ARARs) of promulgated environmental laws and regulations.
- Identifying general response actions that are needed to accomplish the RAOs.
- Identifying a limited number of alternatives appropriate for addressing the RAOs based on the nature and extent of contamination. Whenever practical, the alternative selection process considers CERCLA's preference for treatment.
- Evaluating the selected alternatives against the short- and long-term aspects of effectiveness, implementability, and cost.
- Performing a comparative analysis of the alternatives to evaluate the relative performance of each alternative with respect to each criterion above.
- Identifying the action that best meets the evaluation criteria based on the comparative analysis.

2.0 Site Characterization

2.1 SITE DESCRIPTION AND OPERATION

2.1.1 Site Location

The MPC Site is located in Jackson County, Mississippi at 601 Industrial Road, Pascagoula, MS 39851 (Figure 1-1). The coordinates of the industrial complex are: 30°20’58.80”N, 88°30’05.25”W; the coordinates of the EGS are: 30°22’26.25”N, 88°29’25.21”W; the coordinates of the North Ponds at the WGS are: 30°21’58.83”N, 88°30’04.68”W. The property occupies approximately 1,080 acres and is bounded on the west by Bayou Casotte, on the south and southeast by the Chevron Pascagoula Refinery, on the east by the Grand Bay National Estuarine Research Reserve (NERR), and on the north by a variety of marine and industrial service and chemical production companies.

2.1.2 Property Ownership

Following the bankruptcy of MPC in October 2014, EPA and MDEQ entered into a court-approved bankruptcy Settlement Agreement with the Debtor, Debtor subsidiaries and holding company, and pre-petition lenders (Tetra Tech, 2017). The Settlement Agreement created two trusts from the assets of the firm. The Liquidation Trust assumed control and ownership of marketable assets including the DAP plant, phosphoric acid plant, ammonia tank, sulfuric acid plants, dock, and associated real and tangible personal property and equipment (EPA, 2016; Tetra Tech, 2017). The Environmental Trust assumed ownership of about 628 acres which included the EGS, WGS, ponds and ditches associated with these facilities, and the wastewater treatment plant and its outfall (EPA, 2016).

2.1.3 MPC Site Operations

The MPC industrial complex consisted of processing plants and facilities, a wastewater treatment plant, a diffuser outfall in Bayou Casotte, rail infrastructure, and deep water docks. Figure 2-1 illustrates a general layout of the Site in 2012.

2.1.3.1 Diammonium Phosphate Production

Phosphate ore (primarily the calcium phosphate mineral fluorapatite) was imported by ship from Morocco. The ore was unloaded and stockpiled on site (Figure 2-1). Elemental sulfur obtained from the adjacent Chevron refinery was piped to the Site where it was converted into sulfuric acid in two sulfuric acid plants. As the first step in the diammonium phosphate manufacturing process, phosphate ore (fluorapatite [$Ca_5(PO_4)_3F$]) was dissolved in sulfuric acid to produce phosphoric acid (H_3PO_4):

$$Ca_5(PO_4)_3F + 5H_2SO_4 + 10H_2O \rightarrow 3H_3PO_4 + 5CaSO_4{\cdot}2H_2O + HF \qquad (1)$$

Gypsum ($CaSO_4{\cdot}2H_2O$) was formed as a byproduct of phosphoric acid production and this mineral precipitate was deposited as a waste product on site, initially forming the WGS and subsequently the EGS. Other impurities present in the phosphate ore also were precipitated with the gypsum. These are expected to include various metals including radionuclides; fluoride which is a primary component of the fluorapatite ore also reported to the gypsum waste stream. Process water had low pH. Gypsum precipitate (exact mineralogical formula is uncertain and it may have included anhydrite [$CaSO_4$] and/or bassanite [$CaSO_4{\cdot}0.5H_2O$]) was filtered from the acid process solution, rinsed to remove residual phosphoric acid, then slurried with process water to the storage pond at the active disposal stack (WGS prior to 2002; EGS after 2002).

The phosphoric acid was then reacted with anhydrous ammonia to form diammonium phosphate ($(NH_4)_2HPO_4$) which was pelletized, dried, and sold to market:

$$H_3PO_4 + 2NH_3 \rightarrow (NH_4)_2HPO_4 \qquad (2)$$

The MPC plant had the capacity to produce 900,000 tons of DAP annually.

2.1.3.2 Phosphogypsum Disposal

West Gypsum Stack. From the beginning of operations in 1958 to 2002 (Tetra Tech, 2017), MPC disposed of phosphogypsum in the WGS located north of the industrial complex (Figure 2-2). The WGS was constructed in part atop portions of Bayou Casotte; a tributary to the Bayou was channelized and diverted around the west side of the facility during its construction. The WGS is teardrop shaped with a footprint of approximately 2,800 feet (ft) wide by 4,000ft long and occupies an area of about 235 acres including the surrounding water ditch but excluding the North Ponds. The facility is not known to be lined or enclosed by slurry wall or other feature that may limit groundwater exchange with its surroundings and it does not have an underdrain system. The WGS is underlain by fat clay unit which is present a few ft beneath surficial sands (Section 2.2.3).

Phosphogypsum slurried to the WGS was settled out in a central pond that was retained by berms of gypsum. Settled solids excavated from the pond by dragline were placed on the perimeter berm, thereby raising the height of the pond and the phosphogypsum stack itself. The WGS is enclosed by a ditch (referred to variously as the cooling loop and the DAP ditch) which presently collects leachate from the waste pile and direct precipitation. During operations, the DAP ditch received water discharged from scrubbers at the DAP and phosphoric acid plants (hence the term “cooling loop”; Tetra Tech, 2017). Historical aerial imagery shows that the DAP ditch was connected to and exchanged water with the two southern most ponds of the North Ponds complex from at least September 2004 to January 2015 (exact period is uncertain).

The WGS ceased receiving phosphogypsum in 2002 when disposal operations were shifted to the EGS. MPC began closing the WGS in 2002; closure was completed in 2005. Closure involved grading the stack, capping the crest and benches of the WGS with a geomembrane liner, then covering the crest, benches, and slopes of the pile with a vegetated soil cover. Storm water shed from the cap is routed through geomembrane-lined drainage swales to Bayou Casotte for disposal. Since the pile was capped, leachate draining from the facility has caused the WGS to undergo differential compaction. Elevation changes which may locally approach 30 ft created an uneven upper surface, permitting rainfall to form several small ponds atop the liner in at least 4 locations on the margins of the crest of the pile.

The DAP ditch encloses the capped area as a loop and collects leachate from the interior of the pile at an average rate of 0.06 Mgal/day (EPA, 2016). Water in the DAP ditch is treated at the mechanical treatment plant prior to discharge to Bayou Casotte.

The WGS maintains a generally stable configuration and is well vegetated. On June 29, 2017, a sinkhole was discovered on the west side of the WGS in a location overlying a natural spring. The sinkhole breached the liner and containment berm allowing an estimated 3 Mgal of untreated water to discharge to Bayou Casotte. EPA repaired the sinkhole and breach of the soil cap. Although the WGS maintains its integrity, along the crest, ponds of water which have formed atop the liner in depressions caused by differential compaction are a concern for long-term stability.

North Ponds. The North Ponds comprise 4 ponds arranged in a large square at the north end of the WGS (Figure 2-3). Each is enclosed by a soil berm and is lined with clay. Together, the four ponds occupy an area of about 30 acres. The North Ponds are present on the earliest imagery reviewed for this report (1992; Google Earth historical imagery). The date of their construction is uncertain; initially, the ponds served to aerate and clarify water discharged from the mechanical treatment plant. Aerial imagery from September 2004 (Google Earth historical imagery) shows that the two southernmost ponds are connected to the DAP ditch and as such the ponds may have been used to cool and store process water for reuse at the Site.

Beginning in December 2015, the North Ponds were repurposed as treatment ponds and were used to provide additional capacity to treat contaminated water at the Site. Approximately 250 Mgal of contaminated water from the water return ditch at the EGS was routed to the ponds and treated *in situ* by adding lime slurry to raise pH and precipitate metals. *In situ* treatment continued until July 2016 at which point the buildup of lime sludge within the ponds eliminated the capacity to treat water economically. At present, the ponds contain an estimated 15 ft of lime sludge; a thin water cover is maintained over the sludge. The two northern ponds presently receive only rainfall runoff; the two southern ponds are connected to the DAP ditch which receives leachate from the WGS. The ponds have a total estimated capacity of 24 Mgal (EPA, 2016).

East Gypsum Stack. The EGS was constructed beginning in the mid-1990s at the Site of the former Jackson County Airport and it began accepting phosphogypsum upon completion in 2002, ultimately containing over 400 million cubic ft of gypsum as estimated from 2015 light detection and ranging (LiDAR) data obtained from the State of Mississippi. Figure 2-4 depicts significant features of the EGS.

The EGS and associated ponds comprise an area of about 350 acres. The facility is surrounded by 2.5 ft thick soil-bentonite slurry cut-off wall installed through surficial sands and into the underlying upper "fat" clay layer ranging from a depth of 15 to 20 ft below original grade. An underdrain system routes water from within stack limits to the surrounding water return ditch (WRD). The EGS is considered an unlined stack which relies on the slurry cut-off wall and the underlying "fat" clay to prevent groundwater migration rather than an installed geosynthetic liner beneath the waste gypsum material.

Figure 2-5 illustrates the growth of the EGS over time from aerial imagery of the Site. Initial construction consisted of the gypsum stack and the WRD; Ponds 5 and 6 were added sometime between September 2010 and November 2012. During the early stages of its growth, the EGS was constructed with 3 ponds. Sometime between September 2010 and November 2012, the EGS was reconfigured to the present 2 pond system as the stack was built upward.

The EGS is shaped like a right triangle with rounded apices and is about 120 ft high at Pond 3 and 100 ft high at Pond 4 (Figure 2-4). The legs of the facility are approximately 3,000 ft long. The outer slopes of the EGS are terraced and eroded on a slope of approximately 7H:1V (Horizontal:Vertical [H:V]) on the lower levels and approximately 4H:1V on the upper levels (Figure 2-6); sparse volunteer vegetation is present across the pile. The stack is topped by Pond 3 (24.8 acres) and Pond 4 (14.5 acres) which retain rain water and excess water pumped from the WRD; the water elevation in Pond 3 is higher than in Pond 4 by about 20 ft. The ponds are enclosed by berms of gypsum which have been eroded by wave action and have near vertical faces on their inward (pond-facing) slopes (Figure 2-7). Water elevations vary in Ponds 3 and 4 and they are presently maintained at lowered levels due to concern about the stability of their containment berms. *In situ* treatment conducted periodically in Pond 4 created a layer of lime sludge which varies in thickness across the pond. Sludge thickness is thought to approach 7 ft in the eastern corner of the pond. Pond 3 has an estimated capacity of 100 Mgal; Pond 4 has an estimated capacity of 25 Mgal (capacities from EPA, 2017e). The stack is surrounded on the west, south, and southeast sides by the WRD which collects leachate from the underdrain, process wastewater, rainfall runoff from the outer slopes of the EGS, and direct precipitation. The WRD occupies 48.1 acres and has an estimated capacity of 130 Mgal (EPA, 2017e). Leachate discharges to the WRD at an average rate of about 0.63 Mgal/day (EPA, 2016).

Pond 5, with an estimated capacity of 200 Mgal (EPA, 2017e), borders the northern and northeastern margins of the EGS. It is bounded by the WRD along its eastern margin and by Pond 6 to the north. The pond occupies 60.3 acres and is used to manage water pumped from the WRD, direct runoff from the northeastern slope of the EGS, and direct precipitation. The Pond has a maximum depth of about 15 ft based on the LiDAR data.

Pond 6 has an estimated capacity of 130 Mgal (EPA, 2017e), but is only partly utilized for water storage. The western portion of the pond is presently used for disposal of lime sludge formed by water treatment at the *in situ* plant. Sludge removed from the WRD is tilled into the subgrade of Pond 6. Pond 6 received untreated water from Pond 5 during a one-time, controlled event (EPA, 2016). The pond presently retains contaminated wastewater and precipitation that meets all discharge requirements except for phosphorus.

2.1.3.3 Wastewater Storage

As discussed in the previous sections, untreated wastewater is stored in numerous ponds and ditches at the MPC Site. Table 2-1 summarizes the estimated holding capacities of these ponds.

2.1.3.4 Wastewater Treatment

Depending on rainfall and stored water volumes, water is treated by one of three means at the MPC Site: via the mechanical treatment plant, by *in situ* treatment, or through the emergency bypass procedure. Water is discharged from the Site through 3 outfalls (Figure 2-8). Outfall 001 is an internal outfall for contaminated non-process water from the industrial complex portion of the Site (presently comprising primarily storm water runoff). Outfall 002 is an internal outfall for treated wastewater from phosphogypsum waste pile runoff. Outfalls 001 and Outfall 002 are blended together, pH adjusted as necessary, and discharged via Outfall 003 to Bayou Casotte.

EPA prepares and submits a Discharge Monitoring Report (DMR) to MDEQ Office of Water Pollution Control each month. These reports indicate that Outfall 001 is monitored continuously for pH and flow, and that Outfall 002 is monitored continuously for pH and flow and daily for rainfall. Outfall 003, from which water exits the Site to the surrounding environment, is monitored continuously for temperature, pH, and flow; three times per week for TSS, nitrogen-ammonia, total phosphorus, total fluoride, and total recoverable copper, lead, nickel and zinc; and twice monthly for total recoverable arsenic, cadmium, chromium, selenium, and thallium.

Mechanical Wastewater Treatment Plant. MPC constructed and operated a mechanical waste water treatment plant on the industrial complex to treat process waters using lime neutralization. The plant, which was operated initially by the Environmental Trust and presently is maintained in active operation by EPA, consists of a lime silo, lime slaker, mix tanks, two clarifiers, and discharge lines. It has a treatment capacity of approximately 1 Mgal per day.

The mechanical plant, constructed in 2002, treats leachate and precipitation from the DAP ditch at the WGS and water pumped from the WRD and holding ponds at the EGS. Treatment consists of adding slaked lime ($CaOH_2$) to raise pH from about 2.5 to 4.5 which removes dissolved fluoride by precipitation of calcium fluoride (EPA, 2016). Additional lime is added to raise pH to 10.5 which precipitates calcium phosphate. Ammonia is removed in a third step in which pH is raised to 11.5 and the water is aerated in the S-Pond. Sulfuric acid is added to water discharging from the S-Pond to reduce pH to 6 to 9 prior to discharge to Bayou Casotte through diffuser outfall 003. Underflow from the plant clarifier is pumped to the *in situ* treatment plant at the EGS.

During MPC operations, the mechanical treatment plant operated under NPDES Permit No. MS0003115. Although the permit is no longer valid, the Environmental Trust and, presently, the EPA continue to conduct the monitoring required under the NPDES permit as described above.

***In Situ* Wastewater Treatment.** *In situ* water treatment began in the WRD adjacent to Pond 6 at the EGS in 2017. Prior to this time, contaminated wastewater was treated *in situ* in the North Ponds at the WGS and for a brief period in Pond 4 at the EGS.

In situ treatment is accomplished by pumping lime slurry mixed at the mechanical treatment plant into the WRD where it is mixed with untreated water from the WRD or Pond 5. Mixing is accomplished using tractor pumps aided as necessary using a long-reach track hoe. Treated water is removed from the WRD on the west side of Pond 6 and routed to Outfall 002 where it is pH adjusted prior to discharge through Outfall 003 (Figure 2-2). The *in situ* plant can treat up to 4 Mgal/day.

Emergency Bypass Treatment. Excessive rainfall through 2017 has necessitated bypasses of water to prevent overflow of the system or dangerously high water levels in the various ponds on an emergency basis. In these cases, untreated water is pH adjusted to pH 6 to 9 using sodium hydroxide prior to discharge through Outfall 003.

Throughout the first 10 months of 2017, EPA discharged a total of more than 390 Mgal of water on 5 occasions under the emergency bypass protocol as shown in Table 2-2.

2.2 PHYSICAL SETTING

2.2.1 Climate

The MPC Site has a moist temperate climate that is strongly influenced by the Gulf of Mexico. Rainfall can vary across the Site and as such, daily rainfall is measured at 2 locations at the WGS (north and south) and 6 locations at the EGS (northeast, east, southeast, southwest, west, and northwest).

EPA (2016) cites average annual rainfall at the Site as 66.3 inches per year (in/yr) with a standard deviation of about 14 in/yr (data from MPC facility precipitation records). The average annual evapotranspiration rate is estimated at 31.9 in/yr (41.8 in/yr evaporation from open ponds), although water balance calculations suggest more modest rates (21.6 in/yr). Table 2-3 shows climate data for Moss Point, MS located on the north side of the City of Pascagoula. Average annual precipitation is slightly less than measured at the MPC Site which is closer to the coast. Table 2-3 shows that June through August are typically the wettest months while April, October, and December are typically the driest.

Rainfall in 2017 was significantly above average as measured at the MPC Site. Table 2-4 presents monthly total rainfall at the Site for the period January 1 to November 30, 2017 which shows that the Site received 106.7 inches of rainfall during that time.

Table 2-5 shows the average rainfall associated with 24-hour storms at Moss Point, MS with various return rates. As shown, 9.18 inches of rain constitute the 10-year, 24-hour storm in this area.

2.2.2 Topography

The Site is located on the Gulf of Mexico coastal plain. It occurs on parts of four U.S. Geological Survey 7.5 Minute topographic series maps: the southeast portion of the Pascagoula North, Mississippi quadrangle; the northeast portion of Pascagoula South, Mississippi quadrangle; the southwest portion of Kreole, Mississippi-Alabama quadrangle; and the northwest portion of Grand Bay SW, Mississippi-Alabama quadrangle. Elevations are low and regional topography is flat. LiDAR topography for the Site obtained from the Mississippi Automated Resource Information System(MARIS; 2015) is shown in Figure 2-9. Ground elevation is typically 5 to 20 ft above mean sea level (amsl) across most of the industrial complex and near the base of the WGS and EGS. Maximum elevation of the EGS is about 115 to 120 ft; maximum elevation of the WGS is about 120 ft amsl.

2.2.3 Geology

The MPC Site is underlain by Pleistocene to Recent unconsolidated sands and clays formed from marine and deltaic deposits on the Gulf coastal plain. The stratigraphy of the area beneath the EGS is described in several reports including the URS Corporation ([URS]; 2009) and Dames & Moore (1996) which summarized data collected from subsurface standard penetration testing and piezometer borings. This stratigraphy is believed to apply to the entirety of the Site. The uppermost unit is an unconsolidated, poorly graded sand ranging in thickness from 4 to 10 ft in the area beneath the EGS. The sand is locally overlain by a thin deposit of silty sand. The sand overlies a soft, fat clay unit which is typically 10 to 12 ft thick. The elevation of the top of the fat clay is about 0 ft (sea level). URS cites a plasticity index of 57 for the fat clay with a liquid limit of 82. Underlying the clay is a soft sandy clay unit about 15 ft thick, which in turn rests on a deposit of sand referred to as the intermediate sand. The sandy clay has a plasticity limit of 21 and a liquid limit of 38 (URS, 2009).

Eco-Systems Inc. (2010) and Dames & Moore (1996) state that these unconsolidated units overlie a sequence of Tertiary strata that include (in descending order) the Pliocene-aged Citronelle Formation (primarily nonmarine alluvial and fluvial sands, gravels, and clays; Matson, 1917); the Pliocene-aged Graham Ferry Formation (nonmarine to brackish water deltaic sediments; Hosman, 1996); and the Miocene-aged Pascagoula Formation (marine to brackish water, locally fossiliferous deltaic sediments; Renken, 1996).

2.2.4 Surface Water Hydrology

The MPC industrial complex and WGS drain to Bayou Casotte. Bayou Casotte originates a few kilometers north of the MPC industrial complex on the south side of Highway 90, west of its intersection with Highway 611. It drains an area of about 8.4 square miles (EPA, 2007) and is considered to be a coastal stream by the State of Mississippi. Water in Bayou Casotte and the West Prong of Bayou Casotte flows south through wooded, undeveloped, locally marshy areas and is locally channelized around housing developments. Numerous channelized water diversions and rainfall runoff channels join Bayou Casotte as it flows southward. From the coast inland to the MPC industrial complex, Bayou Casotte has been dredged to create a deep water port for industrial use by numerous businesses.

Bayou Casotte has been channelized around the north and west sides of the WGS. Immediately north of the WGS, runoff ditches from the area of the EGS join the Bayou Casotte channel. Some of these channels pre-date construction of the EGS and can be observed on 1992 aerial imagery draining the south and west sides of the Jackson County Airport which was removed to construct the EGS.

Although the EGS is adjacent to the west of the Grand Bay estuary, runoff from the facility is routed west and south to Bayou Casotte. Consequently, there is no runoff from the MPC Site that is known to flow to the Grand Bay estuary.

Bayou Casotte carries a designated beneficial use classification of Fish and Wildlife (MDEQ, 2007). Portions of Bayou Casotte and the West Prong of Bayou Casotte are listed as impaired for aquatic life use support by the State of Mississippi (MDEQ, 2016). Causes of impairment include organic enrichment and low dissolved oxygen. Impairment is noted in Bayou Casotte from the confluence of the East and West Prongs downstream to the turning basin and in the West Prong from Louise Street to the confluence of the East and West Prongs. Previously, Bayou Casotte was listed as impaired due to un-ionized ammonia (NH_3) and total toxics (EPA, 2007).

The Grand Bay estuary also is designated for Fish and Wildlife; Bangs Lake within the Grand Bay estuary is additionally designated for shellfish harvesting. No impairments were noted in the estuary.

2.2.5 Ground Water Hydrogeology

The Graham Ferry Formation serves as the main regional water supply aquifer in Jackson County (Dames & Moore, 1996; Eco-Systems, Inc., 2010). In Jackson County, this formation occurs at depths of 100 to 500 ft below ground. The Citronelle and Pascagoula Formations also are used for water supply (Dames & Moore, 1996).

Groundwater also is present in the unconsolidated Pleistocene- to Recent-aged sediments that occur at and just below the surface of the MPC Site. Eco-Systems, Inc. (2010) reports an average static groundwater level of about 3 ft below ground at the Site, which places the water table within the surficial sand unit. During prolonged or heavy rain events, the water table is at or above the ground surface creating marshy areas and standing water (Dames & Moore, 1996). Well installation and sampling conducted as part of the Site Characterization Report identified a flow direction south from the WGS then west toward Bayou Casotte at an average gradient of 0.005 (Eco-Systems, Inc., 2010). Dames & Moore (1996) identified a groundwater divide beneath the EGS separating flow to the west and southwest beneath the western part of the EGS from flow to the east beneath the eastern part of the EGS.

Slug tests conducted on two shallow wells on the industrial complex yielded estimated hydraulic conductivities of 5.7×10^{-3} cm/sec (well MW-9) and 8.89×10^{-6} cm/sec (well MW-19) (Eco-Systems, Inc., 2010). Hydraulic conductivity calculated from a pump test of well MW-13 yielded a similar value (2.68×10^{-4} cm/sec; Eco-Systems, Inc., 2010).

2.2.6 Site Water Balance

The Site water balance represents the balance between precipitation and runoff, storage and evapotranspiration. Input to the Site water balance at the MPC Site is from precipitation and water released from storage in the EGS and WGS.

EPA (2016) cites average annual rainfall at the Site of 66.3 inches/year (in/yr) with a standard deviation of about 14 in/yr (data from MPC facility precipitation records). The average annual evapotranspiration rate is estimated at 31.9 in/yr (41.8 in/yr evaporation from open ponds), although water balance calculations suggest more modest rates (21.6 in/yr). Through the end of November, 2017, the MPC Site received 106.7 in of rainfall in 2017 (Table 2-4), well in excess of the annual average.

Contributions to the MPC Site water balance are significantly different for the WGS and EGS. Precipitation falling on the WGS is largely discharged from the Site as non-contact runoff from the cap or is evapotranspired by vegetation that covers the impermeable liner. A subordinate amount of the precipitation infiltrates into the stack where it is held in storage then released to the DAP ditch as contact water that requires treatment. Release from storage in the WGS is estimated at 20,000 gallons per day (7.3 Mgal/year). One inch of rain that falls on the footprint of the WGS (219.3 ac; excluding the DAP ditch and North Ponds) is equivalent to 5.95 Mgal of water. Consequently, in an average rainfall year (66.3 inches = 395 Mgal/year), the contribution to storage within the WGS is about 1.8 % of total precipitation.

In contrast, one inch of rain that falls on the footprint of the EGS (350.5 ac; includes the stack, WRD, Pond 5 and Pond 6) generates an estimated 9.1 Mgal of water that requires treatment (EPA, 2017e). This is equivalent to slightly more than 600 Mgal/year not including water loss to evaporation. Because all of this precipitation contacts contaminants, none is discharged off-site without treatment.

Table 2-6 is modified from EPA (2016) and shows that annual net precipitation on contact areas including Pond 6 is approximately 505 Mgal/yr (1.38 Mgal/day) based on the average annual rainfall and evaporation. The excess rainfall at the Site from January through November 2017 has created an additional 730 Mgal of water to be managed and treated. The excess water has necessitated periodic emergency bypasses of water to protect the integrity of the EGS ponds and prevent flows that may compromise these facilities. Water is neutralized prior to discharge to Bayou Casotte in accordance with EPA's Spill Contingency and Emergency Bypass Plan. Through the end of November 2017, a total of approximately 394 Mgal of water was bypassed on five occasions on an emergency basis (Table 2-2); no adverse effects have been observed in Bayou Casotte.

2.2.7 Geotechnical Characteristics

This section is summarized from URS (2009).

2.2.7.1 Phosphogypsum

The phosphogypsum is a silt-like material with properties of a non-cohesive soil. Wet densities of collected samples ranged from 98 to 110 pounds per cubic foot (pcf) and dry densities ranged from 69 to 80 pcf with an average of 73 pcf. The wet density and dry density increase with increasing depth as the increased overburden stress consolidates the material.

Strength testing shows the material has a peak friction angle between 48^{o} to 64^{o} as the strength also increases with depth and dry density. The residual friction angle does not have a significant change with stress and a slip surface model of strength uses a friction angle of 43^{o}.

The consistency of the phosphogypsum varies from loose to medium dense. In general, consistency becomes denser with depth although pockets of loose material are found at all depths. The consistency also increases with age of the deposits as the older portions of the stack have denser material than the younger portions.

The change in dry density with stress increase and with time is due to the creep rate and time-dependent settlement of the stack. Similar to other phosphogypsum stacks, there is a change in strain rate as stresses change with time and decreasing void ratios. Consequently, younger deposits settle at a faster rate than older deposits and the creep rate decreases with time for all levels within the stack.

Similar to creep rate, vertical conductivity is also anticipated to change with age and with depth. Settlement that decreases void ratio is expected to decrease the hydraulic conductivity of the phosphogypsum. Therefore, the seepage characteristics of the stack are anticipated to vary with time and with depth.

2.2.7.2 Subgrade Properties

The subgrade beneath the phosphogypsum stack consists of approximately 4 to 10 ft of native poorly graded clean sand. The sand has a medium dense consistency and was determined to have an undrained friction angle of 33^{o}.

A very soft, 10- to 12-ft-thick, clay layer beneath the sand has the most impact on the potential for sliding along the underlying native soils. The clay is normally consolidated and has high plasticity. The drained and undrained strength properties vary with the overburden stress imposed by the phosphogypsum stack. Therefore the strength of the clay is lower at the outer limits of the stack where the height of the phosphogypsum material is less. The undrained shear strength of the clay was determined to be 0.23 times the overburden stress. This change in strength with overburden stress requires consideration as increasing the stack height at the outer limits affects limits of sliding by the underlying lower strength clay layer.

Beneath the clay is a sandy clay layer with an approximate thickness of 15 ft. The sandy clay was also normally consolidated with an undrained strength of 0.26 times the overburden stress and the drained strength was found to be a friction angle of 25°. An intermediate sand layer was found beneath the sand clay and was found to have a drained friction angle of 33°.

2.3 PREVIOUS INVESTIGATIONS

Numerous investigations were conducted at the Site in support of operations at MPC and to identify and correct issues related to contamination. Among these are a preconstruction investigation conducted in support of the design and construction of the EGS (e.g., Dames & Moore, 1996), a Total Maximum Daily Load (TMDL) analysis of Bayou Casotte (EPA, 2007), and a Site Characterization Report (Eco-Systems, Inc., 2010).

2.3.1 Geotechnical and Hydrogeologic Investigations

Dames & Moore (1996) conducted geotechnical and hydrogeologic studies in the area of the EGS to support the design and construction of the facility. Geotechnical data were collected from Standard Penetration Test borings, Piezocone Penetration soundings, and other soil borings. Geotechnical samples from the unconsolidated deposits underlying the proposed EGS were analyzed for parameters that include Atterberg limits, grain size, moisture/density, one-dimensional consolidation tests, strength tests, and soil permeability. In addition, Dames & Moore modeled settlement beneath the facility during loading and the flow of groundwater following its construction.

2.3.2 2007 Site Inspection Report

Weston Solutions, Inc. prepared a Site Inspection Report of the MPC Site for EPA in 2007 (Weston, 2007). The purpose of the report was to collect data on the nature and extent of contamination and determine potential human and ecological exposure pathways to provide information to support a HRS package. As part of the investigation, Weston examined the results of samples collected in early 2005 of groundwater, surface and subsurface soil, surface water and sediment. Samples were collected from the industrial complex and adjacent to the WGS and EGS. The report documented a release of metals and gross beta particle activity to the surficial aquifer from the Site; a release of inorganic substances, radionuclides and gross beta particles to Bayou Casotte; and elevated concentrations of several inorganic, extractable organic, and radionuclide compounds to site soil.

2.3.3 Total Maximum Daily Load Investigation

Bayou Casotte was included on the State of Mississippi's 2004 303(d) List of Impaired Waterbodies for impairments due to un-ionized ammonia and total toxics. Consequently, EPA Region 4 prepared a TMDL analysis of these contaminants in Bayou Casotte to achieve compliance with surface water quality standards and protect aquatic life (EPA, 2007). The TMDL calculated waste load allocations based on conditions in August, when water temperatures in Bayou Casotte are likely to be highest and dissolved oxygen concentrations lowest (these factors influence on the proportion of un-ionized ammonia present). The results of the TMDL analysis were used to guide development of effluent limits in the MPC's NPDES discharge permit.

2.3.4 Site Characterization Investigation

The purpose of the 2010 Site Characterization Report was to collect data to characterize the MPC Site, prepare a conceptual site model, and delineate the lateral extent of contaminants of concern in soil and groundwater (Eco-Systems, Inc., 2010). Investigative work was conducted almost exclusively on the industrial complex portion of the Site. As part of their investigation, Eco-Systems, Inc. collected soil samples from monitor well and other subsurface soil borings and submitted these for laboratory chemical and geotechnical analysis; leach tested selected soil samples using the Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) protocols; installed 20 permanent monitoring wells on the industrial complex; collected and analyzed groundwater samples; installed piezometers to investigate tidal influences on groundwater; conducted hydrogeologic testing of selected monitoring wells; and evaluated the lateral and vertical extent of contamination at the Site.

The report concluded that adverse impacts to soil and groundwater are present due to low pH, metals, ammonia, and fluoride. Sulfuric acid production was identified as a contributing source to low pH.

2.3.5 Hazard Ranking System

EPA completed a Hazard Ranking System Documentation Record for the MPC Site in July 2017 (Tetra Tech, 2017). The report reviewed data for the Site and determined that contamination at the Site posed a threat to the surface water pathway sufficient to qualify the Site for the NPL. Consequently, EPA did not score other potential pathways including groundwater migration, drinking water and environmental threats, air, and soil and subsurface intrusion.

2.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination was determined using the results of previous investigations. Few of these studies collected samples of untreated waste water and gypsum solids from the EGS and North Ponds at the WGS. The 2007 site inspection investigation (Weston, 2007) and the 2010 site characterization investigation (Eco-Systems, Inc., 2010) concluded that surface and subsurface soil and groundwater at the Site exhibited evidence of contamination in the area of the industrial complex. Metals, pH, ammonia, fluoride, radionuclides, and organic compounds were identified as contaminants in these studies.

The 2010 Site Characterization Report (Eco-Systems, Inc., 2010) found that EPA Regional Screening Levels (RSL) for industrial soil were exceeded in one or more samples for arsenic, cadmium, chromium, lead, selenium, thallium, and total phosphorus. Low pH soil was identified in a few locations most consistently near the sulfuric acid plant, the construction area on the industrial complex, and the phosphate ore processing plant; most exceedances occurred in surface soils (<2 ft depth). Only arsenic exceeded its MDEQ Target Remediation Goal (TRG) value. The distribution of arsenic exceedances suggests that it may be caused by naturally elevated arsenic concentrations.

The 2010 Site Characterization Report (Eco-Systems, Inc., 2010) identified arsenic, cadmium, iron, lead, thallium, and ammonia as consistently exceeding MDEQ TRG and/or EPA MCL values in groundwater.

Chromium, selenium, and fluoride also exceeded MCL or surface water screening levels. In addition, groundwater pH was below 2 in certain locations on the industrial complex and between 2 and 4 in a more widespread area. Eco-Systems, Inc. characterized sources of most metals to groundwater as natural components of local soils in the shallow saturated zone that have been mobilized by low pH conditions. Lead may have been mobilized from the property adjacent to the south of the industrial complex which was formerly used as a lead ore stockpile by the Port of Pascagoula.

2.4.1 Untreated Wastewater

Untreated wastewater is contained on numerous holding ponds and ditches at the EGS including Ponds 3, 4, 5, 6, and the WRD. Partly to fully treated wastewater is present in the northern part of the WRD where the *in situ* treatment plant is presently located. Untreated wastewater is also present within DAP ditch (cooling loop) at the WGS. Untreated wastewater mixes with water in the North Ponds at the WGS which was treated by the initial *in situ* treatment plant.

Full analyses of untreated wastewater were not available for the various ponds and ditches on the Site. Partial analyses, primarily in the form of pH measurements and total phosphorus analyses were available for many locations and these are summarized in Table 2-7. Summary statements regarding water quality at the Site note that water originating from the EGS typically has ammonia concentrations ranging from 300 to 500 milligrams per liter (mg/L), phosphorus concentrations ranging from 4,000 to 8,000 mg/L, and fluoride concentrations of about 300 mg/L (EPA, 2017c; 2017d).

Table 2-7 shows that untreated wastewater in Pond 5, Pond 6 and the WRD has low pH and high concentrations of phosphorus. Most pH measurements are between 2.4 and 2.9 except in Pond 6 where recent pH measurements range from 2.8 to 3.4. Total phosphorus ranges from 2,052 to 3,338 mg/L in Pond 5 and the WRD. The WRD receives seepage directly from the EGS underdrain system and some of this water is pumped to Pond 5 for storage. Pond 6 has somewhat lower total phosphorus, ranging from 1,180 to 1,494 mg/L in the recent measurements.

Results for pH, nitrogen, total phosphorus, and fluoride are available for one sample collected from Pond 4, which is atop the EGS. This sample had low pH similar to Pond 5 but much lower total phosphorus (223 mg/L). In addition, the Pond 4 sample had low nitrogen but high fluoride. The relatively low concentrations of phosphorus and nitrogen are consistent with on limited interaction with the underlying phosphogypsum solids. Low pH and elevated fluoride suggest that acidity and fluoride may be present in forms that are more soluble.

2.4.2 Treated Wastewater

Table 2-8 summarizes the quality of treated wastewater discharged from the MPC Site to Bayou Casotte through diffuser outfall 003 for the months of February to May, 2017 as reported on monthly DMR (Allen Engineering, 2017a through 2017d). The DMRs are prepared in accordance with NPDES Permit No. MS0003115 (MDEQ, 2015). Although this permit is no longer active, EPA continues to treat water to this standard and prepares and submits reports to the State of Mississippi as required the permit.

Outfall 003 is defined as the combined discharge from internal outfalls 001 and 002 (MDEQ, 2015). Outfall 001 is the internal outfall for contaminated non-process wastewaters from the processing area; outfall 002 is the internal outfall for treated wastewater originating from phosphogypsum stack runoff.

With the exception of pH, metals and ammonia in treated water were within their permit limits. The numerical limits for pH shown in Table 2-8 are the applicable water quality criteria. The DMRs note 537 excursions of pH, which is measured continuously, during the 4 month period February to May, 2017, none of which lasted 60 minutes or more. Compliance of treated water quality with NPDES permit limits indicates that it is not a source of contamination to Bayou Casotte or other off-site locations.

2.4.3 Phosphogypsum Solids

The EGS comprises approximately 15 million cubic yards (cy) of phosphogypsum solids. Analyses of phosphorus and fluoride are not available for samples collected from the EGS solids. However, four samples were collected from the surface of the EGS in 2016 and analyzed for metals and ammonia (Tetra Tech, 2016), and six samples were collected from the EGS in 2017 and analyzed for radionuclides (EPA, 2017a).

Results for ammonia and metals in four samples plus one field duplicate of phosphogypsum from the EGS are shown in Table 2-9. Samples MPC-05 and -05D were collected from the upper tier of the EGS along the southwest corner of the facility; sample MPC-06 was collected from the lower tier along the northwestern corner; sample MPC-07 was collected from the lower tier at the northern corner; and sample MPC-08 was collected from the upper tier from the southern Pond 3 containment dike. Results for the four samples are relatively consistent and suggest the phosphogypsum material comprising the outer layer of the stack is relatively homogeneous. None of the sample results exceeded EPA RSLs for industrial soil (EPA, 2017b). Arsenic in sample MPC-08 was the only sample result to exceed its MDEQ Tier 1 Target Remediation Goal for unrestricted site use (TRG = 0.426 mg/kg) (MDEQ, 2002).

Table 2-10 shows the results for Radium 226 reported in EPA (2017a). Radium 226 activity ranges from 21.8 to 46.9 pCi/g for the 6 samples (average of 31.2 pCi/g excluding the duplicate sample MPC-06D).

2.5 STREAMLINED RISK ASSESSMENT

A streamlined risk assessment was conducted to evaluate site risks due to exposure to site contaminants and potential risk reduction that would be gained by completion of the Removal Alternatives considered in Section 5.0 of this EE/CA. This assessment is included as Appendix A; the reader is referred to Appendix A for more detail.

On-site exposures to ecological receptors are limited, although off-site exposures are potentially significant. Currently, there is negligible habitat value associated with the EGS, its ponds, and the WRD. The ponds could theoretically be a temporary attractive nuisance; however, given the proximity of Bangs Bayou and Lake to the east, birds and mammals would utilize their natural habitats in the estuary. Adverse impacts to the Grand Bay NERR occurred in 2005 following an overflow release of low pH water with high levels of ammonia, phosphate and metals. Such a release could potentially occur again, to either the Grand Bay NERR or to Bayou Casotte, where it would result in adverse exposure to the entire localized ecosystem, from the salt marsh benthic community to fish, birds and other wildlife receptors.

Industrial workers are potentially exposed to the contaminants of concern (COC) as they perform operation and maintenance (O&M) activities at the treatment plant and other site facilities. This includes excavation and grading of the EGS and ponds, shoring up eroded areas and berms, stirring treatment sludge, maintaining the piping system, and monitoring the outfalls. Consequently, workers may incidentally ingest or dermally-contact contaminated water, sludge or the phosphogypsum material. Leaching of COCs through the EGS to groundwater is of concern; however, there are no drinking water intakes within 15 miles of the Site (Tetra Tech, 2017). Given the highly industrialized nature of the Site and fenced security, trespassers are not considered to be adversely exposed, and the potential for a future residential scenario within the Site is considered negligible and would be addressed by various institutional controls.

The Streamlined Risk Assessment concluded that the existing water treatment system and its current permitted effluent conditions are protective of aquatic life in Bayou Casotte. However, the large volumes of untreated water with COC concentrations a few orders of magnitude greater than the acceptable benchmark levels, has a future potential to cause catastrophic harm the environment should untreated water be released through an overflow of excess water or a pond breach, as has happened in the past. Large precipitation events such as tropical storms and hurricanes place undue stress on the existing treatment system. Reducing the volume of untreated water with its low pH and high levels of un-ionized ammonia, phosphate and fluoride is a prudent goal. The removal options being considered in the EE/CA will substantially reduce the threat of overflow releases, and significantly reduce leaching of COCs through the EGS, thereby indirectly protecting the environment better than under current conditions.

3.0 Removal Action Objectives and Goals

Much of the water being treated at the Site is rainfall that becomes contaminated by exposure to gypsum solids at the EGS or that falls directly onto ponds which hold contaminated water. Eliminating these sources of contact will substantially reduce the volume of water requiring treatment and the cost to treat water and maintain the Site in a manner that reduces risk to HH&E. Reducing the area of contact between rainfall and the EGS and North Ponds at the WGS will permit storm runoff from these facilities to be discharged without treatment.

3.1 REMOVAL ACTION OBJECTIVE AND SCOPE

The EPA has established an overall site goal of long term leachate management at the EGS and WGS. Closure of the EGS and the North Ponds complex at the WGS to eliminate contact of rainfall with these facilities is the first step in this process and will be followed at a later date by a site-wide final remedy decision that will include an analysis of water treatment options. Consequently, the scope of this EE/CA is to evaluate means to permanently close these facilities in the quickest and most efficient manner.

The EPA developed the following RAOs to guide the Removal Action process:

- Reduce or eliminate contact of precipitation runoff and surface water with phosphogypsum solids and lime sludge solids comprising the EGS and North Ponds to prevent contamination of water to levels above applicable water quality criteria.
- Reduce or eliminate precipitation infiltration into the EGS to reduce the volume of leachate from the facility that requires treatment.
- Reduce or eliminate contact of precipitation with contaminated water contained in onsite storage ponds and facilities.
- Take additional actions on the EGS as needed to reduce the volume of water requiring treatment and achieve a goal of long-term leachate management at the Site.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP at §300.415(j) requires ARARs under Federal environmental or State environmental or facility siting laws to the extent practicable. ARARs may be either "applicable" or "relevant and appropriate" to removal actions at a site, but not both.

"Applicable" requirements are those cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under State or Federal law that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstances at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at a site.

"Relevant and appropriate" requirements are those cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under State or Federal law that, although not applicable, address problems or situations sufficiently similar to those encountered at the Site that their use is well suited to the particular site or actions at the Site.

In addition to ARARs, certain other State and Federal guidance documents may be considered when conducting a removal action. These "to be considered" (TBC) criteria, which do not have the status of ARARs, are non-promulgated advisories or guidance issued by State or Federal governments which are not legally binding.

ARARs and TBCs are used in the detailed analysis of the effectiveness of removal action alternatives. They are categorized as chemical-specific, action-specific, or location-specific.

Chemical-specific ARARs include those environmental laws and regulations that regulate the release to the environment of chemicals that possess potentially adverse chemical or physical characteristics. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific compounds.

Action-specific ARARs are, for the most part, technology- or activity-based requirements or limitations on specific actions taken with respect to remediating hazardous sites. These requirements are triggered by the particular removal activities that are selected to accomplish the remedy. While action-specific requirements do not in themselves determine the removal alternative, they may indicate how a selected alternative must be employed.

Location-specific ARARs are requirements related to the geographical location of the Site or physical condition of the Site, such as floodplains or wetlands where there could be "relevant and appropriate" requirements under §404 of the Clean Water Act. While specific permits would not be required, substantive requirements may limit the type of removal action to be implemented or may impose constraints on a removal alternative.

Potential ARARs and TBCs for the Removal Action at the Mississippi Phosphates Corporation Site are presented in Table 3-1.

3.3 REMOVAL ACTION GOALS

Removal action goals (RGs) for response actions under CERCLA typically are based on site-specific risk assessments and ARARs. The objectives of this EE/CA are to reduce the contact of precipitation with contaminant source materials, reduce the volume of water requiring treatment, and assist in moving the Site toward a long term goal of leachate management (Section 3.1). Consequently, numerical RGs have not been developed for leachate quality or volume following closure because this water will continue to be collected and treated.

As part of the closure of the EGS and the North Ponds at the WGS, however, storm water from capped areas will be collected and routed to Bayou Casotte without treatment. The effluent concentrations listed in the 2015 NPDES permit (MDEQ, 2015) for Outfalls 006B1 (storm water runoff from the bottom storm water ditch level on the southwest side of the closed West Gypsum Storage Pile) and 006B2 (internal outfall for "Capped Gypsum Stack Runoff" from the bottom storm water ditch level on the south side of the closed WGS West Gypsum Storage Pile) will serve as RGs for storm water from the EGS. Numeric effluent limits for these outfalls are developed only for pH collected as a grab sample during the first 30 minutes as shown in Table 3-2. In addition to pH, reporting for Outfalls 006B1 and 006B2 includes quarterly average and maximum values for ammonia-nitrogen (total), fluoride (total), phosphorus (total), and TSS; these are reported as flow-weighted composites and as grabs during the first 30 minutes of runoff. Storm water quality monitoring for the EGS and North Ponds areas would be required until the runoff quality is demonstrated to be at or below the permit concentrations through several storm runoff events. The frequency and locations of monitoring will be determined as part of a monitoring plan that will be developed upon completion of the Removal Action.

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4.0 Identification and Screening of Technologies

4.1 GENERAL RESPONSE ACTIONS

General Response Actions (GRAs) are general remedial management strategies that are designed to satisfy removal action objectives. After appropriate GRAs have been defined, specific technologies are identified and screened. Technologies passing the screening test are used to develop Removal Action Alternatives. EPA identified the following GRAs that could satisfy the RAOs to quickly and efficiently close the EGS and North Ponds at the WGS:

- **No Action** – Required by CERCLA as a benchmark for comparison against other Removal Action Alternatives. This GRA implies that no direct action will be taken to alter the existing conditions.
- **Treatment** – Treatment actions include technologies that would treat contaminant sources to prevent negative impacts to precipitation infiltration and runoff. An example of a treatment action would be to inject neutralizing compounds into the phosphogypsum solids of the EGS to neutralize acidity and prevent contamination of precipitation infiltration.
- **Engineered Actions** – These include engineered solutions to prevent potential exposure to contaminants. An example of an engineered action would be to install a cover over the EGS to prevent contact between precipitation and phosphogypsum solids.
- **Excavation and Removal** – Excavation and removal include solutions to excavate and remove those materials which are sources that cause contamination that requires treatment. An example of an excavation and removal action would be to excavate the phosphogypsum material comprising the EGS and place the material in a secure location, such as an approved landfill, where it will not degrade the environment.

4.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Technologies applicable to closure of the EGS and North Ponds at the WGS at the MPC Site were screened to determine whether they could be used to develop Removal Action Alternatives for the Site. The screening process evaluated site or regulatory conditions that would preclude a given technology from being effectively implemented at the Site. EPA used the following criteria for this preliminary screening:

- **Technical Feasibility and Implementability** – This criterion refers to the feasibility of reasonably implementing a removal technology at a site. Any technology that has not been previously proven effective in meeting cleanup goals will be considered to be not technically feasible or reasonably implemented and will be screened from further consideration.
- **Administrative Feasibility** – This criterion evaluates the degree to which a removal technology coincides with EPA objectives or goals or requires specialized permits or licenses for implementation. Any technology that does not meet EPA objectives or land use goals will be considered to be not administratively feasible and will be screened from further consideration.
- **Availability of Services and Materials** – This criterion evaluates the degree to which a removal technology requires materials or services that are reasonably attainable, readily available, and accomplished with local equipment and expertise. Any technology that requires services and/or materials that are not reasonably attainable or available to the local area will be considered not to meet this criterion and will be screened from further consideration.

The Removal Action Alternatives that may potentially be used to meet RAOs for the MPC Site are described below.

4.2.1 *In Situ* Treatment

Treatment can be implemented in order to achieve goals of preventing contamination from being released from a phosphogypsum source or preventing infiltrating precipitation from becoming contaminated. In the former, precipitation which infiltrates into a source area such as the EGS becomes contaminated through contact with the stack materials but is treated to neutralize or remove the contaminants from the water prior to discharge from the source materials. In the latter case, the source materials are treated in a manner to render them inert thereby halting the contamination process. In both cases, treatment would be conducted *in situ*.

Water contained within the EGS is contaminated with acidity (low pH), phosphorus, ammonia, and metals. *In situ* treatment of infiltrating precipitation that becomes contaminated through interaction with phosphogypsum solids can be achieved either by injecting materials into the EGS that would treat contaminated water or by constructing treatment systems that would intercept and treat contaminated water prior to its discharge to the environment.

Treating the various contaminants in water within the EGS would require injection of multiple compounds. Injection of chemical reagents is an accepted technology for treating shallow groundwater that has been applied at sites to remove acidity, destroy organic compounds, and treat other contaminants. Key to success of the strategy is obtaining an even distribution of reagents and injecting a quantity of reagents sufficient to maintain treatment over the long term. Reagents could be injected throughout the entirety of the affected area or as treatment barriers or areas that intercept migrating contaminated water. In the case of the EGS, the continual creation of contaminated water as precipitation infiltrates through the stack would require frequent replenishment of reagents as they are exhausted by the chemical reactions effecting treatment. Reinjection would be a continuing requirement at the Site until such time that the phosphogypsum source material has been flushed of the source mass.

Treating contaminated water by installing *in situ* treatment systems also would require the application of technologies in sequence to treat the various contaminants that are present. For example, limestone could be used to neutralize acidity while zero valent iron could be used to remove phosphorus as insoluble iron phosphate. These systems could be constructed by adapting passive barrier technologies to the MPC Site. Similar to injection, *in situ* treatment systems would require frequent monitoring and periodic replenishment of reagents. Most passive treatment barrier systems require a contact or residence time within the cell to allow for treatment reactions to move to completion. Water through the EGS is likely to increase as storage and hydraulic head increase within the stack following large precipitation events. Increased flow velocity following these events may not permit sufficient residence time for effective treatment which could permit contaminants to be discharged from the Site.

Encapsulation technologies have been used to passivate reactive minerals by depositing non-reactive minerals as surface coatings (e.g., silica encapsulation of pyrite in mine tailings). Encapsulation can be accomplished either by injection of appropriate reagents or by more thorough mechanical mixing. In the case of the EGS, it remains unclear whether water percolating through the phosphogypsum material becomes contaminated by reaction with the enclosing phosphogypsum solids or by leaching of contaminants from pore spaces and solids. The presence of ammonia and phosphorus as water contaminants could permit gypsum particles to be encapsulated by precipitation of the mineral struvite ($NH_4MgPO_4 \cdot 2H_2O$). Struvite formation would require the addition of magnesium to the EGS neutralization of acidity since it forms most efficiently under neutral to slightly alkaline pH conditions. Regardless, examples of successful phosphogypsum encapsulation have not been found.

In situ treatment, whether by injection or construction of treatment systems, or contamination prevention through *in situ* encapsulation could be implemented. In the case of *in situ* treatment, it is unknown if this technology could meet discharge quality standards over the long term without some level of secondary treatment or polishing. In addition, significant uncertainty would be present since the technologies would assume an injection radius to achieve coverage with treatment reagents; material anisotropy within the EGS could impact reagent distribution and longevity. On site personnel would be required to monitor water quality and replenish treatment reagents. These would be ongoing O&M costs that would continue until such time that the contaminant mass within the EGS is exhausted. *In situ* encapsulation is an unproven technology in phosphogypsum stacks and would require significant testing to demonstrate that it would be a viable technology to implement at the MPC Site. Due to uncertainties in treatment effectiveness and significant long-term O&M costs, *in situ* treatment technologies were not retained for further evaluation.

4.2.2 Engineered Actions

Engineered actions can be taken to reduce the production of contaminated water at the MPC Site. In general, these involve the placement of caps and covers which are a widely used and accepted technology at phosphogypsum sites in Florida and other parts of the U.S. (Florida Administrative Code [FAC], 1993). Caps and covers prevent or limit precipitation infiltration into phosphogypsum solids thereby limiting the production of contaminated water that requires treatment and reducing the potential for contamination to spread through the environment.

Most commonly, caps and covers are applied to the surface of the phosphogypsum stack (e.g., plastic, geotextile, compacted clay, soil, or a combination) but they may be developed *in situ* by incorporating chemical or physical amendments (e.g., bentonite clay) directly into the phosphogypsum material to decrease permeability.

Phosphogypsum stack regulations promulgated by the State of Florida (FAC, 1993) require either a 12- to 18-inch-thick compacted soil barrier layer or a synthetic liner across the facility, both of which would be protected by an 18- to 24-inch-thick vegetated soil cover. Installation of a compacted soil barrier or synthetic liner could be implemented at the EGS and North Ponds of the WGS. Both types of liners require grading and slope reduction to promote long-term stability, contouring to control the flow of runoff, and grading to create a stable surface on which to apply the liner.

Construction of a compacted soil or clay liner requires a borrow source with significant reserves close to the Site to limit transportation costs. A suitable source is expected to be available in the area since a clay unit 10 to 12 ft thick underlies the EGS at a depth of about 10 ft below ground.

Synthetic liner material, in the form of high-density polyethylene (HDPE), geosynthetic clay liner (GCL), or other geotextile material is widely available and easily applied as cover material at the EGS and North Ponds. This material would be shipped to the Site by truck.

Installation of compacted soil and synthetic caps and covers are retained as viable options for the EGS and North Ponds.

In situ creation of a low permeability cap could potentially be a more cost effective option than either a compacted soil or synthetic liner (Patel, et al., 2002 cite a potential savings of $25,000 per acre over synthetic liners). *In situ* capping creates a cap by compacting the upper surface of the phosphogypsum material in place or incorporating chemical or physical amendments to reduce permeability. Patel et al. (2002) tested the use of bentonite and phosphatic clay as amendments and found that both could create material with the desired hydraulic characteristics in pilot field tests. Similar to compacted soil or synthetic covers, *in situ* caps would be overlain by a vegetated soil layer. Discussions with other vendors, however, indicated that the high ionic concentration of gypsum may interfere with hydration and swelling of sodium bentonite. Consequently, additional testing to identify suitable amendments would be required evaluate the viability of this technology. This testing is expected to require a year or more of monitoring to determine its effectiveness. Given that the potential cost savings to install an *in situ* cover across the 320 acres of the EGS is less than one year of water treatment costs, *in situ* cover technology was not retained for further consideration.

4.2.3 Excavation and Removal

Excavation and removal of the phosphogypsum stack and lime sludge is a viable means to remove source material from the Site to prevent the spread of contamination. Excavation of contaminant sources and transport of the material to an engineered containment area (e.g., landfill) or to a facility where it could be recycled/reused is a common and widely implemented technology. The presence of radionuclides in the phosphogypsum material in concentrations in excess of 20 picoCurie per gram (pCi/g) precludes its reuse under U.S. EPA rules promulgated in 1989 (subsequently amended in 1992 [EPA, 1992]).

Excavation and removal of nearly 15 million cy of phosphogypsum would be expensive and require landfill space for disposal. Although the Site is serviced by rail, a spur would need to be constructed to the EGS in order to remove the material using rail rather than truck. Removal by truck is estimated to require 250,000 truck trips and require over 5 years to complete. Due to the anticipated long time frame to remove the EGS and the cost and usage of landfill space required to do so, excavation and removal of the EGS was not retained for further consideration.

Lime sludge contained within the North Ponds at the WGS could be excavated and removed to permit closure without a liner. Sludge excavated from the ponds would be removed to the EGS where it would be incorporated into soil covers at the facility. Excavation and removal is retained as a viable option for further consideration for the lime sludge contained within the North Ponds at the WGS.

5.0 Identification of Removal Action Alternatives

Per EE/CA guidance, "a limited number of alternatives appropriate for addressing the removal action objectives" should be identified, developed and carried through the detailed analysis (EPA, 1993). The retained technologies and options for the MPC Site were combined into removal action alternatives that are expected to meet the RAOs presented in Section 3. The identified removal alternatives rely on proven technologies with a track record of successful implementation.

The EPA intends to close the EGS in a phased manner utilizing the State of Florida Rule 62-673.610 (*Closure Plan Requirements for Phosphogypsum Stacks*; FAC, 1993) as a guide:

- Phase 1 – Closure of the current EGS footprint (155 acres) including Pond 3, Pond 4 and stack side slopes.
- Phase 2 – Closure of EGS Pond 5 (60 acres) and of the WGS North Ponds (30 acres).
- Phase 3 – Closure of EGS Pond 6 and the EGS Water Return Ditch (WRD) (135 acres).

The EPA has identified the following Removal Alternatives for the EGS and North Ponds closure:

5.1 ALTERNATIVE 1. NO ACTION

This alternative is required under CERCLA to provide a baseline against which to compare the action alternatives. Under the No Action alternative, no funds would be expended to control or remediate the EGS and North Ponds and water would continue to be treated as it is at the present time. The average yearly cost to treat water is $5,559,000 based on an average per gallon treatment cost of $0.012036/gallon (value provided by Kemron Environmental Services, 2017) and net precipitation of 44.7 inches per year (see Section 2.2.6).

Cost. There is no capital cost associated with Alternative 1.

5.2 PHASE 1

EPA developed two alternatives for the Phase 1 Removal Action. The area included in Phase 1 is depicted in Figures 5-1a and 5-1b. Completion of Phase 1 would reduce the initial 380.5 acre EGS and WGS water contact area to 225.6 acres (reduction of 154.9 acres) or approximately 39%.

5.2.1 Alternative 2A. Phase 1 – Partial LLDPE Liner

Under Alternative 2A, EGS Ponds 3 and 4 and the EGS side slopes would be closed by installing a linear low density polyethylene (LLDPE) liner with a vegetated, protective cover on flat areas (benches and the crest of the pile) and a vegetated, protective/amended soil cover only on side slopes. Alternative 2A includes the following major work elements:

- Drain Ponds 3 and 4 and treat water either at the *in situ* plant at Pond 6 or in accordance with the emergency bypass procedure to discharge off-site within a 30 day period prior to commencement of earthwork operations.
- After draining Pond 4, remove lime sludge from Pond 4 and incorporate into the soil cover, with water treated at the Pond 6 *in situ* plant and discharging the water off-site. The lime sludge amendment is intended to reduce the permeability of the surficial material to provide less

infiltration and increase runoff to the lined and drained portions of the slope. If lab testing shows the lime sludge is not sufficient as a singular amendment, or if the volume of lime sludge is insufficient, the addition of imported ground dolomitic limestone may be necessary.

- Fill and regrade Ponds 3 and 4; grade gypsum containment berms inwards thereby reducing the EGS height and creating a sloped top/crest to minimize future surface water ponding on the EGS. The changes in grade would account for anticipated future settlement of the stack to ensure proper post-closure drainage. Therefore, steeper grades will be planned where the stack is thickest.
- Required permeability following regrading would depend on the amount of compaction/densification of the upper, younger gypsum deposits. A compaction plan would be required to determine the required densification and amendments to ensure the planned maximum hydraulic conductivity.
- Swales, berms, and side slope drains would be constructed to provide the required conveyance of runoff to the interceptor ditch.
- Place 40 millimeter (mm) LLDPE linear low liner on the regraded EGS top/crest and on the four 30 ft wide benches sloping at 2% inwards. The geomembrane liner will prevent infiltration into the stack along the shallow sloped portions of the Site including the drainage ditches. Grades within the geomembrane-lined areas would be designed to promote drainage and minimize ponding.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the EGS top/crest and benches. The cover soil is intended to prevent uplift of the liner and ensure contact of the liner with the underlying material and provide a growth medium.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the four 20 ft high side slope (6H:1V) areas. The protective soil cover and topsoil would be constructed to minimize infiltration and promote runoff. Steeper grades are planned to increase runoff and provide for drainage as consolidation settlement occurs within the stack.
- Seed topsoil cover (top/crest/benches/side slopes). Some maintenance of the topsoil, erosion, seeding is expected at the end of construction to promote a strong self-sufficient cover.

Cost. Detailed cost estimate tables are presented in Appendix B. The costs developed and evaluated as part of this EE/CA include only capital costs to implement each alternative. O&M costs specific to the completed Removal Action will be evaluated as part of the future site-wide RI/FS process.

Included in Appendix B are general assumptions used to develop costs for each alternative. Summarized below are additional cost assumptions specific to Alternative 2A.

- Assumes construction in 2018.
- Alternative 2A cost assumes water in Ponds 3 and 4 is treated using the Emergency Bypass protocol and discharged to Bayou Casotte (125,000,000 gallons total at $0.0157 per gallon [rate from Kemron Environmental Services, 2017]). This cost would be lower if all or a portion of the water can be treated using the *in situ* plant or mechanical treatment plant.
- Costs do not include equipment mobilization/demobilization charges.
- The crest, benches, and side slopes of the EGS would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for

phosphogypsum stack closure in Florida (FAC, 1993). Soil on side slopes (where liner is not placed) would be amended with lime to raise pH and compacted to 10^{-7} cm/sec to reduce infiltration.

- Topsoil and clay soil for the protective cover are assumed to be sourced from an off-site location within 15 miles of the Site.
- Letdown piping to remove runoff from each bench was assumed to be installed in one location with the bench contoured to route drainage to this location.

Alternative 2A has an estimated construction cost of $26,741,887 and a total cost of $31,769,362. The total cost includes an 8% contractor fee and 10% contingency. More than half of the cost of this alternative ($17.0M) is to procure, haul, and place the protective clay soil and topsoil layers. The clay soil, which would be compacted on the side slopes of the EGS and is expected to have a higher cost than soil which would be used to protect surfaces with liners, comprises about $10.2M of the total soil cost.

5.2.2 Alternative 2B. Phase 1 – Complete LLDPE Liner

Under Alternative 2B, EGS Ponds 3 and 4 and the EGS side slopes would be closed by installing an LLDPE liner with a vegetated protective soil cover across the entire stack (flats and side slopes). Alternative 2B includes the following major work elements:

- Drain Ponds 3 and 4 and treat water at the *in situ* plant at Pond 6 or in accordance with the emergency bypass procedure to discharge off-site within a 30 day period prior to the commencement of earthwork operations.
- After draining Pond 4, remove lime sludge from Pond 4 and incorporate into the soil cover, with water treated at the Pond 6 *in situ* plant and discharging the water off-site.
- Regrade the stack within the limits of Ponds 3 and 4 with the intent to provide runoff with the anticipated settlement of the EGS. The grades may be steeper than those in Alternative 2A to ensure ponding does not occur over time.
- Place 40 mm LLDPE linear low liner on the regraded EGS top/crest and on the four 30 ft wide benches sloping at 2% inwards and on the four 20 ft high side slopes (6H:1V) areas.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded EGS top/crest, benches and side slopes. The protective soils will support vegetation growth and reduce the potential for erosion.
- Seed topsoil cover (top/crest, benches, side slopes).

Cost. Detailed cost estimate tables are presented in Appendix B. The costs developed and evaluated as part of this EE/CA include only capital costs to implement each alternative. O&M costs specific to the completed Removal Action will be evaluated as part of the future site-wide RI/FS process.

Regrading for placement of the geomembrane would require additional surface preparation for liner subgrade, particularly along steeper slopes. Although geomembrane is planned for the full cover, some infiltration through the liner is to be expected due to construction imperfections. The infiltration volume would be significantly less than that of the partial liner installed under Alternative 2A.

Included in Appendix B are general assumptions used to develop costs for each alternative. Summarized below are additional cost assumptions specific to Alternative 2B.

- Assumes construction in 2018.
- Alternative 2B cost assumes water in Ponds 3 and 4 is treated using the Emergency Bypass protocol and discharged to Bayou Casotte (125,000,000 gallons total at $0.0157 per gallon [rate from Kemron Environmental Services, 2017]). This cost would be lower if all or a portion of the water can be treated using the *in situ* plant or mechanical treatment plant.
- Costs do not include equipment mobilization/demobilization charges.
- The crest, benches, and side slopes of the EGS would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).
- Topsoil and clay soil for the protective cover are assumed to be sourced from an off-site location within 15 miles of the Site.
- Letdown piping to remove runoff from each bench was assumed to be installed in one location with the bench contoured to route drainage to this location.

Alternative 2B has an estimated construction cost of $26,411,109 and a total cost of $31,376,398. The total cost includes an 8% contractor fee and 10% contingency. More than half of the cost of this alternative ($13.7M) is to procure, haul, and place the protective clay soil and topsoil layers. Because the entirety of the pile is covered with the LLDPE liner in this alternative, soil costs are lower than estimated for Alternative 2A because clay soil with would not be required for the side slopes. The lower soil costs offset the cost of the additional liner material that would be installed.

5.3 PHASE 2

EPA developed 2 alternatives for the Phase 2 Removal Action. The area included in Phase 2 is depicted in Figures 5-2A and 5-2B. Phase 2 reduces the 380.5 acre initial EGS and WGS water contact area by an additional 90.3 acres or approximately 63% when combined with the Phase 1 actions (245.2 acres total reduction for Phases 1 and 2 combined).

5.3.1 Alternative 3A. Phase 2 – Pond 5 Closure with North Pond Excavation

Under Alternative 3A, Pond 5 at the EGS and the North Ponds at the WGS would be closed by excavating and removing the lime sludge from these facilities. Alternative 3A includes the following major work elements:

- Drain the EGS Pond 5 and treat water at the *in situ* plant at EGS Pond 6 or in accordance with the emergency bypass procedure to discharge off-site within a 30 day period prior to commencement of earthwork regrading operations.
- Excavate lime sludge from the WGS North Ponds and transport to a portion of the Pond 5 footprint area for incorporation into the soil cover layer. The use of lime sludge alone as an amendment or with additional components will require evaluation during design to ensure the planned surficial cover can achieve the design permeability.
- Backfill the North Ponds excavation will borrow soil.
- Grade the remaining portion of the EGS Pond 5 area and the WGS North Ponds area to provide surface drainage storage/storm water management.
- Place 40 mm LLDPE liner on the regraded EGS Pond 5 area.

- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded EGS Pond 5 area.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded WGS North Ponds area.
- Seed topsoil cover at the EGS Pond 5 and the WGS North Ponds areas.

Cost. Detailed cost estimate tables are presented in Appendix B. The costs developed and evaluated as part of this EE/CA include only capital costs to implement each alternative. O&M costs specific to the completed Removal Action will be evaluated as part of the future site-wide RI/FS process.

Regrading the Pond 5 area is anticipated to be more costly per cy due to the need to place greater amounts of material toward the center of each pond and ensure drainage toward the perimeter. The placement of geomembrane will not completely eliminate the infiltration into the existing gypsum materials. The potential for construction imperfections and manufacturer's defects are to be included in the infiltration estimate.

Included in Appendix B are general assumptions used to develop costs for each alternative. Summarized below are additional cost assumptions specific to Alternative 3A.

- Assumes construction in 2019.
- Alternative 3A cost assumes water in Pond 5 is treated using the Emergency Bypass protocol and discharged to Bayou Casotte (200,000,000 gallons total at $0.0157 per gallon [rate from Kemron Environmental Services, 2017]). This cost would be lower if all or a portion of the water can be treated using the *in situ* plant or mechanical treatment plant.
- Costs do not include equipment mobilization/demobilization charges.
- Alternative 3A assumes the entire Pond 5 footprint would be covered with a liner; this may not be necessary if the volume of phosphogypsum within the pond can be consolidated into a smaller area. The Pond 5 liner would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).
- Alternative 3A assumes the footprint of the North Ponds would be filled with clean soil following excavation of the lime sludge and graded.
- Topsoil and clay soil for the protective cover are assumed to be sourced from an off-site location within 15 miles of the Site.

Alternative 3A has an estimated construction cost of $39,572,349 and a total cost of $47,011,950. The total cost includes an 8% contractor fee and 10% contingency. This includes $21.8M to excavate lime sludge from the ponds and to backfill the excavations with soil fill and about $3.3M to transport the sludge and incorporate it into the Pond 5 soil cover.

5.3.2 Alternative 3B. Phase 2 - Pond 5 Closure with North Pond Capped in Place

Under Alternative 3B, lime sludge at Pond 5 at the EGS and the North Ponds at the WGS would be capped in place without excavation. Alternative 3B includes the following major work elements:

- Drain the EGS Pond 5 and treat water at the *in situ* plant at Pond 6 prior or in accordance with the emergency bypass procedure to discharge off-site within a 30 day period prior to commencement of earthwork regrading operations.
- Place a woven, reinforced geotextile separation layer over the lime sludge at the WGS North Ponds area.
- Grade the remaining portion of the EGS Pond 5 area to provide surface drainage storage/storm water management.
- Place 40 mm LLDPE liner on the regraded EGS Pond 5 area.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded EGS Pond 5 area.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded WGS North Ponds area.
- Seed topsoil cover at the EGS Pond 5 and the WGS North Ponds areas.

Cost. Detailed cost estimate tables are presented in Appendix B. The costs developed and evaluated as part of this EE/CA include only capital costs to implement each alternative. O&M costs specific to the completed Removal Action will be evaluated as part of the future site-wide RI/FS process.

Regrading the Pond 5 area is anticipated to be more costly per cy due to the need to place greater amounts of material toward the center of each pond and ensure drainage toward the perimeter. Grading of the pond areas would use low ground pressure equipment for the first passes of material movement above the geotextile. Planned slope for regrading would consider the underlying properties of the lime sludge due to the potential for sliding stability. The placement of geomembrane will not completely eliminate the infiltration into the underlying materials. The potential for construction imperfections and manufacturer's defects are to be included in the infiltration estimate.

Included in Appendix B are general assumptions used to develop costs for each alternative. Summarized below are additional cost assumptions specific to Alternative 3B.

- Assumes construction in 2019.
- Alternative 3B cost assumes water in Pond 5 is treated using the Emergency Bypass protocol and discharged to Bayou Casotte (200,000,000 gallons total at $0.0157 per gallon [rate from Kemron Environmental Services, 2017]). This cost would be lower if all or a portion of the water can be treated using the *in situ* plant or mechanical treatment plant.
- Costs do not include equipment mobilization/demobilization charges.
- Alternative 3B assumes the entire Pond 5 footprint would be covered with a liner; this may not be necessary if the volume of phosphogypsum within the pond can be consolidated into a smaller area. The Pond 5 liner would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).
- Alternative 3B assumes the North Ponds geotextile liner would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).

- Topsoil and clay soil for the protective cover are assumed to be sourced from an off-site location within 15 miles of the Site.

Alternative 3B has an estimated construction cost of $15,535,420 and a total cost of $18,456,080. The total cost includes an 8% contractor fee and 10% contingency. Placement of a reinforced geotextile liner and a protective soil cap across the ponds has an estimated cost of about $3.5M.

5.4 PHASE 3

EPA developed 1 alternative for the Phase 3 Removal Action. The area included in Phase 3 is depicted in Figure 5-3. Phase 3 reduces the initial EGS and WGS 380.5 acre water contact area by an additional 135.3 acres or by approximately 100% when combined with the Phase 1 and 2 actions.

5.4.1 Alternative 4. Phase 3 – Close Pond 6 and WRD

Under Alternative 4, Pond 6 and the WRD at the EGS would be capped in place and the French drain at the EGS would be connected to the mechanical water treatment plant. Alternative 4 includes the following work elements:

- Drain the EGS WRD and treat water either at the *in situ* plant at EGS Pond 6 or in accordance with the emergency bypass procedure to discharge off-site within a 30 day period prior to commencement of earthwork regrading operations.
- Connect the existing EGS leachate/French drain into a newly constructed EGS perimeter leachate collection system that will be connected to the existing mechanical water treatment plant for treatment and off-site discharge at diffuser Outfall 003.
- Grade the EGS WRD area to promote surface drainage.
- Place 40 mm LLDPE liner on the regraded EGS WRD area.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded EGS WRD area.
- Grade the EGS Pond 6 area to promote surface drainage.
- Place 40 mm LLDPE liner on the regraded EGS Pond 6 area.
- Place 18 inches of protective soil cover and 6 inches of topsoil on the regraded EGS Pond 6 area.
- Seed topsoil cover at EGS WRD and Pond 6 areas.

Cost. Detailed cost estimate tables are presented in Appendix B. The costs developed and evaluated as part of this EE/CA include only capital costs to implement each alternative. O&M costs specific to the completed Removal Action will be evaluated as part of the future site-wide RI/FS process.

Regrading the Pond 6 area is anticipated to be more costly per cy due to the need to place greater amounts of material toward the center of the pond and ensure drainage toward the perimeter. The placement of geomembrane will not completely eliminate the infiltration into the underlying materials. The potential for construction imperfections and manufacturer's defects are to be included in the infiltration estimate.

Included in Appendix B are general assumptions used to develop costs for each alternative. Summarized below are additional cost assumptions specific to Alternative 4.

- Assumes construction in 2020.
- Alternative 4 cost assumes water in the WRD is treated using the Emergency Bypass protocol and discharged to Bayou Casotte (130,000,000 gallons total at $0.0157 per gallon [rate from Kemron Environmental Services, 2017]). This cost would be lower if all or a portion of the water can be treated using the *in situ* plant or mechanical treatment plant.
- Costs do not include equipment mobilization/demobilization charges.
- Alternative 4 assumes the entire WRD footprint would be covered with a liner; this may not be necessary if the volume of phosphogypsum within the WRD can be consolidated into a smaller area. The WRD liner would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).
- Alternative 4 assumes the Pond 6 footprint would be covered with an 18 inch protective soil cover and 6 inches of top soil. The 24 inch protective cover is based on requirements for phosphogypsum stack closure in Florida (FAC, 1993).
- Topsoil and clay soil for the protective cover are assumed to be sourced from an off-site location within 15 miles of the Site.

Alternative 4 has an estimated construction cost of $18,325,287 and a total cost of $21,770,441. The total cost includes an 8% contractor fee and 10% contingency. Installation of the protective soil cover and top soil comprise about $10.1M of the construction cost.

6.0 Comparative Analysis of Removal Action Alternatives

The removal action alternatives presented in Section 5 are evaluated below using the criteria described in *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA, 1993) which are described below. Detailed capital costs are shown in Appendix B.

6.1 EVALUATION CRITERIA

The removal action alternative analysis, which assesses the performance of each alternative relative to effectiveness, implementability, and cost, supports selection of a preferred alternative. The criteria used in the Mississippi Phosphates Corp. site analysis are:

- Effectiveness
- Overall protection of public health, community, workers, and the environment
- Compliance with ARARs and other criteria
- Long-term effectiveness and permanence including the magnitude of residual risk remaining after implementation of the removal action and the adequacy/reliability of controls
- Reduction of toxicity, mobility, or volume (T/M/V) through treatment
- Short-term effectiveness including the effects that implementing the alternative would have on the community, workers, and the environment and an assessment of the time required to achieve the response objectives
- Implementability
- Technical feasibility of constructing and operating the response action and its contribution to the efficient performance of the anticipated overall removal action for the Site
- Administrative feasibility including compliance with the $2 million /12 month implementation statutory limits and requirements for off-site permits or waivers
- Availability of technology, equipment, personnel, and off-site treatment, storage, and disposal
- State (Support Agency) Acceptance
- Community Acceptance
- Cost
- Capital cost (i.e., the cost to implement)
- O&M costs
- Present worth costs (i.e., total lifetime cost of the project including capital and O&M costs represented in present year dollars)

An analysis of how each alternative would reduce, control, or eliminate the quantity of water requiring treatment to achieve the RAOs and overall site goal of long-term leachate management is presented in Table 6-1 and discussed below. Costs are summarized in Table 6-2 and presented in more detail in Appendix B.

This section compares and contrasts the removal action alternatives so that risk managers may select a preferred alternative. The relative rankings of the alternatives were subjectively determined based upon their concurrence with the evaluation criteria.

Each of the sub-criteria shown above was assigned a subjective ranking of 'poor', 'fair', 'average', 'good', or 'very good' against the context of the Site RAOs. Following the ranking, the subjective rankings were converted to numeric rankings (e.g., 'poor' is equal to 1; 'very good' is equal to 5). Sub-criteria scores were averaged to provide a score for each evaluation criterion; higher scores indicate better success or effectiveness at attaining the criterion's stated objective than lower scores. Subjective rankings are shown in Table 6-3.

6.2 ALTERNATIVE 1 – NO ACTION

6.2.1 Effectiveness

6.2.1.1 Overall Protection

EPA has been spending approximately $1,000,000 per month in 2017 to treat water at the Site. This is because every inch of rain falling on the EGS generates 9.1 Mgal of contaminated water that requires treatment prior to discharge. Excessive rainfall in 2017 has necessitated emergency discharges of water treated only by adjusting pH with sodium hydroxide to prevent overtopping or destabilization of containment berms. Because the EGS will remain uncovered, wind dispersion of phosphogypsum is expected to continue and the threat to the surrounding environment posed by failure or overtopping of containment dikes will remain.

Because the No Action alternative does not include any response actions, periodic releases of partly contaminated water would be expected to continue and the cost to treat water would remain high. Alternative 1 would not be protective of the environment and would not meet any of the four RAOs established in Section 3.1. Consequently, Alternative 1 is rated as 'poor' for overall protection.

6.2.1.2 Compliance with ARARs

Under Alternative 1, ARARs for the protection of surface water would continue to be met because water would continue to be treated by the mechanical and *in situ* treatment plants. ARARs regarding closure of the EGS landfill would not be met. Because this alternative does not include any response actions, location- and action-specific ARARs would not be applicable.

6.2.1.3 Long-Term Effectiveness and Permanence

Because Alternative 1 does not include any response actions, there would be no reduction in the volume of contaminated water generated at the Site and wind dispersion of phosphogypsum would continue. In addition, maintenance and repair of containment dikes would be ongoing. Protection of groundwater would continue to rely on the integrity of the slurry wall that encloses the EGS, the underdrain system which collects leachate, and the clay unit which underlies the EGS. Consequently, this alternative is not considered permanent. Under typical precipitation conditions (66.3 inches of annual rainfall minus 21.6 inches of annual evaporation for net precipitation of 44.7 inches annually), the EGS will continue to generate an estimated 461.8 Mgal of contact water requiring treatment. The present treatment system is effective at removing contaminants from water that is fully treated.

Alternative 1 is rated as 'poor' for long-term effectiveness and permanence due to continued generation of large volumes of water requiring treatment and on-going threats to the integrity of the water management system.

6.2.1.4 Reduction of Toxicity, Mobility, or Volume

There would be no reduction of contaminant T/M/V through treatment associated with this alternative above that which is currently achieved. Treatment of 461.8 Mgal of water annually will continue to generate significant quantities of lime sludge that need to be managed at the Site. Since there will be no reduction of T/M/V, Alternative 1 is rated as 'poor' for this sub-criterion.

6.2.1.5 Short-Term Effectiveness

Because there are no response actions to implement, there would be no associated short-term impacts to human health or the environment during implementation. Hence, Alternative 1 is rated as 'very good' for short-term effectiveness.

6.2.2 Implementability

6.2.2.1 Technical and Administrative Feasibility

Because there are no response actions to implement, there are no associated technical or administrative feasibility concerns to be addressed. Alternative 1 is easily implemented and is rated as 'very good' for technical and administrative feasibility.

6.2.2.2 Availability of Technology

There are no technologies or services associated with this alternative. Consequently, Alternative 1 is rated as 'very good' for this sub-criterion.

6.2.2.3 State and Community Acceptance

State and community acceptance will be evaluated following regulatory and public review of this document; however, because this alternative is not protective of HH&E, it is unlikely to meet the approval of the State and affected community. As such, Alternative 1 is rated as 'poor' for State and community acceptance.

6.2.3 Cost

There are no capital or O&M costs associated with the No Action alternative. The cost to treat 461.8 Mgal of contact water is estimated at $5.56 million per year based on the per gallon treatment cost of $0.012036 per gallon incurred at the Site in 2017 (Kemron Environmental Services, 2017). This cost, and the costs with water management and inspection and maintenance of containment dikes and berms, will continue to be incurred at the Site.

6.3 ALTERNATIVE 2A – PHASE 1 – PARTIAL LLDPE LINER AT THE EGS

6.3.1 Effectiveness

6.3.1.1 Overall Protection

Under Alternative 2A, the entirety of the EGS would be graded for drainage. An LLDPE liner would be installed across the top and on the benches of the EGS; side slopes would be covered with compacted soil. The entirety of the EGS would be covered with a vegetated soil cap.

The closure proposed under Alternative 2A is similar to the closure design of the WGS which was closed from 2002 to 2005. Based on experience from the WGS, this design is expected to be protective of HH&E and to result in a decreased production of leachate, elimination of wind dispersion of phosphogypsum, and a reduction in the potential for failure or overtopping of containment dikes that would permit contaminants to impact adjacent land and water including the Grand Bay NERR and Bayou Casotte. The underdrain system of the EGS will permit more complete draining of the facility and contouring of the pile is expected to promote long-term stability.

Because the phosphogypsum material will remain in place and because groundwater contained within the stack will be contained by the original slurry wall, underdrain system, and clay unit below the EGS, Alternative 2A is rated as ‘good’ for overall protectiveness.

6.3.1.2 Compliance with ARARs

Alternative 2A would comply with the ARARs identified in Table 3-1 including those regarding staging piles of excavated wastes (40 CFR § 264.554), capping wastes in place (40 CFR § 264.310(a)), on-site transport of wastes (40 CFR § 262.20(f), discharge of water from a treatment unit (40 CFR § 122.41 and § 122.44), and wastewater conveyance (40 CFR § 264.1(g)(6)).

6.3.1.3 Long-Term Effectiveness and Permanence

The volume of water draining from the EGS is expected to diminish following completion of the cap and it will continue to do so until an equilibrium state is reached. Capping the EGS will eliminate 154.9 acres from the present 380.5 acre footprint of the EGS and associated ponds. Precipitation runoff shed from the 154.9 acre cap will be of sufficient quality that it can be discharged to Bayou Casotte without treatment. On an average annual basis (net precipitation of 44.7 inches), this is expected to reduce the volume of water requiring treatment by about 180.7 Mgal/year[1].

The WGS has had issues related to slope instability due to being constructed atop the former location of the East Prong of Bayou Casotte. However, the EGS is not constructed over a former surface water pathway. Combined with the underdrain system and contouring of the pile, these factors are expected to impart stability over the long term.

The WGS has had issues related to material compaction over time and resulting in precipitation runoff ponding atop the liner on the crest of the stack. Settlement following capping also is anticipated at the

[1] Although removal of 154.9 contact acres from the water budget would remove 188.0 Mgal of contaminated water from treatment annually; an estimated 7.3 Mgal of leachate would continue to be released from the EGS. This leachate is applied to the water balance for all construction phases.

EGS as water drains from the facility. Changes in overburden pressure with time due to lower groundwater elevations will cause the stack to settle/consolidate over time. Table 6-4 presents a preliminary analysis of a Stability Monitoring Program Report for the EGS (URS, 2013). The predicted 27 +/- ft of settlement at the crest of the EGS is consistent with the observed settlement estimated at 30 ft at the WGS over the past 10 to 15 years. Potential consolidation issues could be mitigated during detailed design of the cap.

Similar to Alternative 1 (No Action), protection of groundwater surrounding the EGS would continue to rely on the integrity of the slurry wall that encloses the EGS, the underdrain system which collects leachate, and the clay unit which underlies the EGS. Implementation of Alternative 2A will reduce the volume of shallow groundwater contained within the stack and decrease stress placed on these management systems.

Due to the many positive aspects associated with Alternative 2A, it is rated as 'good' for long-term effectiveness and permanence.

6.3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of Alternative 2A would retain phosphogypsum solids in their present location but would eliminate most or all contact between the solids and precipitation infiltration and surface runoff. This would reduce the volume of contact water requiring treatment by an estimated 180.7 Mgal/year (based on net annual rainfall of 44.7 in/year). This is a 39.1% reduction in the volume of water that would require treatment under Alternative 1 (No Action). Because it will no longer contact phosphogypsum solids or contaminated water in retention ponds and ditches, precipitation runoff from the capped area is expected to have a quality suitable for discharge to Bayou Casotte without treatment.

Reducing the volume of contact water will place less stress on the water management and treatment system. This will decrease the possibility that emergency bypasses would be needed to prevent undue pressure on containment dikes and the potential for uncontrolled releases of contaminants should the dikes fail or be overtopped.

Alternative 2A will not remove the phosphogypsum stack. However, it will eliminate most all contact of precipitation with the phosphogypsum solids and will result in a 39% reduction in the volume of contaminated water that must be collected, stored, managed, and treated. Consequently, Alternative 2A is rated as 'good' for reduction in T/M/V.

6.3.1.5 Short-Term Effectiveness

Grading and contouring of the EGS could create phosphogypsum dust that could affect properties surrounding the construction site. Water sprays and other dust suppression actions would mitigate this issue. Dust issues would potentially occur until the LLDPE or soil cap have been placed. Potential inhalation hazards to on-site workers could be mitigated by personal protective equipment (PPE) as prescribed by a site health and safety plan.

Construction of the cap would increase truck traffic on roads adjacent to the property. These would include trucks hauling the LLDPE liner material, those bringing borrow soil to the Site to be compacted on the side slopes of the facility and to provide a soil cover over the entire capped area, as well as piping and other construction materials and equipment. The soil cover alone requires an estimated 27,050 truck trips to haul the 541,000 yards of soil that are required. This could potentially degrade air quality, increase traffic congestion near the Site and on roads in and around the City of Pascagoula, and promote wear and tear on local highways. Traffic effects would continue until Phase 1 construction is completed which is expected to take one construction year.

As a first step in implementing Alternative 2A, Ponds 3 and 4 atop the EGS will be drained. Depending on the volume of water in the ponds and the amount of precipitation received in the months leading up to the onset of construction, this water may be partly treated and released to Bayou Casotte in accordance with EPA's emergency bypass procedure. Depending on the level of treatment, this could increase the mass of ammonia-nitrogen and total phosphorus released to Bayou Casotte. To some extent, increased load could be mitigated by releasing water during a falling tide which would assist in removing the contaminant mass from the Bayou. Any effects from an emergency bypass would occur at the onset of the project and occur over a period of a few days to a few weeks depending on the volume of water.

Construction of the cap could potentially provide employment to local workers with the appropriate skills and would provide those benefits through the life of the job.

Due to the numerous short-term effects noted above, Alternative 2A is rated as 'average' for short-term effectiveness.

6.3.2 Implementability

6.3.2.1 Technical and Administrative Feasibility

Caps and covers such as that proposed under Alternative 2A are widely used to close phosphogypsum stacks in Florida and other states as well as municipal and other types of landfills. Consequently, the technology is well developed and can be easily implemented. Nevertheless, closure of a 155 acre area is a significant construction project that will require the appropriate equipment, services, and labor to ensure its timely completion.

Work conducted under CERCLA is required to meet the substantive requirements of applicable permits although permits themselves may not be required. Water discharged from the Site in preparation for implementation of Alternative 2A and from the cap following construction would be required to meet the discharge limits specified in the most recent NPDES permit issued to MPC (this permit has been cancelled but EPA continues to conduct the monitoring requirements specified in the permit and to meet discharge limitations set forth therein). The EGS was not permitted by the State of Mississippi and there are no known State requirements specific to closure of phosphogypsum stacks.

Implementation of Alternative 2A would require a waiver of the $2 million/12 month statutory limit on removal actions.

Alternative 2A is rated as 'very good' for technical and administrative implementability.

6.3.2.2 Availability of Technology

Alternative 2A can be implemented using standard construction equipment and technologies that are widely available in the Gulf Coast area. Achieving sufficient soil compaction to limit infiltration on the side slopes of the EGS will require soil with a high clay content. This may be difficult to find in sufficient quantities in a coastal area dominated by sandy deposits and could require multiple borrow sources to complete the project. Although there are no special technologies required and labor is anticipated to be available in the area, Alternative 2A is rated as 'good' due to potential issues related to identifying nearby clay borrow sources.

6.3.2.3 State and Community Acceptance

State and community acceptance cannot be fully evaluated following a public meeting and comment period. However, it is anticipated that Alternative 2A would be accepted by stakeholders since it would provide numerous benefits to the community.

6.3.3 Cost

A detailed table of costs for Alternative 2A is included in Appendix B. The cost to construct Alternative 2A is $26,741,887 with a total cost for the alternative estimated at $31,769,362 (includes 8% contractor fee and 10% contingency). Construction costs include draining and treating water in Ponds 3 and 4, removing lime sludge from Pond 4, grading the EGS, covering the crest and benches with LLDPE liner and a protective soil cover, covering the side slopes with a compacted clay soil cover, covering the entirely of the EGS with topsoil, seeding the topsoil cover, installing drainage piping, and erosion control. The majority of the construction cost ($17.0M; 64%) is the cost to haul, place, compact, and grade the protective soil and topsoil cover. Placement of 2,724,000 square feet (sq ft) of LLDPE liner comprises 6.7% of the construction cost ($1.8M). Treatment of water in Ponds 3 and 4 is assumed to occur via EPA's bypass protocol ($0.0157/gal).

6.4 REMOVAL ACTION ALTERNATIVE 2B – COMPLETE LLDPE LINER AT THE EGS

6.4.1 Effectiveness

6.4.1.1 Overall Protection

Under Alternative 2B, the entirety of the EGS would be graded for drainage, an LLDPE liner would be installed across the entirety of the EGS, including side slopes, and the liner would be covered with a vegetated soil cap.

This design is expected to be protective of HH&E and to result in a decreased production of leachate, elimination of wind dispersion of phosphogypsum, and a reduction in the potential for failure or overtopping of containment dikes that would permit contaminants to impact adjacent land and water including the Grand Bay NERR and Bayou Casotte. The underdrain system of the EGS will permit more complete draining of the facility and contouring of the pile is expected to promote long-term stability.

Because the phosphogypsum material will remain in place and because groundwater contained within the stack will be contained by the original slurry wall, underdrain system, and clay unit below the EGS, Alternative 2A is rated as 'good' for overall protectiveness.

6.4.1.2 Compliance with ARARs

Alternative 2B would comply with the ARARs identified in Table 3-1 including those regarding staging piles of excavated wastes (40 CFR § 264.554), capping wastes in place (40 CFR § 264.310(a)), on-site transport of wastes (40 CFR § 262.20(f), discharge of water from a treatment unit (40 CFR § 122.41 and § 122.44), and wastewater conveyance (40 CFR § 264.1(g)(6)).

6.4.1.3 Long-Term Effectiveness and Permanence

The volume of water draining from the EGS is expected to diminish following completion of the LLDPE cover and soil cap and it will continue to do so until an equilibrium state is reached. The volume of water infiltrating to the stack is expected to be significantly less than that under Alternative 2A. Similar to Alternative 2A, capping the EGS will eliminate 154.9 acres from the water balance, thereby reducing the volume of water requiring treatment by about 180.7 Mgal/year. Precipitation runoff shed from the cap will be of sufficient quality that it can be discharged to Bayou Casotte without treatment.

As discussed under Alternative 2A, the existing underdrain system and contouring of the pile as part of implementing the alternative are expected to impart stability over the long term. Settlement following capping also is anticipated at the EGS as water drains from the facility. Preliminary estimates of the amount of settlement are shown in Table 6-4 (URS, 2013). Potential consolidation issues could be mitigated during detailed design of the cap.

Similar to Alternative 1 (No Action), protection of groundwater surrounding the EGS would continue to rely on the integrity of the slurry wall that encloses the EGS, the underdrain system which collects leachate, and the clay unit which underlies the EGS. Implementation of Alternative 2B will reduce the volume of shallow groundwater contained within the stack and decrease stress placed on these management systems.

Due to the many positive aspects associated with Alternative 2B, it is rated as 'good' for long-term effectiveness and permanence.

6.4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

As described under Alternative 2A, implementation of Alternative 2B would retain phosphogypsum solids in their present location but would mostly eliminate contact between the solids and precipitation infiltration and surface runoff. This would reduce the volume of contact water requiring treatment by an estimated by 39% relative to Alternative 1 (No Action). Because it will no longer contact phosphogypsum solids or contaminated water in retention ponds and ditches, precipitation runoff from the capped area will have a quality suitable for discharge to Bayou Casotte without treatment.

Reducing the volume of contact water will place less stress on the water management and treatment system and decrease the need for emergency bypasses and uncontrolled releases of contaminants.

Alternative 2B will not remove the phosphogypsum stack. However, it will eliminate most all contact of precipitation with the phosphogypsum solids and will result in a 39% reduction in the volume of contaminated water that must be collected, stored, managed, and treated. Consequently, Alternative 2B is rated as 'good' for reduction in T/M/V.

6.4.1.5 Short-Term Effectiveness

As described under Alternative 2A, grading and contouring of the EGS could create phosphogypsum dust that could affect on-site workers and properties surrounding the construction site. Use of PPE, water sprays and other dust suppression actions would mitigate these issues. Dust issues would potentially occur until the LLDPE or soil cap have been placed.

Similar to Alternative 2A, construction of the cap would create a significant increase in truck traffic on road adjacent to the property; the anticipated number of truck trips for Alternative 2B is similar to that estimated for Alternative 2A. Increased traffic could potentially degrade air quality, increase traffic congestion near the Site and on roads in and around the City of Pascagoula, and promote wear and tear on local highways. Traffic effects would continue until Phase 1 construction is completed which is expected to take one year.

As described under Alternative 2A, Ponds 3 and 4 atop the EGS will be drained prior to Phase 1 construction. Some or all of this water may be partly treated and released to Bayou Casotte in accordance with EPA's emergency bypass procedure. Depending on the level of treatment, this could increase the mass of ammonia-nitrogen and total phosphorus released to Bayou Casotte. To some extent, these could be mitigated by releasing water during a falling tide which would help to flush contaminants out of the Bayou. Any effects from an emergency bypass would occur at the onset of the project and occur over a period of a few days to a few weeks depending on the volume of water.

Construction of the cap could potentially provide employment to local workers with the appropriate skills and would provide those benefits through the life of the job.

Due to the numerous short-term effects noted above, Alternative 2B is rated as 'average' for short-term effectiveness.

6.4.2 Implementability

6.4.2.1 Technical and Administrative Feasibility

Caps and covers such as that proposed under Alternative 2B are widely used to close phosphogypsum stacks in Florida and other states as well as municipal and other types of landfills. Consequently, the technology is well developed and can be easily implemented. Nevertheless, closure of a 155 acre area is a significant construction project that will require the appropriate equipment, services, and labor to ensure its timely completion.

Work conducted under CERCLA is required to meet the substantive requirements of applicable permits although permits themselves may not be required. Water discharged from the Site in preparation for implementation of Alternative 2B and from the cap following construction would be required to meet the discharge limits specified in the most recent NPDES permit issued to MPC (this permit has been cancelled but EPA continues to conduct the monitoring requirements specified in the permit and to meet discharge limitations set forth therein). The EGS was not permitted by the State of Mississippi and there are no known State requirements specific to closure of phosphogypsum stacks.

Implementation of Alternative 2B would require a waiver of the $2 million/12 month statutory limit on removal actions.

Alternative 2B is rated as 'very good' for technical and administrative implementability.

6.4.2.2 Availability of Technology

Alternative 2B can be implemented using standard construction equipment and technologies that are widely available in the Gulf Coast area. Insofar as there are no special technologies required and labor is anticipated to be available in the area, Alternative 2B is rated as 'very good' for availability of technology.

6.4.2.3 State and Community Acceptance

State and community acceptance cannot be fully evaluated following a public meeting and comment period. However, it is anticipated that Alternative 2A would be accepted by stakeholders since it would provide numerous benefits to the community.

6.4.3 Cost

A detailed table of costs for Alternative 2B is included in Appendix B. The cost to construct Alternative 2B is $26,411,109 with a total cost for the alternative estimated at $31,376,398 (includes 8% contractor fee and 10% contingency). Construction costs include draining and treating water in Ponds 3 and 4, removing lime sludge from Pond 4, grading the EGS, covering the crest, benches, and side slopes of the EGS with LLDPE liner and a protective soil cover, covering the entirely of the EGS with topsoil, seeding the topsoil cover, installing drainage piping, and erosion control. The majority of the construction cost ($13.7M; 52%) is the cost to haul, place, compact, and grade the protective soil and topsoil cover. Placement of 7,304,000 sq ft of LLDPE liner comprises 18% of the construction cost ($4.7M). Treatment of water in Ponds 3 and 4 is assumed to occur via EPA's bypass protocol ($0.0157/gal).

6.5 REMOVAL ACTION ALTERNATIVE 3A – POND 5 CLOSURE WITH EXCAVATION OF THE NORTH PONDS

6.5.1 Effectiveness

6.5.1.1 Overall Protection

Under Alternative 3A, contaminated water would be drained from Pond 5 and treated prior to discharge, the footprint of Pond 5 would be graded to provide surface drainage and, as needed, storm water management, and the area would be covered with an LLDPE liner and vegetated soil cap. In addition, approximately 728,000 cy of lime sludge would be excavated from the North Ponds and incorporated into the soil cover layer at Pond 5, the footprint of the North Ponds would be backfilled with about 728,000 cy of clean soil, graded for surface drainage, and the area would be covered with an LLDPE liner and vegetated soil cap.

This design is expected to be protective of HH&E and to result in a decreased exposure to contaminated water and a reduction in the potential for failure or overtopping of containment dikes that would permit contaminants to impact adjacent land and water including the Grand Bay NERR and Bayou Casotte.

Alternative 3A is rated as 'very good' for overall protectiveness.

6.5.1.2 Compliance with ARARs

Alternative 3A would comply with the ARARs identified in Table 3-1 including those regarding staging piles of excavated wastes (40 CFR § 264.554), capping wastes in place (40 CFR § 264.310(a)), closure of impoundments with waste in place (40 CFR § 264.228(a)(2), on-site transport of wastes (40 CFR § 262.20(f), discharge of water from a treatment unit (40 CFR § 122.41 and § 122.44), and wastewater conveyance (40 CFR § 264.1(g)(6)).

6.5.1.3 Long-term Effectiveness and Permanence

Treatment and discharge of contaminated water in Pond 5 will eliminate an estimated 200 Mgal of contaminated water from the Site and remove 90.3 acres from the water balance, thereby reducing the volume of water requiring treatment by about 109.6 Mgal/year. Precipitation runoff shed from the cap will be of sufficient quality that it can be discharged to Bayou Casotte without treatment.

Most water contained in the North Ponds remains following their use for *in situ* treatment. It is anticipated that this water will be discharged to Bayou Casotte without treatment. Removal of lime sludge and incorporation into the Pond 5 soil cover will disperse and stabilize this fine-grained material so it is no longer subject to erosion.

Due to the many positive aspects associated with Alternative 3A, it is rated as 'very good' for long-term effectiveness and permanence.

6.5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of Alternative 3A would remove an estimated 200 Mgal of contaminated water from storage on site. Installation of the cap would further remove 90 acres of contact area from the Site water balance, permitting an additional 109.6 Mgal of water to be discharged without treatment. Combined with Phase 1 closure of the EGS, this would reduce the volume of contact water requiring treatment by an estimated by 62.9% relative to Alternative 1 (No Action). Because it will no longer contact contaminated water in retention ponds and ditches, precipitation runoff from the capped area will have a quality suitable for discharge to Bayou Casotte without treatment.

Reducing the volume of contact water will place less stress on the water management and treatment system and decrease the need for emergency bypasses and uncontrolled releases of contaminants. Consequently, Alternative 3A is rated as 'very good' for reduction in T/M/V.

6.5.1.5 Short-term Effectiveness

Excavation of lime sludge from the North Ponds and its incorporation into the Pond 5 soil cap may create fine-grained dust that could affect on-site workers and properties surrounding the construction site. Use of PPE, water sprays and other dust suppression actions would mitigate these issues. Dust issues would potentially occur until the LLDPE or soil cap have been placed.

Construction of the cap would increase truck traffic on road adjacent to the property. These would include trucks hauling the LLDPE liner material, those hauling excavated lime sludge from the North Ponds to the Pond 5 area, and those bringing borrow soil to the Site to be backfilled into the North Ponds and to provide a soil cover over the entire capped area of the North Ponds and Pond 5, as well as piping and other construction materials and equipment. Transport of 728,000 cy of lime sludge would require 36,400 truck trips plus an equivalent number to haul in soil backfill from off-site; the soil cover would require an estimated 12,150 truck trips to haul the 243,000 yards of soil that are required. Trips to haul excavated sludge would be short and would have little impact on traffic in the Site area. In general, truck traffic could potentially degrade air quality, increase traffic congestion near the Site and on roads in and around the City of Pascagoula, and promote wear and tear on local highways. Traffic effects would continue until Phase 2 construction is completed, estimated to be one year.

Pond 5 will be drained prior to Phase 2 construction. Some or all of this water may be partly treated and released to Bayou Casotte in accordance with EPA's emergency bypass procedure. Depending on the level of treatment, this could increase the mass of ammonia-nitrogen and total phosphorus released to Bayou Casotte. To some extent, this could be mitigated by releasing water during a falling tide which would help to flush contaminants from the Bayou. Any effects from an emergency bypass would occur at the onset of the project and occur over a period of a few days to a few weeks depending on the volume of water. Water contained in the North Ponds is not anticipated to require treatment prior to discharge since it is water generated by *in situ* treatment. Sampling of the North Ponds would be conducted prior to discharge to ensure protectiveness.

Removal of Pond 5 will decrease the ability to store contaminated water on site. For the period of time between the onset of construction and installation of the liner and cap, the Site will have a diminished capacity to store contaminated water in the event one or more large rain events occur. This could increase the potential that EPA would need to discharge partly treated water to Bayou Casotte under EPA's emergency bypass protocol which, in turn, could potentially increase the loads of ammonia-nitrogen and phosphorus released to the Bayou as described above.

Construction of the cap could potentially provide employment to local workers with the appropriate skills and would provide those benefits through the life of the job.

Alternative 3A is rated as 'fair' for short-term effectiveness.

6.5.2 Implementability

Caps and covers such as that proposed under Alternative 3A are widely used to close phosphogypsum stacks in Florida and other states as well as municipal and other types of landfills. Consequently, the technology is well developed and can be easily implemented. Nevertheless, closure of a 90 acre area is a significant construction project that will require the appropriate equipment, services, and labor to ensure its timely completion.

Work conducted under CERCLA is required to meet the substantive requirements of applicable permits although permits themselves may not be required. Water discharged from the Site in preparation for implementation of Alternative 3A and from the cap following construction would be required to meet the discharge limits specified in the most recent NPDES permit issued to MPC (this permit has been cancelled but EPA continues to conduct the monitoring requirements specified in the permit and to meet discharge limitations set forth therein).

Implementation of Alternative 3A would require a waiver of the $2 million/12 month statutory limit on removal actions.

Alternative 3A is rated as ‘very good’ for technical and administrative implementability.

6.5.2.1 Availability of Technology

Alternative 3A can be implemented using standard construction equipment and technologies that are widely available in the Gulf Coast area. Implementation would require a significant source of borrow soil in addition to that needed to implement Phase 1 construction. Insofar as there are no special technologies required and labor is anticipated to be available in the area, Alternative 3A is rated as ‘very good’ for availability of technology.

6.5.2.2 State and Community Acceptance

State and community acceptance cannot be fully evaluated following a public meeting and comment period. However, it is anticipated that Alternative 3A would be accepted by stakeholders since it would provide numerous benefits to the community.

6.5.3 Cost

A detailed table of costs for Alternative 3A is included in Appendix B. The cost to construct Alternative 3A is $39,752,349 with a total cost for the alternative estimated at $47,011,950 (includes 8% contractor fee and 10% contingency). Construction costs include draining and treating water in Pond 5, removing lime sludge from the North Ponds and transporting to Pond 5, backfilling the North Pond excavation and grading for drainage, covering the North Pond backfill with a protective soil cover and topsoil, incorporating lime sludge into the Pond 5 soil cover, placing LLDPE liner across the Pond 5 footprint, placing a protective soil cover and topsoil across the Pond 5 liner, seeding topsoil at Pond 5 and the North Ponds, and erosion control. The majority of the construction cost ($22.2M; 56%) is the cost to excavate and transport lime sludge from the North Ponds and to backfill the excavation. Placement of 2,626,688 sq ft of LLDPE liner at Pond 5 comprises 4.3% of the construction cost ($1.7M). Treatment of water in Pond 5 is assumed to occur via EPA’s bypass protocol ($0.0157/gal).

6.6 REMOVAL ACTION ALTERNATIVE 3B – POND 5 CLOSURE WITH *IN SITU* CAPPING OF THE NORTH PONDS

6.6.1 Effectiveness

6.6.1.1 Overall Protection

Under Alternative 3B, Pond 5 would be closed as described in Alternative 3A. Lime sludge contained within the North Ponds would be capped in place without excavation. The North Ponds would be covered with a reinforced geotextile liner, covered with a vegetated soil cap, and graded for surface drainage.

This design is expected to be protective of HH&E and to result in a decreased exposure to contaminated water and a reduction in the potential for failure or overtopping of containment dikes that would permit contaminants to impact adjacent land and water including the Grand Bay NERR and Bayou Casotte.

Alternative 3B is rated as ‘good’ for overall protectiveness.

6.6.1.2 Compliance with ARARs

Alternative 3B would comply with the ARARs identified in Table 3-1 including those regarding staging piles of excavated wastes (40 CFR § 264.554), capping wastes in place (40 CFR § 264.310(a)), closure of impoundments with waste in place (40 CFR § 264.228(a)(2), on-site transport of wastes (40 CFR § 262.20(f), discharge of water from a treatment unit (40 CFR § 122.41 and § 122.44), and wastewater conveyance (40 CFR § 264.1(g)(6)).

6.6.1.3 Long-term Effectiveness and Permanence

Similar to Alternative 3A, treatment and discharge of contaminated water in Pond 5 will eliminate an estimated 200 Mgal of contaminated water from the Site and remove 90.3 acres from the water balance, thereby reducing the volume of water requiring treatment by about 109.6 Mgal/year. Precipitation runoff shed from the cap will be of sufficient quality that it can be discharged to Bayou Casotte without treatment.

Most water contained in the North Ponds remains following their use for *in situ* treatment. It is anticipated that this water will be discharged to Bayou Casotte without treatment. Because lime sludge within the North Ponds will be capped in place, this material would be subject to erosion if the soil cover and underlying reinforced geotextile liner are not maintained.

Due to the many positive aspects associated with Alternative 3B, it is rated as ‘very good’ for long-term effectiveness and permanence.

6.6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Lime sludge formed by *in situ* treatment of contaminated water would remain in place within the North Ponds under Alternative 3B. Placement of a geotextile liner and soil cap will limit erosion of this material reducing its mobility as long as the cap is maintained.

As described under Alternative 3A, implementation of Alternative 3B would remove an estimated 200 Mgal of contaminated water from storage on site while installation of the cap would remove 90 acres of contact area from the Site water balance and reduce the volume of contact water requiring treatment by an estimated by 62.9% annually relative to Alternative 1 (No Action). Precipitation runoff from the capped area will have a quality suitable for discharge to Bayou Casotte without treatment.

Reducing the volume of contact water will place less stress on the water management and treatment system and decrease the need for emergency bypasses and uncontrolled releases of contaminants. Consequently, Alternative 3B is rated as ‘very good’ for reduction in T/M/V.

6.6.1.5 Short-term Effectiveness

Construction of the Pond 5 and North Ponds soil caps would increase truck traffic on road adjacent to the property as described under Alternative 3A; however, truck trips would be substantially fewer since lime sludge would not be excavated and removed and borrow soil to back fill the ponds would not have to be hauled to the Site. Increased construction-related traffic could potentially degrade air quality, increase traffic congestion near the Site and on roads in and around the City of Pascagoula, and promote wear and tear on local highways. Traffic effects would continue until Phase 2 construction is completed, estimated to be one year.

Partial treatment of Pond 5 water using EPA's emergency bypass procedure potentially could increase the mass of ammonia-nitrogen and total phosphorus released to Bayou Casotte. To some extent, this could be mitigated by releasing water during a falling tide and minimizing the volume of water discharged under this treatment protocol. Any effects from an emergency bypass would occur at the onset of the project and occur over a period of a few days to a few weeks depending on the volume of water. Water contained in the North Ponds is not anticipated to require treatment prior to discharge since it is water generated by *in situ* treatment. Sampling of the North Ponds would be conducted prior to discharge to ensure protectiveness.

Removal of Pond 5 will decrease the ability to store contaminated water on site. For the period of time between the onset of construction and installation of the liner and cap, the Site will have a diminished capacity to store contaminated water in the event one or more large rain events occur. This could increase the potential that EPA would need to discharge partly treated water to Bayou Casotte under EPA's emergency bypass protocol which, in turn, could potentially increase the loads of ammonia-nitrogen and phosphorus released to the Bayou as described above.

Construction of the cap could potentially provide employment to local workers with the appropriate skills and would provide those benefits through the life of the job.

Alternative 3B is rated as 'good' for short-term effectiveness.

6.6.2 Implementability

Caps and covers such as that proposed under Alternative 3B are widely used to close phosphogypsum stacks in Florida and other states as well as municipal and other types of landfills. Consequently, the technology is well developed and can be easily implemented. Nevertheless, closure of a 90 acre area is a significant construction project that will require the appropriate equipment, services, and labor to ensure its timely completion.

Work conducted under CERCLA is required to meet the substantive requirements of applicable permits although permits themselves may not be required. Water discharged from the Site in preparation for implementation of Alternative 3B and from the cap following construction would be required to meet the discharge limits specified in the most recent NPDES permit issued to MPC (this permit has been cancelled but EPA continues to conduct the monitoring requirements specified in the permit and to meet discharge limitations set forth therein).

Implementation of Alternative 3B would require a waiver of the $2 million/12 month statutory limit on removal actions.

Alternative 3B is rated as 'very good' for technical and administrative implementability.

6.6.2.1 Availability of Technology

Alternative 3B can be implemented using standard construction equipment and technologies that are widely available in the Gulf Coast area. Implementation would require a significant source of borrow soil in addition to that needed to implement Phase 1 construction. Insofar as there are no special technologies required and labor is anticipated to be available in the area, Alternative 3B is rated as 'very good' for availability of technology.

6.6.2.2 State and Community Acceptance

State and community acceptance cannot be fully evaluated following a public meeting and comment period. However, it is anticipated that Alternative 3B would be accepted by stakeholders since it would provide numerous benefits to the community.

6.6.3 Cost

A detailed table of costs for Alternative 3B is included in Appendix B. The cost to construct Alternative 3B is $15,535,420 with a total cost for the alternative estimated at $18,456,080 (includes 8% contractor fee and 10% contingency). Construction costs include draining and treating water in Pond 5, placing a reinforced geotextile liner over the lime sludge in the North Ponds, covering the geotextile with a protective soil cover and topsoil, placing LLDPE liner across the Pond 5 footprint, placing a protective soil cover and topsoil across the Pond 5 liner, seeding topsoil at Pond 5 and the North Ponds, and erosion control. Placement of 2,626,688 sq ft of LLDPE liner at Pond 5 comprises 11% of the construction cost ($1.7M) while placement of 1,306,800 sq ft of geotextile at the North Ponds comprises 3.8% of the construction cost ($588K). The majority of the cost to construct Alternative 3B is the cost to haul, place, and grade the protective soil and topsoil covers at the North Ponds and Pond 6 ($7.9M; 51%). Treatment of water in Pond 5 is assumed to occur via EPA's bypass protocol ($0.0157/gal).

6.7 REMOVAL ACTION ALTERNATIVE 4 – CLOSURE OF POND 6 AND THE WATER RETURN DITCH

6.7.1 Effectiveness

6.7.1.1 Overall Protection

Under Alternative 4, contaminated water would be drained from Pond 6 and the WRD and treated prior to discharge, the EGS underdrain system would be connected to the mechanical treatment plant, the footprints of Pond 6 and the WRD would be graded to provide surface drainage and, as needed, storm water management. The area of the WRD would be covered with an LLDPE liner and vegetated soil cap; the area of Pond 6 would be covered only with a vegetated soil cap. In addition, lime sludge would be excavated from Pond 6 and incorporated into the soil cover layer.

This design is expected to be protective of HH&E and to result in a decreased exposure to contaminated water and a reduction in the potential for failure or overtopping of containment dikes that would permit contaminants to impact adjacent land and water including the Grand Bay NERR and Bayou Casotte.

Alternative 4 is rated as 'very good' for overall protectiveness.

6.7.1.2 Compliance with ARARs

Alternative 4 would comply with the ARARs identified in Table 3-1 including those regarding staging piles of excavated wastes (40 CFR § 264.554), capping wastes in place (40 CFR § 264.310(a)), closure of impoundments with waste in place (40 CFR § 264.228(a)(2), on-site transport of wastes (40 CFR § 262.20(f), discharge of water from a treatment unit (40 CFR § 122.41 and § 122.44), and wastewater conveyance (40 CFR § 264.1(g)(6)).

6.7.1.3 Long-term Effectiveness and Permanence

Treatment and discharge of contaminated water in Pond 6 and the WRD will eliminate the remaining 150 Mgal of contaminated water stored on site and remove 135.3 acres from the water balance, thereby reducing the volume of water requiring treatment by about 164.2 Mgal/year. Precipitation runoff shed from the capped areas will be of sufficient quality that it can be discharged to Bayou Casotte without treatment. Following completion of Phase 3 an estimated 7.3 Mgal of leachate from the EGS will continue to require treatment; this water will be piped from the underdrain to the mechanical treatment plant.

Most water contained in the Pond 6 portion of the WRD was treated via the *in situ* plant. It is anticipated that this water will be discharged to Bayou Casotte without treatment. Removal of lime sludge and incorporation into the Pond 6 soil cover will disperse and stabilize this fine-grained material so it is no longer subject to erosion.

Alternative 4 is rated as 'very good' for long-term effectiveness and permanence.

6.7.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of Alternative 4 would remove an estimated 150 Mgal of contaminated water from storage on site and would permanently eliminate storage of contaminated water in open ponds at the EGS. Installation of the cap would further remove 135.3 acres of contact area from the Site water balance, permitting an additional 164.2 Mgal of water to be discharged without treatment annually. Combined with Phases 1 and 2 closure of the EGS, this would reduce the volume of contact water requiring treatment by an estimated by 98.4% relative to Alternative 1 (No Action). Because it will no longer contact contaminated water in retention ponds and ditches, precipitation runoff from the capped area will have a quality suitable for discharge to Bayou Casotte without treatment.

Eliminating storage of contaminated contact water at the EGS will remove stress on the water management and treatment system and eliminate the need for emergency bypasses and uncontrolled releases of contaminants except under the most extreme precipitation circumstances. Consequently, Alternative 4 is rated as 'very good' for reduction in T/M/V.

6.7.1.5 Short-term Effectiveness

Excavation of lime sludge from the Pond 6 WRD and its incorporation into the Pond 6 soil cap may create fine-grained dust that could affect on-site workers and properties surrounding the construction site. Use of PPE, water sprays and other dust suppression actions would mitigate these issues. Dust issues would potentially occur until the LLDPE or soil cap have been placed.

Construction of the caps would increase truck traffic on road adjacent to the property. These would include trucks hauling the LLDPE liner material, those bringing borrow soil to the Site to be compacted on the side slopes of the facility and to provide a soil cover over the entire capped area, as well as piping and other construction materials and equipment. The soil cover alone requires an estimated 20,000 truck trips to haul the 400,000 yards of soil that are required. This could potentially degrade air quality, increase traffic congestion near the Site and on roads in and around the City of Pascagoula, and promote wear and tear on local highways. Traffic effects would continue until Phase 3 construction is completed, estimated to be one year.

Pond 6 and the WRD will be drained prior to Phase 3 construction. Some or all of this water may be partly treated and released to Bayou Casotte in accordance with EPA's emergency bypass procedure. Depending on the level of treatment, this could increase the mass of ammonia-nitrogen and total phosphorus released to Bayou Casotte. To some extent, this could be mitigated by releasing water during a falling tide which would help to flush contaminants from the Bayou. Any effects from an emergency bypass would occur at the onset of the project and occur over a period of a few days to a few weeks depending on the volume of water.

Removal of Pond 6 and elimination of the WRD will eliminate the ability to store contaminated water at the EGS. For the period of time between the onset of construction, installation of the liner and cap, and tie-in of the EGS underdrain to the mechanical treatment plant, the Site will have a diminished capacity to store contaminated water in the event one or more large rain events occur. This could increase the potential that EPA would need to discharge partly treated water to Bayou Casotte under EPA's emergency bypass protocol which, in turn, could potentially increase the loads of ammonia-nitrogen and phosphorus released to the Bayou as described above.

Construction of the cap could potentially provide employment to local workers with the appropriate skills and would provide those benefits through the life of the job.

Alternative 4 is rated as 'average' for short-term effectiveness.

6.7.2 Implementability

Caps and covers such as that proposed under Alternative 4 are widely used to close phosphogypsum stacks in Florida and other states as well as municipal and other types of landfills. Consequently, the technology is well developed and can be easily implemented. Nevertheless, closure of a 135 acre area is a significant construction project that will require the appropriate equipment, services, and labor to ensure its timely completion.

Work conducted under CERCLA is required to meet the substantive requirements of applicable permits although permits themselves may not be required. Water discharged from the Site in preparation for implementation of Alternative 4 and from the capped areas following construction would be required to meet the discharge limits specified in the most recent NPDES permit issued to MPC (this permit has been cancelled but EPA continues to conduct the monitoring requirements specified in the permit and to meet discharge limitations set forth therein).

Implementation of Alternative 4 would require a waiver of the $2 million/12 month statutory limit on removal actions.

Alternative 4 is rated as 'very good' for technical and administrative implementability.

6.7.2.1 Availability of Technology

Alternative 4 can be implemented using standard construction equipment and technologies that are widely available in the Gulf Coast area. Implementation would require a significant source of borrow soil in addition to that needed to implement Phase 1 construction. Insofar as there are no special technologies required and labor is anticipated to be available in the area, Alternative 4 is rated as 'very good' for availability of technology.

6.7.2.2 State and Community Acceptance

State and community acceptance cannot be fully evaluated following a public meeting and comment period. However, it is anticipated that Alternative 4 would be accepted by stakeholders since it would provide numerous benefits to the community.

6.7.3 Cost

A detailed table of costs for Alternative 4 is included in Appendix B. The cost to construct Alternative 4 is $18,325,287 with a total cost for the alternative estimated at $21,770,441 (includes 8% contractor fee and 10% contingency). Construction costs include draining and treating water in the WRD, connecting the EGS underdrain to a new perimeter collection system and the mechanical treatment plant via a pump station, grading the Pond 6 and WRD areas to promote drainage, covering the WRD footprint with LLDPE liner, placing a protective soil and topsoil cover over the WRD liner and Pond 6 footprint, seeding topsoil at the WRD and Pond 6, and erosion control. The majority of the construction cost ($10.2M; 53%) is the cost to haul, place, and grade the protective soil and topsoil cover across the WRD and Pond 6 footprints. Placement of 2,792,196 sq ft of LLDPE liner at Pond 6 comprises 9.9% of the construction cost ($1.8M). Treatment of water in the WRD is assumed to occur via EPA's bypass protocol ($0.0157/gal).

6.8 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative analysis which assesses the relative performance of each alternative in relation to each of the evaluation criteria. This analysis identifies the advantages and disadvantages of each alternative relative to the other alternatives. EPA will select an action alternative for each construction phase. The results of the comparative analysis are presented in Table 6-1 and discussed below; sub-criteria scores are shown in Table 6-3.

6.8.1 Effectiveness

The No Action alternative (Alternative 1) is not considered to be protective of HH&E since a large volume of contaminated water would remain in on-site ponds where it poses a threat to the Grand Bay NERR and Bayou Casotte.

Each of the five action alternatives will meet ARARs and are considered to be effective. The two Phase 1 alternatives (2A [Partial LLDPE liner across the EGS] and 2B {Complete LLDPE liner across the EGS]) received similar effectiveness scores and were rated as good for protectiveness, long-term permanence, and reduction of T/M/V. Although the cap and cover system will limit interaction with infiltrating precipitation and significantly reduce the volume of water requiring treatment, neither alternative would remove the phosphogypsum material. Consequently, this places increased importance on the integrity of the perimeter grout wall and underdrain system to continue to limit migration of leachate from the pile to the surrounding environment. Alternatives 2A and 2B both were rated as fair for short-term effectiveness due to the effects of increased traffic that would result from hauling soil cover to the Site by truck.

Alternative 3B (Pond 5 closure with capping of the North Ponds) scored slightly better than Alternative 3A (Pond 5 closure with excavation of the North Ponds) for Phase 2 construction. Although excavation of the lime sludge from the North Ponds and its incorporation into the Pond 5 soil cover under

Alternative 3B is considered to be more protective than capping in place, this would require an estimated 36,400 truck trips to haul the sludge and an additional 36,400 trips to haul soil backfill. Consequently, Alternative 3A received a higher score for short-term effects because it would not result in significant transportation effects on the Site area.

Alternative 4 (Pond 6 and WRD closure) also received high ratings for protectiveness, long-term effectiveness, and reduction in T/M/V. The rating of average for short-term effectiveness reflects impacts from truck traffic to haul soil required for the vegetated cap.

6.8.2 Implementability

Each of the five action alternatives are considered to be implementable. Of these, only Alternative 2A (Partial LLDPE Liner over the EGS) scored below 5 on the relative ranking. This is because Alternative 2A would require a significant volume of clay-rich soil suitable for compaction to the required design limits on the side slopes of the EGS and it is unclear that this quantity could be easily obtained in a coastal area. The remaining action alternatives are each considered to be technically and administratively implementable, can be constructed using commonly available and easily implemented technologies, and are believed to be acceptable to State and community stakeholders. Alternative 1 (No Action), while the easiest to implement technically and administratively, is not expected to be acceptable to State and community stakeholders; Alternative 1 received the lowest implementability score.

6.8.3 Cost

Table 6-2 compares construction and total cost for each of the Removal Action alternatives.

Of the two alternatives for Phase 1 construction, Alternative 2B (Complete LLDPE Liner across the EGS) is slightly less expensive than Alternative 2A (Partial LLDPE Liner across the EGS) (total cost of $31,376,398 vs. $31,769,362). The higher cost to completely line the EGS with LLDPE under Alternative 2B is offset by the lower cost of the soil required to construct the protective soil cover across the side slopes of the stack, which under Alternative 2A, requires clay soil that can be compacted to design specifications.

Alternative 3B (Pond 5 Closure with *In Situ* Capping of the North Ponds) has a significantly lower total cost than Alternative 3A (Pond 5 Closure with Excavation of the North Ponds) for Phase 2 construction ($18,456,080 vs. $47,011,950). This difference is primarily due to the large cost associated with excavating lime sludge from the North Ponds and hauling and placing new backfill soil into the excavation.

Alternative 4 (Closure of Pond 6 and the WRD) has a total cost of $21,770,441, more than half of which reflects the cost to haul, place, and grade protective soil and topsoil covers in both areas.

6.9 SUMMARY OF ASSESSMENT

Table 6-1 presents the comparative assessment of alternatives; sub-criteria scores are shown in Table 6-3. Table 6-5 summarizes the estimated reduction in annual costs to treat contaminated water at the Site following completion of each construction phase.

6.9.1 Alternative 1 – No Action

Alternative 1 (No Action) would not implement any actions to reduce the volume of water requiring treatment at the Site. Therefore, exposure risks to contaminants would not be reduced and the Site would continue to pose a threat to the Grand Bay NERR and Bayou Casotte. Because the alternative does not meet the two threshold criteria of protection of HH&E and compliance with ARARs, it was not considered further.

There is no construction cost associated with Alternative 1. However, the cost to treat contaminated water at the Site would continue in perpetuity at an estimated cost of $5.56M for an average precipitation year.

6.9.2 Phase 1 – Alternatives 2A and 2B

Phase 1 construction would address the EGS including Ponds 3 and 4. Alternatives 2A (Partial LLDPE Liner across the EGS) and 2B (Complete LLDPE Liner across the EGS) would be effective at reducing the volume of water requiring treatment by removing approximately 154.9 acres from the current water balance. This would result in an estimated decrease in the annual volume of water requiring treatment at the Site of 39.1%. Under both alternatives, the phosphogypsum material comprising the EGS would remain in place. Consequently, limiting the spread of leachate contained within the pile depends on the perimeter grout wall, underdrain system, and underlying clay unit to remain intact and functional. Both alternatives would result in significant short term impacts due to increased truck traffic to haul soil cover material to the Site.

Both alternatives are technically and administratively implementable and could be constructed using widely available materials and services. However, Alternative 2A scored slightly lower in implementability because it requires identification of a clay borrow source to provide soil that can be compacted to design requirements on the side slopes of the EGS. Both alternatives would require a waiver of the $2M/12 month statutory limit on Removal Actions

Of the two alternatives, Alternative 2B (Complete LLDPE liner) has a slightly lower capital cost owing to the higher estimated cost of clay borrow soil suitable for compaction on the side slopes of the EGS.

6.9.3 Phase 2 Construction – Alternatives 3A and 3B

Phase 2 construction would address Pond 5 at the EGS and the North Ponds at the WGS. Alternatives 3A (Pond 5 Closure with Excavation of North Ponds) and 3B (Pond 5 Closure with *In Situ* Capping of North Ponds) utilize an identical approach to closure of Pond 5 (treating and discharging the water followed by grading, covering with an LLDPE liner, and vegetated soil cap). In both cases, discharge of Pond 5 water may require use of EPA's emergency by-pass protocol to efficiently remove the water prior to construction. This could potentially cause impacts to Bayou Casotte due to increased loading of ammonia and phosphorus to the waterway. Closure of Pond 5 and the North Ponds would remove an additional 90.3 acres from the Site water balance and decrease the annual volume of water requiring treatment at the Site by an estimated 23.8% (total reduction of 62.9% for Phase 1 and 2 combined).

Alternative 3A (North Ponds excavation) is rated as slightly more protective because the lime sludge material would be excavated, hauled to the Pond 5 area and incorporated into the Pond 5 soil cover whereas it would be capped in place under Alternative 3B. However, the North Pond excavation alternative (Alternative 3A) would require an additional 36,400 truck trips to haul the excavated lime sludge from the North Ponds to the Pond 5 area and an additional 36,400 trips to haul borrow soil to the Site to backfill the North Ponds excavation. The short-term transportation effects associated with Alternative 3A lowered its overall effectiveness score relative to Alternative 3B.

Both alternatives are technically and administratively implementable and use commonly available technologies but would require a waiver of the $2M/12 month statutory limit on Removal Actions.

Alternative 3B (Pond 5 Closure with *In Situ* Capping of the North Ponds) has a significantly lower cost due to the expense to excavate lime sludge from the North Ponds and backfill the excavation to grade.

6.9.4 Phase 3 Construction – Alternative 4

Only one alternative was developed to address Pond 6 and the EGS Water Return Ditch under Phase 3. Alternative 4, which would close Pond 6 and the WRD and connect the EGS underdrain system to the mechanical water treatment plant, would remove the remaining ponds and ditches that are presently used to store contaminated water at the EGS. This would remove an additional 135.3 acres from the Site water balance and decrease the annual volume of water requiring treatment at the Site by an estimated 35.5% (total reduction of 98.4% for Phases 1, 2 and 3 combined). Discharge of water from the WRD and untreated water in Pond 6 may require use of EPA's emergency by-pass protocol to efficiently remove the water prior to construction. This could potentially cause impacts to Bayou Casotte due to increased loading of ammonia and phosphorus to the waterway.

Alternative 4 is considered to be protective because it would eliminate all remaining storage of contaminated water at the EGS. Leachate emanating from the EGS would be piped directly to the mechanical treatment plant. Similar to other action alternatives, Alternative 4 would increase truck traffic in the Site area as soil cover material is hauled to the Site. The short-term transportation effects associated with Alternative 4 lowered its overall effectiveness score.

Alternative 4 is technically and administratively implementable and uses commonly available technologies but would require a waiver of the $2M/12 month statutory limit on Removal Actions.

The cost to implement Alternative 4 is estimated at $21,770,441.

7.0 Recommended Removal Action Alternative

EPA has selected the following alternatives for each construction phase:

- Phase 1 – Alternative 2B: Complete LLDPE Liner across the EGS
- Phase 2 – Alternative 3B: Pond 5 Closure with *In Situ* Capping of the North Ponds
- Phase 3 – Alternative 4: Closure of Pond 6 and the Water Return Ditch

These alternatives will meet ARARs and the RAOs to reduce the volume of water requiring treatment to achieve a long term goal of leachate collection and management at the Site. These alternatives provide the best long-term protectiveness and significantly reduce the risk that site contaminants would be discharged to Grand Bay NERR or Bayou Casotte through uncontrolled releases.

The total cost to implement the three recommended alternatives is $71,602,918.

The site-wide RI/FS phase to follow this EE/CA will provide consideration of long-term O&M of the caps and covers that will be installed at the Site, assess and evaluate the protectiveness of the strategy implemented by this EE/CA, and examine opportunities to further reduce the volume of water requiring treatment and the costs and techniques to do so.

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8.0 References

Allen Engineering, 2017a (March). NPDES Permit No. MS0003115, Discharge Monitoring Reports, Pascagoula, Jackson County, MS. February report submitted to MS Department of Environmental Quality, Office of Pollution Control.

Allen Engineering, 2017b (April). NPDES Permit No. MS0003115, Discharge Monitoring Reports, Pascagoula, Jackson County, MS. March report submitted to MS Department of Environmental Quality, Office of Pollution Control.

Allen Engineering, 2017c (May 15). NPDES Permit No. MS0003115, Discharge Monitoring Reports, Pascagoula, Jackson County, MS. April report submitted to MS Department of Environmental Quality, Office of Pollution Control.

Allen Engineering, 2017d (June 6). NPDES Permit No. MS0003115, Discharge Monitoring Reports, Pascagoula, Jackson County, MS. May report submitted to MS Department of Environmental Quality, Office of Pollution Control.

Dames & Moore, Inc., 1996 (March 22). Geotechnical Engineering and Hydrogeologic Studies for Proposed Gypsum Storage Expansion, Mississippi Phosphates Corp., Pascagoula, Mississippi. Prepared by Dames & Moore, Tampa FL for Mississippi Phosphates Corp., 191 pp.

Department of Justice (DOJ), 2015 (August 19). Mississippi Phosphates Corp. Pleads Guilty to Clean Water Act Violation and Agrees to Transfer 320 Acres to Grand Bay National Estuary. Office of Public Affairs, Press Release No. 15-1026. Viewed at: https://www.justice.gov/opa/pr/mississippi-phosphates-corp-pleads-guilty-clean-water-act-violation-and-agrees-transfer-320, November 29, 2017.

Eco-Systems, Inc., 2010 (November). *Site Characterization Report, Mississippi Phosphates Corporation Production Plant, Pascagoula, Jackson County, Mississippi.* Prepared for Butler, Snow, O'Mara, Stevens & Cannada, PLLC, Jackson, Mississippi, 1818 pp.

Florida Administrative Code (FAC), 1993. Rule-Chapter 62-673, Phosphogypsum Management. Florida Department of State, Florida Administrative Code & Florida Administrative Register. Viewed at: https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-673, 11/30/17.

Hosman, R.L., 1996. Regional Stratigraphy and Subsurface Geology of Cenozoic Deposits, Gulf Coastal Plain, South-Central United States. U.S. Geological Survey Professional Paper 1416-G. Viewed at: https://books.google.com/books?id=X3JzE-xBQhIC&pg=PP42&lpg=PP42&dq=graham+ferry+formation&source=bl&ots=tLObxCugLy&sig=S6WgNUKoJQ1uA_Y0hOB3IibJETk&hl=en&sa=X&ved=0ahUKEwjEybGam87XAhWmqVQKHRL3Cx8Q6AEIQTAE#v=onepage&q=graham%20ferry%20formation&f=false, November 20, 2017.

Kemron Environmental Services, 2017. *MPC Per Gallon Costs.* Email from Rick Cole (Kemron) to Craig Zeller (EPA) and other recipients, October 30, 2017.

Matson, G.C., 1917. The Pliocene Citronelle Formation of the Gulf Coastal Plain. In: *Shorter Contributions to General Geology 1916,* U.S. Geological Survey Professional Paper No. 98, pp. 167-192. Viewed at: https://pubs.usgs.gov/pp/0098l/report.pdf, November 20, 2017.

Mississippi Automated Resource Information System (MARIS), 2015. *MDEM Coastal LiDAR-Derived 1 Foot Contours for Jackson County.* Downloaded from: ftp://www.maris.state.ms.us/ftp2/Contours/Coastal_2015_Contours/, October 2017.

Mississippi Department of Environmental Quality (MDEQ), 2002. Subpart II, Mississippi Department of Environmental Quality Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment of Brownfield Sites. Viewed at: http://www.deq.state.ms.us/MDEQ.nsf/pdf/GARD_brownfieldrisk/$File/Proced.pdf, December 5, 2017.

Mississippi Department of Environmental Quality (MDEQ), 2007. State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters, Adopted August 23, 2007. Office of Pollution Control. Viewed at: http://deq.state.ms.us/MDEQ.nsf/0/e12c3b35e44cbfbc862574670051589e/$FILE/WQS_std_adpt_aug07.pdf, November 20, 2017.

Mississippi Department of Environmental Quality (MDEQ), 2015. State of Mississippi Water Pollution Control Permit, Permit to Discharge Wastewater in Accordance with National Pollutant Discharge Elimination System. Permit MS0003115 issued to Mississippi Phosphates Corporation, October 16, 2015.

Mississippi Department of Environmental Quality (MDEQ), 2016. *Mississippi 2016 Section 303(d) List of Impaired Water Bodies, Final List Ver. 2.0, Adopted June, 2016.* Surface Water Division of the Office of Pollution Control. Viewed at: http://www.deq.state.ms.us/MDEQ.nsf/0/ee877867e79083eb86257fdf006decc7/$FILE/2016_Adopted_Section_303d_List.pdf, November 20, 2017.

Patel, S.K., Ericson, W.A., and Kelley, M.P., 2002. Phosphogypsum Stack Closure: Evaluation of Phosphogypsum as an Alternate Final Cover, Final Report. Report prepared by BCI Engineers & Scientists, Inc., Lakeland, FL for the Florida Institute of Phosphate Research, FIPR Project No. 97-03-125R, 122 pp. plus 1 appendix.

Renken, R.A., 1996. Hydrogeology of the Southeastern Coastal Plain Aquifer System in Mississippi, Alabama, Georgia, and South Carolina: Regional Aquifer System Analysis – Southeastern Coastal Plain. U.S. Geological Survey Professional Paper 1410-B. Viewed at: https://books.google.com/books?id=EP31lB6AUOEC&pg=SL2-PA46&lpg=SL2-PA46&dq=pascagoula+formation+origin&source=bl&ots=S9l4m_7S56&sig=jtnLmpzc2a6Jim7zUoRHb1AVvWw&hl=en&sa=X&ved=0ahUKEwi0rt6Boc7XAhXJj1QKHdcbCkoQ6AEIRjAF#v=onepage&q=pascagoula%20formation%20origin&f=false, November 20, 2017.

Tetra Tech, 2016 (March 16). Letter Report – Phosphogypsum Stack Sampling, Mississippi Phosphate Corporation, Pascagoula, Jackson County, Mississippi, Contract No. EP-S4-14-03, TDD Number: TT-05-

017. Prepared for Ralph Howard, EPA Region 4 Remedial Project Manager by Shanna Davis, Tetra Tech Start IV Project Manager and Andrew F. Johnson, Tetra Tech Start IV Program Manager.

Tetra Tech, 2017 (July). Hazard Ranking System Documentation Record, Mississippi Phosphates Corporation. Prepared for EPA Region 4, July, 2017.

URS Corporation (URS), 2009 (May 29). Geotechnical Report – Reevaluation of Subsurface Conditions and Material Parameters, East Gypsum Stack, Mississippi Phosphates Corp. Report prepared by URS Corporation, Southern.

URS Corporation (URS), 2013 (April 8). Geotechnical Report, Stability Monitoring Program, 1st Quarter 2013, East Gypsum Stack, Mississippi Phosphates Corp., Pascagoula, Mississippi. Report prepared by URS Corporation, Southern.

U.S. Environmental Protection Agency (EPA), 1992. *National Emission Standards for Radon Emissions from Phosphogypsum Stacks.* 40 CFR Part 61, Subpart R, Effective date 6/3/1992. Viewed at: https://www.ecfr.gov/cgi-bin/text-idx?node=sp40.9.61.r, viewed on 12/8/17.

U.S. Environmental Protection Agency (EPA), 1993. *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*. Office of Solid Waste and Emergency Response, EPA 540-R-93-057.

U.S. Environmental Protection Agency (EPA), 2007 (March). Total Maximum Daily Load (TMDL) for Bayou Casotte in the Coastal Streams Basin of Mississippi, Un-Ionized Ammonia and Total Toxics. EPA Region 4, 34 pp.

U.S. Environmental Protection Agency, 2016. EPA Optimization Recommendations for Mississippi Phosphates Corporation. September 15, 2016.

U.S. Environmental Protection Agency (EPA), 2017a (May 8). *Radiochemical Results for Mississippi Phosphate Corporation Site.* Memorandum from Cynthia White, Director, Center for Environmental Radioanalytical Laboratory Science to Benjamin Franco, OSC, EPA Region 4.

U.S. Environmental Protection Agency (EPA), 2017b (November). *Regional Screening Level (RSL) Summary Table, (TR = 1E-06, HQ = 1) November 2017.* Viewed at: https://semspub.epa.gov/work/HQ/197025.pdf, viewed on 12/6/17.

U.S. Environmental Protection Agency (EPA), 2017c (December 8). *POLREP #44, Mississippi Phosphate Corporation (MPC), Pascagoula, MS.* Prepared by Leo Francendese, EPA OSC.

U.S. Environmental Protection Agency (EPA), 2017d (December 1). *POLREP #43, Mississippi Phosphate Corporation (MPC), Pascagoula, MS.* Prepared by Leo Francendese, EPA OSC.

U.S. Environmental Protection Agency (EPA), 2017e. *Mississippi Phosphates Corporation.* MS PowerPoint presentation prepared by Jordan Garrard, On-Scene Coordinator, EPA Region 4 and Craig Zeller, Remedial Project Manager, EPA Region 4, October 2017.

Weston Solutions, Inc., 2007 (August 29). Final Site Inspection Report, Phosphate ESI Initiative, Mississippi Phosphates Corporation, Pascagoula, Jackson County, Mississippi, CERCLIS ID No. MSD077909133. Prepared for U.S. EPA Region 4.

Tables

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Table 2-1. Estimated Wastewater Storage Capacity at the Mississippi Phosphates Corp. Site

Location	Storage Unit	Estimated Storage Capacity (Mgal) [1]
East Gypsum Stack	Pond 3	100
	Pond 4	25
	Pond 5	200
	Pond 6	130
	Water Return Ditch	130
West Gypsum Stack	North Ponds	52
	DAP Ditch	91
	S-Pond	4
Total		**732**

1 Volume Estimates from EPA (2017)

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Table 2-2. Emergency Bypasses of Wastewater in 2017, Mississippi Phosphates Corp. Site

Date of Bypass	Approximate Discharge Volume (Mgal)	Cause
July, 2017	63.3	Excessive rainfall (2 separate discharge events)
August, 2017	121.5	Hurricane Harvey; Lower Ponds 3 and 4
September, 2017	43.6	Hurricane Nate
October, 2017	165.3	Excessive rainfall
Total	**393.7**	

Through November 1, 2017
Data from EPA (2017c)

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Table 2-3. Average Monthly Temperature and Rainfall at Moss Point, Mississippi

	High (°F)	Low (°F)	Precip. (in.)		High (°F)	Low (°F)	Precip. (in.)
Jan	60	39	5.55	**Jul**	89	73	7.09
Feb	63	42	5.16	**Aug**	89	72	7.24
Mar	69	48	5.35	**Sep**	86	67	5.87
Apr	75	55	4.37	**Oct**	79	57	4.21
May	82	63	4.65	**Nov**	70	47	4.57
Jun	87	70	6.38	**Dec**	62	41	4.49
				Total			**64.93**

Data from U.S. Climate Data

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Table 2-4. Monthly Total Rainfall Measured at the Mississippi Phosphates Corp. Site in 2017

	Precip. (in.)		Precip. (in.)
Jan	13.75	**Jul**	12.36
Feb	4.45	**Aug**	17.28
Mar	2.25	**Sep**	5.87
Apr	2.96	**Oct**	19.27
May	8.89	**Nov**	0.45
Jun	19.11	**Dec**	---
		Total	**106.7**

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Table 2-5. Point Precipitation Frequency Estimates (90% Confidence), 24-hour Storm, Pascagoula 3 NE

Return Storm	Precip. (in.)	Return Storm	Precip. (in.)
1 Year	5.02	10 Year	9.18
3 Year	5.98	25 Year	11.4
5 Year	7.67	100 Year	15.3

NOAA Atlas 14, Vol. 9, Ver. 2, Pascagoula 3 NE, Station ID 22-6718, Moss Point, MS

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Table 2-6. Watershed Areas and Annual Contact Water Volumes

Watershed Component / Contact Area	Area	Precipitation (Average Annual)	Evaporation / Evapotranspiration	Net Precipitation Gain (Loss)
	acres	Mgal/yr	Mgal/yr	Mgal/yr
EGS Pond 3	24.8	45	15	30
EGS Pond 4	14.5	26	8	18
EGS Pond 5	60.3	109	35	73
EGS Pond 6	60.0	108	35	73
EGS Ponds 5 & 6 Berms	11.2	20	7	14
EGS Slopes	115.6	208	68	140
EGS WRD including Pond 6 WRD	64.1	115	38	77
WGS DAP Ditch, total	35.0	63	20	43
WGS North Ponds	30.0	54	18	36
Wastewater Treatment Plant	0.8	1.5	0.5	1.0
Total	**416.3**	**750**	**245**	**505**

Modified from EPA (2016). Refer to EPA (2016) for data sources.
Assumes average annual rainfall of 66.3 in; average annual evaporation of 21.6 in.
Mgal – million gallons; EGS – East Gypsum Stack; WGS – West Gypsum Stack

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Table 2-7. Recent Monitoring Results for Wastewaters at the Mississippi Phosphates Corp. Site

Date	WRD		Pond 4			
	pH	Total Phosphorus (mg/L)	pH	Nitrogen (mg/L)	Fluoride (mg/L)	Total Phosphorus (mg/L)
10/2/2017			2.67	0.03	27	223.1
10/24/2017						
10/26/2017						
10/27/2017	2.68	2,052				
10/29/2017	2.90	2,175				
10/30/2017						
11/3/2017	2.53	3,338				
11/4/2017	2.53	3,338				

Date	Pond 5		Pond 6	
	pH	Total Phosphorus (mg/L)	pH	Total Phosphorus (mg/L)
10/2/2017				
10/24/2017			2.96	1,180
10/26/2017	2.45	2,693	2.84	1,450
10/27/2017	2.51	2,208	3.05	1,494
10/29/2017			3.02	1,150
10/30/2017	2.75	2,938	3.41	1,392
11/3/2017			3.42	1,417
11/4/2017			3.42	1,417

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Table 2-8. Summary of Effluent Quality, Outfall 003, Mississippi Phosphates Corporation Site, February to May 2017

	pH		Ammonia-N (mg/L)		Arsenic (mg/L)		Cadmium (mg/L)	
2017	**Mo. Min**	**Mo. Max**	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**
Feb	2.9	9.8	29.5	76.1	0.012	0.019	0.005	0.005
Mar	2.5	9.9	26.9	43.8	0.027	0.032	0.005	0.005
Apr	5.7	9.3	40.7	80.2	0.052	0.059	0.005	0.005
May	2.6	10.1	32.3	72.9	0.005	0.005	0.005	0.005
NPDES Limit	6.0	9.0	48.0	86.2	report	report	report	report

	Chromium (mg/L)		Copper (mg/L)		Lead (mg/L)		Nickel (mg/L)	
2017	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**
Feb	0.012	0.013	0.010	0.010	0.005	0.005	0.023	0.035
Mar	0.010	0.010	0.010	0.010	0.005	0.005	0.030	0.050
Apr	0.010	0.010	0.010	0.013	0.005	0.005	0.040	0.059
May	0.010	0.010	0.010	0.011	0.005	0.005	0.035	0.068
NPDES Limit	report	report	0.078	0.121	0.204	report	0.209	1.89

	Selenium (mg/L)		Thallium (mg/L)		Zinc (mg/L)	
2017	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**	**Mo. Ave**	**Daily Max**
Feb	0.011	0.011	0.010	0.010	0.021	0.026
Mar	0.010	0.010	0.010	0.010	0.021	0.032
Apr	0.010	0.010	0.010	0.010	0.020	0.020
May	0.010	0.010	0.010	0.010	0.021	0.029
NPDES Limit	report	report	report	report	report	2.27

NPDES Permit No. MS0003115
Mo. Min - Monthly minimum, the minimum pH value over the calendar month
Mon. Max - Monthly maximum, the maximum pH value over the calendar month
Mo. Ave - Monthly average, the average of "daily discharges" over the calendar month
Daily Max - Daily maximum, the highest 'daily discharge' over the calendar month

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Table 2-9. Analyses of Phosphogypsum Solids Collected from the EGS at the MS Phosphates Corp. Site, January 2016

		Industrial Soil RSL	MPC-05	MPC-05D	MPC-06	MPC-07	MPC-08
Ammonia	mg/kg	---	2.5 U	25	11	2.5 U	32
Aluminum	mg/kg	1.1E+06	310 J	310	390	380	980
Antimony	mg/kg	4.7E+02	0.49 U	0.49 U	0.19 U	0.19 U	0.42
Arsenic	mg/kg	3.0E+00	0.49 U	0.49 U	0.49 U	0.48 U	1.6 J
Barium	mg/kg	2.2E+05	26	26	20	21	36
Cadmium	mg/kg	9.8E+02	2.1	2.0	2.2	1.8	3.0
Calcium	mg/kg	---	160,000	160,000	140,000	140,000	150,000
Chromium	mg/kg	1.8E+06	4.9 U	4.9 U	5.6	4.8 U	18
Iron	mg/kg	8.2E+05	99 U	99 U	170	230	1,700
Lead	mg/kg	8.0E+02	1.1	0.98	1.1	1.1	1.7
Selenium	mg/kg	5.8E+03	0.99 U	0.99 U	0.97 U	0.97 U	1.2
Strontium	mg/kg	7.0E+05	400	390	340	340	390
Titanium	mg/kg	---	8.2	6.7	7.9	12	11
Vanadium	mg/kg	5.8E+03	4.9 U	4.9 U	5.3	4.8 U	14
Yttrium	mg/kg	---	77	74	60	60	110
Zinc	mg/kg	3.5E+05	9.9 U	9.9 U	9.7 U	9.7 U	14

Data are from Table 1 of Tetra Tech (2016)
Industrial Soil HQ=1 RSL values from EPA (2017b)
U = non-detected, result shown is the detection limit
J = value is an estimate
mg/kg – milligrams per kilogram

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Table 2-10. Radium 226 Activity Measured in Phosphogypsum Samples from the EGS, MS Phosphates Corp. Site

Sample	Units	Ra^{226} Activity
MPC-01	pCi/g	23.0
MPC-02	pCi/g	37.3
MPC-03	pCi/g	27.6
MPC-04	pCi/g	21.8
MPC-05	pCi/g	30.5
MPC-06	pCi/g	46.9
MPC-06D	pCi/g	46.5

Data are from EPA (2017a)
pCi/g = picoCuries per gram

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ARARs and TBCs
Mississippi Phosphates Corporation Superfund Site
Pascagoula, Mississippi

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	General Construction Standards – All Land Disturbing Activities			
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction management techniques in accordance with the substantive requirements for permits issued pursuant to 40 CFR § 122.26(c) – storm water discharges associated with industrial activity.	Dewatering or storm water discharges associated with small construction activity as defined in 40 CFR 122.26(b)(15) – **applicable**	40 CFR Part § 122.26(c)(1)	
Activities causing storm water runoff (e.g., clearing, grading, excavation) *cont.*	Shall provide a narrative description of: (A) The location (including a map) and the nature of the construction activity; (B) The total area of the site and the area of the site that is expected to undergo excavation; (C) Proposed measures, including BMPs to control stormwater discharges during construction, including a brief description of applicable State and local erosion and sediment control requirements; (D) Proposed measures to control pollutants in storm water discharges that will occur after construction operations have been completed, including a brief description of applicable State or local erosion and sediment control requirements; (E) Estimate of the runoff coefficient of the site and the increase in impervious area after the construction is completed, the nature of fill material and existing data describing the soil or the quality of the discharge; and (F) The name of the receiving water.		40 CFR Part § 122.26(c)(1)(ii)	
Activities causing fugitive dust emissions	Shall not cause, allow, or permit the emission of particles, or any contaminants in sufficient amounts or of such duration from any process as to be injurious to humans, animals, plants, or property, or to create a condition of air pollution.	Fugitive emissions from construction operations, grading, or the clearing of land – **applicable**	MDEQ Regulation APC-S-1, Section 3, Paragraph 3	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
Waste Generation, Characterization–Primary waste (excavated soils, debris) and Secondary wastes (treatment residuals)[1]				
Characterization of ***solid waste*** (all primary and secondary wastes)	Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR § 261.4; and Must determine if waste is listed as a hazardous waste under 40 CFR Part 261.	Generation of solid waste as defined in 40 CFR § 261.2 – **applicable**	40 CFR § 262.11(a) and (b)	
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR part 261by either: • Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or • Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.		40 CFR § 262.11(c)(1)and (2)	
	Must refer to 40 CFR Parts 261, 262, 264, 265, 266, 268, and 273 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste that is determined to be hazardous – **applicable**	40 CFR § 262.11(d)	
Characterization of ***hazardous waste*** (all primary and secondary wastes)	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR §§ 264 and 268	Generation of RCRA hazardous waste for storage, treatment, or disposal – **applicable**	40 CFR § 264.13(a)(1)	

[1] The State of Mississippi incorporates by reference the federal regulations governing waste generation, characterization, segregation, and storage. See MDEQ Regulations HW-1 (Sept. 29, 2008). Accordingly, only the federal regulations are cited in this table.

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Determinations for management of hazardous waste	Must determine each EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 *et seq.*. This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter. *NOTE:* For purposes of part 268, the waste will carry the code any applicable listed waste (40 CFR 261, subpart D). In addition, where the waste exhibits a characteristic, the wastes will carry one or more characteristic codes (40 CFR 261, subpart C).	Generation of RCRA hazardous waste for storage, treatment, or disposal – **applicable**	40 CFR § 268.9(a)	
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 CFR § 268.9(a)	
	A generator of hazardous waste must determine if the waste has to be treated before it can be disposed. This is done by determining if the hazardous waste meets the treatment standards in 40 *CFR* 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *NOTE:* This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 CFR § 268.7(a)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Characterization of remediation wastes	Obtain a detailed chemical and physical analysis of a representative sample of the hazardous remediation wastes to be managed at the site. At a minimum, the analysis must contain all of the information which must be known to treat, store or dispose of the waste according to this part and part 268 of this chapter and must be kept up to date.	Management of remediation wastes at facility that does not have a RCRA permit – **applicable**	40 CFR § 264.1(j)(2)	
Waste Storage – Primary waste (excavated soils/sludge/debris) and Secondary wastes (treatment residuals)[2]				
Temporary on-site storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • waste is placed in containers that comply with 40 CFR §§ 265.171-173; and • the date upon which accumulation begins is clearly marked and visible for inspection on each container; • container is marked with the words "hazardous waste" or	Accumulation of RCRA hazardous waste on-site as defined in 40 CFR § 260.10 – **applicable**	40 CFR § 262.34(a); 40 CFR § 262.34(a)(1)(i) 40 CFR § 262.34(a)(2) and (3)	
	• container may be marked with other words that identify contents	Accumulation of 55 gals. or less of RCRA hazardous waste or 1 qrt. Of acutely hazardous waste at or near any point of generation – **applicable**	40 CFR § 262.34(c)(1)	
Use and management of hazardous waste in containers	If container is not in good condition or if it begins to leak, must transfer waste into container in good condition	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR § 265.171	
	Use container made with lined materials compatible with waste to be stored so that the ability of the container is not impaired		40 CFR § 265.172	

[2] The State of Mississippi incorporates by reference the federal regulations governing waste generation, characterization, segregation, and storage. See MDEQ Regulations HW-1 (Sept. 29, 2008). Accordingly, only the federal regulations are cited in this table.

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	Keep containers closed during storage, except to add/remove waste		40 CFR § 265.173(a)	
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak		40 CFR § 265.173(b)	
Storage of hazardous waste in a container area	Area must have a containment system designed and operated in accordance with 40 CFR § 264.175(b)	Storage of RCRA hazardous waste in containers *with free liquids* – **applicable**	40 CFR § 264.175(a)	
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid	Storage of RCRA hazardous waste in containers that do not contain free liquids (other than F021, F022, F023, F026 and F027) – **applicable**	40 CFR § 264.175(c)	
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • minimizes the need for further maintenance; • controls, minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • complies with the closure requirements of subpart, but not limited to, the requirements of 40 CFR § 264.178 for containers.	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR §264.111	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 CFR § 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit with a containment system – **applicable**	40 CFR §264.178	
Temporary on-site storage of remediation waste in staging piles (e.g., excavated soils, sludges/debris)	Must be located within the contiguous property under the control of the owner/operator where the wastes are to be managed in the staging pile originated.	Accumulation of *non-flowing hazardous remediation waste* (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR § 260.10 – **applicable**	40 CFR § 264.554(a)(1)	
	May be temporarily stored (including mixing, sizing, blending, or other similar physical operations intended to prepare the wastes for subsequent management or treatment) at a facility if used only during remedial operations provided that the staging pile: • must facilitate a reliable, effective, and protective remedy; • must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer as necessary to protect human health and the environment (e.g., use of liners, covers, run-off/run-on controls)		40 CFR § 264.554(a)(1)(i) and (ii)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
	The staging pile must not operate for more than two years, except when the Director grants an operating term extension under 40 *CFR* § 264.554(i). *NOTE:* Must measure the 2-year limit (or other operating term specified) from first time remediation waste placed in staging pile.	Accumulation of *non-flowing hazardous remediation waste* (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR § 260.10 – **applicable**	40 CFR §§ 264.554(d)(1)(iii)	
Operation of a staging pile *cont.*	The Director may allow a staging pile to operate for up to two years after the hazardous waste is first placed into the pile. Must not use staging pile longer than the length of time designated by the Director in the permit, closure plan, or order ("operating term"), except as provided in paragraph (i) of this section. *NOTE: Additional time limits for storage will be justified and documented in an ESD or ROD Amendment issued by EPA.*	Accumulation of *non-flowing hazardous remediation waste* (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR § 260.10 – **applicable**	40 *CFR* §264.554(h)	
	The Director may grant one operating term extension of up to 180 days beyond the operating term limit contained in the permit, closure plan, or order. To justify to the Director the need for the extension, you must provide sufficient and accurate information to enable the Director to determine that continued use of the staging plie: (i) Will not pose a threat to human health and the environment; and (ii) Is necessary to ensure timely and efficient implementation of the remedial actions at the facility.		40 *CFR* §264.554(h)(i)(1)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Temporary on-site storage of remediation waste in staging piles (e.g., excavated soils, sludges, debris)	In setting standards and design criteria, must consider the following factors: • length of time pile will be in operation; • volumes of waste intended to store in pile; • physical and chemical characteristics of waste to be stored in unit • potential for releases from the unit hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • potential for human and environmental exposure to potential releases from the unit	Accumulation of *non-flowing hazardous remediation waste* (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR § 260.10 – **applicable**	40 CFR § 264.554(d)(2)(i)-(vi)	
	Must not place ignitable or reactive remediation waste in a staging pile unless the remediation waste has been treated, rendered, or mixed before placed in the staging pile so that: • the remediation waste no longer meets the definition of ignitable or reactive under 40 CFR 261.21 or 40 CFR 261.23; and • you have complied with 40 CFR 264.17(b); or Must manage the remediation waste to protect it from exposure to any material or condition that may cause it to ignite or react.	Storage of "ignitable" or "reactive" remediation waste in staging pile – **applicable**.	40 CFR § 264.554(e) 40 CFR § 264.554(e)(1)(i) 40 CFR § 264.554(e)(1)(ii) 40 CFR § 264.554(e)(2)	
	Must not place in the same staging pile unless you have complied with 40 CFR 264.17(b).	Storage of "incompatible" remediation waste (as defined in 40 CFR 260.10) in staging pile – **applicable**	40 CFR § 264.554(f)(1)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
	Must separate the incompatible waste of materials, or protect them from one another using a dike, berm, wall, or other device.	Staging pile of remediation waste stored nearby to incompatible wastes or materials in containers, other piles, open tanks or land disposal units – **applicable**.	40 CFR § 264.554(f)(2)	
	Must not pile remediation waste on same base where incompatible wastes or materials were previously piled unless the base has been sufficiently decontaminated in compliance with 40 CFR § 264.17(b)		40 CFR § 264.554(f)(3)	
Closure of staging pile of remediation waste	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate.	Storage of remediation waste in staging pile in *previously contaminated area* – **applicable**	40 CFR § 264.554(j)(1)	
	Must decontaminate contaminated sub-soils in a manner that EPA determines will protect human health and the environment.		40 CFR § 264.554(j)(2)	
	Must be closed within 180 days after the operating term according to 40 CFR §§ 264.258(a) and 264.111 or 265.258(a) and 265.111.	Storage of remediation waste in staging pile *in uncontaminated area* – **applicable**	40 CFR § 264.554(k)	
Waste Treatment and Disposal – Primary waste (e.g., excavated soils, sludges, debris) and Secondary wastes (treatment residuals)[3]				
Disposal of RCRA hazardous waste in land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR § 268.40 before land disposal.	Land disposal, as defined in 40 CFR § 268.2, of restricted RCRA waste – **applicable**	40 CFR § 268.40(a)	

[3] The State of Mississippi incorporates by reference the federal regulations governing land disposal restrictions. See MDEQ Regulations HW-1 (Sept. 29, 2008). Accordingly, only the federal regulations are cited in this table.

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	All underlying hazardous constituents [as defined in 40 CFR § 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR § 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 CFR § 268.40(e)	
Disposal of RCRA characteristic wastewaters in a CWA wastewater treatment unit	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 the CWA (i.e., NPDES permitted), unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR §268.40, or are D003 reactive cyanide. *NOTE:* For purposes of this exclusion, a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a system, is considered a wastewater treatment system that is NPDES permitted.	Land disposal of RCRA restricted hazardous wastewaters that hazardous only because they exhibit a characteristic and are not otherwise prohibited under 40 CFR §268 – **applicable**	40 CFR § 268.1(c)(4)(i)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
Transport and conveyance of collected RCRA wastewater to WWTU located on the facility	Any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to an on-site NPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards. *NOTE:* For purposes of this exclusion, any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey CERCLA remediation wastewater to a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a facility, are exempt from the requirements of RCRA Subtitle C standards.	On-site wastewater treatment unit (as defined in 40 CFR 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., NPDES-permitted) that manages hazardous wastewaters – **applicable**.	40 CFR 264.1(g)(6)	
Treatment of RCRA *hazardous waste soil* on-site	Prior to land disposal, all “constituents subject to treatment,” as defined in 40 CFR § 268.49(d), must be treated as follows:	Treatment of restricted hazardous waste soils – **applicable**	40 CFR § 268.49(c)(1)	
	• **For non-metals** (except carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations, except as provided in 40 CFR § 268.49(c)(1)(C)		40 CFR § 268.49(c)(1)(A)	
Treatment of RCRA *hazardous waste soil*	• **For metals** and carbon disulfide, cyclohexanone, and methanol, treatment must achieve a 90 percent reduction in total constituent concentrations as measure in leachate from the treated media (tested according to TCLP) <u>or</u> 90 percent reduction in total constituent concentrations (when a metal removal technology is used), except as provided in (c)(1)(C)		40 CFR § 268.49(c)(1)(B)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
	• When treatment of any constituent subject to treatment to a 90 percent reduction standard would result in a concentration less than 10 times the Universal Treatment Standard (UTS) for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. UTS are identified in 40 CFR § 268.48 Table UTS		40 CFR § 268.49(c)(1)(C)	
Treatment of RCRA *hazardous waste soil* on-site	In addition to the treatment requirement required by paragraph (c)(1) of 40 CFR § 268.49, soils must be treated to eliminate these characteristics.	Soils that exhibit the characteristic of ignitability, corrosivity, or reactivity intended for land disposal – **applicable**	40 CFR § 268.49(c)(2)	
	Provides methods on how to demonstrate compliance with the alternative treatment standards for contaminated soils that will be land disposed.	Treatment of restricted hazardous waste soils – **TBC**	*Guidance on Demonstrating Compliance with LDR Alternative Soil Treatment Standards*, U.S. EPA 530-R-02-003 (July 2002)	
Treatment of hazardous waste in Misc. Treatment Unit with air emissions (e.g., low temperature thermal system)	Unit must be located, designed, constructed, operated and maintained, and closed in a manner that will ensure protection of human health and the environment.	Treatment of RCRA hazardous waste in miscellaneous units, except as provided in 40 CFR § 264.1– **relevant and appropriate**	40 CFR § 264.601	
	Protection of human health and the environment includes, but is not limited to: prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air, considering the factors listed in 40 CFR § 264.601(c)(1) thru (7).		40 CFR § 264.601(c)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	The requirements of RCRA Subpart CC – Air Emission Standards for Tanks, Surface Impoundments, and Containers do not apply to a waste management unit that is solely used for on-site treatment or storage of hazardous waste that is placed in the unit as result of implementing remedial activities required under RCRA 3004(u) and (v), or 3008(h), or CERCLA authorities.	Air pollutant emissions with volatile organics from a hazardous waste tank, surface impoundment, or container – **relevant and appropriate**	40 CFR § 264.1080(a)(5)	
Disposal of RCRA-*hazardous waste debris* in a land-based unit (i.e., landfill)	Must be treated prior to land disposal as provided in 40 CFR §268.45(a)(1)-(5) unless EPA determines under 40 CFR § 261.3(f)(2) that the debris no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard provided in 40 CFR § 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 CFR § 268.2, of restricted RCRA hazardous debris – **applicable**	40 CFR §268.45(a)	
Disposal of *treated hazardous debris*	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 CFR § 268.45 and which no longer exhibits a characteristic is not a hazardous waste and need not be managed in RCRA Subtitle C facility Hazardous debris contaminated with listed waste that is treated by immobilization technology must be managed in a RCRA Subtitle C facility.	Treated debris contaminated with RCRA listed or characteristic waste –**applicable**	40 CFR § 268.45(c)	
Disposal of *hazardous debris treatment residues*	Except as provided in § § 268.45(d)(2) and (d)(4), must be separated from debris by simple physical or mechanical means, and such residues are subject to the waste-specific treatment standards for the waste contaminating the debris.	Residue from treatment of hazardous debris – **applicable**	40 CFR §268.45(d)(1)	
Discharge of Wastewater from Treatment Unit				
General duty to mitigate for discharge of wastewater treatment unit	Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has a reasonable likelihood of adversely affecting human health or the environment.	Discharge of pollutants to surface waters **– applicable**.	40 CFR §122.41(d)	

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Operation and maintenance of treatment unit	Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with the effluent standards. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures.	Discharge of pollutants to surface waters – **applicable**.	40 CFR §122.41(e)	
Technology-based treatment requirements for wastewater discharge	To the extent that EPA promulgated effluent limitations are inapplicable, shall develop on a case-by-case Best Professional Judgment (BPJ) basis under § 402(a)(1)(B) of the CWA, technology based effluent limitations by applying the factors listed in 40 *CFR* §125.3(d) and shall consider: • The appropriate technology for this category or class of point sources, based upon all available information; and • Any unique factors relating to the discharger.	Discharge of pollutants to surface waters from other than a POTW – **applicable**.	40 CFR §125.3(c)(2)	
Water quality-based effluent limits for wastewater discharge	Must develop water quality based effluent limits that ensure that: • The level of water quality to be achieved by limits on point source(s) established under this paragraph is derived from, and complies with all applicable water quality standards; and • Effluent limits developed to protect narrative or numeric water quality criteria are consistent with the assumptions and any available waste load allocation for the discharge prepared by the State and approved by EPA pursuant to 40 CFR §130.7.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard established under § 303 of the CWA – **applicable**.	40 CFR §122.44(d)(1)(vii)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	Must attain or maintain a specified water quality through water quality related effluent limits established under § 302 of the CWA.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard— **applicable**.	40 CFR §122.44(d)(2)	
Minimum Conditions Applicable to All Waters in the State of Mississippi	Waters shall be free from substances attributable to municipal, industrial, agricultural, or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits.	Discharge of waste or other source of water pollution into surface water classified as Ephemeral Stream – **relevant and appropriate**	MDEQ Regulation WP-2, Section II.1.	
	Waters shall be free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, agricultural, or other discharges in amounts to be unsightly or deleterious.		MDEQ Regulation WP-2, Section II.2.	
Minimum Conditions Applicable to All Waters in the State of Mississippi	Waters shall be free from substances attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended solids, sediment, turbidity, or other conditions in such a degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use.	Discharge of waste or other source of water pollution into surface water classified as Ephemeral Stream – **relevant and appropriate**	MDEQ Regulation WP-2, Section II.3.	
	Environmental restoration projects which will result in reasonable and temporary deviations may be exempt from the turbidity standard if reviewed and approved by MDEQ and EPA.		MDEQ Regulation WP-2, Section II.3.B.	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	Waters shall be from substances attributable to municipal, industrial, agricultural, or other discharges in concentrations or combinations that are toxic or harmful to humans, animals, or aquatic life. Specific requirements for toxicity are found in MDEQ Regulation WP-2, Section II.10.		MDEQ Regulation WP-2, Section II.4.	
	Municipal wastes, industrial wastes, or other wastes shall receive effective treatment or control in accordance with Section 301, 306, 307 of the Federal CWA. A degree of treatment greater than defined in these sections may be required when necessary to protect legitimate uses.		MDEQ Regulation WP-2, Section II.5.	
Monitoring requirements for treatment unit discharges	In addition to 40 CFR §122.48(a) and (b) and to assure compliance with effluent limitations, one must monitor, as provided in subsections (i) thru (iv) of § 122.44(i)(1). *NOTE: Monitoring parameters, including frequency of sampling, will be developed as part of the CERCLA process and included in a Remedial Design, Remedial Action Work Plan, or other appropriate CERCLA document.*	Discharge of pollutants to surface waters – **applicable**.	40 CFR §122.44(i)(1)	
	All effluent limitations, standards and prohibitions shall be established for each outfall or discharge point, except as provided under § 122.44(k)		40 CFR §122.45(a)	
	All effluent limitations, standards and prohibitions, including those necessary to achieve water quality standards, shall unless impracticable be stated as: • Maximum daily and average monthly discharge limitations for all discharges.	Continuous discharge of pollutants to surface waters – **applicable**.	40 CFR §122.45(d)(1)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
Capping Waste in Place – Landfill or Surface Impoundment Closure and Post-Closure				
Installation of low-permeability cover	Must cover the landfill (or cell) with a final cover designed and constructed to: (1) provide long-term minimization of migration of liquids through the closed landfill; (2) function with minimum maintenance; (3) promote drainage and minimize erosion or abrasion of the cover; (4) accommodate settling and subsidence so that the cover's integrity is maintained; and (5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Closure of RCRA hazardous waste landfill – **relevant and appropriate**	40 *C.F.R.*§ 264.310(a)	
Clean closure of surface impoundment	At closure, the owner or operator must: Remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste unless § 261.3(d) of this chapter applies.	Closure of RCRA hazardous waste surface impoundment – **relevant and appropriate**	40 *C.F.R.*§ 264.228(a)(1)	3A only

Action	**Requirements**	**Prerequisite**	**Citation**	**Remedial Alternative**
Closure of surface impoundment with waste-in-place	At closure, the owner or operator must: (i) Eliminate free liquids by removing liquid wastes or solidifying the remaining wastes and waste residues; (ii) Stabilize remaining wastes to a bearing capacity sufficient to support final cover; and (iii) Cover the surface impoundment with a final cover designed and constructed to: (A) provide long-term minimization of migration of liquids through the closed landfill; (B) function with minimum maintenance; (C) promote drainage and minimize erosion or abrasion of the cover; (D) accommodate settling and subsidence so that the cover's integrity is maintained; and (E) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Closure of RCRA hazardous waste surface impoundment – **relevant and appropriate**	40 *C.F.R.*§ 264.228(a)(2)	
Installation of low-permeability cover	EPA guidance provides technical recommendations on the design parameters for a multi-layer low permeability cover including a two component low permeability layer, a soil drainage layer, and a two component top layer. The guidance acknowledges that other final cover designs may be acceptable.	Design and construction of cover – **TBC**	Sections 1.4.1, 2, 3, and 4 of the EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments, EPA OSWER 530- SW-89-047, (July 1989)	
Post-closure care of surface impoundment	The owner or operator must comply with all post-closure requirements contained in §§264.117 through 264.120, including maintenance and monitoring throughout the post-closure care period.	Closure of RCRA hazardous waste surface impoundment with some waste residues or contaminated materials left in place – **relevant and appropriate**	40 *C.F.R.*§ 264.228(b)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
	The owner and operator must: • Maintain the integrity and effectiveness making repairs to the cap as necessary to correct the effects of settling, subsidence erosion, or other events; • Maintain and monitor the ground-water monitoring systems and comply with all other applicable requirements of subpart F of this part; and • Prevent run-on and run-off form eroding or otherwise damaging the final cover.		40 *C.F.R.*§ 264.228(b)(1), (3) and (4)	
Post-closure care and use of property	Must begin after completion of the closure of the unit and continue for 30 years after that date and must consist of: • Monitoring and reporting; and • Maintenance and monitoring of waste containment systems. *NOTE:* Monitoring of final cover and groundwater will be performed in accordance with a CERCLA Remedial Action Work Plan.	Closure of RCRA hazardous waste management unit – **relevant and appropriate**	40 *C.F.R.*§ 264.117(a)(1)	
Disturbance of integrity of low-permeability cover	Must never allow disturbance of the integrity of the cover, or any other components of the containment system, or the function of the facility's monitoring systems, unless the disturbance: • Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or • Is necessary to reduce a threat to human health or the environment.		40 *C.F.R.*§ 264.117(c)	

Action	Requirements	Prerequisite	Citation	Remedial Alternative
Post-closure notices (former RCRA surface impoundments closed as landfill)	Must record, in accordance with State law, a notation on the deed to the facility property, or on some other instrument which is normally examined during a title search, that will in perpetuity notify any potential purchaser of the property that: • Land has been used to manage hazardous wastes; • Its use is restricted under 40 *C.F.R.* Part 264 Subpart G regulations; and • The survey plat and record of the type, location, and quantity of hazardous wastes disposed within each cell or other hazardous waste disposal unit of the facility required by Sections 264.116 and 264.119(a) have been filed with the local zoning authority and with the EPA Regional Administrator.	Closure of a RCRA hazardous waste surface impoundment or landfill with some waste residues or contaminated materials left in place – **applicable**	40 C.F.R.§ 264.119(b)(1)(i)-(iii)	
Waste Transportation – Primary and Secondary wastes				
Transportation of hazardous waste *on-site*	The generator manifesting requirements of 40 CFR § 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR § 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way – **applicable**	40 CFR § 262.20(f)	
Transportation of hazardous waste *off-site*	Must comply with the generator requirements of 40 CFR § 262.20-262.23 for manifesting, § 262.30 for packaging, § 262.31 for labeling, § 262.32 for marking, § 262.33 for placarding, §§ 262.40 and 262.41(a) for record keeping requirements, and § 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of RCRA hazardous waste off-site – **applicable**	40 C.F.R § 262.10(h)	

ARARs and TBCs
Mississippi Phosphates Corporation Superfund Site
Pascagoula, Mississippi

Action	Requirements	Prerequisite	Citation	Remedial Alternative
Transportation of waste samples	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • the sample is being transported to a laboratory for the purpose of testing; or • the sample is being transported back to the sample collector after testing.	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 CFR §261.4(d)(1) 40 CFR §261.4(d)(1)((i) 40 CFR §261.4(d)(1)(ii)	
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements. • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 CFR §261.4(d)(2)(i) 40 CFR §261.4(d)(2)(i)(A) 40 CFR §261.4(d)(2)(i)(B)	
Transportation of *hazardous materials*	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 CFR §§ 171-180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material – **applicable**	49 CFR § 171.1(c)	

ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CWA = Clean Water Act of 1972
DEACT = deactivation
DOT = U.S. Department of Transportation
EPA = U.S. Environmental Protection Agency
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
NPDES = National Pollution Discharge Elimination System
POTW = publicly owned treatment works
RCRA = Resource Conservation and Recovery Act of 1976
TBC = to be considered
UTS = Universal Treatment Standard

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Table 3-2. Effluent Concentration Limits for Outfalls 006B1 and 006B2, Mississippi Phosphates Corp. Site

		Daily Minimum	Daily Maximum
pH	units	6	9

State of Mississippi Water Pollution Control Permit MS0003115, October 15, 2015

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Table 6-1. Comparative Analysis of Removal Alternatives for Closure of the East Gypsum Stack, Mississippi Phosphates Corp. Site

Criterion	Alternative 1 *No Action*	Alternative 2A *Partial LLDPE Liner Across EGS*	Alternative 2B *Complete LLDPE Liner Across EGS*	Alternative 3A *Close Pond 5, Excavate North Ponds*	Alternative 3B *Close Pond 5, Cap North Ponds In Situ*	Alternative 4 *Close Pond 6 and WRD*
Effectiveness Score						
Overall Protection of Public Health and Environment	Not protective. Would not meet RAOs.	Would meet RAO for reducing volume of water requiring treatment. Would leave phosphogypsum materials in place and rely on existing slurry wall and underdrain to limit leachate impacts to groundwater.	Would meet RAO for reducing volume of water requiring treatment. Would leave phosphogypsum materials in place and rely on existing slurry wall and underdrain to limit leachate impacts to groundwater.	Would meet RAO for reducing volume of water requiring treatment. Would disperse lime sludge from water treatment by incorporating into soil cap.	Would meet RAO for reducing volume of water requiring treatment. Would leave lime sludge from water treatment in place.	Would meet RAO for reducing volume of water requiring treatment. Combined with other alternatives would eliminate storage of contaminated water at the EGS.
Compliance with ARARs						
Long-Term Effectiveness and Permanence	No reduction in residual risk; not permanent.	Effective. Will increase physical stability of the EGS and decrease the volume of water requiring treatment.	Effective. Will increase physical stability of the EGS and decrease the volume of water requiring treatment.	Effective. Will decrease the volume of water requiring treatment by a greater amount than Alternative 2A. Would incorporate lime sludge into soil cap at Pond 5.	Effective. Will decrease the volume of water requiring treatment. Would leave lime sludge in place protected by geotextile liner and soil cap.	Effective. Will decrease the volume of water requiring treatment. Would incorporate lime sludge from *in situ* treatment into soil cap at Pond 6.
Reduction of Toxicity, Mobility, and Volume through Treatment	No reduction in the volume of water requiring treatment.	Will reduce the volume of water requiring treatment by 39% over Alternative 1 assuming an average precipitation year.	Will reduce the volume of water requiring treatment by 39% over Alternative 1 assuming an average precipitation year.	Will reduce the volume of water requiring treatment by about 110 Mgal over Phase 1 construction and when combined with Phase 1 by 63% over Alternative 1 assuming an average precipitation year.	Will reduce the volume of water requiring treatment by about 110 Mgal over Phase 1 construction and when combined with Phase 1 by 63% over Alternative 1 assuming an average precipitation year.	Will reduce the volume of water requiring treatment by about 164 Mgal over Phases 1 and 2 construction and when combined with Phases 1 and 2 by more than 98% over Alternative 1 assuming an average precipitation year.
Short-Term Effectiveness	None.	Construction will increase truck traffic in the area and would require dust control to limit emissions during construction. Could potentially require discharge of partly treated water from Ponds 3 and 4 to facilitate construction. Could potentially increase employment in the area.	Construction will increase truck traffic in the area and would require dust control to limit emissions during construction. Could potentially require discharge of partly treated water from Ponds 3 and 4 to facilitate construction. Could potentially increase employment in the area.	Construction will increase truck traffic in the area and would require dust control to limit emissions during construction. An estimated 72,800 truck trips are required to remove lime sludge and bring soil backfill. Could potentially require discharge of partly treated water from Pond 5 to facilitate construction. Could potentially increase employment in the area.	Construction will increase truck traffic in the area and would require dust control to limit emissions during construction. Could potentially require discharge of partly treated water from Pond 5 to facilitate construction. Could potentially increase employment in the area.	Construction will increase truck traffic in the area and would require dust control to limit emissions during construction. Could potentially require discharge of partly treated water from Pond 6 to facilitate construction. Could potentially increase employment in the area.
Implementability Score	**3.7**	**4.7**	**5.0**	**5.0**	**5.0**	**5.0**
Technical and Administrative Feasibility	Easily implemented.	Technically and administratively implementable.	Technically and administratively implementable.	Technically and administratively implementable.	Technically and administratively implementable.	Technically and administratively implementable.
Availability of Technology	None.	Relies on commonly used construction equipment and	Relies on commonly used construction equipment and	Relies on commonly used construction equipment and	Relies on commonly used construction equipment and	Relies on commonly used construction equipment and

Table 6-1. Comparative Analysis of Removal Alternatives for Closure of the East Gypsum Stack, Mississippi Phosphates Corp. Site

Criterion	Alternative 1 *No Action*	Alternative 2A *Partial LLDPE Liner Across EGS*	Alternative 2B *Complete LLDPE Liner Across EGS*	Alternative 3A *Close Pond 5, Excavate North Ponds*	Alternative 3B *Close Pond 5, Cap North Ponds In Situ*	Alternative 4 *Close Pond 6 and WRD*
		techniques. Identifying a sufficient quantity of clay borrow soil could be a limitation.	techniques. Identifying a sufficient quantity of borrow soil could be a limitation.	techniques. Identifying a sufficient quantity of borrow soil could be a limitation.	techniques. Identifying a sufficient quantity of borrow soil could be a limitation.	techniques. Identifying a sufficient quantity of borrow soil could be a limitation.
State and Community Acceptance	Will be determined following public meeting and comment period. Not expected to be acceptable.	Will be determined following public meeting and comment period. Expected to be acceptable.	Will be determined following public meeting and comment period. Expected to be acceptable.	Will be determined following public meeting and comment period. Expected to be acceptable.	Will be determined following public meeting and comment period. Expected to be acceptable.	Will be determined following public meeting and comment period. Expected to be acceptable.
Cost						
Construction Cost	**$0**	**$26,741,887**	**$26,411,109**	**$39,572,349**	**$15,535,420**	**$18,325,287**
Total Cost	**$0**	**$31,769,362**	**$31,376,398**	**$47,011,950**	**$18,456,080**	**$21,770,441**

Table 6-2. Summary of Estimated Costs for Removal Action Alternatives

Alternative	Construction Cost	Total Cost
1. No Action	$0	$0
2A. Partial LLDPE Liner across EGS	$26,741,887	$31,769,362
2B. Complete LLDPE Liner across EGS	$26,411,109	$31,376,398
3A. Close Pond 5, Excavate North Ponds	$39,572,349	$47,011,950
3B. Close Pond 5, Cap North Ponds in Place	$15,535,420	$18,456,080
4. Close Pond 6 and WRD	$18,325,287	$21,770,441

Total cost includes 8% contractor fee and 10% contingency

See Appendix B for detailed cost estimates

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Table 6-3. Summary of Relative Effectiveness, Implementability, and Cost for Removal Action Alternatives

Criterion and Sub-Criterion	Alternative 1 No Action	Phase 1: Alternative 2A Partial Liner	Phase 1: Alternative 2B Complete Liner	Phase 2: Alternative 3A Close Pond 5; Excavate North Ponds	Phase 2: Alternative 3B Close Pond 5; Cap North Ponds in Place	Phase 3: Alternative 4 Close Pond 6 & WRD
Effectiveness (average of sub-criteria)	**2.0**	**3.8**	**3.8**	**4.3**	**4.5**	**4.5**
Overall Protection	1	4	4	5	4	5
Compliance with ARARs						
Long-Term Permanence	1	4	4	5	5	5
Reduction in Toxicity, Mobility, & Volume	1	4	4	5	5	5
Short-Term Effectiveness	5	3	3	2	4	3
Implementability (average of sub-criteria)	**3.7**	**4.7**	**5.0**	**5.0**	**5.0**	**5.0**
Technical and Administrative Feasibility	5	5	5	5	5	5
Availability of Technology	5	4	5	5	5	5
State and Community Acceptance	1	5	5	5	5	5
Total Cost[1]	**$5,341,000 [2]**	**$31,769,362**	**$31,376,398**	**$47,011,950**	**$18,456,080**	**$21,770,441**

Criterion Scores: 1 = poor; 2 = fair; 3 = average; 4 = good; 5 = very good

1 - Total cost is the construction cost plus 8% contractor fee and 10% contingency

2 - Cost for Alternative 1 is $0; cost shown is the current cost of annual water treatment assuming average rainfall (net precipitation of 44.7 inches)

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Table 6-4. Estimated Change in EGS Elevation with Consolidation Over Time Following Capping

Current EGS Elevation (ft)	Estimated Settlement in 10 Years (ft)
110	27.0
50	12.0
20	4.5

From URS (2013)

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Table 6-5. Estimated Reduction in Water Treatment Cost by Construction Phase

	Contributing Area (acres)	Annual Water Volume (gal)[1]	Annual Water Treatment Cost[2,3]	Percent Cost Reduction from Baseline
No Action	380.5	461,850,000	$5,559,000	---
After Phase 1	225.6	281,130,000	$3,384,000	39.1
After Phase 2	135.3	171,530,000	$2,065,000	62.9
After Phase 3	0 (EGS leachate only)	7,300,000	$88,000	98.4

1 Includes 7,300,000 gal EGS leachate after completion of Phase 1.

2 Additional one-time treatment costs would be incurred during each construction phase as ponds are treated and discharged; these costs are not shown.

3 Assumes average treatment cost of $0.012036 per gallon (Kemron Environmental Services, 2017).

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Figures

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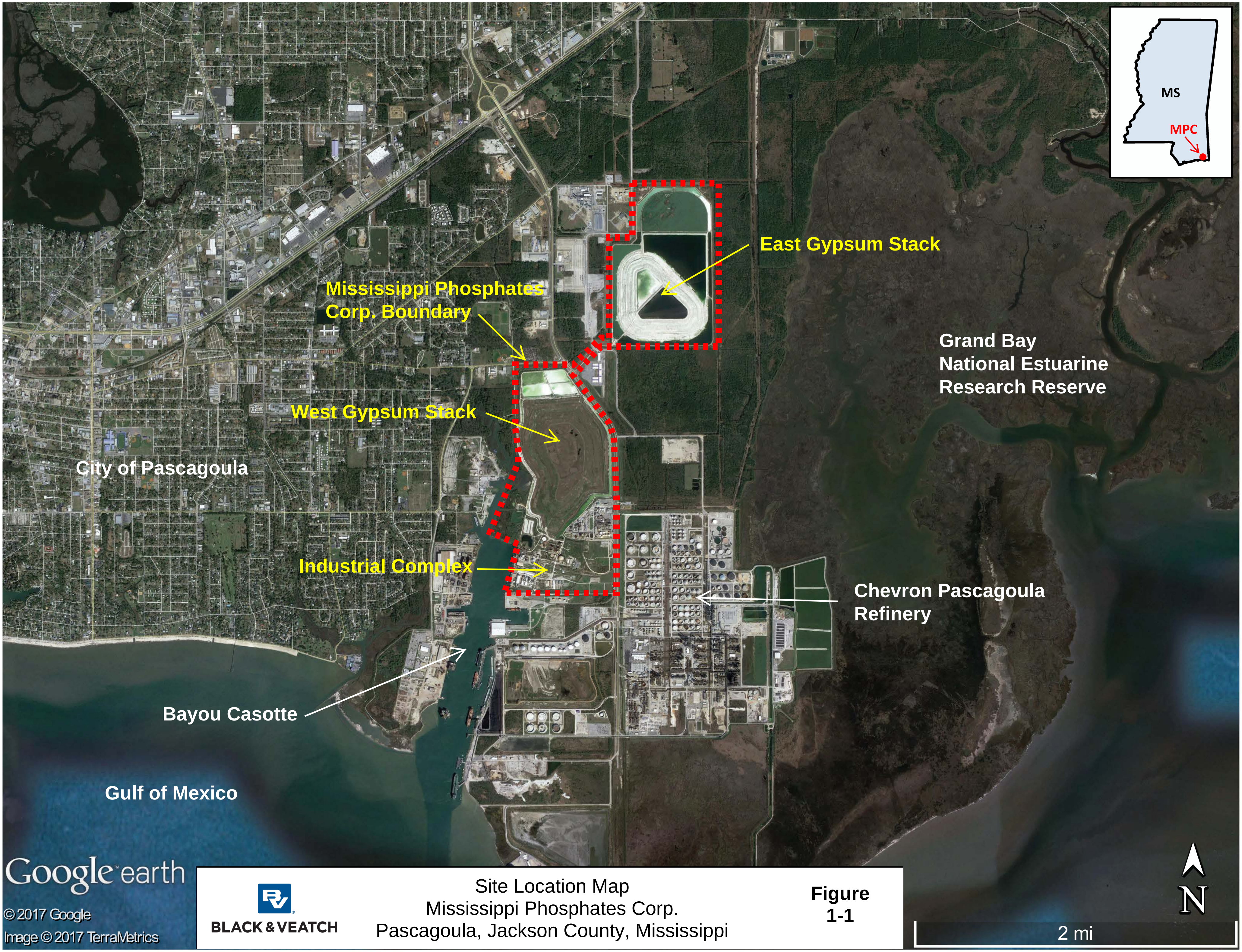

Site Location Map
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

Figure 1-1

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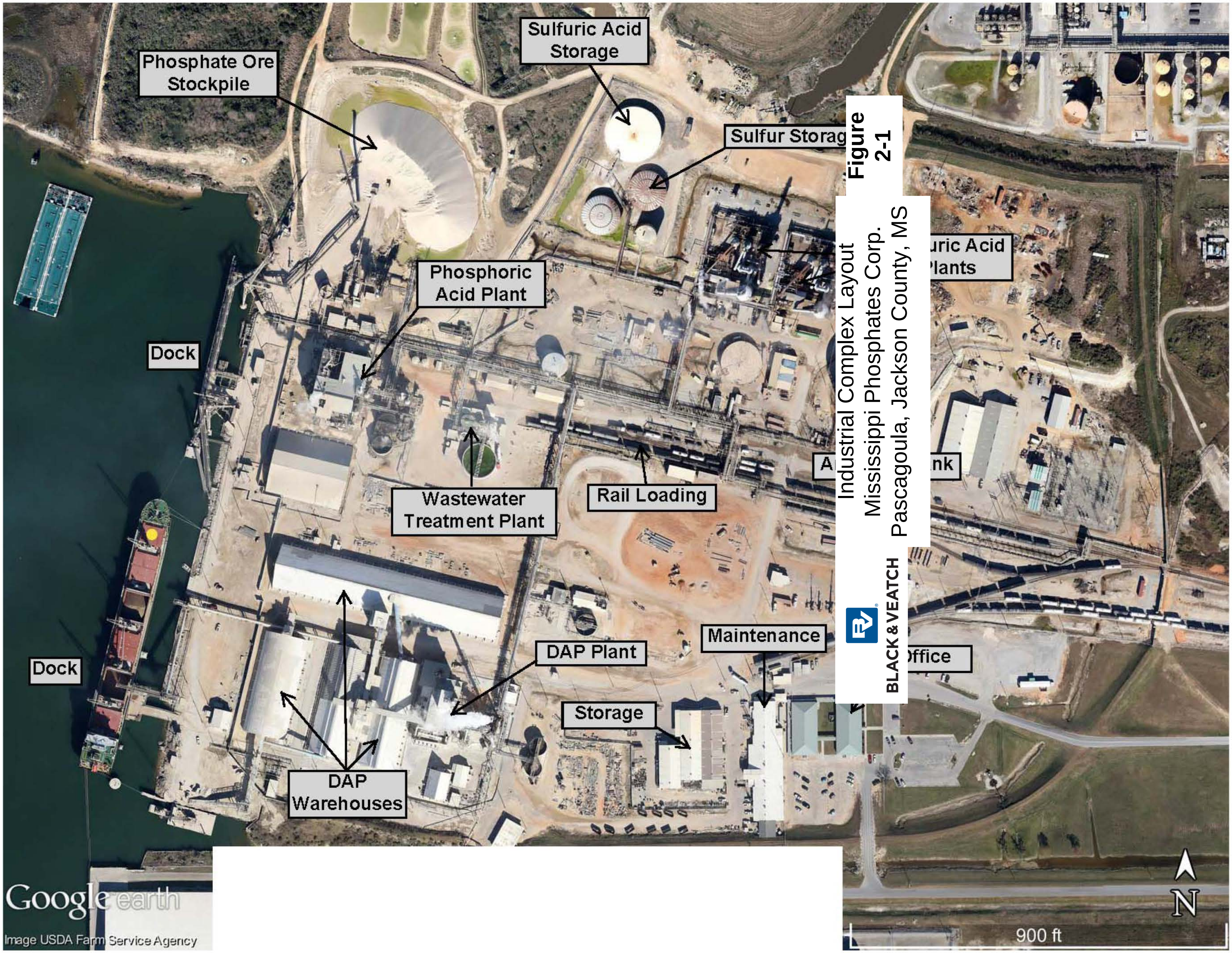

Figure 2-1

Industrial Complex Layout
Mississippi Phosphates Corp.
Pascagoula, Jackson County, MS

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West Gypsum Stack and North Ponds
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi
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Figure
2-2
Treatment Ponds
North Ponds
Complex
West Prong
Bayou Casotte
West Gypsum
Stack
DAP Ditch
DAP Ditch
Outfalls
001 & 002
S-Pond
Bayou Casotte
Water Treatment
Plant
Outfall 003
Google earth
© 2017 Google
3000 ft
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Figure 2-3. Photos of the North Ponds at the West Gypsum Stack in October 2017. Top: Northeastern pond, looking southeast. Bottom: Northwestern pond looking southwest.

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Features of the East Gypsum Stack
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

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Figure 2-4

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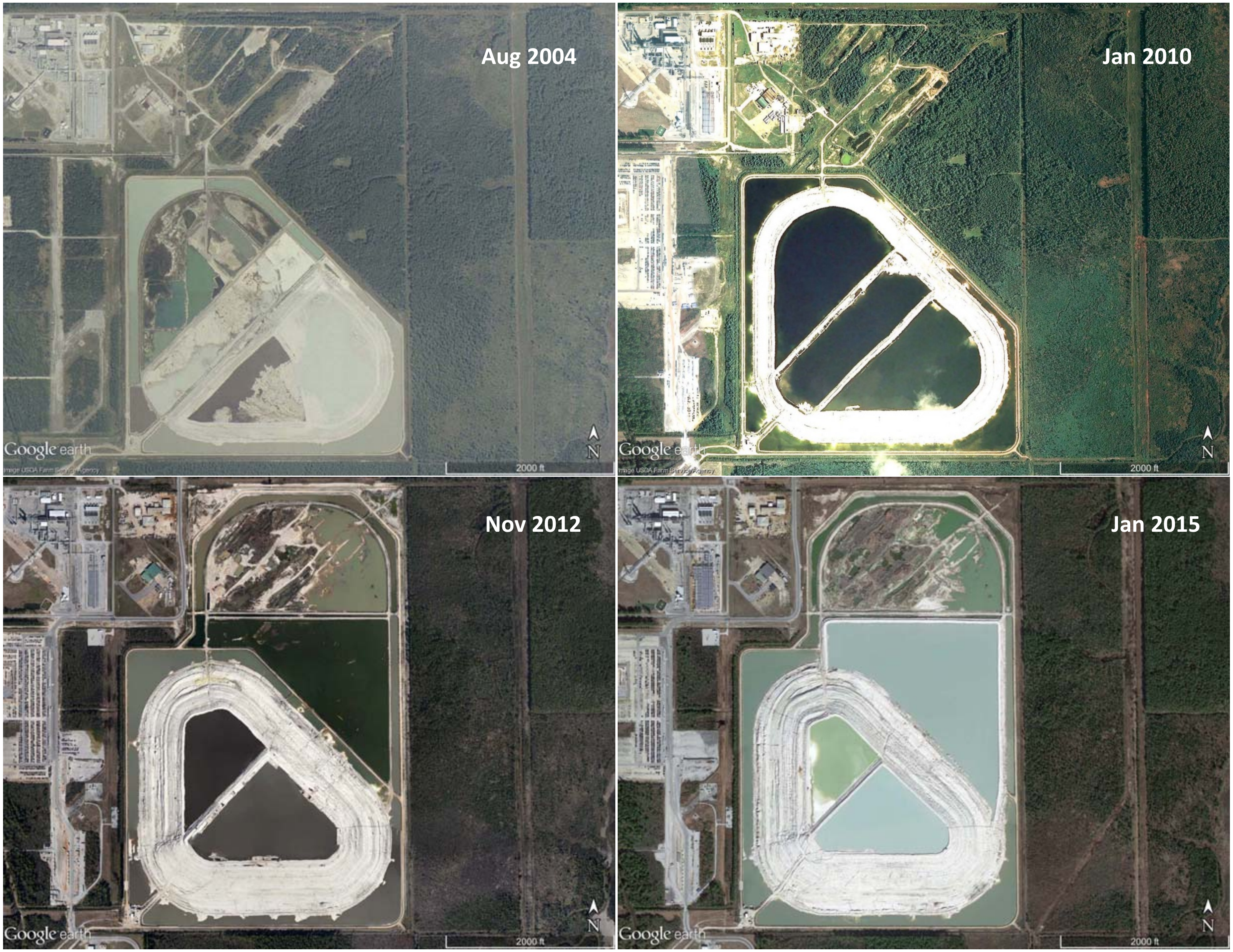

Figure 2-5. Aerial imagery showing the growth of the EGS over time.

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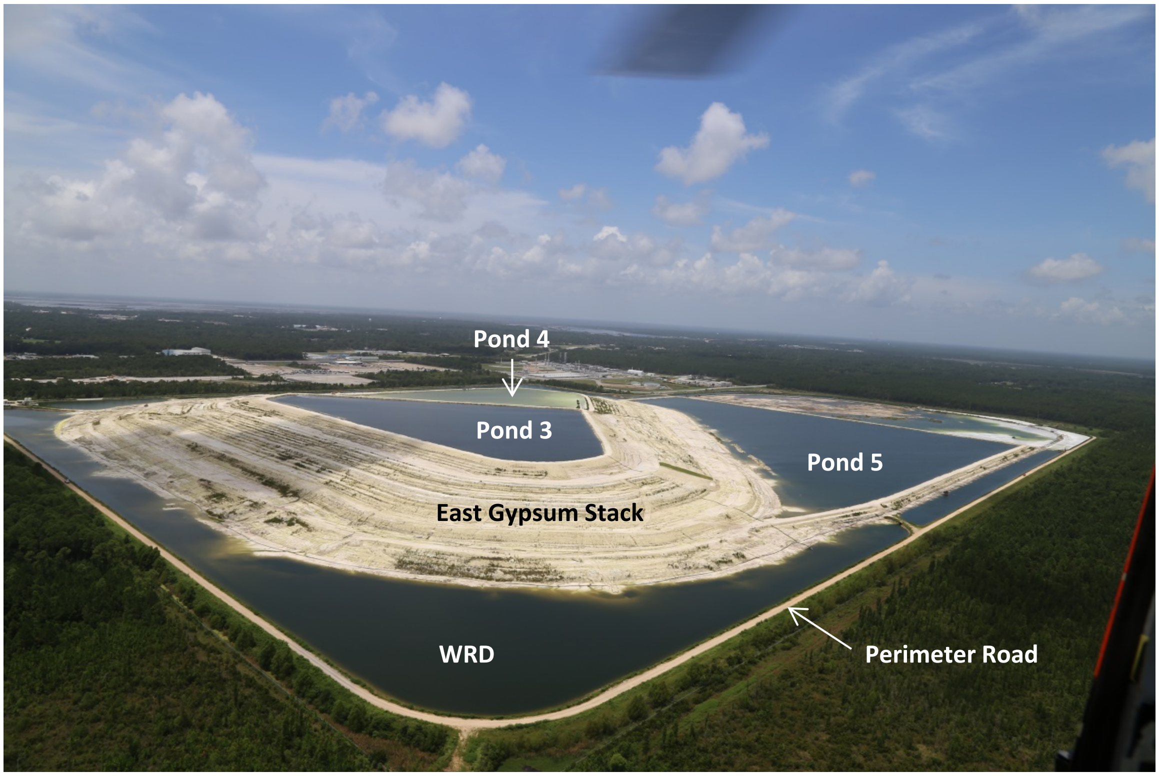

Top: Looking NW from SE corner. Bottom: Looking S from N end of EGS.

BLACK & VEATCH	Oblique Aerial Views of East Gypsum Stack Mississippi Phosphates Corp. Pascagoula, Jackson County, Mississippi	**Figure 2-6**

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Figure 2-7. Photos of Pond 3 at the EGS showing wave cut steepening and erosion of the containment dike taken on October 5, 2017. Top: Looking east at northeast dike wall; Bottom: Looking southwest at southwest dike wall.

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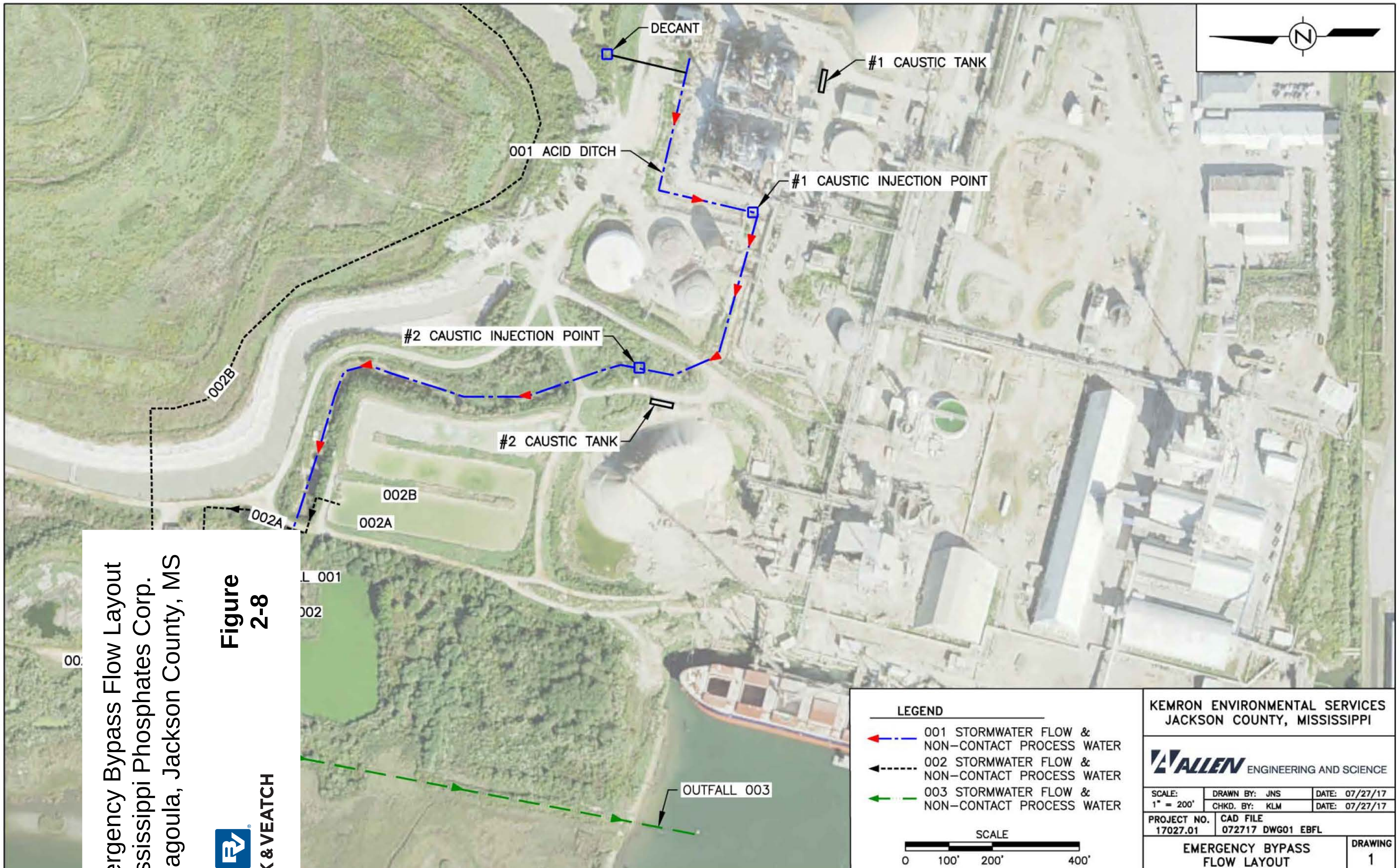

Emergency Bypass Flow Layout
Mississippi Phosphates Corp.
Pascagoula, Jackson County, MS

Figure 2-8

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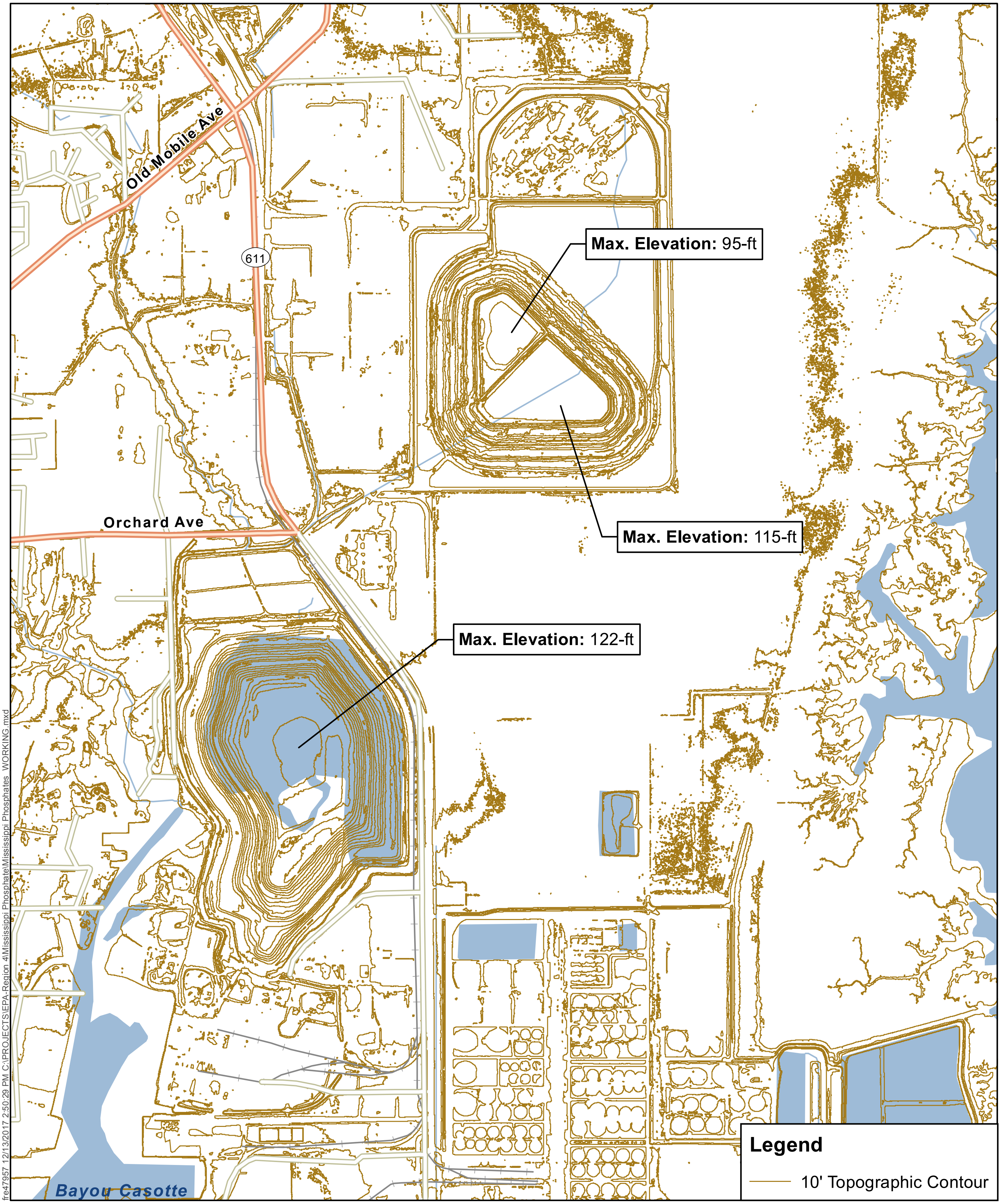

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LiDAR Topography
Mississippi Phosphates Corp. Site
Pascagoula, Jackson County, Mississippi

Figure 2-9

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Phase 1 Removal Area - East Gypsum Stack
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

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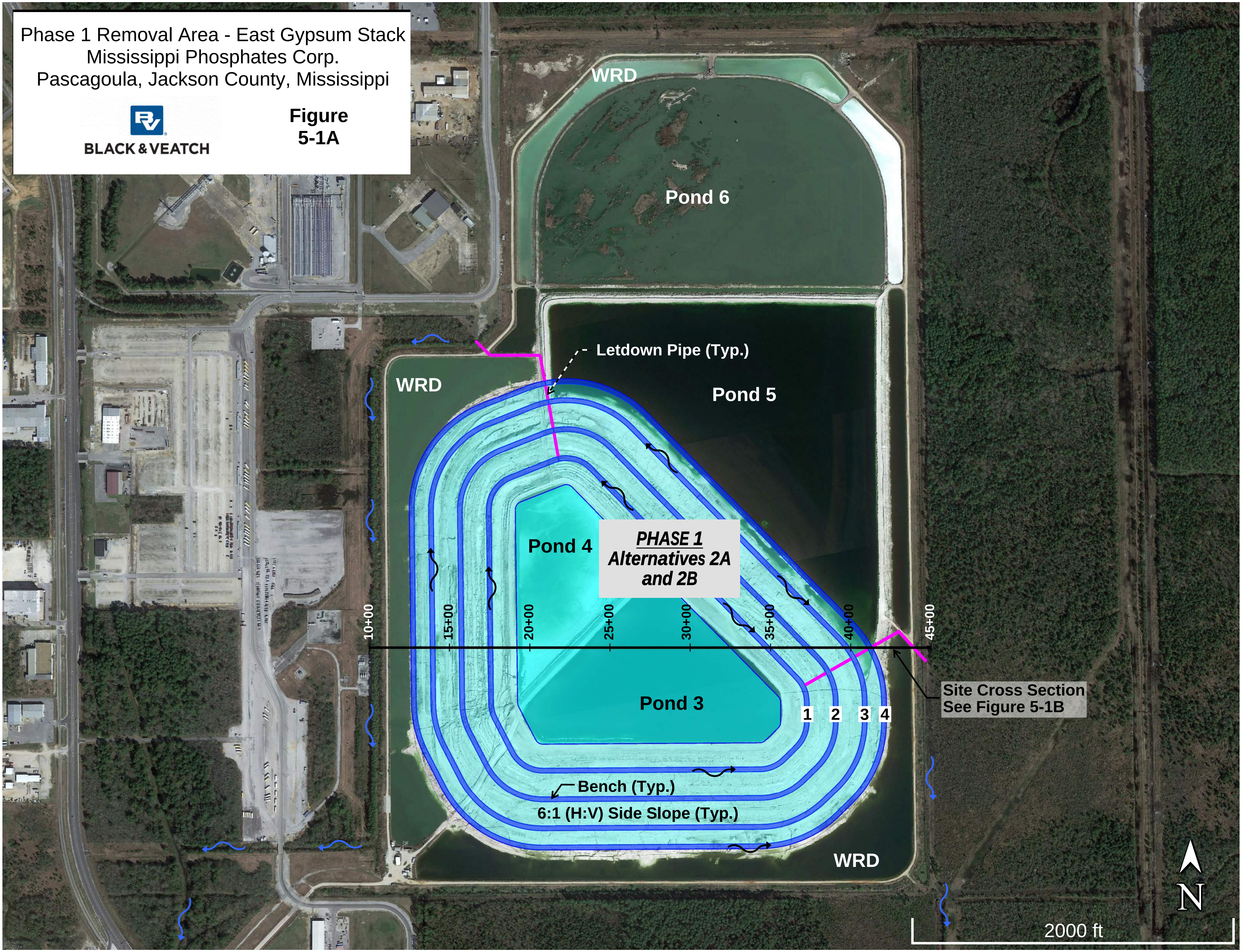
Figure 5-1A



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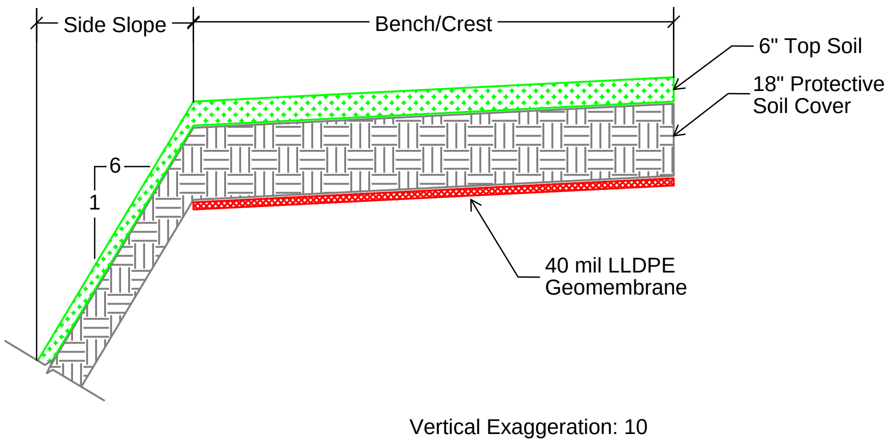
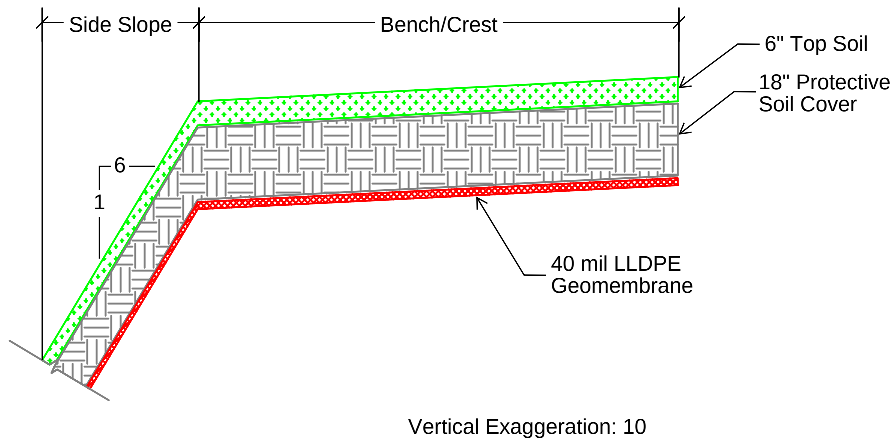
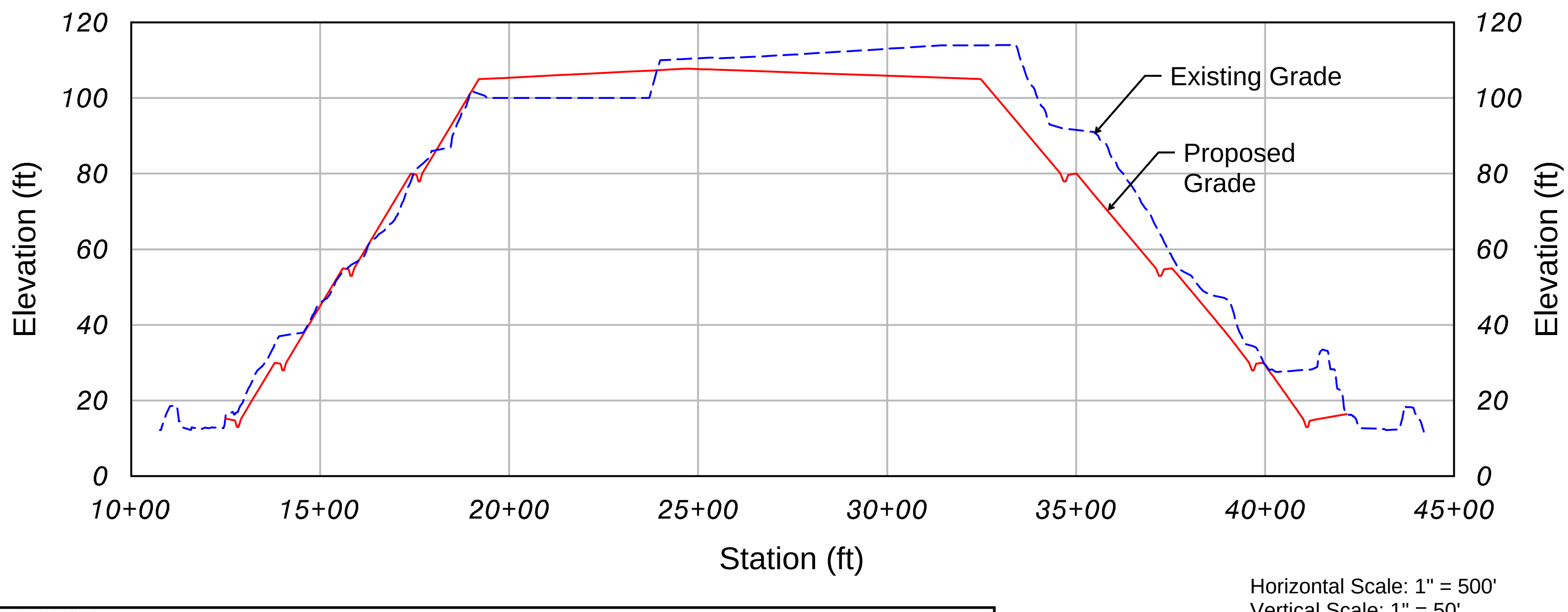
Alternative 2A Cover Profile



Alternative 2B Cover Profile



Phase 1 EGS Site Cross Section



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Phase 1 Removal Area - Cross Sections
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

Figure 5-1B

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Phase 2 Removal Area - East Gypsum Stack
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

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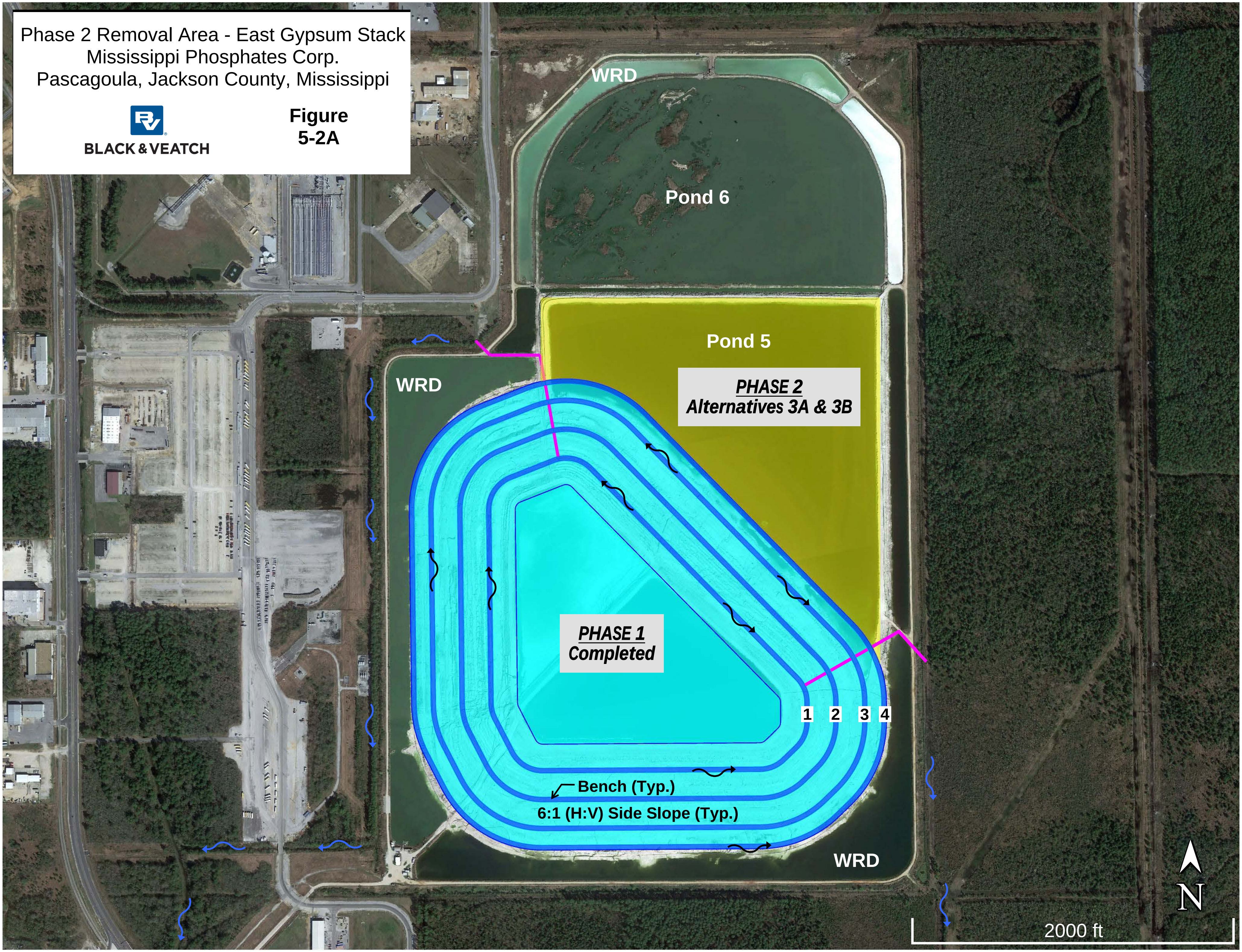
Figure 5-2A



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Phase 2 Removal Action Area - North Ponds
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi
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Figure
5-2B
North Ponds
PHASE 2
Alternatives 3A & 3B
West Gypsum
Stack
DAP Ditch
DAP Ditch
N
3000 ft
Google earth
© 2017 Google

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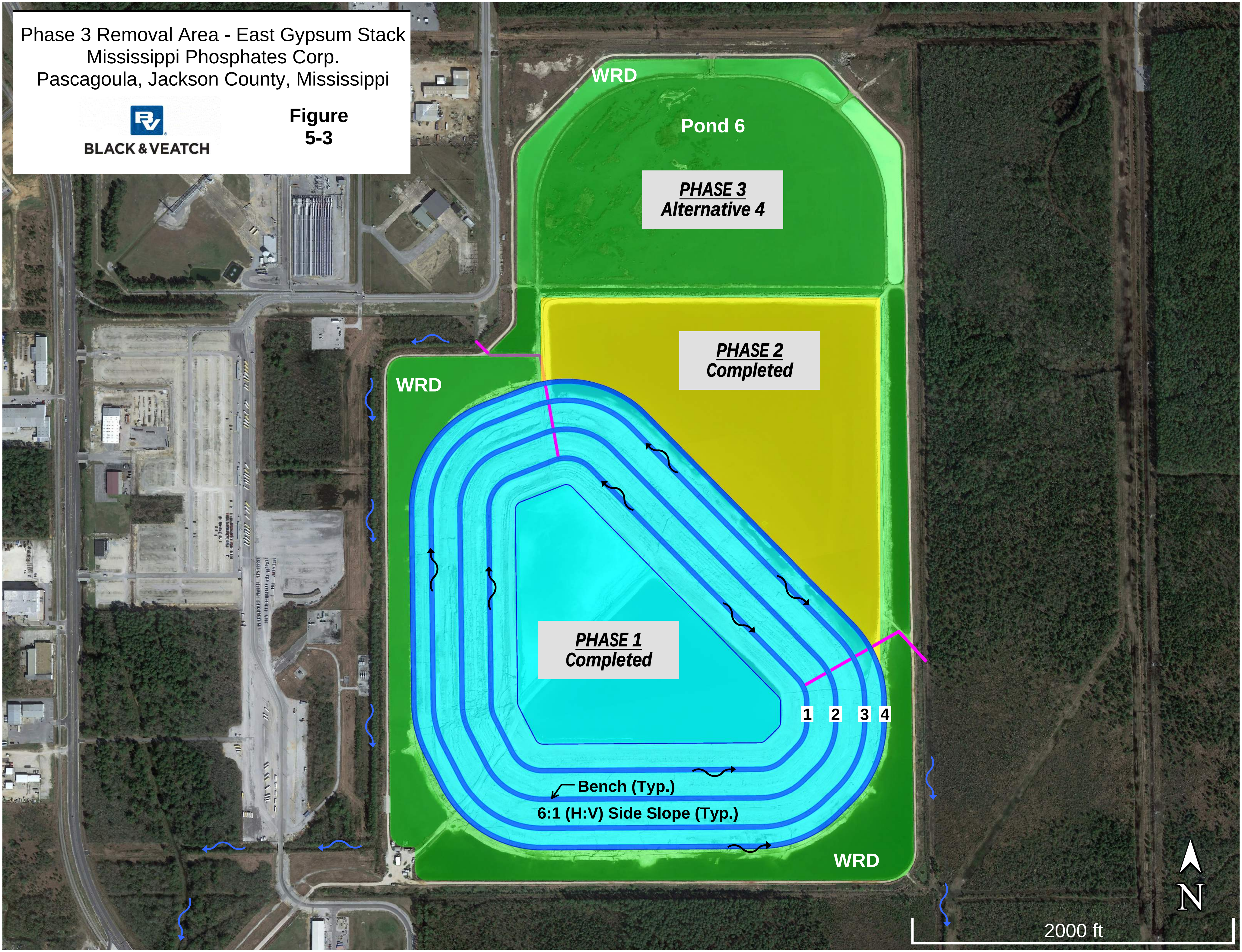

Phase 3 Removal Area - East Gypsum Stack
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

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Figure
5-3

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Appendix A. Streamlined Risk Assessment

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STREAMLINED RISK EVALUATION

REVISION 0

Mississippi Phosphate Corporation

Pascagoula, Mississippi

Prepared Under:
U.S. EPA Contract No. EP-S4-09-02
U.S. EPA Task Order No. 090
Black & Veatch Project No. 049090
DCN: 49090-0107-01-A-02868R0

Prepared For:
U.S. Environmental Protection Agency Region 4
Superfund Division
Atlanta, Georgia

Prepared By:

Black & Veatch Special Projects Corp.
1120 Sanctuary Parkway, Suite 200
Alpharetta, Georgia 30009

DECEMBER 2017

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Table of Contents

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Acronyms and Abbreviations

Black & Veatch	Black & Veatch Special Project Corp.
COC	chemical of concern
CSM	conceptual site model
DAP	diammonium phosphate
EE/CA	Engineering Evaluation/Cost Analysis
EGS	East Gypsum Stack
EPA	U.S. Environmental Protection Agency
ft	feet/foot
HRS	hazard ranking system
LIDAR	light detection and ranging
MCL	Maximum Contaminant Level
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
mg/L	milligrams per liter
Mgal	million gallons
MPC	Mississippi Phosphate Corporation
MS	Mississippi
NERR	National Estuarine Research Reserve
NTCRA	Non-Time-Critical Removal Action
O&M	operations and maintenance
pH	hydrogen ion concentration
Site	Mississippi Phosphates Corporation Site
s.u.	standard units
TMDL	Total Maximum Daily Load
WGS	West Gypsum Stack
WRD	water return ditch

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1.0 Introduction

This appendix presents the streamlined risk evaluation developed for the Removal Action Alternatives being considered by the U.S. Environmental Protection Agency (EPA) as part of an Engineering Evaluation/Cost Analysis (EE/CA) for the Mississippi Phosphates Corporation (MPC) Site. In accordance with the EPA guidance for preparing EE/CAs, this streamlined evaluation focuses on closure alternatives for the East Gypsum Stack at the MPC Site and is being performed based on the EPA guidance for Non-Time-Critical Removal Action (NTCRA) projects (USEPA, 1993).

Unlike the Remedial Investigation/Feasibility Study process which often seeks to determine whether remedial action is necessary, the NTCRA process focuses on accelerated design and implementation of removal actions to reduce exposure of humans and ecological receptors to site contaminants. The NTCRA guidance suggests the use of risk assessment to the extent necessary to support decisions on design and selection of the removal alternative. NTCRA risk analysis should be streamlined and focused on the specific media or sources for which the removal decision is needed. As a result, uncertainty associated with streamlined risk assessments is expected to be high, and not all exposure pathways are evaluated. However, the analysis is conservatively biased to ensure protection of human health and the environment for the pathways that are addressed.

The goal of the MPC EE/CA closure plan for the East Gypsum Stack is to reduce the quantity, and improve the quality of surface water and leachate that currently requires treatment to prevent an uncontrolled release of wastewater that would be detrimental to Bayou Casotte and/or to Grand Bay Estuary.

1.1 BACKGROUND

Detailed discussions of the project background including site description, site history, and the associated environmental impacts are provided in the EE/CA report.

The MPC site, located at 601 Industrial Road in Pascagoula, MS, consists of approximately 1,080 acres and is serviced by a deep water dock, rail, and highway. The Site is bounded on the west by Bayou Casotte, on the south and southeast by the Chevron Pascagoula Refinery, on the east by the Grand Bay National Estuarine Research Reserve, and on the north by a variety of marine and industrial service and chemical production companies (Figure 1).

The MPC site comprises an industrial complex consisting of sulfuric acid plants, a diammonium phosphate (DAP) production facility, a wastewater treatment plant, various storage tanks, support buildings, and shipping infrastructure; two large waste disposal areas (east and west gypsum stacks and associated ponds and water storage facilities); and pumping and piping infrastructure to move water across the Site, slurry waste materials, and dispose of water through an outfall in Bayou Casotte.

MPC began operation in the late 1950s; and ultimately filed for bankruptcy and ceased production in December 2014. MPC manufactured DAP fertilizer by reacting sulfuric acid (produced on-site) with phosphate ore (imported from Morocco) to produce phosphoric acid. Phosphoric acid was then reacted with ammonium to produce the granulated DAP product. The phosphoric acid step of the process produced a waste by-product known as phosphogypsum which was disposed of on-site in two gypsum stacks. An estimated 5,000 tons of the gypsum waste were produced daily. Phosphogypsum is primarily composed of calcium sulfate, silicon, phosphate, fluoride, and other metals. The West Gypsum Stack

(WGS) was closed in the early 2000's. While the WGS still generates leachate and has environmental issues, it is not the primary focus of this EE/CA which is for the East Gypsum Stack (EGS).

The EGS area remains exposed and contains approximately 750 million gallons (Mgal) of low hydrogen ion concentration (pH) water (approximately pH 2.5 to 3 standard units [s.u.]). More than 9 Mgal of contaminated water is generated with every one inch of rainfall. The gypsum contains low levels of radioactivity inherent in the ore rock and the material is acidic as a byproduct of its production. Groundwater contained within the stacks also has low pH (2 to 3 s.u.) and elevated concentrations of fluoride, phosphorous, ammonia, and heavy metals. The gypsum solids also contain low levels of radioactivity that occurs naturally in the ore rock.

As part of the bankruptcy, two trusts were created to manage the remaining assets: 1) a Liquidation Trust to market and sell facility assets; and 2) an Environmental Trust to operate the wastewater treatment plant and to maintain the gypsum stacks to the extent of its assets. The EPA Region 4 Removal Program assumed financial responsibility and daily operations at the MPC Site in February 2017. Daily water treatment volumes average about 5 Mgal per day (1 Mgal via the mechanical treatment plant and 4 Mgal via the *in situ* treatment plant), and the monthly expenditure rate is approximately $1 million per month. This is not a sustainable pace for the Region 4 Removal Program, so the MPC site was proposed to the National Priorities List in August 2017 with final listing pending.

This EE/CA evaluates closure (capping) of the EGS and associated ponds that cumulatively generate approximately 440 Mgal of contact water per year. The primary threat to the environment is the likelihood of overflows of acidic contaminated water from the existing water storage and treatment system that could adversely impact Bayou Casotte or Grand Bay Estuary.

This Streamlined Risk Assessment is divided into six sections. Chapter 2 describes the site and surrounding land use. Section 3 describes the chemicals of concern and their potential toxicity. Section 4 discusses exposure pathways, receptors and depicts a Conceptual Site Model (CSM). Characterization of risks and a summary conclusion is presented in Section 5, and reference citations are listed in Section 6.

2.0 Site Description and Surrounding Environment

The unlined EGS and associated ponds comprise an area of about 350 acres (Figure 2). It is approximately 120 feet (ft) high with outer terraced slopes of about 7H:1V (Horizontal:Vertical) on the lower levels and 4H:1V on the upper levels with sparse volunteer vegetation. The stack is topped by Pond 3 (24.8 acres) and Pond 4 (14.5 acres) which retain rain water and excess water pumped from the water return ditch (WRD). Water elevations vary in Ponds 3 and 4 and they are presently maintained at lowered levels due to concern about the stability of their containment berms. The stack is surrounded on the west, south, and southeast sides by the WRD which collects leachate from the underdrain, process wastewater, rainfall runoff from the outer slopes of the EGS, and direct precipitation. The WRD occupies 48.1 acres and has an estimated capacity of 130 Mgal (EPA, 2017a). Leachate discharges to the WRD at an average rate of about 0.63 Mgal/day (EPA, 2016). An underdrain system also routes water from within stack limits to the WRD.

Pond 5, with an estimated capacity of 200 Mgal (EPA, 2017a) occupies 60.3 acres and is used to manage water pumped from the WRD, direct runoff from the northeastern slope of the EGS, and direct precipitation. The Pond has a maximum depth of about 15 ft based on the light detection and ranging (LIDAR) data.

Pond 6 has an estimated capacity of 130 Mgal (EPA, 2017a), but is only partly utilized for water storage. The western portion of the pond is presently used for disposal of lime sludge formed by water treatment at the *in situ* plant. Sludge removed from the WRD is tilled into the subgrade of Pond 6. Pond 6 received untreated water from Pond 5 during a one-time, controlled event (EPA, 2016). The pond presently retains contaminated wastewater and precipitation that meets all discharge requirements except for phosphorus.

Figure 2 depicts the location of the North Ponds at the WGS. The North Ponds comprise a complex of four ponds that contain lime sludge created by the pre-treatment of wastewater. The North Ponds cover an area of about 15 acres; details of their construction are unknown. The ponds are filled with lime sludge that has an estimated thickness of 15 ft. The two northern ponds presently receive only rainfall runoff; the two southern ponds are connected to the DAP ditch which receives leachate from the WGS. These four ponds have a total estimated capacity of 24 Mgal (EPA, 2016).

2.1 WATER TREATMENT

Water from the WGS and some portion of water from the EGS is treated at the mechanical treatment plant located on the industrial complex (Figure 2). Treatment consists of adding slaked lime to raise pH from about 2.5 to 4.5 which removes dissolved fluoride by precipitation of calcium fluoride (EPA, 2016). Additional lime is added to raise pH to 10.5 which precipitates calcium phosphate. Ammonia is removed in a third step in which pH is raised to 11.5 and the water is aerated in the S-Pond. Sulfuric acid is added to water discharging from the S-Pond to reduce pH to 6 to 9 prior to discharge to Bayou Casotte through diffuser Outfall 003. The mechanical treatment plant has a treatment capacity of about 1 Mgal/day.

Water at the EGS is also treated at the *in situ* treatment plant located in the WRD on the east side of Pond 6 (Figure 2). Lime slurry from the mechanical treatment plant is pumped to the *in situ* plant and discharged into the WRD where it is mixed with untreated water from the WRD or Pond 5. Mixing is accomplished using tractor pumps and aided as necessary using a long-reach track hoe. Treated water is removed from the WRD on the west side of Pond 6 and routed to Outfall 002 where it is pH adjusted prior to discharge through Outfall 003. The *in situ* plant can treat up to 4 Mgal/day.

As necessary to prevent overflow of the system or dangerously high water levels in the various ponds, water is discharged to Bayou Casotte as an emergency release. In these cases, untreated water is pH adjusted to pH 6 to 9 using sodium hydroxide prior to discharge through Outfall 003.

In 2004, Bayou Casotte was listed as an impaired water body under Section 303(d) of the Clean Water Act for un-ionized ammonia and total toxics. To address this concern, the EPA developed a Total Maximum Daily Load (TMDL) for Bayou Casotte for un-ionized ammonia and total toxics (EPA, 2007). A National Pollutant Discharge Elimination System (NPDES) permit (MS0003115) was issued to MPC with specific waste load allocations and pertain to discharge Outfall 003.

Currently, a portion of Bayou Casotte is listed as impaired for organic enrichment and low dissolved oxygen (Mississippi Department of Environmental Quality [MDEQ], 2016b). This designation applies to the confluence of the east and west prongs of the bayou to the turning basin. The MPC discharge Outfall 003 is currently located in the upper end of the turning basin.

2.2 SURROUNDING LAND USE

As shown in Figure 1-1, land use to the east lies within the Bayou Casotte industrial complex. There is approximately 0.5 mile of undisturbed forested wetland area immediately to the south of the EGS and to the north of the stack. To the east, the forested wetland transitions to the Grand Bay National Estuarine Research Reserve. The future land use to the east is expected to remain the same. Residential land use occurs approximately 1 mile to the west. It is possible that some of the areas to the north and south of the EGS could become industrial; however future residential use is not anticipated.

According to the owner of a local bait shop, recreational fishing occurs within Bayou Casotte as well as in Mississippi Sound between Bayou Casotte and Horn Island and Petit Bois Island. The type of fish caught and consumed include speckled trout, white trout, ground mullet, flounder, red fish, mangrove snapper, sheep head, and crabs (as cited in EPA 2017b). Bayou Casotte and Mississippi Sound are tidally influenced and the Bayou rises and falls approximately 2 ft with the tide (USACE, 2014).

2.3 SENSITIVE ECOSYSTEMS, VEGETATION AND WILDLIFE

Vegetation observed around the EGS and pond areas is sparse and limited to a few herbaceous plants and shrubs. Bird species noted at the site included the black-bellied whistling duck, black-necked stilt, killdeer, red-winged blackbird, osprey, and great blue heron (Eco Systems, Inc., 2010). The presence of these birds suggests that the phosphate ponds may provide an “attractive nuisance” due to their large sizes relative to the adjacent marsh to the east.

The Grand Bay National Estuarine Research Reserve (NERR) lies east of the site and is managed by the Mississippi Department of Marine Resources as part of the National Oceanic and Atmospheric Administration’s National Estuarine Research Reserve System. The Grand Bay NERR is comprised of approximately 18,000 acres and contains intertidal estuarine salt marshes, salt pannes, bays and bayous, pine savannas and other terrestrial habitats that are unique to the coastal zone. This sensitive ecosystem nearest the EGS is primarily salt water marsh habitat that includes Bangs Lake and Bayou which drain into Point Aux Chenes Bay.

The salt marsh consists largely of smooth cordgrass, black needlerush, saltmeadow cordgrass and other halophytic plants tolerant of saline conditions. Other vegetation in the flooded areas include slash pine, pond cypress, oaks, sweetgum, southern bayberry and threeawn grass. The benthic sediments account for a large portion of the bayous, bays and shoreline areas within the Grand Bay NERR. Over 100 macrofauna taxa have been identified in the NERR and include numerous species of polychaetes, molluscs, crustaceans and echinoderms (McLelland, 2004). The NERR also provides an ideal environment for estuarine and freshwater fisheries along with numerous species of amphibians and reptiles. Birds are the most conspicuous wildlife component of the intertidal areas. These include herons, egrets, sandpipers, plovers, willets, gulls, ducks, and many others. Common mammals of the NERR include various bat species, swamp rabbits, muskrat, opossum and raccoon. The bottlenose dolphin and manatee are occasionally seen in the NERR (Peterson, et al. 2007).

Some recreational oyster harvesting occurs in the NERR; however, the Mississippi Department of Marine Resources (MDMR) has closed oyster harvesting in nearby Bangs Lake east of the Site.

Several federally listed threatened and endangered species occur along the coast of Jackson County such as the Kemp's Ridley Sea Turtle, the Leatherback Sea Turtle, West Indian manatee, Gulf sturgeon, Alabama red-bellied turtle, the Mississippi sandhill crane, and piping plover. Although Bayou Casotte is within these species' habitat ranges, these species are not likely to occupy the Bayou because it is not a preferred habitat and does not support their likely food sources.

2.4 PHOSPHATE CONTAMINATION EVENTS

The following description is largely taken from Lytle and Lytle (2007). On the morning of 14 April 2005, a catastrophic pollution event occurred along the western border of Grand Bay NERR. A breach occurred in the levee surrounding the retaining ponds (WRD) at MPC. Approximately 17.5 million gallons of untreated water were released from the ditch and ponds. MPC could not estimate the extent of release into Bangs Lake or to Bayou Casotte. The released wastewater had a pH of 2.2 - 2.4 and contained elevated levels of phosphorus (4,000 – 5,000 mg/L), ammonia (280 – 350 mg/L), and fluoride. The breach was apparently caused in part, by unusually high rainfall (> 17 inches) during 31 March - 11 April and new levee construction.

Damage to flora and fauna from this event was well documented. Approximately 20 acres of tidal marsh and 190 acres of upland habitats were killed or seriously damaged from the chemicals in the polluted water. The average oyster mortality in Bangs Lake was estimated to be 74 percent (MDMR, unpublished data). MDEQ sampled the fish and decapod populations and extrapolated their results to the area of Bangs Lake and estimated damage to local fisheries to be approximately $400,000 based on the market value.

The Grand Bay NERR System Wide Management Program station in Bangs Lake located 1.2 miles away from the spill site, recorded pH readings as low as 3.7 as the tide fell on the night of April 14. Eleven days later, when researchers became aware of the unreported spill, nutrient samples were taken from the lake. Phosphate levels were about 5,000 times greater than they had been the month before and chlorophyll a was nonexistent. Five weeks later when another set of nutrient samples were taken, phosphate levels remained about 500 times greater than before the spill and chlorophyll a was still nonexistent 2 kilometers (km) from the spill site (Lytle and Lytle, 2007).

Hurricane Katrina and Hurricane Rita struck the U.S. Gulf Coast August 29, and September 24, 2005, respectively. U.S. Geological Survey real-time instruments in Gautier, Mississippi recorded wind speeds up to 140 miles per hour and rainfall totals of approximately two feet (EPA, October 2005). Tidal surges in Bayou Casotte were reported to be as high as 20 ft during Hurricane Katrina. The storm surge from Hurricane Katrina resulted in a breach of the top of the cooling ditches surrounding the gypsum piles at MPC, thereby mixing water in the cooling ditches with ocean water and vice-versa. MPC released water into Bayou Casotte to reduce water levels in their holding ponds to prevent structural failure of the dyke system. The water was minimally treated prior to release. The release caused a large plume, believed to be from lime, to emanate from Outfall 003 of the facility.

In August 2013, MPC admitted discharging more than 38 million gallons of acidic wastewater that greatly exceeded their permit limits, resulting in the death of more than 47,000 fish and the closing of Bayou Casotte (DOJ, 2015). MPC entered a guilty plea and agreed to transfer 320 acres of adjacent property to become a part of the Grand Bay NERR. Also, in February 2014, MPC discharged oily wastewater from an open gate on a storm water culvert into Bayou Casotte, creating an oily sheen that extended approximately one mile down the bayou from MPC (DOJ, 2015).

The threat of potential future untreated overflows from dangerously high water levels in the EGS ponds, WRD and treatment system to Bangs Bayou or Bayou Casotte could again impair overall ecological function, wildlife and fish propagation, recreation and commercial fishing and shellfish harvesting.

3.0 Chemicals of Concern

Multiple investigations have been conducted by MPC and included collection of ground water, surface water, sediment, and soil samples (Eco-Systems Inc., 2013; 2012a,b; 2011; 2010) in the vicinity of the main facility and western gypsum stack area. These reports were used to identify relevant data for determining chemicals of concern (COCs). In this evaluation COCs are defined as chemicals exceeding ecological or human health screening level benchmarks.

As stated in the NTCRA (1993) guidance, where water quality standards or other benchmarks for one or more constituents in a given medium (e.g. surface and ground waters) are clearly exceeded, a removal action is generally warranted, and further detailed quantitative assessment of risks that considers all chemicals and their potential additive effects, are generally not necessary.

Given the past uncontrolled releases of acidic pond waters and severe environmental consequences, this section focuses on COCs that would impact ecological resources.

The primary source area targeted by the removal alternatives is the EGS due to the leaching of ammonia, phosphorus, fluoride, acidity and metals into the groundwater, ponds and WRD. Therefore, the focus is on hazardous substances that require treatment prior to discharge through the outfall. Constituents within the EGS will also be evaluated.

3.1 ECOLOGICAL CHEMICALS OF CONCERN

The largest stressor is acidity in the ponds and WRD prior to treatment. Table 3-1 presents recent data for pH and phosphorus. The low pH (2 – 3 s.u.) mobilizes phosphate, metals, and halogens such as fluoride. In addition, high levels of ammonia are of concern. Table 3-1 shows concentrations of chemicals in the various ponds along with protective ecological benchmarks (State and/or Federal water quality criteria for chronic effects), prior to treatment and discharge to Bayou Casotte. Phosphorus levels ranging from 1,150 to 3,338 mg/L are approximately 4 orders of magnitude higher than the benchmark level of 0.1 mg/L. Fluoride (27 mg/L) is approximately 5 times the protective level of 5 mg/L. Nitrogen in Pond 4 is currently within the benchmark; however higher levels of ammonia have been reported and is the primary constituent for the Bayou Casotte TMDL.

Two forms of reduced inorganic nitrogen exist in equilibrium in natural waters, ammonia (NH_3) and ammonium (NH_4^+). Concentrations of each depend on the pH, salinity, and temperature of the waters in which they are found. Of the two, ammonia is considerably more toxic to organisms and can cause significant harm to fish and other aquatic organisms.

It is well known that low pH mobilize positively charged metal cations such as cadmium (Cd^{+2}) that would remain dissolved in an aqueous solution unless it has the opportunity to bond with an anion such as hydroxide (OH^-) or sulfate ($SO4^{-2}$) to form insoluble precipitates. While dissolved metals in the ponds appear to be a direct function of low pH levels (2 – 4 s.u.), ammonia concentrations are a function of oxidization-reduction or redox conditions. The degradation of ammonia to nitrite and nitrate require an electron donor such as oxygen or organic carbon.

Several samples of the EGS source material were collected in January 2016 (Tetra Tech, 2016). Table 3-2 compares the results to conservative ecological and human health screening levels. Antimony, cadmium, selenium, strontium and vanadium exceeded the ecological screening levels with cadmium being highest with a hazard quotient of 8.3. However, none of the chemicals exceeded the human health screening levels. The phosphogypsum stack currently does not support any habitat, primarily due to a lack of organic carbon and nutrients.

3.2 HUMAN HEALTH CHEMICALS OF CONCERN

Human exposures to the ponds and EGS are limited to workers in the site treatment area. Workers at the water treatment facilities currently use best management practices to minimize exposure to contaminated surface water. As shown previously in Table 3-2, the EGS source material does not pose a risk to industrial workers. Although groundwater in the plant vicinity is also contaminated from leaching of ammonia, fluoride, phosphorus and metals from the phosphogypsum stacks, there are no water intakes for potable uses in the area. Table 3-3 compares constituents detected in groundwater to available maximum contaminant levels (MCLs) for drinking water. Table 3-3 shows constituents in groundwater from two wells closest to the migration pathway from the WGS and also not impacted from other chemical spills. Fluoride exceeded the MCL; however, it is not a COC because groundwater is not used as a source of potable water. Although there are no MCLs for ammonia, phosphorus or sulfate, these constituents are substantially elevated relative to un-impacted groundwater.

4.0 Exposure Pathways, Receptors and Conceptual Site Model

This section provides a discussion of the existing pathways of exposure to hazardous substances related to the EGS and associated ponds and water conveyance system.

As mentioned previously, the EE/CA seeks to prevent or control leaching of hazardous substances that are currently contained and treated through the water treatment plants at high monetary costs. It is expected that there will be a significant reduction in the release of COCs and that the existing treatment system will be able to reduce the threat of overflows to Bayou Casotte.

4.1 EXPOSURE TO ECOLOGICAL RECEPTORS

Currently, there is negligible habitat value associated with the EGS, its ponds and the WRD. Vegetation is sparse and the disturbed area with human activity is not conducive to wildlife use. The ponds could theoretically be a temporary attractive nuisance; however, given the proximity of Bangs Bayou and Lake to the east, birds and mammals would utilize their natural habitats in the estuary.

In the event of an overflow release of low pH water with high levels of ammonia, phosphate and metals, to either the Grand Bay NERR (as previously occurred in 2005) or to Bayou Casotte would result in adverse exposure to the entire localized ecosystem, from the salt marsh benthic community to fish, birds and other wildlife receptors.

4.2 HUMAN EXPOSURES

Industrial workers are potentially exposed to the COCs as they perform operation and maintenance (O&M) activities at the treatment plant and other site facilities. This includes excavation and grading of the EGS and ponds, shoring up eroded areas and berms, stirring treatment sludge, maintaining the piping system, and monitoring the outfalls. Consequently, the worker may incidentally ingest or dermally-contact contaminated water, sludge or the phosphogypsum material. Leaching of COCs through the EGS to groundwater is of concern and was the primary pathway evaluated in the hazard ranking system (HRS) scoring (EPA, 2017b). However, there are no drinking water intakes within 15 miles of the site (Tetra Tech, 2017).

Given the highly industrialized nature of the site and fenced security, trespassers are not considered to be adversely exposed, and the potential for a future residential scenario within the site is considered negligible and would be addressed by various institutional controls.

4.3 CONCEPTUAL SITE MODEL

Figure 3 depicts a generalized CSM that portrays contaminant pathways associated with the EGS complex to potential ecological and human receptors. Currently, the water treatment system is fully functional; however there remains the threat of another adverse overflow release from high rainfall events where excess water could not be treated or from a breach of the WRD from erosion.

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5.0 Risk Characterization and Conclusion

The existing water treatment system and its current permitted effluent conditions are protective of aquatic life in Bayou Casotte. There are no COCs for human health and risks are limited to potential impact on ecological receptors. The large volumes of untreated water have concentrations of COCs (acidity [pH], ammonia, fluoride, phosphorus) that are a few orders of magnitude greater than the acceptable benchmark levels. There is a future potential to cause catastrophic harm the environment upon an overflow release of excess water or a pond breach, as has happened in the past. High precipitation events such as tropical storms and hurricanes place undue stress on the existing treatment system. Reducing the volume of untreated water with its low pH and high levels of unionized ammonia, phosphate and fluoride is a prudent goal. The removal options being considered in the EE/CA will substantially reduce the threat of overflow releases, and significantly reduce leaching of COCs through the EGS, thereby indirectly protecting the environment better than under current conditions.

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6.0 References

Eco-Systems, Inc. 2013. *Bayou Casotte Sediment and Surface Water Supplemental Sampling Event* Report. Prepared for EPA 3013(a) RCRA Administrative Order On Consent. April 2013. 89 Pages.

Eco-Systems, Inc. 2012a. Groundwater Monitoring Report. Mississippi Phosphates Corporation Production Plant. July 2012. 240 Pages.

Eco-Systems, Inc. 2012b. Ammonia Source Soil Investigation Report. Mississippi Phosphates Corporation Production Plant. October 2012. 106 Pages.

Eco-Systems, Inc. 2011. Sampling and Analysis Surface Water Event Four Report. Prepared for EPA 3013(a) RCRA Administrative Order On Consent. September 2011. 89 Pages.

Eco-Systems, Inc. 2010. Site Characterization Report. Mississippi Phosphates Corporation Production Plant. November 2010. 1,824 Pages.

EPA, 2017a. Mississippi Phosphates Corporation. MS PowerPoint presentation prepared by Jordan Garrard, On-Scene Coordinator, EPA Region 4 and Craig Zeller, Remedial Project Manager, EPA Region 4, October 2017.

EPA, 2017b. Hazard Ranking System Documentation Record, Mississippi Phosphates Corporation. Pascagoula, Jackson County, Mississippi. July, 2017

EPA, 2017c. Regional Screening Levels (RSLs). November 2017. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017

EPA, 2016. EPA Optimization Recommendations for Mississippi Phosphates Corporation. September 15, 2016.

EPA, 2015. Region 4 Ecological Risk Assessment Supplemental Guidance Interim Draft. https://www.epa.gov/sites/production/files/2015-09/documents/r4_era_guidance_document_draft_final_8-25-2015.pdf

EPA, 2007. Total Maximum Daily Load (TMDL) for Bayou Casotte in the Coastal Streams Basin of Mississippi, Un-Ionized Ammonia and Total Toxics. Prepared by EPA Region 4, Atlanta, GA. March 2007.

Florida Department of Environmental Protection (FDEP). 2016. Surface Water Quality Standards. Rule 62-302.530. November 2016. https://floridadep.gov/dear/water-quality-standards/content/surface-water-quality-standards-classes-uses-criteria#criteria

Kemron Environmental Services (Kemron). 2017. Mississippi Phosphate Corporation Pond Sampling Monitoring Reports, October 2 – November 4, 2017.

Lytle, J.S. and Lytle, T.F. 2007. Pollution Impacts. In: Grand Bay National Estuarine Research Reserve: An Ecological Characterization (Peterson, M.S., Waggy, G.L. and Woodrey, M.S., editors). Grand Bay National Estuarine Research Reserve, Moss Point, Mississippi. Pages 96-102

McLelland, J.A. 2004. Assessment of Mudflat Invertebrate Communities in the Grand Bay National Estuarine Reserve Associated with Shorebird Feeding Areas. Final Report Submitted to the Mississippi Department of Marine Resources. Contract no. 04-046.

Mississippi Department of Environmental Quality (MDEQ). 2016a. Water Quality Criteria for Intrastate , Interstate, and Coastal Waters. Adopted February, 2016. MDEQ, Jackson, MS. https://www.epa.gov/sites/production/files/2014-12/documents/ms-wqs.pdf

MDEQ. 2016b. Mississippi 2016 Section 303(d) list of Impaired Waterbodies. Adopted June, 2016. MDEQ, Jackson, MS.

Peterson, M.S., Waggy, G.L., and Woodrey, M.S. (editors). 2007. Grand Bay National Estuarine Research Reserve: An Ecological Characterization. Grand Bay National Estuarine Research Reserve, Moss Point, Mississippi. 268 pp.

Tetra Tech. 2016. Letter Report – Phosphogypsum Stack Sampling, Mississippi Phosphate Corporation. Letter from Shanna Davis and Andrew Johnson, Tetra Tech to Ralph Howard, EPA Region 4. March 16, 2016.

U.S. Army Corp of Engineers. Draft Environmental Impact Statement. Bayou Casotte Harbor Channel Improvement Project. May 2014. 277 Pages.

U.S. Department of Justice (DOJ). 2015. Mississippi Phosphates Corp. Pleads Guilty to Clean Water Act Violation and Agrees to Transfer 320 Acres to Grand Bay National Estuary. Office of Public Affairs, Press Release No. 15-1026, August 19, 2015. https://www.justice.gov/opa/pr/mississippi-phosphates-corp-pleads-guilty-clean-water-act-violation-and-agrees-transfer-320

Tables

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Table 3-1. Comparison of Constituents in Untreated Pond Waters with Ecological Benchmarks *

	Water Return Ditch		Pond 4				Pond 5		Pond 6	
Date	pH	Phosphorus	pH	Nitrogen	Fluorine [1]	Phosphorus	pH	Phosphorus	pH	Phosphorus
10/2/2017	--	--	2.67	0.03	27	223.1	--	--	--	--
10/24/2017	--	--	--	--	--	--	--	--	2.96	1,180
10/26/2017	--	--	--	--	--	--	2.45	2,693	2.84	1,450
10/27/2017	2.68	2,052	--	--	--	--	2.51	2,208	3.05	1,494
10/29/2017	2.9	2,175	--	--	--	--	--	--	3.02	1,150
10/30/2017	--	--	--	--	--	--	2.75	2,938	3.41	1,392
11/3/2017	2.53	3,338	--	--	--	--		--	3.42	1,417
11/4/2017	2.53	3,338	--	--	--	--	--	--	3.42	1,417

All concentrations in mg/L

* - Source: Kemron (2017)

1 - soluble fluoride

-- - not analyzed

Chronic concentrations considered to be protective of estuarine aquatic life:

pH	6 - 9	(MDEQ, 2014)
Total Phosphorus	0.1 mg/L	(FDEP, 2016)
Nitrogen as ammonia	0.035 mg/L	(EPA, 2007)
Fluoride	5 mg/L	(FDEP, 2016)

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Table 3-2. Comparison of Constituents in East Gypsum Stack with Ecological and Human Health Benchmarks *

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Chemical	Frequency	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Ecological Screening Level	Ecological Hazard Quotient	Human Health Screening Level [1]	Human Health Hazard Quotient [2]
Ammonia	3 / 4	2.5 U	32	--	--	--	--
Aluminum	4 / 4	310	980	--	--	110,000	0.01
Antimony	1 / 4	0.19 U	0.42	0.27	***1.6***	47	0.01
Arsenic	1 / 4	0.48 U	1.6 J	18	0.1	3	--
Barium	4 / 4	21	36	330	0.1	22,000	0.002
Cadmium	4 / 4	1.8	3.0	0.36	***8.3***	98	0.03
Calcium	4 / 4	140,000	160,000	--	--	--	--
Chromium	2 / 4	4.8 U	18	23	0.8	180,000	0.0001
Iron	3 / 4	99 U	1,700	--	--	82,000	0.02
Lead	4 / 4	0.98	1.7	11	0.2	800	0.002
Selenium	1 / 4	0.97 U	1.2	0.52	***2.3***	580	0.002
Strontium	4 / 4	340	400	95	***4.2***	70,000	0.01
Titanium	4 / 4	6.7	12	77	0.2	--	--
Vanadium	2 / 4	4.8 U	14	7.8	***1.8***	580	0.02
Yttrium	4 / 4	60	110	--	--	--	--
Zinc	1 / 4	9.7 U	14	46	0.3	35,000	0.0004

Notes:

* Source: Tetra Tech (2016)

1 - EPA Regional Screening Levels - Industrial screen at HQ of 0.1 (EPA, 2017c)

2 - EPA Region 4 soil screening levels (EPA, 2015)

U - Not detected

J - Estimated value

Bold italic - Exceeds screening level

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Table 3-3. Comparison of Constituents in Groundwater with Human Health Benchmarks *

Constituent	Bank Well MW-2	Interior Well MW-3	Groundwater MCL
Ammonia	68,000	250,000	--
Phosphorus	9,200	5,200	--
Fluoride	22,000	14,000	***4,000***
Sulfate	3,600,000	3,200,000	--
Arsenic	< 1.3	3.1	10
Cadmium	< 2.5	< 2.5	5
Chromium	< 2.5	< 2.5	100
Iron	9,000	86,000	--
Lead	< 1.3	< 1.3	15
Selenium	< 1.3	3.1	50

Notes:

* Source: Eco-Systems, Inc. (2012a)

All concentrations in μg/L

MCL - Maximum Contaminant Level

bold italic - exceedes benchmark

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Figures

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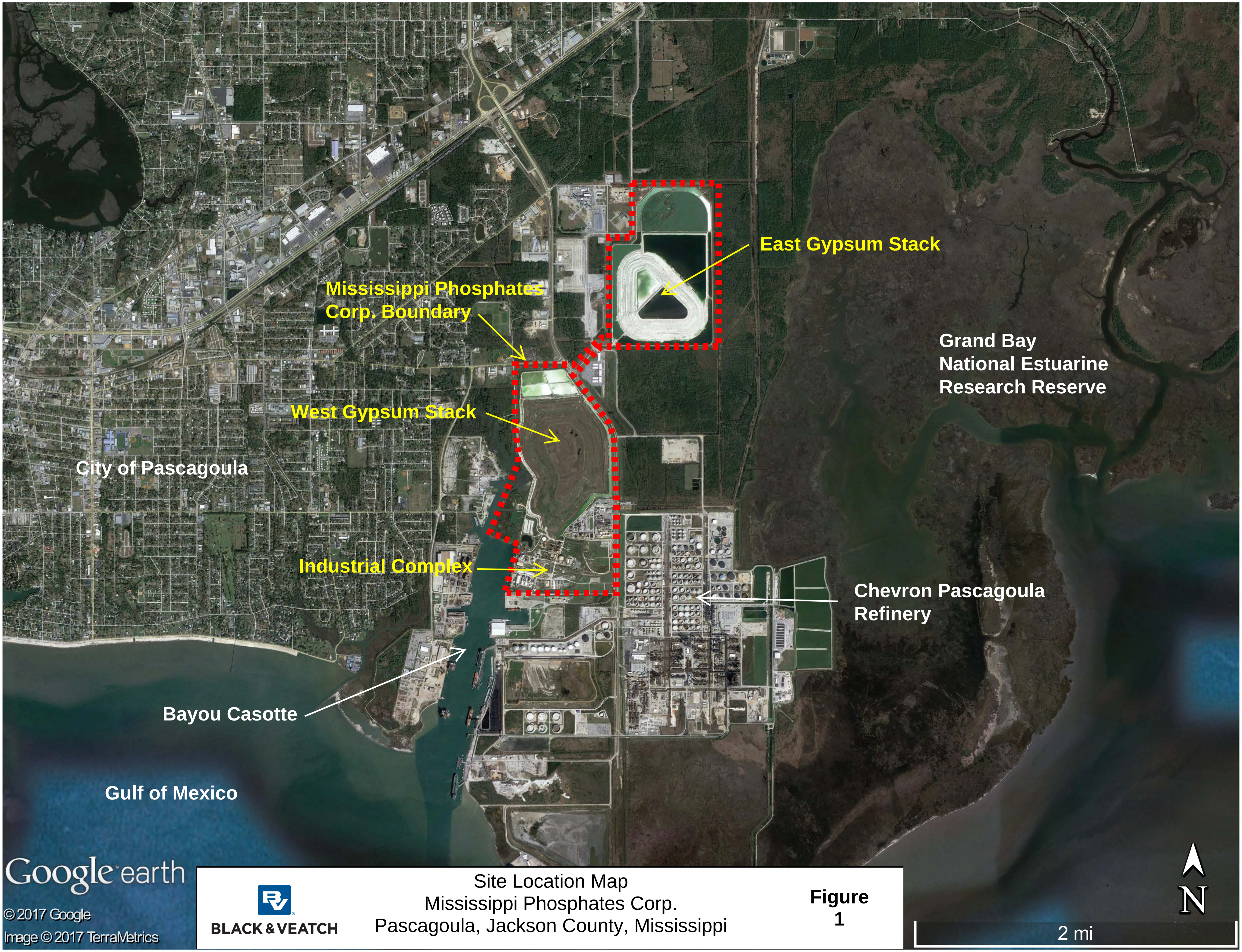

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Site Location Map
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi

Figure 1

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Features of the East Gypsum Stack
Mississippi Phosphates Corp.
Pascagoula, Jackson County, Mississippi
BLACK & VEATCH
Figure
2
WRD
Pond 6
In Situ Water
Treatment Plant
WRD
Pond 5
Slurry Wall Beneath
Entire Perimeter
Road
East Gypsum Stack
Leachate Discharge
Outlet
Lime
Sludge
Pond 4
Water Return Ditch
(WRD)
Pond 3
East Gypsum Stack
Pump Station
Google earth
© 2017 Google
N
2000 ft

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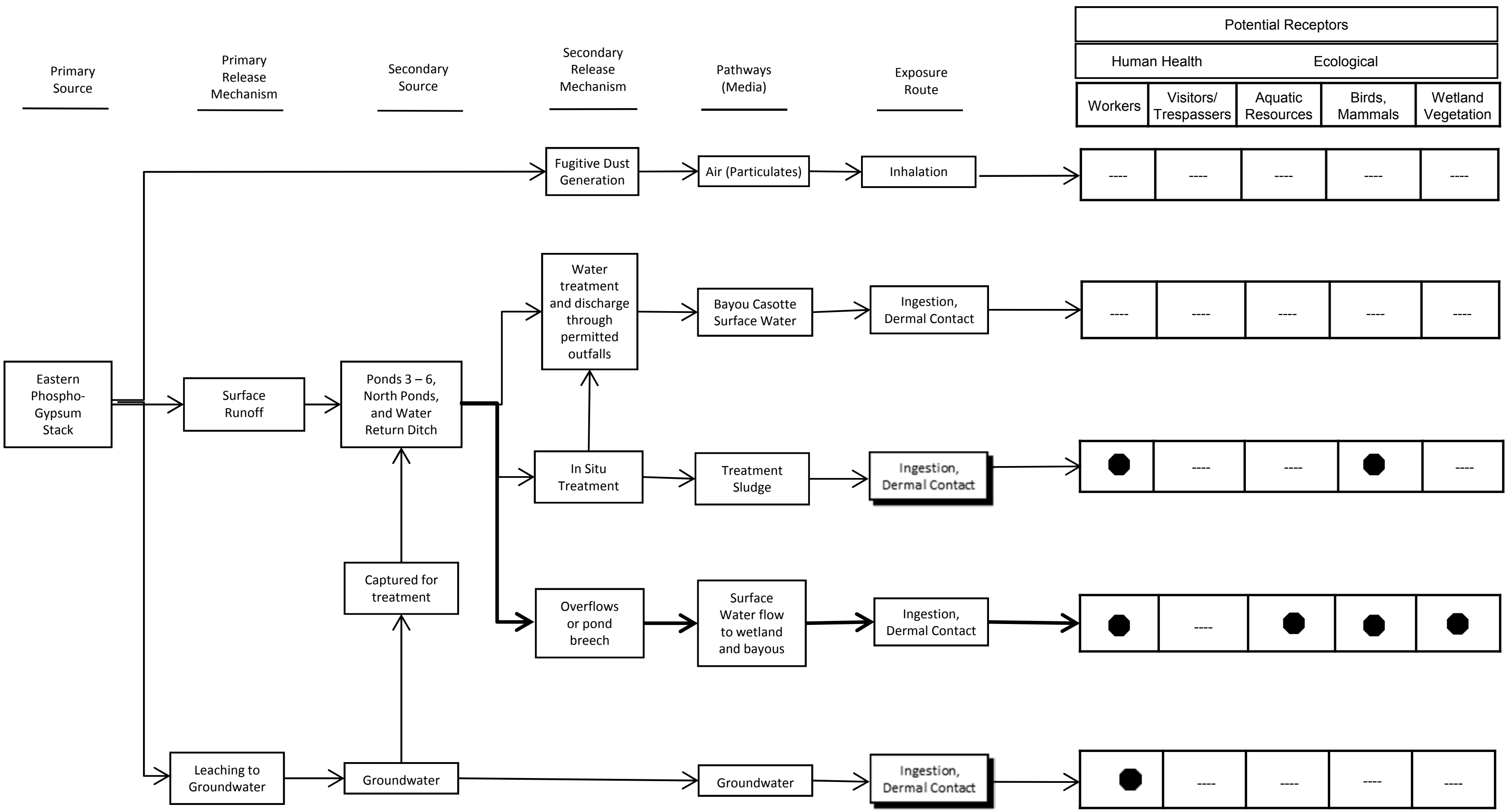

LEGEND

= Pathways: current, historical and future

= Receptors of primary concern

----- = Receptors of negligible concern

Figure 3
Conceptual Site Model
Mississippi Phosphate

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Appendix B. Detailed Cost Estimate Tables

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Appendix B – Detailed Costs

Listed below are the general assumptions used to develop the construction costs for each of the Removal Action alternatives at the MPC site. Assumptions specific to each alternative are listed in Section 6 of the EE/CA report.

- EGS leachate volume is assumed constant at 20,000 gallons/day after EGS closure, but in actuality will decrease over time.
- Pond drainage at the beginning of a Phase will be completed within a 30 day window and that no further drainage is required during construction of the ponds being removed from the contact area.
- Estimated water treatment costs are as follows per the current MPC facility operator (Kemron Environmental Services):
  - *In Situ* Plant (Pond 6)- $0.0102/gallon
  - Bypass (caustic)- $0.0157/gallon
  - CPG Overall - $0.0120/gallon
- Engineering, Administration, Mobilization, Demobilization, Oversight, and Reporting costs are not included.
- The protective soil cover and topsoil account for approximately 50% of the cost on the preferred Alternatives with a unit cost of $27/cubic yard and $20/cubic yard, respectively.
- Cost to drain ponds is included in the cost to treat the ponds.
- Cost to treat Pond 5, Pond 6, and the WRD during the Phase 2 and 3 construction cycles is not included since it would still be considered an ordinary yearly treatment cost.
- Grading costs assume an average depth across the area being modified.
- Assumed 18 inch protective soil cover and 6 inch topsoil will be procured and hauled in from a source within 15 miles.
- In Phase 1 – Alternative 2A the 18 inch of amended soil on side slopes will be clay material that is lime stabilized (1 ton/acre) prior to placement.
- Erosion control cost includes placing an erosion control mat over final graded areas.
- The entire scope of work is assumed to be completed by a single contractor.

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MPC Cost Summary	Construction Cost	Contractor Markup 8.0%	Contingency 10.0%	Total Contract Cost
No Action - Alternative 1	$ -	$ -	$ -	$ -
Phase 1 - Alternative 2A	$ 26,741,887	$ 2,139,351	$ 2,888,124	$ 31,769,362
Phase 1 - Alternative 2B (Preferred)	$ 26,411,109	$ 2,112,889	$ 2,852,400	$ 31,376,398
Phase 2 - Alternative 3A	$ 39,572,349	$ 3,165,788	$ 4,273,814	$ 47,011,950
Phase 2 - Alternative 3B (Preferred)	$ 15,535,420	$ 1,242,834	$ 1,677,825	$ 18,456,080
Phase 3 - Alternative 4 (Preferred)	$ 18,325,287	$ 1,466,023	$ 1,979,131	$ 21,770,441
Total - Preferred Alternatives	$ 60,271,817	$ 4,821,745	$ 6,509,356	$ 71,602,918

MPC Phase 1 -Alternative 2A - Partial Synthetic Liner					
Item	**Bid item**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
	EGS Crest/Top				
1	Drain/Treat Pond 3 - bypass protocol	Gallon	$0.0157	100,000,000	$ 1,572,700
2	Drain/Treat Pond 4 - bypass protocol	Gallon	$0.0157	25,000,000	$ 393,175
3	Remove Lime sludge from Pond 4	CY	$4.25	150,000	$ 637,500
4	Place lime sludge on EGS side slopes	CY	$6.00	150,000	$ 900,000
5	Grade EGS to fill in Ponds 3 and 4	CY	$2.50	515,556	$ 1,288,889
7	40 mm LLDPE liner (linear low)	SF	$0.65	1,740,000	$ 1,131,000
8	Place 18" protective soil cover over LLDPE liner	CY	$27.00	96,667	$ 2,610,000
9	Place 6" topsoil over protective soil cover	CY	$20.50	32,222	$ 660,556
10	Seeding	AC	$3,000.00	40	$ 119,835
11	Erosion Control	LS	$435,000.00	1	$ 435,000
	EGS Side Slope 1				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	890,000	$ 133,500
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	Place 18" protective/amended soil over gypsum	CY	$40.00	49,444	$ 1,977,778
4	Place 6" topsoil over protective soil cover	CY	$20.50	16,481	$ 337,870
5	Seeding	AC	$3,000.00	20	$ 61,295
6	Erosion Control	LS	$222,500.00	1	$ 222,500
	EGS Bench 1				
1	Grade EGS Bench to 2% Slope	SF	$0.10	195,000	$ 19,500
2	40 mm LLDPE liner (linear low)	SF	$0.65	195,000	$ 126,750
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	10,833	$ 292,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	3,611	$ 74,028
5	Seeding	AC	$3,000.00	4	$ 13,430
6	Erosion Control	LS	$48,750.00	1	$ 48,750
	EGS Side Slope 2				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,060,000	$ 159,000
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	Place 18" protective/amended soil over gypsum	CY	$40.00	58,889	$ 2,355,556
4	Place 6" topsoil over protective soil cover	CY	$20.50	19,630	$ 402,407
5	Seeding	AC	$3,000.00	24	$ 73,003
6	Erosion Control	LS	$265,000.00	1	$ 265,000
	EGS Bench 2				
1	Grade EGS Bench to 2% Slope	SF	$0.10	229,000	$ 22,900
2	40 mm LLDPE liner (linear low)	SF	$0.65	229,000	$ 148,850
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	12,722	$ 343,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	4,241	$ 86,935
5	Seeding	AC	$3,000.00	5	$ 15,771
6	Erosion Control	LS	$57,250.00	1	$ 57,250
	EGS Side Slope 3				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,230,000	$ 184,500
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	Place 18" protective/amended soil over gypsum	CY	$40.00	68,333	$ 2,733,333
4	Place 6" topsoil over protective soil cover	CY	$20.50	22,778	$ 466,944
5	Seeding	AC	$3,000.00	28	$ 84,711
6	Erosion Control	LS	$307,500.00	1	$ 307,500
	EGS Bench 3				
1	Grade EGS Bench to 2% Slope	SF	$0.10	263,000	$ 26,300
2	40 mm LLDPE liner (linear low)	SF	$0.65	263,000	$ 170,950
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	14,611	$ 394,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	4,870	$ 99,843
5	Seeding	AC	$3,000.00	6	$ 18,113
6	Erosion Control	LS	$65,750.00	1	$ 65,750
	EGS Side Slope 4				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,400,000	$ 210,000
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	Place 18" protective/amended soil over gypsum	CY	$40.00	77,778	$ 3,111,111
4	Place 6" topsoil over protective soil cover	CY	$20.50	25,926	$ 531,481
5	Seeding	AC	$3,000.00	32	$ 96,419
6	Erosion Control	LS	$350,000.00	1	$ 350,000
	EGS Bench 4				
1	Grade EGS Bench to 2% Slope	SF	$0.10	297,000	$ 29,700
2	40 mm LLDPE liner (linear low)	SF	$0.65	297,000	$ 193,050
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	16,500	$ 445,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	5,500	$ 112,750
5	Seeding	AC	$3,000.00	7	$ 20,455
6	Erosion Control	LS	$74,250.00	1	$ 74,250
	Total Phase 1 - Alternative 2A Cost				$ 26,741,887

MPC Phase 1 -Alternative 2B - Complete Synthetic Liner					
Item	**Bid item**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
	EGS Crest/Top				
1	Drain/Treat Pond 3 - bypass protocol	Gallon	$0.0157	100,000,000	$ 1,572,700
2	Drain/Treat Pond 4 - bypass protocol	Gallon	$0.0157	25,000,000	$ 393,175
3	Remove Lime sludge from Pond 4	CY	$4.25	150,000	$ 637,500
4	Place lime sludge on EGS side slopes	CY	$6.00	150,000	$ 900,000
5	Grade EGS to fill in Ponds 3 and 4	CY	$2.50	515,556	$ 1,288,889
6	40 mm LLDPE liner (linear low)	SF	$0.65	1,740,000	$ 1,131,000
7	Place 18" protective soil cover over LLDPE liner	CY	$27.00	96,667	$ 2,610,000
8	Place 6" topsoil over protective soil cover	CY	$20.50	32,222	$ 660,556
9	Seeding	AC	$3,000.00	40	$ 119,835
10	Erosion Control	LS	$435,000.00	1	$ 435,000
	EGS Side Slope 1				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	890,000	$ 133,500
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	40 mm LLDPE textured liner (linear low)	SF	$0.65	890,000	$ 578,500
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	49,444	$ 1,335,000
5	Place 6" topsoil over protective soil cover	CY	$20.50	16,481	$ 337,870
6	Seeding	AC	$3,000.00	20	$ 61,295
7	Erosion Control	LS	$222,500.00	1	$ 222,500
	EGS Bench 1				
1	Grade EGS Bench to 2% Slope	SF	$0.10	195,000	$ 19,500
2	40 mm LLDPE liner (linear low)	SF	$0.65	195,000	$ 126,750
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	10,833	$ 292,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	3,611	$ 74,028
5	Seeding	AC	$3,000.00	4	$ 13,430
6	Erosion Control	LS	$48,750.00	1	$ 48,750
	EGS Side Slope 2				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,060,000	$ 159,000
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	40 mm LLDPE textured liner (linear low)	SF	$0.65	1,060,000	$ 689,000
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	58,889	$ 1,590,000
5	Place 6" topsoil over protective soil cover	CY	$20.50	19,630	$ 402,407
6	Seeding	AC	$3,000.00	24	$ 73,003
7	Erosion Control	LS	$265,000.00	1	$ 265,000
	EGS Bench 2				
1	Grade EGS Bench to 2% Slope	SF	$0.10	229,000	$ 22,900
2	40 mm LLDPE liner (linear low)	SF	$0.65	229,000	$ 148,850
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	12,722	$ 343,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	4,241	$ 86,935
5	Seeding	AC	$3,000.00	5	$ 15,771
6	Erosion Control	LS	$57,250.00	1	$ 57,250
	EGS Side Slope 3				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,230,000	$ 184,500
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	40 mm LLDPE textured liner (linear low)	SF	$0.65	1,230,000	$ 799,500
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	68,333	$ 1,845,000
5	Place 6" topsoil over protective soil cover	CY	$20.50	22,778	$ 466,944
6	Seeding	AC	$3,000.00	28	$ 84,711
7	Erosion Control	LS	$307,500.00	1	$ 307,500
	EGS Bench 3				
1	Grade EGS Bench to 2% Slope	SF	$0.10	263,000	$ 26,300
2	40 mm LLDPE liner (linear low)	SF	$0.65	263,000	$ 170,950
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	14,611	$ 394,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	4,870	$ 99,843
5	Seeding	AC	$3,000.00	6	$ 18,113
6	Erosion Control	LS	$65,750.00	1	$ 65,750
	EGS Side Slope 4				
1	Grade EGS Side Slope - 6H:1V	SF	$0.15	1,400,000	$ 210,000
2	24" HDPE Letdown Piping	LF	$35.00	200	$ 7,000
3	40 mm LLDPE textured liner (linear low)	SF	$0.65	1,400,000	$ 910,000
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	77,778	$ 2,100,000
5	Place 6" topsoil over protective soil cover	CY	$20.50	25,926	$ 531,481
6	Seeding	AC	$3,000.00	32	$ 96,419
7	Erosion Control	LS	$350,000.00	1	$ 350,000
	EGS Bench 4				
1	Grade EGS Bench to 2% Slope	SF	$0.10	297,000	$ 29,700
2	40 mm LLDPE liner (linear low)	SF	$0.65	297,000	$ 193,050
3	Place 18" protective soil cover over LLDPE liner	CY	$27.00	16,500	$ 445,500
4	Place 6" topsoil over protective soil cover	CY	$20.50	5,500	$ 112,750
5	Seeding	AC	$3,000.00	7	$ 20,455
6	Erosion Control	LS	$74,250.00	1	$ 74,250
	Total Phase 1 - Alternative 2B Cost				$ 26,411,109

MPC Phase 2 -Alternative 3A - Pond 5 Closure with North Ponds Excavation					
Item	**Bid item**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
	Drain Pond 5				
1	Drain/Treat Pond 5 - bypass protocol	Gallon	$0.0157	200,000,000	$ 3,145,400
2	Grade Pond 5 to Drain	CY	$2.50	384,191	$ 960,476
3	40 mm LLDPE liner (linear low)	SF	$0.65	2,626,668	$ 1,707,334
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	145,926	$ 3,940,002
5	Place 6" topsoil over protective soil cover	CY	$20.50	48,642	$ 997,161
6	Seeding	AC	$3,000.00	60	$ 180,900
7	Erosion Control	LS	$656,667.00	1	$ 656,667
	North Ponds				
1	Excavate lime sludge from North Ponds	CY	$3.00	727,867	$ 2,183,601
2	Transport to excavated lime sludge to Pond 5	CY	$0.50	727,867	$ 363,933
3	Incorporate excavated lime sludge into Pond 5 soil cover	CY	$4.00	727,867	$ 2,911,468
4	Grade and fill North Ponds to drain	CY	$27.00	727,867	$ 19,652,406
5	Place 18" protective soil cover	CY	$27.00	72,600	$ 1,960,200
6	Place 6" topsoil over protective soil cover	CY	$20.50	24,200	$ 496,100
7	Seeding	AC	$3,000.00	30	$ 90,000
8	Erosion Control	LS	$326,700.00	1	$ 326,700
	Total Phase 2 - Alternative 3A Cost				$ 39,572,349

MPC Phase 2 -Alternative 3B - Pond 5 Closure with North Ponds Capped Place					
Item	**Bid item**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
	Drain Pond 5				
1	Drain/Treat Pond 5 - bypass protocol	Gallon	$0.0157	200,000,000	$ 3,145,400
2	Grade Pond 5 to Drain	CY	$2.50	384,191	$ 960,476
3	40 mm LLDPE liner (linear low)	SF	$0.65	2,626,668	$ 1,707,334
4	Place 18" protective soil cover over LLDPE liner	CY	$27.00	145,926	$ 3,940,002
5	Place 6" topsoil over protective soil cover	CY	$30.50	48,642	$ 1,483,581
6	Seeding	AC	$3,000.00	60	$ 180,900
7	Erosion Control	LS	$656,667.00	1	$ 656,667
	North Ponds				
1	Place reinforced geotextile liner over lime sludge	SF	$0.45	1,306,800	$ 588,060
2	Place 18" protective soil cover	CY	$27.00	72,600	$ 1,960,200
3	Place 6" topsoil over protective soil cover	CY	$20.50	24,200	$ 496,100
4	Seeding	AC	$3,000.00	30	$ 90,000
5	Erosion Control	LS	$326,700.00	1	$ 326,700
	Total Phase 2 - Alternative 3B Cost				$ 15,535,420

MPC Phase 3 - Alternative 4 - Pond 6 and WRD Closure					
Item	**Bid item**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
	WRD				
1	Drain/Treat the EGS WRD using bypass protocol	Gallon	$0.0157	130,000,000	$ 2,044,510
2	Connect existing underdrain to new perimeter	LF	$15.0000	10,500	$ 157,500
	leachate collection system (6" HDPE)				
3	Connect perimeter leachate system to	LF	$35.0000	20,000	$ 700,000
	mechanical plant (24" HDPE)				
4	100 gpm pump station	LS	$3.50	150,000	$ 525,000
5	Grade to promote drainage	CY	$2.50	413,659	$ 1,034,147
6	40 mm LLDPE liner (linear low)	SF	$0.65	2,792,196	$ 1,814,927
7	Place 18" protective soil cover over LLDPE liner	CY	$27.00	155,122	$ 4,188,294
8	Place 6" topsoil over protective soil cover	CY	$20.50	51,707	$ 1,060,000
9	Seeding	AC	$3,000.00	64	$ 192,300
10	Erosion Control	LS	$698,049.00	1	$ 698,049
	Pond 6				
1	Grade Pond 6 to promote drainage	CY	$0.85	193,600	$ 164,560
2	Place 18" protective soil cover	CY	$27.00	145,200	$ 3,920,400
3	Place 6" topsoil over protective soil cover	CY	$20.50	48,400	$ 992,200
4	Seeding	AC	$3,000.00	60	$ 180,000
5	Erosion Control	LS	$653,400.00	1	$ 653,400
	Total Phase 3 - Alternative 4 Cost				$ 18,325,287

MPC - Treatment Cost Summary										
Phase	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	7 Year Cost	Yearly Savings	7 Year Savings
Existing Condition - Baseline	$5,560,100	$5,560,100	$5,560,100	$5,560,100	$5,560,100	$5,560,100	$5,560,100	$38,920,702	-	-
Treat all Existing Ponds										
EGS Leachate (included in WRD)										
Phase 1 - Construct 2018	$5,350,344	$3,384,469	$3,384,469	$3,384,469	$3,384,469	$3,384,469	$3,384,469	$25,657,157	$209,756	$13,263,545
Reductions from Baseline										
Remove EGS Pond 3 Contact Area	$362,393	$362,393	$362,393	$362,393	$362,393	$362,393	$362,393			
Remove EGS Pond 4 Contact Area	$211,883	$211,883	$211,883	$211,883	$211,883	$211,883	$211,883			
Remove EGS Side Slopes Contact Area	$1,689,218	$1,689,218	$1,689,218	$1,689,218	$1,689,218	$1,689,218	$1,689,218			
Total	$2,263,494	$2,263,494	$2,263,494	$2,263,494	$2,263,494	$2,263,494	$2,263,494			
Additions to Baseline										
EGS Leachate (after EGS closure Phase 1,2, 3)	$87,863	$87,863	$87,863	$87,863	$87,863	$87,863	$87,863			
Treat EGS Pond 3 Existing Volume	$1,572,700	$0	$0	$0	$0	$0	$0			
Treat EGS Pond 4 Existing Volume	$393,175	$0	$0	$0	$0	$0	$0			
Total	$2,053,738	$87,863	$87,863	$87,863	$87,863	$87,863	$87,863			
Phase 2 - Construct 2019	$5,350,344	$7,522,219	$2,064,950	$2,064,950	$2,064,950	$2,064,950	$2,064,950	$23,197,311	$3,495,151	$15,723,391
Reductions from Baseline										
Remove EGS Pond 5 Contact Area		$881,141	$881,141	$881,141	$881,141	$881,141	$881,141			
Remove WGS North Ponds Contact Area		$438,378	$438,378	$438,378	$438,378	$438,378	$438,378			
Total		$1,319,519	$1,319,519	$1,319,519	$1,319,519	$1,319,519	$1,319,519			
Additions to Baseline										
Treat EGS Pond 5 Existing Volume		$3,145,400	$0	$0	$0	$0	$0			
Treat WGS North Ponds Existing Volume		$2,311,869	$0	$0	$0	$0	$0			
Total		$5,457,269	$0	$0	$0	$0	$0			
Phase 3 - Construct 2020	$5,350,344	$7,522,219	$4,176,883	$87,863	$87,863	$87,863	$87,863	$17,400,897	$5,472,237	$21,519,805
Reductions from Baseline										
Remove EGS Pond 6 Contact Area			$876,757	$876,757	$876,757	$876,757	$876,757			
Remove EGS WRD Contact Area			$936,669	$936,669	$936,669	$936,669	$936,669			
Remove EGS Ponds 5 and 6 Berms			$163,661	$163,661	$163,661	$163,661	$163,661			
Total			$1,977,087	$1,977,087	$1,977,087	$1,977,087	$1,977,087			
Additions to Baseline										
Treat EGS Pond 6 Existing Volume			$2,044,510	$0	$0	$0	$0			
Treat EGS WRD Existing Volume			$2,044,510	$0	$0	$0	$0			
Total			$4,089,020	$0	$0	$0	$0			

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Appendix C. EPA Responses to Comments by MS DEQ (to be included in Final)

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Appendix D. EPA Responses to Public Comments (to be included in Final)

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Appendix E. Engineering Evaluation/Cost Analysis Approval Memo (to be included in Final)

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