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Document Transmittal

Sulphur Brine Field - Containment Levee Plan

DATE: 3/11/2024
TO: Westlake South
1300 PPG Drive
Lake Charles, LA 70602
ATTENTION: Meg Quinn
PROJECT TITLE: No. 7 Investigation Work

TRANSMITTAL NUMBER: 013
RECON PROJECT NUMBER: 23261173
CLIENT REFERENCE NUMBER:

Issued For:

- ☐ As-Builts
- ☐ For Approval
- ☐ For Review & Comment
- ☐ For Construction
- ☐ For Construction Revised
- ☐ For Design Approval
- ☐ Preliminary
- ☐ For Estimate Only
- ☑ For Record
- ☐ For Reference Only
- ☐ Return of Documents
- ☐ Unchecked

Transmittal includes:

- ☐ Bid Tabulations
- ☐ Calculations
- ☐ Drawings
- ☐ Engineering Estimate
- ☐ Opinion of Probable Cost
- ☑ Report
- ☐ Scope of Work
- ☐ Sketch
- ☐ Specifications
- ☐ Tie-In Schedule
- ☐ Vendor Data / Quotations
- ☐ FEL-3 Report

Transmittal Details: Transmitted via email in .pdf format.

Special Notes:

Document	Revision	Description	Issue
Attachment 1	1	Containment Levee Plan	For Record

Prepared By: *Stacy Skaggs, Document Control*

Issued By: Nathan Anderson *, Project Manager*

Distribution:

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Sulphur Brine Field

Containment Levee Plan

Submitted by:

Westlake

Prepared by:

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ReCon Engineering Project No. 23261173

Revision 1

March 11, 2024

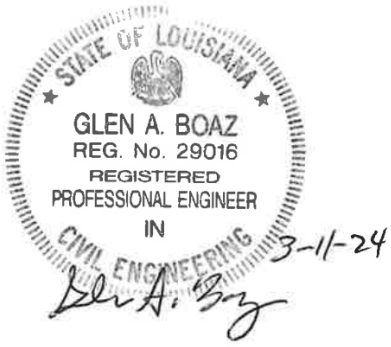


TABLE OF CONTENTS

APPENDIX

1.0 BACKGROUND

Order 3.i. of the Third Supplement to Compliance Order No. IMD 2022-027 issued by the State of Louisiana Department of Natural Resources Office of Conservation requires Westlake US 2, LLC (Westlake) to submit "a plan to construct a containment system around the potential affected area at the surface."

Westlake and its contractors prepared the plan described herein in response to the above-described order. Westlake's compliance with that order is not an admission that such a system is needed currently or a commitment to construct the described structures and improvements. Westlake reserves the right to challenge any order requiring construction of a containment system and to change the components of this proposal based on changes in circumstances occurring after its submission.

Westlake proposes the following components:

- Engineered earthen levees constructed with low permeability compacted clay soils surrounding the possible impact site (see Figure 1). Due to area restrictions, a portion of the levee will utilize steel sheet piles with an impermeable interior liner. These levees will be constructed by improving the levee surrounding the existing reservoir commonly referred to as Salt Lake and installing an additional levee east of PPG 6 and 7. The additional levee will be referred to herein as the "Well Levee."
- Two major weir drainage structures will allow transfer of water from one side of the containment levee to the other. Each structure will include three 36-inch diameter drainpipes that run through the levees. Each pipe will have valves which can be manually opened or closed to allow water transfer to the outside of the levee.
- Two smaller single pipe weir structures are planned for the east side Well Levee and one near the southwest corner of Salt Lake. The Well Levee weir will drain to Central Pond.
- A pump station will be constructed within the levee system to remove and/or utilize containment water following an event. Two electric pumps and one diesel pump are proposed for the station. One pump will be the primary pump and the others will be installed spares for redundancy.

2.0 INTRODUCTION

This Plan describes the basis of the levee system layout, drainage structures, levee elevation, materials of construction, etc.:

- Anticipated impact zone;
- Levee location;
- Current runoff receiving streams;
- Elevation of containment levee;
- Levee construction materials;
- Water Control and Treatment Plan;
- Pre-Event, Event, and Post-Event Action Plans

Each of these items is addressed in greater detail in the sections that follow in this Levee System Plan.

3.0 SITE INFORMATION

The majority of the brine field site in question is currently owned by Sulphur Dome, LLC and Westlake. Westlake also leases property to mine brine that is used in the Chlor-Alkali process at the Westlake South facility. Other landowners that may be impacted by the levee construction are Brimstone History Society, Apollo Lake Charles, Bell Mineral LLC, Julia B Est. Pollock, Keith Hobgood, and LOLC LLC according to public records gathered from Calcasieu Parish Police Jury.

The soils at the site are identified as Guyton, Judice, and Morey by USDA Soil Survey and fall into the Hydraulic Soil Groups C or D. These soils typically have land slopes in the 0 to 1% range and rarely flood. Vegetation consists of grass, naturally growing trees, and ponds. A large portion of the containment system will surround the existing Salt Lake.

4.0 LEVEE SYSTEM PLAN

The initial levee system plan submitted by Westlake has been revised based on comments noted during the January 30, 2024 meeting with DNR, land owners, and operators held at the Sulphur Brine Field.

During the meeting a recommendation was made to determine if the high bank line of the Salt Lake could be used as the main confining structure in combination with another structure/levee to confine Brine Wells 6 and 7 located on the east side of the pond.

Following the meeting, using the high bank line of the Salt Lake as the main confining structure/levee was investigated and found to be favorable. As such, the levee configuration has been revised to reflect the utilization of the Salt Lake bank in combination with a Well Levee to manage water discharge from the site following an event.

Action plans are in development outlining activities and infrastructure to be implemented pre-event, event, and post-event. Action items related to the levee system have been added to this containment plan, and the report has been modified to include verbiage identifying whether an item is pre, event, or post event. See Section 5.0 for additional information.

4.1 IMPACT ZONE

The impact zone was identified in the Lonquist “Surface Expression Impact Zone Estimate” document updated November 2, 2023. See Figure 4 page 6 of 41 of indicated document. The initial impact zone has been identified to have a diameter of 678 feet with the epicenter located 488 feet due west of Well 7B. The final impact zone is indicated to have a diameter of 1841 feet. See following Figure 1 and drawings SK-APP1-02.01 through SK-APP1-05.01 that indicated both impact zones in the Appendix.

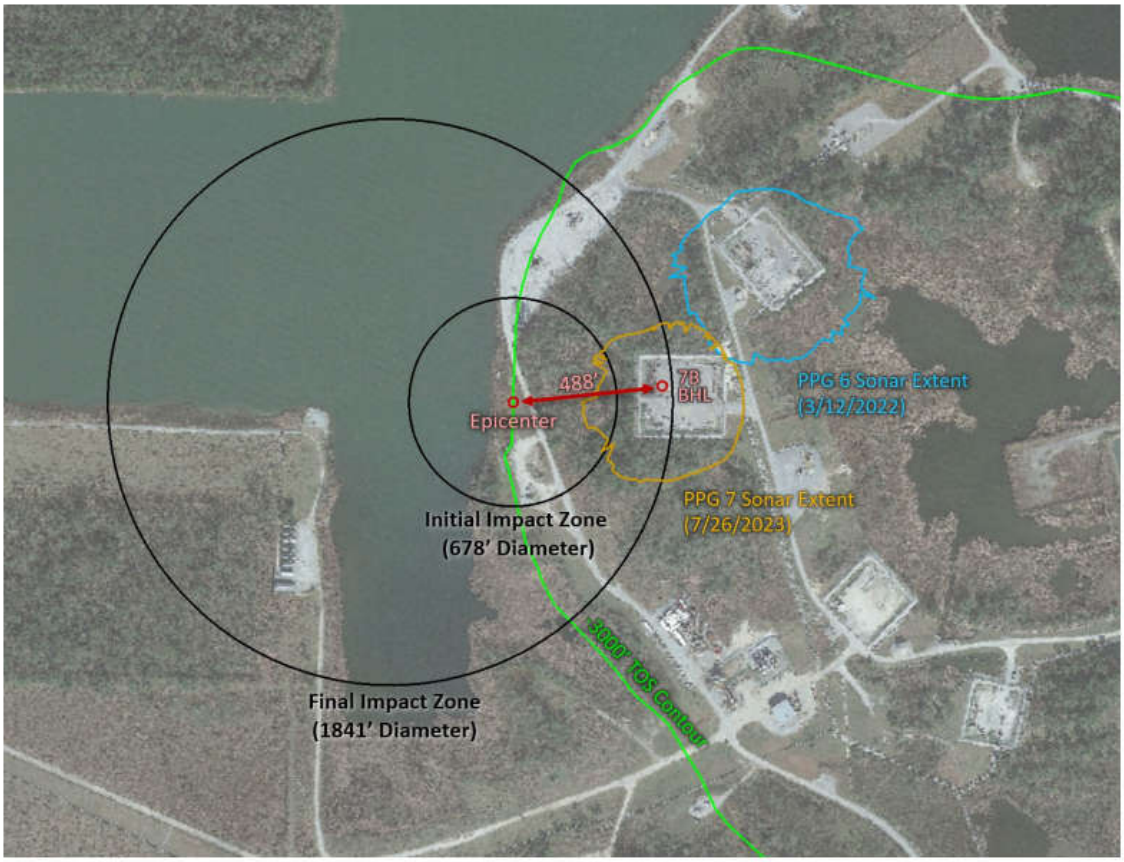


Figure 1 – Impact Zone Diagram (Obtained from Lonquist document dated 11/2/2023)

4.2 LEVEE SYSTEM LAYOUT

Using the indicated impact zones as the starting point, the Pre-Event Levee was positioned along the high bank line of Salt Lake. Slight adjustments were made at the southwest side of Salt Lake due to a lower elevation of the high bank line. Preliminary investigations of the elevations along Salt Lake bank yielded a typical elevation near 14.0 feet with the water elevation at 11.0 feet MSL. In addition to the Salt Lake levee, a well levee was routed around Wells No. 6 and 7 to complete the Pre-Event Levee System.

A Post-Event Levee is being planned to encompass Central Pond and inactive Wells Number 2 and 4 along with the abandoned and plugged Well No. 5. See diagrams in the appendix for Pre-Event and Post Event proposed levee layouts.

The proposed levee layout (Pre-Event) encompasses an approximate 286 acres for the Salt Lake and 31.4 acres within the Well Levee. The Central Pond Levee (Post-Event) will encompass approximately 59.7 acres.

4.3 RECEIVING STREAMS

Two stormwater receiving streams have been identified at the Brine Field site as shown in Figure 2. One is the Bayou Choupique drainage lateral located on the south side of the

property. It receives stormwater runoff that originates from the west side of the property. The other receiving stream is Bayou D'Inde drainage lateral that enters the east side of the property at about the midpoint of the facility and receives stormwater from the east side of the property.

Two main and two minor weir drainage structures are planned for the Salt Lake Levee. One main structure will be located on the west side (Weir Structure 1) and one minor weir structure (Weir Structure 2) will be in the southwest corner of the Salt Lake Levee. Both water control structures will discharge to Bayou Choupique drainage lateral. The other major weir structure (Weir Structure 3) will be located on the east side of Salt Lake at a current drainage culvert that is located about mid-way along the Northeast Pond's east bank. This culvert currently discharges runoff to the ponds located east of the Brine site and then to a Bayou D'Inde drainage ditch.

A fourth minor drainage weir (Weir Structure 4) will be located in the Well Levee. This drainage structure will only drain runoff collected within the confines of the Well Levee and discharge to Central Pond.

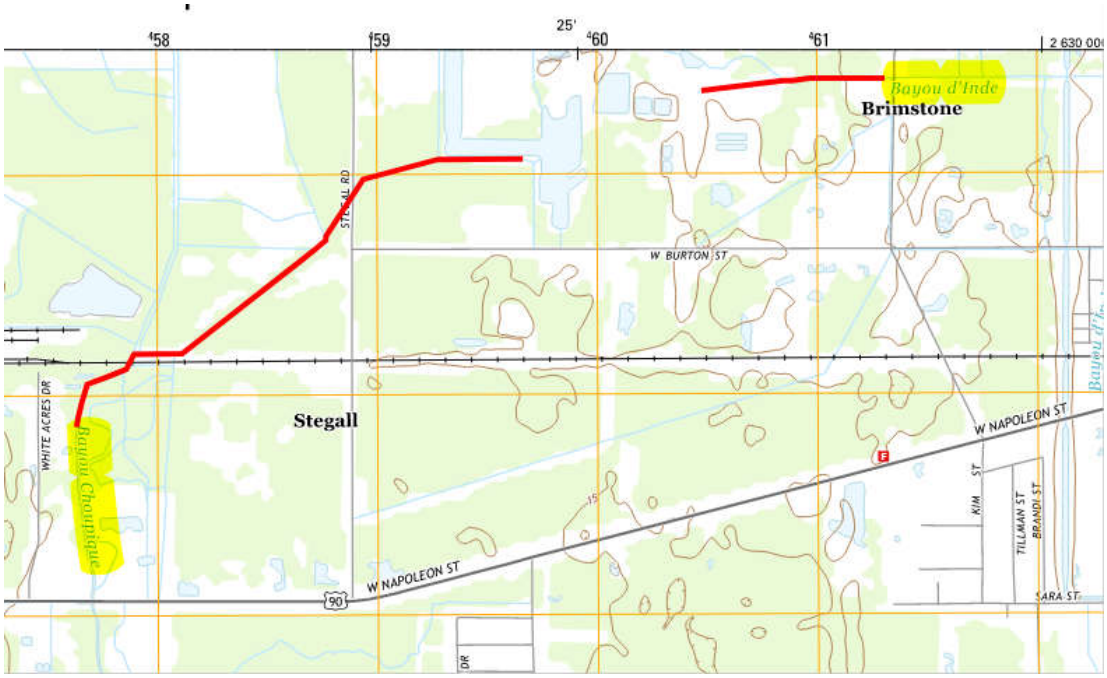


Figure 2 – Topographic Map Indicating Two Receiving Streams

4.4 TOP ELEVATION OF LEVEE SYSTEM

The water elevation in Salt Lake fluctuates depending on the amount of rainfall, but typically ranges from 11 to 12 feet MSL. The ground level varies across the site from 8 to 17 feet averaging between 12 and 13 feet. The high bank line around Salt Lake is typically around 14.0 feet (MSL).

The Sulphur Dome site is located outside of FEMA indicated flood zones and is designated Zone X, which indicates the site is not in a flood zone.

Based on the typical high bank line elevation around Salt Lake of 14.0 feet, the top of levee

was set at a minimum elevation of 14.5 feet. This elevation would allow 3.5 feet of freeboard above Salt Lake's normal water surface elevation of 11.0 feet.

Several rainfall frequency estimates were considered for an Event or Post-Event site status during which the weirs are closed. It was determined that maintaining 3.5 feet of freeboard in should not overtop the levee for most rainfall events. Example: A 500 Year storm event having a 60-day duration would produce 40.6 inches of rainfall, which is less than the 42 inches of freeboard. Rainfall amounts were obtained from NOAA Atlas 14 Volume 9 Version 2. Information is included in Appendix, page 21.

4.5 LEVEE CONFIGURATION

The top of the levee will be set at approximately 3.5 feet above the Salt Lake surface elevation of 11.0 feet. The levee top will be the access road for the containment system and will be 14 to 16 feet wide to provide mobility for vehicles and equipment. The top will be surfaced with crushed aggregate placed on top of a geotextile fabric. Side slopes of the fill material will be 2 on 1. The total base width of the levee will vary depending on the existing ground elevations but can approach a width of 40 feet. See levee detail in appendix drawing SK-APP1-09.01.

4.6 LEVEE SYSTEM CONSTRUCTION MATERIALS

Clay soil material has been selected as the main levee construction material due to its low permeability properties and reliability over long durations. The following table includes the preliminary materials and quantities for the construction of the Pre-Event Levee System Plan.

Pre-Event Major Construction Materials and Supplies

ITEM	APPROXIMATE QUANTITY
Clay Soil Material	12,500 cubic yards
Sheet Piles (24 ft long)	1,900 feet
Impermeable flexible barrier	1900 feet by 14 ft wide
Geotextile Fabric	19,055 feet at 16 feet wide
Aggregate	5,100 cubic yards
Weir Structures	2 major and 2 minor (4 total)
Grass Seeding	10 acres
Pump Station 2000 gpm	1 Unit
Cable Tray and Power Feed	3350 feet
12" Dia. HDPE Pipe	3350 feet

5.0 WATER CONTROL AND TREATMENT PLAN

In the event of a surface expression of the No.7B Brine Well all surface water at the expression site should be contained to prevent offsite freshwater contamination. The proposed levee system(s) and water treatment plans are divided into three stages, pre-event, event, and post-event. Each plan will have its own requirements and be interlinked with the previous plans. The full description of the individual plans are as follows.

5.1 PRE-EVENT ACTION PLAN

The outlined pre-event levee system on drawing SK-APP1-03.01 will be designed and installed proactively to contain the potential release of hydrocarbons and brackish water into the downstream drainage laterals. New drainage ditches around the perimeter of the Salt Lake will be constructed diverting current surface drainage outside directly to Bayou Choupique.

Four weirs are planned to control the Salt Lake level at 11 feet (Pre-Event); providing the necessary freeboard for the potential No.7 expression. These locations will be equipped with salinity monitors and lighting for routine monitoring of the containment structure's stormwater discharge. The Salt Lake pump structure (Pump Station 1) as shown on drawing SK-APP1-06.01 will be constructed pre-event. Preliminary engineering and design development will be performed for the pumps and water treatment equipment.

5.2 EVENT ACTION PLAN

Pre-event seismic and subsidence monitoring serve as early indicators of the potential onset of a No.7 surface expression. All levee weir structures are to be closed following any indication of anomalous seismicity or subsidence to prevent the release of any contaminants or brackish water. After seismic and subsidence has ceased, and it is deemed safe to assess damage the following will be implemented as part of the event action plan.

Inspection of the levees, weirs and pump structures will be performed, and plans established for repairs and/or modifications will be implemented as deemed necessary. Efforts to minimize environmental impacts will be implemented during this phase. This will include the capture of surface hydrocarbons and water sampling to determine the appropriate water treatment equipment.

Temporary water treatment equipment and pumps will be utilized to treat and maintain the water levels inside the containment levees until such time as a permeant solution can be installed. A combination of water treatment for solution brine mining and surface drainage discharge will be utilized. To discharge in the bayous the water will need to be treated for hydrocarbons, sludge, and salinity levels. If used for brine mining the water will need to be treated so that it has no negative effects on chlorine manufacturing equipment.

5.3 POST-EVENT ACTION PLAN

The post-event action plan will be the implementation of long-term water treatment and usage plans. Future requirements for treating water during an event and post-event will be further developed. Westlake will work with knowledgeable water treatment experts to determine the appropriate treatment process(es) as outlined in the "Sulphur Brine Field Alternate Water

Source” document submitted to the Louisiana Department of Natural Resources Office of Conservation in response to Order 5.a of the Third Supplement to Compliance Order No. IMD 2005-027. Preliminary calculations show the need to treat approximately 2,000 gpm based on pond size and sizeable rainfall events. Treatment equipment will be designed for a combination of on-site solution mining use as well as discharge to the local drainage system if required. Site infrastructure will be evaluated for potential future needs along with preliminary layouts of temporary and/or permanent process equipment locations.

The levee system(s) boundaries will be routinely monitored, and revisions made if required. Unaffected brine wells will continue operations utilizing water from water wells and Salt Lake. Active and dormant brine wells will be monitored in accordance with regulatory requirements and changes to pressures reported promptly. The outlined Post-Event Levee System on drawing SK-APP1-05.01 can be implemented should an event occur on the remaining brine wells.

APPENDIX

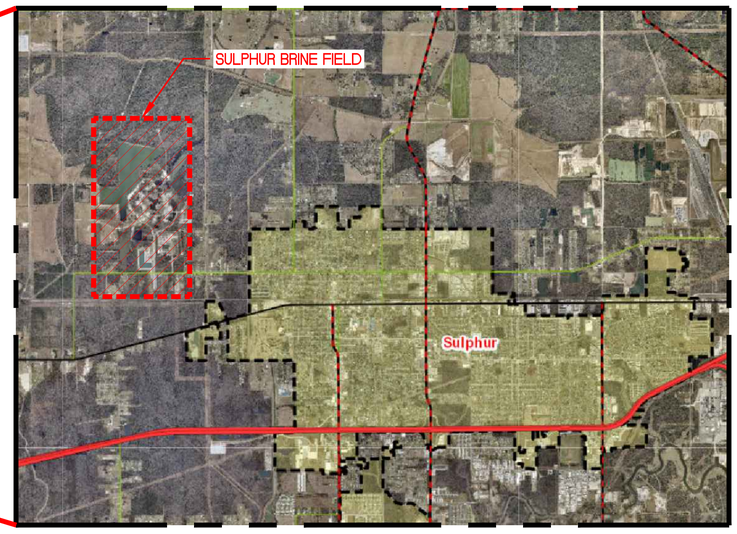
WESTLAKE US2, LLC

CALCASIEU PARISH, LOUISIANA

SULPHUR BRINE FIELD

LEVEE SYSTEM REV. 1 (MARCH 11, 2024)

STATE MAP
SCALE: N.T.S.



VICINITY MAP
SCALE: N.T.S.

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SHEET INDEX:

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JOB NO.: 23261173
FILE: SK-APP1-01.DWG
APPROVED:

Glen A. Boaz, PE
LA LIC #29016

DATE: 3/2024

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Westlake
North American Chlor-Alkali & Derivatives ™
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
COVER SHEET

DRAWN BY B. WHITTINGTON DATE 3/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE –
APPROVED BY DATE SHEET 1 OF 9
DWG. SK-APP1-01.01

FORM NO. 32A10808

LEVEE SYSTEM PRE-EVENT
SITE PLAN
SCALE: N.T.S.

NOTES:

1. LEVEE SYSTEM TO BE BUILT SURROUNDING EXTERIOR OF MAIN POND AND IMPACT ZONE.
2. FOUR DRAINAGE WEIRS ARE TO BE CONSTRUCTED AROUND THE SALT LAKE. THEY WILL BE LOCATED ON THE WEST SIDE, SOUTHWEST SIDE, NORTHEAST SIDE, AND EAST SIDE AT THE SHEET PILE WALL.
3. PUMPS WILL BE INSTALLED SOUTH OF THE SALT LAKE.

LEGEND:

SALT LAKE LEVEE

IMPACT ZONE ESTIMATE

** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM PRE-EVENT
SITE PLAN

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DWG. SK-APP1-02.01

FORM NO. 32A10808

LEVEE SYSTEM PRE-EVENT
SCALE: 1" = 300'

N

NOTES:

1. FOUR WEIR STRUCTURES ARE TO BE CONSTRUCTED TO CONTROL POND WATER ELEVATION FOR RAINFALL EVENTS.
2. STRUCTURES 1 & 2 DISCHARGES TO BAYOU CHOUPIQUE. WEIR STRUCTURES 3 & 4 DISCHARGE TO BAYOU D'INDE.

LEVEE SYSTEM NOTES:

APPROX. AREA WITHIN SALT LAKE LEVEE: 286 ACRES

APPROX. AREA TO BE CLEARED FOR LEVEE: 6.5 ACRES

APPROX. LENGTH OF SALT LAKE LEVEE: 19,410'

APPROX. AREA OF WELL LEVEE: 34.1 ACRES

APPROX. LENGTH OF WELL LEVEE: 2,589'

LEGEND:

SALT LAKE LEVEE

IMPACT ZONE ESTIMATE FROM LONQUIST

** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM PRE-EVENT
LEVEE SYSTEM PLAN

DRAWN BY B. WHITTINGTON DATE 3/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE
APPROVED BY DATE SHEET 3 OF 9
DWG. SK-APP1-03.01

FORM NO. 32A10808

LEVEE SYSTEM POST-EVENT
SITE PLAN
SCALE: N.T.S.

NOTES:

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LEGEND:

- SALT LAKE LEVEE
- IMPACT ZONE ESTIMATE
- ** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023
- CENTRAL POND LEVEE

REVISIONS

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Glen A. Boaz, PE
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Westlake
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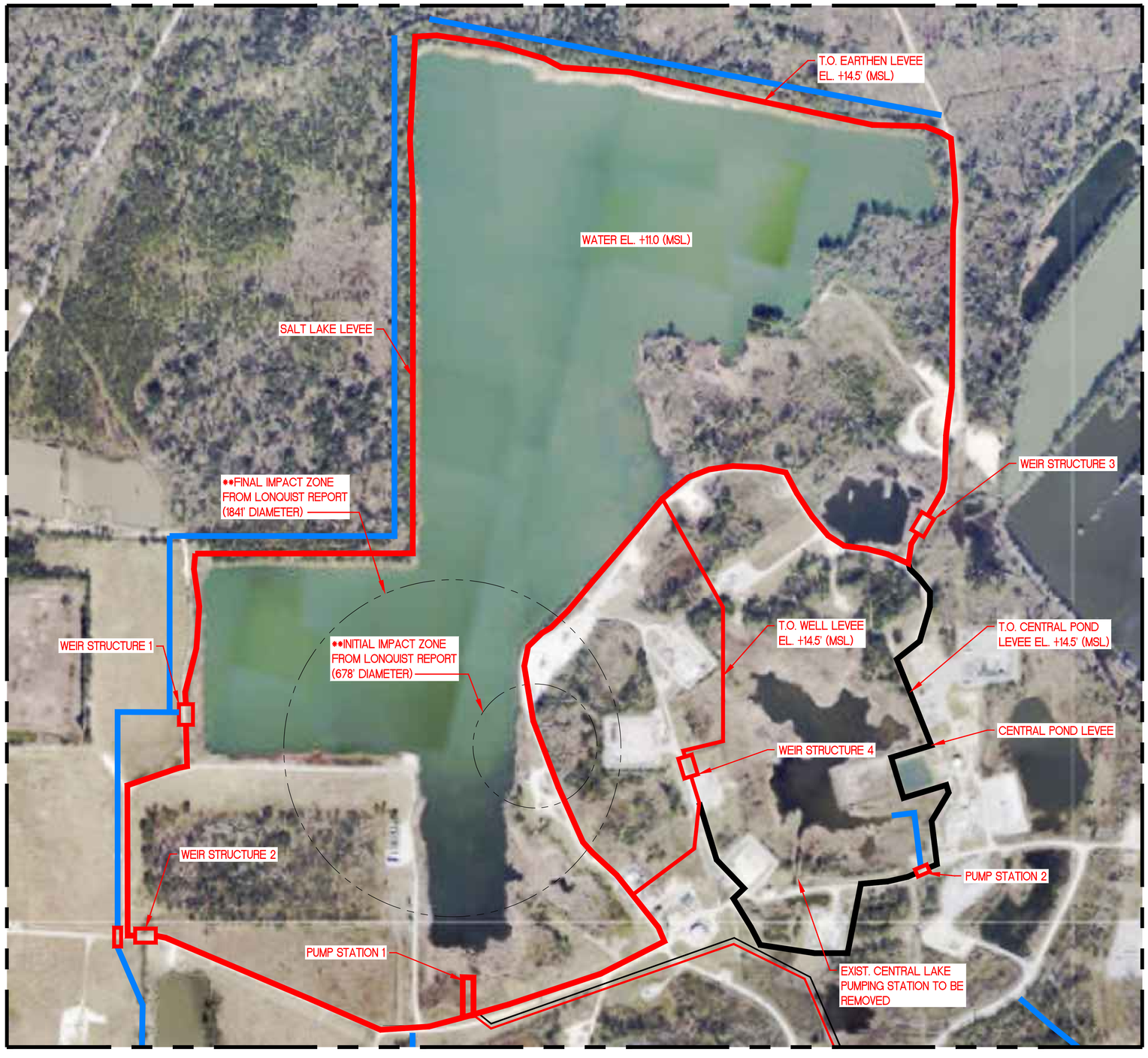
Lake Charles South Complex
1300 PPG Drive, Westlake, LA 70669

SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM POST-EVENT
SITE PLAN

DRAWN BY B. WHITTINGTON DATE 3/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE –
APPROVED BY DATE SHEET 4 OF 9
DWG. SK-APP1-04.01

FORM NO. 32A10808



LEVEE SYSTEM POST-EVENT
SCALE: 1" = 300'

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APPROX. AREA OF WELL LEVEE: 34.1 ACRES
APPROX. LENGTH OF WELL LEVEE: 2,589'
APPROX. AREA OF CENTRAL POND LEVEE: 59.7 ACRES
APPROX. LENGTH OF CENTRAL POND LEVEE: 4,531'

LEGEND:

- SALT LAKE LEVEE
- IMPACT ZONE ESTIMATE
- ** FROM LONQUIST REPORT DATED NOVEMBER 2, 2023
- CENTRAL POND LEVEE

REVISIONS

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LEVEE SYSTEM POST-EVENT
LEVEE SYSTEM PLAN

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DWG. SK-APP1-05.01

FORM NO. 32A10808

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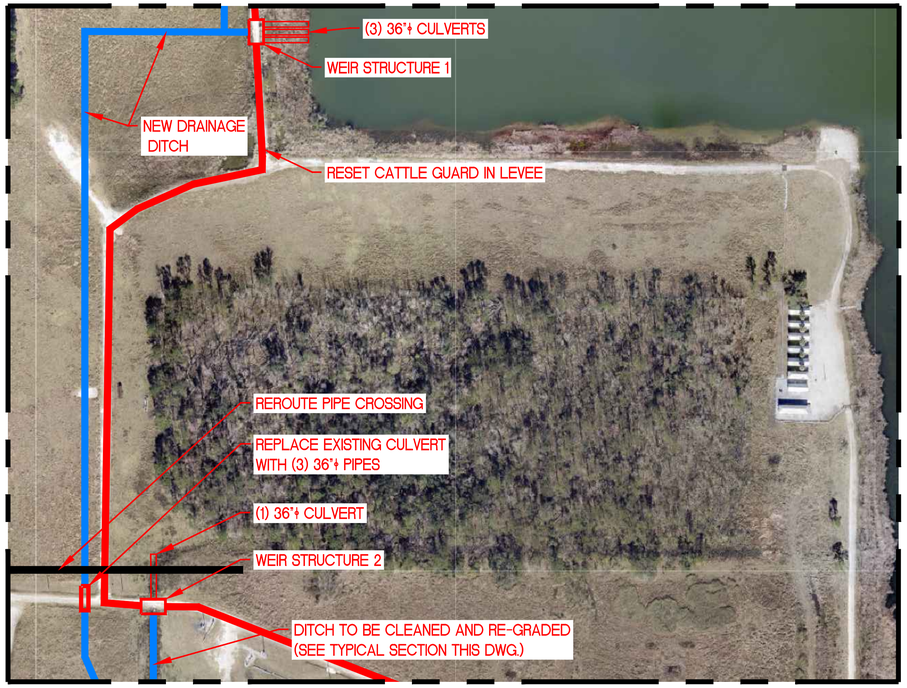

WEIR STRUCTURE 1 & 2
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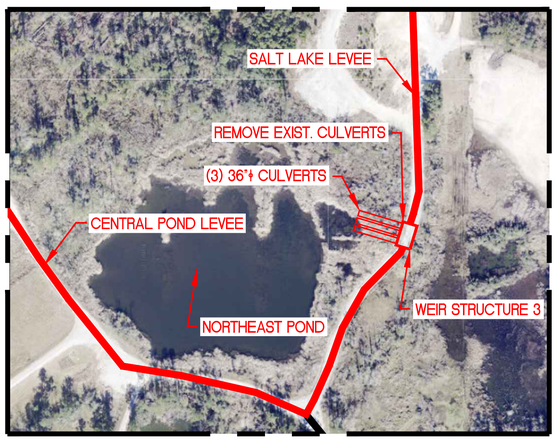

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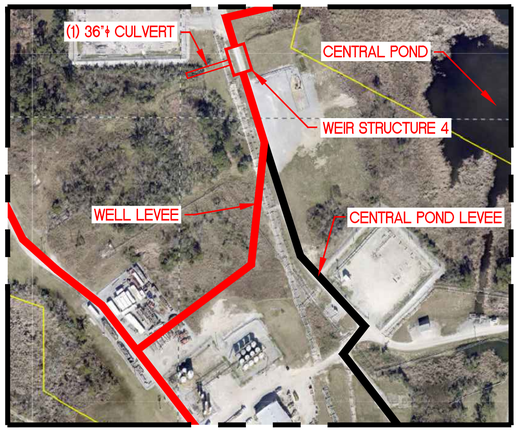

WEIR STRUCTURE 4
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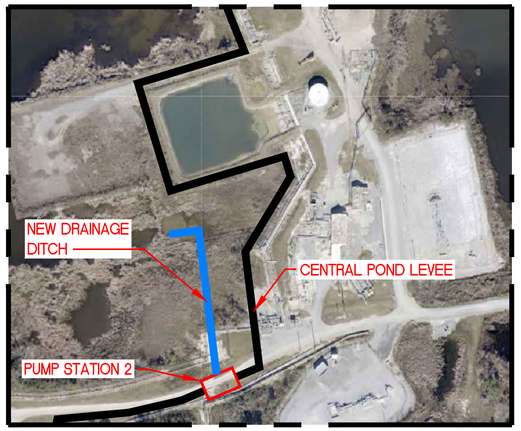

PUMP STATION 2
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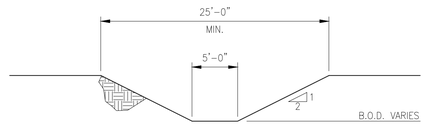

SECTION

DRAINAGE DITCH
SCALE: 1/8" = 1'-0"

Glen A. Boaz, PE
LA LIC #29016

DATE: 3/2024

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
WEIR STRUCTURE AND PUMP PLANS

DRAWN BY B. WHITTINGTON DATE 3/2024 SCALE AS SHOWN
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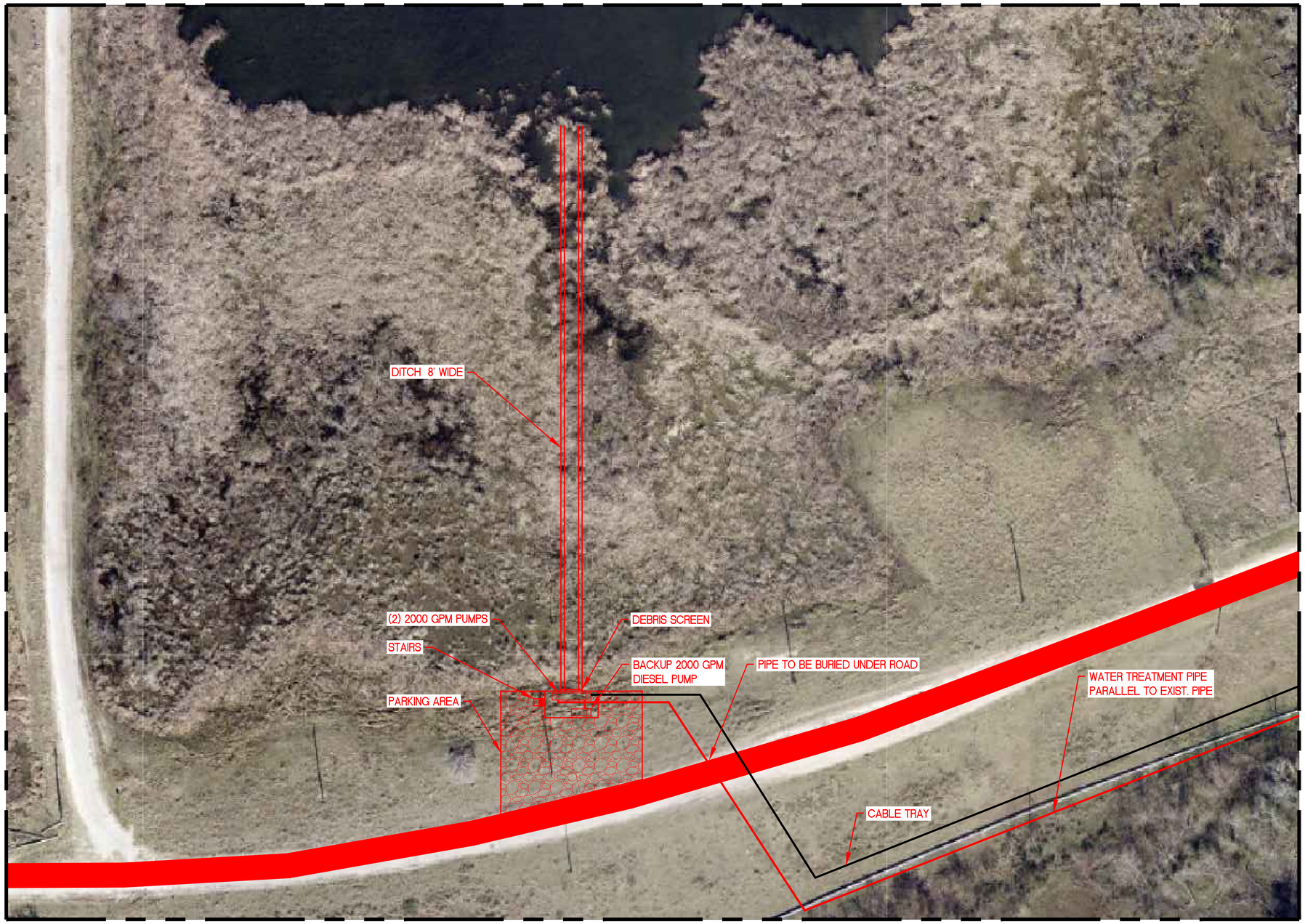
APPROVED BY DATE SHEET 6 OF 9
DWG. SK-APP1-06.01

FORM NO. 32A10808



PUMP STATION 1 ENLARGED PLAN
SCALE: 1" = 30'

N

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Glen A. Boaz, PE
LA LIC #29016

DATE: 3/2024

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SULPHUR BRINE FIELD — CIVIL
PUMP STATION 1
ENLARGED PLAN

DRAWN BY	B. WHITTINGTON	DATE	3/2024
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APPROVED BY		DATE	
SCALE	AS SHOWN		
CHARGE	–		
SHEET	7 OF 9		

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FORM NO. 32A10808

WATER TREATMENT AREA ENLARGED PLAN
SCALE: 1" = 50'

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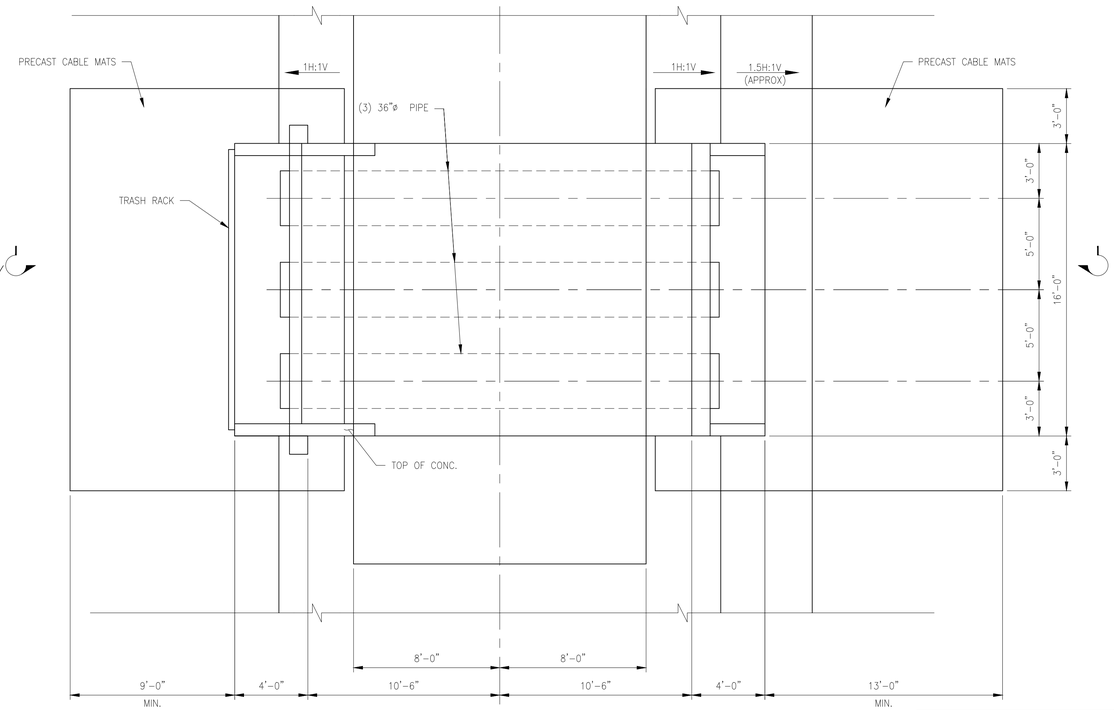
SULPHUR BRINE FIELD — CIVIL
PROPOSED WATER TREATMENT STATION
ENLARGED PLAN

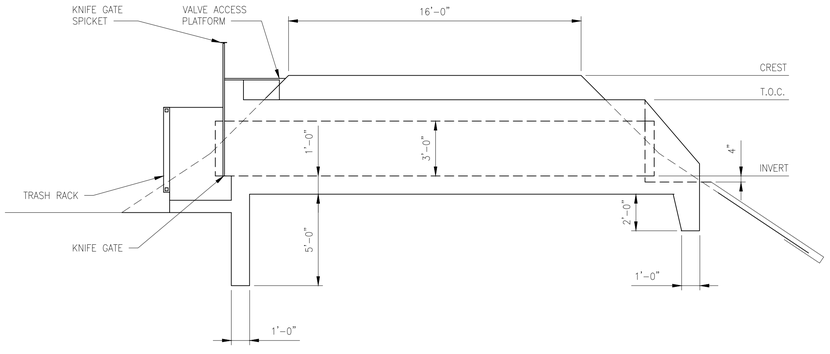
DRAWN BY B. WHITTINGTON DATE 3/2024 SCALE AS SHOWN
CHECKED BY DATE CHARGE –
APPROVED BY DATE SHEET 8 OF 9
DWG. SK-APP1-08.00

FORM NO. 32A10808



NOTE:
A MAJOR WEIR IS DEFINED AS (3) 36"ø CULVERTS AND A MINOR WEIR IS DEFINED AS HAVING A SINGLE (1) 36"ø CULVERT.

TYPICAL WEIR STRUCTURE PLAN
SCALE: 1/4" = 1'-0"



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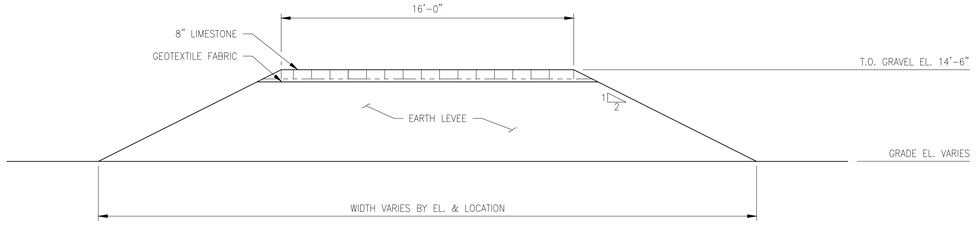
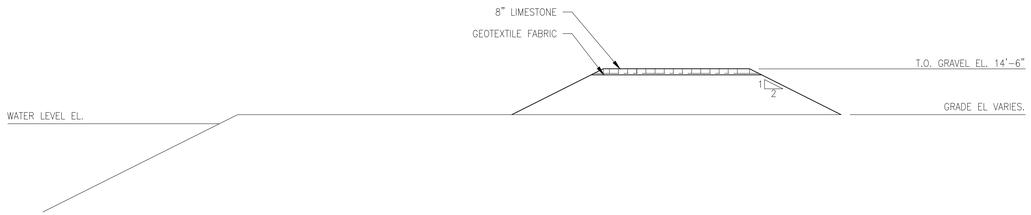


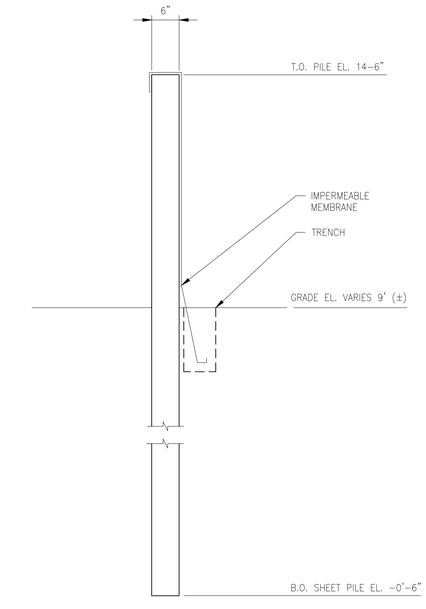
SECTION

LEVEE DETAIL
SCALE: 1/4" = 1'-0"



SECTION

LEVEE DETAIL
SCALE: 1/8" = 1'-0"



ELEVATION

SHEET PILE DETAIL
SCALE: 3/4" = 1'-0"

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LA LIC #29016

DATE: 3/2024

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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
LEVEE AND WEIR STRUCTURES

DRAWN BY B.WHITTINGTON DATE 3/2024 SCALE AS SHOWN
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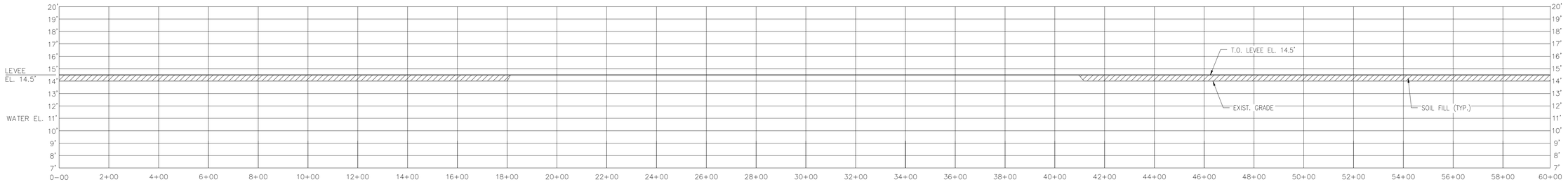
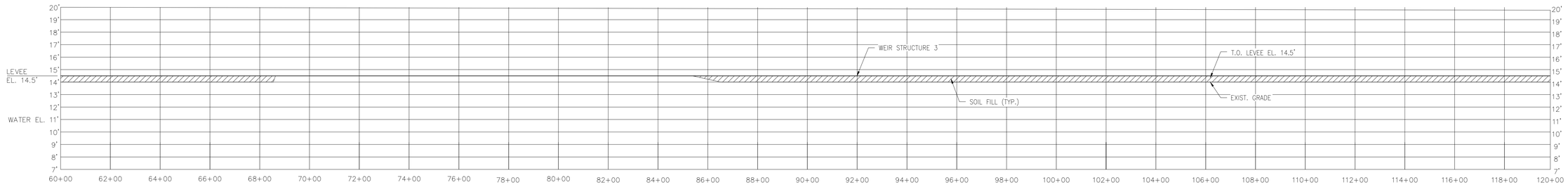
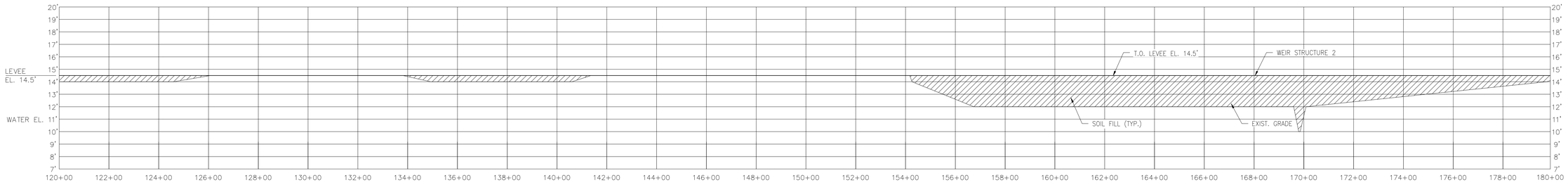
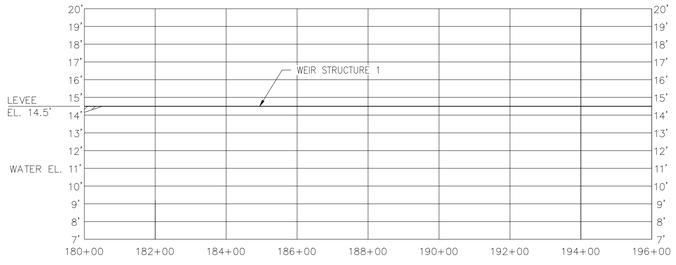
DWG. SK-APP1-09.01

FORM NO. 32A10808









SALT LAKE HIGH BANK LEVEE PROFILE

SCALE:
HORIZONTAL: 1" = 200'
VERTICAL: 1" = 4'

Glen A. Boaz, PE
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DATE: 02/2024

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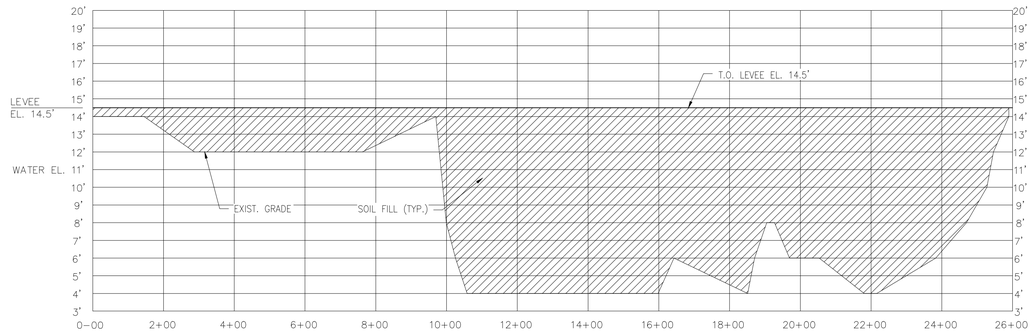
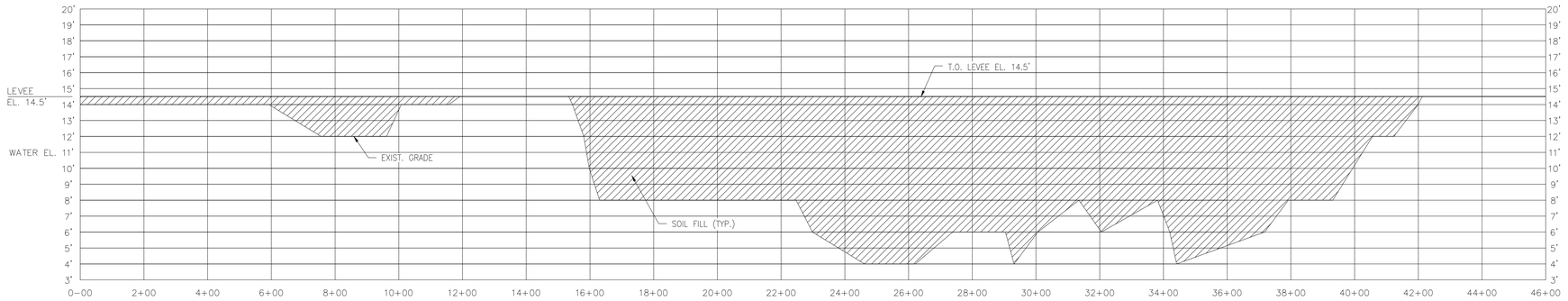
SULPHUR BRINE FIELD — CIVIL
SALT LAKE HIGH BANK LEVEE
PROFILE

DRAWN BY _____ DATE 3/2024 SCALE AS SHOWN
CHECKED BY _____ DATE _____ CHARGE _____
APPROVED BY _____ DATE _____ SHEET _____ OF _____
DWG. SK-APP1-10.00

FORM NO. 32A10808



WELL LEVEE PROFILE



CENTRAL POND LEVEE PROFILE

SCALE:
HORIZONTAL: 1" = 200'
VERTICAL: 1" = 4'

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LA LIC #29016

DATE: 3/2024

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JOB NO.:
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SULPHUR BRINE FIELD — CIVIL
CENTRAL POND AND WELL LEVEE PROFILES

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APPROVED BY ____ DATE ____ SHEET ____ OF ____
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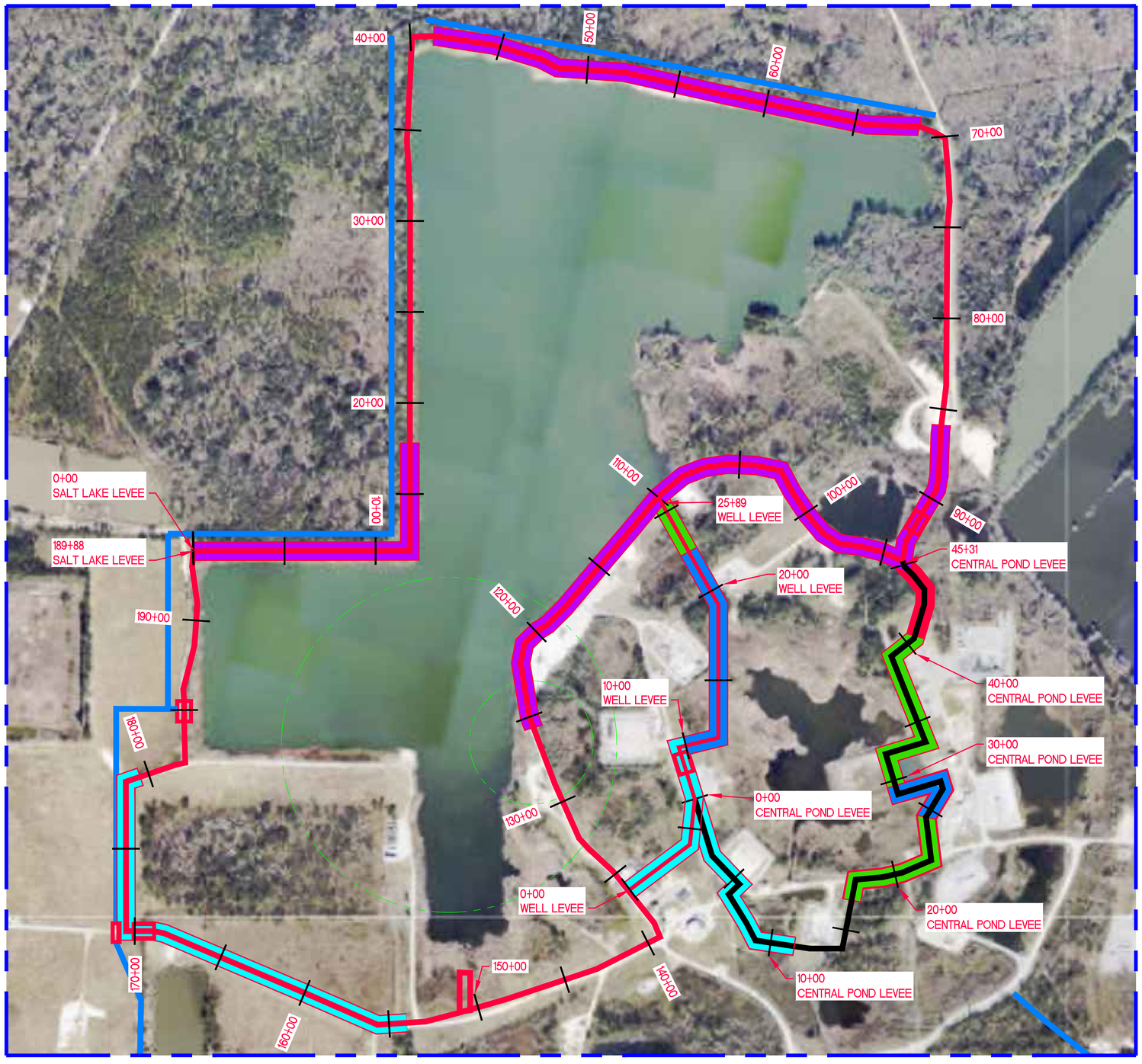

LEVEE SYSTEM FILL SCHEMATIC
SCALE: 1" = 300'

N

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FOR: CONST.
BULLETIN NO.: CONST.

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LEVEE SYSTEM NOTES:

APPROX. AREA WITHIN SALT LAKE LEVEE: 286 ACRES
APPROX. AREA TO BE CLEARED FOR LEVEE: 6.5 ACRES
APPROX. LENGTH OF SALT LAKE LEVEE: 19,410'
APPROX. AREA OF WELL LEVEE: 31.4 ACRES
APPROX. LENGTH OF WELL LEVEE: 2,548'
APPROX. AREA OF CENTRAL POND LEVEE: 59.7 ACRES
APPROX. LENGTH OF CENTRAL POND LEVEE: 4,531'

LEGEND:

- SALT LAKE LEVEE
- IMPACT ZONE ESTIMATE FROM LONQUIST
- CENTRAL POND LEVEE
- STATIONS EVERY 500'
- 0-1' FILL
- 1'-3' FILL
- 3'-6' FILL
- 6'-9' FILL/SHEET PILE
- 9'-12' FILL/SHEET PILE

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SULPHUR, LA.
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FILE: SK-APP1-12.DWG
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SULPHUR BRINE FIELD — CIVIL
LEVEE SYSTEM
FILL SCHEMATIC

DRAWN BY _____ DATE 3/2024 SCALE AS SHOWN
CHECKED BY _____ DATE _____ CHARGE _____
APPROVED BY _____ DATE _____ SHEET _____ OF _____
DWG. SK-APP1-12.00

FORM NO. 52A10808

NOAA Atlas 14, Volume 9, Version 2
Location name: Sulphur, Louisiana, USA*
Latitude: 30.2556°, Longitude: -93.413°
Elevation: 6 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.567** (0.456-0.716)	**0.646** (0.519-0.817)	**0.776** (0.621-0.983)	**0.883** (0.703-1.12)	**1.03** (0.792-1.35)	**1.14** (0.860-1.52)	**1.25** (0.913-1.72)	**1.36** (0.957-1.93)	**1.51** (1.02-2.20)	**1.62** (1.07-2.41)
10-min	**0.830** (0.667-1.05)	**0.947** (0.760-1.20)	**1.14** (0.909-1.44)	**1.29** (1.03-1.65)	**1.51** (1.16-1.98)	**1.67** (1.26-2.23)	**1.83** (1.34-2.51)	**2.00** (1.40-2.82)	**2.21** (1.50-3.22)	**2.37** (1.57-3.52)
15-min	**1.01** (0.814-1.28)	**1.15** (0.927-1.46)	**1.39** (1.11-1.76)	**1.58** (1.26-2.01)	**1.84** (1.41-2.41)	**2.04** (1.54-2.72)	**2.23** (1.63-3.06)	**2.43** (1.71-3.44)	**2.70** (1.82-3.93)	**2.89** (1.91-4.30)
30-min	**1.48** (1.19-1.86)	**1.70** (1.36-2.15)	**2.06** (1.65-2.61)	**2.35** (1.87-3.00)	**2.75** (2.12-3.61)	**3.06** (2.30-4.08)	**3.36** (2.45-4.61)	**3.66** (2.57-5.17)	**4.06** (2.74-5.91)	**4.35** (2.88-6.47)
60-min	**1.97** (1.58-2.49)	**2.27** (1.82-2.86)	**2.76** (2.21-3.50)	**3.20** (2.54-4.07)	**3.82** (2.96-5.06)	**4.32** (3.27-5.80)	**4.84** (3.54-6.68)	**5.38** (3.79-7.65)	**6.13** (4.16-8.98)	**6.72** (4.44-9.98)
2-hr	**2.47** (1.99-3.10)	**2.83** (2.29-3.56)	**3.47** (2.79-4.37)	**4.04** (3.23-5.11)	**4.88** (3.81-6.46)	**5.58** (4.25-7.48)	**6.31** (4.66-8.69)	**7.10** (5.04-10.1)	**8.21** (5.61-12.0)	**9.09** (6.04-13.4)
3-hr	**2.79** (2.26-3.49)	**3.20** (2.59-4.01)	**3.95** (3.18-4.95)	**4.63** (3.72-5.84)	**5.69** (4.48-7.54)	**6.58** (5.05-8.83)	**7.55** (5.60-10.4)	**8.60** (6.14-12.2)	**10.1** (6.96-14.8)	**11.3** (7.57-16.7)
6-hr	**3.38** (2.75-4.20)	**3.89** (3.16-4.83)	**4.85** (3.94-6.05)	**5.78** (4.66-7.23)	**7.23** (5.75-9.60)	**8.49** (6.57-11.4)	**9.88** (7.40-13.6)	**11.4** (8.22-16.1)	**13.7** (9.47-19.8)	**15.5** (10.4-22.6)
12-hr	**4.01** (3.28-4.94)	**4.66** (3.81-5.75)	**5.89** (4.80-7.29)	**7.08** (5.74-8.80)	**8.95** (7.16-11.8)	**10.6** (8.23-14.1)	**12.4** (9.32-16.9)	**14.4** (10.4-20.2)	**17.3** (12.1-24.9)	**19.7** (13.3-28.5)
24-hr	**4.69** (3.86-5.74)	**5.48** (4.51-6.72)	**6.98** (5.72-8.59)	**8.41** (6.86-10.4)	**10.7** (8.56-14.0)	**12.6** (9.86-16.7)	**14.7** (11.2-20.0)	**17.1** (12.5-23.9)	**20.5** (14.4-29.4)	**23.3** (15.9-33.7)
2-day	**5.43** (4.49-6.61)	**6.35** (5.25-7.74)	**8.07** (6.64-9.86)	**9.69** (7.94-11.9)	**12.2** (9.85-15.9)	**14.4** (11.3-18.9)	**16.7** (12.7-22.5)	**19.3** (14.2-26.8)	**23.1** (16.3-32.9)	**26.2** (18.0-37.5)
3-day	**5.89** (4.88-7.14)	**6.89** (5.71-8.37)	**8.74** (7.22-10.6)	**10.5** (8.60-12.8)	**13.1** (10.6-16.9)	**15.4** (12.1-20.1)	**17.8** (13.6-23.9)	**20.5** (15.1-28.3)	**24.4** (17.3-34.6)	**27.6** (19.0-39.3)
4-day	**6.24** (5.19-7.55)	**7.31** (6.07-8.85)	**9.25** (7.66-11.2)	**11.1** (9.10-13.5)	**13.8** (11.2-17.8)	**16.1** (12.7-21.0)	**18.7** (14.3-24.9)	**21.4** (15.8-29.4)	**25.4** (18.0-35.8)	**28.6** (19.7-40.6)
7-day	**7.15** (5.97-8.60)	**8.32** (6.94-10.0)	**10.4** (8.66-12.6)	**12.3** (10.2-15.0)	**15.2** (12.4-19.5)	**17.7** (14.0-22.9)	**20.4** (15.6-27.0)	**23.2** (17.2-31.7)	**27.3** (19.5-38.3)	**30.7** (21.3-43.4)
10-day	**8.00** (6.70-9.58)	**9.22** (7.71-11.1)	**11.4** (9.50-13.7)	**13.4** (11.1-16.2)	**16.3** (13.3-20.7)	**18.8** (15.0-24.2)	**21.5** (16.6-28.4)	**24.4** (18.1-33.1)	**28.5** (20.4-39.8)	**31.8** (22.1-44.8)
20-day	**10.5** (8.86-12.5)	**11.9** (10.0-14.2)	**14.3** (12.0-17.1)	**16.3** (13.6-19.6)	**19.3** (15.7-24.1)	**21.7** (17.3-27.5)	**24.2** (18.7-31.5)	**26.9** (20.0-36.0)	**30.5** (21.9-42.2)	**33.4** (23.4-46.8)
30-day	**12.6** (10.6-15.0)	**14.2** (12.0-16.8)	**16.8** (14.1-20.0)	**19.0** (15.9-22.7)	**22.0** (17.9-27.3)	**24.4** (19.5-30.7)	**26.9** (20.8-34.7)	**29.4** (21.9-39.0)	**32.7** (23.6-44.8)	**35.3** (24.8-49.2)
45-day	**15.2** (12.9-17.9)	**17.1** (14.4-20.2)	**20.1** (16.9-23.8)	**22.5** (18.9-26.8)	**25.9** (21.0-31.7)	**28.4** (22.6-35.4)	**30.9** (23.9-39.5)	**33.3** (24.9-44.0)	**36.5** (26.4-49.7)	**38.9** (27.5-54.0)
60-day	**17.4** (14.7-20.4)	**19.5** (16.5-23.0)	**23.0** (19.4-27.1)	**25.7** (21.6-30.6)	**29.4** (23.9-35.9)	**32.1** (25.7-39.9)	**34.8** (27.0-44.3)	**37.4** (27.9-49.1)	**40.6** (29.4-55.0)	**43.0** (30.4-59.5)

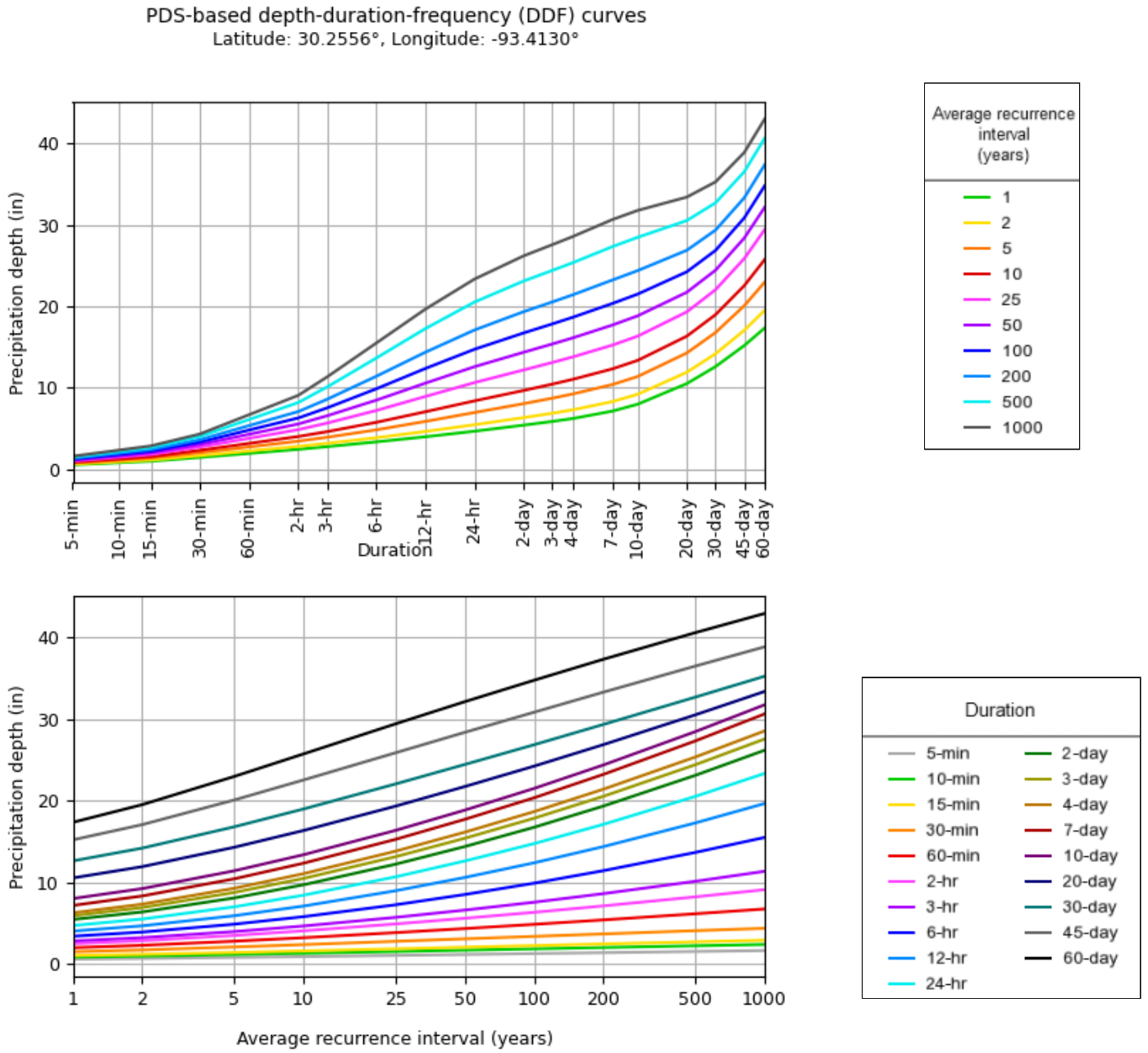
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



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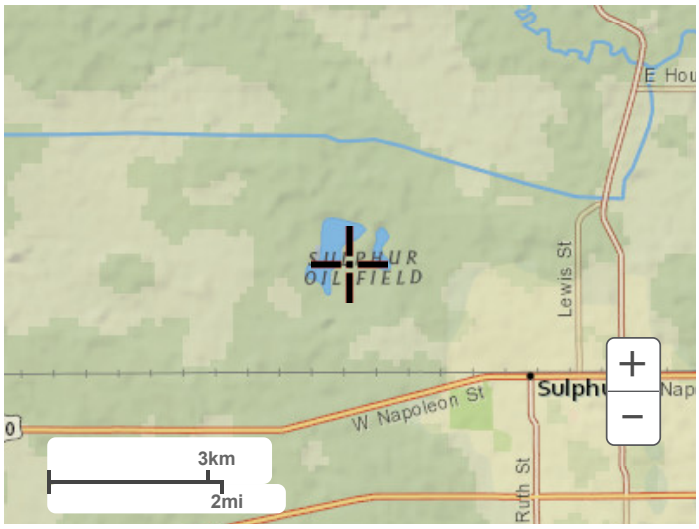
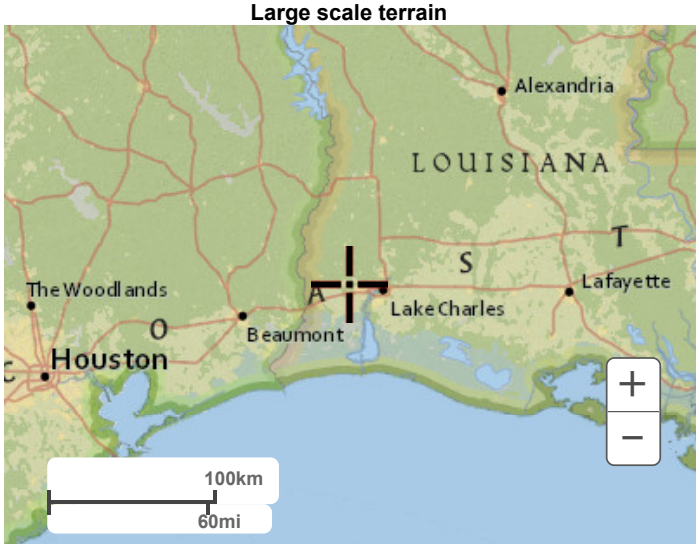
Maps & aerials

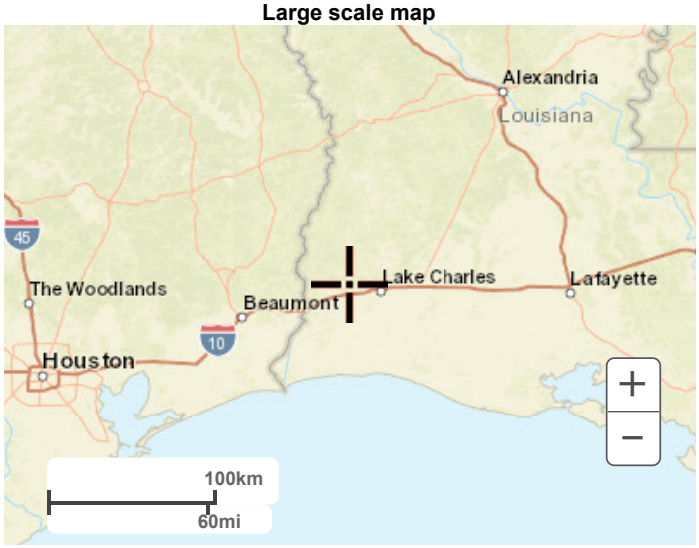
Small scale terrain



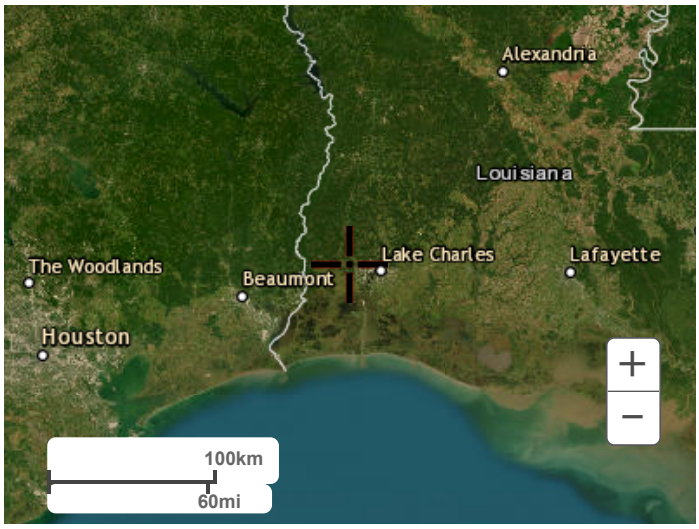
Large scale terrain



Large scale map



Large scale aerial



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