DOCKETED	
Docket Number:	09-AFC-05C
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Submitted On: 11/29/2023
Docket Number: 09-AFC-05C

Mojave Solar Pond's Liner Extension Project

Additional submitted attachment is included below.

Atlantica
Sustainable Infrastructure

Petition To Amend

Pond's Liner Extension Project

Mojave Solar

NO: 09-AFC-05
11-29-2023

Atlantica
Sustainable Infrastructure

Contents

1 Definitions

A-E	Alpha East Pond
A-W	Alpha West Pond
B-E	Beta East Pond
B-W	Beta West Pond
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
COCs	Conditions of Certifications
GEN-1	General Condition
HAI	Hushmand Associates, Inc.
LORS	Laws, Ordinances, Regulations, and Standards
AMSP	Abengoa Mojave Solar Project
MDAQMD	Mojave Desert Air Quality Management District
MS	Mojave Solar
MSP	Mojave Solar Project
PTA	Petition to Amend
PTO	Permit To Operate
TAC	Toxic Air Contaminant

2 Summary

Mojave Solar LLC (MS) is submitting this petition for a post Certification Amendment of the Abengoa Mojave Solar Project (AMSP), Docket 09-AFC-5. The following changes are included in this petition:

1- Project name's change from "Abengoa Mojave Solar Project" to "Mojave Solar Project".

2- In order to facilitate the pond's maintenance and enhance its storage capacity, MSP is proposing to extend the current 60 mil HDPE liner in the lower elevation areas of the evaporation ponds by up to 2 feet. The additional 2 feet will be considered as the required 2 feet of freeboard.

This Petition to Amend (PTA) is filed to make the changes necessary to final design approved by the California Energy Commission (CEC) in accordance with California Code of Regulations (CCR) title 20, section 1769 (a)(1).

3 Organization of the Petition

This petition for post certification license modification (Petition) is based on the requirements of Title 20, California Code of Regulations (CCR), section 1769(a), describing the contents of post certification amendments. The Petition provides the following:

- A complete description of the modifications, including new language for any conditions that will be affected.
- A discussion of the necessity of the proposed modification.
- An explanation that the modification was not known at the time of the certification.
- An explanation that the information was not known, and why the change should be permitted.
- An analysis of the impacts the modification may have on the environment and proposed measures to mitigate any significant adverse impacts, if appropriate.
- A discussion of how the modification may impact the facility's ability to comply with applicable laws and regulations.
- A discussion of how the modification affects the public.
- A list of property owners potentially affected by the modification; and
- A discussion of the potential effect on nearby property owners, the public and parties in the application proceedings.

This petition is based on MS's determination that environmental impact concerns of the Pond's Liner Extension Project would not differ substantially from the original project approved in September 2010.

4 Project Location

Mojave Solar LLC (MS) owns Mojave Solar Project, an operating 280 megawatt (MW) concentrated solar project at 42134 Harper Lake Road, Hinkley in San Bernardino County, California. The facility includes two (2) evaporation pond areas, Alpha Pond area located north of the site and Beta Pond area in the southern part of the site. Each pond area has two (2) ponds (east and west ponds) and four (4) sumps, two (2) in the east pond and two (2) in the west pond. The Alpha and Beta Pond systems are identical. There are three (3) pipe runs at each pond, each about 717 feet long. Thus, for the four (4) ponds at the Mojave Solar Project, there are twelve (12) pipe runs, approximately 8,604 feet in total length. These

ponds were designed and constructed as part of the plant construction project in 2012 and 2013. Each pond excluding the slopes is 312 ft x 294 ft in the plan area. By adding the slopes, pond dimensions will increase by about 50 to 60 ft. The depth of the ponds is about 15 feet, but they are not full to the top. The ponds are currently in service and are partially filled with the Water Treatment Plant RO Waste Discharge.

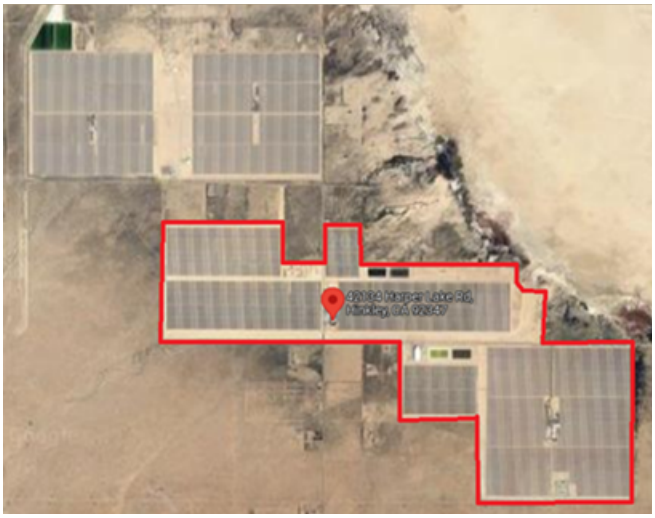


Figure 4-1: Aerial View of the Mojave Solar Project and Surrounding Area

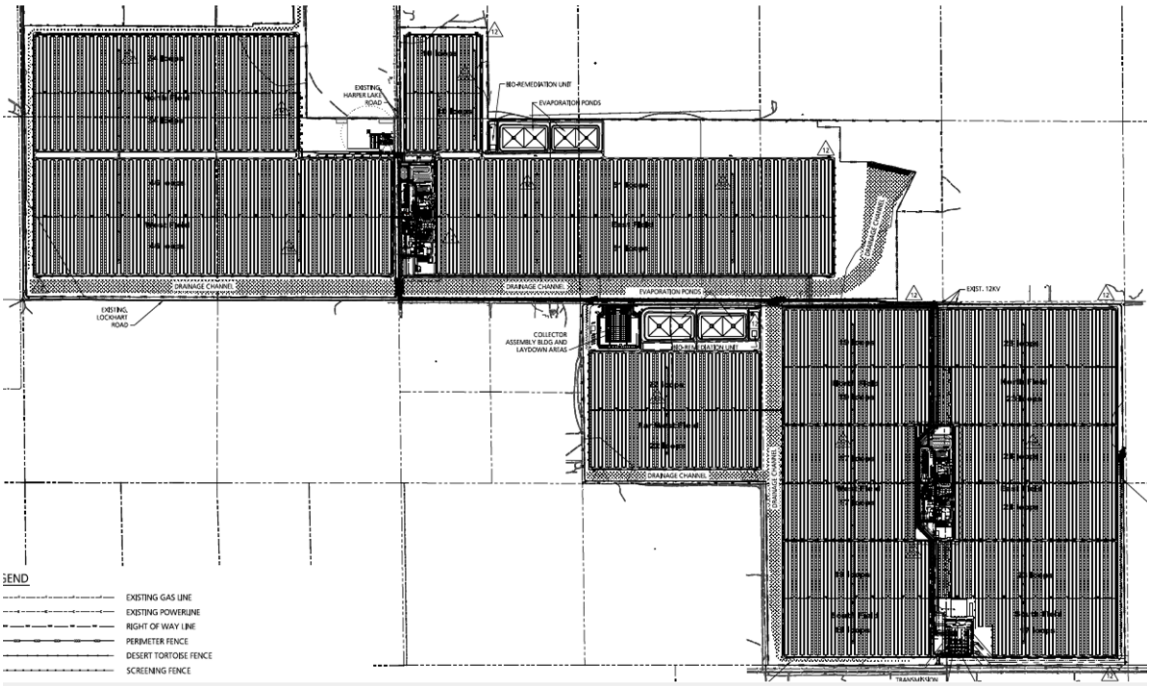


Figure 4-2: Site Plan

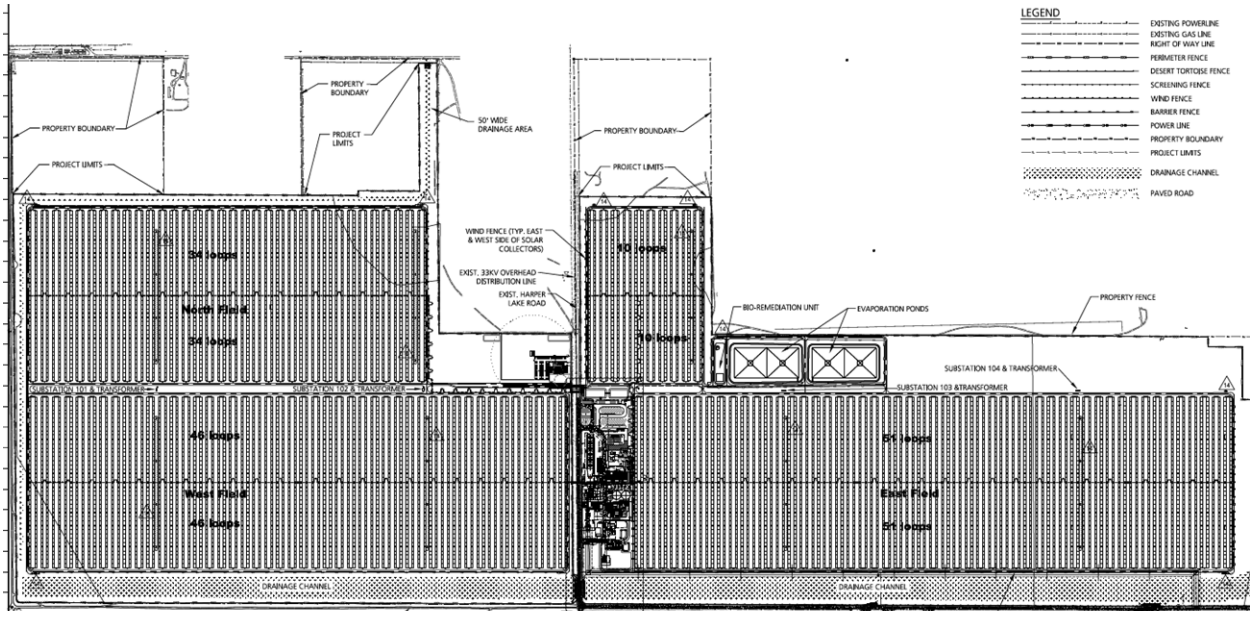


Figure 4-3: Alpha Plant Layout

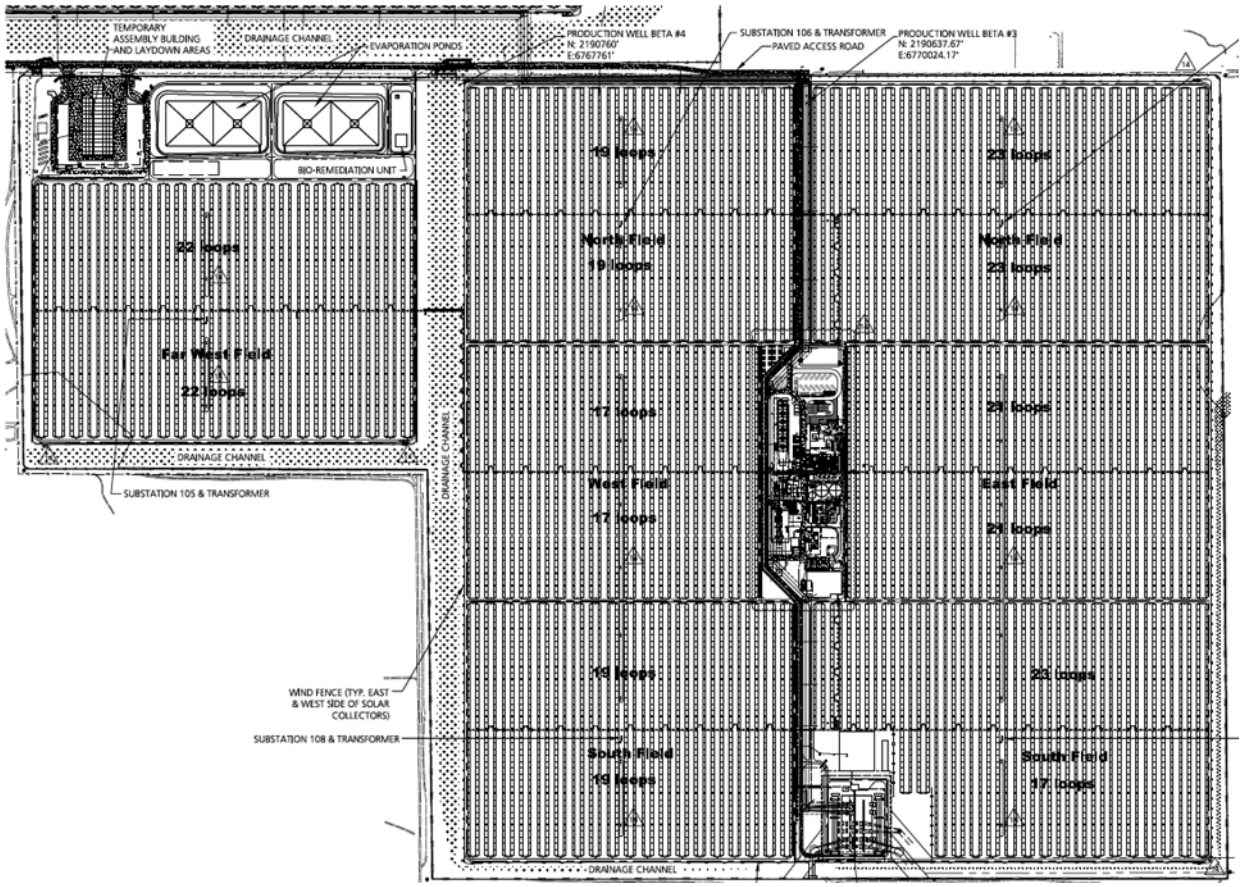


Figure 4-4: Beta Plant Layout

5 Facility Permitting Background

The MSP was certified by the CEC with a Final Decision on September 8, 2010, and began commercial operation on December 24, 2014. Some of the subsequent amendments made to the COCs in the Final Decision are described below:

- On June 27, 2016, MS proposed use of evaporators at Evaporation Ponds, SWAT02-15-00 and received approval for installation of the evaporators on March 2, 2017. (SWAT02-16-00)
- On February 13, 2020, MS submitted the proposal for Carbon Absorption System Improvement, upon CEC approval the modification was completed on February 26, 2021.
- On January 28, 2020, MS filed a petition (TN231771) for the construction of new warehouse building, which was approved on February 13, 2020, and the construction completed on September 24, 2020.
- On January 13, 2022, MS filed a petition for a post certification change (TN#241162) with the California Energy Commission (CEC) for the MSP to install a hydrogen generation system, including an electrolyzer that uses electricity from MSP to decompose demineralized water into hydrogen and oxygen. The change was approved on June 13,2022; Order No: 22-0608-4. This change is still on the construction phase and the unit has not been installed yet.

6 Description of Proposed Change

6.1 Project Name Change

As described above and in the original Petition, Mojave Solar LLC is the owner of the Mojave Solar Project.

In 2017, Abengoa Yield plc, the parent company of Mojave Solar LLC, changed its name to Atlantica Sustainable Infrastructure plc and became an independent entity, no longer affiliated with Abengoa.

As of today, Mojave Solar LLC continues to be under the structure of Atlantica Sustainable Infrastructure plc.

Mojave Solar LLC hereby confirms that no ownership change has occurred at the Project level. Mojave Solar LLC, original Applicant, continues to own MSP.

Mojave Solar LLC hereby requests the CEC to update the name of the Project from "Abengoa Mojave Solar" to "Mojave Solar".

6.2 Mojave Solar Pond's Liner Extension Project Overview

The evaporation ponds have been receiving wastewater since August 2014 to date. The depth of the wastewater has tended to increase year over year and the evaporation rate has been decreased gradually due to the nature of the water evaporation which increases the salt concentration at the ponds and effects the evaporation rate. In addition to above, the netting installation over Beta West Pond (B-W) has shown a significant decrease of the natural evaporation as well as preventing MSP to utilize the use of the sprayers in the netted ponds resulting rapid increase of the B-W pond's level. Since all other ponds must be netted by April 2024, MSP retained Hushmand Associates, Inc. (HAI) to evaluate options for optimizing maintenance and maintaining storage capacity of the existing and potential future evaporation ponds. Based upon the site inspections, HAI recommended that an extension to the 60 mil HDPE geomembrane will allow an additional 2.0 feet of temporary storage capacity for pond maintenance purposes.

The extension liner would be a single 60 mil HDPE geomembrane that would be extrusion welded to the existing 60 mil HDPE geomembrane. The extension liner would not generally be providing containment of the wastewater but would be providing the containment system for the minimum 2 feet of freeboard that is required to be maintained. Therefore, the extension liner is not expected to be inundated by the wastewater. Additionally, since the grade around the top of the ponds varies, the extension is only required to be constructed around the lower 40 to 80% of the ponds. Based on this expectation, a single liner system will provide adequate containment in the event the freeboard is encroached upon by wave action or similar short-term events. During normal operations there should be no liquids in contact with the liner extension.

The addition of the extension liner system provides 2 feet of additional temporary capacity in each pond or an overall increase of approximately 25% more volume to the evaporation ponds for optimizing maintenance activities at the plant.

6.3 Evaporation Pond Liner Extension Design Plans

HAI has prepared design plans for the construction of the liner extensions. The concept of the liner extension is to provide a 60 mil HDPE liner that extends the lower (in elevation) areas of the ponds by up to 2.0 feet. The ponds are required to maintain 2.0 feet of freeboard to ensure containment of the liquids stored in the ponds. The 2 feet of freeboard is a common requirement of dams and wastewater containment ponds. The 2.0 feet of freeboard provides a reasonable amount of containment in the event of storms, wave action, or emergency events to ensure that overtopping will not occur.

6.4 Based on HAI's observations the following are recommended:

Alpha Pond East – the lowest point around the perimeter of the pond is 2041. The highest point around the perimeter of the pond is 2044. To install the liner extension to elevation 2043 will require construction of an approximately 1,650 feet long berm, with maximum height of 2 feet. The interior of the berm will be lined with 60 mil HDPE

geomembrane. The maximum storage level in the pond would increase by 2 feet to elevation 2041.

Alpha Pond West – the lowest point around the perimeter of the pond is 2043. The highest point around the perimeter of the pond is 2047. To install the liner extension to elevation 2045 will require construction of an approximately 800-foot-long berm, with maximum height of 2 feet. The interior of the berm will be lined with 60 mil HDPE geomembrane. The maximum storage level in the pond would increase by 2 feet to elevation 2043.

Beta Pond East – the lowest point around the perimeter of the pond is 2051. The highest point around the perimeter of the pond is 2055. To install the liner extension to elevation 2053 will require construction of an approximately 900-foot-long berm, with maximum height of 2 feet. The interior of the berm will be lined with 60 mil HDPE geomembrane. The maximum storage level in the pond would increase by 2 feet to elevation 2051.

Beta Pond West – the lowest point around the perimeter of the pond is 2055. The highest point around the perimeter of the pond is 2059. To install the liner extension to elevation 2057 will require construction of an approximately 1,025-foot-long berm, with maximum height of 2 feet. The interior of the berm will be lined with 60 mil HDPE geomembrane. The maximum storage level in the pond would increase by 2 feet to elevation 2055.

6.5 Berm Construction

The construction of the berm to provide the containment has been evaluated by HAI considering access to the work areas, cost for construction of the berm, and general construction procedures.

Currently the Alpha ponds are fully accessible and have limited interference with equipment around the ponds. Based on discussions during the site visits, MSP indicated that existing equipment could be moved, or field adjustments could be considered to allow for construction of a soil berm around both Alpha ponds. The soil berm provides a firm foundation for the liner extension, material is readily available and would be generally consistent with the construction of the existing ponds. Based on these considerations, HAI recommends raising the soil berm height around the Alpha ponds for the liner extension using the existing excavated soil stockpiles. A bird netting system is proposed to be added to the Alpha ponds by April 2024. If the soil berm height buildup is not constructed prior to the bird netting system alternative methods for construction of the berm may need to be considered due to limited access around the ponds. The alternative methods are discussed below for the Beta ponds.

Additionally, in areas where soil berm cannot be constructed due to presence of the existing equipment, K-rails might be used as shown in the plans. Once the soil berm is constructed, the 60 mil HDPE geomembrane will be installed by extrusion welding the extension to the

existing liner system and extending the liner up and into an anchor trench. The anchor trench will be backfilled with compacted soil to secure the geomembrane. Field tests will be performed to measure in-place density and moisture content of the compacted soil using nuclear gage (ASTM D6938) and laboratory soil compaction test (ASTM D1557). The extrusion welds will be non-destructively tested for leaks by use of the vacuum box test or similar method.

For the Beta ponds, bird netting is existing or in the process of being added over the ponds. The poles to suspend the cables/netting over the pond are offset from the edge of liner between 3 and 8 feet. Given the limited space, a conventional soil berm is difficult to construct. HAI recommends construction of a cast-in-place concrete stem wall/berm. The concrete wall can be formed between the existing liner anchor trench and the bird netting, concrete will be pumped to the form work from outside the pond fencing and netting. Once the concrete wall is constructed, the 60 mil HDPE geomembrane will be installed by extrusion welding the extension to the existing liner system and extending the liner up and onto the top of the wall. The geomembrane will be secured using a batten strip and anchor bolts. The extrusion welds would be non-destructively tested for leaks by use of the vacuum box test or similar method.

Based on the above, HAI has developed the design plans for construction of the liner extension for both the Alpha and Beta Ponds. Each pond is independent of the others and therefore, the liner extensions can be constructed individually or as a group depending on MSP's need and budget. The design plans are attached as Sheets 1 and 2. Appendix 10.1

6.6 Technical Specifications and CQA Plan

HAI has prepared Technical Specifications and CQA Plan for the construction of the liner extension. The Technical Specifications in combination with execution of the CQA Plan will ensure the project is completed in accordance with the intent of the design plans and meets industry standards for the materials used in the construction of the project. Appendix 10.2 and Appendix 10.3

6.7 Construction Schedule

MSP plans to initiate the project at Alpha Plant as soon as possible, with a contractor prepared to commence construction in December 2023. However, the construction schedule for Beta ponds is currently undecided.

6.8 Necessity of the modification

The modification is necessary to accommodate the decrease in the evaporation rate in the ponds resulting from the installation of netting over them. This adjustment will provide additional storage capacity, enabling MSP to sustain plant operations until the construction of the new ponds. Without this modification, electricity production at the plant may be interrupted during the summer of 2024.

6.9 Why the change should be permitted.

The proposed change should be permitted to enable MSP to continue providing electrical energy through clean, renewable sources. This modification will ensure the reliable operation of MSP during the summer of 2024 while the company is in the process of obtaining the necessary permits and authorizations for the construction of a new pond. The environmental resources will continue to be protected under this proposed change, striking a balance between the needs of both the human and natural environment.

6.10 Proposed Changes to the Conditions of Certification

COMPIANCE-14 The project owner must petition the Energy Commission pursuant to Title 20, California Code of Regulations, section 1769, in order to modify the project (including linear facilities) design, operation or performance requirements, and to transfer ownership or operational control of the facility.

SOIL&WATER-2 Any changes to the design, construction, or operation of the ponds, treatment units, or storm water system shall be requested in writing to the CPM, with copies to the Lahontan RWQCB, and approved by the CPM, in consultation with the Lahontan RWQCB, prior to initiation of any changes.

7 Potential Environmental Impacts

7.1 Air Quality

The proposed change will result in short-term construction emissions, including fugitive dust and emissions from construction equipment combustion. The construction period for the Alpha ponds is estimated to be 8 weeks. The berm's length impacted by this construction will be approximately 1.1 miles, and the maximum daily disturbed area is 5,000 square feet. To control dust and support construction, one water truck will be in use full time during the project.

Additionally, emissions from construction workers commuting to the site are anticipated. However, given that the average crew size for this project is expected to be 6 employees, the impact on emissions is not expected to be significant.
Any construction-related emissions are temporary and will occur over the two-month construction period, with no significant impact anticipated after the project's completion.

7.2 Biological Resources

The proposed project components will be integrated within the existing facility footprint and will not alter any habitat from its natural condition. Consequently, no direct impacts on biological resources or wetlands from habitat changes have been identified.

7.3 Cultural Resources

The proposed project is scheduled to take place within the existing facility, covering the areas around the evaporation ponds and within the pond's secondary fence line. The terrain is already leveled, disturbed, and compacted. Importantly, constructing an additional berm will not necessitate ground excavation in undisturbed areas. The required soil for the berm extension will be sourced from the existing soil stockpile resulting from the plant's initial construction. Consequently, there will be no impact on cultural resources.

7.4 Geological Hazards and Paleontology Resources

The geological study was conducted during the initial plant design, indicating low geological hazards at the plant site. Necessary mitigations were imposed to address potential risks. Additionally, flood risk was assessed by Gannet Fleming during the initial plant design. Measures, such as the construction of retention basins to collect storm runoffs, were implemented next to the evaporation ponds to prevent runoffs from reaching the ponds. Therefore, with the implementation of the Conditions of Certification, the project adheres to applicable LORS related to geological resources.

Furthermore, as there will be no disturbance of soil inside or outside MSP's footprint that has not been previously disturbed, there will be no impact on paleontological resources.

7.5 Efficiency and Reliability

The proposed project will have positive impact on Efficiency and Reliability of the MSP by providing extra storage capacity to store water treatment discharge water.

7.6 Hazardous Materials Management

The proposed project will not affect the facility's Hazardous Materials Management not during the project nor after the project completion. Therefore, there would be no impact on the amount of stored hazardous materials.

7.7 Land Use

The proposed change does not impact the conditions of use outlined in the Land Use analysis or the findings of the final commission Decision 2010-09. Consequently, no impacts related to land use are anticipated. The proposed change will take place within the MSP facility, and the existing Conditions of Certification are deemed sufficient to safeguard land use resources.

7.8 Noises and Vibration

Construction noise is a temporary phenomenon and, in this case, is expected to occur over a period of about 2 months. The closest and only noise-sensitive noise receptors within several miles are six to eight residential homes at four widely separated locations between approximately 2,400 feet and 4,500 feet from the plant. Noisy construction is limited to daytime hours so that potential impacts of affected residents are mitigated to a level of insignificance.

Because of the distance of the nearest residents no vibration effects would be likely during the construction.

With the implementation of the Conditions of Certification, the project conforms to applicable LORS related to noise and all potential noise and vibration impacts will be mitigated to insignificance.

7.9 Public Health

This Petition does not affect any of the findings, conclusions, or conditions of certification in the Public Health section of the Final Decision and the implementation of the existing conditions would be adequate to prevent adverse impacts.

7.10 Socioeconomic Resources

The proposed project is not expected to result in significant adverse direct or cumulative impacts on housing, employment, schools, public services, or utilities. The project aligns with applicable LORS related to socioeconomic matters, and any potential socioeconomic impacts are anticipated to be insignificant.

7.11 Soil and Water Resources

The pond's liner extension will change the original design of the evaporation ponds; however, this will not change the operation of the ponds nor the monitoring plan. The concept of the liner extension is to provide a 60 mil HDPE liner that extends the lower (in elevation) areas of the ponds by up to 2.0 feet. The ponds are required to maintain 2.0 feet of freeboard to ensure containment of the liquids stored in the ponds. The 2 feet of freeboard is a common requirement of dams and wastewater containment ponds. The proposed change affects the 2 ft freeboard which is not used during the normal operation but provides a reasonable amount of containment in the event of storms, wave action, or emergency events to ensure that overtopping will not occur. Implementation of Conditions Soil&Water-2, Soil&Water-6 and Soild&Water-7 will ensure the plant continues to operate without adverse impact to the environment.

The final decision calls for the removal of accumulated solids from the surface impoundments when the depth reaches two feet above the impoundment. The sludge depth measurement was conducted by DWI Water on 10/17/2023 with the following observations: (The full report is attached in appendix 10.4.)

- Alpha West: The average sediment depth was 2.3", with the deepest point at 3".
- Alpha East: The average sediment depth was 9.38", with the deepest point at 11".
- Beta West: The average sediment depth was 2.84", with the deepest point at 3".
- Beta East: The average sediment depth was 3.86", with the deepest point at 5".

The sediment level is currently acceptable based on the sludge measurement results, and the implementation of the existing conditions would be adequate to prevent adverse impacts from waste-generation impacts.

7.12 Traffic and Transportation

The proposed project does not require any changes in the workforce for plant operation; hence, there will be no traffic or transportation impact due to the worker's commute.

7.13 Transmission Line Safety & Nuisance and System Engineering

The proposed project does not impact the transmission systems.

7.14 Visual Resources

The California Environmental Quality Act (CEQA) Guidelines define a "significant effect" on the environment to mean a substantial, or potentially substantial, adverse change in any of the physical conditions in the area affected by the project including…objects of historic or aesthetic significance (Cal. Code Regs., tit. 14, subsection 15382).
The proposed change will occur inside the facility and does not affect any of the findings, conclusions, or conditions of certification in the visual resources section of the Final Decision.

7.15 Waste Management

The proposed change will not affect the level of solid waste production from the MSP; hence, there will be less than significant impact.

7.16 Worker Safety and Fire Protection

As a result of the safety procedures in place, the proposed project will have a less than significant impact on worker safety and fire protection.

8 Potential Compliance Impacts and Landowner Impacts

8.1 Impacts the Modification May Have on the Facilities' Ability to Comply with Applicable Laws, Ordinances, Regulations and Standards

The project modification, as proposed, would have no adverse effect on the ability of the certified facility to comply with applicable LORS. The project would allow the MSP facility to continue to run efficiently, and to meet environmental goals and the current demand for electricity. The project would continue to operate in compliance with all applicable LORS.

8.2 How the Modification Affects the Public

With implementation of the modification as proposed, the pond's liner extension would have no immediately detectable effect on the public.

8.3 Property Owners Potentially Affected by the Modification

No impacts to any proximate or distant property owners could be identified. The closest properties are between 2,400 feet and 4,500 feet from the plant.

9 References

Final Commission Decision, September 2010, CEC-800-2010-008-CMF, Docket Number 09-AFC-5

10 Appendix

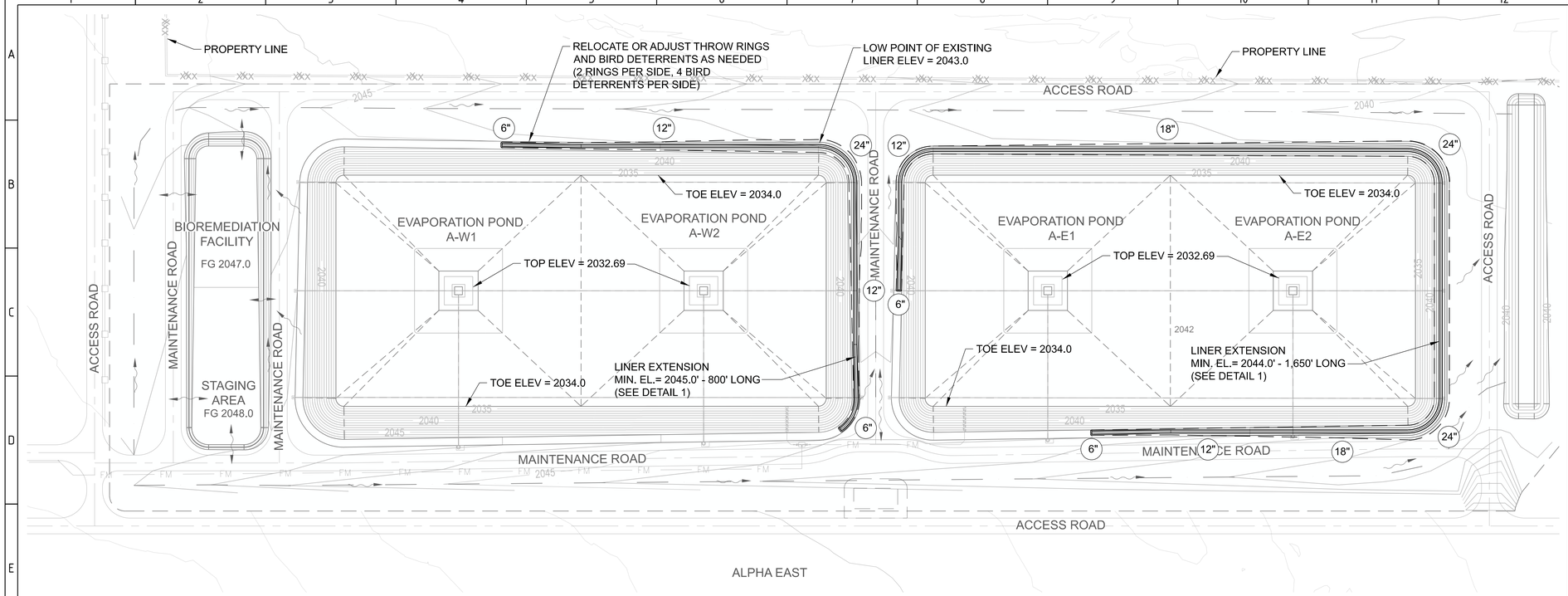
10.1 Design Plans

10.2 Technical Specifications

10.3 CQA Plan

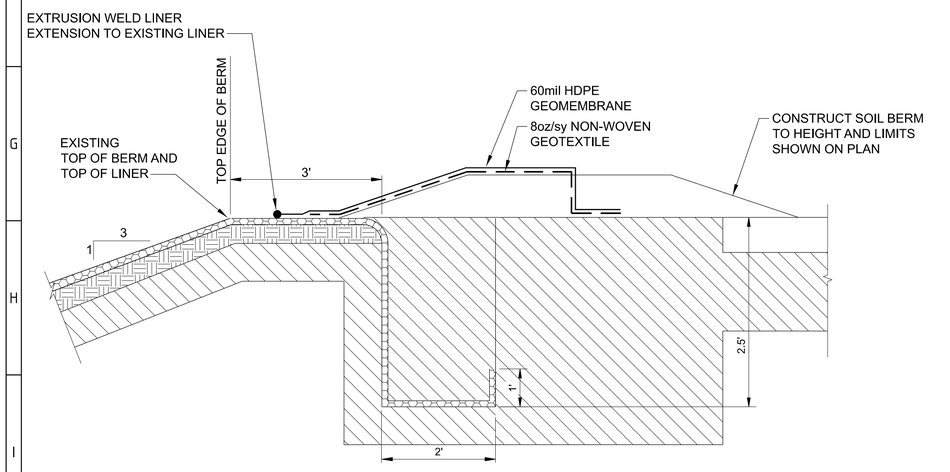
10.4 Evaporation Pond's Sediment Measurement Report

10.1 Design Plans



ALPHA EAST

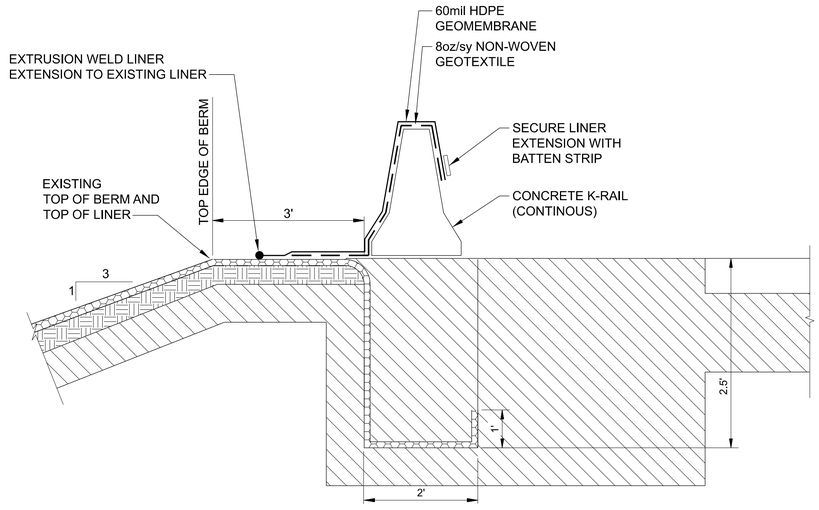
ALPHA EVAPORATION PONDS LINER EXTENSION LIMITS PLAN



DETAIL 1 - LINER EXTENSION WITH SOIL BERM

NTS

NOTE: ANCHOR TRENCH SHALL BE MINIMUM 1-FOOT DEEP AND 1-FOOT WIDE, BACKFILL SHALL BE COMPACTED



DETAIL 2 - ALTERNATE LINER EXTENSION WITH CONCRETE K-RAIL

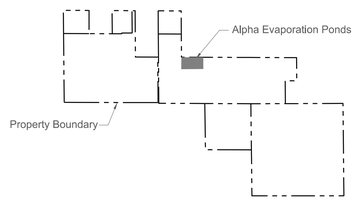
CONSTRUCTION NOTES

1. PROJECT IS TO CONSTRUCT A LINER EXTENSION TO INCREASE THE POND CAPACITY.
2. CONSTRUCT A SOIL BERM TO THE HEIGHT SHOWN ON THE PLAN. HEIGHT OF BERM SHALL BE LINEARLY INTERPOLATED BETWEEN LABELED LOCATIONS. (I.E. AT MIDPOINT BETWEEN 12" AND 24" LABELS BERM HEIGHT WILL BE 18".
3. BERM SHALL BE CONSTRUCTED OF SOIL PROVIDED BY THE OWNER. BERM TO BE 6" TO 24" HIGH, 4 FOOT TOP WIDTH AND SLOPED AT 3:1.
4. SOIL SHALL BE COMPACTED NEAR OPTIMUM WATER CONTENT PER ASTM D1557. SOIL SHALL BE COMPACTED IN LIFTS NOT TO EXCEED 12 INCHES. COMPACT WITH MINIMUM OF 4 PASSES OF SMOOTH DRUM COMPACTOR.
5. SURFACE OF SOIL BERM SHALL BE SMOOTH AND FREE OF ROCKS OR OTHER MATERIALS GREATER THAN 0.5".
6. AN ALTERNATIVE TO THE COMPACTED SOIL BERM IS CONCRETE K-RAIL (SEE DETAIL 2). ALTERNATE SHALL BE USED IN LOCATIONS WOULD INTERFER WITH EXISITNG EQUIPMENT. ALTERNATIVE LIMITS SHALL BE AGREED UPON WITH OWNER.
7. WHERE ALTERNATE K-RAIL IS USED, GROUND SHALL BE LEVELED TO PROVIDE SMOOTH TRANSITION BETWEEN SECTIONS OF THE K-RAIL.
8. CONTRACTOR SHALL PROVIDE 60 MIL HDPE (BLACK) AND 8 OZ/SY NON-WOVEN GEOTEXTILE.

ELECTRONIC VERSION
REFER TO APPROVED PERMIT DRAWING

Rev.	Date	Description	Drawn By	Checked By	Passed By
A	10/13/2023	FOR REVIEW (NOT FOR CONSTRUCTION)	KJK	SGS	---

Situation:



HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

MOJAVE SOLAR PROJECT

ATLANTICA SUSTAINABLE INFRASTRUCTURE

Scale:		Plan No:	
1"= 80'	EVAPORATION PONDS - ALPHA SITE LINER EXTENSION LIMITS	Sheets: 2	Sheet No: 1
		Plan No. Int:	

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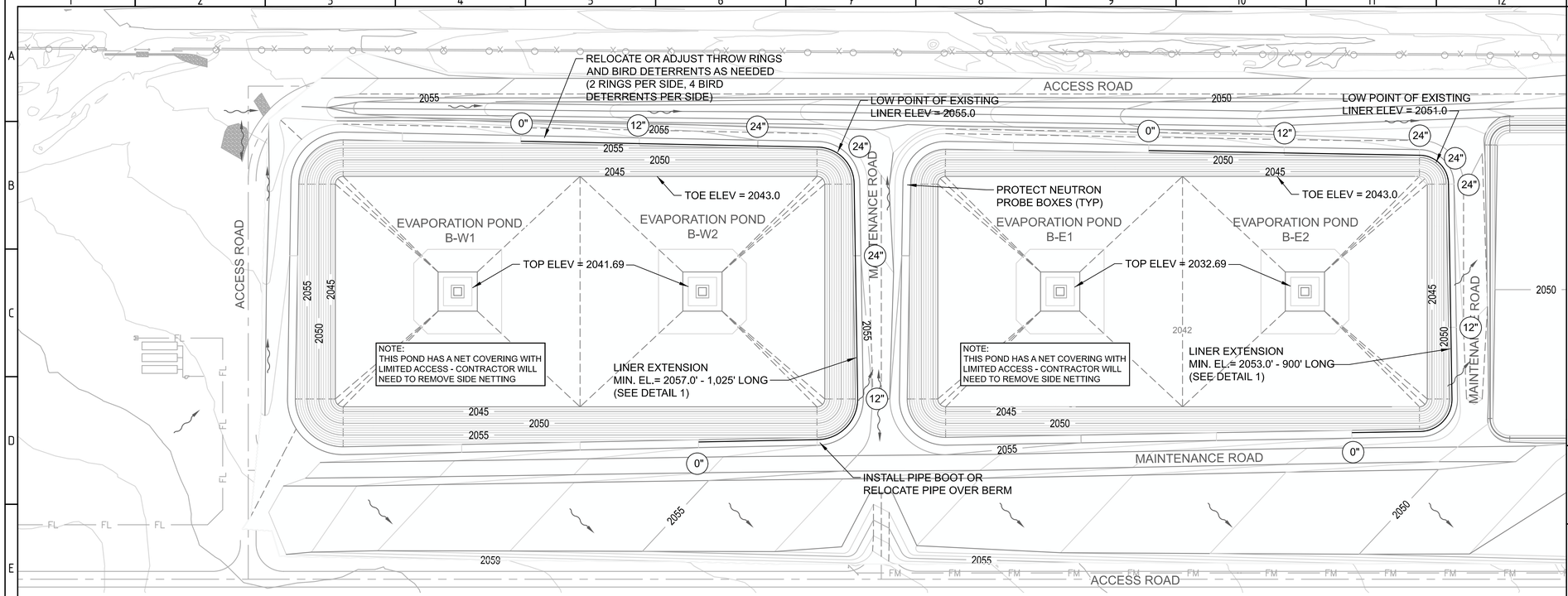
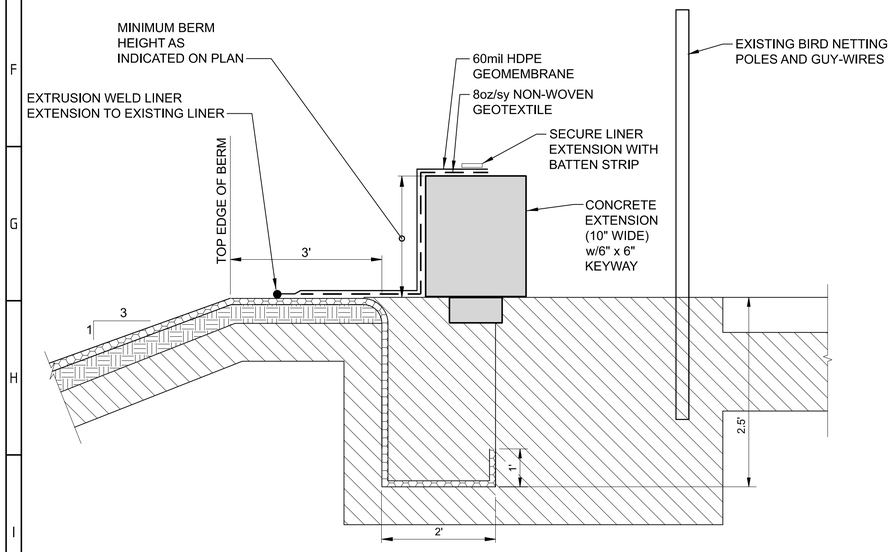
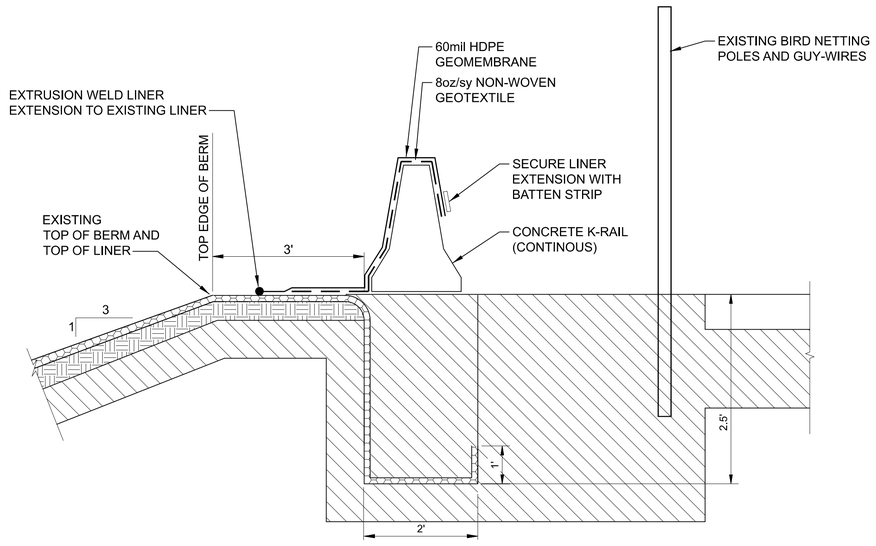


BETA EVAPORATION PONDS LINER EXTENSION LIMITS PLAN



DETAIL 1 - LINER EXTENSION WITH CONCRETE BERM

NTS



DETAIL 2 - ALTERNATE LINER EXTENSION WITH CONCRETE K-RAIL

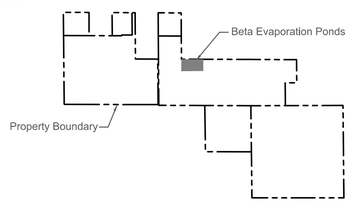
CONSTRUCTION NOTES

1. PROJECT IS TO CONSTRUCT A LINER EXTENSION TO INCREASE THE POND CAPACITY.
2. CONSTRUCT A CONCRETE EXTENSION TO THE HEIGHT SHOWN ON THE PLAN. HEIGHT OF CONCRETE EXTENSION SHALL BE LINEARLY INTERPOLATED BETWEEN LABELED LOCATIONS. (I.E. AT MIDPOINT BETWEEN 12" AND 24" LABELS BERM HEIGHT WILL BE 18".
3. CONCRETE EXTENSION SHALL BE CONSTRUCTED OF CONCRETE WITH A MINIMUM 28-DAY COMPRESSIVE STREGTH OF 2,500 PSI. CONCRETE EXTENSION TO BE 6" TO 24" HIGH.
4. AN ALTERNATIVE TO THE CAST-IN-PLACE CONCRETE EXTENSION IS CONCRETE K-RAIL (SEE DETAIL 2). ALTERNATIVE LIMITS SHALL BE AGREED UPON WITH OWNER.
5. WHERE ALTERNATE K-RAIL IS USED, GROUND SHALL BE LEVELED TO PROVIDE SMOOTH TRANSITION BETWEEN SECTIONS OF THE K-RAIL.
6. CONTRACTOR SHALL PROVIDE 60 MIL HDPE (BLACK) AND 8 OZ/SY NON-WOVEN GEOTEXTILE.

ELECTRONIC VERSION
REFER TO APPROVED
PERMIT DRAWING

Rev.	Date	Description	Drawn By	Checked By	Passed By
A	10/13/2023	FOR REVIEW (NOT FOR CONSTRUCTION)	KJK	SGS	---

Situation:



HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

MOJAVE SOLAR PROJECT

ATLANTICA SUSTAINABLE INFRASTRUCTURE

Scale: 1"= 80'

EVAPORATION PONDS
-
BETA SITE
LINER EXTENSION LIMITS

Plan No:
Sheets: 2 Sheet No: 2
Plan No. Int:

ANSI D

File: $(getvar,dwgprefix)$(getvar,dwgname)
Plotted: $(edtime, 0, M/D/YY at H:MMam/pm) By: $(getvar,loginname)

10.2 Technical Specifications

MOJAVE SOLAR PROJECT
EVAPORATION POND – LINER EXTENSION

TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Health and Safety Plan.

C. Construction progress schedule.

D. Work Plan.

E. Proposed products list.

F. Shop drawings.

G. Product data.

H. Soil and aggregate samples.

I. Manufacturer's installation instructions.

J. Manufacturers' certificates.

K. Survey equipment certification.

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control and Quality Assurance: Manufacturers' field services and reports.

1.3 SUBMITTAL PROCEDURES

A. CONTRACTOR shall submit a submittal register in duplicate or electronically within 10 days after Notice of Award and prior to preconstruction meeting. The submittal register shall identify all submittal requirements contained in the plans and specifications, with references to the plan or specification numbers.

B. Transmit each submittal with a transmittal form. Provide two copies of each submittal or submit electronically.

C. Sequentially number the transmittal form. For revised submittals add an alphabetic suffix to the original number.

D. Schedule submittals to expedite the Project and deliver in the time frame specified. Coordinate submission of related items.

E. Allow 10 days review time for each submittal excluding delivery time to and from the CONTRACTOR.

F. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

G. If necessary, revise and resubmit, and identify all changes made since previous submission.

1.4 HEALTH & SAFETY PLAN

A. The CONTRACTOR shall submit to the OWNER within 10 days following Notice of Award and prior to pre-construction meeting a site-specific Health & Safety Plan. The plan shall include all safety actions and measures to be implemented during Work in order to minimize the risk of occupational injuries and illnesses.

B. The OWNER shall review the Health and Safety Plan and shall have the right to require the CONTRACTOR to amend it if necessary. The CONTRACTOR shall make the recommended corrections and resubmit to the OWNER for review and final acceptance. The CONTRACTOR shall under no circumstances commence work prior to the OWNER's full acceptance of the plan.

C. Review and acceptance of the Health & Safety Plan by the OWNER shall not in any way impart liability on the OWNER. The CONTRACTOR is solely responsible for his safety plan and its implementation.

1.5 CONSTRUCTION PROGRESS SCHEDULES

A. CONTRACTOR shall submit initial schedule in duplicate within 10 days after date of Notice of Award and prior to the preconstruction meeting. The initial schedule, after approval by OWNER, will represent the project target schedule. All subsequent schedule revisions must detail the initial target schedule.

B. Revise and resubmit as requested, but no less than every 7 calendar days.

C. Update progress schedules weekly and, if greater detail is needed, present a two week "look ahead" schedule. The CONTRACTOR shall present updated schedules at weekly meetings.

D. Submit a computer-generated graphic-type schedule with a separate line for each item of Work or operation identifying first workday of each week.

F. Indicate submittal dates and review periods required for shop drawings, product data, samples, and product delivery dates, including those furnished by OWNER.

G. Indicate surveys for layout, as-builts, and measurement for payment.

1.6 WORK PLAN

A. Submit when specified.

B Describe personnel, equipment, and procedures required to accomplish specified items of work.

1.7 PROPOSED PRODUCTS LIST

A. Within 10 days after date of Notice to Proceed, and prior to preconstruction meeting submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.8 SHOP DRAWINGS

A. Shop drawings shall be submitted as required in individual specifications sections. Shop drawings may include the following:

1. Soil Placement sequence drawings and procedures,

2. Geosynthetic panel layouts.

1.9 MANUFACTURER INSTALLATION INSTRUCTIONS

A. When specified in individual specification sections, submit three copies of printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing to OWNER.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.10 MANUFACTURER CERTIFICATES

A. When specified in individual specification sections, submit manufacturer's certification in specified quantities.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, certifications, and quality control testing.

C. Certificates must be specific to material or product, delivered to the site.

1.11 SURVEY EQUIPMENT CALIBRATIONS

A. Provide certificates of calibration for all survey equipment used during the project.

B. Submit calibrations to OWNER 5 days prior to putting equipment into use.

C. Re-calibrate as recommended by equipment manufacturer, then re-submit.

1.12 CORRESPONDENCE

A. OWNER will provide a correspondence matrix identifying requirements for submitting and sharing correspondence among the parties involved in the project.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

****END OF SECTION 01300****

SECTION 01410
QUALITY ASSURANCE TESTING, QUALITY CONTROL TESTING, AND CERTIFICATES OF COMPLIANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Acceptance testing by OWNER (Construction Quality Assurance [CQA] testing).

B. Control testing by CONTRACTOR.

C. Certificates of compliance.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

1.3 SOURCE OF MATERIALS

A. CONTRACTOR must notify OWNER in writing of the sources from which it proposes to obtain material requiring OWNER approval, certification, or quality assurance testing. Such notification must be made as soon as possible after award of Contract but no later than 10 days after receipt of the Notice to Proceed.

1.4 CONSTRUCTION QUALITY ASSURANCE TESTING

A. Construction quality assurance (CQA) testing is the testing of materials, before their inclusion in the work, and materials and workmanship, after their inclusion in the work.

B. CQA testing will be performed by the OWNER at the OWNER's expense as a basis for acceptance of the completed work.

C. OWNER will perform CQA testing in accordance with the CQA Manual. However, OWNER reserves the option to perform additional CQA testing at any time to determine conformance of the materials and workmanship with the Contract Documents.

D. CQA testing performed by the OWNER does not relieve the CONTRACTOR or the Manufacturer of materials produced for the CONTRACTOR, and of the obligation to perform and document quality control testing of materials and workmanship.

1.5 CONSTRUCTION QUALITY CONTROL TESTING

A. Construction Quality Control (CQC) testing is the testing of materials performed by the material supplier before their delivery or during construction, such as geomembrane manufacturing, geomembrane seam testing, and such other tests as

are specified in the various sections of the Specifications to ensure compliance with the Contract Documents. CONTRACTOR must assume full responsibility for quality control testing and give sufficient notice to OWNER to permit OWNER to witness the tests. Control testing will be at the expense of CONTRACTOR and where specifically required, must be performed by an independent testing firm.

1.6 CERTIFICATES OF COMPLIANCE

A. CONTRACTOR may use certificates of compliance for certain materials and products in lieu of the specified sampling and testing procedures. However, certificates of compliance will not be accepted for any geosynthetic materials testing. Submit certificates required to demonstrate proof of compliance of materials with specification requirements in duplicate with each lot of material delivered to the Work site or prior to delivery as required by the Contract. The lots so certified must be clearly identified by the certificate. Certificates must be signed by an authorized representative of the producer or manufacturer and state that the material complies in all respects with the requirements of the Contract Documents. In the case of multiple shipments, each shipment must be accompanied or preceded by a Certificate of Compliance.

B. The Certificate of Compliance must be accompanied by a certified copy of test results or state that such test results are on file with the producer or manufacturer and must be furnished to OWNER on request. The certificate must give the information specified for samples in Section 01300, the name and address of the organization performing the tests, the date of the tests, the quantity of material shipped, and a description of material.

C. Materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance does not relieve CONTRACTOR of responsibility for incorporating material in the Work which conforms to the requirements of the Contract and any such material not conforming to such requirements will be subject to rejection, whether in place or not.

D. OWNER reserves the right to refuse the use of certain materials on the basis of a Certificate of Compliance.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

****END OF SECTION 01410****

SECTION 02120

PREPARATION OF SUBGRADE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section covers the work necessary for the preparation of subgrade.

B. This work requires close coordination between the Earthwork Contractor and the Geosynthetics Contractor. The Earthwork Contractor shall meet the requirements of these Specifications and of the Geosynthetics Contractor, as approved by the Construction Quality Assurance (CQA) Engineer and the Design Engineer.

1.2 RELATED SECTIONS

A. Section 02200 - Earthwork

1.3 REFERENCES

A. Construction Quality Assurance Plan (CQA Plan)

1.4 DEFINITIONS

A. Subgrade shall be considered as those areas and surfaces upon which the Geosynthetics Contractor shall install geosynthetic materials.

PART 2 - PRODUCTS

2.1 EQUIPMENT

Furnish all necessary equipment required to accomplish the excavating, shaping, grading, rolling, and compaction specified herein.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Construct material limits within a tolerance of ±0.5 foot for horizontal state plane coordinates and elevations to ±0.1 foot.

3.2 FINAL GEOSYNTHETIC SUBGRADE SURFACE

A. The surface of the final subgrade in areas to receive geosynthetics shall be smooth, free from holes, or depressions more than $^1/_2$ inch deep and protrusions extending above the surface more than $^1/_2$ inch. Roll the finished surface of the subgrade with a smooth steel drum roller or rubber-tired roller to eliminate tire or

roller marks and provide a smooth, dense surface. Final surface of the subgrade shall be prepared to the satisfaction of the CQA Engineer and the Geosynthetics Contractor.

3.3 PROTECTION OF SUBGRADE

A. After preparing the subgrade as specified above, all unnecessary traffic shall be kept off the subgrade. Should it be necessary to haul over the prepared subgrade, the Earthwork Contractor shall drag and roll the traveled way as frequently as necessary, to remove ruts, cuts, and breaks in the surface. All cuts, ruts, and breaks in the subgrade surface that are not removed by the above operations shall be rolled to eliminate protrusions greater than ½ inch in areas of geosynthetic material installation.

B. Continued use of sections of prepared subgrade for hauling, so as to cut up or deform it from the true cross-section, shall not be permitted. The Earthwork Contractor shall protect the prepared subgrade from all on-site traffic.

C. The subgrade shall be maintained in the finished condition until the HDPE geomembrane is installed.

D. The Earthwork Contractor is responsible for the protection of the subgrade during wet weather. The cost of subgrade protection during wet weather shall be included in the bid item for Preparation of Subgrade. Any additional work required to prepare the subgrade prior to placement of the liner system shall be performed by the Earthwork Contractor and no additional compensation shall be allowed.

****END OF SECTION 02120****

SECTION 02200

EARTHWORK

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. This section covers the earthwork necessary to support the construction of the liner extension berm, including liner grading (excavation and fill), and anchor trenches.

B. The work shall consist of performing all operations necessary to excavate materials, construct engineered fills, and backfill trenches regardless of existing soil character and subsurface conditions.

C. Provide all labor, materials, and equipment necessary to accomplish the work specified in this section.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

B. Section 02120 – Preparation of Subgrade

C. Section 02245 – Geotextile

D. Section 02778 – Geomembrane

1.3 REFERENCES

A. Construction Quality Assurance Plan

B. Hushmand Associates, Inc. (HAI), Mojave Solar Project Liner Extension Limits, Sheets 1 and 2, October 2023

C. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

D. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

E. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Construction Quality Assurance (CQA) Plan: Refers to a program of activities which shall provide adequate confidence that materials and workmanship meet

the requirements of the Contract and fulfill the projects objectives. Quality Assurance includes quality control tests and procedures.

B. Quality Control: Refers to those activities that verify that the materials and workmanship have substantially met the requirements of the Project Documents.

C. Classification System: Unified Soil Classification System (ASTM D2487).

D. Compaction: The process of increasing the density or unit weight of soil by rolling, tamping, vibrating, or other mechanical means approved by the Design Engineer and/or CQA Engineer.

E. Compactor Pass: A pass is defined as one trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface if the compacting equipment has front and back (dual) compacting rollers.

F. Engineered Fill: Soils meeting the characteristics required by this Section, placed, wetted, and compacted to the required specifications.

G. Optimum Moisture Content: Moisture content corresponding to maximum dry density as determined by ASTM D1557.

H. Scarified and compacted subgrade: The ground surface after clearing, grubbing, stripping, excavation, scarification, removal of soil particles not meeting specifications, and compaction.

1.5 SAFETY

A. The Earthwork Contractor shall be solely responsible for performing earthwork in a safe manner in accordance with the requirements of the Health and Safety Plan. CONTRACTOR shall comply with all applicable California Occupational Safety and Health Administration (OSHA) regulations. Provide appropriate measures to ensure that people working in or near the project area are protected.

B. The Earthwork Contractor, and any sub-contractors, shall become familiar with, and comply with, all applicable codes, ordinances, statutes, and bear sole responsibility for the penalties imposed for noncompliance.

C. Install and maintain shoring, sheeting, bracing, and sloping necessary to support the sides of excavations, to keep and to prevent any movement which may damage adjacent facilities or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by OSHA and other applicable governmental regulations and agencies.

1.6 TOLERANCES

All material limits shall be constructed within a tolerance of ±0.5 foot for horizontal state plane coordinates, ±0.1-foot vertical for elevations, and +0.1 foot where dimensions or grades are shown or specified as minimum. All grading shall be performed to maintain slopes and drainage as shown. No reverse slopes shall be permitted.

PART 2 – PRODUCTS

2.1 SUBSURFACE CONDITIONS

Geotechnical explorations have been performed in the general project area. The Earthwork Contractor shall be responsible for becoming familiar with subsurface conditions at the site, whether covered in the geotechnical reports or not, and shall thoroughly understand all recommendations associated with the designed grading, presented in the Construction Documents. The Earthwork Contractor shall be responsible for performing any additional site explorations required to plan and perform the required grading work.

2.2 EQUIPMENT

A. Compaction equipment shall be of suitable mechanical type and adequate to obtain the densities specified and shall provide satisfactory breakdown of materials to form a dense fill. Flooding or jetting methods of compaction shall not be used.

B. Compaction equipment shall be operated in strict accordance with the Manufacturer's instructions and recommendations. Equipment shall be maintained in such condition that it shall deliver the Manufacturer's rated compactive effort. If inadequate relative compaction is obtained, the Earthwork Contractor shall provide larger and/or different types of additional equipment at no additional cost. Hand-operated equipment shall be capable of achieving the specified densities.

C. Equipment for applying water shall be of a type and quality adequate for the work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

D. On-site water source shall be made available for the Earthwork Contractor for the work included in this Section. The water source shall be identified in the pre-bid meeting at the site.

2.3 SELECT SOIL FILL

Select soil shall be on-site material suitable for construction of the soil berm, backfilling anchor trenches and any other specific use, as determined by the CQA Monitor. Select soil is material having at least 40% material smaller than ¼-inch in size, no particles larger than 3 inches, and not having any sharp, angular pieces or perishable, spongy, deleterious, or otherwise unsuitable material. Select soil fill shall be compacted in accordance with Part 3.2 of this section.

2.6 EXCAVATION

A. Excavation is all soil and rock excavated from the project site within the limits of work.

B. Excavation material not used for the designated Select Soil Fill shall be hauled to one of the stockpiles indicated by the Owner or Owner's Representative. These stockpile areas will receive general fill material, select fill, operations soils, and other soils. Stockpiles may be constructed to a maximum side slope inclination of 3.5H:1V (horizontal:vertical), unless directed by the Owner or Owner's Representative, to the maximum capacity of the stockpile or as directed by the Owner or Owner's Representative. Erosion and sediment control measures, such as silt fences shall be placed around the stockpiles to control sediment.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Perform all excavations, regardless of the type, nature, or condition of material encountered, as specified, shown, or required or implied to accomplish the construction. Transport excavated material to where it shall be placed as Select Soil Fill, or to designated stockpile area.

B. Allow for working space, overlying materials, and finish grades as shown or required.

3.2 SELECT SOIL FILL

A. Construct Select Soil Fills to lines and grades shown on the Construction Drawings. Use on-site soils for Select Soil Fill materials. Deposit material in lifts not exceeding uncompacted thicknesses of 8 inches across full width of each Select Fill area. Compact each lift with a minimum of 4 passes of a smooth drum compactor. The Select Soil Fill will be tested for compaction, and it is expected to obtain a density of approximately 90% relative compaction as determined by ASTM D1557. At the time of compaction, the water content of the material shall be at ±3% of optimum moisture content. At locations not meeting the intent of the specifications, additional work shall be required including, but not limited to moisture control, re-compaction, or material replacement.

B. Select soil fill that will have geosynthetic liner placed over it shall have a maximum protrusion height of ½ inch.

3.3 ANCHOR TRENCHES

A. Anchor trenches (as illustrated on the Construction Drawings) shall be required at the liner perimeter to secure the geosynthetic components of composite liner systems and shall have a smooth edge over which the liner enters the trench. The Earthwork Contractor shall take precautions to minimize loose soil underlying the

geosynthetics in the anchor trenches. The Earthwork Contractor shall ensure that desiccation of trench soils does not occur prior to backfilling.

B. After placement of the geosynthetics in the anchor trench, place select soil in the trench and compact. This soil shall be placed in maximum 12-inch uncompacted lifts and compacted. At the time of compaction, the water content of the material shall be at ±3% of optimum moisture content.

3.4 FIELD QUALITY CONTROL

A. The minimum frequency and details of quality assurance testing are provided in the CQA Plan. The Earthwork Contractor shall be aware of all field quality assurance requirements and activities and shall incorporate these into the construction schedule.

B. If a defective area is discovered in the earthwork, the Owner or Owner's Representative will determine the extent and nature of the defect by performing additional tests, observations, a review of records, or other means that the Owner or Owner's Representative deems appropriate.

C. After the Owner or Owner's Representative determines the extent and nature of a defect, the Earthwork Contractor shall correct the deficiency at their expense to the satisfaction of the Owner or Owner's Representative.

D. Additional testing may be performed to verify that the defect has been corrected before the Earthwork Contractor performs any additional work in the area of the deficiency.

E. The Owner or Owner's Representative will observe compaction and moisture content of the Select Soil Fill.

F. If necessary, the Owner or Owner's Representative will determine in-place density and moisture content by any one or combination of the following methods: ASTM D1556, D2216, D6938, or other methods selected by the Owner or Owner's Representative. The Earthwork Contractor shall cooperate with this testing work by leveling small test areas designated by the Owner or Owner's Representative. Backfilling of test areas shall be at Earthwork Contractor's sole expense. The frequency and location of testing shall be determined solely by the Owner or Owner's Representative. The Owner or Owner's Representative may test any lift of fill at any time, location, or elevation.

3.5 PROTECTION OF WORK

A. The Earthwork Contractor shall use all means necessary to protect all prior work, including all materials and work completed pursuant to other sections of the Specifications.

B. In the event of damage, the Earthwork Contractor shall immediately make all repairs and replacements necessary to the approval of the Owner or Owner's Representative at no additional cost to the Owner.

C. At the end of each day, the Earthwork Contractor shall verify that entire work area was left in a state that promotes surface drainage off and away from the area and from finished work. If threatening weather conditions are forecast, compacted surfaces shall be seal-rolled with a smooth drum roller to protect finished work.

****END OF SECTION 02200****

SECTION 02245

GEOTEXTILE

PART 1 – GENERAL

1.1 SUMMARY

A. This section describes the work necessary to install non-woven geotextiles (fabrics) in the liner system.

B. The work includes furnishing all labor, supervision, tools, construction equipment, and materials necessary to install the fabrics described by these Specifications and the Construction Drawings.

1.2 RELATED SECTIONS

A. Section 01300 – Submittals

B. Section 01410 – Quality Assurance Testing, Quality Control Testing, and Certificates of Compliance

C. Section 02200 – Earthwork

D. Section 02778 – Geomembrane

1.3 REFERENCES

A. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles

B. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

C. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

D. ASTM D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles

E. Construction Quality Assurance (CQA) Plan

1.4 SUBMITTALS

A. Submittals shall conform to the requirements in Section 01300 - Submittals.

B. Certification Submittals: shall be submitted to the CQA Engineer for approval prior to shipment to the project site, including the following:

1. Manufacturer's written certification that the geotextiles meet the physical and hydraulic properties listed in Part 2 of this section.
2. Thread properties and seam and stitch details to be used for sewn seams.
3. Manufacturer's and Geosynthetics Contractor's qualifications.

C. Pre-Construction Submittals: shall be submitted to the CQA Engineer within 5 days of the intended shipment date.

1. Written list of the specific rolls to be shipped to the project site.
2. Manufacturer's Quality Control data for rolls to be shipped to the project site.

1.6 DELIVERY, STORAGE, AND HANDLING

Geotextile shall be protected from precipitation, inundation, ultraviolet exposure, dirt puncture, cutting, and other damaging or deleterious conditions, in accordance with ASTM D4873.

PART 2 - PRODUCTS

2.1 GENERAL

A. Contractor shall furnish materials whose "Minimum Average Roll Values", as defined by the Federal Highway Administration (FHWA), meet, or exceed the criteria listed in this section.

B. No Geotextiles shall be delivered until the requirements of Section 01410 have been met.

2.2 EQUIPMENT

The Geosynthetics Contractor shall furnish all necessary equipment required to accomplish the installation of the woven cushion geotextile and the non-woven filter fabric geotextiles specified herein.

2.3 MATERIALS

A. The geotextile, supplied by the Geosynthetics Supplier, shall be a non-woven, needle-punched, staple fiber or continuous filament, polypropylene or polyester material meeting the requirements of Table 02245-1.

2.4 GEOTEXTILE SEAMING THREAD

Geotextile seams shall be heat bonded or sewn with polymeric thread. The thread shall be capable of supplying a seam strength efficiency of 80% of the required tensile strength utilizing a Type 401 two-thread chain stitch with a "J" seam.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. All geotextiles shall be deployed in accordance with the Manufacturer's recommendations, standards, and guidelines.

B. Geotextile procurement, transportation, storage, handling, and installation shall be the responsibility of the Geosynthetics Contractor. Any damaged or unacceptable material shall be replaced at the sole expense of the Geosynthetics Contractor. During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings, in accordance with ASTM D4873.

C. Geotextile rolls shall be handled in such a way that they are not damaged, in accordance with ASTM D4873.

D. During placement of filter fabric, care shall be taken not to entrap in the geotextile, stones, excessive dirt, or moisture that could damage the geomembrane or hamper subsequent seaming.

E. Geotextile shall not be exposed to precipitation prior to being installed. Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, the geotextile shall not be exposed to direct sunlight for more than 21 days (unless otherwise approved by the CQA Engineer).

3.2 SEAMING OF GEOTEXTILE

A. On slopes flatter than or equal to 10H:1V, adjacent geotextile panels may be sewn, heat bonded or overlapped. All seaming, heat bonding or overlapping of sheets shall be done in accordance with the Manufacturer's recommendations. For overlapped seams, overlap distances shall be a minimum of 12 inches.

B. On slopes greater than 10H:1V, adjacent panels shall be sewn, or heat bonded. All seams on such slopes shall be oriented parallel to (in the direction of) the slope.

C. Sewn seams shall use a Type 401 stitch. One or two rows of stitching may be used to achieve the required density in 3.2.G.

D. Seams may be heat bonded using hot plate, hot knife, or ultrasonic devices.

E. Adjacent panels shall be overlapped a minimum of 6 inches prior to heat bonding.

F. All sewing shall be done using polymeric thread with properties equal to or exceeding those of the geotextile.

G. The seam shall have 8 stitches per inch and the stitches shall be a minimum of 2 inches from the fabric edge.

3.3 REPAIRS

A. Holes or tears in the fabric shall be repaired as follows: A fabric patch made from the same geotextile shall be sewn or heat-bonded into place using a double sewn lock stitch (1/4 inch to 3/4 inch apart and sewn no closer than 1 inch from any edge). Provide a minimum overlap of 12 inches in all directions. Should any tear exceed 10 % of the width of the roll, that roll shall be removed from the slope and replaced.

B. Care shall be taken to remove any soil or other materials that may have penetrated the torn geotextile.

C. Log any defects, holes, and tears that are identified and repaired.

3.3 CONFORMANCE TESTING

A. Conformance testing shall be performed at the frequencies presented in the CQA Plan by the Owner’s laboratory for conformance with properties listed in Part 2 of this Section. The Contractor shall assist in the collection of these samples. Samples shall be taken across the entire width of geotextile roll and shall not include the first 3 feet. Samples shall be 3 feet long by roll width. Machine direction shall be marked on the sample with an arrow.

B. Field quality assurance activities shall be performed in accordance with the CQA Plan and shall include visual field inspection by the CQA Engineer.

C. In the event that a portion of the material fails the conformance testing, the entire area represented by the failing test shall be removed and replaced.

D. Additional samples of geotextile delivered to the site may be collected for testing to confirm conformance with geotextile properties listed in Part 2 at the Design Engineer's discretion.

3.4 PROTECTION

Geotextiles shall be stored in such a manner to protect them from puncture, dirt, grease, water, mud, and exposure to the sun or excessive heat.

TABLE 02245-1

NONWOVEN FILTER FABRIC PROPERTIES

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values
Mass/Unit Area (min. ave.)	ASTM D5261	1 per 100,000 sf	7.2 oz/yd^2
Grab Strength (min. ave.)	ASTM D4632	1 per 100,000 sf	200 lbs
Puncture Strength (min. ave.)	ASTM D6241	1 per 100,000 sf	575 lbs
UV Resistance	ASTM D4355	1 per resin formulation	70%(1)

Notes:
(1) Ultraviolet (UV) resistance requirement is at 500 hours. Certification by manufacturer may be accepted.

****END OF SECTION 02245 ****

SECTION 02778

GEOMEMBRANE

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Manufacture, fabrication, and installation of 60-mil high-density polyethylene (HDPE) geomembrane as shown on the Construction Drawings.

B. Manufacture, fabrication, and installation of all materials necessary for the installation and anchoring of an ultraviolet (UV) protection layer as shown on the Construction Drawings.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01410 - Quality Assurance Testing, Quality Control Testing, and Certificates of Compliance

C. Section 02245 - Geotextile

1.3 REFERENCES

A. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

B. ASTM D1004 – Standard Test Method for Initial Tear Resistance (Graves Tear) of Plastic Film and Sheeting

C. ASTM D1238 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D. ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique

E. ASTM D1603 – Standard Test Method for Carbon Black in Olefin Plastics

F. ASTM D2663 - Standard Test Methods for Carbon Black-Dispersion in Rubber

G. ASTM D3895 – Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry

H. ASTM D4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

I. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

J. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

K. ASTM D5199 – Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

L. ASTM D5397 (Appendix A) – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

M. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

N. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

O. ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes

P. ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

Q. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry

R. ASTM D5994 - Standard Test Method for Measuring the Core Thickness of Textured Geomembranes

S. ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

T. ASTM D6693 – Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

U. GRI GM13 – Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

V. GRI GM19 – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

W. Construction Quality Assurance (CQA) Plan

1.4 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01300 - Submittals.

B. Certification Submittals: Prior to delivery of materials to the site, submit the following to the Owner or Owner's Representative for approval:

1. Manufacturer’s certification and physical property tests for representative geomembrane material.

2. Statement that no reclaimed polymer is added to resin during manufacture of actual 60-mil geomembrane to be used in this project.

3. Proposed Panel Layout Drawings shall be submitted prior to liner installation. These drawings shall be in sufficient detail to provide an accurate representation of the field seaming and anchor trench details that will be performed. The diagram shall be shown on a drawing with a

one-inch equal to 60-feet scale (or larger), shall include the approved construction reference grid, bottom of slopes, anchor trench areas, North arrow, title of drawing, labeling of all features and any other information to define the work. It shall identify each sheet and panel by number. The layout shall conform to the following:

a) Proposed field seams shall be shown.

b) No horizontal seams (defined as less than 45 degrees from horizontal shall be allowed on slopes, unless approved by the Design Engineer.

c) On side slopes, panels shall be aligned with long axis parallel to the line of maximum slope.

d) All overlaps shall be in the downslope direction.

e) Panel layout shall be established such that the total length of seam shall be minimized.

4. Proposed Panel Layout Drawing for the UV protection layer panel and sandbag configurations (if applicable) and method to tie them together, dimensions, details, location of seam overlaps, as well as any variance or additional details which deviate from the Construction Drawings shall be submitted prior to installation. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc. The layout drawings, as modified and/or approved by the Owner or Owner's Representative, shall become part of these specifications.

5. Proposed installation sequence and schedule.

6. Manufacturer's and Geosynthetics Contractor's Qualifications.

7. List of personnel performing field geomembrane seaming operation, along with pertinent experience information.

8. Description of the actual seaming apparatus proposed to be used and extrudate properties.

9. Detailed description of proposed field seaming and installation procedures and detailed description of proposed field seam testing methods.

10. The Geosynthetics Supplier shall arrange for a minimum 3-foot-wide by roll width sample of geomembrane, with the exception of the UV protection layer geomembrane, at the frequencies provided in the CQA Plan, to be shipped to the Owner or Owner's Representative for the completion of the pre-construction geosynthetic materials testing, to be conducted by the Owner's laboratory.

C. Pre-Construction Submittals: Submit the following to the Owner or Owner's Representative at least 10 working days prior to the intended shipment date of the geomembrane rolls.

1. Written list of the lot numbers and specific rolls to be shipped to the project site.
2. Manufacturer's Quality Control data for rolls to be shipped to the site indicating compliance with requirements of Part 2.
3. Manufacturer's data for raw materials:
   a) Copy of quality control certificates issued by resin suppliers.
   b) HDPE resin production date(s).
   c) Results of Manufacturer's quality control tests indicating the quality of resin used to manufacture geomembrane rolls assigned to the site conforms with the requirements in Part 2 of this specification.

D. Construction Submittals: Submit the following to the Owner or Owner's Representative for review on a weekly basis during geomembrane installation.
1. Daily subgrade acceptance by Geosynthetics Contractor.
2. Quality Control documentation by Geosynthetics Contractor.
3. Revised Panel Layout Drawings (field sketches).
4. Updated Installation Schedules.

E. Post-Construction Submittals:
1. Geomembrane Warranty.
2. Record Documentation as detailed in Part 3 of this Section.

1.5 CONSTRUCTION QUALITY CONTROL

A. Geomembrane Quality Control by the Geosynthetics Contractor shall include:
1. Visual inspection for installation damage and conformance with the Specifications.
2. Non-destructive/destructive seam testing in accordance with this section.

B. Conformance Testing
1. Conformance testing shall be performed by the CQA Engineer based on the frequencies presented in the CQA Plan. The sample shall be randomly selected and sent to the Owner's laboratory for conformance testing. Random selection shall be on-site or prior to delivery by choosing roll numbers from shipment lists. Conformance tests shall be as listed in the CQA Plan.
2. Samples shall be taken across the entire width of the geomembrane roll and shall not include the outer wrap. Samples shall be 3 feet long by the roll width and fully identified including machine direction. Samples shall be rolled and not folded for transfer to the laboratory. Samples may be cut for shipping purposes.

3. The Geosynthetics Contractor shall bear any additional costs due to failing any of the required tests.

4. In the event that a portion of the material fails the quality control criteria, the Geosynthetics Contractor shall remove non-conforming rolls from the job site. The Geosynthetics Contractor may elect to perform additional conformance testing to better delineate failing materials at the expense of the Geosynthetics Contractor.

5. In the event the material failing the quality control criteria has already been installed, the Geosynthetics Contractor shall remove and replace the entire area failing the test at the sole expense of the Geosynthetics Contractor.

1.6 QUALIFICATIONS

A. Manufacturer:

1. Manufacturer shall have at least 5 years continuous experience in the manufacture of HDPE geomembrane rolls or similar products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 15 million square feet of manufacture of HDPE geomembrane or similar products.

B. Geosynthetics Contractor:

1. Geosynthetics Contractor shall have at least 5 years continuous experience in installation of polyethylene geomembrane or similar products. The Geosynthetics Contractor must demonstrate a minimum of 5 million square feet of HDPE geomembrane installed for at least 10 completed facilities.

2. Personnel performing seaming operations shall have demonstrated expertise on previous geomembrane installations. Each welder shall have experience seaming a minimum of 1 million square feet of polyethylene geomembrane within the last three years. All seaming personnel shall have experience seaming textured polyethylene material.

1.7 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping:

1. Geomembrane shall be packaged and shipped by appropriate means to prevent damage to the material and to facilitate off-loading.

2. Geomembrane rolls shall be marked or tagged with the following information:

a) Product identification information (Manufacturer’s name and address, brand product code).

b) Lot, number, and roll number.

c) Roll thickness, length, and width.

3. Geosynthetics Contractor shall prepare a full inventory of materials delivered to the site and submit the inventory to the Owner or Owner's Representative within 2 days of receipt.

4. Perform in accordance with ASTM D4873.

B. Storage and Protection:

1. The Geosynthetics Contractor shall provide on-site storage area(s) for geomembrane rolls from time of delivery until installation.

2. Store and protect geomembrane rolls from puncture, dirt, grease, vandalism, ultraviolet light exposure, and other sources of damage.

a) Place geomembrane rolls on smooth, level, elevated surfaces.

b) Cover geomembrane rolls with heavy, waterproof tarpaulin.

3. Geosynthetics Contractor shall preserve integrity and readability of geomembrane roll labels.

4. Geomembrane that is received that does not have proper Manufacturer's documentation shall be stored at a separate location until all documentation has been received, reviewed, and accepted.

C. On-site Handling:

1. Unloading, on-site handling, and storage of the geomembrane is the responsibility of the Geosynthetics Contractor.

2. Use appropriate handling equipment when unloading or moving geomembrane rolls from one place to another. Follow the Manufacturer's recommendations for handling geomembrane rolls so as not to cause damage.

3. Report any observed damage to the Owner or Owner's Representative.

PART 2 - PRODUCTS

2.1 60-MIL GEOMEMBRANE

A. A 60-mil HDPE geomembrane shall be provided. The geomembrane shall be produced in sufficient quantities to complete the work per these Specifications and the Construction Drawings. Geomembranes shall also be produced in rolls free of holes, blisters, striations, undispersed raw materials, or any sign of contamination by foreign matter.

B. Resin used in the manufacturing of the Geomembrane shall be new, first-quality, virgin polyethylene resin. The addition of reworked polymer (from the manufacturing process) to resin shall be permitted if it does not exceed 2% by weight, contains no encapsulated scrim, and is performed with appropriate cleanliness. The addition of post-consumer resin shall not be permitted.

C. Geomembrane shall be manufactured from a pure polyethylene resin having a minimum density in accordance with Table 02778-1. The resin shall be mixed with the specified amount of carbon black. The carbon black shall be pre-blended with the resin prior to melting.

D. The geomembrane shall exhibit the minimum physical properties listed in Table 02778-1. Manufacturer quality control testing shall be performed in accordance with the frequencies presented in Table 02778-1.

E. Geomembrane seams shall meet the minimum requirements listed in GRI Test Method GM-19a, shown in Table 02778-2. Frequency of seam testing shall be in accordance with the CQA Plan.

F. Resin used for extrusion welding shall be produced from the same resin type as the geomembrane. Physical properties of the welding resin shall be the same as those of the resin used in the geomembrane.

TABLE 02778-1
60-MIL TEXTURED HDPE GEOMEMBRANE PROPERTIES

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values[10]
Thickness (min. ave.) Lowest individual for 8 out of 10 values Lowest individual for any of the 10 values	ASTM D5994	1 per Roll	57 mil 54 mil 51 mil
Formulated Density (min ave.)	ASTM D792 or ASTM D1505	1 per 200,000 lb	0.940 g/cc
Tensile Properties[1] (min. ave.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 20,000 lb	 126 lb/in 228 lb/in 12% 700%
Tear Resistance (min. ave.)	ASTM D1004	1 per 45,000 lb	42 lbs
Puncture Resistance (min. ave.)	ASTM D4833	1 per 45,000 lb	108 lbs
Stress Crack Resistance [2]	ASTM D5397 (App.)	per GRI GM 10	500 hours
Carbon Black Content (range)	ASTM D4218[3]	1 per 20,000 lb	2.0-3.0%
Carbon Black Dispersion[4]	ASTM D5596	1 per 45,000 lb	A1,A2,B1 Category 1, 2, or 3 [4]

TABLE 02778-1 (cont.)

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values[10]
Oxidative Induction Time (OIT) (min. ave.)[5] Std. OIT, or High Pressure OIT	 ASTM D8117 ASTM D5885	 1 per 200,000 lb	 100 min. 400 min.
Oven Aging at 85°C [5][6] Std. OIT (min. ave.), % retained after 90 days, or High Pressure OIT (min. ave.), % retained after 90 days	ASTM D5721 ASTM D8117 ASTM D5885	per each formulation	 55% 80%
UV Resistance [7] Std. OIT (min. ave.), or High Pressure OIT (min. ave.) % retained after 1600 hrs [9]	ASTM D7238 ASTM D8117 ASTM D5885	per each formulation	 (8) 50%

Notes:

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongation is calculated using a gage length of 1.3 inches.

Break elongation is calculated using a gage length of 2.0 inches.

(2) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

(3) Other methods such as D 1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

9 in Categories 1 or 2, and

1 in Category 3.

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(10) Based on GRI GM13, Rev. 16, 3/17/2021.

TABLE 02778-2
MINIMUM HDPE SEAM PROPERTIES

Property	Qualifier	Unit	Specified Value 60-mil HDPE	Test Method
Shear Strength (at yield point)	Minimum	lb./in. width	120 and FTB[1]	ASTM D6392
Shear Elongation at break(2)	Maximum	%	50	ASTM D6392
Peel Adhesion Fusion	Minimum	lb./in. width	91 and FTB[1]	ASTM D6392
Peel Adhesion Extrusion	Minimum	lb./in. width	78 and FTB[1]	ASTM D6392
Peel Separation	Maximum	%	25	ASTM D6392

(1) FTB[1] = Film Tear Bond per NSF Standard 54, Part 5 Figures A-2 and A-4. Film tear bond is defined as failure of one of the sheets by tearing, instead of separating from the other sheet at the weld interface area (i.e., sheet fails before the weld fails).

(2) Elongation measurements should be omitted for field testing.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Front-end loaders, cranes, or other approved heavy equipment used for geomembrane deployment shall not be operated over geotextile.

B. Panel deployment shall utilize a spreader-bar or similar equipment to prevent slings from damaging the roll edges.

C. Equipment used shall not contaminate or damage geotextile or geomembrane by handling, trafficking, spilling of hydrocarbons (such as gasoline or oil) or other means. Defects in material installation arising from the use of equipment shall be repaired at the sole expense of the Geosynthetics Contractor.

D. Direct equipment contact with components of the geosynthetic liner system shall be minimized. The geomembrane shall be protected by geotextile “rub sheets”, scrap geomembranes, or other suitable materials, in trafficked areas or other areas requiring geomembrane protection.

3.2 PLACEMENT

A. General:

1. Place geotextile and geomembrane as shown on the construction drawings.
2. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
3. Methods used to unroll panels shall not cause scratches or crimps in the geomembrane.
4. Methods used to place panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).
5. The geomembrane shall be securely anchored and then rolled in such a manner as to continually keep the geomembrane in tension to preclude folding.
6. The geomembrane shall be weighted with sandbags or the equivalent ballast materials, to prevent movement caused by wind. Such sandbags shall be installed during placement and shall remain until replaced with subsequent liner system materials and cover soils and/or other materials capable of providing sufficient ballast against wind uplift. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind uplift of panels.
7. Verify that the surface beneath the geomembrane has not deteriorated since the previous acceptance.

B. Install panels as follows:

1. Follow instructions on boxes or wrapping containing geomembrane materials to ensure panels are unrolled in proper direction for seaming.
2. On slopes 10H:1V and steeper, deploy geomembrane panels down-slope, in a controlled manner, with panels parallel to the slope.
3. Panel sizes shall be detailed in the Geosynthetics Contractor's Panel Layout Drawing showing dimensions, panel numbering and installation details.
    a) Field panel is roll or portion of roll cut in field.
    b) When placed, designate each roll with panel number (identification code) consistent with layout plan. Panel is unit area of geomembrane to be seamed in field (e.g., one roll may be cut into several panels). Position panels on-site as shown in Panel Layout Drawings.
4. Place panels one at a time. Deploy no more panels than can be seamed on the same day. No more than one panel shall be unrolled prior to seaming, unless authorized by the Owner or Owner’s Representative.

5. Install 60-mil geomembranes in locations indicated on the Construction Drawings.

C. Weather Conditions:

1. Do not place panels at ambient temperature below or above the Manufacturer's suggested ambient temperature range for installation.

2. Do not place during precipitation, in presence of excessive moisture (e.g., fog, dew), in areas of ponded water, or during excessive winds, as determined by the Owner or Owner's Representative.

D. Damage:

1. Any panel which, in judgment of the Owner or Owner's Representative, becomes seriously damaged (such as torn or twisted permanently) shall be replaced at sole expense of the Geosynthetics Contractor. Less serious damage shall be repaired as approved by the Owner or Owner's Representative.

2. Remove rejected damaged panels or portions of rejected damaged panels from work area.

E. Materials in Contact with Geomembrane:

1. Carefully install materials in contact with geomembrane surfaces to minimize potential damage. Geotextile materials may be temporarily placed loosely on top of the geomembrane for protection, if approved by the Owner or Owner's Representative.

2. Clamps, clips, bolts, nuts, or other fasteners used to secure geomembrane to each appurtenance shall have life span equal to or exceeding that of the geomembrane.

3. Pipes and Other Appurtenances:

a) Install geomembrane around any appurtenances, such as pipes, protruding through geomembrane as shown on the Construction Drawings. Unless otherwise specified, initially install geomembrane sleeve or apron around each appurtenance prior to geomembrane installation.

b) After material is placed and seamed, complete final field seam connection between appurtenance sleeve or apron and geomembrane. Maintain sufficient initial overlap of appurtenance sleeve so shifts in location of geomembrane can be accommodated.

c) Extreme care shall be taken while seaming around appurtenances because both nondestructive and destructive seam testing might not be feasible. Do not damage geomembrane while making connections to appurtenances.

3.3 GEOMEMBRANE FIELD SEAMING

A. Seam Layout:

1. In general, orient seams parallel to line of maximum slope, i.e., oriented along, not across the slope. In corners and odd-shaped geometric locations, minimize numbers of field seams.

2. No horizontal seams (defined as less than 45 degrees from horizontal shall be allowed on the slopes, unless approved by the Design Engineer.

B. Overlapping and Temporary Bonding:

1. Overlap panels a minimum of 3 inches unless otherwise recommended by the geomembrane Manufacturer.

2. Procedure used to temporarily bond adjacent panels together for extrusion welding, shall not damage geomembrane; in particular, temperature of air at nozzle of any spot-welding apparatus shall be controlled such that the geomembrane is not damaged.

3. No solvent or adhesive shall be used unless the product is approved in writing by the Owner or Owner's Representative (samples shall be submitted for testing and evaluation).

C. Seam Preparation:

1. Prior to seaming, seams shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, the process shall be completed according to Manufacturer's instructions and in a way not damaging to geomembrane.

3. Align seams with the least possible number of wrinkles and "fish mouths".

D. Seaming Equipment and Products:

1. General:

a) Approved processes for field seaming are fusion welding and extrusion welding. Proposed alternate processes shall be documented and submitted to the Design Engineer and/CQA Engineer for approval prior to use. Extrusion welding shall be restricted to repairs and welding applications not possible by the fusion process.

b) Only use apparatus specifically approved by geomembrane Manufacturer.

c) Seams shall meet the specifications contained in Part 2 of this Section.

2. Fusion Process:

   a) Use automated, vehicular-mounted fusion welding apparatus suitable for HDPE geomembranes that will prevent seams defects such as puckering.

   b) Equip apparatus with gauges indicating applicable temperatures and pressures.

   c) Maintain at least one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage, particularly in heavily trafficked areas.

   d) In all locations where the GCL is not present, use movable protective layer directly below each overlap of geomembrane that is to be seamed to prevent build-up of moisture between panels to be welded.

   e) Place the electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use. When protective material is in place, sudden stops or starts, sharp turns, and stationary churning of vehicles shall be strictly prohibited.

3. Extrusion Process:

   a) Complete grinding no more than one hour prior to seaming.

   b) Exposed grinding marks shall not extend more than 1/4 inch from the seamed area.

   c) Use only clean and dry welding rods.

   d) Use apparatus equipped with gauges giving temperature in apparatus and at nozzle.

   e) Provide documentation of extrudate to the Owner or Owner's Representative and certify that extrudate is compatible with specifications and is comprised of same resins as geomembrane.

   f) Maintain at least one spare operable extrusion seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage in heavily trafficked areas.

   g) Purge extruder prior to beginning seam until all heat-degraded extrudate has been removed from barrel.

   h) Place electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use.

   i) Grind edges of cross seams to an incline prior to welding.

E. Weather Conditions for Seaming:

1. No seaming shall be attempted below 0°C (32°F) or above 43°C (110°F) without approval of the Owner or Owner's Representative.

2. Below 0°C (32°F), seaming shall be performed in accordance with GRI GM-9 “Cold Weather Seaming of Geomembranes.”

3. Geomembrane shall be dry and protected from wind.

4. In the event of seaming below 0°C (32°F) or above 43°C (110°F), certify in writing that low-temperature or high-temperature seaming procedures does not cause any physical or chemical modification to geomembrane that will generate any short or long-term damage to geomembrane.

F. General Seaming Procedures:

1. Use double hot wedge welding for installation seaming wherever possible.

2. Seaming shall extend to the outside edge of panels to be placed in anchor trench.

3. If required, provide firm substrate by using flat board, conveyor belt or similar hard surface directly under seam overlaps to achieve proper support.

4. Cut "fish mouths" or wrinkles at seam overlaps along ridge of wrinkle in order to achieve flat overlap. Seam cut "fish mouths" or wrinkles. Patch any portion where overlap is inadequate with oval or round patch of same geomembrane extending a minimum of 6 inches beyond cut in each direction.

5. Patch tee seams (location where more than one seam crosses or connects) with oval or round patch of same geomembrane extending a minimum of 6 in. beyond tee in each direction.

G. Trial Seams:

1. Before the start of geomembrane welding and during welding operations, trial welds shall be made by each seamer for each piece of seaming equipment to be used during production seaming on fragment pieces of geomembrane to confirm seaming conditions are adequate. Trial seams shall be made at the beginning of each seaming period and at mid-shift for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. The Owner or Owner's Representative may, at their discretion, require additional trial welds.

2. The trial weld sample shall be at least 42 inches long by 1 foot wide with seam centered lengthwise. Six random test specimens will be cut, each 1-inch wide from trial seam sample. Test Specimens shall be tested for bonded seam strength and peel adhesion (shear and peel strengths; 3 specimens for shear and 3 specimens for peel) using a digital field tensiometer. All specimens must meet the required seam properties

provided in Table 02778-2. One specimen failure shall result in a failure for the entire seam sample. If an additional trial seam fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until deficiencies are corrected and two consecutive successful full trial seams are achieved.

3. Results of peel and shear tests shall be recorded on a trial weld form.

4. Trial welds must be completed under conditions similar to those under which geomembrane panels will be welded.

5. Trial welds shall be allowed to cool before being tested.

6. An additional trial weld shall be performed if a wide change in temperature (±30ºF), humidity, or wind speed occurs since the previous trial weld.

H. Nondestructive Seam Continuity Testing:

1. Nondestructively test field seams over their full length using vacuum test unit or air pressure (for double hot wedge fusion process). Continuity testing shall be done as seaming work progresses, not at completion of field seaming.

2. Complete required repairs.

3. The following procedures shall apply to locations where seams cannot be nondestructively tested, as determined by the Owner or Owner's Representative:

a) If the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.

b) All such seams shall be cap-stripped with the same geomembrane where possible.

c) If seam cannot be tested prior to final installation, seaming and cap-stripping operations shall be observed by Owner or Owner's Representative for uniformity and completeness.

4. Vacuum testing shall be performed in accordance with ASTM D5641.

5. Air Pressure testing for dual track hot wedge fusion seams shall be performed in accordance with ASTM D5820 and the following:

a) Seal both ends of seam to be tested.

b) Insert needle or other approved pressure feed device into tunnel created by double hot wedge fusion weld. Place protective cushion between air pump and geomembrane.

c) Energize air pump to a pressure between 27 and 37 pounds per square inch (psi) for 60-mil geomembrane, close valve, and sustain pressure for 5 minutes.

d) If pressure loss of more than 3 psi for 60-mil thick geomembrane is noticed, locate faulty area and repair (or as otherwise directed in ASTM D5820).

e) At the end of test, puncture the end of air channel opposite from the end with the pressure gauge and observe release of pressure to ensure air channel is not blocked. If the channel does not depressurize, find and repair the portion of the seam containing the blockage per Subpart J.3 of this Section. Repeat the air pressure test on the resulting segments of the original seam created by the repair and the ends of the seam. Repeat the process until the entire length of seam has successfully passed pressure testing or contains a repair. Repairs shall also be non-destructively tested per Subpart J.3 of this Section.

f) Remove needle or other approved pressure feed device, and all penetration holes in accordance with Subpart J.3 of this Section.

I. Destructive Seam Strength Testing:

1. Field Testing:

a) Cut a 1-inch-wide strip sample at the beginning and the completion of all seams. Cut samples from areas that do not require patching, if possible, for example at anchor trench areas or runouts beyond slopes.

b) Field test samples. If the field test passes, proceed with the destructive test, if the field test fails, follow the Destructive Test Seam Failure procedure described within this section.

2. Location and Frequency:

a) Conduct a minimum of one test per 1,000 feet of seam length (at non-critical locations such as anchor trench locations whenever possible).

b) Maximum frequency of test locations shall be agreed upon by Geosynthetics Contractor and Owner or Owner's Representative prior to commencement of installation.

c) Additional test locations shall be determined during seaming at Owner or Owner's Representative’s discretion. Selection of such locations may be prompted by adverse weather conditions, insufficient overlap, failing tests, extrusion welding, presence of excessive wrinkling in the seam area, suspicion of excess crystallinity, weld contamination, offset welds, suspect seaming equipment or techniques, or other considerations.

d) Geosynthetics Contractor will not be informed in advance of locations where seam samples will be taken.

e) Specimens shall not be taken from areas that will be subject to prolonged future leachate contact (e.g., leachate collection sumps) without prior approval by Owner or Owner's Representative.

f) Destructive seam testing shall not be required for UV protection layer geomembrane.

3. Sampling Procedure:

a) Cut samples as seaming progresses in order to obtain laboratory test results prior to completion of geomembrane installation. Number each sample and identify sample number and location on Panel Layout Drawings.

b) Immediately repair holes in geomembrane resulting from destructive seam sampling. Test continuity of new seams in repaired area using the vacuum box method of non-destructive testing (ASTM D5641).

c) Cut two 1-inch x 12-inch samples with seam centered parallel to the width with a distance between the strips of 44 inches. Field test the strips for peel and shear with a digital field tensiometer capable of quantitatively measuring shear and peel strengths.

d) For double wedge welding, test both welds for peel and shear strength for conformance with the seam strength requirements of this section.

e) If one or both of the 1-inch specimens fail in either peel or shear strength, implement procedures specified in Part I.6 of this section.

f) If the samples pass the field test remove a 12-inch wide by 42-inch-long section between the two samples. Cut section into three parts and distribute as follows:

i) One portion to the Geosynthetics Contractor for laboratory testing, 12-inch x 12 inch

ii) One portion for the Owner's independent laboratory testing, 12-inch x 18 inch

iii) One portion to the Owner for archive storage, 12-inch x 12 inch

4. Geosynthetics Contractor's Laboratory Testing:

a) Submit test results to CQA Engineer and Owner or Owner's Representative as soon as they become available.

5. Independent Laboratory Testing:

a) Test for "seam strength" and "peel adhesion" according to ASTM D6392. Minimum acceptable values are indicated in Table 02778-2 of Part 2. Test at least five replicate specimens for

each test method. To be acceptable, four of the five replicates shall pass seam strength and peel adhesion criteria in Part 2. Report test results to Owner or Owner's Representative no more than 24 hours after laboratory receives samples.

6. Procedures for Destructive Test Seam Failure:

   a) The following procedures shall apply whenever a destructive seam sample fails field destructive testing:

      i) Reconstruct seam between any two passed test locations; or

      ii) Retrace welding path to intermediate location, at 10 feet minimum from location of failed test in each direction and take samples for additional field tests. If the second test passes, then seam shall be either reconstructed or cap stripped between the two passed locations. If any sample fails, the process shall be repeated.

      iii) The boundary samples shall be tested in the same manner as the original sample.

   b) In any case, acceptable seams shall be bounded by two passed test locations (i.e., above procedure shall be followed in both directions from original failed location), and one sample for laboratory destructive testing shall be taken within reconstructed area.

   c) In event that seam sample fails laboratory destructive test (whether conducted by Owner's independent laboratory or by Geosynthetics Contractor's laboratory), then above procedures shall be followed considering laboratory tests exclusively. Because the final seam must be bounded by two passing test locations, it may then be necessary to take one or more samples for laboratory testing in addition to one required in reconstructed seam area.

J. Defects and Repairs:

1. Identification: Broom or wash geomembrane if amount of dust, mud, or other debris inhibits inspection.

2. Evaluation: Nondestructively test each suspect location in seam and non-seam areas. Repair each seam, pinhole, damaged area or defect location that fails nondestructive testing.

3. Repair Procedures:

   a) Patching: Used to repair holes, tears, panel defects, undispersed raw materials, welds, contamination by foreign matter, and destructive sample locations.

   b) Extrusion: Used to repair pinholes or other small defects (e.g., scratches, crimps). In general, this procedure should be used for defects less than 1/8 inch in largest dimension.

c) Capping (Cap Strip): Used to repair lengths of failed welds or to cover seams where welds cannot be destructively tested. Cap strips 150 feet in length or greater shall be destructively tested.

d) Removal: used to replace area with large defects where preceding methods are not appropriate. Also used to remove excess material from the installed geomembrane (e.g., "fishmouths", wrinkles, etc.). Areas of removal shall be patched or capped.

e) Surfaces of geomembrane to be patched shall be abraded no more than 1 hour prior to extrusion repair.

f) Seams used in repairs shall be approved extrusion or fusion welded seams and may be subject to the same destructive test procedure as outlined for other seams.

g) Patches or caps shall be round or oval in shape, made of same geomembrane, extend a minimum of 6 in. beyond edge of defects, and applied using approved methods only.

4. Seam Reconstruction Procedures:

a) Seam reconstruction for fusion welded seams shall be achieved by welding a top cover cap strip, 12-inches in width and centered over the seam in question.

b) Seam reconstruction for extrusion process shall be achieved by grinding and re-welding small seam sections, or by capping for large seam sections.

5. Verification of Repairs:

a) Test each repair nondestructively.

b) Repairs passing nondestructive test shall be taken as indication of adequate repair.

c) Failed tests indicate repair shall be redone and re-tested until passing tests result.

3.4 GEOMEMBRANE ACCEPTANCE

Geosynthetics Contractor shall retain ownership and responsibility for geomembrane until the Final Acceptance of the work by the Owner or Owner's Representative.

3.5 UV PROTECTION LAYER GEOMEMBRANE

A. General:

1. Personnel working on the UV protection layer geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the UV protection layer geomembrane or underlying materials.

2. Methods used to install the UV protection layer geomembrane shall not cause scratches or crimps in the UV protection layer geomembrane and shall not damage the underlying materials.

3. The UV protection layer geomembrane shall be weighted with sandbags or the equivalent ballast materials, to prevent movement caused by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind uplift of panels.

B. Install UV protection layer on top of all exposed slope liners. UV protection layer shall be anchored in the top of the slope anchor trench and shall extend a minimum length along slope of two feet beneath the soil operations layer.

C. Carefully install materials in contact with UV protection layer geomembrane surfaces to minimize potential damage.

D. UV protection layer geomembrane seams shall be joined in accordance with manufacturer recommendations.

3.6 RECORD DOCUMENTATION

Record documentation specific to geomembrane installation, shall be provided as follows:

A. Installation Report - The Geosynthetics Contractor shall provide a report to the Owner or Owner's Representative at the conclusion of the work, including the following:

1. Complete identification of membrane material, including type of resin, batch numbers, roll numbers, Manufacturer, and thickness.
2. Complete identification of field seaming, including extrudate material, seaming method, seaming temperature, and date of fabrication of field seams.
3. The quality control tests used as specified and/or directed.
4. Complete description of field sampling procedure, number of test specimens, and size of test specimens.
5. Type of test machine used, grip separation, and crosshead speed.
6. Method of recording, loading, and determining stresses for destructive test methods.
7. Peel and shear test values for individual specimens in pounds per inch of width, and also the average load value for each group of specimens.
8. Manufacturer’s quality control testing, test results, certifications, etc.
9. Type of failure in all destructive testing, that is, within the seam, within the sheet material, clamp edge, seam edge, etc., for each individual specimen.

10. For non-destructive testing: type of non-destructive test, results, identification of failures, date of re-testing, and repairs.
11. Seam length.
12. Length of seam welded.
13. Identity of the seamer.
14. Identity of seam testers.
15. Weather conditions at the time of seaming and any mitigative measures taken to address heat, cold, or wind.
16. Record Drawings, in AutoCAD® (.dwg) and Adobe® Acrobat® (.pdf) formats, showing actual layout of geomembrane sheets, and anchor trench details. Each repair shall be identified on Record Drawings.
17. Manufacturer's and Geosynthetics Contractor's warranties.

B. HDPE Geomembrane Supplemental Record Drawing: The Geosynthetics Contractor shall prepare a Record panel diagram locating and identifying seams, individual rolls, and panels as they have been placed within the facility, and liner penetrations. The Geosynthetics Contractor shall also indicate in that diagram, or accompanying list, the date each seam was made. Record Drawings shall also show destructive test locations, pipe penetrations and where any repairs were made to the geomembrane. The Record Drawings shall include the size, cause, and date of repair.

C. Letter of Certification: Upon completion of the geomembrane installation, the Geosynthetics Contractor shall provide a letter of certification that the installation was properly performed and in compliance with all Construction Drawings and Specifications. A detailed Record Panel Diagram shall accompany this certification.

****END OF SECTION 02778****

SECTION 03400

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, transportation, and equipment necessary to construct a cast-in-place as shown on the Construction Drawings and as specified herein.

B. The Work shall include, but not be limited to, procurement, delivery, subgrade preparation, formwork, concrete placement, control joints, surface treatment, and curing.

1.2 RELATED SECTIONS

None

1.3 REFERENCES

A. Construction Quality Assurance Plan, (CQA Plan)

B. Latest version of American Concrete Institute (ACI) standards:

1. ACI 117 Tolerances for Concrete Construction and Materials
2. ACI 211.1 Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. ACI 301 Structural Concrete for Buildings
4. ACI 304R Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 308 Standard Practice for Curing Concrete
6. ACI 318 Building Code Requirements for Reinforced Concrete
7. ACI 347R Formwork for Concrete

C. Latest version of the ASTM International (ASTM) standards:

1. ASTM A615 Standard Specifications for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
2. ASTM C33 Standard Specifications for Concrete Aggregates

3. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

4. ASTM C94 Standard Test Method for Ready-Mixed Concrete

5. ASTM C127 Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

6. ASTM C128 Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate

7. ASTM C143 Standard Test Method for Slump of Hydraulic Cement Concrete

8. ASTM C150 Standard Specifications for Portland Cement

9. ASTM C171 Standard Specifications for Sheet Materials for Curing Concrete

10. ASTM C192 Standard Practices for Making and Curing Concrete Test Specimens in the Laboratory

11. ASTM C309 Standard Specifications for Liquid Membrane - Forming Compounds for Curing Concrete

12. ASTM C403 Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

13. ASTM C494 Standard Test Method for Chemical Admixtures for Concrete

14. ASTM C618 Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

1.4 SUBMITTALS

A. Provide the following submittals in accordance with the requirements in Section 01300 Submittals:

B. At least 7 days prior to construction of the concrete, Contractor shall submit a mix design for the type of concrete. Submit a complete list of materials including types, brands, sources, amount of cement, fly ash, pozzolans, retardants, and admixtures, and applicable reference specifications for the following:

1. Slump design based on total gallons of water per cubic yard.

2. Type and quantity of cement.

3. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.

4. Compressive strength based on 28-day compression tests.

C. Delivery Tickets:

1. Provide duplicate delivery tickets with each load of concrete delivered, one for Contractor's records and one for the CQA Engineer, with the following information:

a. Date and serial number of ticket.

b. Name of ready-mixed concrete plant, operator, and job location.

c. Type of cement, admixtures, if any, and brand name.

d. Cement content, in bags per cubic yard (CY) of concrete and mix design.

e. Truck number, time loaded, and name of dispatcher.

f. Amount of concrete, reported in CY per load delivered.

g. Gallons of water added at job, if any, and slump of concrete after water was added.

D. Delivery

1. The Concrete Manufacturer shall be liable for all damage to the materials incurred prior to and during transportation to the Site.

1.5 MANUFACTURER QUALITY CONTROL (MQC)

A. Aggregates shall be sampled and tested in accordance with ASTM C33.

B. Concrete test specimens shall be made, cured, and stored in conformity with ASTM C192 and tested in conformity with ASTM C39.

C. Slump shall be determined in accordance with ASTM C143.

1.6 LIMITING REQUIREMENTS

A. Unless otherwise specified, each concrete mix shall be designed, and concrete shall be controlled within the following limits:

1. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough compaction. Unless otherwise authorized by the CQA Engineer, slump shall not exceed 5 inches.

2. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the Manufacturer's recommendations for minimum shrinkage and for compliance with this Section. A water-reducing admixture may be included in concrete.

PART 2 - MATERIALS

2.1 PROPORTIONING AND DESIGN MIXES

A. Concrete shall have the following properties, unless otherwise noted on the Construction Drawings.

1. 2,500 psi, 28-day compressive strength.

2. Slump range of 1 to 5 inches.

3. Coarse Aggregate Gradation, ASTM C33, Number 57 or 67.

B. Retarding admixture in proportions recommended by the Manufacturer to attain additional working and setting time from 1 to 5 hours.

2.2 CONCRETE MATERIALS

A. Cement shall conform to ASTM C150 Type II.

B. Water shall be fresh, clean, and potable, free from oils, acids, alkalis, salts, organic materials, and other substances deleterious to concrete.

C. Aggregates shall conform to ASTM C33. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement and shall not possess properties or constituents that are known to have specific unfavorable effects in concrete.

D. The Contractor may use a water reducing chemical admixture. The water reducing admixture shall conform to ASTM C494, Type A. The chemical admixture shall be approved by the CQA Engineer.

2.3 REINFORCING

A. The reinforcing shall be glass fiber.

PART 3 - EXECUTION

3.1 BATCHING, MIXING, AND TRANSPORTING CONCRETE

A. Batching shall be performed according to ASTM C94, ACI 301, and ACI 304R, except as modified herein. Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: 1 % for

cement and water, 2% for aggregate, and 3% for admixtures. Concrete Manufacturer shall furnish mandatory batch ticket information for each load of ready-mix concrete.

B. Machine mixing shall be performed according to ASTM C94 and ACI 301. Mixing shall begin within 30 minutes after the cement has been added to the aggregates. Concrete shall be placed within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

C. Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.2 SUBGRADE PREPARATION

A. Subgrade shall be prepared in accordance with Section 02120.

B. Subgrade shall be graded to the lines and elevations as shown on the Construction Drawings.

C. Standing water, mud, debris, and foreign matter shall be removed before concrete is placed.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 301, ACI 318, and ACI 304R. Place concrete as soon as practicable after the forms and the reinforcement have been approved by the CQA Engineer. Do not place concrete when weather conditions prevent proper placement and consolidation, in uncovered areas during periods of precipitation, or in standing water. Prior to placing concrete, remove dirt, construction debris, and water from within the forms. Deposit concrete as close as practicable to the final position in the forms. Place concrete in one continuous operation from one end of the structure towards the other

B. Ensure reinforcement is not disturbed during concrete placement.

C. Do not allow concrete temperature to decrease below 50 degrees F while curing. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 5 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

D. Do not spread concrete with vibrators. Concrete shall be placed in final position without being moved laterally more than five feet.

E. When placing of concrete is temporarily halted or delayed, provide construction joints.

F. Concrete shall not be dropped a distance greater than five feet.

G. Place concrete with aid of internal mechanical vibrator equipment capable of 9,000 cycles/min. Transmit vibration directly to concrete.

H. Hot Weather:

1. Comply with ACI 304R.

2. Concrete temperature shall not exceed 90°F.

3. At air temperatures of 80°F or above, keep concrete as cool as possible during placement and curing. Cool forms by water wash.

4. Evaporation reducer shall be used in accordance with Manufacturer recommendations (Subpart 2.03).

3.4 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury in accordance with ACI 308.

B. Immediately after placement, protect concrete from plastic shrinkage by applying evaporation reducer in accordance with Manufacturer recommendations (Subpart 2.03).

C. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete (Subpart 2.03).

D. Protect from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

E. Membrane curing compound shall be spray applied at a coverage of not more than 300 square ft per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out.

F. Curing compound shall be suitably protected against abrasion during the curing period.

G. Film curing will not be allowed.

3.5 FORMS

A. Formwork shall prevent leakage of mortar and shall conform to the requirements of ACI 347R.

B. Do not disturb forms until concrete is adequately cured.

C. Form system design shall be the Contractor's responsibility.

3.6 CONTROL JOINTS

A. Control joints shall consist of plastic strips set flush with finished surface or ¼ inch wide joints formed with a trowel immediately after pouring or cut with a diamond saw within 12 hours after pouring.

B. Control joints shall be installed in a 15-foot x 15-foot grid spacing along the slab unless otherwise approved by the CQA Engineer. Control joints shall be no greater than 1 ½ inch below the surface.

3.7 SLAB FINISHES

A. Unformed surfaces of concrete shall be screeded and given an initial float finish followed by additional floating and troweling where required.

B. Concrete shall be broom finished.

3.8 SURVEY

A. The Surveyor shall locate the features of the concrete structure. The dimensions, locations and elevations of the features shall be presented on the Surveyor's Record Drawings.

****END OF SECTION 03400****

10.3 CQA Plan

CONSTRUCTION QUALITY ASSURANCE PLAN

for the construction of

MOJAVE SOLAR PROJECT
ALPHA AND BETA EVAPORATION PONDS
LINER EXTENSION

Prepared for:

Atlantica Sustainable Infrastructure
ASI Operations, Inc.
42134 Harper Lake Road
Hinkley, California 92347

Prepared by:

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers
250 Goddard
Irvine, CA

October 2023

CERTIFICATION PAGE

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN
for the construction of

MOJAVE SOLAR PROJECT
ALPHA AND BETA EVAPORATION PONDS
LINER EXTENSION

The Engineering material and data contained in this CQA Plan were prepared under the supervision and direction of the undersigned, whose seal as a registered Professional Engineer is affixed below.

Ben Hushmand

Ben Hushmand, P.E.
Engineer of Record

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TABLES

1. INTRODUCTION

1.1 Terms of Reference

Hushmand Associates, Inc. (HAI) has prepared this Construction Quality Assurance (CQA) Plan for the construction of liner extension for the Alpha and Beta Evaporation Ponds at the Mojave Solar Project. This CQA Plan was prepared by Dr. Ben Hushmand, P.E., of HAI.

1.2 Purpose and Scope of the Construction Quality Assurance Plan

The purpose of the CQA Plan is to address the CQA procedures and monitoring requirements for construction of the project. The CQA Plan is intended to: (i) define the responsibilities of parties involved with the construction; (ii) provide guidance in the proper construction of the major components of the project; (iii) establish testing protocols; (iv) establish guidelines for construction documentation; and (v) provide the means for assuring that the project is constructed in conformance to the *Technical Specifications*, permit conditions, applicable regulatory requirements, and *Construction Drawings*. This CQA Plan addresses the earthworks and geosynthetic components of the liner system for the project. This CQA Plan delineates procedures to be followed for monitoring construction utilizing these materials. The CQA protocols applicable to manufacturing, shipping, handling, and installing all geosynthetic materials are also included. However, this CQA Plan does not specifically address installation specifications of earthworks and geosynthetic materials as these requirements are addressed in the *Technical Specifications*.

1.3 References

The CQA Plan includes references to test procedures in the latest editions of the American Society for Testing and Materials (ASTM).

1.4 Organization of the Construction Quality Assurance Plan

The remainder of the CQA Plan is organized as follows:

- Section 2 presents definitions relating to CQA;
- Section 3 describes the CQA personnel organization and duties;
- Section 4 describes site and project control requirements;
- Section 5 presents CQA documentation;
- Section 6 presents CQA of the earthworks;
- Section 7 presents CQA of the geomembrane;
- Section 8 presents CQA of the cast-in place concrete;
- Section 9 presents CQA surveying; and
- Appendices A-K field documentation forms.

2. DEFINITIONS RELATING TO CQA

This CQA Plan is devoted to Construction Quality Assurance. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

Construction Quality Assurance (CQA) - A planned and systematic pattern of means and actions designed to assure adequate confidence that materials and/or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the CQA Consultant to assure conformity of the project "Work" with this CQA Plan, the *Drawings*, and the *Technical Specifications*. CQA testing of geosynthetic components is provided by the CQA Consultant.

Construction Quality Control (CQC) - Actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements. Construction Quality Control refers to those actions taken by the Contractor, Manufacturer, or Geosynthetic Installer to verify that the materials and the workmanship meet the requirements of this CQA Plan, the *Drawings*, and the *Technical Specifications*. In the case of the geosynthetic components of the Work, CQC is provided by the Manufacturer, Geosynthetic Installer, and Contractor.

2.1 Owner

The Owner of this project is Atlantica Sustainable Infrastructure.

2.2 Construction Manager

Responsibilities

The Construction Manager is responsible for managing the construction and implementation of the *Drawings*, and *Technical Specifications* for the project work. The Construction Manager is selected/appointed by the Owner.

2.3 Engineer

Responsibilities

The Engineer is responsible for the design, *Drawings*, and *Technical Specifications* for the project work. In this CQA Plan, the term "Engineer" refers to HAI.

Qualifications

The Engineer of Record shall be a qualified engineer, registered as required by regulations in the State of California.

The Engineer should have expertise, which demonstrates significant familiarity with geosynthetics, as appropriate, including design and construction experience related to liner systems.

2.4 Contractors

Responsibilities

In this CQA Plan, Contractor refers to an independent party or parties, contracted by the Owner, performing the work in general accordance with this CQA Plan, the *Drawings*, and the *Technical Specifications*. The Contractor (s) will be responsible for the installation of the soil berm, concrete wall and geosynthetic liner system extension and construction of the liner tie-in and anchoring systems as shown on the drawing details. This work will include preparation of the existing liner surface, installation of the geomembranes and geotextile, welding of the extension geomembrane to the existing geomembrane, and construction of the anchor trench.

The Contractor will be responsible for constructing the liner system and appurtenant components in general accordance with the *Drawings* and complying with the quality control requirements specified in the *Technical Specifications*.

Qualifications

Qualifications of the Contractor are specific to the construction contract. The Contractor should have a demonstrated history of successful liner system construction and shall maintain current state and federal licenses as appropriate.

2.5 Resin Supplier

Responsibilities

The Resin Supplier produces and delivers the resin to the Geosynthetics Manufacturer.

Qualifications

Qualifications of the Resin Supplier are specific to the Manufacturer's requirements. The Resin Supplier will have a demonstrated history of providing resin with consistent properties.

2.6 Manufacturers

Responsibilities

The Manufacturers are responsible for the production of finished material (geomembrane and geotextile) from appropriate raw materials.

Qualifications

The Manufacturer(s) will be able to provide sufficient production capacity and qualified personnel to meet the demands of the project. The Manufacturer(s) must be a well-established firm(s) that meets the requirements identified in the *Technical Specifications*.

2.7 Geosynthetic Installer

Responsibilities

The Geosynthetic Installer is responsible for field handling, storage, placement, seaming, ballasting or anchoring against wind uplift, and other aspects of the geosynthetic material installation. The Geosynthetic Installer may also be responsible for specialized construction tasks (i.e., including construction of anchor welds for the geosynthetic materials).

Qualifications

The Geosynthetic Installer will be trained and qualified to install the geosynthetic materials of the type specified for this project. The Geosynthetic Installer shall meet the qualification requirements identified in the *Technical Specifications*.

2.8 CQA Consultant

Responsibilities

The CQA Consultant is a party, independent from the Owner, Contractor, Manufacturer, and Geosynthetic Installer, who is responsible for observing, testing, and documenting activities related to the CQC and CQA of the earthwork, piping, and geosynthetic components used in the construction of the Project as required by this CQA Plan and the *Technical Specifications*. The CQA Consultant will also be responsible for issuing a CQA report at the completion of the Project construction, which documents construction and associated CQA activities. The CQA report will be signed and sealed by the CQA Officer who will be a Professional Engineer registered in the State of California.

Qualifications

The CQA Consultant shall be a well-established firm specializing in geotechnical and geosynthetics engineering who possess the equipment, personnel, and licenses necessary to conduct the geotechnical and geosynthetic tests required by the project plans and *Technical Specifications*.

The CQA Consultant will provide qualified staff for the project, as necessary, which will include, at a minimum, a CQA Officer and a CQA Site Manager. The CQA Officer will be a professionally licensed engineer as required by State of California regulations. The CQA Consultant will be experienced with installation of geosynthetic materials similar to those

materials used in construction of the Project. The CQA Consultant will be experienced in the preparation of CQA documentation including CQA Plans, field documentation, field testing procedures, laboratory testing procedures, construction specifications, construction *Drawings*, and CQA reports.

The CQA Site Manager will be specifically familiar with the construction of geosynthetic lining systems. The CQA Manager will be trained by the CQA Consultant in the duties as CQA Site Manager.

2.9 Surveyor

Responsibilities

The Surveyor is a party, independent from the Contractor, Manufacturer, and Geosynthetic Installer, that is responsible for surveying, documenting, and verifying the location of all significant components of the Work, if required. The Surveyor's work, if required, is coordinated and employed by the Engineer.

Qualifications

The Surveyor will be a well-established surveying company with at least 3 years of surveying experience in the State of California. The Surveyor will be a licensed professional as required by the State of California regulations. The Surveyor shall be fully equipped and experienced in the use of total stations and the recent version of AutoCAD. All surveying will be performed under the direct supervision of the Engineer.

2.10 CQA Laboratory

Responsibilities

The CQA Laboratory is a party, independent from the Contractor, Manufacturer, Geosynthetic Installer, that is responsible for conducting tests in general accordance with ASTM and other applicable test standards on samples of geosynthetic materials, soil, and in the field and in either an on-site or off-site laboratory.

Qualifications

The CQA Laboratory will have experience in testing soils and geosynthetic materials and will be familiar with ASTM and other applicable test standards. The CQA Laboratory will be capable of providing test results within a maximum of seven days of receipt of samples and will maintain that capability throughout the duration of earthworks construction and geosynthetic materials installation.

The CQA Laboratory will also be capable of transmitting geosynthetic destructive test results within 24 hours of receipt of samples and will maintain that capability throughout the duration of geosynthetic material installation.

2.11 Deficiency Identification and Rectification

If a defect is discovered in the work, the CQA Engineer will evaluate the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate.

After evaluating the extent and nature of a defect, the CQA Engineer will notify the Construction Manager and schedule appropriate re-tests when the work deficiency is corrected by the Contractor. The Contractor will correct the deficiency to the satisfaction of the CQA Engineer. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Engineer will develop and present to the Design Engineer suggested solutions for approval. Defect corrections will be monitored and documented by CQA personnel prior to subsequent work by the Contractor in the area of the deficiency.

3. CQA CONSULTANTS PERSONNEL ORGANIZATION AND DUTIES

3.1 Overview

The CQA Officer will provide supervision within the scope of work of the CQA Consultant. The scope of work for the CQA Consultant includes monitoring of construction activities including the following:

- Construction of the soil berm or concrete wall to support the liner extension;
- Preparation of the existing liner surface;
- installation of geotextiles;
- installation of geomembranes.

Duties of CQA personnel are discussed in the remainder of this section.

3.2 COA Personnel

The CQA Consultant's personnel will include:

- the CQA Officer, who works from the office of the CQA Consultant and who conducts periodic visits to the site as required; and
- the CQA Site Manager, who is located at the site.

3.3 COA Officer

The CQA Officer shall supervise and be responsible for monitoring and CQA activities relating to the construction of the earthworks, piping, and installation of the geosynthetic materials of the Project. Specifically, the CQA Officer:

- reviews the project design, this CQA Plan, *Drawings*, and *Technical Specifications*;
- attends Pre-Construction Meetings as needed;
- administers the CQA program (i.e., provides supervision of and manages on-site CQA personnel, reviews field reports, and provides engineering review of CQA related activities);
- provides quality control of CQA documentation and conducts site visits;
- reviews the *Record Drawings*; and
- with the CQA Site Manager, prepares the CQA report documenting that the project was constructed in general accordance with the Construction Documents.

3.4 COA Site Manager

The CQA Site Manager:

- acts as the on-site representative of the CQA Consultant;
- attends CQA-related meetings (e.g., pre-construction, daily, weekly (or designates a representative to attend the meetings);
- oversees the ongoing preparation of the *Record Drawings*;
- reviews test results provided by Contractor;
- assigns locations for testing and sampling;
- oversees the collection and shipping of laboratory test samples;
- reviews results of laboratory testing and makes appropriate recommendations;
- reviews the calibration and condition of on-site CQA equipment;
- prepares a daily summary report for the project;
- reviews the Manufacturers QC documentation;
- reviews the Geosynthetic Installer's personnel Qualifications for conformance with those pre-approved for work on site;
- notes on-site activities in daily field reports and reports to the CQA Officer and Construction Manager;
- reports unresolved deviations from the CQA Plan, *Drawings*, and *Technical Specifications* to the Construction Manager; and
- assists with the preparation of the CQA report.

Note: To facilitate documentation of the work this CQA Plan includes forms (extracted from the GSE Geomembrane CQA Manual) in Appendices A-K for use, as appropriate, by the CQA Manager.

4. SITE AND PROJECT CONTROL

4.1 Project Coordination Meetings

Meetings of key project personnel are necessary to assure a high degree of quality during installation and to promote clear, open channels of communication. Therefore, Project Coordination Meetings are an essential element in the success of the project. Several types of Project Coordination Meetings are described below, including: (i) pre-construction meetings; (ii) progress meetings; and (iii) problem or work deficiency meetings.

4.1.1 Pre-Construction Meeting

A Pre-Construction Meeting will be held at the site prior to construction of the Project. At a minimum, the Pre-Construction Meeting will be attended by the Contractor, the Geosynthetic Installer's Superintendent, the CQA Consultant, and the Construction Manager.

Specific items for discussion at the Pre-Construction Meeting include the following:

- appropriate modifications or clarifications to the CQA Plan;
- the *Drawings* and *Technical Specifications*;
- the responsibilities of each party;
- lines of authority and communication;
- methods for documenting and reporting, and for distributing documents and reports;
- acceptance and rejection criteria;
- protocols for testing;
- protocols for handling deficiencies, repairs, and re-testing;
- the time schedule for all operations;
- procedures for packaging and storing archive samples;
- panel layout and numbering systems for panels and seams;
- seaming procedures;
- repair procedures; and
- soil stockpiling locations.

The Construction Manager will conduct a site tour to observe the current site conditions and to review construction material and equipment storage locations. A person in attendance at the meeting will be appointed by the Construction Manager to record the discussions and decisions of the meeting in the form of meeting minutes. Copies of the meeting minutes will be distributed to all attendees.

4.1.2 Progress Meetings

Progress meetings will be held between the CQA Site Manager, the Contractor, Construction Manager, and other concerned parties participating in the construction of the project. This meeting will include discussions on the current progress of the project, planned activities for the next week, and revisions to the work plan and/or schedule. The meeting will

be documented in meeting minutes prepared by a person designated by the CQA Site Manager at the beginning of the meeting. Within 2 working days of the meeting, draft minutes will be transmitted to representatives of parties in attendance for review and comment. Corrections and/or comments to the draft minutes shall be made within 2 working days of receipt of the draft minutes to be incorporated in the final meeting minutes.

4.1.3 Problem or Work Deficiency Meeting

A special meeting will be held when and if a problem or deficiency is present or likely to occur. The meeting will be attended by the Contractor, the Construction Manager, the CQA Site Manager, and other parties as appropriate. If the problem requires a design modification, the Engineer should either be present at, consulted prior to, or notified immediately upon conclusion of this meeting. The purpose of the work deficiency meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions;
- select a suitable solution agreeable to all parties; and
- implement an action plan to resolve the problem or deficiency.

The Construction Manager will appoint one attendee to record the discussions and decisions of the meeting. The meeting record will be documented in the form of meeting minutes and copies will be distributed to all affected parties. A copy of the minutes will be retained in facility records.

5. DOCUMENTATION

5.1 Overview

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant will document that quality assurance requirements have been addressed and satisfied.

The CQA Site Manager will provide the Construction Manager with signed descriptive remarks, data sheets, and logs to verify that monitoring activities have been carried out. The CQA Site Manager will also maintain, at the job site, a complete file of *Drawings* and *Technical Specifications*, a CQA Plan, checklists, test procedures, daily logs, and other pertinent documents.

5.2 Daily Recordkeeping

Preparation of daily CQA documentation will consist of daily field reports prepared by the CQA Site Manager which may include CQA monitoring logs and testing data sheets. This information may be regularly submitted to and reviewed by the Construction Manager. Daily field reports will include documentation of the observed activities during each day of activity. The daily field reports may include monitoring logs and testing data sheets. At a minimum, these logs and data sheets will include the following information:

- the date, project name, location, and other identification;
- a summary of the weather conditions;
- a summary of locations where construction is occurring;
- equipment and personnel on the project;
- a summary of meetings held and attendees;
- a description of materials used and references of results of testing and documentation;
- identification of deficient work and materials;
- results of re-testing corrected “deficient work;”
- an identifying sheet number for cross referencing and document control;
- descriptions and locations of construction monitored;
- type of construction and monitoring performed;
- description of construction procedures and procedures used to evaluate construction;
- a summary of test data and results;
- calibrations or re-calibrations of test equipment and actions taken as a result of re-calibration;
- decisions made regarding acceptance of units of work and/or corrective actions to be taken in instances of substandard testing results;
- a discussion of agreements made between the interested parties which

may affect the work; and
- signature of the respective CQA Site Manager.

5.3 Construction Problems and Resolution Data Sheets

Construction Problems and Resolution Data Sheets, to be submitted with the daily field reports prepared by the CQA Site Manager, describing special construction situations, will be cross-referenced with daily field reports, specific observation logs, and testing data sheets and will include the following information, where available:

- an identifying sheet number for cross-referencing and document control;
- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of responses;
- measures taken to prevent a similar situation from occurring in the future; and
- signature of the CQA Site Manager and a signature indicating concurrence by the Construction Manager.

The Construction Manager will be made aware of significant recurring nonconformance with the *Drawings*, *Technical Specifications*, or CQA Plan. The cause of the nonconformance will be determined and appropriate changes in procedures or specifications will be recommended. These changes will be submitted to the Construction Manager for approval. When this type of evaluation is made, the results will be documented and any revision to procedures or specifications will be approved by the Contractor and Engineer. A summary of supporting data sheets, along with final testing results and the CQA Site Manager's approval of the work, will be required upon completion of construction.

5.4 Photographic Documentation

Photographs will be taken and documented in order to serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Construction Manager upon completion of the project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s).

5.5 Design and/or Specifications Changes

Design and/or specifications changes may be required during construction. In such cases, the CQA Site Manager will notify the Engineer. Design and/or specification changes will be made with the written agreement of the Engineer and will take the form of an addendum to the *Drawings* and *Technical Specifications*.

5.6 COA Report

At the completion of the Project, the CQA Consultant will submit to the Owner a CQA report signed and sealed by the Professional Engineer licensed in the State of California. The CQA report will acknowledge: (i) that the work has been performed in compliance with the *Drawings* and *Technical Specifications*; (ii) physical sampling and testing has been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information. At a minimum, this report will include:

- MQC documentation;
- a summary report describing the CQA activities and indicating compliance with the *Drawings* and *Technical Specifications* which is signed and sealed by the CQA Officer;
- a summary of CQA/CQC testing, including failures, corrective measures, and retest results;
- Contractor and Installer personnel resumes and qualifications as necessary;
- documentation that the geomembrane trial seams were performed in general accordance with the CQA Plan and *Technical Specifications*;
- documentation that field seams were non-destructively tested using a method in general accordance with the applicable test standards;
- documentation that nondestructive testing was monitored by the CQA Consultant, that the CQA Consultant informed the Geosynthetic Installer of any required repairs, and that the CQA Consultant monitored the seaming and patching operations for uniformity and completeness;
- records of sample locations, the name of the individual conducting the tests, and the results of tests;
- *Record Drawings* as provided by the CQA Engineer; and
- daily field reports.

The *Record Drawings* will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., plan dimensions and appropriate elevations). These documents will be prepared by the CQA Consultant and included as part of the CQA Report.

6. EARTHWORKS

6.1 Introduction

This section prescribes the CQA activities to be performed to monitor that earthwork components are constructed in general accordance with *Drawings* and *Technical Specifications*. The earthworks construction procedures to be monitored by the CQA monitor(s) include:

- Placement and compaction of soil berm materials;
- Preparation of subgrade for geosynthetic liner materials;
- Subgrade preparation for berm and concrete wall;
- Placement and compaction of soil for anchor trench.

6.2 Testing and Monitoring Activities

Soil observation/testing will be performed for material qualification, material conformance, and construction quality assurance (CQA). These stages of testing/observation are defined as follows:

- Material qualification tests or observations are used to evaluate the conformance of a proposed soil source to the material specifications for qualification of the source prior to construction.
- CQA tests are performed on completed portions of the earthwork during construction to demonstrate that the placement procedures are resulting in a product that meets or exceeds both material and performance specifications.

Soil testing will be conducted in general accordance with the current versions of the corresponding American Society for Testing and Materials (ASTM) test procedures.

6.2.1 Sample Frequency

The frequency of soils observation/testing for material qualification, conformance, and CQA will correspond to the minimum frequencies presented in the *Technical Specifications*. Actual frequency of observation/testing required will be increased by the CQA Consultant as necessary if variability of materials is noted at the site, during adverse conditions, or to isolate failing areas of the construction.

6.2.2 Sample or Test Location Selection

Testing locations will be selected by the CQA Monitor(s). The CQA Monitor must document testing locations so that failing areas can be immediately isolated.

Additional testing for suspected areas will be considered when:

- rollers slip during rolling operation;
- lift thickness is greater than specified;
- fill is at improper and/or variable moisture content;
- less than typical number of passes are made;
- dirt-clogged rollers are used to compact the material;
- rollers may not have used optimum ballast;
- fill materials differ substantially from those specified;
- the degree of compaction is doubtful; and
- as directed by the Construction Manager or the CQA Monitor(s).

The frequency of observations/testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- material fails to meet specifications; and
- the work area is reduced.

6.3 CQA Monitoring Activities

6.3.1 Existing Liner Surface Inspection

The CQA Monitor shall inspect the surface of the existing liner prior to placement of the overlay lining system. Any sharp protrusions or clumps larger than 2 inches shall be brought to the attention of the Contractor for his repair/removal.

6.3.2 Select Soil Fill and Anchor Trench Backfill

Monitoring the earthwork for the soil berm (select soil fill) anchor trench backfill material specifically includes the following:

- monitoring soil for maximum particle size and deleterious materials;
- observing that the berm/trench is prepared with slightly rounded corners where the geomembrane will be in contact with the soil
- monitoring the thickness of lifts during placement of the materials;
- monitoring compaction operations and equipment used;
- observing the number of passes of the compaction equipment and moisture content of the soil result in a firm and unyielding berm
- or if observations dictate, measuring and recording the field density and the field moisture content of the in-place material.

6.4 Deficiencies

If a defect is discovered in the earthwork product, the CQA Managing Engineer will immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Managing Engineer will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Managing Engineer deems appropriate. If the defect is related to adverse site conditions the CQA Managing Engineer will define the limits and nature of the defect.

6.4.1 Notification

After evaluating the extent and nature of a defect, the CQA Monitor(s) will notify the Construction Manager and Contractor and schedule appropriate re-tests when the work deficiency is to be corrected.

6.4.2 Repairs and Re-Testing

At locations where the field observation or testing of the soil indicates that the compacted unit weight, moisture content, or other criteria do not meet the requirements presented in the *Technical Specifications,* the failing area will be reworked as indicated below. The Contractor will correct the deficiency to the satisfaction of the CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant will develop and present to the Engineer of Record and/or Construction Manager suggested solutions for his approval.

All re-tests recommended by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant will also verify that installation requirements are met and that submittals are provided.

Corrective Action

- Perform two additional tests of the same type in the vicinity of the failed test. If either of the two additional tests results in a failure, then this area will be considered in nonconformance and will be removed, reworked, and recompacted to meet the requirements specified in the Technical Specifications.
- Obtain samples of soil material from nonconforming areas for potential laboratory testing to evaluate differences in soil properties that could contribute to the nonconforming test results.

Criteria to be used for determination of acceptability will be as identified in the *Technical Specifications* and this CQA Plan.

7. GEOMEMBRANE

7.1 General

This section discusses and outlines the CQA activities to be performed for high density polyethylene (HDPE) geomembrane installation. The CQA Site Manager will review the *Drawings*, *Technical Specifications*, and any approved Addenda regarding this material.

7.2 Geomembrane Material Conformance

7.2.1 Introduction

The CQA Site Manager will document that the geomembrane delivered to the site meets the requirements of the *Technical Specifications* prior to installation. The CQA Site Manager will:

- review the manufacturer's submittals for compliance with the *Technical Specifications*;
- document the delivery and proper storage of geomembrane rolls; and
- conduct conformance testing of the rolls before the geomembrane is installed.

The following sections describe the CQA activities required to verify the conformance of geomembrane.

7.2.2 Review of Quality Control

7.2.2.1 Material Properties Certification

The Manufacturer will provide the Construction Manager and the CQA Site Manager with the following:

- Property data sheets, including, at a minimum, all specified properties, measured using test methods indicated in the *Technical Specifications*, or equivalent;
- Sampling procedures and results of testing. The CQA Site Manager will document that: the property values certified by the Manufacturer meet all of the requirements of the *Technical Specifications*; and the measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

7.2.2.2 Geomembrane Roll MQC Certification

Prior to shipment, the Manufacturer will provide the Construction Manager and the CQA Site Manager with MQC certificates for every roll of geomembrane provided.

The MQC certificates will be signed by a responsible party employed by the Geomembrane Manufacturer, such as the production manager. The MQC certificates shall include:

- roll numbers and identification; and
- results of MQC tests - as a minimum, results will be given for thickness, specific gravity, carbon black content, carbon black dispersion, tensile properties, and puncture resistance evaluated in general accordance with the methods indicated in the *Technical Specifications* or equivalent methods approved by the Construction Manager.

The CQA Site Manager will document that:

- MQC certificates have been provided at the specified frequency, and that the certificates identify the rolls related to the roll represented by the test results; and
- review the MQC certificates and monitor that the certified roll properties meet the specifications.

7.2.3 Conformance Testing

The CQA Site Manager shall obtain conformance samples (at the manufacturing facility or site) at the specified frequency and forward them to the Geosynthetics CQA Laboratory for testing to monitor conformance to both the *Technical Specifications* and the list of properties certified by the Manufacturer. The test procedures will be as indicated in Table 1. Where optional procedures are noted in the test method, the requirements of the *Technical Specifications* will prevail.

Samples will be taken across the width of the roll and will not include the first linear 3 ft of material. Unless otherwise specified, samples will be 3 ft long by the roll width. The CQA Site Manager will mark the machine direction on the samples with an arrow along with the date and roll number. The required minimum sampling frequencies are provided in Table 1.

The CQA Site Manager will examine results from laboratory conformance testing and will report any non-conformance to the Construction Manager and the Geosynthetic Installer. The procedures prescribed in the *Technical Specifications will* be followed in the event of a failing conformance test.

7.3 Delivery

7.3.1 Transportation and Handling

The CQA Site Manager will document that the transportation and handling does not pose a risk of damage to the geomembrane.

Upon delivery of the rolls of geomembrane, the CQA Site Manager will document that the rolls are unloaded and stored on site as required by the Technical Specifications. Damage caused by unloading will be documented by the CQA Site Manager and the damaged material shall not be installed.

7.3.2 Storage

The Geosynthetic Installer will be responsible for the storage of the geomembrane on site. The Contractor will provide storage space in a location (or several locations) such that on-site transportation and handling are optimized, if possible, to limit potential damage.

The CQA Site Manager will document that storage of the geomembrane provides adequate protection against sources of damage.

7.4 Geomembrane Installation

7.4.1 Introduction

The CQA Consultant will document that the geomembrane installation is carried out in general accordance with the *Drawings, Technical Specifications,* and Manufacturer's recommendations.

7.4.2 Existing Liner Surface Preparation

7.4.2.1 Surface Preparation

The CQA Site Manager will document that:

- the prepared surface meets the requirements of the *Technical Specifications* and has been approved; and
- placement of the overlying materials does not damage, create large wrinkles, or induce excessive tensile stress in any underlying geosynthetic materials.

The Geosynthetic Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable.

The Certificate of Acceptance, as presented in the *Technical Specifications*, will be signed by the Geosynthetic Installer and given to the CQA Site Manager prior to commencement of geomembrane installation in the area under consideration.

After the existing liner surface has been accepted by the Geosynthetic Installer, it will be the Geosynthetic Installer's responsibility to indicate to the Construction Manager any change in the surface that may require repair work. If the CQA Site Manager concurs with the Geosynthetic Installer, then the CQA Site Manager shall monitor and document that the existing liner surface is repaired before geosynthetic installation begins.

At any time before and during the geomembrane installation, the CQA Site Manager will indicate to the Construction Manager locations that may not provide adequate support to the geomembrane.

7.4.2.2 Geosynthetic Termination

The CQA Site Manager will document that the geosynthetic terminations (welds to existing liners) have been constructed in general accordance with the *Drawings*.

7.4.3 Geomembrane Placement

7.4.3.1 Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field. It will be the responsibility of the CQA Site Manager to document that each field panel is given an "identification code" (number or letter-number) consistent with the Panel Layout Drawing. This identification code will be agreed upon by the Construction Manager, Geosynthetic Installer and CQA Site Manager. This field panel identification code will be as simple and logical as possible. Roll numbers established in the manufacturing plant must be traceable to the field panel identification code.

The CQA Site Manager will establish documentation showing correspondence between roll numbers, and field panel identification codes. The field panel identification code will be used for all CQA records.

7.4.3.2 Field Panel Placement

Location

The CQA Site Manager will document that field panels are installed at the location indicated in the Geosynthetic Installer's Panel Layout Drawing, as approved or modified by the Construction Manager.

Installation Schedule

Field panels may be installed using one of the following schedules:

- all field panels are placed prior to field seaming in order to protect the subgrade from erosion by rain;
- field panels are placed one at a time and each field panel is seamed after its placement (in order to minimize the number of unseamed field panels exposed to wind); and
- any combination of the above.

If a decision is reached to place all field panels prior to field seaming, it is usually beneficial to begin at the high point area and proceed toward the low point with "shingle" overlaps to facilitate drainage in the event of precipitation. It is also usually beneficial to proceed in the direction of prevailing winds. Accordingly, an early decision regarding installation scheduling should be made if and only if weather conditions can be predicted with reasonable certainty. Otherwise, scheduling decisions must be made during installation, in general accordance with varying conditions. In any event, the Geosynthetic Installer is fully responsible for the decision made regarding placement procedures.

The CQA Site Manager will evaluate every change in the schedule proposed by the Geosynthetic Installer and advise the Construction Manager on the acceptability of that change. The CQA Site Manager will document that the condition of the subgrade soil has not changed detrimentally during installation.

The CQA Site Manager will record the identification code, location, and date of installation of each field panel.

Weather Conditions

Geomembrane placement will not proceed unless otherwise authorized when the ambient temperature is below 40°F or above 122°F. In addition, wind speeds and direction will be monitored for potential impact to geosynthetic installation. Geomembrane placement will not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), and/or in an area of ponded water.

The CQA Site Manager will document that the above conditions are fulfilled. Additionally, the CQA Site Manager will document that the subgrade soil has not been damaged by weather conditions. The Geosynthetics Installer will inform the Construction Manager if the above conditions are not fulfilled.

Method of Placement

The CQA Site Manager will document the following:

- equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

- geosynthetic elements immediately underlying the geomembrane are clean and free of debris;
- personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels); and
- adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels).

The CQA Site Manager will inform the Construction Manager if the above conditions are not fulfilled.

Damaged panels or portions of damaged panels that have been rejected will be marked and their removal from the work area recorded by the CQA Site Manager. Repairs will be made in general accordance with procedures described in Section 7.4.5.

7.4.4 Field Seaming

This section details CQA procedures to document that seams are properly constructed and tested in general accordance with the Manufacturer's specifications and industry standards.

7.4.4.1 Requirements of Personnel

All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests, as outlined in the *Technical Specifications*. The most experienced seamer, the "Master Seamer", will provide direct supervision over less experienced seamers.

The Geosynthetic Installer will provide the Construction Manager and the CQA Site Manager with a list of proposed seaming personnel and their experience records. These documents will be reviewed by the Construction Manager and the Geosynthetics CQA Manager.

7.4.4.2 (top and bottom) prior to welding;

- the electric generator is placed on a smooth cushioning base such that no damage occurs to the geomembrane from ground pressure or fuel leaks;
- a smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
- the geomembrane is protected from damage in heavily trafficked areas.

7.4.4.3 Seam Preparation

The CQA Site Manager will document that:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material; and
- seams are aligned with the fewest possible number of wrinkles and "fishmouths."

7.4.4.4 Weather Conditions for Seaming

The normally required weather conditions for seaming are as follows unless authorized in writing by the Engineer:

- seaming will only be approved between ambient temperatures of 40°F and 122°F.

If the Geosynthetic Installer wishes to use methods that may allow seaming at ambient temperatures below 40°F or above 122°F, the Geosynthetic Installer will demonstrate and certify that such methods produce seams which are entirely equivalent to seams produced within acceptable temperature, and that the overall quality of the geomembrane is not adversely affected.

The CQA Site Manager will document that these seaming conditions are fulfilled and will advise the Geosynthetics Installer if they are not.

7.4.4.5 Overlapping and Temporary Bonding

The CQA Site Manager will document that:

- the panels of geomembrane have a finished overlap of a minimum of 3 in. for both extrusion and fusion welding;
- no solvent or adhesive bonding materials are used; and
- the procedures utilized to temporarily bond adjacent panels together does not damage the geomembrane.

The CQA Site Manager will log appropriate temperatures and conditions, and will log and report non-compliances to the Construction Manager.

7.4.4.6 Trial Seams

Trial seams shall be prepared with the procedures and dimensions as indicated in the *Technical Specifications*. The CQA Site Manager will observe trial seam procedures and will document the results of trial seams on trial seam logs. Each trial seam samples will be assigned a number.

The CQA Site Manager, will log the date, time, machine temperature(s), seaming unit identification, name of the seamer, and pass or fail description for each trial seam sample tested. Separate trial seaming logs shall be maintained for fusion welded and extrusion welded trial seams.

7.4.4.7 General Seaming Procedure

Unless otherwise specified, the general production seaming procedure used by the Geosynthetic Installer will be as follows:

- Fusion-welded seams are continuous, commencing at one end to the seam and ending at the opposite end.
- Cleaning, overlap, and shingling requirements shall be maintained.
- If seaming operations are carried out at night, adequate illumination will be provided at the Geosynthetic Installer's expense.
- Seaming will extend to the outside edge of panels to be placed in the anchor trench.

The CQA Site Manager shall document geomembrane seaming operations on seaming logs. Seaming logs shall include, at a minimum:

- Seam identifications (typically associated with panels being joined);
- Seam starting time and date;
- Seam ending time and date;
- Seam length;
- Identification of person performing seam; and
- Identification of seaming equipment.

Separate logs shall be maintained for fusion and extrusion welded seams. In addition, the CQA Site Manager shall monitor during seaming that:

- Fusion-welded seams are continuous, commencing at one end of the seam and ending at the opposite end.
- Cleaning, overlap, and shingling requirements are maintained.

7.4.4.8 Nondestructive Seam Continuity Testing

Concept

The Geosynthetic Installer will non-destructively test field seams over their length using a vacuum test unit, air pressure test (for double fusion seams only), or other method approved by the Construction Manager. The purpose of nondestructive tests is to check the continuity of seams.

It does not provide information on seam strength. Continuity testing will be carried out as the seaming work progresses, not at the completion of field seaming.

The CQA Site Manager will:

- observe continuity testing;
- record location, date, name of person conducting the test, and the results of tests; and
- inform the Geosynthetic Installer of required repairs.

The Geosynthetic Installer will complete any required repairs in general accordance with Section 7.4.5.

The CQA Site Manager will:

- observe the repair and re-testing of the repair;
- mark on the geomembrane that the repair has been made; and
- document the results.

The following procedures will apply to locations where seams cannot be non-destructively tested:

All such seams will be cap-stripped with the same geomembrane.

- If the seam is accessible to testing equipment prior to final installation, the seam will be non-destructively tested prior to final installation.
- If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations will be observed by the CQA Site Manager and Geosynthetic Installer for uniformity and completeness.

The seam number, date of observation, name of tester, and outcome of the test or observation will be recorded by the CQA Site Manager.

Vacuum Testing

Vacuum testing shall be performed utilizing the equipment and procedures specified in the *Technical Specifications*.

The CQA Site Manager shall observe the vacuum testing procedures and document that they are performed in accordance with the *Technical Specifications*. The result of vacuum testing shall be recorded on the CQA seaming logs. Results shall include, at a minimum, the personnel performing the vacuum test and the result of the test (pass or fail), and the test date. Seams failing the vacuum test shall be repaired in accordance with the procedures listed in the *Technical Specifications*. The CQA Site Manager shall document seam repairs in the seaming logs.

Air Pressure Testing

Air channel pressure testing shall be performed on double-track seams created with a fusion welding device, utilizing the equipment and procedures specified in the *Technical Specifications*. The CQA Site Manager shall observe the vacuum testing procedures and document that they are performed in accordance with the *Technical Specifications*. The result of air channel pressure testing shall be recorded on the CQA seaming logs. Results shall include, at a minimum, personnel performing the air pressure test, the starting air pressure and time, the final air pressure and time, the drop in psi during the test, and the result of the test (pass or fail). Seams failing the air pressure test shall be repaired in accordance with the procedures listed in the *Technical Specifications*. The CQA Site Manager shall document seam repairs in the seaming logs.

7.4.4.9 Destructive Testing

Concept

Destructive seam testing will be performed on site and at the independent CQA laboratory in general accordance with the *Drawings* and the *Technical Specifications*. Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

Location and Frequency

The CQA Site Manager will select locations where seam samples will be cut out for laboratory testing. Those locations will be established as follows.

- The frequency of geomembrane seam testing is a minimum of one destructive sample per 500 feet of weld. The minimum frequency is to be evaluated as an average taken throughout the entire facility.
- A minimum of one test per seaming machine over the duration of the project.
- Additional test locations may be selected during seaming at the CQA Site Manager's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Geosynthetic Installer will not be informed in advance of the locations where the seam samples will be taken.

Sampling Procedure

Samples will be marked by the CQA Site Manager following the procedures listed in the *Technical Specifications*.

Preliminary samples will be taken from either side of the marked sample and tested before obtaining the full sample per the requirements of the *Technical Specifications*. Samples shall be obtained by the Geosynthetic Installer. Samples shall be obtained as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Site Manager will:

- observe sample cutting and monitor that corners are rounded;
- assign a number to each sample, and mark it accordingly;
- record sample location on the Panel Layout Drawing; and
- record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Holes in the geomembrane resulting from destructive seam sampling will be immediately repaired in general accordance with repair procedures described in Section 7.4.5. The continuity of the new seams in the repaired area will be tested in general accordance with Section 7.4.4.8.

Size and Distribution of Samples

The destructive sample will be 12 in. (0.3 m) wide by 42 in. (1.1 m) long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- one portion, measuring 12 in. × 12 in. (30 cm × 30 cm), to the Geosynthetic Installer for field testing;
- one portion, measuring 12 in. × 18 in. (30 cm × 45 cm), for CQA Laboratory testing; and
- one portion, measuring 12 in. × 12 in. (30 cm × 30 cm), to the Construction Manager for archive storage.

Final evaluation of the destructive sample sizes and distribution will be made at the Pre-Construction Meeting.

Field Testing

Field testing will be performed by the Geosynthetic Installer using a gauged tensiometer. Prior to field testing the Geosynthetic Installer shall submit a calibration certificate for gauge tensiometer to the CQA Consultant for review. Calibration must have been performed within one year of use on the current project.

The destructive sample shall be tested according to the requirements of the *Technical Specifications*. The specimens shall not fail in the seam and shall meet the strength requirements outlined in the *Technical Specifications*. If any field test specimen fails, then the procedures outlined in *Procedures for Destructive Test Failures* of this section will be followed.

The CQA Site Manager will witness field tests and mark samples and portions with their number. The CQA Site Manager will also document the date and time, ambient

temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

CQA Laboratory Testing

Destructive test samples will be packaged and shipped, if necessary, under the responsibility of the CQA Site Manager in a manner that will not damage the test sample. The Construction Manager will be responsible for storing the archive samples. This procedure will be outlined at the Pre-construction Meeting. Samples will be tested by the CQA Laboratory. The CQA Laboratory will be selected by the CQA Site Manager with the concurrence of the Engineer.

Testing will include "Bonded Seam Strength" and "Peel Adhesion." The minimum acceptable values to be obtained in these tests are given in the *Technical Specifications*. At least five specimens will be tested for each test method. Specimens will be selected alternately, by test, from the samples (i.e., peel, shear, peel, shear...). A passing test will meet the minimum required values in at least four out of five specimens.

The CQA Laboratory will provide test results no more than 24 hours after they receive the samples. The CQA Site Manager will review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

Geosynthetic Installer's Laboratory Testing

The Geosynthetic Installer's laboratory test results will be presented to the Construction Manager and the CQA Site Manager for comments.

Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether that test conducted by the CQA Laboratory, the Geosynthetic Installer's laboratory, or by gauged tensiometer in the field.

The Geosynthetic Installer has two options:

- The Geosynthetic Installer can reconstruct the seam between two passed test locations.

- The Geosynthetic Installer can trace the welding path to an intermediate location at 10 ft (3 m) minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

Acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. Repairs will be made in general accordance with Section 7.4.5.

The CQA Site Manager will document actions taken in conjunction with destructive test failures.

7.4.5 Defects and Repairs

This section prescribes CQA activities to document that defects, tears, rips, punctures, damage, or failing seams shall be repaired.

7.4.5.1 Identification

Seams and non-seam areas of the geomembrane shall be examined by the CQA Site Manager for identification of defects, holes, blisters, undispersed raw materials and signs of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination.

7.4.5.2 Evaluation

Potentially flawed locations, both in seam and non-seam areas, shall be non-destructively tested using the methods described in Section 7.4.4.8 as appropriate. Each location that fails the nondestructive testing will be marked by the CQA Site Manager and repaired by the Geosynthetic Installer. Work will not proceed with any materials that will cover locations which have been repaired until laboratory test results with passing values are available.

7.4.5.3 Repair Procedures

Portions of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, will be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure will be at the discretion of the CQA Consultant with input from the Construction Manager and Geosynthetic Installer.

The procedures available include:

- patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
- grinding and re-welding, used to repair small sections of extruded seams;
- spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws;
- capping, used to repair large lengths of failed seams;
- removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams).

In addition, the following provisions will be satisfied:

- surfaces of the geomembrane which are to be repaired will be abraded no more than 20 minutes prior to the repair;
- surfaces must be clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures must be approved;
- the repair procedures, materials, and techniques will be approved in advance by the CQA Consultant with input from the Engineer and Geosynthetic Installer;
- patches or caps will extend at least 6 in. (150 mm) beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 in. (75 mm); and
- cuts and holes to be patched shall have rounded corners

7.4.5.4 Verification of Repairs

The CQA Monitor shall monitor and document repairs. Records of repairs shall be maintained on repair logs. Repair logs shall include, at a minimum:

- panel containing repair and approximate location on panel;
- approximate dimensions of repair;
- repair type, i.e. fusion weld or extrusion weld
- date of repair;
- seamer making the repair; and
- results of repair non-destructive testing (pass or fail).

Each repair will be non-destructively tested using the methods described herein, as appropriate. Repairs that pass the non-destructive test will be taken as an indication of an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, per the requirements of the *Technical Specifications*. Failed tests shall be redone and re-tested until passing test results are observed.

7.4.5.5 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane liner is completed) and prior to placing overlying materials, the CQA Site Manager will observe the geomembrane wrinkles. The CQA Site Manager will indicate to the Geosynthetic Installer which wrinkles should be cut and re-seamed. The seam thus produced will be tested like any other seam.

7.4.6 Lining System Acceptance

The Geosynthetic Installer and the Manufacturer(s) will retain all responsibility for the geosynthetic materials in the liner system until acceptance by the Construction Manager.

The geosynthetic liner system will be accepted by the Construction Manager when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- all documentation of installation is completed including the CQA Site Manager's acceptance report and appropriate warranties; and
- CQA report, including "as built" drawing(s), sealed by a registered professional engineer has been received by the Construction Manager.

The CQA Site Manager will document that installation proceeded in general accordance with the *Technical Specifications* for the project.

8. GEOTEXTILE

8.1 Introduction

This section of the CQA Plan outlines the CQA activities to be performed for the geotextile installation. The CQA Consultant will review the *Drawings*, and the *Technical Specifications*, and any approved addenda or changes.

8.2 Manufacturing

The Manufacturer will provide the CQA Consultant with a list of certified "minimum average roll value" properties for the type of geotextile to be delivered. The Manufacturer will also provide the CQA Consultant with a written certification signed by a responsible representative of the Manufacturer that the geotextile actually delivered have "minimum average roll values" properties which meet or exceed all certified property values for that type of geotextile.

The CQA Consultant will examine the Manufacturers' certifications to document that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile. Deviations will be reported to the Construction Manager.

8.3 Labeling

The Manufacturer will identify all rolls of geotextile with the following:

- Manufacturer's name;
- product identification;
- lot number;
- roll number; and
- roll dimensions.

The CQA Site Manager will examine rolls upon delivery and deviation from the above requirements will be reported to the Construction Manager.

8.4 Shipment and Storage

During shipment and storage, the geotextile will be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. The CQA Site Manager will observe rolls upon delivery to the site and deviation from the above requirements will be reported to the Construction Manager. Damaged rolls will be rejected and replaced.

The CQA Site Manager will observe that geotextile is free of dirt and dust just before installation. The CQA Site Manager will report the outcome of this observation to the Construction Manager, and if the geotextile is judged dirty or dusty, they will be cleaned by the Geosynthetic Installer prior to installation.

8.5 Conformance Testing

8.5.1 Tests

The geotextile material will be tested for mass/unit area (ASTM D 5261), grab strength (ASTM D4632) and for puncture strength (ASTM D 6241) at the frequencies presented in Table 2.

8.5.2 Sampling Procedures

Upon delivery of the geotextile rolls, the CQA Site Manager will document that samples are obtained from individual rolls at the frequency specified in this CQA Plan. The geotextile samples will be forwarded to the CQA Laboratory for testing to evaluate conformance to both the *Technical Specifications* and the list of physical properties certified by the Manufacturer.

Samples will be taken across the width of the roll and will not include the first 3 linear ft. Unless otherwise specified, samples will be 3 ft long by the roll width. The CQA Consultant will mark the machine direction on the samples with an arrow.

8.5.3 Test Results

The CQA Site Manager will examine results from laboratory conformance testing and compare results to the *Technical Specifications*. The criteria used to evaluate acceptability are presented in the *Technical Specifications*. The CQA Site Manager will report any nonconformance to the Construction Manager.

8.5.4 Conformance Test Failure

The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA Laboratory:

- The Manufacturer will replace every roll of geotextile that is in nonconformance with the *Technical Specifications* with a roll that meets specifications; or
- The Geosynthetic Installer will remove conformance samples for testing by the CQA Laboratory from the closest numerical rolls on both sides of the failed roll. These two samples must conform to the *Technical Specifications*. If either of these samples fail, the numerically closest rolls on the side of the failed sample that is not tested, will be tested by the CQA Laboratory. These samples must conform to the *Technical Specifications*.

If any of these samples fail, every roll of geotextile on site from this lot and every subsequently delivered roll that is from the same lot must be tested by the CQA Laboratory for conformance to the *Technical Specifications*.

The CQA Site Manager will document actions taken in conjunction with conformance test failures.

8.6 Handling and Placement

The Geosynthetic Installer will handle all geotextile in such a manner as to document they are not damaged in any way. The Geosynthetic Installer will comply with the following:

- If in place, special care must be taken to protect other materials from damage, which could be caused by the cutting of the geotextile.
- The Geosynthetic Installer will take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
- During placement of geotextile, care will be taken to prevent entrapment of dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geotextile, it should be cleaned prior to placement of the next material on top of it. In this regard, care should be taken with the handling or sandbags, to prevent rupture or damage of the sandbag.
- A visual examination of the geotextile will be carried out over the entire surface, after installation to document that no potentially harmful foreign objects are present.

The CQA Site Manager will note noncompliance and report it to the Construction Manager.

8.7 Geotextile Seams and Overlaps

Adjacent geotextile panels will be joined in general accordance with *Construction Drawings* and *Technical Specifications*. As a minimum, the adjacent rolls will be overlapped by at least 6 in. and secured by heatbonding or overlapped 12 inches, in general accordance with the *Technical Specifications*. The CQA Consultant will note any noncompliance and report it to the Construction Manager.

8.8 Repair

Holes or tears in the geotextile will be repaired by placing a patch extending 2 ft beyond edges of the hole or tear.

If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area will be cut out and the two portions of the geotextile will be joined in general accordance with Section 8.7. The CQA Site Manager will observe repairs, note non-compliances with the above requirements and report them to the Construction Manager.

9. CONSTRUCTION QUALITY ASSURANCE FOR CAST-IN-PLACE CONCRETE

9.1 Acceptance Testing and Certification

The Contractor shall provide written certificates of compliance certifying that the cement, fine and coarse aggregate, admixtures, mix design(s), and compressive strength meet the requirements listed in the Specifications and that admixtures used in the same concrete mix are compatible with each other and the aggregates. The certificates of compliance shall be accompanied by certified laboratory test results showing that the concrete delivered to the job site was tested in accordance with and meets the Specifications. The certificates of compliance shall be signed by responsible personnel employed by the Contractor and submitted to the CQA Manager at least 14 calendar days prior to shipment to the job site. The certificates of compliance shall include the following:

- The test procedures and the results of the laboratory evaluation.
- Certification that the tests described in the Specifications and herein were performed and that test results conform with the Specifications.

9.2 Conformance Testing

The CQA Monitor will collect field cylinder concrete specimens at his/her discretion upon the arrival of concrete at the job site, in compliance with ASTM C31. Selected specimens will be tested by a third-party testing laboratory. The number of sets of concrete cylinder specimens taken of each class of concrete placed each day shall not be less than one set, nor less than one set for each 50 cubic yards of concrete. Specimens taken will be tested for compressive strength per ASTM C39. Test results shall conform to the requirements of the Specifications.

10. SURVEYING

10.1 Survey Control

Survey control will be performed by the Surveyor as needed. A permanent benchmark will be established for the site(s) in a location convenient for daily tie-in. The vertical and horizontal control for this benchmark will be established within normal land surveying standards.

10.2 Precision and Accuracy

A wide variety of survey equipment is available for the surveying requirements for these projects. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the projects.

10.3 Lines and Grades

The following structures will be surveyed to verify and document the lines and grades achieved during construction of the Project:

- geomembrane terminations; and
- centerlines of pipes.

10.4 Frequency and Spacing

A line of survey points no further than 50 ft apart must be taken at the top of pipes or other appurtenances to the liner.

10.5 Documentation

Field survey notes should be retained by the Land Surveyor. The findings from the field surveys should be documented on a set of Survey *Record Drawings*, which shall be provided to the Construction Manager in AutoCAD format or other suitable format as directed by the Construction Manager.

TABLE 1

GEOMEMBRANE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	FREQUENCY
Specific Gravity	ASTM D 792 Method A or ASTM D 1505	200,000 ft^2 or minimum of 2
Thickness	ASTM D 5199	200,000 ft^2 or minimum of 2
Tensile Strength at Yield	ASTM D 638	200,000 ft^2 or minimum of 2
Tensile Strength at Break	ASTM D 638	200,000 ft^2 or minimum of 2
Elongation at Yield	ASTM D 638	200,000 ft^2 or minimum of 2
Elongation at Break	ASTM D 638	200,000 ft^2 or minimum of 2
Carbon Black Content	ASTM D 1603	200,000 ft^2 or minimum of 2
Carbon Black Dispersion	ASTM D 5596	200,000 ft^2 or minimum of 2

TABLE 2

GEOTEXTILE CONFORMANCE TESTING REQUIREMENTS

TEST NAME	TEST METHOD	MINIMUM FREQUENCY
Mass/Unit Area	ASTM D 5261	1 test per 200,000 ft^2 or minimum of 2
Grab Strength	ASTM D 4632	1 test per 200,000 ft^2 or minimum of 2
Puncture Strength	ASTM D 6241	1 test per 200,000 ft^2 or minimum of 2

Atlantica
Sustainable Infrastructure

10.4 Evaporation Pond's Sediment Measurement Report

November 28, 2023

Nicole Brewer
Mojave Solar LLC

Re: Mojave Solar Site Visit & Aquatic Inspection

Dear Nicole,

A site visit was conducted by DWI technicians on Tuesday, November 17, 2023, at the Mojave Solar Project located at 42134 Harper Lake Rd., Hinkley, CA 92347. The inspection focused on four ponds, involving probing and sonar mapping to assess sediment accumulation.

The property comprises two sites, Alpha and Beta, each with two ponds labeled Alpha West, Alpha East, Beta West, and Beta East from left to right.

- **Alpha West:** The average sediment depth was 2.3", with the deepest point at 3". Hard pack deposits ranged from approximately 0.25 to 1". Refer to Plate 1, Alpha West.
- **Alpha East:** The average sediment depth was 9.38", with the deepest point at 11". Similar hard pack deposits of approximately 0.25 to 1" were observed. Refer to Plate 1, Alpha East.
- **Beta West:** The average sediment depth was 2.84", with the deepest point at 3". Hard pack deposits ranged from approximately 0.25 to 1". Refer to Plate 2, Beta West.
- **Beta East:** The average sediment depth was 3.86", with the deepest point at 5". Comparable hard pack deposits of approximately 0.25 to 1" were noted. Refer to Plate 2, Beta East.

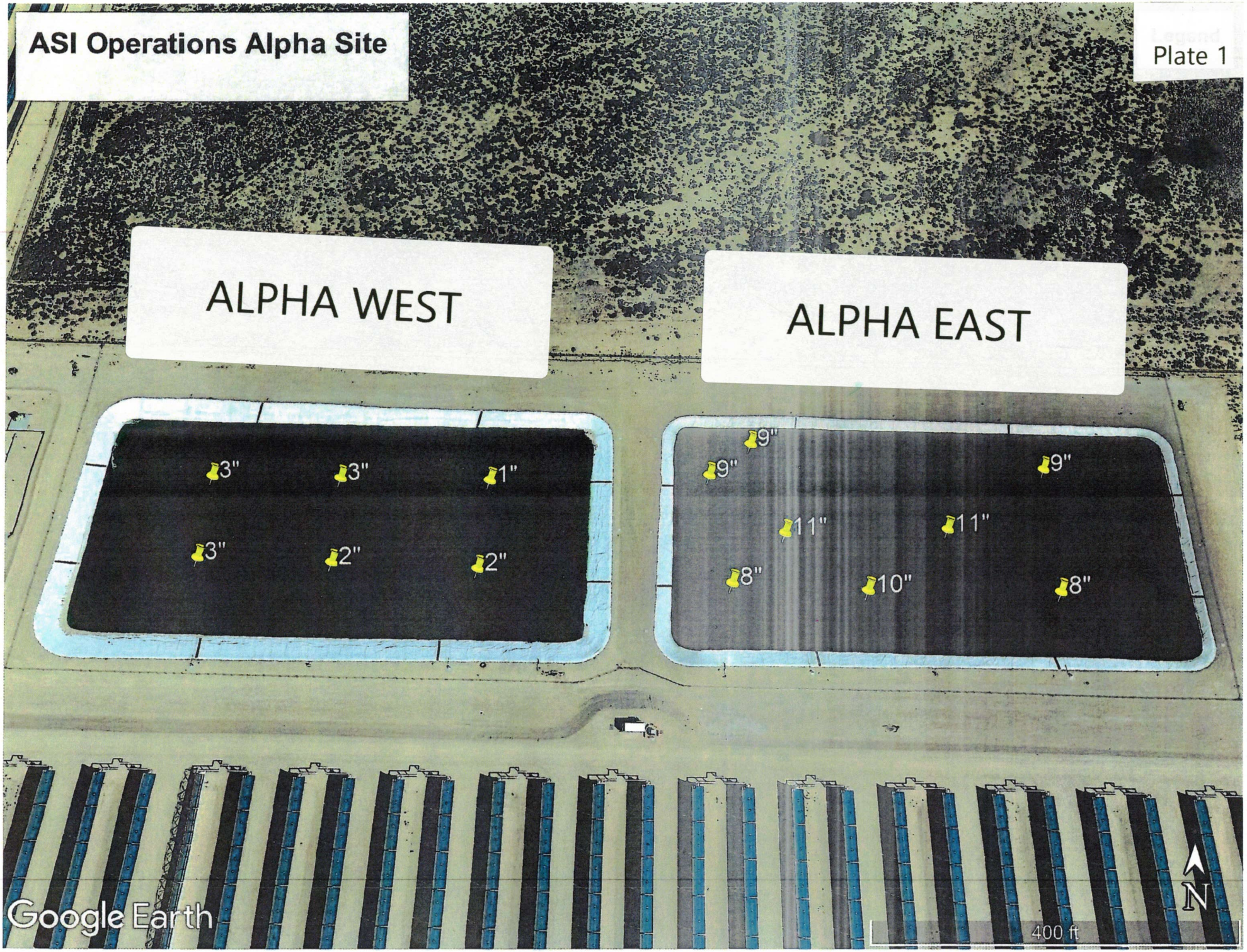
Alpha Two exhibited the highest accumulation of salt and sand, being the only pond where we could break through the crust multiple times. The deepest sediment found was 11".

As of now, sediment removal does not seem necessary. It is important to highlight that vacuum sediment removal is currently impractical. Mechanical removal will be required during the extraction and disposal of hard mineral deposits due to their nature. It is anticipated that the liner may be severely damaged during this process. Therefore, it is advisable to plan for the replacement of the pond liner when the need arises.

Respectfully Submitted,

Patrick Simmsgeiger
President/QAL CLM
DWI – Certified Lake Manager & Products for Water Treatment
Sustainable Aquatic Management since 1973
Email: 343c@dwiwater.com

27324 Camino Capistrano, Suite 213 – Laguna Niguel, CA 92766-1118
Phone 949-582-5414 / 760-837-3700 – Fax 949-582-5420


ASI Operations Alpha Site
Plate 1
ALPHA WEST
ALPHA EAST
3"
3"
1"
3"
2"
2"
9"
9"
9"
11"
11"
8"
10"
8"
Google Earth
400 ft
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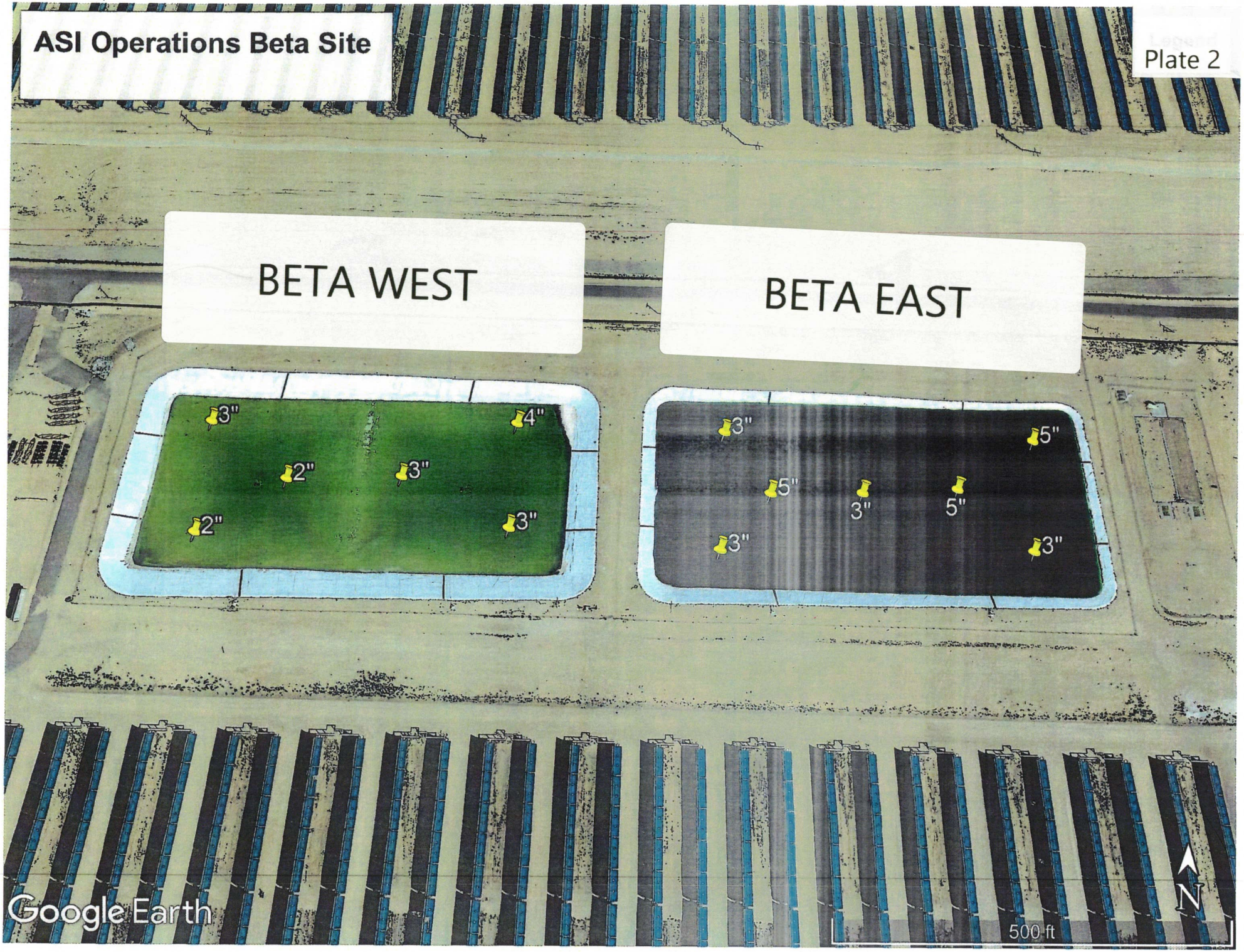
ASI Operations Beta Site
Plate 2
BETA WEST
BETA EAST
3"
4"
2"
3"
2"
3"
3"
5"
5"
3"
5"
3"
3"
Google Earth
500 ft
N

Alpha West Pond

ASK THE EXPERTS

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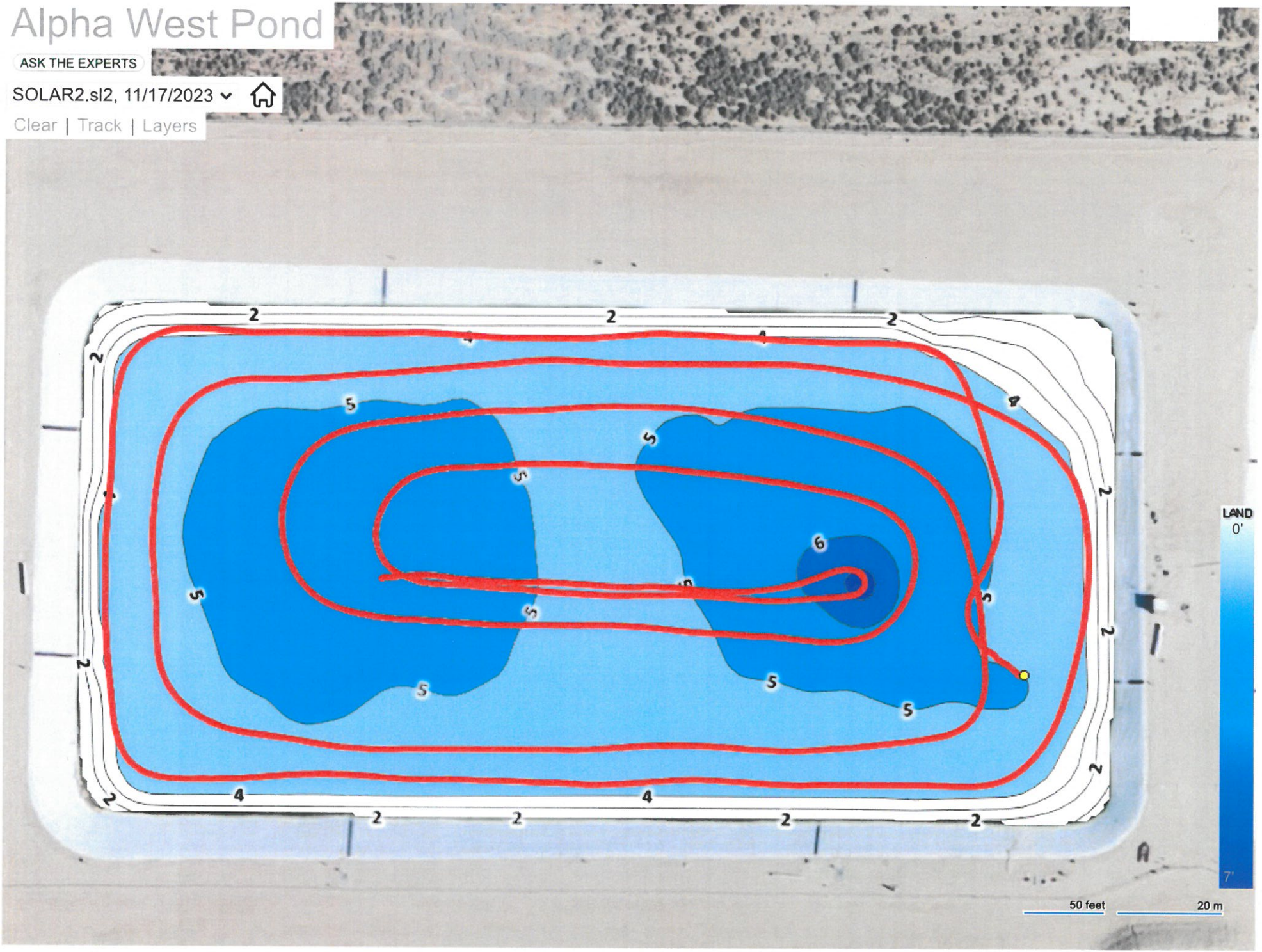

Alpha West Pond

ASK THE EXPERTS

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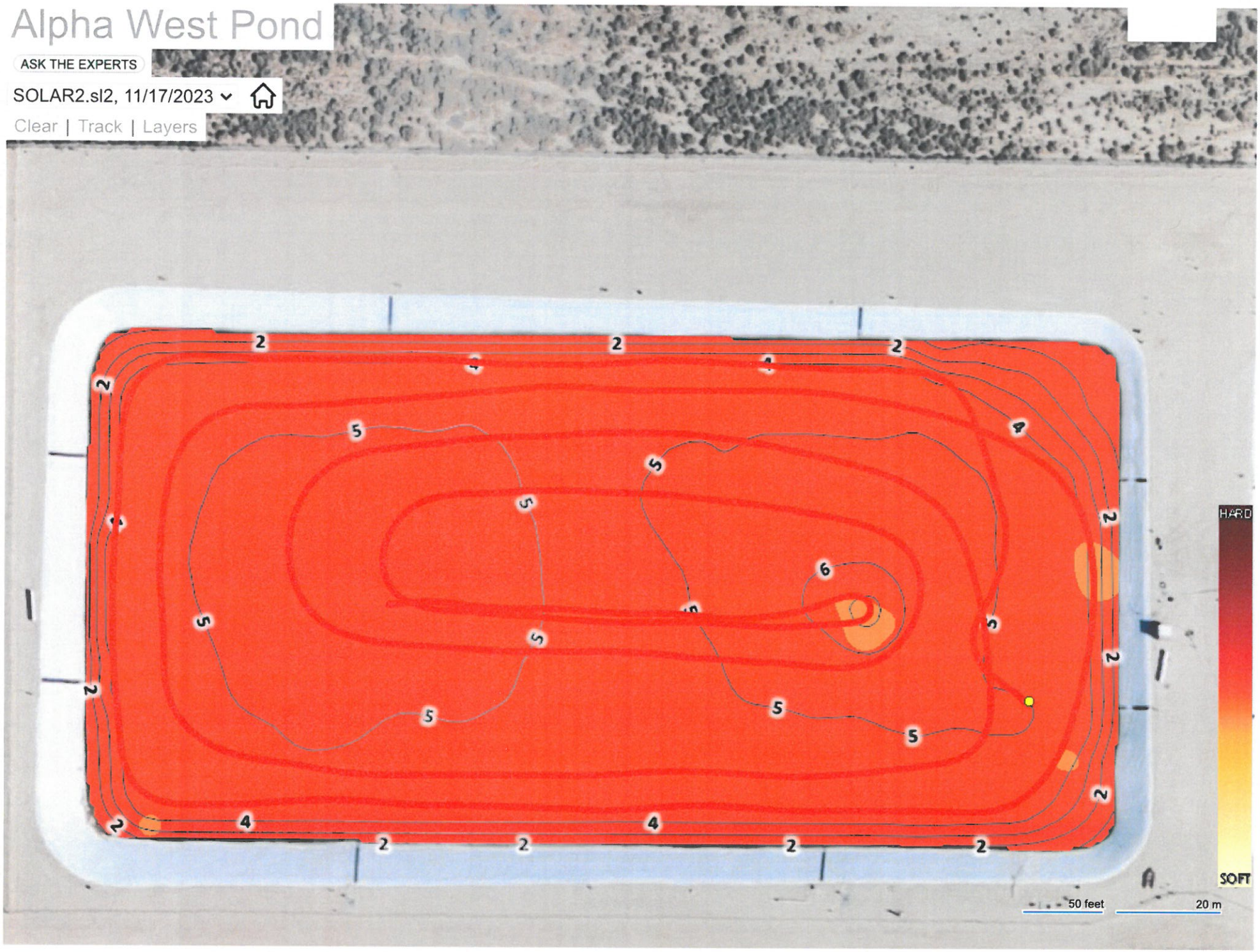

Alpha East Pond

ASK THE EXPERTS

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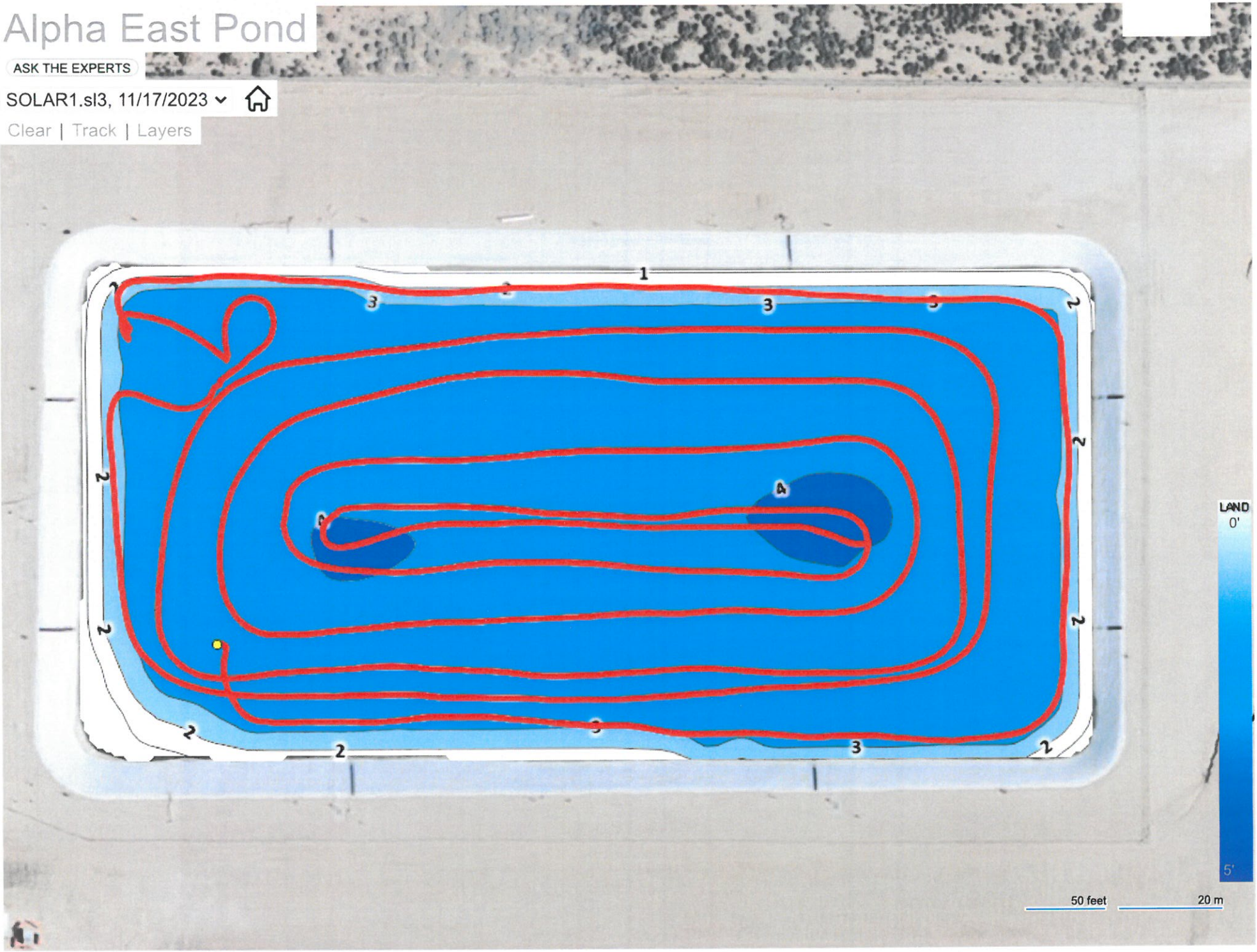

Alpha East Pond

ASK THE EXPERTS

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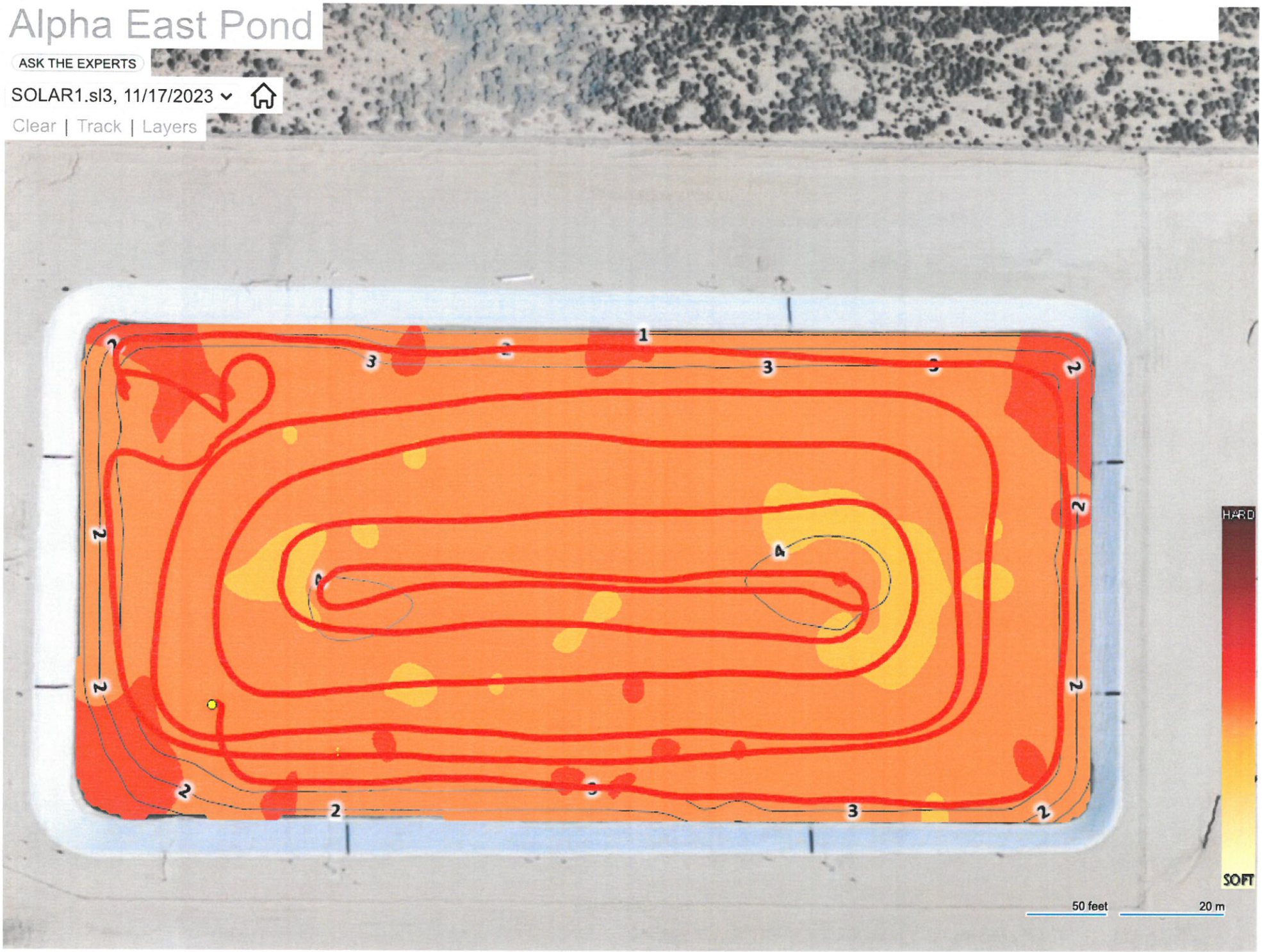

Beta West Pond

ASK THE EXPERTS

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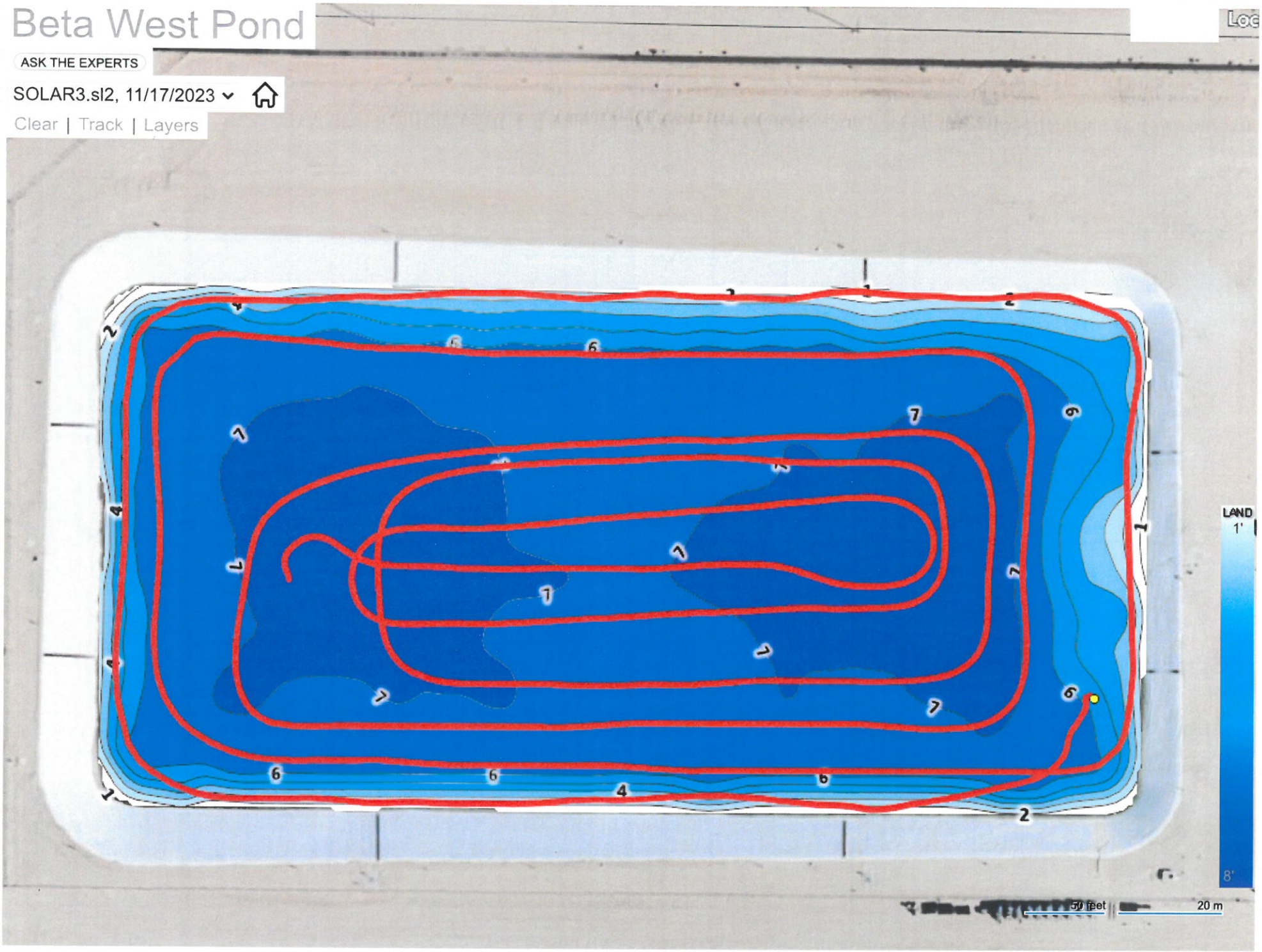

Beta West Pond

ASK THE EXPERTS

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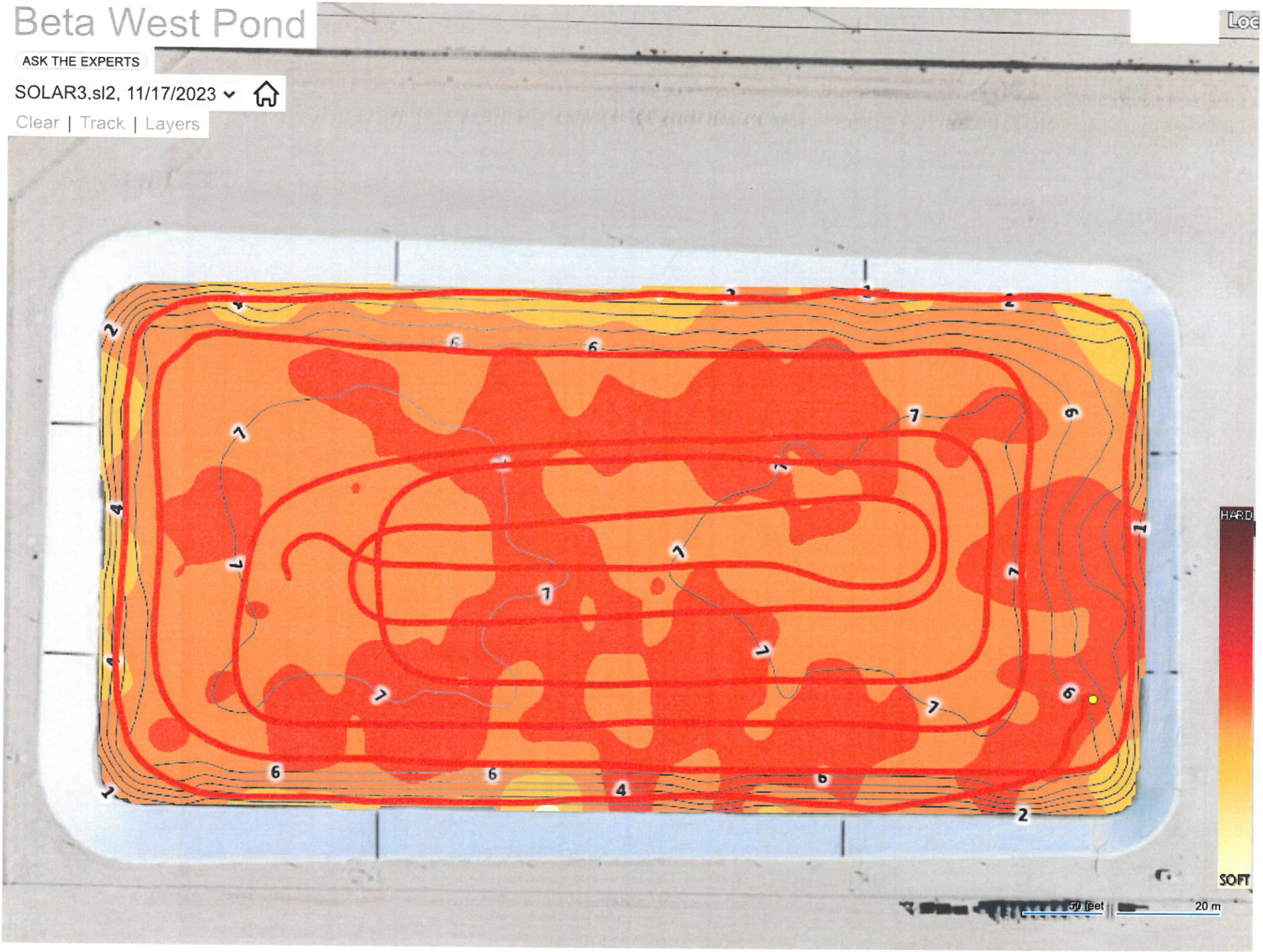

Beta East Pond

ASK THE EXPERTS

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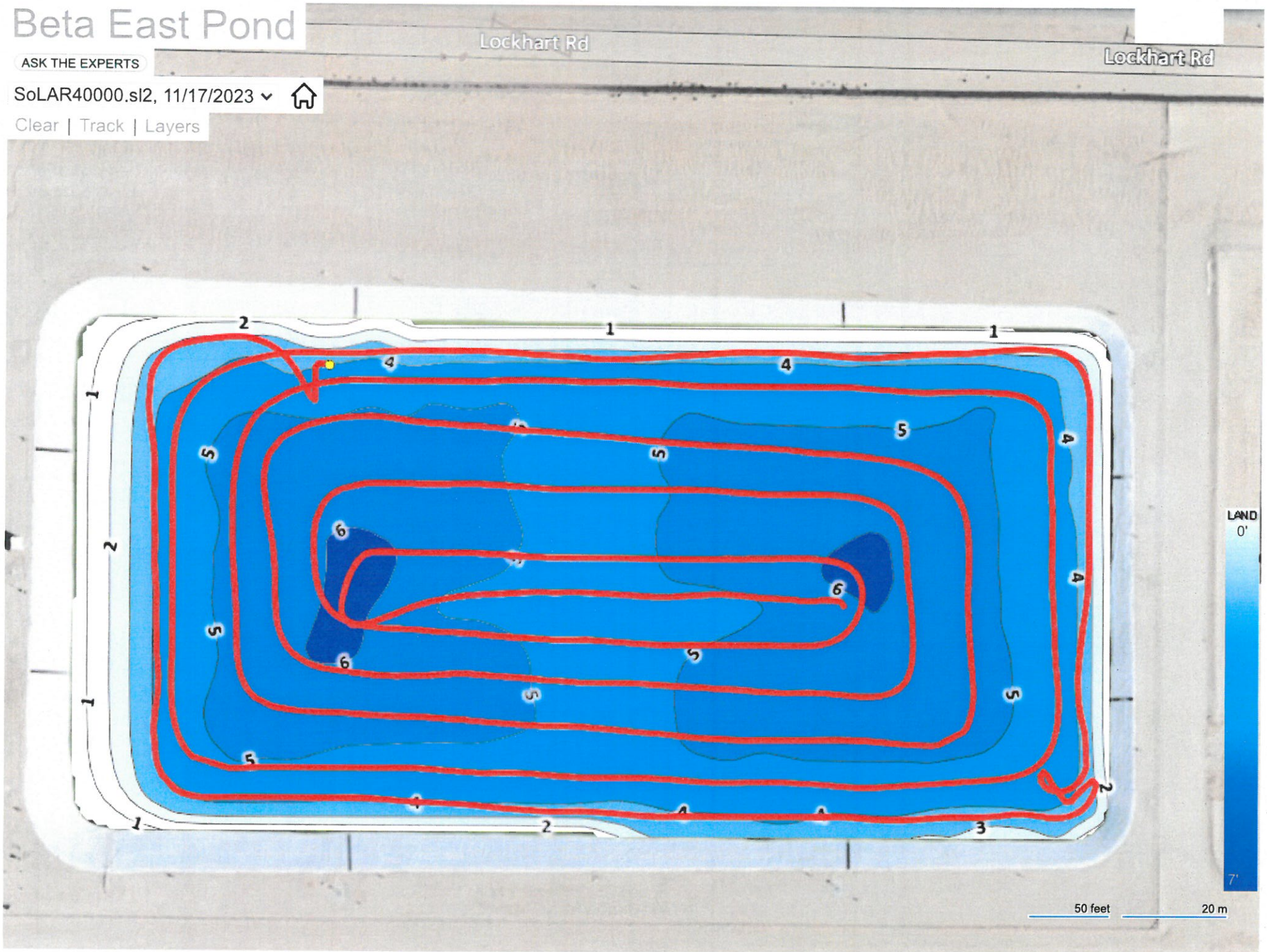

Beta East Pond

ASK THE EXPERTS

SoLAR40000.sl2, 11/17/2023

Clear | Track | Layers