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Tiffany A. James
Vice President Project Development
and Government Affairs
Magnum Development Solution Mining
3165 East Millrock Drive, Suite 330
Holladay, Utah 84121

Dear Ms. James:

Subject: **Construction Permit** for Sawtooth Brine Pond 2

On April 6, 2015, the Division of Water Quality (DWQ) received the engineering plans and specifications for Sawtooth Brine Pond 2 prepared by Newfields Mining Design and Technical Services and stamped by Matthew Thomas Haley Utah Certified Professional Engineer.

The following is a summary of the proposed major construction projects:

- Construction of Brine Pond 2. Brine Pond 2 is directly south of the previously constructed Brine Pond 1 and will share the southern embankment with Brine Pond 1. Brine Pond 2 will have an approximate footprint of 190 acres and have a minimum operating volume of 5,600 acre-feet (ac-ft). Brine Pond 2 will have two HDPE liners with leak detection sumps and pump back systems.

Because the proposed evaporation ponds are very large and will be holding a significant amount of brine, The Division of Dam Safety in the Utah Department of Natural Resources is also reviewing the engineering plans and specifications. Dam Safety will be issuing an Order Granting to Construct a Dam. The terms and conditions required by Dam Safety will also be required as part of this Construction Permit.

The plans and specifications, as submitted, comply with *the Utah Water Quality Rules, (R317, Utah Administrative Code).* A **Construction Permit** is hereby issued as constituted by this letter, subject to the following conditions:

1. *Any revisions or modifications to the approved plans and specifications must be submitted to DWQ for review and approval, before construction or implementation thereof. Please submit any changes for review and approval directly to Woodrow Campbell, P.E., of the DWQ Ground Water Protection Section.*

2. *A written operations and maintenance manual, containing a description of the functioning of the facilities, an outline of routine maintenance procedures, and all checklists and maintenance logs needed for proper operation of the system, must be submitted and approved before the final inspection and operation of the system.*

3. *The approved facilities must not be placed in service unless DWQ has conducted a final inspection, reviewed and approved the As-Built Construction Certification Report, and provided written authorization to place the constructed facilities in service.*

4. *Construction activities that disturb one acre or more are required to obtain coverage under the Utah Pollutant Discharge Elimination System (UPDES) Storm Water General Permit for Construction Activities. The permit requires the development of a storm water pollution prevention plan (SWPPP) to be implemented and updated from the commencement of any soil disturbing activities at the site until final stabilization of the project. For more information, or to obtain permit coverage on-line, please go to: http://www. waterquality. utah.gov/UPDES/stormwater. Htm*

The plans and specifications for this project have been stamped and signed by a Professional Engineer currently licensed to practice in the state of Utah. The construction design, inspection supervision, and written construction certification of all work associated with this Construction Permit must be performed by a Professional Engineer licensed to practice in the state of Utah.

This Construction Permit will expire one year from the date of its issuance, as evidenced by the date of this letter, unless substantial progress is made in constructing the approved facilities or the plans and specifications have been resubmitted and the construction permit is reissued. This permit does not relieve you, in any way, of your obligations to comply with other applicable local requirements. You may contact Central Utah Public Health Department at (435) 896-5451 or District Engineer John Chartier at (435)896-5451, Ext. 314, for further assistance regarding local matters.

Because of the inherent hazard potential at lagoons and ponds, warning signs should be posted at these facilities to state the dangers of drowning and asphyxiation. Safety ropes running down the pond side slopes, and fastened to posts at the top of the dikes should be available to allow anyone trapped in the ponds to escape.

Please contact Mr. Campbell at the beginning of construction to allow periodic inspections to be scheduled. Upon completion of the project, a final inspection and approval of the As-Built Construction Certification Report is required before the approval to operate the completed facilities can be issued. Please remain in contact with Mr. Campbell to schedule the final inspection. The Construction Certification Report with final as-built drawings must include test results for the following construction quality assurance and quality control (CQA/QC) elements:

<u>Soil Subgrade</u>

- Proctor Curves,
- Soil Classification,
- Field Compaction Testing, and
- Subgrade Acceptance Certification.

<u>Concrete</u>

- Concrete Mix Verification,
- Concrete ASTM Testing Method, Frequency, and Results,
- Concrete Testing Pass/Fail Criteria, and
- Crack Inspection and Repair.

<u>Flexible Membrane Liner</u>

- Panel Placement Log,
- Trial Seam Test Log,
- Seaming Record,

- Seam Test Record,
- Repair Log,
- As-Built Drawing,
- Manufactures Certification including QA/QC Testing of the Rolls, and
- Professional Engineer Certification.

If we can be of further assistance, please contact Mr. Woodrow Campbell at wwcampbell@utah.gov or (801) 536-4353.

Sincerely,

Walter L. Baker, P.E.
Director

WLB/WWC/RFH:

cc: John Chartier, District Engineer (via email)
Central Utah Public Health Department (via email)

DWQ-2015-004798

SAWTOOTH BRINE POND #2
FINAL DESIGN REPORT

Prepared for:
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3165 East Millrock Drive, Suite 330
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Prepared by:
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REGISTERED PROFESSIONAL ENGINEER
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MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

NewFields Job No. 475.0093.003
April 6, 2015

MAGNUM SAWTOOTH NGL CAVERNS

NewFields
Perspective. Vision. Solutions.

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1. INTRODUCTION

NewFields Mining Design and Technical Services (NewFields) was commissioned by Magnum Development Solution Mining (Magnum) to provide engineering services including final design and permitting approval for the Sawtooth Brine Pond 2. Brine Pond 2 has a minimum operating volume of 5,600 acre-ft and has been designed to the same standards of the existing Brine Pond 1 which has a high performance record. A geotechnical investigation of the site was also completed in the area with findings presented herein.

1.1. Project Background

The Western Energy Hub project includes a series of solution mined storage caverns for compressed natural gas located in a subsurface salt deposit. The resulting brine solution from the mining process will be stored in dual lined engineered brine ponds.

The design for three Brine ponds was originally completed by AMEC in the, "Magnum Gas Storage, LLC, Evaporation Ponds Final Design Report, May 23, 2011," and included a series of 3 evaporation ponds in a west to east alignment. After receipt of a Utah Division of Water Rights Dam Impoundment Permit and Division of Water Quality Groundwater Discharge Permit, Magnum constructed one of the three ponds, Sawtooth Brine Pond 1 in 2013. The original permitted design with be referred to hereon as the AMEC Final Design Report.

1.2. Project Description

After the construction completion of Sawtooth Brine Pond 1, Sawtooth proposed another new pond south of the existing Sawtooth Brine Pond 1. The remaining two brine ponds which have not yet been constructed are still planned to be constructed in the future. The goal of this design for the Sawtooth Brine Pond 2 provided by NewFields within this report is intended to obtain a Utah Division of Water Rights Dam Impoundment Permit and Division of Water Quality Groundwater Discharge Permit.

The proposed Sawtooth Brine Pond 2 is located in line and south of the constructed Sawtooth Brine Pond 1 with an approximate footprint of 190 acres. The pond will share the southern embankment of Sawtooth Brine Pond 1 and will have a minimum operating volume of 5,600 acre-ft (ac-ft).

The original design and design assumptions have been utilized to the greatest extent possible with the exception of modifications that have been requested. Any modification will be noted as such.

1.3. Project Location

The project is located approximately 10 miles north of Delta in Millard County, Utah and includes leased lands from the Utah School and Institutional Trust Lands Administration (SITLA). A county and vicinity map is shown on Drawing A000.

1.4. Site Conditions

Site conditions are similar to those described for the Sawtooth Brine Pond 1 design. A detailed field investigation was performed within the footprint of the proposed facility as described in Section 2 of this report and surface and subsurface conditions encountered are discussed in further detail in Section 3 of this report.

1.5. Scope of Work

Per the proposal submitted to Magnum on February 23, 2015 (Newfields Proposal No. 14PD.0081) the scope of work included the following:

- Complete a geotechnical investigation within the proposed limits of Sawtooth Brine Pond 2 and obtain soil samples of the underlying subgrade materials for laboratory test work.
- Provide engineering design and permitting support for Sawtooth Brine Pond 2 including:
  - Review and revise existing design criteria developed during the previous phase,
  - Develop a grading plan for Sawtooth Brine Pond 2 utilizing AutoCAD Civil3D. The plan will utilize locally available material and will balance cut and fills to the greatest extent possible. The groundwater level in the sump area of the ponds will be a limiting factor for the grading plans and will be considered as the design is developed and advanced.
  - Prepare geomembrane plans and details for installation,
  - Prepare Leak Collection and Recovery System (LCRS) and Process Component Monitoring System (PCMS) plans and details as well as recommend pumping systems,
  - Draft design drawings to be stamped by the Engineer of Record (EOR),
  - Review and utilize the existing technical specifications for earthworks, geosynthetic materials, concrete and pipework. These specifications will be revised as necessary.

1.6. Use of this Report

This report has been prepared exclusively for Magnum and Sawtooth. No third party, other than the design team (NewFields), shall be entitled to rely on any information, conclusions,

opinions or other information contained herein without the express written consent of Magnum and Sawtooth.

2. GEOTECHNICAL INVESTIGATION

A field investigation was completed between March 3rd and March 7th, 2015 and was used to identify the geotechnical conditions beneath the proposed Sawtooth Brine Pond 2. NewFields findings were consistent with that of the previous investigation as presented in the AMEC Final Design Report.

The program consisted of seven soil borings and eighteen test pits as shown on Drawing A030. The purpose of the soil borings were to: (1) define lithology and subsurface conditions, (2) estimate the density and strength of subsurface materials through penetration tests, (3) collect samples for laboratory testing, and (4) identify groundwater depth. The borings were advanced to depths from 26.5 to 76.5 feet (ft) below the ground surface (bgs). The purpose of the test pits was to augment the data from the borings for near surface soil conditions and to assess potential borrow materials.

2.1. Soil Borings

Borings were advanced using a CME-75 drill rig equipped with 4 ¼ in ID keyed, pin-connected hollow-stem augers. When drilling occurred at significant depths below the water table, mud-rotary drilling methods were employed. The drill rig was owned and operated by Haz-Tech Drilling based out of Meridian, Idaho and under the full-time supervision of a NewFields geologist while on-site.

Driven samples were retrieved using a Standard Penetration Test (SPT) split-spoon sampler (2-in O.D / 1.375 inch ID). Driven samples were collected at approximately 5 ft intervals. A 140-lb automatic trip hammer with a drop height of 30-in was used to drive the samplers, per the ASTM D1586 standard. The field geologist logged the subsurface conditions based on the materials recovered from the driven samples and soil cuttings brought to the surface.

Groundwater was encountered in all of the borings at depths between 11 and 27 ft bgs. Bedrock was not encountered in any of the borings. The geotechnical borings were abandoned by either grouting the entire boring or backfilling the hole with bentonite chips.

The final boring logs summarize the results of penetration tests, sediment types and observations made at each boring location (Appendix D1). These records include drilling depth, sample depth, sample type, blowcounts per 6-in interval, water encountered, plasticity data, strata delineation, and a description of each strata encountered. The stratification lines represent the approximate boundary between soil types and the transition was often gradual.

The logs are a compilation of information gathered during the field investigation as well as laboratory testing program.

2.2. Test Pits

The test pits were excavated within the footprint of Sawtooth Brine Pond 2. The subsurface information was used to identify potential borrow sources for construction of the pond embankments and evaluate processing requirements, if needed, to generate a suitable construction material.

The test pits were excavated using a Caterpillar 320 track mounted excavator operated by Westside Grading. Test pit depths ranged from 14 to 21 ft bgs. Groundwater was encountered at the base of many test pits. A NewFields geologist was present during pit excavation. The geologist logged the subsurface material and gathered disturbed bulk samples for laboratory testing. Test pits were abandoned by replacing the excavated material. The final test pit logs summarize the results for field observations at each pit location (Appendix D2).

2.3. Laboratory Test Work

The bulk and driven samples obtained during the field investigation were transported to the NewFields laboratory in Elko, NV where index testing was performed. The index testing includes particle size analyses and Atterberg limits tests. Standard Proctor moisture-density relationships were also established for a few select samples. Strength tests were performed at Knight Piésold in Denver, CO. All data was critically evaluated by a geotechnical engineer prior to identifying design parameters for the site materials.

Appended Table 1 presents a summary sheet of the Proctor and index test results. The Unified Soil Classification System (USCS) classification was determined for all samples obtained from the boreholes and test pits and group symbols are listed on Appended Table 1. Classifications are based on the particle size distributions and Atterberg Limits. Field observations were used to estimate the USCS classification when sufficient laboratory data was not available.

The index tests indicate that the subsurface contains few gravel size particles (greater than 4.75mm nominal diameter) and varying amounts of sand, silt, and clay particles. Atterberg Limits results indicate the fines present in the subsurface soils have a plasticity index (PI) ranging from 2 to 31 and a liquid limit (LL) ranging from 22 to 53. The lower-bound values correlated to a silt and the upper bound correlated to a highly plastic (fat) clay. In general, the majority of clay encountered was of medium to high plasticity. Gravimetric moisture contents for all samples tested ranged between 4 and 36 percent. Fine-grained soils held the most moisture and all soil types indicated a distinct increase in moisture below the inferred groundwater table.

One remolded silty sand sample was designated for direct shear testing. The sample was remolded to 95 percent of the standard Proctor maximum dry density at approximately 3 percent over the optimum moisture content. Normal loads during testing were approximately 10, 20, and 40 pounds per square in (psi). The specimens exhibited strain softening behavior. The friction angle (ϕ) and cohesion (c) was calculated at both peak shear stress and large displacement, as follows:

- ϕ_{peak} = 32 degrees c_{peak} = 665 pounds per square ft (psf)
- ϕ_{LD} = 31 degrees c_{LD} = 370 pounds per square ft (psf)

3. GEOLOGIC AND GEOTECHNICAL CONDITIONS

3.1. Geologic Setting

The project site is located within the Sevier Desert in east-central Millard County, Utah. The Sevier Desert basin is within the eastern margin of the Basin and Range Physiographic Provence. Beginning 20 to 7 million years before present (Ma), the basin opened up dominantly by crustal extension through normal faulting within the region rather than graben subsidence (Oviatt, 1989). The basin is bounded on the east by the Canyon Range and the Gilson Mountains, on the north by the Sheeprock Mountains, Simpson Mountains, and Keg Mountain, and on the west by the Drum Mountains, Little Drum Mountains, and the House Range. The southern margin is less defined before transitioning into the Black Rock Desert.

The basin was a freshwater lake during the early Pleistocene, as indicated by the presence of calcareous clays and silts. During the Middle Pleistocene the basin experience a time of erosion and sediment degradation by receding lake waves lifting sediments into suspension where they were transported away in fluvial systems (Oviatt, 1989). Wind degradation also occurred during this time as the lake(s) shorelines receded. A shallow, freshwater lake filled the basin again prior to the transgression of Lake Bonneville around 20 to 21 thousand years ago. As Lake Bonneville began to regress into the Great Salt Lake basin, another freshwater lake formed in the basin. This lake was present long enough to develop a prominent 10-mile long shoreline northeast of Sevier Lake. This was Lake Gunnison, which overflowed north into the Great Salt Lake Desert via the Old River Bed channel. After Lake Gunnison retreated, the Sevier and Beaver Rivers deposited low gradient alluvial fans comprised of fine-grained sediments.

Surficial sediments in the area consist of fine-grained lacustrine deposits of Lake Bonneville and of pre-Bonneville lakes, vast areas of fine-grained alluvium deposited by the Sevier and Beaver Rivers, and coarser-grained deposits in piedmont areas. Thin aeolian deposits are also found throughout the area.

Regional structure near the project site was discussed by IGES (2009) and consists of two northeast trending normal faults.

3.2. Surface Conditions

The surface of the proposed Sawtooth Brine Pond 2 is moderately vegetated with small shrubs and grasses. It is generally flat to undulating with an overall slope to the southwest. The southwest corner and western and northern margins of the proposed footprint is an old lake bottom. There are occasional dunes with their axis generally northeast to southwest, perpendicular to the prevailing wind direction from the northwest, in the middle of the proposed pond. These dunes, and the surface sediments to the east, are aeolian sediments that were likely deposited after the historic lakes drained.

3.3. Subsurface Conditions

The subsurface soils beneath Sawtooth Brine Pond 2 to a depth of approximately 75 ft bgs are generally interbedded fluvial and lacustrine deposits with significant crossbedding sedimentary structure in the fluvial deposits. The predominant soil type is poorly-graded sand to silty sand with thin to thick sequences of lacustrine clays sporadically located through the subsurface.

Two cross sections were generated along the proposed interior toes of the Sawtooth Brine Pond 2 east and west embankments, as shown on Appended Figure 1. These sections extend to the north into the existing Sawtooth Brine Pond 1 footprint to present similar depositional environments of complexly interbedded fluvial deposits with lacustrine sediments within the subsurface conditions of the two facilities. The western and eastern cross sections are shown on Figures 2 and 3, respectively.

The groundwater depth was determined to decrease to the south and west of the facility. In general, the existing groundwater table is approximately 10 ft bgs at the southwest corner of Sawtooth Brine Pond 2 and increase to about 25 to 30 ft bgs in the northeast corner. This indicates the direction of groundwater flow is to the southwest. As groundwater generally follows topography towards local drainages, the current groundwater condition and gradient could be a result of pumping within the area.

SPT blowcounts from field penetration tests are commonly used to estimate engineering parameters of soil deposits such as relative density or stiffness, strength, and compressibility. Based on blowcounts, the cohesionless sediments tend to be medium dense to very dense and the cohesive sediments tend to be stiff to hard. Strength properties of the foundation materials for the geotechnical evaluation of the facility were also estimated from blowcounts.

3.4. Seismic Hazard

The seismic hazard for the site was updated using the United States Geologic Survey (USGS) interactive deaggregation tool. The maximum credible earthquake (MCE) was assumed to be a probabilistic event with a return period of approximately 5,000 years and the operating basis earthquake was assumed to be a probabilistic event with a return period of approximately 200 years. The resulting peak ground accelerations at the site were determined to be 0.215g and 0.049g for the MCE and OBE events, respectively, as shown in Appended Figures 4 and 5.

4. SAWTOOTH BRINE POND 2 DESIGN

4.1. Sawtooth Brine Pond 2 Configuration

Sawtooth Brine Pond 2 was designed very similarly to that of Sawtooth Brine Pond 1. Containment will be provided by embankments constructed with homogenous fill material excavated from the pond area. The embankments will have a crest width of 22 ft, 2.5H:1V interior slopes and 2H:1V exterior slopes. Sawtooth Brine Pond 2 will share the northern embankment with the existing Sawtooth Brine Pond 1 southern embankment. As the embankment crest heights vary, the Sawtooth Brine Pond 2 will buttress against the Sawtooth Brine Pond 1 embankment. See Drawing A110 for embankment sections and details.

The pond depth varies from 32 to 50 ft and the maximum embankment height is approximately 47 ft that correlates to a crest elevation of 4678 ft above mean sea level (amsl). To contain the required operational volume of 5,600 ac-ft and provide sufficient storage for the 100 year/24 hour storm event, the resulting maximum pond elevation is 4674 ft. Given this elevation, the resultant distance to the embankment crest is 4 ft.

It is assumed that the embankment will settle a maximum of 1 foot over the operating life (see Section 5.2) and as such the 4 ft distance to the crest includes a design freeboard of 3 ft with a 1 foot settlement allowance. To verify that a 3 ft design freeboard is sufficient, a wave height calculation was completed. The potential total wave run up was calculated to be 1.18 feet and therefore the 3 ft of freeboard is sufficient. See Appendix C4 for calculation details.

Note that the operational volume was given by Sawtooth and the meteoric volume for the 100 year/24 hour storm event, which results in a storm depth of 2 inches (in), was determined from the original design. See Appended Figure 6 and Appended Table 2 for the Sawtooth Brine Pond 2 filling curve and table.

These design elements in addition to the design features discussed in the following sections are presented in the Design Criteria in Appendix A. See Drawing A020 and A100 for details regarding the Sawtooth Brine Pond 2 layout and configuration.

4.2. Site Grading

The disturbance area of Sawtooth Brine Pond 2 is approximately 190 acres. The area will be cleared of deleterious material (assumed depth of 3-inches) and the earthwork construction will include excavation of borrow material from the pond bottom and placement of the material as a continuous embankment terminating along the southern boundary of Sawtooth Brine Pond 1. The basin grading will generally conform to the existing natural grade and will slope at an approximate 0.5 percent grade from the northeast corner to the southwest corner, where the LCRS and PCMS sumps will be located. Full descriptions of these systems are presented in Sections 4.5 and 4.6 of this report.

The interior surface of the pond will be constructed with a prepared subgrade that will be constructed and compacted in accordance with the Technical Specification presented in Appendix B.

4.3. Embankment Crest

As stated previously the embankment crest width is 22 ft and provides for a 10.5 ft wide access road and 1.5 ft tall safety berms. The access road will be overlain by a 6-in thick layer of wearing course. Anywhere the access road crosses a brine or overflow pipe a 1 ft minimum ramp will be constructed. Refer to Drawings A110, A120 and A130 for embankment crest and pipe ramp details.

4.4. Liner System

Sawtooth Brine Pond 2 will have a composite liner system that includes both an LCRS and PCMS. The system design consists of a primary liner of 80-mil HDPE single-sided textured geomembrane and a secondary 60-mil HDPE geomembrane liner. The liners will be separated by a drainage layer using 130-mil drainage studs fabricated with the primary liner and installed face down against the secondary liner. The double liner system will cover the pond basin and interior embankment slopes. Installation requirements are presented in the Technical Specifications in Appendix B.

The liner anchor trench will be constructed at a setback of 3 ft with trenched dimensions of 4 ft deep by 3 ft wide. To further secure the anchor trench on the embankment crest, 6 inches of the total trench backfill will be compacted on the secondary liner prior to placement of the primary liner. The factor of safety for tensile failure and anchor pull-out due to self-weight was analyzed and the configuration was deemed suitable. See Appendix C2 for calculations.

4.5. Leak Collection and Recovery System (LCRS)

The LCRS utilizes the interstitial space created by the drainage layer to transmit potential flows between the primary and secondary liners. In the event that a leak occurs in the primary liner,

the fluid will drain along the secondary liner to the LCRS sump which is located in the pond's low point in the southwest corner of the pond. In addition to the transmission of flows through the liners, a 4-in diameter perforated CPe collection pipe will be placed along the west and south embankment toes to increase lateral flows to the sump.

Any potential leaks will be detected through the use of level transmitters and be removed from the sump using submersible pumps. The pumps will be encased in two 18-in diameter HDPE DR11 pump sleeves that will be installed between the primary and secondary liners. The discharged fluid will be circulated back to the pond. The fluid that is discharged can be tested for the presence of brine to indicate a leak through the primary system.

The LCRS sump has 25 by 25 ft base dimensions, is 3.5 ft deep from the pond bottom and has 2.5H:1V sideslopes. The sump is sized consistent with Sawtooth Brine Pond 1. For sump sizing see Appendix C3 which presents an excerpt from Appendix D-3 from the AMEC Final Design Report.

The sump will be lined with 60-mil HDPE geomembrane that runs continuous from the pond basin lining and be overlain by a 10-oz non-woven cushion geotextile. Select gravel will be placed in the sump to a depth of 3.5 ft which is overlain by 10-oz non-woven geotextile and primary liner which runs continuous from the pond basin lining. See Drawing A220 for further details and the Technical Specifications in Appendix B for construction details.

Leakage flow rates were calculated based on principles from Giroud et al. (1997) using a formula for the "Geomembrane Leakage Rate Underlain by Permeable Media." Given the average head on the liner and the total wetted area of Sawtooth Brine Pond 2 (the maximum operating level) the leakage rate was calculated to be 455 gallons per minute (gpm) or 2.7 gpm per acre. For further details, see the leakage rate calculation presented in Appendix C1.

4.6. Process Component Monitoring System (PCMS)

A PCMS will be installed, consistent with Sawtooth Brine Pond 1, to detect potential leaks in the secondary liner. The PCMS consists of toe drains along the length of the embankment that is made up of 4 in diameter perforated CPe pipes placed in 0.5 ft deep trenches located beneath the secondary liner. Additionally, three (3) trenches will be excavated along the pond bottom, orthogonal to the pond basin grading. The pipes will transmit flows to the PCMS sump located in the ponds low point in the southwest portion of the pond.

The PCMS sump was sized consistent with the PCMS dimensions of Sawtooth Brine Pond 1. For sump sizing see Appendix C3 which presents an excerpt from Appendix D-3 from the AMEC Final Design Report.

The PCMS has 25 by 25 ft base dimensions and 2.5H:1V side slopes. An 80-mil HDPE single-sided textured geomembrane will be placed on the sump bottom to prevent vertical infiltration of water. Overlaying the geomembrane will be a 10-oz non-woven geotextile followed by 2 ft of select gravel and the double liner system which runs continuous from pond basin lining. One (1) – 18 in diameter DR 11 pipe pump sleeves will be installed from the sump bottom to the pond crest to be used as a riser pipe. See Drawing A230 for further details and the Technical Specifications in Appendix B for construction details.

Leakage flow rates were calculated based on principles from Giroud (1997) on "Geomembrane Leakage Rate Underlain by Relatively Low Permeability Soil." Assuming that the hydraulic head on the secondary liner is equal to or less than 1 foot, the maximum leakage rate was calculated to be 11 gallons per minute (gpm). For further details, see the leakage rate calculation presented in Appendix C1.

4.7. Diversion Channel

A stormwater diversion channel was designed to the east of Sawtooth Brine Pond 2 which ties into the channel constructed for Sawtooth Brine Pond 1. As the channel will include stormwater runoff from a watershed that was not previously included in the channel sizing analysis, a hydrologic analysis and stormwater control design was completed. Peak runoff from the upstream watershed was estimated using a HEC-HMS model and the required channel size was determined.

From the analysis it was determined the channel will be trapezoidal and constructed with a 12 ft bottom width, 3H:1V side slopes, and a minimum depth of 2 ft. A perimeter road will be constructed adjacent to the channel and be 15 ft wide overlain by a 6 in thick road wearing course. See Appendix C5 for the analysis details and Drawing A400 for further diversion channel details.

4.8. Groundwater Monitoring

To monitor groundwater impacts for the area, seven (7) proposed monitoring well locations have been proposed around the Sawtooth Brine Pond 2 facility. See Drawing A300 for the proposed locations and installation details. Additionally two (2) groundwater monitoring wells which were installed as part of the Sawtooth Brine Pond 1 construction will be abandoned to allow for the Sawtooth Brine Pond 2 construction. These ground water monitoring wells will be abandoned according to the Utah Administrative Code (UAC) R655-4-14 "Abandonment of Wells."

4.9. Spillway

Consistent with the construction of Sawtooth Brine Pond 1 a spillway will not be installed as the pond is sized to contain both the brine solution and meteoric water up to the 100-yr/24-hr storm event. Solution from the pond will be recycled through a brine recovery system back to caverns to aid in the mining process or from Sawtooth Brine Pond 2 to Sawtooth Brine Pond 1 based on capacity conditions. For details on the brine recovery system see Drawings A130 and A140.

5. GEOTECHNICAL EVALUATION

5.1. Sawtooth Brine Pond 2 Stability Evaluation

Stability assessment of the Sawtooth Brine Pond 2 slopes was completed for both static and seismic conditions. Stability analyses were performed using the computer program SLIDE 6 by Rocscience. SLIDE is a two-dimensional slope stability program for evaluating circular or noncircular failure surfaces in soil or rock slopes using limit equilibrium methods. Spencer's procedure, which is applicable to all slope geometries and soil profiles, was utilized within the stability model and assumes all interslice forces are parallel and have the same inclination. Sawtooth Brine Pond 2 is considered an earthen embankment dam, and under the Utah Administration Code (UAC) 655-11 is required to maintain a factor of safety for static and pseudo-static conditions of 1.5 and 1.0, respectively.

To assess the stability of slopes during seismic loadings, a pseudo-static approach was utilized in which the potential sliding mass is subjected to an additional, destabilizing horizontal force that represents the effects of earthquake motions and is related to the PGA. Very simply, the seismic force is the weight of the sliding mass multiplied by a horizontal pseudo-static earthquake coefficient (k_H).

The seismic hazard for the site was discussed in Section 3.4 of this report, and the resulting PGA for the MCE and OBE events are 0.215g and 0.049g, respectively. A k_H equal to 2/3 of the PGA was adopted by AMEC (2011) in their stability analysis of Sawtooth Brine Pond 1 and has subsequently been adapted for the current stability analysis of Sawtooth Brine Pond 2.

5.1.1. Stability Model Development

Cross-section A was cut along the southern embankment perimeter adjacent to the access ramp, while cross-section B was cut along the western perimeter of the embankment, as shown in Appended F, Figure 1. The location of cross-section A was selected due to a slightly higher embankment height at this location, while the location of cross-section B was selected due to an elevated groundwater table. The geometry of each section was developed by overlaying the existing grade with the proposed final grade. The overall interior embankment slope was

modeled as 2.5H:1V, exterior slope modeled as 2H:1V, and the impounded brine modeled 3 ft below the crest. Subsurface soils were modeled with a surficial sand layer followed by alternating layers of clay and groundwater depth ranged between 22 ft in section A to 12 ft in section B as encountered during the subsurface investigation.

5.1.2. Material Properties

Material properties used for the stability evaluation are summarized in the Table 1. The material and strength characteristics of the sediments were developed considering the recent penetration test data (blowcounts) from the field investigation and results from recent and historic laboratory testwork (IGES, 2009; 2010a; 2010b). Brine impounded within the facility was modeled as layer with no strength and was not allowed to percolate into the embankment or subsurface soils since the pond is fully lined.

TABLE 1 - MATERIAL PROPERTIES USED IN THE STABILITY ANALYSES

Material	Moist Unit Weight (lb/ft^3)	Friction Angle (degrees)	Cohesion (lb/ft^2)
Embankment Fill	125	30	300
Clay Foundation	110	22	0
Sand Foundation	120	30	0
Brine	65	0	0

5.1.3. Results of the Stability Evaluation

The stability analysis resulted in acceptable factors of safety for both static and pseudo-static conditions, as shown on Table 2. A circular failure along the exterior slope of the embankment represented the critical failure form. Non-circular failure forms were evaluated but determined to be less critical than the circular failure forms. Failure output graphics from the stability model are included in Appendix F. Based on these results the proposed geometry of the pond embankments will remain stable under both static and pseudo-static conditions.

TABLE 2 - SUMMARY OF CALCULATED MINIMUM FACTORS OF SAFETY

Cross Section	Circular Static Stability	Circular OBE Pseudo-Static Stability	Circular MCE Pseudo-Static Stability
A	1.6	1.5	1.1
B	1.7	1.6	1.3

5.2. Settlement Evaluation

Settlement of the subgrade soils due to the embankment construction was estimated for Sawtooth Brine Pond 2. Settlements were assessed to quantify the range of potential vertical deformation within the foundation soils caused by the increase in static load from the facility. Elastic parameters of the granular soils were estimated based on blowcounts from the penetration tests, and consolidation parameters for the saturated clay materials were estimated from site specific laboratory testwork from the Sawtooth Brine Pond 1 design (IGES, 2009; 2010a; 2010b). Estimates predict that one foot of settlement or less will occur for the maximum facility loading. This estimate of potential settlement is conservative in consideration of monitoring of eight settlement monuments around Sawtooth Brine Pond 1. In general, the monitoring data indicates that the majority of the facility has seen a slight settlement underneath the embankments with a maximum recorded movement of 0.8-in.

To monitor the settlement of the Sawtooth Brine Pond 2 embankment, six (6) settlement monuments will be installed along the crest of the embankment. See Drawing A400 for details.

6. CONSTRUCTION QUALITY CONTROL AND CONSTRUCTION QUALITY ASSURANCE (CQC/CQA) PLAN

The "Magnum CQC/CQA Plan for Construction of Brine Ponds," prepared by Hansen, Allen & Luce, Inc., February 2013, which was used for the construction of Sawtooth Brine Pond 1 will be used in its entirety for the construction of Sawtooth Brine Pond 2. It is presented in Appendix G.

7. REFERENCES

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IGES (2010a). "Geotechnical Investigation, Western Energy Hub Gas Storage Facility Plant Site, near Delta, Utah," IGES Job No. 01286-004, April 19, 2010.

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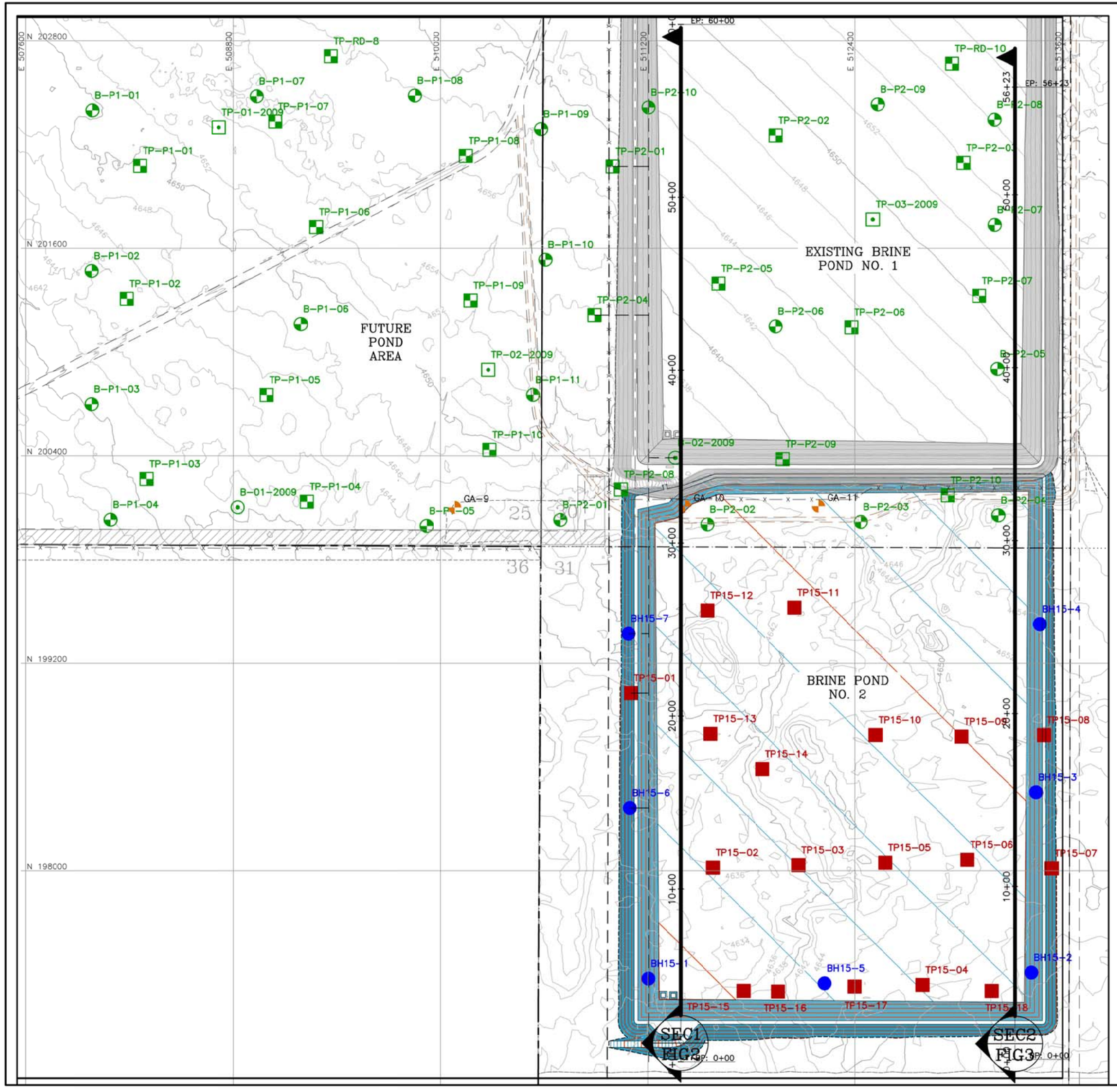
FIGURES



LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUNDWATER CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- EXISTING BRINE LINE
- B-01-2009 — BOREHOLE (IGES, 2009)
- TP-01-2009 — TEST PIT (IGES, 2009)
- B-P1-01 — BOREHOLE (IGES, 2010)
- TP-P1-02 — TEST PIT (IGES, 2010)
- BH15-1 — BOREHOLE (NEWFIELDS, 2015)
- TP15-01 — TEST PIT (NEWFIELDS, 2015)
- GA-10 — EXISTING GROUND WATER MONITORING WELLS

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

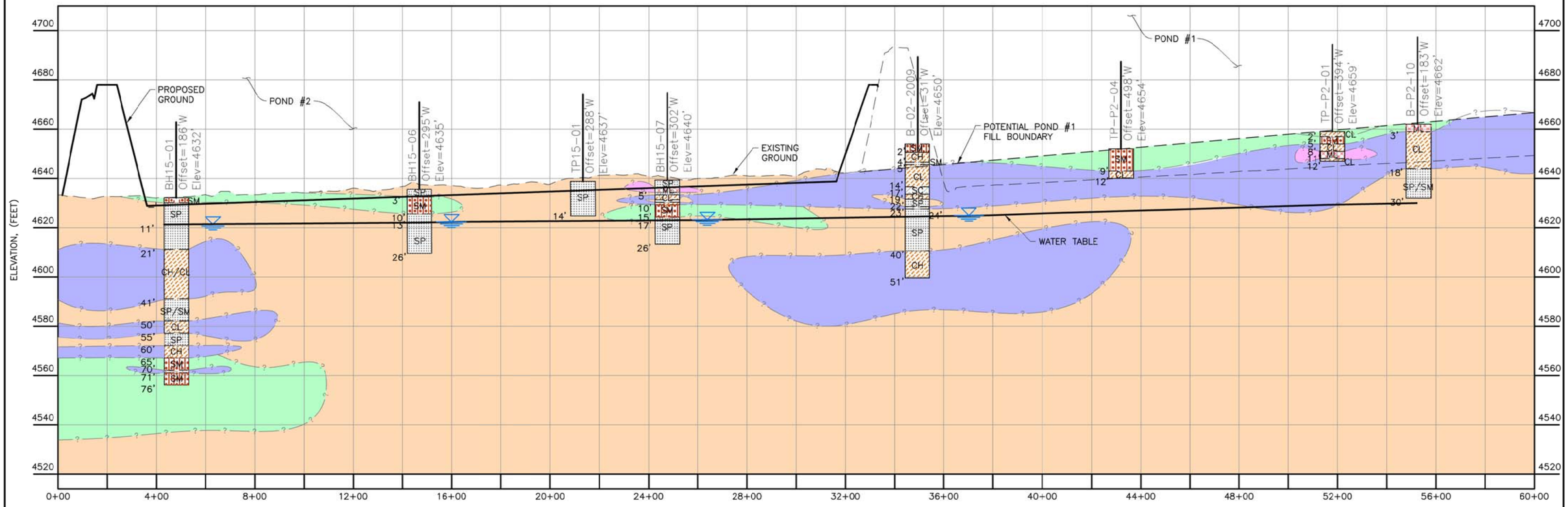
PROJECT: SAWTOOTH BRINE POND 2

TITLE: GEOTECH SECTIONS PLAN VIEW

FILENAME: Figure 01

FIGURE NO.: 1

REVISION: 0



0 200 400 FEET
HORIZONTAL

0 20 40 FEET
VERTICAL

10X EXAGGERATION

BORING LEGEND:

- CLAY (CL/CH)
- SILT (ML)
- POORLY GRADED SAND (SP)
- SILTY SAND (SM)
- CLAYEY SAND (SC)

INFERRED SOIL STRATIGRAPHY:

- CLAY DOMINATED
- SILT DOMINATED
- SAND DOMINATED
- SANDY SILT/ SILTY SAND

NOTES:

1. COLORED SHADING HAS NOT BEEN VERIFIED AND ONLY REPRESENTS MAJOR SOIL CLASSIFICATIONS INFERRED BY NEWFIELDS BASED ON BOREHOLE LOGS.

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

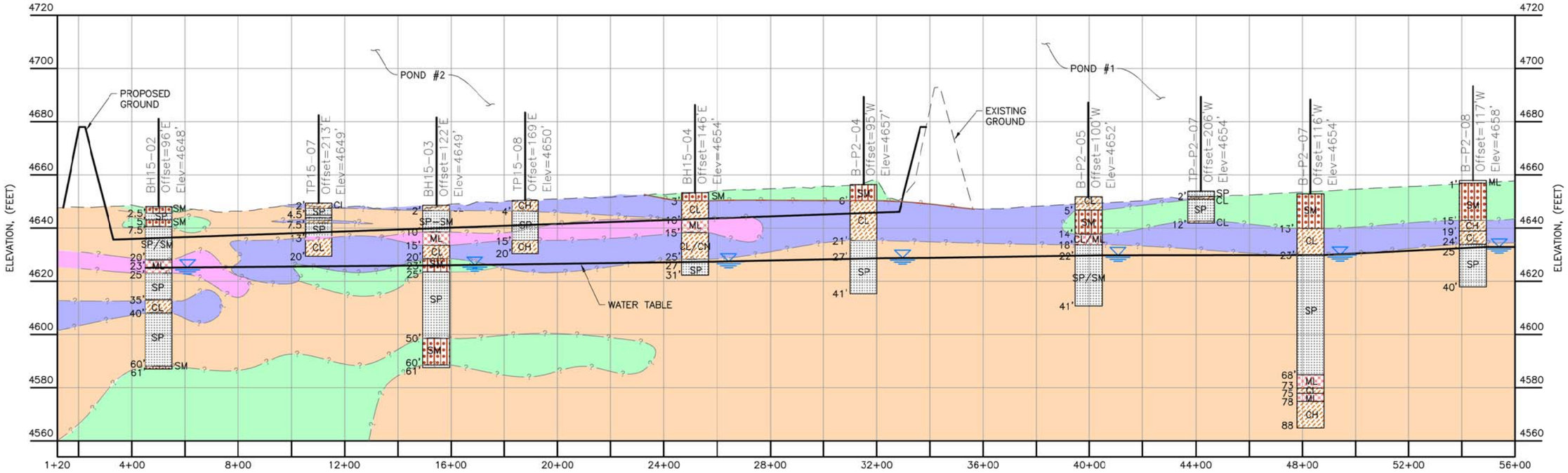
PROJECT: SAWTOOTH BRINE POND 2

TITLE: GEOTECH CROSS SECTION 1

FILENAME: Figure 02

FIGURE NO.: 2

REVISION: 0



0 200 400 FEET
HORIZONTAL

0 20 40 FEET
VERTICAL

10X EXAGGERATION

BORING LEGEND:

- CLAY (CL/CH)
- SILT (ML)
- POORLY GRADED SAND (SP)
- SILTY SAND (SM)
- CLAYEY SAND (SC)

INFERRED SOIL STRATIGRAPHY:

- CLAY DOMINATED
- SILT DOMINATED
- SAND DOMINATED
- SANDY SILT/ SILTY SAND

NOTES:

1. COLORED SHADING HAS NOT BEEN VERIFIED AND ONLY REPRESENTS MAJOR SOIL CLASSIFICATIONS INFERRED BY NEWFIELDS BASED ON BOREHOLE LOGS.

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

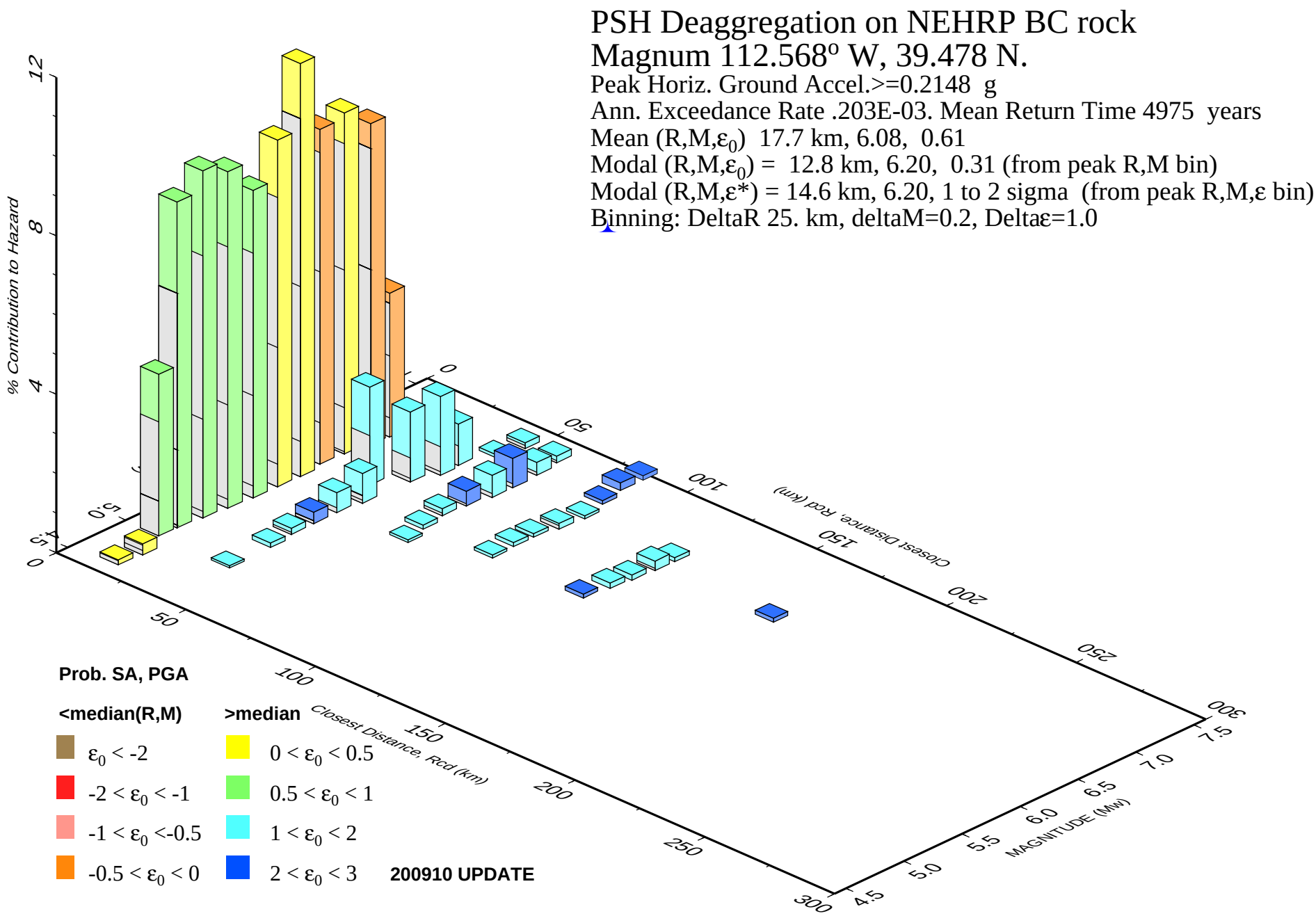
TITLE: GEOTECH CROSS SECTION 3

FILENAME: Figure 03

FIGURE NO.: 3

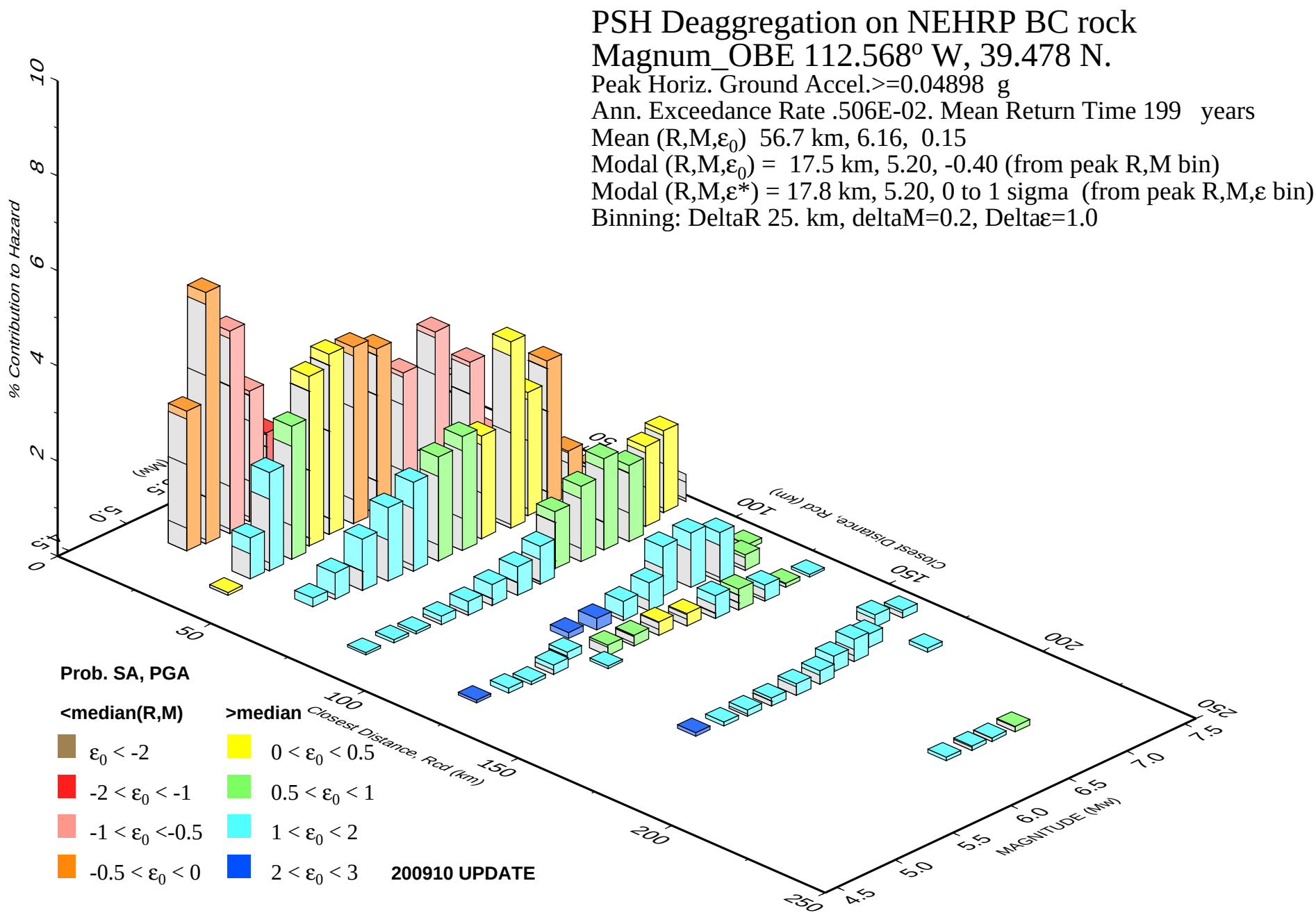
REVISION: 0

FIGURE 4 - PEAK GROUND ACCELERATION FOR THE MCE EVENT



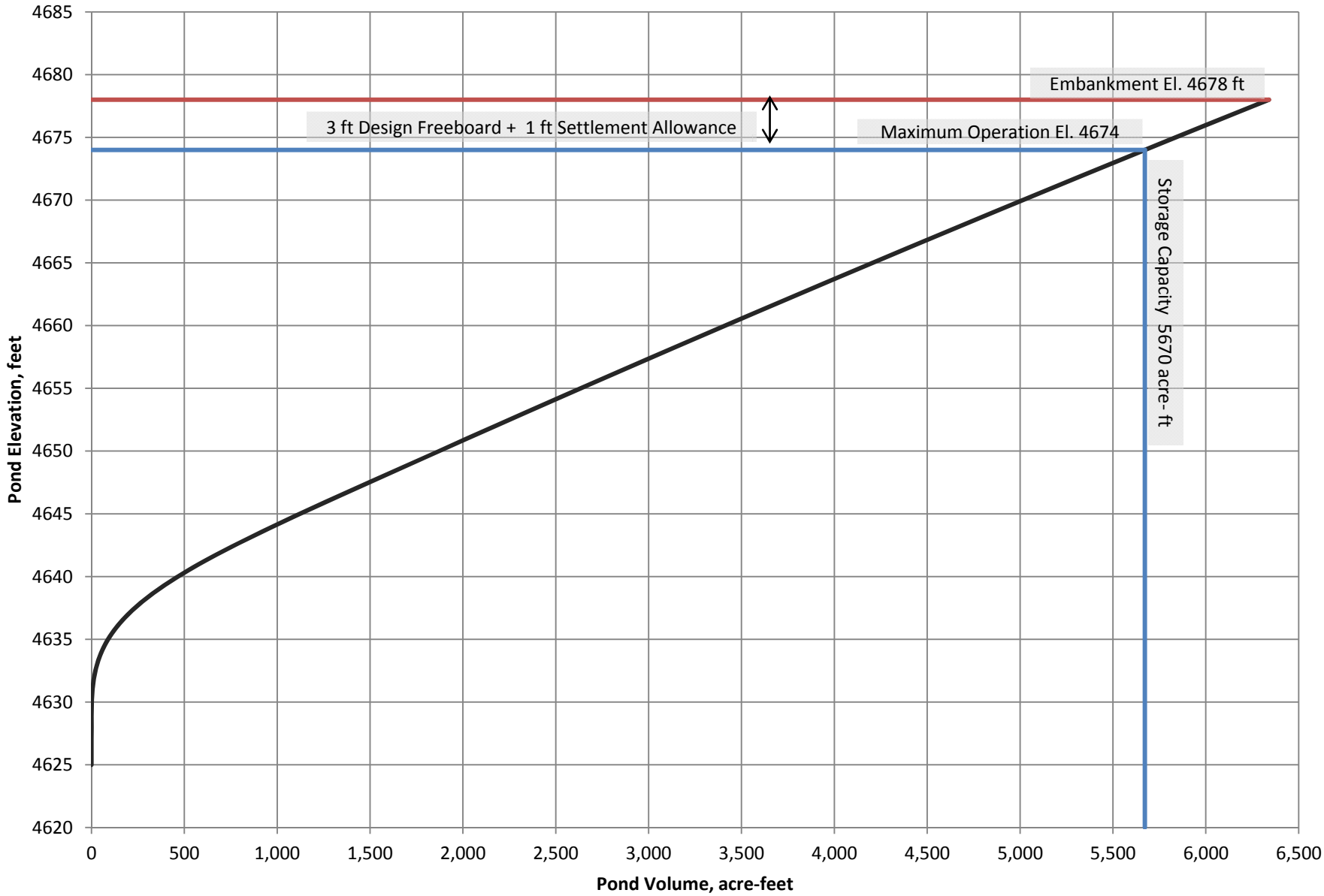
GMT 2015 Mar 31 23:09:47 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

FIGURE 5 - PEAK GROUND ACCELERATION FOR THE OBE EVENT



GMT 2015 Apr 1 13:51:40 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

FIGURE 6 - Sawtooth Brine Pond 2 Filling Curve



TABLES

NewFields

TABLE 1

Sawtooth Brine Pond #2

Geotechnical Investigation Laboratory Testing Summary

2015 Geotechnical Field Investigation
Borehole Test Pit Samples
NewFields Project # 475.0093.003

NewFields Sample ID	Depth (feet bgs)	DESCRIPTION	USCS	GRAIN SIZE DISTRIBUTION (% PASSING)										Insitu Moisture Content (%)	ATTERBERG LIMITS			STANDARD PROCTOR COMPACTION	
				GRAVEL		SAND						FINES	CLAY		PLASTIC LIMIT	LIQUID LIMIT	PLASTIC INDEX	OPTIMUM MOISTURE CONTENT	MAX DRY DENSITY (PCF)
				0.75"	0.375"	#4	#10	#16	#40	#50	#100	#200	2µm						
TP15-02	10'	lean CLAY	CL	**	**	100.0	99.9	99.8	99.8	99.2	94.6	87.7	**	26.4%	19	43	24		
TP15-03	5'	silty SAND	SM	**	**	100.0	99.7	99.3	98.8	98.5	81.3	40.1	**	8.8%				18.3%	101.2
TP15-05	3'	lean CLAY	CL	**	**	100.0	100.0	100.0	99.6	99.1	97.6	96.4	**	34.1%	22	46	24	31.7%	88.8
TP15-05	9'	slity SAND	SM	**	100.0	99.5	98.8	98.0	88.8	77.4	48.3	29.5	**	9.9%					
TP15-06	8'	lean CLAY	CL	**	100.0	99.8	99.5	99.1	96.6	94.1	87.4	74.5	37.2	20.7%	18	34	16	20.3%	106.2
TP15-08	3'	fat CLAY	CH	**	**	100.0	100.0	100.0	99.9	99.8	99.3	98.8	**	32.4%	22	53	31		
TP15-09	16'	lean CLAY	CL	**	**	100.0	100.0	100.0	99.8	99.6	98.9	98.2	**	35.9%	23	49	6	34.8%	86.4
TP15-09	12' & 16'	composite of (2) LD samples		**	100.0	99.7	99.4	99.1	95.6	90.1	75.1	49.9	**	**				22.4%	101.5
TP15-11	6'	silty SAND	SM	**	100.0	99.7	98.0	96.4	91.8	86.3	61.7	40.2	**	11.4%	NP	NP	NP	18.1%	106.0
TP15-13	4'	lean CLAY	CL	**	**	100.0	100.0	100.0	99.7	99.2	98.1	97.7	**	20.4%	19	41	22		
TP15-14	7'	lean CLAY w/ sand	CL	**	100.0	99.5	99.0	98.7	96.9	93.8	82.8	71.5	**	34.0%	14	31	17		
BH15-1	5 - 6.5'	poorly graded SAND	SP	**	100.0	99.5	98.1	97.2	84.1	56.6	12.3	5.2	**	3.8%					
BH15-1	25-26.5'	lean CLAY	CL	**	**	100.0	100.0	99.9	99.3	98.7	96.1	84.9	**	24.7%	22	30	8		
BH15-2	7.5-9'	poorly graded SAND w/ silt	SP-SM	**	100.0	99.4	98.5	98.1	95.0	82.6	23.8	8.4	**	**					
BH15-2	35-36.5'	lean CLAY w/ sand	CL	**	**	100.0	98.6	96.9	94.1	92.5	89.0	83.2	**	29.0%	22	44	22		
BH15-3	2.5-4'	poorly graded SAND w/ silt	SP-SM	**	100.0	98.1	95.2	91.9	72.0	52.1	20.1	10.5	**	3.5%					
BH15-3	10-11.5'	SILT w/ sand	ML	**	100.0	99.9	99.1	98.6	97.8	97.2	91.2	81.2	**	16.5%	NP	NP	NP		
BH15-3	15-16.5'	sandy lean CLAY	CL	100.0	99.5	99.1	97.4	96.8	94.5	90.9	72.4	53.7	**	26.3%	18	28	10		
BH15-4	2.5-4'	lean CLAY	CL	**	**	100.0	100.0	100.0	99.7	99.2	97.3	95.1	**	21.4%	18	45	27		
BH15-4	7.5-9'	lean CLAY	CL	**	**	100.0	100.0	100.0	99.9	99.7	97.9	95.6	**	27.4%	19	44	25		
BH15-4	10-11.5'	SILT	ML	**	**	100.0	100.0	100.0	99.9	99.7	98.1	95.7	**	**					
BH15-4	20-21.5'	lean CLAY	CL	**	**	100.0	99.9	99.7	98.8	97.0	90.4	84.7	**	34.1%	21	38	17		
BH15-5	5-6.5'	lean CLAY	CL	**	**	100.0	100.0	100.0	100.0	100.0	99.9	99.2	**	18.6%	15	31	16		
BH15-5	15-16.5'	SILT w/ sand	ML	**	**	100.0	99.9	99.6	97.8	96.5	91.4	79.2	**	19.9%	20	22	2		
BH15-5	25-26.5'	silty SAND	SM	100.0	99.1	98.4	96.4	94.4	82.2	69.1	53.1	39.5	**	20.6%					
BH15-6	2.5-4'	silty SAND	SM	**	**	100.0	99.9	99.5	97.6	95.2	73.1	48.9	**	9.9%	NP	NP	NP		
BH15-6	5-6.5'	silty SAND	SM	**	100.0	99.5	98.2	97.4	92.5	80.3	42.6	23.1	**	7.9%					
BH15-6	20-21.5'	slity SAND	SM	**	100.0	99.8	99.6	99.1	93.9	84.5	55.0	49.0	**	18.6%					
BH15-7	2.5-4'	SILT w/ sand	ML	**	**	100.0	100.0	100.0	99.7	98.6	88.5	78.7	**	5.5%	NP	NP	NP		
BH15-7	10-11.5	slity SAND	SM	**	**	100.0	100.0	100.0	99.9	99.5	69.0	15.1	**	4.3%					

TABLE 2

Project: Magnum Development Solution Mining
Subject: Sawtooth Brine Pond No. 2 Filling Table
Date: 2015.03.30
By: Kevin J.

ELEVATION	CUMULATIVE AREA (SF)	CUMULATIVE VOLUME (CY)	CUMULATIVE VOLUME (AC-FT)	
4625	739	10	0	SUMP
4626	1,883	61	0	
4627	2,585	141	0	
4628	3,395	247	0	
4629	12,786	424	0	
4630	99,967	2,246	1	OPERATING
4631	270,113	8,827	5	
4632	523,224	23,236	14	
4633	859,301	48,540	30	
4634	1,278,343	87,810	54	
4635	1,780,351	144,113	89	
4636	2,364,380	220,516	137	
4637	2,980,029	319,336	198	
4638	3,598,642	440,976	273	
4639	4,204,456	585,411	363	
4640	4,753,328	751,208	466	
4641	5,236,107	936,128	580	
4642	5,641,851	1,137,451	705	
4643	5,970,557	1,352,320	838	
4644	6,222,225	1,577,877	978	
4645	6,396,855	1,811,265	1,123	
4646	6,494,448	2,049,628	1,270	
4647	6,528,319	2,290,201	1,420	
4648	6,555,929	2,531,754	1,569	
4649	6,583,590	2,774,257	1,720	
4650	6,611,302	3,017,713	1,870	
4651	6,639,065	3,262,122	2,022	
4652	6,666,880	3,507,486	2,174	
4653	6,694,745	3,753,808	2,327	
4654	6,722,661	4,001,089	2,480	
4655	6,750,628	4,249,331	2,634	
4656	6,778,647	4,498,535	2,788	
4657	6,806,716	4,748,704	2,943	
4658	6,834,837	4,999,838	3,099	
4659	6,863,008	5,251,941	3,255	
4660	6,891,231	5,505,013	3,412	
4661	6,919,504	5,759,056	3,570	
4662	6,947,829	6,014,072	3,728	
4663	6,976,205	6,270,064	3,886	
4664	7,004,633	6,527,032	4,046	
4665	7,033,112	6,784,978	4,206	
4666	7,061,642	7,043,904	4,366	
4667	7,090,224	7,303,813	4,527	
4668	7,118,857	7,564,705	4,689	
4669	7,147,542	7,826,582	4,851	
4670	7,176,278	8,089,447	5,014	
4671	7,205,066	8,353,300	5,178	
4672	7,233,905	8,618,145	5,342	
4673	7,262,795	8,883,982	5,507	
4674	**7,291,737**	**9,150,813**	**5,672**	
4675	7,320,730	9,418,641	5,838	FREEBOARD
4676	7,349,775	9,687,466	6,005	
4677	7,378,871	9,957,291	6,172	
4678	7,408,019	10,228,117	6,340	

APPENDIX A – DESIGN CRITERIA

Magnum Development Solution Mining
Sawtooth Brine Pond #2
Design Criteria

DESCRIPTION	VALUE	SOURCE
Brine Pond 2		
Storm event direct precipitation, 100-year/24-hour storm event	2-in	Permitted Evaporation Pond Design[1]
Pond Minimum Storage Volume	5600 acre-ft	MDSM[2]
Freeboard	3-ft design freeboard with 1-ft settlement allowance	Permitted Evaporation Pond Design[1]
Brine Pond Features		
Construction Materials	homogenous earthfill	Permitted Evaporation Pond Design[1]
Pond side-slopes (Inner Embankment)	2.5(Horizontal):1(Vertical)	Permitted Evaporation Pond Design[1]
Pond side-slopes (Outer Embankment)	Upstream slope: 2.5H:1V, downstream slope: 2H:1V	Permitted Evaporation Pond Design[1]
Crest Width	22-ft	Permitted Evaporation Pond Design[1]
Crest Access Road Width	10.5-ft	Permitted Evaporation Pond Design[1]
Safety Berm Height	18-in	Permitted Evaporation Pond Design[1]
Design Flow - Brine Pond 1 to Brine Pond 2	5,000 gpm	MDSM[2]
Lining system	80 mil HDPE single-sided textured primary geomembrane with 130-mil drainage studs installed face down , 60 mil HDPE secondary liner	NewFields MDTS[3] & Permitted Evaporation Pond Design[1]
Leak Collection and Recovery System (LCRS)		
System	Drainage layer, Cpe pipes between primary and secondary liner to transmit flows to the LCRS sump	Permitted Evaporation Pond Design[1]
LCRS Sump Dimensions	25-ft by 25-ft	Permitted Evaporation Pond Design[1]
LCRS Sump Sideslopes	2.5H:1V	Permitted Evaporation Pond Design[1]
Sump Basin Grading	2 percent	Permitted Evaporation Pond Design[1]
LCRS Sump Depth	3.5-ft	Permitted Evaporation Pond Design[1]
Process Component Monitoring System (PCMS)		
System	Trenches will be excavated beneath the secondary liner containing Cpe pipe in drainage material to transmit flows to a PCMS sump	Permitted Evaporation Pond Design[1]
PCMS Sump Dimensions	25-ft by 25-ft	Permitted Evaporation Pond Design[1]
PCMS Sump Sideslopes	2.5H:1V	Permitted Evaporation Pond Design[1]
PCMS Sump Depth	3.5-ft	Permitted Evaporation Pond Design[1]
Geotechnical Evaluation		
Maximum Credible Earthquake		
Annual Exceedance Probability (Return Period)	0.0002 (4975 yrs)	UAC R655-11-5A
Mean Magnitude	6.08	USGS Deagg. Tool
Rupture Distance	17.7 km	USGS Deagg. Tool
Peak Ground Acceleration	0.215g	USGS Deagg. Tool
Operating Basis Earthquake		
Annual Exceedance Probability (Return Period)	0.05 (200 yrs)	UAC R655-11-5A
Mean Magnitude	6.16	USGS Deagg. Tool
Rupture Distance	56.7 km	USGS Deagg. Tool
Peak Ground Acceleration	0.049g	USGS Deagg. Tool
Static Minimum Factor of Safety	≥1.5	UAC R655-11-6A
Psuedo-static Minimum Factor of Safety	≥1.0	UAC 655-11-5C
Allowance for Facility Settlement	1 ft	NewFields MDTS[3]

1. Permitted design for Evaporation Ponds 1 -3 is based on the "Magnum Gas Storage, LLC, Evaporation Ponds Final Design Report, May 23, 2011," by AMEC
2. Magnum Development Solution Mining
3. NewFields Mining Design and Technical Services

APPENDIX B – TECHNICAL SPECIFICATIONS

APPENDIX B1 – TECHNICAL SPECIFICATIONS FOR EARTHWORKS MATERIALS AND CONSTRUCTION

NewFields	**CLIENT** MAGNUM DEVELOPMENT SOLUTION MINING	**PROJECT NO** 475.0093.003
PROJECT SAWTOOTH BRINE POND 2		
TITLE TECHNICAL SPECIFICATIONS FOR EARTHWORKS MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-EW-0

REV	DATE	PAGES	APPROVALS			REMARKS
			ORIGINATOR	PM/PIC	CLIENT	
0	04/06/15	18	KCW	KJ	SQ	Issued for Construction

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NewFields	**CLIENT** MAGNUM DEVELOPMENT SOLUTION MINING	**PROJECT NO** 475.0093.003
PROJECT SAWTOOTH BRINE POND 2		
TITLE TECHNICAL SPECIFICATIONS FOR EARTHWORKS MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-EW-0

REV	DATE	PAGES	APPROVALS			REMARKS
			ORIGINATOR	PM/PIC	CLIENT	
0	04/06/15	18	KCW	KJ	SQ	Issued for Construction

LIST OF TABLES

1.0 GENERAL

This specification defines the requirements for the earthwork construction activities for Sawtooth Brine Pond 2. The specifications set forth in this document cover the foundation conditioning and workmanship for earthworks construction.

Any alternatives or exceptions to this specification shall be submitted in writing to the Owner or its designated representative(s)/agent(s) and shall be approved by the Engineer.

1.1 Definition of Terms

- "Owner" is defined as Sawtooth NGL Caverns, LLC.
- "Owner's Construction Representative" is defined as Magnum Development Solution Mining LLC.
- "Engineer" is defined as the Consultant or Engineering Company responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "Contractor" is defined as the party(s) that has executed the contract agreement for the specified Work with the Owner or its authorized representative(s)/agent(s). The Owner may elect to perform the services of the Contractor.
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the Owner, the Engineer, or others that apply to the Work.
- "Drawings" are defined as the Drawings for Sawtooth Brine Pond 2 furnished by the Owner, Engineer, or others that apply to the Work.
- "Site" is defined as the Project site near Delta, Utah that is being developed by the Owner and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the Owner or its authorized representative(s)/agent(s) with the Contractor to complete specified portions of the Work.
- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.
- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by Owner and Engineer in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.
- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" – In general, these Specifications and the Drawings will utilize English units, however metric units will be used when appropriate.

2.0 EARTHWORKS

This section presents the technical requirements for the earthworks construction for Sawtooth Brine Pond 2.

All equipment used by the Contractor shall meet satisfactory conditions and comply with the Specifications with the approval of the Engineer. The Engineer or Owner reserves the right to request in writing a change in the required equipment or procedure of any work and the earthwork Contractor shall comply.

2.1 Control of Surface Water Runoff

The surface water runoff control including temporary and permanent berms, canals and any other control measures, shall be built according to the line and grade indicated on the Drawings and maintained throughout the work.

The earthwork Contractor shall build berms, and embankments and other erosion control measures required to prevent significant run on or transport of sediments from the rock storage area, and other areas of the work that may be subject to the effects of meteoric waters.

The earthwork Contractor shall provide equipment and perform all necessary work to maintain the areas of surface water collection to remove sediments from the water before it leaves the immediate area. The Contractor shall provide the temporary erosion control measures and make improvements immediately to these control measures if deemed necessary by the Owner or Engineer. The earthwork Contractor shall prevent damage to the work areas due to drying, water runoff and sediment control.

The earthwork Contractor shall remove all temporary installations of erosion control measures when they are no longer necessary and restore the areas affected by these measures.

The earthwork Contractor shall be responsible for the damage that results from rainfall runoff and for failed erosion control measures.

2.2 Earthwork Specifications

2.2.1 Clearing and Stripping

The natural ground surface is to be cleared and stripped of all organic and objectionable materials to the limits shown on the Drawings or as required by the Engineer. The limits of stripping shall generally extend approximately 10 feet outside of the Work activity areas as shown on the Drawings. Any clearing and stripping beyond the limits shown on the Drawings, or as required by the Engineer, shall be subject to the approval of the Owner.

Stripping shall mean the removal of topsoil, which shall be defined as soil of any gradation or degree of plasticity that contains significant quantities of visually identifiable plant matter, sod, roots, or humus as determined by the Engineer. Over much of the facility and associated construction areas, stripping will consist of removal of the sagebrush and vegetation cover with limited removal of surface soil (approximately 6 inches) generally being required. In areas where the topsoil extends to depths greater than 6 inches, the excavations shall extend to a greater depth as directed by the Owner. The stripped material shall be hauled to stockpile areas as instructed by the Owner. Stripped surface soils and vegetation suitable for use for future reclamation purposes shall be stockpiled separately from material viewed as unsuitable for reclamation purposes.

Clearing and stripping will be carried out using whatever method is deemed necessary, providing it is consistent with producing an acceptable end result as determined by the Owner and the Engineer.

After stripping of the required area, the surface shall be treated as specified on the Drawings or in the Technical Specifications. Prior to any surface treatment on a stripped area, the Engineer shall be notified to inspect the stripped area and designate the method of treatment required for continuance of Work. A survey shall be taken of the area if necessary to determine quantities and/or for verification of lift/layer thickness.

2.2.2 Grading/Embankment and Foundation Preparation

Once the work area has been cleared and stripped to the satisfaction of the Engineer, the surface shall be prepared before any overlying materials are placed. All work areas shall be graded according to the limits shown on the Drawings. Areas of both cut and fill shall be required to bring the grading of the work area to the elevations specified in the Drawings.

Areas that are to be filled within the basin area and embankment random fill zones shall have the exposed surface scarified to a depth of approximately 8 inches; moisture conditioned; and compacted to 90 percent of the maximum dry density as determined by ASTM 01557 to ensure a good foundation is provided for the first lift of fill. (Note: The Engineer may waive this requirement if the exposed surface soils, without manipulating, will provide a firm, non-yielding surface for fill placement, in which case the surface shall be moistened, lightly scarified, and the first layer of fill placed.) Cut surfaces and/or natural ground surfaces, on which fill will not be placed within the basin area, shall be scarified to a depth of 8 inches; moisture conditioned; and compacted to form a firm non-yielding surface suitable for placement of the overlying geomembrane liner. Areas where in situ materials are not suitable as a geomembrane subgrade (i.e., coarse gravel and rock) shall be covered with imported, fine-grained materials, moisture conditioned, and compacted to the specified requirements.

All boulders and cobbles that are located at the surface and/or partially exposed in a finish cut or fill area that could be detrimental to the overlying construction shall be removed as directed by the Engineer.

Areas of unsuitable material as determined by the Engineer or areas of pre-existing fill not compacted to the specifications shall be excavated to the limits designated by the Engineer and replaced with compacted random fill.

The Earthwork Contractor is responsible for maintaining the surface in a satisfactory condition after approval of the Engineer. The Contractor shall protect the prepared surface from weather, construction equipment and other factors.

2.2.3 Excavations and Borrow Areas

Excavation methods, techniques, and procedures shall be developed with consideration to the nature of the materials to be excavated and shall include all precautions that are necessary to preserve, in an undisturbed condition, all areas outside the lines and grades shown on the Drawings or as required by the Engineer. Excavation, shaping, etc., shall be carried out by whatever method is considered most suitable, providing it is consistent with producing an acceptable result as determined by the Engineer. Excavations shall be graded to provide drainage and prevent ponding. For excavations that cannot be graded to drain, the Contractor shall make provisions for the equipment and labor necessary to keep the excavations free of standing water.

No excavation beyond the lines and grades shown on the Drawings or as required by the Engineer shall be completed without the prior approval of the Engineer/Owner. If such additional excavation is done without prior approval and, in the opinion of the Engineer, requires backfilling to satisfactorily complete the Work, such backfilling shall be approved by the Engineer and shall be completed at the Contractor's cost. The Contractor shall protect and maintain all excavations until the adjacent placement or overlying placement of material has been completed.

The Contractor shall coordinate borrow activities with the Engineer to allow the sampling and testing of materials prior to their excavation. The Contractor shall allow the Engineer adequate time to evaluate potential borrow materials. Materials from excavations within the works or borrow areas that meet the specified requirements for other construction materials shall be stockpiled or placed in fill areas as directed by the Engineer/Owner. Unsuitable or excess materials shall be hauled to waste or stockpile areas.

The materials obtained from borrow pits or Owner-stockpiled material shall be selected to ensure that the gradation requirements for the various construction materials are achieved and

that the materials are as homogeneous as possible. Care shall be taken to avoid cross-contaminating different types of materials.

On-site borrow areas shall be developed within the limits shown on the Drawings or as required by the Owner. Should the Contractor wish to develop additional borrow sources, the Contractor shall receive written approval from the Owner prior to proceeding. Approval by the Owner may require that subsurface investigations be carried out to obtain samples as are required by the Engineer to make an appropriate assessment of the suitability of the borrow materials in the area for the intended use.

Borrow pit operations shall be subject to the approval of the Owner and Engineer and shall avoid waste of any suitable construction material therein. Clearing and stripping of any borrow area is to be completed with all salvageable topsoil stockpiled in areas designated on the Drawings or as directed by the Owner. Each borrow area shall be developed with due consideration for drainage and runoff from the excavated surfaces so as not to cause erosion of the adjacent terrain. Each borrow area shall be excavated in near-horizontal layers and in such a manner that water will not collect and pond except as approved by the Owner. Before being abandoned, the sides of any borrow areas outside the Work area shall be brought to stable slopes (not steeper than 2.5H:1V) with slope intersections rounded and contoured to provide a natural, neatly graded appearance.

Waste and topsoil piles shall be leveled, trimmed, and shaped to prevent the occurrence of ponding and concentrations of surface runoff and to provide a neat appearance. Finished slopes of the waste and topsoil stockpiles shall be graded to 2.5H:1V for interim reclamation. All surface water runoff shall be directed to available natural drainage courses.

Care shall be taken to minimize and control the generation of dust.

2.2.4 Fill Materials

Earthfill shall not be placed until the clearing and stripping, and required foundation preparations have been completed; and the foundation has been inspected and approved by the Engineer; and any required surveys completed.

All material used for fill shall be loaded and hauled to the placement site, dumped, spread, and leveled to the specified layer thickness. Fill shall be moisture conditioned and compacted to form a dense integral fill in accordance with the Technical Specifications and as approved by the Engineer. Care shall be taken at all times to avoid segregation of the material being placed and, if required by the Engineer, all pockets of segregated or undesirable material shall be removed and replaced with material that matches the surrounding material. All oversize material shall be removed from the fill material either prior to it being placed or after it is dumped and spread

but prior to compaction. No additional payment will be made to remove oversized materials unless the work is specifically identified as a payment item on the Schedule of Quantities.

For most construction conditions, the fill is to be constructed in near horizontal layers with each layer being completed over the full length and breadth of the zone before placement of subsequent layers. Each zone shall be constructed with materials meeting the specified requirements and shall be free from lenses, pockets, and layers of materials that are substantially different in gradation from the surrounding material in the same zone, as determined by the Engineer.

Except in areas approved by the Engineer, where space is limited or as otherwise specified, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of fill. The hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their travel routes evenly over the surface of the fill to aid in compaction of the fill placed.

Moisture conditioning is the operation required to increase or decrease the moisture content of material to within the specified limits. If moisture conditioning is necessary, it may be carried out by whatever method the Contractor deems is suitable, provided it produces the moisture content specified in these Technical Specifications or designated by the Engineer. The contractor shall take the necessary measures to ensure that moisture is being distributed uniformly throughout each layer of material being placed immediately prior to compaction. Measures shall be adopted as are necessary to ensure that the designated moisture content is preserved after compaction until the overlying layer is placed.

All particles having dimensions that interfere with compaction in the fill as determined by the Engineer shall be removed from the zone in which they were placed either prior to or during compaction.

The rolling pattern for compaction of all zone boundaries or construction joints shall be such that the full number of roller passes required in one of the adjacent zones, or on one side of the construction joint, extends completely across the boundary or joint.

2.2.4.1 Random Fill

The random fill for the embankment will generally be borrowed within the pond basin.

Material Properties - The random fill containing less than 30 percent rock (materials above ¾-inch size and up to 8-inch maximum rock size) and rock fill containing more than 30-percent rock (materials above ¾-inch size) will have a wide range of Unified Soil Classifications and may contain significant variations in gradation and compaction properties. Random fill shall be

placed in areas where the material is not required to be of uniform character and engineering properties. Random fill shall be free of roots, grass and other organic material and consist of inorganic soil and rock materials from required excavations, mine waste, or borrow material from other sources, as approved by the Engineer.

Materials containing rock or cobbles, and gravel from required excavations may be used subject to the Engineer's approval and provided the rock be reasonably graded such that large void spaces do not result. Further, the maximum size rock shall be no larger than 2/3 the lift thickness.

Placement Methods - Random fill shall be moisture conditioned to within 2 percent of the optimum moisture content, placed in 12-inch maximum loose lifts, and compacted to 90 percent of the maximum dry density (ASTM D1557). Slight variations from the specified moisture range may be acceptable subject to the acceptance of the Engineer and provided the required compacted densities are achieved. The random fill material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift layer. If the random fill placement and compaction utilizes 90-ton or larger haul trucks, the lift thickness can be increased subject to the approval of the Engineer.

Rock fill containing more than 30-percent rock (materials above ¾-inch size) shall be spread, placed, and compacted using procedures based on the results of a test fill. The type of compaction equipment, number of passes, and maximum rock size and loose lift thickness will be approved by the Engineer in writing based on the acceptable test fill performance. The Contractor shall outline his proposed procedures for moisture conditioning and fill placement, and submit them to the Engineer for review and approval.

For rock fills, the Contractor shall construct a test fill to verify the adequacy of the compaction equipment for achieving the required density. The test fill may be located so that it is incorporated into the fill area. The test fill shall be constructed and monitored in accordance with the U. S. Army Corps of Engineers' (USACE) guidelines for test fill construction (USACE, EM 1110-2-2301).

The data to be collected during construction of the test fill shall include the following:

- Lift thickness of 1, 2, and 4-feet (three test fills to determine optimum lift thickness)
- Amount of settlement after every two passes of the compactor to a maximum of 25 passes
- Gradation and moisture content of in-place material
- In-place fill density at completion of the test by nuclear gauge or other methods approved by the Engineer. If rock fill the water replacement method may be required to assess compaction.

A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the required minimum number of passes for acceptable compaction. In general, the minimum number of passes will be that number to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the Engineer of the lift thickness and minimum required passes will be based on review of the test data.

Maximum rock size for rock fills shall be two thirds of the compacted lift thickness, unless otherwise approved by the Engineer. Oversize materials shall be removed from the fill.

2.2.4.2 Select Gravel

Material Properties - Select gravel shall be a processed or natural clean gravel material containing nonplastic fines in accordance with ASTM D4318. The select gravel shall consist of processed gravels composed of hard, durable stone particles free from organic material and generally free of thin, flat, and elongated pieces. The material used for select gravel shall not breakdown appreciably when subjected to solutions with a pH of less than 5.0 as typically generated by sulfide bearing minerals.

Sieve Size (square openings)	Percent Passing (by dry weight)
2 -inch	100
1 ½ -inch	30-70
1 -inch	0-15
½ -inch	0-5

The select gravel material shall be non-plastic when tested.

2.2.4.3 Placement of Select Gravel

It is anticipated that the Select Gravel material will be imported from an off-site source by the Earthworks Contractor. The material will be hauled to the project site and stockpiled at locations approved by the owner. Care shall be used while placing this material as not to damage underlying CPe pipes or geomembrane.

2.2.4.4 Riprap

Riprap shall be hard, angular, durable, and reasonably well graded rock and shall be free of overburden, spoil, organic, or other deleterious material. Rounded stone is not acceptable. The riprap shall generally conform to the following gradation requirements as determined by

ASTM C136. The stone shall have a minimum specific gravity of 2.5. The riprap stone shall be such that its greatest dimension is not greater than three times its least dimension.

D60 = 3 inch

Sieve Size	Passing (%)	Typical Stone Mass
6 in (150 mm)	100	
3 in (75 mm)	35 – 55	1.3 lbs
1.5 in (32.5 mm)	0 - 20	

D60 = 6 inch

Sieve Size	Passing (%)	Typical Stone Mass
12 in (300 mm)	100	
9 in (225 mm)	50-70	35 lbs
6 in (150 mm)	35 – 55	10 lbs
2 in (50 mm)	2 - 10	0.5 lbs

D60 = 12 inch

Sieve Size	Passing (%)	Typical Stone Mass
24 in (525 mm)	100	
21 in (450 mm)	70 - 100	440 lbs
18 in (375 mm)	50-70	275 lbs
12 in (300 mm)	35 – 55	88 lbs
4 in (100 mm)	2 - 10	3 lbs

Minor deviations from the above may be acceptable, subject to the review and approval of the Engineer.

2.2.4.5 Placement of Rip Rap

Surfaces and piping to be protected by riprap shall be dressed to a smooth surface. All soft or objectionable material shall be removed as directed by the Engineer and replaced with an approved material. Materials underlying the riprap shall be placed in accordance with each materials specific placement specifications.

The riprap shall be placed as shown on the Drawings or as required by the Engineer in a manner that will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids and good stone interlocking/contact. The entire mass of stone shall be placed in reasonable conformance with the lines, grades, and thicknesses shown on the Drawings. Riprap shall be placed to its full thickness during a single operation and in such a manner as to avoid damaging or displacing the underlying bedding material or geotextile.

The larger stones shall be well distributed and the materials shall be placed and distributed so that there will be no large accumulations of either the larger or the smaller size stones. Hand placing or rearranging of individual stones by mechanical equipment may be required to achieve the results specified.

For grouted riprap, stones shall be placed with due care to prevent soil, sand, or spall from filling the voids. The rock shall be wet immediately prior to commencing the grouting operation. Joints shall be filled with grout from bottom to top and the surfaces swept with a stiff broom. Full depth penetration of the concrete mortar (grout) into the riprap shall be required. To achieve this spading and rodding and /or a small diameter vibrator (pencil vibrator) will be required.

Grouting shall not be done in freezing weather. In hot, dry weather, the work shall be protected and kept moist for at least three days after grouting, or clear membrane curing compound may be used.

No loads will be allowed on the finished grouted riprap until 70 percent of the specified concrete mortar strength has been achieved or as approved by the Engineer.

2.2.4.6 Road Wearing Coarse (Aggregate Base)

Material Properties - The roadway-wearing surface is to be constructed using select mine-waste material. A source for the material will be provided by the Owner. Some removal of oversized rock will be required. Wearing course shall generally conform to the following gradation requirements as determined by ASTM C136 and C117 or as approved by the Engineer.

Sieve Size (square openings)	Percent Passing (by dry weight)
4 -inch	100
3/4 -inch	50-70
No. 4	35-50
No. 16	15-40
No. 200	2-10

The plasticity index for wearing course materials shall be no greater than 15.

Placement Methods –Wearing Course shall be placed in a maximum 12-inch lift to 95% of the maximum dry density as determined by ASTM D1557. The moisture content shall be sufficient to obtain adequate density.

2.2.4.7 Pipe Bedding and Pipe Backfill - Non-Perforated Pipe, Trench Installations

Material Properties - Pipe bedding and backfill material for foundations and corrugated metal circular culverts shall consist of materials with the following typical characteristics:

Sieve Size (square openings)	Percent Passing (by dry weight)	
	Pipe Backfill	Pipe Bedding
4 -inch	100	
3 -inch	90-100	
1-½ -inch	--	100
¾ -inch	--	90-100
No. 4	--	30-70
No. 40	--	--
No. 200	20 max	20 max
Plasticity Index	10 max	10 max

Pipe bedding and pipe backfill shall be free of organic or frozen material.

Placement Methods - Backfilling shall be done as soon as possible after pipe/culvert installation/construction. Suitable backfill, free from large lumps, clods, or rocks shall be placed alongside the structure in loose layers not exceeding 8–inches (200mm) thick to provide a berm

of compacted earth on each side of the pipe or structure (where applicable). The fill materials shall be a minimum of 5-feet wide or the width of the pipe diameter/structure but no less than required to operate the appropriate compaction equipment. Each 8-inch (200mm) layer shall be moisture-conditioned, as required to facilitate compaction, and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D1557 or as directed by the Engineer.

If it is necessary to construct a haul or other vehicle road over the pipe trench, the Engineer shall be consulted prior to the initiation of trench construction for specification modification to achieve structure sufficient for such traffic loading.

Backfill shall be placed symmetrically on each side of the structure. The backfill differential on either side of the pipe shall not exceed 8–inches (200mm), or one quarter of the diameter of the structure (whichever is less).

Prior to adding each new layer of loose backfill material until a minimum 12-inches (300mm) of cover is obtained, an inspection shall be made of the inside of the structure for local or unequal deformation caused by the backfilling operation. Only hand-operated tamping equipment shall be allowed within vertical planes 3-feet (approximately 1-meter) beyond the horizontal projection of the outside surfaces of the structure (or as recommended by the culvert/structure manufacturer/designer). No heavy earthmoving equipment shall be permitted over the structure until a minimum of 150 percent of the largest buried pipe diameter of compacted fill has been placed over the top of the structure (or the minimum cover recommended by the culvert manufacturer/designer). In no case shall the minimum compacted structural cover be less than 12-inches (300mm).

Backfill material shall not be placed against any concrete foundation, abutment, wing wall, or culvert until the concrete has been in place at least seven days or the compressive strength of the concrete is 75 percent of the required 28-day strength. On structures that are not permanently supported laterally and that cannot tolerate horizontal movement, internal bracing or support should be placed during backfill operations..

2.2.5 Finished Surface Preparation of Areas to Receive Geomembrane Lining

Areas to receive geomembrane lining shall be free of angular particles over 3/4-inch diameter and hard objects that may damage the geomembrane. Where excessive coarse material is exposed at the surface, rock removal by appropriate methods or other surface finishing as directed by the Engineer will be required. Rough areas with depressions or loose material shall be covered with a cushion of fine-grained materials or for large depressions, with screened prepared subgrade material (passed over ½--inch mesh screen) or equivalent. A smooth drum

compactor shall make a minimum of 1 pass over all areas to receive geomembrane, including the embankment slopes.

Once the Contractor believes that the prepared subgrade surface preparation is complete, an inspection will be completed by the geomembrane Liner Installation Contractor, Engineer, and Owner with the Earthworks Contractor present. Any areas requiring repairs shall be fixed by the Earthworks Contractor.

2.2.6 Compaction Equipment

Sufficient compaction equipment, of the types and sizes required to complete the work, shall be provided for compaction of the various fill materials. The use of alternative equipment will be dependent upon completion of suitable test fills to the satisfaction of the Engineer to confirm that the alternative equipment will compact the fill materials to the specified density.

Compaction equipment shall be maintained in good working condition at all times to ensure that the amount of compaction obtained is a maximum for the equipment. The Contractor shall provide the Owner and Engineer a list of proposed compaction equipment to be used before commencing Work.

2.2.6.1 Smooth Drum Vibratory Roller

Smooth drum vibratory rollers shall be equipped with a suitable cleaning device to prevent the accumulation of material on the drum during rolling. Each roller shall have a total static weight of not less than 20,000 pounds at the drum when the roller is standing on level ground. The drum shall be not less than 60-inches in diameter and 78-inches in width. The vibration frequency of the roller drum during operation shall be between 1,100 and 1,500 vibrations per minute, and the centrifugal force developed by the roller, at 1,250 vibrations per minute, shall not be less than 38,000 pounds.

For compaction by the vibratory roller, a single coverage shall be defined as one pass of the roller. A minimum overlap of 12-inches shall be maintained between the surfaces traversed by adjacent passes of the roller drum. During compaction, the roller shall be propelled at 2 miles per hour (mph) or lesser speed as approved by the Engineer. The power of the motor driving the vibrator shall be sufficient to maintain the specified frequency and centrifugal force under the most adverse conditions that may be encountered during the compaction of the fill. Propulsion equipment for the roller shall be adequate to propel the roller at speeds up to 4 mph.

2.2.6.2 Tamping-Foot ("Sheepsfoot") Roller

The majority of the fill may be compacted with a tamping-foot roller. The tamping foot roller shall be self-propelled and fully ballasted with a standard tamping-foot design developing 5,000 pounds in force per linear foot of width at rest on level ground or equivalent as approved by the Engineer.

2.2.6.3 Special Compactors

Special compactors shall be used to compact materials that, in the opinion of the Engineer, cannot be compacted properly by the specified larger vibratory roller because of location or accessibility.

Special compaction measures shall be adopted such as hand-held or small walk behind compactors or other methods approved by the Engineer to compact fill in trenches, around structures, and in other confined areas that are not accessible to the larger vibratory roller or tamping-foot roller. Such compaction shall be to the specified density for the particular material.

3.0 QUALITY CONTROL

The Engineer will take samples of fill materials and perform gradation, moisture content, Atterberg Limits, and field density tests on the compacted fill and any other tests that the Engineer considers necessary to ensure that the fill being placed meets the specified requirements. The results of the tests carried out by the Engineer will be final and conclusive in determining compliance with the Technical Specifications. Test Methods are listed in Table 1 of Section 5.0.

Each lift of fill will be approved by the Engineer prior to placement of additional fill materials. Sufficient time shall be allowed by the Contractor for the Engineer to carry out the required test work and interpret the test results in order to determine the acceptability of each lift. Cooperation shall be given by the Contractor, to the Owner and the Engineer, for taking samples or making tests, and such assistance shall be rendered as is necessary to enable sampling and testing to be carried out expeditiously.

Tests carried out by the Engineer will be performed in accordance with the latest test methods prescribed by the American Society for Testing and Materials (ASTM) and other such recognized industry standards. The tests shall include Control and Record Tests.

3.1.1.1 Control Tests

Tests for gradation, moisture content, moisture density relationship, and other tests, where applicable, will be made by the Engineer on samples of fill materials taken from borrow areas

and on the fill after spreading and prior to compaction at frequencies sufficient to ensure that the fill material is in full compliance with the Technical Specifications.

3.1.1.2 Record Tests

The Engineer will conduct field density, moisture content, and other tests on the compacted in-place fill and will obtain samples of the compacted fill for related laboratory testing at such frequency as the Engineer considers necessary to determine that the compacted fill is in full compliance with the Technical Specifications.

4.0 QUALITY ASSURANCE CONSTRUCTION TOLERANCES

The Contractor shall construct the various aspects of the evaporation ponds to the lines and grades shown on the Drawings, or as required by the Engineer, within the following tolerances:

- Finish grades and slopes for the embankment and basin shall be in general conformance with the Drawings. Deviations from finished grades/slopes are subject to approval by the Engineer and shall not result in low spots; pockets; non-uniform slopes or contours; or result in slopes, which deviate by more than 1 percent from the design; or result in slopes of less than 1/2 percent within the basin
- The maximum permissible combined horizontal and vertical deviation of the perimeter boundaries of the embankment from the lines and grades shown on the Drawings or as required by the Engineer shall be 36 inches
- The finished surface of the basin prepared surface shall not deviate vertically by more than 4 inches than the lines and grades shown on the drawings.
- The elevation and width of the embankment crest shall not be less than the dimensions shown on the Drawings or required by the Engineer

All pipes shall be constructed to the following tolerances:

- Alignment and grade shall not deviate more than 5 percent of the nominal diameter of the pipe from a straight line between control points.

5.0 TESTING FREQUENCIES

The Engineer will carry out frequent quality control/assurance tests as described herein to determine compliance of the Work with the Technical Specifications. The latest edition of standard procedures shall be used for all activities, and in general, these will be adopted from recognized organizations such as the American Society of Testing and Materials (ASTM). The following tables outline the test methods and the minimum testing requirements for the project:

Table 1
Test Methods

Test	Type of Test	Test Method (ASTM)
C1, R1	Atterberg Limits	D4318
C2, R2	Moisture Content	D2216
C3, R3	Particle Size Distribution	D422 [a]
C4, R4	Laboratory Compaction-Mod. Proctor	D1557
R5a	Nuclear Density	D2922
R5b	Sand Cone	D1556
R5c	Water Replacement	D5030
C6, R6a	Laboratory Permeability	D5084

Notes: C = Control Tests; R = Record Tests

[a] **Hydrometer tests down to the 2-micron size will be carried out as directed by the QA Engineer but will generally not be required; all samples to be washed over a No.200 sieve.**

Table 2
Test Fre uency – Random Fill

Test	Type of Test	Frequency (one per)
R1	Atterberg Limits	50,000 yd^3
C2, R2	Moisture Content	15,000 yd^3
C3, R3	Particle Size Distribution	50,000 yd^3
C4, R4	Laboratory Compaction	Soil type/200,000 yd^3
R5a	Nuclear Density	15,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	1 per 10 nuclear density tests
C8, R8	Shear Strength	1 per 1,000,000 yd^3

Note: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests.

Table 3
Test Fre uency – Select Gravel

Test	Type of Test	Frequency (one per)
C1, R1	Atterberg Limits	1,000 yd³
C3, R3	Particle Size Distribution	1,000 yd³ or minimum of 2 tests
Note: Sample sizes to be sampled in accordance with ASTM standards.		

Table 4
Pipe Backfill/Pipe Bedding

Test	Type of Test	Frequency (one per)
R1	Atterberg Limits	Soil type/5,000 yd³ or 1 per structure
C2, R2	Moisture Content	per nuclear density requirements
C3, R3	Particle Size Distribution	5,000 yd³ or 1 per structure
C4, R4	Laboratory Compaction	Soil type/5,000 yd³
R5a	Nuclear Density	Greater of 4 per structure or 500 yd³
R5b	Sand Cone Density	every 10 nuclear density tests

Table 5
Test Fre uency – Road Wearing Course

Test	Type of Test	Frequency (one per)
R1	Atterberg Limits	2,000 yd³
R3	Particle Size Distribution	2,000 yd³

Table
Test Fre uency – Embankment Foundation

Test	Type of Test	Frequency (one per)
R1	Atterberg Limits	Soil type/100,000 ft^2
C2, R2	Moisture Content	50,000 ft^2
C3, R3	Particle Size Distribution	100,000 ft^2
C4, R4	Laboratory Compaction	Soil type/250,000 ft^2
R5a	Nuclear Density	50,000 ft^2
R5b	Sand Cone Density	1 per 10 nuclear density tests

Table
Test Fre uency – Basin Foundation

Test	Type of Test	Frequency (one per)
R1	Atterberg Limits	Soil type/200,000 ft^2
C2, R2	Moisture Content	100,000 ft^2
C3, R3	Particle Size Distribution	200,000 ft^2
C4, R4	Laboratory Compaction	Soil type/500,000 ft^2
R5a	Nuclear Density	100,000 ft^2
R5b	Sand Cone Density	1 per 10 nuclear density tests

APPENDIX B2 – TECHNICAL SPECIFICATIONS FOR CORRUGATED POLYETHYLENE PIPE (CPEP) MATERIALS AND INSTALLATION

NewFields	**CLIENT** MAGNUM DEVELOPMENT SOLUTION MINING	**PROJECT NO** 475.0093.003

PROJECT SAWTOOTH BRINE POND 2

TITLE TECHNICAL SPECIFICATIONS FOR CORRUGATED POLYETHYLENE PIPE (CPeP) MATERIALS AND INSTALLATION	**SPECIFICATION NO.** 0093.003-SPT-CPeP-0

			APPROVALS			
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1.0 GENERAL

This specification defines the requirements for Corrugated Polyethylene Pipe (CPeP) materials, installation, and quality control for Sawtooth Brine Pond 2.

Any alternatives or exceptions to this specification shall be submitted in writing to the Owner or its designated representative and shall be approved by the Engineer.

1.1 Definition of Terms

- "Owner" is defined as Sawtooth NGL Caverns, LLC.
- "Owner's Construction Representative" is defined as Magnum Development Solution Mining LLC.
- "Engineer" is defined as the Consultant or Engineering Company (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "Contractor" is defined as the party(s) that has executed the contract agreement for the specified Work with the Owner or its authorized representative(s)/agent(s).
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the Owner, the Engineer, or others that apply to the Work.
- "Drawings" are defined as the Construction Drawings for Sawtooth Brine Pond 2 furnished by the Owner, Engineer, or others that apply to the Work.
- "Site" is defined as the Project site near Delta, Utah that is being developed by the Owner and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the Owner or its authorized representative(s)/agent(s) with the Contractor to complete specified portions of the Work.
- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.
- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by Owner and Engineer in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.
- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" – In general, these Specifications and the Drawings will utilize English units, however metric units will be used when appropriate.

1.2 Codes and Standards

All pipe work shall be of the best quality available complying with the latest standards for the following:

- ANSI American National Standard Institute
- ASTM American Society of Testing and Materials
- AWWA American Water Works Association
- AASHTO American Association of State Highway Officials
- SPI Society of the Plastics Industry, Inc.
- PPI Plastics Pipe Institute

1.3 Material Properties

1.3.1 Corrugated Polyethylene Pipe (CPeP) with Smooth Interior

Pipe and fittings shall be made of virgin polyethylene compounds that conform with the applicable current edition of the AASHTO Material Specifications for cell classification as defined and described in ASTM D 3350. Resins that have higher cell classifications in one or more properties, with the exception of density, are acceptable provided the product requirements are met.

For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant tensile load (NCTL) test in accordance with ASTM F2136 except that the applied stress for the NCTL test shall be 600 psi (Note: The notched depth of 20 percent of the nominal thickness of the specimen is critical to this procedure). The average failure time of the five test specimens must exceed 24 hours with no single test specimen's failure time less than 17 hours.

Pipe and fittings shall be manufactured and comply with the current edition of AASHTO Standard Specifications M252 and M294. All sizes shall conform to the AASHTO classification "Type S" for smooth wall interior solid pipe and "Type SP" for smooth wall interior perforated pipe.

CPe pipe and couplings for watertight application shall be Advanced Drainage System ADS N12 WT IB. Prefabricated fittings for the watertight application shall have bell ends suitable for connecting to the pipe or alternatively shall have plain ends suitable for using bell-to-bell push-on gasketed couplings.

The pipe shall have a minimum pipe stiffness of 5-percent deflection when tested in accordance with ASTM D2412, as follows:

Nominal Diameter (inches)	Pipe Stiffness (psi)
4	70
6	65
8	60
10-12	50
15	42
18	40
24	34
30	28
36	22
42	20
48	18
60	14

The diameters refer to the inside pipe diameter.

Where perforations are specified, they shall conform to the requirements as follows:

- AASHTO M252 “Class 2” for 4-inch to 10-inch diameter CPeP
- AASHTO M294 “Class 2” for 12-inch to 36-inch diameter CPeP

Couplings (non-watertight) shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Couplings, unless watertight connections are specified, shall be split collar and shall engage at least two full corrugations on each pipe section. Where pipe is joined to other materials or fittings, or joined by other methods, the manufacturer’s recommendations shall be strictly enforced.

CPeP-to-HDPE pipe connections, if specified, shall be made using CPeP-to-HDPE adapters supplied by the CPeP manufacturer. The HDPE pipe end of the adapter shall match the DR (Dimensional Ratio) of the pipe being connected.

Pipe sizes and types shall be as specified on the Drawings, or as required by the Engineer.

1.4 Submittals

The CPeP material supplier shall submit to the Owner, upon request, a manufacturer's certification that all pipe and fittings they intend to supply comply with the applicable portions of the specifications.

1.5 Pipe Delivery, Handling, and Storage

Pipe, fittings, valves, and other appurtenances shall be loaded and unloaded by lifting with hoists in such a manner as to avoid damage or hazard. Under no circumstances shall pipe or pipe fittings be dropped to the ground or into trenches. Pipe handled on skid ways shall not be skidded or rolled against pipe already on the ground. The interior of all pipe and pipe fittings shall be kept free from dirt and foreign material at all times.

The Earthworks Contractor shall be responsible for any material furnished to him by the Owner and shall replace or repair, in a manner approved by the Engineer at the Earthworks Contractor's expense, all such material damaged in handling after delivery. This shall include the furnishing of all materials and labor required for the replacement of installed material damaged prior to the final acceptance of the Work.

1.6 Pipe Installation

CPe pipe shall be installed to the sizes, lines, and grades shown on the Drawings. Pipe sections shall be joined with manufacturer-supplied couplers with the open seam of the coupler turned to the side of the pipe. End caps shall be installed on the upstream ends of the pipe. Pipes shall be closely monitored during backfilling activities to ensure no damage is done to the pipe.

The pipe shall be installed to the lines and grades and generally in the manner shown on the Drawings. Where specific lines and grades are not indicated on the Drawings, the lines and grades will be determined by the Engineer in the field to suit the existing ground conditions. The Earthworks Contractor shall use equipment and methods acceptable to the Engineer and in accordance with the pipe manufacturer's recommendations for handling and placement of the pipe and fittings.

The Earthworks Contractor shall provide and install all piping required to complete the piping installation in accordance with good piping practices, regardless of whether such piping is specifically detailed on the Drawings. The general layout as shown on the Drawings shall be maintained. Where interference is encountered during installation or relocation of pipelines is deemed necessary, the Engineer shall be consulted before any changes are made.

All pipelines shall be erected to preserve accurate alignment. Care shall be taken in the installation of pipeline runs where drainage is required to ensure that the pipeline has a continuous slope to the point of drainage.

Prior to installation, each segment of pipe and all fittings shall be inspected for defects and/or damage. All pipe, fittings, and other appurtenances shall be carefully lowered into position, piece by piece. Under no circumstances shall such materials be dropped into position. Extreme care shall be taken to prevent foreign material from entering the pipe while it is being installed. Temporary end caps or other approved means shall cover open ends of the pipe when installation is not in progress.

Pipe bends to form curves either in the horizontal or vertical plane shall not exceed that recommended by the manufacturer or approved by the Engineer. The cutting of pipe for inserting fittings or closure pieces shall be done in a neat manner and with good workmanship without damage to the pipe and leaving a smooth end at right angles to the axis of the pipe.

Wherever obstructions not shown on the plans are encountered during construction, and where such obstructions interfere with the work to an extent that an alteration in the lines or grades of the pipe is required, the Engineer shall approve any deviation or arrange for removal, relocation, or reconstruction of the obstructions.

APPENDIX B3 – TECHNICAL SPECIFICATIONS FOR GEOMEMBRANE MATERIALS AND CONSTRUCTION

NewFields	CLIENT MAGNUM DEVELOPMENT SOLUTION MINING	PROJECT NO 475.0093.003
PROJECT SAWTOOTH BRINE POND 2		
TITLE TECHNICAL SPECIFICATIONS FOR GEOMEMBRANE MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-GM-0

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NewFields	CLIENT MAGNUM DEVELOPMENT SOLUTION MINING	PROJECT NO 475.0093.003
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TITLE TECHNICAL SPECIFICATIONS FOR GEOMEMBRANE MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-GM-0

REV	DATE	PAGES	APPROVALS			REMARKS
			ORIGINATOR	PM/PIC	CLIENT	
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0	04/06/15	17	KCW	KJ	SQ	Issued for Construction

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LIST OF TABLES

1.0 GENERAL

This specification defines the requirements for geomembrane materials, installation, and quality control associated with the Sawtooth Brine Pond 2.

Any alternatives or exceptions to this specification shall be submitted in writing to the Owner's Construction Representative with the bid.

1.1 Definition of Terms

- "Owner" is defined as Sawtooth NGL Caverns, LLC.
- "Owner's Construction Representative" is defined as Magnum Development Solution Mining LLC.
- "Engineer" is defined as the Consultant or Engineering Company (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "Construction Manager" is defined as the Consultant or Engineering Company responsible for the overall project completion.
- "Third Party Testing Contractor" is defined as the Consultant or Engineering Company (to be determined) hired by the owner to provide third party inspection and testing services for the overall project.
- "Contractor" is defined as the party(s) that has executed the contract agreement for the specified Work with the Owner or its authorized representative(s)/agent(s).
- "Installer" is defined as the qualified 3rd party(s) that have been hired to install the geomembrane for the specified Work.
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the Owner, the Engineer, or others that apply to the Work.
- "Drawings" are defined as the Construction Drawings for Brine Pond 2 furnished by the Owner, Engineer, or others that apply to the Work.
- "Site" is defined as the Project site near Delta, Utah that is being developed by the Owner and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the Owner or its authorized representative(s)/agent(s) with the Contractor to complete specified portions of the Work.

- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.

- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by Owner and Engineer in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.

- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.

- "Units" – In general, these Specifications and the Drawings will utilize English units, however metric units will be used when appropriate.

1.2 References

American Society for Testing and Materials (ASTM):

- ASTM Standard D4437, 1988 (1999), "Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes", ASTM International, West Conshohocken, PA, 1999, DOI: 10.1520/D4437-99, www.astm.org.

- ASTM Standard D5199, 2001 (2006), "Standard Test Method for Measuring the Nominal Thickness of Geosynthetics", ASTM International, West Conshohocken, PA, 1999, DOI: 10.1520/D5199-01R06, www.astm.org.

- ASTM Standard D5641, 1994 (2006), "Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber", ASTM International, West Conshohocken, PA, 1999, DOI: 10.1520/D5641-94R06, www.astm.org.

- ASTM Standard D5820, 1995 (2006), "Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes", ASTM International, West Conshohocken, PA, 1995, DOI: 10.1520/D5820-95R06, www.astm.org.

- ASTM Standard D5994, 1994 (2003), "Standard Test Method for Measuring Core Thickness of Textured Geomembrane", ASTM International, West Conshohocken, PA, 1994, DOI: 10.1520/D5994-98R03, www.astm.org.

- ASTM Standard D6365, 1999 (2006), "Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test", ASTM International, West Conshohocken, PA, 1999, DOI: 10.1520/D6365-99R06, www.astm.org.

- ASTM Standard D6392, 2010 (2012), "Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods", ASTM International, West Conshohocken, PA, 1999, DOI: 10.1520/D6392-10R12, www.astm.org.

- ASTM Standard 7240, 2006 (2011), "Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)", ASTM International, West Conshohocken, PA, 2006, DOI: 10.1520/D7240-06R11, www.astm.org.

Geosynthetic Research Institute (GRI):

- GRI GM 9, 1995, "Cold Weather Seaming of Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GRI GM 10, 1997 (2006), "The Stress Crack Resistance of HDPE Geomembrane Sheet", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GRI GM 13, 1997 (2009), "Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GRI GM 14, 1998, "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GRI GM 17, 2000 (2009), "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GRI GM 19, 2002 (2010), "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.

2.0 GEOMEMBRANE

The geomembrane used for Brine Pond 2 shall be the following:

- Secondary Liner consisting of 60-mil (1.5mm) Smooth High Density Polyethylene (HDPE)
- Primary Liner consisting of 80-mil (2.0mm) Single Sided Textured High Density Polyethylene (HDPE) Drain liner with 130 mil high raised studs

2.1 Manufacturer's Quality Control

The HDPE geomembrane shall be a high quality formulation containing approximately 97 percent polymer and 3 percent carbon black with antioxidants and heat stabilizers. It shall be resistant to ultraviolet (UV) rays. All resin shall be hexene-based, consist of all virgin material

from the same manufacturer, shall not be intermixed, and no reclaimed polymer may be added to the resin. The manufacturing process shall not use more than 10 percent rework. If rework is used, it must be similar HDPE to the parent material.

The geomembrane material shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures as applied to the mining industry. The material shall be produced to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. The geomembrane shall be supplied in roll form. Each roll shall be identified with labels indicating roll number, thickness, length, width, and manufacturer's name and date of manufacture.

The manufacturer's laboratory must be certified by Geosynthetic Accreditation Institute (GAI)/Laboratory Accreditation Program (LAP) for the tests being performed and shall have a third-party independent quality assurance program. The third party shall perform the required tests at the required frequency as stated in this specification or at such frequency as mutually agreed by the **Owner**, the **Engineer**, and the manufacturer at the time of award. All test results shall be provided to the **Engineer** and the rolls of material shall be clearly identified and correlate to the test results.

Extrudate rod or bead material shall be made from the same type of resin as the geomembrane and be from the same resin supplier as the resin used for manufacture of the geomembrane.

The material shall be warranted against manufacturer's defects as well as degradation due to UV light for exposed areas for a minimum of 20 years from the date of installation or as mutually agreed prior to award of the contract for supply between the **Owner** and the geomembrane manufacturer. This warranty shall cover the cost of material, freight and duties, handling, labor, and equipment to replace the defective or failed material.

2.2 Submittals Post-Award

The manufacturer shall furnish the following product data, in writing, to the **Owner** and the **Engineer** prior to shipment of the geomembrane material:

Resin data including the following:

- Certification stating that the resin meets the specification requirements and that it is all from the same manufacturer (see Table 4).
- Statement certifying no reclaimed polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).
- Copy of quality assurance and quality control certificates issued by resin supplier.

- All rolls shall be delivered with labels affixed to the selvage edge clearly stating the manufacturer's name, product identification, material thickness, roll number, roll type, roll dimensions and roll weight.

  Geomembrane roll, extrudate rod and bead material:

- Copy of quality assurance and quality control certificates issued by the geomembrane manufacturer and the HDPE third-party independent quality assurance tester.
- Certification that the geomembrane material delivered to the project complies with these specifications.
- Certification that extrudate rod or bead is from one manufacturer, is the same resin type, and was obtained from the same resin supplier as used to manufacture the geomembrane rolls.

2.3 Third Party Conformance Testing

During manufacturing of the geomembrane, samples are obtained and forwarded to the Geomembrane Quality Assurance Testing Laboratory by a third party (to be determined by the Engineer and Owner) for testing to ensure conformance with the Specifications.

Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise stated, samples shall be 3 feet long by the width of the roll. Unless otherwise stated, samples shall be taken at a frequency of no less than one per 2,000,000 square feet or one per lot, whichever is less.

The conformance tests shall be performed to verify conformance to the design Specifications as listed on Tables 1 for smooth geomembrane and Table 2 for textured geomembrane.

3.0 GEOMEMBRANE INSTALLATION

3.1 General

The HDPE geomembrane shall be installed on the areas shown on the Drawings or as directed by the **Engineer**. The **Installer** shall be an approved installer by the Manufacturer.

Prior to deployment of geomembrane, the **Installer** shall inspect and accept, with the **Engineer, Third Party Testing Contractor** and the **Owner**, all surfaces on which the geomembrane is to be placed. The surface on which the geomembrane is to be installed shall be free of sharp particles, rocks, or other debris to the satisfaction of the **Engineer**, the **Owner**, and the **Installer**. Sharp objects shall be removed by raking, sweeping, or handpicking as necessary.

The **Installer** shall supply the **Engineer** with panel layouts of the liner that must be approved by the **Engineer** prior to commencing the Work. It is the **Installer**'s responsibility to submit timely proposals (allowing a minimum of two weeks for approval).

Installation of the geomembrane shall be performed under the direction of a field engineer or supervisor who has installed a minimum of 10,000,000 square feet (ft^2) of the specified type of geomembrane or similar. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) with seaming experience of a minimum of 3,000,000 ft^2 of the geomembrane type specified or similar product, using the same type of seaming apparatus to be used in the current project. During the seaming, the Field Installation Supervisor or Master Seamer are present. Qualified technicians employed by the **Installer** complete all seaming, patching, testing, and other welding operations.

The geomembrane shall be placed over the prepared surfaces using methods and procedures that ensure a minimum of handling. Adequate temporary and permanent anchoring devices and ballasting shall be provided to prevent uplift and damage due to winds. The **Installer** is solely responsible for the safety of his operations including decisions regarding deployment in adverse weather conditions and the amount of temporary anchoring and ballasting required. The **Contractor** shall take necessary precautions to protect the geomembrane from any damage including prohibiting workers from smoking and wearing foot apparel that would damage the membrane.

To the extent possible, seams shall be oriented parallel to the fall line, slope or grade of the ground. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the geomembrane has been permanently anchored. Ballast material shall conform to the specified requirements for drainage material.

The **Installer** shall take into account that high winds are prevalent at the project site and may result in liner damage and delays. The **Installer** shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind. Fusion of panels and repairs will only be permitted under weather conditions allowing such work, and within the warranty limits of the geomembrane manufacturer, as approved by the **Owner** and the **Engineer**.

Horizontal field seams on slopes shall be kept to a minimum and require the approval of the **Engineer**. Horizontal seams on steep slopes shall be avoided where possible by cutting the liner at a 45-degree angle. Generally, horizontal seams are to be no closer than 10-feet from the toe of the slope. Horizontal seams shall be made by lapping the uphill material over the downhill material. Panels shall be shingled in a manner that prevents water from running beneath the liner.

The geomembrane shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. The installed geomembrane shall contain sufficient slack material to allow for thermal expansion and contraction during the annual extreme temperatures the geomembrane is expected to endure. Individual wrinkles should take the form of undulations in the liner but should not be large enough for the material to fold over on itself.

During installation, the **Installer** shall give each field panel an "identification" code number consistent with the layout plan. The **Third Party Testing Contractor** shall agree upon the numbering system. The **Installer** shall update the layout plan as each panel is installed to show the location of each panel. A field panel is defined as the area of geomembrane that is to be seamed in the field (roll or portion of a roll cut in the field).

Individual panels of geomembrane material shall be laid out in a pattern that will produce the least number of seams. The material shall be overlapped prior to welding. Extreme care shall be taken by the **Installer** in the preparation of the areas to be welded. The joint interface shall be cleaned and prepared according to industry standard procedures, those specified by the material manufacturer and those approved by the **Engineer**. Seaming shall not take place unless the panels are dry and clean. All sheeting shall be welded together by thermal methods.

Any area showing damage due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The cost of replacing or repairing the geomembrane shall be borne solely by the **Installer**.

No "fish mouths" will be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap extrusion weld applied.

Geomembrane panels must have a finished overlap of 4 to 6-inches for double-wedge welding seams and minimum 6-inches for extrusion welding seams. Notwithstanding this provision, sufficient overlap shall be provided to allow shear and peel tests to be performed on any seam.

Handling and storage of the geomembrane material shall be in accordance with the manufacturer's printed instructions. Persons walking or working on the geomembrane shall not engage in activities or wear foot apparel that could damage the geomembrane.

An adequate amount of handling equipment, welding apparatuses, and test equipment shall be maintained on site to avoid delays due to problems with equipment failures.

3.2 Geomembrane Installation Quality Control

General

The **Installer** shall submit a copy of his Quality Control Manual to the **Engineer** and **Owner** prior to the start of installation of any geomembrane. If there are discrepancies between this specification and the **Installer**'s Quality Control Manual, the more stringent requirements will apply unless determined otherwise by the **Engineer**.

The **Installer** shall be fully responsible for carrying out all quality control tests on the geomembrane and shall do so to the satisfaction of the **Engineer** and in accordance with this Specification and the **Installer**'s Quality Control Manual. On-site physical nondestructive and destructive testing shall be completed on all joints to ensure that watertight uniform seams are achieved on a continuous basis as installation proceeds. The **Third Party Testing Contractor** shall be present and witness all destructive tests. At the time of bid submission, details shall be provided by the **Installer** that set forth the method proposed for both destructive and nondestructive testing of seams. The **Engineer** shall approve these methods prior to the **Installer** commencing the Work. Visual inspection alone is unacceptable.

Fusion of panels and repairs will only be permitted under weather conditions allowing work that is in conformance to the Specifications and within the warranty limits imposed by the manufacturer and to the approval of the **Engineer**.

At a minimum, the **Installer**'s field installation test program shall consist of visual observations and continuity and strength tests as defined in the following subsections. The **Installer** shall not have more than 500,000 square feet of geomembrane deployed at any time without final QA/QC and acceptance by the **Third Party Testing Contractor**. At the beginning of each day's work, the **Installer** shall provide the **Third Party Testing Contractor** with copies of all the previous days' completed paperwork as well as an update of the quantity and location of geomembrane placed.

Trial Welds

Trial welds shall be completed to verify the performance of the welding equipment and operator prior to performing production welds. No welding equipment or operator shall perform production welds until equipment and operator have successfully completed a trial weld and approved by the **Third Party Testing Contractor**. The following procedures shall be followed for trial welds:

- Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

- Minimum of two trial welds per day per welding apparatus – one made prior to the start of work and one completed at mid-shift or for every 5 hours of seaming operations.
- Cut five 1-inch-wide-by-6-inch long test strips from the trial weld.
- Quantitatively test specimens for peel adhesion and for bonded seam strength (shear).
- Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear tests and:

  The break, when peel testing, occurs by Separation in the Plane of the sheet (SIP), not through adhesion failure separation (AD). When the seam separation is equal to or greater than 25% of the track width, it is a failed test.

  The break is ductile.
- Repeat the trial weld, in its entirety, when the trial weld samples fail in either peel or shear as defined on Table 3.

Field Seaming

The **Installer** shall have at least one Master Welder who shall provide direct supervision to other welders. The Master Welder's and other welder shall submit a description of their qualifications and experience to the **Owner and Engineer** for approval prior to arrival on site.

- The welding equipment shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the material to ensure changes in environmental conditions will not affect the integrity of the weld.
- The seam area shall be cleaned of dust, mud, moisture, and debris immediately ahead of the welding apparatus.
- The seam overlaps shall be aligned consistent with the requirements of the welding equipment being used. A 4-inch to 6-inch overlap shall be used for double-wedge welded seams and 6-inches for extrusion welded seams unless approved otherwise by the **Engineer**.
- Seaming shall not proceed when the ambient air temperature or adverse weather conditions jeopardize the integrity of the geomembrane installation. If adverse weather prevents work from being completed then the installer shall make-up the work during a scheduled day off. If enough adverse weather causes the schedule to extend beyond the agreed upon completion date then the **Owner** may compensate the **Contractor** for delays beyond their control.
- Extrusion welding apparatus' shall be purged of heat-degraded extrudate before welding.
- The double-wedge fusion welding process shall be used unless alternate methods are approved by the **Engineer**. Extrusion welding shall be permitted to weld short seams to repair small areas where double-wedge welding is not feasible, and for caps and patches.

Field Seam and Panel Inspection and Testing

Nondestructive Testing and Inspection

The **Installer** shall perform visual inspections of deployed and welded HDPE panels to identify defects, damage, or protrusion of sharp objects that may affect the integrity of the geomembrane. Defective or damaged areas shall be marked and repaired according to the technical specifications and the guidelines in the **Installer**'s Quality Control Manual.

A quality control technician or field engineer acting for the **Installer** and **Third Party Testing Contractor** shall inspect each seam, marking his initials and date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

Continuity Testing

A maximum effort shall be made by the **Installer** to install a perfect geomembrane liner. This implies that all seams completed in the field, patches, and extrusions shall be tested and recorded. All failures shall be isolated and repaired as directed by the **Engineer and Third Party Testing Contractor**. A general testing procedure for the **Installer** is included as follows:

- Test all field seams and patches with interseam pressure, vacuum box, spark tester, or other approved methods. Non-destructive testing methods are discussed in following subsections.
- Isolate and repair all areas indicating any leakage. Retest the repair.

Interseam Pressure Testing. Test procedure in accordance with ASTM D 5820 for interseam pressure for seams (for double-wedge welding only):

- Seal both ends of the seam to be tested by applying heat to the end of the seam via a heat gun until flow temperature is achieved. Clamp off the ends and let cool.
- Insert a pressure gauge with needle assembly into the end of the seam and seal.
- Pressurize the air channel between the two seams to between 30 psi and 35 psi. Following pressure stabilization, take the initial pressure reading, hold the pressure a minimum of 5 minutes and take a second reading.
- The allowable leak-down for the seam is 3 psi maximum.
- If the pressure does not drop below the maximum allowable 3 psi, open the air channel at the end away from the pressure gauge. Air should rush out and the pressure gauge should register an immediate drop in pressure, indicating that the entire length of seam has been tested. If this does not happen, either the air channel is blocked or the equipment is faulty, and the test is not valid.

- Enter the results of the leak test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.
- Repair the area where the pressure gauge/needle assembly was installed and where the air was released.

Vacuum Box Testing: Where possible, the **Installer** shall test all extrusion seams as follows:

- Mix a solution of liquid detergent and water and apply an ample amount to the area to be tested. If a seam contains excess overlap or loose edges, it must be trimmed before testing.
- Place a rigid transparent vacuum box over the area and apply a slight amount of downward pressure to the box to seat the seal strip to the liner.
- Apply a vacuum of 3 psi to 5 psi for a minimum of 15 seconds to the area. The **Installer** shall examine the geomembrane through the viewing window for the presence of soap bubbles indicating a leak. If no bubbles appear after 15 seconds, consider the area leak free. Once the area is leak free, depressurize the box and move it over the next adjoining area with an appropriate overlap and repeat the process.
- Enter the results of the leak test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

Spark Testing: Extrusion welded patches, caps, pipe boots, etc., in lieu of being vacuum-box testing, shall be spark tested in accordance with ASTM D 6365 and the following procedures:

- The seam shall be prepared for extrusion welding in accordance with the **Installer's** procedures.

- Just prior to applying the extrusion bead, a small-gauge copper wire (18-gauge bare copper wire or equivalent) shall be placed into the seam. The wire should be grounded at one end and placed at the edge of the top sheet of the overlap seam. Tucking the wire under the edge of the top sheet will help hold the wire in place during welding, but this should be done prior to grinding to avoid the risk of contamination of the weld area. Electrically conductive tape placed along the edge of the overlying patch can also be used instead of copper wire.

- Apply the extrudate bead as normal and allow the weld to cool.

- Complete a calibration test on a trial seam containing a non-welded segment ensuring the identification of such a defect (non-welded segment) under the planned spark tester settings and procedures.

- Energize the spark tester and move the electrode wand near the trial seam to determine the maximum length of spark that can be generated. Adjust the output voltage setting until the spark length exceeds the greatest potential leak path distance. This is typically the diagonal distance from the embedded wire to the edge of the weld bead at a "T" joint.

- Once the output voltage has been set testing may be started. Testing is performed by passing the electrode over the seams with the electrode in contact with the membrane or the extruded weld bead. The audible and visual indication of a spark provides the determination of a potential leak path.

- If a potential leak is detected the area can be repaired with a patch. Applying additional weld beads adjacent to the leaking weld is not an acceptable repair technique. This will only lengthen the leak path to the extent that the spark tester may not be capable of generating a spark of sufficient length to breach the lengthened gap.

- After patching, the seam must be retested until no defects are indicated.

- Enter the results of the spark test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

- When flammable gasses are present, use special care and precautions in the area to be tested.

Destructive Testing

Peel and shear seam strength testing shall be carried out on samples of seams removed from the installed panels. For these tests, the following procedures shall be followed:

- Coupon sampling of all field seams, including patches and repair areas, shall be taken by cutting perpendicular to the seams a sample approximately 36-inch by 12-inch. This sample shall be cut into three 12-inch by 12-inch samples and labeled with the sample number, date, time, location and seam number, and individually marked "**Owner** (Archive) Sample," "QA (**Third Party Testing Contractor**) Sample," and "**Installer** QC Sample." The frequency and location shall be determined by the **Third Party Testing Contractor** but shall not be less than one sample per 500-feet of field seams. These coupons shall be tested by the Installer on-site for peel and shear seam strength and thickness in accordance with ASTM D6392.
- Heat-welded seams shall be allowed to cool or warm to about 70°F prior to testing. Solvent seams, when used, shall be allowed to cure according to the manufacturer's recommendations. Additionally, at the **Engineer**'s option, approximately 10 percent of the coupons (size 1-inch by 6-inches) shall be sent to an independent laboratory for

confirmation testing. Should the lab and field tests conflict, installation shall halt until the conflict is resolved to the satisfaction of the **Engineer**.

The **Third Party Testing Contractor** shall continuously inspect the installation of the HDPE liner to ensure that the procedures specified in this section are adhered to fully.

Weld specimens shall pass the requirements for shear and peel presented in Table 3 and as follows:

- During testing, the break shall occur by Separation in the Plane of the sheet (SIP) not through adhesion failure separation (AD). When the seam separation is equal to or greater than 25% of the track width, it is a failed test.
- The break is ductile.

In the event of a failing test result, the following procedures shall be used:

The Installer shall follow one of two options:

- Reconstruct the seam between any two passed test locations, or
- Trace the weld to an intermediate location at least 10-feet or to where the seam ends in both directions from the location of the failed test. Once the failing limits of the seam are isolated, that portion of the seam shall be reconstructed or capped.

Seams welded prior to and after the failed seam using the same welding device and/or operator shall also be tested.

- Enter the results of the destructive testing on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

Repair Procedures

Damaged or defective geomembrane or seam areas failing a destructive or non-destructive test shall be repaired. Each repair requires a non-destructive test using either a vacuum box or spark testing methods. The **Installer** shall be responsible for repair of damaged or defective areas. The repair method shall be decided by the **Installer** but must be agreed upon by the **Third Party Testing Contractor.** Procedures available include the following:

- Replacement: Remove damaged geomembrane or unacceptable seam and replace with acceptable geomembrane materials if the damage cannot be satisfactorily repaired.
- Patching: Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Capping: Used to repair large lengths of failed seams.

Abrading and rewelding of small seam areas and welding the flap on fusion-welded seams are not acceptable repair procedures and shall not be accepted.

In addition, the following procedures shall be observed:

- Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to ensure cleanliness.
- All geomembrane shall be clean and dry at the time of repair.
- Extend patches or caps at least 6-inches for extrusion welds and 4-inches for wedge welds beyond the edge of the defect, and round the corners of the patch material. The edges of all patches are to be beveled.

Furthermore, repair verification shall be performed as follows:

Number, date, location, technician and test outcome of each patch.

Non-destructively test each repair using methods specified in this technical specification.

- Enter the results of the repair procedures on the appropriate documentation, indicating the repair verification. If the repair fails, the repair work and subsequent testing should be recorded on the same document.

4.0 CERTIFICATION

At the completion of the geomembrane installation, the **Installer** shall provide the **Engineer** and **Owner** with a certification stating that the geomembrane was installed and tested in accordance with the technical specifications together with a report of the test results. The certification shall be provided to the **Owner** prior to the demobilization of the installation personnel from the site unless agreed otherwise by the **Owner**. The report of the test results shall be provided in hard copy and digital format to the **Owner** and the **Engineer** no later than 30 days after the installation work has been completed.

5.0 COMPLETION

At the completion of the installation, the **Installer** shall provide a set of as-built drawings showing the actual geomembrane panel layout, seams, location of destructive test samples, and the location of major repairs including repaired seams and capped areas. The as-built panel layout must be submitted in hard copy and digital format to the **Owner** and the **Engineer** no later than 30 days after the installation work has been completed.

Table 1
HDPE Geomembrane - Smooth
(per GRI Test Method GM13 revision 12 dated 11/14/2014)

Properties	Test Method	Test Value		Testing Frequency (minimum)
		1.5 mm (60 mil)	2 mm (80 mil)	
Thickness (min. avg.) ▪ Lowest individual of 10 values	ASTM D5199	Nominal -10%	Nominal -10%	Each roll
Density mg/L (min.)	ASTM D1505/D792	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties[1] (min. avg.) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	ASTM D6693 Type IV	 126 lbs/in 228 lbs/in 12% 700%	 168 lbs/in 304 lbs/in 12% 700%	20,000 lbs
Tear Resistance (min. avg.)	ASTM D1004	42 lbs	56 lbs	45,000 lbs
Puncture Resistance (min. avg.)	ASTM D4833	108 lbs	144 lbs	45,000 lbs
Stress Crack Resistance [2]	ASTM D5397 (Appendix)	500 hrs	500 hrs	Per GRI-GM10
Carbon Black Content (range)	ASTM D4218 [3]	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	ASTM D5596	Note 4	Note 4	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.)[5] a) Standard OIT	ASTM D3895	100 min.	100 min.	200,000 lbs
--OR--				
b) High Pressure OIT	ASTM D5885	400 min.	400 min.	
Oven Aging at 85°C [5, 6] a) Standard OIT (min. avg.) – % retained after 90 days	ASTM D5721 ASTM D3895	55%	55%	Each formulation
--OR--				
b) High Pressure OIT (min. avg.) – % retained after 90 days	ASTM D5885	80%	80%	
UV Resistance[7] Standard OIT (min. avg.)	ASTM D7238 ASTM D3895	N.R.[8]	N.R.[8]	Each formulation
--OR--				
High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	ASTM D5885	50%	50%	

[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 yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
[3] Other methods such as D1603 (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.

Table 2
HDPE Geomembrane - Textured
(per GRI Test Method GM13 revision 12 dated 11/14/2014)

Properties	Test Method	Test Value		Testing Frequency (minimum)
		60 mils	80 mils	
Thickness (min. avg.)	ASTM D5994	Nominal (-5%)	Nominal (-5%)	Per roll
▪ Lowest individual for 8 out of 10 values		-10%	-10%	
▪ Lowest individual for any of the 10 values		-15%	-15%	
Asperity Height mils (min. avg.)[1]	D 7466	16 mil	16 mil	Every 2nd roll[2]
Density mg/L (min. avg.)	ASTM D1505/D792	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties[3] (min. avg.)	ASTM D6693 Type IV			20,000 lbs
▪ Yield strength		126 lbs/in	168 lbs/in	
▪ Break strength		90 lbs/in	120 lbs/in	
▪ Yield elongation		12%	12%	
▪ Break elongation		100%	100%	
Tear Resistance (min. avg.)	ASTM D1004	42 lbs	56 lbs	45,000 lbs
Puncture Resistance (min. avg.)	ASTM D4833	90 lbs	120 lbs	45,000 lbs
Stress Crack Resistance [4]	ASTM D5397 (App.)	500 hrs	500 hrs	Per GRI-GM10
Carbon Black Content (range)	ASTM D4218 [5]	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	ASTM D5596	Note 6	Note 6	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.)[7]				200,000 lbs
a) Standard OIT	ASTM D3895	100 min.	100 min.	
--OR--				
b) High Pressure OIT	ASTM D5885	400 min.	400 min.	
Oven Aging at 85°C[7, 8]	ASTM D5721			Per each formulation
Standard OIT (min. avg.) - % retained after 90 days	ASTM D3895	55%	55%	
--OR--				
High Pressure OIT (min. avg.) - % retained after 90 days	ASTM D5885	80%	80%	
UV Resistance[9]	D7238			Per each formulation
Standard OIT (min. avg.)	ASTM D3895	N.R.[10]	N.R.[10]	
--OR--				
High Pressure OIT (min. avg.) - % retained after 1,600 hrs [11]	ASTM D5885	50%	50%	

1 **Of 10 readings; 8 out of 10 readings must be ≥ 14 mils, and the lowest individual reading must be ≥ 12 mils. Also see note 6.**
2 **Alternate the measurement side for double-sided textured sheet.**
3 **Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.**
Yield elongation is calculated using a gauge length of 1.3 inches.
Break elongation is calculated using a gauge length of 2.0 inches.
4 **P-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.**
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
5 **Other methods, such as D1603 (tube furnace) orD6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.**
6 **Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.**
7 **The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.**
8 **It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.**
9 **The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.**
10 **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.**
11 **UV resistance is based on percent-retained value regardless of the original HP-OIT value.**

Table 3
Seam Strength and Related Properties of Thermally Bonded
Smooth and Textured HDPE Geomembranes as per GRI Test Method GM19 Revision 7
updated 11/4/2013

Geomembrane Nominal Thickness	1.5 mm (60 mil)	2.0 mm (80 mil)
Hot Wedge Seams[1]		
Shear strength[2] (lbs/in.)	120	160
Shear elongation at break[3] (%)	50	50
Peel strength[2] (lbs/in.)	91	121
Peel separation (%)	25	25
Extrusion Fillet Seams		
Shear strength[2] (lbs/in.)	120	160
Shear elongation at break[3] (%)	50	50
Peel strength[2] (lbs/in.)	78	104
Peel separation (%)	25	25

[1] Also for hot air and ultrasonic seaming methods
[2] Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values
[3] Elongation measurements should be omitted for field testing

Table 4: Raw Material Properties

Property	Test Method	HDPE
Density (g/cm^3)	ASTM D1505	$\geq$0.932
Melt Flow Index (g/10 min)	ASTM D1238 (190/2.16)	$\leq$1.0
OIT (minutes)	ASTM D3895 (1atm/200^{o}C)	$\geq$100

APPENDIX B4 – TECHNICAL SPECIFICATIONS FOR GEOTEXTILE MATERIALS AND CONSTRUCTION

NewFields	**CLIENT** MAGNUM DEVELOPMENT SOLUTION MINING	**PROJECT NO** 475.0093.003
PROJECT SAWTOOTH BRINE POND 2		
TITLE TECHNICAL SPECIFICATIONS FOR GEOTEXTILE MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-GT-0

			APPROVALS			
REV	**DATE**	**PAGES**	**ORIGINATOR**	**PM/PIC**	**CLIENT**	**REMARKS**
0	04/06/15	8	KCW	KJ	SQ	Issued for Construction

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NewFields	CLIENT MAGNUM DEVELOPMENT SOLUTION MINING	PROJECT NO 475.0093.003
PROJECT SAWTOOTH BRINE POND 2		
TITLE TECHNICAL SPECIFICATIONS FOR GEOTEXTILE MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0093.003-SPT-GT-0

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1.0 GENERAL

1.1 SCOPE

This specification defines the requirements for geotextile materials, installation, and quality control for use as a protection (cushioning) material and as a separation material associated with the Sawtooth Brine Pond 2.

All geotextile for this project shall be 10 oz/yd^2. Any alternatives or exceptions to this specification shall be submitted in writing to the Owner or its designated representative with the bid.

1.2 Definition of Terms

- "Owner" is defined as Sawtooth NGL Caverns, LLC.
- "Owner's Construction Representative" is defined as Magnum Development Solution Mining LLC.
- "Engineer" is defined as the Consultant or Engineering Company (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "Third Party Testing Contractor" is defined as the Consultant or Engineering Company (to be determined) hired by the owner to provide third party inspection and testing services for the overall project.
- "Contractor" is defined as the party(s) that has executed the contract agreement for the specified Work with the Owner or its authorized representative(s)/agent(s).
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the Owner, the Engineer, or others that apply to the Work.
- "Drawings" are defined as the Construction Drawings for Sawtooth Brine Pond 2 furnished by the Owner, Engineer, or others that apply to the Work.
- "Site" is defined as the Project site near Delta, Utah that is being developed by the Owner and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the Owner or its authorized representative(s)/agent(s) with the Contractor to complete specified portions of the Work.
- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.
- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by Owner and Engineer in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.

- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" – In general, these Specifications and the Drawings will utilize English units, however metric units will be used when appropriate.

1.3 References

1.3.1 American Society for Testing and Materials (ASTM):

- D1883 – Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
- D4354 – Practice for Sampling of Geosynthetics for Testing
- D4491 – Standard Test Method for Water Permeability of Geotextiles by Permittivity
- D4533 – Test Method for Trapezoidal Tearing Strength of Geotextiles
- D4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4759 – Practice for Determining the Specification Conformance of Geosynthetics
- D4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
- D4873 – Guide for Identification, Storage and Handling of Geotextiles
- D5261 – Test Method for Measuring Mass per Unit Area of Geotextiles
- D5494 – Test Method for the Determination of Pyramid Puncture Resistance of Unprotected and Protected Geomembranes
- D6241 – Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Product Using a 50-mm Probe
- D7238 – Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Apparatus

1.3.2 American Association of State Highway and Transportation Officials (AASHTO):

- M288-05 – Geotextile Specification for Highway Applications

1.3.3 Geosynthetic Research Institute (GRI):

- GT12(a) – Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials, Revision 1, December 18, 2012, www.geosynthetic-institute.org.
- GT13(a) – Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate, Revision 3: December 19, 2012 www.geosynthetic-institute.org.

1.4 Submittals Post-Award

- Prior to material delivery to the project site, the **Contractor** shall provide the **Engineer** with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds the values specified herein.

- The **Contractor** shall submit, if required by the **Engineer**, manufacturer's quality control manual for the geotextile to be delivered to the site.

1.5 Submittals during Manufacturing

- Manufacturer quality control certificates stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile.
- The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.
- The manufacturer's certificate shall state that the finished geotextile meets the Minimum Average Roll Value (MARV) requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.
- Mislabelling or misrepresentation of materials shall be reason to reject those geotextile products.

1.6 Shipment, Storage and Handling

- Geotextile labelling, shipment and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.
- During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160^{o}F (71oC), and any other environmental condition that may damage the property values of the geotextile.

2.0 PRODUCT

2.1 Geotextile

- The nonwoven needle punched geotextile specified herein shall be made from staple fiber.

- The geotextile shall be of new prime quality virgin polymer of 100-percent polyethylene (97-percent polypropylene and 3-percent carbon black with antioxidants and heat stabilizers), or polyester/polypropylene blend designed and manufactured specifically for the purpose of separation, tensile reinforcement, planar flow, filtration and protection and shall be used as designated on the Drawings.
- The geotextile shall be able to withstand direct exposure to ultraviolet radiation from the Sun for up to 30 days without any noticeable effect on index or performance properties.
- Rolls shall be free of holes, contamination and foreign debris.
- Geotextile shall meet or exceed all material properties listed herein based on the specific purpose and expected conditions.

Table 1 – Required Properties, Test Methods and Values for Geotextiles Used as Geomembrane Protection (or Cushioning) Materials

Property[1]	Test Method ASTM	Unit	Mass/Unit Area (oz/yd^2)					
Mass per unit area	D5261	oz/yd^2	10	12	16	24	32	60
Grab Tensile strength	D4632	lb	230	300	370	450	500	630
Grab tensile elongation	D4632	%	50	50	50	50	50	50
Trap. Tear strength	D4533	lb	95	115	145	200	215	290
Puncture (pin) strength	D4833	lb	120	140	170	250	300	390
UV resistance[2]	D7238	%	70	70	70	70	70	70

Table 2 – Alternative Puncture Test Methods to be Considered in Place of Pin Puncture, ASTM D4833, in Table 1

Property[1]	Test Method ASTM	Unit	Mass/Unit Area (oz/yd^2)					
Mass per unit area	D5261	oz/yd^2	10	12	16	24	32	60
Puncture (pyramid) strength	D5494	lb	300	320	410	440	510	760
Puncture (CBR) strength	D6241	lb	700	800	900	1100	1700	2400
Puncture (CBR) elongation	D6241	in	1.5	1.5	1.5	1.5	1.5	1.5

Notes:

1. All values are MARV except UV resistance which is a minimum value. For geosynthetics, MARV is a manufacturing quality control tool used to establish published values such that the purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, “MARV” is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.
2. Evaluation to be on 2.0 inch strip tensile specimens after 500 lt. hours exposure.

- For the purposes of separation the geotextile shall meet the minimum required values as defined in the Tables 3, 4 and 5 below with the exception of AOS which is maximum average roll value (MaxARV) and UV stability which is a minimum average value:

Table 3– Geotextile Properties Class 1 (High Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	315	203
Trapezoid Tear Strength	D4533	lb	112	79
CBR Puncture Strength	D6241	lb	630	440
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	50	50

Table 4 – Geotextile Properties Class 2 (Moderate Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	248	158
Trapezoid Tear Strength	D4533	lb	90	56
CBR Puncture Strength	D6241	lb	500	320
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	50	50

Table 5– Geotextile Properties Class 3 (Low Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	180	113
Trapezoid Tear Strength	D4533	lb	68	41
CBR Puncture Strength	D6241	lb	380	230
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	50	50

Table 6 – Required Degree of Survivability as a Function of Subgrade Conditions, Construction Equipment and Lift Thickness (Class 1, 2 and 3 Properties are Given in Table 3, 4 and 5; Class 1+ Properties are Higher than Class 1 but Not Defined at this Time)

	Low ground-pressure equipment ≤ 25 kPa (3.6 psi)	Medium ground-pressure equipment > 25 to ≤ 50 kPa (> 3.6 to ≤ 7.3 psi)	High ground-pressure equipment > 50 kPa (> 7.3psi)
Subgrade has been cleared of all obstacles except grass, weeds, leaves and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 450mm (18 in.) in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 150mm (6 in.) above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High (Class 1)	Very High (Class 1+)	Not Recommended

*Recommendations are for 150 to 300 mm (6 to 12 in.) initial lift thickness. For other initial lift thicknesses:

300 to 450mm (12 to 18 in.): reduce survivability requirement one level;
450 to 600mm (18 to 24 in.): reduce survivability requirement two levels;
>600mm (24 in.): reduce survivability requirement three levels;

Note 1: While separation occurs in every geotextile application, this pavement-related specification focuses on subgrade soils being "firm" as indicated by CBR values higher then 3.0 (soaked) or 8.0 (unsoaked).

Source: Modified after Christopher, Holtz and DiMaggio

3.0 EXECUTION

3.1 Quality Assurance

A. The **Engineer** or **Third Party Testing Contractor** shall examine the geotextile rolls upon delivery to the site and report any deviations from project specifications to the contractor.
B. The **Engineer** may decide to arrange conformance testing of the rolls delivered to the job site. For this purpose, the **Engineer** shall take a sample three feet (along roll length)

by roll width according to ASTM Practice D 4354 The sample shall be properly marked, wrapped and sent to an independent laboratory for conformance testing.

C. The pass or fail of the conformance test results shall be determined according to ASTM Practice D 4759.

3.2 Installation

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the **Contractor** damage the geotextile to the extent that it is no longer usable as determined by these specifications or by the **Engineer** or **Third Party Testing Contractor**, the **Contractor** shall replace the geotextile at his own cost.

B. The geotextile shall be installed to the lines and grades as shown on the contract drawings and as described herein.

C. The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self-weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

D. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

E. The **Contractor** shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage to such material occur due to the fault of the **Contractor**, the latter shall repair the damaged materials at his own cost and to the satisfaction of the **Engineer**.

F. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the **Engineer or Third Party Testing Contractor**.

G. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct Sun light for more than 15 days after installation.

H. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the **Engineer**. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.

I. The contractor shall not use heavy equipment to traffic above the geotextile without approved protection.

J. The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

K. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

L. Holes in the geotextile material shall be repaired using a patch of identical material extending a minimum 6 inches on all sides of the hole and heat bonded. If heat bonding is not possible, the patch shall extend a minimum of 18 inches on all sides of the hole.

M. In areas where the non-woven geotextile is used as separation or filtration, care shall be taken to install the layer without producing holes or gaps where the migration of fines into the drainage system could occur. This is accomplished by ensuring sufficient overlap of seams of 18-inches minimum overlap and properly wrapping the edges of the geotextile under the gravel areas being protected or by over running the edges of the geotextile beyond the area requiring separation or filtration.

4.0 CERTIFICATION

At the completion of the geotextile installation, the **Contractor** shall provide the **Owner** with a certification stating that the geotextile was installed and tested in accordance with the Specifications together with a report of the test results. The certification shall be provided to the **Owner** prior to the demobilization of the installation personnel from the site unless agreed otherwise by the **Owner**. The report of the test results shall be provided in hard copy and digital format to the **Owner** and the **Engineer** no later than 30 days after the installation work has been completed.

APPENDIX C – DESIGN CALCULATIONS

APPENDIX C1 – LCRS AND PCMS LEAKAGE RATES

Geomembrane Leakage Rate Underlain by Permeable Media	
Project:	Evaporation Ponds
Client:	Magnum Development Solution Mining
Facility:	Sawtooth Pond #2 LCRS calculation
Engineer:	Anna M. Horn
Date	30-Mar-15

NewFields

Inputs
Outputs

$$Q = n\left(0.6 \times a \times \sqrt{2gh}\right)$$ (Giroud, 1997)

Where: $$n = \left(A / 43{,}560\ ft^2\right) \times DefectsPer\ Acre$$

$$a = \pi\left(d^2 / 4\right)$$

Inputs Defined:

Q = Leakage Rate
n = Number of Defects in Geomembrane
a = Area of Circular Defect
g = Acceleration of Gravity (32.2 ft/s^2 or 9.81 m/s^2)
h = Hydraulic Head Above Geomembrane
d = Diameter of Circular Defect
A = Area of Geomembrane Lined Facility

Typical Installation Damage

Installation Quality	Defects per Acre
Excellent	Up to 1
Good	1 to 4
Fair	4 to 10
Poor	10 to 20

Assume 2 Defects Per Acre

Variable Inputs

English Units		Metric Units	
d (in)	0.138	d (m)	0.0035
A (ft^2)	7,267,544	A (m^2)	675,177
h (ft)	37.0	h (m)	11.3

Calculated Values

English Units		Metric Units	
n	334	n	334
a (ft^2)	1.04E-04	a (m^2)	9.64E-06
Q (ft^3/s)	1.014	Q (m^3/s)	0.029

Conversion

$$0.029\ \frac{m^3}{\sec} \times \frac{60\ \sec}{\min} \times \frac{264.1\ gal}{m^3} = 455\ \frac{gal}{\min}$$

Assumptions

1. Above flow rate based upon Bernoulli's equation which describes free flow through an orifice. This condition is valid if the hydraulic conductivity of the underlying media is greater than 10e-1 m/s, which is valid for most gravels and geonets.
2. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.
3. Bernoulli's equations tends to overestimate leakage rate, as impedance to flow (geonet, gravel, etc.) is not considered.

References

1. Giroud, J.P. 1984. "Impermeability: The Myth and a Rational Approach". Proceedings of the International Conference on Geomembranes. Denver, CO. 1:157-162.
2. Giroud, J.P., Khire, M.V. and Soderman, K.L. 1997. "Liquid Migration Through Defects in a Geomembrane Overlain and Underlain by Permeable Media". Geosynthetics International. Vol 4, Nos. 3-4, pp. 293-321.

Geomembrane Leakage Rate Underlain by Relatively Low Permeability Soil	
Project:	Evaporation Ponds
Client:	Magnum Development Solution Mining
Facility:	Sawtooth Pond #2 PCMS calculation
Engineer:	Anna M. Horn
Date	30-Mar-15

NewFields

Inputs
Outputs

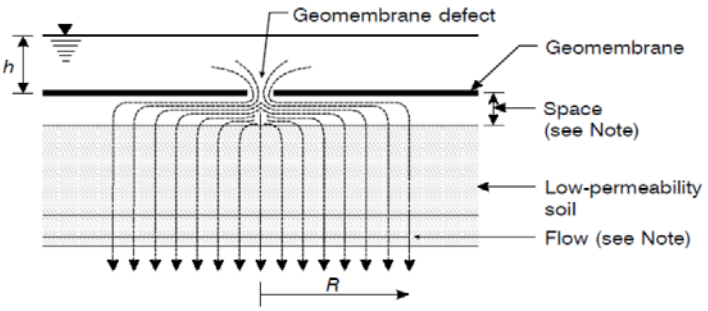


Figure 1. Liquid migration through a composite liner.

$$Q = C_{qo}\left[1 + 0.1\left(h/t_s\right)^{0.95}\right]a^{0.1}h^{0.9}k_s^{0.74}n \quad \text{(Giroud, 1997)}$$

Where: $n = \left(A/43{,}560\ ft^2\right) \times DefectsPer\ \ Acre$

$$a = \pi\left(d^2/4\right)$$

Typical Installation Damage

Installation Quality	Defects per Acre
Excellent	Up to 1
Good	1 to 4
Fair	4 to 10
Poor	10 to 20

Assume 2 Defects Per Acre

Contact Quality Factor, C_{qo}

Liner/Soil Contact	Factor (Circ. Defect)
Good	0.21
Poor	1.15

Assume 0.21 for Contact Quality

Inputs Defined:

- Q = Leakage Rate
- n = Number of Defects in Geomembrane
- a = Area of Circular Defect
- g = Acceleration of Gravity (32.2 ft/s^2 or 9.81 m/s^2)
- h = Hydraulic Head Above Geomembrane
- d = Diameter of Circular Defect
- A = Area of Geomembrane Lined Facility
- C_{qo} = Contact Quality Factor
- k_s = Permeability of Underlying Soil Layer
- t_s = Thickness of Underlying Soil Layer

Variable Inputs

English Units			Metric Units	
d (in)	0.138		d (m)	0.0035
A (ft^2)	7,267,544		A (m^2)	675,177
h (ft)	1.0000		h (m)	0.3048
k_s (ft/sec)	1.02E-05		k_s (m/s)	3.10E-06
t_s (ft)	1.0		t_s (m)	0.3

Calculated Values

English Units			Metric Units	
n	334		n	334
a (ft^2)	1.04E-04		a (m^2)	9.64E-06
Q (ft^3/s)	2.47E-02		Q (m^3/s)	6.99E-04

Conversion

6.99E-04 $\frac{m^3}{\sec} \times \frac{60\ \sec}{\min} \times \frac{264.1 gal}{m^3} =$ 11.08 $\frac{gal}{\min}$

Assumptions

1. Above equations are for a circular defect with a diameter less than 25 mm.
2. The hydraulic head above the liner should be equal to or less than 3 m
3. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.

References

1. Giroud, J.P. 1997. "Equations for Caulculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects". Geosynthetics International. Vol 4, Nos. 3-4, pp. 335-348.

APPENDIX C2 – LINER PULL-OUT CALCULATIONS

Calculation: Factor of Safety for Tensile Failure and Anchor Pull-out due to self-weight.
Project: Sawtooth Brine Pond 2 Evaporation Pond
Date: 3/30/15
By: Anna Horn

Input Parameters		
Height of Slope (ft)	50	ft
Slope (Z:1)	2.5	
FML Thickness (mil)	80	mil
FML Yield Stress (psi)	2100	psi
FML Yield Stress (ppi)	168	ppi
FML Specific Gravity	0.94	
Soil Friction Angle	30	degrees
Liner-Soil Interface Friction Angle (degrees)	15	degrees
Anchor Trench Depth (ft)	4	ft
Anchor Trench Width (ft)	3	ft
Anchor Set-Back (ft)	3	ft
Soil Depth over Setback	0	ft
Soil Unit Weight (pcf)	115	pcf

TENSILE FAILURE OF LINER FROM SELF-WT CALC S			
FML Density	58.66	pcf	
Slope Length	134.63	ft	
Slope Angle	21.80	degrees	
Liner Total Wt./ Unit ft.	52.65	lbs/ft	
Max. Tensile Force From Self-Wt.	19.55	lbs/ft	
Frictional Resistance	13.10	lbs/ft	
Tensile Stress (neg. frictional resistance)	20.37	psi	
Tensile Stress (w/ frictional resistance)	6.72	psi	
FOS Tensile failure (MIN)	103	PASS	Required FOS 10 or greater
FOS Tensile failure (MAX)	312	PASS	Required FOS 10 or greater
Max. Heat/Cool Force:	32.65	lbs/ft	
Max. Tensile Stress Developed	45.35	psi	
FOS Tensile Failure	46	PASS	Required FOS 10 or greater

LINER ANCHOR CALC S		
At Rest Coeff.	0.50	
Active Pressure Coeff.	0.33	
Passive Pressure Coeff.	3.00	
Allowable Liner Force	2016.00	lbs/ft
Shear Force Above Membrane Due to Soil Cover	0.00	lbs/ft
Shear Force Below Liner Due to Soil Cover	0.00	lbs/ft
Shear Force Below Liner Due to Liner Pull-Down	200.62	lbs/ft
Active Pressure Anchor Backfill Side	306.67	lbs/ft
Passive Pressure Anchor InSitu Side	2760.00	lbs/ft
Sum of Forces	2653.95	lbs/ft
FOS Pull-out	1.42	PASS

Based on methods presented in Designing With Geosynthetics 4th edition
Robert M. Koerner, 1 Prentice-Hall

APPENDIX C3 – LCRS AND PCMS SUMP SIZING

EXCERPT FROM: AMEC, "MAGNUM GAS STORAGE, LLC, EVAPORATION PONDS FINAL DESIGN REPORT, APPENDIX D-3," MAY 23, 2011

LCRS Sizing Worksheet for East Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	3.5	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Top Length	42.5	ft
Sump Top Width	42.5	ft
Sump Volume without gravel	4,255	ft3
Pond Area	6,761,280	ft2
Pond Area	155	acres
Number of Defects	2	holes per acre
Q from geonet per hole	0.001426564	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1.1	
Sump Volume with gravel	1,489	ft3

PCMS Sizing Worksheet for East Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	2	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Top Length	35	ft
Sump Top Width	35	ft
Sump Volume without gravel	1,850	ft3
Pond Area	6,761,280	ft2
Pond Area	155	acres
Number of Defects	2	holes per acre
Q from geonet per hole	2.26429E-05	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1	
Sump Volume with gravel	648	ft3

LCRS Sizing Worksheet for Middle Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	3.5	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Bottom Area	625	
Sump Top Length	42.5	ft
Sump Top Width	42.5	ft
Sump Top Area	1806.25	
Sump Volume without gravel	4,255	ft3
Pond Area	6,797,720	ft2
Pond Area	156	acres
Number of Defects	2	holes per acre
Q from geonet per hole	0.003516269	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1.1	
Sump Volume with gravel	1,489	ft3

PCMS Sizing Worksheet for Middle Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	2	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Top Length	35	ft
Sump Top Width	35	ft
Sump Volume without gravel	1,850	ft3
Pond Area	6,797,720	ft2
Pond Area	156	acres
Number of Defects	2	holes per acre
Q from geonet per hole	2.27128E-05	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1	
Sump Volume with gravel	648	ft3

LCRS Sizing Worksheet for West Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	3.5	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Top Length	42.5	ft
Sump Top Width	42.5	ft
Sump Volume without gravel	4,255	ft3
Pond Area	5,567,620	ft2
Pond Area	128	acres
Number of Defects	2	holes per acre
Q from geonet per hole	0.00149144	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1.1	
Sump Volume with gravel	1,489	ft3

PCMS Sizing Worksheet for West Pond

Project Name:	Magnum Evaporation Ponds	
Project Number:	7420140900	
Client:	Magnum Energy LLC	
By:	MTH	
Date:	5/17/2011	
Sump Depth	2	ft
Sump Side Slope	2.5	H:1V
Sump Bottom Length	25	ft
Sump Bottom Width	25	ft
Sump Top Length	35	ft
Sump Top Width	35	ft
Sump Volume without gravel	1,850	ft3
Pond Area	5,567,620	ft2
Pond Area	128	acres
Number of Defects	2	holes per acre
Q from geonet per hole	2.27128E-05	ft^3/sec/hole
porosity (n)	0.35	
Factor of Safety (FS)	1	
Sump Volume with gravel	648	ft3

APPENDIX C4 – WAVE RUN UP ANALYSIS FOR FREEBOARD

Freeboard Allowances for Solution Brine Pond #2	
Project:	Solution Brine Pond 2
Client:	Magnum Development Solution Mining
Facility:	Sawtooth Pond #2 Wave Height Calculation
Engineer:	Dan T. Maurais
Date	31-Mar-15

Wave Height Calculation: (Base on USBR ACER Technical Memorandum No. 2 Freeboard Criteria and Guidelines for Computing Freeboard Allowances for Storage Dams)

Wave Run-up Analysis:

$V = Fastest\ Mile\ of\ Record = 63mph\ \ (Figure\ 2, USBR\ suggest\ 50\ mph\ during\ IDF)$

$F = Wind\ Fetch = \ 2870.05feet = 0.54\ miles$

$\theta = Slope\ of\ Upstream\ Face = 21.80^0$

$\cot\theta = 2.4999$

$D = Average\ Depth\ of\ Reservoir = 36.5\ feet$

$T = Wave\ Period = 0.559(0.589V^{1.23}F)^{0.33} = 2.06\ seconds$

$L = Wave\ Length = 5.12T^2 = 21.79\ feet$

$H_s = Significant\ Wave\ Height = 0.0177V^{1.23}F^{0.5} = 2.13\ feet$

Calculate $\frac{D}{H_S}$ and $\frac{H_S}{gT^2}$ to Find R on Figure 11 (Assume Rubble−Mound Slope):

$\frac{D}{H_s} = 17.1\ > 3.0\ \ \rightarrow Use\ Figure\ 11$ $\qquad$ $\frac{H_s}{gT^2} = 0.0156$

Determine R from Figure 11:

$\frac{R}{H} = 0.485$ $\qquad$ $R = H0.485 = 1.03$

Determine Runup Correction for Scale Effects from Figure 13:

$\cot\theta = 2.4999$ $\qquad$ $k = 1.15$

Determine Total Wave Runup:

$R_{Tot} = kR = 1.18\ feet < 3\ feet\ to\ embankment\ crest \quad ok$

Assumptions:

1. Above equations are for a rubble-mound slopes.
2. Analysis was based on maximum pond water surface.

References:

1. USBR ACER Technical Memorandum No. 2 Freeboard Criteria and Guidelines for Computing Freeboard Allowances for Storage Dams

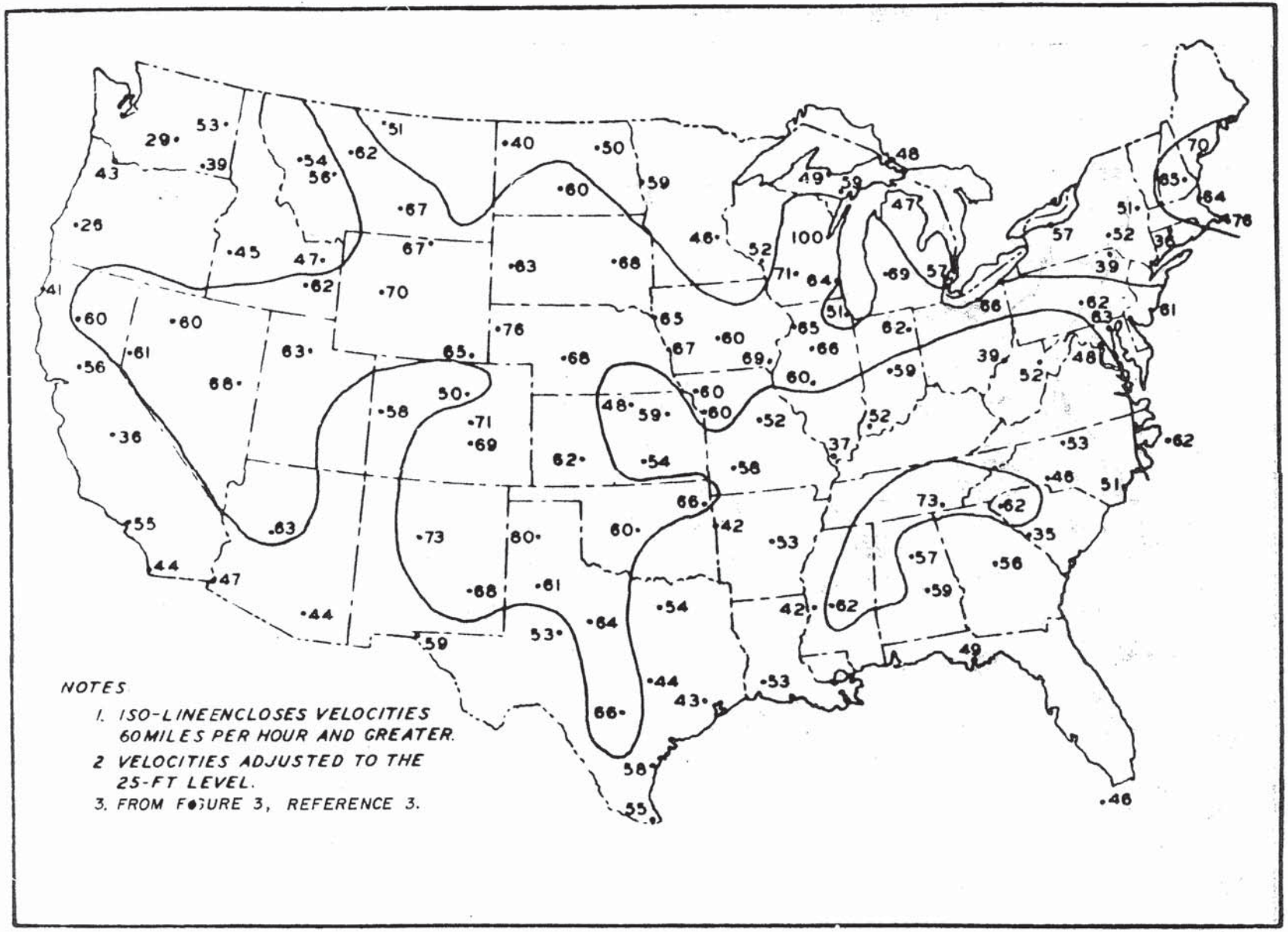


FIGURE 2.-FASTEST MILE OF RECORD-SPRING

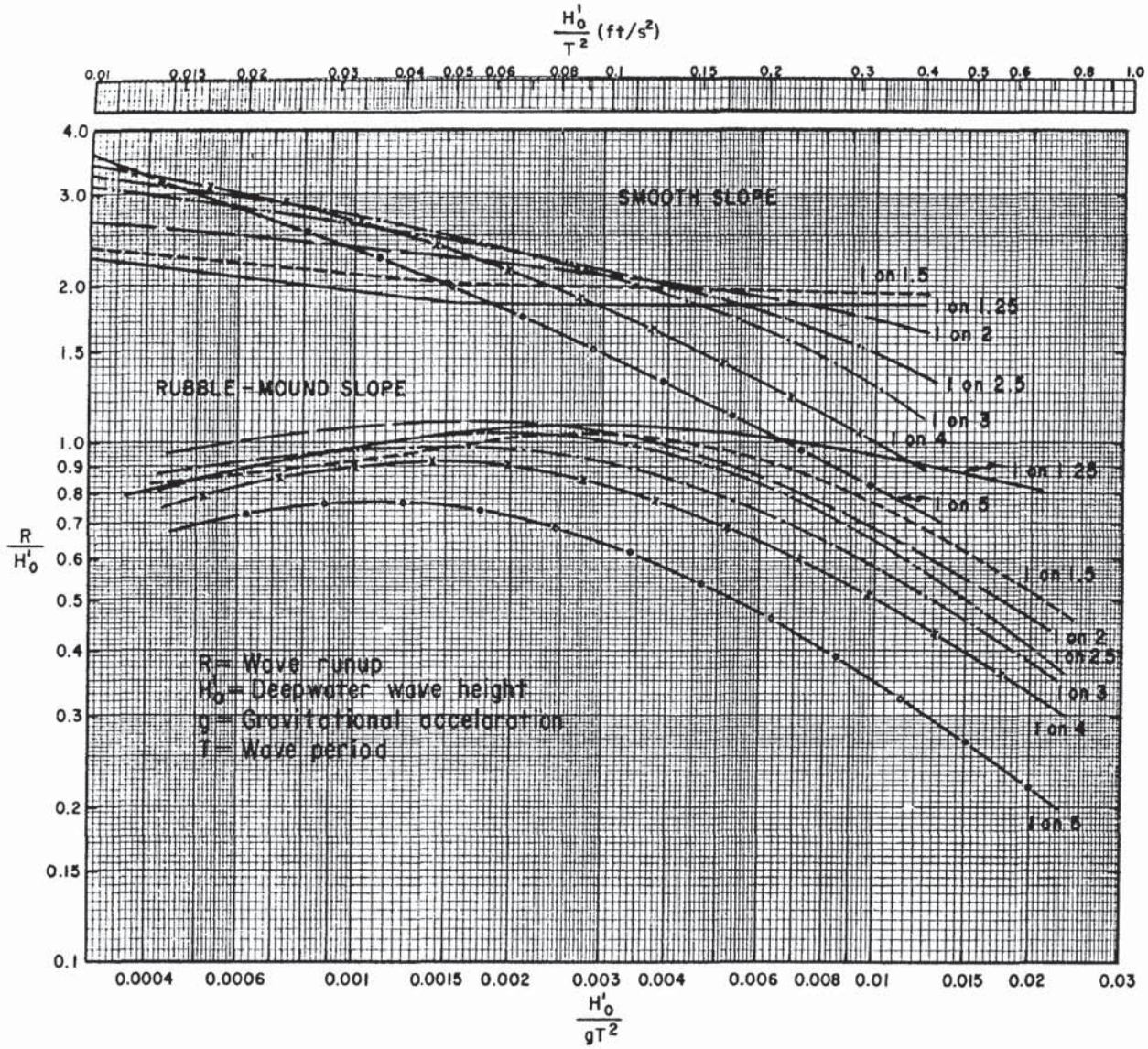


FIGURE 11.- COMPARISON OF WAVE RUNUP ON SMOOTH SLOPES WITH RUNUP ON PERMEABLE RUBBLE SLOPES (DATA FOR $d_s/H'_0 > 3.0$) (FROM FIGURE 7-20, REF. 6)

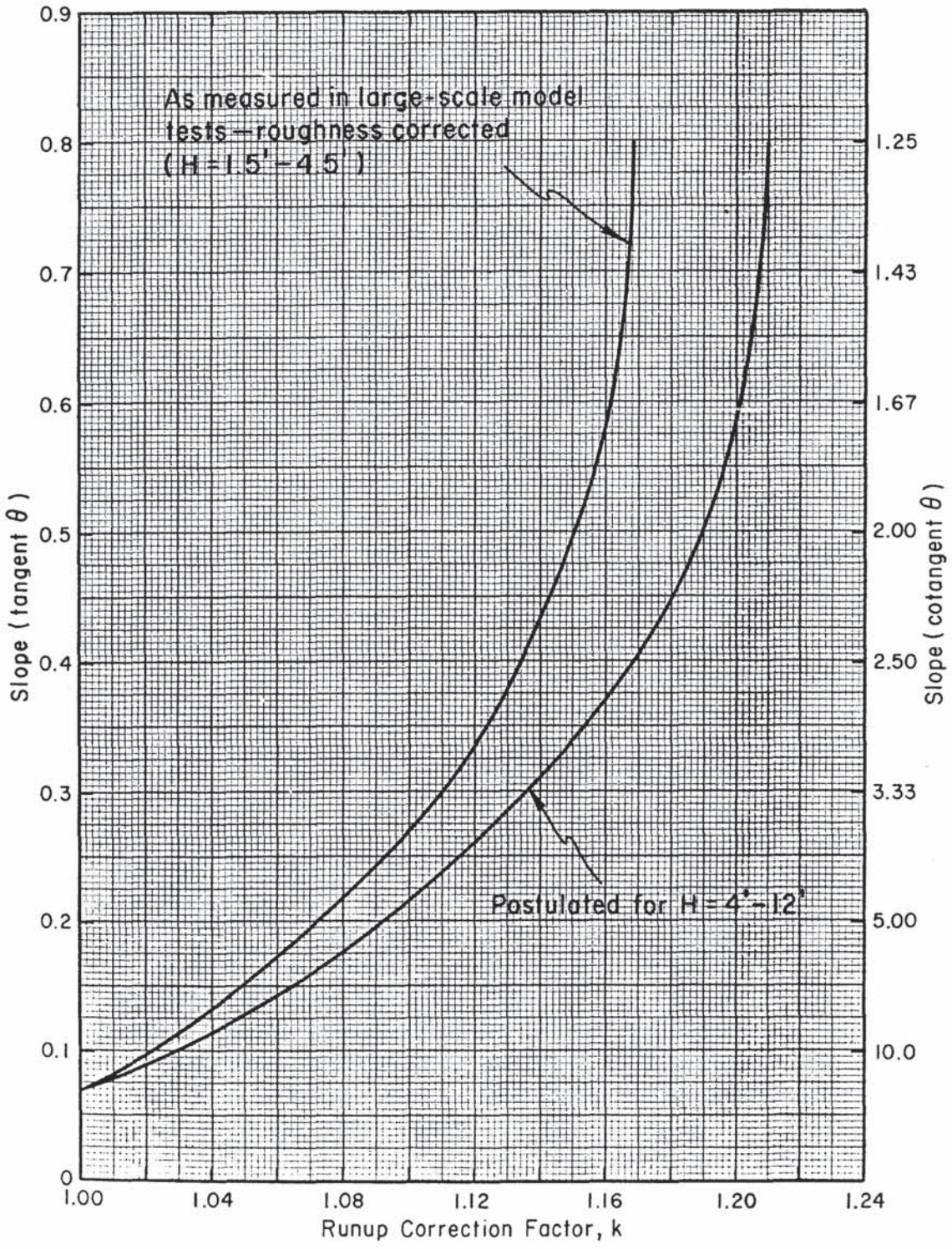


FIGURE 13.- RUNUP CORRECTION FOR SCALE EFFECTS
(FROM FIGURE 7-13, REF. 6)

APPENDIX C5 – DIVERSION CHANNEL SIZING

NewFields	DESIGN CALCULATIONS			
Project #	475.0093.003	Preparer:	Z. Recine	3/30/2015
Revision	0	Checked:	KNJ	4/1/2015

Client:	Magnum Development Solution Pond
Project:	Sawtooth Brine Pond #2
Title:	Hydrology Analysis and Stormwater Control Design

Calculation Objective:

1. Estimate the peak runoff from upstream watersheds to design stormwater diversion channels that will experience 100 year 24-hour.
2. Determine the required size of the diversion channels, detention areas, and erosion protection.

Assumptions/Methodology/Reference:

Assumptions:

- Curve number (CN) for existing ground is based on the NRCS web soil survey classification ,Hydrologic Soil Group , and TR-55 CN. A composite curve number was generated for the watersheds based on areas of disturbed and undisturbed lands from aerial photos.

Methodology:

- Storm peak flows and volumes estimated using HEC-HMS
  - Excess Precipitation hydrograph generated by NRCS Unit Hydrograph Method
  - Rainfall Distribution - NRCS Type II
- Lag times estimated from:

$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

- Watershed areas, average slope, basin lengths and reach lengths are based on topography from "StromWater.dwg", and surfaces created in Civil 3D project P:\Projects\0093.003 Magnum Brine Pond 2 Geotech and Design\A-CAD\FIGS

References:

- U.S. Army Corp. of Engineers (USACE). Hyrologic Engineering Center, "Hydrologic Modeling System HEC-HMS: Application Guide," March 2008.
- www.nws.noaa.gov , Noaa Atlas 2 Volume 1
- U.S. Department of Army Corps of Engineers, HYDROMETEOROLOGICAL REPORT NO. 55A - Probable Maximum Precipitation Estimates-United States Between the Continental Divide and the 103rd Meridian. June 1988 (Snowmelt-pg 220, 6HR PMP - Plate IIa)

STORM EVENTS **From Previous Design**

Average Recurrence Interval	Precipitation Depth (inches)
100-year	2.16

MAGNUM DEVELOPMENT SOLUTION MINING

5.0 Diversion Channel

To route stormwater around the facility, stormwater diversion channels were designed to divert runoff waters around the Evaporation Ponds and back into a natural drainage. The general arrangement of the diversion channel locations can be found on Drawing A400.

The design criterion for a diversion channel is to convey storm water runoff generated from the 100-year/24-hour storm event. The channel slopes will range from a minimum of 0.5 percent to 2 percent. Typical diversion channel cross sections are shown on Drawing A400. The maximum expected flow rate was 28.37 cubic feet per second (cfs) and the diversion channel was designed to accommodate a minimum of 62 cubic feet per second based on a 0.5 percent channel slope.

5.1 Watershed Characteristics

Watershed basins and volumes were generated by IGES and provided to AMEC. The diversion channel sizes were based upon the provided peak flow of 28.37 cfs. This is based on a 100-year/24-hour storm event which produces 2.16 inches of precipitation. The surface soils are classified as a sandy loam. The calculations for determining the peak discharge and a map of the watershed basins are included in Appendix D-5.

5.2 Diversion Channel Sizing

The diversion channels were sized to the provided flows in a trapezoidal shape. They have a bottom width of 12 feet, side slopes of 3H:1V and a minimum depth of 1 foot. The peak flow can be contained in an 8-inch-deep channel but the depth was increased to 1 foot to provide additional freeboard. Diversion channel sizing calculations are included in Appendix D-5.

5.3 Erosion and Sediment Control

Due to the low velocities and shallow slopes of the diversion channels, riprap is not required.

Technical Release 55
Urban Hydrology for Small Watersheds

Graphical Peak Discharge Method

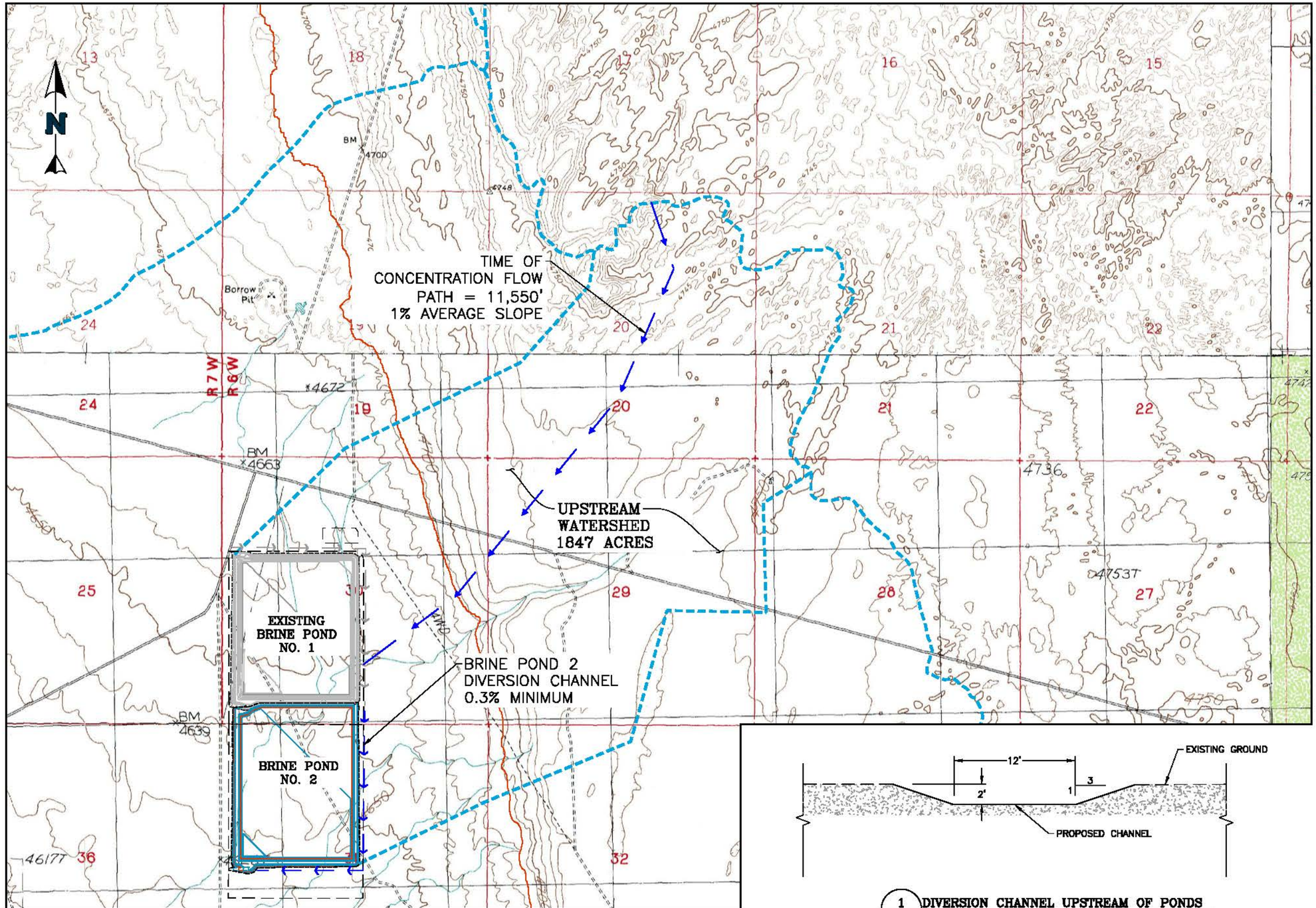
Project:	Magnum Energy		By: JAH	Date:	3/31/2010
Location:	Delta, Utah		Checked: JFW	Date:	3/31/2010
Condition:	Existing	Comments:	Area 1 - southernmost across Section 29		

SOLUTION M

1	Data		
	Drainage Area, Am	mi^2	0.3578125
	Runoff curve number	CN	67
	T_c	hr	1.305702768
	Rainfall Distribution		II
	Pond or Swamp Areas	% of Am	0.0

			Storm #1	Storm #2	Storm #3
2	Frequency	yr	100		
	Duration		24-hr		
3	Rainfall, P	in	2.16		
4	Initial Abstraction, I_a	in	0.985075		
5	Compute I_a/P		0.456053		
	Tc	hr	1.305703		
6	Unit peak discharge, q_u	csm/in	170		
7	Runoff, Q	in	0.226292		
8	Pond and Swamp Factor, F_p		1		
9	Peak Discharge	ft^3/sec	13.76493		

DATA FROM PREVIOUS DESIGN



LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- TIME OF CONCENTRATION FLOW PATH
- WATERSHED BOUNDARY
- DIVERSION CHANNEL FLOW DIRECTION
- EXISTING DIVERSION CHANNEL FLOW DIRECTION

1 — DIVERSION CHANNEL UPSTREAM OF PONDS

REFERENCE:

EXISTING GROUND TOPOGRAPHY CREATED IN THE STATE PLANE NAD83 COORDINATE SYSTEM FROM FILE XXXXXX.dwg RECEIVED ON XXXXX XX, 20XX FROM COMPANY X.

NewFields	CLIENT: MAGNUM DEVELOPMENT SOLUTION POND	
PROJECT: SAWTOOTH BRINE POND #2		
TITLE: PROJECT STORMWATER CONTROL MAP	FILENAME: Figure 05	FIGURE NO.: 1 / REVISION: A

P:\Projects\0093.003 Magnum Brine Pond 2 Geotech and Design\A-CAD\FIGS\Figure 05.dwg-4/1/2015 5:19 PM

HYDROLOGY ANALYSIS and STORMWATER CONTROL
WATERSHED CHARACTERISTICS and LAG TIME CALCULATION

$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)

Input Values

Lag Time									
Watershed	**Area (ft^2)**	**l (ft.)**	**CN**	**High (ft.)**	**Low (ft.)**	**y**	**S**	**t_p (hr.)**	**t_p (min.)**
WPV									
1	80,471,125	11,194	67.0	4,775	4,650	1%	4.93	3.00	180.1

Reach Data	
	Reach 1
length (ft)	11,194
high el. (ft)	4,775
lowel. (ft)	4,650
slope (ft/ft)	0.011
slope (%)	1%

STORMWATER ANALYSIS (HEC-HMS OUTPUT)

Brine Pond 2				
		(2.16-inches) 100 YEAR - 24 Hour Storm		
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak- (Date, Min)	Volume (ac-ft)
1	2.89	**49.7**	01Jan2015, 16:05	29.3

Brine Pond 2 - 0.3% DIVERSION CHANNEL

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.30000	%
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	49.70	ft^3/s

Results

Normal Depth	1.31	ft
Flow Area	20.94	ft^2
Wetted Perimeter	20.31	ft
Hydraulic Radius	1.03	ft
Top Width	19.88	ft
Critical Depth	0.76	ft
Critical Slope	0.02097	ft/ft
Velocity	2.37	ft/s
Velocity Head	0.09	ft
Specific Energy	1.40	ft
Froude Number	0.41	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.31	ft
Critical Depth	0.76	ft
Channel Slope	0.30000	%

MAX SLOPE FOR DIVERSION CHANNEL

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	3.00000	%
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	49.70	ft^3/s

Results

Normal Depth	0.68	ft
Flow Area	9.62	ft^2
Wetted Perimeter	16.33	ft
Hydraulic Radius	0.59	ft
Top Width	16.11	ft
Critical Depth	0.76	ft
Critical Slope	0.02097	ft/ft
Velocity	5.17	ft/s
Velocity Head	0.41	ft
Specific Energy	1.10	ft
Froude Number	1.18	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.68	ft
Critical Depth	0.76	ft
Channel Slope	3.00000	%

Culvert Calculator Report
Access Road Culvert

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.50	ft	Headwater Depth/Height	0.95	
Computed Headwater Elev	2.66	ft	Discharge	49.70	cfs
Inlet Control HW Elev.	2.46	ft	Tailwater Elevation	1.25	ft
Outlet Control HW Elev.	2.66	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	0.27	ft	Downstream Invert	0.00	ft
Length	54.00	ft	Constructed Slope	0.5000	%

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.38	ft
Slope Type	Mild		Normal Depth	2.20	ft
Flow Regime	Subcritical		Critical Depth	1.38	ft
Velocity Downstream	5.99	ft/s	Critical Slope	1.6185	%

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	2.66	ft	Upstream Velocity Head	0.28	ft
Ke	0.90		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.46	ft	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	14.7	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

APPENDIX D – BOREHOLE AND TEST PIT LOGS

APPENDIX D1 – BOREHOLE LOGS

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SW Embankment Corner
LOGGED BY: JWR
START DATE: 03/03/2015
END DATE: 03/03/2015

NORTHING: 511,204.55
EASTING: 197,376.16
GROUND ELEV.: 4,632.16
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA and Mud Rotary

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/3/15	13.5	4,618.66
3/3/15	10.8	4,621.36

BACKFILLED: 6% Bentonite Grout
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		1-3-4				CL SM			Topsoil - CLAY (CL), sandy, with silt, trace fine gravel, medium stiff, fat, gray, moist - lacustrine SAND (SM), silty, fine grained, poorly graded, loose, non-plastic, brown, damp - aeolian(?)	
2											
2.5	S-2		5-5-8				SP			SAND (SP), trace silt, fine to medium grained, poorly graded, angular to rounded, medium dense, non-plasitc, brown, moist - fluvial	Moisture Content = 3.8%
4											
5.0	S-3		7-7-11								
6											
7.5	S-4		7-14-23							medium grained, dense	Moisture Contents = 4.3%
8											
10											
10.0	S-5		13-26-27							medium to coarse grained, some gravel, subrounded, very dense	
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SW Embankment Corner
DRILLING METHOD: 4 1/4" HSA and Mud Rotary
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,204.55
EASTING: 197,376.16
GROUND ELEV.: 4,632.16
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/03/2015
END DATE: 03/03/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		26-28-39							fine grained, no gravel observed, wet	Water observed on rods approximately 13.5ft depth - flowing sands Water poured in augers to counter flowing sands and heave - wait a few minutes prior to measuring depth to water of 10.8ft
16											
18											
20.0	S-7		5-6-8							medium dense, wet	Advanced augers to 20ft depth before switching to 4in tricone mud rotary and SPT sampling from 20-21.5ft depth
							CH			CLAY (CH), some silt, trace fine sand, stiff, fat, light brown, moist - lacustrine	
22											
24											
25.0	S-8		6-9-13							some silt to silty, very stiff. lower plasticity	Moisture Content = 24.7% LL=30 / PI=8
26											
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SW Embankment Corner
DRILLING METHOD: 4 1/4" HSA and Mud Rotary
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,204.55
EASTING: 197,376.16
GROUND ELEV.: 4,632.16
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/03/2015
END DATE: 03/03/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 3 of 6

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
30											
30.0	S-9		8-10-23							sandy, hard	
32											
34											
35.0	S-10		15-13-23								
36											
38											
40											
40.0	S-11		7-7-17				CL			CLAY (CL), silty, some fine sand, very stiff, lean, light brown, moist - lacustrine	Moisture Content = 21.7%
							SP-SM			SAND (SP-SM), with silt, fine grained, poorly graded, subangular to rounded, medium dense, non-plastic, brown, wet - fluvial	
42											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SW Embankment Corner
DRILLING METHOD: 4 1/4" HSA and Mud Rotary
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,204.55
EASTING: 197,376.16
GROUND ELEV.: 4,632.16
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/03/2015
END DATE: 03/03/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 4 of 6

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
44											
45.0	S-12		20-18-26				SP			SAND (SP), trace silt, fine grained, poorly graded, subangular to rounded, dense, non-plastic, brown, wet - fluvial	
46											
48											
50.0	S-13		7-8-21				CL			CLAY (CL), silty, trace fine sand, very stiff, lean, light brown, moist - lacustrine	Moisture Content = 26.9%
52											
54											
55.0	S-14		8-14-17				SP			SAND (SP), trace silt and fine gravel, fine to medium grained, poorly graded, subangular to rounded, max. particle size 0.06ft, dense, non-plastic, brown, wet - fluvial	
56											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech | NORTHING: 511,204.55 | START DATE: 03/03/2015

PROJECT No.: 475.0093.003 | EASTING: 197,376.16 | END DATE: 03/03/2015

LOCATION: SW Embankment Corner | GROUND ELEV.: 4,632.16 | LOGGED BY: JWR

DRILLING METHOD: 4 1/4" HSA and Mud Rotary | DATUM: Magnum Local Grid | BACKFILLED: 6% Bentonite Grout

OPERATOR: Jason Adams - Haz-Tech | EQUIPMENT: CME 75 | Page 5 of 6

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
58											
60.0	S-15		9-16-17				CH			CLAY (CH), trace silt, hard, fat, light brown, moist - lacustrine	Moisture Content = 26.0%
62											
64											
65.0	S-16		12-14-19				SM/ML			SAND/SILT (SM/ML), silty/sandy, some clay, fine grained, poorly graded, dense/hard, non-plastic, brown, rapid dilatancy, wet - lacustrine	Continue drilling due to variable sediment types and time of day
66											
68											
70.0	S-17		10-12-14				CL			CLAY (CL), some silt, trace fine sand, very stiff, lean, light brown, moist - lacustrine	
							SM/ML			SAND/SILT (SM/ML), silty/sandy, some clay, fine grained, poorly graded, medium dense/very stiff, non-plastic, brown, rapid dilatancy, wet - lacustrine	Continued drilling due to sediment type change in bottom 0.6ft of spoon
72											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-1

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SW Embankment Corner
DRILLING METHOD: 4 1/4" HSA and Mud Rotary
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,204.55
EASTING: 197,376.16
GROUND ELEV.: 4,632.16
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/03/2015
END DATE: 03/03/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 6 of 6

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
74											
75.0	S-18		24-12-13				CL			CLAY (CL), some silt, trace fine sand, very stiff, lean, light brown, moist - lacustrine	Moisture Content = 22.3%
76											
										Boring terminated at 76.5ft depth in very stiff clay Maintain circulation 100% 4 1/4" HSA to 20ft depth 4" tricone mud rotary with bentonite gel and EZ-Mud from 20ft depth to TD Water observed on the rods at approx. 13.5ft depth Depth to water measured at 10.8ft, but after water was added to the hole to counter flowing sands Borehole grouted to surface via tremmie pipe from 74.5ft depth	Theoretical hole volume = 11.8cf = 88.1USgal Grout batch: 70gal clean water 8 bags of type I/II portland cement (94lbs) 1 bag of bentonite gel (50lbs) - pumped 30% from 74.5ft to surface - tripped rods - filled augers - alternating pull 5ft auger and filling hole with grout to surface
78											
80											
82											
84											
86											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-2

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SE Embankment Corner
LOGGED BY: JWR
START DATE: 03/04/2015
END DATE: 03/04/2015

NORTHING: 513,421.02
EASTING: 197,411.12
GROUND ELEV.: 4,648.40
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/4/15	23.5	4,624.90
3/4/15	22.8	4625.60

BACKFILLED: 3/8" bentonite chips
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		2-2-2				SM			Topsoil SAND (SM), silty, fine grained, poorly graded, loose, non-plastic, brown, damp - aeolian(?)	
2											
2.5	S-2		3-2-3				SP			SAND (SP), trace silt and clay, fine to medium grained, poorly graded, sugangular to rounded, loose, non-plastic, light brown, damp - fluvial	
4											
5.0	S-3		5-8-7				SM			SAND (SM), silty, fine grained, poorly graded, medum dense, non-plastic, brown, damp - fluvial	Moisture Content = 8.0%
6											
7.5	S-4		7-8-13				SP-SM			SAND (SP-SM), with silt, fine grained, poorly graded, subangular to angular, rounded, medium dense, non-plastic, brown, damp - fluvial	
8											
10											
10.0	S-5		18-13-20							trace silt and clay, dense	
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-2

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SE Embankment Corner
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,421.02
EASTING: 197,411.12
GROUND ELEV.: 4,648.40
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/04/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 2 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		10-16-18							some clay, dense	Moisture Content = 14.6%
16											
18											
20.0	S-7		3-13-15				ML			SILT (ML), sandy, trace clay, very stiff, non-plastic, brown, moist - lacustrine	Moisture Content = 24.2%
22											
24											
25.0	S-8		13-21-23				SP			SAND (SP), some silt, trace clay, fine grained, poorly graded, subrounded to rounded, dense, non-plastic, brown, wet - fluvial	
26											
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-2

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SE Embankment Corner
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,421.02
EASTING: 197,411.12
GROUND ELEV.: 4,648.40
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/04/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 3 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
30											
30.0	S-9		7-28-50/5"							trace silt, very dense	
32											
34											
35.0	S-10		6-8-16				CL			CLAY (CL), trace silt and fine sand, very stiff, medium to high plasticity, light grayish-brown, moist - lacustrine	Moisture Content = 29.0% LL=44 / PI=22
36											
38											
40											
40.0	S-11		11-11-20							more silt, trace coarse sand, hard	Moisture Content = 21.6%
42											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-2

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SE Embankment Corner
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,421.02
EASTING: 197,411.12
GROUND ELEV.: 4,648.40
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/04/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 4 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
44											
45.0	S-12		4-7-16				SP			SAND (SP), some clay, trace silt, fine grained, poorly graded, sub angular to rounded, medium dense, lean, brown, wet - fluvial (flood sequence?)	Occasional clayey sand lens up to 0.1ft thick
46							CL			clay lens (bed?) trace fine sand, very stiff, lean, pale brown to tan	
							SP				
48											
50											
50.0	S-13		33-38-43							trace silt, very dense	
52											
54											
55.0	S-14		9-13-28								Flowing sands - countered by pouring water into augers prior to pulling center plug
56											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-2

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: SE Embankment Corner
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,421.02
EASTING: 197,411.12
GROUND ELEV.: 4,648.40
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/04/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 5 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
58											
60.0	S-15		13-38-50/ 6"				SM			SAND (SM), silty, fine grained, poorly graded, very dense, non-plastic, slow dilatancy, wet - lacustrine	Moisture Content = 21.8%
62										Boring terminated at 61.5ft depth in very dense silty sand Water observed on rods at 25.3ft depth Water measured to 23.5ft depth at 09:04 Water measured to 22.8ft depth at 11:32 prior to backfilling Theoretical hole volume = 20.9cf Borehole backfilled with 3/8" bentonite chips - 5.5 bags poured from surface and measured to approx. 30ft depth - poured 11.5 bags to surface - total length of chips approx 32ft - bridged above the phreatic surface for approx 10lf - 16 total bags of chips, hydrated	
64											
66											
68											
70											
72											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-3

Page 1 of 5

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
LOGGED BY: JWR
START DATE: 03/04/2015
END DATE: 03/05/2015

NORTHING: 513,448.10
EASTING: 198,453.75
GROUND ELEV.: 4,648.89
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA and Tricone Mud

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/4/15	22.7	4626.19

BACKFILLED: 6% Bentonite Grout
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		2-4-4				CL			Topsoil CLAY (CL), silty, trace fine sand, medium dense, stiff, lean, light gray, damp - lacustrine	Sand not retained in sample S-1
2							SP-SM			SAND (SP-SM), silty, fine grained, poorly graded, light brown, non-plastic, damp - fluvial	
2.5	S-2		4-5-6							trace clay, fine to coarse grained, poorly graded, subangular to rounded, medium dense, moist	Moisture Content = 3.5%
4											
5.0	S-3		4-4-6							trace silt, loose	
6											
7.5	S-4		5-6-8							medium dense	
8											
10											
10.0	S-5		6-5-6				ML			SILT (ML), sandy, fine grained, poorly graded, subangular to rounded, medium dense, non-plastic, light brown, moist - fluvial	Moisture Content = 16.5%
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-3

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA and Tricone Mud
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,448.10
EASTING: 198,453.75
GROUND ELEV.: 4,648.89
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 2 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		1-4-5				CL			CLAY (CL), silty, some fine sand, medium stiff, lean, light gray, moist - lacustrine rootlets and limonite staining	Moisture Content = 26.3% LL=28 / PI=10
16											
18											
20.0	S-7		12-14-7				SM			SAND (SM), silty, fine grained, poorly graded, medium dense, non-plastic, slow dilatancy, brown, wet - fluvial	Moisture Content = 24.2%
22									▽		
24											
25.0	S-8		2-6-14				SW			SAND (SW), some fine gravel, trace silt, fine to coarse grained, well graded, subrounded to rounded, max. particle size 0.08ft, medium dense, non-plastic, dark brown, wet - fluvial	Moisture Content = 13.7% Water not observed on rods Measured water at 22.7ft depth prior to changing drill method over to 4in tricone mud rotary
26											
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-3

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA and Tricone Mud
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,448.10
EASTING: 198,453.75
GROUND ELEV.: 4,648.89
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 3 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
30											
30.0	S-9		22-32-23				SP			SAND (SP), trace silt, fine to medium grained, poorly graded, subrounded to rounded, very dense, non-plastic, dark brown, wet - fluvial	Moisture Content = 19.2%
32											
34											
35.0	S-10		26-28-23							35.6ft - clay lens <0.1ft thick	
36											
38											
40											
40.0	S-11		20-23-25							dense	Moisture Content = 21.6%
42											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-3

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA and Tricone Mud
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,448.10
EASTING: 198,453.75
GROUND ELEV.: 4,648.89
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 4 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
44											
45.0	S-12		15-27-47							fine grained, very dense	
46											
48											
50.0	S-13		16-15-13				SM			SAND (SM), silty, fine grained, poorly graded, medium dense, non-plastic, slow dilatancy, brown, wet - fluvial	Moisture Content = 25.3%
52											
54											
55.0	S-14		31-29-40							very dense	
56											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-3

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA and Tricone Mud
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,448.10
EASTING: 198,453.75
GROUND ELEV.: 4,648.89
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/04/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 6% Bentonite Grout
Page 5 of 5

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
58											
60											
60.0	S-15		12-19-31				SP			SAND (SP), trace silt, fine grained, poorly graded, subangular to rounded, dense, non-plastic, brown, wet - fluvial	Moisture Content = 20.9%
62										Boring terminated at 61.5ft depth in dense sand Maintain circulation 100% 4 1/4" HSA to 20ft depth 4" tricone mud rotary with bentonite gel and EZ-Mud from 25ft depth to TD Depth to water measured at 22.7ft Borehole grouted to surface via tremmie pipe from 54.5ft depth	Theoretical hole volume = 11.8cf = 88.1USgal Grout batch: 75gal clean water 8 bags of type I/II portland cement (94lbs) 1 bag of bentonite gel (50lbs) - pumped 30% from 54.5ft to surface - tripped rods - filled augers - alternating pull 5ft auger and filling hole with grout to surface - hole took approx. 110gal of grout
64											
66											
68											
70											
72											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-4

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
LOGGED BY: JWR
START DATE: 03/05/2015
END DATE: 03/05/2015

NORTHING: 513,470.74
EASTING: 199,425.94
GROUND ELEV.: 4,654.07
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/5/15	27.0	4627.07

BACKFILLED: 3/8" bentonite chips
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		1-2-3				SM			Topsoil SAND (SM), silty, some clay, rootlets, loose, non-plastic to lean, brown, damp - aeolian(?)	
2											
2.5	S-2		3-6-9				CL			CLAY (CL), some silt to silty, trace fine sand, stiff, lean, brown, moist - lacustrine	Moisture Content = 21.4% LL=45 / PI=27
4											
5.0	S-3		6-8-9							trace rootlets and limonite staining, very stiff	
6											
7.5	S-4		1-2-2							trace silt, soft, medium to high plasticity, some limonite staining	Moisture Content =27.4% LL=44 / PI=25
8											
10											
10.0	S-5		411-11-20				ML			SILT (ML), trace sand, trace clay in lenses up to 0.1ft thick, fine grained, poorly graded, dense, non-plastic, light orangish brown, damp - lacustrine	
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-4

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,470.74
EASTING: 199,425.94
GROUND ELEV.: 4,654.07
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/05/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 2 of 3

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		4-3-3				CH			CLAY (CH), trace silt, medium stiff, fat, light gray, moist - lacustrine	
16											
18											
20.0	S-7		8-18-24				CL			CLAY (CL), silty, with fine sand, very stiff, lean, brown, moist - lacustrine	Moisture Content = 34.1% LL=38 / PI=17
22											
24											
25.0	S-8		8-18-24				SP			SAND (SP), trace silt and fine gravel, fine to coarse grained, poorly graded, subrounded to rounded, dense, non-plastic, brown, wet - fluvial	
26											
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-4

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: E Embankment
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 513,470.74
EASTING: 199,425.94
GROUND ELEV.: 4,654.07
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/05/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 3 of 3

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
30.0	S-9		18-21-38							fine to medium grained, very dense	Moisture Content = 18.9%
										Boring terminated at 31.5ft depth in very dense sand Water measured at 27.0ft depth Backfilled with 10, 50lbs bags of 3/8" bentonite chips, hydrated	
32											
34											
36											
38											
40											
42											

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH15-5

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: S Embankment
LOGGED BY: JWR
START DATE: 03/05/2015
END DATE: 03/05/2015

NORTHING: 512,223.26
EASTING: 197,348.69
GROUND ELEV.: 4,644.00
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/5/15	22.1	4,621.90

BACKFILLED: 3/8" bentonite chips
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		WOH-1-2				SP			SAND (SP), some silt, fine grained, poorly graded, rounded, very loose, non-plastic, light brown, damp - aeolian dune	Topsoil not observed
2											
2.5	S-2		4-5-5							loose	
4											
5.0	S-3		2-4-10				CL			CLAY (CL), some silt, trace fine sand, stiff, lean, light brown, moist - lacustrine	Moisture Content = 18.6% LL=31 / PI=16
6							SM			SAND (SM), silty, fine grained, poorly graded, non-plastic, light brown, moist - fluvial (lacustrine?)	
7.5	S-4		4-7-5				CL			CLAY (CL), some silt, trace fine sand, stiff, lean, brown, moist - lacustrine	
8											
10											
10.0	S-5		18-17-30				SM			SAND (SM), silty, some clay, fine grained, poorly graded, dense, non-plastic, brown, moist - fluvial	
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-5

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: S Embankment
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 512,223.26
EASTING: 197,348.69
GROUND ELEV.: 4,644.00
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/05/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 2 of 2

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		14-14-21				ML			SILT (ML), sandy, low plastic to non-plastic, brown, moist to wet - fluvial	Moisture Content = 19.9% LL=22 / PI=2
16											
18											
20.0	S-7		9-13-18				SP-SM			SAND (SP-SM), with silt, trace clay, fine grained, poorly graded, rounded, dense, non-plastic, brown, wet - fluvial	
22									▽		
24											
25.0	S-8		24-24-33				SP SM SP			SAND (SP), trace silt and fine gravel, fine to medium grained, poorly graded, rounded, max. particle size 0.05ft, very dense, non-plastic, brown, wet - fluvial silty sand lens, non-plastic, brown, wet - fluvial (flood event?)	Moisture Content = 20.6%
26										Boring terminated at 26.5ft depth in very dense sand Water measured to 22.1ft depth Backfilled with 8, 50lbs bags of 3/8" bentonite chips, hydrated	
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-6

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: W Embankment
LOGGED BY: JWR
START DATE: 03/05/2015
END DATE: 03/05/2015

NORTHING: 511,095.83
EASTING: 198,362.76
GROUND ELEV.: 4,635.45
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/5/15	13.3	4,622.15

BACKFILLED: 3/8" bentonite chips
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		WOH-4-8				SP			SAND (SP), some silt, trace clay, rootletes, fine grained, poorly graded, medium dense, non-plastic, brown, damp - aeolian dune	Topsoil not observed
2.5	S-2		14-21-20				SM			SAND (SM), silty, very dense, non-plastic, light gray, damp - lacustrine	Moisture Content = 9.9%
5.0	S-3		5-12-17							clay lens 0.2ft thick	Moisture Content = 7.9%
7.5	S-4		15-20-23							dense	
10.0	S-5		5-15-20				SP			SAND (SP), trace silt and gravel, fine grained, poorly graded, subrounded to rounded, max. particle size 0.06ft, dense, non-plastic, brown, moist - fluvial	
12											
14											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-6

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: W Embankment
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,095.83
EASTING: 198,362.76
GROUND ELEV.: 4,635.45
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/05/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 2 of 2

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		25-30-40							fine to medium grained, max. particle size 0.04ft, very dense, wet	
16											
18											
20.0	S-7		11-25-30							more silt, fine grained, no gravel observed	Flowing sands - water measured at 13.3ft depth prior to pouring water into augers to counter heave Moisture Content = 18.6%
22											
24											
25.0	S-8		11-22-33							trace clay	Flowing sands
26										Boring terminated at 26.5ft depth in very dense sand Water measured at 13.3ft depth Backfilled with 6, 50lbs bags of 3/8" bentonited chips, hydrated	
28											

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-7

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: W Embankment
LOGGED BY: JWR
START DATE: 03/05/2015
END DATE: 03/05/2015

NORTHING: 511,088.25
EASTING: 199,371.12
GROUND ELEV.: 4,639.99
DATUM: Magnum Local Grid
EQUIPMENT: CME 75
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (m)	ELEV. (m)
3/5/15	17.5	4,622.49

BACKFILLED: 3/8" bentonite chips
OPERATOR: Jason Adams - Haz-Tech

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
0	S-1		1-2-2				SP			Topsoil SAND (SP), some clay (lens), fine grained, poorly graded, subrounded to rounded, loose, non-plastic, brown, damp - aeolian	
2.5	S-2		15-15-15				ML			SILT (ML), sandy, fine grained, poory graded, subrounded to rounded, very stiff , non-plastic, light brown, damp - aeolian(?)	Moisture Content = 5.5%
5.0	S-3		10-12-12				SP CL			SAND (SP), trace silt, fine grained, poorly graded, subrounded to rounded, medium dense, non-plastic, light brownish gray, damp - fluvial CLAY (CL), silty, trace fine sand, very stiff, lean, light brown, damp - lacustrine	
7.5	S-4		10-9-9				SP CL			SAND (SP), some silt, fine grained, poorly graded, angular to subrounded, medium dense, non-plastic, pale orange, damp - fluvial CLAY (CL), some silt, very stiff, lean (fat?), light brown, damp - lacustrine	too stiff for field plasticity tests
10.0	S-5		19-30-37				SM			SAND (SM), silty, fine grained, poorly graded, subrounded to rounded, very dense, non-plastic, light orangish brown, damp - fluvial	Moisture Content = 4.3%

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH15-7

PROJECT: Sawtooth Brine Pond 2 Geotech
PROJECT No.: 475.0093.003
LOCATION: W Embankment
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Jason Adams - Haz-Tech

NORTHING: 511,088.25
EASTING: 199,371.12
GROUND ELEV.: 4,639.99
DATUM: Magnum Local Grid
EQUIPMENT: CME 75

START DATE: 03/05/2015
END DATE: 03/05/2015
LOGGED BY: JWR
BACKFILLED: 3/8" bentonite chips
Page 2 of 2

Depth (ft)	Sample ID	Sample Type	SPT 6 Inch Increments	Tons/ft2 Torvane	Tons/ft2 Pocket Penetrometer	Graphic Log	USCS	Weathering Profile Horizon	Water Table	Material Description	Remarks
15.0	S-6		15-25-30				SP			SAND (SP), trace silt and gravel, fine grained, poorly graded, rounded, max. particle size 0.07ft, very dense, non-plastic, brown, wet - fluvial	
20.0	S-7		8-18-35							fine to medium grained, max. particle size 0.05ft	Flowing sands - water measured to 17.5ft depth prior to adding water into augers to counter heave
25.0	S-8		8-29-31								Moisture Content = 18.9%
										Boring terminated at 26.5ft depth in very dense sand Water measured at 17.5 ft depth Backfilled with 7, 50lbs bags of 3/8" bentonite chips, hydrated	

APPENDIX D2 –TEST PIT LOGS

NewFields

Pit ID: **TP15-01**

Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/6/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E511102.00 N199027.34	Elevation: 4637.08	Total Pit Depth: 14.0ft
Shoring (if used):	None	Surface Condtions: Gently sloping SSE	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0			0.2 Clay, some silt, fine gravel veneer	
2.5			SAND (SP), some silt, fine grained, poorly graded, subangular to rounded, light brown, damp	Hard digging to 3.5ft depth
5.0				
7.5			7.5	
			8.0 7.5-8.5ft - Gravelly	
10.0			SAND (SP), trace fine gravel, fine to medium grained, poorly graded, maximum particle size 0.04ft, subangular to rounded, brown, moist to wet	
12.5				
	▼ 13.5ft		14.0	
15.0			TD = 14.0ft depth	
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)

NewFields

Pit ID: **TP15-02**

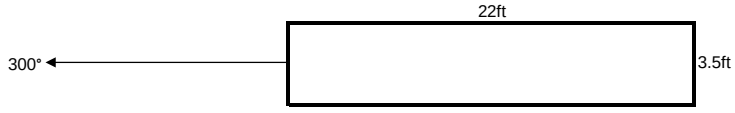
Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/6/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E511577.77 N198.018.01
Elevation: 4636.21
Total Pit Depth: 15.5ft
Shoring (if used): None
Surface Condtions: Undulating
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
		 0.3	Topsoil	
2.5			SAND (SP), some silt, some partial cement (halite), fine grained, poorly graded, light brown, damp	Hard digging to 3ft depth
5.0	SD-1 at 6ft			
7.5				
10.0	LD-1 at 10ft	9.0	CLAY (CL), some silt, trace sand, rootlets, light gray, borwn and red, mottled, lean, moist	Moisture Content = 26.4% LL=43 / PI =26
12.5		11.0	SAND (SP), trace gravel, fine to medium grained, poorly graded, subrounded to rounded, brown, moist	Hard digging
15.0	SD-3 at 13ft ▼ 15.0ft			
17.5			TD = 15.5ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-03**

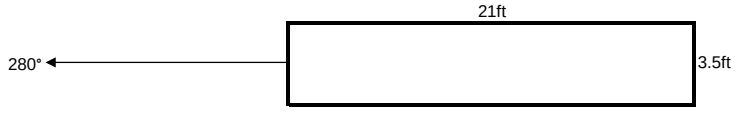
Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/6/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E512072.17 N198032.50
Elevation: 4639.31
Total Pit Depth: 16.0ft
Shoring (if used): None
Surface Condtions: Gently sloping SSE
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			Topsoil	
2.5			SAND (SM), silty, fine grained, poorly graded, some cement (halite) at 4ft, subangular to rounded, light brown, damp	Hard digging at 4ft depth
5.0	SD-1 at 3ft LD-1 at 5ft			Moisture Content =8.8%
7.5			7.0ft - stronger salt cement	Harder to dig at 7ft
10.0				
12.5				
13.0			SAND (SP), trace fine gravel, fine to medium grained, poorly graded, rounded, brown, moist	Hard digging
15.0	SD-2 at 15ft ▼ 15.6ft			
17.5			TD = 16.0ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: TP15-04

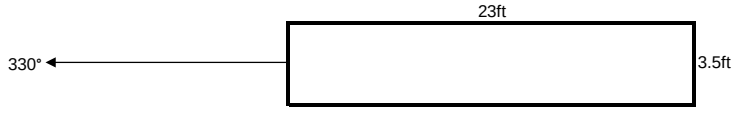
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/6/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E512790.84 N197339.08	Elevation: 4643.68	Total Pit Depth: 20.0ft
Shoring (if used):	None	Surface Condtions: Undulating	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SM), silty, fine grained, poorly graded, light brown, damp - aeolian(?)	0.2ft topsoil
		1.6		
			CLAY (CH), some silt, lean - medium plastic, rootlets, light gray, damp - lacustrine	
		2.9		
5.0	SD-1 at 5ft		SAND (SP), some gravel, fine to coarse grained, poorly graded, rounded, brown, damp, cross bedded and hummocky - fluvial	
7.5				
		8.0		Hard digging from 8ft depth
10.0			CLAY (CL), trace to some silt, hard, brown, damp	
		10.0		
12.5			SAND (SM), silty, with clay lenses, fine grained, poorly graded, brown, moist	
15.0				
17.5	SD-2 at 17ft			
		19.0		
20.0	▼ 19.5ft		SAND (SP), trace fine gravel, fine to medium grained, poorly graded, brown, wet TD = 20.0ft depth	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: TP15-05

Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/6/2015
Equipment:	CAT 320 Excavator	Contractor:	Westside Grading
Logged by:	J. Roberts		
Local Grid Coordinates:	E512.574.68 N198146.55	Elevation:	4647.94
Total Pit Depth:	19.5ft		
Shoring (if used):	None	Surface Condtions:	Lee side of stabilized dune
Backfilled:	Yes		

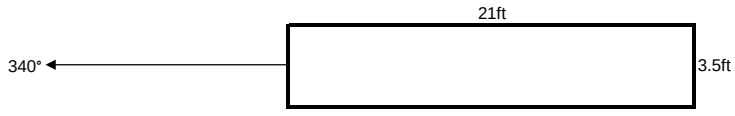
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SM), silty, some clay, fine grained, poorly graded, brown, damp - fluvial	Topsoil not observed
	LD-1 at 3ft		CLAY (CL), trace silt, lean - medium plastic, light gray and tan, mottled, moist - lacustrine	Moisture Content = 34.1% LL=46 / PI =24
5.0			SAND (SM), silty, fine grained, poorly graded, brown, damp - fluvial	
7.5			CLAY (CL), lean - medium plastic, brown, moist - lacustrine	
	SD-1 at 9ft		SAND (SM), with silt, interbedded clay lenses up to 0.3ft thick, fine grained, poorly graded, brown, damp - fluvial	Moisture Content = 9.9%
10.0				
12.5				
15.0				
17.5				
	SD-2 at 18ft		SAND (SP), trace silt, fine grained, poorly graded, rounded, brown, damp - fluvial	Groundwater not observed
20.0			TD = 19.5ft depth	

2.0
4.0
6.0
7.0
16.0

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-0**

Project: Sawtooth Brine Pond 2 Geotechnical Investigation | Project No.: 475.0093.003

Project Location: Sawtooth Brine Pond 2; Delta, Utah | Date: 3/6/2015

Equipment: CAT 320 Excavator | Contractor: Westside Grading | Logged by: J. Roberts

Local Grid Coordinates: E513050.82 N198063.39 | Elevation: 4645.08 | Total Pit Depth: 21.0ft

Shoring (if used): None | Surface Condtions: Flat - undulating | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			CLAY (CL), some silt, rootlets, lean - medium plastic, light gray, damp - lacustrine	
5.0	SD-1 at 4ft		SAND (SP), trace silt, fine grained, poorly graded, rounded, brown, damp, cross bedded - hummocky - fluvial	1.5-2.0ft limonite staining
7.5			CLAY (CL), some silt, rootlets, lean - medium plastic, light gray, damp - lacustrine 6.8-7.0ft depth - orange fine sand	
10.0	LD-1 at 8ft			Moisture Content = 20.7% LL=34 / PI=16
12.5				
15.0			SAND (SM), silty, with clay lens, fine grained, poorly graded, non-plastic to lean - low plastic, brown, moist - fluvial	
17.5				
20.0			SAND (SP), trace gravel, silt and clay lens, fine grained, poorly graded, subrounded to rounded, brown, moist - fluvial	▼ Water encountered at 20.5ft depth TD = 21ft depth

1.5
6.0
12.0
18.5

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)

NewFields

Pit ID: **TP15-0**

Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/6/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E513538.20 N198013.98
Elevation: 4648.91
Total Pit Depth: 20.0ft
Shoring (if used): None
Surface Condtions: Flat
Backfilled: Yes

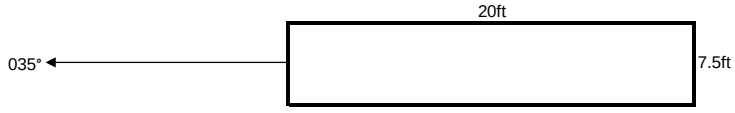
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			CLAY (CL), some silt, rootlets, lean - medium plastic, light gray, damp - lacustrine	0.3ft topsoil
				2.0-2.6ft - limonite staining
5.0	SD-1 at 4ft		SAND (SP), trace fine gravel and silt, fine to coarse grained, poorly graded, subangular to rounded, brown, damp - lenticular cross bedded - fluvial	
			GRAVEL (GP), sandy, fine to coarse grained, poorly graded, rounded, maximum particle size <0.1ft, brown, damp - fluvial	
7.5	SD-2 at 7ft		SAND (SP), trace fine gravel and silt, fine to coarse grained, poorly graded, subangular to rounded, brown, damp - lenticular cross bedded - fluvial	
			CLAY (CL), sandy, rootlets, local limonite staining, lean, brown, moist - lacustrine	
10.0			SAND (SM), silty, with clay lens, fine grained, poorly graded, non-plastic, brown, damp - fluvial	
12.5				12.0ft hard digging
15.0			CLAY (CL), silty, lean - medium plastic, hard - pocket penetrometer >>4.5 tons/ft^2, brown, moist - lacustrine	
17.5			18.0ft - few light gray mottled layers	
20.0			TD=20.0ft depth	Groundwater not observed

2.0
4.5
5.5
6.4
7.5
13.6

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-0**

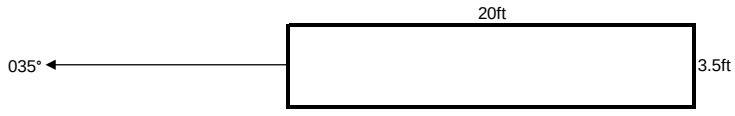
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/6/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E513494.26 N198784.44	Elevation: 4649.95	Total Pit Depth: 20.0ft
Shoring (if used):	None	Surface Condtions: Flat	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			CLAY (CH), silty, rootlets, local limonite staining, lean - medium plastic, light gray, mottled, damp - lacustrine	Moisture Content = 32.4% LL=53 / PI=31
5.0	SD-1 at 3ft			
			4.4	
7.5			SAND (SP), some silt, fine grained, poorly graded, brown, damp - cross bedded - hummocky - fluvial	upper 0.7ft of sand is limonite stained
10.0	SD-2 at 8ft			
12.5				
15.0				
			15.4	
17.5			CLAY (CH), trace fine sand and silt, ubiquitous rootlets, some limonite staining, fat - high plastic, light gray, moist - lacustrine	Groundwater not observed
20.0			TD = 20.0ft depth	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▽	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-0**

Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Pond 2; Delta, Utah
Date: 3/6/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E513015.52 N198775.68
Elevation: 4649.66
Total Pit Depth: 20.0ft
Shoring (if used): None
Surface Condtions: Flat
Backfilled: Yes

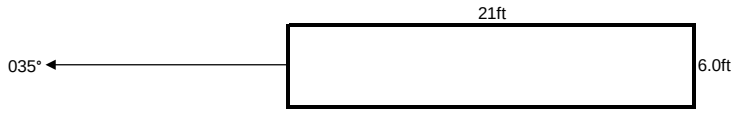
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SM), silty, fine grained, poorly graded, brown, damp - aeolian(?)	
			CLAY (CL), some silt, trace fine sand, lean - medium plastic, light gray, damp - lacustrine	
5.0				
7.5			SAND (SP), trace silt, fine grained, poorly graded, brown, damp - cross bedded - fluvial	
10.0				
12.5	LD-1 at 12ft		SAND (SM), silty, fine grained, poorly graded, light brown, damp - fluvial	Relatively hard digging from 10.7ft Moisture Content = 10.6%
15.0				
17.5	LD-2 at 16ft		CLAY (CL), trace silt and fine sand, ubiquitous rootlets, local limonite staining, medium plastic, light gray, moist - lacustrine	Moisture Content = 35.9% LL=49 / PI=26
20.0	SD-1 at 19ft		SAND (SP), trace fine gravel and silt, fine grained, poorly graded, rounded, brown, moist - fluvial TD = 20.0ft depth	Moisture Content = 4.1% Groundwater not observed

1.0
3.5
0.7
14.5
18.0

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-10**

Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/6/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E512519.38 N198784.99	Elevation: 4646.92	Total Pit Depth: 20.5ft
Shoring (if used):	None	Surface Condtions: Flat	Backfilled: Yes

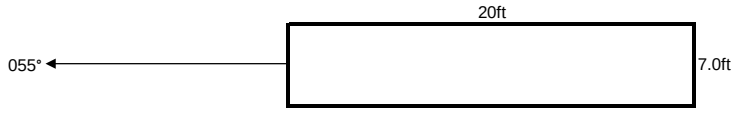
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SP-SM), with silt, fine grained, poorly graded, brown, damp - aeolian(?)	0.2ft Topsoil
			CLAY (CL), some silt, trace fine sand, lean - medium plastic, light gray, damp - lacustrine	2.5-3.1ft limonite staining
5.0				Planar beds attitude approximately 325°, 10°NE
7.5			SAND (SP), some fine gravel, trace silt, fine to medium grained - trace coarse sand, poorly graded, rounded, brown, damp - cross bedded and hummocky to 3.5ft depth - planar - fluvial	
10.0				
12.5				
15.0	SD-1 at 13ft		SAND (SM), silty, trace clay, fine grained, poorly graded, non-plastic, tan, damp to moist - fluvial	
17.5				
20.0	SD-2 at 19ft		SAND (SP), trace silt, fine to medium grained, poorly graded, subrounded to rounded, brown, damp - fluvial	Graoundwater not observed
			TD = 20.5ft depth	

1.0
11.7
18.4

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▽	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-11**

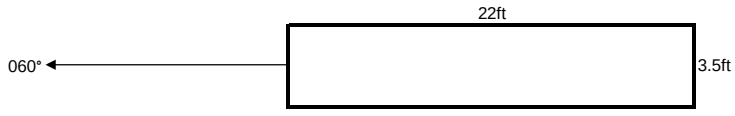
Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/6/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E512049.11 N199521.37
Elevation: 4640.56
Total Pit Depth: 17.0ft
Shoring (if used): None
Surface Condtions: Flat
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD-1 at 2ft		CLAY (CL), silty, some fine sand, lean - medium plastic, tan, moist - lacustrine	0.3ft topsoil and orange silty sand
5.0		3.0		Very hard digging from 3ft depth
7.5	LD-1 at 6ft		SAND (SM), silty, weakly cemented (halite), fine grained, poorly graded, lean(?), light gray, damp - lacustrine	Moisture Content = 11.4%
10.0				
12.5		12.3		
15.0	SD-2 at 14ft		SAND (SP), trace gravel and silt, fine to coarse grained, moderately graded, subrounded to rounded, maximum particle size 0.06ft, brown, moist - fluvial	
17.5	▼ 16.6ft	17.0	TD = 17.0ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-12**

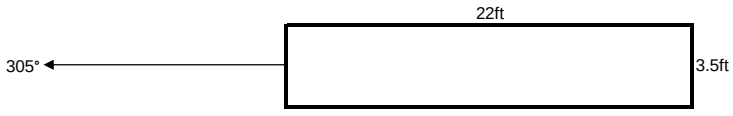
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/7/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E511545.60 N199504.77	Elevation: 4640.77	Total Pit Depth: 18.0ft
Shoring (if used):	None	Surface Condtions: Gently sloping north	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			0.2ft clay veneer overlying fine sand with some silt	
2.5		0.8	CLAY (CL), sandy, partially cemented (halite), fine grained, poorly graded, interbedded sands >0.2ft thick, hard, light grayish brown, damp - lacustrine	Hard digging at 2.0ft
5.0		4.4	SAND (SP), some silt, fine grained, poorly graded, subangular to rounded, brown, damp - cross bedded - hummocky - fluvial	
7.5		7.0	some gravels	
10.0	LD-1 at 10ft	11.0		
12.5				
15.0				
	SD-1 at 16ft	16.0	fine to medium grained, poorly graded	
17.5	▼ 17.4ft			
			TD = 18.0ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-13**

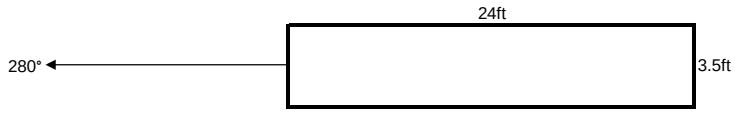
Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/7/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E511563.19 N198791.79
Elevation: 4637.94
Total Pit Depth: 15.5ft
Shoring (if used): None
Surface Condtions: Undulating
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD-1 at 1.5ft		SAND (SP), trace silt, fine grained, poorly graded, brown, damp - aeolian(?)	Topsoil not observed
			1.9 SAND (SC), clayey, fine to coarse, poorly graded, lean - medium plastic, brown, moist - lacustrine	
5.0	LD-1 at 4ft		2.9 CLAY (CL), some sand, lean - medium plastic, brown, moist - lacustrine	Moisture Content = 20.4% LL=41 / PI=22
7.5	SD-2 at 7ft		5.0 SAND (SM), silty, fine grained, poorly graded, weak cement (halite), non-plastic, tan, damp - fluvial	Hard digging from 5.0ft
10.0			8.6 SAND (SP), trace to some gravel, trace silt, fine grained, poorly graded, brown damp - cross bedded - fluvial	Easy digging
12.5			10.6 some gravels 12.1	
15.0	▼ 15.0ft			
17.5			TD = 15.5ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-14**

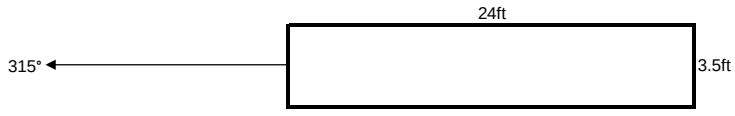
Project: Sawtooth Brine Pond 2 Geotechnical Investigation
Project No.: 475.0093.003
Project Location: Sawtooth Brine Pond 2; Delta, Utah
Date: 3/7/2015
Equipment: CAT 320 Excavator
Contractor: Westside Grading
Logged by: J. Roberts
Local Grid Coordinates: E511861.95 N198587.57
Elevation: 4644.63
Total Pit Depth: 21.0ft
Shoring (if used): None
Surface Condtions: Flat - crest of dune
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SC), clayey - to some clay, fine grained, poorly graded, lean - medium plastic, brown, moist - lacustrine	Topsoil not observed
			2.0	
			CLAY (CL), silty, some sand, lean - medium plastic, light gray, moist - lacustrine	
5.0			2.9	
			SAND (SP), some gravel, trace silt, fine grained, poorly graded, subangular ro rounded, brown, damp - cross bedded - planar - fluvial	
			5.4	
7.5	LD-1 at 7ft		CLAY (CL), trace fine sand and silt, rootlets, limonite staining - locally heavy, medium plastic, light grayish brown, moist - lacustrine	Moisture Content = 34.0% LL=31 / PI=17 8.0ft increase moisture content
10.0				
12.5			12.4	
			SAND (SC), clayey, fine grained, poorly graded, lean - medium plastic, orangish brown, moist - lacustrine	
15.0				
17.5			17.1	
	SD-1 at 18ft		SAND (SP), some gravel, trace silt, fine to coarse grained, poorly graded, subrounded to rounded, maximum particle size 0.08ft, brown, moist - fluvial	
20.0	▼ 20.3ft			TD = 21.0ft depth

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-15**

Project: Sawtooth Brine Pond 2 Geotechnical Investigation | Project No.: 475.0093.003

Project Location: Sawtooth Brine Pond 2; Delta, Utah | Date: 3/7/2015

Equipment: CAT 320 Excavator | Contractor: Westside Grading | Logged by: J. Roberts

Local Grid Coordinates: E511755.47 N197304.59 | Elevation: 4636.70 | Total Pit Depth: 18.5ft

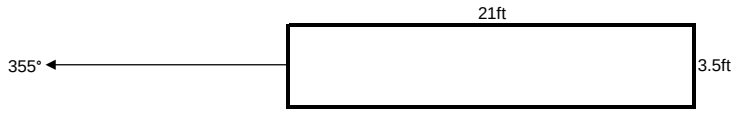
Shoring (if used): None | Surface Condtions: Flat - crest of dune (?) | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			SAND (SP), trace silty, fine grained, poorly graded, brown, moist - fluvial	Topsoil not obsesrved
5.0			some silt, fine to coarse, moderately graded, subrounded to rounded, weak cement (halite)	
7.5	SD-1 at 7ft BL-1 at 7ft		SILT (ML), some sand to sandy, fine grained, non-plastic to lean - low plastic, tubular voids randomly oriented - root casts, brown, moist - lacustrine *Interbedded - lenticular - discontinuous* SAND (SM), silty, fine grained, poorly graded, tubular voids randomly oriented - root casts, light brown and orange, moist - lacustrine	Very hard digging from 5.5ft depth
10.0				
12.5			SAND (SP), trace silt, fine to medium grained, poorly graded, subrounded to rounded, brown, moist - fluvial	
15.0				
17.5				
20.0	▼ 17.8ft		TD = 18.5ft depth	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-1**

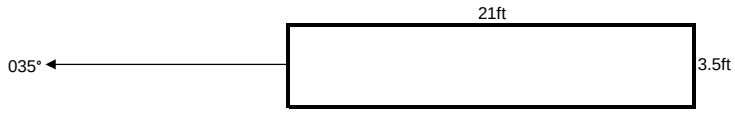
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/7/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E511954.13 N197300.97	Elevation: 4639.02	Total Pit Depth: 16.8ft
Shoring (if used):	None	Surface Condtions: Flat to gently sloping to the NW	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			SAND (SP-SM), with silt, fine grained, poorly graded, grayish brown, damp - aeolian(?)	
0.7				
2.5				
5.0			SAND (SC), clayey, some silt, fine grained, poorly graded, non-plastitc to lean - low plastic, orangish brown, moist - lacustrine	Very hard digging at 4ft
6.0				
7.5	SD-1 at 7.5ft BL-1 at 7.5ft			
10.0			Grades between silty sand and sandy silt (SM/ML), with some clay lenes, moderately cemented (halite), tubular vugs - root casts up to 5mm with some halite precipitate infill, clay lenses are up to 0.2ft thick, light gray or red with rootlets - lacustrine	
12.5				Decrease hardness at 12ft
15.0				
15.4				
	▼ 16.1ft		Sand (SP), trace silt, fine grained, poorly graded, brown, moist - fluvial	
17.5			TD = 16.8ft depth	
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-1**

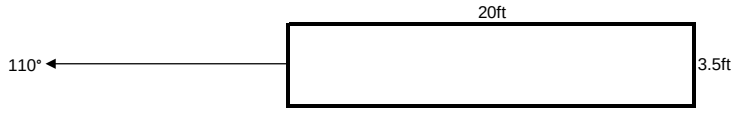
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/7/2015
Equipment:	CAT 320 Excavator	Contractor:	Westside Grading
Logged by:	J. Roberts		
Local Grid Coordinates:	E512398.74 N197329.65	Elevation:	4642.55
Total Pit Depth:	19.0ft		
Shoring (if used):	None	Surface Condtions:	Flat, just east of dune lee toe
Backfilled:	Yes		

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			SAND (SP), trace silt, fine grained, poorly graded, brown, damp - aeolian(?)	Topsoil not observed
1.0				
1.5			Light gray silty band observed in east half of pit	No samples collected
2.5				
2.4			fine gravels	
2.8				
3.3				
4.3			CLAY (CL), some silt, trace sand, rootlets, lean - medium plastic, red - becomes brown at 4.0ft, moist - lacustrine	
5.0				
7.5			SAND (SM), silty, fine grained, poorly graded, weak cement (halite), light brown, moist - lacustrine	Very hard digging from 7ft depth
10.0				
12.0				Clay lens at 12ft had free water in void space
12.5				
15.0			Grades between clayey sand and sandy clay (SC/CL), weak cement (halite), tubular voids - root casts	
17.5				
	▼ 18.4ft			
20.0			TD = 19.0ft depth	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



NewFields

Pit ID: **TP15-1**

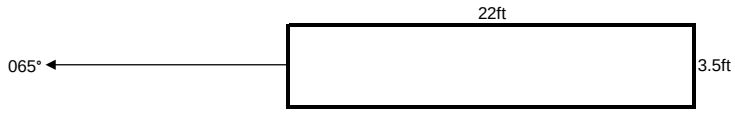
Project:	Sawtooth Brine Pond 2 Geotechnical Investigation	Project No.:	475.0093.003
Project Location:	Sawtooth Brine Pond 2; Delta, Utah	Date:	3/7/2015
Equipment:	CAT 320 Excavator	Contractor: Westside Grading	Logged by: J. Roberts
Local Grid Coordinates:	E513191.42 N197304.09	Elevation: 4646.16	Total Pit Depth: 20.6ft
Shoring (if used):	None	Surface Condtions: Flat	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			SAND (SP), trace to some silt, fine grained poorly graded, brown, damp - aeolian(?)	Topsoil not observed
1.0			CLAY (CL), silty, trace fine sand, thinly bedded, lean - medium plastic, damp to moist - lacustrine	No samples collected
2.0				
2.5				
5.0				
7.5			SAND (SP), some gravel, trace silt, fine to medium grained, poorly graded, rounded, brown, moist - cross bedded - fluvial	
10.0				
11.5				
12.5				
15.0			CLAY (CL), silty to some silt, rootlets, lean - medium plastic, reddish brown, moist - lacustrine at 13.5ft depth, tubular voids - root casts, trace rootlets	Significantly less root casts in clay here compared to observations made to the west
17.5				Hard digging 14.5ft to TD
20.0			TD = 20.6ft depth	Groundwater not observed

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit: (include width, length, and azimuth)



APPENDIX E – LABORATORY TESTING

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #16

Client: Magnum Development Solution Mining		**Location:**	**Various Test Pits & Borings**
Project Title: Sawtooth Brine Pond #2		**Elevation:**	**Variable**
Project Number: 475.0093.003		**Test Start Date:**	
Project Engineer: KCW		**Tested By:**	**NewFields Laboratory, Elko NV**
Field Sample ID:		**Checked By:**	**NTR**
Laboratory Sample ID:		**Sample Description: Variable**	

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		15-050-01	15-050-02	15-050-03	15-050-04	15-050-05
Location		**TP15-02**	**TP15-03**	**TP15-05**	**TP15-05**	**TP15-06**
Depth		10'	5'	3'	9'	8'
Soil Description						
(USCS)		CL	SM	CL	SM	CL
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.		NF3	NF87	NF113	NF107	NF75
Tare + Wet Soil	**A**	1245.9	994.1	1037.8	981.6	763.9
Tare + Dry Soil	**B**	1041.8	929.6	821.9	910.1	665.4
Tare	**C**	267.5	193.4	188.5	189.5	190.6
Wt. of Water	**D= A-B**	204.1	64.5	215.9	71.5	98.5
Dry Soil, Ws	**E= B-C**	774.3	736.2	633.4	720.6	474.8
Moisture Content, (%)	**(D/E) x100**	**26.4%**	**8.8%**	**34.1%**	**9.9%**	**20.7%**

Sample No.		15-050-06	15-050-07	15-050-08	15-050-09	15-050-10
Location		**TP15-08**	**TP15-09**	**TP15-09**	**TP15-09**	**TP15-11**
Depth		3'	12'	16'	19'	6'
Soil Description						
(USCS)		CH	SM	CL	SP	SM
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.		NF46	NF90	NF14	NF43	punch
Tare + Wet Soil	**A**	742.8	1002.3	1344.3	949.6	640.3
Tare + Dry Soil	**B**	616.1	924.8	1059.8	920.8	592.5
Tare	**C**	225.4	190.8	267.2	223.1	173.2
Wt. of Water	**D= A-B**	126.7	77.5	284.5	28.8	47.8
Dry Soil, Ws	**E= B-C**	390.7	734	792.6	697.7	419.3
Moisture Content, (%)	**(D/E) x100**	**32.4%**	**10.6%**	**35.9%**	**4.1%**	**11.4%**

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #16

Client: Magnum Development Solution Mining		**Location:**	**Various Test Pits & Borings**
Project Title: Sawtooth Brine Pond #2		**Elevation:**	**Variable**
Project Number: 475.0093.003		**Test Start Date:**	
Project Engineer: KCW		**Tested By:**	**NewFields Laboratory, Elko NV**
Field Sample ID:		**Checked By:**	**NTR**
Laboratory Sample ID:		**Sample Description: Variable**	

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		15-050-11	15-050-12		15-051-01	15-051-02
Location		**TP15-13**	**TP15-14**		**BH15-01**	**BH15-01**
Depth		4'	7'		5.0 - 6.5'	7.5 - 9.0'
Soil Description						
(USCS)		CL	CL		SP	SP
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.		gota	NF91		NF33	NF44
Tare + Wet Soil	**A**	934.9	826.5		801.6	931.5
Tare + Dry Soil	**B**	821.2	664.7		780.2	902.1
Tare	**C**	264.8	189.2		223.4	223.8
Wt. of Water	**D= A-B**	113.7	161.8		21.4	29.4
Dry Soil, Ws	**E= B-C**	556.4	475.5		556.8	678.3
Moisture Content, (%)	**(D/E) x100**	**20.4%**	**34.0%**		**3.8%**	**4.3%**

Sample No.		15-051-03	15-051-04	15-051-05	15-051-06	15-051-07
Location		**BH15-01**	**BH15-01**	**BH15-01**	**BH15-01**	**BH15-01**
Depth		25-26.5'	40-41.5'	50-51.5'	60-61.5'	75-76.5'
Soil Description						
(USCS)		CL	CL	CL	CH	CL
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.		NF56	NF45	NF67	NF68	NF75
Tare + Wet Soil	**A**	1236.7	1219	1199.8	1273.7	924.2
Tare + Dry Soil	**B**	1029.1	1035.9	985.3	1050.2	790.4
Tare	**C**	189.9	193.3	189.3	189.9	190.5
Wt. of Water	**D= A-B**	207.6	183.1	214.5	223.5	133.8
Dry Soil, Ws	**E= B-C**	839.2	842.6	796	860.3	599.9
Moisture Content, (%)	**(D/E) x100**	**24.7%**	**21.7%**	**26.9%**	**26.0%**	**22.3%**

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #16

Client: Magnum Development Solution Mining		**Location:**	**Various Test Pits & Borings**
Project Title: Sawtooth Brine Pond #2		**Elevation:**	**Variable**
Project Number: 475.0093.003		**Test Start Date:**	
Project Engineer: KCW		**Tested By:**	**NewFields Laboratory, Elko NV**
Field Sample ID:		**Checked By:**	**NTR**
Laboratory Sample ID:		**Sample Description: Variable**	

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		15-051-08	15-051-10	15-051-11	15-051-12	15-051-13
Location		**BH15-02**	**BH15-02**	**BH15-02**	**BH15-02**	**BH15-02**
Depth		5-6.5'	15-16.5'	20-21.5'	35-36.5'	40-41.5'
Soil Description						
(USCS)		SM	SP-SM	ML	CL	CL
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.		NF113	Phat	NF77	NF99	NF107
Tare + Wet Soil	**A**	835.9	1012.9	1179.8	528.5	1290
Tare + Dry Soil	**B**	788.1	907.9	987.2	452.2	1094.9
Tare	**C**	188.4	189.2	190.4	189.5	189.7
Wt. of Water	**D= A-B**	47.8	105	192.6	76.3	195.1
Dry Soil, Ws	**E= B-C**	599.7	718.7	796.8	262.7	905.2
Moisture Content, (%)	**(D/E) x100**	**8.0%**	**14.6%**	**24.2%**	**29.0%**	**21.6%**

Sample No.		15-051-14	15-051-15	15-051-16	15-051-17	15-051-18
Location		**BH15-02**	**BH15-03**	**BH15-03**	**BH15-03**	**BH15-03**
Depth		60-61.5'	2.5-4'	10-11.5	15-16.5'	20-21.5'
Soil Description						
(USCS)		SM	SP-SM	ML	CL	SM
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.		NF91	NF62	NF98	NF9	NF102
Tare + Wet Soil	**A**	1053.9	839.7	946	695.1	1083.9
Tare + Dry Soil	**B**	899.2	817.9	838.9	605.4	909.6
Tare	**C**	189	191.8	189.7	264.7	188.3
Wt. of Water	**D= A-B**	154.7	21.8	107.1	89.7	174.3
Dry Soil, Ws	**E= B-C**	710.2	626.1	649.2	340.7	721.3
Moisture Content, (%)	**(D/E) x100**	**21.8%**	**3.5%**	**16.5%**	**26.3%**	**24.2%**

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #16

Client: Magnum Development Solution Mining		**Location:**	**Various Test Pits & Borings**
Project Title: Sawtooth Brine Pond #2		**Elevation:**	**Variable**
Project Number: 475.0093.003		**Test Start Date:**	
Project Engineer: KCW		**Tested By:**	**NewFields Laboratory, Elko NV**
Field Sample ID:		**Checked By:**	**NTR**
Laboratory Sample ID:		**Sample Description: Variable**	

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		15-051-19	15-051-20	15-051-21	15-051-22	15-051-23
Location		**BH15-03**	**BH15-03**	**BH15-03**	**BH15-03**	**BH15-03**
Depth		25-26.5'	30-31.5'	40-41.5'	50-51.5'	60-61.5'
Soil Description						
(USCS)		SW	SP	SP	SM	SP
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.		NF94	NF24	NF87	NF65	NF43
Tare + Wet Soil	**A**	1069.9	927.2	1033.8	962.4	1116.3
Tare + Dry Soil	**B**	963.8	797.3	884.2	806	961.7
Tare	**C**	188.2	121.1	192.1	188	223.2
Wt. of Water	**D= A-B**	106.1	129.9	149.6	156.4	154.6
Dry Soil, Ws	**E= B-C**	775.6	676.2	692.1	618	738.5
Moisture Content, (%)	**(D/E) x100**	**13.7%**	**19.2%**	**21.6%**	**25.3%**	**20.9%**

Sample No.		15-051-24	15-051-25	15-051-27	15-051-28	15-051-29
Location		**BH15-04**	**BH15-04**	**BH15-04**	**BH15-04**	**BH15-05**
Depth		2.5-4'	7.5-9'	20-21.5'	30-31.5'	5-6.5'
Soil Description						
(USCS)		CL	CL	CL	SP	CL
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.		NF25	NF83	NF11	NF111	dirty
Tare + Wet Soil	**A**	509.8	594.9	640.5	1353.6	618.9
Tare + Dry Soil	**B**	441.3	508	545.1	1168.4	551.4
Tare	**C**	120.9	190.9	265.7	188.3	189.4
Wt. of Water	**D= A-B**	68.5	86.9	95.4	185.2	67.5
Dry Soil, Ws	**E= B-C**	320.4	317.1	279.4	980.1	362
Moisture Content, (%)	**(D/E) x100**	**21.4%**	**27.4%**	**34.1%**	**18.9%**	**18.6%**

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #16

Client: Magnum Development Solution Mining		**Location:**	**Various Test Pits & Borings**
Project Title: Sawtooth Brine Pond #2		**Elevation:**	**Variable**
Project Number: 475.0093.003		**Test Start Date:**	
Project Engineer: KCW		**Tested By:**	**NewFields Laboratory, Elko NV**
Field Sample ID:		**Checked By:**	**NTR**
Laboratory Sample ID:		**Sample Description: Variable**	

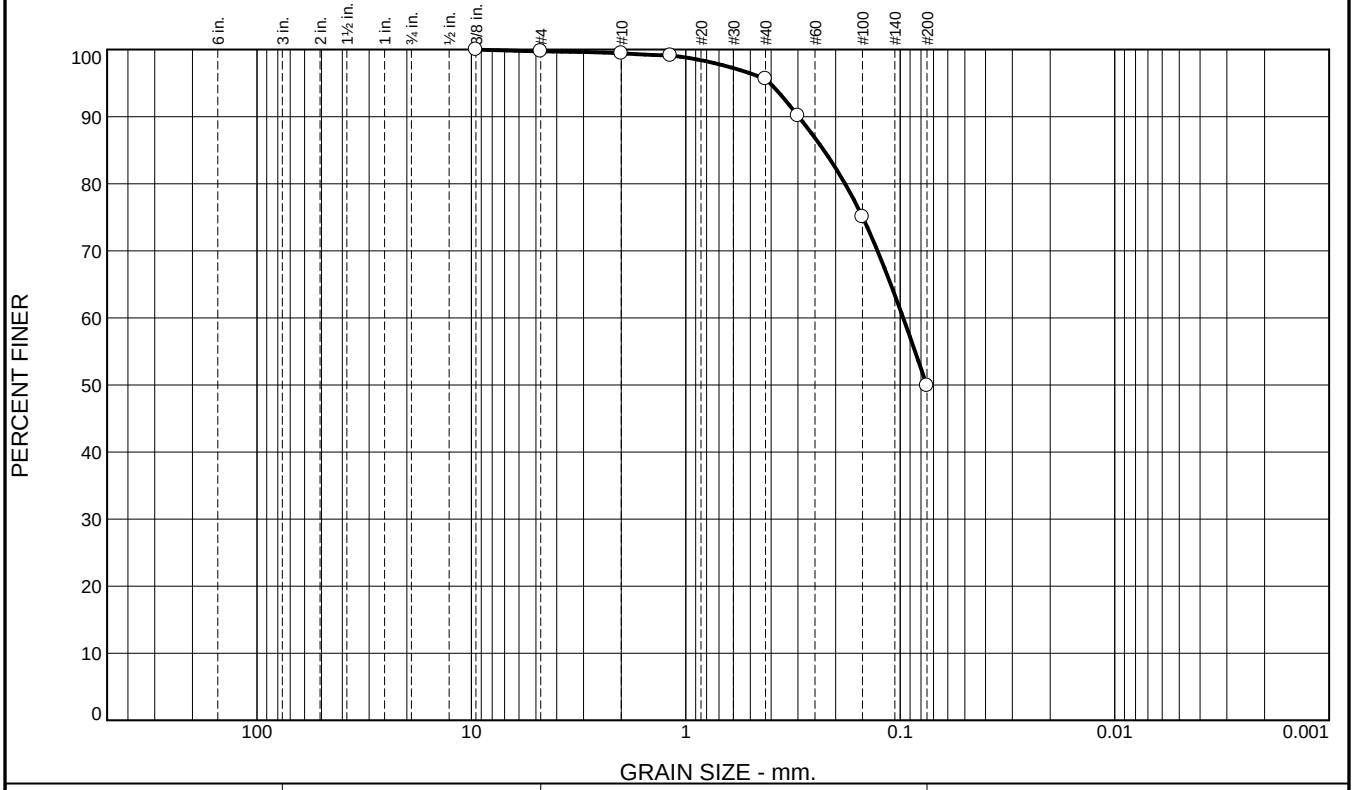
Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		15-051-30	15-051-31	15-051-32	15-051-33	15-051-34
Location		**BH15-05**	**BH15-05**	**BH15-06**	**BH15-06**	**BH15-06**
Depth		15-16.5'	25-26.5'	2.5-4'	5-6.5'	20-21.5'
Soil Description						
(USCS)		ML	SM	SM	SM	SM
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.		NF74	NF66	NF34	NF58	NF85
Tare + Wet Soil	**A**	628.5	1239.3	929.3	904.5	994.1
Tare + Dry Soil	**B**	556	1060.1	865.7	852.4	867.9
Tare	**C**	192	191.8	222.9	190	190.8
Wt. of Water	**D= A-B**	72.5	179.2	63.6	52.1	126.2
Dry Soil, Ws	**E= B-C**	364	868.3	642.8	662.4	677.1
Moisture Content, (%)	**(D/E) x100**	**19.9%**	**20.6%**	**9.9%**	**7.9%**	**18.6%**

Sample No.		15-052-01	15-052-02	15-052-03		
Location		**BH15-07**	**BH15-07**	**BH15-07**		
Depth		2.5-4'	10-11.5'	25-26.5'		
Soil Description						
(USCS)		ML	SM	SP		
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.		cat	NF8	NF21		
Tare + Wet Soil	**A**	972.4	1050.6	1106.4		
Tare + Dry Soil	**B**	936	1018.6	948.7		
Tare	**C**	272.6	270.9	116.2		
Wt. of Water	**D= A-B**	36.4	32	157.7		
Dry Soil, Ws	**E= B-C**	663.4	747.7	832.5		
Moisture Content, (%)	**(D/E) x100**	**5.5%**	**4.3%**	**18.9%**		

Remarks:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.3	3.8	45.7	49.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.7		
#10	99.4		
#16	99.1		
#40	95.6		
#50	90.1		
#100	75.1		
#200	49.9		

* (no specification provided)

Material Description

Light gray clayey sand

Atterberg Limits

PL= 14 LL= 28 PI= 12

Coefficients

D_{90}= 0.2979 D_{85}= 0.2274 D_{60}= 0.0969
D_{50}= 0.0752 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(4)

Remarks

Location: TP-9 Composite Sample
Sample Number: 15-050

Date: 3/26/2015

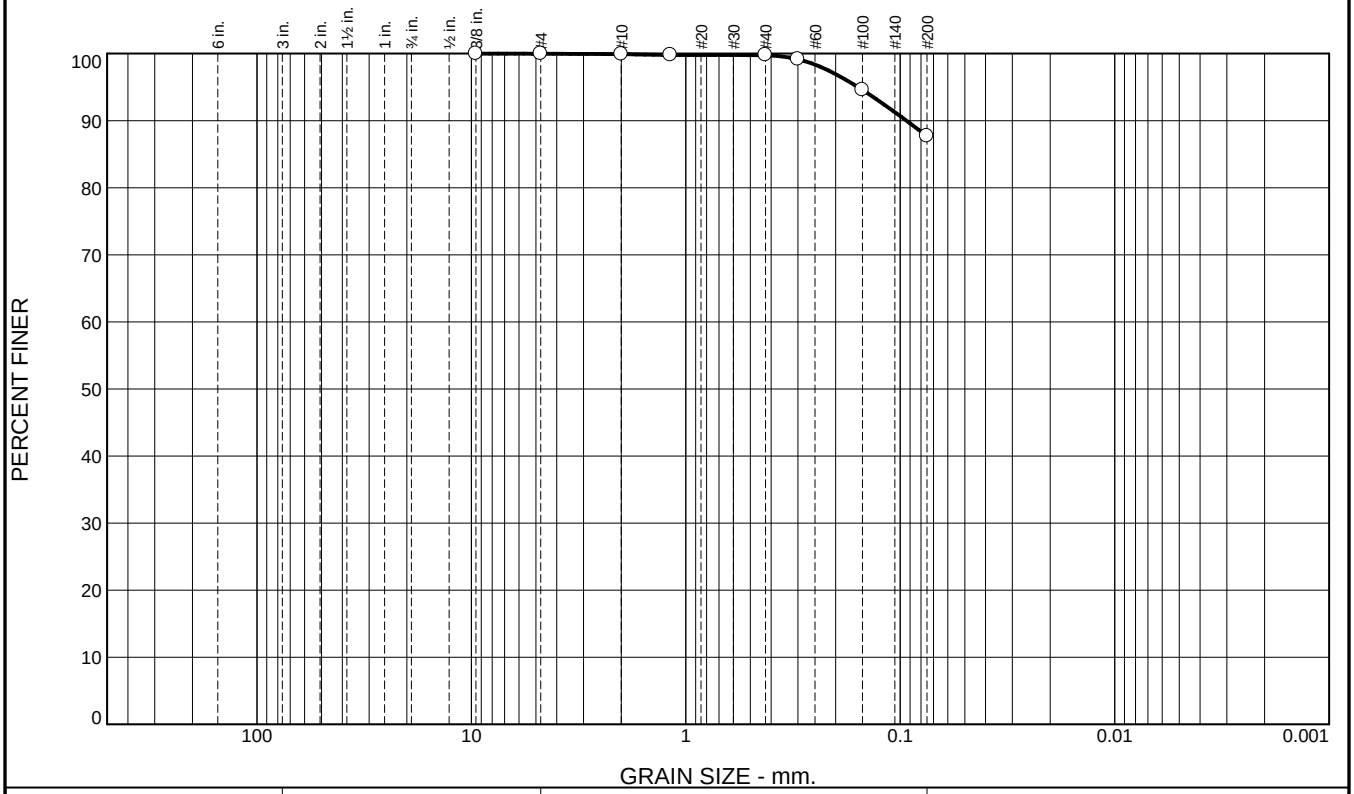
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050

Tested By: TW **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.1	12.1	87.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	100.0		
#10	99.9		
#16	99.8		
#40	99.8		
#50	99.2		
#100	94.6		
#200	87.7		

* (no specification provided)

Material Description

Light brown lean clay

Atterberg Limits

PL= 19 LL= 43 PI= 26

Coefficients

D_{90}= 0.0936 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(22)

Remarks

Location: TP15-2
Sample Number: 15-050-01 **Depth:** 10' **Date:** 3/24/2015

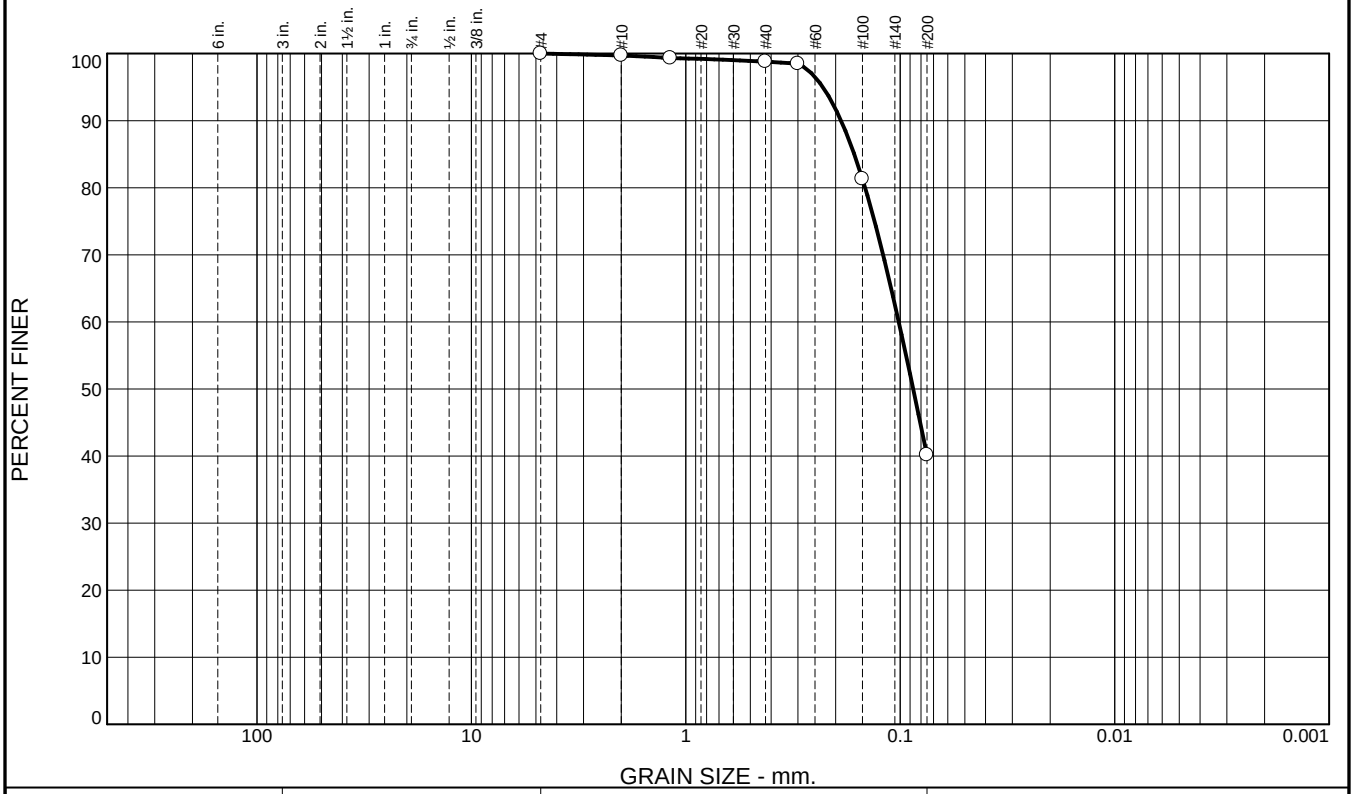
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-01

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	0.9	58.7	40.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.7		
#16	99.3		
#40	98.8		
#50	98.5		
#100	81.3		
#200	40.1		

* (no specification provided)

Material Description

Light brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.1887 D_{85}= 0.1638 D_{60}= 0.1017
D_{50}= 0.0870 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: TP15-3
Sample Number: 15-050-02 **Depth:** 5' **Date:** 3/24/2015

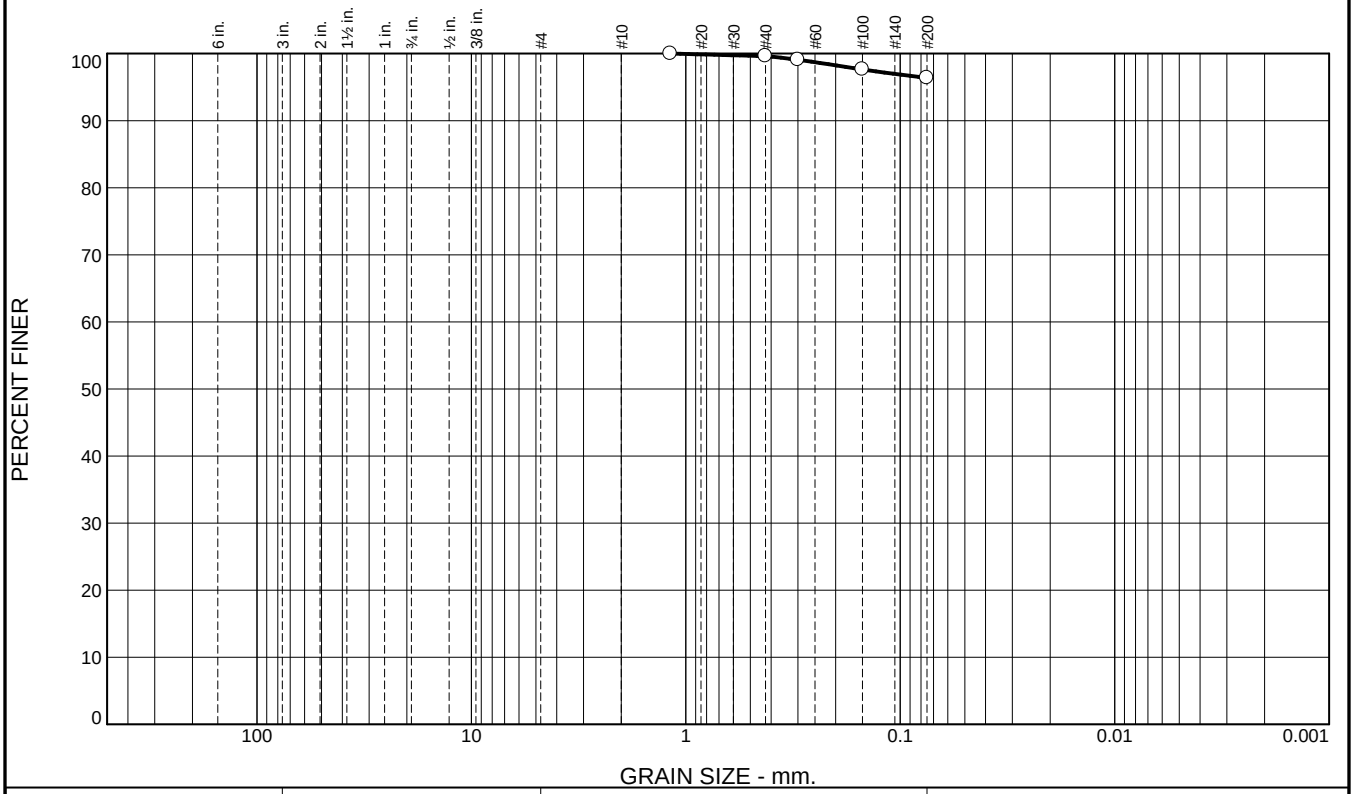
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-02

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	3.2	96.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.6		
#50	99.1		
#100	97.6		
#200	96.4		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 22 LL= 46 PI= 24

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(25)

Remarks

Location: TP15-5
Sample Number: 15-050-03 **Depth:** 3' **Date:** 3/24/15

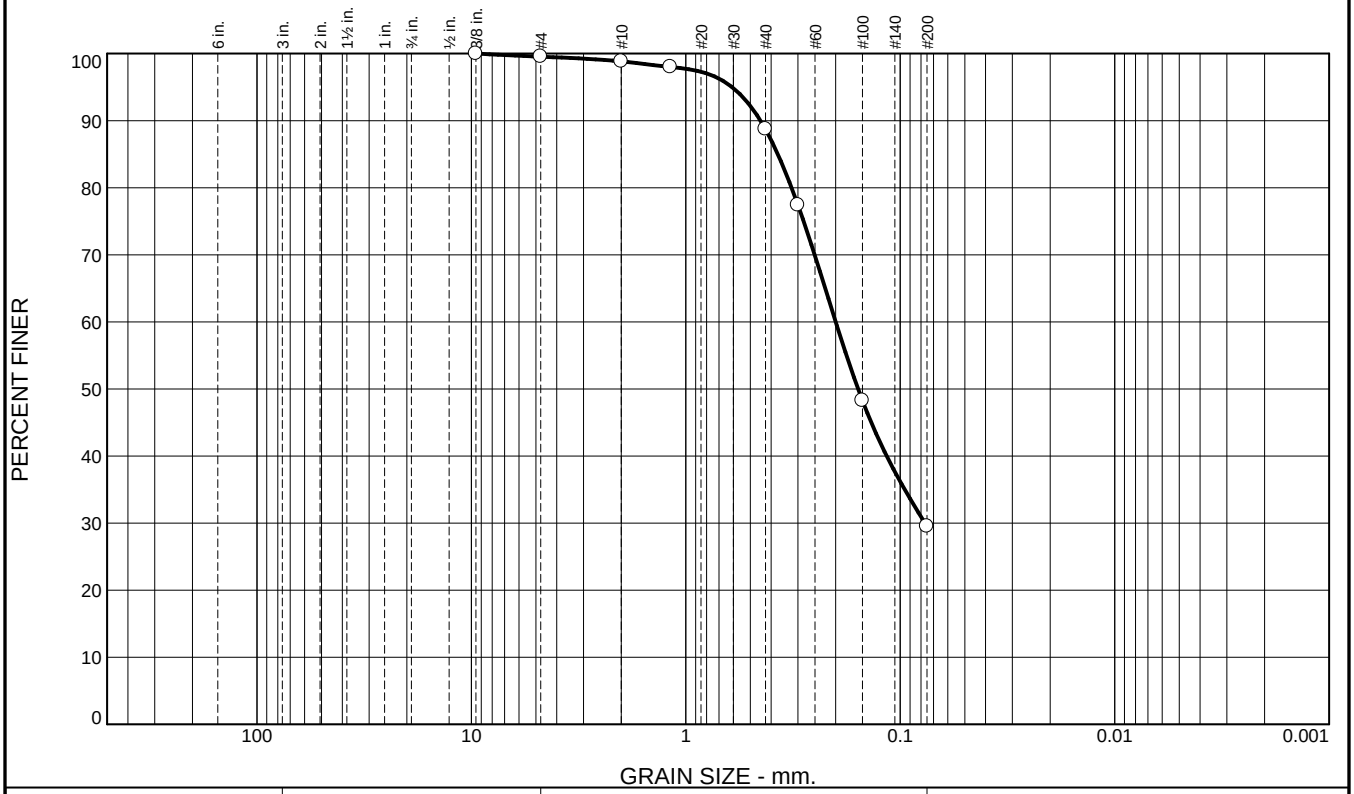
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-03

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.7	10.1	59.2	29.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.5		
#10	98.8		
#16	98.0		
#40	88.7		
#50	77.4		
#100	48.3		
#200	29.5		

* (no specification provided)

Material Description

Grayish brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.4485 D_{85}= 0.3721 D_{60}= 0.1999
D_{50}= 0.1572 D_{30}= 0.0766 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: TP15-5
Sample Number: 15-050-04 **Depth:** 9' **Date:** 3/24/2015

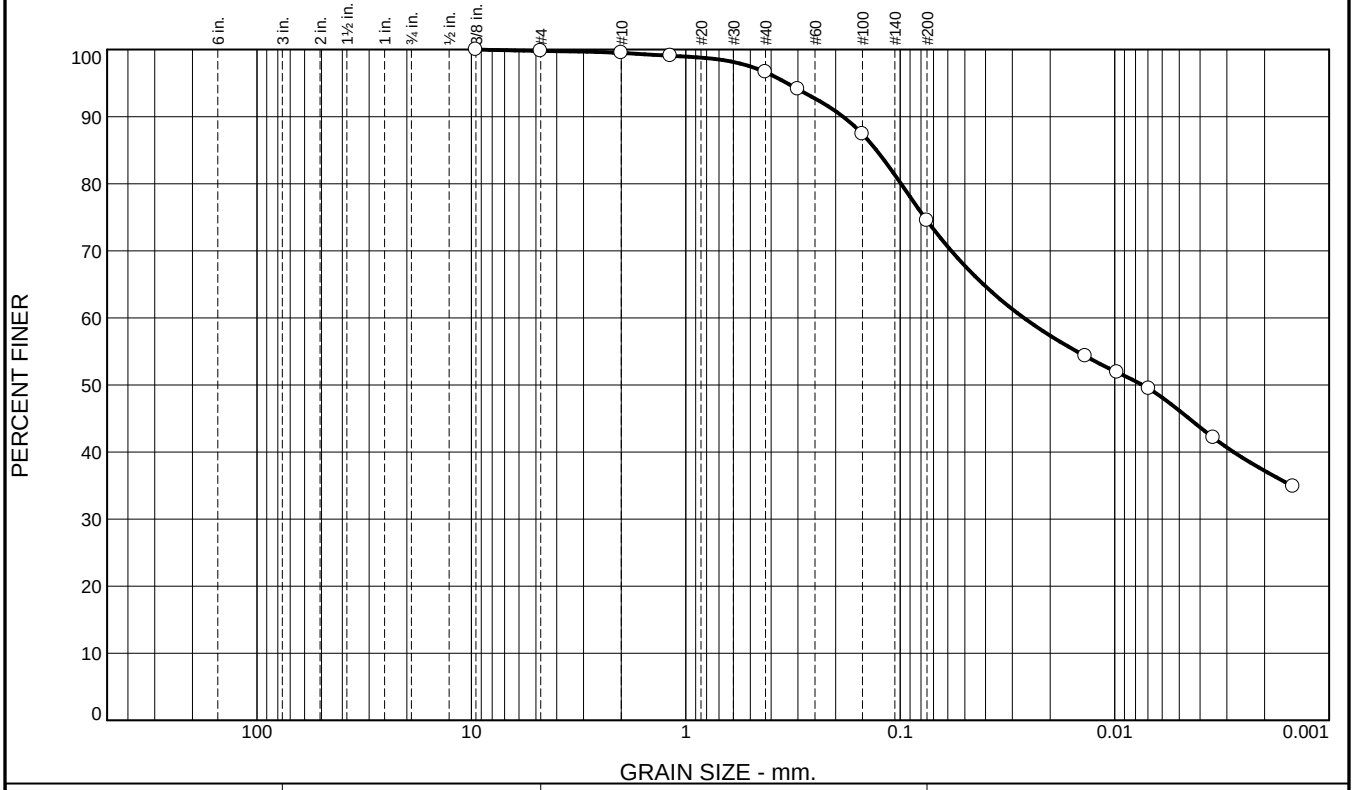
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-04

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.3	2.9	22.1	37.3	37.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.8		
#10	99.5		
#16	99.1		
#40	96.6		
#50	94.1		
#100	87.4		
#200	74.5		

* (no specification provided)

Material Description

Gray lean clay with sand

Atterberg Limits

PL= 18 LL= 34 PI= 16

Coefficients

D_{90}= 0.1846 D_{85}= 0.1292 D_{60}= 0.0265
D_{50}= 0.0074 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(10)

Remarks

Location: TP15-6
Sample Number: 15-050-05 **Depth:** 8' **Date:** 3/24/15

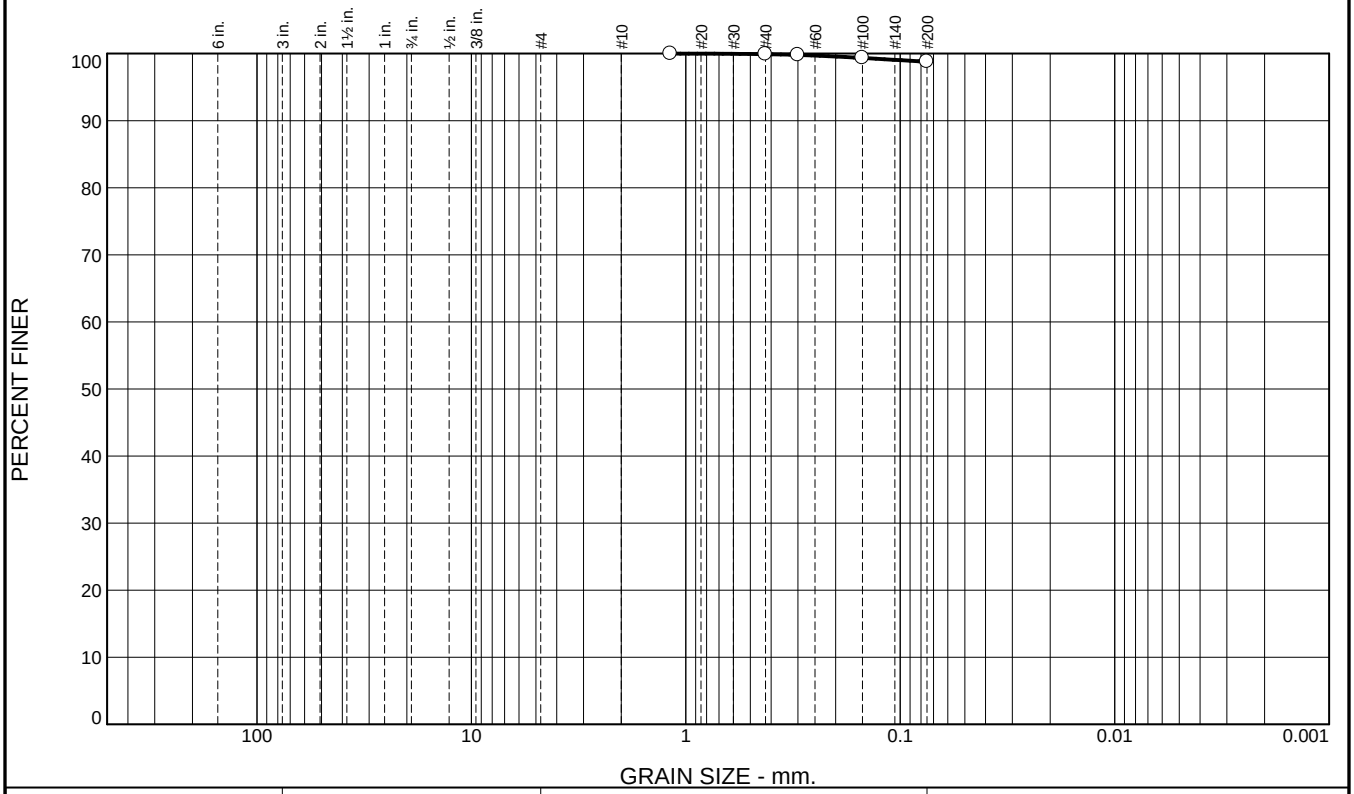
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-05

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	1.1	98.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.9		
#50	99.8		
#100	99.3		
#200	98.8		

* (no specification provided)

Material Description

Gray fat clay

Atterberg Limits

PL= 22 LL= 53 PI= 31

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(35)

Remarks

Location: TP15-8
Sample Number: 15-050-06 **Depth:** 3' **Date:** 3/24/2015

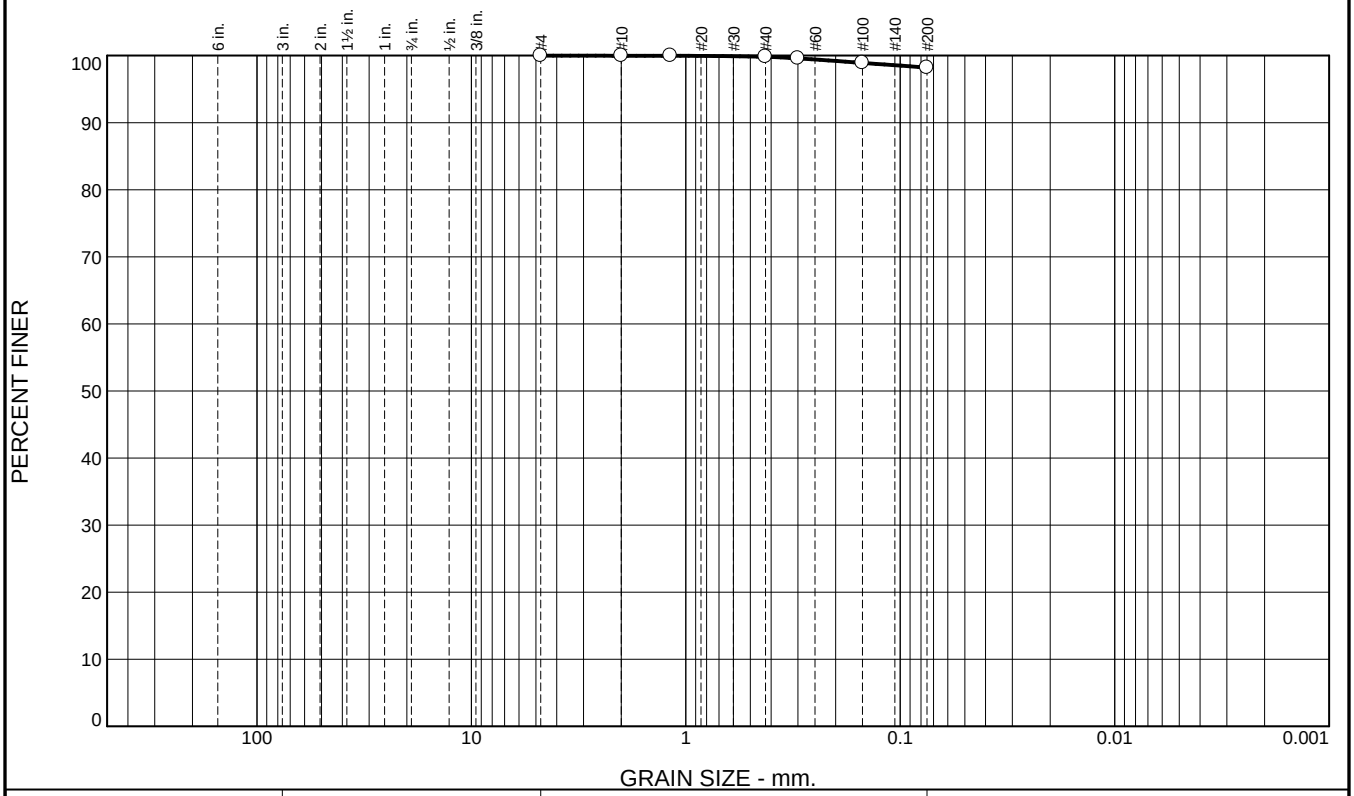
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-06

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	1.6	98.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#16	100.0		
#40	99.8		
#50	99.6		
#100	98.9		
#200	98.2		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 23 LL= 49 PI= 26

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(29)

Remarks

Location: TP15-9
Sample Number: 15-050-08 **Depth:** 16' **Date:** 3/24/15

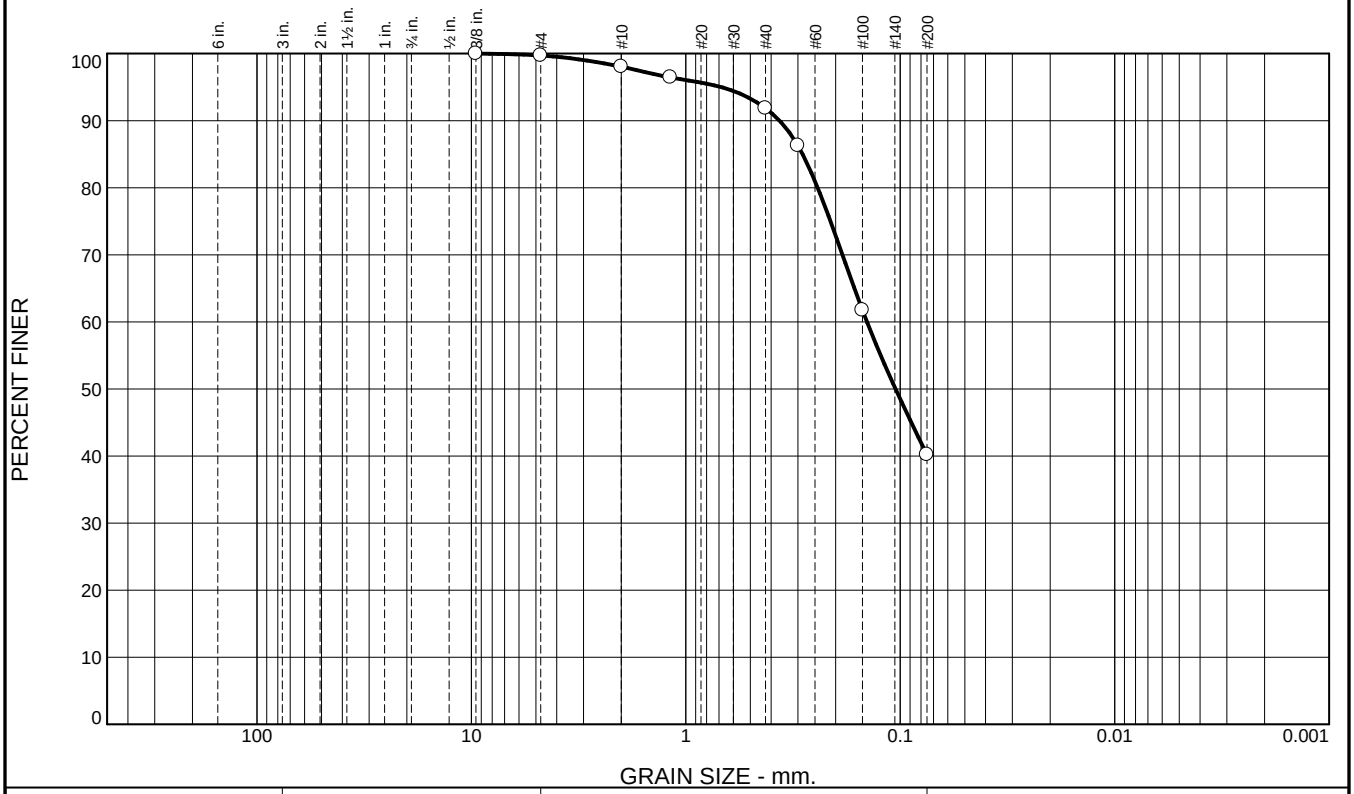
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-08

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	1.7	6.2	51.6	40.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.7		
#10	98.0		
#16	96.4		
#40	91.8		
#50	86.3		
#100	61.7		
#200	40.2		

* (no specification provided)

Material Description

Light brown silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.3654 D_{85}= 0.2856 D_{60}= 0.1429
D_{50}= 0.1053 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Location: TP15-11
Sample Number: 15-050-10 **Depth:** 6' **Date:** 3/24/15

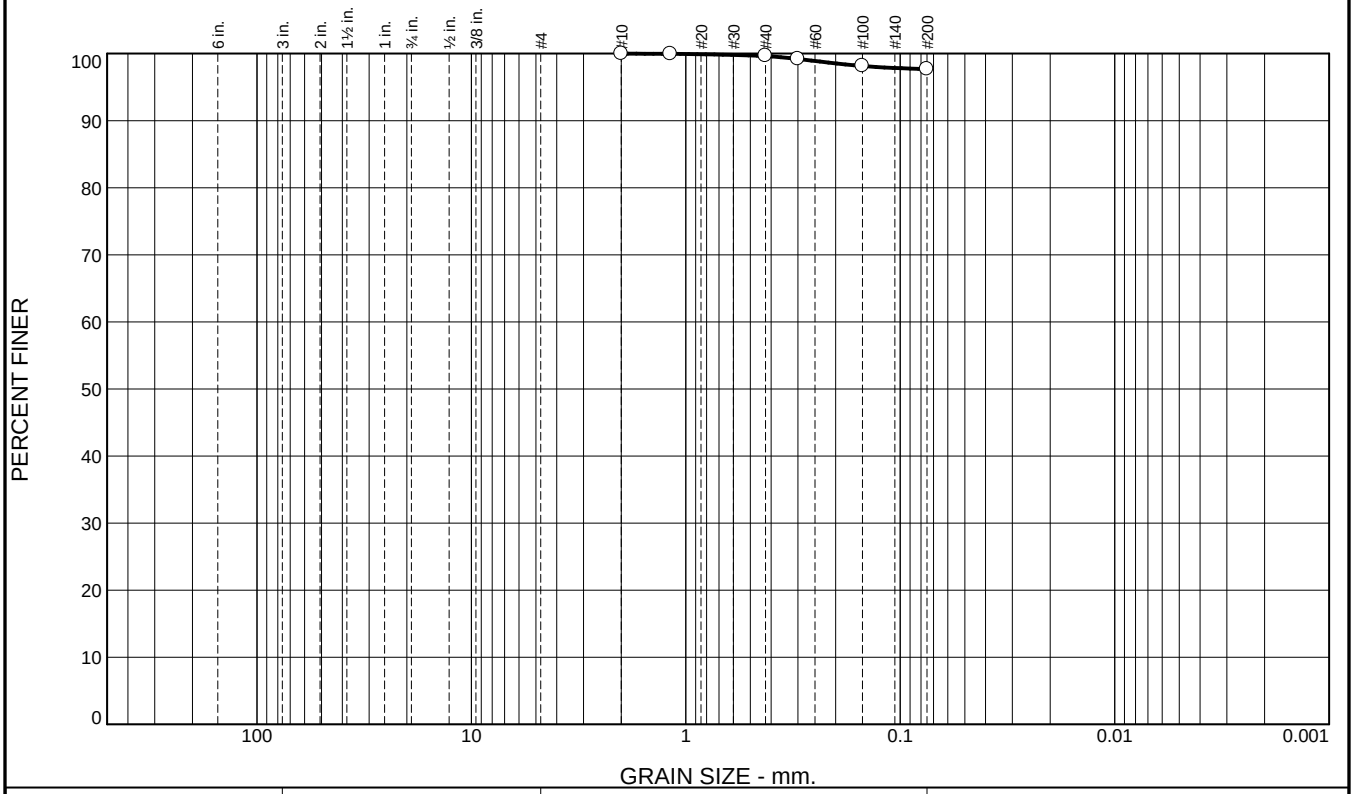
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-10

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	2.0	97.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	100.0		
#40	99.7		
#50	99.2		
#100	98.1		
#200	97.7		

* (no specification provided)

Material Description

Tan lean clay

Atterberg Limits

PL= 19 LL= 41 PI= 22

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(23)

Remarks

Location: TP15-13
Sample Number: 15-050-11 **Depth:** 4' **Date:** 3/24/2015

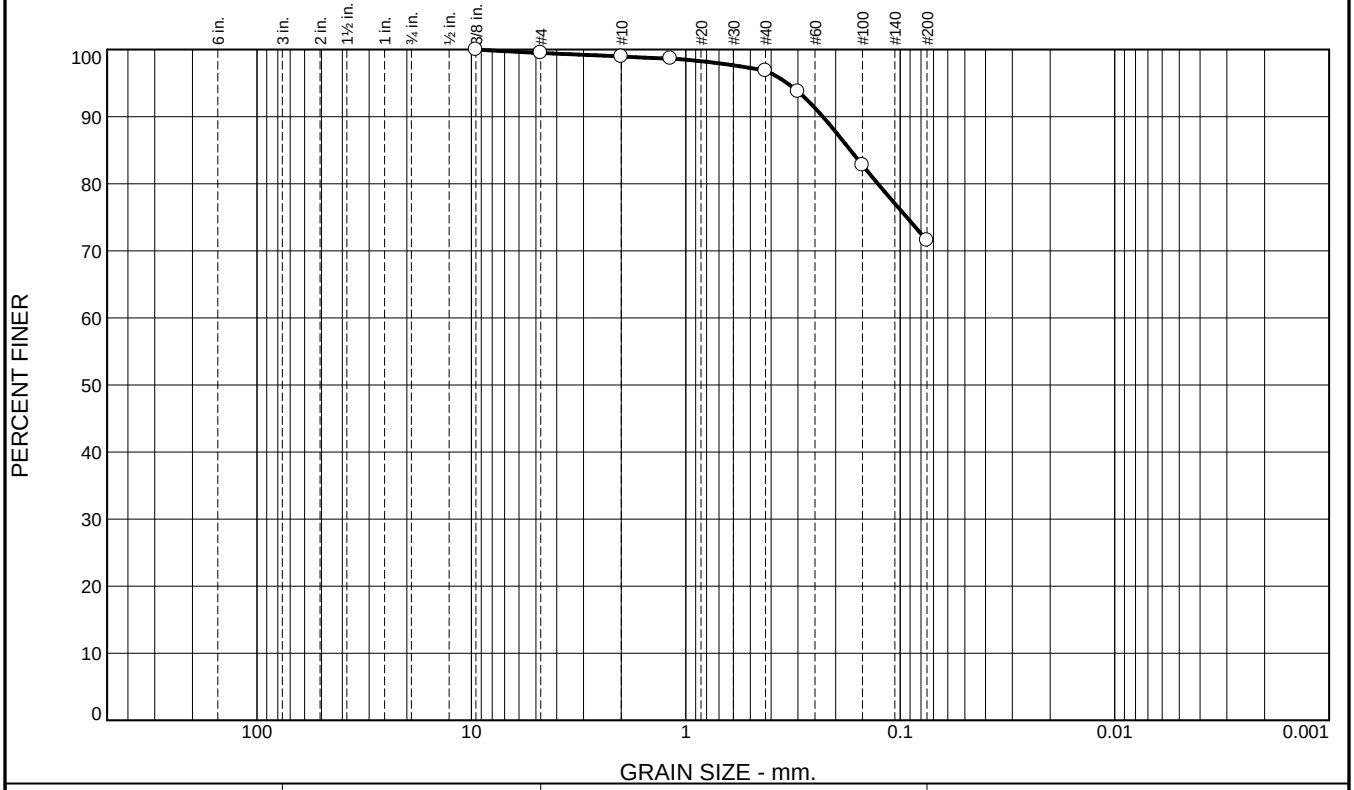
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-050-11

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.5	2.1	25.4	71.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.5		
#10	99.0		
#16	98.7		
#40	96.9		
#50	93.8		
#100	82.8		
#200	71.5		

* (no specification provided)

Material Description

Grayish brown lean clay with sand

Atterberg Limits

PL= 14 LL= 31 PI= 17

Coefficients

D_{90}= 0.2297 D_{85}= 0.1706 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(10)

Remarks

Location: TP15-14
Sample Number: 15-050-12 **Depth:** 7' **Date:** 3/23/2015

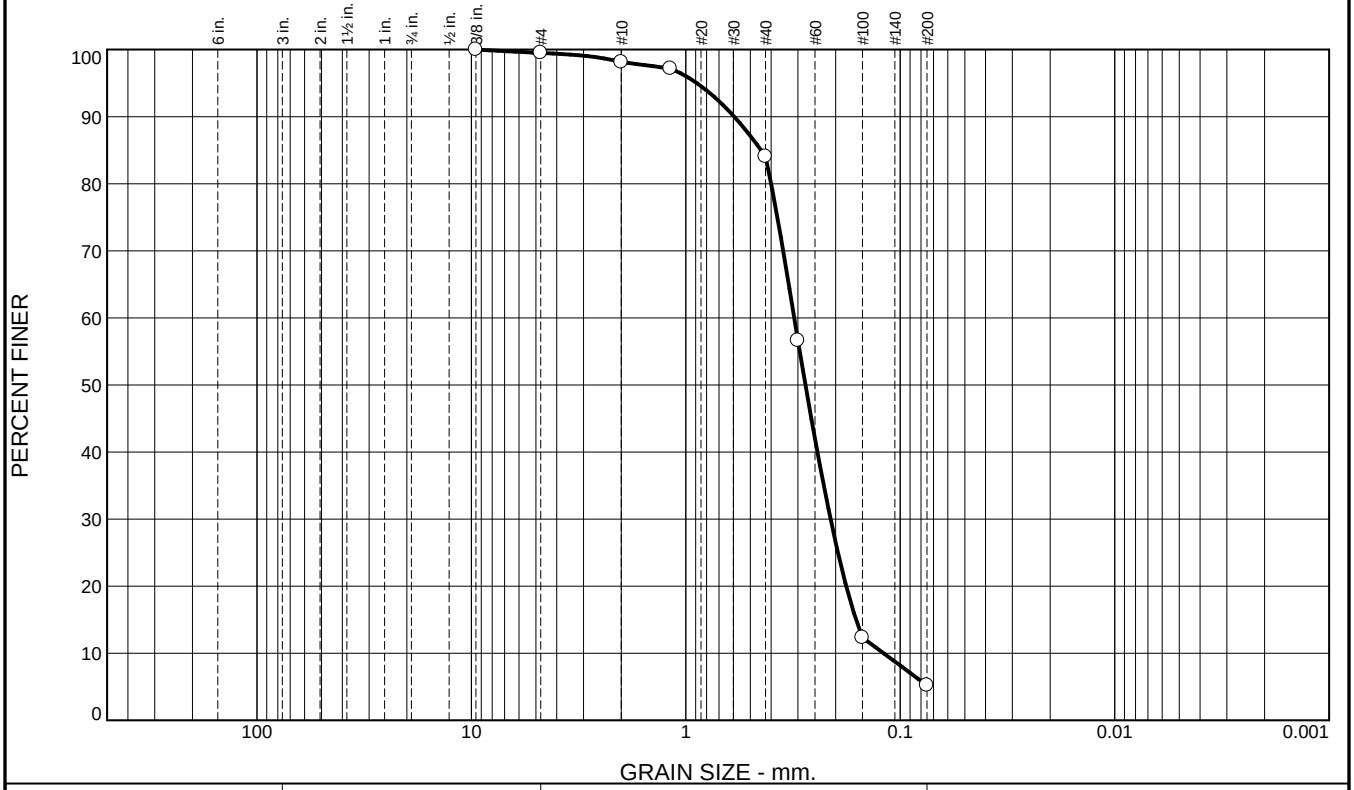
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-50-12

Tested By: OS/TW **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	1.4	14.0	78.9	5.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	99.5		
#10	98.1		
#16	97.2		
#40	84.1		
#50	56.6		
#100	12.3		
#200	5.2		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.5946 D_{85}= 0.4459 D_{60}= 0.3122
D_{50}= 0.2769 D_{30}= 0.2114 D_{15}= 0.1607
D_{10}= 0.1196 C_u= 2.61 C_c= 1.20

Classification

USCS= AASHTO=

Remarks

Location: BH15-1
Sample Number: 15-051-01 **Depth:** 5.0'-6.5' **Date:** 3/24/15

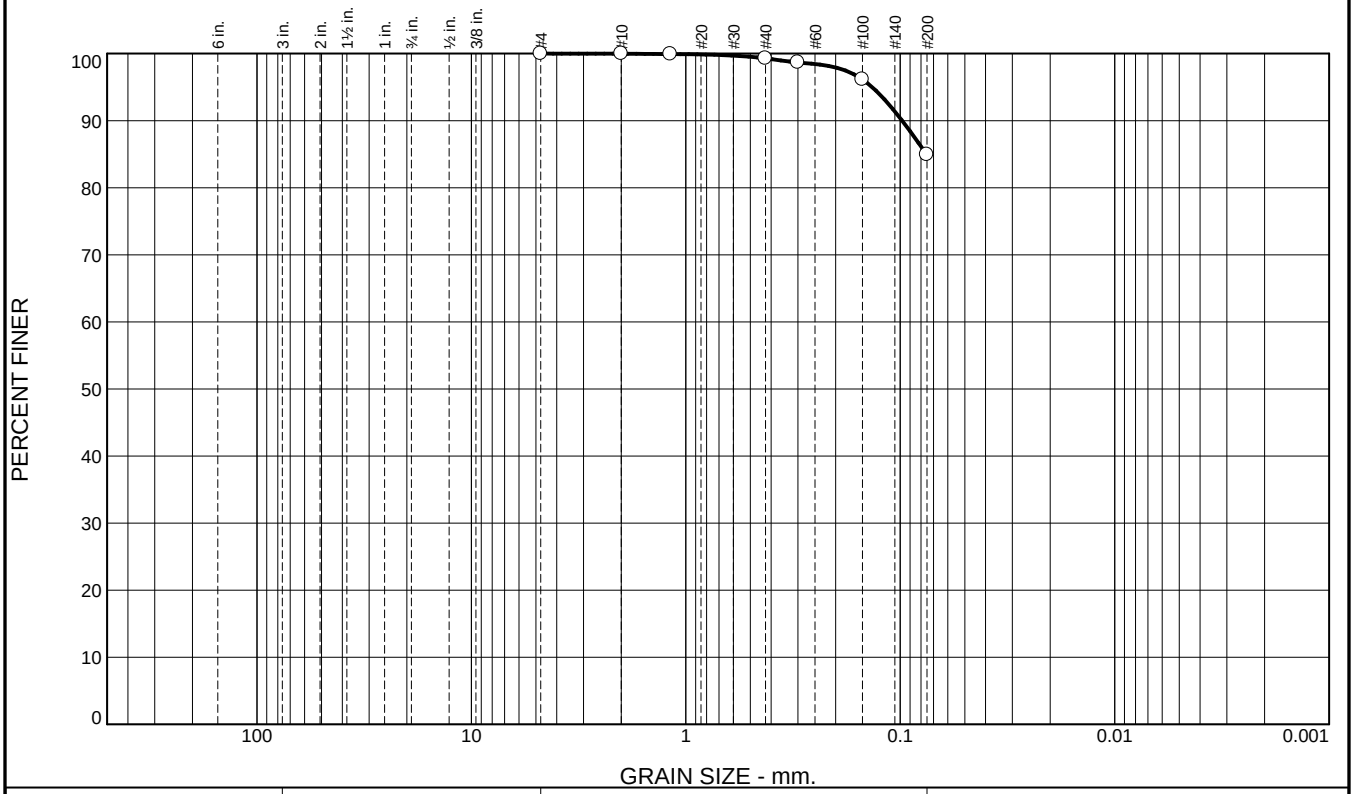
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-01

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.7	14.4	84.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#16	99.9		
#40	99.3		
#50	98.7		
#100	96.1		
#200	84.9		

* (no specification provided)

Material Description

Tan lean clay

Atterberg Limits

PL= 22 LL= 30 PI= 8

Coefficients

D_{90}= 0.0981 D_{85}= 0.0753 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(6)

Remarks

Location: BH15-1
Sample Number: 15-051-03 **Depth:** 25'-25.5' **Date:** 3/24/15

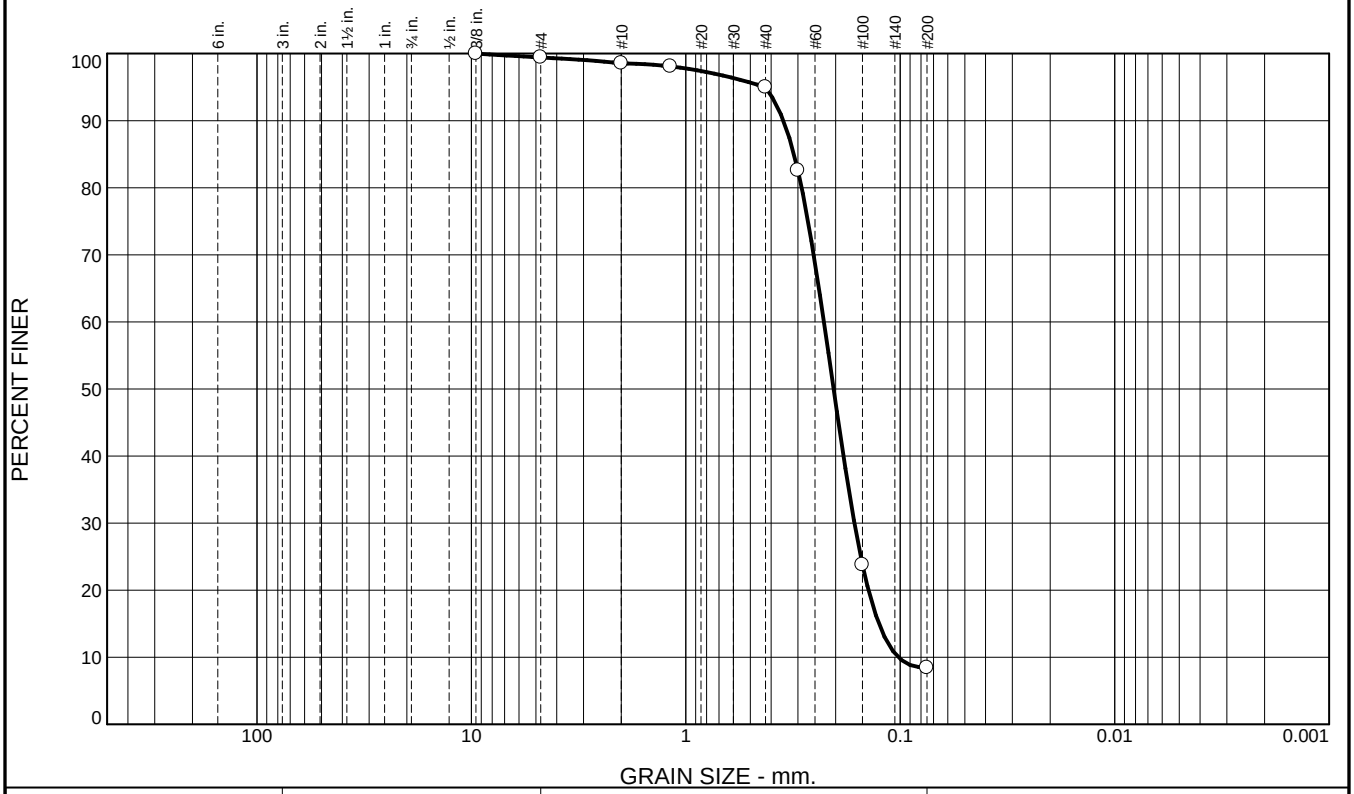
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-03

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	0.9	3.5	86.6	8.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	99.4		
#10	98.5		
#16	98.1		
#40	95.0		
#50	82.6		
#100	23.8		
#200	8.4		

* (no specification provided)

Material Description

Grey

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.3505 D_{85}= 0.3129 D_{60}= 0.2271
D_{50}= 0.2045 D_{30}= 0.1635 D_{15}= 0.1258
D_{10}= 0.1022 C_u= 2.22 C_c= 1.15

Classification

USCS= AASHTO=

Remarks

Location: BH15-2
Sample Number: 15-051-09 **Depth:** 7.5'-9.0' **Date:** 3/24/15

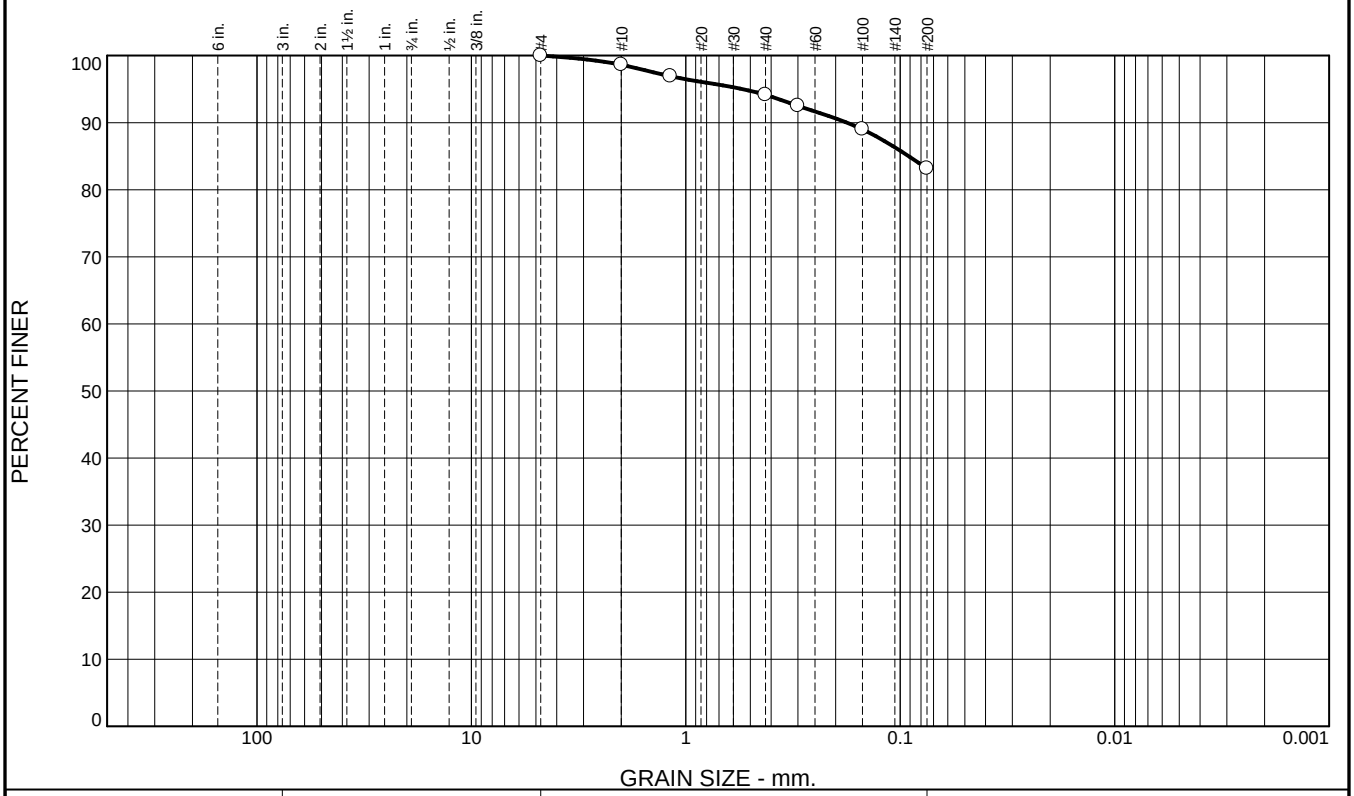
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-09

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.4	4.5	10.9	83.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	98.6		
#16	96.9		
#40	94.1		
#50	92.5		
#100	89.0		
#200	83.2		

* (no specification provided)

Material Description

Light brown lean clay with sand

Atterberg Limits

PL= 22 LL= 44 PI= 22

Coefficients

D_{90}= 0.1773 D_{85}= 0.0914 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(19)

Remarks

Location: BH15-2
Sample Number: 15-051-12 **Depth:** 35.0'-36.5' **Date:** 3/24/15

NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-12

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	2.9	23.2	61.5	10.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	98.1		
#10	95.2		
#16	91.9		
#40	72.0		
#50	52.1		
#100	20.1		
#200	10.5		

* (no specification provided)

Material Description

Light Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.8915 D_{85}= 0.6227 D_{60}= 0.3420
D_{50}= 0.2894 D_{30}= 0.1967 D_{15}= 0.1189
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH15-3
Sample Number: 15-051-15 **Depth:** 2.5'-4.0' **Date:** 3/24/15

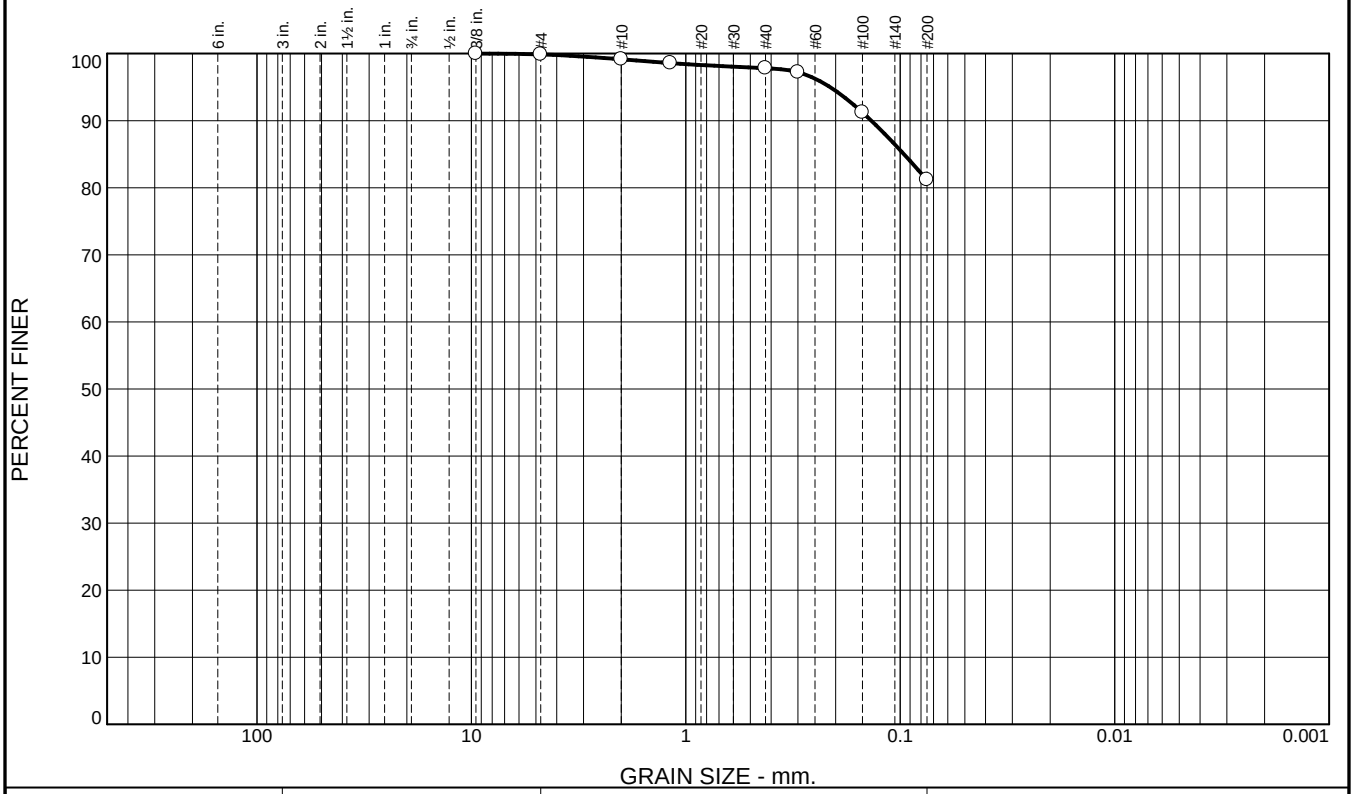
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-15

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.8	1.3	16.6	81.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	99.9		
#10	99.1		
#16	98.6		
#40	97.8		
#50	97.2		
#100	91.2		
#200	81.2		

* (no specification provided)

Material Description

Light Brown silt with sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1364 D_{85}= 0.0962 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH15-3
Sample Number: 15-051-16 **Depth:** 10.0'-11.5' **Date:** 3/24/15

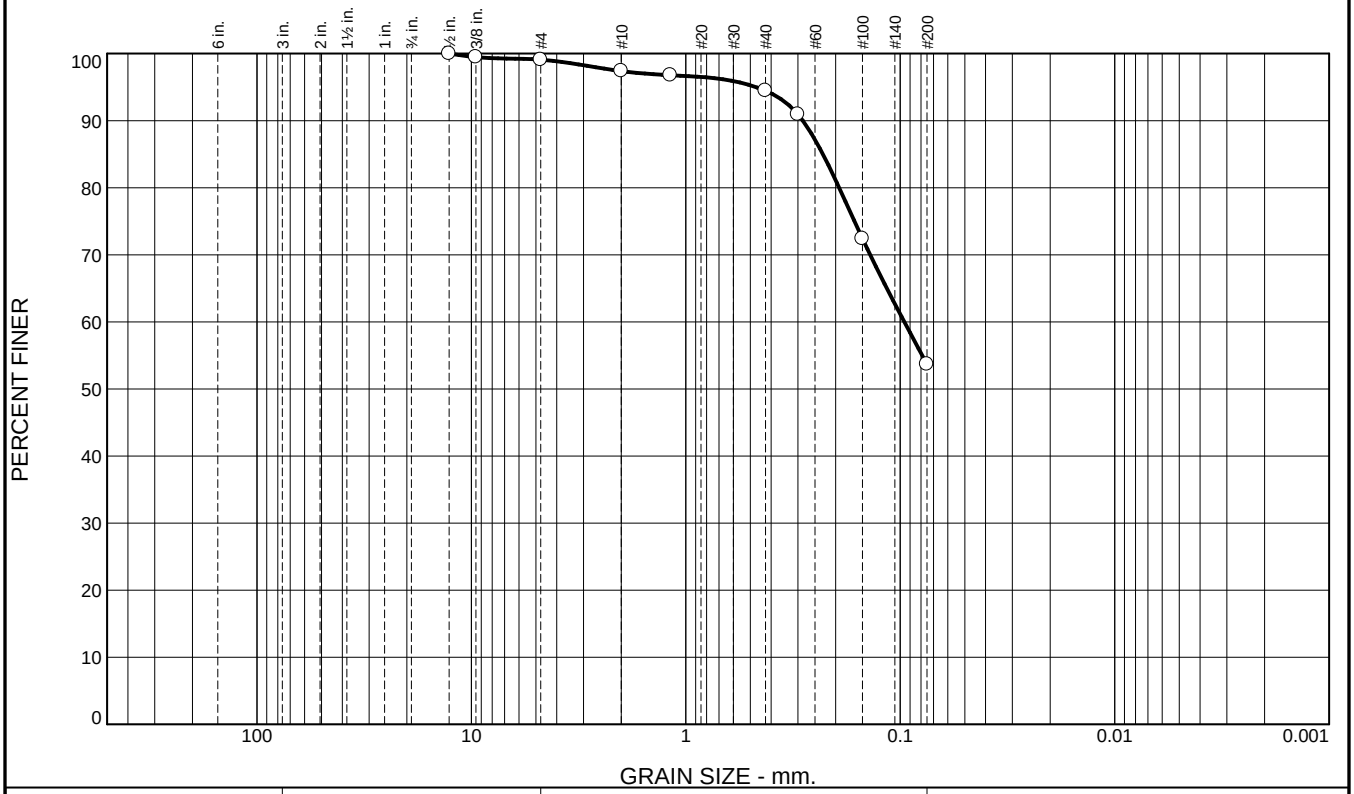
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-16

Tested By: be/tw/os **Checked By:** ke

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	1.7	2.9	40.8	53.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5"	100.0		
0.375"	99.5		
#4	99.1		
#10	97.4		
#16	96.8		
#40	94.5		
#50	90.9		
#100	72.4		
#200	53.7		

* (no specification provided)

Material Description

Tan sandy lean clay

Atterberg Limits

PL= 18 LL= 28 PI= 10

Coefficients

D_{90}= 0.2847 D_{85}= 0.2296 D_{60}= 0.0958
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

Location: BH15-3
Sample Number: 15-051-17 **Depth:** 15.0'-16.5' **Date:** 3/24/15

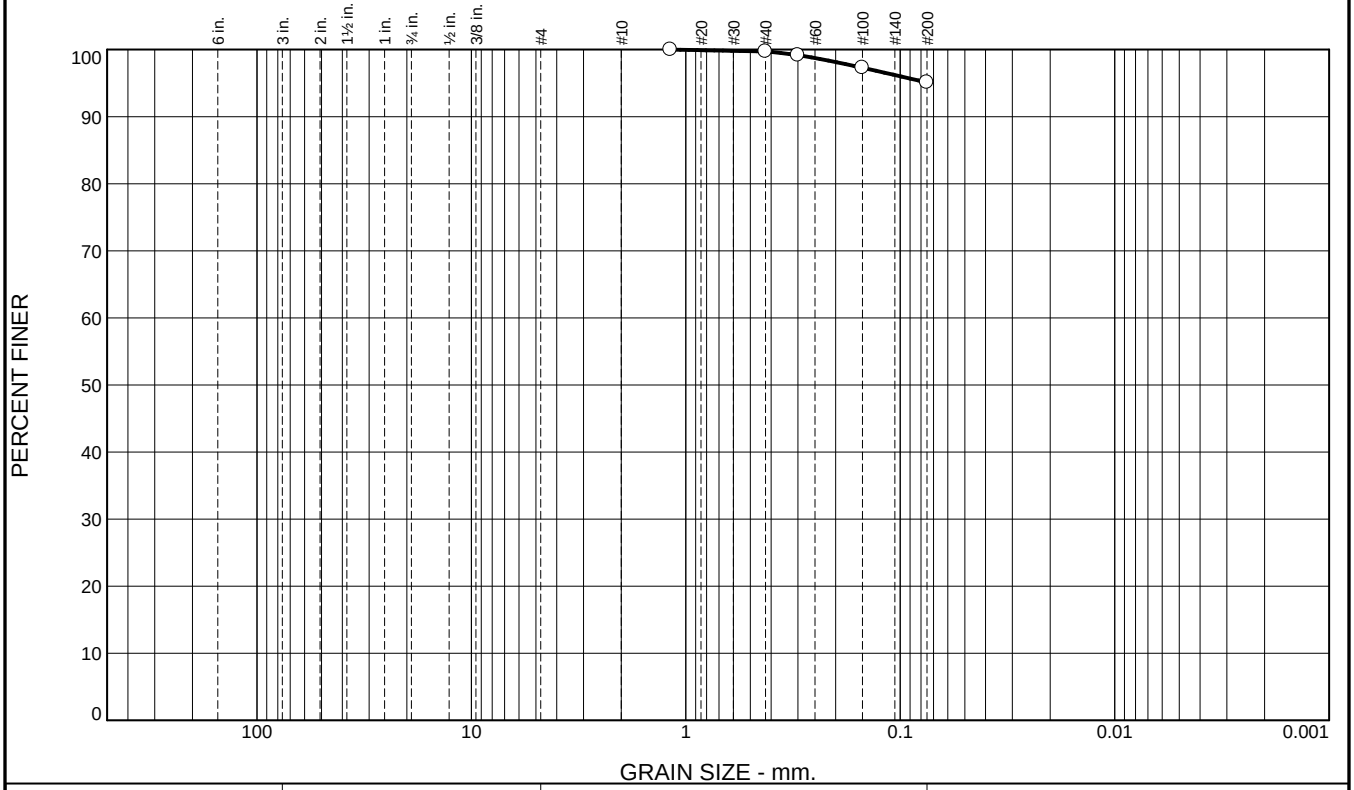
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-17

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	4.6	95.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.7		
#50	99.2		
#100	97.3		
#200	95.1		

* (no specification provided)

Material Description

Dark Brown lean clay

Atterberg Limits

PL= 18 LL= 45 PI= 27

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(27)

Remarks

Location: BH15-4
Sample Number: 15-051-24 **Depth:** 2.5'-4.0' **Date:** 3/24/15

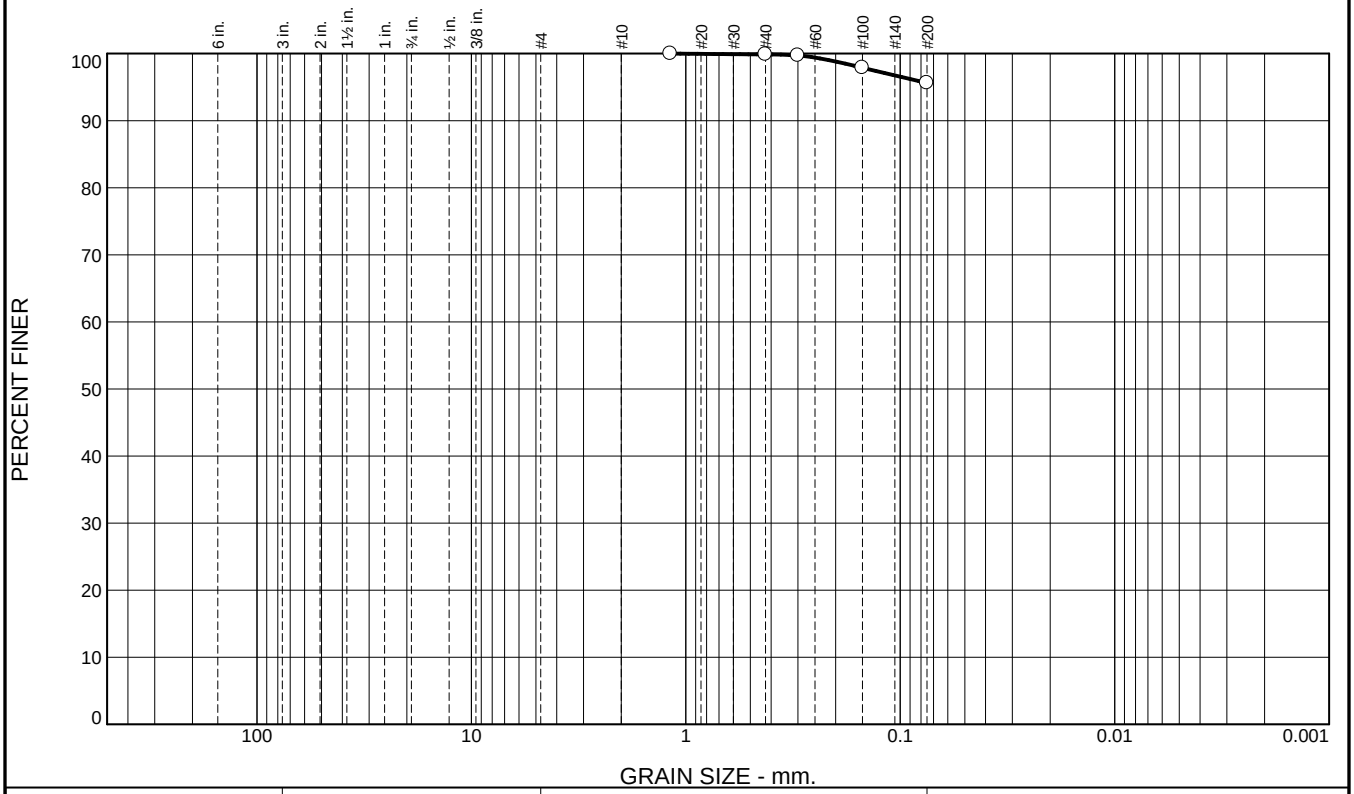
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-24

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	4.3	95.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.9		
#50	99.7		
#100	97.9		
#200	95.6		

* (no specification provided)

Material Description

Dark Brown lean clay

Atterberg Limits

PL= 19 LL= 44 PI= 25

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(26)

Remarks

Location: BH15-4
Sample Number: 15-051-25 **Depth:** 7.5'-9.0' **Date:** 3/24/15

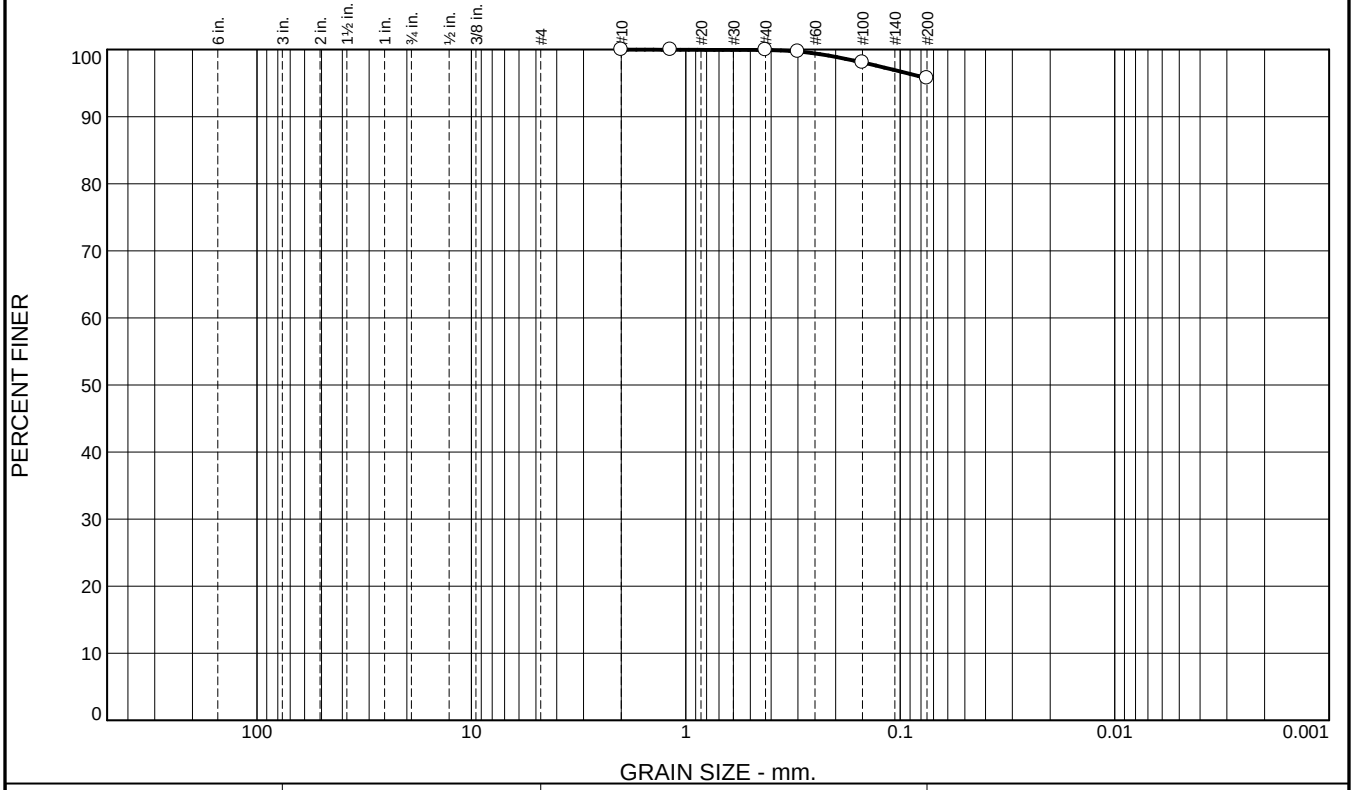
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-25

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	4.2	95.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	100.0		
#40	99.9		
#50	99.7		
#100	98.1		
#200	95.7		

* (no specification provided)

Material Description

Ligh Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH15-4
Sample Number: 15-051-26 **Depth:** 10.0'-11.5' **Date:** 3/24/15

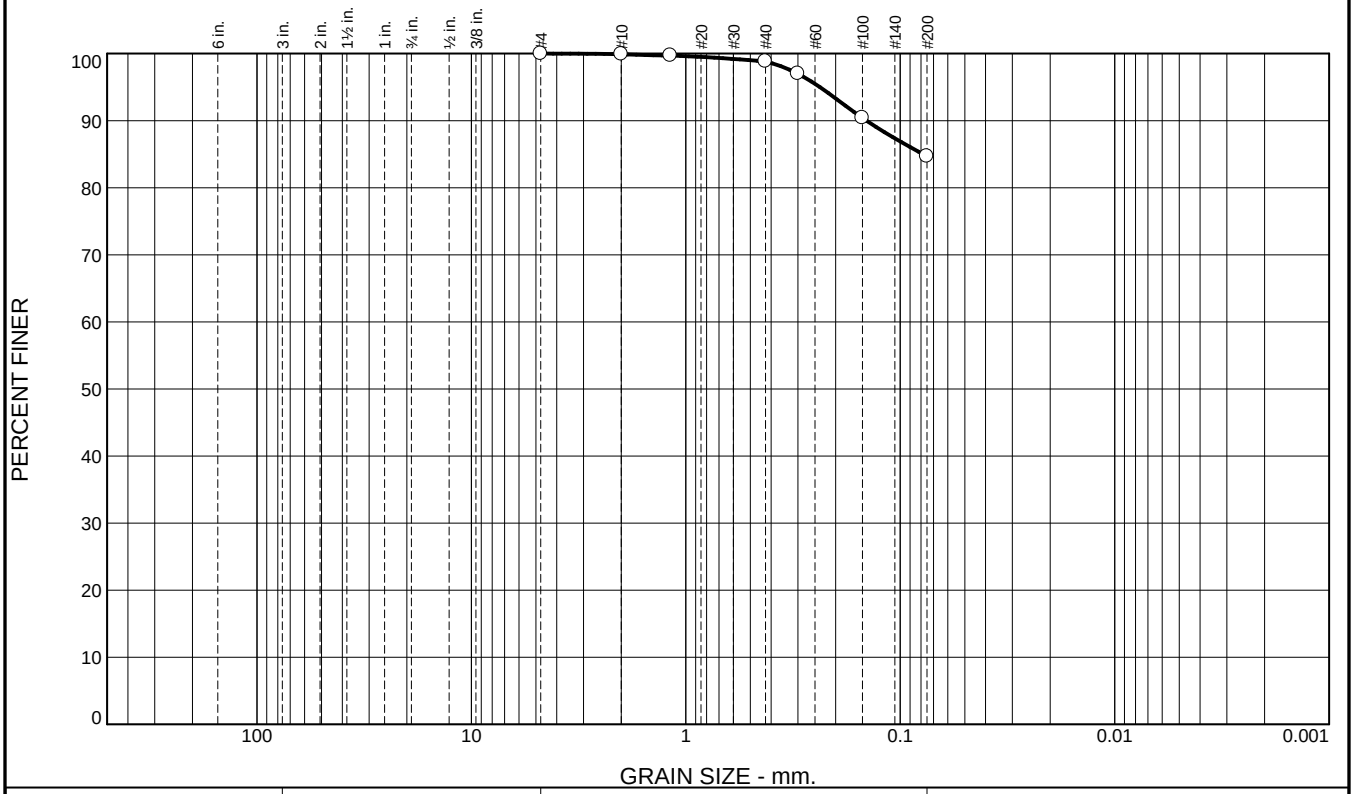
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-26

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.1	14.1	84.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#16	99.7		
#40	98.8		
#50	97.0		
#100	90.4		
#200	84.7		

* (no specification provided)

Material Description

Light Brown lean clay

Atterberg Limits

PL= 21 LL= 38 PI= 17

Coefficients

D_{90}= 0.1437 D_{85}= 0.0782 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(14)

Remarks

Location: BH15-4
Sample Number: 15-051-27 **Depth:** 20.0'-21.5' **Date:** 3/24/15

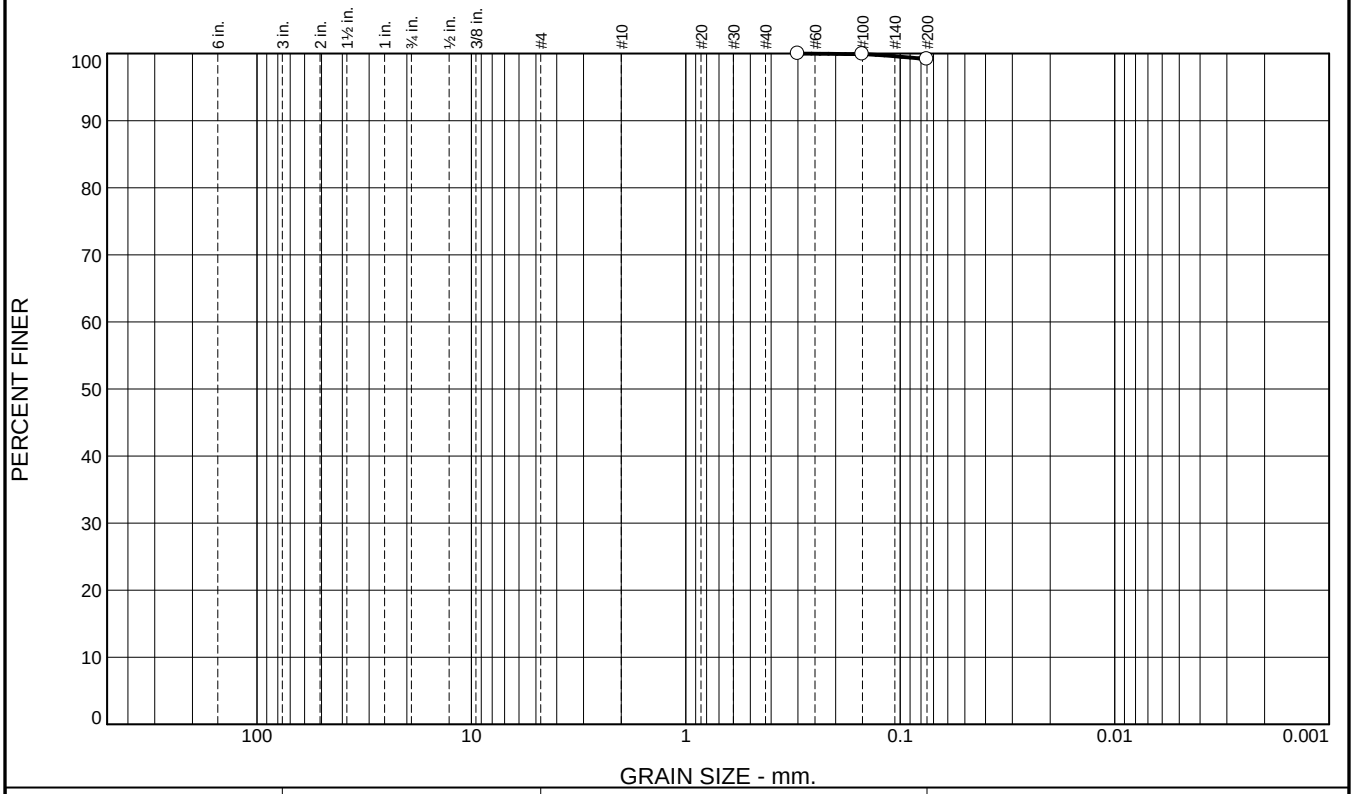
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-27

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.8	99.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#50	100.0		
#100	99.9		
#200	99.2		

* (no specification provided)

Material Description

Light Brown lean clay

Atterberg Limits

PL= 15 LL= 31 PI= 16

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

Location: BH15-5
Sample Number: 15-051-29 **Depth:** 5.0'-6.5' **Date:** 3/24/15

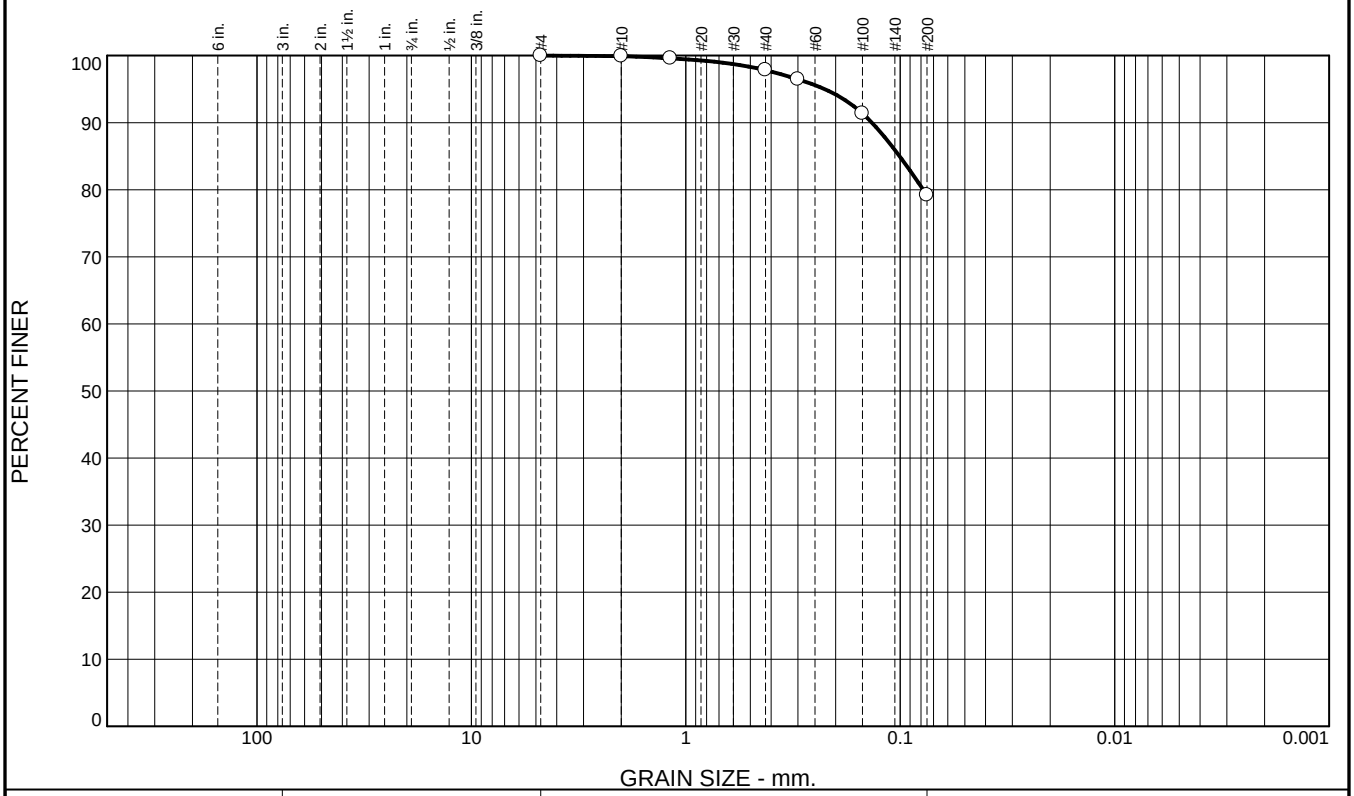
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-29

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	2.1	18.6	79.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#16	99.6		
#40	97.8		
#50	96.5		
#100	91.4		
#200	79.2		

* (no specification provided)

Material Description

Light Brown silt with sand

Atterberg Limits

PL= 20 LL= 22 PI= 2

Coefficients

D_{90}= 0.1356 D_{85}= 0.1008 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH15-5
Sample Number: 15-051-30 **Depth:** 15.0'-16.5' **Date:** 3/24/15

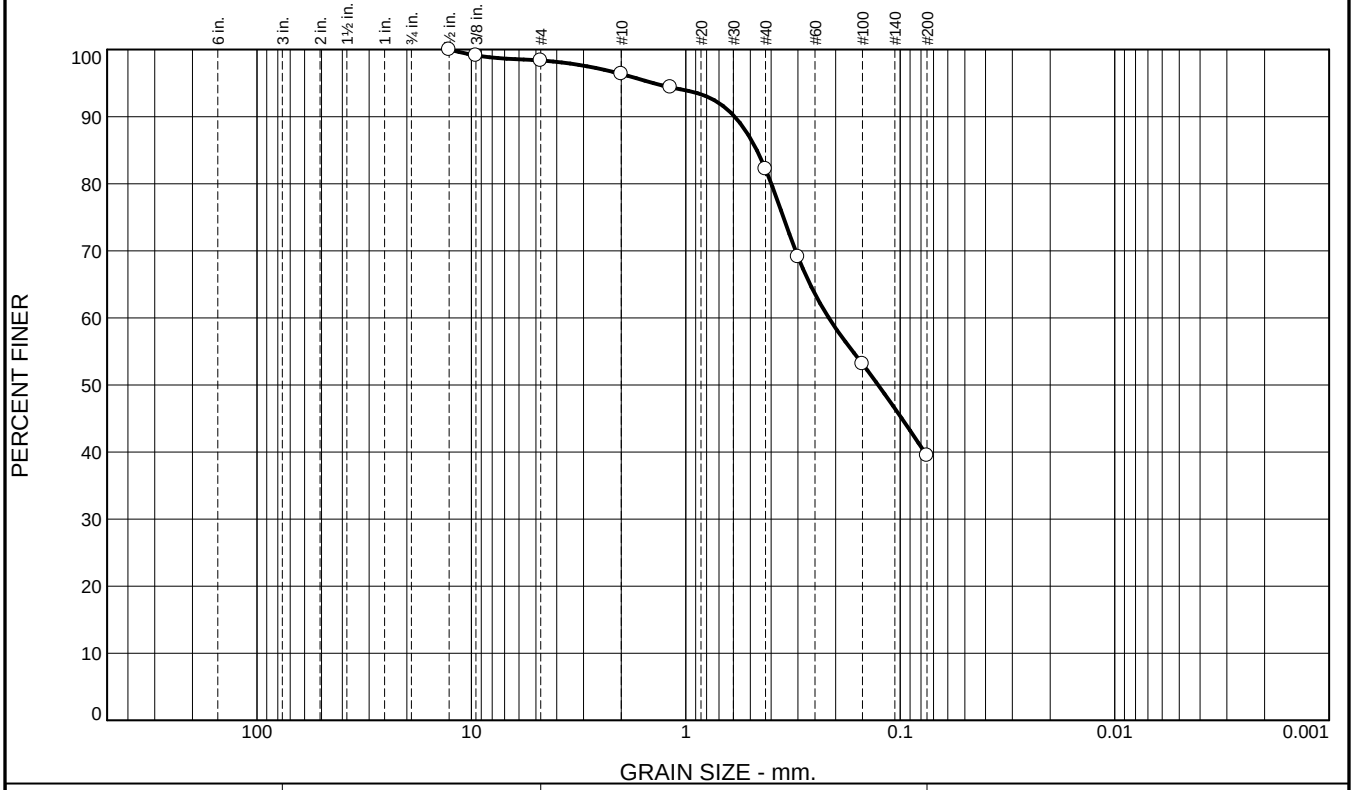
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-30

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	2.0	14.2	42.7	39.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.5"	100.0		
0.375"	99.1		
#4	98.4		
#10	96.4		
#16	94.4		
#40	82.2		
#50	69.1		
#100	53.1		
#200	39.5		

* (no specification provided)

Material Description

Light Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.5916 D_{85}= 0.4663 D_{60}= 0.2155
D_{50}= 0.1269 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH15-5
Sample Number: 15-051-31 **Depth:** 25.0'-26.5' **Date:** 3/24/15

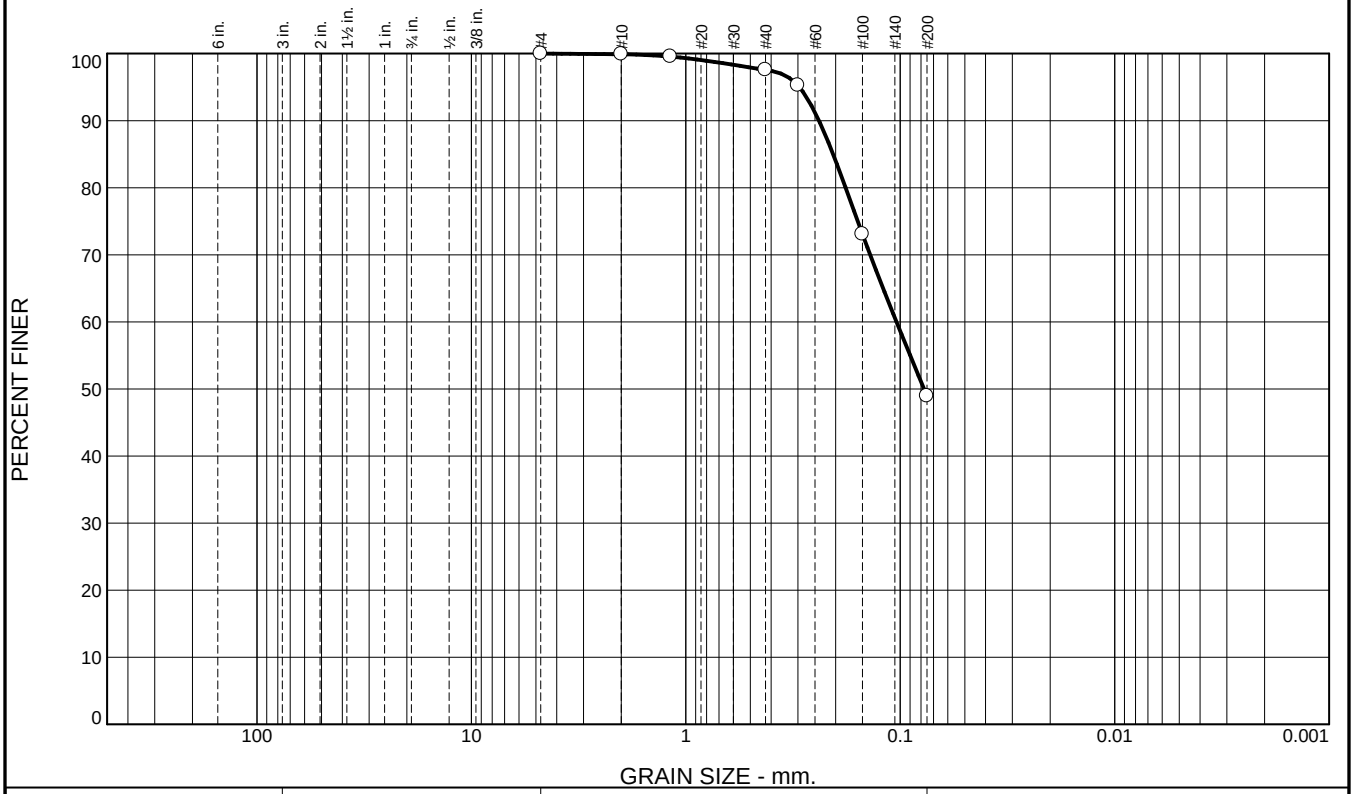
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-31

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	2.3	48.7	48.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#16	99.5		
#40	97.6		
#50	95.2		
#100	73.1		
#200	48.9		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.2394 D_{85}= 0.2057 D_{60}= 0.1042
D_{50}= 0.0774 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Location: BH15-6
Sample Number: 15-051-32 **Depth:** 2.5'-4.0' **Date:** 3/24/15

NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-32

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	1.3	5.7	69.4	23.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	99.5		
#10	98.2		
#16	97.4		
#40	92.5		
#50	80.3		
#100	42.6		
#200	23.1		

* (no specification provided)

Material Description

Light brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.3874 D_{85}= 0.3347 D_{60}= 0.2074
D_{50}= 0.1739 D_{30}= 0.1036 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH15-6
Sample Number: 15-051-33 **Depth:** 5.0'-6.5' **Date:** 3/24/15

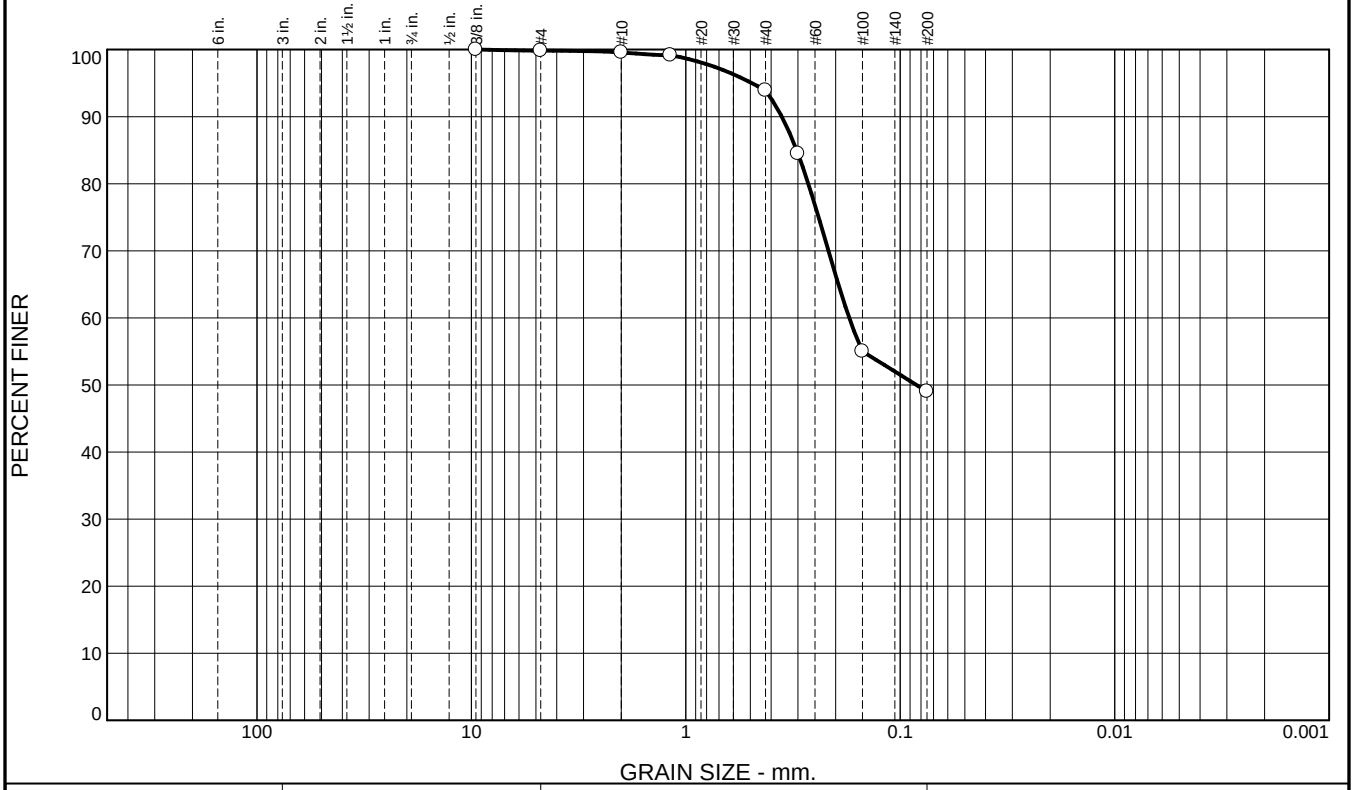
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-33

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.2	5.7	44.9	49.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375"	100.0		
#4	99.8		
#10	99.6		
#16	99.1		
#40	93.9		
#50	84.5		
#100	55.0		
#200	49.0		

* (no specification provided)

Material Description

Light brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.3567 D_{85}= 0.3041 D_{60}= 0.1729
D_{50}= 0.0840 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH15-6
Sample Number: 15-051-34 **Depth:** 20.0'-21.5' **Date:** 3/24/15

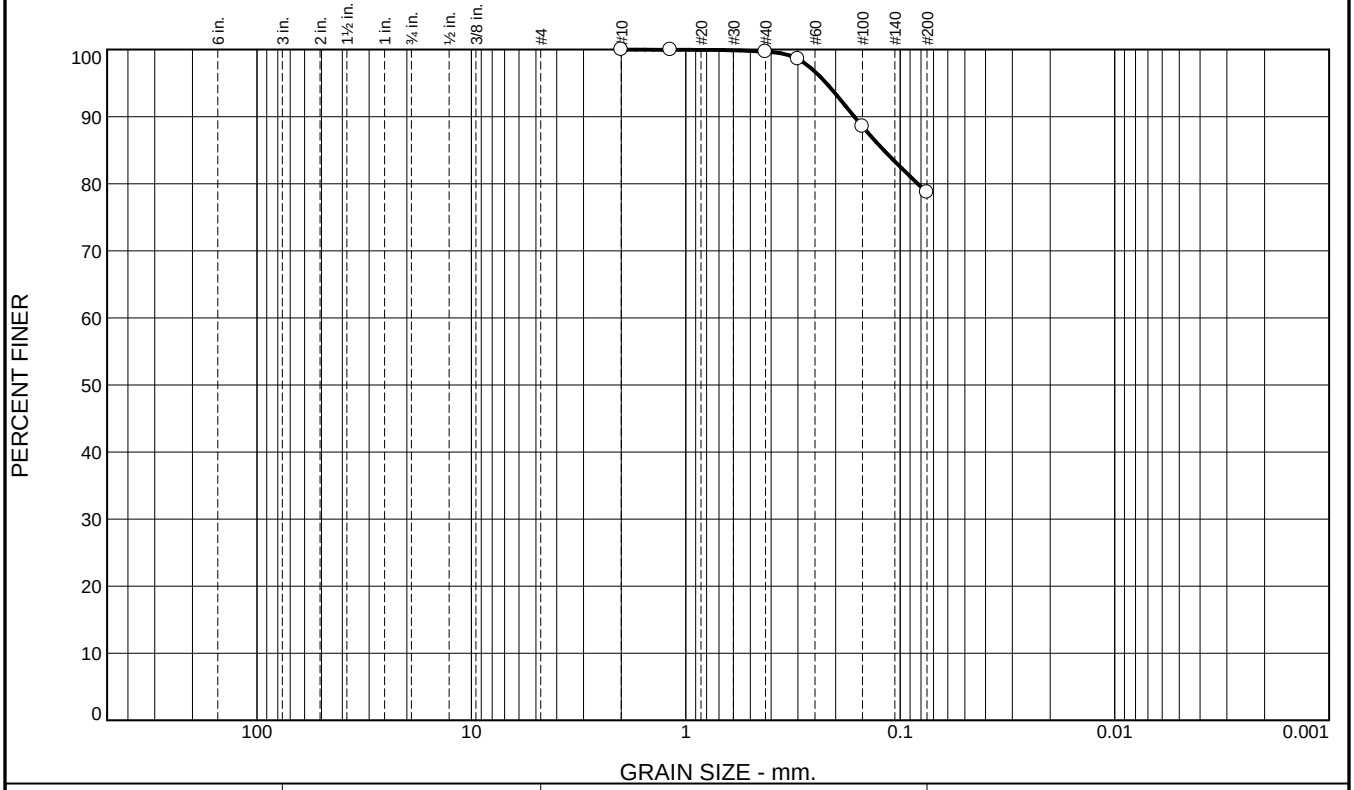
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-051-34

Tested By: BE/TW/OS **Checked By:** KE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	21.0	78.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	100.0		
#40	99.7		
#50	98.6		
#100	88.5		
#200	78.7		

* (no specification provided)

Material Description

Tan silt with sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.1638 D_{85}= 0.1194 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH15-7
Sample Number: 15-052-01 **Depth:** 2.5'-4.0' **Date:** 3/24/15

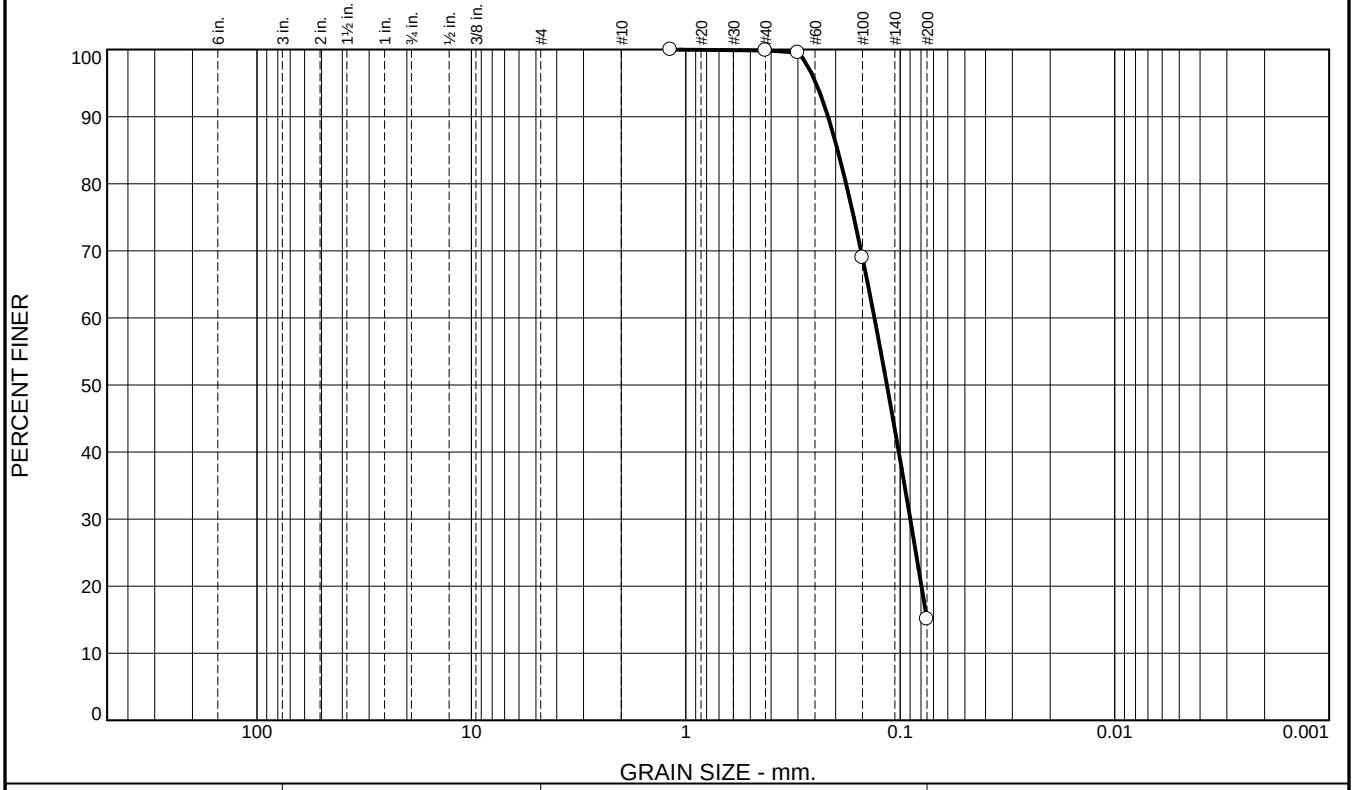
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

Project No: 475.0093.003 **Figure** 15-052-01

Tested By: TW/OS/BE **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	84.8	15.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.9		
#50	99.5		
#100	69.0		
#200	15.1		

* (no specification provided)

Material Description

Tan

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.2172 D_{85}= 0.1957 D_{60}= 0.1320
D_{50}= 0.1155 D_{30}= 0.0898 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

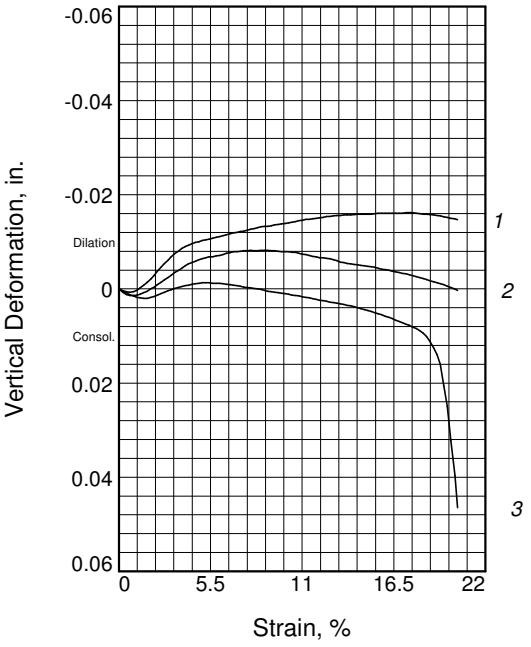
Location: BH15-7
Sample Number: 15-052-02 **Depth:** 10.0'-11.5' **Date:** 3/24/2015

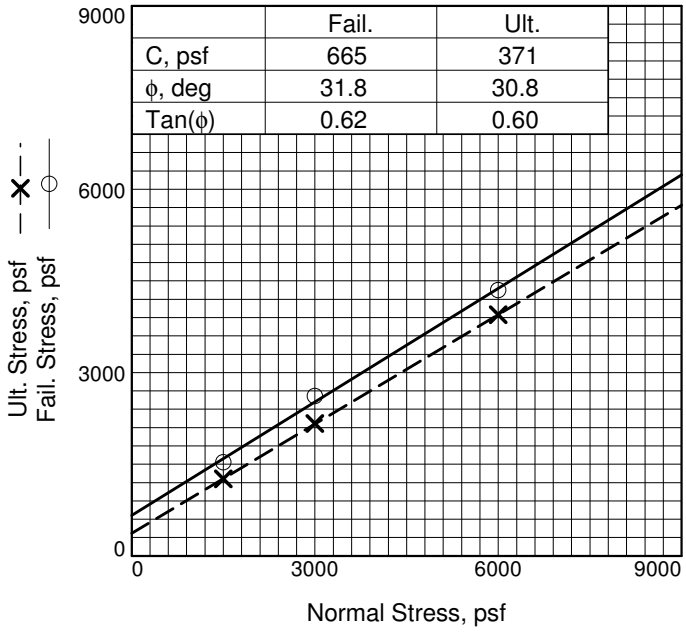
NewFields

Client: Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

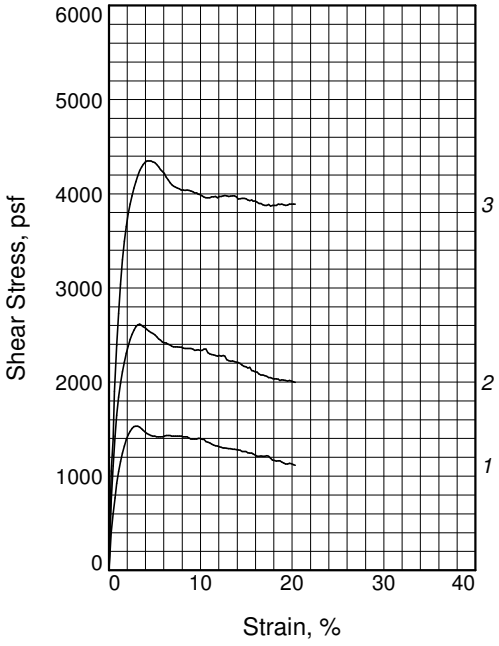
Project No: 475.0093.003 **Figure** 15-052-02

Tested By: TW/OS/BE **Checked By:** TW





	Fail.	Ult.
C, psf	665	371
ϕ, deg	31.8	30.8
Tan(ϕ)	0.62	0.60



Specimen No.		1	2	3
Initial	Water Content, %	21.6	21.6	21.6
	Dry Density, pcf	100.7	100.7	100.7
	Saturation, %	86.6	86.6	86.6
	Void Ratio	0.6744	0.6744	0.6744
	Diameter, in.	2.42	2.42	2.42
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	23.8	23.5	22.4
	Dry Density, pcf	102.5	103.1	105.1
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.6438	0.6356	0.6045
	Diameter, in.	2.42	2.42	2.42
	Height, in.	0.98	0.98	0.96
Normal Stress, psf		1500	3000	6000
Fail. Stress, psf		1532	2615	4349
Strain, %		2.9	3.4	4.2
Ult. Stress, psf		1262	2165	3947
Strain, %		14.9	14.9	14.9
Strain rate, in./min.		0.01	0.01	0.01

Sample Type: Remolded
Description:

Assumed Specific Gravity= 2.7
Remarks: Failure tangents drawn at peak shear stress and 15% strain. Test was inundated.

Figure _____

Client: NewFields

Project: Magnum

Location: TP15-11
Depth: 16'
Proj. No.: DV108-305-04 **Date Sampled:** 3/25/15

Knight Piésold CONSULTING

Tested By: JHK **Checked By:** JDB

DIRECT SHEAR TEST

3/27/2015

Date: 3/25/15
Client: NewFields
Project: Magnum
Project No.: DV108-305-04
Location: TP15-11
Depth: 16'
Description:
Remarks: Failure tangents drawn at peak shear stress and 15% strain. Test was inundated.
Type of Sample: Remolded
Assumed Specific Gravity=2.7 **LL=** **PL=** **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	515.320		260.350
Moisture content: Dry soil+tare, gms.	444.640		231.510
Moisture content: Tare, gms.	117.990		110.570
Moisture, %	21.6	23.8	23.8
Moist specimen weight, gms.	147.2		
Diameter, in.	2.42	2.42	
Area, in.²	4.58	4.58	
Height, in.	1.00	0.98	
Net decrease in height, in.		0.02	
Wet density, pcf	122.4	127.0	
Dry density, pcf	100.7	102.5	
Void ratio	0.6744	0.6438	
Saturation, %	86.6	100.0	

Test Readings for Specimen No. 1

Load ring constant = 31.437 lbs. per input unit
Normal stress = 1500 psf
Strain rate, in./min. = 0.01
Fail. Stress = 1532 psf **at reading no.** 14
Ult. Stress = 1262 psf **at reading no.** 72

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	0.0000
1	0.0060	0.4107	12.9	0.2	406	-0.0004
2	0.0110	0.6113	19.2	0.5	604	-0.0006
3	0.0160	0.7768	24.4	0.7	768	-0.0007
4	0.0210	0.9328	29.3	0.9	922	-0.0006
5	0.0260	1.0601	33.3	1.1	1048	-0.0003
6	0.0310	1.1684	36.7	1.3	1155	0.0002
7	0.0360	1.2607	39.6	1.5	1246	0.0008
8	0.0410	1.3339	41.9	1.7	1318	0.0014
9	0.0460	1.4040	44.1	1.9	1388	0.0021
10	0.0510	1.4549	45.7	2.1	1438	0.0029
11	0.0560	1.4931	46.9	2.3	1476	0.0038
12	0.0610	1.5250	47.9	2.5	1507	0.0046

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
13	0.0660	1.5441	48.5	2.7	1526	0.0054
14	0.0710	1.5504	48.7	2.9	1532	0.0061
15	0.0760	1.5504	48.7	3.1	1532	0.0068
16	0.0810	1.5377	48.3	3.4	1520	0.0075
17	0.0860	1.5218	47.8	3.6	1504	0.0080
18	0.0910	1.5027	47.2	3.8	1485	0.0086
19	0.0960	1.4868	46.7	4.0	1469	0.0090
20	0.1010	1.4708	46.2	4.2	1454	0.0093
21	0.1060	1.4581	45.8	4.4	1441	0.0096
22	0.1110	1.4485	45.5	4.6	1432	0.0099
23	0.1160	1.4422	45.3	4.8	1425	0.0100
24	0.1210	1.4422	45.3	5.0	1425	0.0103
25	0.1260	1.4358	45.1	5.2	1419	0.0104
26	0.1310	1.4358	45.1	5.4	1419	0.0106
27	0.1360	1.4358	45.1	5.6	1419	0.0108
28	0.1410	1.4358	45.1	5.8	1419	0.0110
29	0.1460	1.4422	45.3	6.0	1425	0.0111
30	0.1510	1.4485	45.5	6.3	1432	0.0113
31	0.1560	1.4485	45.5	6.5	1432	0.0115
32	0.1610	1.4485	45.5	6.7	1432	0.0117
33	0.1660	1.4422	45.3	6.9	1425	0.0119
34	0.1710	1.4422	45.3	7.1	1425	0.0120
35	0.1760	1.4422	45.3	7.3	1425	0.0122
36	0.1810	1.4422	45.3	7.5	1425	0.0123
37	0.1860	1.4422	45.3	7.7	1425	0.0125
38	0.1910	1.4422	45.3	7.9	1425	0.0127
39	0.1960	1.4358	45.1	8.1	1419	0.0128
40	0.2010	1.4358	45.1	8.3	1419	0.0130
41	0.2060	1.4358	45.1	8.5	1419	0.0132
42	0.2110	1.4231	44.7	8.7	1406	0.0133
43	0.2160	1.4103	44.3	8.9	1394	0.0133
44	0.2210	1.4103	44.3	9.2	1394	0.0134
45	0.2260	1.4103	44.3	9.4	1394	0.0136
46	0.2310	1.4103	44.3	9.6	1394	0.0137
47	0.2360	1.4167	44.5	9.8	1400	0.0138
48	0.2410	1.4167	44.5	10.0	1400	0.0139
49	0.2460	1.4072	44.2	10.2	1391	0.0140
50	0.2510	1.4072	44.2	10.4	1391	0.0142
51	0.2560	1.3849	43.5	10.6	1369	0.0143
52	0.2610	1.3785	43.3	10.8	1362	0.0145
53	0.2660	1.3690	43.0	11.0	1353	0.0146
54	0.2710	1.3562	42.6	11.2	1340	0.0148
55	0.2760	1.3467	42.3	11.4	1331	0.0148
56	0.2810	1.3403	42.1	11.6	1325	0.0149
57	0.2860	1.3339	41.9	11.8	1318	0.0150
58	0.2910	1.3276	41.7	12.0	1312	0.0151
59	0.2960	1.3212	41.5	12.3	1306	0.0152

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
60	0.3010	1.3148	41.3	12.5	1299	0.0154
61	0.3060	1.3148	41.3	12.7	1299	0.0154
62	0.3110	1.3117	41.2	12.9	1296	0.0155
63	0.3160	1.3085	41.1	13.1	1293	0.0156
64	0.3210	1.3085	41.1	13.3	1293	0.0156
65	0.3260	1.3021	40.9	13.5	1287	0.0157
66	0.3310	1.3021	40.9	13.7	1287	0.0157
67	0.3360	1.2989	40.8	13.9	1284	0.0157
68	0.3410	1.2957	40.7	14.1	1281	0.0158
69	0.3460	1.2894	40.5	14.3	1274	0.0159
70	0.3510	1.2766	40.1	14.5	1262	0.0159
71	0.3560	1.2766	40.1	14.7	1262	0.0159
72	0.3610	1.2766	40.1	14.9	1262	0.0159
73	0.3660	1.2639	39.7	15.2	1249	0.0159
74	0.3710	1.2607	39.6	15.4	1246	0.0160
75	0.3760	1.2607	39.6	15.6	1246	0.0161
76	0.3810	1.2512	39.3	15.8	1236	0.0161
77	0.3860	1.2384	38.9	16.0	1224	0.0161
78	0.3910	1.2257	38.5	16.2	1211	0.0161
79	0.3960	1.2257	38.5	16.4	1211	0.0161
80	0.4010	1.2289	38.6	16.6	1214	0.0161
81	0.4060	1.2257	38.5	16.8	1211	0.0161
82	0.4110	1.2257	38.5	17.0	1211	0.0161
83	0.4160	1.2321	38.7	17.2	1218	0.0162
84	0.4210	1.2257	38.5	17.4	1211	0.0162
85	0.4260	1.2066	37.9	17.6	1192	0.0162
86	0.4310	1.1843	37.2	17.8	1170	0.0161
87	0.4360	1.1811	37.1	18.1	1167	0.0160
88	0.4410	1.1748	36.9	18.3	1161	0.0159
89	0.4460	1.1779	37.0	18.5	1164	0.0159
90	0.4510	1.1779	37.0	18.7	1164	0.0158
91	0.4560	1.1620	36.5	18.9	1148	0.0157
92	0.4610	1.1525	36.2	19.1	1139	0.0156
93	0.4660	1.1429	35.9	19.3	1130	0.0155
94	0.4710	1.1429	35.9	19.5	1130	0.0153
95	0.4760	1.1493	36.1	19.7	1136	0.0152
96	0.4810	1.1461	36.0	19.9	1133	0.0150
97	0.4860	1.1366	35.7	20.1	1123	0.0149
98	0.4910	1.1302	35.5	20.3	1117	0.0147

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	515.320		267.100
Moisture content: Dry soil+tare, gms.	444.640		238.660
Moisture content: Tare, gms.	117.990		117.790
Moisture, %	21.6	23.5	23.5
Moist specimen weight, gms.	147.2		
Diameter, in.	2.42	2.42	
Area, in.²	4.58	4.58	
Height, in.	1.00	0.98	
Net decrease in height, in.		0.02	
Wet density, pcf	122.4	127.3	
Dry density, pcf	100.7	103.1	
Void ratio	0.6744	0.6356	
Saturation, %	86.6	100.0	

Test Readings for Specimen No. 2

Load ring constant = 31.437 lbs. per input unit
Normal stress = 3000 psf
Strain rate, in./min. = 0.01
Fail. Stress = 2615 psf **at reading no.** 16
Ult. Stress = 2165 psf **at reading no.** 72

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	0.0001
1	0.0060	0.7513	23.6	0.2	743	-0.0006
2	0.0110	1.1238	35.3	0.5	1111	-0.0011
3	0.0160	1.4422	45.3	0.7	1425	-0.0013
4	0.0210	1.6650	52.3	0.9	1646	-0.0013
5	0.0260	1.8624	58.5	1.1	1841	-0.0012
6	0.0310	2.0089	63.2	1.3	1985	-0.0010
7	0.0360	2.1330	67.1	1.5	2108	-0.0007
8	0.0410	2.2381	70.4	1.7	2212	-0.0004
9	0.0460	2.3336	73.4	1.9	2306	0.0001
10	0.0510	2.4100	75.8	2.1	2382	0.0005
11	0.0560	2.4800	78.0	2.3	2451	0.0010
12	0.0610	2.5373	79.8	2.5	2508	0.0015
13	0.0660	2.5819	81.2	2.7	2552	0.0020
14	0.0710	2.6201	82.4	2.9	2589	0.0025
15	0.0760	2.6392	83.0	3.1	2608	0.0030
16	0.0810	2.6456	83.2	3.4	2615	0.0036
17	0.0860	2.6329	82.8	3.6	2602	0.0040
18	0.0910	2.6201	82.4	3.8	2589	0.0045
19	0.0960	2.6074	82.0	4.0	2577	0.0050
20	0.1010	2.5883	81.4	4.2	2558	0.0054
21	0.1060	2.5692	80.8	4.4	2539	0.0057
22	0.1110	2.5564	80.4	4.6	2526	0.0060
23	0.1160	2.5469	80.1	4.8	2517	0.0063
24	0.1210	2.5310	79.6	5.0	2501	0.0065
25	0.1260	2.5119	79.0	5.2	2482	0.0067
26	0.1310	2.4864	78.2	5.4	2457	0.0069

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
27	0.1360	2.4737	77.8	5.6	2445	0.0069
28	0.1410	2.4546	77.2	5.8	2426	0.0071
29	0.1460	2.4482	77.0	6.0	2420	0.0072
30	0.1510	2.4418	76.8	6.3	2413	0.0074
31	0.1560	2.4291	76.4	6.5	2401	0.0077
32	0.1610	2.4227	76.2	6.7	2394	0.0078
33	0.1660	2.4100	75.8	6.9	2382	0.0080
34	0.1710	2.4036	75.6	7.1	2375	0.0080
35	0.1760	2.4036	75.6	7.3	2375	0.0081
36	0.1810	2.4004	75.5	7.5	2372	0.0082
37	0.1860	2.3973	75.4	7.7	2369	0.0082
38	0.1910	2.3973	75.4	7.9	2369	0.0083
39	0.1960	2.3877	75.1	8.1	2360	0.0082
40	0.2010	2.3845	75.0	8.3	2357	0.0082
41	0.2060	2.3845	75.0	8.5	2357	0.0083
42	0.2110	2.3845	75.0	8.7	2357	0.0083
43	0.2160	2.3845	75.0	8.9	2357	0.0083
44	0.2210	2.3782	74.8	9.2	2350	0.0082
45	0.2260	2.3654	74.4	9.4	2338	0.0082
46	0.2310	2.3686	74.5	9.6	2341	0.0081
47	0.2360	2.3718	74.6	9.8	2344	0.0080
48	0.2410	2.3654	74.4	10.0	2338	0.0080
49	0.2460	2.3654	74.4	10.2	2338	0.0080
50	0.2510	2.3782	74.8	10.4	2350	0.0079
51	0.2560	2.3782	74.8	10.6	2350	0.0079
52	0.2610	2.3400	73.6	10.8	2313	0.0077
53	0.2660	2.3272	73.2	11.0	2300	0.0075
54	0.2710	2.3209	73.0	11.2	2294	0.0074
55	0.2760	2.3145	72.8	11.4	2287	0.0072
56	0.2810	2.3081	72.6	11.6	2281	0.0070
57	0.2860	2.3018	72.4	11.8	2275	0.0069
58	0.2910	2.3081	72.6	12.0	2281	0.0067
59	0.2960	2.3018	72.4	12.3	2275	0.0067
60	0.3010	2.3081	72.6	12.5	2281	0.0066
61	0.3060	2.3018	72.4	12.7	2275	0.0065
62	0.3110	2.2636	71.2	12.9	2237	0.0063
63	0.3160	2.2540	70.9	13.1	2228	0.0061
64	0.3210	2.2476	70.7	13.3	2221	0.0058
65	0.3260	2.2508	70.8	13.5	2224	0.0057
66	0.3310	2.2445	70.6	13.7	2218	0.0055
67	0.3360	2.2381	70.4	13.9	2212	0.0054
68	0.3410	2.2317	70.2	14.1	2206	0.0053
69	0.3460	2.2222	69.9	14.3	2196	0.0052
70	0.3510	2.2062	69.4	14.5	2180	0.0051
71	0.3560	2.1935	69.0	14.7	2168	0.0050
72	0.3610	2.1903	68.9	14.9	2165	0.0049
73	0.3660	2.1744	68.4	15.2	2149	0.0048

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
74	0.3710	2.1808	68.6	15.4	2155	0.0047
75	0.3760	2.1489	67.6	15.6	2124	0.0045
76	0.3810	2.1426	67.4	15.8	2117	0.0043
77	0.3860	2.1330	67.1	16.0	2108	0.0042
78	0.3910	2.1298	67.0	16.2	2105	0.0041
79	0.3960	2.1107	66.4	16.4	2086	0.0039
80	0.4010	2.0980	66.0	16.6	2073	0.0037
81	0.4060	2.0980	66.0	16.8	2073	0.0036
82	0.4110	2.0916	65.8	17.0	2067	0.0034
83	0.4160	2.0853	65.6	17.2	2061	0.0033
84	0.4210	2.0725	65.2	17.4	2048	0.0031
85	0.4260	2.0725	65.2	17.6	2048	0.0029
86	0.4310	2.0598	64.8	17.8	2036	0.0027
87	0.4360	2.0566	64.7	18.1	2033	0.0025
88	0.4410	2.0566	64.7	18.3	2033	0.0023
89	0.4460	2.0534	64.6	18.5	2029	0.0021
90	0.4510	2.0407	64.2	18.7	2017	0.0018
91	0.4560	2.0471	64.4	18.9	2023	0.0016
92	0.4610	2.0439	64.3	19.1	2020	0.0014
93	0.4660	2.0407	64.2	19.3	2017	0.0012
94	0.4710	2.0343	64.0	19.5	2010	0.0010
95	0.4760	2.0407	64.2	19.7	2017	0.0007
96	0.4810	2.0343	64.0	19.9	2010	0.0004
97	0.4860	2.0280	63.8	20.1	2004	0.0001
98	0.4910	2.0216	63.6	20.3	1998	-0.0002

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	515.320		260.470
Moisture content: Dry soil+tare, gms.	444.640		233.510
Moisture content: Tare, gms.	117.990		113.060
Moisture, %	21.6	22.4	22.4
Moist specimen weight, gms.	147.2		
Diameter, in.	2.42	2.42	
Area, in.²	4.58	4.58	
Height, in.	1.00	0.96	
Net decrease in height, in.		0.04	
Wet density, pcf	122.4	128.6	
Dry density, pcf	100.7	105.1	
Void ratio	0.6744	0.6045	
Saturation, %	86.6	100.0	

Test Readings for Specimen No. 3

Load ring constant = 31.4208 lbs. per input unit
Normal stress = 6000 psf
Strain rate, in./min. = 0.01
Fail. Stress = 4349 psf **at reading no.** 20
Ult. Stress = 3947 psf **at reading no.** 72

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	0.0001
1	0.0060	1.0665	33.5	0.2	1053	-0.0004
2	0.0110	1.4103	44.3	0.5	1393	-0.0007
3	0.0150	1.9261	60.5	0.6	1903	-0.0011
4	0.0210	2.4164	75.9	0.9	2387	-0.0014
5	0.0260	2.7602	86.7	1.1	2726	-0.0017
6	0.0310	3.0786	96.7	1.3	3041	-0.0018
7	0.0360	3.3396	104.9	1.5	3299	-0.0019
8	0.0410	3.5402	111.2	1.7	3497	-0.0019
9	0.0460	3.6962	116.1	1.9	3651	-0.0017
10	0.0510	3.8331	120.4	2.1	3786	-0.0015
11	0.0560	3.9381	123.7	2.3	3890	-0.0012
12	0.0610	4.0273	126.5	2.5	3978	-0.0009
13	0.0660	4.1101	129.1	2.7	4060	-0.0006
14	0.0710	4.1801	131.3	2.9	4129	-0.0003
15	0.0760	4.2438	133.3	3.1	4192	-0.0001
16	0.0810	4.3011	135.1	3.4	4248	0.0002
17	0.0860	4.3361	136.2	3.6	4283	0.0004
18	0.0910	4.3647	137.1	3.8	4311	0.0006
19	0.0960	4.3902	137.9	4.0	4337	0.0008
20	0.1010	4.4029	138.3	4.2	4349	0.0009
21	0.1060	4.4029	138.3	4.4	4349	0.0011
22	0.1110	4.4029	138.3	4.6	4349	0.0012
23	0.1160	4.3934	138.0	4.8	4340	0.0013
24	0.1210	4.3838	137.7	5.0	4330	0.0014
25	0.1260	4.3647	137.1	5.2	4311	0.0014
26	0.1310	4.3393	136.3	5.4	4286	0.0014

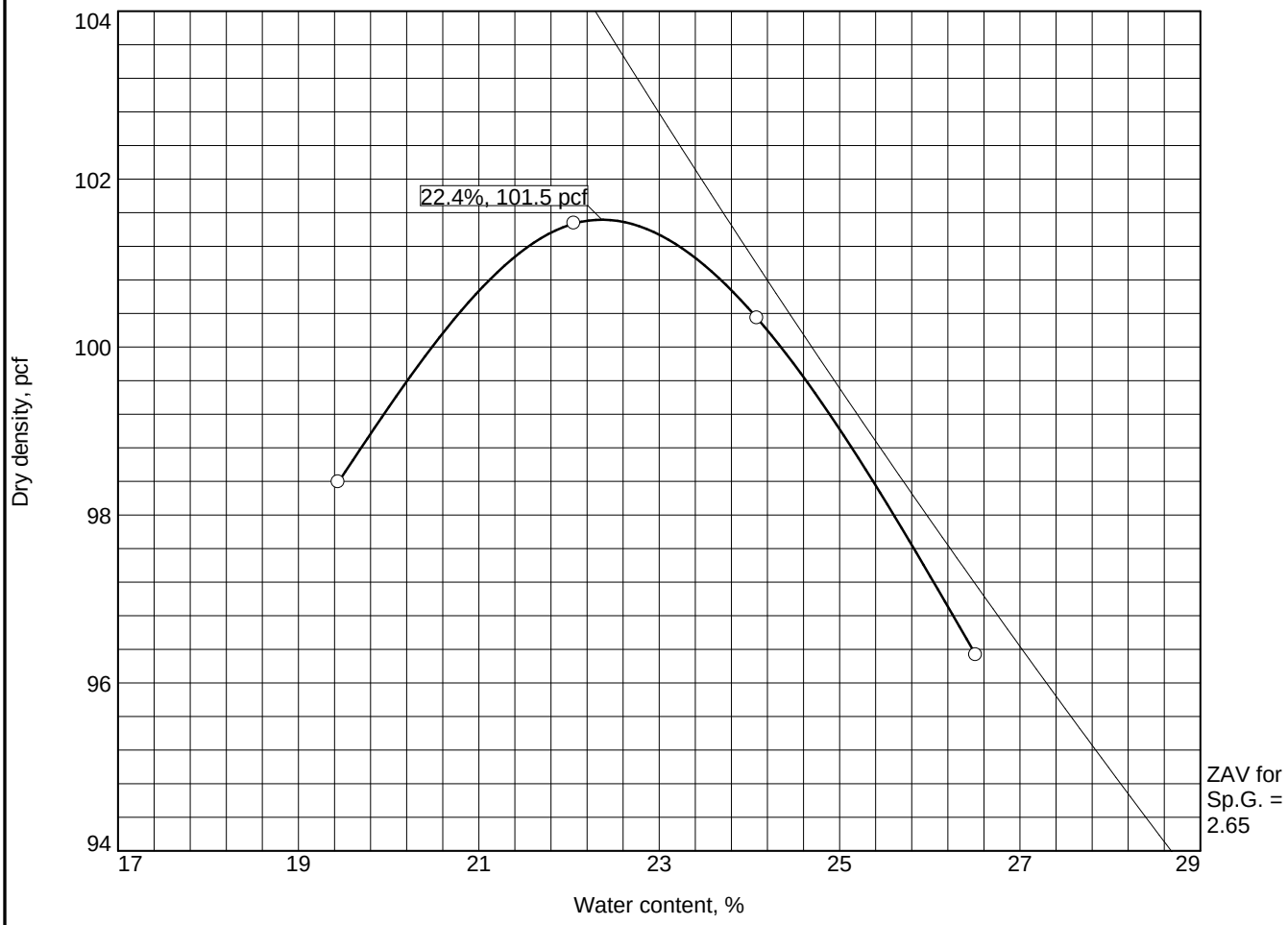
Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
27	0.1360	4.3106	135.4	5.6	4258	0.0013
28	0.1410	4.2883	134.7	5.8	4236	0.0013
29	0.1460	4.2692	134.1	6.0	4217	0.0013
30	0.1510	4.2278	132.8	6.3	4176	0.0012
31	0.1560	4.1992	131.9	6.5	4148	0.0011
32	0.1610	4.1674	130.9	6.7	4116	0.0010
33	0.1660	4.1483	130.3	6.9	4098	0.0009
34	0.1710	4.1292	129.7	7.1	4079	0.0008
35	0.1760	4.1196	129.4	7.3	4069	0.0007
36	0.1810	4.1101	129.1	7.5	4060	0.0005
37	0.1860	4.1037	128.9	7.7	4053	0.0004
38	0.1910	4.0910	128.5	7.9	4041	0.0003
39	0.1960	4.0878	128.4	8.1	4038	0.0002
40	0.2010	4.0846	128.3	8.3	4035	0.0001
41	0.2060	4.0878	128.4	8.5	4038	0.0000
42	0.2110	4.0846	128.3	8.7	4035	-0.0002
43	0.2160	4.0782	128.1	8.9	4028	-0.0004
44	0.2210	4.0719	127.9	9.2	4022	-0.0005
45	0.2260	4.0591	127.5	9.4	4009	-0.0006
46	0.2310	4.0591	127.5	9.6	4009	-0.0007
47	0.2360	4.0464	127.1	9.8	3997	-0.0008
48	0.2410	4.0400	126.9	10.0	3991	-0.0009
49	0.2460	4.0273	126.5	10.2	3978	-0.0010
50	0.2510	4.0145	126.1	10.4	3965	-0.0012
51	0.2560	4.0082	125.9	10.6	3959	-0.0013
52	0.2610	4.0082	125.9	10.8	3959	-0.0014
53	0.2660	4.0082	125.9	11.0	3959	-0.0016
54	0.2710	4.0177	126.2	11.2	3969	-0.0017
55	0.2760	4.0177	126.2	11.4	3969	-0.0018
56	0.2810	4.0209	126.3	11.6	3972	-0.0020
57	0.2860	4.0082	125.9	11.8	3959	-0.0021
58	0.2910	4.0209	126.3	12.0	3972	-0.0023
59	0.2960	4.0209	126.3	12.3	3972	-0.0024
60	0.3010	4.0273	126.5	12.5	3978	-0.0025
61	0.3060	4.0305	126.6	12.7	3981	-0.0027
62	0.3110	4.0273	126.5	12.9	3978	-0.0028
63	0.3160	4.0209	126.3	13.1	3972	-0.0029
64	0.3210	4.0241	126.4	13.3	3975	-0.0031
65	0.3260	4.0273	126.5	13.5	3978	-0.0032
66	0.3310	4.0273	126.5	13.7	3978	-0.0034
67	0.3360	4.0177	126.2	13.9	3969	-0.0035
68	0.3410	3.9923	125.4	14.1	3943	-0.0037
69	0.3460	3.9954	125.5	14.3	3947	-0.0039
70	0.3510	3.9986	125.6	14.5	3950	-0.0041
71	0.3560	3.9986	125.6	14.7	3950	-0.0043
72	0.3610	3.9954	125.5	14.9	3947	-0.0045
73	0.3660	3.9827	125.1	15.2	3934	-0.0047

Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
74	0.3710	3.9763	124.9	15.4	3928	-0.0050
75	0.3760	3.9827	125.1	15.6	3934	-0.0052
76	0.3810	3.9700	124.7	15.8	3921	-0.0054
77	0.3860	3.9732	124.8	16.0	3925	-0.0057
78	0.3910	3.9572	124.3	16.2	3909	-0.0059
79	0.3960	3.9445	123.9	16.4	3896	-0.0062
80	0.4010	3.9445	123.9	16.6	3896	-0.0065
81	0.4060	3.9318	123.5	16.8	3884	-0.0068
82	0.4110	3.9254	123.3	17.0	3877	-0.0071
83	0.4160	3.9254	123.3	17.2	3877	-0.0074
84	0.4210	3.9350	123.6	17.4	3887	-0.0076
85	0.4260	3.9190	123.1	17.6	3871	-0.0080
86	0.4310	3.9254	123.3	17.8	3877	-0.0083
87	0.4360	3.9254	123.3	18.1	3877	-0.0088
88	0.4410	3.9254	123.3	18.3	3877	-0.0093
89	0.4460	3.9381	123.7	18.5	3890	-0.0100
90	0.4510	3.9350	123.6	18.7	3887	-0.0111
91	0.4560	3.9381	123.7	18.9	3890	-0.0124
92	0.4610	3.9318	123.5	19.1	3884	-0.0139
93	0.4660	3.9254	123.3	19.3	3877	-0.0159
94	0.4710	3.9286	123.4	19.5	3881	-0.0205
95	0.4760	3.9381	123.7	19.7	3890	-0.0249
96	0.4810	3.9381	123.7	19.9	3890	-0.0321
97	0.4870	3.9381	123.7	20.2	3890	-0.0396
98	0.4910	3.9381	123.7	20.3	3890	-0.0464

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	SC	A-6(4)		2.65	28	12	0.3	49.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 101.5 pcf Optimum moisture = 22.4 %	Light gray clayey sand

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP-9 Composite Sample **Sample Number:** 15-050

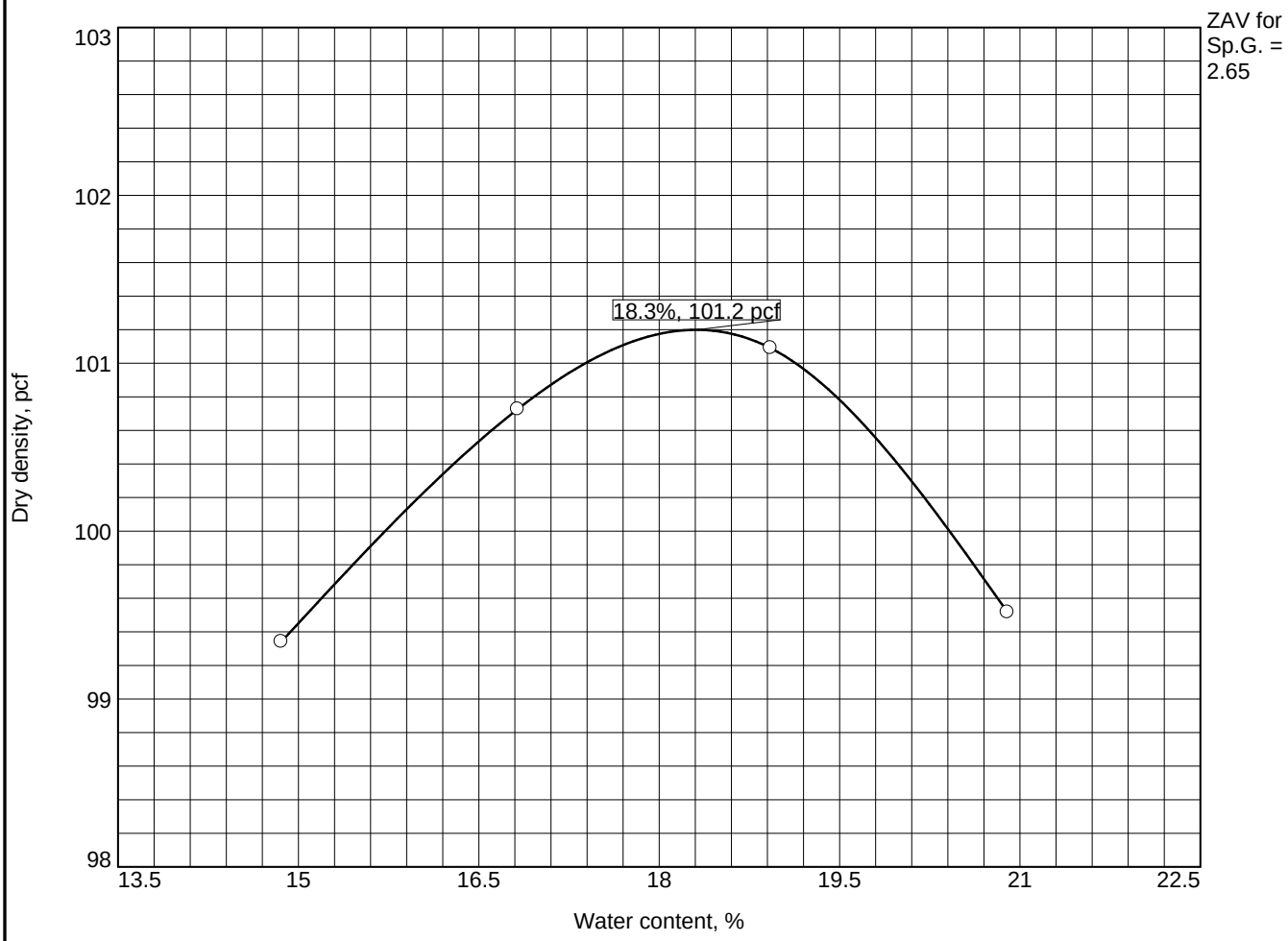
Remarks:
2.65 is an assumed specific gravity.

NewFields

Figure 15-050

Tested By: TW **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
5'				2.65	NR	NR	0.0	40.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 101.2 pcf Optimum moisture = 18.3 %	Light brown

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP15-3 **Sample Number:** 15-050-02

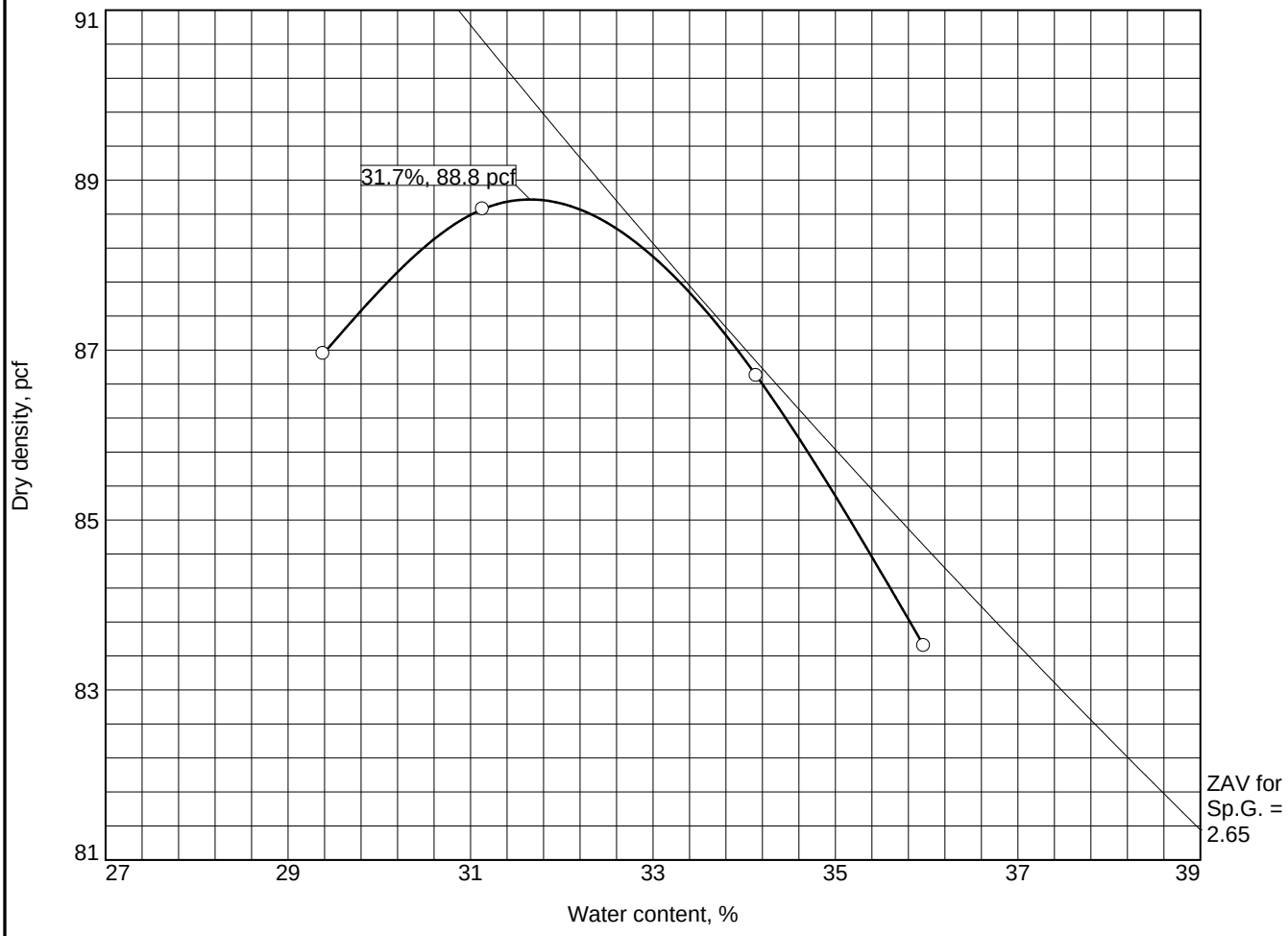
Remarks:
2.65 is an assumed sepcific gravity.

NewFields

Figure 15-050-02

Tested By: OS **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
3'	CL	A-7-6(25)		2.65	46	24	0.0	96.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 88.8 pcf Optimum moisture = 31.7 %	Gray lean clay

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP15-5 **Sample Number:** 15-050-03

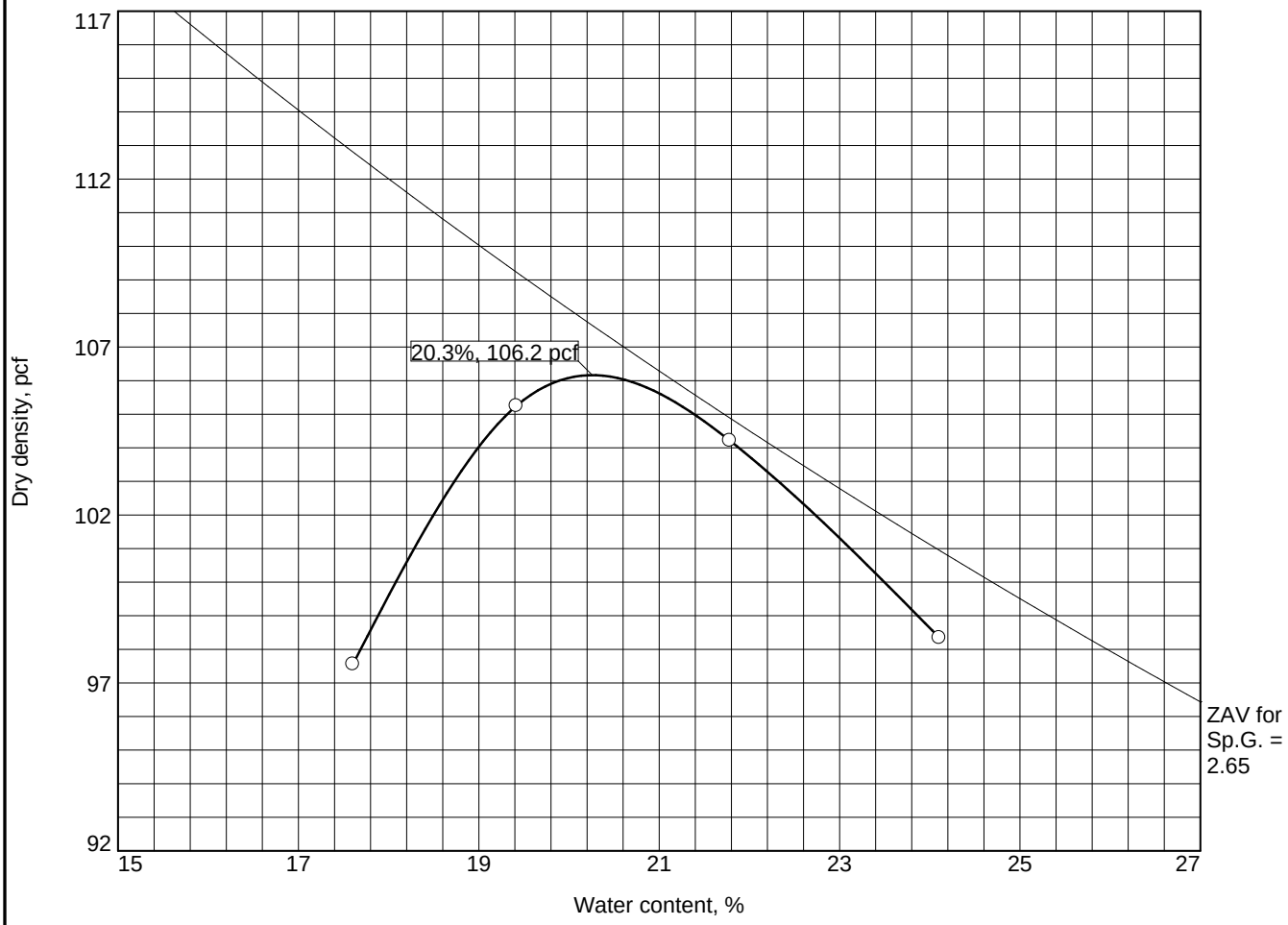
NewFields

Remarks:
2.65 is an assumed specific gravity.

Figure 15-050-03

Tested By: OS **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
8'	CL	A-6(10)		2.65	34	16	0.0	74.5

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 106.2 pcf Optimum moisture = 20.3 %	Gray lean clay with sand

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP15-6 **Sample Number:** 15-050-05

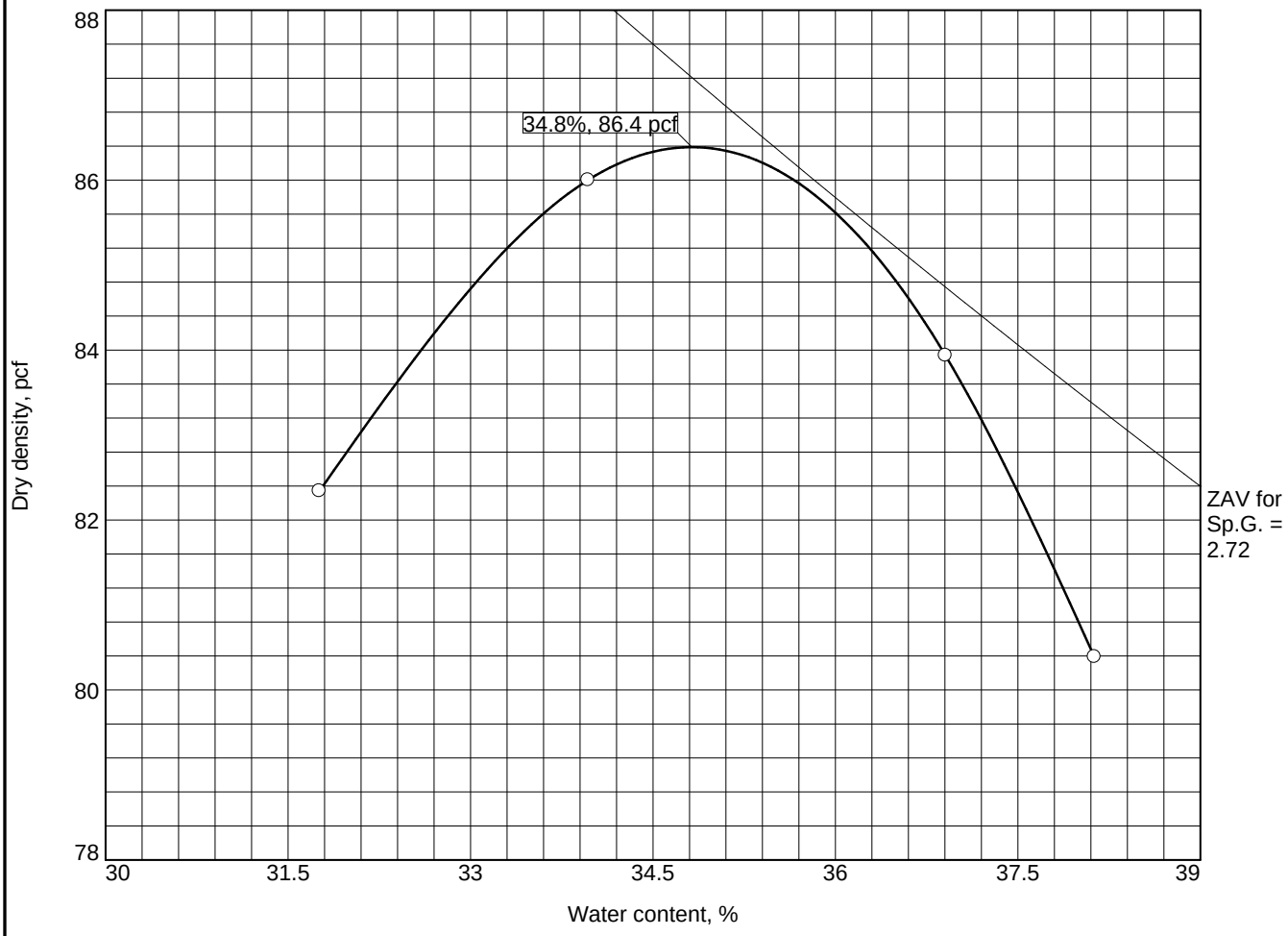
Remarks:
2.65 is an assumed specific gravity.

NewFields

Figure 15-050-05

Tested By: OS/TW **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
16'	CL	A-7-6(29)		2.65	49	26	0.0	98.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 86.4 pcf Optimum moisture = 34.8 %	Gray lean clay

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP15-9 **Sample Number:** 15-050-08

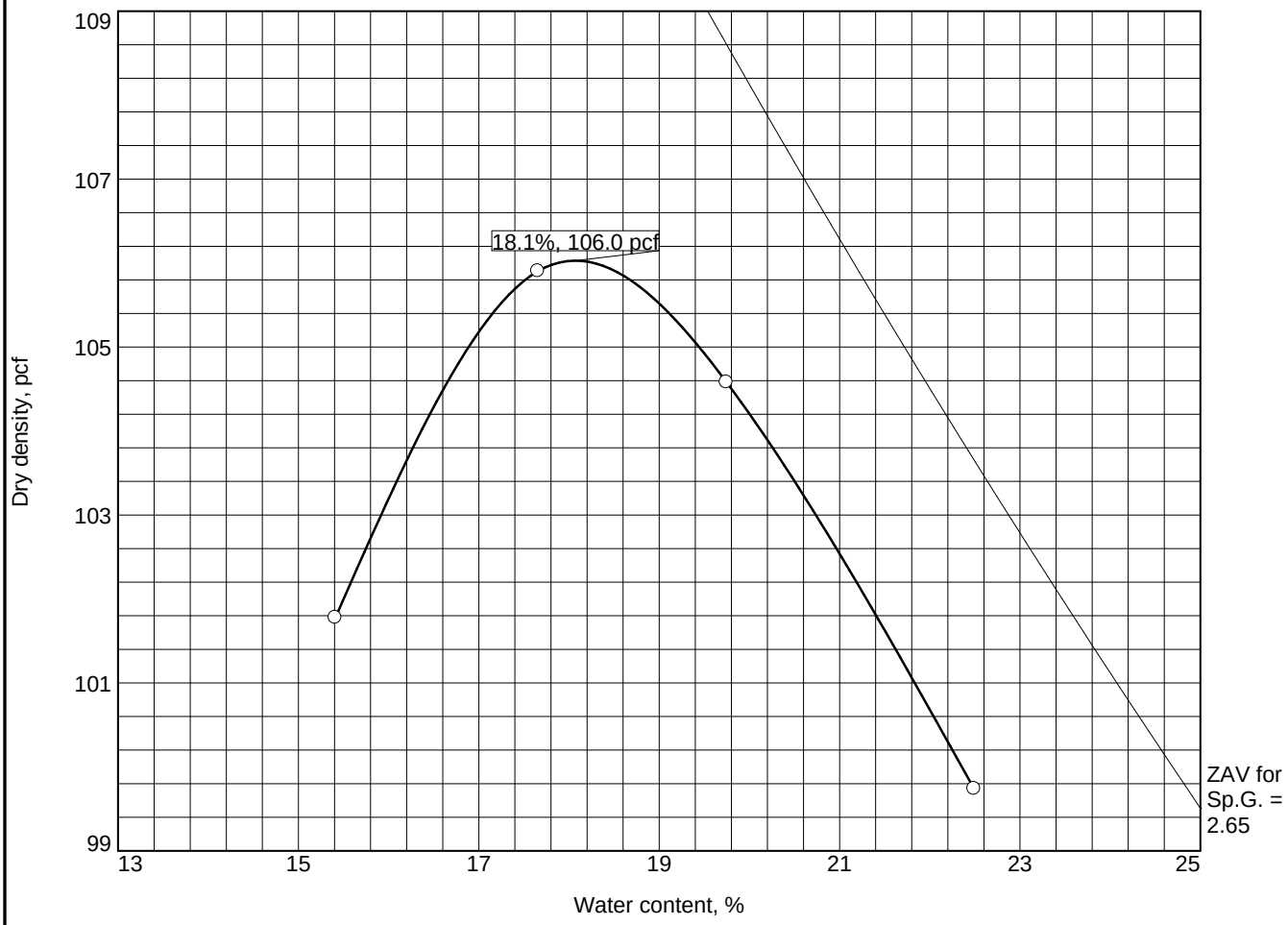
Remarks:
2.65 is an assumed specific gravity.

NewFields

Figure 15-050-08

Tested By: OS **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-07 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
6'	SM	A-4(0)	11.4	2.65	NP	NP	0.0	40.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 106.0 pcf Optimum moisture = 18.1 %	Light brown silty sand

Project No. 475.0093.003 **Client:** Magnum Development Solution Mining
Project: Sawtooth Brine Pond 2 Geotech & Des.

○**Location:** TP15-11 **Sample Number:** 15-050-10

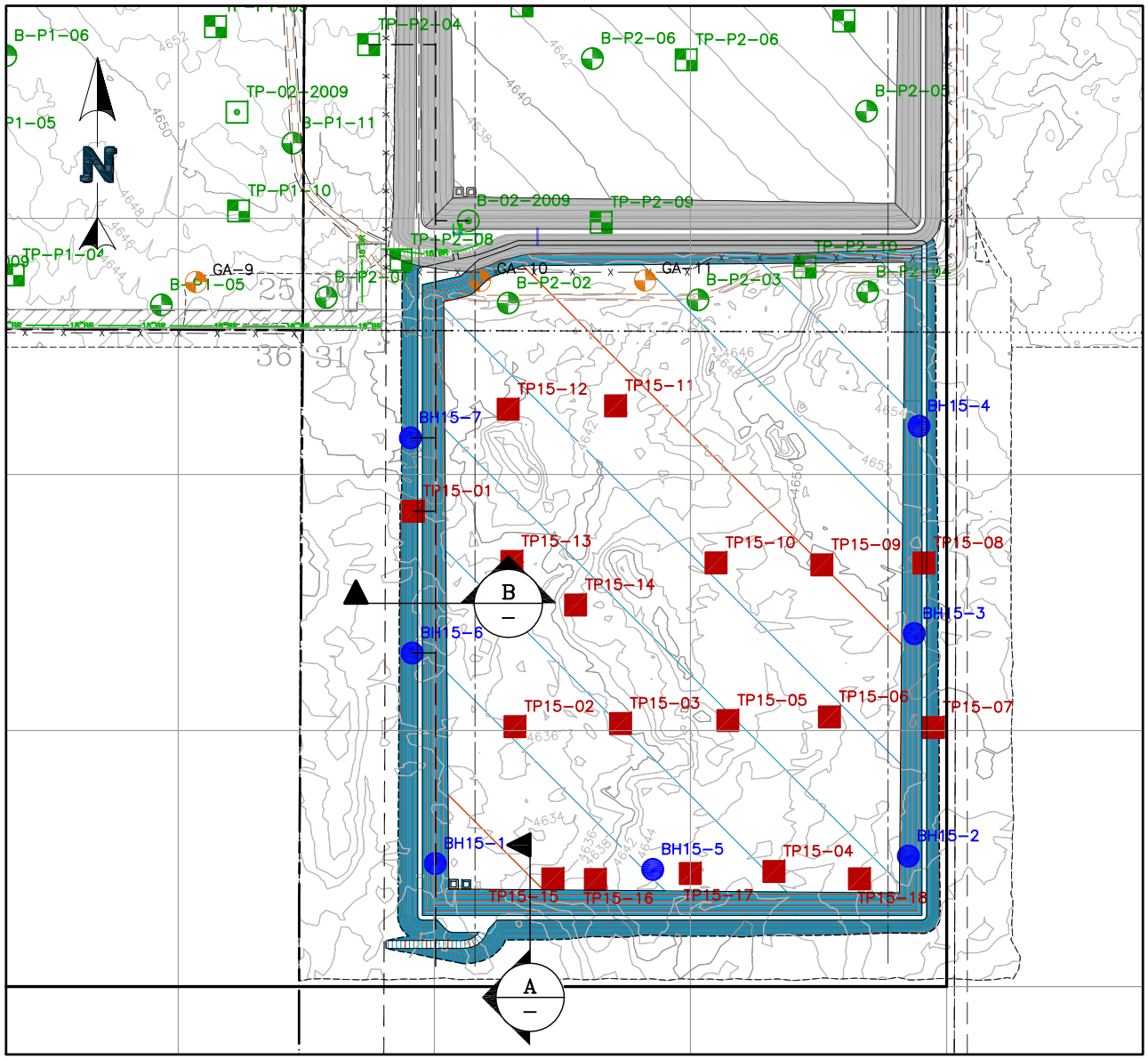
NewFields

Remarks:
2.65 is an assumed specific gravity.

Figure 15-050-10

Tested By: TW **Checked By:** TW

APPENDIX F – STABILITY ANALYSIS



0 400 800 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUNDWATER CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- EXISTING BRINE LINE
- B-01-2009 — BOREHOLE (IGES, 2009)
- TP-01-2009 — TEST PIT (IGES, 2009)
- B-P1-01 — BOREHOLE (IGES, 2010)
- TP-P1-02 — TEST PIT (IGES, 2010)
- BH15-1 — BOREHOLE (NEWFIELDS, 2015)
- TP15-01 — TEST PIT (NEWFIELDS, 2015)
- GA-10 — EXISTING GROUND WATER MONITORING WELLS

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: SLOPE STABILITY SECTION LAYOUT

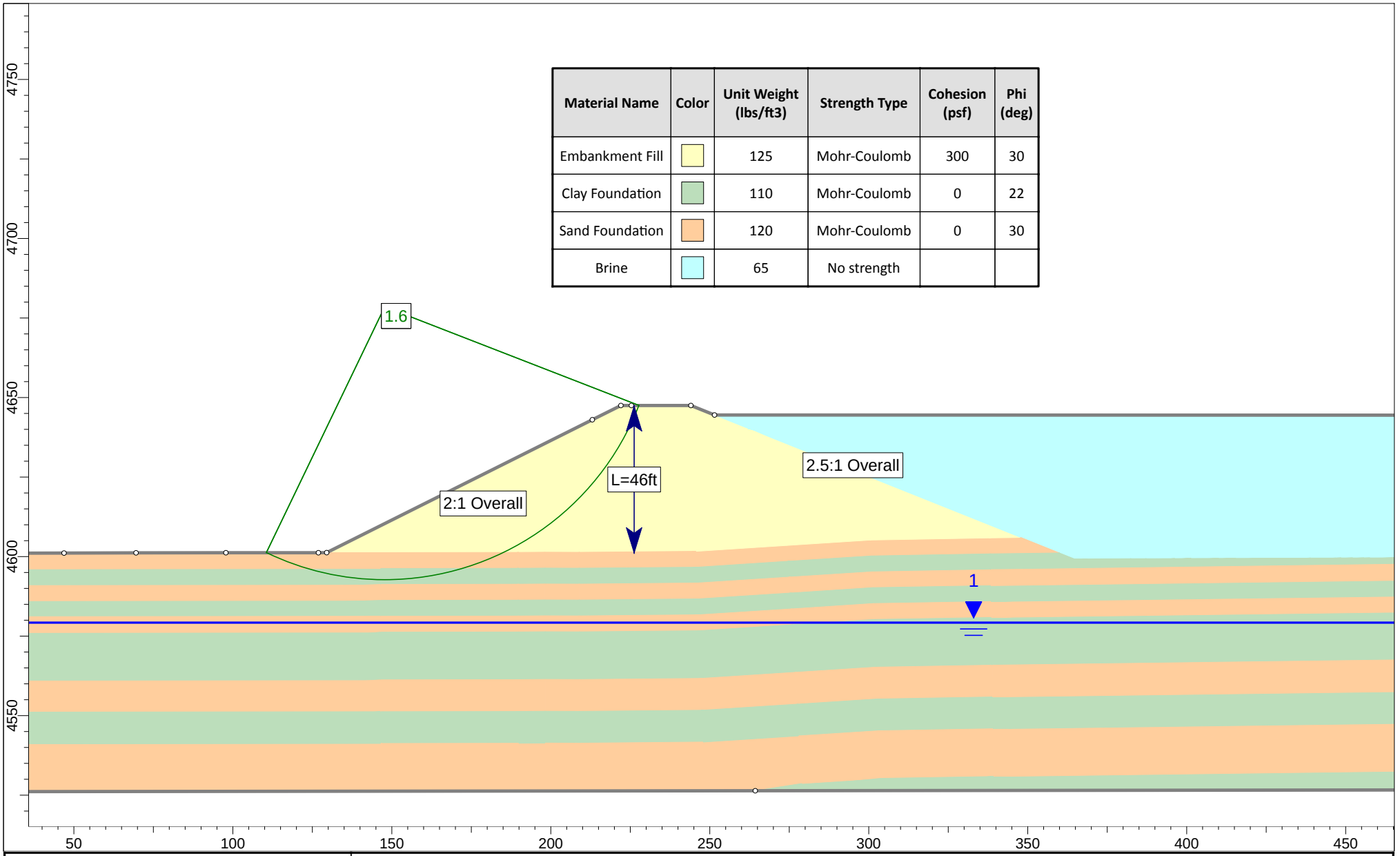
FILENAME: Figure 04

FIGURE NO.: 1

REVISION: A

P:\Projects\0093.003 Magnum Brine Pond 2 Geotech and Design\A-CAD\FIGS\Figure 04.dwg-4/1/2015 4:20 PM

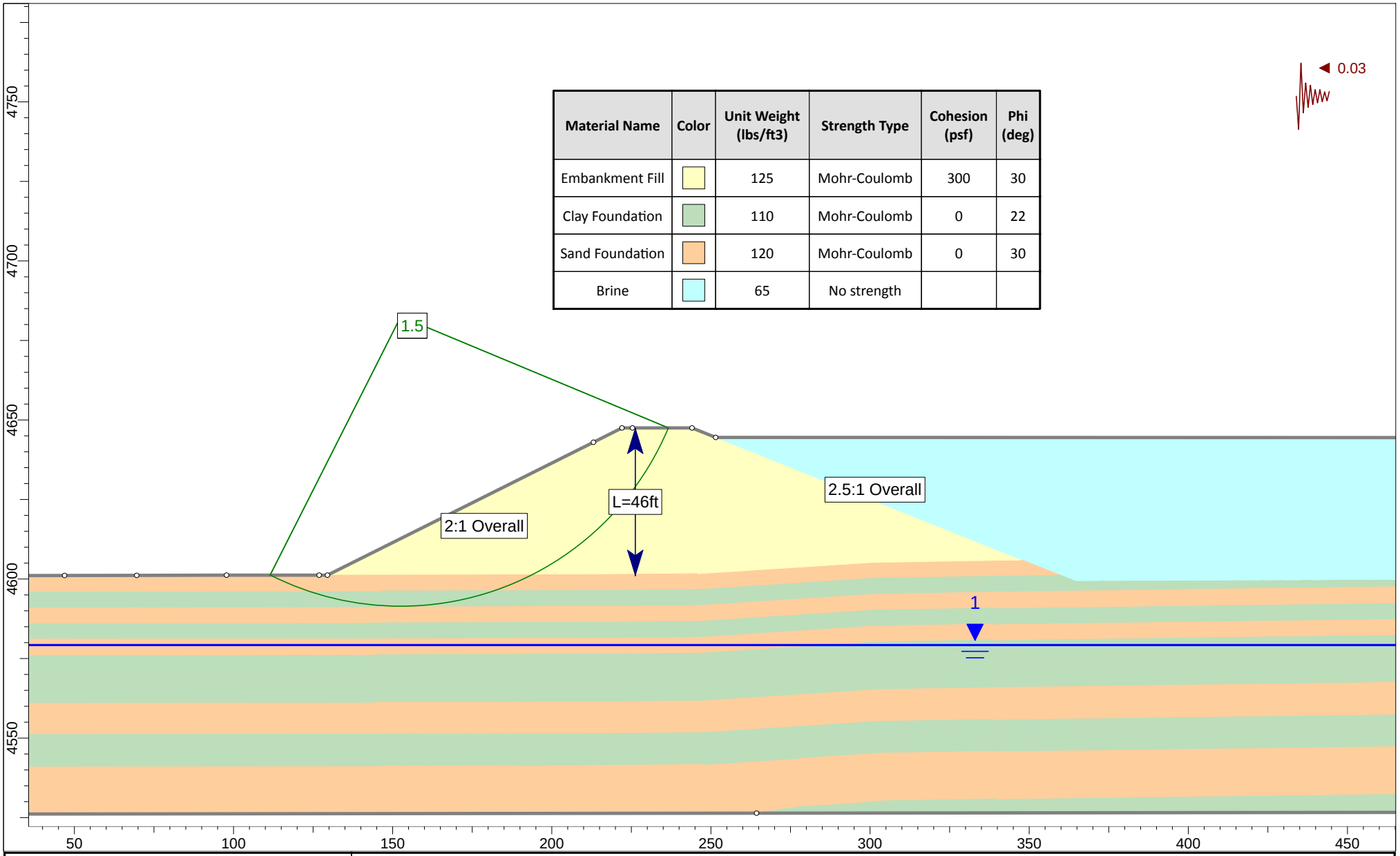
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		125	Mohr-Coulomb	300	30
Clay Foundation		110	Mohr-Coulomb	0	22
Sand Foundation		120	Mohr-Coulomb	0	30
Brine		65	No strength		



NewFields

SLIDEINTERPRET 6.029

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS		
Analysis Description	CROSS SECTION A - STATIC CIRCULAR		
Drawn By	RJB	Company	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015	File Name	CROSS SECTION A.slim

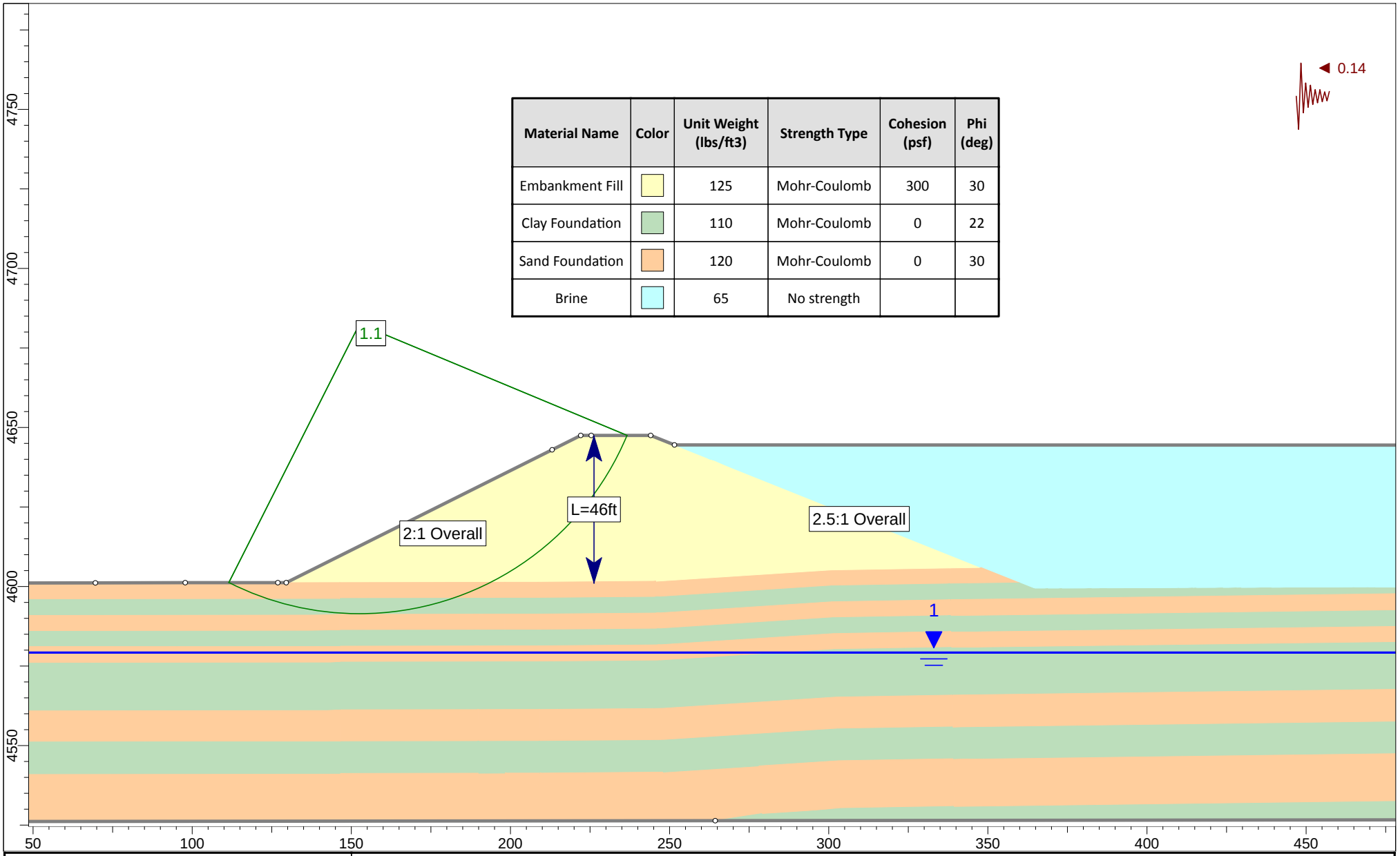


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		125	Mohr-Coulomb	300	30
Clay Foundation		110	Mohr-Coulomb	0	22
Sand Foundation		120	Mohr-Coulomb	0	30
Brine		65	No strength		

NewFields

SLIDEINTERPRET 6.029

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS		
Analysis Description	CROSS SECTION A - OBE PSEUDO-STATIC CIRCULAR		
Drawn By	RJB	*Company*	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015	*File Name*	CROSS SECTION A circular pseudo OBE.slim

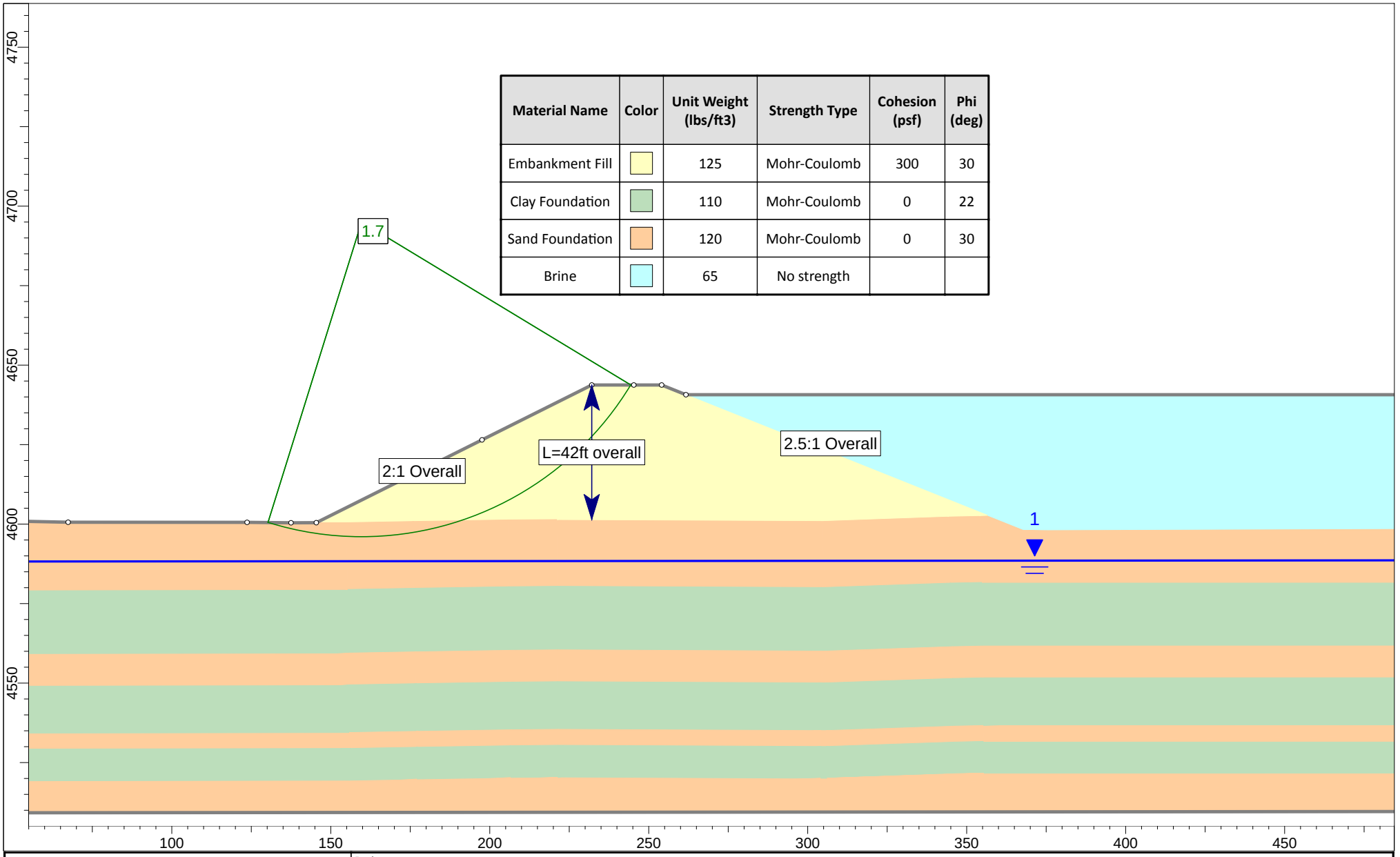


NewFields

SLIDEINTERPRET 6.029

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS
Analysis Description	CROSS SECTION A - MCE PSEUDO-STATIC CIRCULAR
Drawn By	RJB
Company	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015
File Name	CROSS SECTION A circular pseudo MCE.slim

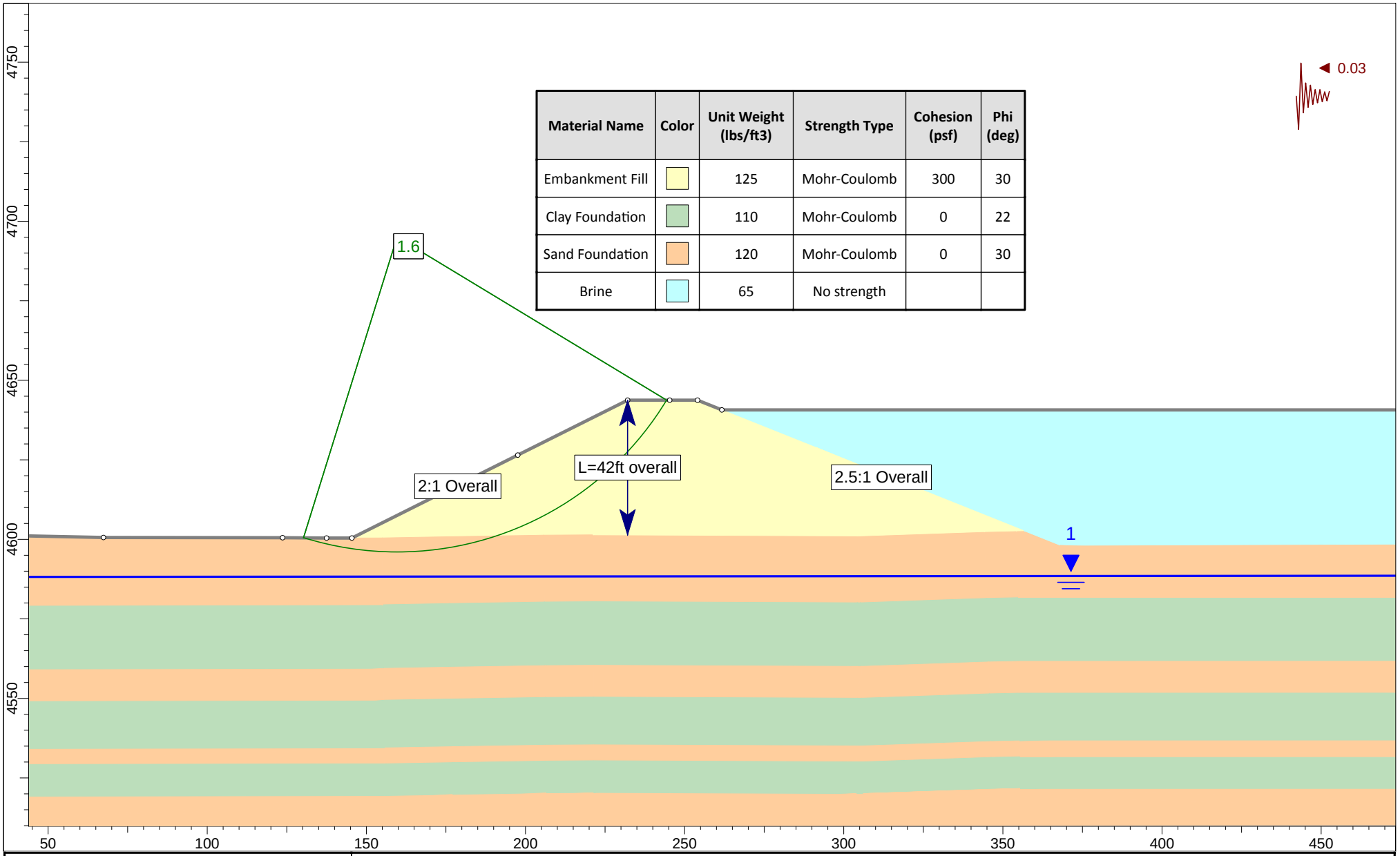
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		125	Mohr-Coulomb	300	30
Clay Foundation		110	Mohr-Coulomb	0	22
Sand Foundation		120	Mohr-Coulomb	0	30
Brine		65	No strength		



NewFields

SLIDEINTERPRET 6.029

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS		
Analysis Description	CROSS SECTION B - STATIC CIRCULAR		
Drawn By	RJB	Company	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015	File Name	CROSS SECTION B circular static.slim

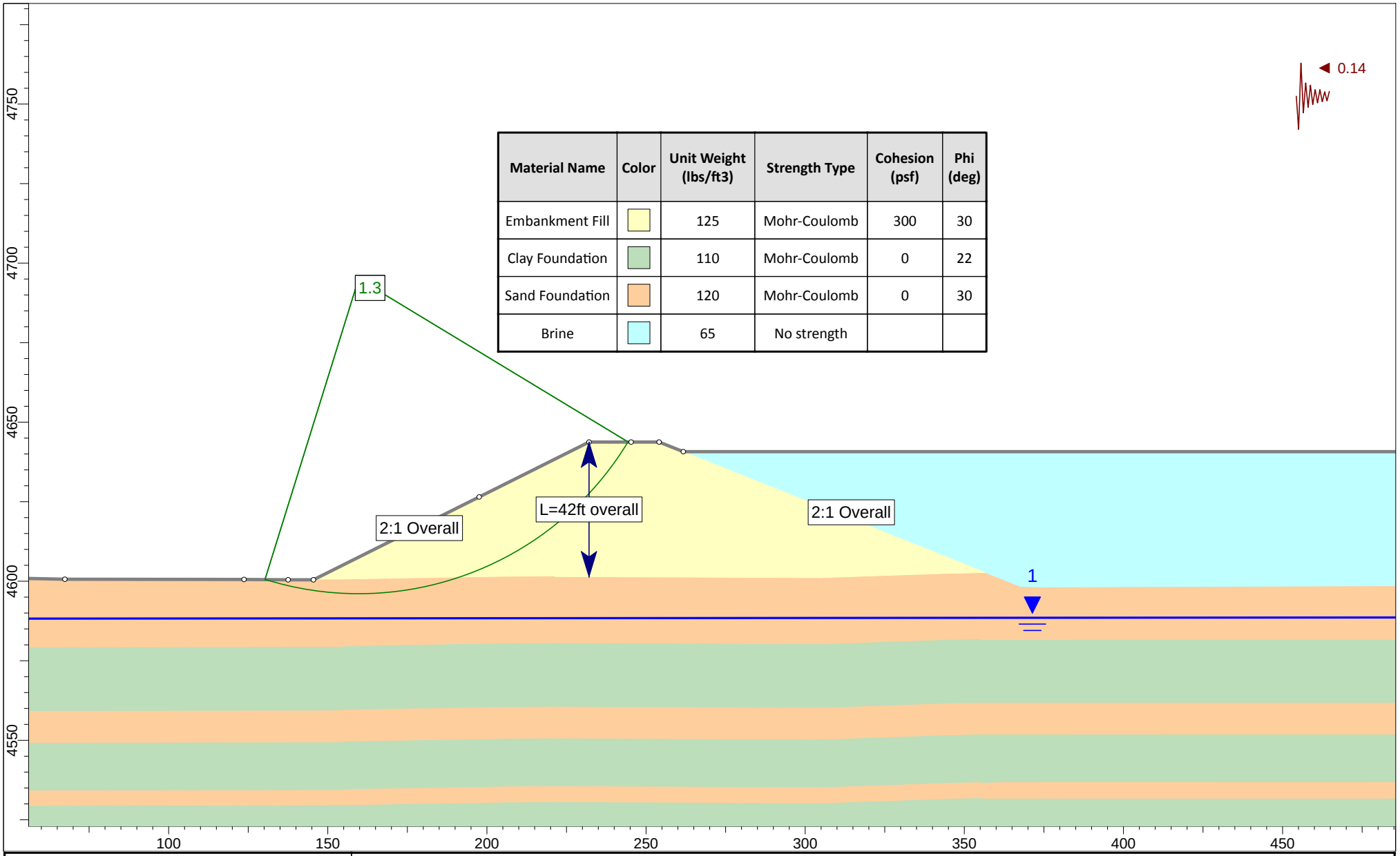


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		125	Mohr-Coulomb	300	30
Clay Foundation		110	Mohr-Coulomb	0	22
Sand Foundation		120	Mohr-Coulomb	0	30
Brine		65	No strength		

NewFields

SLIDEINTERPRET 6.029

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS		
Analysis Description	CROSS SECTION B - OBE PSEUDO-STATIC CIRCULAR		
Drawn By	RJB	*Company*	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015	*File Name*	CROSS SECTION B circular Pseudo OBE.slim



NewFields

Project	SAWTOOTH BRINE POND 2 STABILITY ANALYSIS
Analysis Description	CROSS SECTION B - MCE PSEUDO-STATIC CIRCULAR
Drawn By	RJB
Company	MAGNUM DEVELOPMENT SOLUTION MINING
Date	3/31/2015
File Name	CROSS SECTION B circular Pseudo MCE.slim

SLIDEINTERPRET 6.029

APPENDIX G – CONSTRUCTION QUALITY CONTROL/CONSTRUCTION QUALITY ASSURANCE (CQC/CQA) PLAN

PREPARED BY HANSEN, ALLEN & LUCE, INC.

MAGNUM NGLs

CONSTRUCTION QUALITY CONTROL CONSTRUCTION QUALITY ASSURANCE (CQC/CQA) PLAN

FOR CONSTRUCTION OF BRINE PONDS

HAL Project No.: 345.03.102

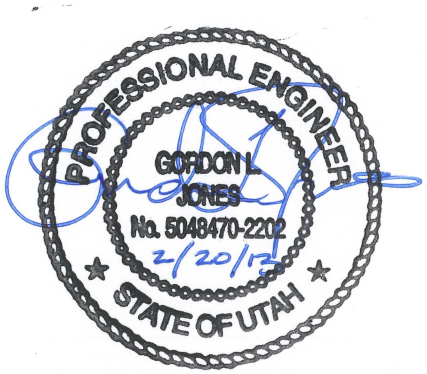
February 2013

HANSEN ALLEN & LUCE inc
ENGINEERS

MAGNUM

CONSTRUCTION QUALITY CONTROL / CONSTRUCTION QUALITY ASSURANCE (CQC/CQA) PLAN

FOR CONSTRUCTION OF BRINE PONDS



Project Engineer

Prepared by:

Hansen, Allen & Luce, INC.
Consulting Engineers
6771 South 900 East
Midvale, Utah 84047

February 2013

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TABLES

FIGURES

APPENDICES

I. INTRODUCTION

Magnum NGLs, L.L.C. (Magnum) has developed this Construction Quality Control / Construction Quality Assurance (CQC/CQA) Plan to ensure that its NGLs project with its accompanying brine ponds complies with the applicable EPA and Utah Department of Water Quality (UDWQ) regulations and demonstrates that the regulatory requirements for the construction impoundment structures, including the inspection of liners, will be met. The plan is intended as a reference for both construction and regulatory personnel. The plan first discusses the project organization, responsibilities, and authority of the various personnel involved. It describes the qualifications of personnel involved in the administration and implementation of the CQA Plan. The inspection activities associated with the project are defined. It discusses meetings that should be held during the project. Finally, the plan details the documentation required to provide evidence of adherence to this plan.

The professional work and good judgment of each contractor and each employee, supplemented by strong management commitment and resources, is essential to maintaining the expected quality of construction. This CQC/CQA Plan is accepted by management of Magnum as their standard for brine pond construction. All employees shall adhere to its provisions and are encouraged to report all issues of non-conformance or of conditions affecting quality.

The process of continuous quality improvement leads to the development of a better and more responsive CQC/CQA Plan. Lessons learned from each aspect of construction, operation, and technological evaluations and updates should be used to augment or enhance Magnumôs CQC/CQAS Plan. Contractors and consultants are empowered to perform to the best of their abilities and are encouraged to identify opportunities for improvement, problems, and to offer solutions to problems. Magnum management seeks continuous quality improvement and encourages and supports meeting or exceeding the expectations of customers and regulatory agencies whenever possible.

II. ORGANIZATION, RESPONSIBILITY, AND AUTHORITY

Magnum NGLs, L.L.C. (Magnum) will be the operator of the brine ponds at their facility. As such, it recognizes that it is ultimately responsible for the design, construction, and operation of the facilities at the site. Magnum recognizes that it is responsible for complying with the requirements of the permitting agency in these activities, including providing high quality CQC/CQA that provides the proper documentation that the facility was constructed as specified in the CQC/CQA Plan. Magnum has the authority and responsibility to determine what individuals or organizations will be responsible for the design, CQA, and construction activities. Magnum also has the authority and responsibility for determining the organizational structure for these activities.

Organization and Authority

Magnum has assigned the above indicated responsibilities of overseeing all activities associated with the design and construction of their brine ponds, with specific emphasis to the CQA program, to the Project Manager. The organizational structure for the CQA program is illustrated in Figure 1. As illustrated in Figure 1, the Project Manager is ultimately responsible for all activities associated with the successful construction of the brine ponds. The construction quality assurance has been organized so that all individuals involved in construction will ultimately report to the CQA Officer, who will report to the Project Manager.

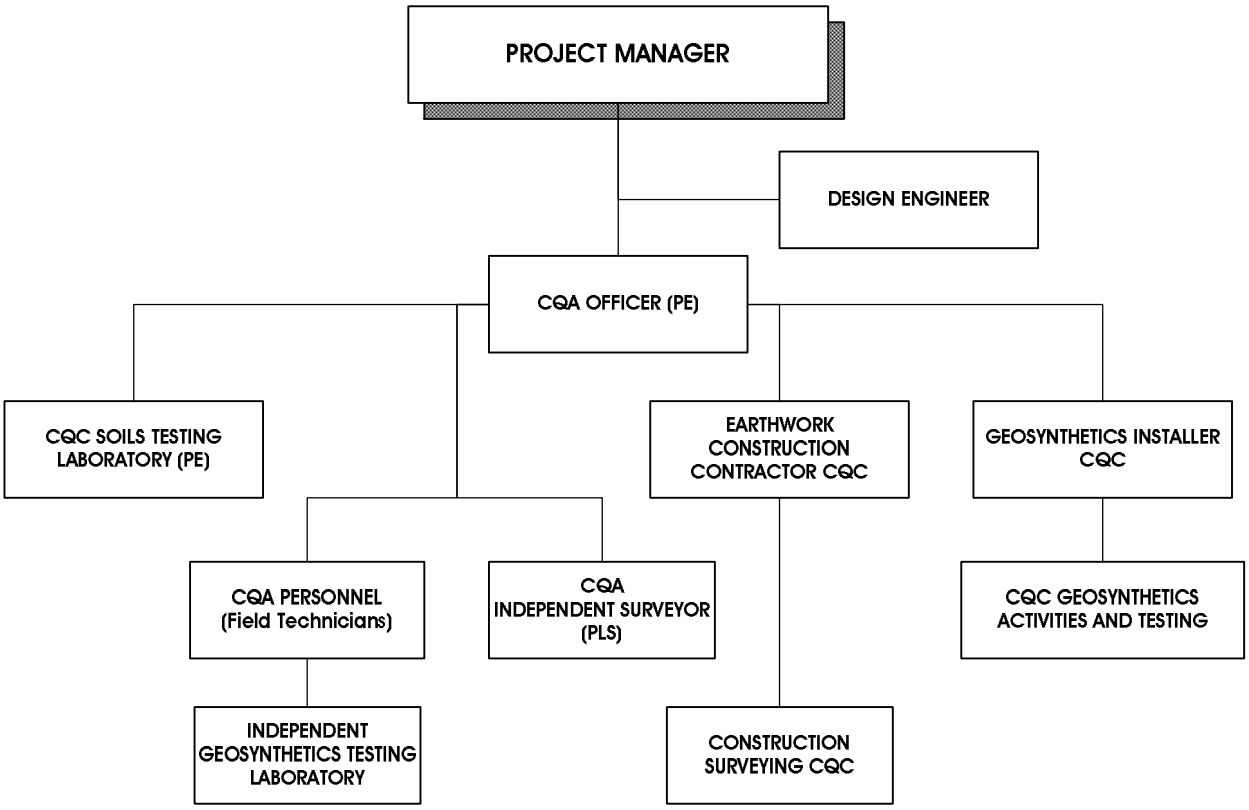
The implementation of the CQA Plan occurs through the CQA Officer. The Construction Quality Control (CQC) personnel will function independently of the CQA personnel and will be responsible for ensuring that the work items associated with the ponds are constructed in accordance with the plans and the specifications defined herein. CQC personnel will be responsible for conducting the various tests and observations within their assigned areas as specified in the CQA Plan, for documenting those tests, and for reporting and reviewing the test results with the CQA personnel.

CQA personnel will ensure that all observation and testing activities required to ensure compliance with the plans and the specifications are being carried out by CQC personnel. CQA personnel will ensure that the designated frequency of testing is being accomplished and that all aspects of the CQA Plan are being carried out. The primary responsibility of the CQA personnel will be to review the documentation prepared and/or obtained by the CQC personnel, as defined herein. The review of documentation by the CQA personnel will also include field observation of activities associated with the CQA Plan at the frequencies specified herein to ensure that the CQA Plan is being executed properly.

Responsibilities

The specific responsibilities of the various individuals or entities presented in the organizational chart of Figure 1 are presented on the following page.

FIGURE 1
CQA PROGRAM ORGANIZATIONAL STRUCTURE



Project Manager

As indicated, the Project Manager has the responsibility for overseeing all aspects associated with the design and construction of the brine ponds at the Western Energy Hub. The Project Manager assumes the responsibilities of the facility owner.

The specific responsibilities of the Project Manager include:

1. Ultimately responsible for successful design and construction of the brine ponds and for selecting and dismissing organizations or individuals charged with design, construction, CQC and CQA activities.

2. Oversee CQC and CQA activities.

CQA Officer

The Project Manager assigns the CQA Officer the specific responsibility of overseeing the construction quality assurance aspects of the project. The CQA Officer coordinates aspects of the CQA Plan with the Project Manager. In the absence of the CQA Officer from the work site, the duties and responsibilities of the CQA Officer shall be delegated to one of the CQA personnel. The CQA Officer shall have the following qualifications:

- Licensed Professional Engineer in the State of Utah
- 10 years of experience.
- Two years of similar project construction observation and management experience.

The specific responsibilities of the CQA Officer include:

1. Report directly to the Project Manager.
2. Interaction with CQC Personnel.
3. Review soils and geosynthetic materials testing documentation completeness.
4. Review of Surveying documentation.
5. Periodic site visits during the brine pond construction.
6. Responsible for activities of CQA personnel. CQA personnel will not be on-site during the earthwork construction other than periodic site visits by the CQA Officer. CQA personnel will be on-site during geosynthetics installation.
7. Verify that the CQC personnel are completing and properly documenting all on-site observations and tests required to ensure compliance with the CQA Plan. This is accomplished by verifying that CQA personnel are reviewing and approving, on a daily basis, the results of on-site observations and testing completed by the CQC personnel and that CQA personnel are satisfied that testing and observations are in accordance with the CQA Plan.
8. Review, coordinate, and approve CQA activities to ensure that testing and documentation are complete and accurate (as specified in Table 1 and Appendix A)
9. Oversee preparation of the final construction report at the completion of the project, which will be a compilation of all of the daily reports generated during the course of construction, as well as a summary report of all CQC and CQA activities.

Design Engineer

The responsibilities of the Design Engineer include those design activities which occur during the construction of the project. The specific responsibilities include the following:

1. Review and approve minor design changes to the brine ponds to meet the operational requirements of the owner and the permitting requirements of the agencies.

2. Coordinate design changes with the CQA Officer.

3. Approve corrective measures to be implemented where deviation occurs during construction from the design.

The Design Engineer has authority to work within the framework of the design and CQA Plan. The Design Engineer does not have the authority to make any decisions that would alter the design and the CQA Plan for the facility without the express approval of the CQA Officer (refer to Section V ï Minor Design Change Procedures) and the regulatory agency (UDWQ and UDWRi), where applicable.

Earthwork Contractor

The Earthwork Contractor will have the following qualifications:

- Licensed as a General Contractor in the State of Utah.

Specific responsibilities of the Earthwork Contractor with regard to CQC are as follows:

1. Facilitate CQC activities associated with earthwork construction.

2. Report to the Project Manager.

3. Ensure that all construction activities performed by the Earthwork Contractor and all Sub-contractors is in accordance with the project specifications and the CQA/CQC Plan.

4. Facilitate all testing required to ensure compliance with project specifications.

5. Provide for grade control and construction surveying beyond site survey controls provided.

6. Ensure that all regulatory requirements associated with construction activities and the construction contract are met.

7. Obtain all required environmental and safety permits required by regulations (including but not limited to dust control, storm water pollution prevention, health and safety, etc.)

Construction Quality Assurance (CQA) Personnel

The Construction Quality Assurance (CQA) personnel will work under the direction of the CQA Officer to ensure that the CQA Plan is executed properly. The CQA personnel will ensure that all observation and testing activities required to ensure compliance with the CQA Plan are being carried out by the CQC personnel. The authority of the CQA personnel will be limited to the performance of observation and documentation requirements of the CQA Plan. The CQA personnel will not have the authority to modify in any way the design or requirements of the CQA Plan. The CQA personnel will have authority to stop work as per the directive of the CQA Officer. Specific responsibilities of the CQA personnel include the following:

1. Conduct all reviews and observations defined in the CQA Plan that have been established as measures to determine the effectiveness of all testing, observations, and controls conducted or established to ensure a quality outcome for the construction of the cells and closure caps. This includes daily reviews of the results of all testing and observations conducted by CQC personnel as defined herein. It includes additional observations required to be conducted by CQA personnel directly to ensure compliance of the CQC personnel with testing and observation requirements.

2. Verify that the equipment used in testing has been calibrated.

3. Ensure that all required testing is conducted in accordance with the CQA Plan.

4. Report to the CQC personnel immediately the results of observations and tests that fail to meet the CQA Plan.

5. Verify that corrective action has been taken (where required) and recorded on the daily construction reports.

6. Prepare and assemble the required documentation of the results of on-site observations, testing, and reviews conducted by CQC and CQA personnel.

7. Provide the results of on-site observations, testing, and documentation of the work in progress to the CQA Officer.

Geosynthetics Installer Contractor

The Earthwork Contractor will have the qualifications set forth in the CQA/CQC Plan (Table 1).

The geosynthetics installer will provide CQC according to the following:

1. Perform all CQC activities defined in this CQA/CQC Plan for geosythetics installation.

2. Report to the Project Manager and interaction with the CQA Officer and CQA personnel.

3. Provide all submittals regarding qualifications, personnel, materials, etc. required by the specifications and this CQA/CQC Plan to the CQA Officer.

4. Provide all documentation and required testing associated with installation of geosynthetic materials as defined in this CQA/CQC Plan. Document the results of all required testing and submit the documentation to the CQA Officer.

Independent Geosynthetics Testing Laboratory (CQA)

The independent geosynthetics testing laboratory will provide CQA according to the following:

1. Perform all CQA activities defined in this CQA/CQC Plan for independent geosythetics testing.

2. Report to the CQA Officer and Project Manager.

3. Provide testing of geosynthetic materials required of the independent geosynthetics testing laboratory as defined in this CQA/CQC Plan. Document the results of all required testing and submit the documentation to the CQA Officer.

Soils Testing Laboratory (CQC)

The soils testing laboratory will provide CQC and will have the following qualifications:

- Necessary equipment and personnel to conduct required testing.

- Licensed Professional Engineer in the State of Utah in charge of all testing activities.

The soils testing laboratory will provide CQC testing according to the following:

1. Report to the Project Manager and interaction with the CQA Officer for field CQC testing of soils.

2. Provide all documentation and required testing associated with soils placement as defined in this CQA/CQC Plan and in the specifications. Document the results of all required testing and submit the documentation to the CQA Officer.

3. Prepare and submit a report to the CQA Officer certifying the results of all materials testing performed by the Soils Testing Laboratory. Provide a Professional

Engineer seal on the certification report by the Professional Engineer responsible for soils testing activities certification report.

Independent Survey (CQA)

The surveyor will provide CQA and will have the following qualifications:

- Necessary equipment and personnel to conduct required survey.
- Registered Land Surveyor in the State of Utah.

The surveyor will provide CQA survey according to the following:

1. Report to the Project Manager and the CQA Officer.
2. Provide surveying if requested by the CQA Officer to document grade controls and grading tolerances from design lines and grades.
3. Provide certification of all survey documentation.

III. PROJECT MEETINGS

Meetings should be held during the project to enhance communications between personnel responsible for design, inspection, and construction of the project. These meetings will include a pre-construction CQA meeting and weekly construction/CQA meetings.

Pre-Construction CQA Meeting

Pre-construction CQA meetings should be held prior to the commencement of soils-related construction activities and geosynthetics-related installation activities for the project. Those to attend should include the Project Manager, CQA Officer, CQC and CQA personnel, and the earthwork construction contractor and liner installation contractor, as appropriate. Copies of the CQA Plan should be distributed to the above indicated parties prior to the pre-construction CQA meeting. Minutes of the meeting should be prepared and transmitted to all personnel in attendance. The CQA Officer should notify the UDWQ and UDWRi of the proposed pre-construction meeting date. Items to be discussed in this meeting should include, but not be limited to:

1. Familiarizing each organization with the CQA Plan and their role relative to the CQA Plan.

2. Reviewing the responsibilities, lines of authority, and communication of each organization.

3. Discussing the procedures for observations and testing (as specified in Table 1 and Appendix A).

4. Discussing procedures for handling construction deficiencies, repairs, and retesting.

5. Reviewing methods for reporting and documenting testing and inspection activities.

6. Reviewing methods for distributing and storing documents and reports.

7. Identifying work areas and equipment and materials storage areas.

8. Identifying required submittals for the project.

9. Discussing procedures employed by soils contractor and/or geosynthetics installer to train operators and/or technicians to provide a quality work product.

Weekly Construction/CQA Meetings

Meetings should be held approximately once per week to discuss the progress of the project during both earthwork construction and liner installation. Those to attend should include the CQA Officer, a representative of the CQC personnel, a representative of the CQA personnel, and a representative of the contractor (as needed). When earthwork and liner installation are

happening at the site simultaneously then the weekly meeting will combine CQA and construction update discussions for both earthwork and liner installation. Additional meetings can be called by the CQA Officer to address critical problems. Items to be discussed in this meeting should include, but not be limited to:

1. Discussing the CQC, CQA, and construction activities and accomplishments of the previous week.

2. Exchanging, reviewing, and discussing required documentation of construction, observation, and testing activities.

3. Defining and discussing problems or deficiencies associated with the work and CQC and CQA activities. Documenting problems or deficiencies discussed in the CQC file.

4. Reviewing alternative solutions.

5. Implementing corrective actions to resolve problems or deficiencies.

CQA personnel should prepare minutes of the meeting for distribution to all attending parties.

IV. INSPECTION ACTIVITIES

This section of the CQA Plan describes the inspection activities (observations and tests) that will be performed by the CQC and CQA personnel during the construction and installation of the work elements associated with the project.

Table 1 provides the specific requirements of the CQC/CQA Plan for the pond construction for both the earthwork and the liner installation and includes the major work elements that comprise the project; the specifications governing each work element; the CQC activities to be performed in a timely manner to ensure a quality outcome of each work element; and the CQA activities to be performed in a timely manner to determine and ensure the effectiveness of the CQC activities. Table 1 identifies the observations and tests to be conducted by the CQC and CQA personnel, the frequency of observations and tests, the acceptance/rejection criteria that will be used in the evaluation of the tests, and how the observations and tests are to be recorded and documented. Table 1 may also refer to tests and frequencies located in the technical specifications for the project.

Measuring and testing equipment (M&T) used for critical items of construction must be controlled in order to ensure the quality outcome of the project. M&T equipment used for critical items of construction include the nuclear gage, scales, sealed single ring infiltrometer used by the CQC personnel associated with the testing of the soils related aspects of the project, surveying equipment used by the surveyor in checking and controlling construction grades, pressure gages used in the non-destructive testing of the HDPE liner welds and tensiometers, for peel and shear tests of HDPE welds. The M&T equipment is provided to the project by the firm that provides the CQC services. This equipment is to be calibrated annually at a minimum. At the beginning of the project, the CQC firm will provide the CQA personnel with documentation confirming that the equipment has been calibrated. This documentation will be included in the construction documentation report at the completion of construction of the project.

V. MINOR DESIGN CHANGE PROCEDURES FOR EITHER EARTHWORK OR LINER

This section describes the procedure for initiating and approving minor changes in a timely manner necessary to maintain or enhance quality during construction. As the need for minor changes occurs, they must be controlled by both Magnum and by the regulatory agency. A minor change can be defined as changes that do not decrease the environmental protection or stability of the unit (minor changes will not include decreasing the number or thickness of liners, changing lining requirements, providing steeper sideslopes, etc.).

Mutual agreement between the regulatory authority and Magnum as to the proposed change will normally occur prior to submission of supporting documentation to the regulatory agency for processing. The following procedures will be applicable:

1. The need for a design change, engineering, or construction changes may become apparent during the course of construction of the project and a request for a change may be initiated by any individual associated with the project.

2. All proposed design engineering and construction changes will be reviewed and approved by the Design Engineer and the Project Manager. If approved, the Project Manager will provide documentation to the CQA Officer indicating that the proposed change(s) will meet the minimum quality requirements of the project.

3. The Project Manager will review and approve or disapprove the proposed change(s) based on the documentation and recommendation of the Design Engineer.

4. If the Project Manager approves the proposed change(s), verbal notification of the proposal should be made to the Utah Department of Water Quality (UDWQ) and Utah Division of Water Rights (UDWRi). The scope of the proposal will be discussed to obtain a mutual understanding and agreement as to the proper type of change action.

5. All documentation submitted to the agencies regarding change(s) will be included in the construction documentation report. Record Drawing details of the project will be prepared that will reflect approved changes.

VI. DOCUMENTATION

Documentation of construction and inspection activities associated with the CQA Plan will consist of daily recordkeeping and a final report to be prepared under the direction of the CQA Officer. Daily reporting procedures associated with the CQC and CQA activities are described based on specific work elements in Table 1 of the CQC and CQA activities section and are to be performed in a timely manner.

The results of testing and observations as recorded on the daily construction reports will be reviewed and accepted by the CQA Officer or his designee. Acceptance of the daily construction reports will consist of either counter-signing the forms directly or having one of the CQA personnel sign the forms indicating that they have been reviewed and accepted on behalf of the CQA Officer. During the construction of the facility, the CQA Officer will be responsible for maintaining and storing the originals or copies of all data sheets and reports that are generated in carrying out the CQA Plan as identified herein. The Project Manager will review and approve of the construction reports and documentation at appropriate intervals as the project progresses.

Results of all material tests and daily inspection reports will be submitted to the UDWRi on a weekly basis during the construction phase.

The CQA Officer will direct the preparation of a final construction documentation report at the completion of the project. This report will contain all of the documentation associated with the daily reporting procedures, as well as the following summary reports:

1. CQA Report
2. Soils Report ï Completed by CQC Soils Testing Laboratory
3. Synthetic Liner Report ï Completed by the Geosynthetics Installer Contractor
4. "Record" Drawings

The CQA report will provide a summary of CQA activities and will demonstrate that the construction satisfied the CQA Plan and applicable State and Federal regulations. The CQA report will provide an evaluation of the degree of reconciliation between non-conforming work and the specifications as defined in the CQA Plan and the ability of the CQA program to meet the quality objectives of the CQA Plan.

The Soils Report will provide a summary of the soils observation and testing aspects of the construction or closure project. The report will certify that the soils portions of the pond were constructed in accordance with the CQA Plan and any field design, engineering, or construction changes made in accordance with the minor change procedures.

The Synthetic Liner Report will include a summary of the synthetic liner observation and testing aspects of the project. The report will certify that the synthetic liner portions of the pond are constructed in accordance with the CQA Plan and any field design, engineering, or construction changes made in accordance with the minor change procedures. The Synthetic Liner Report will be certified by the geosynthetics installer.

The Final Report will be reviewed and approved by the Project Manager and will be submitted to the UDWQ and UDWRi following the completion of the project. The CQA Officer must certify that the CQA Plan has been successfully carried out.

TABLE 1 ï BRINE POND CONSTRUCTION INSPECTION ACTIVITIES

EARTHWORKS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
	Review geotechnical investigation report to become familiar with the expected site conditions.	Review geotechnical investigation report to become familiar with the expected site conditions.
CLEARING & STRIPPING: Remove all organic and objectionable materials to the limits shown on the Drawings or as required by the Engineer. Stripping is defined as the removal of topsoil, which shall be defined as soil of any gradation or degree of plasticity that contains significant quantities of visually identifiable plant matter, sod, roots, or humus as determined by the engineer. Prior to any surface treatment on a stripped area notify CQC so that inspection of area may be completed.	Observe and document the clearing and stripping operation. Ensure soft and yielding spots are corrected by drying and recompacting the material or are removed and disposed of as directed by the CQA Officer. Ensure material so removed is replaced with a suitable material and is compacted to the density requirements. Provide daily observation until task is completed. Record observations and corrective actions taken on "Daily Construction Reports". Provide CQA personnel with copies of "Daily Construction Reports" and obtain their signature on reports indicating acceptance. Ensure that corrective actions required by CQA personnel are accomplished.	Observe area when task is complete. Review daily reports generated by CQC personnel. Report deficiencies to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Construction Reports". Record findings of observations, review, and actions taken.
GRADING/EMBANKMENT FOUNDATION PREPARATION: Grade all work areas according to the limits shown on the drawings and as described in the technical specifications. All standards laid out in technical specifications are to be met. Areas of unsuitable material shall be excavated to the limits designated by CQC and replaced with compacted random fill. No fill material shall be placed on the foundation without prior approval of the State Engineer. Arrangements to place such fill shall be made with the State Engineerôs personnel sufficiently in advance to avoid construction delays. Any conditions that differ appreciably from those assumed during design must be reported to the State Engineer before work continues.	Ensure sub-grade is prepared according to technical specifications. Conduct in-place moisture and density tests. Testing is to be conducted at the frequency and using applicable methods as indicated in technical specifications. The location of the tests shall be chosen on a random basis. 1. Approve areas with tests indicating a density ≥ 95.0% 2. Approve areas with moisture contents from minus (-) 2.0% to plus (+) 2.0%. 3. Identify each area that does not meet compaction criteria and verify the area is brought into compliance via the contractor reworking the area. 4. Retest areas reworked and approve areas meeting criteria of "1" above. 5. Continue reworking and retesting until the area meets criteria of "1" above. 6. Record all results and corrective actions taken on "Daily Construction Reportsò 7. Provide CQA personnel with copies of the "Daily Construction Reports" and obtain their signature on Reports indicating acceptance. 8. Ensure that corrective actions required by CQA personnel are accomplished. Ensure that areas of unsuitable material as defined in technical specification are removed.	Review density test results recorded on ñDaily Construction Reportsò 1. Verify frequency of tests. 2. Verify that compaction in areas accepted is at least 95.0%. 3. Verify that the moisture content in areas accepted is within the range of minus (-) 2.0% to plus (+) 2.0% of the optimum moisture content. Report deficiencies to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Construction Reportsò Record findings of observations, review, and actions taken. Send the results of all material tests and daily inspection reports to the UDWRi on a weekly basis and to UDWQ as requested.

TABLE 1 ï BRINE POND CONSTRUCTION INSPECTION ACTIVITIES

EARTHWORKS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
EXCAVATIONS AND BORROWS: Remove vegetation, debris, organic, or deleterious material from excavation and borrow areas and other activities as stated in technical specifications. If historical resources such as human remains (skeletons), prehistoric arrowheads/spear points, waste flakes from stone tool production, pottery, ancient fire pits, historical building foundations/remains, artifacts (glass, ceramic, metal, etc.) are found, call the Utah Division of State History at (801) 533-3555.	Observe excavation and borrow areas once they has been cleared and grubbed. Record observations and corrective actions taken on "Daily Construction Reports". Provide CQA personnel copies of "Daily Construction Reports" and obtain their signature on reports indicating acceptance. Ensure that corrective actions required by CQA personnel are accomplished. Observe that no historical resources are found.	Observe excavation and borrow areas when task is complete. Review daily reports generated by CQC personnel. Report deficiencies to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Construction Reports." Record findings of observations, review, and actions taken.
EMBANKMENT AND BACKFILL: Embankment and backfill material will be placed with heavy construction equipment and will be compacted to at least 95% of the Standard Proctor density as determined by ASTM D-698 with a moisture content of minus (-) 2.0% to plus (+) 2.0% of the optimum moisture content. Material compacted with hand operated tampers will be compacted to 95% of the maximum dry density as determined by ASTM-D-698 with a moisture content of minus (-) 2.0% to plus (+) 2.0% of the optimum moisture content.	Conduct in-place moisture and density tests. Testing is to be conducted using applicable methods and at a frequency indicated in the technical specifications. The location of the test site shall be chosen on a random basis. 1. Approve areas with tests indicating a density 95.0%. Approve areas with moisture content from minus (-) 2.0% to plus (+) 2.0% of the optimum moisture content. 2. Identify each area that does not meet compaction criteria and verify that the area is brought into compliance via the contractor reworking the area or by removing and replacing the material. 3. Retest areas reworked or for which material was removed and replaced, and approve areas meeting criteria of "1" above. 4. Continue "2" and "3" until the area meets criteria of "1" above. 5. Record all results and corrective actions taken on "Daily Construction Reportsò 6. Provide CQA personnel with copies of the "Daily Construction Reportsò and obtain their signature on reports indicating acceptance. 7. Ensure that corrective actions required by CQA personnel are accomplished.	Review density test results recorded on the ñDaily Construction Reportsò 1. Verify frequency of tests. 2. Verify that compaction in areas accepted is 95.0%. Verify that the moisture content in areas accepted is (-) 2.0% to plus (+) 2.0% of the optimum moisture content. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Observation and Testing" reports. Record findings of observations, review, and actions taken. Send the results of all material tests and daily inspection reports to the UDWRi on a weekly basis and to UDWQ as requested.
PLACEMENT: Backfill and fill shall be placed in uniform lifts. A lift is defined as 8 inches or less in loose depth for material compacted by heavy compaction equipment, and 4 inches or less in loose depth for material compacted by hand-operated tampers. In anchor trenches, the first lift shall be placed not more than 12 inches in loose depth with subsequent lifts placed 4 inches in loose depth. Where backfill is placed around pipes, the first lift will be	Observe material as it is placed. Record observations and corrective actions taken in "Daily Construction Reports" throughout fill placement. Provide CQA personnel with copies of the "Daily Construction Reports" and obtain their signature on reports indicating acceptance. Ensure that corrective actions required by CQA personnel are accomplished.	Review daily reports generated by CQC personnel. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Construction Reports." Record findings of observations, review, and actions taken.

EARTHWORKS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
placed to a depth slightly higher than the spring-line of the pipe, to prevent displacement of the pipe. If the ambient air temperature is less than 32 degrees Fahrenheit for more than 2 hours over the preceding 24 hours the temperature of any fill materials being placed must be measured to determine if fill is frozen. The contractor may either remove and replace frozen fill or wait until subsequent temperature monitoring indicates the fill is unfrozen, prior to placing additional materials.	Ensure fill is not frozen my measuring the temperature of in-place fill according to technical specifications. Construction may not continue without corrective action. Record observations and corrective actions taken in "Daily Construction Reports." Provide CQA personnel with copies of the "Daily Construction Reports" and obtain their signature on reports indicating acceptance. Ensure that corrective actions required by CQA personnel are accomplished.	
GRADING: In-place embankment materials and natural soils shall be fine graded to the designed elevation and typical sections. Acceptable grading tolerance limits for finished embankment surfaces shall be as follows: 1. Finish grades and slopes for the embankment and basin shall be in general conformance with the Drawings. Deviations from finished grades/slopes are subject to approval by CQC and shall not result in low spots; pockets; non-uniform slopes or contours; or result in slopes which deviate by more than 1% from the design; or result in slopes of less than 0.5% within the basin. 2. The maximum permissible combined horizontal and vertical deviation of the perimeter boundaries of the embankment from the lines and grades shown on the Drawings or as required by CQC shall be 36 inches 3. The finished surface of the basin prepared surface shall not deviate vertically by more than 4 inches than the lines and grades shown on the drawings. 4. The elevation and width of the embankment crest shall not be less than the dimensions shown on the Drawings or required by CQC.	Review certified record survey for compliance to CQA Plan. Document results in ñDaily Construction Reportò	Ensure a licensed surveyor conducts survey at completion. Survey points will be on at least a 50 foot grid and at all control points. Surveyor shall indicate where the embankment meets the design line and grade. Deficiencies shall be reported to the CQC personnel. Once corrective action has been taken the deficient area will be re-surveyed to verify line and grade. Final survey measurement will be documented, certified, and provided to the design engineer and the CQA Officer. Review final survey data. Verify the frequency of survey measuring points. Verify that the surveyor certified that the construction is to the specified line and grade. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Record findings of observations, review, and actions taken.
ANCHOR TRENCH: The anchor trenches shall be completed in accordance with the drawings. Smooth out or cushion rough areas of the trench prior to placement of the geomembrane in the trench. The geomembrane shall be seamed or welded through the bottom of the anchor trench. Acceptable backfill shall be select native clay and	Periodically inspect backfill materials, welding of geomembrane in anchor trench, & lift thickness. Test primary anchor trench backfill for density and moisture content at a rate of one test per 200 feet of trench per lift of backfill.	Observe and document that welding of geomembrane materials in the anchor trench is completed as specified.

TABLE 1 ï BRINE POND CONSTRUCTION INSPECTION ACTIVITIES

EARTHWORKS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
silt materials and shall not consist of sand or other coarse grained materials. The backfill shall be placed in an initial twelve inch lose lift. Subsequent lifts shall be six loose inches. The backfill will be placed and compacted to Ó 95% of the maximum dry density by ASTM D-698		

TABLE 1 ï BRINE POND CONSTRUCTION INSPECTION ACTIVITIES

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
REQUIREMENTS PRIOR TO LINER PLACEMENT: Prior to geomembrane installation, the liner manufacturer and installer contractor shall provide the CQA and CQC personnel: 1. Quality Control Certificates: Each roll of liner must have a unique identification number, an indication of thickness, length, width, and manufacturerôs name. A QC certificate must be provided for every 25,000 square feet of material manufactured consecutively. A certificate will be provided for each roll that was not produced consecutively. If liner certificates indicate material does not meet the specifications defined in the Technical Specifications, the material is to be marked conspicuously and removed from the construction area. 2. Polymer Raw Material Certificates: The liner manufacturer is to supply certification that the resin meets the density specification defined in the Technical Specifications and that it is all from the same manufacturer. 3. Welding Rod Certification: The welding rod manufacturer is to provide certification that the rod is of the same polymer as the sheet and from the same manufacturer. 4. Résumé of Installation Supervisor: Installation supervisor is to have prior experience supervising installation of a minimum of ten (10) million square feet of liner. 5. Installerôs Quality Control Manual.	Review installerôs Quality Control Manual to ensure adherence to the stricter of the guidelines between the installerôs manual and the Engineers Technical Specifications. Review required submittals for compliance with specifications. Rolls of liner not meeting specifications are to be marked conspicuously and moved to a location designated by the CQA personnel. Rolls of liner shall not be deployed until approval has been received from the CQA personnel indicating that the rolls meet specifications. Submit a copy of the installerôs Quality Control Manual to the Engineer and to CQA personnel.	Review installerôs Quality Control Manual to ensure adherence to the stricter of the guidelines between the installerôs manual and the Engineers Technical Specifications. The Lead technician over CQA personnel shall have a minimum of 10,000,000 square feet of geosynthetics CQA experience. Receive, review, and approve required submittals prior to allowing liner to be deployed in landfill. Review the results of the required submittals with the CQA Officer. 1. Document roll numbers and quality control certificates received. Note any rolls not meeting specifications and document that roll was removed from the construction area. 2. Document the polymer raw material certificates received and the package number of the polymer raw material certificates with corresponding roll numbers to which it pertains. 3. Ensure that the welding rod certification is received and included in the documentation record. 4. Provide documentation to CQC personnel noting which rolls of liner were approved and installation supervisors and master welders that have been approved.
GEOMEMBRANE LINER SUBSURFACE PREPARATION: The surfaces on which the HDPE liner is to be placed is to be free of sharp particles, rocks, or other debris that might damage the overlying geosynthetics. Sharp objects shall be removed by raking, sweeping or handpicking as necessary. No standing water shall be allowed.	Activities identifying the requirements for surveying to check grades of the surfaces are identified under the earthwork section of this table. In addition to these requirements, CQC personnel and the liner contractor are to observe the surface which will form the subgrade. The contractor is to certify in writing that the surface on which the HDPE liner is to be installed is acceptable.	Activities regarding grading are identified under the earthwork section of this table. Observe the subgrade for the HDPE liners with the CQC personnel and the liner contractor. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on CQC "Daily Construction Reports." Countersign "Daily Construction

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
	Record observations and corrective actions taken on the "Daily Construction Reports." Provide CQA personnel with copies of the "Daily Construction Reports" and obtain their signature on reports indicating acceptance. Verify that corrective actions required by CQA personnel are accomplished.	Reports" indicating documentation is adequate, correct, and has been accepted by CQA. Record findings of observations, reviews, and action taken.
HANDLING OF GEOMEMBRANE LINER: HDPE liner shall be labeled with manufacturer, thickness, and roll number prior to shipment to the site. When transported to the site, the HDPE liner shall be handled by appropriate means so that no damage is caused to the liner. Transportation to the site shall be the responsibility of the installer. On-site unloading, storage, and handling are the responsibilities of the installer. Liner materials shall be stored in a location away from possible sources of deterioration. Appropriate handling equipment shall be used to move HDPE liner. The liner shall not be dragged on the ground. Persons walking or working on the geomembrane shall not engage in activities or wear shoes that could damage the geomembrane liner.	Review HDPE liner rolls to ensure that they are labeled according to the specifications. Ensure HDPE liner is handled according to specifications.	Note any rolls not labeled properly and have them removed from the construction area. Observe and document that the HDPE rolls are handled according to the specifications.
GEOMEMBRANE LINER PLACEMENT: Prior to installation, the liner contractor shall present to the CQA Officer a liner placement plan. The plan shall indicate the panel configuration and location of seams. Seams shall be oriented parallel to the line of the maximum slope. Seams placed in high stress areas will be minimized (i.e., cell corners, parallel with the top of the embankment, or at the toe of the side slopes). No seams shall be placed parallel to and within 10 feet of the toe of the slope. The installer shall take into account that frequent high winds may result in delays. The installer shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the geomembrane liner has been permanently anchored. Fusion of panels and repairs will only be permitted under weather conditions allowing work that is in conformance to	Review liner placement plan and submit plan to the CQA officer for approval.	The CQA Officer is to review the liner placement plan and approve or disapprove the plan. The CQA Officer is to review and approve any modifications to the proposed layout plan during construction. Observe panel deployment and verify that the placement specification items have been met. Review the panel deployment forms for accuracy and completeness. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on the form. Record findings of review and actions taken. Countersign form indicating acceptance of documentation and accuracy and completeness of data. Include copy of executed form in CQA documents.

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
the specifications and within the warranty limits imposed by the manufacturer and to the approval of the Engineer.		
The liner is to be placed as closely as practical to the layout plan. The installer shall give each field panel an identification code number consistent with the layout plan. The record drawing will be updated to reflect any modifications to the layout plan. Care shall be exercised to not damage the HDPE liner during installation.	Observe that the liner is placed in accordance with the approved layout plan. Advise the CQA Officer of contractor-proposed modifications. Maintain a record drawing showing the placement of the panels. Document the deployment of the panels on the appropriate form.	Observe that the liner is placed in accordance with the approved layout plan. Maintain a record drawing showing the placement of the panels.
Rolls are to be inspected as they are unwound for equipment damage, holes, blisters, thin spots, undispersed raw materials, or any signs of contamination by foreign material. Note: In several instances, visual defects (such as blisters) are small enough that the repair of a visual defect may consist of placing a bead of extrudate from the extrusion welding gun over the visual defect. Welding beads placed to repair such visual defects are not considered extrusion welding and therefore do not require vacuum testing. Any form of hole or penetration through the liner must be patched with a liner cap which must be vacuum tested.	Observe the liner as the rolls are unwound for holes, blisters, thin spots, undispersed raw materials, or any signs of contamination by foreign material. Mark roll number conspicuously on the panel and then more closely inspect the panel for defects. Mark defective areas found for repair or removal. Document that defective areas were repaired.	Observe the liner as the rolls are unwound for holes, blisters, thin spots, undispersed raw materials, or any signs of contamination by foreign material. Mark roll number conspicuously on the panel and then more closely inspect the panel for defects. Mark defective areas found for repair or removal. Document that defective areas were repaired.
WELDING: The double-wedge fusion welding process shall be used unless alternate methods are approved by the Engineer. Extrusion welding will be permitted to weld short seams, to repair small areas, where double-wedge welding is not feasible, and where test samples have been removed.	Document the type of weld, the date welded, and the welding technician for each seam on the appropriate form.	Review results recorded on CQC and CQA forms for accuracy and completeness.
No welding equipment or operator shall perform production welds until equipment and operator have successfully completed a trial weld. Trial welds shall be completed under the same surface and environmental conditions as the production welds. A minimum of two trial welds per day per welding apparatus shall be completed ï one prior to the start of work and one at mid-shift or for every 5 hours of seaming operations. Five 1-inch-wide-by-6-inch-long test strips will be cut from the trial weld and will be tested for peel adhesion and for bonded seam strength. Trial weld specimens shall pass when the results shown in Table 4 of the Geomembrane technical specifications in both peel and shear tests and the break, when peel testing, occurs by Separation in the Plane of the sheet (SIP), not through adhesion failure separation (AD) and the break is ductile. The trial weld is to be repeated in its entirety when the trial weld samples fail in either peel or	Observe pre-weld testing and record results on the appropriate form. Ensure that problems are corrected and actions taken to correct problems are recorded.	Observe pre-weld testing. Review results recorded on CQC forms for accuracy and completeness. Report deficiencies (if any) to CQC personnel and the CQA Officer and record communications. Verify that corrective action has been taken (where required) and recorded on the above form. Record findings of review and actions taken. Countersign forms indicating acceptance of documentation and accuracy and completeness of data. Include copy of executed forms in CQA documentation.

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
shear as defined on Table 4, footnote 2 of the Geomembrane technical specifications. After any second pre-weld test failure, two consecutive pre-weld samples must be made, tested, and have passing results before that particular technician/equipment combination is put into production welding. Seams shall be cleaned of dust, mud, moisture, and debris immediately ahead of welding apparatus and shall be aligned consistent with the requirements of the welding equipment being used. Overlap shall be 4 to 6-inches for double wedge welded seams and 6-inches for extrusion welded seams unless approved otherwise by the Engineer. No overlaps shall be placed parallel to and within 10 feet of the toe of the embankment. Seams must be aligned with the fewest amount of wrinkles or fishmouths.	Observe seams prior to welding to ensure compliance with the specifications.	Review results recorded on CQC and CQA forms for accuracy and completeness.
NON-DESTRUCTIVE SEAM TESTING: All production welding using the Fusion Weld method will be tested using the "Seam Air Pressure Test", while seams using the extrusion process will be tested by vacuum testing or electrostatic spark testing. Procedures for the non-destructive testing as well as procedures for repairing or patching the seams in the event of failure are presented in the technical specifications.	Perform non-destructive testing of welds. Record and document the results of the non-destructive seam testing on the appropriate form. Mark each panel with initials and date inspected at the end of each panel. Mark any area showing a defect and repaired in accordance with the applicable repair procedures.	Observe the testing performed by the CQC personnel on the seam welds. Where defective results are obtained, require and verify that the seams are repaired in accordance with the requirements presented in the technical specifications. Review daily the forms prepared by CQC personnel.
DESTRUCTIVE SEAM TESTING: Seams of the installed geomembrane shall be destructively tested including patches and repair areas in accordance with technical specifications. Destructive testing is to be accomplished by cutting a sample of a seam for the purpose of verifying conditions through field and laboratory testing. One sample of destructive testing will be cut from seams at least every 500 linear feet or part of 500 feet if the part is Ó 50 feet. The sample shall be taken by cutting perpendicular to the seams a sample approximately 36 by 12 inches. These samples shall be tested on site for peel and shear seams strength and thickness in accordance with D6392. 20% of these samples shall also be sent to an independent third party laboratory to be tested. The third party laboratory shall perform the tests required in the technical specifications.	Obtain samples for destructive testing at the intervals indicated. Pass/fail criteria will be according to GRI GM-19. Number each sample obtained and document the seam number associated with the sample, the seam length, the sample number, the sample location, etc. on the appropriate forms. Record sampling locations on the liner placement plan. Divide the sample into three approximately 12 inch x 12 inch samples, one of which is to be tested in the peel and shear modes. The other samples are to be divided between CQA personnel and the owner of the facility.	Accompany CQC personnel and designate sampling locations in accordance with required frequency. Review the forms prepared by the CQC personnel to ensure that sample numbers with corresponding information have been properly recorded. Verify that indicated locations for samples on the form correspond with locations in the field by observation and measurement. Resolve any discrepancies with CQC personnel. Archive samples (approximately 12 inches x 12 inches or portions thereof) as directed by the CQA Officer. The CQA Officer shall send 20& of destructive samples to third party laboratory for testing and review results to confirm independent testing meets specifications and confirm passing/failing results to CQC personnel.
ANCHOR TRENCH: The anchor trenches shall be completed in accordance with the drawings. Smooth out or cushion rough areas of the trench prior to placement of	Periodically inspect backfill materials, welding of geomembrane in anchor trench, & lift thickness. Test primary anchor trench backfill for density and moisture	Observe and document that welding of geomembrane materials in the anchor trench is completed as specified.

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
the geomembrane in the trench. The geomembrane shall be seamed or welded through the bottom of the anchor trench. Acceptable backfill shall be select native clay and silt materials and shall not consist of sand or other coarse grained materials. The backfill shall be placed in an initial twelve inch lose lift. Subsequent lifts shall be six loose inches. The backfill will be placed and compacted to Ó 95% of the maximum dry density by ASTM D-698	content at a rate of one test per 200 feet of trench per lift of backfill.	
REPAIR PROCEDURES: Damaged or defective geomembrane or seam areas failing a destructive or non-destructive test shall be repaired. The Installer shall be responsible for repair of damaged or defective areas. The repair method shall be decided by the installer but shall be decided agreed upon by the Engineer.	Perform non-destructive testing on the seams of all patches and caps. Where defective results are obtained, require, verify, and document that seams are repaired. Record and document observations on the appropriate form. Perform field peel and shear testing on coupons taken from the samples as indicated above. Record the results of the peel and shear testing on the appropriate form. If a sample fails the destructive testing, then the following shall be done: 1. Two coupons shall be taken from the same seam approximately 10 feet from each side of the original sample. The coupons are to be tested for peel & shear. 2. If any one of the coupons fails to meet the passing criteria, more coupons will be taken at a distance away from the failure at the discretion of the CQA personnel. The coupons are to be tested for peel & shear. 3. Item b. is to be repeated until it is determined that the extent of the defective seam has been defined. 4. When the extent of the defective seam has been defined, a regular 36" x 12" sample will be taken at the perceived end of the defect for testing. 5. Each sample hole and coupon hole shall be individually patched, then the entire length of the defective seam, including the patches, shall be capped; or each sample hole and coupon hole shall be individually patched, then the entire length of	Inspect, on a daily basis when the activity is occurring, patches and caps prior to welding to ensure that seams are clean, dry, and have adequate overlap, as per the specifications. Observe seams for excessive grinding. Observe the non-destructive testing performed by CQC personnel. Where defective results are obtained, require and verify that seams are repaired. Review daily the forms prepared by CQC personnel. Observe, on a daily basis when the activity is occurring, the peel and shear testing conducted by the CQC personnel. Determine, based on the pass/fail criteria, whether or not the peel and sheer tests have passed or failed. Review daily the form prepared by CQC personnel to ensure that the results are immediately recorded and are recorded accurately. Obtain copies of the report for the CQA file. Ensure destructive testing is completed in accordance with the criteria set forth under the CQC column in the event that destructive testing indicates a failure. Designate required additional sampling locations to CQC personnel. Review daily destructive seam testing forms prepared by CQC personnel to ensure that sample numbers with corresponding information have been properly recorded. Verify that the indicated locations for samples on the form correspond with locations in the field by observation and measurement. Resolve any discrepancies with the CQC personnel. Once each page of the above indicated form is complete and the CQA personnel have reviewed and accepted the results indicated on the form, the CQA personnel shall approve data thereon. A copy of the forms are then retained for CQA documentation. Compare peel and shear testing results with the acceptance-rejection criteria to ensure that welds meet the criteria. Review the above indicated forms to ensure that the results have

GEOMEMBRANE LINERS		
SPECIFICATION	QUALITY CONTROL	QUALITY ASSURANCE
	defective seam between holes previously patched and vacuum tested shall be either capped and vacuum tested or, if the seam was welded using the fusion welding method, the loose flap of the upper sheet (which extends beyond the outer track) shall be extrusion welded to the bottom sheet and vacuum tested. In the latter case, where the loose flap of the upper sheet is extrusion welded to the bottom sheet, the extrusion weld becomes the primary seam.	been recorded. Follow procedures indicated above if results indicate a seam failure.
CERTIFICATION: At the completion of the geomembrane installation the installer shall provide the Owner with a certification stating that the geomembrane was installed and tested in accordance with the Specifications together with a report of the test results.	Provide Owner with the certification and the report of the test results as a digital and hard copy prior to the demobilization of the installation personnel from the site and no later than 30 days after the installation has been completed.	Participate in final walk through and inspection of the project with UDWRi designated personnel from Dam Safety Section and representatives from UDWQ.
COMPLETION: At the completion of the installation, the Installer shall provide a set of record drawings showing the actual geomembrane panel layout, seams location of destructive test samples, and the location of major repairs including repaired seams and capped areas.	Provide CQA personnel and Owner with set of record drawings no later than 30 days after the installation work has been completed.	Provide CQA Officer with record drawings completed by and according to CQA personnel observations showing the actual geomembrane panel layout. CQA officer is to review and approve CQA personnel record drawings. CQA officer is to review and approve installer provided record drawings. Upon approval of CQA Officer, provide record drawings to the Owner and include them in the final CQA report to be submitted to UDWQ and UDWRi.

APPENDIX A

TESTING FREQUENCY TABLES

From Approved Technical Specifications – Completed by AMEC

5.0 TABLE 1–TEST METHODS

Test	Type of Test	Test Method (ASTM)
C1, R1	Atterberg limits	D4318
C2, R2	Moisture content	D2216
C3, R3	Particle size distribution	D422 [a]
C4, R4	Laboratory compaction	D1557
R5a	Nuclear density	D2922
R5b	Sand cone	D1556
R5c	Water replacement	D2167
C6, R6	Laboratory permeability	D5084

Notes:
C = Control Tests; R = Record Tests

[a] Hydrometer tests down to the 2-micron size will be carried out as directed by the QA Engineer but will generally not be required; all samples to be wash graded over a #200 sieve.

6.0 TABLE 2–TEST FREQUENCY–RANDOM FILL

Test	Type of Test	Frequency (1 per)
R1	Atterberg limits	50,000 yd^3
C2, R2	Moisture content	Minimum of 1 per lift per day of production or 15,000 yd^3
C3, R3	Particle size distribution	50,000 yd^3
C4, R4	Laboratory compaction	Minimum 1 per Soil type or 200,000 yd^3
R5a	Nuclear density	Minimum of 1 per lift per day of production or 15,000 yd^3
R5b/R5c	Sand cone or water replacement density	1 per 10 nuclear density tests
C8, R8	Shear strength	1 per 1,000,000 yd^3

7.0 TABLE 10–TEST FREQUENCY–CLEAN GRAVEL

Test	Type of Test	Frequency (1 per)
C3, R3	Particle size distribution	1,000 yd^3 or minimum 2 tests

Note: Sample sizes to be sampled in accordance with ASTM standards.

8.0 TABLE 11–TEST FREQUENCY–EMBANKMENT FOUNDATION

Test	Type of Test	Frequency (1 per)
R1	Atterberg limits	Lesser of soil type/100,000 ft^2
C2, R2	Moisture content	50,000 ft^2
C3, R3	Particle size distribution	100,000 ft^2
C4, R4	Laboratory compaction	Lesser of soil type/250,000 ft^2
R5a	Nuclear density	50,000 ft^2
R5b	Sand cone density	1 per 10 nuclear density tests

9.0 TABLE 12–TEST FREQUENCY–BASIN FOUNDATION

Test	Type of Test	Frequency (1 per)
R1	Atterberg limits	Lesser of soil type/200,000 ft^2
C2, R2	Moisture content	100,000 ft^2
C3, R3	Particle size distribution	200,000 ft^2
C4, R4	Laboratory compaction	Lesser of soil type/500,000 ft^2
R5a	Nuclear density	100,000 ft^2
R5b	Sand cone or water replacement density	1 per 10 nuclear density tests

TABLE 1 – HDPE GEOMEMBRANE, SMOOTH

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. avg.) ▪ Lowest individual of 10 values	D5199	Nominal -10%	Nominal -10%	Nominal -10%	Nominal -10%	Nominal -10%	Nominal -10%	Nominal -10%	Per roll
Density mg/L (min.)	D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [1] (min. avg.) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 63 lbs/in 114 lbs/in 12% 700%	 84 lbs/in 152 lbs/in 12% 700%	 105 lbs/in 190 lbs/in 12% 700%	 126 lbs/in 228 lbs/in 12% 700%	 168 lbs/in 304 lbs/in 12% 700%	 210 lbs/in 380 lbs/in 12% 700%	 252 lbs/in 456 lbs/in 12% 700%	20,000 lbs
Tear Resistance (min. avg.)	D1004	21 lbs	28 lbs	35 lbs	42 lbs	56 lbs	70 lbs	84 lbs	45,000 lbs
Puncture Resistance (min. avg.)	D4833	54 lbs	72 lbs	90 lbs	108 lbs	144 lbs	180 lbs	216 lbs	45,000 lbs
Stress Crack Resistance [2]	D5397 (Appendix)	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	Per GRI-GM10
Carbon Black Content (range)	D1603 [3]	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	D5596	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	Note [4]	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [5] a) Standard OIT --OR-- b) High Pressure OIT	 D3895 D5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lbs
Oven Aging at 85°C [3,6] a) Standard OIT (min. avg.) - % retained after 90 days --OR-- b) High Pressure OIT (min. avg.) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	Per each formulation

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
UV Resistance [7] a) Standard OIT (min. avg.) --OR-- b) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	GM11 D3895 D5885	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	Per each formulation

[1] Machine direction (MD) and cross-machine direction (XMD) average values should be based on five (5) test specimens each direction.
- Yield elongation is calculated using a gauge length of 1.3 inches.
- Break elongation is calculated using a gauge length of 2.0 inches.

[2] The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

[3] Other methods, such as D4218 (muffle furnace) or microwave methods, are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.

[4] Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (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-hour UV cycle at 75°C followed by 4-hour 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.

TABLE 2 – HDPE GEOMEMBRANE, TEXTURED

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. avg.) ▪ Lowest individual of 10 values	D5994	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Per roll
Asperity Height mils (min. avg.) [1]	GM 12	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	Every 2nd roll [2]
Density mg/L (min.)	D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [3] (min. avg.) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 63 lbs/in 45 lbs/in 12% 150%	 84 lbs/in 60 lbs/in 12% 150%	 105 lbs/in 75 lbs/in 12% 150%	 126 lbs/in 90 lbs/in 12% 150%	 168 lbs/in 120 lbs/in 12% 150%	 210 lbs/in 150 lbs/in 12% 150%	 252 lbs/in 180 lbs/in 12% 150%	20,000 lbs
Tear Resistance (min. avg.)	D1004	21 lbs	28 lbs	35 lbs	42 lbs	56 lbs	70 lbs	84 lbs	45,000 lbs
Puncture Resistance (min. avg.)	D4833	54 lbs	72 lbs	90 lbs	108 lbs	144 lbs	180 lbs	216 lbs	45,000 lbs
Stress Crack Resistance [4]	D5397 (App.)	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	300 hrs	Per GRI-GM10
Carbon Black Content (range)	D1603 [5]	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	D5596	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	Note [6]	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [7] c) Standard OIT --OR-- d) High Pressure OIT	 D3895 D5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lbs
Oven Aging at 85°C [7, 8] c) Standard OIT (min. avg.) - % retained after 90 days --OR-- d) High Pressure OIT (min. avg.) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	Per each formulation

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
UV Resistance [7] c) Standard OIT (min. avg.) --OR-- d) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	GM11 D3895 D5885	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	Per each formulation

[1] Of 10 readings; 8 out of 10 readings must be ≥ 7 mils, and the lowest individual reading must be ≥ 5 mils

[2] Alternate the measurement side for double-sided textured sheet.

[3] Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.
- Yield elongation is calculated using a gauge length of 1.3 inches.
- Break elongation is calculated using a gauge length of 2.0 inches.

[4] P-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.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

[5] Other methods, such as D4218 (muffle furnace) or microwave methods, are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.

[6] Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.

[7] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

[8] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

[9] The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.

[10] 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.

[11] UV resistance is based on percent-retained value regardless of the original HP-OIT value.

TABLE 3 – HDPE GEOMEMBRANE, DRAIN LINER

Properties	Test Method	Test Value				Testing Frequency (minimum)
		50 mils	60 mils	80 mils	100 mils	
Thickness (min. avg.) ▪ Lowest individual of 10 values	D5994	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Nominal (-5%) -10%	Per roll
Drainage Stud Height (min. avg.) [1]	GM 12	130 mil	130 mil	130 mil	130 mil	Every 2nd roll [2]
Density mg/L (min.)	D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [3] (min. avg.) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 110 lbs/in 110 lbs/in 13% 300%	 132 lbs/in 132 lbs/in 13% 300%	 176 lbs/in 176 lbs/in 13% 300%	 220 lbs/in 220 lbs/in 13% 300%	20,000 lbs
Tear Resistance (min. avg.)	D1004	38 lbs	50 lbs	67 lbs	83 lbs	45,000 lbs
Puncture Resistance (min. avg.)	D4833	80 lbs	95 lbs	126 lbs	158 lbs	45,000 lbs
Stress Crack Resistance [4]	D5397 (App.)	300 hrs	300 hrs	300 hrs	300 hrs	Per GRI-GM10
Carbon Black Content (range)	D1603 [5]	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	D5596	Note [6]	Note [6]	Note [6]	Note [6]	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [7] e) Standard OIT --OR-- f) High Pressure OIT	 D3895 D5885	 ≥100 min.	 ≥100 min.	 ≥100 min.	 ≥100 min.	200,000 lbs
Oven Aging at 85°C [7, 8] e) Standard OIT (min. avg.) - % retained after 90 days --OR-- f) High Pressure OIT (min. avg.) - % retained after 90 days	D5721 D3895 D5885	 N.R. 80%	 N.R. 80%	 N.R. 80%	 N.R. 80%	Per each formulation

Properties	Test Method	Test Value				Testing Frequency (minimum)
		50 mils	60 mils	80 mils	100 mils	
UV Resistance [7] e) Standard OIT (min. avg.) --OR-- f) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	GM11 D3895 D5885	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	 N.R. [8] 50%	Per each formulation

[1] Of 10 readings; 8 out of 10 readings must be ≥ 7 mils, and the lowest individual reading must be ≥ 5 mils

[2] Alternate the measurement side for double-sided textured sheet.

[3] Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.
- Yield elongation is calculated using a gauge length of 1.3 inches.
- Break elongation is calculated using a gauge length of 2.0 inches.

[4] P-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.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

[5] Other methods, such as D4218 (muffle furnace) or microwave methods, are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.

[6] Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.

[7] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

[8] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

[9] The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.

[10] 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.

[11] UV resistance is based on percent-retained value regardless of the original HP-OIT value.

TABLE 4 – SEAM STRENGTH AND RELATED PROPERTIES OF THERMALLY BONDED SMOOTH AND TEXTURED HDPE GEOMEMBRANES

Geomembrane Nominal Thickness	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams [1]							
Shear strength [2], lb/in.	57	80	100	120	160	200	240
Shear elongation at break [3], %	50	50	50	50	50	50	50
Peel strength [2], lb/in.	45	64	76	91	121	151	181
Peel separation, %	25	25	25	25	25	25	25
Extrusion Fillet Seams							
Shear strength [2], lb/in.	57	80	100	120	160	200	240
Shear elongation at break [3], %	50	50	50	50	50	50	50
Peel strength [2], lb/in.	39	52	65	78	104	130	156
Peel separation, %	25	25	25	25	25	25	25

[1] Also for hot air and ultrasonic seaming methods

[2] Value listed for shear and peel strengths are for four out of five test specimens; the fifth specimen can be as low as 80% of the listed values

[3] Elongation measurements should be omitted for field testing

APPENDIX B

NON-DESTRUCTIVE SEAM TESTING PROCEDURES

B.1 Procedure for Fusion Weld Testing

This test is intended to provide a nondestructive evaluation of the integrity of geomembrane seams made in the form of two closely spaced tracks by the fusion weld technique. The presence of the un-welded channel between the two distinct seamed regions allows for inflation of the sealed channel with air to a predetermined pressure. Extremely long lengths of seam can be evaluated, e.g., greater than 300 feet. The tightness of the pressurized air channel over time is noted and recorded. If air pressure cannot be maintained, a leak in the seam is indicated and corrective actions are taken.

The fusion weld technique utilizes a dual, or double, bonded seam where an air channel exists between the two seam tracks. Both ends of the air channel are sealed as designated below using Alternative A or Alternative B with a hollow needle with attached pressure gage inserted into the air space. Air pressure is applied and the gage is monitored for excessive air pressure drop. Air pressures are related to the thickness and stiffness of the geomembrane and vary from 24 to 30 lb/in^2. Monitoring time shall be a minimum of 5 minutes. Maximum allowable loss of air pressure varies from 2 to 4 lb/in^2 depending upon thickness and stiffness of the geomembrane.

A hot air device is necessary to seal either one or both ends of the air channel. Wide mouth vice grips are sometimes necessary to further lock-off these sealed ends. A sharp, hollow needle with a properly functioning pressure gage is necessary to insert air into the open channel and monitor its pressure. An air pump capable of generating and sustaining the required air pressures is necessary. The pump is not to be attached while the air pressure is being monitored.

The procedure for conducting the non-destructive test on a fusion weld seam shall be as follows:

1. After making the desired dual track seam and deciding upon the length of seam that is to be evaluated, seal off the two ends of the continuous air channel and insert the air pressure needle into the air channel using either Alternative A or Alternative B below.

   Alternative A: Heat both of the ends of the air channel with a hot air device. Clamp both ends of the air channel with wide-mouth vice grips so as to form an air-tight seal at both ends of the channel. The wide-mouth vice grips can remain in place throughout the test or be removed as the installer sees fit.

   Insert the air pressure needle into the air channel by penetrating the upper geomembrane. The needle is to be inserted at the shallowest possible angle and only until the upper sheet is penetrated. The lower sheet beneath the air channel must not be penetrated. The pressure gage is connected directly to the end of the hollow needle. If problems are encountered in obtaining a good seal around the needle, heating of the needle with hot air may be helpful.

   Alternative B: Seal off one end of the air channel by heating the end with the hot air devise. Clamp this end of the air channel with wide-mouth vice grips so as to form an

air-tight seal at this end of the channel. The wide-mouth vice grips can remain in place throughout the test or be removed as the installer sees fit.

Insert the air pressure needle with attached pressure gage into the air space at the other end of the channel. The needle is to be fitted with a prefabricated end piece which can be clamped onto the other end of the air channel with vice grips so as to form an air tight seal around the needle and at the end of the air channel. Clamp the needle with prefabricated end piece onto the end of the air channel with vice grips so as to form an air-tight seal at this end of the channel.

2. Connect an air pump to the pressure gage and pressurize the air channel. The pressure schedule for high density polyethylene (HDPE) geomembranes is as follows:

Geomembrane Thickness (mil)	Minimum Pressure (lb/in^2)	Maximum Pressure (lb/in^2)
60	30	35
80	30	35

Maintain these pressures with the air pump connected during a two-minute stabilization period.

3. Disconnect the air pump. Observe the air pressure gage for a minimum of 3 minutes. Record the time and pressure of the beginning and end of the test. The maximum allowable pressure drop should not exceed the following schedule.

Geomembrane Thickness (mil)	Maximum Pressure Drop (lb/in^2)
60	3.0
80	3.0

4. If the pressure does not drop below the above value after the minimum 3 minute test period, cut the air channel open at the end away from the pressure gage. Air should rush out and the pressure gage should register an immediate drop in pressure, indicating that the entire length of the seam has been tested. If this does not happen, the air channel is blocked. Walk the seam to look and feel for the location of the blockage. The channel should be inflated up to that point.

Cut the air channel on the gage side of the blockage and verify the pressure loss. Then inflate the weld from the far side. If the pressure holds, cut the seam just prior to the blockage and verify the pressure drop. If the location of the blockage can not be found, it may be necessary to cut the seam in the middle and treat both halves as separate welds. Patch all cuts and seal small holes with extrudate from a fillet extrusion seam device.

Note 1: If multiple blocked locations are suspected or if the seam is short, it may be easiest to cut the seam out and remake the weld.

5. For a pressure drop greater than the above value, check the end seals and where the needle enters into the air channel. Reseal these areas with a hand held hot air device if a leak is noticed and then repeat the entire test.

    Note 2: Leaks around the end seals and air pressure insertion needle can usually be located by putting moisture around the suspected area and looking for bubbles to occur.

6. If the problem is not located, perform peel tests at the beginning and end of the seam to determine seam strength.

7. If the seam strength is inadequate, the edge of the loose flap of the upper sheet (which extends beyond the outer track) is extrusion fillet welded to the bottom sheet. Thus the extrusion fillet weld becomes the primary seam. It is then vacuum box tested until satisfactory performance is obtained.

8. If the seam passes the destructive tests, the leak is looked for with the flap in place. If the leak is found, it is repaired. If it cannot be found, cut away the flap. Then vacuum box test the outer track of the seam. If a leak is found, repair it. In both cases, repairs are made by extrusion fillet welds.

9. If no leak is found in the outer track and all other leak location possibilities have been eliminated, the leak is assumed to be in the inner track. Since this inner track is for the purpose of air channel testing only, it is redundant and can be ignored. The single good outer track is adequate and should be accepted as such.

    Note 3: If the outer air track cannot be accepted as the primary and only seam, a cap strip over the entire seam, or the entire seam cut out and rewelded, are alternative possibilities.

10. Record the results for seam air pressure testing.

B.2 Procedure For Vacuum Testing

In those locations where extrusion welding is used, all of the welding will be vacuum tested. Defects found will be repaired and retested. Vacuum testing, repair procedures, and retesting will be recorded and made part of the CQA Report.

The procedure that will be followed for vacuum testing will conform to the procedure identified in ASTM Designation D4437-84 "Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes." This procedure will be followed with two exceptions. First, the vacuum pressure applied to the vacuum box will not be less than 5 psi which is in accordance with the current EPA specifications given in guidance memorandum, "Use of Construction Quality Assurance (CQA) Programs and Control of Stress Cracking in Flexible Membrane Liner's Seams," rather than the 4 to 8 inches of mercury (approximately 2 psi to 4 psi) as indicated in the ASTM D4437-84 standard. Second, a dwell time of 15 seconds will be specified in accordance with the EPA current guidance. There is no designated dwell time in the ASTM D4437-84 standard. The procedure will be as follows:

All seams welded using the extrusion process shall be inspected for unbonded areas by applying a vacuum to a soaped section of the seam. The vacuum shall be applied by a vacuum box equipped with a vacuum gage, a clear glass view panel in the top, and a soft rubber gasket on the periphery of the open bottom. Thoroughly soap a section of the seam and place the inspection box over the soaped seam section and the gasket sealed to the liner. Apply a vacuum of not less than 5 psi to the box by use of a vacuum pump. The vacuum will be applied for a minimum dwell time of fifteen (15) seconds. The applied vacuum will show bubbles over unbonded areas; the unbonded areas shall then be marked for repair.

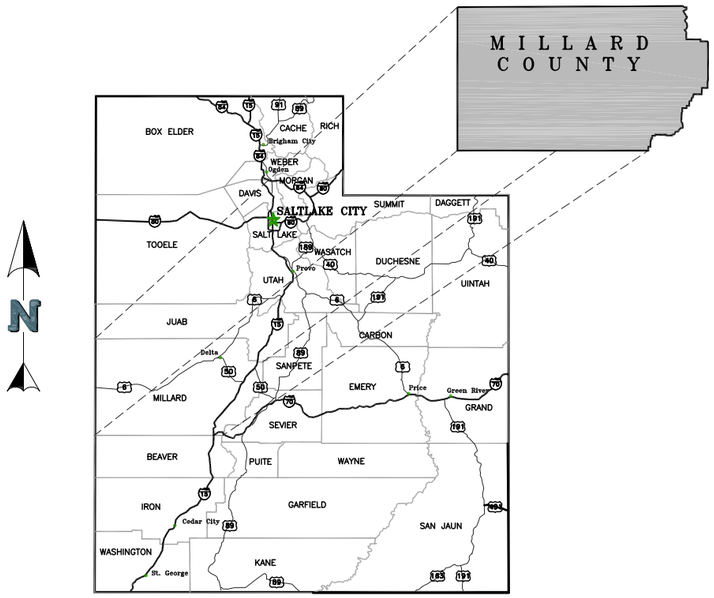
Record the results for the vacuum testing.

B.3 Procedure For Electrostatic Spark Test

The electrostatic spark test is a non-destructive test used to detect voids, pinholes, or unbonded areas primarily in HDPE extrusion welds. Seams tested by this method are provided with a copper wire properly embedded in the seam and grounded. A high voltage electric current is then applied to a probe which is slowly moved along the length of the seam and any leakage to ground (i.e., through a pinhole to the copper wire) is detected by sparking. Procedures for conducting the electrostatic spark test are as follows:

A. Prepare the seam to be welded.
B. Insert an 18 gauge bare copper wire in the seam area, where it will appear at the bottom of the weld after the seam is welded, with one end of the wire left exposed.
C. Weld the seam.
D. After the weld has cooled, connect the exposed end of the copper wire to the ground terminal on a high voltage spark tester capable of operating in a range of 10 to 55 KV.
E. Turn the spark tester on and adjust the output voltage control to minimum. Hold the test probe on the spark tester near the exposed end of the copper wire and increase the output voltage until a spark can be obtained at least twice as long as the thickness of the material to be tested (or twice as thick as the weld).
F. Move the probe slowly along the length of the welded seam. Document and mark on the HDPE liner adjacent to the weld locations where sparking is observed. Locations where sparking is observed indicates the presence of leaks in the weld.
G. After testing the seam, verify that the length of the spark to the exposed end of the copper wire is still adequate before turning the power to the machine off. If the spark is not adequate, readjust the output voltage and retest the seam.
H. Record the results from the spark test.
I. Repair locations indicating the presence of a leak by grinding and re-welding.
J. Retest repair area.

DRAWINGS

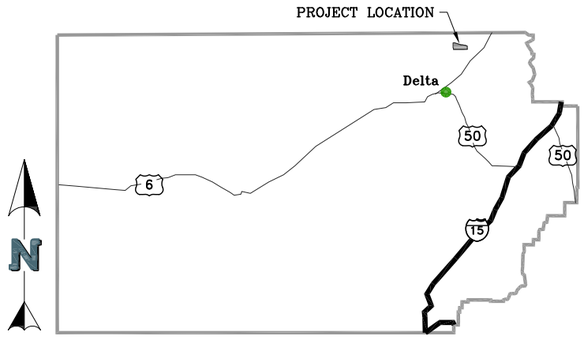


UTAH COUNTY MAP

MAGNUM DEVELOPMENT
SOLUTION MINING

BRINE POND NO.2

ISSUED FOR PERMITTING
APRIL 6th, 2015



MILLARD COUNTY VICINITY MAP

Sheet List Table		
Sheet Number	Sheet Title	REV
A000	COVER SHEET	B
A020	GENERAL LAYOUT	B
A030	GEOTECHNICAL INVESTIGATION LOCATIONS	B
A100	OVERALL GRADING PLAN	B
A110	TYPICAL EMBANKMENT SECTIONS AND DETAILS	B
A120	SOUTHWEST CORNER ACCESS RAMP PLAN AND PROFILE	B
A130	NORTHWEST CORNER GRADING PLAN	B
A140	BRINE RECOVERY SYSTEM SECTION AND DETAILS	B
A150	POND INLET DETAILS	B
A200	POND BASIN PIPING	B
A220	LEAK COLLECTION AND RECOVERY SYSTEM DETAILS	B
A230	PROCESS COLLECTION AND MONITORING SYSTEM DETAILS	B
A300	POND SITE GROUNDWATER DEPTHS PLAN AND PROFILE	B
A400	STORMWATER DIVERSION PLAN	B

MAGNUM

MAGNUM NGLs, LLC
3165 E MILLROCK DRIVE
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SAWTOOTH NGL CAVERNS

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REGISTERED PROFESSIONAL ENGINEER
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MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

NewFields

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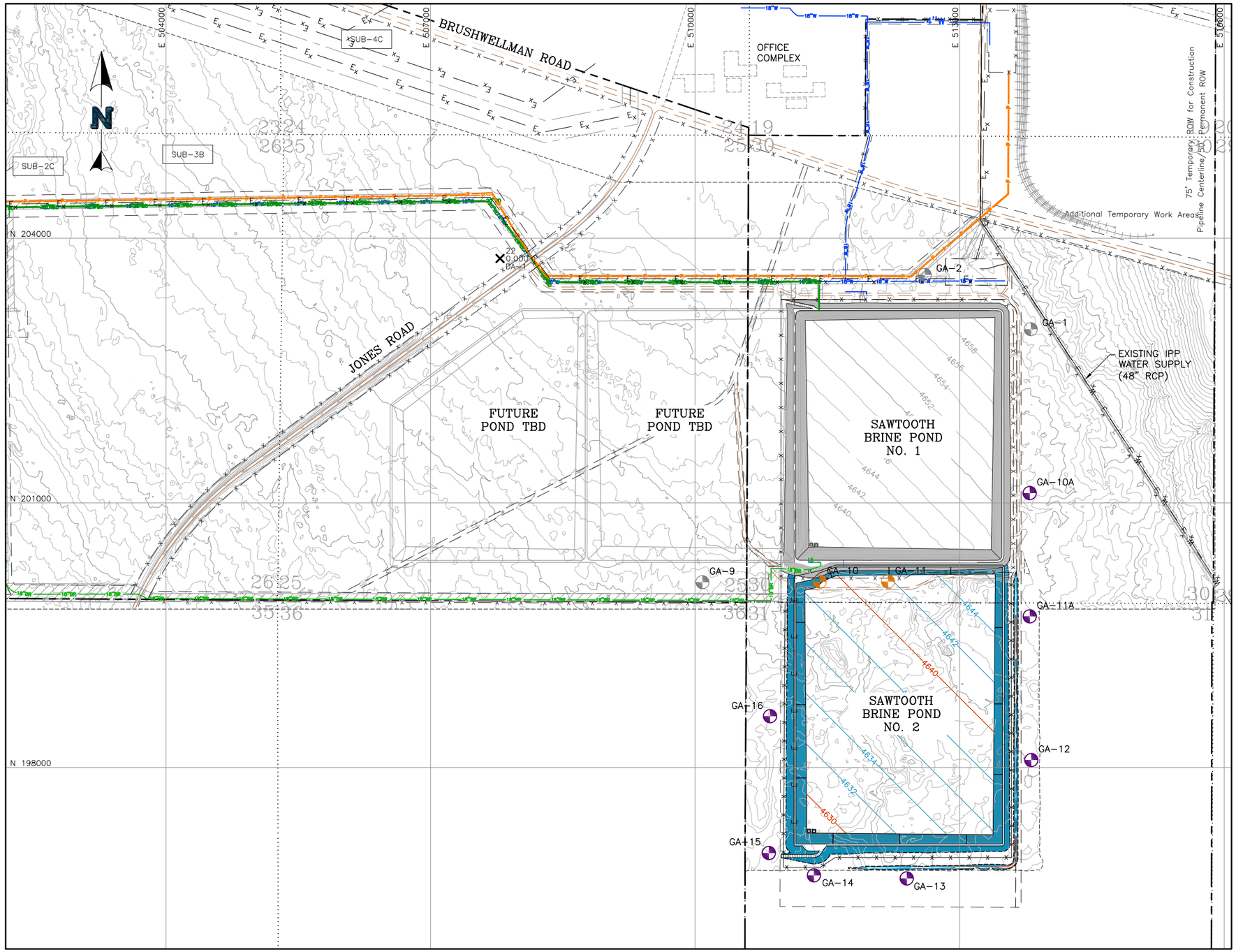

0 600 1200 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- MAGNUM SITE BOUNDARY
- SITE BOUNDARY
- SECTION LINES
- 20 — SECTION NUMBER
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- EXISTING BRINE LINE
- EXISTING BRINE LINE
- EXISTING POWER LINE
- EXISTING WATER LINE
- EXISTING PIPE
- EXISTING 18" WATER
- EXISTING 4" WATER
- GA-01 — EXISTING GROUND WATER MONITORING WELLS TO REMAIN
- GA-10 — EXISTING GROUND WATER MONITORING WELLS TO BE ABANDONED
- GA-12 — PROPOSED GROUND WATER MONITORING WELLS

NOTES:

1. EXISTING MONITORING WELLS GA-9, GA-10 AND GA-11 TO BE ABANDONED PER STATE REGULATION R655-4-14 "ABANDONMENT OF WELLS."

REGISTERED PROFESSIONAL ENGINEER
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04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: GENERAL LAYOUT

FILENAME: 93.003.001M

DRAWING NO.: A020

REVISION: 0

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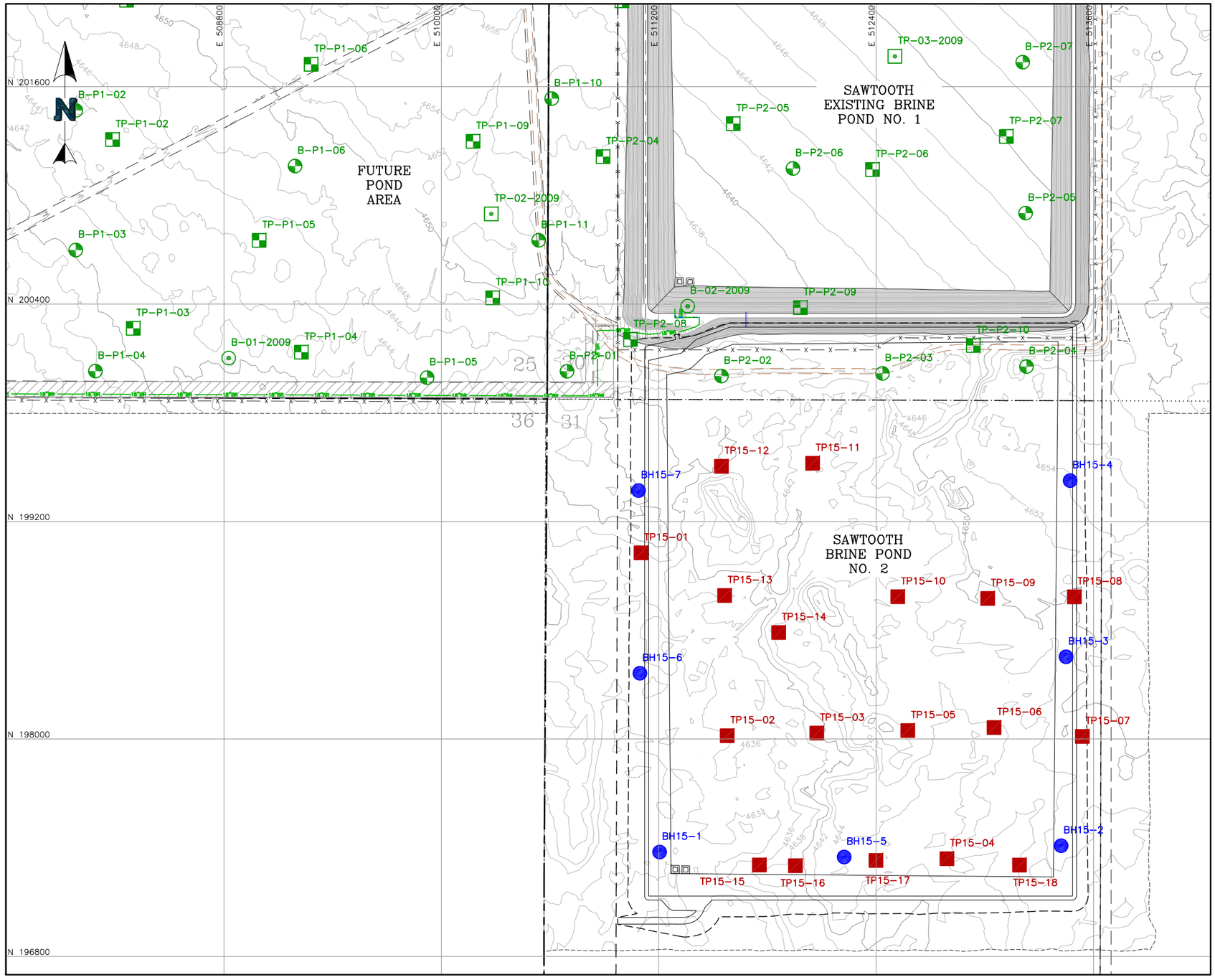

0 300 600 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- SECTION LINES
- 20 SECTION NUMBER
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- EXISTING BRINE LINE
- B-01-2009 BOREHOLE (IGES, 2009)
- TP-01-2009 TEST PIT (IGES, 2009)
- B-P1-01 BOREHOLE (IGES, 2010)
- TP-P1-02 TEST PIT (IGES, 2010)
- BH15-1 BOREHOLE (NEWFIELDS, 2015)
- TP15-01 TEST PIT (NEWFIELDS, 2015)

REGISTERED PROFESSIONAL ENGINEER
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04/06/15
STATE OF UTAH

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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: GEOTECHNICAL INVESTIGATION LOCATIONS

FILENAME: 93.003.002M

DRAWING NO.: A030

REVISION: 0

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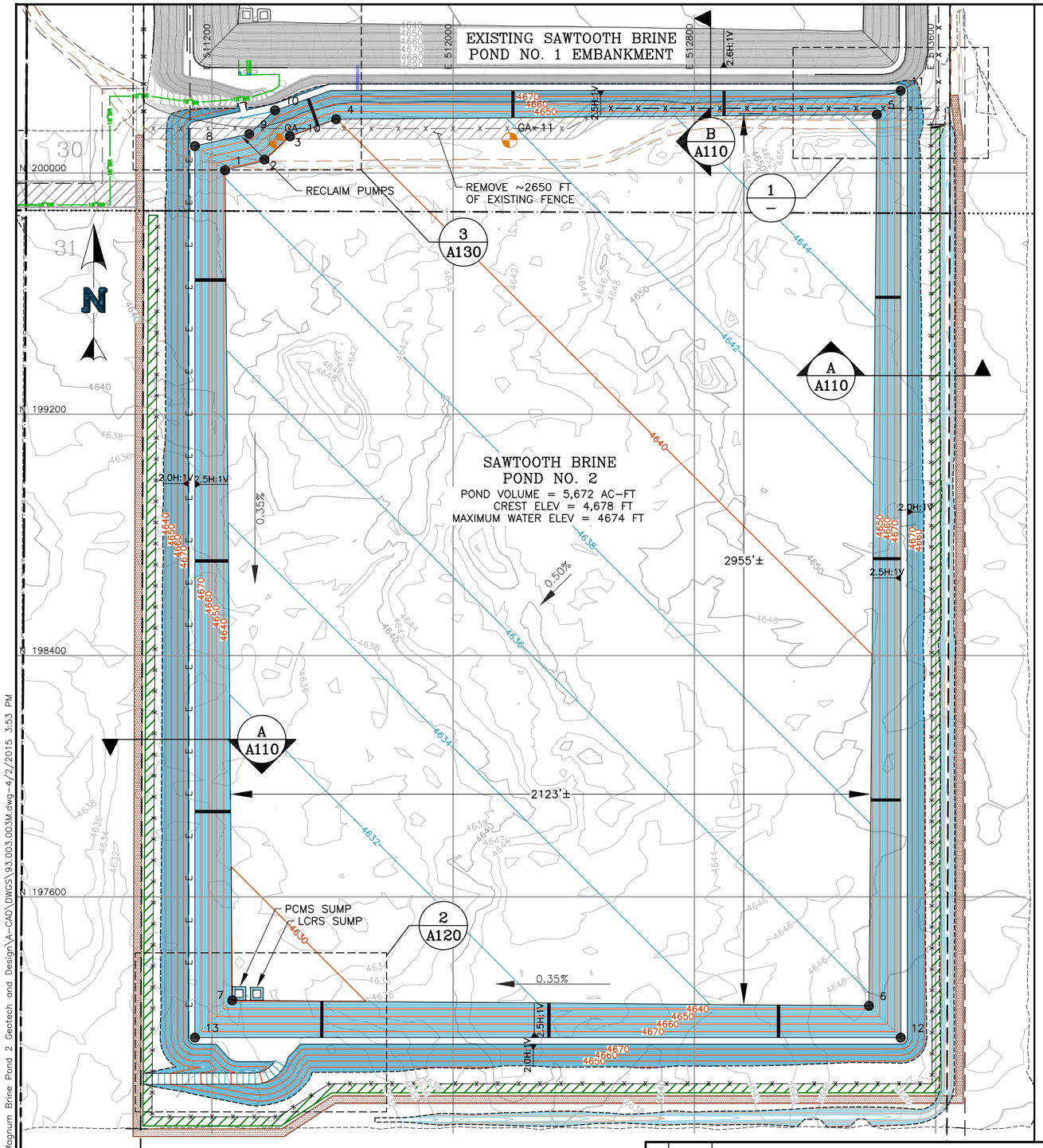

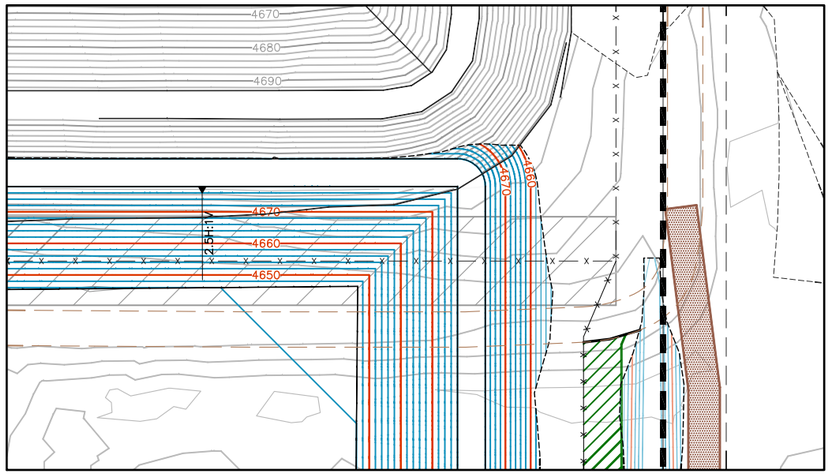

1 — NORTHEAST CORNER GRADING PLAN

0 60 120 FEET

SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	200,008.91	511,243.69	4,638.09
2	200,044.42	511,374.23	4,638.68
3	200,121.23	511,458.92	4,639.25
4	200,177.81	511,611.66	4,639.99
5	200,193.80	513,404.89	4,646.39
6	197,238.76	513,378.54	4,635.85
7	197,257.25	511,267.80	4,628.45
8	200,088.97	511,143.93	4,678.00
9	200,128.94	511,324.03	4,678.00
10	200,207.30	511,409.43	4,678.00
11	200,272.84	513,483.93	4,678.00
12	197,133.38	513,483.93	4,678.00
13	197,133.38	511,143.93	4,678.00

NOTES:

1. EXISTING MONITORING WELLS GA-10 AND GA-11 TO BE ABANDONED PER STATE REGULATION R655-4-14 "ABANDONMENT OF WELLS."
2. THE AVERAGE DEPTH OF TOPSOIL IS ASSUMED TO BE 3 INCHES FOR THE EARTHWORK BALANCE.
3. THE COMPACTION PERCENTAGE FOR THE EARTHWORK BALANCE IS ASSUMED TO BE 15 PERCENT. THE PROJECT IS A CUT-TO-FILL BALANCE USING THE COMPACTION PERCENTAGE ON THE FILL.

GEOSYNTHETIC LINER SYSTEM NOTE:

1. THE LINER SYSTEM SHALL BE A COMPOSITE SYSTEM WITH THE PRIMARY LINER CONSISTING OF 80-mil (2.0MM) SINGLE SIDED TEXTURED HDPE DRAIN LINER WITH 130 MIL HEIGHT RAISED STUDS AND A SECONDARY LINER CONSISTING OF 60-mil (1.5MM) SMOOTH HDPE.

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS PRIOR TO LINER DEPLOYMENT
- PROPOSED DIVERSION CHANNEL GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- SECTION LINES
- 20 SECTION NUMBER
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- GA-10 EXISTING GROUNDWATER MONITORING WELL
- E_x EXISTING POWER LINE
- E PROPOSED POWERLINE
- 18" BRI EXISTING BRINE LINE
- POND CREST ROAD
- VEGETATION WINDROW
- PROPOSED PERIMETER ROAD
- HDPE ACCESS LADDER WITH WHITE LINER STRIP FOR VISUAL IDENTIFICATION
- DIVERSION CHANNEL

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: OVERALL GRADING PLAN

FILENAME: 93.003.003M

DRAWING NO.: A100

REVISION: 0

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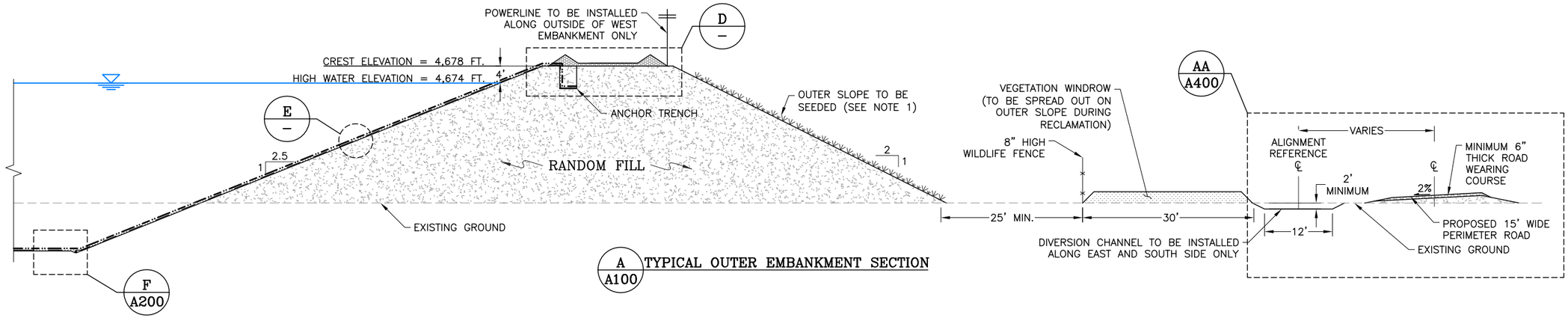
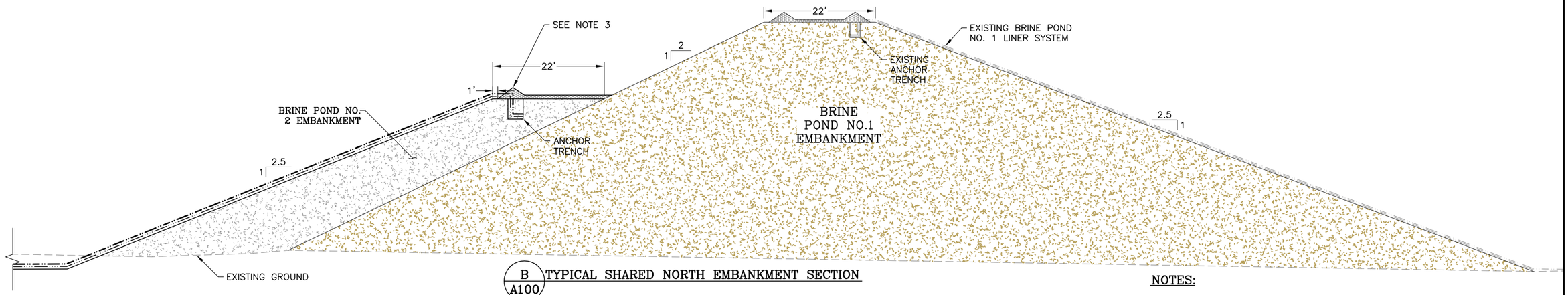
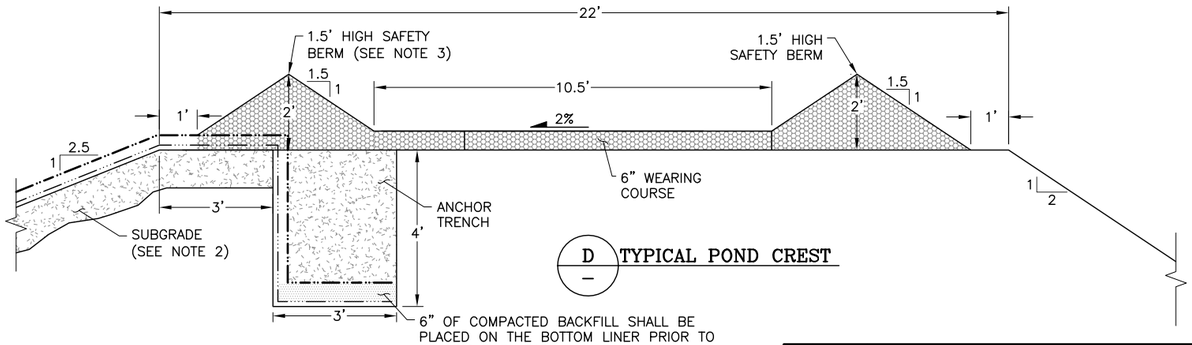


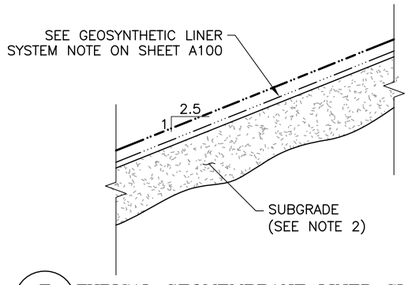
A A100 TYPICAL OUTER EMBANKMENT SECTION



B A100 TYPICAL SHARED NORTH EMBANKMENT SECTION



D — TYPICAL POND CREST



E — TYPICAL GEOMEMBRANE LINED SLOPE

NOTES:

1. THE DOWNSTREAM EMBANKMENT SLOPES SHALL BE SEEDED IN ACCORDANCE WITH THE MILLARD COUNTY ROAD CONSTRUCTION SEMI-DESERT SEED MIX AS BASED ON THE INTERMOUNTAIN PLANTING GUIDE. THE TIMING OF THE SEEDING TO BE DONE WITH RECLAMATION.
2. SEE EARTHWORKS TECHNICAL SPECIFICATIONS SECTION 2.1.5 FOR PREPARING SURFACES TO RECEIVE GEOMEMBRANE.
3. PROVIDE A 1 FOOT WIDE BREAK IN THE INSIDE BERM EVERY 50 FEET FOR SURFACE WATER DRAINAGE.
4. ALL PRIMARY LINER SHALL HAVE TEXTURED SIDE FACING UP.

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04/06/15
STATE OF UTAH

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A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

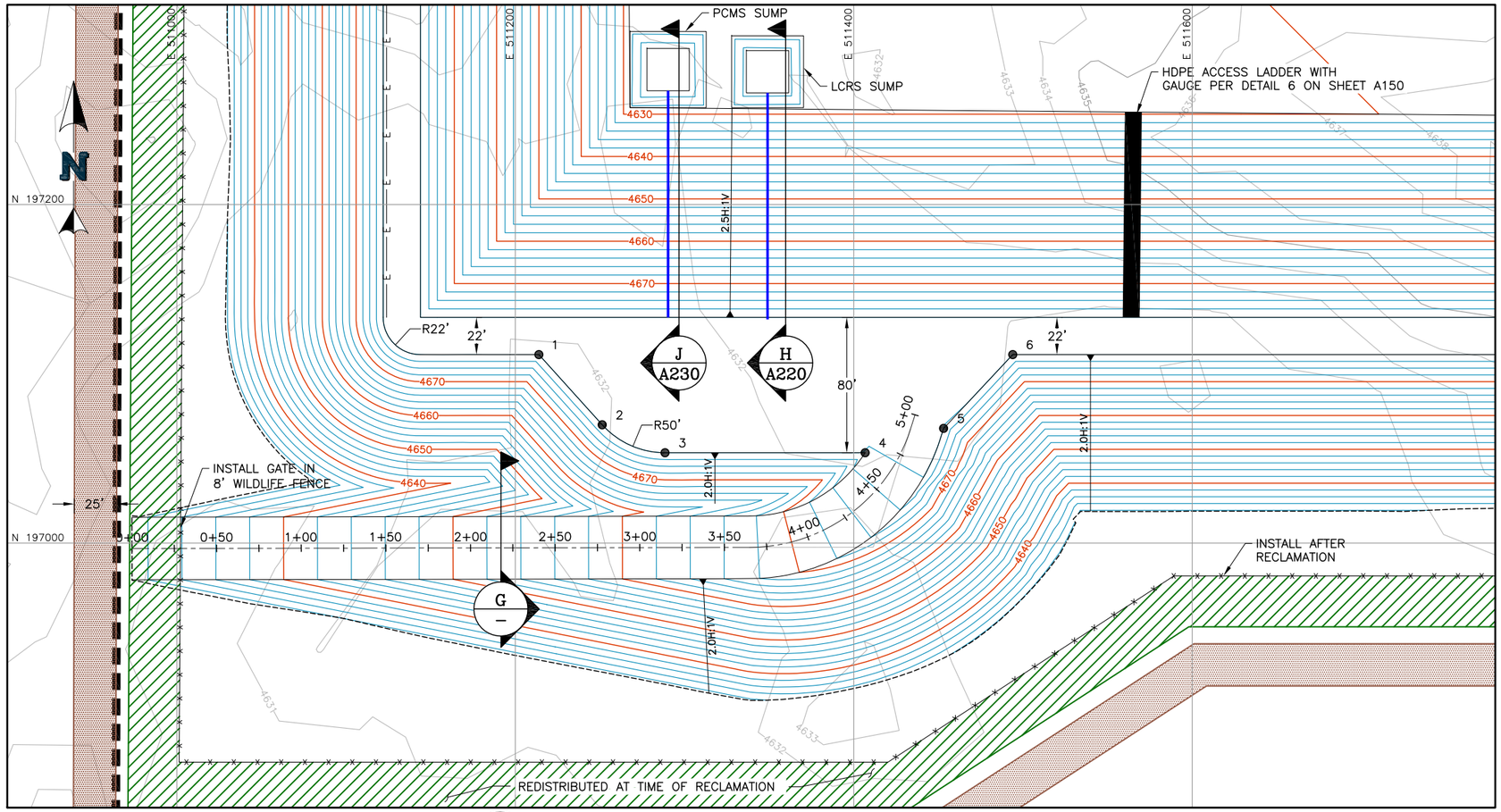
PROJECT: SAWTOOTH BRINE POND 2

TITLE: TYPICAL EMBANKMENT SECTIONS AND DETAILS

FILENAME: 93.003.001D

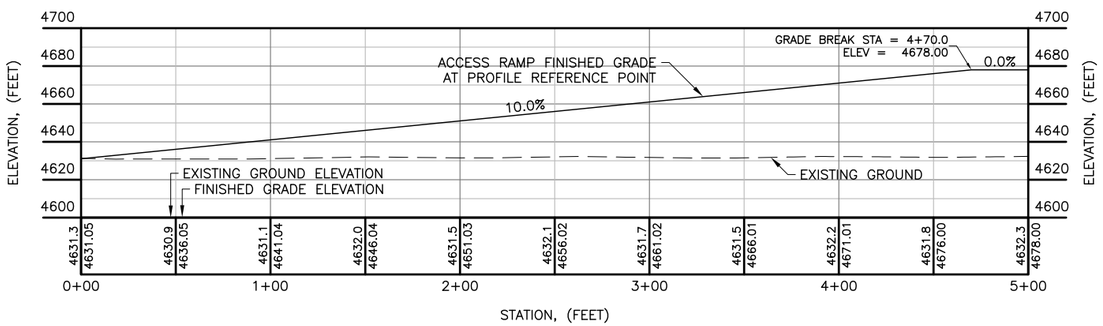
DRAWING NO.: A110

REVISION: 0



2 / A100 SOUTHWEST CORNER GRADING PLAN

0 40 80 FEET



0 40 80 FEET HORIZONTAL

0 40 80 FEET VERTICAL

NO EXAGGERATION

LEGEND:

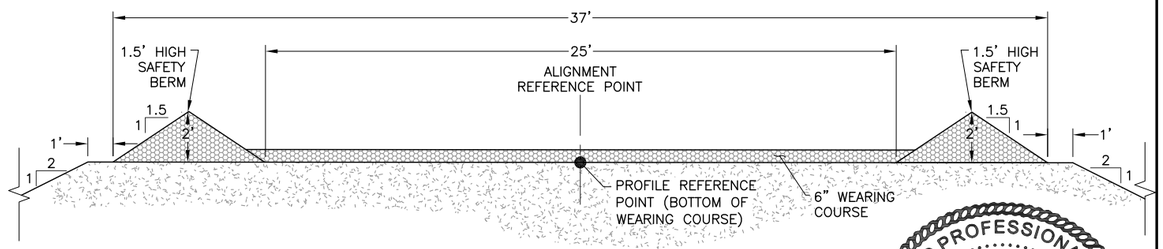
- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- SITE BOUNDARY
- PROPOSED WILDLIFE FENCE TO BE INSTALLED AFTER RECLAMATION
- E — PROPOSED POWERLINE
- VEGETATION WINDROW
- PROPOSED PERIMETER ROAD

ACCESS RAMP HORIZONTAL LAYOUT DATA

	STATION	NORTHING	EASTING	DELTA (D–M–S)	LENGTH (FT)	RADIUS (FT)
PI	0+00.00	196,996.77	510,973.53			
PC	3+64.83	196,997.46	511,338.36	072–23–35	126.35	100.00
PT	4+91.18	197,067.39	511,433.54			
PI	5+00.00	197,075.80	511,436.19			

SW CORNER SETTING OUT DATA

POINT	NORTHING	EASTING	ELEVATION
1	197,111.38	511,213.93	4,678.00
2	197,069.88	511,251.36	4,678.00
3	197,053.38	511,288.48	4,678.00
4	197,053.38	511,406.71	4,677.46
5	197,067.79	511,453.07	4,678.00
6	197,111.38	511,493.93	4,678.00



G / — TYPICAL ACCESS RAMP SECTION

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: SOUTHWEST CORNER ACCESS RAMP PLAN AND PROFILE

FILENAME: 93.003.0011P

DRAWING NO.: A120

REVISION: 0

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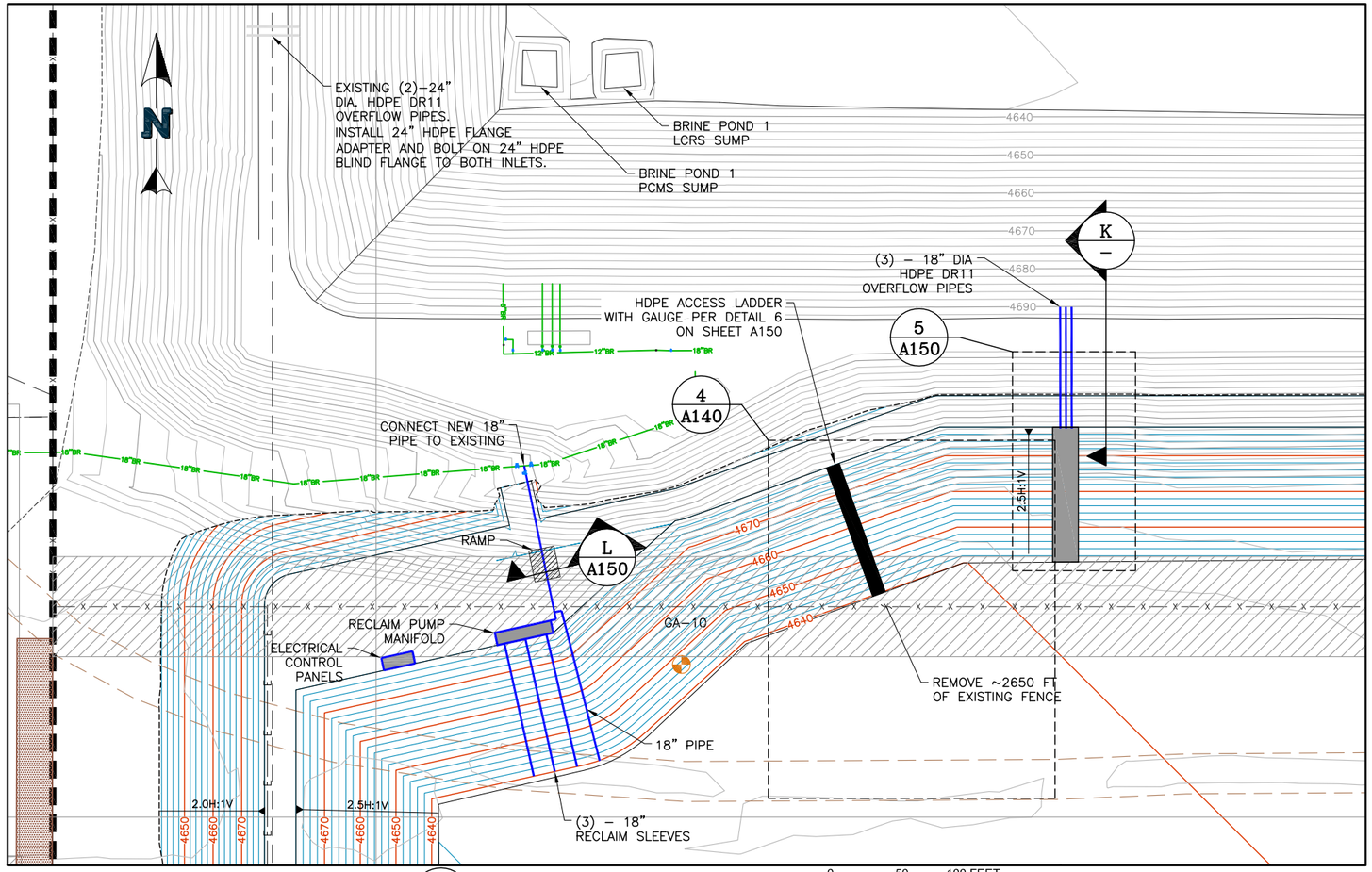
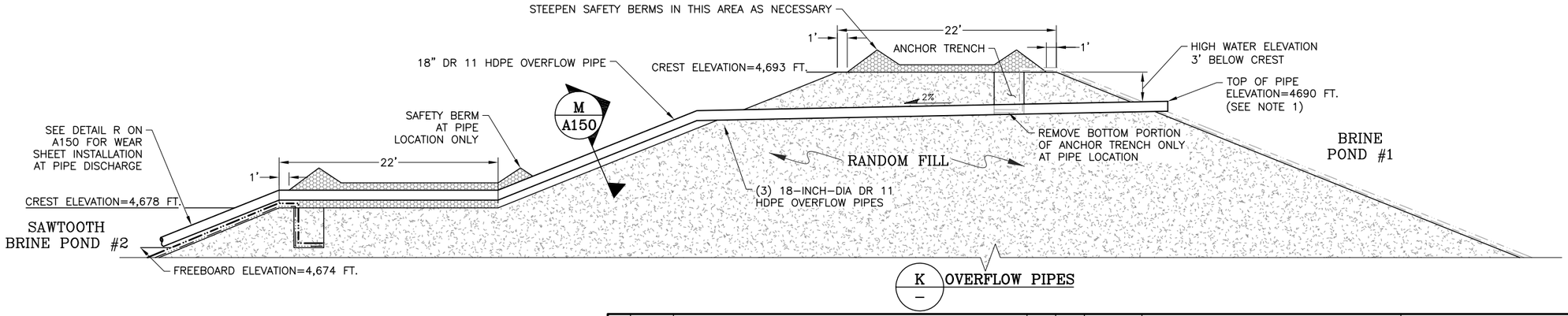


3 A100 NORTHWEST CORNER GRADING PLAN



K – OVERFLOW PIPES

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- SECTION LINES
- 20 SECTION NUMBER
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- EXISTING BRINE LINE
- 18 IN DIA. DR11 HDPE OVERFLOW PIPE
- HDPE ACCESS LADDER WITH WHITE LINER STRIP FOR VISUAL IDENTIFICATION
- PROPOSED ACCESS ROAD

NOTES:

1. ALLOW PIPE TO PROTRUDE FROM EMBANKMENT TO ALLOW FOR PIPE BOOT INSTALLATION. DISTANCE TO BE DISCUSSED WITH GEOMEMBRANE INSTALLER.

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: NORTHWEST CORNER GRADING PLAN

FILENAME: 93.003.004M

DRAWING NO.: A130

REVISION: 0

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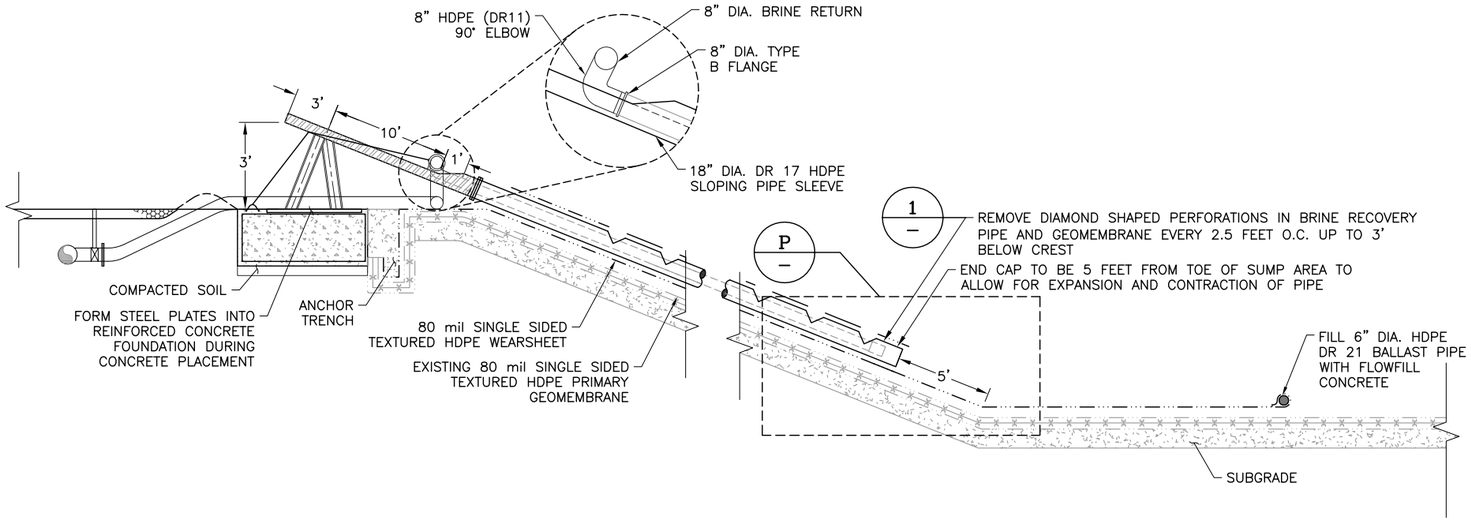
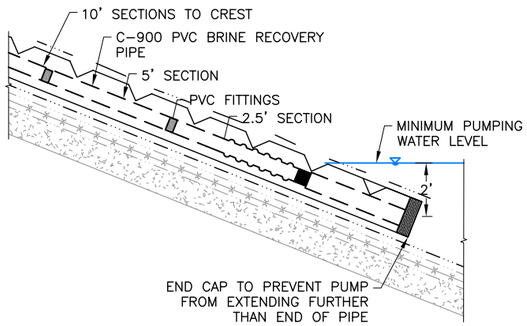
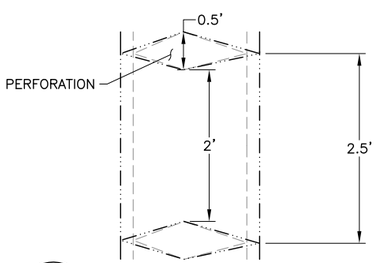


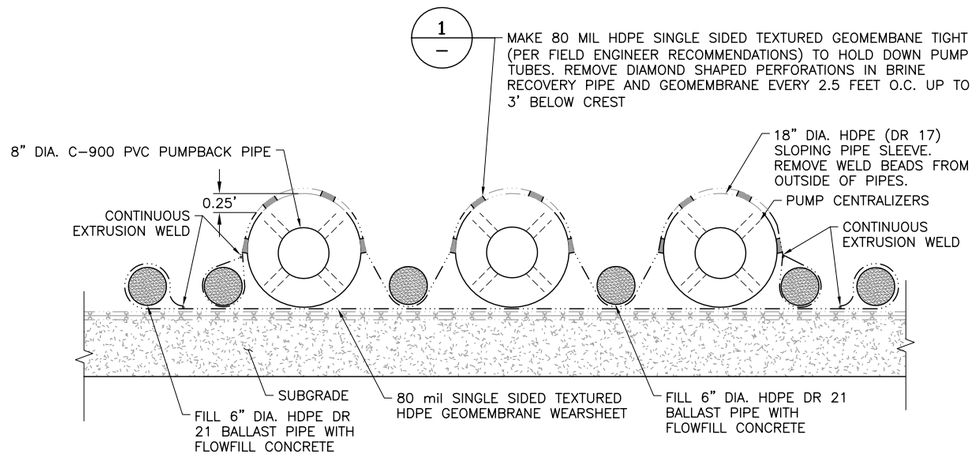
N — BRINE RECOVERY PIPE SYSTEM



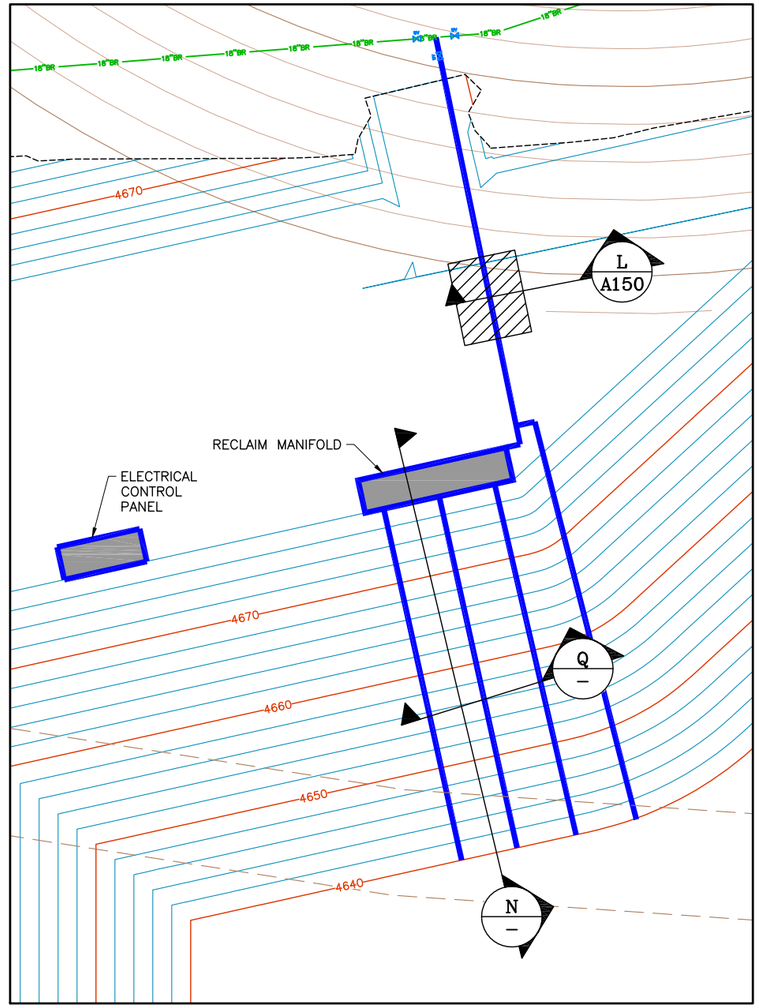
P — BRINE RECOVERY SYSTEM



1 — DIAMOND PERFORATION DETAIL



Q — PIPE SLEEVE SECTION



4 / A130 — RECLAIM PUMPBACK SYSTEM PLAN

0 20 40 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- EXISTING ROADS/TRAILS
- SITE BOUNDARY
- EXISTING BRINE LINE
- 18 IN DIA. DR11 HDPE OVERFLOW PIPE
- HDPE ACCESS LADDER WITH WHITE LINER STRIP FOR VISUAL IDENTIFICATION
- PROPOSED ACCESS ROAD

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: BRINE RECOVERY SYSTEM SECTION AND DETAILS

FILENAME: 93.003.0010D

DRAWING NO.: A140

REVISION: 0

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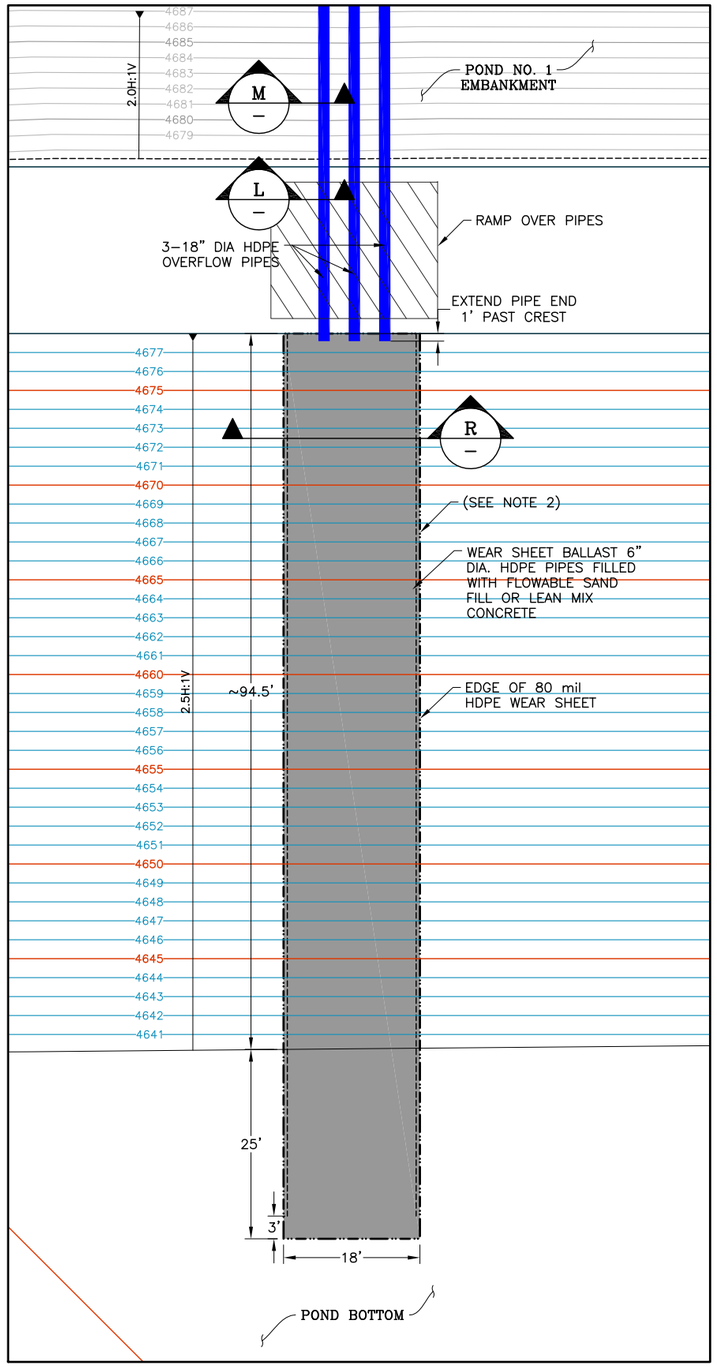
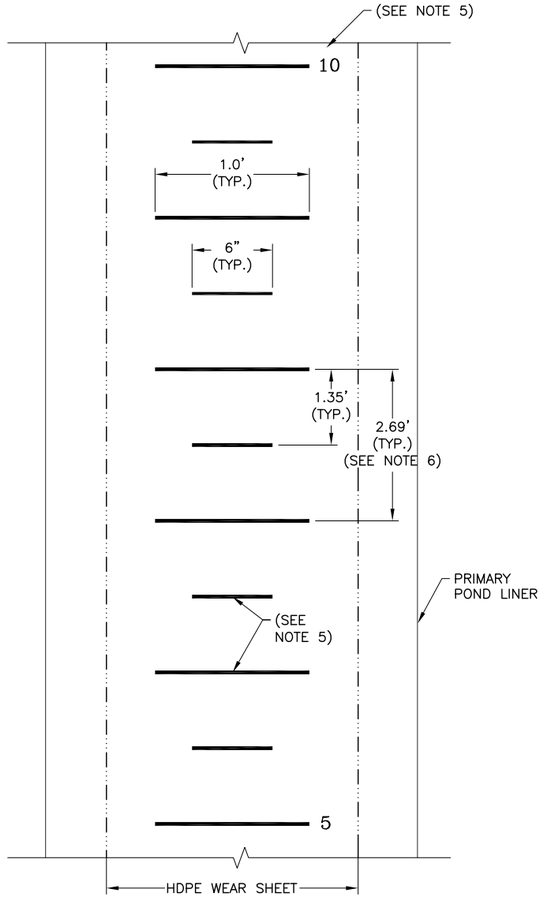
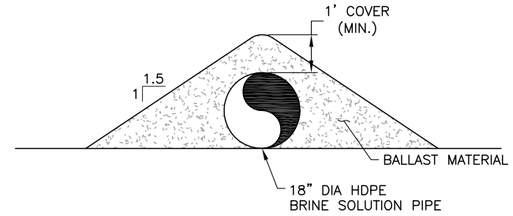


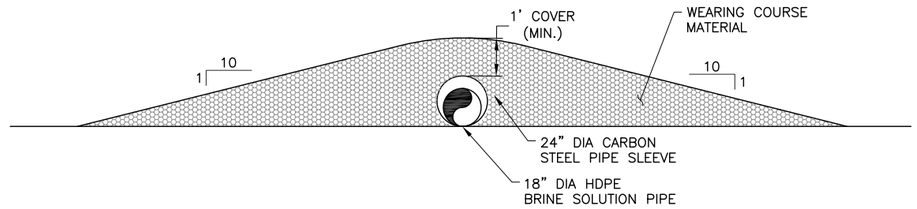
5 / A130 POND INLET PLAN



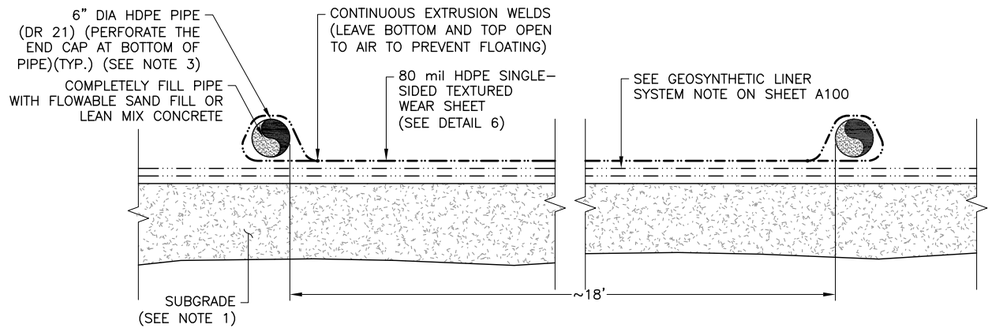
6 / – WATER LEVEL GAUGE DETAIL



M / – M / A130 PIPE BALLAST ON DOWNSTREAM EMBANKMENT SLOPE



L / – L / A130 L / A140 PIPE CROSSING



R / – POND WEAR SHEET BALLASTING

NOTE:

1. SEE TECHNICAL SPECIFICATIONS FOR PREPARING SURFACES TO RECEIVE GEOMEMBRANE.
2. PLACE GEOTEXTILE IN THE END OF THE PIPE BEFORE WELDING THE END CAP ON.
3. PIPE BALLASTS ANCHORED AT CREST OF SLOPE BEYOND THE EXTENTS OF THE GEOMEMBRANE.
4. ALL PRIMARY LINER SHALL HAVE TEXTURED SIDE FACING UP.
5. EXTRUDE INCREMENTS ONTO HDPE WEARSHEET AND APPLY FLUORESCENT COLOR PAINT TO ALL INCREMENTS AND LABEL EVERY 5 FEET.
6. HORIZONTAL DISTANCES SHOWN CORRELATE TO VERTICAL INCREMENTS OF 6" ON A 2.5:1 (HORZIONTAL:VERTICAL) SLOPE (TO BE FIELD VERIFIED BY SURVEY).

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

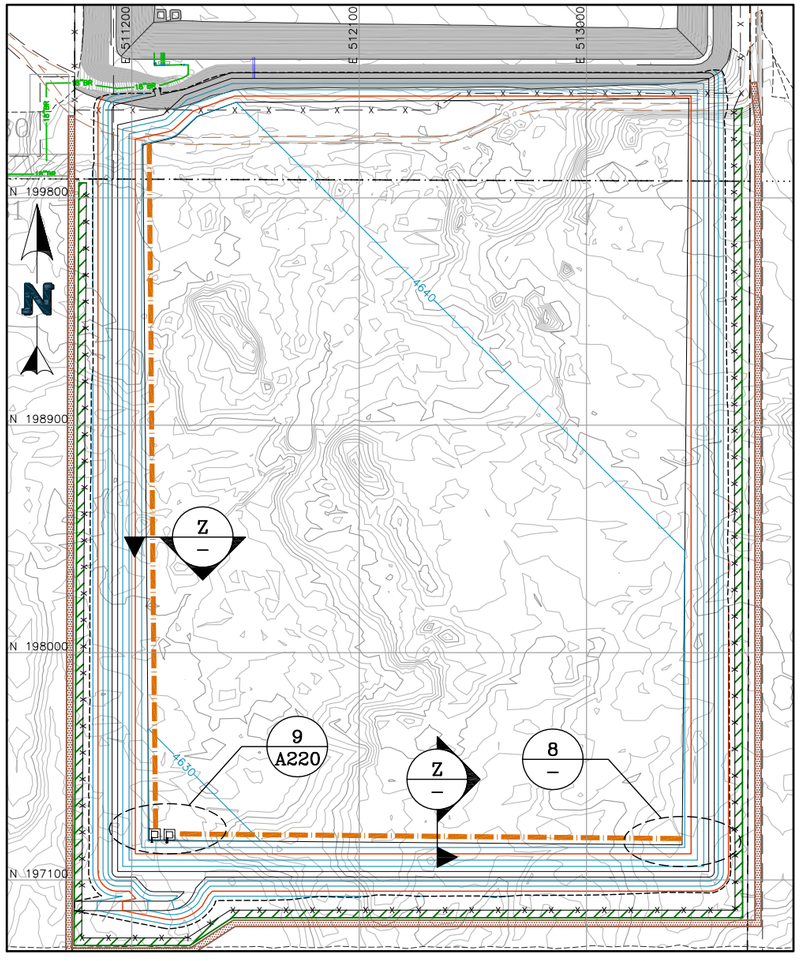
PROJECT: SAWTOOTH BRINE POND 2

TITLE: POND INLET DETAILS

FILENAME: 93.003.002D

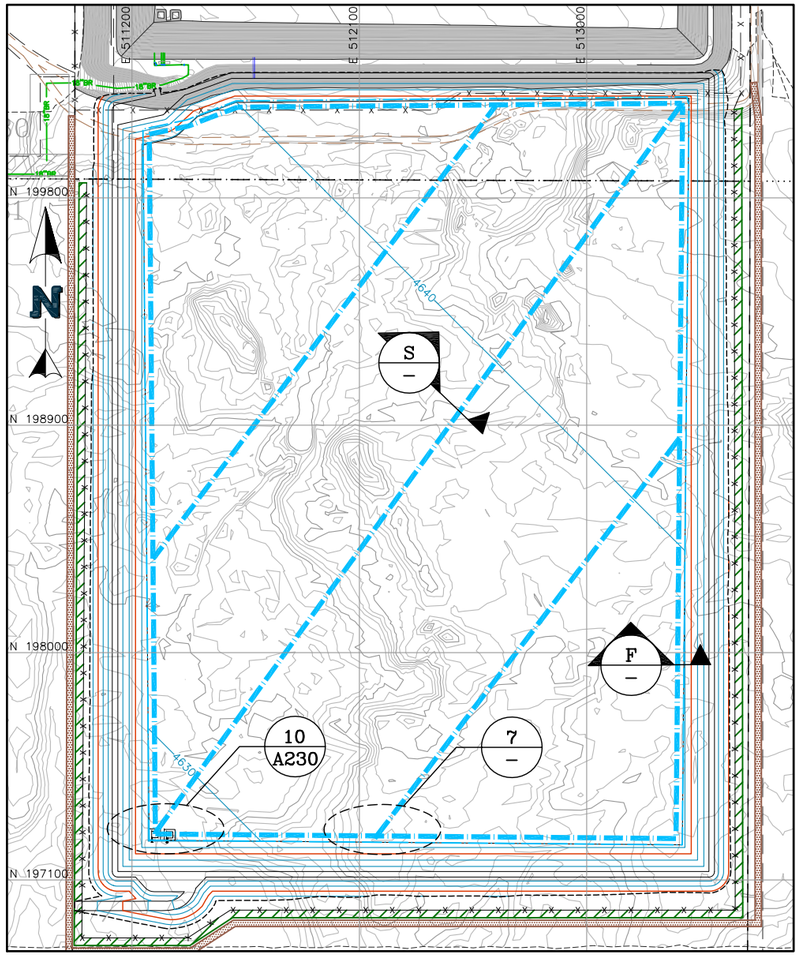
DRAWING NO.: A150

REVISION: 0



LCRS PIPING AND SUMP

0 300 600 FEET



PCMS PIPING AND SUMP

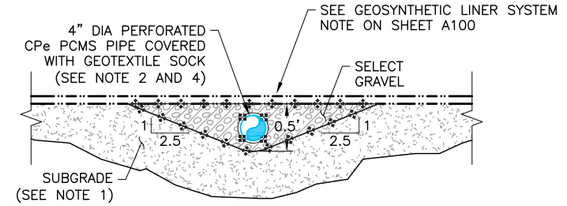
0 300 600 FEET

LEGEND:

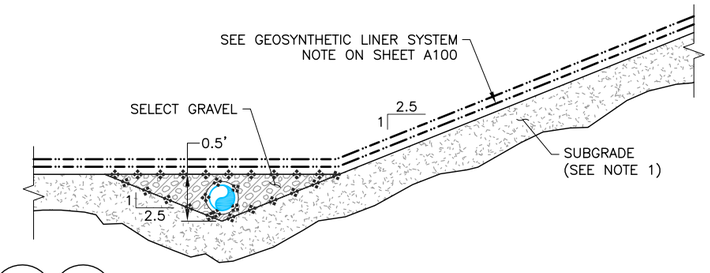
- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- SECTION LINES
- 20 SECTION NUMBER
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- EXISTING BRINE LINE
- 4 IN DIA. PERFORATED CPe COLLECTION LCRS PIPE
- 4 IN DIA. PERFORATED CPe COLLECTION PCMS PIPE
- VEGETATION WINDROW
- PROPOSED PERIMETER ROAD

NOTES:

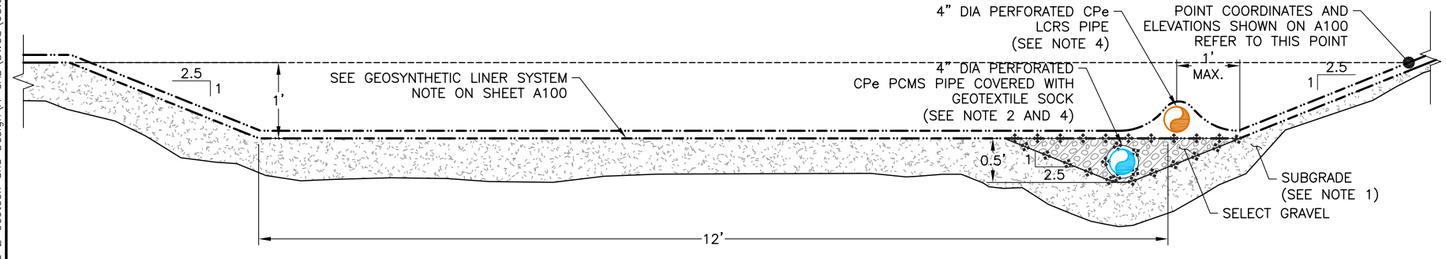
1. SEE EARTHWORKS MATERIALS AND CONSTRUCTION TECHNICAL SPECIFICATIONS SECTION 2.1.5 FOR PREPARING SURFACES TO RECEIVE GEOMEMBRANE.
2. GEOTEXTILE SOCK SHALL BE NON-WOVEN 10 oz/yd^2.
3. ALL PRIMARY LINER SHALL HAVE TEXTURED SIDE FACING UP.
4. PIPE PERFORATIONS SHALL BE IN ACCORDANCE WITH CLASS II AASHTO M252 SPECIFICATION OR APPROVED EQUIVALENT. (SLOT LENGTH = 0.875 IN., WIDTH = 0.125 IN.)



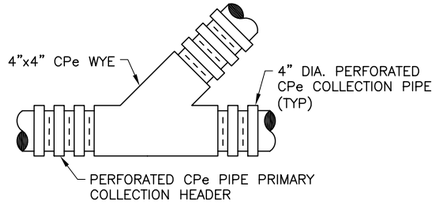
S — PCMS CHANNEL



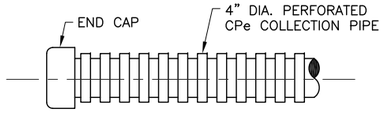
F A110 — F — TYPICAL EAST AND NORTH TOE DRAIN SECTION



Z — TYPICAL WEST AND SOUTH TOE DRAIN SECTION



7 — COLLECTION PIPE CONNECTION



8 — TYPICAL COLLECTION PIPE TERMINATION

REGISTERED PROFESSIONAL ENGINEER
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04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

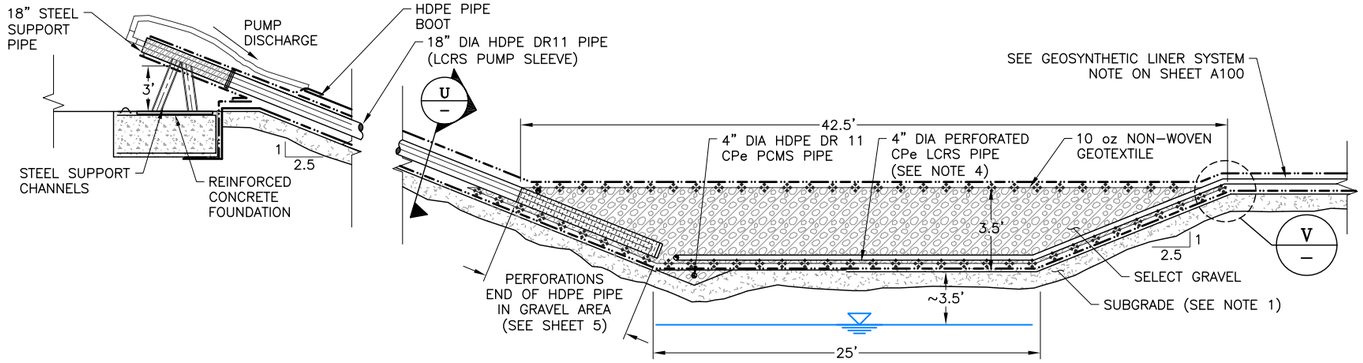
PROJECT: SAWTOOTH BRINE POND 2

TITLE: POND BASIN PIPING

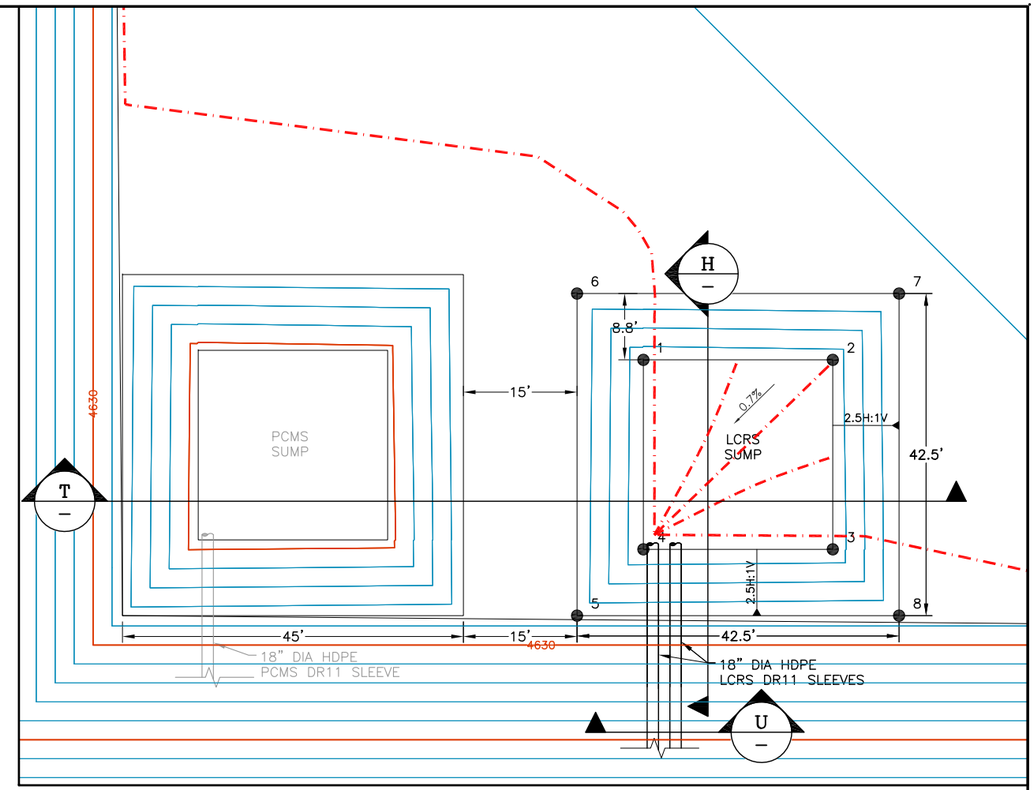
FILENAME: 93.003.006D

DRAWING NO.: A200

REVISION: 0

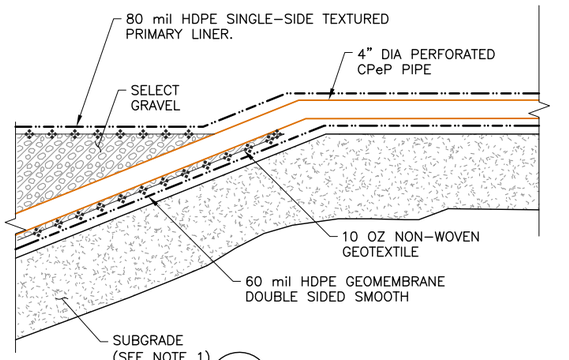


H A120 H — TYPICAL LCRS SUMP SECTION

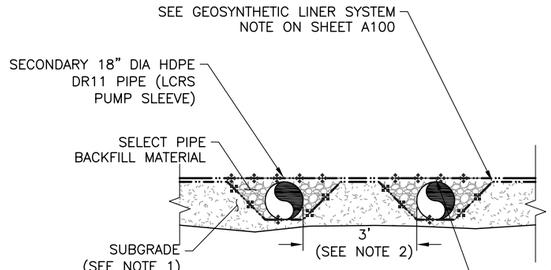


9 A200 LCRS PIPING AND SUMP

0 10 20 FEET

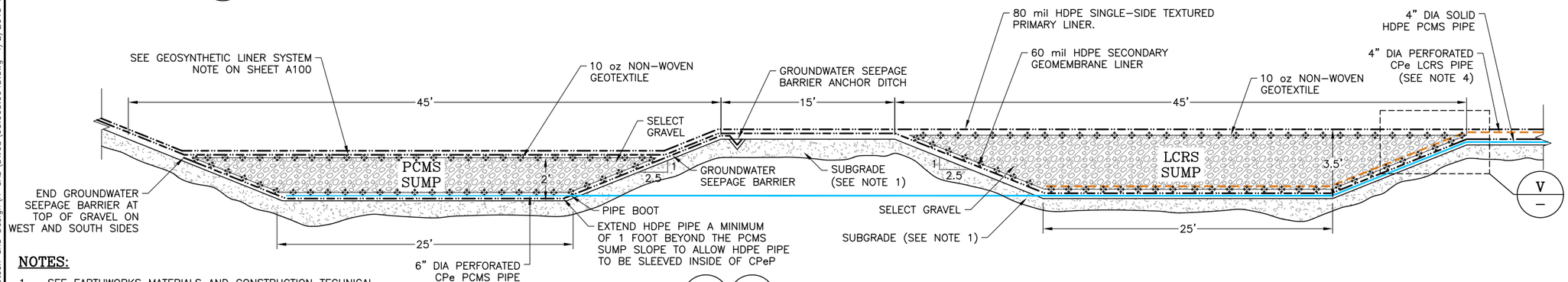


V — LCRS GEOSYNTHETICS DETAIL



U — LCRS PIPE

SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	197,291.00	511,336.55	4,625.28
2	197,291.00	511,361.55	4,625.43
3	197,266.00	511,361.55	4,625.28
4	197,266.00	511,336.55	4,625.19
5	197,257.25	511,327.80	4,628.66
6	197,299.75	511,327.80	4,628.81
7	197,299.75	511,370.30	4,628.96
8	197,257.25	511,370.30	4,628.81



T A230 T — LCRS AND PCMS SECTION

NOTES:

1. SEE EARTHWORKS MATERIALS AND CONSTRUCTION TECHNICAL SPECIFICATIONS SECTION 2.1.5 FOR PREPARING SURFACES TO RECEIVE GEOMEMBRANE.
2. PIPE SPACING CAN BE ADJUSTED TO ACCOMMODATE PIPE BOOT CONSTRUCTION AT THE CREST.
3. ALL PRIMARY LINER SHALL HAVE TEXTURED SIDE FACING UP.
4. PIPE PERFORATIONS SHALL BE IN ACCORDANCE WITH CLASS II AASHTO M252 SPECIFICATION OR APPROVED EQUIVALENT. (SLOT LENGTH = 0.875 IN., WIDTH = 0.125 IN.)
5. THE PIPE SCREENS FOR THE LCRS PIPES SHALL HAVE ROWS CONTAINING FOUR 3/8" WIDE PERFORATIONS EQUALLY SPACED AROUND THE CIRCUMFERENCE OF THE PIPE, WITH 2-12" SPACING BETWEEN SLOTS. THE ROWS OF PERFORATIONS WILL BE SPACED AT 1-3/8" ON CENTER. THE LENGTH OF THE PERFORATED SECTIONS OF THE LCRS PIPE SCREENS WILL BE 5-FEET.

REGISTERED PROFESSIONAL ENGINEER
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04/06/15
STATE OF UTAH

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0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
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CLIENT MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT SAWTOOTH BRINE POND 2

TITLE LEAK COLLECTION AND RECOVERY SYSTEM DETAILS

FILENAME 93.003.004D

DRAWING NO. A220

REVISION 0

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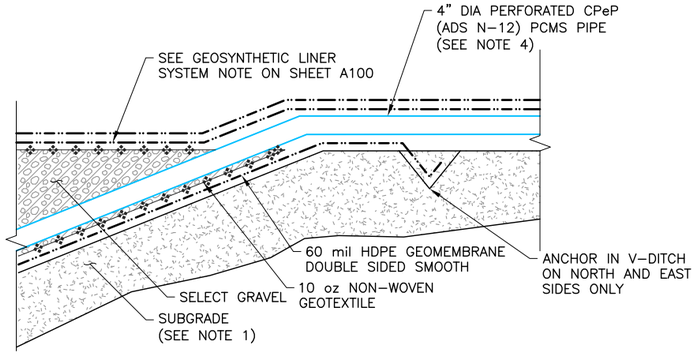
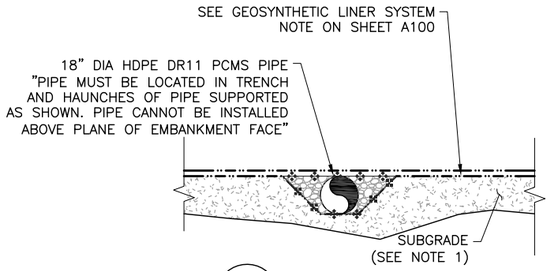
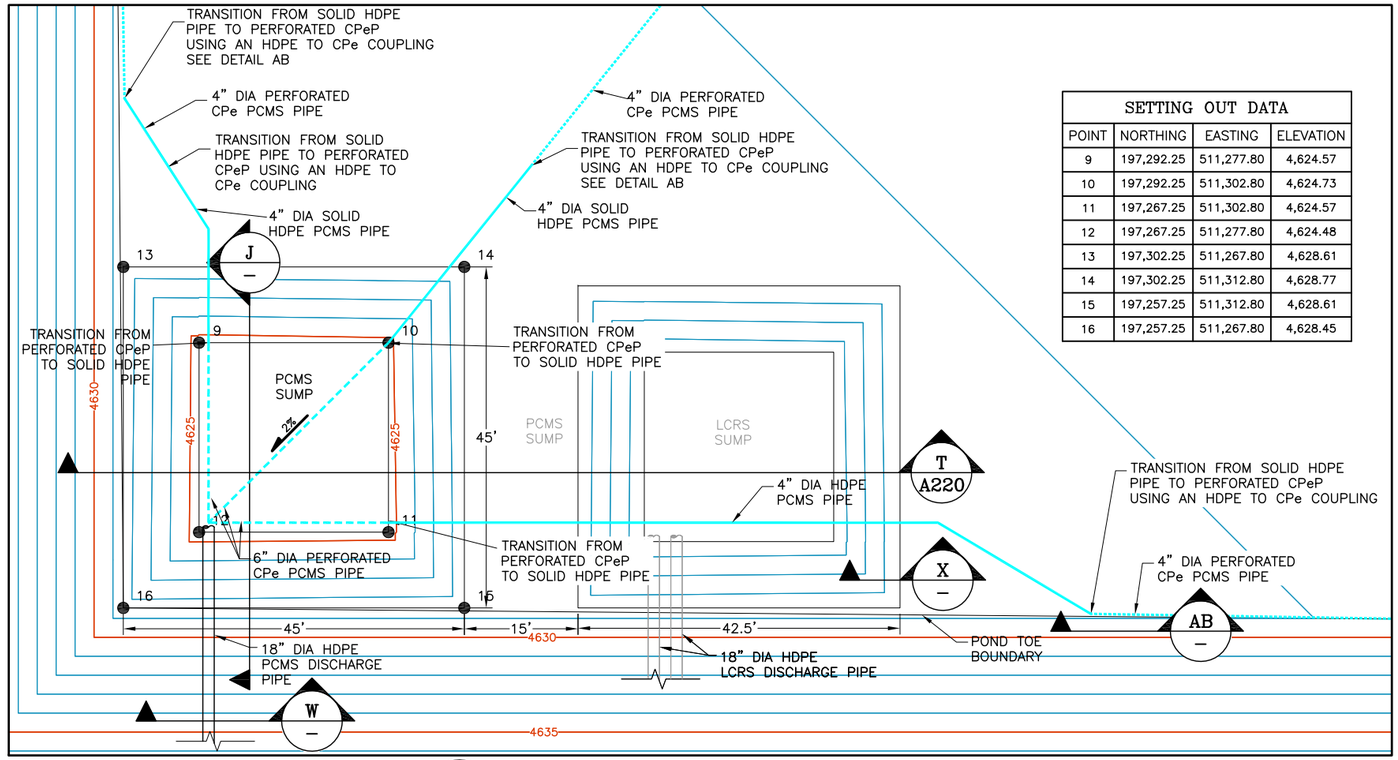


X — PCMS GEOSYNTHETICS DETAIL



W — PCMS PIPE



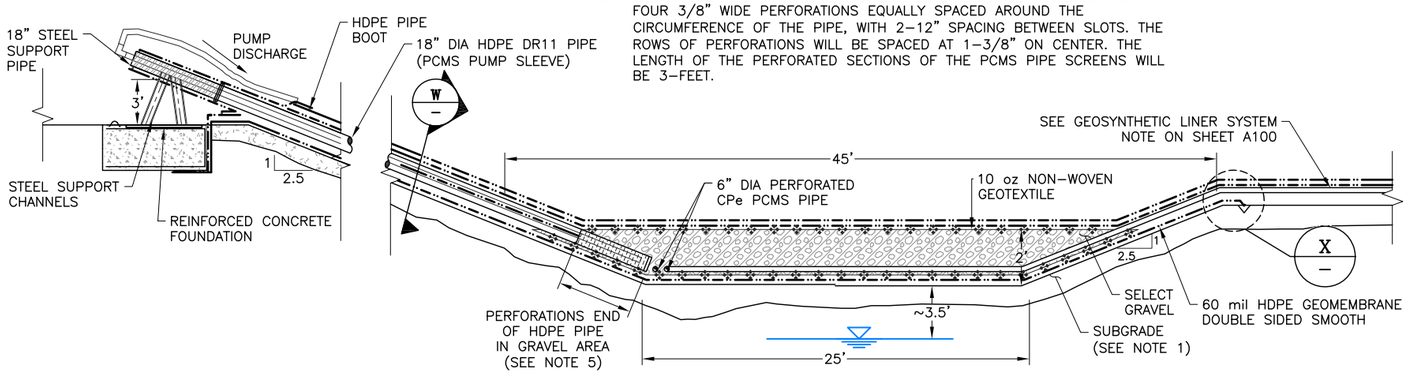
10 / A200 — PCMS PIPING AND SUMP

0 10 20 FEET

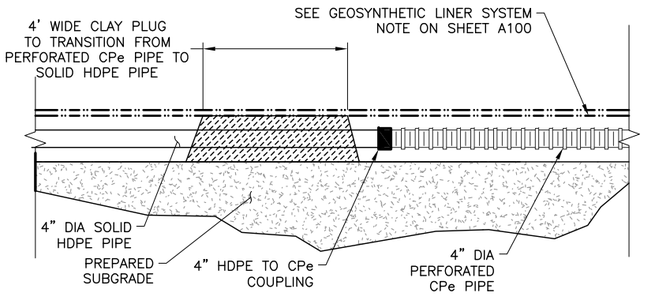
SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
9	197,292.25	511,277.80	4,624.57
10	197,292.25	511,302.80	4,624.73
11	197,267.25	511,302.80	4,624.57
12	197,267.25	511,277.80	4,624.48
13	197,302.25	511,267.80	4,628.61
14	197,302.25	511,312.80	4,628.77
15	197,257.25	511,312.80	4,628.61
16	197,257.25	511,267.80	4,628.45

NOTES:

1. SEE EARTHWORKS MATERIALS AND CONSTRUCTION TECHNICAL SPECIFICATIONS SECTION 2.1.5 FOR PREPARING SURFACES TO RECEIVE GEOMEMBRANE.
2. GEOTEXTILE SOCK SHALL BE NON-WOVEN 10 oz/yd^2.
3. ALL PRIMARY LINER SHALL HAVE TEXTURED SIDE FACING UP.
4. PIPE PERFORATIONS SHALL BE IN ACCORDANCE WITH CLASS II AASHTO M252 SPECIFICATION OR APPROVED EQUIVALENT. (SLOT LENGTH = 0.875 IN., WIDTH = 0.125 IN.)
5. THE PIPE SCREENS FOR THE PCMS PIPES SHALL HAVE ROWS CONTAINING FOUR 3/8" WIDE PERFORATIONS EQUALLY SPACED AROUND THE CIRCUMFERENCE OF THE PIPE, WITH 2-12" SPACING BETWEEN SLOTS. THE ROWS OF PERFORATIONS WILL BE SPACED AT 1-3/8" ON CENTER. THE LENGTH OF THE PERFORATED SECTIONS OF THE PCMS PIPE SCREENS WILL BE 3-FEET.



J / A120 — J / — TYPICAL PCMS SUMP SECTION



AB / — PCMS PIPE TRANSITION FROM PERFORATED TO SOLID

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
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04/06/15
STATE OF UTAH

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DESIGNED BY: RGF
DRAWN BY: RGF

NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: PROCESS COLLECTION AND MONITORING SYSTEM DETAILS

FILENAME: 93.003.003D

DRAWING NO.: A230

REVISION: 0

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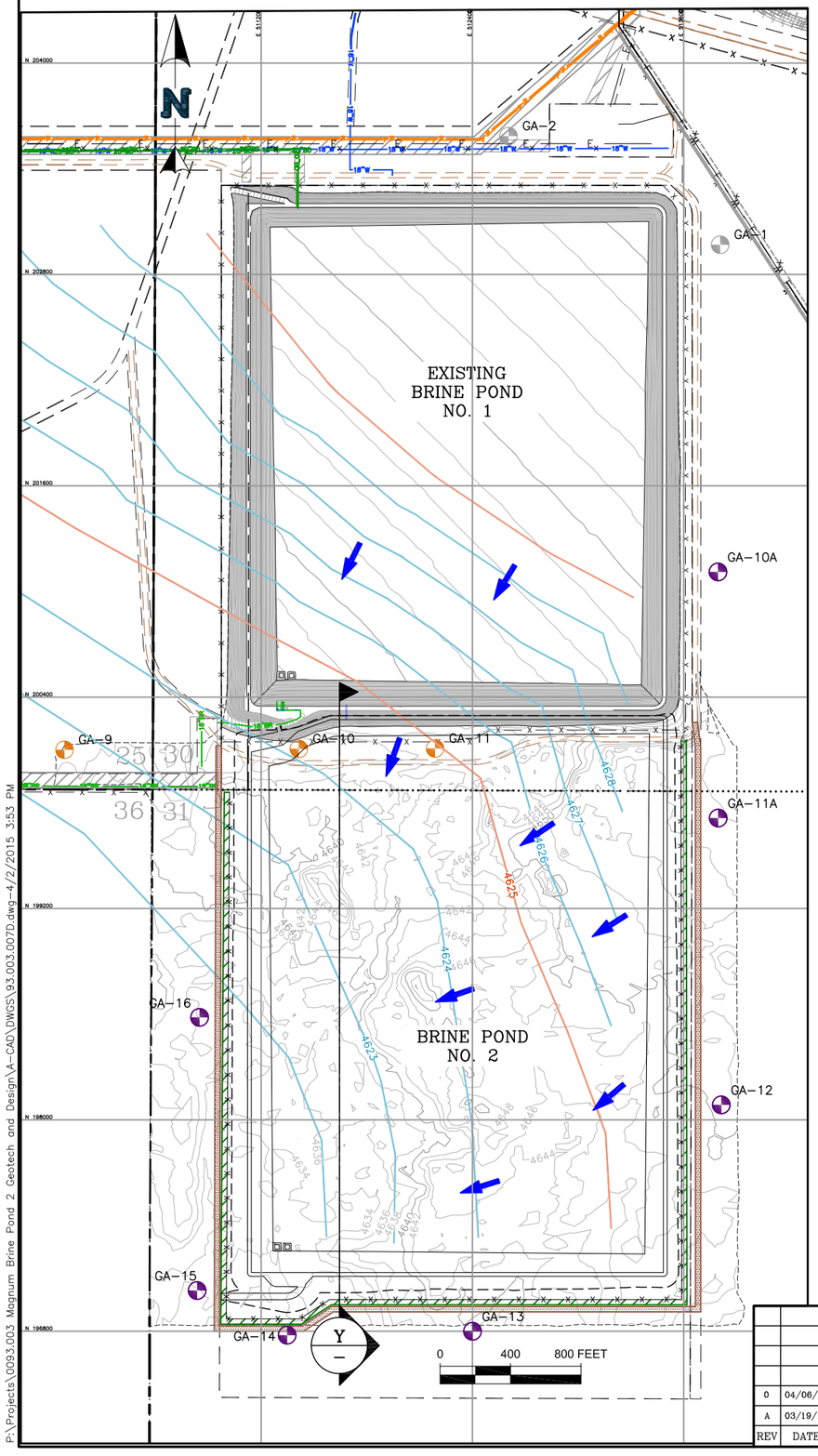

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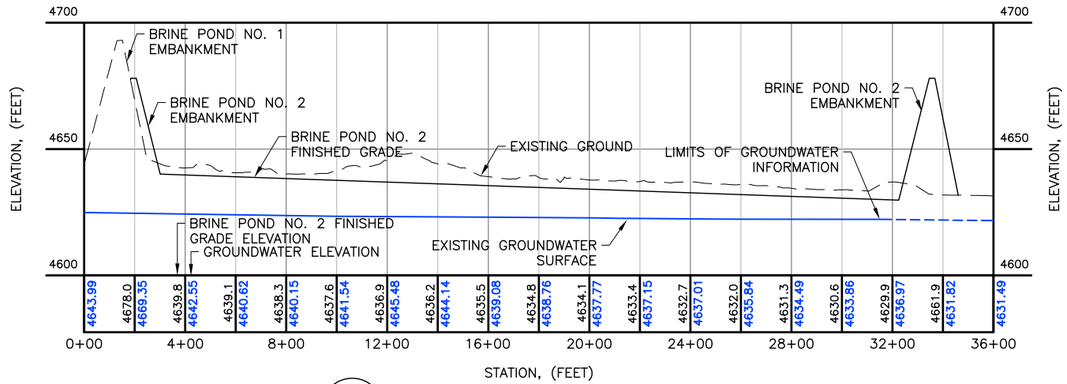


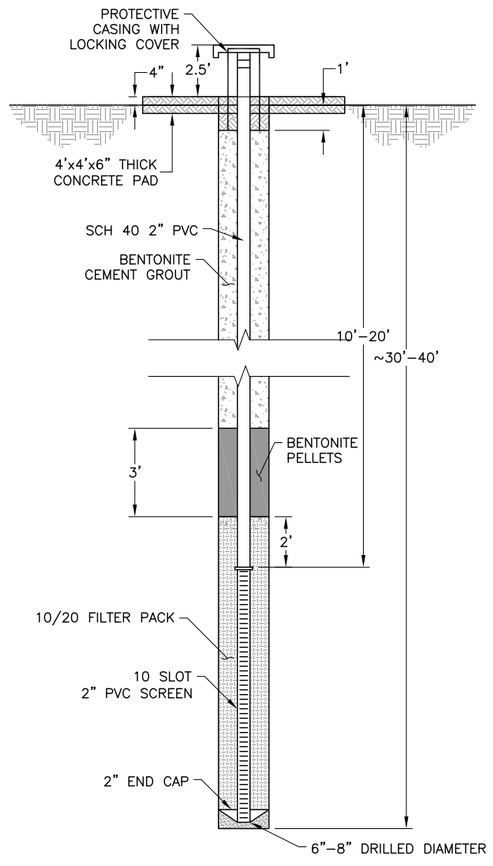
Y
–

BRINE POND NO. 2 GROUNDWATER DEPTHS

0 300 600 FEET — HORIZONTAL

0 30 60 FEET — VERTICAL

10X EXAGGERATION



TYPICAL GROUNDWATER MONITORING WELL DETAIL

LEGEND:

- EXISTING GROUND CONTOURS
- APPROXIMATE GROUNDWATER CONTOURS BASED ON MARCH 2015 SITE INVESTIGATION AND IGES 2011 SITE INVESTIGATION
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- EXISTING FENCE
- PROPOSED WILDLIFE FENCE
- 18"BR — EXISTING BRINE LINE
- VEGETATION WINDROW
- PROPOSED ACCESS ROAD
- GA–01 — EXISTING GROUND WATER MONITORING WELLS TO REMAIN
- GA–10 — EXISTING GROUND WATER MONITORING WELLS TO BE ABANDONED
- GA–12 — PROPOSED GROUND WATER MONITORING WELLS
- APPROPRIATE GROUNDWATER FLOW DIRECTION

PROPOSED MONITORING WELL LOCATIONS

POINT	NORTHING	EASTING
GA–10A	201,111.27	513,793.96
GA–11A	199,713.92	513,795.17
GA–12	198,085.38	513,812.74
GA–13	196,800.00	512,400.00
GA–14	196,777.92	511,347.28
GA–15	197,031.37	510,836.11
GA–16	198,582.32	510,850.02

REGISTERED PROFESSIONAL ENGINEER
No. 7935651-2202
MATTHEW THOMAS HALEY
04/06/15
STATE OF UTAH

REV	DATE	DESCRIPTION	TECH	ENG
0	04/06/15	ISSUED FOR PERMITTING	RGF	MTH
A	03/19/15	70% SET ISSUED FOR CLIENT REVIEW	RGF	MTH

APPROVED BY: MTH
CHECKED BY: KNJ
DESIGNED BY: RGF
DRAWN BY: RGF

DISCLAIMER

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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

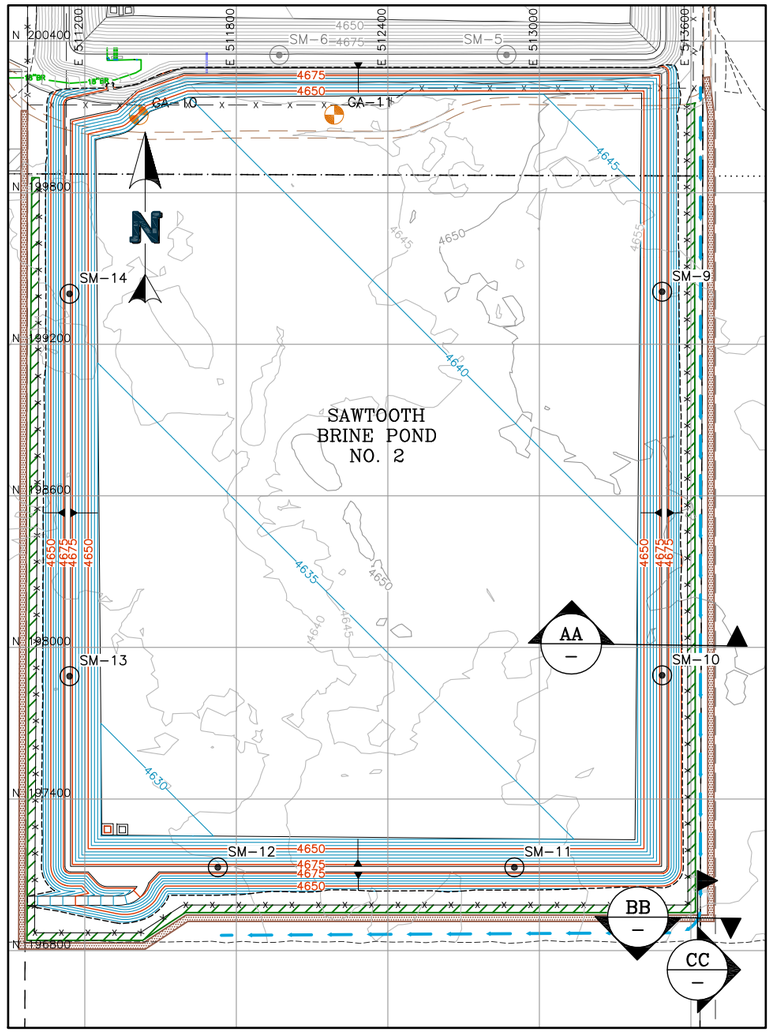
PROJECT: SAWTOOTH BRINE POND 2

TITLE: POND SITE GROUNDWATER DEPTHS PLAN AND PROFILE

FILENAME: 93.003.007D

DRAWING NO.: A300

REVISION: 0

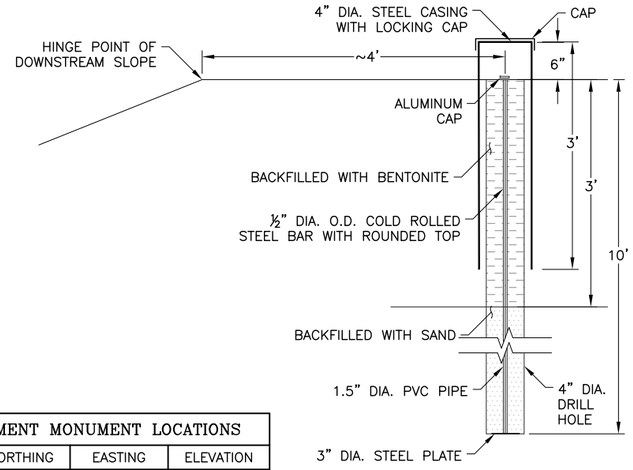


0 300 600 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED BRINE POND NO. 2 GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING EASEMENTS
- SITE BOUNDARY
- EXISTING FENCE
- PROPOSED FENCE
- EXISTING BRINE LINE
- PROPOSED STORMWATER DIVERSION CHANNEL
- SM-5 EXISTING EMBANKMENT SETTLEMENT MONUMENTS
- SM-9 PROPOSED EMBANKMENT SETTLEMENT MONUMENTS (SEE NOTE 6)
- VEGETATION WINDROW
- PROPOSED PERIMETER ROAD

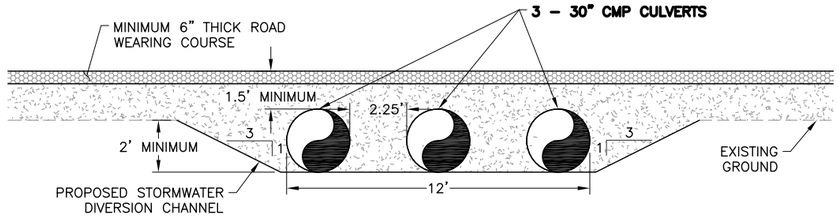
SETTLEMENT MONUMENT LOCATIONS			
POINT	NORTHING	EASTING	ELEVATION
SM-9	199,408.10	513,485.93	4,678.00
SM-10	197,889.62	513,485.93	4,678.00
SM-11	197,129.38	512,900.93	4,678.00
SM-12	197,129.38	511,726.93	4,678.00
SM-13	197,886.20	511,139.93	4,678.00
SM-14	199,399.84	511,139.93	4,678.00



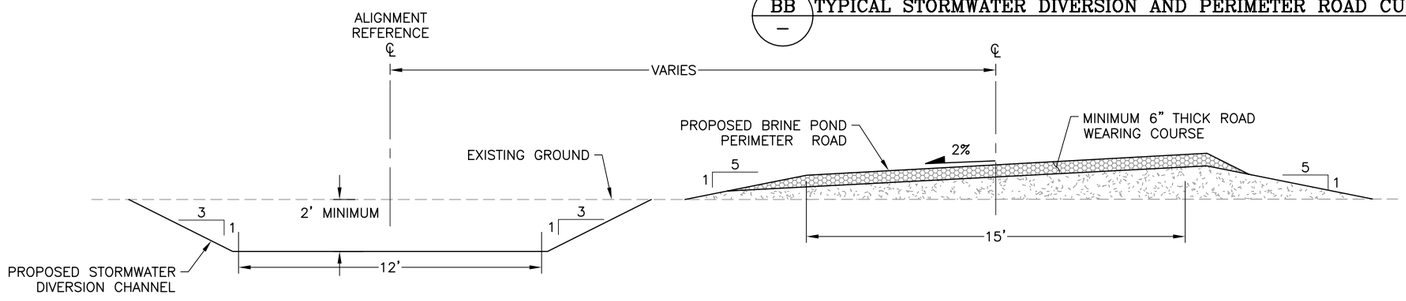
TYPICAL SETTLEMENT MONUMENT

NOTES:

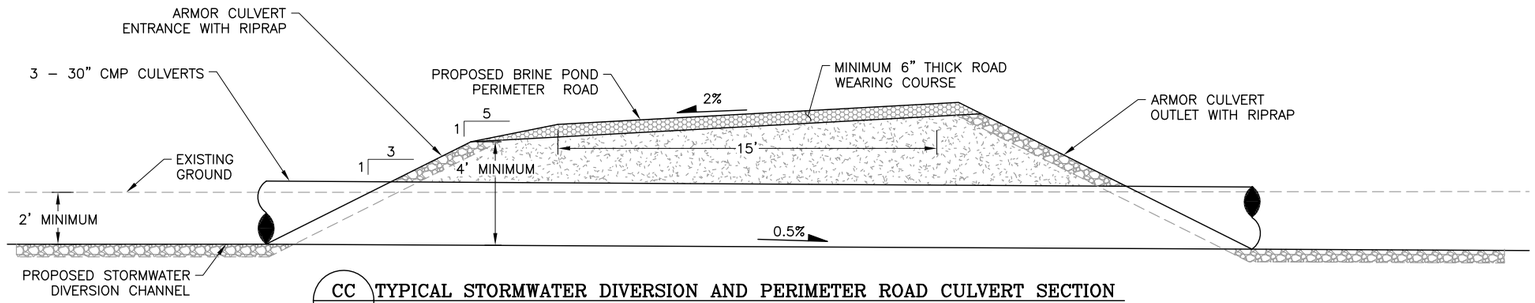
1. FINAL LOCATION OF ROAD AND DIVERSION CHANNEL TO BE DETERMINED DURING CONSTRUCTION BY THE FIELD ENGINEER.
2. DIVERSION CHANNELS SHALL BE CONSTRUCTED AT A MINIMUM 0.3% SLOPE TO MINIMIZE EARTHWORKS.
3. DIVERSION CHANNELS SHALL BE CONSTRUCTED WITH A MINIMUM 2 FOOT DEPTH.
4. BRINE POND PERIMETER ROAD SHALL BE CONSTRUCTED WITH A MINIMUM 6" THICK WEARING COURSE.
5. CULVERTS AND LOCAL DITCHES SHALL BE CONSTRUCTED AS REQUIRED TO MINIMIZE PONDING OF SURFACE WATER, LOCATIONS TO BE DETERMINED IN THE FIELD.
6. FINAL LOCATION OF SETTLEMENT MONUMENTS TO BE DETERMINED DURING CONSTRUCTION BY THE OWNER OR OWNER'S REPRESENTATIVE.
7. FIELD VERIFY AND EXTEND CHANNEL IF NECESSARY TO ALLOW PROPER DRAINAGE SLOPE.
8. THE DIVERSION CHANEL SHALL BE GRADED AS SUCH TO OUTFALL INTO NATURAL DRAINAGE WAYS WHEN POSSIBLE.



BB – TYPICAL STORMWATER DIVERSION AND PERIMETER ROAD CULVERT SECTION



AA – TYPICAL STORMWATER DIVERSION AND PERIMETER ROAD SECTION



CC – TYPICAL STORMWATER DIVERSION AND PERIMETER ROAD CULVERT SECTION

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04/06/15
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NewFields

CLIENT: MAGNUM DEVELOPMENT SOLUTION MINING

PROJECT: SAWTOOTH BRINE POND 2

TITLE: STORMWATER DIVERSION PLAN

FILENAME: 93.003.008D

DRAWING NO.: A400

REVISION: 0

P:\Projects\0093.003 Magnum Brine Pond 2 Geotech and Design\A-CAD\DWGS\93.003.008D.dwg-4/2/2015 2:39 PM