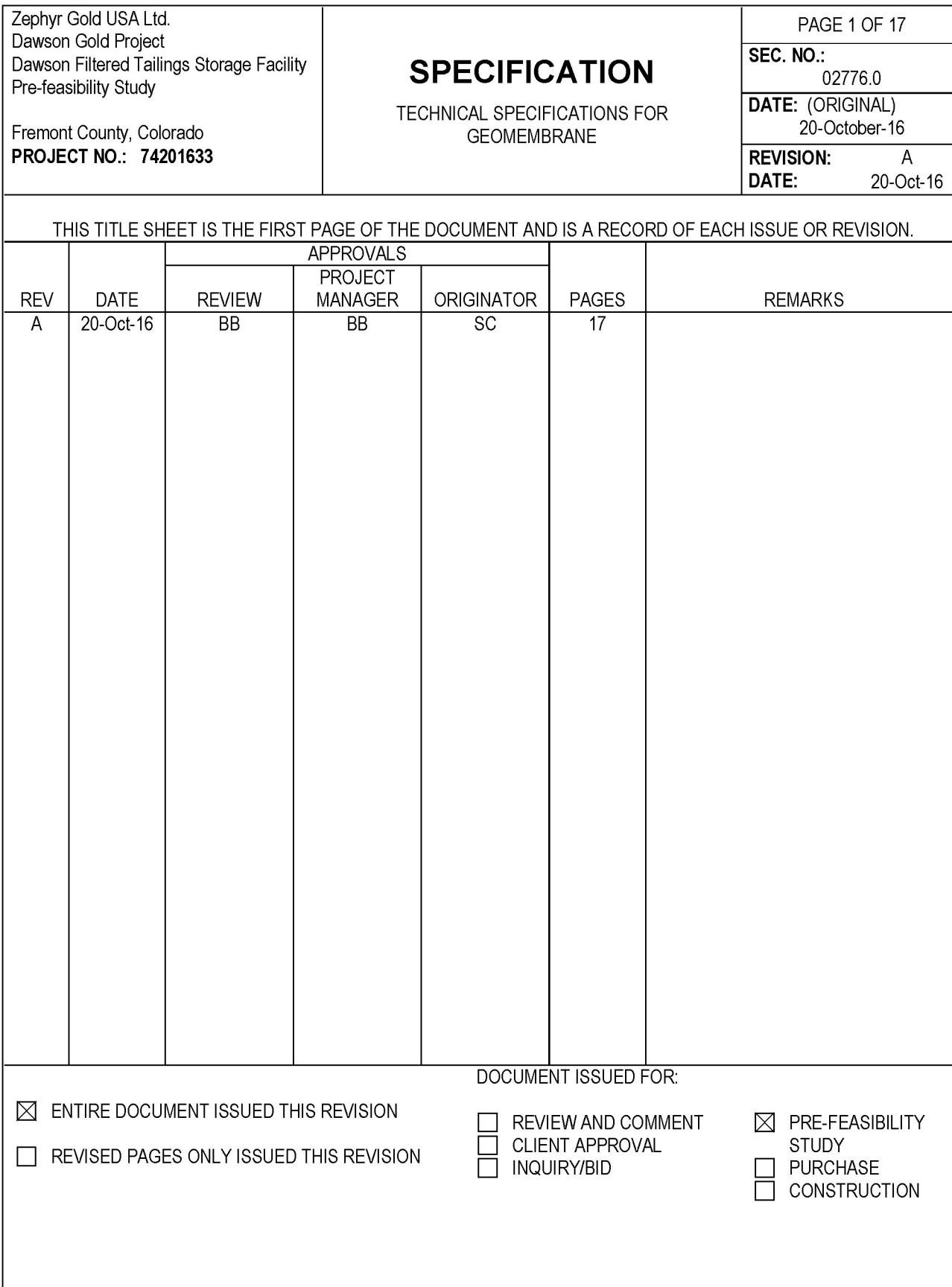


APPENDIX F: TECHNICAL SPECIFICATIONS AND CQA PLANS



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1.0 GENERAL

1.1 SUMMARY

This SPECIFICATION was prepared for the Pre-feasibility Study for the Dawson Filtered Tailings Storage Facility (FTSF). This SPECIFICATION describes requirements for the manufacture, fabrication (if needed), supply, and installation of polyethylene geomembrane for lining the contact water pond associated with the Dawson Filtered Tailings Storage Facility (FTSF) as developed for the Pre-feasibility level design. These SPECIFICATIONS are not intended for construction or bidding purposes.

1.2 CONSTRUCTION QUALITY ASSURANCE

All Work shall be constructed, monitored, and tested in compliance with the requirements of the CQA Plan (Section 01400.2). **CONTRACTOR** and **MANUFACTURER** shall participate in and comply with all items in these SPECIFICATIONS and requirements of the CQA Plan. Quality Control testing shall be the responsibility of the **INSTALLER**.

1.2.1 FIELD SAMPLES

Geomembrane sampling and testing shall be conducted in accordance with the project SPECIFICATIONS for the following:

- Trial seam testing
- Destructive seam testing

CONTRACTOR shall maintain on-site a minimum of one spare operable tensiometer and provide documentation indicating that all tensiometers used at the project were calibrated within sixty (60) days prior to the tensiometer arriving on-site for testing field samples.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 PACKING AND SHIPPING

Labels on each roll delivered to Site shall identify the following:

- **MANUFACTURER'S** name;
- Product Identification;
- Thickness;

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- Roll number;
- Batch or lot number; and
- Roll dimensions.

Geomembrane delivered to the project shall be protected by a relatively impermeable and opaque protective cover, with individual straps for unloading.

1.3.2 STORAGE AND PROTECTION

MANAGER will provide area for on-site storage of the geomembrane rolls from time of delivery until installation.

The storage and handling of the materials is the responsibility of **CONTRACTOR** from the time the materials are manufactured until the time the completed installation is accepted. **CONTRACTOR** is responsible for preparing the storage location and for the protection of the materials from the elements (e.g., ultraviolet light, moisture, temperature, etc.). After **CONTRACTOR** has removed material from storage, **CONTRACTOR** shall protect geomembrane from puncture, dirt, grease, water, moisture, mud, mechanical abrasion, excessive heat or cold, and other sources of damage.

CONTRACTOR shall preserve integrity and readability of the geomembrane roll labels, and store the rolls such that **CONSTRUCTION MANAGER** and **CQA MONITOR** have access to the package slips or roll labels for each roll to verify roll acceptance.

The geomembrane rolls shall be stored on a prepared surface (not wooden pallets) and should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four rolls).

1.4 SITE CONDITIONS

1.4.1 GEOMEMBRANE DEPLOYMENT

Do not proceed with deployment at an ambient temperature below -14°F or above 100°F unless otherwise authorized, in writing, by **MANAGER**, **ENGINEER**, and **CONSTRUCTION MANAGER**. Temperature monitoring shall be performed by the **CQA MONITOR**.

Do not deploy during precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

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Do not undertake deployment if weather conditions will preclude material seaming on same day as deployment.

1.4.2 SEAMING

1.4.2.1 NORMAL WEATHER CONDITIONS

Normal seaming procedures may take place if the following weather conditions exist:

- Ambient temperature between 35°F and 100°F;
- Dry conditions, i.e., no precipitation or other excessive moisture, such as fog or dew; and
- No excessive winds.

1.4.2.2 ADVERSE WEATHER CONDITIONS

Do not seam if ambient temperature is below 14°F or above 100°F. Do not seam during precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

If the ambient air temperature is between 14°F and 35°F for the entire shift, Cold Weather Seaming provisions will govern:

- The **INSTALLER** will be required to perform a minimum of four trial seams during the planned Work shift, at approximately the same time interval throughout the scheduled workday.
- If the subgrade materials are considered frozen, the **INSTALLER** must place seaming boards or slip sheets when seaming. Seaming boards or slip sheets shall be removed by **INSTALLER**.

2.0 PRODUCTS

The geomembrane shall be a single-sided textured high density polyethylene (HDPE). The geomembrane shall be manufactured of new, first-quality resin and shall be manufactured specifically for this type of application. No inclusion of reclaimed polymer is acceptable.

The resin **MANUFACTURER** shall certify each batch of raw material for the following properties:

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TABLE 02776.0-1
HDPE GEOMEMBRANE RESIN PROPERTIES

Property	Test Method	Requirements
Base Resin Specific Gravity (g/ml)	ASTM D1505	>0.932
Melt Flow Index (g/10 min.)	ASTM D1238	≤1.0

The **MANUFACTURER** of HDPE products is required to meet the Geosynthetic Research Institute (GRI) Test Method GM13 standards.

The geomembrane sheet shall be comprised of a minimum ninety-six (96) percent pure polyethylene. The remaining portion shall be made up of materials necessary for the performance of the liner (such as carbon black, anti-oxidants, etc.). The geomembrane rolls shall meet the following SPECIFICATIONS:

- The surface of the geomembrane shall not have striations, roughness (except texture as specified), pinholes, or bubbles and shall be free of holes, blisters, undispersed raw materials, or any contamination by foreign matter. **MANAGER** and **CONSTRUCTION MANAGER** may request additional testing in order to support such acceptance. All such testing shall be done at the sole expense of the **CONTRACTOR**.
- Contain a maximum of two (2) percent by weight of additives, fillers or extenders (not including carbon black).
- Contain between two (2) percent and three (3) percent carbon black for ultra-violet light resistance.
- The geomembrane rolls shall have the properties presented in Table 02776.0-2 for single-sided textured HDPE geomembrane.

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TABLE 02776.0-2
TYPICAL 60 mil SINGLE-SIDED TEXTURED HDPE GEOMEMBRANE PROPERTIES

Property	Test Method	Requirements
Thickness (minimum average), mils Lowest individual for 8 out of 10 values Lowest individual for any of the 10 values	ASTM D5994	57 54 51
Formulated Density (g/cm ³) Carbon Black Dispersion Carbon Black Content (%) Asperity Height	ASTM D1505/D792 ASTM D5596 ASTM D4218 ASTM D7466	0.940 (See Note 1) 2.0 – 3.0 16 mil (min. ave.)
Tensile Properties (each direction)² Yield Strength, lb/in Yield Elongation, % Break Strength, lb/in Break Elongation, %	ASTM D6693, Type IV	126 (min. ave.) 12% 90 (min. ave.) 100% (min. ave.)
Puncture Resistance (lb)	ASTM D4833	90 (min. ave.)
Tear Resistance (lb)	ASTM D1004	42 (min. ave.)
Field Fusion Seam Properties³ Peel Strength (lb/in) Shear Strength (lb/in)	ASTM D6392	91 120
Field Extrusion Seam Properties³ Peel Strength (lb/in) Shear Strength (lb/in)	ASTM D6392	78 120

Notes:

- Carbon Black dispersion (only applies to near spherical agglomerates) for 10 different views:
 - 9 or 10 views shall be Category 1 or 2; and
 - No more than 1 view from Category 3.
- 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 33 mm
 - Break elongation is calculated using a gage length of 50 mm
- 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.

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3.0 SEAMING AND TESTING EQUIPMENT:

3.1 SEAMING

Approved field seaming processes are hot shoe double fusion welding and extrusion welding, when approved by **ENGINEER**. Use double fusion welding as primary method of seaming adjacent field panels.

CONTRACTOR shall maintain on-site a minimum of two spare operable seaming apparatuses.

Welding rods or beads used for extrusion welding shall have the same physical properties as the resin used in the manufacture of the type of geomembrane that is being installed at the project.

CONTRACTOR shall use fusion welding apparatus which are self-propelled devices equipped with a gauge indicating temperature of heating element, and a gauge indicating the speed of the welding apparatus.

3.2 VACUUM TESTING (FOR EXTRUSION SEAM ONLY)

The equipment shall consist of the following:

- Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to the bottom of the housing or port hole and valve assembly, and vacuum gauge;
- Pump assembly equipped with pressure controller and pipe connections;
- Rubber pressure/vacuum hose with fittings and connections;
- Bucket of soapy solution; and
- Wide paint brush or other means of applying soapy solution.

3.3 AIR PRESSURE TESTING (FOR DOUBLE FUSION SEAM ONLY)

The equipment shall consist of the following:

- Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 25 and 30 psi and mounted on a cushion to protect geomembrane;
- Rubber hose with fittings and connections;
- Sharp hollow needle, or other approved pressure feed device; and
- An air pressure monitoring device.

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4.0 EXECUTION

4.1 SUBGRADE

INSTALLER, on a daily basis, shall certify in writing that the surface on which the geomembrane will be installed is acceptable. It will be the **CONTRACTOR'S** responsibility to maintain, protect, and if required return, the subgrade in the condition that was originally accepted, prior to geosynthetic deployment until accepted by **OWNER**, under criteria identified in Section 02200.0 as per the subgrade SPECIFICATIONS.

4.2 ACCEPTANCE

CONTRACTOR shall retain all ownership and responsibility for the geomembrane until final acceptance. The geomembrane shall be accepted by **OWNER** when all of the following conditions are met:

- Installation is finished;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;
- Certification, including QC documentation is provided by **CONTRACTOR** to **MANAGER**;
- Recommended acceptance by **MANAGER** and **ENGINEER**; and
- The entire Project is complete.

4.3 ANCHOR TRENCH

The anchor trenches shall be excavated to the lines, grades, and widths shown on the DRAWINGS, prior to geomembrane placement. **CONSTRUCTION MANAGER** shall verify that the anchor trench has been constructed according to the DRAWINGS.

The anchor trench shall be backfilled and compacted as approved by **MANAGER**, **ENGINEER** and **CONSTRUCTION MANAGER**. Trench backfill material shall be placed in 8-in to 12-in thick loose lifts and compacted by wheel rolling with light, rubber-tired or other light compaction equipment as approved by **ENGINEER**.

Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. At no time shall construction equipment come into direct contact with the geomembrane. If damage occurs, it shall be repaired by **CONTRACTOR** prior to the completion of backfilling, at no cost to **OWNER**.

Extend geomembrane into the anchor trench as shown in the DRAWINGS. The geomembrane shall be seamed along the entire distance of the anchor trench to the termination of the geomembrane sheet.

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4.4 FIELD SEAMS

4.4.1 SEAM LAYOUT

Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

No horizontal or base T-seam or tie-in seams shall be closer than 5 feet from the toe of the slope. Seams shall be aligned to prevent wrinkles and "fishmouths." If a fishmouth or wrinkle is found, it shall be removed and capped.

Panels of geomembrane will have sufficient overlap provided to allow peel tests to be performed on the seam.

4.4.2 SEAMING METHODS

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

CONTRACTOR shall use double fusion welding as the primary method of seaming adjacent field panels.

For cross seam tees associated with fusion welding, **CONTRACTOR** shall patch panel intersections consisting of three or more panels and extrusion weld to a minimum distance of 4 inches on each side of patch. The edge of the sheet shall be ground to a 45 degree angle prior to welding.

Use conventional extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair work.

4.5 SEAMING PROCEDURES

4.5.1 GENERAL

Areas to be seamed shall be cleaned and free of moisture, debris, or any marking on the geomembrane. Use a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support if required.

Cut fishmouths or wrinkles at the seam overlap along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate

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shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 in beyond the cut in all directions.

Extend seaming to the outside edge of panels placed in the anchor trench.

4.5.2 FIELD TRIAL SEAMS

Trial seams shall be conducted at the beginning of each seaming period and within thirty (30) minutes of commencement of seaming, at the **CONSTRUCTION MANAGER'S** discretion, and immediately following any Work stoppage (i.e., lunch, weather conditions, etc.) of thirty (30) minutes or more for each seaming apparatus used that day. Each Seamer shall make at least one trial seam each day.

All trial seams shall be made at a location selected by the **CQA MONITOR** in the area of the seaming and in contact with the subgrade. The trial seam samples shall be 10 ft long for fusion seaming and 5 ft long for extrusion seaming, with the seam centered lengthwise. Specimens 1 in. wide shall be cut from opposite ends of the test seam by **INSTALLER**. **INSTALLER** shall use a tensiometer to test these specimens for shear and peel. Both inside and outside tracks of fusion welds will be tested for peel. For both fusion and extrusion welds, two (2) coupons will be tested for peel and one (1) coupon for shear. The tensiometer shall have a grip separation of 4 in plus the width of the seam. The seam is to be centered between the clamps. These tests shall not fail according to the criteria in Article 2.0. A break through the weld or at the weld/sheet interface shall be considered a failure in both shear and peel strength tests unless the weld strength exceeds the sheet strength, as discussed in Article 2.0. If a trial seam fails to meet field seam SPECIFICATIONS, the seaming apparatus and/or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

CONTRACTOR shall mark the test weld with date, ambient temperature, welding machine number, welding technician identification, machine temperature and speed. For extrusion welding, **CONTRACTOR** shall record the nozzle and extrusion settings.

CONTRACTOR shall cut remainder of successful trial seams into two pieces, one to be retained in **OWNER'S** archives and one to be retained by **INSTALLER**.

4.6 NONDESTRUCTIVE TESTING

CONTRACTOR shall non-destructively test all field seams over their full length. All test equipment shall be furnished by **CONTRACTOR**.

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The following vacuum box procedures are applicable to extrusion seaming and shall be followed by **CONTRACTOR**:

- Excess sheet overlap shall be trimmed away.
- Clean the vacuum box window, gasket surfaces and check for leaks.
- Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
- Wet a strip of geomembrane the approximate dimensions of the vacuum box with the soapy solution.
- Place the box over the wetted area and compress.
- Close the bleed valve and open the vacuum valve.
- Ensure that a leak-tight seal is created.
- For a period of not less than ten (10) seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- If no bubbles appear after ten (10) seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-in overlap and repeat the process.
- All areas where soap bubbles appear shall be marked and repaired and then retested.
- Test locations, documentation number, date and tester will be indicated with an indelible marker on the geomembrane for each repair or seam section. The color code for indelible markers is to be determined at the Pre-construction Meeting, and strictly adhered too.

The following nondestructive test procedures are applicable to fusion seaming and shall be followed by **CONTRACTOR**:

- Seal one end of the seam to be tested.
- Insert needle or other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld.
- Energize the air pump to verify the unobstructed passage of air through the channel.
- Seal the other end of the channel.
- Energize the air pump to the pressure of approximately 30 psi, close valve, and sustain pressure for approximately five (5) minutes.

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<ul style="list-style-type: none"> • If loss of pressure exceeds 3 psi, or pressure does not stabilize, locate faulty area, repair and retest. • Puncture opposite end of the seam to release air. If blockage is present, locate and test seam on both sides of blockage. • Remove needle or other approved pressure feed device. • Repair pressure test locations as described in Article 4.8. • Beginning and ending pressures and times, test locations, documentation number, date and tester will be indicated with an indelible marker on the liner at each test interval location. <p>The following procedures shall apply to locations where seams cannot be non-destructively tested, as determined by CONSTRUCTION MANAGER:</p> <ul style="list-style-type: none"> • If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation. • If the seam cannot be tested prior to final installation, the seaming operations shall be observed by CQA MONITOR for uniformity and completeness. <p>In the event that seam continuity cannot be demonstrated for a non-destructive test of a fusion seam as outlined above, the CONTRACTOR shall perform the non-destructive testing over smaller areas as a means of defining the questionable area, and shall:</p> <ul style="list-style-type: none"> • Extrusion weld the outside edge of the questionable seam area and vacuum box test the extrusion weld; or • Cap the questionable area and vacuum test the cap. <p>4.7 DESTRUCTIVE TESTING</p> <p>INSTALLER shall test a minimum of one (1) destructive test sample per 500 ft of seam length from a location specified by the CQA MONITOR. INSTALLER shall not be informed in advance of the sample location. The samples shall be taken centered over the seam and prioritized as follows:</p> <ul style="list-style-type: none"> • A minimum of one sample per day; • All areas identified as suspect during seaming, non-destructive testing/monitoring, and in unusual working conditions. • A minimum of one sample for each geomembrane seamer. • A minimum of one sample every 500 ft of seaming. 		

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Samples shall be cut by **INSTALLER** as the seaming progresses. Sampling locations shall be determined by **CQA MONITOR**. **CQA MONITOR** must witness the obtainment of all destructive test samples by **INSTALLER**. **INSTALLER** shall mark all samples with their seam number, date, welding machine number, welding technician identification, extruder and nozzle/wedge temperature, and ambient air temperature. **INSTALLER** shall document the date, time, roll and seam number, ambient temperature, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested.

The samples shall be a minimum 12 in wide by 24 in long with the seam centered lengthwise. The sample shall be cut into two equal length pieces, half to be given to **OWNER** and the other half kept by **INSTALLER**.

INSTALLER shall cut and test ten (10) 1 in wide specimens from the destructive test sample. All testing shall be conducted at room temperature (60°F – 80°F). **INSTALLER** shall test five (5) specimens for seam shear strength and five (5) for peel strength. Both inside and outside tracks of fusion seams will be tested for peel strength. To be acceptable, four (4) out of the five (5) specimens must pass according to criteria established in Article 2.0. Any specimen that fails through the weld or at the weld/sheet interface shall be considered a failure, unless the weld strength exceeds the sheet strength, as discussed in Article 2.0 of this Section. The tensiometer shall have a grip separation of 4 inches plus the width of the seam. The seam is to be centered between the clamps. These tests shall not fail according to the criteria in Article 2.0.

Failing tests shall be subjected to additional testing until a passing area is found. A passing area is defined as a seam(s) bounded at each end by a passing destructive test. Seams will be tracked in each direction until a passing destructive test is found or until a previous passing destructive test is reached. Seams will be tracked according to the welding apparatus and the machine operator. The following procedures shall apply whenever a sample fails the field destructive test:

- **INSTALLER** can retrace the welding path to an intermediate location (at a minimum of 10 ft from the location of the failed test), at **CONSTRUCTION MANAGER'S** discretion, and take a small sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, the process shall be repeated.
- Over the length of seam failure, **INSTALLER** shall either cut out the old seam, reposition the panel and reseat, or add a cap strip, as required by **CONSTRUCTION MANAGER**.
- After reseaming or placement of the cap strip, additional destructive field test(s) shall be taken within the resealed area. The resealed sample shall be found acceptable if test results are approved by **CONSTRUCTION MANAGER**. If test results are not acceptable, this process shall

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<p>be repeated until the resealed length is judged satisfactory by MANAGER and CONSTRUCTION MANAGER.</p> <ul style="list-style-type: none"> Samples taken as the result of failed tests do not count toward the total number of destructive tests required. <p>INSTALLER shall document all actions taken in conjunction with destructive test failures, with CONSTRUCTION MANAGER providing Quality Assurance documentation.</p> <p>Cap strips shall be non-destructively tested as described in Article 4.6 of this Section.</p> <p>4.8 DEFECTS AND REPAIRS</p> <p>All seams and non-seam areas of the geomembrane shall be observed by CQA MONITOR for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of observation. The geomembrane surface shall be brushed, blown, or washed by INSTALLER if the amount of dust or mud inhibits inspection. MANAGER and CONSTRUCTION MANAGER shall determine if cleaning of the geomembrane is needed to facilitate observation at no additional cost to OWNER.</p> <p>Each suspect location in seam and non-seam areas shall be non-destructively tested as determined appropriate by CQA MONITOR, in the presence of CQA MONITOR. Each location that fails the non-destructive testing shall be marked by INSTALLER, and repaired accordingly.</p> <p>Defective seams shall be reconstructed as described in these SPECIFICATIONS.</p> <p>Small holes shall be repaired by abrading the sheet surface and welding an extrusion bead. If the hole is larger than one-quarter (1/4) inch in diameter, it shall be patched. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end, it must be rounded prior to patching. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.</p> <p>Surfaces of geomembrane that are to be patched shall be abraded and cleaned no more than fifteen (15) minutes prior to the repair. No more than ten (10) percent of the thickness shall be removed.</p> <p>Patches shall be round or oval in shape, and extend a minimum of 6 inches beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled to an approximate 45 degree angle with an angle grinder prior to placement of the patch. Patches shall be applied using approved methods only.</p>		

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Each repair shall be non-destructively tested, except when **CQA MONITOR** requires a destructive seam sample be obtained from a repaired seam. Repairs that pass the destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.

Recording the results:

- Daily documentation of all non-destructive and destructive testing shall be provided to **MANAGER** and **CONSTRUCTION MANAGER** by **CQA MONITOR**.
- This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

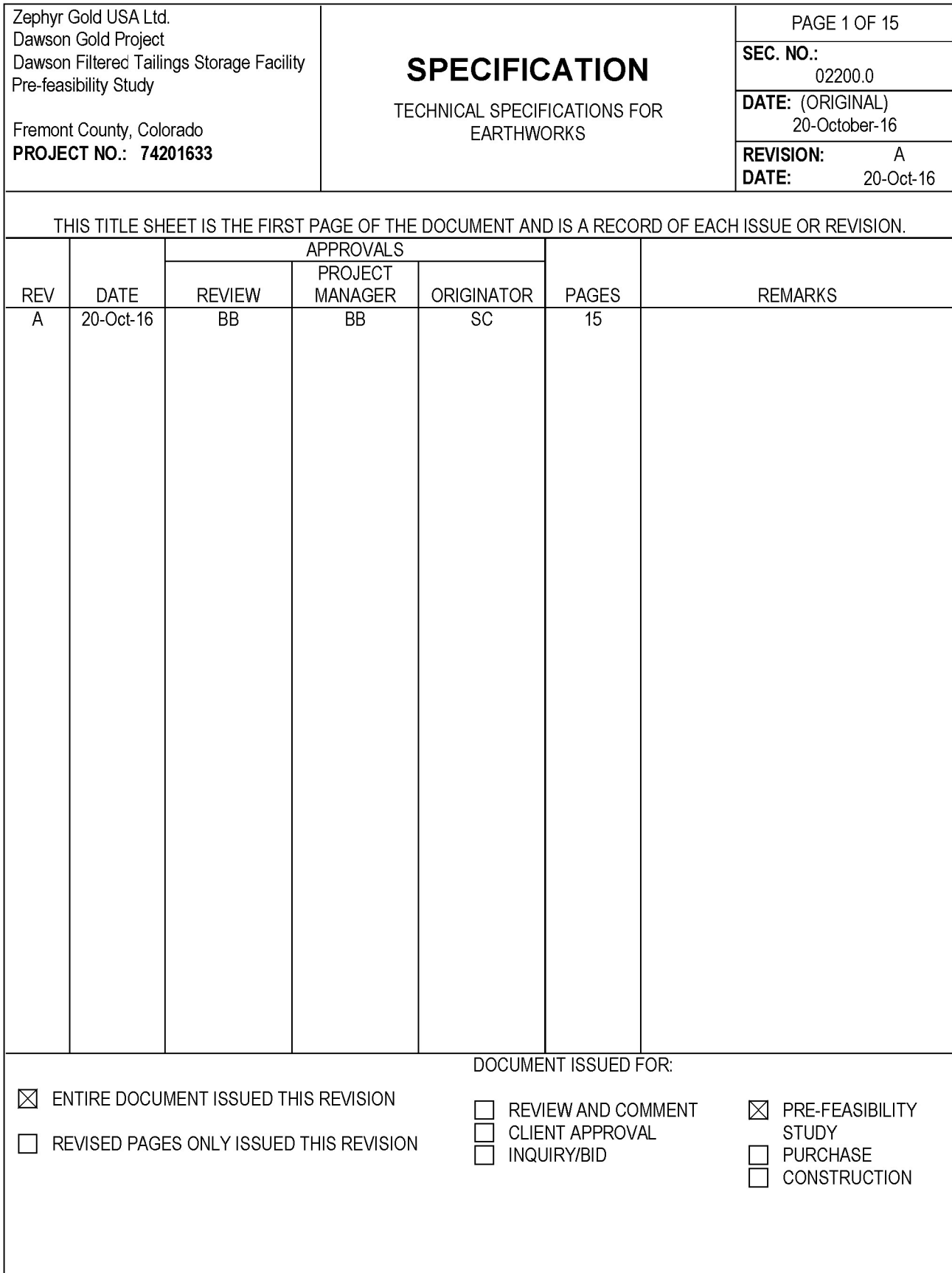
4.9 CONFORMANCE TESTING

During manufacturing of the geomembrane, **CQA MONITOR** will coordinate sampling and forwarding of samples to the Quality Assurance Testing Laboratory for testing to ensure conformance with the SPECIFICATIONS.

Samples will be taken across the entire width of the roll and shall not include the first three feet (3 ft). Unless otherwise stated, samples will be three (3) feet long by the width of the roll. **CQA MONITOR** will mark the machine direction on the samples with an arrow. Unless otherwise stated, samples shall be taken at a frequency of no less than one per one hundred fifty thousand (150,000) square feet. As a minimum, the following tests will be performed to verify conformance to the design SPECIFICATIONS with minimum values specified in Article 2.0 of this Section:

TABLE 02776.0-3
GEOMEMBRANE CONFORMANCE TESTING

Property	Test Method
Thickness (mm)	ASTM D5994/D5199
Formulated Density (g/cm ³)	ASTM D1505
Tensile Strength (Both yield and ultimate strength and elongation, as specified)	ASTM D6693, Type IV
Carbon Black Content (%)	ASTM D4218



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1.0 GENERAL

1.1 SUMMARY

This SPECIFICATION was prepared for the Pre-feasibility Study for the Dawson Filtered Tailings Storage Facility (FTSF). This SPECIFICATION describes the properties and placement requirements for earthworks materials for construction and operations of the FTSF as developed by the Pre-feasibility level design. These SPECIFICATIONS are not intended for construction or bidding purposes.

1.2 APPLICABLE STANDARDS

The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect at the date of the contract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the DRAWINGS, the Work included under this Section shall conform to the applicable provisions of these publications. Design of the work is based upon the American Society for Testing and Materials (ASTM) and United States Army Corp of Engineers (USACE) standards.

- ASTM C88 – Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
- ASTM C117 – Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C127 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C535 – Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils (SANS 201:2002)
- ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

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- ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75- μ m) Sieve
- ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D2216 – Standard Test Method for Laboratory Determination of Water Moisture Content of Soil and Rock by Mass
- ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (SANS 5852:1976)
- ASTM D5030 – Standard Test Method for Density of Soil and Rock in Place by Water Replacement Method in a Test Pit
- ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- U.S. Army Corps of Engineers, 1994. "Engineering and Design Test Quarries and Test Fills", EM 1110-2-2301.

1.3 DEFINITIONS

Borrow: Material excavated on the site or taken from designated borrow areas.

Coverage: One coverage is defined as the result of successive passes by a piece of compaction equipment, which by means of sufficient overlap, to ensure that all areas of the layer or lift being compacted have been subjected to one pass of the compaction equipment.

Fines: Material passing the 0.075 mm (No. 200) sieve.

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Lift: An individual layer of materials placed on the prepared surface (or prepared foundation surface in the case of the first lift) at the specified thickness and compacted in the specified manner or to the specified end product before placing the next layer (lift).

Lift Thickness: The thickness that materials are placed before being compacted with specified compaction effort.

Maximum Dry Density: The maximum dry unit weight of a soil by a given compactive effort.

Optimum Moisture Content: The water (moisture) content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

Percent Compaction: The ratio, expressed as a percentage, of the dry unit weight of a soil, to the maximum dry unit weight obtained in a laboratory compaction test at optimum moisture content.

Suitable Material: Imported material or material excavated from cut areas which meets the SPECIFICATION requirements for use in constructing fills and has been approved by the **ENGINEER**.

Unsuitable Materials: Materials that contain waste, debris, roots, organic matter, frozen matter, or any other materials determined by the **ENGINEER** to not meet the SPECIFICATIONS for any embankment zone or required fill, or any material not approved by the **ENGINEER**. Unsuitable material includes all material containing unbroken masses of earth materials which might arch or bridge and leave pockets or voids.

2.0 CONSTRUCTION QUALITY ASSURANCE:

All Work shall be monitored and tested in compliance with the requirements of the Earthworks CQA Plan (Section 01400.1). All CQA soils testing (both field and laboratory testing) will be the responsibility of **MANAGER** and **CQA MONITOR(S)**, as identified in the Earthworks CQA Plan (Section 01400.1). Quality Control testing shall be the responsibility of the **CONTRACTOR**.

3.0 MATERIALS

3.1 FILTERED TAILINGS

Tailings will be produced from gravity separation and flotation circuits and are assumed to be thickened prior to feeding to the tailings filter plant. The filtered tailings will be dewatered to a moisture content of approximately the standard Proctor (ASTM D698) optimum moisture content.

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A synthetic tailings sample generated from exploration core of the Windy Gulch deposit during the Pre-feasibility Study were found to be non-plastic and contain approximately 60% passing the #200 sieve by weight.

3.2 ROCKFILL

Rockfill shall consist of inorganic, non-mineralized (non-PAG) rock and will be used in the construction of the starter buttresses. It is anticipated that the rockfill will be sourced from non-mineralized mine waste rock, on-site quarries or imported. The **CONTRACTOR** will be responsible for loading, and transporting, placing and compacting Rockfill material. Rockfill shall meet the following specification:

Sieve Size	Percent Passing
12-inch	100
No. 4 (4.75 mm)	0 – 30
No. 200 (0.075 mm)	0 – 15

Non-plastic fines

Rockfill material shall have a maximum particle size of 12-inches or sixty-seven (67) percent of the approved lift height, whichever is smaller, unless otherwise approved by **ENGINEER**. Rockfill material shall be inert, hard and durable with a minimum uniaxial compressive strength of 40 MPa and no more than 45% loss during the Los Angeles Abrasion test

3.3 STRUCTURAL FILL

Structural Fill shall consist of inorganic structural earthfill used in the construction of the contact water pond berms and other ancillary fills as required. It is anticipated that native alluvial/colluvial soils at the project site may be used for structural fill. The **CONTRACTOR** will be responsible for excavating, sorting suitable from unsuitable materials, and loading, and transporting, placing, moisture conditioning and compacting Structural Fill material. Structural Fill shall meet the following specification:

Sieve Size	Percent Passing
3-inches	100
No. 4 (4.75 mm)	30 – 80
No. 200 (0.075 mm)	0 – 30

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3.4 GEOMEMBRANE CUSHION MATERIAL

Geomembrane Cushion Material shall consist of fine-grained soil placed as geomembrane bedding layer for the construction of the contact water pond as designated on the DRAWINGS. It is anticipated that the Geomembrane Cushion Material may be sourced from on-site alluvial/colluvial soils. The **CONTRACTOR** will be responsible for processing, loading, transporting, placing, moisture conditioning and compacting Geomembrane Cushion Material. The Geomembrane Cushion Material shall conform to the following gradation and plasticity requirements:

Sieve Size	Percent Passing
¾ inch	100
No. 4 (4.75 mm)	60 - 100
No. 200 (0.075 mm)	25 - 80

Plasticity Index (PI) > 10

3.5 UNDERDRAIN MATERIAL

Underdrain Material shall consist of processed material conforming to these SPECIFICATIONS and is to be used in construction of the underdrains. The **CONTRACTOR** will be responsible for manufacturing, loading, transporting, placing, processing and compacting Underdrain Material. The Underdrain Material shall be angular, durable, crushed, processed and screened, and shall conform to the following gradation and plasticity requirements:

Sieve Size	Percent Passing
¾ inch	95 - 100
No. 4 (4.75 mm)	70 - 100
No. 10 (2.00 mm)	50 - 80
No. 40 (0.425 mm)	10 - 50
No. 200 (0.075 mm)	0 - 5

Plasticity Index: Fines shall be non-plastic

Underdrain Material shall conform with ASTM C33 requirements for Abrasion and Magnesium Sulfate Soundness.

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3.6 EROSION PROTECTION LAYER

The Erosion Protection Layer shall consist of non-mineralized (non-PAG) sand and rock and will be used progressively placed on the downstream slope of the FTSF for erosion protection. It is anticipated that the material will be sourced from fine, non-mineralized mine waste rock, on-site quarries or imported. The **CONTRACTOR** will be responsible for loading, and transporting, placing the Erosion Protection Layer material. The Erosion Protection Layer material shall meet the following specification:

Sieve Size	Percent Passing
6-inch	100
3-inch	70 - 100
1.5 inch	50 – 90
3/4-inch	40 – 80
No. 4 (4.75 mm)	30 - 50
No. 200 (0.075 mm)	0 – 10

3.7 RIPRAP

Riprap will be used for erosion protection for diversion channels and contact water ditches. Riprap shall be composed of dense, angular, reasonably well-graded, sound fragments resistant to abrasion. Material shall be free of cracks, seams, clay, organic material and other defects that would hasten degradation by water and/or frost action. Rounded boulders or cobbles shall not be accepted as Riprap unless otherwise approved by the **ENGINEER**. Riprap material may be sourced from suitable non-mineralized waste rock, on-site quarries or imported from off-site. The **CONTRACTOR** will be responsible for manufacturing, loading, transporting, placing, and processing Riprap material.

Material for Riprap shall meet the following properties:

- The D₅₀ size for the Riprap material will be as shown on the DRAWINGS.
- Riprap shall be clean material, and shall not contain more than 5 percent fines (material passing the No. 200 sieve) by weight.

Riprap shall conform to the size types as follows:

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Riprap Stone Size	Percentage Passing
1.5 D ₅₀ to 1.7 D ₅₀	100
1.2 D ₅₀ to 1.4 D ₅₀	85
1.0 D ₅₀ to 1.4 D ₅₀	50
0.4 D ₅₀ to 0.6 D ₅₀	15

4.0 EXECUTION

4.1 CLEARING AND GRUBBING

Clearing and grubbing shall be done within the footprint of the limits of the construction area, as delineated on the DRAWINGS. Clearing shall extend a maximum of 30 feet and a minimum of 10 feet outside of the construction limits or as directed by **MANAGER**. Areas for clearing shall be released to **CONTRACTOR** by **MANAGER**. No pioneering of roads across undisturbed areas shall be allowed without prior approval of **MANAGER**.

Clearing shall consist of cutting brush to the ground level, removing such material, along with wood, rubbish, tree stumps, and any other vegetation with roots in excess of 1-inch diameter, and other deleterious materials. Stripped and grubbed vegetation shall be removed and disposed of in stockpiles or other approved methods in an area designated by **MANAGER**.

4.2 TOPSOIL REMOVAL

Topsoil is defined as an acceptable growth medium as approved by **MANAGER** that has no chemical or physical characteristics which will exclude its use as such. **CONTRACTOR** shall excavate and remove topsoil in a manner that will minimize contamination with other soil horizons, and will take such measures as are necessary to ensure that the removal of topsoil does not result in erosion or excessive sedimentation.

CONTRACTOR shall stockpile topsoil at locations designated by **MANAGER**. Stored topsoil shall not be disturbed by mining operations or construction activities, and shall be protected from wind and water erosion, compaction, and contamination. **CONTRACTOR** shall grade topsoil stockpiles to prevent erosion and ponding of precipitation in the stockpile areas. The maximum topsoil stockpile height will be approved by **MANAGER**. The **CONTRACTOR** shall protect stockpiled topsoil by an effective cover of

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non-noxious, quick-growing, annual and perennial plants, approved by **MANAGER**, which shall be seeded or planted during the first appropriate growing season after removal.

4.3 SUBGRADE PREPARATION AND FOUNDATION ACCEPTANCE

Rockfill and structural fill shall not be placed until the foundation has been inspected and accepted by the **CQA MONITOR(S)**. The **CONTRACTOR** shall remove unsuitable materials, roads, slope wash, and all other deposits that have accumulated within the area after excavation and foundation clearing have been completed in accordance with the **ENGINEER'S** recommendations.

The **CQA MONITOR(S)** will inspect and approve the exposed subgrade prior to any fill or geosynthetics being placed to confirm that the surface of the subgrade is smooth and free of debris, grade stakes, large rocks, roots, branches, vegetation, mud, or cracks larger than one-quarter inch (0.25 in) in width. The subgrade shall have no sudden sharp or abrupt changes in grade. Protrusions extending more than 0.5 inches from the surface shall be either removed, crushed, or pushed into the surface with a smooth-drum compactor.

Prior to placement of fill materials, **CONTRACTOR** shall scarify all in-situ materials to a depth of 6 inches, moisture condition, and recompact the subgrade. Compactive effort shall be adequate to obtain a minimum of ninety-five (95) percent of maximum dry density as determined by the Standard Proctor test (ASTM D698) for the particular fill material. Moisture conditioning shall be adequate to achieve a uniform moisture and density. If rock is encountered, the **CONTRACTOR** shall prepare the subgrade by removing loose rock fragments until competent foundation material is encountered as approved by **ENGINEER**.

4.4 CQA TESTING

The **CQA MONITOR(S)** will take samples of materials and perform testing in the borrow areas, stockpile areas, and the embankments as a quality assurance check on quality control testing done by the **CONTRACTOR**. Testing by the **CQA MONITOR(S)** will not relieve the **CONTRACTOR** of responsibility for quality control testing by the **CONTRACTOR** to ensure compliance with the SPECIFICATIONS. The results of field and laboratory testing will be made available to the **OWNER, MANAGER** and **CONTRACTOR**.

4.5 FILL PLACEMENT AND COMPACTION

4.5.1 GENERAL GUIDELINES

No fill materials shall be placed until the foundation and subgrade preparations have been completed. No organic soil, brush, roots, sod, or other deleterious or unsuitable materials shall be incorporated in the fills. The distribution of materials shall be such that the fill is free from voids, lenses, pockets, streaks, or layers

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of material differing substantially in texture or gradation from the surrounding material. The suitability of all materials intended for use in the fill shall be subject to approval by **MANAGER** and **ENGINEER**. Fill placement shall be temporarily stopped by **CONTRACTOR** due to weather conditions or if materials and installation do not meet the SPECIFICATIONS at no cost to **OWNER**.

CONTRACTOR shall apply water required for moisture conditioning on the fill or in the borrow areas. **CONTRACTOR** shall maintain fill materials within the moisture content range required to permit proper compaction to the specified density with the equipment being used. The moisture content of the fill materials, prior to and during compaction, shall be uniform throughout each layer of the material.

After each layer of fill has been placed, spread, and moisture-conditioned, the layer shall be compacted by passing compaction equipment over the entire surface of the layer a sufficient number of times to obtain the required density, as specified herein.

Placement, spreading, and compaction for embankments shall be done parallel to the embankment axis in that part of the embankment, unless otherwise specified by the **MANAGER** or **ENGINEER**. Materials shall be placed and spread over the surface of the underlying compacted lift. Coverage of the compaction equipment shall be carried out so that the compactive effort is uniformly distributed in a systematic manner over the entire lift. Compaction of individual lanes of a lift shall be completed before beginning compaction of adjacent portions of the lift. Individual lanes shall be overlapped by at least 1 ft.

4.5.2 FILTERED TAILINGS

Underdrain Tailings shall be placed according to a method specification based on a trial compaction program conducted at the start-up of operations. The compacted density of the tailings shall be verified periodically throughout operations. This specification shall be subject to the approval of **ENGINEER** and **MANAGER**.

There will be two zones for tailings placement: (i) Shell Placement Area (Zone 1), and (ii) General Placement Area (Zone 2). The placement moisture content for Filtered Tailings material in the shell placement area (Zone 1) shall be plus or minus 2 percentage points from the optimum moisture content (ASTM D698) and distributed uniformly throughout each layer of material prior to and during compaction. The lift thickness and compaction requirements for the two zones are as follows:

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FILTERED TAILINGS PLACEMENT AREAS COMPACTION REQUIREMENTS

	Max. Loose Lift Thickness (in)	Minimum Compacted Density (ASTM D698)
Shell Placement Area (Zone 1)	12	95% Max. Dry Density
General Placement Area (Zone 2)	12	90% Max. Dry Density

Filtered Tailings material shall be compacted, graded and sealed to promote runoff of precipitation off the filtered tailings storage facility (FTSF) or to the designated contact water ditches.

4.5.3 ROCKFILL

The following placement procedures apply to Rockfill as classified by the criteria in Article 3.2.

CONTRACTOR shall condition, place, and compact Rockfill by a method compaction technique with placement in controlled engineered lifts and compaction effort applied by construction traffic or by drum-drive smooth-drum vibratory compactors. The specifics of the method specification, including the lift thickness, will be dependent on test fill(s) constructed by the **CONTRACTOR** and on the available construction equipment. The test fill(s) shall be conducted in general accordance with the U.S. Army Corps of Engineers EM 1110-2-2301.

It is recommended that the minimum size of compaction equipment consist of a minimum 10 tonne (static drum weight) vibratory smooth-drum compactor. The number of passes and loose lift thickness shall be subject to the size of compaction equipment used and to the approval of the **ENGINEER**.

4.5.4 STRUCTURAL FILL

The following placement procedures apply to Structural Fill material as classified by the criteria in Article 3.3:

- The moisture content of Structural Fill shall be distributed uniformly throughout each layer of material prior to and during compaction.
- Materials too dry for compaction shall be pre-wetted in the stockpile or borrow areas. Materials too wet for compaction shall be dried to the proper moisture content before compaction.
- Spread materials in horizontal layers not exceeding 12 inches in loose thickness.

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Compact by rolling with approved compaction equipment of adequate weight and size to achieve the specified degree of compaction. The placement moisture content for Structural Fill material shall be plus or minus 2 percentage points from the optimum moisture content (ASTM D698). Structural Fill material shall be compacted to 95 percent of the maximum standard Proctor (ASTM D698) dry density.

4.5.5 GEOMEMBRANE CUSHION MATERIAL

The following placement procedures apply to Geomembrane Cushion Material as classified by the criteria in Article 3.4:

The moisture content of Geomembrane Cushion Material shall be distributed uniformly throughout each layer of material prior to and during compaction. The Geomembrane Cushion Material surface shall be prepared to provide an adequate surface for placement of the geomembrane. This preparation should be performed as follows:

- **CONTRACTOR** shall place and compact Geomembrane Cushion Material in loose lifts such that the compacted thickness is a maximum of 12 in.
- The minimum number of passes shall be determined by the **MANAGER** and **ENGINEER** based on observations.
- The **CONTRACTOR** shall inspect the face after completion of the compaction, and shall clean the surface by hand or other authorized means, in order to eliminate all protruding particles with a size over ½ inch.
- If needed, the **CONTRACTOR** shall repeat the manual cleaning until the surface is accepted by the **MANAGER** or **ENGINEER** for geomembrane installation.
- It will be the **CONTRACTOR'S** responsibility to maintain the approved surface in good condition for geomembrane installation. Any damage to the approved surface shall be repaired by the **CONTRACTOR**.

Immediately prior to periods of shutdown of Geomembrane Cushion Material placement operations, including periods when rain is forecast, the exposed surface of the Geomembrane Cushion Material shall be rolled with two static passes by a 10-ton, smooth drum, vibratory roller.

4.5.6 UNDERDRAIN MATERIAL

The following placement procedures apply to Underdrain Material as classified by the criteria in Article 3.5:

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CONTRACTOR shall place Underdrain Material according to a method specification subject to the approval of **ENGINEER** and **MANAGER**. The preliminary method specification shall be as follows:

- Place Underdrain Material in continuous lifts no more than 12 inches in compacted thickness.
- The material as placed and compacted shall be free from segregation and free of unsuitable materials. Moisture condition the Underdrain Material prior to compaction, as appropriate, maintaining the moisture content required to achieve satisfactory compaction. Use moisture addition procedures during compaction as approved by the **MANAGER** or **ENGINEER**.
- Compact Underdrain Material with a minimum of two (2) passes of an approved smooth drum vibratory roller with a static drum weight between 8 and 12 tons to achieve a target relative density between 70 and 80%. The number of passes may be modified based on the results of a test fill completed at the start of the embankment construction and/or as approved by the **MANAGER** or **ENGINEER**. Excessive compaction of the Underdrain Material that could result in particle breakdown is prohibited.

CONTRACTOR shall minimize the amount of traffic over the Underdrain Material to prevent contamination. Remove and replace Underdrain Material containing unsuitable material.

4.5.7 EROSION PROTECTION LAYER

The following placement procedures apply to Erosion Protection Layer as classified by the criteria in Article 3.6:

The Erosion Protection Layer shall be placed by dozers in a single lift working in an upslope direction. The filtered tailings surface abutting the erosion protection layer shall be prepared by wetting and compacting immediately prior to placement of the erosion protection material.

Placement of the Erosion Protection Layer should be concurrent with tailings placement and should be maintained to the crest of the downstream slope of the FTSF to avoid slopes of exposed tailings.

4.5.8 RIPRAP

The following placement procedures apply to Riprap as classified by the criteria in Article 3.7:

Placement of Riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread with an excavator or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller

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stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.

Where Riprap is placed over geotextile, the Riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 18 inches, nor shall large stones be allowed to roll down slope.

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1.0 INTRODUCTION

This plan addresses the construction quality assurance (CQA) procedures for the installation of the geosynthetic components of the Dawson Filtered Tailings Storage Facility (FTSF) at the Dawson Gold Project in Fremont County, Colorado. This CQA plan was prepared for the Pre-feasibility Study for the Dawson Filtered Tailings Storage Facility (FTSF). This plan is not intended for construction or bidding purposes.

This CQA plan has been developed to assure that the construction of the geosynthetic components are in compliance with the project SPECIFICATIONS. The objective of this plan is to assure that proper materials, construction techniques, and procedures are utilized by the **OWNER/CONTRACTOR** and that the intent of the design is met.

This plan addresses quality assurance (QA), and not quality control (QC). This CQA Plan is independent of any QC programs conducted by the **INSTALLER**. The intent of the CQA Plan is to provide verification and testing of construction materials and to demonstrate that the **INSTALLER** has met the requirements of the project DRAWINGS and SPECIFICATIONS. Quality control is provided by the **INSTALLER** and refers to those actions taken by the **INSTALLER** to ensure that materials and workmanship meet the requirements of the DRAWINGS and SPECIFICATIONS.

2.0 DESCRIPTION OF PARTIES

The following Section provides descriptions of the parties to this CQA Plan including their responsibilities and qualifications.

OWNER: In this CQA Plan, **OWNER** refers specifically to Zephyr Gold USA Ltd. (Zephyr). Zephyr is the **OWNER** and will operate the Dawson FTSF and other site features.

MANAGER: In this CQA Plan, **MANAGER** is the official representative of the **OWNER**, appointed by the **OWNER**, and is responsible for all construction activities including oversight and direction during construction. **MANAGER** is also responsible for coordinating construction and CQA activities for the project. **MANAGER**, **CQA MONITOR**, and **ENGINEER** shall be responsible for the resolution of all CQA issues.

Duties for this position include the following:

- Review and approval of DRAWINGS and SPECIFICATIONS for all geosynthetic components of the Dawson FTSF construction and other site construction, as required.

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- Preconstruction coordination with the **INSTALLER, ENGINEER** and **CQA MONITOR** to ensure that the CQA Plan can be implemented.
- Coordination of all construction activities associated with required CQA testing and activities.
- Approve with the **ENGINEER** and **CQA MONITOR** specific corrective measures to be implemented during construction when deviations from these SPECIFICATIONS occur.

ENGINEER: The **ENGINEER** is responsible for the design and preparation of the DRAWINGS and SPECIFICATIONS, and for confirming that the construction was performed in compliance with the DRAWINGS and SPECIFICATIONS. The **ENGINEER** is responsible for approving all design and SPECIFICATION changes, modifications, or clarifications encountered during construction. **MANAGER** and **ENGINEER** shall be responsible for the resolution of all quality assurance issues.

Additional duties for this position include the following:

- Preconstruction coordination with the **CQA MONITOR(S)** to ensure that the **CQA MONITOR(S)** has performed a reviews of the DRAWINGS and SPECIFICATIONS and that the CQA Plan can be implemented.
- Approve specific corrective measures to be implemented during construction when deviations from the SPECIFICATIONS occur.
- Ensure that required quality assurance testing has been performed in accordance with the CQA Plan.
- Ensure that the CQA personnel are provided with all documentation required in the CQA Plan and project SPECIFICATIONS.
- Prepare a Construction Completion Report describing the construction, any deviations from SPECIFICATIONS or DRAWINGS and details, details of all field and laboratory test data, test results (both laboratory and field), and statement that construction was completed in accordance with the DRAWINGS and SPECIFICATIONS. The Construction Completion Report will be signed by the **ENGINEER**.

CONSTRUCTION QUALITY ASSURANCE MONITOR(S): The **CQA MONITOR(S)** is responsible for performing the CQA tasks outlined in this CQA Plan. The **CQA MONITOR(S)** is a representative of the **ENGINEER** and has the responsibility of overseeing all CQA pertinent to the Work. In this CQA Plan, the **CQA MONITOR(S)** reports to the **ENGINEER**. The **CQA MONITOR(S)** has the authority to stop any Work that is not in compliance with the SPECIFICATIONS. Work would then be resumed once corrective action has been approved by the **MANAGER**, and **ENGINEER**.

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The specific responsibilities of the **CQA MONITOR(S)** include:

- Review the DRAWINGS, SPECIFICATIONS, and related guidance documents.
- Review all **CONTRACTOR** QC submittals and make appropriate recommendations.
- Obtain and test geosynthetic conformance samples during geosynthetics manufacture.
- Observe geosynthetic material delivery, unloading, and storage.
- Observe prepared subgrade prior to geosynthetic deployment.
- Monitor and document geosynthetic material placement, trial seam testing, non-destructive testing, seaming and repair operations, and destructive testing.
- Identify seam samples for CQA destructive testing.
- Assure that testing equipment used, and tests performed are conducted according to project SPECIFICATIONS and industry standards.
- Perform or observe, document, and report test results to the **ENGINEER** and **MANAGER** as required.
- Report any deficiencies to the **ENGINEER** and **MANAGER** that are not corrected to the satisfaction of the **CQA MONITOR(S)**, including project DESIGN or SPECIFICATION changes.

GEOSYNTHETICS MANUFACTURER: The Geosynthetics **MANUFACTURER**, also referred to as the **MANUFACTURER**, is responsible for production of the geosynthetic components outlined in this plan. Each **MANUFACTURER** must verify prior to construction that the **MANUFACTURER** can produce material that meets the requirements outlined in the project SPECIFICATIONS.

GEOSYNTHETICS INSTALLATION CONTRACTOR: The Geosynthetics Installation **CONTRACTOR**, also referred to as the **INSTALLER**, is responsible for installation of the geosynthetic components, as outlined in the project SPECIFICATIONS.

The **INSTALLER** must meet the requirements outlined in the project SPECIFICATIONS.

The **INSTALLER** will be responsible for storage, handling, deploying, temporary geomembrane anchoring, seaming, repairs, destructive testing, and non-destructive testing, in accordance with the project DRAWINGS, SPECIFICATIONS and the **INSTALLER'S** internal quality control program. It is the **INSTALLER'S** responsibility to see that all submittals are received as outlined in the project SPECIFICATIONS.

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EARTHWORKS CONTRACTOR: The Earthworks **CONTRACTOR**, also referred to as **CONTRACTOR**, is responsible for proper delivery and placement of earthwork components as outlined in the project SPECIFICATIONS.

3.0 DEFICIENCIES

When deficiencies (items that do not meet SPECIFICATIONS or DRAWINGS) are discovered, the **CQA MONITOR(S)** will immediately determine the nature and extent of the inadequacy and notify the **INSTALLER** or **CONTRACTOR**. If unsatisfactory test results identify a failure to meet the SPECIFICATIONS, additional tests will be performed to define the extent of the deficient area.

The **INSTALLER** or **CONTRACTOR** shall correct the deficiency to the satisfaction of the **CQA MONITOR(S)**. If **CONTRACTOR** is unable to correct the problem, the **CQA MONITOR(S)** will notify the **ENGINEER** and **MANAGER** who will assist in problem resolution.

Upon completion of remedial work, the **CQA MONITOR(S)** shall retest for compliance with the project SPECIFICATIONS and the **ENGINEER** and **MANAGER** will approve the corrected deficiencies. The questionable zone will have acceptable test results prior to any additional related Work being performed by **INSTALLER** or **CONTRACTOR**. All retests and related documentation shall be recorded by the **CQA MONITOR(S)** and provided to the **ENGINEER** for inclusion in the Construction Completion Report.

4.0 GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

Construction of the Dawson FTSF and related structures shall be in accordance with the DRAWINGS and SPECIFICATIONS. A CQA monitoring and testing program shall be implemented to ensure construction compliance by the **INSTALLER** and **CONTRACTOR**. The CQA testing program shall consist of construction testing of materials used in the geosynthetics components of the Dawson FTSF and other site construction.

The types of geosynthetics used in the construction of the Dawson FTSF and other site construction include polyethylene pipe, geomembrane, and geotextile. These geosynthetics are defined in the project SPECIFICATIONS. Prior to and during construction, these geosynthetics shall be sampled and tested to determine if they meet project SPECIFICATIONS. All tests shall be performed in a geosynthetics laboratory approved by the **ENGINEER** and **MANAGER**.

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5.0 REVIEW QUALITY CONTROL SUBMITTALS

Prior to geosynthetic installation, the **CQA MONITOR** shall review the **MANUFACTURER'S** and **INSTALLER'S** Quality Control submittals to evaluate or confirm that these materials meet project requirements.

6.0 GEOMEMBRANE CONFORMANCE TESTING

Prior to geosynthetic installation, the **CQA MONITOR(S)** shall obtain samples of the geomembrane for conformance testing to confirm that these materials meet project requirements. The conformance testing frequency shall be at a rate of one (1) test per 150,000 square feet. Samples shall be taken across the entire width of the roll and shall not include the first three (3) feet. The samples shall be 3 feet wide by the roll width. The **CQA MONITOR(S)** shall mark the machine direction and roll number on the sample, date when the sample was obtained, and forward the sample to a third party geosynthetic testing laboratory. As a minimum, the following conformance tests shall be conducted, with project requirements outlined in Section 02776.0.

- Formulated Density (ASTM D1505)
- Carbon Black Content (ASTM D4218)
- Thickness (ASTM D5199/D5994)
- Tensile Strength (ASTM D6693)

All conformance tests shall be performed in compliance with the project SPECIFICATIONS. The **CQA MONITOR(S)** shall review the test results and shall report any nonconformance to **ENGINEER, MANAGER**, and the Geosynthetics **INSTALLER**.

7.0 CONSTRUCTION MONITORING AND TESTING

The **CQA MONITOR(S)** shall monitor and test all geosynthetic components of the construction to verify that the construction is in compliance with the project SPECIFICATIONS. The **CQA MONITOR(S)** shall identify inadequate construction methodologies or materials, which may adversely impact the performance of the facility being constructed and existing structures. Visual observations throughout the construction process shall be made to ensure that the materials are placed to the lines and grades as shown on the DRAWINGS.

The **CQA MONITOR(S)** shall review the following submittals by the **INSTALLER** during the project:

- Verification that a qualified land surveyor has verified all lines and grades; and

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- Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the **INSTALLER**.

The **CQA MONITOR** shall:

- Inspect all geosynthetic materials delivered to site. The **CQA MONITOR(S)** shall document any damage and notify the **MANAGER**.
- Obtain geosynthetic packaging identification slips for verification and generation of an on-site materials inventory.
- Observe subgrade conditions prior to geosynthetics installation and verify that any deficiencies are corrected.
- Observe permanent anchoring of geosynthetics to verify that project SPECIFICATIONS are met.
- Observe that the required overlap distances are met.
- Monitor and record ambient air temperatures.
- Verify that no continuous horizontal seams are placed on slopes unless approved by the **ENGINEER**.
- Observe and document that ballast and any soil materials placed on top of the geosynthetics are done in such a manner as to ensure that the geosynthetics are not damaged.

7.1 GEOMEMBRANE

During geomembrane installation, the **CQA MONITOR(S)** shall observe and document deployment, trial seams, field seaming, non-destructive and destructive seam testing, and repairs to assess that the installation is in compliance with the SPECIFICATIONS.

Deployment - The **CQA MONITOR(S)** shall verify that only approved materials are used, each panel is given a unique panel number, no geomembrane is placed during unsuitable weather conditions, the geomembrane is not damaged during installation, and anchoring is performed in compliance with the SPECIFICATIONS and design DRAWINGS. The **CQA MONITOR(S)** shall record the deployment on the deployment log form.

Trial Seams - The **CQA MONITOR(S)** shall verify that seaming conditions are performed in compliance with the SPECIFICATIONS, tests are performed at required intervals, specified test procedures are followed, and retests are performed in compliance with the SPECIFICATIONS. The **INSTALLER** shall perform trial seams at the beginning of each crew shift, and immediately following any Work stoppage (i.e.,

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for lunch, weather conditions, etc.) of 30 minutes or more for each seaming apparatus used that day. Each Seamer shall make at least one trial seam each day. Seaming operations shall not commence until the **CQA MONITOR(S)** has determined that the seaming process is meeting the SPECIFICATION requirement and is acceptable. The **CQA MONITOR(S)** shall record the trial weld results on the trial seam log form.

Field Seaming - The **CQA MONITOR(S)** shall verify that only approved equipment and personnel perform welding, all welding is performed under suitable conditions as specified in the project SPECIFICATIONS, specified overlaps are achieved, seams are oriented in compliance to project requirements, and that grinding techniques and extrudate meet project requirements for extrusion welding. The **CQA MONITOR(S)** shall record all field seaming on field seaming log forms.

Non-Destructive Seam Continuity Testing - The **CQA MONITOR(S)** shall verify that the seams and repair are non-destructively tested by CQC personnel in compliance with the project SPECIFICATIONS. If a seam cannot be tested, the **CQA MONITOR(S)** shall ensure that CQC monitors observe cap strip operations. The **CQA MONITOR(S)** shall verify that test equipment and gauges are functioning properly and that test procedures are in compliance with the project SPECIFICATIONS. The **CQA MONITOR(S)** shall verify that the seams and repairs with failing test results are repaired and/or re-tested until passing results are achieved. The **CQA MONITOR(S)** shall record observed non-destructive test locations on the vacuum test and pressure test log forms.

Destructive Seam Testing - The **INSTALLER** shall obtain samples, at locations selected by the **CQA MONITOR(S)**, of the field seamed geomembrane approximately 24 in along and 12 in across the seam and centered over the seam as follows:

- A minimum of one sample for each geomembrane Seamer.
- A minimum of one sample every 500 feet of seaming is required unless, in the opinion of the **CQA MONITOR(S)** and **ENGINEER**, the Seamer has demonstrated sufficient quality/experience to increase the seam sample interval. In no event shall the sampling interval exceed 1000 feet.
- Seams that appear suspect to the **CQA MONITOR**.
- The **CQA MONITOR(S)** shall witness the testing of destructive seam samples by the **INSTALLER'S** CQC personnel. The **INSTALLER** shall mark all samples with their roll and seam number, date, machine number, welding technician identification, extruder and nozzle/wedge temperature, and ambient air temperature.
- The **INSTALLER** shall test all destructive samples in compliance with the project SPECIFICATIONS.

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- The **INSTALLER** shall be responsible for patching all areas cut for test samples in accordance with the SPECIFICATIONS and **MANUFACTURER'S** requirements and performing non-destructive testing (i.e., vacuum box) of the seams. The **CQA MONITOR(S)** shall record test locations on the geomembrane defect log forms. Additional testing information will be recorded on the geomembrane seam destructive sample log form. The **CQA MONITOR(S)** shall track failing tests as described in the SPECIFICATIONS.

Repairs - The **CQA MONITOR(S)** shall observe and document that all repair materials, techniques, and procedures used for repairs are approved in advance and meet the requirements of the project SPECIFICATIONS. The **CQA MONITOR(S)** shall verify that all defects and repairs are marked, recorded, repaired, tested, and wrinkles are addressed, prior to being covered by other materials, and that repairs are performed as specified, including proper patch size or dimension. The **CQA MONITOR(S)** shall record defects and repairs on the defect and repair log forms.

7.2 GEOTEXTILE

During geotextile installation, the **CQA MONITOR(S)** shall observe and document deployment, field seaming, and repairs to assess that the installation is in compliance with the SPECIFICATIONS.

Deployment - The **CQA MONITOR(S)** shall verify that the subgrade is free of deleterious materials prior to deployment, anchoring is installed as specified, specified methods are used to minimize wrinkles and protect underlying layers during cutting of materials, and deployment procedures are performed in compliance with the project SPECIFICATIONS.

Seams - The **CQA MONITOR(S)** shall verify sufficient overlap and that the specified seam procedures were followed in compliance with the project SPECIFICATIONS.

Repairs - The **CQA MONITOR(S)** shall verify that all repairs are performed in compliance with the SPECIFICATIONS.

Protection - The **CQA MONITOR(S)** shall observe and document that all ballast and soil materials placed on top of the geosynthetics are done in such a manner as to ensure that the geosynthetics and underlying materials are not damaged.

8.0 DOCUMENTATION

Documentation kept by the **CQA MONITOR(S)** shall consist of field notes, observation and testing data sheets, summary of daily meetings with **INSTALLER** and/or **CONTRACTOR**, and reporting of construction

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problems and resolutions. The **CQA MONITOR(S)** shall submit this information on a regular basis to the **ENGINEER** for review, and then submit to the **MANAGER**.

8.1 DAILY RECORD KEEPING

Daily records kept by the **CQA MONITOR(S)** shall consist of field notes, observation and testing data sheets, summary of the daily meetings with **INSTALLER** and/or **CONTRACTOR**, and reporting of construction problems and resolutions. The **CQA MONITOR(S)** shall submit this information to the **ENGINEER** for review, and then submit to the **MANAGER**.

8.2 GEOSYNTHETIC OBSERVATION AND TESTING FORMS

The **CQA MONITOR(S)** shall work with the CQC personnel to document geosynthetic observations and test results on forms that include the following information:

- Date, project name, location, and weather data, including high and low daily temperatures and precipitation (if any).
- Identification of panel or seam numbers.
- Description of ongoing construction detailing deployment areas and equipment utilized by **CONTRACTOR** and **INSTALLER**.
- Numbering system identifying test or sample number.
- Location and identification of repairs and date of repair.
- Length, width and thickness measurements for geomembrane panels or seams.
- Welding machine temperatures and settings.
- Welding machine and technician identifications.
- Test equipment calibrations, if necessary.
- Location of tests and test results.
- Identification of testing technicians and time of tests.
- Summary of meetings held.
- Resolutions of deficient test results.
- Signature or initials of the **CQA MONITOR(S)**.

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8.3 PHOTO DOCUMENTATION

The **CQA MONITOR(S)** and/or **ENGINEER** shall photograph all phases of construction. Photographs shall be identified by location, time, date, and name of the **CQA MONITOR(S)** and/or **ENGINEER** taking the photograph.

8.4 DESIGN AND SPECIFICATION CHANGES

During construction, the need to address design and SPECIFICATION changes, modifications or clarifications may arise. In such cases the **CQA MONITOR(S)** shall notify the **MANAGER** and **ENGINEER**. Design and SPECIFICATION changes shall only be made with written agreement from the **ENGINEER**.

8.5 WEEKLY PROGRESS REPORTS

The **CQA MONITOR** shall prepare weekly progress reports summarizing all construction and CQA activities. This report shall be submitted to the **MANAGER** and shall include the following information:

- Date, project name, and location.
- Summary of construction related activities.
- Summary of geomembrane deployed (per day).
- Summary of samples taken and test results, as provided by the **CQA MONITOR**.
- Summary of geomembrane areas completed.
- Summary of deficiencies and/or defects and resolutions.
- Signature of the **CQA MONITOR**.

8.6 MONTHLY CONSTRUCTION REPORTS

The **CQA MONITOR** shall prepare monthly construction reports summarizing all construction activities. This report shall be submitted to the **MANAGER** and shall include the following information:

- Date, project name, and location.
- Health and safety statistics for the project.
- Summary of construction-related activities.
- Summary of deficiencies and/or defects and resolutions.
- Design or SPECIFICATION changes.

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- Items of concern.
- Work planned for next period.
- Signature of the **CQA MONITOR**.

8.7 CONSTRUCTION COMPLETION REPORT

At the completion of the project, the **CQA MONITOR** shall submit to the **MANAGER** and **OWNER** a Construction Completion Report. This report shall indicate that the Work has been performed in compliance with the design **DRAWINGS** and **SPECIFICATIONS** and will contain the following information:

- Summary of all construction activities.
- Photographic documentation.
- Test data sheets.
- Copies of monthly reports.
- **INSTALLER'S** subgrade acceptance forms.
- Temperature monitoring results.
- Geosynthetic quality control documents.
- Geosynthetic quality assurance documents.
- Geomembrane installation observations, such as for deployment, trial seams, defect repair, destructive testing and non-destructive testing.
- Sampling, testing locations, and test results.
- Changes to the design **DRAWINGS** or project **SPECIFICATIONS** and the justification for these changes.
- Record **DRAWINGS**.
- A statement that construction was completed in compliance with the **DRAWINGS** and **SPECIFICATIONS**, signed by the **ENGINEER**.

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1.0 INTRODUCTION

This plan addresses the construction quality assurance (CQA) procedures for the installation of the earthworks (soils) components of the Dawson Filtered Tailings Storage Facility (FTSF) at the Dawson Gold Project in Fremont County, Colorado. This CQA plan was prepared for the Pre-feasibility Study for the Dawson Filtered Tailings Storage Facility (FTSF). This plan is not intended for construction or bidding purposes.

This CQA plan has been developed in order to assure that site construction is in compliance with the project SPECIFICATIONS. The objective of this plan is to assure that proper materials, construction techniques, and procedures are utilized by the **CONTRACTOR** and that the intent of the design is met. This plan also provides the means for resolution of problems and conflicts that may occur during construction.

This plan addresses quality assurance (QA), and not quality control (QC). This CQA Plan is independent of any QC programs conducted by the **CONTRACTOR**. The intent of the CQA Plan is to provide verification and testing of construction materials and to demonstrate that the **CONTRACTOR** has met the requirements of the project DRAWINGS and SPECIFICATIONS. Quality control is provided by the **CONTRACTOR** and refers to those actions taken by the **CONTRACTOR** to ensure that materials and workmanship meet the requirements of the DRAWINGS and SPECIFICATIONS.

QA testing shall be performed at the place of installation. QC testing may be performed at the point of processing, from the stockpile, or at the place of installation.

2.0 DESCRIPTION OF PARTIES

The following section provides descriptions of the parties to this CQA Plan, including their responsibilities and qualifications.

OWNER: In this CQA Plan, **OWNER** refers specifically to the Zephyr Gold USA Ltd. (Zephyr). Zephyr is the **OWNER** and will operate the Dawson FTSF and other site features.

MANAGER: In this CQA Plan, **MANAGER** is the official representative of the **OWNER**, appointed by the **OWNER**, and is responsible for all construction activities including oversight and direction during construction. **MANAGER** is also responsible for coordinating construction and CQA activities for the project. **MANAGER** and **ENGINEER** shall be responsible for the resolution of all CQA issues.

Duties for this position include the following:

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- Review and approval of DRAWINGS and SPECIFICATIONS for all soil components of the Dawson FTSF construction and related facilities as required.
- Preconstruction coordination with the **ENGINEER** and **CQA MONITOR** to ensure that the CQA Plan can be implemented.
- Coordination of all construction activities associated with required CQA testing and activities.
- Scheduling and coordinating construction activities with the **ENGINEER** and **CQA MONITORS** for required CQA testing and activities.
- Approve with the **CQA MONITOR** specific corrective measures to be implemented during construction when deviations from these SPECIFICATIONS occur.
- **MANAGER** shall serve as communications coordinator for the project, initiating preconstruction and resolution meetings. As communications coordinator, **MANAGER** will serve as a liaison between all parties involved in the project to ensure that ongoing communications are maintained.

CONTRACTOR: The Earthworks **CONTRACTOR**, also referred to as “**CONTRACTOR**”, is responsible for proper processing, delivery, and placement of all components of the Dawson FTSF as shown on the DRAWINGS and as outlined in the SPECIFICATIONS.

ENGINEER: The **ENGINEER** is responsible for the design and preparation of the DRAWINGS and SPECIFICATIONS, and for confirming that the construction was performed in compliance with the DRAWINGS and SPECIFICATIONS. The **ENGINEER** is also responsible for approving all design and SPECIFICATION changes, modifications, or clarifications encountered during construction. **MANAGER** and **ENGINEER** shall be responsible for the resolution of all quality assurance issues.

Additional duties for this position include the following:

- Preconstruction coordination with the **CQA MONITOR(S)** to ensure that the **CQA MONITOR(S)** has performed reviews of the DRAWINGS and SPECIFICATIONS and that the CQA Plan can be implemented.
- Overseeing the construction QC operations performed by **CONTRACTOR**.
- Approve specific corrective measures to be implemented during construction when deviations from the SPECIFICATIONS occur.
- Ensure that required quality assurance testing has been performed in accordance with the CQA Plan.

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- Ensure that the CQA personnel are provided with all documentation required in the CQA Plan and project SPECIFICATIONS.
- Prepare a Construction Completion Report describing the construction, any deviations from SPECIFICATIONS or DRAWINGS and details, details of all field and laboratory test data, test results (both laboratory and field), and statement that construction was completed in accordance with the DRAWINGS and SPECIFICATIONS. The Construction Completion Report will be signed by the **ENGINEER**.

CONSTRUCTION QUALITY ASSURANCE MONITOR(S): The **CQA MONITOR(S)** is responsible for performing the CQA tasks outlined in this CQA Plan. The **CQA MONITOR(S)** is a representative of the **ENGINEER** and has the responsibility of overseeing all CQA pertinent to the Work. In this CQA Plan, the **CQA MONITOR(S)** reports to the **ENGINEER**. The **CQA MONITOR(S)** has the authority to stop any Work that is not in compliance with the SPECIFICATIONS. Work would then be resumed once corrective action has been approved by the **MANAGER**, and **ENGINEER**.

The specific responsibilities of the **CQA MONITOR(S)** include:

- Review the DRAWINGS, SPECIFICATIONS, and related guidance documents.
- Obtain preconstruction and construction samples and perform material evaluation testing as required.
- Monitor foundation preparation activities and material placement.
- Assure that testing equipment used and tests performed are conducted according to SPECIFICATIONS and industry standards.
- Document and report test results to **MANAGER** and **ENGINEER**.
- Report any deficiencies to **ENGINEER** and **MANAGER** that are not corrected to the satisfaction of the **CQA MONITOR**, including DESIGN or SPECIFICATION changes.
- Monitor the ambient air temperature and fill temperature, as outlined in the SPECIFICATIONS.
- Supervise an on-site soils laboratory and oversee regular calibration of equipment.

3.0 DEFICIENCIES

When deficiencies (items that do not meet SPECIFICATIONS or DRAWINGS) are discovered, the **CQA MONITOR(S)** will immediately determine the nature and extent of the inadequacy and notify the **CONTRACTOR**. Test results that fail to meet the SPECIFICATIONS require that additional tests be performed to define the extent of the failing area. **CONTRACTOR** shall correct the deficiency to the

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satisfaction of the **CQA MONITOR**. If **CONTRACTOR** is unable to correct the problem, the **CQA MONITOR(S)** will notify **ENGINEER, MANAGER** and **OWNER**, who will assist in problem resolution.

Upon completion of remedial work, the **CQA MONITOR(S)** shall retest and the **ENGINEER** and **MANAGER** will approve the corrected deficiencies. The questionable zone will have acceptable test results prior to any additional related work being performed by **CONTRACTOR**. All retests and related documentation shall be recorded by the **CQA MONITOR(S)** and provided to the **ENGINEER** for inclusion in the Construction Completion Report.

4.0 EARTHWORKS CONSTRUCTION QUALITY ASSURANCE

Construction of the Dawson FTSF and related structures shall be in accordance with the **DRAWINGS** and **SPECIFICATIONS**. A CQA monitoring and testing program shall be implemented to ensure construction compliance by the **CONTRACTOR**. The CQA testing program shall consist of construction testing of materials used in the earthworks components of the facility construction. The types of materials are defined in the **SPECIFICATIONS**. During construction, the **CQA MONITOR(S)** shall sample and test these soil types to determine if they meet **SPECIFICATIONS**. The **CQA MONITOR(S)** shall obtain and test soil samples in accordance with American Society for Testing and Material (ASTM) standards or engineer approved alternative. All tests shall be performed by the **CQA MONITOR(S)** onsite or in a geotechnical laboratory approved by the **ENGINEER** and **MANAGER**.

5.0 CONSTRUCTION TESTING

During construction, the **CQA MONITOR(S)** shall test all earthwork components to verify that the construction is in accordance with the **SPECIFICATIONS**. Testing shall be performed on all materials used in the construction to confirm that the materials meet the **SPECIFICATIONS**. The **CQA MONITOR(S)** shall conduct testing after final placement of the materials. The tests to be performed and the testing frequency for each material type are listed in Table 01400.1-1. The testing frequencies shall be increased when the **CQA MONITOR** determines that construction conditions (such as adverse weather, equipment breakdown, excessive lift thickness, improper soil type, improper moisture conditioning and compaction) warrant additional tests. Additional tests will be approved by the **MANAGER** and directed by the **CQA MONITOR(S)**.

6.0 CONSTRUCTION MONITORING

The **CQA MONITOR(S)** will monitor and test all earthworks construction materials to verify that the construction is in accordance with the **SPECIFICATIONS**. The **CQA MONITOR(S)** shall identify inadequate construction methodologies or materials that may adversely impact the performance of the facility being

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constructed and existing structures. The **CQA MONITOR(S)** will record visual observations throughout the construction process to ensure that the materials are placed to the minimum dimensions as shown on the **DRAWINGS**.

6.1 FOUNDATION PREPARATION

The **CQA MONITOR(S)** shall observe and document the foundation preparation including:

- Initial Foundation Cleaning: Stripping and excavation activities required to remove any unsuitable materials such as loose or embedded rock, soft soils or tailings, organic material, and any other deleterious material (such as debris, roots, branches, vegetation, or mud). The **CQA MONITOR** will document that any unsuitable materials, as determined by the **ENGINEER**, are removed and placed in an appropriate stockpile facility.
- Stockpiling activities to include verification of location of stockpile, material type, and dressing.
- Excavations for seeps, unsuitable foundation soil, elevation, and proper drainage.
- Foundation subgrade preparation to confirm that the surface of the subgrade is free of soft, organic, and otherwise deleterious materials, and that soil and rock surfaces that contain joints or fractures are adequately filled in accordance with the **SPECIFICATIONS**.
- Construction of access roads, site grading, drainage control features and erosion control features to verify compliance with the **DRAWINGS** and **SPECIFICATIONS**.

6.2 PLACEMENT OF MATERIALS

During placement of any engineered fill such as Rockfill, Structural Fill, Geomembrane Cushion Material, Filter Material, Drain Gravel, and Riprap, the **CQA MONITOR(S)** shall:

- Verify the use of appropriate fills.
- Monitor and document that the material placement, including soil type, particle size, loose lift thickness, moisture conditioning process, compaction equipment, methods used to attain compaction, including number of passes, uniformity of compaction coverage, compacted lift thickness, bonding of lifts, in-place moisture content and dry density is in compliance with the **SPECIFICATIONS**.
- Monitor surface preparation to verify that the soil surface is suitable for geomembrane installation as discussed in the **SPECIFICATIONS**.
- Monitor the soil placement to confirm that they comply with the **SPECIFICATIONS**.

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- Monitor the placement of fill to ensure that **CONTRACTOR** exercises care in the vicinity of pipes, geosynthetics, and other design components that could potentially be damaged during fill placement.

7.0 DOCUMENTATION

Documentation kept by the **CQA MONITOR** shall consist of daily record-keeping, construction problem resolutions, documentation of DESIGN and SPECIFICATION changes, photographic records of construction, weekly progress reports, monthly progress reports, and a Construction Completion Report. Chain of custody forms for test sample tracking and field and laboratory test documentation shall be maintained by the **CQA MONITOR**.

7.1 DAILY RECORD KEEPING

Daily records kept by the **CQA MONITOR** shall consist of field notes, observation and testing data sheets, and summaries of daily meetings with the **CONTRACTOR**. Daily records shall include reporting of construction problems and resolutions. The **CQA MONITOR** and **ENGINEER** shall submit this information on a regular basis to the **MANAGER** for review.

7.2 SOILS OBSERVATION AND TESTING FORMS

The **CQA MONITOR(S)** will document soils observations on forms that generally include the following information:

- Date, project name, location, and weather data, including high and low daily temperatures and precipitation (if any).
- A site plan showing Work areas and test locations.
- Descriptions of ongoing construction detailing Work areas and equipment utilized by **CONTRACTOR**.
- Summary of test results and samples obtained, with locations and elevations.
- Resolutions of deficient test results.
- Test equipment calibrations, if necessary.
- Summary of meetings held.
- Signature or initials of the **CQA MONITOR(S)**.

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7.3 PHOTO DOCUMENTATION

The **CQA MONITOR(S)** and/or **ENGINEER** shall photograph all phases of construction. Photographs shall be identified by location, time, date, and name of the **CQA MONITOR(S)** or **ENGINEER** taking the photograph.

7.4 DESIGN AND SPECIFICATION CHANGES

During construction, the need to address design and SPECIFICATION changes, modifications or clarifications may arise. In such cases, the **CQA MONITOR(S)** shall notify the **ENGINEER**. Design and SPECIFICATION changes shall only be made with written agreement from the **ENGINEER**.

7.5 WEEKLY PROGRESS REPORTS

The **CQA MONITOR** shall prepare weekly progress reports summarizing all construction and quality assurance activities. This report shall be submitted to the **MANAGER** and shall include the following information:

- Date, project name, and location.
- Summary of construction-related activities.
- Summary of samples taken and test results obtained from the **CQA MONITOR**.
- Summary of deficiencies and/or defects and resolutions.
- Signature of the **CQA MONITOR**.

7.6 MONTHLY CONSTRUCTION REPORTS

The **CQA MONITOR** shall prepare monthly construction reports summarizing all construction activities. This report shall be submitted to the **MANAGER** and shall include the following information:

- Date, project name, and location.
- Health and safety statistics for the project.
- Summary of construction-related activities.
- Summary of deficiencies and/or defects and resolutions.
- DESIGN or SPECIFICATION changes.
- Areas of concern.

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- Work planned for next period.
- Signature of the **CQA MONITOR**.

7.7 CONSTRUCTION COMPLETION REPORT

At the completion of the project, the **CQA MONITOR** shall submit to the **MANAGER** and **OWNER** a Construction Completion Report. This report shall indicate that the Work has been performed in compliance with the **DRAWINGS** and **SPECIFICATIONS** and will contain the following information:

- Summary of all construction activities.
- Photographic documentation.
- Test data sheets.
- Copies of monthly reports.
- CQA test results, including date, test locations and resolutions of deficient test results.
- Staff schedule summary.
- A description of significant construction problems and the resolution of these problems.
- Changes to the **DRAWINGS** or **SPECIFICATIONS** and the justification for these changes.
- Record **DRAWINGS**.
- A statement that construction was completed in compliance with the **DRAWINGS** and **SPECIFICATIONS**, signed by the **ENGINEER**.

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TABLE 01400.1-1
MINIMUM EARTHWORKS TESTING FREQUENCY¹ VOLUME PER TEST

Test and ASTM Designation	Filtered Tailings (yd ³)	Rockfill (yd ³)	Structural Fill (yd ³)	Geomembrane Cushion Material (yd ³)	Filter Material, Drain Gravel, Riprap (yd ³)
Proctor Compaction (ASTM D698)	Note 4	Note 4	1,000	1,000	Note 4
Particle Size ² (ASTM C117, C136, D422, D1140)	5,000	Note 4	300	300	500
Atterberg Limits (ASTM D4318)	5,000	Note 4	300	300	-
Moisture Content ³ (ASTM 2216)	Note 4	Note 4	300	500	Note 4
In-place Density ³ (ASTM D6938)	Note 4	Note 4	300	500	Note 4

Notes:

1. Tests shall be performed at the specified frequency or one per material type, whichever is greater.
2. Use the Unified Soil Classification System (USCS) for description and identification (ASTM D2488).
3. In-place moisture content and in-place density.
4. Will be placed in accordance with an approved method SPECIFICATION. A trial compaction program will be conducted for tailings placement at start-up of operations.

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1.0 GENERAL

1.1 SUMMARY

This SPECIFICATION was prepared for the Pre-feasibility Study for the Dawson Filtered Tailings Storage Facility (FTSF). This SPECIFICATION describes requirements for the manufacture, fabrication (if needed), supply, and installation of geotextile for the Dawson Filtered Tailings Storage Facility (FTSF) as developed for the Pre-feasibility level design. These SPECIFICATIONS are not intended for construction or bidding purposes.

1.2 SUBMITTALS

The following items shall be submitted to the **ENGINEER** for review and release prior to purchasing any materials for the Work. The **ENGINEER'S** review will be made to verify that the general scope of Work is adequate and that the **CONTRACTOR** is qualified to perform the Work. Review and release of submittals does not relieve **CONTRACTOR** of any of the responsibilities and requirements of this Section and the DRAWINGS.

CONTRACTOR shall provide the following information relating to the geotextile **MANUFACTURER** with its proposal:

- **MANUFACTURER'S** technical SPECIFICATIONS and product data for all materials and products furnished, installed or used in the performance of the Work under this Section. **MANUFACTURER'S** technical SPECIFICATIONS shall include product name, lot number or identification, product properties and recommended conditions of use.
- A copy of the **MANUFACTURER'S** geotextile quality control (QC) test results of properties outlined in Article 3.0 of this Section. The **ENGINEER** reserves the right to refuse use of any geotextile supplied without the proper QC documentation.

1.3 QUALITY ASSURANCE

All Work shall be constructed, monitored, and tested in compliance with requirements in the CQA Plan (Section 01400.2). **CONTRACTOR** and **MANUFACTURER** shall participate and comply with all items in these SPECIFICATIONS and requirements of the CQA Plan.

CONTRACTOR shall ensure that geotextile **MANUFACTURER** has an internal product quality control program that meets Contract requirements.

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CONTRACTOR shall be aware of all activities outlined in the CQA Plan, and the **CONTRACTOR** shall account for these activities in the construction schedule.

CONTRACTOR shall assure that geotextile is delivered to the site at least five (5) calendar days prior to installation. Conformance testing must be completed, reviewed and approved by **CQA MONITOR** prior to shipping of geotextile to the site.

Geotextile rolls that do not meet the requirements of this SPECIFICATION will be rejected. **CONTRACTOR** will be required to replace the rejected material with new material that complies with the SPECIFICATIONS, at no additional cost to **OWNER**.

In order to prevent weather damaged geotextile from being placed, the following Quality Assurance procedures shall be followed:

- **CONTRACTOR** shall perform its Work and utilize sufficient ballast as necessary to prevent wind uplift of the geotextile panels.
- If weather damage should occur, **CQA MONITOR** shall determine if the geotextile shall be repaired or replaced. Weather damage to the geotextile will include tears and dirty fabric, as determined by the **CQA MONITOR**.
- Repair or replacement of the weather-damaged geotextile shall be completed by **CONTRACTOR** at no additional cost to **OWNER**.
- As determined by **CQA MONITOR** and **MANAGER**, the geotextile panel may be rejected.

1.4 APPLICABLE STANDARDS

The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect at the date of the Contract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the DRAWINGS, the Work included under this Section shall conform to the applicable provisions of these publications:

- ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

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- ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile
- ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
- ASTM D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- ASTM D6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.5 DEFINITIONS

Geotextile: A permeable geosynthetic material comprised of synthetic or natural fibers.

Minimum Average Roll Value (MARV): Minimum of series of average roll values representative of geotextile provided.

Sample: Portion of finished geotextile taken for testing.

Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

2.0 DELIVERY, STORAGE, AND HANDLING

2.1 PACKING AND SHIPPING

Geotextile shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers, with straps for unloading.

Geotextile rolls shall be marked or tagged with the following information:

- **MANUFACTURER'S** name;
- Product information;
- Roll number;
- Batch or lot number; and
- Roll dimensions.

CONTRACTOR shall ensure that geotextile rolls are properly loaded and secured to prevent damage during transit. **CONTRACTOR** shall protect geotextile from excessive heat, cold, puncture, cutting, or other

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damaging or deleterious conditions. **CONTRACTOR** shall ensure personnel responsible for loading, transport and unloading of geotextile are familiar with handling and transport constraints imposed by **MANUFACTURER**.

2.2 STORAGE AND PROTECTION

MANAGER will provide on-site storage area for geotextile rolls from time of delivery until installation.

The storage of the materials is the responsibility of **CONTRACTOR** from the time the materials are manufactured until the time the completed installation is accepted. **CONTRACTOR** is responsible for preparing the storage location and for the protection of the material from the elements (e.g. ultraviolet light, moisture, temperature, etc.).

After **CONTRACTOR** has removed material from storage area, protect geotextile from puncture, dirt, groundwater, moisture, mud, mechanical abrasion, excessive heat, ultraviolet light exposure, and other sources of damage. Geotextile shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers, with straps for unloading.

CONTRACTOR shall preserve integrity and readability of the geotextile roll labels, and store such that **MANAGER** and **CQA MONITOR** have access to the package slips or roll labels for each roll to verify roll acceptance.

3.0 PRODUCTS

Geotextile shall be a twelve-ounce (12 oz.) per cubic yard non-woven, continuous filament, mechanically needle punched fabric. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

Sheet Edges: Salvaged or finished to prevent outer material from separating from sheet.

Physical Properties: Conform to requirements of Table 02777.0-1 for use in as separation and as otherwise indicated on the DRAWINGS.

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TABLE 02777.0-1
AVERAGE ROLL VALUES FOR 12 oz/yd³ NON-WOVEN GEOTEXTILE

Property	Requirement	Test Method
Mass Per Unit Area	11.9	ASTM D5261
Apparent Opening Size (max.)	No. 80 to 140 Sieve	ASTM D4751
Puncture Strength (min.)	130 lbs	ASTM D6241

4.0 EXECUTION

4.1 PLACING GEOTEXTILE

CONTRACTOR shall handle geotextile in a manner to ensure that geotextile is not damaged, and shall comply with the following:

- Notify the **CQA MONITOR** whenever geotextile is to be placed.
- Do not place geotextile prior to obtaining **CQA MONITOR'S** approval of underlying materials.
- No equipment or tools shall damage the geotextile by handling, transporting, or other means.

No personnel working on the geotextile shall smoke, wear damaging shoes or engage in other activities that could damage the geotextile.

Cross seams between two (2) panels of geotextile shall be staggered by a minimum distance of 5 feet on slopes greater than ten (10) percent.

In the presence of wind, all geotextile shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

Geotextile panels shall be deployed in such a manner as to preclude wrinkles and folds. Any wrinkle or fold that may manifest itself into other geosynthetic layers shall be removed. If necessary, the **CONTRACTOR** shall position the geotextile by hand after it is unrolled to eliminate wrinkles.

During placement of geotextile, care shall be taken not to entrap, in or beneath the geotextile, excessive dust, mud, or moisture that could cause clogging of drains or filters, or hamper subsequent seaming.

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Following the installation of all geotextile, an examination of the entire surface shall be conducted to detect potentially harmful foreign objects. Any such foreign objects found shall be removed or the panel shall be replaced by the **CONTRACTOR**.

Geotextile panels shall not be deployed over frozen ground, unless approved by **CQA MONITOR**.

Geotextile panels shall be either welded or overlapped as approved by **ENGINEER**. Where overlaps are approved, the overlap must be in accordance with **MANUFACTURER'S** recommendations or **DRAWINGS**, whichever is more stringent.

4.2 JOINTS

All geotextile overlaps shall be continuously field seamed using light weight hand-held wedge welders or similar thermal equipment suitable for geosynthetic welding (i.e., hot air spot welding and flame bonding are not allowed). Geotextiles shall be overlapped a minimum 4 inches prior to welding. No horizontal seams shall be allowed on slopes steeper than 5H:1V (horizontal:vertical) (i.e., seams shall be along, not across, the slopes), except as part of a patch, unless approved by the **CQA MONITOR** or **ENGINEER**.

No horizontal seam shall be closer than 5 feet to the toe of the slope or other areas of potential stress concentrations.

Areas to be seamed shall be clean and free of foreign material.

4.3 PLACING PRODUCTS OVER GEOTEXTILE

Before placing material over geotextile, notify **CQA MONITOR**. Do not cover installed geotextile prior to receiving authorization from the **CQA MONITOR** to proceed.

If tears, punctures, or other damage occurs to the geotextile during placement of overlying materials, remove overlying materials as necessary to expose the damaged geotextile. Repair damage as indicated below.

4.4 REPAIRING GEOTEXTILE

Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 12 inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Heat weld patches or secure them as indicated above, or by other means approved by the **CQA MONITOR**.