NORTH CAMU QA/QC PLAN

# NORTH CORRECTIVE ACTION MANAGEMENT UNIT

# QUALITY ASSURANCE / QUALITY CONTROL PLAN

## Exide Technologies Frisco Recycling Center
## 7471 Old Fifth Street, Frisco, Texas 75034

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**May 2019**

**Project No. 130208606**

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# 1.0 INTRODUCTION AND PURPOSE

## 1.1 Introduction

Golder Associates Inc. (Golder) has prepared this Quality Assurance/Quality Control (QA/QC) Plan for the North Corrective Action Management Unit (North CAMU) at the Former Operating Plant (FOP) at the Exide Technologies (Exide) Frisco Recycling Center (FRC) in Frisco, Collin County, Texas (Site). The North CAMU will be used for the disposal of Class 2 wastes generated during the ongoing demolition and remediation activities at the FRC, including metals-impacted soils from the Undeveloped Buffer Property (J-Parcel) surrounding the Site, and then will be capped.

## 1.2 Purpose

This QA/QC Plan has been prepared in order to document the quality assurance and quality control procedures that will be followed during operation and closure of the North CAMU. This QA/QC Plan includes a description of the following or references to locations where information is included in other documents:

- Geosynthetic Clay Liner (GCL) Evaluation
- Geomembrane Evaluation
- Soil Cover Layer Evaluation
- QA/QC for Air Monitoring and Dust Suppression
- QA/QC for Waste Sampling and Analysis
- QA/QC for Groundwater Sampling
- Other QA/QC Procedures

Exide shall be responsible for contracting a qualified QA/QC Professional prior to the time when cell final cover construction operations are initiated. Each phase of the final cover construction shall be conducted under the supervision of the QA/QC Professional. The QA/QC Professional shall be an independent third-party professional engineer (PE) licensed in the State of Texas with experience in civil or geotechnical engineering and soils testing. A qualified construction quality assurance (CQA) monitor performing daily QA/QC observation and testing shall be under the direct supervision of the QA/QC Professional. The QA/QC Professional or his/her qualified representative(s) shall provide fulltime monitoring.

# 2.0 GEOSYNTHETIC CLAY LINER EVALUATION

This section presents quality assurance and quality control testing requirements, and installation procedures for the geosynthetic clay liner (GCL) construction. The GCL shall consist of sodium bentonite encapsulated between two geotextile layers, needle-punched or stitched-bonded together.

## 2.1 Pre-Installation Material Evaluation

### *2.1.1 Manufacturer's Quality Control Certificates*

Prior to the installation of the GCL, the manufacturer or installer shall provide the QA/QC Professional with quality control certificates signed by a responsible party employed by the manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in accordance with project-specific testing methods and subject to the minimum testing frequency shown in Table 1. Exide Technologies (Exide) may require more frequent testing at its discretion.

The quality control testing may be performed in the manufacturing plant. The QA/QC Professional shall review the test results prior to acceptance of the GCL to ensure that the certified minimum properties meet the values presented in Table 1.

In addition to the manufacturer's quality control certificates, samples of rolls of GCL will be obtained for conformance testing. The samples shall be tested by an independent third-party laboratory in accordance with Table 1(B). The QA/QC Professional shall review the test results to ensure that they meet the values presented in Table 1(A).

In order to prevent premature hydration, the GCL rolls shall be shipped in plastic wrapping that shall remain intact until material installation. Upon delivery of the GCL, storage and handling procedures shall be documented. The rolls will be stacked, stored and handled in accordance with ASTM D5888.

**TABLE 1 – GCL Pre-Installation Testing**

**(A) QC Submittal Frequency & Material Specifications**

| **Bentonite** | | | | | |
|---|---|---|---|---|---|
| **Property** | **Qualifier** | **Unit** | **Value** | **Test Method(1)** | **Frequency** |
| Fluid Loss | max. | ml | 18 | ASTM D5891 | 1 per 50 tons or every truck or railcar |
| Free Swell | min. | ml | 24 | ASTM D5890 | |
| **Geotextile** | | | | | |
| **Property** | **Qualifier** | **Unit** | **Value** | **Test Method(1)** | **Frequency** |
| Mass per Unit Area | min. | oz/yd$^2$ | 5.9 (nonwoven)<br>3.0 (woven) | ASTM D5261 | 1 per 200,000 ft$^2$ |
| Tensile Properties: | -- | lb | -- | ASTM D4632 | |
| **GCL Product** | | | | | |
| **Property** | **Qualifier** | **Unit** | **Value** | **Test Method(1)** | **Frequency** |
| Bentonite Mass | min. | lb/ft$^2$ | 0.8 | ASTM D5993 | 1 per 40,000 ft$^2$ |
| Bentonite Moisture Content | -- | % | -- | ASTM D5993 | |
| Grab Tensile Strength | -- | lb/in | 23 | ASTM D6768 | 1 per 200,000 ft$^2$ |
| Hydraulic Flux | max. | m$^3$/m$^2$-s | 1 x 10$^{-8}$ | ASTM D5887 | 1 per 250,000 ft$^2$ |

Notes:
1. Updated ASTM methods may be implemented based on a review by the QA/QC Professional. Alternate test methods may not be used without first revising the quality assurance plan with TCEQ approval.
2. GCLs that include nonwoven needle-punched geotextiles must be verified to have been continuously inspected for the presence of broken needles using metal detectors and found to be needle-free.
3. For those properties that do not indicate a value, the GCL material must meet the manufacturer's minimum specification

**(B) GCL Conformance Test Schedule**

| **TEST** | **METHOD(1)** | **FREQUENCY** |
|---|---|---|
| Bentonite Mass/Unit Area | ASTM D5993 | Not less than 1 test per 100,000 ft$^2$ |
| Hydraulic Flux | ASTM D5887 | |

Notes:
1. Updated methods may be implemented based on a review by the QA/QC Professional.

## 2.2 Installation Procedures

### 2.2.1 GCL Subgrade Preparation

The final surface of waste will be covered with a minimum 12-inch thick working surface layer placed and graded according to the design plans. The surface will be drum rolled to a smooth condition and surveyed at 100-foot intervals to establish the elevations of the surface prior to placement of the GCL. The working surface soil material will be obtained from an on- or off-site source, delivered using haul trucks, and spread with a dozer to prepare a smooth surface for the GCL. The working surface soil layer may be composed of waste soil provided it meets the requirements listed below.

- The upper 4 inches of the working surface layer must be compacted, smooth, and free of all rocks greater than 0.75-inch diameter, sharp/angular objects, sticks, roots, or debris of any kind. The surface should provide a firm, unyielding foundation for the GCL with no sudden, sharp or abrupt changes or break in grade. Loose rocks and/or dry soil particles that could damage the GCL shall be removed. Excessive voids or dimples shall be filled with soil.
- The lower 8 inches must be compacted and free of rocks greater than 1.5-inch diameter.

Standing water or excessive moisture on the subgrade will not be allowed. The subgrade shall be maintained in a smooth, uniform, and drained condition.

### 2.2.2 Anchor Trench Construction

The anchor trench shall be constructed according to Figure 2 of the Final Cover System Drawings provided in Appendix C of the Closure Plan, and the excavation and backfilling operations shall be documented. The inside edge of the trench shall be rounded so as to avoid stresses from sharp bends in the GCL. The GCL will not be placed into the anchor trench on top of any rocks greater than 0.75-inch diameter, sharp/angular objects, sticks, roots, or debris of any kind. The anchor trench shall be adequately drained to prevent ponding or hydration of the GCL while the trench is open. The anchor trench shall be backfilled and compacted, with compaction equipment as deemed suitable by the QA/QC representative.

### 2.2.3 GCL Deployment

Equipment used to deploy GCL must not cause excessive rutting of the subgrade. Deployed GCL panels should contain no folds or excessive slack. Installation personnel must not smoke or wear damaging shoes on GCL; and GCL should not be placed during excessive winds. Vehicle traffic other than low contact pressure vehicles such as smooth-tired ATVs or golf carts must not be allowed on the deployed GCL. Generators, gasoline or solvent cans, tools, or supplies must not be stored directly on the GCL.

Panels shall be overlapped and seamed as recommended by the manufacturer. End-to-end seams on sideslopes shall be kept to a minimum. If end-to-end seams are necessary (i.e., if the GCL roll lengths are insufficient to cover the entire slope length), a minimum overlap of 3 feet will be required.

Alternatively, seams may be glued as recommended by the manufacturer. In addition, end-to-end seams may be placed only in the lower half of the slope and must be staggered.

To limit the potential for pre-mature hydration, the GCL deployment shall be limited to the amount that can be covered with the overlying geomembrane liner the same day. GCL deployment shall not be undertaken during precipitation or when there is an impending threat of precipitation.

Following deployment, the CQA monitor shall visually examine the entire surface of the GCL for even bentonite distribution, thin spots, or other panel defects. All defects will be recorded and repaired. The QA/QC representative shall also verify and document the following:

- Proper overlap during deployment
- Seams between GCL panels are constructed per manufacturer's recommendations
- Defects are patched and overlapped properly
- The bentonite has not become excessively hydrated

Excessively hydrated GCL shall be removed and replaced with new GCL in accordance with the specifications.

### 2.2.4 GCL Repairs

Torn or otherwise damaged geosynthetic facing must be patched with the same type of geosynthetic. The geosynthetic patch must extend at least 12 inches beyond the damaged area and must be adhesive or heat bonded or otherwise attached to the main GCL to avoid shifting during backfilling or placement of overlying geosynthetics. If the GCL damage includes loss of bentonite, the patch must consist of full GCL extending at least 12 inches beyond the damaged area. Lapping procedures must be the same as specified for original laps of GCL panels.

### 2.2.5 GCL Protection

The overlying geosynthetics and soil layers shall be deployed in such a manner as to ensure that the GCL is not damaged. To avoid local bentonite displacement, and the possible impact on the hydraulic performance of a GCL, the soil cover layer shall be placed over a GCL as soon as practicable following installation of the geomembrane and geotextile.

# 3.0 GEOMEMBRANE EVALUATION

This section presents QA and QC testing requirements and construction specifications for geomembrane installation. The composite final cover liner system will generally include the following components above GCL cover, from bottom to top:

- 40-mil high density polyethylene (HDPE) geomembrane;
- 8-oz/sy nonwoven geotextile;
- 18-inch thick layer of general clean fill; and
- 18-inch thick layer of vegetative soil layer. The upper six inches is an erosion control layer and must be capable of sustaining native plant growth.

## 3.1 Pre-Installation Material Evaluation

### *3.1.1 Manufacturer's Quality Control Certificates*

Prior to installation of any geomembrane, the manufacturer or installer shall provide the QA/QC Professional with quality control certificates signed by the responsible party employed by the manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in the manufacturing plant using the test methods and frequencies listed in the most recent version of the Geosynthetic Research Institute (GRI) test method GM13.

The HDPE resin supplier shall provide the QA/QC Professional with quality control certificates signed by a responsible party employed by the supplier using the test methods and frequency listed in Table 2.

**Table 2 - HDPE Resin QC Test Frequency and Specifications**

| Test | Method | Frequency | Required Value |
|---|---|---|---|
| Density | ASTM D1505 or D792 | Per manufacturer's specifications | ≤ 0.932 |
| Melt Index | ASTM D1238 (190/2.16) | | < 1.0 g/10 min. |

The QA/QC Professional shall review the test results prior to acceptance of the geosynthetics to assure that the certified minimum properties of the resin meet specified values listed in Table 2, and that the geomembrane meets the specified values as determined by the most recent GRI test method GM13 as shown on Table 3.

The geomembrane must be manufactured from virgin raw materials. Reground, reworked, or trim materials from the same lot may be acceptable but recycled or reclaimed materials must not be used in the manufacturing process. HDPE material and required welding rods must contain between two and

three percent carbon black. All sheets must be free from pinholes, surface blemishes, scratches, or other defects (e.g., non-uniform color, streaking, roughness, agglomerates of carbon black or other undesirable additives or fillers, visibly discernable regrind or rework, etc.).

The rolls delivered to the site shall be inspected and inventoried, recording the manufacturer's name and product identification, and the roll thickness, number and dimensions. Manufacturer's certificates should be cross-referenced to rolls delivered to the site.

**Table 3 - HDPE Geomembrane (Smooth) Material Specifications**

| Properties | Test Method | Test Value | Minimum Testing Frequency |
|---|---|---|---|
| Thickness (min. ave.) | D 5199 | 40 mils | per roll |
| lowest individual for any of the 10 values | | 36 mils | |
| Density g/cc (max.) | D 1505/D 792 | 0.940 | 200,000 lb |
| Tensile Properties (1) (min. ave.)<br>• yield strength – lb/in<br>• yield elongation - %<br>• break strength – lb/in<br>• break elongation - % | D 6693<br>Type IV | <br>84<br>12<br>152<br>700 | 20,000 lb |
| Tear Resistance – lb (min. ave.) | D 1004 | 28 | 45,000 lb |
| Puncture Resistance – lb (min. ave.) | D 4833 | 72 | 45,000 lb |
| Stress Crack Resistance (2) | D 5397<br>(App.) | 500 hr. | Per GRI GM10 |
| Carbon Black Content - % | D 4218 (3) | 2.0 - 3.0 | 20,000 lb |
| Carbon Black Dispersion | D 5596 | (4) | 45,000 lb |
| Oxidative Induction Time (OIT) (min. ave.) (5)<br>(a) Standard OIT<br>- or-<br>(b) High Pressure OIT | D 3895<br><br>D 5885 | 100 min.<br><br>400 min | 200,000 lb |
| Oven Aging at 85°C (6)<br>(a) Standard OIT (min. ave.) - % retained after 90 days<br>- or –<br>(b) High Pressure OIT (min. ave.) - % retained after 90 days | D 5721<br>D 3895<br><br>D 5885 | <br>55<br><br>80 | Per formulation |
| UV Resistance (7)<br>(a) Standard OIT (min. ave.)<br>- or –<br>(b) High Pressure OIT (min. ave)-% retained after 1600 hr (9) | D 3895<br><br>D 5885 | N.R. (8)<br><br>35 | Per formulation |

Notes:

1. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
   - Yield elongation is calculated using a gage length of 1.3 in.
   - Break elongation is calculated using a gage length of 2.0 in.
2. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing
3. Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (tube furnace) can be established.
4. Carbon black dispersion ( only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2 and 1 in Category 3
5. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
6. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 days response.
7. The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
8. Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
9. UV resistance is based on percent retained value regardless of the original HP-OIT value.

Resumes of the installer's supervisor(s) or Master Seamer(s) shall be obtained to verify that adequate seaming experience will be utilized on the project. The installer's supervisor or Master Seamer should have had experience totaling a minimum of 2,000,000 square feet of geomembrane installation.

Upon delivery of geosynthetic material, storage and handling procedures shall also be documented. Rolls of geosynthetic materials shall be handled and stored in such a way as not to damage the material. As a general rule, rolls of geosynthetic materials should not be stacked more than four rolls high.

In addition to the manufacturer's quality control certificates, samples of the geomembrane will be obtained for conformance testing. Either at the manufacturing facility or upon delivery of the rolls of geomembrane, the test samples shall be obtained for conformance testing at an independent third party laboratory in accordance with the testing schedule shown in Table 4.

**Table 4. Geomembrane Conformance Test Schedule**

| Test | Method[1] | Minimum Frequency |
|---|---|---|
| Thickness (laboratory) | ASTM D5199, [2] | 1 per 100,000 ft$^2$ (not less than 1 per resin lot) |
| Density | ASTM D1505 or D792 | Minimum 1 per 100,000 ft$^2$ (not less than one per resin lot) |
| Carbon black content | ASTM D4218 | |
| Carbon black dispersion | ASTM D5596 | |
| Tensile properties [3] | ASTM D6693 | |

Notes:

1. Test values must meet the values as determined by the most recent GRI test method GM13.
2. No single measurement shall be less than ten percent below the required nominal thickness in order for the panel to be acceptable. A minimum of 5 measurements shall be made per panel.
3. 2-inch initial gauge length assumed for elongation at break.

## 3.2 Installation Procedures

### *3.2.1 GCL Preparation for Geomembrane Installation*

Preparation of the soil underlying the GCL will be as discussed in Section 2. A final inspection of the GCL surface will be conducted prior to deployment of the geomembrane to insure all defects have been properly repaired, no folds are present, and no tools, debris, etc. have been left on the GCL surface.

### *3.2.2 Geomembrane Deployment*

The geomembrane shall be installed in direct and uniform contact with the GCL. Wrinkles shall be walked-out or removed as much as possible prior to field seaming. The geomembrane shall not be placed during inclement weather such as high winds or rain. Seaming should generally not take place when ambient temperatures are below 32 degrees Fahrenheit (°F), unless preheating is used. For fusion welding, preheating may be waived if the installer demonstrates that quality welds may be obtained without preheating. Seaming shall not be permitted at ambient temperatures above 104°F, unless the installer can demonstrate that seam quality is not compromised.

The geomembrane shall be installed over the GCL the same day that the GCL is deployed to prevent damage to the GCL, as described in Section 2.

No vehicular traffic shall be allowed on the geomembrane prior to the placement of the soil cover layer. Only low-ground pressure supporting equipment (e.g., golf carts, ATVs or other small rubber tired equipment with a ground pressure less than 5 pounds per square inch and a total weight less than 750 pounds) may be allowed to traverse the surface of the geomembrane. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in any other activity likely to damage the geomembrane. Only those sections that are to be placed and seamed in one day should be unrolled. Panels left unseamed shall be anchored with sandbags or other suitable weights. In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams should be minimized.

Panels shall be overlapped as recommended by the manufacturer as appropriate for the type of seam welding to be performed; however, overlapping shall be no less than 2 inches. Field seaming shall be performed by the method or methods approved by the manufacturer only, either by extrusion welding or double-tracked fusion welding. All foreign matter (dirt, water, oil, etc.) should be removed from the area to be seamed. No seaming shall take place without the installer's supervisor or Master Seamer and QA/QC representative being present. Fishmouths or large wrinkles at the seam overlap shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut shall be seamed and/or patched. Seams made to correct fishmouths or large wrinkles shall extend to the outside edge of panels placed in the anchor trench.

Panel layout and field seams shall be given an identification code, mapped, and logged to record relevant installation information. Inspection and testing records shall be logged as well as repair and retest data. Section 5.0 includes a thorough listing of items to be documented during geomembrane construction and testing.

## 3.3 Installation Monitoring and Testing

Field seaming will be performed in strict accordance with methods approved by the manufacturer. This is usually fusion welding or extrusion welding for high density polyethylene (HDPE). Tack welds (if used) with HDPE geomembrane will use heat only. No double-sided tape, glue, or other method will be permitted when extrusion or fusion welding is used for bonding.

### *3.3.1 Trial Seam*

Each day prior to commencing field seaming, trial seams shall be made on pieces of geomembrane material to verify that conditions are adequate for production seaming. Trial seams shall be made at the beginning of each seaming period and shift (generally, at least twice each day) for each combination of production seaming machine and operator to be used that day. The trial test seam shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Four (6 when possible using dual track fusion welding) 1-inch wide specimens shall be die-cut from the trial seam sample. Two specimens shall be tested in the field for shear and 2 for peel (4 when possible if testing both inner and outer welds for dual track fusion welding) and shall be compared to the minimum seam strength requirements specified in Table 5 and discussed below.

If any of the trial seam specimens fail, the entire trial seam operation shall be repeated. If an additional specimen fails from the second trial seam, the seaming machine and seamer shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. Additional trial seams shall be performed if frequent field seaming problems are experienced or if power to the seaming machines is interrupted sufficiently long to require rewarming.

Weld Acceptance Criteria: For HDPE seams, the strength of four out of five 1.0-inch wide strip specimens in shear should meet or exceed the values given in Table 5. The fifth must meet or exceed 80% of the given values.

The shear percent elongation shall be calculated as described in GRI Test Method GM19.

The strength of 4 out of 5 of the 1.0-in. wide strip specimens tested in peel should meet or exceed the values given in Table 5. The fifth must meet or exceed 80% of the given values.

In addition, the peel separation (or incursion) should not exceed the values given in Table 5. The value shall be calculated as described in GRI Test Method GM19.

Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in ASTM D6392 (SIP is an acceptable break code);

- Hot Wedge:
  - AD and AD-Brk > 25%
- Extrusion Fillet:
  - AD1, AD2
  - AD-WLD (unless strength is achieved).
- The break codes are illustrated on Figures 1 and 2.

**Table 5. Seam Strength 40-mil HDPE Geomembrane**

| Property | Unit | Specified Value | Test Method |
|---|---|---|---|
| Hot Wedge Seams | | | ASTM D6392 |
| shear strength(1) | lb/in. | 80 | |
| shear elongation at break(2) | % | 50 | |
| peel strength(1) | lb/in. | 60 | |
| peel separation | % | 25 | |
| Extrusion Fillet Seams | | | ASTM D6392 |
| shear strength(1) | lb/in. | 80 | |
| shear elongation at break(2) | % | 50 | |
| peel strength(1) | lb/in. | 52 | |
| peel separation | % | 25 | |

Notes:
1. 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.
2. Elongation measurements should be omitted for field testing.

### *3.3.2 Non-Destructive Testing*

Continuous, non-destructive testing shall be performed on all seams by the installer. Air pressure testing on dual-track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for HDPE geomembrane seams. All leaks must be isolated and repaired by following the procedures described in this QA/QC Plan.

Air-Pressure Testing- The ends of the air channel of the dual-track fusion weld must be sealed and pressured to approximately 30 psi, if possible. The air pump must then be shut off and the air pressure observed after 5 minutes. A loss of less than 4 psi is acceptable if it is determined that the air channel is not blocked between the sealed ends. A loss of 4 psi or more indicates the presence of a seam leak that must then be isolated and repaired by following the procedures described in this QA/QC Plan. Test results, initial and final pressure readings, and start and stop

times will be recorded for all pressure tests. The QA/QC Professional or his/her qualified representatives must observe and record all pressure gauge readings.

Vacuum-Box Testing- A suction value of approximately 3 to 5 inches of gauge vacuum must be applied to all extrusion welded seams that can be tested in this manner. Examples of extrusion welded seams that do not easily lend themselves to vacuum testing would be around boots, some sump areas, appurtenances, etc. The seam must be observed for leaks at least 10 seconds while subjected to this vacuum. The QA/QC Professional or his/her qualified representative must observe and document 100 percent of this testing.

Other Testing- Other non-destructive testing must have prior written approval from the Engineer.

### *3.3.3 Destructive Seam Testing*

Destructive samples shall be taken at a minimum frequency of one test location, selected randomly, within each 500 linear feet of seam length, inclusive of both primary longitudinal and cross seams, cap strips and repairs or 20 $ft^2$ or larger. Each test sample should be about 44 to 56 inches long and 12 inches wide with the seam located in the middle. Test specimens, approximately 1 inch wide, shall be cut from both ends of the sample for field testing (peel and shear). The remaining sample should be cut into three parts (one for quality assurance laboratory testing, one for installer quality control laboratory testing, and one for archive storage to be maintained at a location selected by the owner).

The field tests shall be conducted on a certified calibrated tensiometer capable of maintaining a constant extension rate of 2 inches per minute. If one of the field test specimens from the ends of the destructive sample fail, then the seam will be considered to have failed, and repairs shall be initiated as described below. If both specimens pass, then a sample for laboratory testing will be sent to the quality assurance laboratory for testing in both peel and shear. Seam strengths for HDPE geomembranes shall meet the minimum values specified in Table 5 and as discussed above for weld acceptance criteria.

Destructive test results for both field and laboratory tests shall include qualitative data including the location of the failure and locus-of-break code as described on Figures 1 and 2. Peel tests on double-tracked fusion welds shall be performed on both inside and outside tracks of the weld.

At a minimum, a destructive test must be done for each welding machine used for seaming or repairs. A sufficient amount of the seam must be removed in order to conduct field testing, independent laboratory testing, and archiving of enough material in order to retest the seam when necessary. Field testing shall include at least two peel test specimens (four when testing both tracks on dual-track fusion welded seams) and at least two shear specimens. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-

destructively tested. Additional destructive test samples may be taken if deemed necessary by the QA/QC professional or his\her qualified representative.

### 3.3.4 Seam Failure Delineation

When a sample fails a destructive test, the installer shall follow the welding path to an intermediate location at least 10 feet in each direction, or a distance determined by the QA/QC Professional, from the point of the failed test in each direction and take 1-inch wide specimens for an additional set of field tests. If these additional samples pass the tests, then two laboratory destructive samples shall be taken adjacent to the intermediate locations or at locations determined by the QA/QC Professional or his/her representative. If these laboratory samples pass the tests, then the seam shall be repaired between these locations. If either sample fails, then the process shall be repeated to establish the zone where the seam should be repaired. All acceptable repaired seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

### 3.3.5 Seam Failure Repairs and Retesting

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. Repair methods may include spot welding (extrusion) for minor flaws and punctures; patches for larger holes and tears; capping for large lengths of failed seams or panel damage; and extrusion welding of the outer flap for repair on an inadequate fusion seam (less than 100-ft cumulative length) which has an exposed edge. All seam leaks and destructive test locations shall be repaired for a distance of at least six inches on each side of the faulty spot or area detected. At a minimum, those repairs shall be non-destructively retested and possibly destructively tested (refer to destructive testing criteria for repaired seams as described above in Destructive Seam Testing).

For any repair method, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair;
- All surface shall be clean and dry at the time of repair;
- Patches or caps shall extend at least six inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately three inches or more;
- All repairs shall be nondestructively tested as previously described; and
- All seaming equipment, personnel, and operation procedures used in repair work shall meet the same requirements as for new seaming operations.

The QA/QC Professional or his/her qualified representative shall observe and document all destructive and nondestructive testing of repairs and shall record the number of each repair, type, date and test outcome. Repairs that pass the nondestructive tests shall be taken as an indication of an adequate repair. Repairs more than 150 ft long shall also be required to have a destructive test performed.

Repairs that fail the initial retest shall be redone and retested until a passing test results. All work and testing of repairs shall be fully documented in a repair log.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. In no case shall the geomembrane be allowed to fold over on itself.

## 4.0 GEOTEXTILE LAYER

A nonwoven geotextile layer shall be placed over the 40-mil HDPE geomembrane. The nonwoven geotextile shall be an 8-oz/sy, nonwoven, needle-punched made from staple fiber. The geotextile shall meet the following material properties.

**Table 6. Geotextile QC Submittal Frequency & Material Specifications**

| Property | Test Method | Frequency | Min. Ave. Roll Value |
|---|---|---|---|
| Mass per unit area, oz/yd$^2$ | ASTM D5261 | 90,000 ft$^2$ | 8 |
| Grab Tensile Strength, lb | ASTM D4632 | 90,000 ft$^2$ | 220 |
| Grab Elongation, % | ASTM D4632 | 90,000 ft$^2$ | 50 |
| Trapezoidal Tear, lb | ASTM D4533 | 90,000 ft$^2$ | 90 |

The geotextile shall be deployed in a manner meeting the restrictions described in Section 3.2.2.

Geotextile panels will be overlapped and seamed as recommended by the manufacturer.

## 5.0 SOIL COVER LAYER EVALUATION

The soil cover layer will consist of an 18-inch thick layer of general clean fill and an 18-inch thick layer of topsoil.

Soil cover does not require compaction control; however, it should be stable for construction traffic. Care shall be exercised in placement so as not to shift, wrinkle or damage any underlying geosynthetic layers, and the placement methods shall be documented. Soil cover placement shall be monitored by the QA/QC Professional or his representative on a full-time basis.

Light equipment such as low ground pressure dozers (less than 5 pounds per square inch contact pressure) shall be used to place the soil cover and a minimum of 12 inches of material shall be maintained between the dozer and the underlying geosynthetics. If possible, cover should be placed during the coolest weather available. Soil cover material shall be deployed in “fingers” along the geosynthetics to control the amount of slack, and minimize wrinkles and prevent folds.

The final thickness of the soil cover layer shall be a minimum of 36 inches directly above the geomembrane layer. The required thickness of the layer shall be verified by survey techniques on an established grid system with not less than one verification point per 10,000 square feet of surface area. A minimum of two verification points is required.

The soil used as the topsoil layer will be capable of sustaining native plant growth and must be hydroseeded immediately after completion of the final cover (weather permitting). Temporary or permanent erosion control materials (i.e., mulches, containment meshes, geomatting systems, etc.) may be used to minimize erosion and aid establishment of vegetation. An alternative erosion layer may also be constructed (subject of the approval of the Engineer and TCEQ) consisting of cobbles, riprap, or other hard armor systems for areas in which the establishment of vegetation cover has proven difficult.

Other quality assurance for the soil cover layer should consist of continuous observation by the QA/QC Professional or his representative during construction, including verification that the soil is free of deleterious materials; and performing any additional test believed necessary by the QA/QC Professional to verify that the layer has been constructed in accordance with the closure plan.

## 6.0 QA/QC FOR AIR MONITORING

QA/QC Procedures for Air Monitoring activities conducted during closure activities are included in Section 6.0 of the North CAMU Air Monitoring Plan, included as Appendix H to the Closure Plan.

## 7.0 QA/QC FOR WASTE SAMPLING AND ANALYSIS

Waste characterization for the Class 2 non-hazardous remediation waste associated with clean-up activities for the J-Parcel will be performed in accordance with the Response Action Soil Sampling and Analysis Plan included in the Undeveloped Buffer Property VCP Investigation Response Action Plan, prepared by Pastor, Behling & Wheeler, LLC (PBW). QA/QC procedures applicable to this sampling program are included in that plan.

Other Class 2 remediation waste may also be disposed of at the Site. These wastes may include soils from surface or subsurface excavation areas, concrete, sediment, or other appropriate wastes. QA/QC procedures related to sampling and analysis for waste are included in the Waste Analysis Plan, which is included as Attachment Q to the August 2018 supplement to the industrial and hazardous waste permit renewal application.

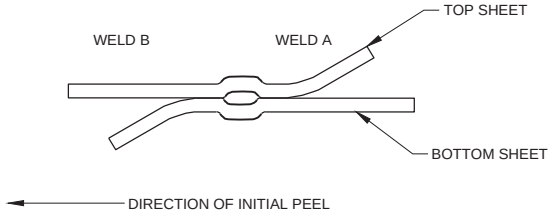
## 8.0 GROUNDWATER MONITORING

QA/QC procedures for groundwater monitoring are included in various sections, including Section 4.3 of the Final Closure Plan.

## 9.0 OTHER QA/QC PROCEDURES

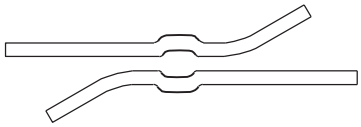
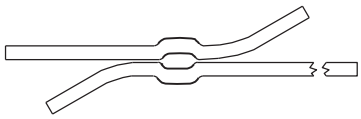
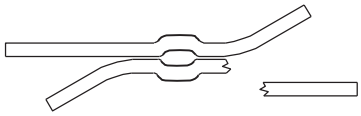
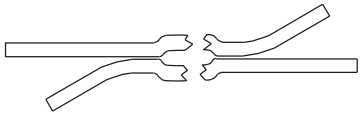
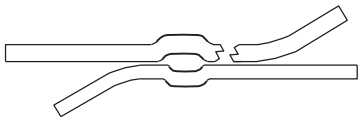
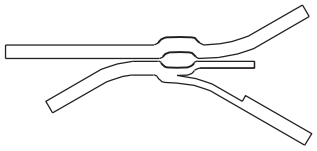
In the event that additional sampling related to closure activities is required, the sampling activities will be performed in general accordance with the procedures outlines in the Sampling and Analysis Work Plan dated November 2011 prepared by Conestoga-Rovers & Associates, which includes a Quality Assurance Project Plan.

# FIGURES




SCHEMATIC OF UNTESTED SPECIMEN


GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

| TYPES OF FAILURE | LOCUS-OF-BREAK CODE | BREAK |
|---|---|---|
|  | AD | ADHESION FAILURE |
|  | BRK | BREAK IN SHEETING. BREAK CAN BE IN EITHER TOP OR BOTTOM SHEET. |
|  | SE1 | BREAK AT OUTER EDGE OF SEAM. BREAK CAN BE IN EITHER TOP OR BOTTOM SHEET. |
|  | SE2 | BREAK AT INNER EDGE OF SEAM THROUGH BOTH SHEETS. |
|  | AD-BRK | BREAK IN FIRST SEAM AFTER SOME ADHESION FAILURE BREAK CAN BE IN EITHER THE TOP OF BOTTOM SHEET |
|  | SIP | SEPARATION IN THE PLANE OF THE SHEET. BREAK CAN BE IN EITHER TOP OF BOTTOM SHEET. |

CLIENT

EXIDE TECHNOLOGIES

PROJECT

EXIDE TECHNOLOGIES FRISCO RECYCLING CENTER
ON-SITE INDUSTRIAL NORTH CAMU FINAL COVER SYSTEM

CONSULTANT

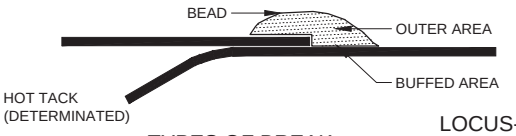
Golder Associates

| | |
|---|---|
| YYYY-MM-DD | 2015-08-20 |
| PREPARED | TGM |
| DESIGN | TGM |
| REVIEW | JBF |
| APPROVED | MRS |

TITLE

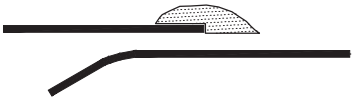
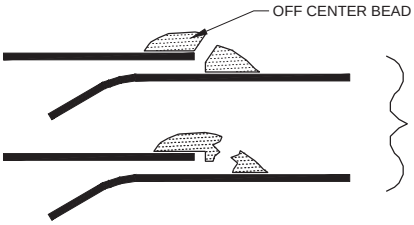
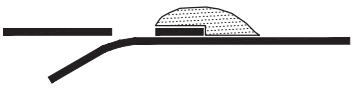
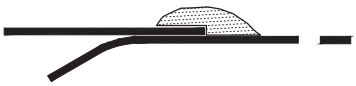
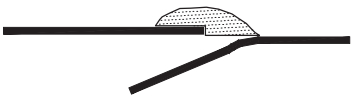
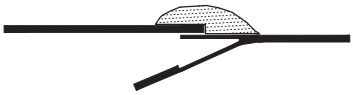
**FUSION WELD SEAM BREAK CLASSIFICATIONS**

PROJECT No. 130208602 | Rev. | FIGURE 1




UNTESTED SPECIMEN
EXTRUSION WELD WITH LEISTER HEAT SEAM


GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

| TYPES OF BREAK | LOCUS-OF-BREAK CODE | BREAK DESCRIPTION |
|---|---|---|
|  | AD1 | FAILURE IN ADHESION. SPECIMENS MAY ALSO DELAMINATE UNDER THE BEAD AND BREAK THROUGH THE THIN EXTRUDED MATERIAL IN THE OUTER AREA. |
|  | AD2 | FAILURE IN ADHESION |
|   | AD-WLD | BREAKS THOUGH THE FILLET. BREAKS THOUGH THE FILLET RANGE FROM BREAKS STARTING AT THE EDGE OF THE TOP SHEET TO BREAKS THOUGH THE FILLET AFTER SOME ADHESION FAILURE BETWEEN THE FILLET AND THE BOTTOM SHEET. |
|  | SE1 | BREAK AT SEAM EDGE IN THE BOTTOM SHEET. SPECIMENS MAY BREAK ANYWHERE FROM THE BEAD/OUTER AREA EDGE TO THE OUTER AREA/BUFF AREA. (APPLICABLE TO SHEAR ONLY). |
|  | SE2 | BREAK AT SEAM EDGE IN THE TOP SHEET. SPECIMENS MAY BREAK ANYWHERE FROM THE BEAD/OUTER AREA EDGE TO THE OUTER AREA/BUFF AREA. (APPLICABLE TO SHEAR ONLY). |
|  | SE3 | BREAK AT SEAM EDGE IN THE BOTTOM SHEET. (APPLICABLE TO PEEL ONLY). |
|  | BRK1 | BREAK IN THE BOTTOM SHEETING. A "B" IN PARENTHESIS FOLLOWING THE CODE MEANS THE SPECIMEN BREAK IN THE BUFFED AREA. (APPLICABLE TO SHEAR ONLY). |
|  | BRK2 | BREAK IN THE TOP SHEETING. A "B" IN PARENTHESIS FOLLOWING THE CODE MEANS THE SPECIMEN BREAK IN THE BUFFED AREA. (APPLICABLE TO SHEAR ONLY). |
|  | AD-BRK | BREAK IN THE BOTTOM SHEETING AFTER SOME ADHESION FAILURE BETWEEN THE FILLET AND THE BOTTOM SHEET. (APPLICABLE TO PEEL ONLY). |
|  | HT | BREAK AT THE EDGE OF THE HOT TACK FOR SPECIMENS WHICH COULD NOT BE DELAMINATED IN THE HOT TACK. |
|  | SIP | SEPARATION IN THE PLANE OF THE SHEET. |

CLIENT

EXIDE TECHNOLOGIES

PROJECT

EXIDE TECHNOLOGIES FRISCO RECYCLING CENTER
ON-SITE INDUSTRIAL NORTH CAMU FINAL COVER SYSTEM

CONSULTANT

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|---|---|
| YYYY-MM-DD | 2015-08-20 |
| PREPARED | TGM |
| DESIGN | TGM |
| REVIEW | JBF |
| APPROVED | MRS |

TITLE

**EXTRUSION WELD SEAM BREAK CLASSIFICATIONS**

PROJECT No. 130208602 | Rev. | FIGURE 2

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Golder Associates

**Engineering Earth's Development, Preserving Earth's Integrity**