# APPENDIX III-3D

# LINER QUALITY CONTROL PLAN (LQCP)

# FIGURES

# PART III, ATTACHMENT 3

# APPENDIX III-3D

# LINER QUALITY CONTROL PLAN (LQCP)

## Hawthorn Park Recycling and Disposal Facility

## Houston, Harris County, Texas

## TCEQ Permit MSW-2185A

**Owner/Site Operator/Permittee:**

WASTE MANAGEMENT

**USA Waste of Texas Landfills, Inc.**
**24275 Katy Freeway, Suite 450**
**Katy, Texas 77494**

STATE OF TEXAS
2/12/21
CHARLES G. DOMINGUEZ
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LICENSED
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**Submitted By:**

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

**INTENDED FOR PERMITTING PURPOSES ONLY**

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# 1.0 PURPOSE

## 1.1 Purpose and Scope

This Liner Quality Control Plan (LQCP) has been prepared in accordance with 30 TAC §330.339 and §330.63(d)(4)(G). This LQCP establishes the procedures for construction, testing, and documentation of the soils and liner system for the Hawthorn Park Recycling and Disposal Facility (RDF).

The construction and testing of all liner system components must be according to this LQCP to ensure that the liner system is constructed in accordance with the site-specific permitted design and in compliance with the applicable regulations of the Texas Commission on Environmental Quality (TCEQ) for liners and groundwater protection.

A copy of a current version of this LQCP must be maintained on-site at all times in the Site Operating Record. The LQCP shall be available for review by TCEQ and construction and testing personnel. Revisions to this LQCP shall receive written approval from TCEQ prior to implementation. Quality control of construction and quality assurance of sampling and testing procedures will follow the latest technical guidelines of the TCEQ Executive Director.

## 1.2 Liner System

### *1.2.1 Existing Liner Systems*

Using the available SLER information and existing permit data, the existing landfill liners have been constructed and approved with the liner systems described below, along with the associated permit. The liner system layers are listed from the bottom up.

**TABLE III-3D-1: Existing Liner Systems**

| Permit No. | Liner System |
|---|---|
| MSW-1135 | In-situ clay bottom liner, or;<br>Constructed 3-ft (min.) clay sidewall liner extended 2-ft into clay strata |
| MSW-1148 and MSW1148A | 3-ft (min.) in-situ clay bottom liner, or;<br>In-situ clay, clay fill for total 3-ft (min.) bottom liner |
| MSW-1643 | 3-ft (min.) in-situ clay bottom liner, or;<br>3-ft (min.) in-situ liner; 3-ft (min) constructed and/or in-situ sidewall liner, 1-ft protective cover |
| MSW-2185 | 3-ft compacted clay liner, 1-ft protective cover |

For the landfill areas under current Permit No. MSW-2185 (which includes Permit Nos. MSW-1448A and MSW-1643), a minimum 3-ft bottom liner was specified. All the waste areas developed to-date have sidewall liners composed of a minimum 3-ft-thick clay liner that is in-situ, constructed, or a combination of both.

### *1.2.2 Proposed Liner System*

The cross-section for the proposed liner system for the facility is shown in Part III, Figure III-3-5 of this Permit Amendment Application (PAA). The liner system for the proposed disposal cells will consist of, from the bottom up, in accordance with 30 TAC §§330.331(d)(2) and 330.339(d):

- 3 feet of compacted clay liner
  - Material coefficient of permeability must not exceed $1 \times 10^{-7}$ cm/s (i.e., $k \leq 1 \times 10^{-7}$ cm/s)
- 1 foot of protective cover soil

The proposed liner will tie into existing liner where applicable. Any area that is designated for waste disposal in this PAA will be constructed over existing or proposed liner.

## 1.3 General Responsibilities

The landfill owner/operator is responsible for fully implementing this LQCP. It is the owner/operator's responsibility to ensure that adequate and approved disposal space is available at all times and to arrange for the construction of new cells as the need arises. The Site Manager (SM) or designated alternate shall be responsible for contracting a qualified Professional of Record (POR) prior to initiating liner system construction.

Each phase of the soil and liner evaluation shall be conducted by or under the supervision of the POR. The POR 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 Engineering Technician (QET) performing daily quality assurance/quality control (QA/QC) observation and testing shall be under the direct supervision of the POR. The POR or his/her qualified representative(s) shall provide full-time monitoring.

The required qualifications for the POR and QET are summarized as follows:

- Professional of Record (POR) — a professional engineer registered in the state of Texas who possesses professional experience in geotechnical engineering, construction oversight, geosynthetics, and soil testing, or as otherwise identified in technical guidance documents developed by TCEQ.
- Qualified Engineering Technician (QET) — a representative of the POR who is NICET-certified in geotechnical technology at level 2 or higher or certified through the Geosynthetic Certification Institute's Inspectors Certification Program (GCI-ICP), an engineering technician with a minimum of four years of directly related experience, or a graduate engineer or geologist with one year of directly related experience.

# 2.0 SOIL LINER

This section of the LQCP outlines generally acceptable construction practices and specifications and the minimum quality control testing requirements for soil liners.

## 2.1 Pre-construction Material Evaluation

The first step in constructing a soil liner is to pre-qualify the soil materials that are selected for liner construction. Soil liner material may be obtained from in-situ soil strata that will be excavated as the liner is constructed or from a select borrow source. Representative samples from either source shall be subject to the minimum pre-construction testing program shown in Table III-3D-2.

**TABLE III-3D-2: Soil Liner Materials Pre-Construction Testing Schedule**

| TEST | METHOD USED | FREQUENCY(1) |
|---|---|---|
| Soil Classification | ASTM D2487 | 1 per soil type |
| Particle-Size Analysis | ASTM D422 or D1140 | 1 per soil type |
| Atterberg Limits | ASTM D4318 | 1 per soil type |
| Hydraulic Conductivity(2) | ASTM D5084(3) | 1 per soil type |
| Proctor Test | ASTM D698 or D1557 | 1 per soil type |
| Moisture Content | ASTM D2216 | 1 per soil type |

Notes:

1. If either the liquid limit (LL) or plasticity index (PI) varies by more than 10 points from other samples, the soil is considered a different soil type.
2. Conduct this test on a remolded sample that is compacted at or less than 95% of the maximum dry density and at the optimum moisture content as determined from the standard Proctor test or at or less than 90% of the maximum dry density and at the optimum moisture content as determined from the modified Proctor test. If pre-construction samples are compacted at higher or lower densities and/or respective moisture contents, then these values will govern for field control. Pre-construction tests should represent the "worst-case" condition in the field concerning hydraulic conductivity results.
3. Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative method. Permeability tests will be conducted using tap water or 0.05N calcium sulfate solution as the permeant fluid. Distilled or deionized water is not acceptable.

Where soil types vary substantially and are not segregated, representative blends of those soil types anticipated to be utilized for soil liner construction should also be sampled and tested. The material tested shall comply with the following minimum material specifications:

- Plasticity Index ≥ 15
- Liquid Limit ≥ 30
- Percent Passing No. 200 Sieve ≥ 30
- Particle Size ≤ 1 inch
- Hydraulic Conductivity (k) ≤ $1 \times 10^{-7}$ cm/sec

The Proctor moisture-density curves shall be developed for each type of soil determined suitable as liner material and shall be used during the construction phase as a performance reference for compaction and moisture control.

The POR should consider the potential adverse effects on and/or inconsistencies of results due to laboratory drying procedures, as some materials may exhibit variation in results for Proctor and Atterberg limits tests. Samples should not be oven-dried nor dried back more than 2% to 3% below the lowest anticipated moisture content needed to develop the Proctor moisture-density relationship. The zero air voids line shall be computed and included along with the Proctor curves, indicating the specific gravity value used.

Pre-construction samples to be run for hydraulic conductivity testing shall be molded at or less than the optimum moisture content and at or less than 95% of the maximum dry density according to the standard Proctor test (ASTM D698) or at or less than 90% of the maximum dry density and at the optimum moisture content as determined from the modified Proctor test. These points should represent reasonable worst-case conditions for hydraulic conductivity results on appropriately compacted soils. If higher moisture contents or dry densities are used for the hydraulic conductivity tests, then the higher values will be used for field control during placement. However, if lower moisture or density values are used and confirmed to achieve acceptable hydraulic conductivities, field control will still be based on the minimum compaction requirements in Section 2.2.

As a general rule, a minimum of one series of pre-construction tests should be performed for every 15,000 to 20,000 cubic yards of soil to be used in liner construction, unless soil types are limited and easily distinguished. As soil is usually made available after excavation during liner construction, additional pre-construction samples should be taken, and tests performed when soils vary or as soon as the initial pre-construction test results appear inappropriate or questionable. If the same borrow source is utilized for the soil supply of more than one liner area, results from previous tests may be used to supplement the pre-construction data.

## 2.2 Soil Liner Construction Specifications and Practices

The soil liner shall be constructed in accordance with the requirements included in this section. Also, certain construction practices shall be utilized as described herein when appropriate.

### *2.2.1 Liner Subgrade Preparation*

Subgrade surfaces for both the bottom and the side slope of waste disposal areas to receive constructed soil liners shall be prepared to ensure a stable foundation and to facilitate bonding of the soil liner to the subgrade material. Upon achieving the design subgrade level, zones of soft or unsuitable soils and deleterious material shall be excavated and removed and replaced with appropriate general fill or soil liner material. Free shallow groundwater or excess soil moisture shall be removed by providing drainage and/or aeration.

The exposed subgrade should be proof-rolled, processed and recompacted, or over-excavated and replaced, as necessary. The POR shall determine sufficient stability based on observation of acceptable deflection, pumping, and strength of the subgrade material. The subgrade lines and grades shall be determined by instrument survey methods prior to subsequent soil liner construction.

The prepared subgrade shall be tied into the first soil liner lift in a manner deemed suitable by the POR, such that the integrity of the first lift will be maintained.

### 2.2.2 Work Area Selection and Sizing

Work areas for soil liner construction should be selected, sized, and sequenced so that work on each lift can begin and be completed in the same day. The area worked at any one time should be of such size that placement, processing, and compaction will be uniform, with minimal variation caused by weather conditions. It is critical that completed lifts be tested and covered with the next loose lift before that completed lift dries out in the sun or becomes damaged by heavy precipitation. Furthermore, the selection of size and shape of work areas shall be consistent, so that uniform construction techniques and equipment can be selected. Adequate numbers of quality control personnel will be provided to suit the pace of construction, so proper monitoring and documentation is performed.

### 2.2.3 Lift Placement and Processing

Reduction of soil clods, uniform moisture distribution, and consistent placement thickness are key elements to achieving uniform compaction of soil liners. Soil liner material shall be placed in loose lifts, generally not exceeding 8-inches after spreading and leveling and/or processing, with the expectation that the finished lift, following compaction, will be about 6-inches or less. In no case will the loose lift thickness, after spreading and leveling, be greater than the length of the compactor feet. The intent of limiting the loose thickness is to achieve good interlift bonding and to minimize bridging or layering effects.

The loose lift of soil shall be mechanically processed, either in-place or in a separate processing area, to break down the original soil structure and to reduce clod size. Additional processing, if necessary, will be used to blend variable soil types within the loose lift and incorporate additional water. The goal of processing is to yield a relatively uniform mass of soil that is devoid of original structure that may contribute to excess hydraulic conductivity. Processing may be achieved by discing, grading, compacting, or pulverizing. Pneumatic-tired or tracked equipment will not generally be acceptable to provide processing action, although this equipment may be used to pull the other acceptable implements.

Moisture adjustment may be required, particularly during dry seasons, and reasonable practices shall be used to distribute added water uniformly within the lift. Care shall be taken to prevent over-watering and ponding of water within the loose lift, as this excess water is difficult to redistribute. Drying back of overly wet soils during processing can result in clods having dry, crusting surfaces, which may not bond together adequately. If such drying is allowed, then additional effort will be necessary to assure even moisture distribution and hydration. Hydration times shall be evaluated and determined if acceptable by the POR.

### 2.2.4 Minimum Compaction Requirements

Processed loose lifts shall be leveled prior to compaction to provide uniform compaction effort over the lift. Each lift shall be compacted to the moisture and density requirements established for the project and as set forth in the provisions of this LQCP. The lifts shall be compacted to at least 95% of the maximum dry density with a corresponding moisture content at or up to 5% above optimum determined by standard Proctor test results (ASTM D698) or at least 90% of the maximum dry density and moisture content at or up to 5 percentage points above optimum determined from the modified Proctor test. The above criteria shall be utilized, unless pre-construction hydraulic conductivity tests were performed at higher or lower densities or moisture contents, in which case these density and moisture values will be used as field compaction minimums.

If subsequent laboratory testing of samples from an area of constructed liner indicate an alternate moisture density curve is appropriate for the soil type, the QET will switch to the appropriate curve as necessary. It is recognized that laboratory data become available often several days after construction of an area of clay liner. If the laboratory data indicate that the area constructed using the incorrect moisture-density curve meets the permeability requirements for a constructed clay liner (i.e., less than or equal to 1 x $10^{-7}$ cm/sec), the area will be considered acceptable as clay liner.

Soil liners shall not be compacted with a bulldozer or any track-mobilized equipment unless it is used to pull a footed roller; however, this practice is not encouraged. All soil liners shall be compacted with a pad-footed or prong-footed roller only. Bulldozers, pneumatic rollers or scrapers, and flat-wheeled rollers will not be permitted for compaction.

Construction survey control should be conducted routinely during lift placement to verify that loose and finished lifts are of the proper thickness to ensure uniform compaction.

### 2.2.5 Lift Bonding and Liner Tie-In

Interlift bonding shall be accomplished prior to placing the subsequent loose lift. Compactors shall be of sufficient weight and foot length to penetrate the current lift when loose and provide bonding to the previous lift.

When lifts of the soil liner are not constructed continuously, a vertical construction joint may occur. To remove the vertical construction joint(s), the edge of the adjoining liner section shall be cut back or flattened to permit offsetting the tie-in for subsequent lifts as shown on Figure III-3D-1. For each 6-inch lift, the edge should be cut back at least 2.5 feet or graded to a maximum slope of 5H:1V, and then the corresponding adjoining lift should be placed against the existing finished lift. The new loose lift and at least 2 feet of the adjoining existing lift will be processed together, and then recompacted, so that the existing liner edge is tied to new construction without superimposed vertical construction joints. This tie-in procedure shall be repeated lift-by-lift until all corresponding adjacent lifts are constructed to the required elevation. The cut back edge of the existing liner may be done all at once or one lift at a time.

### 2.2.6 Sidewall Liner Considerations

The previously referenced construction specifications and practices apply equally to floor liner and sidewall liner construction. However, sidewall liners may be constructed using either parallel lifts in a continuation of the floor liner up the slope or using horizontal lifts placed against the slope. Slopes steeper than 3H:1V will generally be constructed in successive horizontal lifts. Adequate longitudinal offsetting of the horizontal lifts will be made to allow tie-in of adjoining lifts as described above when lift sections are not constructed continuously.

Where parallel lifts are used, observations will be made to verify that the eccentric weight of the equipment (with its tendency to slide down the slope) does not cause shearing of the upper portion of the lift. Where horizontal lifts are constructed, observations will be made to verify that the necessary width of the narrow lifts is uniformly processed and compacted.

## 2.3 Construction Monitoring and Conformance Testing

Quality assurance of recompacted soil liners shall consist of monitoring the work as soil liner construction proceeds and laboratory and field testing to assure that liner material conformance and construction performance specifications are achieved.

### 2.3.1 Monitoring and Observations

Full-time quality assurance monitoring and testing will be performed during the course of soil liner construction. The work will be performed by the POR, or by a QET working under the general supervision of the POR. The QET will be on-site at all times when liner construction is ongoing, so that all relevant activities can be observed and documented. The POR will visit the site periodically as construction progress warrants. Such visits will be frequent enough so that the POR is fully knowledgeable of the construction methods and performance, so that the POR can determine that quality control monitoring and testing activities are adequate to meet the terms and intent of this LQCP.

Visual observation shall include, but not be limited to, the following:

- Moisture content and distribution, particle size, and other physical properties of the soil during processing, placement, and compaction.
- Type and level of compactive effort, including roller type and weight, drum size, foot length and face area, and number of passes.
- Action of compaction equipment on soil surface (i.e., foot penetration, rolling, pumping, or shearing).
- Maximum clod size and breakdown of soil structure.
- Method of bonding lifts together and making liner tie-ins.

- Stones or other inclusions, which may adversely affect compaction, lift bonding, and in-place testing/sampling.
- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

### 2.3.2 Construction Testing

During soil liner construction, the minimum testing and sampling program presented in Table III-3D-3 shall be conducted to determine that adequate compaction and material conformance are being achieved.

**TABLE III-3D-3: Soil Liner Construction Testing Schedule**

| TEST | METHOD | PARALLEL LIFTS MINIMUM FREQUENCY(1)(5)(6) | HORIZONTAL LIFTS MINIMUM FREQUENCY(2)(5)(6) |
|---|---|---|---|
| Field Moisture/ Density Test | ASTM D6938, D2937, or D1556 | 1 per 8,000 ft², 3 minimum, per 6-inch lift for each monolithic liner section | 1 per 100 linear feet per 12-inch height of clay berm |
| Percent Finer Than No. 200 Sieve | ASTM D1140 or D422 | 1 per 100,000 ft², 1 minimum, per 6-inch lift for each monolithic liner section | 1 per 2,000 lineal feet per 12-inches of clay berm (horizontal lifts)(4) |
| Atterberg Limits | ASTM D4318 | 1 per 100,000 ft², 1 minimum, per 6-inch lift for each monolithic liner section | 1 per 2,000 lineal feet per 12-inches of clay berm (horizontal lifts) (4) |
| Hydraulic Conductivity(3) | ASTM D5084 | 1 per 100,000 ft², 1 minimum, per 6-inch lift for each monolithic liner section | 1 per 2,000 lineal feet per 12-inches of clay berm (horizontal lifts) (4) |

Notes:

1. For bottom liner and sidewall liner placed parallel to the slope.
2. For clay berm constructed with horizontal lifts.
3. Testing shall be conducted on undisturbed samples. Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternate.
4. For tall, but lengthwise short sections constructed with horizontal lifts, the frequency of tests may be great. Owner may consult with TCEQ on a case-by-case basis prior to construction for approval to reduce the frequency.
5. A voluntary increase in the number of any tests performed does not in turn require a commensurate increase in the other testing requirements to meet the above program.
6. A minimum of one of each of the designated tests must be conducted for each lift of liner regardless of surface area.

Typically, field moisture-density tests will be performed using a nuclear density gage (ASTM D6938). Other acceptable test methods include the Sand Cone Method (ASTM D1556) or Drive Cylinder Test (ASTM D2937). Questions concerning the accuracy of any single field moisture-density test shall be addressed by retesting in the same general location. Periodic checks using the various test methods may be performed to verify the field moisture-density test results. Alternatively, field moisture-density checks may be performed using laboratory measurements of tube samples obtained adjacent to the field test locations.

The percent finer than No. 200 Sieve, Atterberg Limits, and hydraulic conductivity tests will be performed on samples generally obtained with a thin-walled tube sampler. If more material is needed, the extra material can be obtained from cuttings at the same location. These construction test samples will be obtained from the recently completed lift, taken one lift at a time, so that sample penetrations only go through one lift and do not penetrate from one lift into the next. Undisturbed samples will generally be sent to the geotechnical laboratory in the sampling tube, which will be properly sealed to preserve the moisture content and integrity of the sample.

### 2.3.3 Failure Repairs

Sections of compacted soils liner that do not pass either the density or moisture requirements in the field shall be reworked and retested until the section in question does pass. All field density results shall be reported in the Soil and Liner Evaluation Report (SLER), whether they indicate passing or failing values.

In the event of a failed moisture-density test, additional tests will be performed between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests will be reworked and retested until passing. If the additional tests fail, then additional tests will be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure will be repeated until the failing area is defined, reworked, and retested with passing results.

### 2.3.4 Clay Liner Perforations

When taking field densities and undisturbed samples, all holes dug or created in the liner for density probes or samples must be backfilled with a mixture of bentonite-rich soil material, bentonite granules, bentonite chips, or some other form of bentonite. This backfill will be tamped in the hole to remove pockets of air or loose soil, and to assure a tight compact seal.

### 2.3.5 Liner Thickness Verification

Soil liner thickness verification shall be determined by instrument survey method only; no test probes that create holes will be allowed. The verification points for record purposes shall be on a grid not exceeding 5,000 square feet per grid. If the area under evaluation is less than 5,000 square feet, a minimum of two grid points is required for verification. The selected grid shall be the same for both beginning and finished elevations of the soil liner, so that minimum thicknesses can be calculated and verified.

### 2.3.6 Post-Construction Care of Soil Liner

The integrity of the soil liner shall be maintained by moistening to prevent the material from desiccating. Conversely, the soil liner shall be kept free of standing water by adequately pumping after rainfall events. Damage caused by rain shall be repaired, and if the lift must be reworked, as determined by the POR, then appropriate retesting (including field moisture-density and permeability tests) shall be performed.

# 3.0 PROTECTIVE COVER

This section of the LQCP outlines generally acceptable construction practices and specifications and the minimum quality control testing requirements for the protective cover layer proposed for placement above the soil liner.

Protective cover will be placed over the soil liner after completion of construction and completion of Quality Assurance (QA) testing of the soil liner. Pre-construction evaluation of material sources, material conformance testing during construction, and field testing of the protective cover layer is not required.

## 3.1 Protective Cover Material Evaluation

Protective cover materials shall be earthen material with a 3-inch diameter maximum particle size and free of deleterious materials. Visual observations shall be made to verify that no deleterious materials are present in the protective cover that could damage the lining system or impede its performance as designed.

Alternate protective cover material, such as shredded tire chips, may only be used when overlying a protective layer of sufficient puncture resistance to prevent penetration of steel belting fragments or other deleterious materials. Prior to use of an alternate protective cover material, written approval will be obtained from TCEQ.

## 3.2 Protective Cover Construction Specifications and Practices

Protective cover does not require compaction control; however, it should be stable for construction and disposal traffic. Care shall be exercised in placement so as not to damage the underlying soil liner, and the placement methods shall be documented. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires, quick stops, or sharp turns.

The final thickness of the protective cover shall be a minimum of 12 inches above the soil liner layer.

## 3.3 Construction Monitoring and Conformance Testing

The installation of the protective cover system will have continuous inspection by the POR or his/her qualified representative(s).

### *3.3.1 Monitoring and Observations*

The POR or his/her qualified representative(s) shall visually monitor and document that the construction of the protective cover layer is in accordance with the requirements and specifications set forth in this LCQP.

### *3.3.2 Thickness Verification*

Protective cover thickness verification shall be determined by instrument survey method only. The verification points for record purposes shall be on a grid not exceeding 5,000 square feet per grid. If the area under evaluation is less than 5,000 square feet, a minimum of two grid points is required for verification.

The beginning survey grid shall be the previously completed top of soil liner survey. The finished elevations of the protective cover shall be taken using the same horizontal survey locations, so that minimum thicknesses can be calculated and verified.

### 3.3.3 Post-Construction Care of Protective Cover

The integrity of the protective cover layer shall be maintained by moistening to prevent the material from desiccating. Conversely, the protective cover shall be kept free from standing water by adequately pumping after rainfall events. Damage caused by rain shall be repaired, and if the protective cover layer must be reworked, as determined by the POR, then appropriate retesting (such as thickness verification) shall be performed.

# 4.0 SPECIAL CONDITIONS – EXCAVATIONS BELOW THE SEASONAL HIGH GROUNDWATER TABLE

## 4.1 Introduction

This section of the LQCP addresses the issue of cell construction below the seasonal high groundwater table and provides information pertaining to site-specific conditions, analysis and design methods, construction methods, and documentation/reporting procedures to be considered during development of future disposal cells at the facility.

In landfill excavation areas that have been identified as extending below the seasonal high groundwater table, the liner system and the waste placed above the liner system will provide ballast (weight) to protect the liner system from uplift forces from groundwater. Soil or a soil/waste combination may also be used to ballast the liner system.

In accordance with 30 TAC §330.337(e), prior to excavating any unit below the seasonal high water table, the owner/operator is required to perform a preliminary foundation evaluation and provide that evaluation to TCEQ for review and approval. The foundation evaluation must consider stability, settlement, and constructability. A foundation evaluation has been performed as part of this PAA and is provided in Part III, Attachment 3. This section of the LQCP addresses additional measures to be implemented to verify the integrity of lining systems constructed below the seasonal high groundwater table.

The stability of the liner systems against uplift is considered for two cases: 1) short-term, i.e., during construction and filling operations; and 2) long-term, i.e., after filling and into post-closure. Short-term stability against uplift of the liner system will be provided by an active dewatering/depressurization system. Long-term stability against uplift of the sidewall and floor liner systems is provided by the weight of the protective cover, waste material, and cover system components, collectively referred to as ballast.

## 4.2 Site Characterization

The site stratigraphy consists of four distinct strata, namely (in order from ground surface down):

- Layer I is composed predominantly of clays and sandy clays with minor amounts of sand and silt. Layer I is found from the ground surface to approximately 22 to 31 feet below ground surface (ft-bgs). Due to this layer's high clay content, it serves as an effective confining bed to the underlying transmissive unit.
- Layer II is generally found approximately 20 ft-bgs and has an average thickness of 30 ft. This layer is composed of channel fill deposits consisting predominantly of fine sands with gradations to silty fine sands and silts. This layer is considered the uppermost groundwater-bearing unit at the site.
- Layer III is found approximately 59 to 100 ft-bgs and is correlatable across the site. This layer consists primarily of clays, sandy clays, and silty clays, and is primarily a zone of low

permeability; however, due to the sand and silt content present within this layer, internal transmissive zones are present.

- Layer IV is composed of fine sands and varying amounts of silt within the stratum. This layer is found at depths greater than 100 ft-bgs.

The groundwater flow is primarily contained within the sand beds of Layer II. Layer III is considered the lower confining unit to the uppermost aquifer, Layer II. Full discussion of the site stratigraphy and site hydrogeology can be found in the Geology Report in Part III, Attachment 4 of this PAA.

## 4.3 Seasonal High Groundwater Table

Site monitor well records were reviewed and used to determine the historical seasonal high groundwater table for the expansion cell areas. Figure III-3D-2 presents the seasonal high groundwater table elevations. A list of the monitor wells and readings used in developing this figure is presented in Appendix III-3D-1.

For each new increment of liner construction, the POR shall reevaluate the seasonal high groundwater table for the area being evaluated as part of the Soil Liner Evaluation Report (SLER) submittal. The specific information to be included in the SLER is:

- A description of the seasonal high groundwater table established in the Site Development Plan (SDP) or previous SLER, as applicable.
- A summary of the groundwater data collected since development of the SDP or previous SLER, as applicable.
- An evaluation of whether the seasonal high groundwater table must be adjusted upward based on these data.
- An analysis of the changes required in the groundwater drains or ballast requirements because of the revised seasonal high groundwater table.

The most recent seasonal high groundwater table data will be included in the SLER submitted for each excavation area.

## 4.4 Short-Term Excavation Stability

Measures will be taken to protect the liner system during construction below the seasonal high groundwater table. One or more of the following methods are allowed by 30 TAC §330.337(b) to provide short-term protection:

1. Providing calculations satisfactory to TCEQ that the weight of the liner systems, including any ballast, is sufficient to offset by a factor of 1.2 any otherwise unbalanced upward or inward hydrostatic forces on the liner.
2. Incorporating an active or passive dewatering system in the design to reduce upward or inward hydrostatic forces on the liner by a factor of 1.2 and by providing calculations satisfactory to TCEQ that the dewatering system will perform to adequately reduce those forces.

3. Providing evidence satisfactory to TCEQ that the soil surrounding the landfill is so poorly permeable that groundwater cannot move sufficiently to exert force that would damage the liner.
4. Providing evidence that the seasonal high water table is below the deepest planned excavation.

Excavations below the water table can result in bottom or slope instability or excessive groundwater influx that may make construction of the liner system difficult. During excavation, control of groundwater can be accomplished by temporarily lowering the groundwater level. Since soil will be excavated gradually for use as daily cover or compacted clay liner material, cell excavation will take place over an extended time period. Therefore, in areas where excessive seepage is encountered, the seepage will be directed away from the cell or into sumps using ditches, and excavation activities will be paused or moved to another location while the groundwater is allowed to drain.

As the design base grades are approached, groundwater pressurization will be controlled by installing wells along the boundary of the proposed landfill expansion cells as needed. A dewatering system will be installed to reduce the hydrostatic pressure within Layer II. The system will prevent excessive pressure head from developing beneath Layer I and the liner system during construction and filling operations. The system will be operated until adequate ballast is achieved and approval is obtained from TCEQ to deactivate and abandon the system.

Calculations for the short-term depressurization for the Hawthorn Park RDF are included in Appendix III-3D-2.

## 4.5 Long-Term Excavation Stability

As described previously, it is anticipated that portions of the proposed expansion area liner system will be founded below the seasonal high groundwater table. Example ballast calculations have been prepared to demonstrate that long-term excavation stability will be provided by the weight (ballast) of the soil liner, protective cover and waste, assuming seasonal high groundwater potentiometric levels. The ballast counteracting the hydrostatic forces resulting from this high groundwater include the soil liner, the protective cover, and waste above the liner.

Example waste for ballast calculations are presented in Appendix III-3D-3. Figures III-3D-3 and III-3D-4 show the locations of the points analyzed and the seasonal high groundwater table. In each SLER, waste for ballast calculations will be provided to determine the minimum amount of waste needed to offset the hydrostatic uplift from the seasonal high groundwater table.

## 4.6 Ballast Thickness Calculations

The required ballast thickness will be calculated using the following procedures:

1. Determine the hydrostatic uplift pressure, *P*, acting on the base of the soil liner on the floor and sidewall from the assumed seasonal high groundwater table, and the resistance provided by the ballast:

   A. Bottom of Soil Liner

   Determine the maximum hydrostatic uplift pressure, *P*, acting on the bottom of the soil liner using the unit weight of water, $\gamma_w$, times the vertical distance from the base of the soil liner to the seasonal high water table, $H_{wt}$.

   $$P = \gamma_w H_{wt}$$

   The resisting pressure, *R*, provided by the ballast is equal to the sum of the unit weights of each ballast component, $\gamma_i$, times their respective vertical thickness, $T_i$, as shown in the following equation:

   $$R = \Sigma(\gamma_i T_i)$$

   B. Sidewall Soil Liner

   Determine the normal uplift pressure, $P_N$, acting at a location on the base of the sidewall soil liner using the unit weight of water times the vertical distance from the location on the sidewall to the seasonal high piezometric level.

   $$P_N = \gamma_w H_{wt}$$

   The resisting pressure, $R_N$, provided by the ballast is equal to the normal component of the sum of the unit weights of each ballast component, $\gamma_i$, times their respective vertical thickness, $T_i$, as shown in the following equation:

   $$R_N = \Sigma(\gamma_i T_i)\cos^2\beta$$

   Where $\beta$ is the angle between the sidewall liner and horizontal.

2. The equations for *R* and *P* are solved for equilibrium to find the thickness of ballast required to counteract the calculated water pressure.

   The safety factors indicated in the regulations, either 1.2 or 1.5 depending on the type and configuration of ballast used, are incorporated into the above referenced equations by multiplying by the appropriate factor. If only soil ballast is used, a factor of 1.2 is used in the equation, and if some combination of soil layers and waste is used as ballast, a factor of 1.5 is used.

   $$1.2P = R \qquad or \qquad 1.5P = R$$

   When the equations for *R* and *P* are input, the required waste thickness, and/or required ballast thickness, is then determined. The equations can be solved for any location within or near an excavation where the piezometric profile is known or can be estimated. The factor of safety can also be computed using the actual thickness of waste and other ballast and the result compared to the appropriate required factor of safety.

Example waste for ballast calculations are presented in Appendix III-3D-3. Figures III-3D-3 and III-3D-4 show the locations of the points analyzed and the seasonal high groundwater table. In each SLER, waste for ballast calculations will be provided to determine the minimum amount of waste or soil needed, if any, to offset the hydrostatic uplift from the seasonal high water table.

If soil is used for ballast, then the soil ballast will be placed immediately after construction of the protective cover layer to minimize the potential for uplift. The soil ballast shall be free of organics, foreign objects, rocks greater than 2-inches in diameter, or other deleterious materials. The physical characteristics of the soil ballast shall be evaluated through visual observation and laboratory testing. The ballast thickness shall be verified with surveying procedures at the same frequency as that used for the clay liner construction. After completion of ballast placement, the Ballast Evaluation Report (BER) will be submitted to TCEQ. The measured in-place density will be used as the soil ballast density value to offset the hydrostatic force.

## 4.7 Slope Stability of Sidewall Liners

The calculations described above evaluate the factor of safety of the landfill liner system against uplift in the direction normal to the liner system. On the sidewalls, these normal hydrostatic pressures also decrease the resistance to translational sliding along the bottom of the liner system. For this reason, the stability of the sidewall liners may be of concern.

As described previously, where groundwater pressurization is a concern, hydrostatic pressure on the liner will be reduced using the dewatering/depressurization system. This system will be maintained and operated until sufficient ballast is in place to resist the uplift pressures below the liner system. The groundwater control measures will limit the buildup of hydrostatic pressures at the base of the liner system. It is therefore concluded that the stability of the sidewall liner systems has been adequately addressed.

## 4.8 Observations and Documentation

### *4.8.1 Verification During Construction*

The POR shall verify that the dewatering and ballast meets the established criteria and that uplift of the liner system did not occur during construction. The verification shall be documented in the BER, which will be submitted to TCEQ for approval.

### *4.8.2 Construction Observations*

The POR shall observe the liner subgrade and liner system materials for the presence of groundwater seepage during construction to verify the subgrade is suitable for liner system construction.

The entire subgrade shall be observed during excavation, and the occurrence of the following shall be noted:

- Groundwater seepage within the subgrade
- Softening of the subgrade surface resulting from groundwater seepage

- Softness or sheen in the secondary features resulting from groundwater seepage

In each SLER, observations and subgrade evaluations performed by the POR will be presented to verify that the subgrade soils are suitable for liner system construction.

### *4.8.3 Water Table Observation*

The landfill groundwater monitoring system near the construction area will be monitored during excavation below the seasonal high groundwater table. If the observations indicate the groundwater level is different than the previously determined seasonal high groundwater table, the design seasonal high groundwater table will be adjusted upward, and the ballast calculations will be revised accordingly.

## 4.9 Reporting

Once the soil liner, protective cover, waste have been placed in accordance with ballast calculations, a BER will be completed and filed with TCEQ documenting that sufficient ballast has been placed in the cell to offset the hydrostatic uplift forces that may exist below the soil liner. The temporary short-term depressurization and dewatering system must remain operational and pumped until approval of the BER is received from TCEQ. The following information will be included, as applicable, with the BER:

1. A summary of in-place density measurements will be presented verifying that the weight of the soil liner and compacted clay in the final cover required as ballast complied with the calculations.

2. The top of protective cover will be surveyed after installation to assure that the liner system did not undergo uplift prior to waste placement.

3. Water level measurements obtained from appropriate site piezometer and monitor wells near each excavation area will be presented verifying that the groundwater levels do not exceed the design seasonal high groundwater table. If the observed water levels exceed the design seasonal high groundwater level, the ballast calculations will be adjusted accordingly.

4. A TCEQ Waste-as-Ballast Placement Record form completed by the SM or designated representative will be presented confirming that the waste material in the first 5 feet of waste was free of brush and large bulky items, daily operations of the pressure dewatering/depressurization system (if required) were completed, and a wheeled trash compactor having a minimum weight of 40,000 pounds was used to place waste.

The BER will be signed and sealed by the POR, signed by the SM or his/her authorized representative, and submitted to TCEQ for approval. If no response is received, either oral or written, within 14 days after receipt by TCEQ, then the BER will be considered approved.

## 5.0 MARKING AND IDENTIFYING EVALUATED AREAS

In accordance with 30 TAC Section §330.143(b)(1) and (6), markers shall be placed so that all areas for which SLERs have been submitted and approved by TCEQ are readily identifiable. Such markers are to provide site personnel with immediate knowledge of the extent of approved disposal areas and shall be placed in accordance with the Site Operating Plan.

Markers shall be metal, wooden, or recycled posts and shall extend at least 6 feet above ground level. Markers shall not be obscured by vegetation and shall be placed so that they are not destroyed during operations. Sufficient intermediate markers shall be installed to show the required boundary. Lost markers shall be promptly replaced. Limits of the evaluated area shall be referenced to the site grid system. Markers shall not be placed inside the evaluated area. Markers shall be color coded red in accordance with 30 TAC §330.143(b)(1)(E).

# 6.0 DOCUMENTATION AND REPORTING

## 6.1 Liner Evaluation Reports

Upon completion of all required liner construction and evaluation, the POR shall prepare and submit in triplicate the SLER to TCEQ for review and approval.

The SLER shall be signed and sealed by the POR performing the evaluation and counter-signed by the SM or his/her authorized representative. The area covered by the SLER shall not be used for the receipt of solid waste until written acceptance of the SLER is received from TCEQ. If no response, either written or verbal, is received within 14 days, the SLER shall be considered accepted and the site may continue facility construction or operations.

The construction documentation provided in the SLER will contain a narrative describing the conduct of work and testing programs required by the LQCP, "as-built" or record drawings, and appendices of field and laboratory data. The construction documentation report will contain or discuss the following information at a minimum:

For soil liners:

- Pre-construction soil test results
- Summary of construction material conformance tests results
- Summary of field moisture-density control test methods and results
- Summary of hydraulic conductivity test results
- Soil liner construction practices for floor and sidewall sections
- Placement and processing methods
- Observations of soil conditions prior to and after compaction, including soil structure, clod size, and presence of inclusions
- Compaction methods, equipment type, compactor weight and foot length, and number of passes
- Lift tie-in and bonding observations
- Repair of failed and damaged lifts
- Any and all deviations from the permitted design
- Liner thickness verification
- Post-construction care of soil liner
- Laboratory worksheets for hydraulic conductivity tests

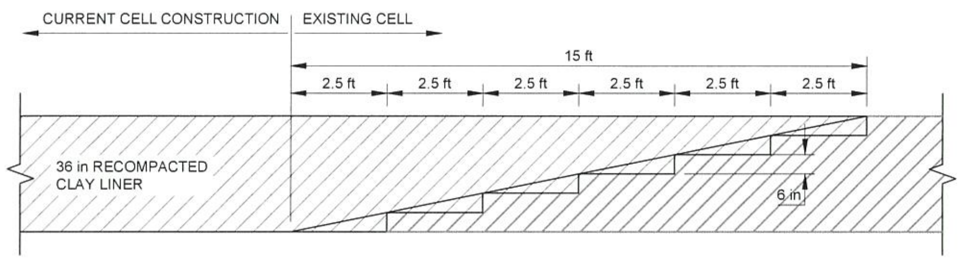
- Sample calculations for hydraulic conductivity tests

The report shall also include pertinent record drawings including:

- Phase layout plan
- Location of the subject cell with SLER markers
- Previous filled and active areas
- As-built drawings showing elevations of protective cover to confirm its thickness

## 6.2 Interim Status Report

An Interim Status Report (ISR) should be provided to TCEQ for portions of a liner system that remain uncovered with waste for more than six months from the date that the protective cover was applied, and the area shall be reevaluated by the POR.




CHARLES G. DOMINGUEZ
83247
2/12/21

GOLDER ASSOCIATES INC.
TEXAS REGISTRATION F-2578

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CLIENT
WM

PROJECT
HAWTHORN PARK RECYCLING & DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION
TCEQ PERMIT NO. MSW-2185A

CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2021-02 |
| DESIGNED | TNB |
| PREPARED | TNB |
| REVIEWED | JBF |
| APPROVED | CGD |

TITLE
**TYPICAL TIE-IN DETAIL**

| PROJECT NO | APPLICATION SECTION | REV | FIGURE |
|---|---|---|---|
| 1894269 | III Attachment 3 - APP. D | 0 | III-3D-1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

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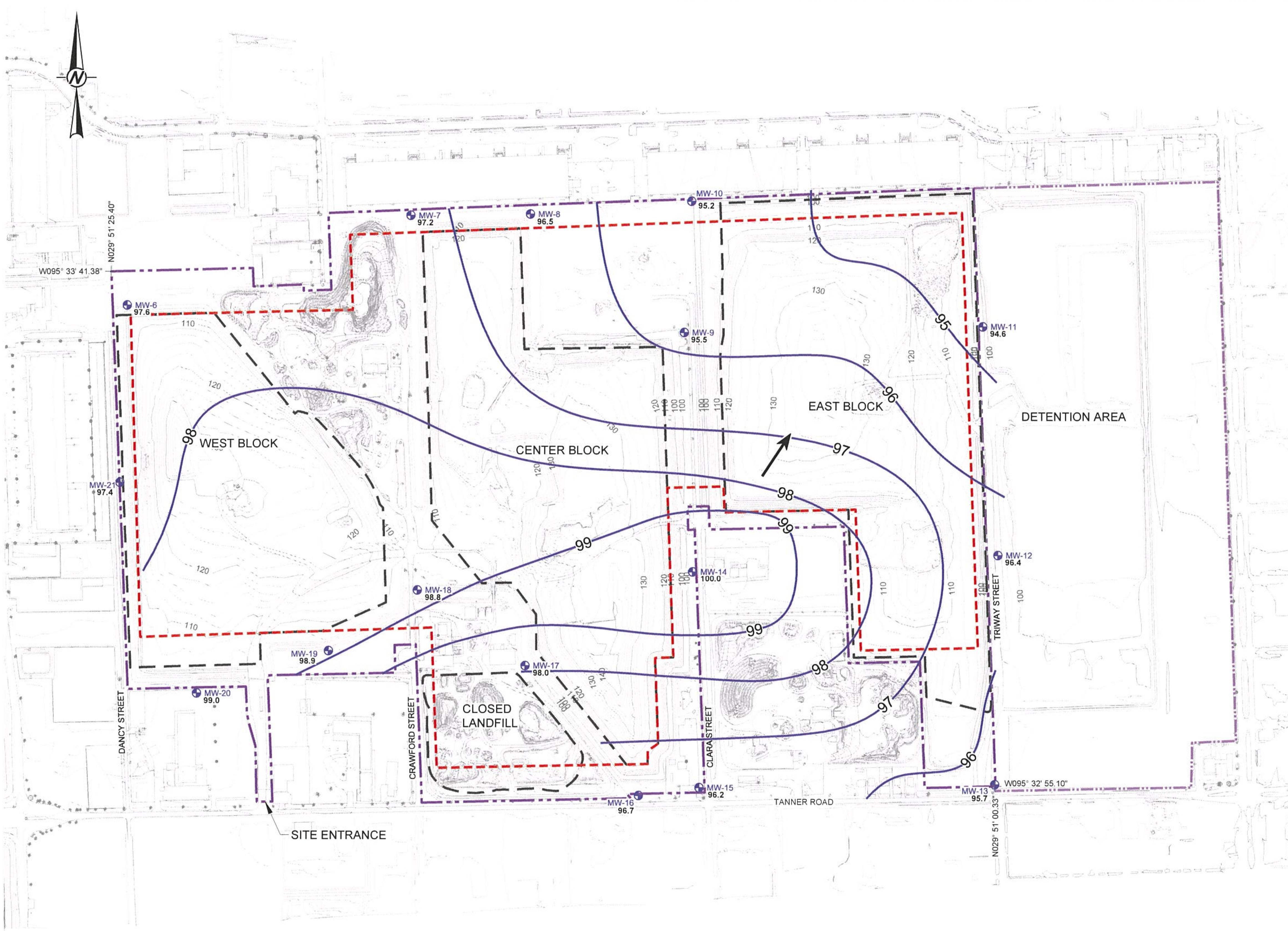


LEGEND

- PERMIT BOUNDARY
- PROPERTY BOUNDARY
- LIMITS OF WASTE PLACEMENT (MSW-2185A)
- WASTE FOOTPRINT (PRIOR TO MSW-2185A)
- EXISTING GROUND 10 ft CONTOURS
- EXISTING GROUND 2 ft CONTOURS
- 95 SEASONAL HIGH GROUNDWATER CONTOUR
- EXISTING MONITORING WELL
- GROUNDWATER FLOW DIRECTION
- 96.7 WATER LEVEL ELEVATION (FT MSL)

NOTE(S)

1. THE HIGHEST MEASURED GROUNDWATER CONTOURS WERE CREATED USING THE HIGHEST MEASURED HISTORICAL GROUNDWATER LEVELS AND DO NOT REPRESENT AN OBSERVED POTENTIOMETRIC SURFACE.

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0 250 500
1" = 500' FEET

| REV | YYYY-MM-DD | DESCRIPTION | DESIGNED | PREPARED | REVIEWED | APPROVED |
|---|---|---|---|---|---|---|
| 0 | 2021-02 | ISSUED FOR PERMITTING PURPOSES | TNB | TNB | JBF | CGD |

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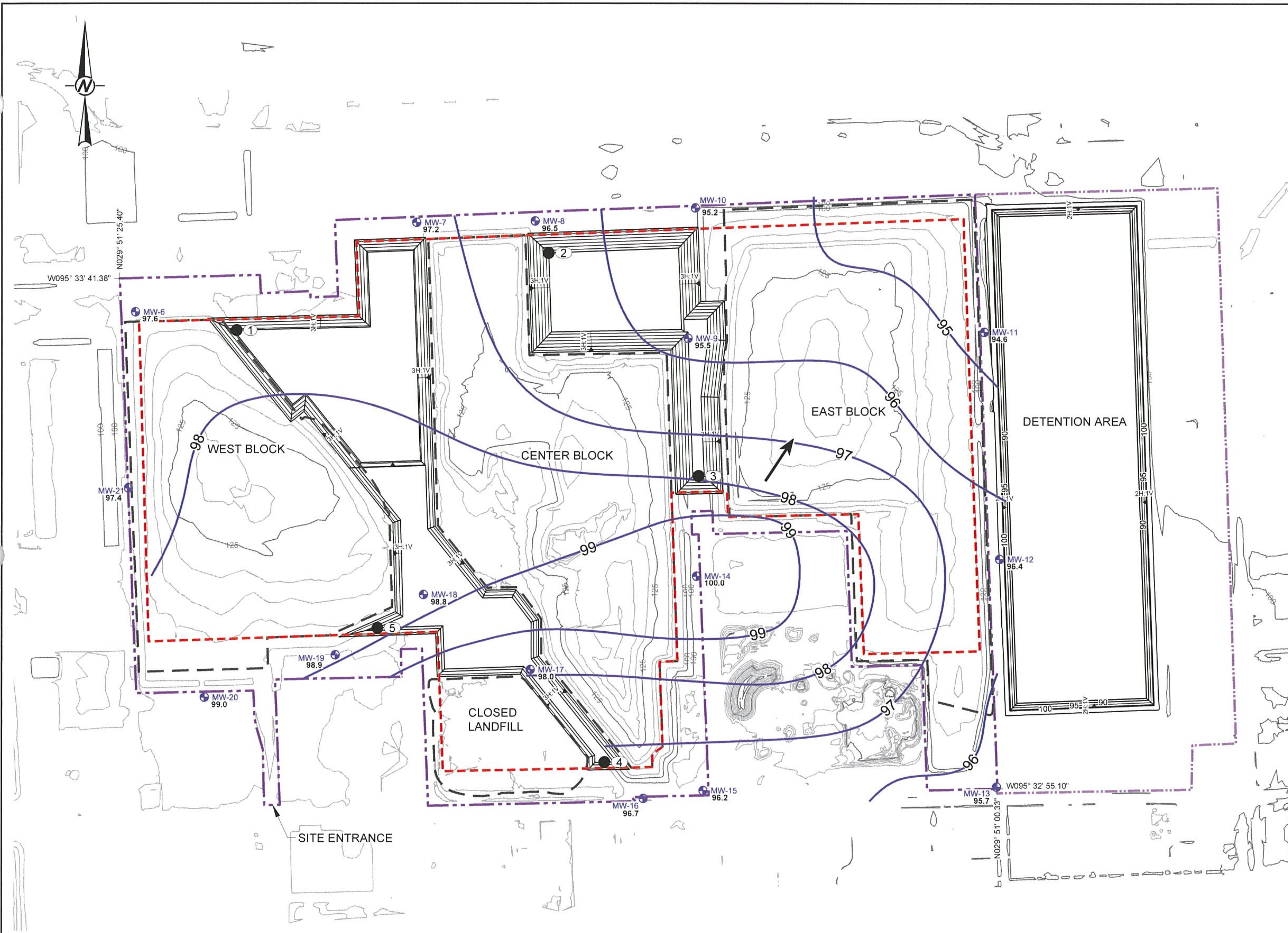
HAWTHORN PARK RECYCLING & DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION
TCEQ PERMIT NO. MSW-2185A

TITLE
**SEASONAL HIGH GROUNDWATER TABLE**

| PROJECT NO. | APPLICATION SECTION | REV | 2 of 4 | FIGURE |
|---|---|---|---|---|
| 1894269 | III Attachment 3 - APP. D | 0 | | III-3D-2 |




LEGEND

- PERMIT BOUNDARY
- PROPERTY BOUNDARY
- LIMITS OF WASTE PLACEMENT (MSW-2185A)
- WASTE FOOTPRINT (PRIOR TO MSW-2185A)
- 95 GROUNDWATER CONTOUR
- EXCAVATION CONTOURS 25 ft CONTOURS
- EXCAVATION CONTOURS 5 ft CONTOURS
- EXISTING GROUND 10 ft CONTOURS
- EXISTING GROUND 2 ft CONTOURS
- EXISTING MONITORING WELL
- BALLAST CALCULATION POINT

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0 250 500
1" = 500' FEET

| REV | YYYY-MM-DD | DESCRIPTION | DESIGNED | PREPARED | REVIEWED | APPROVED |
|---|---|---|---|---|---|---|
| 0 | 2021-02 | ISSUED FOR PERMITTING PURPOSES | TNB | TNB | JBF | CGD |

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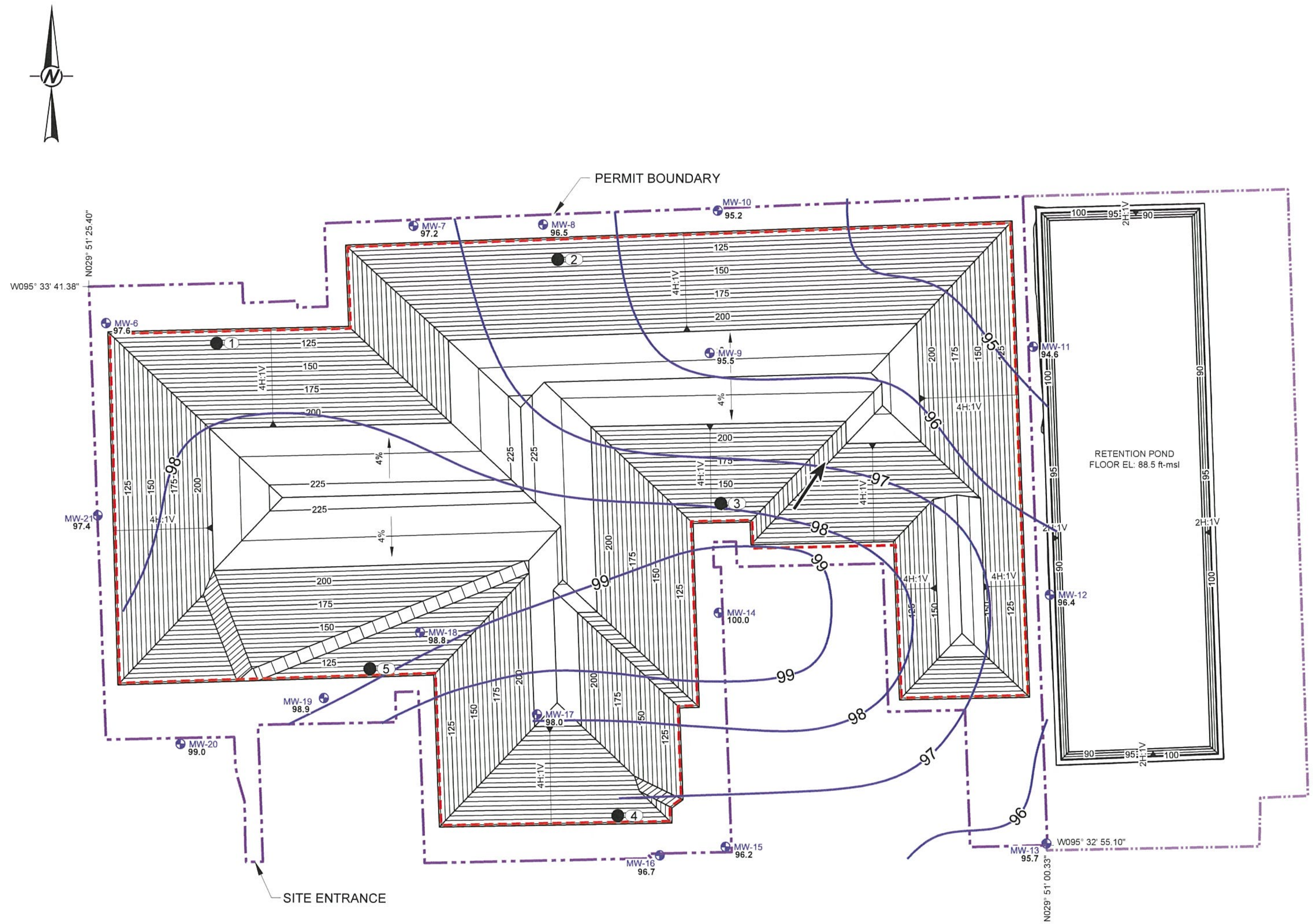
PERMIT AMENDMENT APPLICATION
TCEQ PERMIT NO. MSW-2185A

TITLE
**SEASONAL HIGH POTENTIOMETRIC SURFACE WITH EXCAVATION SURFACE AND BALLAST CALCULATIONS POINTS**

| PROJECT NO. | APPLICATION SECTION | REV | 3 of 4 | FIGURE |
|---|---|---|---|---|
| 1894269 | III Attachment 3 - APP. D | 0 | | III-3D-3 |




LEGEND

- PERMIT BOUNDARY
- PROPERTY BOUNDARY
- LIMITS OF WASTE PLACEMENT (MSW-2185A)
- 95 GROUNDWATER CONTOUR
- FINAL CONTOURS 25 ft CONTOURS
- FINAL CONTOURS 5 ft CONTOURS
- EXISTING MONITORING WELL
- BALLAST CALCULATION POINT

ISSUED FOR PERMITTING PURPOSES ONLY

0 250 500
1" = 500' FEET

| REV. | YYYY-MM-DD | DESCRIPTION | DESIGNED | PREPARED | REVIEWED | APPROVED |
|---|---|---|---|---|---|---|
| 0 | 2021-02 | ISSUED FOR PERMITTING PURPOSES | TNB | TNB | JBF | CGD |

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PROJECT

HAWTHORN PARK RECYCLING & DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION
TCEQ PERMIT NO. MSW-2185A

TITLE

**SEASONAL HIGH POTENTIOMETRIC SURFACE WITH FINAL COVER AND BALLAST CALCULATIONS POINTS**

| PROJECT NO | APPLICATION SECTION | REV. | | FIGURE |
|---|---|---|---|---|
| 1894269 | III Attachment 3 - APP. D | 0 | 4 of 4 | III-3D-4 |