RAILROAD COMMISSION OF TEXAS
HEARINGS DIVISION

OIL & GAS DOCKET NO. 08-0318617

APPLICATION OF HR MARTIN COUNTY LANDFILL, LLC (407462) FOR A PERMIT TO OPERATE A COMMERCIAL OIL AND GAS WASTE STATIONARY TREATMENT FACILITY UNDER STATEWIDE RULE 8 AND STATEWIDE RULE 78, FOR THE MARTIN COUNTY DISPOSAL FACILITY, MARTIN COUNTY, TEXAS

PROPOSAL FOR DECISION

EXAMINERS: Ashley Correll, P.G., Technical Examiner
Jennifer Cook, Administrative Law Judge
Charles Zhang, Administrative Law Judge

PROCEDURAL HISTORY:

Hearing Dates - October 1-4, 7-8, 2019; January 23, 2020; February 3-7, 10-11, 2020
Close of Record - June 1, 2020
Proposal for Decision Issued - September 17, 2020

APPEARANCES:

For Applicant HR Martin County Landfill, LLC -
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Olga Kobzar
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For Protestants Edward Kelton, Betty Kelton Howell, Jeffrey M. Johnston and Sandra K. Johnston -
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I. Statement of the Case

HR Martin County Landfill, LLC ("Applicant" or "HR Martin"), Operator No. 407462, filed an Application ("Application") for a permit to operate a commercial oil and gas waste stationary treatment facility (No. STF-0129) in Martin County, Texas, under 16 Tex. Admin. Code § 3.8 ("Statewide Rule 8"). Protests were filed by John W. Mabee and Joseph "Guy" Mabee, ("Mabee Protestants"). Protests were also filed by Edward Kelton, Betty Kelton Howell, Jeffrey M. Johnston, and Sandra K. Johnston ("Kelton and Johnston Protestants"). The protestants are nearby and adjacent landowners. All protestants request that the Application be denied.

The Application includes separate applications for each of the 14 landfill cells (Nos. P012602A, P012602B, P012602C, P012602D, P012602E, P012602F, P012602G, P012603A, P012603B, P012603C, P012603D, P012603E, P012603F, P012603G), 3 drying pads (Nos. P012655, P012656, P012657), 2 receiving pits (Nos. P012752), P012753), a truck washout pad (No. P012654), and 2 contact stormwater ponds (Nos. P012604, P012605). Applicant asserts that the facility is designed to prevent the pollution of groundwater from the handling and permanent disposal of oil and gas waste. Applicant argues that the 14 permanent disposal cells, the 2 contact stormwater ponds, the truck washout pit, and the 2 receiving pits are constructed with a double HDPE liner with a leak detection system, on top of a geosynthetic clay liner, which would prevent the contamination of groundwater measured at approximately 63 to 70 feet below ground surface ("bgs"). Applicant further states that the subsurface contains large amounts of hard, dense caliche that impedes recharge to the Ogallala Aquifer. Applicant states that the location of the facility has no recharge features and the climate is very dry.

The Mabee Protestants maintain the site is in an Ogallala Aquifer recharge zone that contains sandy soils above permeable, fractured caliche. The Mabee Protestants assert that the aquifer is unconfined and there are no impermeable barriers such as fat clays between the bottom of the facility and shallow groundwater to prevent the contamination of the aquifer if the liner system should fail or a spill should occur in an unlined area of the facility. The Mabee Protestants contend the proposed landfill design and construction will not contain waste due to operations on unlined areas, the insufficiency of the design and construction of the facility, and other sources with the potential to contaminate the soil and ultimately the groundwater in the Ogallala Aquifer.

The Kelton and Johnston Protestants claim that they are concerned about the impact of the facility on the Ogallala Aquifer below their property that is used for domestic and livestock needs. Jeff Johnston testified that the human habitation, livestock, and agriculture in the area are all supported by the Ogallala Aquifer and that the landfill operation would be a risk to that groundwater. Mr. Johnston further testified that he was also concerned about the health impacts and water contamination.

The Technical Examiner and Administrative Law Judges ("Examiners") respectfully submit this Proposal for Decision ("PFD") and recommend the Railroad Commission of Texas ("RRC" or "Commission") deny the Application.

II. Jurisdiction and Notice of Hearing[1]

Sections 81.051 and 81.052 of the Texas Natural Resources Code provide the Commission with jurisdiction over all persons owning or engaged in drilling or operating oil or gas wells in Texas and the authority to adopt all necessary rules for governing and regulating persons and their operations under the jurisdiction of the Commission. Section 91.101 of the Texas Natural Resources Code provides the Commission with authority to issue orders to prevent pollution of surface water or subsurface water in the State of Texas.

On May 21, 2019, the Hearings Division of the Commission sent a Notice of Hearing for the Application via first-class mail setting hearing dates of October 1, 2019 through October 8, 2019.[2] The notice contained (1) a statement of the time, place and nature of the hearing; (2) a statement of the legal authority and jurisdiction under which the hearing is to be held; (3) a reference to the particular sections of the statutes and rules involved; and (4) a short and plain statement of the matters asserted.[3] The hearing was held on October 1, 2019 through October 8, 2019, as noticed. The hearing was recessed at the end of the day on October 8, 2019 and resumed at the agreed date of January 23, 2020. The hearing was recessed at the end of the day on January 23, 2020 and resumed at the agreed dates February 3, 2020 through February 11, 2020. Consequently, all parties received more than 10 days' notice. HR Martin, the Mabee Protestants, and the Kelton and Johnston Protestants appeared at the hearing and presented evidence.

III. Applicable Legal Authority

In this case, HR Martin has filed an application for a commercial waste disposal facility under Statewide Rule 8. Following are pertinent Commission rule provisions.

Statewide Rule 8(b) states:

> (b) No pollution. No person conducting activities subject to regulation by the commission may cause or allow pollution of surface or subsurface water in the state.

Statewide Rule 8(d)(1) states:

> (d) Pollution control.
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> (1) Prohibited disposal methods. Except for those disposal methods authorized for certain wastes by paragraph (3) of this subsection, subsection (e) of this section, or § 3.98 of this title (relating to Standards for

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[1] The hearing transcript in this case is referred to as "Tr. Vol. [volume no.] at [pages:lines]." Applicant's exhibits are referred to as "Applicant Ex. [exhibit no(s).]." The Mabee Protestants' exhibits are referred to as "Mabee Ex. [exhibit no(s).]." The Kelton and Johnston Protestants' exhibits are referred to as "Kelton and Johnston Ex. [exhibit no(s).]."
[2] *See* Notice of Hearing issued May 21, 2020.
[3] *See* Tex. Gov't Code §§ 2001.051, 052; 16 Tex. Admin. Code §§ 1.45, 1.48.

> Management of Hazardous Oil and Gas Waste), or disposal methods required to be permitted pursuant to § 3.9 of this title (relating to Disposal Wells) (Rule 9) or § 3.46 of this title (relating to Fluid Injection into Productive Reservoirs) (Rule 46), no person may dispose of any oil and gas wastes by any method without obtaining a permit to dispose of such wastes. The disposal methods prohibited by this paragraph include, but are not limited to, the unpermitted discharge of oil field brines, geothermal resource waters, or other mineralized waters, or drilling fluids into any watercourse or drainageway, including any drainage ditch, dry creek, flowing creek, river, or any other body of surface water.

These provisions prohibit pollution of surface or subsurface water and prohibit disposal of oil or gas wastes without first obtaining a permit to do so.

Statewide Rule 8(d)(6(A) provides direction as to the requirements to obtain a permit and what requirements may be contained in the permit. It states:

> (6) Permits.
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> (A) Standards for permit issuance. A permit to maintain or use a pit for storage of oil field fluids or oil and gas wastes may only be issued if the commission determines that the maintenance or use of such pit will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface waters. A permit to dispose of oil and gas wastes by any method, including disposal into a pit, may only be issued if the commission determines that the disposal will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface water. A permit to maintain or use any unlined brine mining pit or any unlined pit, other than an emergency saltwater storage pit, for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters may only be issued if the commission determines that the applicant has conclusively shown that use of the pit cannot cause pollution of surrounding productive agricultural land nor pollution of surface or subsurface water, either because there is no surface or subsurface water in the area of the pit, or because the surface or subsurface water in the area of the pit would be physically isolated by naturally occurring impervious barriers from any oil and gas wastes which might escape or migrate from the pit. Permits issued pursuant to this paragraph will contain conditions reasonably necessary to prevent the waste of oil, gas, or geothermal resources and the pollution of surface and subsurface waters. A permit to maintain or use a pit will state the conditions under which the pit may be operated, including the conditions under which the permittee shall be required to dewater, backfill, and compact the pit. Any permits issued pursuant to this paragraph may contain requirements concerning the design and construction of pits and disposal facilities, including

requirements relating to pit construction materials, dike design, liner material, liner thickness, procedures for installing liners, schedules for inspecting and/or replacing liners, overflow warning devices, leak detection devices, and fences. However, a permit to maintain or use any lined brine mining pit or any lined pit for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters will contain requirements relating to liner material, liner thickness, procedures for installing liners, and schedules for inspecting and/or replacing liners.

IV. Discussion of Evidence

Applicant applies for a permit to operate a commercial oil and gas waste stationary treatment facility to dispose of oil and gas waste. Applicant maintains the proposed landfill is protective of groundwater and the Application should be granted. The protestants claim the proposed landfill is not protective of groundwater and the Application should be denied due to the shallow groundwater and lack of any impermeable natural layer between the landfill and groundwater.

A. Summary of Applicant's Evidence and Position

Applicant provided evidence and witnesses in an effort to demonstrate the Application should be approved. In presentation of HR Martin's evidence, it utilized a consulting firm, Trihydro Corporation ("Trihydro").

1. Operator Information

Luke Garrett testified about HR Martin's plans for the facility, the proposed facility location, and the administrative application process. He is the Chief Operating Officer of HR Martin and High Roller Group ("High Roller"), which is a parent company of HR Martin. For oil and gas waste facilities, Mr. Garrett is responsible for the process from the permitting through the completion of the project. He is familiar with the Application and signed it on behalf of HR Martin.[4]

Initially, HR Martin filed the Application in October of 2017, which resulted in a denial of the application administratively[5]. The Application was resubmitted in about March 2018 with revisions. Additional revisions were made during the administrative process and the final version of the Application is dated August 16, 2018.[6] Mr. Garrett signed and certified the various versions, including the most recent version on behalf of HR Martin.[7] HR Martin has an active organization report, Commission Form P-5, on file with the Commission.[8]

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[4] Tr. Vol. I at 23:16 to 24:25.
[5] Applicant Ex. 1, 30.
[6] Applicant Ex. 24A-24B.
[7] Tr. Vol. I at 26:3 to 32:25; Applicant Ex. 1-4.
[8] Tr. Vol. I at 33:1 to 37:5; Applicant Ex. 5.

HR Martin or one of its affiliate companies currently owns the property where the facility is to be located and has owned it for more than a year prior to filing the Application.[9] A third-party operator has an in-ground pipeline that runs from a saltwater disposal well on the southwestern portion of the property to the surface location of the saltwater disposal facility on the northeastern corner of the property. The pipeline connects that surface facility with the saltwater disposal well. HR Martin has an agreement with the third-party operator to move the pipeline to the perimeter of the property.[10]

Mr. Garrett testified that it is his understanding transactional documents are in place for a third party, referred to as Milestone Environmental Services ("Milestone"), to purchase HR Martin after the permit is issued and before construction. Milestone is expected to take over responsibility for operating the landfill in addition to construction.[11]

Kevin Matte, Senior Vice President for Operations and Safety for Milestone, testified on behalf of the Applicant. Milestone is in the exploration and production waste disposal business.[12] He confirmed it is his understanding that Milestone is expected to acquire HR Martin if the permit is approved.[13] He testified that he would be responsible for operations and safety of the proposed facility and that he has been preparing for acquiring HR Martin.[14]

Milestone does not currently operate any oil and gas waste landfills. As of October 2019 (when Mr. Matte testified), Milestone was preparing to start operations of two waste landfills in Texas. Milestone has seven active injection well operations within Texas that Mr. Matte oversees. Mr. Matte is not involved with the construction of the facilities. Milestone hires a contractor to construct its facilities.[15] Milestone has not yet determined who the contractor would be and would go through a bid process. Mr. Matte confirmed that if the Application were approved and a permit was issued, Milestone would then acquire HR Martin and be responsible for construction and operation of the landfill.[16] Milestone estimates that the landfill would be operational through 2049.[17] Mr. Matte has no opinion as to how long the closure process and post-closure monitoring will take for the proposed landfill.[18]

2. Notice of the Application

Witness Chris Ryan is a petroleum landman and was responsible for running title and confirming ownership for the tract for the proposed landfill and the adjacent landowners to the subject tract.[19]

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[9] Tr. Vol. I at 41:2 to 43:24.
[10] Tr. Vol. I at 48:13 to 49:20.
[11] Tr. Vol. I at 51:11 to 54:13.
[12] Tr. Vol. 4 at 16:17 to 16:25.
[13] Tr. Vol. 4 at 17:1 to 17:9.
[14] Tr. Vol. 4 at 17:10 to 17:22.
[15] Tr. Vol. 4 at 24:16 to 25:4.
[16] Tr. Vol. 4 at 26:20 to 31:4.
[17] Tr. Vol. 4 at 32:12 to 32:24.
[18] Tr. Vol. 4 at 32:25 to 33:12.
[19] Tr. Vol. I at 55:5 to 55:14, 56:1 to 57:8; Applicant Ex. 6.

To confirm the correct addresses of the adjacent surface owners, Mr. Ryan ran title in the courthouse and looked at public documents from sovereignty to present on 12 different tracts that are the subject tract and the adjacent tracts.[20] He provided a deed showing HR Martin is the current owner of the 160.037-acre tract where the proposed landfill will be located. According to the deed there are various reservations and easements traversing the tract. It is his understanding that if the permit were approved, HR Martin will work to move the easements.[21]

Mr. Ryan provided a map showing the adjacent tracts and identifying the adjacent surface owners.[22] He also provided a table showing the addresses of the adjacent surface owners to show they were served notice of the hearing in this case.[23]

Ken Schreuder, a senior engineer and senior geologist at Trihydro, provided copies of letters that were sent to adjacent landowners notifying them of the Application.[24] The applicant is required to notify the city clerk, but the facility is in an unincorporated area so there is no city clerk to notify.[25] The application was published in the Martin County Messenger for two weeks per regulations.[26]

3. Procedural history of the Application

Ken Schreuder has 30 years of experience with landfills on the regulatory side and as a consultant.[27] He is the project manager for the proposed landfill, and is responsible for overseeing all aspects of the Application including preparation, initial site investigation, applying for permits with the Commission, and air permitting with the Texas Commission on Environmental Quality ("TCEQ").[28] Mr. Schreuder testified that he started developing the design and permit application for the facility after Trihydro's Report of Subsurface Investigation dated May 2017.[29] The initial application was submitted October 1, 2017, and HR Martin initiated public notice requirements for the Commission in November 2017. In December 2019, HR Martin received administrative denial from the Commission.[30]

HR Martin met with Commission staff ("Staff") in February 2018 to discuss Staff's concerns regarding the presence of the Ogallala Aquifer and to address Staff's other comments.[31] Mr. Schreuder testified that Staff requested HR Martin alter the design depths of the landfill to provide at least 35 feet of separation between the bottom of the landfill and the water table.[32] HR Martin responded by raising the landfill an average of

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[20] Tr. Vol. I at 55:17 to 55:25.
[21] Tr. Vol. I at 57:18 to 59:22; Applicant Ex. 7, 8.
[22] Tr. Vol. I at 61:16 to 63:3; Applicant Ex. 9.
[23] Tr. Vol. I at 63:7 to 64:10; Applicant Ex. 10.
[24] Applicant Ex. 27, 24A at HR001451; Tr. Vol. 2 at 108:8-17, 83:19-20.
[25] Tr. Vol. 2 at 109:22-110:1.
[26] Applicant Ex. 24A at HR001470-HR001475; Tr. Vol. 2 at Pg.110:2-5.
[27] Tr. Vol. 9 at 118:1-13.
[28] Tr. Vol. 2 at 85:18-86:1.
[29] Tr. Vol. 2 at 86:3-9.
[30] Tr. Vol. 2 at 86:14-87:1.
[31] Tr. Vol. 2 at 87:2-8.
[32] Tr. Vol. 2 at 87:9-13, 98:20-99:4

10 feet to ensure 35 feet of separation.[33] HR Martin resubmitted the application in March 2018 with a revised design and responses to Staff's comments.[34] HR Martin provided public notice again due to the changes to the application and to ensure affected parties had current information.[35] In April 2018, HR Martin provided documentation that the public notice requirements had been completed.[36] HR Martin continued to respond to requests for additional information from Staff from July 2018 to February 2019.[37] HR Martin received the draft permit in March 2019.[38] Mr. Schreuder testified that the draft permit references the application and includes a narrative description of the operational procedures for the facility.[39]

Mr. Schreuder testified that each of the regulated units that qualify as a pit has a Commission Form H-11.[40] The non-contact stormwater pond does not have a Form H-11.[41]

4. Site Location Information

Rick Johnston, petroleum engineer, testified for the Applicant.[42] He was retained by HR Martin to look at the artificial penetrations on the site and the artificial penetrations within a one half-mile of the site. The scope of his study was to see if any of the artificial penetrations or wells would act as conduits to allow any liquids that leak out of the facility to percolate down to groundwater. He looked at how the wells were plugged and if the surface casing of the wells was properly cemented. In his opinion, none of the wells in the study area will act as a conduit to groundwater should there be a leak at the facility.[43]

Mr. Johnston provided a map showing 57 artificial penetrations within a half-mile of the proposed facility location. He reviewed the completion papers filed at the Commission for the 57 wells. He reviewed the cementing affidavits, other cementing information, and cement volumes. He opined that looking at wells within a half-mile is sufficient in that leaks from the facility will not move that far laterally from the proposed facility location. Mr. Johnston only evaluated artificial penetrations that were oil and gas wells; he did not evaluate penetrations that were water wells.[44]

Mr. Johnston provided a map identifying all wells within a 10-mile radius of the proposed landfill location to show that there are significant oilfield operations in the area. It is his understanding that the proposed facility will take RCRA[45]-exempt solid waste

[33] Tr. Vol. 2 at 87:14-17.
[34] Tr. Vol. 2 at 87:18-22.
[35] Tr. Vol. 2 at 87:23-88:3.
[36] Tr. Vol. 2 at 88:4-15.
[37] Tr. Vol. 2 at 88:4-89:15.
[38] Tr. Vol. 2 at 89:10-15.
[39] Applicant Ex. 31, Tr. Vol. 2 at 100:12-19.
[40] Tr. Vol. 2 at 106:20-22.
[41] Tr. Vol. 2 at 106:13-19.
[42] Applicant Ex. 56 (Mr. Johnston's resume).
[43] Tr. Vol. 7 at 9:2 to 11:12.
[44] Tr. Vol. 7 at 70:3 to 70:14.
[45] The Resource Conservation and Recovery Act (RCRA) is the federal law that creates the framework for the management of hazardous and non-hazardous solid waste. *See, e.g.,*

materials that are generated by normal oilfield operations, such as drill cuttings. He considers this area to be an area of high activity in the Midland Basin.[46]

Mr. Johnston reviewed the drilling history in Martin County; the proposed landfill is to be located in southwestern Martin County. He provided a bar diagram showing the number of drilling permits for the years 2015, 2016, 2017, 2018 and 2019; he also provided the underlying data supporting the bar diagram. There were 455 drilling permits approved in 2015, and there has been an increase in the number of approved drilling permits per year for 2016, 2017, 2018 and 2019. He testified he expects the proposed landfill to provide services for oilfield operations in both Andrews and Midland County as well.[47]

Mr. Johnston presented the information regarding substantial oilfield activity in the area of the proposed facility to demonstrate a need for such a facility. He testified and provided maps showing significant horizontal drilling in the area. He opined that the proposed facility is needed to support the activity. He stated that there needs to be a facility such as the proposed facility to accept drill cuttings and other solid wastes generated by the drilling of long horizontal wells. He also testified that having a landfill near the area of activity would minimize transportation of the waste.[48]

Mr. Johnston provided production information from the producing wells within a 10-mile radius of the proposed facility. He provided a composite plot of the production. The production was approximately 300,000 to 400,000 barrels of oil per month in 1995. As of January 2020, this area was producing between two and three million barrels of oil per month. The number of producing wells has also increased from about 1,200 to 3,000 wells. There has also been an increase in gas production. He also provided a production composite plot for the Mabee Protestants wells. As of January 2020, the Mabee Protestants had about 1,100 wells in the area producing approximately 500,000 barrels of oil per month.[49]

Mr. Johnston provided Commission records showing John William Mabee, one of the Mabee Protestants, is an officer of Wasser Operating, LLC ("Wasser"), an operator with an active organization report on file with the Commission.[50] Mr. Johnston provided Commission records showing Wasser operates approximately eight wells, four of which are in Martin County. He provided Commission records showing that Wasser has filed applications for disposal well permits. Wasser has four active saltwater disposal wells in Martin County.[51] Wasser has seven permits that have been issued since August 2016 and two applications that are pending with protests. Mr. Johnston argued that Wasser's disposal wells accept RCRA-exempt waste, which is the same waste stream that the proposed facility will accept, indicating the proposed landfill would compete with Wasser

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https://www.epa.gov/rcra#:~:text=The%20Resource%20Conservation%20and%20Recovery,and%20non%2Dhazardous%20solid%20waste.

[46] Tr. Vol. 7 at 15:22 to 19:1; Applicant Ex. 58.
[47] Tr. Vol. 7 at 19:3 to 21:5; Applicant Ex. 59.
[48] Tr. Vol. 7 at 21:6 to 23:1.
[49] Tr. Vol. 7 at 24:12 to 27:9; Applicant Ex. 60.
[50] Tr. Vol. 7 at 28:5 to 28:25; Applicant Ex. 61.
[51] Tr. Vol. 7 at 32:8 to 33:5; Applicant Ex. 62.

disposal wells.[52] Mr. Johnston acknowledged that Wasser's operations relate solely to disposal wells, not landfill facilities.[53]

5. Regional Geology

a. Ogallala Aquifer

Brad Pekas is a senior engineer and hydrogeologist for Trihydro Corporation. He has 32 years of experience working in environmental remediation, contamination, water supply, underground injection wells, power plants, and mines. He is a registered professional engineer in 14 states and a professional geologist in 5 states.[54] He testified that the Ogallala Aquifer, also referred to as the High Plains Aquifer in this hearing,[55] covers eight to nine states and is one of the "largest, most productive, and heavily used aquifers in the entire center part of the United States."[56] The geologic setting for the proposed landfill is in the Midland Basin and southern part of the Ogallala Aquifer.[57] The formations that comprise the geology of the proposed site is sedimentary and developed in part by the erosion of the Rocky Mountain uplift.[58] As the mountains eroded, alluvial fans came down into this area.[59] The primary materials are sands, gravels, silts, and clays.[60] The Ogallala Formation is the primary hydrogeologic unit of the aquifer at this location and contains sandstone, siltstone, clays, and mixtures of these materials.[61] That material is overlain by younger, reworked material.[62]

The total dissolved solids ("TDS") of the water in this area is 300 to 1,000 parts per million ("ppm").[63] The EPA secondary drinking water standard is 500 ppm.[64] Water levels in the aquifer have been tracked and are declining over time.[65] Mr. Pekas provided data from the US Geological Society for a water well adjacent to the proposed landfill showing the depths from surface to groundwater increasing from 35 feet in 1952 to 48 feet in 1982.[66]

b. Caliche Formation

Mr. Pekas testified that caliche develops in arid to semiarid climates like in West Texas.[67] Mr. Pekas stated that the Ogallala Formation contains caliche, a calcium carbonate concentration that occurs in the subsurface. The redeposition of that calcium

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[52] Tr. Vol. 7 at 33:7 to 35:23, 37:7 to 39:13, 62:16 to 62:22; Applicant Ex. 63, 64, 65.
[53] Tr. Vol. 7 at 68:1 to 68:5.
[54] Applicant Ex. 11; Tr. Vol. 1 at 85:18-86:6.
[55] Tr. Vol. 1 at Pg.88:6-15.
[56] Applicant Ex. 12; Tr. Vol. 1 at 88:6-15; 90:18-22.
[57] Applicant Ex. 12; Tr. Vol. 1 at 91:7-22; 92:10-23.
[58] *Id.*
[59] *Id.*
[60] Tr. Vol. 1 at 92:18-23.
[61] Tr. Vol. 1 at 92:24-93:13.
[62] *Id.*
[63] Tr. Vol. 1 at 93:20-94:9.
[64] Tr. Vol. 1 at 93:20-94:9; 94:15-21.
[65] Tr. Vol. 1 at 95:18-25.
[66] *Id.*
[67] Tr. Vol. 1 at 101:20-103:1.

carbonate can create a hard pan or cement type layer.[68] Calcium carbonate material is present in shallow surficial soils, and when it rains, the calcium carbonate dissolves and migrates through the subsurface.[69] As the water flows within the soil column, gravity pulls the water down and coats the grains.[70] The materials that were originally dissolved at shallow depths are then brought down to depth, and as the water evaporates, calcium is being redeposited at the bottom sides of stones due to gravity.[71] As this process is repeated, calcium carbonate builds up in the subsurface and begins to fill the pore spaces between the sand and other rocks, and develops into a solid soil cement zone that is "a solid layer of rock."[72] Once the solid layer has developed, continuing rainfall and dissolution of calcium material will create a hard horizontal layer that can impede the rate at which water moves down into the subsurface.[73]

In response to cross examination Mr. Pekas clarified that hard cemented caliche can be a barrier to the vertical migration of water either up and down, but caliche can be soft as well.[74] Mr. Pekas stated that soft caliche may be caliche that is younger and not fully developed.[75] Caliche tends to be harder on the bottom and less developed on the top.[76] Mr. Pekas agreed that there can be cracks, fissures, or fractures in caliche.[77] He testified that the cracks can be refilled or cemented through the same process that formed the caliche initially.[78] He did not see evidence of cavities, voids, cracks, fissures or fractures in his review of the Trihydro's Report of Subsurface Investigation ("Trihydro May 2017 Report").[79] Mr. Pekas opined that the hardness and difficulty drilling suggested that the material was extremely hard and cemented.[80] Mr. Pekas agreed that hard rocks can have fractures, and further agreed that fractures in hard caliche can be preferential zones for the migration of fluids, but the formation of caliche would also refill voids with redeposition of calcium or other material.[81]

Terracon, another consulting company, completed a Geotechnical Data Report dated August 29, 2019 ("Terracon Report").[82] No one from Terracon testified at the hearing. In response to cross examination, Mr. Pekas stated he reviewed the number of blows and hydraulic conductivity from the Terracon Report to confirm the hardness of the caliche. He further testified there is some vertical variability in the material regarding how complete the formation of caliche may be, but the data suggests the caliche is "dense, hard, and compact." Mr. Pekas agreed that water was encountered in the hard, dense, caliche as represented in the Terracon Report.[83]

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[68] Tr. Vol. 1 at 100:19-16.
[69] Tr. Vol. 1 at 101:20-102:1.
[70] Applicant Ex. 14; Tr. Vol. 1 at 104:4-16.
[71] Tr. Vol. 1 at 104:4-16.
[72] Tr. Vol. 1 at 104:17-105:5.
[73] Tr. Vol. 1 at 105:6-17.
[74] Tr. Vol. 3 at 48:17-25.
[75] Tr. Vol. 3 at 49:16-50:3.
[76] Applicant Ex. 14; Tr. Vol. 3 at 50:20-51:7.
[77] Tr. Vol. 3 at 53:9-14.
[78] Tr. Vol. 3 at 53:15-21.
[79] Tr. Vol. 3 at 53:4-10.
[80] Tr. Vol. 3 at 55:1-15.
[81] Tr. Vol. 3 at 59:5-60:9.
[82] Applicant Ex. 26.
[83] Applicant Ex. 26 at 9936 and 9967; Tr. Vol. 3 at 65:20-67:1.

c. Playa versus Interplaya Areas

Mr. Pekas defined a playa as “a fairly small, shallow, closed basin where water can accumulate, but there's no external exit for the water to drain out of.”[84] Water that accumulates in the playa does not have an outlet, therefore the water evaporates or percolates down into the subsurface.[85] Mr. Pekas stated, “The general current scientific and engineering understanding is that playas are a main contributing source of recharge to the Ogallala Aquifer in this part of Texas.”[86] He asserted the water in playas percolates down to the Ogallala Aquifer.[87]

Mr. Pekas testified that interplayas are areas of higher elevation that drain down into playas. Playas do not need to be deep, but can be shallow depressions, as long as water cannot flow out of the depression.[88] He provided USGS Circular 1333 to demonstrate recharge rates for playas and interplaya areas.[89] The exhibit shows that playa areas have an order or two magnitude higher recharge rates as opposed to interplaya areas, which demonstrates that water collects in the shallow depressions and migrates down into the subsurface.[90] Mr. Pekas stated that the travel time for water to go from the surface to the water table ranges from years to centuries when traveling from the bottom of a playa, but takes millennia from interplaya areas.[91]

Mr. Pekas provided a map of the probable playas in Martin County in relation to the proposed landfill location.[92] He asserted there are no playas immediately in the area of the landfill site.[93] He further testified that the landfill site is an interplaya area that is currently non-irrigated cropland, though it has been irrigated in the past.[94] Mr. Pekas reviewed photographs from the proposed landfill site that he considers an interplaya area and compared them with photographs of an area with a playa.[95] Mr. Pekas stated that based on his observations there is no playa on the landfill site; it is part of an interplaya area.[96] He further stated he would expect recharge rates at the proposed landfill location to be those of an interplaya area ranging from 0.01 to 2 inches per year.[97] In cross examination, Mr. Pekas agreed that the soils at the proposed landfill site are not conducive to the formation of playas and there are no physical structures to facilitate playa development.[98]

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[84] Tr. Vol. 1 at 106:12-15.
[85] Tr. Vol. 1 at 106:25-107:16.
[86] Tr. Vol. 1 at 108:18-19.
[87] Tr. Vol. 1 at 108:22-24.
[88] Tr. Vol. 1 at 128:21-129:4.
[89] Applicant Ex. 15; Tr. Vol. 1 at 110:20-24.
[90] Applicant Ex. 15; Tr. Vol. 1 at 110:115:23-116:11.
[91] Applicant Ex. 16; Tr. Vol. 1 at 119:19-24.
[92] Applicant. Ex. 17.
[93] Tr. Vol. 1 at 121:5-20.
[94] Tr. Vol. 1 at 122:14-24; 124:2-7.
[95] Applicant Ex. 18-22.
[96] Tr. Vol. 2 at 6:12-20.
[97] Applicant Ex. 15, Tr. Vol. 2 at 8:1-10.
[98] Tr. Vol. 3 at 77:2-12.

Mr. Pekas testified caliche could become a barrier that can impede the vertical movement of water either up or down.[99] He opined the Ogallala Aquifer may be locally semiconfined in areas.[100]

During cross examination, Mr. Pekas stated that he visited the proposed landfill site to observe whether or not there were playas on site and visited an offsite playa about seven miles away from the proposed site to compare the two sites.[101] He also reviewed the site investigation as part of his evaluation.[102] He stated that there were no clay in soils or circular features that would be considered a playa at the landfill location, but silty clayey materials are identified at the roadside playa.[103] Mr. Pekas agreed that finer clayey soils are more conducive to playa formation.[104] He stated the nearest playa is 2 to 2.5 miles away.[105]

6. Weather and Climate

Mr. Schreuder testified that the mean annual precipitation in Midland is approximately 15 inches, and the mean annual lake evaporation is approximately 71 inches.[106] The 25-year, 24-hour storm event in the area is expected to generate approximately 5.5 inches of precipitation.[107] The mean annual temperature in the area is approximately 66 degrees Fahrenheit, and the mean monthly temperature range varies from a low of 31 to a high of approximately 96. The average growing season is 215 days.[108]

7. Site Characterization

Mr. Schreuder presented a Water Balance Map showing potential percolation rates in the US, and this map shows the Midland area to have the rate of evaporation exceeding the rate of transpiration, which indicates minimal extra precipitation is expected to be available to infiltrate the soil profile to reach groundwater.[109] He testified that since there are no playas at the site, and based on climatic conditions, the potential for water to soak down and reach groundwater is limited.[110]

He further stated there are no federal or state threatened or endangered species identified in the vicinity of the site.[111] There are no perennial or ephemeral surface water features at the site.[112] The only surface water features were three small freshwater

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[99] Tr. Vol. 2 at 10:6-22.
[100] Applicant EX. 13; Tr. Vol. 3 at 88:20-89:21.
[101] Tr. Vol. 3 at 30:5-31:2.
[102] Tr. Vol. 3 at 30:5-31:2.
[103] Tr. Vol. 3 at 72:3-16.
[104] Tr. Vol. 3 at 73:14-21.
[105] Applicant Ex. 17; Tr. Vol. 3 at74:1-11.
[106] Tr. Vol. 2 at 112:3-10.
[107] Tr. Vol. 2 at 112:11-17.
[108] Tr. Vol. 2 at 112:11-17.
[109] Applicant Ex. 33: Tr. Vol. 2 at 117:7-22.
[110] Tr. Vol. 2 at 118:13-119:6.
[111] Tr. Vol. 2 at 119:24-120:2.
[112] Tr. Vol. 2 at 120:5-8.

emergent wetlands identified over a half mile away from the site.[113] FEMA flood maps do not exist for the area, which Mr. Schreuder testified essentially means it is not within the 100-year flood plain.[114]

In the vicinity of the facility is the Mabee airport runway, water wells, oil and gas well pads, and tank batteries.[115] The primary land use near the site is oil and gas activity and farmland.[116] Trihydro was unable to find official records for the irrigation wells that are reportedly on the property, and Mr. Schreuder stated any irrigation wells that coincide with the proposed landfill will be plugged and abandoned.[117]

Mr. Schreuder testified that precipitation is the primary and only source of water at the site, because the waste that will be placed in the unit will be dry.[118] He stated if there is enough precipitation at one time and runoff occurs at the surface, it would flow to a low spot, such as a playa.[119] The rest of the precipitation would be absorbed into the soil profile where it will either evaporate from the surface or it will soak into the subsurface where plant roots can access the water.[120] Water in the soil profile will be pulled into the roots of plants, and the plants will transpire the water into the atmosphere.[121] Mr. Schreuder testified if the rates of transpiration and evaporation are greater than the rate of precipitation, water would not percolate into deeper soil to groundwater.[122]

Fritz Krembs is a senior engineer and senior geologist with Trihydro.[123] He has worked as an environmental consultant since 2002 with experience in geotechnical and environmental investigations. He is a registered professional geoscientist in the State of Texas, and he sealed the subsurface investigation report that was included in the Application.[124] He has experience in the Texas Panhandle and sites over the Ogallala Aquifer.[125] Trihydro performed soil borings to document site specific conditions, utilized publicly available data for water levels, and evaluated groundwater at the facility with the installation of seven monitoring wells.[126] Mr. Krembs also performed water quality analysis from the onsite monitor wells.[127]

He worked on the Trihydro May 2017 Report with Michelle Harper, the on-site geologist.[128] The report documents the work performed by Trihydro on behalf of HR Martin to document the subsurface geologic and groundwater conditions at the proposed

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[113] Tr. Vol. 2 at 120:13-121:1.
[114] Tr. Vol. 2 at 121:2-23.
[115] Tr. Vol. 2 at 123:8-124:4.
[116] Tr. Vol. 2 at 124:16-20.
[117] Tr. Vol. 2 at 125:4-13.
[118] Applicant Ex. 32; Tr. Vol. 2 at 113:17-21.
[119] Applicant Ex. 32; Tr. Vol. 2 at 113:22-114:1.
[120] Applicant Ex. 32; Tr. Vol. 2 at 114:2-10.
[121] Applicant Ex. 32; Tr. Vol. 2 at 114:17-23.
[122] Applicant Ex. 32; Tr. Vol. 2 at115:3-6.
[123] Applicant Ex. 23.
[124] Tr. Vol. 2 at 11:18-13:1.
[125] Tr. Vol. 2 at 19:9-21.
[126] Tr. Vol. 2 at 16:18-17:21.
[127] Tr. Vol. 2 at 18:1-6.
[128] Applicant Ex. 1; Pg. 652; Tr. Pg. 20:14-250.

facility.[129] The fieldwork began on the site in February 2017 for the Trihydro May 2017 Report.[130] He was not present during the field work for Trihydro's site investigation.[131]

There is no surface water within one-mile of facility.[132] The site is underlain by quaternary wind-blown cover sand deposits and pond deposits.[133] The windblow cover sand is described as fine to medium quartz and also has silt with a thickness of up to ten feet.[134] The pond deposits are sandy silt and silty clay deposited in ponds and shallow swales.[135] The pond deposits are from the existence of a pond in last 2.6 million years and there are currently no ponds on the site.[136] Mr. Krembs utilized the USDA soil maps to determine that most of the soils on the site are loamy, calcareous soils with prominent lime accumulations. The site is underlain by Midessa and Amarillo soil series, which is described as a fine sandy loam.[137] The soil is 50 to 65 percent sand, 15 to 20 percent silt, and 15 to 30 percent clay.[138] The soils will generally be removed during the construction of the landfill and the pits in landfill will be dug to a depth that penetrates through soils.[139]

Soil borings GW-1 through GW-7 were installed around the perimeter of the site and BH-1 through BH-3 were in the center of the site.[140] Soil borings executed down to depths of 70 to 80 feet.[141] Trihydro utilized hollow stem auger drilling methods at most of the boring locations to collect soil borings and used a core barrel inside the bottom to collect continuous five-foot samples.[142] In the locations where Trihydro encountered hard drilling conditions such as drilling through caliche, air was used to evacuate soil out of the auger. When the air was used, the boring was logged from cuttings at the ground surface as opposed to from the core barrel sampler.[143] The three locations in the center of the site, BH-1 through BH-3 were backfilled and the other seven locations were converted to groundwater monitor wells.[144]

From the information collected from the soil borings, Trihydro developed a cross section going north to south and a cross section west to east across the site.[145] In the west to east cross section two soil layers at the top of the cross section were evaluated silty sand down to ten feet bgs. Below the silty sand is caliche down to the termination depth of the soil borings.[146] Mr. Krembs opined that silty sand soil is continuous across

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[129] Tr. Vol. 2 at 21:7-21.
[130] Tr. Vol. 2 at 22:3-9.
[131] Tr. Vol. 3 at 94:13-18.
[132] Tr. Vol. 2 at 23:11-13.
[133] Applicant Ex. 1 at HR000653, HR000664.
[134] Tr. Vol. 2 at 28:3-17.
[135] Tr. Vol. 2 at 28:18-5.
[136] Tr. Vol. 2 at 28:18-5.
[137] Applicant Ex. 1 at HR000653, HR000665.
[138] Tr. Vol. 2 at 30:5-19.
[139] Tr. Vol. 2 at 31:2-9.
[140] Applicant Ex. 1 at HR000666; Tr. Vol. 2 at 31:14-21.
[141] Tr. Vol. 2 at 32:3-10.
[142] Tr. Vol. 2 at 33:10-14.
[143] Tr. Vol. 2 at 33:15-34:2.
[144] Tr. Vol. 2 at 34:6-21.
[145] Tr. Vol. 2 at 35:9-20.
[146] Applicant Ex. 1at HR000667; Tr. Vol. 2at 36:7-37:13.

the site.[147] The soil boring logs the caliche layer starting at approximately 10 feet bgs.[148] The findings in the north to south cross section is consistent with the west to east cross section.[149]

Mr. Krembs stated the caliche interval is very hard and it was difficult to penetrate through with drilling equipment.[150] The cementation of the space between the grains created a very hard layer from 10 feet bgs down to the termination of the borings.[151] There is variation with gravel being present in the caliche and the amount of cementation.[152] Mr. Krembs testified that an extensively developed caliche horizon is present.[153]

Mr. Krembs testified the depth to first water is deeper than the static water level in the groundwater monitor wells. In the west to east cross section, depth to first encountered groundwater ranged from 63 to 75 feet bgs, except for one boring that did not encounter groundwater.[154] The static water level in the groundwater monitor wells, not the soil borings, prior to well development ranged from 58 to 63 feet bgs.[155] In the north to south cross section, water was first encountered at depths ranging from 73 to 75 feet bgs, and the static water level was 60.51 to 64.55 feet below measuring point.[156] He opined the difference between these two water levels demonstrates a dense, low permeability layer is keeping the water in the saturated caliche under pressure and confined.[157] All seven monitor wells shows this behavior.[158] Mr. Krembs asserted that the site is underlain by a dense, low-permeability layer of caliche that does not allow water to move through it from above or below.[159] He further argued that this demonstrates that there are no vertical fractures in caliche.[160] The potentiometric map shows groundwater flowing to the east.[161]

The Terracon Report, as discussed previously by Mr. Pekas, was performed after the Trihydro May 2017 Report.[162] Terracon drilled three additional borings in similar locations of BH-1, BH-2, and BH-3 in the central part of the site to document geologic conditions.[163] Terracon used split spoon sampling. A 140-pound hammer was used push the tube into the earth.[164] Mr. Krembs testified to the number of times the sampler is hit to drive it a certain distance is a quantitative measure the soil density.[165] Mr. Krembs

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147 Tr. Vol. 2 at 38:12-20.
148 Tr. Vol. 2 at 39: 5-21.
149 Applicant Ex. 1at HR000668; Tr. Vol. 2at 40:9-19.
150 Tr. Vol. 2 at 40:20-41:7.
151 Tr. Vol. 2 at 40:20-41:7.
152 Tr. Vol. 2 at 41:8-19.
153 Tr. Vol. 2 at 41:8-19.
154 Applicant Ex. 1 at HR000667; Tr. Vol. 2at 47:17-21.
155 Applicant Ex. 1 at HR000667; Tr. Vol. 2 at 48:11-14.
156 Applicant Ex. 1 at HR000668.
157 Applicant Ex. 25; Tr. Vol. 2at 51:14-52:6.
158 Tr. Vol. 2 at 52:7-22.
159 Tr. Vol. 2 at 52:23-53:10.
160 Tr. Vol. 2 at 55:9-56:1.
161 Applicant Ex. 1 at HR000669; Tr. Vol. 2 at 56:22-25.
162 Applicant Ex. 26.
163 Tr. Vol. 2 at 61:5-13.
164 Tr. Vol. 2 at 61:17-62:1.
165 Tr. Vol. 2 at 61:17-62:1.

testified that Terracon's findings were similar to Trihydro's in that the surface is silty sand with a dense layer underneath.[166]

The blow count in the Terracon Report is an ASTM standard used by drillers performing geotechnical investigations.[167] Within this soil profile, Terracon took over 100 blows to advance the sampler 6 inches, so Mr. Krembs opined that the soil profile is dense caliche.[168] The number of blows tended to increase as they moved further down the soil profile.[169]

Mr. Krembs testified that the Terracon Report confirmed Trihydro's opinions about the site.[170] In response to voir dire examination, Mr. Krembs conceded that no one in his company was directly involved in the Terracon Report.[171]

HR Martin also included water well information that is available online to support the Application.[172] Monitor wells are in place around the perimeter of the site to monitor the groundwater elevation in each well and to collect samples to detect chemicals in water.[173] Mr. Krembs testified that once the landfill is in operation there will be periodic fluid level determinations and chemical analyses for the seven monitor wells.[174] The Terracon Baseline Groundwater Monitoring Report from June 2017 provides baseline conditions of the seven wells at the landfill about one month after Trihydro's report was prepared.[175]

Terracon found the groundwater flow direction to be to the east and the groundwater depths slightly deeper than Trihydro's data.[176] Terracon submitted groundwater samples for lab analysis. Volatile organic compounds and total petroleum hydrocarbons ("TPH"), common for petroleum sites, were not detected.[177] Some inorganics were detected with arsenic exceeding the action levels. TDS results ranged from 1,000 to 2,640 milligrams per liter which exceeds the EPA secondary drinking water standard.[178] Mr. Krembs testified the operator of the facility will use the baseline results from the this report as a comparison for future groundwater monitor results.[179]

Michelle Harper testified on behalf of HR Martin. She is an assistant project scientist with a focus on geology.[180] She was a field geologist investigating the site of the proposed landfill for Trihydro. Her primary role is to do the drilling for installing monitoring

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[166] Tr. Vol. 2 at 62:11-17.
[167] Tr. Vol. 2 at 79:14-18.
[168] Tr. Vol. 2 at 80:5-16.
[169] Applicant Ex. 26; Pg. HR 009936; Tr. Vol. 2 at 81:3-21.
[170] Tr. Vol. 2 at 64:2-4.
[171] Tr. Vol. 2 at 63:24-64:4.
[172] Tr. Vol. 2 at 67:1-23.
[173] Tr. Vol. 2 at 69:21-70:7.
[174] Tr. Vol. 2 at 70:13-17.
[175] Applicant Ex. 2, Appendix Gat HR001006; Tr. Vol. 2 at 71:2-72:5.
[176] Applicant Ex. 2 at HR001012; Tr. Vol. 2 at 73:20-74:7.
[177] Applicant Ex. 2 at HR001014; Tr. Vol. 2 at 75:8-77:12.
[178] Applicant Ex. 2 at HR001014, Tr. Vol. 2 at 75:8-77:12.
[179] Tr. Vol. 2 at 77:25-78:8.
[180] Tr. Vol. 4 at 61:11 to 61:22; Applicant Ex. 43.

wells, soil borings, groundwater sampling, surface water sampling and sediment sampling.[181] She helped developed a work plan for the investigation. The work plan is basically an instruction manual of what she is to do when in the field. She worked on it with the project manager, Mike Bradford, the engineer assigned to the project.[182]

Ms. Harper explained that HR Martin originally planned to do the work with an auger but after she started, they had to use an air rotary type of machine for some of the work. The drilling commenced in the following order:

- MW-1 (monitoring well 1), which also became GW-1 (groundwater well 1)
- MW-7/GW-7
- MW-2/GW-2
- MW-5/GW-5
- MW-3/GW-3
- BH-2 (boring hole 2)
- MW-4/GW-4
- MW-6/GW-6
- BH-1
- BH-3

She and the drillers with her used one rig and moved from one well to the next, one at a time. They started with an auger and then had to move to air rotary. The first five monitoring wells were completed with the auger machine: MW-1, MW-7, MW-2, MW-5, and MW-3. Then BH-2 was started with an auger; the last portion was drilled with an air rotary after she had trouble with the rig. The remaining work was completed with the air rotary: MW-4, MW-6, BH-1, and BH-3.[183]

Ms. Harper explained the work she did with a hollow-stem auger and a core barrel sampler. The auger is a medium sized drilling rig that has a pipe and that cuts the earth similar to a corkscrew as it bores down into the earth. The samples go into the hollow center of the pipe. She used the auger to take samples of the underground earth and retrieve them to the surface. In her role as a geologist, she then observes the lithology in the core barrel sample and records what she sees. The inner diameter of the auger was 4.25 inches. The outer diameter she believes was 8.5 inches. At the bottom end of the auger it has a bit that has triangle-shaped mechanisms that act similar to teeth to drill through the ground.[184]

Ms. Harper testified that a five-foot long stainless-steel core sampler is inside the hollow stem. It consists of two metal plates that connect together. On the bottom of the sampler is a screw-on attachment and the top end has another screw-on attachment. She explained that as the auger is used to dig the hole and as the auger advances deeper

[181] Tr. Vol. 4 at 61:23 to 67:5; Applicant Ex. 1, Appendix E.
[182] Tr. Vol. 4 at 67:13 to 70:4; Applicant Ex. 44.
[183] Tr. Vol. 4 at 72:2 to 75:13.
[184] Tr. Vol. 4 at 75:14 to 78:6.

and deeper down, the core barrel is brought to the surface and the contents observed.[185] She stated the auger drills down and breaks up the subsurface material. Some goes outside the auger and a portion goes into the core barrel sampler. The core barrel sampler is periodically brought to the surface for examination to observe its contents as representative of the subsurface materials at the depth of the auger. To observe the contents, she places the core barrel sampler on a drill stand, where it is opened in half sideways similar to a clam such that there are two five-foot-long hemispheres. She stated that the sampler can get hot when drilling into formations that are very hard or very tight, because heat is being generated by the auger as it breaks the subsurface material.[186]

She discussed what observations she makes and documents. She observes how much is contained in the core barrel, called the percentage recovery. She explained that there is more recovery when there is loose soil and less recovery when the material is hard and tight.[187] She looks at the material and touches it. She stated part of her responsibility is to describe the lithology based on her observations. She describes the color and feeling which allows her to identify the texture and plasticity.[188] She also notes whether the contents are “dry,” “moist,” and “wet.” She notes it as dry if no moisture is detected. She notes it is moist if she can see and feel moisture but there is no dripping of liquids; a color change can also indicate some moisture. She notes it as wet or saturated if she can see liquids.[189]

She also notes the first observance of water by looking for the transition from dry to moist to wet. She can also see water on the outside of the core barrel. She can determine the depth of the materials by noting the depth of the auger for each of the five-foot segments; the sampler is retrieved from the auger at a depth of every five feet. She records the depth in her notes. The sampler is not watertight; so if there is water, she can observe it dripping as it is retrieved.[190]

Once she sees water, she lowers a water level indicator into the hole. She uses the depth measure from the water level indicator and her observations to note the water level in her field notes.[191]

Ms. Harper testified that to know at what depth to place the monitoring well, the first encounter of groundwater is important in determining how much farther to drill to set the well. For monitoring wells, there is a screened portion with slots that allows the water to enter the well from the formation. A portion of the screen needs to be above the water.[192]

Ms. Harper described her methodology when using air rotary drilling. She said it was similar to using a hollow stem auger but instead air is used as the drilling technique.

[185] Tr. Vol. 4 at 78:7 to 79:11.
[186] Tr. Vol. 4 at 79:12 to 82:8.
[187] Tr. Vol. 4 at 82:9 to 83:16.
[188] Tr. Vol. 4 at 83:17 to 85:1.
[189] Tr. Vol. 4 at 85:2 to 86:24.
[190] Tr. Vol. 4 at 87:4 to 90:24.
[191] Tr. Vol. 4 at 90:25 to 93:9.
[192] Tr. Vol. 4 at 93:10 to 96:2.

The same rig is used and an air hose goes through the drill stem and blows air to turn the bit and create the hole going underground; it blows at approximately 350 to 400 pounds per square inch ("psi"). A box-shaped mechanism with flaps is placed at the top of the hole. As subsurface material comes to the surface it hits the flaps and deposits the subsurface materials around the hole.[193] Every few minutes a shovelful of the subsurface cuttings is removed, and she examines them. When using the air rotary method, instead of having a core of samples, the samples appear as a batch of what she described as "shards of dirt." She watches as the material comes to the surface and stops the air rotary if she observes a change in the material. She asks the driller on the drilling crew she works for the approximate depth so she can document that. She also documents the depth that water is first observed. She described what occurs when water is encountered as similar to seeing a geyser coming from the borehole.[194] When water is detected, Ms. Harper uses the water level detector by having the drilling team stop the rig.[195]

Some of the soil samples collected were sent to a laboratory for geotechnical analysis which is an evaluation of the physical properties of the soil. For example, the composition and grain-size are evaluated.[196]

Ms. Harper explained the work plan changes that occurred while she was in the field. One change was the depth of the samples she would send to the lab. Originally it was anticipated that she would collect samples from 5 to 15 feet bgs. While drilling with the hollow stem auger with the sampler, she was not getting the kind of recovery anticipated. She testified the percent recovery was approximately 20 percent with a maximum of 50 percent. For example, she testified that when drilling into caliche, she would get only a couple of inches in one five-foot core sample. She contacted the laboratory to see how much volume they required for analysis. Depending on the recovery in the core barrel sampler, she would need to take samplings from 5 to 25 feet to obtain enough soil for analysis.[197]

Ms. Harper stated the other major change to the original work plan was the use of the air rotary drilling method for part of the drilling. It began in the drilling of BH-2.[198]

Seven borings were made into monitoring wells. Ms. Harper testified about the process of creating the monitoring wells from the boreholes. After she took a water level reading, the drillers constructed and installed the actual well. It is made of PVC. She described the screen on the bottom as a .010 slotted screen. Then she backfilled the area to get a sand back around the well screen to filter and remove the fine materials that are in the water in the aquifer. She wants the sand to be a minimum of two feet above the screened interval. Then bentonite chips were placed on top of the sand to two feet below surface. She stated that bentonite is a clay that expands when it gets wet. It expands to fill the annulus of the borehole so no water can come from the surface down and get into

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[193] Tr. Vol. 4 at 96:18 to 100:9.
[194] Tr. Vol. 4 at 100:10 to 104:10.
[195] Tr. Vol. 4 at 104:11 to 105:19.
[196] Tr. Vol. 4 at 105:20 to 106:20.
[197] Tr. Vol. 4 at 106:21 to 108:11.
[198] Tr. Vol. 4 at 108:12 to 110:1.

where the water is within the screened interval. Concrete was placed from two feet bgs to surface.[199]

After the monitoring wells were set, Ms. Harper described a process she uses to develop wells. She usually leaves the wells for a minimum of 24 hours to 48 hours after installation before well development. This allows the water to stabilize after the stirring that can occur with drilling and creating the well. It also allows the bentonite to cure. Typically, her team would be drilling another hole during this waiting period. She said the purpose of developing the well is to ensure fresh water is coming into the well for sampling. She pumps water from the well at a minimum of 10 well volumes, which is based on the depth of the static water level that she measured initially and the total depth. The purpose is to move water from the formation and into the well. That process was performed for all monitoring wells, and it is a process she is familiar with and has performed many times.[200]

For the samples that went to the lab, Ms. Harper collected five five-gallon buckets, put lids on them and labeled them. Then she shipped them to the lab.[201]

Ms. Harper provided her field notes and described what she observed. First, she discussed MW-2, which was the first well drilled. For each core sample interval, some of the observations she noted were the depth bgs, the texture, and grain size, the color, the plasticity, consistency, and moisture content. For MW-2, from zero to five feet bgs, the major constituent was sand, and she listed a minor as “silty.” According to her, this indicated a silty sand. She noted the color was brown and the material was soft. From five to 10 feet bgs she noted that the color was pinkish white. From zero to 10 feet bgs, she noted it was soft and moist. From 10 to 15 feet there was fine medium and coarse-grain sand and silt. She said it was a silty sand again. It was pink and white. It was hard to very hard. It was moist to dry. She had 20 percent recovery. She defined it as caliche that is cemented; she explained it was not the same silty sand she encountered from zero to 10 feet. She based her determination that the material was hard to very hard on the following:

1. The rig was slow and bouncing due to the resistance of the material;
2. She only had a 20 percent recovery;
3. It was hard to her touch in that she could not scratch it or break it; and
4. It was compact and she had to use a hammer to get it all out of the container.

She described it as “very hard drilling.” Through the rest of drilling this hole, she recovered 20 percent except for one time she was able to recover 50 percent in the core barrel sampler. At the deepest depths, there was no recovery. She went down to approximately 60 feet bgs. She noted that for the rest of the drilling, the material was hard to very hard.

[199] Tr. Vol. 4 at 110:13 to 114:21.
[200] Tr. Vol. 4 at 114:22 to 117:15.
[201] Tr. Vol. 4 at 117:23 to 118:20.

She noted it started becoming moist after 40 feet and saturated at approximately 65 feet.[202]

Ms. Harper went through the remaining boreholes and wells that were drilled. She testified that she consistently observed hard to very hard caliche after the soft surface soils and continued to consistently get low recoveries. It was hard until she encountered water; it was moist and softer for an interval before and after she encountered water. She opined that the water caused the caliche to be moist and soft during this interval. She testified that after the water, she encountered hard wet red caliche. She testified she consistently observed hard rock-like cemented caliche above the water level. She pointed out as an example, that she observed cemented nodules in some of the samples.[203]

Ms. Harper discussed her observations from drilling BH-2, the boring hole for which she had to change from using a core barrel sampler to air rotary drilling. It was originally drilled with the auger, but then redrilled five feet over with the air rig. She testified what occurred when the auger broke. She stated that she got poor recovery and components of the auger and rig would get cracks and need to be welded due to how hard the caliche was. The drill would go no further at approximately 70 feet bgs; she described it as the rig bouncing up and down and making no progress. When they pulled up the auger, it was broken and part of it, including the bit, was stuck at the bottom of the hole. Since her goal for this boring hole was 100 feet, they redrilled a hole 5 feet away using air rotary. She only logged from 70-80 feet, since she had already logged the first 70 feet using the core barrel sampler. She observed hard caliche until she found water at about 75 feet.[204] After BH-2, the remainder of drilling on the project was via air rotary. Generally, she observed water between 65-75 feet bgs.[205]

Ms. Harper testified the diameter of the interior of the core barrel sampler, i.e. the diameter of a core sample is two inches.[206] She did not take pictures of the core samples that she examined.[207]

For determining the depth of first water, if she has sufficient recovery, she can see a line reflective of where the water was in the soil with the drier above and the saturated below. When she has low recovery, such as less than 50 percent, she stated she does not have the soil so she cannot rely on that, so she observes where there is water on the core barrel sampler and makes an educated guess as to the depth of first water. She double checks her estimate with the water level indicator.[208] She testified she drops the water level indicator down into the well through the auger where the core barrel would otherwise be when using a hollow stem auger drilling methodology; she clarified that since water is coming in from the bottom that influx of water could affect the reliability of the readings from the water indicator. She measures again when she sets the well after the

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[202] Tr. Vol. 4 at 120:22 to 134:25.; Applicant Ex. 45; *see also* Applicant Ex. 1, Appendix E, Attachment E (computer generated printed logs based on her notes in Exhibit 45 et al.).
[203] Tr. Vol. 4 at 135:1 to 144:5; Applicant Ex. 46-49.
[204] Tr. Vol. 4 at 144:6 to 154:5; Applicant Ex. 50.
[205] Tr. Vol. 4 at 154:6 to 157:10; Applicant Ex. 51-54.
[206] Tr. Vol. 4 at 163:6 to 163:14.
[207] Tr. Vol. 4 at 163:18 to 163:20.
[208] Tr. Vol. 4 at 165:4 to 166:10.

auger is moved and it is an open borehole.[209] She uses a similar methodology when using an air rotary methodology.[210] She does not record the depth readings from the water level indicator. If the water level indicator reading is a similar estimate in the general area of her estimate, she leaves her estimate. If it is a significant change, she changes it. She acknowledged at the time of drilling; the water was not in a state of equilibrium due to the disturbance caused by drilling activities.[211]

For the soil samples sent to the lab, she sent samples from five borings. For each boring, she filled a five-gallon bucket and sent one bucket from each boring for a total of five buckets.[212] The samples for the lab were taken from the borings around the perimeter and one from the center.[213]

Ms. Harper testified that her handwritten notes should be relied on, if inconsistent with the computer-generated logs; the computer-generated logs were generated from her handwritten notes and errors in translation or typos can occur in the computer-generated logs.[214]

Ms. Harper stated it is possible to identify fractures, fissures, vugs, solution cavities, and those types of things to a certain extent from the hollow stem auger drilling and the air rotary drilling. The less percent return, the less likely she would be able to identify these features.[215] She acknowledged while it is possible, she does not always see them due to the fact that the sample is ground and broken up by the drilling activity. She does not know the probability of her being able to detect the presence of these features; she stated if she does not get good recovery, she is not going to be able to see it.[216]

Mr. Schreuder testified laboratory tests were run on five boring samples for gradation to determine if the material in the borings is gravel, sand, silts, or clays for the Unified Soil Classification, and to identify soil samples for additional tests.[217] The information from these tests was used by HR Martin for slope analysis.[218] The tests utilized material that was smaller than the No. 4 sieve and remolded to determine the optimum moisture content and tested for shear strength.[219] The samples were also tested for Natural Moisture Content.[220] The information obtained by the laboratory tests was used to assist with the design work at the facility.[221]

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[209] Tr. Vol. 4 at 167:12 to 168:3.
[210] Tr. Vol. 4 at 168:4 to 169:17.
[211] Tr. Vol. 4 at 169:18 to 170:9.
[212] Tr. Vol. 4 at 170:10 to 173:21.
[213] Tr. Vol. 4 at 189:20 to 189:22.
[214] Tr. Vol. 4 at 176:6 to 178:13.
[215] Tr. Vol. 4 at 178:14 to 181:9.
[216] Tr. Vol. 4 at 186:17 to 188:3.
[217] Tr. Vol. 5 at 137:5-8, 137:19-21, 138:19-139:6.
[218] Tr. Vol. 5 at 139:7-12.
[219] Tr. Vol. 5 at 140:8-12.
[220] Tr. Vol. 5 at 140:13-24.
[221] Tr. Vol. 5 at 141:21-23.

8. Design of proposed facility

Mr. Schreuder and George Mathes provided testimony on behalf of HR Martin regarding the design of the facility. George Mathis, senior vice president with Trihydro, is a registered professional engineer in the State of Texas. He has been registered and practicing since 2002, and has worked on a similar facility in Orla, Texas.[222] He stated that Mr. Schreuder was primarily responsible for the design of the adjoining landfill facility layout. [223]

Mr. Schreuder testified that the primary guidance for the design requirements of pits is the Commission's Surface Waste Management Manual and the Supplemental Application Information for Permit to Maintain and Use a Commercial Oil and Gas Waste Disposal Pit.[224] He asserts that the guidance states that a pit may be unlined if there is two feet of soil with of permeability of $1x10^{-7}$ centimeters per second ("cm/sec") to inhibit seepage into groundwater.[225]

HR Martin will have access controls to prevent unauthorized access to the facility, including livestock or wildlife.[226] The entire perimeter will be fenced.[227]

Mr. Schreuder testified that HR Martin will submit a Spill, Prevention, Control, and Countermeasures ("SPCC") plan to the Commission.[228] The plan is not required as it is more for petroleum products such as fuel for equipment and vehicles, but HR put one together so there are minimum procedures in place.[229]

a. Waste Types

There are three types of waste that will be accepted at the facility: RCRA exempt oil and gas waste,[230] RCRA non-exempt oil and gas waste,[231] and waste associated with oil and gas facilities and reclamation plants, as long as the waste does not contain recoverable hydrocarbons.[232] Only oil and gas waste under the jurisdiction of the Commission may be accepted at the facility.[233]

The types of waste listed in the Application is water and oil-based drilling fluids and associated cuttings, tank bottoms,[234] solids associated with frac flow-back, formation

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[222] Tr. Vol. 5 at 6:8 to 7:3.
[223] Tr. Vol. 9 at 12:20 to 12:22; Applicant Exhibit No. 4.
[224] Applicant Ex. 28 and 29; Tr. Vol. 2 at 90:1-91:22.
[225] Applicant Ex. 28; Tr. Vol. 2 at 92:7-22.
[226] Tr. Vol. 2 at 132:3-17.
[227] Tr. Vol. 2 at 132:3-17.
[228] Applicant Ex. 24A at HR000547; Tr. Vol. 5 at 142:20-143:14.
[229] Tr. Vol. 5 at 142:20-143:14.
[230] Applicant Ex. 24A at HR002472-2473; Tr. Vol. 2 at 135:5-9.
[231] Tr. Vol. 2 at 135:19-23.
[232] Tr. Vol. 2 at 136:9-19.
[233] Applicant Ex. 31 at HR015636-HR015637, Item No. II (A).
[234] Applicant Ex. 31 at HR015636-HR015637.

sand, and contaminated soils. All waste haulers transporting waste to the facility must be permitted by the RRC.[235]

All waste entering the facility will be screened for naturally occurring radioactive material ("NORM") or technically enhanced radioactive material ("TENORM"). Waste with readings over limits will not be accepted at the facility.[236]

A waste manifest must be prepared prior to the waste being transported to the facility.[237] Any testing that is required is provided in advance and the facility is contacted prior to the waste being received at the facility.[238] HR Martin must keep records of all waste screening activities, including the manifest and laboratory test data.[239]

The tests will be required for every source of waste.[240] The generator of the waste will fill out the manifest and demonstrate if that the waste is exploration and production exempt.[241] From commercial oil and gas facilities and reclamation plants, waste must be tested for Total Organic Halides ("TOX") or Extractable Organic Halides ("EOX"). RCRA non-exempt waste must be tested for corrosivity, ignitability, reactivity, and toxicity; and RCRA metals and benzene using the Toxicity Characteristic Leaching Procedure ("TCLP").

Mr. Schreuder testified that waste will be tested for liquids use the Paint Filter Liquids Test, Method 9095B.[242] If the water content of the waste is too high to be placed immediately in the landfill, the operator of the facility may reject the load of waste, put the waste in the concrete drying pads for drying or mixing with clean soil, or if the waste will dry out quickly, the waste will be transported receiving pits where liquids will be removed or evaporated.[243]

b. Proposed Facility Overview

The proposed facility will consist of the following:

- Three drying pads,
- Two waste receiving pits,
- One truck washout pad,
- Two contact stormwater ponds,
- One non-contact stormwater pond, and
- 14 landfill cells.

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[235] Applicant Ex. 31 at HR015637, Item Nos. II (D), II (E), and II (F).
[236] Tr. Vol. 2 at 138:24-139:17; Applicant Ex. 24A at HR002490.
[237] Tr. Vol. 2 at 139:18-25.
[238] Tr. Vol. 2 at 140:19-25.
[239] Tr. Vol. 2 at 143:17-144:1.
[240] Tr. Vol. 2 at 147:18-23.
[241] Tr. Vol. 2 at 149:1-4.
[242] Applicant Ex. 34; Tr. Vol. 2 at 141:9-16.
[243] Tr. Vol. 2 at 142:16-143:16.

Mr. Schreuder testified for the units that will contain waste for a longer period of time—the contact stormwater pond, two receiving pits, truck washout pad, and the landfill cells—the pits will be excavated by removing soil to the top of the caliche.[244] The caliche will be a rough surface which will require eight inches of "clean, engineer-approved" soil to be placed on the caliche's rough surface, and on top of the clean soil will be a geosynthetic clay liner ("GCL"), in lieu of two feet of natural clay below the pits.[245]

Mr. Schreuder testified that in the northeastern corner of the facility is the non-contact stormwater pond with the contact stormwater ponds directly to the south.[246] In the southeast corner on the facility, south of the drying pads, is the truck washout pad.[247] Caliche that will be excavated during the construction of the site will be temporarily stored onsite along with stockpiles of soil.[248] A 30 foot berm to control surface water run-on and runoff will go around the facility.[249]

Mr. Schreuder testified for stormwater, the operator will put a 30-foot wide, two-foot high berm around the perimeter of the landfill, which is enough to block water from running onto the property, around the property, and cause all the water that falls on the property to remain on the property.[250] He stated the only run-on stormwater would potentially be from the western side of the facility, and the berm will divert it where it can follow the natural drainage towards the east.[251]

i. Drying Pads

Mr. Schreuder testified that waste that does not pass the Paint Filter Test will either go to the drying pads or the receiving pits.[252] The drying pads will be for waste that can be handled quickly and may be mixed with soil to reduce free liquids.[253] Once the waste passes the Paint Filter Liquids Test, it will go to the active landfill cell for disposal.[254]

The three drying pads will be constructed with a reinforced concrete floor and sidewalls to accommodate trucks or heavy equipment inside of them.[255] Mr. Mathes testified the drying pads have ramps on the left and right side and walls on the upper and lower side. There is a five foot to one-foot ("5:1") ramp concrete apron. The walls are 1-foot.[256]

244 Tr. Vol. 2 at 170:18-171:12.
245 Tr. Vol. 2 at 170:18-171:12.
246 Applicant Ex. 24A at HR002495; Tr. Vol. 2 at 165:3-9.
247 Applicant Ex. 24A at HR002495; Tr. Vol. 2 at 165:10-17.
248 Tr. Vol. 2 at 166:7-24.
249 Tr. Vol. 2 at 168:2-5.
250 Tr. Vol. 2 at 127:8-21.
251 Tr. Vol. 2 at 128:21-6.
252 Tr. Vol. 2 at 158:23-159.8.
253 Tr. Vol. 2 at 158:23-159.8.
254 Tr. Vol. 2 at 159:9-16.
255 Tr. Vol. 2 at 169:12-22.
256 Tr. Vol. 5 at 89:1 to 90:23; Applicant Exhibit No. 4.

Mr. Schreuder testified that waste will be stored temporarily; it will be "dumped in there, mixed, and hauled out."[257] The pits will be inspected on a regular basis for cracks in the concrete, and any cracks will be repaired on a continual basis.[258] Mr. Mathes testified that the permit calls for the emptying of the pads once a year for visual inspection. Therefore, if the pad is covered during the 12 months between emptying then there is no way to tell if the concrete is cracked.[259] Mr. Schreuder stated that there is no time limit for how long waste can be stored in the drying pads, but the intention is for temporary storage such as one to two days.[260]

ii. Non-Contact Stormwater Pond

Mr. Schreuder testified that the non-contact stormwater pond is not regulated by the Commission and did not have a Commission Form H-11 filed for it.[261] Mr. Schreuder stated the non-contact water is collected in an engineered channel on the outside of the landfill cells and drains with the natural west to east slope of the site, continues around the inside perimeter berm of the landfill, and ends up in the southwest corner of the non-contact stormwater pond.[262] Once the facility is filled and capped, all the stormwater at the reclaimed site will be non-contact stormwater and will go to the non-contact stormwater pond.[263] Mr. Schreuder clarified that the stormwater from the road goes into the non-contact stormwater pond.[264]

iii. Waste Receiving Pits

The two waste receiving pits are similar in size, but have different capacities due to the geometry of the ground.[265] The pits will be constructed with at least eight inches of prepared subgrade, GCL, 60-mil HDPE secondary liner, 200-mil geonet, and 60-mil HDPE primary liner.[266] The receiving pits will be equipped with a leak detection system ("LDS") that will be monitored weekly.[267]

In the receiving pits and the landfill cells, two feet of protective soil will be placed on top of the leachate collection system ("LCS") to allow for heavy equipment to operate on it.[268] Any water that goes through the two feet of protective soil will be collected in the LCS.[269] On top of the two feet of soil will be the waste material.[270]

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[257] Tr. Vol. 2 at 169:12-22.
[258] Tr. Vol. 2 at 169:23-170:2.
[259] Tr. Vol. 9 at 17:13 to 19:1; Applicant Exhibit No. 31.
[260] Tr. Vol. 2 at 170:9-17.
[261] Tr. Vol. 2 at 152:6-11.
[262] Tr. Vol. 2 at 168:17-169:6; 131:5-16.
[263] Tr. Vol. 2 at 131:17-21.
[264] Tr. Vol. 5 at 131:19-22.
[265] Tr. Vol. 2 at 152:12-20.
[266] Applicant Ex. 31 at HR015643, VI (F); Tr. Vol. 3 at 6:22-7-4.
[267] Applicant Ex. 31 at HR015643, VI (G)-(L).
[268] Tr. Vol. 3 at 8:20-23.
[269] Tr. Vol. 3 at 9:7-15.
[270] Tr. Vol. 3 at 9:16-21.

iv. Truck Washout

The truck wash pad is used to wash out trucks before they leave the facility.[271] Mr. Schreuder testified that any water that collects on the pad drains into a sump, which is pumped to remove liquid as it accumulates.[272]

Mr. Schreuder stated that the truck wash pad will be constructed with compacted subgrade above the excavated caliche, following by the GCL, a 60-mil HDPE liner, the eight-ounce geotextile with eight-inches of washed rock, with eight-inch thick reinforced concrete over the rock.[273]

George Mathes testified that the truck wash has a 5:1 ramp leading down into it, meaning 5 units horizontal and 1 unit vertical. The function of the ramp is to confine the liquids in the truck wash pad to the truck wash area. There is a wall around the truck wash structure except for where the ramp is located. There is a one-foot apron on the areas where there is no wall. The water flows into the collection sump and is collected and taken to the contact stormwater pond.

v. Contact Stormwater Ponds

Mr. Schreuder stated that there are two different contact stormwater ponds so that the operator can drain and inspect one pond and have the other available for use, and operations will not need to be interrupted.[274]

In the contact stormwater ponds, above the prepared subgrade will be the GCL, 60-mil HDPE secondary liner, geonet, 60-mil HDPE primary liner, and an LDS to detect leaks in the primary liner. [275] Mr. Schreuder testified that the bottom of the pond is sloped so liquid flows to the sump that is equipped with rock and perforated pipe that is deeper than the rest of the pond.[276] The perforated pipe connects to a solid pipe that goes up the side of the pond to the surface so that a lysimeter can detect the presence of water, and that water can be pumped out.[277] There is no leachate collection in the contact stormwater ponds, because the ponds are for the storage of liquids.[278]

All contact stormwater will be pumped from the cells or the other pits (drying pads, receiving pits, or truck washout) and trucked or piped to the lined contact stormwater pond.[279] If the contact stormwater pond ever approaches its capacity, water will be pumped out and transported offsite to a permitted facility for disposal.[280]

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[271] Applicant Ex. 24A at HR000572; Tr. Vol. 2 at 151:14-21.
[272] Applicant Ex. 24A at HR000572; Tr. Vol. 2 at 151:14-21.
[273] Applicant Ex. 31 at HR015641-HR015642, V(D); Tr. Vol. 5 at 117:4-20.
[274] Tr. Vol. 2 at 151:22-152:5.
[275] Tr. Vol. 2 at 184:14-19.
[276] Tr. Vol. 2 at 184:22-185:4.
[277] Tr. Vol. 2 at 185:5-12.
[278] Tr. Vol. 3 at 8:17-20.
[279] Tr. Vol. 2 at 130:18-24.
[280] Tr. Vol. 2 at 130:25-131:4.

vi. Landfill Cells

The landfill cells will be constructed with a compacted subgrade at the bottom, GCL, 60-mil HDPE secondary liner, geonet, and 60-mil HDPE liner.[281] The leachate collection system ("LCS") will be on top of the double liner leak detection system to collect any water so that it can be removed from the cell. The cells are going to be excavated to 15 to 20 feet bgs.[282] In the landfill, there will be two feet of protective soil on top of the leachate collection material to allow for heavy equipment to operate on it.[283] The landfill cells will be filled to approximately 100 feet above ground in the shape of a pyramid with the tops cut off, slight sloped to promote runoff.[284]

Landfill cells will only receive dry waste that passes the Paint Filter Test. The landfill cells will be constructed with eight inches of compacted subgrade at the bottom, GCL, 60-mil HDPE secondary liner, geonet, and a 60-mil HDPE liner.[285] The LCS will be on top of the double liner leak detection system to collect any liquids that leak through the primary liners, so the water can be removed from the cell.[286]

Mr. Schreuder testified when waste is being placed within the active cell, the temporary access roads within the landfill will be used to transport waste to disposal.[287] These roads will change frequently as waste is going to different cells or different parts of cells.[288] The interior road in the landfill will be an "all-weather road" that will be surfaced with gravel or caliche.[289] Mr. Schreuder testified that trucks that come into the facility are unlikely to contact the waste in the landfill.[290] In contrast, Mr. Mathes testified that trucks will drive on top of the waste, after it has driven on the waste, it will drive onto the perimeter road and to the truck washout pad. The stormwater that contacts the road follows a channel to the noncontact stormwater pond.[291] He considers the contact of waste on the road to be "de minimis."[292]

The primary way into the interior of the landfill will be by Landfill Cell S-7, by the receiving pits.[293] There is a permanent road all the way around the landfill that is 30 feet wide that can also be used to access the landfill cells temporarily.[294] The permanent perimeter road will be used for routine inspections, maintenance, and to transport waste that comes into the landfill.[295]

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[281] Tr. Vol. 3 at 6:22-7-4.
[282] Tr. Vol. 2 at 154:14-18.
[283] Tr. Vol. 3 at 8:20-23.
[284] Tr. Vol. 2 at 154:22-155:3.
[285] Tr. Vol. 3 at 6:22-7-4.
[286] Applicant Ex. 4, C-40; Tr. Vol. 3 at 9:7-15.
[287] Tr. Vol. 5 at 123:4-18.
[288] Tr. Vol. 5 at 123:4-18.
[289] Tr. Vol. 5 at 132:10-24.
[290] Tr. Vol. 9 at 132:15-25.
[291] Tr. Vol. 5 at 63:5 to 64:6; Applicant Exhibit No. 4.
[292] Tr. Vol. 5 at 66:8 to 67:13; Applicant Exhibit No. 4.
[293] Tr. Vol. 5 at 124:23-125:9.
[294] Tr. Vol. 5 at 130:13-20.
[295] Tr. Vol. 5 at 131:4-10.

The waste will be placed in the cells in lifts that will periodically be compacted and overlain by interim cover. Mr. Schreuder testified that contact stormwater is going to be limited within the cells by applying interim clean soil cover to the exterior slopes of the landfill cell as it is filled, and any water that falls on those slopes will run into a contact stormwater system.[296]

The landfill will be constructed one cell at a time; when the first cell is reaching final grade with waste in the northwestern part of the facility, the next cell to the southwest starts being constructed. The landfill will be constructed from west to east, following the overall slope of the facility. [297]

The northwestern most cell, Cell N-1 will be constructed first. Once that cell is constructed and is approaching being filled to final grade, construction will begin on the next cell to the south, Cell S-1.[298] The waste in Cell N-1 will have a four foot horizontal to one foot vertical ("4:1") slope facing its boundary with Cell S-1 and Cell N-2 with a temporary berm containing waste along the boundaries of those future cells. The temporary berm between Cells N-1 and S-1 will be removed and the liner systems between the two cells will be welded together and connected. The solid waste being disposed in Cell S-1 will overlap with the waste already in Cell N-1 to form one large section of waste between the two cells.

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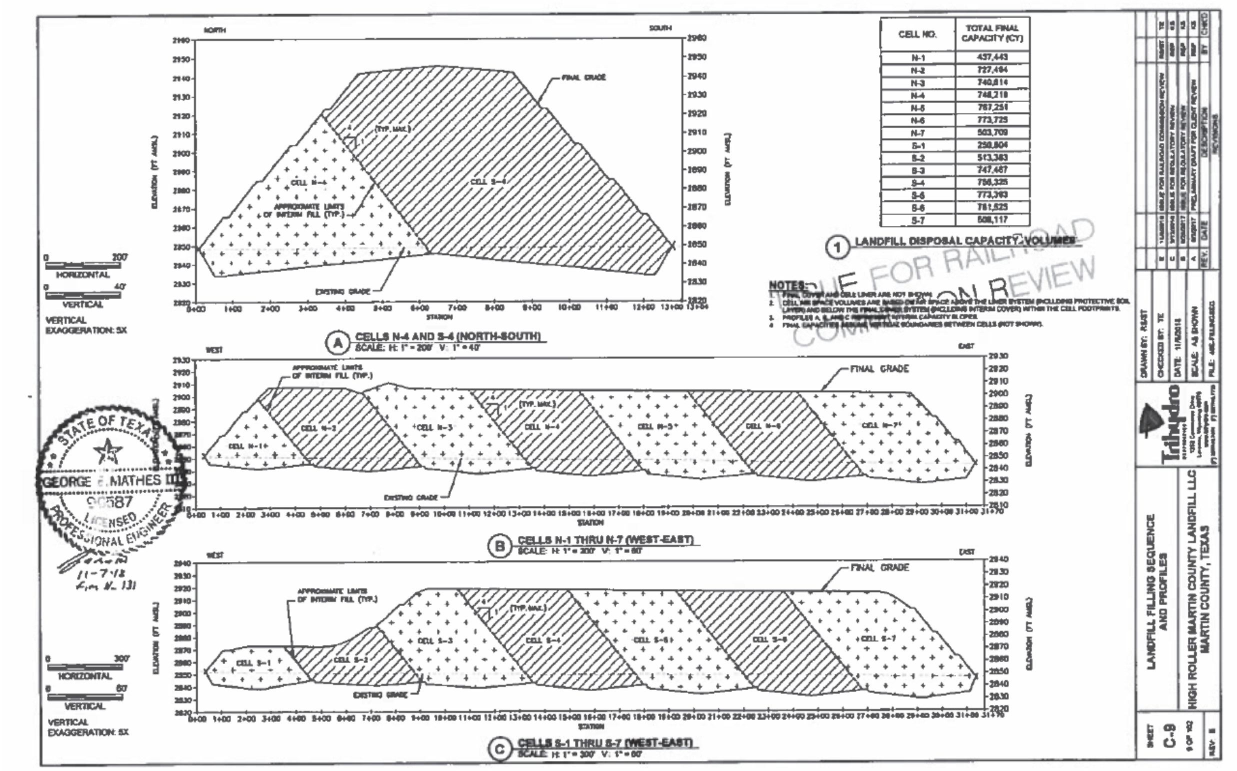
[296] Tr. Vol. 2 at 129:7-19.
[297] Tr. Vol. 5 at 124:23-125:9; Tr. Vol. 2 at 159:17-164:15.
[298] Tr. Vol. 2 at 163:21-164:15.

Design drawing of waste overlapping between landfill cells.[299]



Once Cell S-1 approaches final grade, construction will begin on Cell N-2, the cell adjacent to Cell N-2 to the east. The temporary toe berm between Cell N-1 and the new Cell N-2 will be removed and the liner systems of Cells N-1 and N-2 be welded together. Waste being disposed of in Cell N-2 will overlap with the waste in Cell N-1, until one large section of waste between the two cells approaches final grade.

The next cell, Cell S-2 will be constructed when Cell N-2 approaches final grade. The temporary toe berms between Cells S-2 and S-1 and between Cells S-2 and N-2 will be removed, and their liners will be connected. Waste being disposed in Cell S-2 will overlap with waste in Cells S-1 and N-2 until they approach final grade.

The sequence of cell construction will be in the following order: Cell N-1, Cell S-1, Cell N-2, Cell S-2, Cell N-3, Cell S-3, Cell N-4, Cell S-4, Cell N-5, Cell S-5, Cell N-6, Cell S-6, Cell N-7, and Cell S-7. The cells will be built in phases over the life of the facility.[300]

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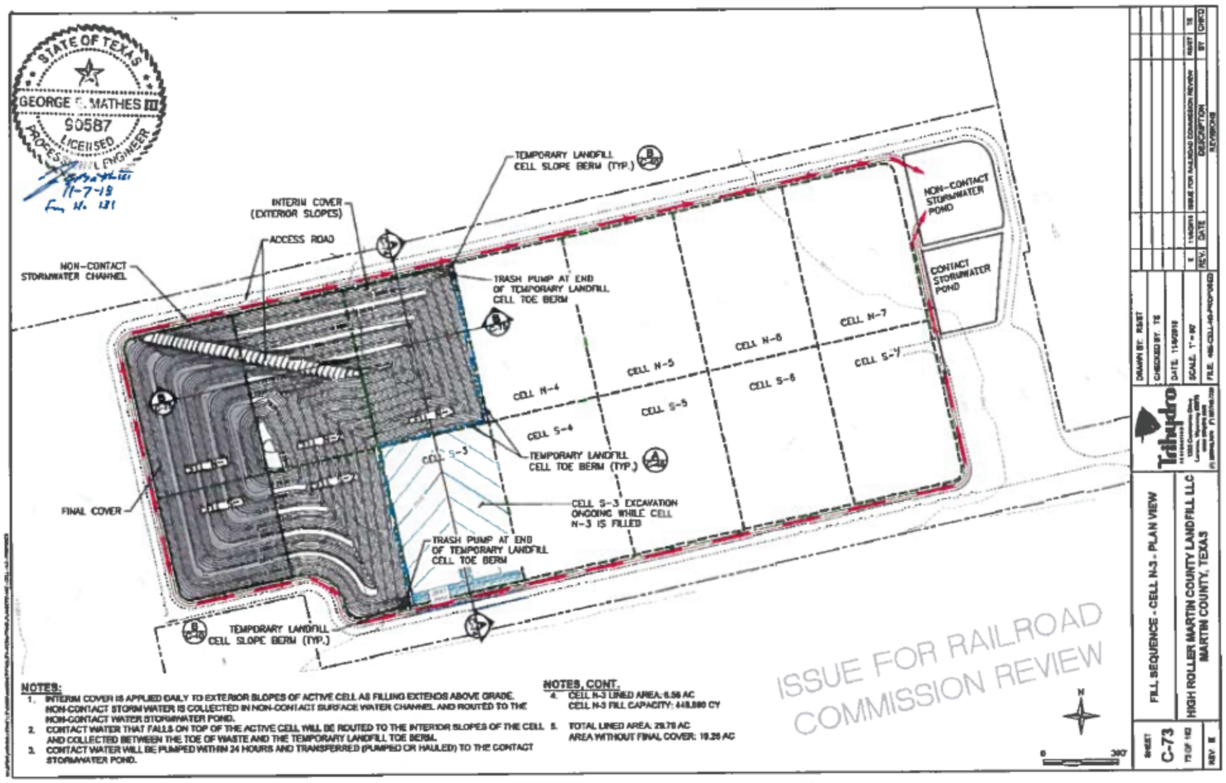
[299] Applicant Ex. 4, C-9.
[300] Tr. Vol. 2 at 159:9-160:17.

Design drawing of phased construction of the facility. Cell N-3 is approaching final and Cell S-3 is getting excavated and constructed.[301]



Mr. Schreuder testified for the landfill cells, the double liner LDS goes over the outer berm and the liner system is anchored over the outer slope.[302] As the landfill is transitioning from a near filled cell to a new cell, the waste in the previous cell will be filled to 10 feet from the edge of the cell, then constructed with a 4:1 slope facing the new cell.[303] Between the two cells is a temporary toe berm that prevents runoff from precipitation on the waste from leaving the cell.[304] The GCL, liner system, and LDS will be installed from the outer berm, down the slope, along the bottom of the pit, up to the edge of the cell boundary up to the temporary toe berm, then the primary and secondary liners are welded partially up the berm, and only the secondary liner goes over the top of the temporary berm to the anchor trench.[305] The plywood is put over the top liner so that the two feet of protective soil does not damage the surface of the liner.[306]

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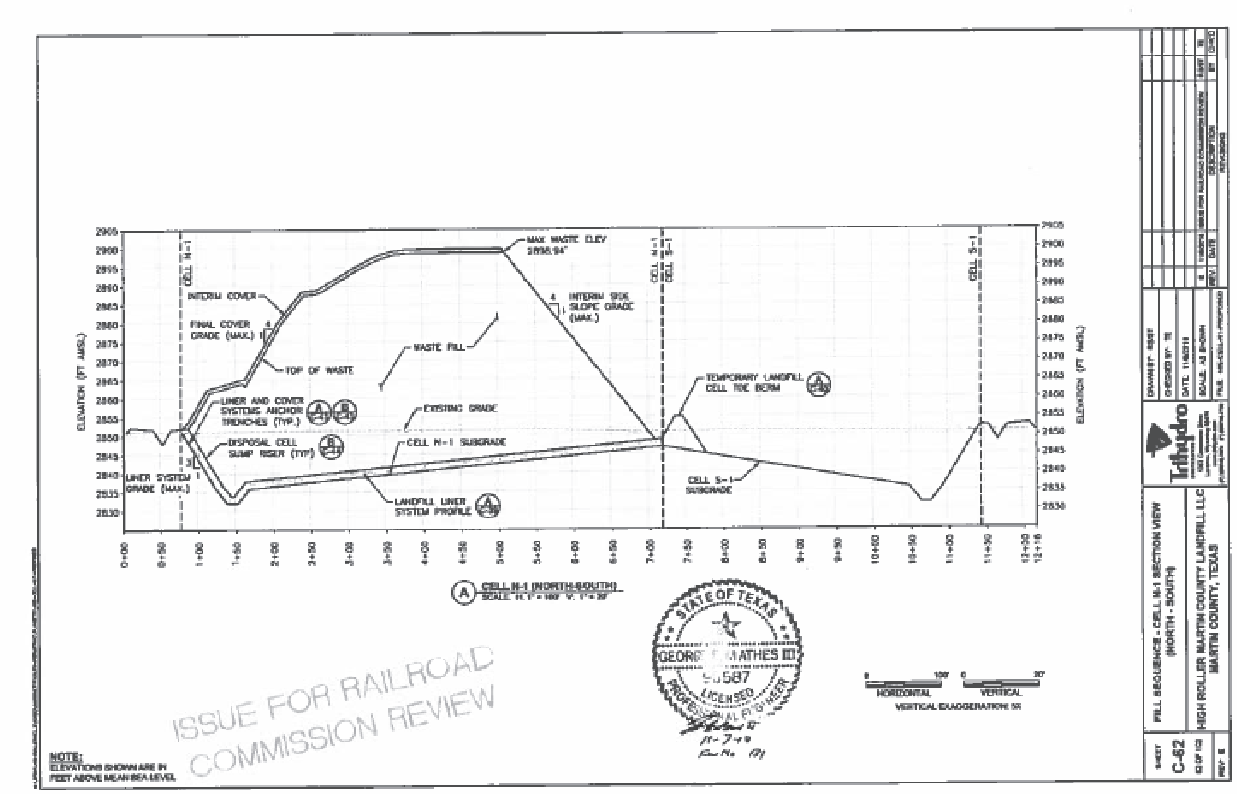
[301] Applicant Ex. 4 at C-73.
[302] Tr. Vol 6 at 38:10-13. 40:5-7
[303] Applicant Ex. 4 at C-40; Tr. Vol. 5 at 180:18-23; 182:3-6. Tr. Vol 6 at 9:24-10:5.
[304] Applicant Ex. 4 at C-40; Tr. Vol. 5 at 180:13-17.
[305] Applicant Ex. 4 at C-40; Tr. Vol. 5 at 182:7-12.
[306] Tr. Vol. 5 at 185:22-185:2.

Design drawing of Cell N-1 filled to final grade with waste is piled with a 4:1 interim slope facing the new cell. The GCL and double liner leak detection system for Cell N-1 terminate prior to the temporary toe berm. Only one liner goes over the top of the temporary berm.[307]



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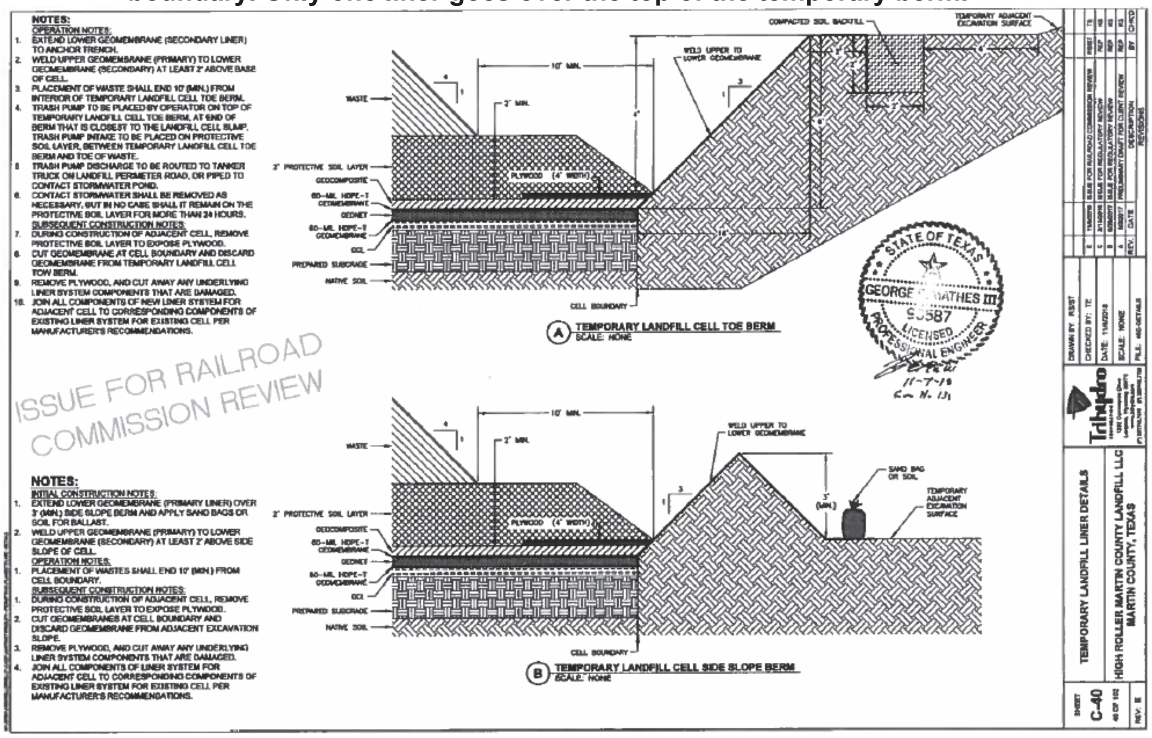
307 Applicant Ex. 4 at C-62.

Design drawing of the GCL and double liner LDS ending at the interior cell boundary. Only one liner goes over the top of the temporary berm.[308]



As soon as cells approach final grade, interim cover is placed prior to the construction of the new cells and will have interior slopes facing the next cell to be constructed.[309] When the next cell is constructed, the temporary berm will be removed, the protective soil will be pulled back, the plywood over the liner will be lifted, and there will be fresh liner surface to weld to.[310] All berm slopes for the cells will have three foot to one foot (“3:1”) slopes.[311] When the new cell is built, the berm is removed and the liners for the two cells are welded together making one continuous liner system between the two cells.[312] The waste is put into the new cell in a way to match the final waste grades in the previous cell.[313]

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[308] Applicant Ex. 4 at C-40.
[309] Applicant Ex. 72; Tr. Vol 8 at 33:7-21.
[310] Tr. Vol. 5 at 185:3-8.
[311] Tr. Vol. 5 at 187:2-5; 20:23-2
[312] Tr. Vol. 5 at 187:11-14. 26:11-16, Tr. Vol 6 at 28:4-17.
[313] Tr. Vol 6 at 24:3-8.

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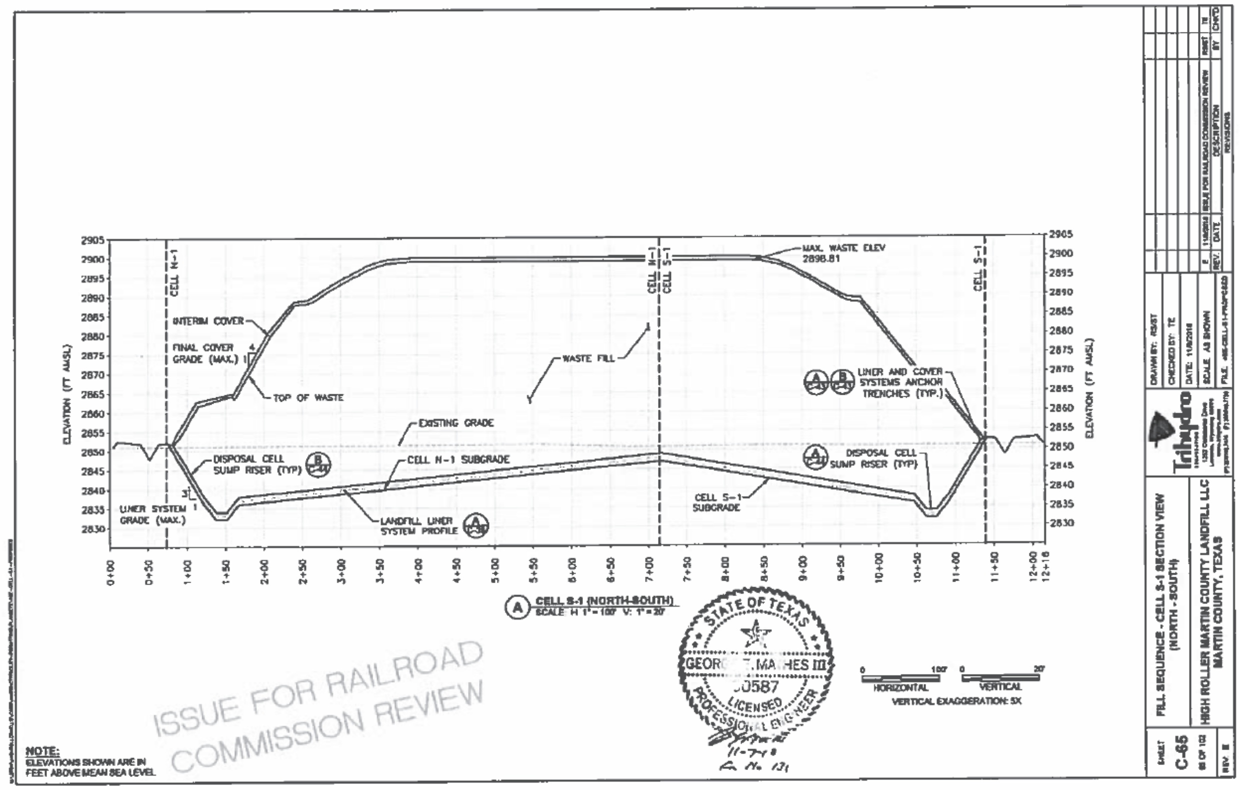
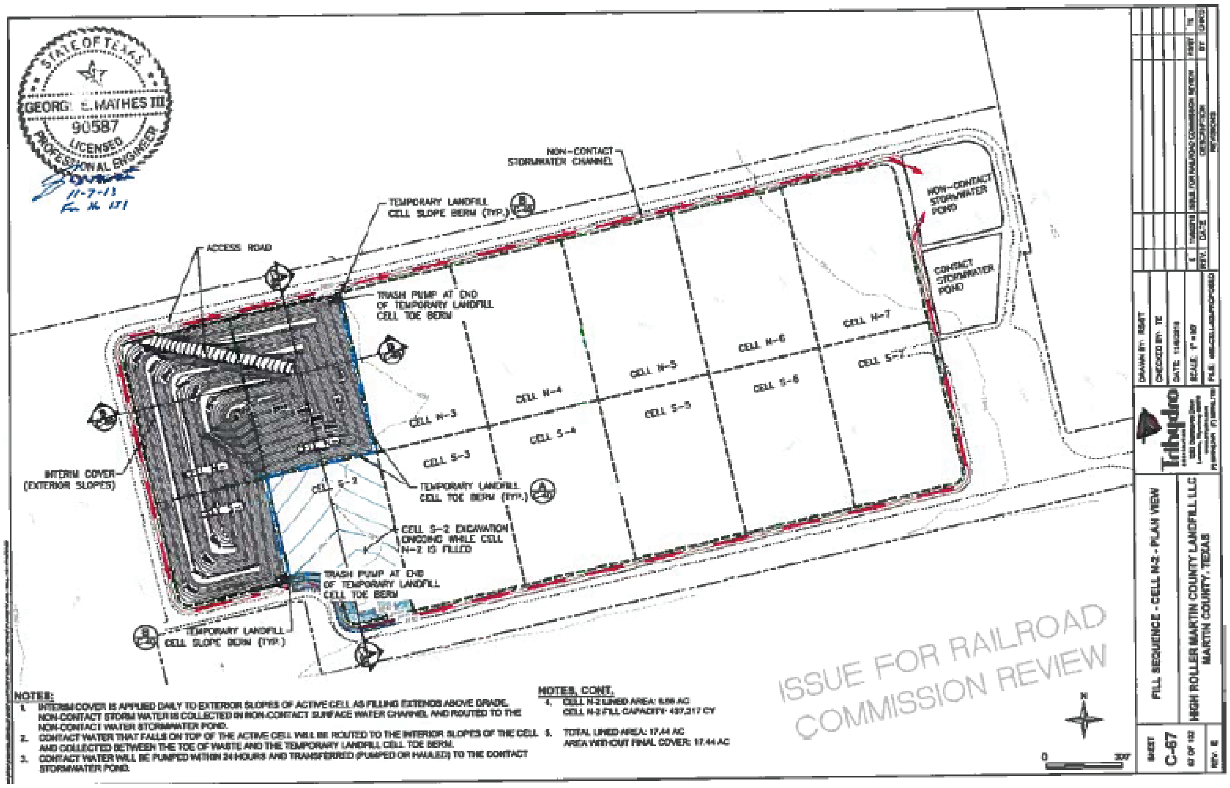
The temporary toe berm between Cells N-1 and S-1 is removed and the liner systems for the two cells are welded together. The waste in the cells reach final grade with interim cover.[314]



When three cells are filled and another needs to be constructed, there will be a corner where the interim slopes of three cells meet and open to a newly constructed cell, and the different slopes intersect at different elevations.[315] The single lined landfill cell temporary toe berm will used on the interior slopes for that corner.[316]

[314] Applicant Ex. 4 at C-65.
[315] Applicant Ex. 4 at C-67; Tr. Vol 6 at 34:20-35:1
[316] Tr. Vol 6 at 35:10-17.

Cells N-1, S-1, and N-2 have reached final grade with interim slopes facing the new cell to be constructed, Cell S-2. Precipitation runoff will collect from the interim slopes of the three cells in the interior temporary toe berm.



Mr. Schreuder testified that the waste will be surveyed and the operator will utilize AutoCAD to calculate the volume of waste between the bottom of the pit and the top of the waste.[317] The bottom of the landfill is not flat and slopes in various directions, and the landfill top is not perfectly flat, so AutoCAD will be utilized to calculate total height of the waste.[318] The volume within each cell is reported to the Commission, and at the five-year renewal, the Commission will be able to estimate how much longer the landfill will remain operational.[319] Mr. Schreuder admits it would be difficult for a Commission inspector to estimate the amount of waste in each cell, and the only way to determine volumes would be to request a survey.[320] The survey must be performed at least every five-years.[321]

Mr. Schreuder testified that the cells will be excavated using bulldozers, excavators, and scrapers for bulk soil removal.[322] The new cell will be excavated to grade up two percent to meet the edge of the previous cell, and the liners will then be welded together.[323] The operator will begin filling waste into the cell on the edge with the previous cell's waste where it is piled with a 4:1 slope.[324] The closed cell will have one foot of

[317] Tr. Vol. 5 at 102:1-18; Tr. Vol. 5 at 103:1-2.
[318] Tr. Vol. 9 at 139:14-140:3.
[319] Tr. Vol. 5 at 105:21-25.
[320] Tr. Vol. 5 at 105:1-14.
[321] Tr. Vol. 5 at 105:15-106:10.
[322] Tr. Vol. 5 at 188:11-17.
[323] Tr. Vol. 5 at 189:7-13.
[324] Tr. Vol. 5 at 191:15-19.

interim cover with a permeability of $1x10^{-7}$ cm/sec for up to a year, to allow the next cell to be operational.[325]

Mr. Schreuder stated that within a year of a cell reaching capacity, interim cover will be placed over the cell, and a 40-mil HDPE geomembrane will be installed with liner testing and a leak location survey will be performed.[326] Twelve-inches of clean soil will be compacted to 95 percent of standard proctor with a permeability specification of $1x10^{-7}$ cm/sec placed as interim cover immediately on top of waste when it reaches final grade.[327] A geocomposite will be placed above the geomembrane then 18-inches of protective soils will be placed on top that will be graded and reseeded.[328] The final cover system is done on a cell-by-cell basis.[329] The primary geomembrane cover is welded and tested to verify that they it is not leaking and a leak location survey is performed.[330] The geocomposite allows the soil to drain over the impermeable HDPE liner.[331] The top of the landfill is sloped to allow excess precipitation to run off the facility rather than soak in.[332] The 18-inch soil layer is deep enough to provide adequate rooting depth for native plants.[333]

The outside of the landfill slopes down and has benches to slow down runoff to prevent erosion.[334] The one-foot thick interim cover on the cells is to prevent precipitation from contacting waste until final cover is applied.[335] Mr. Schreuder testified that the water from the interim cover becomes non-contact stormwater and that water flows via channels to the non-contact stormwater pond.[336]

The filled cells that have reached final grade and do not border an active cell will be topped with the final cover with the 40-mil HDPE liner. Cells adjacent to active cells will be filled to final grade in some areas and will have interim slopes facing the adjacent active. Interim soil will be placed on top of the waste and the interim slopes in these cells. The interim slopes end at the temporary landfill cell berm.[337]

Mr. Schreuder conceded in cross examination, that the temporary toe berms do not necessarily have the volumetric capacity to contain the water from a 25-year, 24-hour storm fall event, but will utilize pumps to remove water in the berms to prevent the berms from overflowing.[338]

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[325] Tr. Vol. 5 at 192:191:25-192:6.
[326] Applicant Ex. 24A, HR000554; Tr. Vol. 5 at 165:2-13.
[327] Tr. Vol. 5 at 166:17-25.
[328] Tr. Vol. 5 at 165:14-17.
[329] Tr. Vol. 5 at 165:19-22.
[330] Tr. Vol. 5 at 170:18-25.
[331] Tr. Vol. 5 at 171:8-18.
[332] Tr. Vol. 5 at 171:22-172:3.
[333] Tr. Vol. 5 at 172:4-11.
[334] Tr. Vol 8 at 35:11-17.
[335] Tr. Vol 8 at 36:10-16.
[336] Tr. Vol 8 at 36:17-22.
[337] Tr. Vol 6 at 68:16-72:15
[338] Tr. Vol. 2 at 129:20-130:4.

c. Geosynthetic Clay Liner

Mr. Schreuder testified that based on the subsurface investigation, Trihydro included a GCL in its design due to no clay material below the site.[339] He further stated that HR Martin is substituting natural impermeable material with manufactured relatively impermeable material.[340] Mr. Schreuder stated that the GCL has equivalent characteristics as two foot of natural clay, which meets the Commission's guidance for an unlined pit.[341]

Mr. Schreuder testified that the Application has material specifications for the GCL and an installation quality assurance manual.[342] The industry standard for permeability is $1x10^{-7}$ cm/sec.[343] The GCL is manufactured with processed bentonite that has had impurities and imperfections removed.[344] The GCL has a fabric layer, followed by a plastic film to maintain the clay's moisture content, the clay, another layer of plastic, and another layer of fabric.[345] The materials are sewn together and rolled up in 15 by 100 foot long rolls that are transported in plastic to protect the GCL from sun or temperature changes.[346] The surface on which the GCL will be installed is a smooth surface with sharp objects removed.[347] The rolls are laid flat down the slope of the landfill.[348] The next roll is laid next to the previous roll and before the GCL's overlap, a strip of powdered bentonite is placed on the overlap seam to a width of 6 to 12 inches, then the adjacent overlapping roll is placed on top of that seam area to create a seal.[349] The bentonite powder is not hydrated upon installation, because if water gets to it, it will hydrate naturally and seal horizontally.[350] When the GCL is installed per the manufacturer's instruction, it has a permeability of $5x10^{-9}$ cm/sec.[351]

d. Leachate Collection System and Leak Detection System

Mr. Schreuder testified that leachate is any fluid that has contacted waste whether it is from precipitation or from the waste.[352] Above the liner system is a 200-mil geocompsite that comprises the LCS, which collects any liquid that accumulates at the bottom of a pit.[353] The geocomposite consists of a geonet that is heat welded to a geofabric.[354] It is constructed so the net is not rubbing against the solid plastic and provides friction to keep it in place and the top geofabric prevents overlying soil from filling

339 Tr. Vol. 2 at 92:25-93:5.
340 Applicant Ex. 28 at HR014866; Tr. Vol. 2 at 94:12-23.
341 Tr. Vol. 2 at 95:16-21. Tr. Vol. 2 at 180:6-9.
342 Tr. Vol. 2 at 172:7-10.
343 Tr. Vol. 2 at 174:17-21.
344 Tr. Vol. 2 at 174:22-175:5.
345 Tr. Vol. 2 at 175:12-20.
346 Tr. Vol. 2 at 175:21-176:12.
347 Tr. Vol. 2 at 176:13-17.
348 Tr. Vol. 2 at 176:18-24.
349 Tr. Vol. 2 at 176:25-177:9.
350 Tr. Vol. 2 at 176:25-177:9.
351 Tr. Vol. 2 at 177:10-22.
352 Tr. Vol. 2 at 180:20-181:1.
353 Tr. Vol. 2 at 196:10-19; Tr. Vol. 2 at 197:8-13.
354 Tr. Vol. 2 at 196:10-19.

the holes of the geonet.[355] When the rain falls in the active cell, the rain will go down the slope of the waste and collect at a berm with the primary liner covering the berm.[356] According to Mr. Schreuder, any liquid, including stormwater runoff or liquids in waste, is routed through the geonet to the LCS sump where it is detected and removed.[357]

In the truck washout pad, two receiving pits, landfill cell, and contact stormwater pond, a LDS is designed between the primary and secondary 60-mil HDPE liners.[358] The LDS is the 200-mil permeable geonet is installed between the two 60-mil HDPE liners and allows liquids that leak through the 60-mil HDPE primary liner to flow above the 60-mil HDPE secondary liner to a sump at the bottom of the pit where it can be detected and removed.[359]

In the sump for each pit there are two pipes, one for the LDS and one for the LCS.[360] There are two layers in the sump, each two feet thick filled with coarse rock where the perforated pipe for each system is located.[361] If there is over one foot of water accumulating in the sump, the water will be removed.[362] The primary liner will separate the water in the sump that is collected in the LCS and the LDS.[363] The LCS and LDS are different systems with different pipe to do detection and removal.[364]

George Mathes testified that the leak detection pipe is not expected to have any liquid whereas the leachate collection pipe is expected to handle more volume particularly when the cells are first being operated and filled as there will be more leachate. He testified as the interim cover and final cover is placed upon the waste there is no way for water to enter the system. Therefore, less water will be coming out of the bottom.[365]

Mr. Schreuder described that as the cells close and there are rainfall events, the water that collects in the LCS or LDS should flow towards the active cells due to the overall west to east grade of the facility.[366]

i. Action Leakage Rate

Mr. Schreuder testified that under Commission rules, the primary liner can have a small amount of leakage, but once it exceeds the action leakage rate, rules and regulations require the operator to notify the Commission and take corrective measures to identify and repair the leak or close the cell.[367]

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355 Tr. Vol. 2 at 196:10-19.
356 Tr. Vol. 5 at 218:3-14.
357 Tr. Vol. 2 at 198:18-24. Tr. Vol. 5 at 210:18-23.
358 Tr. Vol. 2 at 181:7-20; Tr. Vol. 2 at 182:6-23.
359 Tr. Vol. 2 at 182:12-183:4.
360 Tr. Vol. 2 at 198:25-199:4.
361 Tr. Vol. 2 at 199:14-18.
362 Tr. Vol. 2 at 199:19-200:3.
363 Tr. Vol. 2 at 200:17-201:4.
364 Tr. Vol. 2 at 201:6-17.
365 Tr. Vol. 5 at 41:19 to 42:10; Applicant Exhibit No. 4.
366 Tr. Vol. 5 at 208:6-209:3.
367 Tr. Vol. 2 at 195:23-11.

The action leakage rate for the landfill cells is 100 gallon per acre per day ("GAPD"). Each cell is approximately 6.5 acres, therefore the action leakage rate for one cell would be approximately 650 gallons per day. This would be the leakage through the primary liner.[368]

The federal standard for pits that store liquids is 1,000 GAPD, because the head on the primary liner would be greater for a pit designed to hold liquids.[369] The action leakage rate for the 0.8-acre stormwater ponds is 800 GAPD for each pit.[370] The action leakage rate for the receiving pits is 1,600 GAPD for each pit.[371]

When the leakage system reaches one foot of head on the sump, the water is pumped out and will be sent to a tank or directly to the contact stormwater pond.[372] The pump is computerized and records all the pump cycles and the data associated with it.[373]

In response to liner failure, the draft permit shows, "After inspection, the identified failure component must be replaced or repaired and re-inspected by RRC personnel before resuming use of the pit."[374] Mr. Schreuder testified if a leak is detected, the leak will get repaired or the operator would be required to close the pit and increase monitoring and inspection activities.[375]

e. Leakage Calculations

Jeff Fassett is a geotechnical engineer with Golder & Associates, an earth science company.[376] The focus of Mr. Fassett's career has primarily been related to waste containment systems for mines, industrial plants, coal-fired powerplants, and landfills. He testified he worked for Golder & Associates for approximately 30 years.[377] Mr. Fassett testified that approximately 80 percent of his work has involved landfills.[378]

Mr. Fassett testified the LCS is an important component of landfill design. It is important to ensure that the system functions adequately initially and through the life of the facility. The design must be able to handle the different rates and variations in liquid generation rates throughout the life of the site.[379] He stated the LDS is an effective means of controlling liquid leakage through the bottom of a liner system because it maintains a very small liquid head over the secondary containment liner, and the head determines the amount of leakage.[380]

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[368] Tr. Vol. 10 at 117:16-22.
[369] Tr. Vol. 10 at 133:9-21; 139:1-2.
[370] Applicant Ex. 31 at HR015646.
[371] Applicant Ex. 31 at HR015644.
[372] Tr. Vol. 10 at 117:23-118:11.
[373] Tr. Vol. 10 at 118:12-19.
[374] Applicant Ex. 31 at HR015644; Tr. Vol. 5 at 160:21-161:21.
[375] Tr. Vol. 10 at 119:5-19.
[376] Tr. Vol. 8 at 63:1-63:6.
[377] Tr. Vol. 8 at 63:17-63:22.
[378] Tr. Vol. 8 at 64:24-65:3.
[379] Tr. Vol. 8 at 65:21-66:6.
[380] Tr. Vol. 8 at 66:7-66:15.

Mr. Fassett stated that for this project he used a modeling method and an empirical analytical method. The modeling method, known as the Hydrologic Evaluation of Landfill Performance model ("HELP model") was developed specifically to compare different liner systems.[381]

The second methodology, the engineering analysis known as the Giroud method, was developed to analyze leakage through composite liner systems.[382] A composite liner system consists of a geomembrane and a soil component.[383]

Mr. Fassett stated that the testimony of Mr. Schreuder was consistent with the engineering plans and the Application which he reviewed.[384] He concluded that although he and Mr. Schreuder used some different assumptions, they came to the same conclusions that leakage through a double liner system was very small. Mr. Fassett used less conservative assumptions and therefore his leakage rate calculation was not as high as the leakage rate reported in the Application.[385] Specifically, the maximum value was 30 times less than the value reported by Mr. Schreuder.[386] Mr. Fassett testified that whereas Mr. Schreuder calculated a hypothetical 0.9 gallons over an approximate 20-acre area representing three active cells, he calculated four ounces over the same area.[387] Jeff Fassett stated the calculations confirm that double liner systems are very effective at controlling leakage.[388]

The HELP model tracks liquid migration through the waste into the LCS, through the primary liner and the secondary liner. Mr. Fassett testified that per the HELP model, the estimated peak leakage rate through the secondary liner system over the 20-year simulation is 2.2 $x10^{-4}$ gallons per acre per day ("GPAD").

Mr. Fassett testified that the Giroud method is the industry standard for calculating or estimating the leakage through a composite liner system. It calculates the flow of head through a defect under Darcy's law.

Mr. Fassett applied two different assumptions for contact in the Giroud method. The first assumption used the head modeled in the HELP model and the second assumption assumed that the entire LDS was full of water and at capacity. He testified they also considered good contact in comparison poor contact with the leak detection layer. The scenario for good contact resulted in a leakage rate of 2.6 $x10^{-5}$ GPAD, while the poor contact scenario resulted in $1.5x10^{-3}$ GPAD. Both of those figures were less than what Mr. Schreuder used in his calculations.

[381] Tr. Vol. 8 at 67:20-68:24.
[382] Tr. Vol. 8 at 69:6-69:19.
[383] Tr. Vol. 8 at 69:19-69:22.
[384] Tr. Vol. 8 at 69:23-70:15.
[385] Tr. Vol. 8 at 70:16-71:9.
[386] Tr. Vol. 8 at 71:15-71:21.
[387] Tr. Vol. 8 at 71:22-72:25.
[388] Tr. Vol. 8 at 73:2-73:6.

Mr. Schreuder's performance assessment on the liner system focused on the secondary HDPE liner to evaluate the potential for leakage.[389] He calculated how much leakage could occur out of the secondary liner through the clay material underneath to be released into the environment.[390] Mr. Schreuder testified that he used in the equation a defect rate of one defect per an acre, and one-foot of head that could collect in the sumps of the landfill.[391] To be conservative, he estimated the leakage rate at the sump could occur over the entire facility, which realistically could not happen with a 3:1 slope.[392] Mr. Schreuder assumed the leakage rate at the sump with one foot of head, and applied that to the entire active cell.[393] He testified that he also assumed one cell is open, and two cells are filled, but uncapped.[394] Mr. Schreuder stated that once a cell is capped, the leakage rate drops off quickly, and will eventually be going to zero.[395]

Each landfill cell will have its own sump and LDS.[396] Mr. Schreuder's testified that his assumptions are conservative and show a greater amount of leakage than what is expected.[397] His calculations show the amount of fluid is less than six ounces per an acre of the landfill, which totals less than one gallon per day, 115 ounces, if the three open cells were leaking at one time.[398] Based on construction, quality assurance measures, that much leakage is unlikely to occur.[399] He further stated that the fluid would not necessarily make it to the water table, due to the waste drying up in the cells and not leaking as much or at all, and the liquid would have to go through 35 feet of low permeability subsurface material.[400]

f. Liner Testing

Mr. Schreuder testified that the 60-mil HDPE liner is the "gold standard in either pond liner or landfill liner material."[401] The liner is transported in large rolls that will be installed by being manually laid down the slope to the bottom of the facility, then the rolls of liner will be overlapped and welded together.[402] Mr. Schreuder testified that the welded seams will be tested by cutting out patches or "coupons" of welded strips and testing them for strength by pulling the seams apart.[403] Further the seams are tested by adding soapy water to the seams and using a vacuum box to see if there are any bubbles indicating leaks in the seams.[404] Mr. Schreuder assured that this test will be done on all of the seams.[405] The liners are also tested using a leak location survey where the operator

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[389] Tr. Vol. 3 at 10:8-12; Tr. Vol. 3 at 11:1-4.
[390] Tr. Vol. 3 at 16:11-14.
[391] Tr. Vol. 3 at 12:14-13:8.
[392] Tr. Vol. 3 at 13:9-13.
[393] Tr. Vol. 3 at 13:19-24.
[394] Tr. Vol. 3 at 13:24-14:5.
[395] Tr. Vol. 3 at 14:10-15:8.
[396] Tr. Vol. 3 at 15:12-15.
[397] Tr. Vol. 3 at 15:22-16:8.
[398] Tr. Vol. 3 at 16:16-17:10.
[399] Tr. Vol. 3 at 17:13-18.
[400] Tr. Vol. 3 at 17:24-18:12.
[401] Tr. Vol. 2 at 185:17-22.
[402] Tr. Vol. 2 at 186:11-24.
[403] Tr. Vol. 2 at 187:13-24.
[404] Tr. Vol. 2 at 187:25-188:13.
[405] Tr. Vol. 9 at 209:3-210:1.

detects electrical conductivity between the top and the bottom.[406] The leak location survey will be done every time the liner material is installed.[407]

g. Monitoring

Mr. Schreuder testified that the waste manifest, records of daily and monthly inspections, weekly inspections of LCS and LDS, and groundwater monitoring records will be maintained by the operator.[408]

Mr. Schreuder testified the operator of the facility would be responsible for inspections and according to Mr. Schreuder, the operator would be required to inspect all active portions of the facility on a daily basis, and "report any releases, equipment failures, damage, or other problems that could pose a safety hazard, impact operations or threaten the environment."[409] The monthly inspection checklist includes the perimeter fence, stormwater ditches and berms, internal access roads, culverts, components of stormwater system, both contact and non-contact, inspecting the drying areas, the truck washout, and the landfill, and the proactive layers in the bottom of the cells, intermediate cover that been applied, or final cover that has already been applied.[410] Any oil accumulating on the contact stormwater pond must be removed.[411]

According to Mr. Schreuder, the operator will monitor the sump in the LCS of each pit once per a week and after any major storm event, and pump water if it accumulates over one foot. The pumped water will be placed in the contact stormwater pond or disposed of offsite. [412] The LDS will also be monitored weekly for all units with a LDS, and if more than one foot of water volume is in the LDS, and the water is removed.[413] The drying pads do not have a LDS, only a LCS.[414] The contact stormwater ponds, the receiving pits, truck wash pad, and the landfill all have a LDS with action leakage rates.[415] The contact stormwater ponds and receiving pits have higher action leakage rates because those pits will hold liquids.[416]

According to Mr. Schreuder, groundwater monitoring wells GW-1 through GW-7 will be monitored quarterly, and monitoring will include measuring the static water level, total well depth, pH, temperature, and conductivity; and collecting groundwater samples for laboratory analysis.[417] The information collected during monitoring would be compared to baseline values.[418]

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[406] Tr. Vol. 2 at 188:24-189:11.
[407] Tr. Vol. 2 at 189:18-24.
[408] Applicant Ex. 24A, HR000554; Tr. Vol. 5 at 164:2-10.
[409] Applicant Ex. 24A at HR000551.
[410] Applicant Ex. 24A at HR00551; Tr. Vol. 5 at 147:13-22.
[411] Tr. Vol. 5 at 147:23-148:5.
[412] Tr. Vol. 5 at 148:16-23. Tr. Vol. 5 at 149:24-149:5.
[413] Tr. Vol. 5 at 149:9-20.
[414] Tr. Vol. 5 at 150:3-7.
[415] Tr. Vol. 5 at 150:15-24.
[416] Tr. Vol. 5 at 150:25-151:4.
[417] Tr. Vol. 5 at 163:7-16.
[418] Tr. Vol. 5 at 163:20-23.

Mr. Schreuder testified the operator of the facility must continuously survey the waste in the cells to ensure final grade is not exceeded.[419] The permit states the permittee must retain a record of the volume of waste material received in the units, and requires a report to be submitted to Commission with the volume of waste received during each quarter.[420] The main way the operator determines the volume of waste in a pit is by conducting a survey and comparing it to a survey done the previous quarter.[421] Mr. Schreuder testified that the permit states that a new cell cannot be constructed until the previous cell is approaching final grade.[422]

h. Facility Closure

Prior to closing the landfill, any solid waste in the drying pads, truck washout, and receiving pits will be allowed to dry then will be removed and disposed in the landfill. The liner systems and six inches of underlying soil will be removed. The soil under the excavation will be tested and compared to closure limits. The excavated area will be backfilled to original grade and reseeded.[423] The receiving pits are in the last landfill cell to be constructed and filled, Cell S-1, so the receiving pits will be closed prior to Cell S-7 being constructed.[424]

Mr. Schreuder testified that when the landfill is completely closed and capped, there should be no more contact stormwater runoff. The only water in the contact stormwater pond would be liquids removed from the LCS or LDS.[425] The contact stormwater pond will be closed in conjunction with the closure of the landfill and any waste in the ponds will be removed and disposed in a permitted facility. [426]

The soil below the six-inch removed layer will be tested and compared with closure standards set by the Commission. If there is contamination, the contaminated soils will be removed until clean soil in encountered.[427] Once excavation is completed, the ponds will be backfilled with clean soil back to original grade.[428]

Mr. Schreuder stated the life of the landfill is estimated to be 20 to 25 years or until the landfill reaches capacity.[429] The landfill permit is required to be renewed every five years by the Commission, and as part of the reporting requirements, the operator must report how much capacity has been used and the estimated life of facility.[430]

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[419] Tr. Vol. 5 at 194:10-19.
[420] Tr. Vol. 5 at 196:7-13; Tr. Vol. 5 at 197:9-21.
[421] Tr. Vol. 5 at 197:22-198:1.
[422] Tr. Vol. 5 at 201:5-13.
[423] Tr. Vol. 5 at 175:16-177:4.
[424] Tr. Vol. 5 at 177:5-8.
[425] Tr. Vol. 5 at 173:19-24.
[426] Tr. Vol. 5 at 173:25-174:10.
[427] Tr. Vol. 5 at 174:18-24.
[428] Tr. Vol. 5 at 174:25-175:2.
[429] Tr. Vol. 2 at 153:9-12.
[430] Tr. Vol. 2 at 153:16-25.

Mr. Schreuder testified that the non-contact stormwater pond will be maintained after closure and throughout the post-closure period, because it will be used to contain runoff from the closed facility.[431]

i. Post-Closure Monitoring

After closure, the non-contact stormwater pond in the northeast corner of the facility will remain active.[432] Mr. Schreuder testified that closing the landfill cells involves the waste reaching final grade with one foot of interim cover, and on top of the interim cover, the liner and drainage net are put in place, covered by 18 inches of soil.[433] Mr. Mathes testified that the 4:1 side slope of the final placed waste material and cover system is appropriate in terms of not sloughing or not sliding down. He performed calculations of the slope under static and dynamic conditions, such as a potential seismic event, and found the slope to be suitable. The soil on top of the landfill will be revegetated.[434]

When the landfill is closed, the operator must perform a minimum of five-year post closure monitoring and care of the facility. [435] The post-closure period can be renewed by the Commission until the site has stabilized and there is no longer the threat of pollution.[436] Mr. Schreuder testified that post closure monitoring involves performing inspections of the facility, removing any leachate from the LCS or LDS, and conducting groundwater monitoring.[437]

Post-closure reporting requirements include the results of quarterly facility inspections, LCS monitoring, LDS monitoring, and groundwater monitoring. Mr. Schreuder testified that the LCS will be operational during post closure, and will be monitored quarterly, and any leachate in the system will be removed.[438] The LDS will also be monitored quarterly through the post-closure period and liquids in the LDS will be compared to the action leakage rate.[439] Groundwater will also be monitored throughout post-closure on a quarterly basis.[440]

j. Financial Security

Mr. Schreuder testified the operator is required to post financial security for facilities in the event that the operator is unwilling or unable to properly close the facility or maintain post-closure activities.[441] HR Martin developed the Closure Cost Estimate for the worst-case scenario, the most expensive point during the operation of the facility, and calculated what the cost would be to close the facility.[442] Mr. Schreuder stated that it also

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[431] Tr. Vol. 5 at 175:6-9.
[432] Tr. Vol 8 at 42:20-42:15.
[433] Tr. Vol 8 at 48:18-23.
[434] Tr. Vol 8 at 48:18-23.
[435] Exhibit 24A, Section 11.0-11.3; Tr. Vol 8 at 49:3-17.
[436] Tr. Vol 8 at 49:3-17.
[437] Tr. Vol 8 at 49:3-17.
[438] Applicant Ex. 24A at HR000559; Tr. Vol 8 at 52:6-16.
[439] Applicant Ex. 24A at HR000559; Tr. Vol 8 at 52:19-53:4.
[440] Applicant Ex. 24A at HR000559; Tr. Vol. 8 at 53:5-13.
[441] Tr. Vol. 8 at 55:12-17.
[442] Tr. Vol. 8 at 55:18-25.

included a 10 percent contingency for the costs for post-closure.[443] He testified that the Commission requires the money upfront in case something goes wrong.[444] He stated that the Closure Cost Estimate was developed in conjunction with input from Staff based on tasks or activities that would need to be completed at closure and during post-closure.[445] The sum of the closure costs is approximately $5.6 million with post closure costs being approximately $400,000.[446] The closure costs of approximately $6 million are included in the draft permit.[447] Once closure is complete, $5.6 million is released back to the operator, but approximately $400,000 in financial security would remain for the post-closure period.[448]

k. Similar Facilities and Permit Requirements

Pat Behling, a registered professional engineer, testified as a consultant for HR Martin. He is employed by Golder and Associates. Golder and Associates is an environmental consulting firm that specializes in environmental engineering and geology. He has been an environmental consultant for 35 years. He has been a consultant regarding oil and gas stationary treatment facility permitting and design for the last eight years. He testified that he has in the past worked on seven applications for the Commission for similar stationary treatment facilities that have disposal pits and receiving pits and similar operations as that of the proposed landfill. All seven applications were approved. Six have been constructed, and he believes five of those are in operation. Two of the seven applications were approved after a hearing. Mr. Behling was hired by HR Martin to evaluate the proposed facility regarding its consistency with the previous permits he has worked on and Commission requirements.[449] He was retained after the Application was submitted to the Commission, approximately six months prior to him testifying, and did not participate in the processing of this Application.[450]

Mr. Behling testified he researched a geographical review of the similar facilities within a hundred miles of the proposed landfill as well as the previous permits he has worked on. He provided a map showing permitted facilities within a hundred-mile radius of the proposed landfill and permitted facilities he had worked on. There are 18 facilities on the map. Five of the facilities are facilities he worked on, three of which are outside the hundred-mile radius but were shown on the map.[451] Mr. Behling provided a table summarizing some of engineering characteristics of the 18 facilities that he reviewed. For each of the 18 facilities, he compared the permit for the facility to the permit requirements of the proposed landfill. He looked at liner design, closure design and the closure cost estimate, which he stated he believed were the key engineering parameters for a disposal design. He characterized the lining system of the proposed landfill starting from the bottom layer as having:

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[443] Tr. Vol. 8 at 56:1-8.
[444] Tr. Vol. 8 at 56:9-13.
[445] Tr. Vol. 8 at 57:12-23; Tr. Vol. 8 at 58:7-19.
[446] Tr. Vol. 8 at 58:20-59:4.
[447] Applicant Ex. 31 at HR015634; Tr. Vol. 8 at 59:5-8.
[448] Tr. Vol. 8 at 59:9-21.
[449] Tr. Vol. 7 at 40:5 to 44:4; Applicant Ex. 66.
[450] Tr. Vol. 7 at 81:15 to 82:4.
[451] Tr. Vol. 7 at 44:5 to 46:19; Applicant Ex. 67.

1. A prepared subgrade;
2. A geosynthetic clay liner, which he stated is a bentonite liner designed to swell and seal upon getting wet;
3. A 60-mil high-density polyethylene liner;
4. A geonet, which is a leak detection system;
5. A second 60-mil high-density polyethylene liner;
6. A leachate collection system; and
7. A layer of protective soil to prevent damage to the liner when waste is placed in the pit.

He testified that the liner system for the proposed facility is consistent with most of the liner systems of the 18 facilities he reviewed. He testified it is a superior system compared to two of the 18. He testified it is "extremely unlikely" that liquid waste will penetrate the liner system and into an underlying natural formation. He testified that the closure proposed for each individual cell of the proposed landfill is consistent with what the Commission requires for these types of facilities. He stated the Closure Cost Estimate, which is the financial assurance required to be submitted to the Commission prior to operating the facility, is approximately $6 million, which is higher than many of the other facilities that he reviewed. He testified the Commission issues these types of permits on a five-year cycle. The Commission will reissue the permit continually even after the facility is closed. Monitoring requirements are included in these types of permits. He stated that there is not a defined time for post-closure monitoring to be completed, but a typical rule of thumb is 30 years at a minimum, which he opined in his experience perpetuity is equivalent to 30 years. He has not seen any facilities similar to the proposed landfill in which the post-closure monitoring has been completed. He noted that the facilities he has reviewed are not that old. In his professional experience, the Application should be approved. He further testified that it is his opinion that if there were no protest of the Application, it would have already been approved administratively because Commission staff has issued a draft permit.[452]

During cross-examination, Mr. Behling clarified that his opinion regarding whether or not the Application should be approved is based on the fact that he believes it is consistent with other permits issued by the Commission. He did not review the applications of the facilities he reviewed or the subsurface review. His focus was on the engineering design as reflected in the permits.[453]

Mr. Behling testified that in his experience Staff prefers sites to be in areas without shallow groundwater; a site that does not have groundwater within a hundred feet is preferred. Secondly, Staff prefers that there be a layer of low permeability under the proposed site to protect the groundwater. He clarified that there is no prohibition on placing a facility in an area with shallow groundwater and without a confining layer protecting the groundwater.[454] It is his opinion that there are engineering solutions for

[452] Tr. Vol. 7 at 46:21 to 61:18; Applicant Ex. 68.
[453] Tr. Vol. 7 at 82:5 to 84:1.
[454] Tr. Vol. 7 at 104:19 to 106:10.

situations when there is shallow groundwater present with no confining layer above it.[455] He agrees Commission guidance provides that pits in the outcrop of major and minor aquifers need much more critical review than other permit applications; whenever dealing with a major aquifer in particular that a more strict or closer review of the application is necessary to ensure that that water is protected.[456]

Mr. Behling provided a map showing the location of the 18 facilities he studied in relation to aquifers. He opined that 15 or 16, depending how you interpret the map, are located over major aquifers. He qualified that he is not a geologist and got the information about the aquifers from publicly available information from the Texas Water Development Board.[457] He acknowledged that some of the facilities do not have groundwater monitoring, which indicates there is not groundwater identified within at least one hundred feet of depth.[458]

Mr. Behling testified that he knows of no other facility that has as many as 14 cells, such as the proposed facility. He believes seven is the most he has seen. Some are as large as the proposed landfill but will fewer cells. He testified that in the permits he is familiar with there would not be four cells open at once; he has not been involved in any permit cell design like the proposed landfill, with four cells being open at a time and two exposed toe berms.[459]

Mr. Behling testified that the newer facilities have sequential placement of cells, but he is not familiar with how the cells are separated from each other. He does recall that one of the permits he worked on did have engineered berms in between the cells that did not extend to the full height of the landfill. There were still open faces of waste that came into contact with each of the cells as the construction and filling progressed.[460] He testified the purpose of the berm is to provide a clean line of separation and ease the process of attaching the liner system for the subsequent cell construction. He stated that such a berm would assist to confine potential rainwater to a particular cell thus making it easier to locate a leak, should one occur; that is why the berms are included. He did not evaluate the intermediate berms or interim process of closing cells and does not know if the permits he reviewed had intermediate berms or other mechanisms to contain rainwater or provide a line of separation between cells.[461]

Mr. Behling testified that the permits do not specify what GCL is required; the permit just states one is required. He stated that which GCL is being used is important based on the type of waste involved. For example, some GCLs do not perform well when exposed to saltwater or brine. He stated a GCL is typically ½ to ¼ inch thick. He further testified that it is equivalent to two feet of compacted clay. He stated the engineering definition of an impermeable clay is $1x10^{-7}$ cm/sec. The permeability of a GCL once it is

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[455] Tr. Vol. 7 at 111:20 to 111:23.
[456] Tr. Vol. 7 at 139:8 to 139:18; Applicant Ex. 69 at 14.
[457] Tr. Vol. 7 at 124:9 to 125:23; Applicant Ex. 76.
[458] Tr. Vol. 7 at 141:16 to 149:16.
[459] Tr. Vol. 7 at 149:1 to 151:12.
[460] Tr. Vol. 7 at 106:11 to 107:6.
[461] Tr. Vol. 7 at 126:12 to 127:18.

activated is 1x10^{-9} or 1x10^{-10} cm/sec; it is much thinner but less permeable. He agrees that it should be required to have a GCL suitable for the waste at issue; he stated that there are GCLs suitable for the waste to be placed in the proposed landfill.[462]

Mr. Behling testified that he has never artificially hydrated a GCL. He stated that typically GCL hydration comes from the underlying soils or overtopping soils if it is in a cap. Then a HDPE liner over the GCL retains the moisture in the GCL. He opined that desiccation cracks are not going to occur in a properly installed GCL with the liner on top of it.[463] He also testified that placing weight or load on top of the GCL will not damage the GCL. He further stated that hundreds of feet of waste can be placed on top of GCLs, and there are established procedures from the liner manufacturers to calculate the stresses and what is acceptable and not for a GCL.[464]

Mr. Behling testified that a stormwater pollution and prevention plan ("SWPPP") is a required part of the draft permit in this case. He testified that the SWPPP is a best management practice plan that addresses things like minor spills, dirt from trucks, and other similar spills, to maintain the integrity of the noncontact water at the site. He explained further that during an operation of any disposal pit facility there is the possibility of pieces of waste, leaking engines from a truck, and other such things that if left unattended could potentially cause contamination of stormwater if it rains. The SWPPP requires regular inspections of the facility. If facility personnel notice any type of waste material outside disposal pits or the receiving pits or any vehicular debris, they are responsible for noting it and cleaning it up. There is also a spill prevention control and countermeasure plan. Both plans are requirements that would be in the permit for the proposed landfill.[465]

B. Summary of the Mabee Protestants' Position

The Mabee Protestants assert that the landfill site is over the Ogallala Aquifer recharge zone, and there is no impermeable naturally occurring barrier between the bottom of the landfill and the groundwater beneath the proposed landfill's location.

a. Landowner's Concerns

John W. Mabee is a protestant and the landowner of the 69,000-acre Mabee Ranch. The southern border of the property is approximately 9.5 or 10 miles north of Midland.[466] Mr. Mabee, his brother Joe "Guy" Mabee, and the Mabee Foundation are owners of the Mabee Ranch. John and Guy Mabee are the Mabee Protestants. The Mabee Foundation is not included in the protest.[467] John Mabee and Guy Mabee are life

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[462] Tr. Vol. 7 at 107:15 to 110:9; 122:13 to 123:24.
[463] Tr. Vol. 7 at 117:24 to 119:5.
[464] Tr. Vol. 7 at 122:2 to 122:22.
[465] Tr. Vol. 7 at 119:6 to 121:8.
[466] Tr. Vol. 3 at 209:8 to 209:9.
[467] Tr. Vol. 3 at 213:14 to 214:9.

tenants on the surface and the final remainderman of the Mabee Ranch is the Mabee Foundation.[468]

The Mabee Ranch borders the proposed landfill site on its southern border and western border. There are other properties between the northern border of the proposed site and the Mabee Ranch.[469] The primary uses of the Mabee Ranch are for running Red Angus cattle and for oil and gas.[470] There is an airport on the ranch and the landing strip is approximately one mile west of the border of the proposed landfill.[471] John Mabee testified that the proposed landfill site used to be farmland before HR Martin purchased the property.[472] To the east of the proposed landfill site is farmland as indicated by crop circles.[473]

There are approximately 53 windmills on the Mabee Ranch used for running water wells for livestock and there are approximately 300 other water wells in various places throughout for agriculture use, oil and gas development, household irrigation use, and human consumption.[474] The water wells are completed at depths between approximately 80 to 140 feet. Mr. Mabee testified the water wells draw from the Ogallala Aquifer.[475]

Mr. Mabee testified that when the house on the ranch was built approximately 30 years ago the water was tested and met the applicable TCEQ standards. In the last three years, the Mabee Ranch has been testing the water primarily for monitoring purposes since there have been oil and gas spills and disposal line spills.[476] Mr. Mabee is the manager responsible for coordinating business activities and operations such as monitoring the wells.[477]

Mr. Mabee testified that he contacted Martin Water Laboratories, Inc. ("Martin Labs") to perform tests on the wells on his property.[478] According to the Martin Labs test, the TDS for Well Nos. 1, 2, and 3 are 651 ppm, 531 ppm, and 888 ppm, respectively.[479] Martin Labs also tested for arsenic levels. Per the report, the arsenic levels for Well Nos. 1, 2, and 3 are 0.00702, 0.00631, and 0.00698 ppm, respectively.[480]

Mr. Mabee testified that there is oil and gas development on the Mabee Ranch as well as disposal operations.[481] He determines whether to authorize development on the

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[468] Tr. Vol. 3 at 213:14 to 214:24.
[469] Tr. Vol. 3 at 209:13 to 209:17.
[470] Tr. Vol. 3 at 209:24 to 209:25.
[471] Tr. Vol. 3 at 210:1 to 210:4.
[472] Tr. Vol. 3 at 220:21 to 220:24; Mabee Ex. 1.
[473] Tr. Vol. 3 at 221:4 to 221:11; Mabee Ex. 1.
[474] Tr. Vol. 3 at 210:14 to 211:7.
[475] Tr. Vol. 3 at 211:8 to 211:21.
[476] Tr. Vol. 3 at 213:1 to 213:13.
[477] Tr. Vol. 3 at 214:10 to 214:16.
[478] Tr. Vol. 3 at 214:18 to 216:15; Mabee Ex. 1.
[479] Tr. Vol. 3 at 217:19 to 217:25; Mabee Ex. 1.
[480] Tr. Vol. 3 at 218:1 to 218:9; Mabee Ex. 1.
[481] Tr. Vol. 3 at 221:12 to 221:19.

ranch based on how an operator keeps their operations in order and the ability to confine what is coming out or going into the ground.[482]

The Mabee Ranch has four caliche pits or quarries that are being actively operated, and there are also several abandoned pits or quarries.[483] Some of the quarries are as deep as 60 feet. Scrapers can achieve a depth of approximately 20 to 25 feet, however, blasting can increase the depth an additional 30 or 40 feet.[484] The closest caliche quarry to the proposed landfill is approximately 2 or 2.5 miles southwest of the site.[485]

Mr. Mabee testified that the caliche rock is hard, but there is variation in the hardness. Additionally, there are cracks, voids, or fractures within the caliche wall.[486] Mr. Mabee stated he has observed the quarry after a heavy rain and has seen approximately 1.5 feet to 2 feet of water in the quarry.[487] Once the rain stops, it takes approximately 2 or 3 weeks for the water to disappear.[488] He contended the 1.5 feet of water does not evaporate based on his observation of the evaporation rate on frac water tanks which on average is less than approximately 8 to 10 feet a year.[489] He asserted that the water goes down into the earth.[490]

Mr. Mabee testified the closest water well to the site had a TDS of 664 ppm and the arsenic levels are at 0.002 ppm.[491] The well location is approximately 2.5 miles from the proposed landfill site.[492]

In response to cross-examination, Mr. Mabee testified that there were oil and gas wells, facilities, and injection wells on his property. He does not personally operate any of the oil and gas wells. However, his son operates Wasser Operating, of which Mr. Mabee and other family members are participants, that operates disposal wells on the property.[493] There are five disposal wells operated by John Mabee's son and family, and there are several more that are permitted.[494]

There are approximately 600 oil and gas wells on the ranch.[495] In response to cross-examination, Mr. Mabee stated that one operator has 13 deep disposal wells on his ranch.[496] Approximately a dozen shallow San Andres disposal wells are on the property,

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[482] Tr. Vol. 3 at 221:20 to 222:6.
[483] Tr. Vol. 3 at 222:11 to 222:21.
[484] Tr. Vol. 3 at 223:1 to 223:7.
[485] Tr. Vol. 3 at 223:8 to 223:14.
[486] Tr. Vol. 3 at 223:20 to 224:14.
[487] Tr. Vol. 3 at 224:22 to 225:7.
[488] Tr. Vol. 3 at 225:13 to 225:17.
[489] Tr. Vol. 3 at 225:18 to 225:23.
[490] Tr. Vol. 3 at 226:1 to 226:2.
[491] Tr. Vol. 4 at 6:19 to 7:1; Mabee Ex. 1.
[492] Tr. Vol. 4 at 6:4 to 6:12, 7:4 to 7:8; Mabee Ex. 1.
[493] Tr. Vol. 4 at 13:6 to 13:15.
[494] Tr. Vol. 4 at 8:1 to 9:25.
[495] Tr. Vol. 4 at 9:14 to 9:20.
[496] Tr. Vol. 4 at 9:3 to 9:4.

which Mr. Mabee testified will be plugged.[497] The new deeper wells will be in the Ellenberger which is approximately 13,000 feet deep.[498]

In response to cross-examination, Mr. Mabee testified regarding the caliche quarries that the topsoil layer can be anywhere between a few inches to ten feet of soil.[499] Below the soil is caliche. After about 20 feet of caliche, blasting with explosives such as dynamite is required to continue deeper.[500] When the caliche is blasted, multiple two-inch small holes are drilled closely together, and the blasts occur in sequence.[501]

b. Geology

i. Playas in Martin County

Dr. William James Rogers testified on behalf of the Mabee Protestants. He has his PhD in wildlife and fisheries studies, and is a regents professor at Texas A&M and a professor at West Texas A&M. He is a consultant to the World Bank and the UN on environmental issues including waste, waste management remediation and contamination, and development of landfills and remediation technologies. He has experience with landfills and response activities in both West Texas and with the Ogallala Aquifer, and internationally in Azerbaijan, Russia, Argentina, and Colombia.[502] He was accepted as an expert in playas, inner playa studies, aquifer recharge, site characterization, remediation, and environmental risk assessment.[503]

Dr. Rogers testified that based on the geology and surface soils, the site lies within the Ogallala recharge zone.[504] The Mabee Ranch is the adjacent property on two sides of the proposed landfill, and the occupants use shallow groundwater for livestock.[505] Due to the proximity to the Mabee Ranch, Dr. Rogers was asked to perform an environmental risk assessment.[506] Dr. Rogers testified that oil and gas waste is RCRA exempt hazardous waste.[507]

Dr. Rogers agrees with the administrative denial issued by the Commission dated December 11, 2017, which states the following:

- "This location poses a pollution threat to subsurface waters should there be any failure in the liner system for permanently interned or staged waste."[508]
- "The soil pathology is not compatible with disposal of waste staging activities."[509]

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[497] Tr. Vol. 4 at 9:4 to 9:13. Tr. Vol. 4 at 16:3 to 16:5.
[498] Tr. Vol. 4 at 15:5 to 15:21.
[499] Tr. Vol. 4 at 11:8 to 11:18.
[500] Tr. Vol. 4 at 11:19 to 12:5.
[501] Tr. Vol. 4 at 13:16 to 13:25.
[502] Tr. Vol. 11 at 34:9-41:9.
[503] Tr. Vol. 11 at 48:18-25.
[504] Tr. Vol. 11 at 62:6-8
[505] Mabee Ex. 6 at 1, Tr. Vol. 11 at 50:6-22.
[506] Tr. Vol. 11 at 52:11-14.
[507] Tr. Vol. 11 at 52:19-53:15.
[508] Mabee Ex. 6 at 5. Tr. Vol. 11 at 57:19-24.
[509] Tr. Vol. 11 at 57:25-58:7.

- "Disposal pits should be in areas of in situ fat clays that can provide an additional barrier between the bottom of the liner system for waste management units and the top of any groundwater bearing unit."[510]

Dr. Rogers testified that he does not think these issues have been resolved.[511] He disagrees with HR Martin's response to the denial, which stated that there were no playas, therefore, no recharge, and that the site is underlain by a thick, well cemented zone of caliche.[512] He further testified that there is nothing to stop waste on unlined activities from going directly into the Ogallala Aquifer.[513] He stated the Application should be denied.[514]

Dr. Rogers testified that a playa is a depression in the ground, but if the ground does not have a depression, water may be infiltrating through the subsurface material to the Ogallala Aquifer before it can flow as runoff to a playa.[515] In areas with sandy soils, there may be smaller playas or none at all, and runoff will not occur in sandy areas like in areas with clays.[516] Recharge in sandy soils occurs as permeation recharge.[517] Dr. Rogers provided the Permian Basin Management Plan produced by the Permian Basin Underground Water Conservation District that states "The levels of the Ogallala are primarily influenced by the rate of recharge to and discharge from the aquifer. Recharge to the aquifer primarily through infiltration of precipitation falling on the surface."[518] Dr. Rogers opined that this means recharge occurs not solely through playas.[519]

Dr. Rogers testified that the site is located in a non-playa area of Martin County, and the soil type is not conducive to runoff and because the soils are well drained.[520] Areas with greater clay content in soil is conducive to playa development.[521] The site is sloping one percent, and the topography is not favorable to playa development.[522] Runoff is required to fill playas. As the playas start to fill with water, dissolution occurs, and the playas get deeper. If there are clays in the soils, those clays accumulate at the bottom of the playas producing an impermeable barrier, until desiccation cracks form.[523]

The site is not located in an area where playas can form, therefore it is not in an inner-playa area (also referred to previously in this hearing as "interplaya area" because the soils do not support playa formation.[524] The site is covered by fine sandy loam with high infiltration rates.[525] Dr. Rogers testified that the soils are well drained with no

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[510] Mabee Ex. 6 at 5.
[511] Tr. Vol. 11 at 57:19-58:15.
[512] Tr. Vol. 11 at 60:14-25.
[513] Tr. Vol. 11 at 61:1-11.
[514] Tr. Vol. 11 at 61:1-11.
[515] Tr. Vol. 11at 63:8-18.
[516] Tr. Vol. 11 at 63:19-7.
[517] Tr. Vol. 11 at 63:19-7.
[518] Tr. Vol. 11 at 65:2-66:1.
[519] Tr. Vol. 11 at 66:3-4.
[520] Tr. Vol. 11 at 66:15-67:6.
[521] Mabee Ex. 6 at 8; Tr. Vol. 11 at 67:10-18.
[522] Mabee Ex. 6 at 9; Tr. Vol. 11 at 67:22-68:13.
[523] Tr. Vol. 11 at 68:23-69:5.
[524] Tr. Vol. 11 at 72:14-19.
[525] Mabee Ex. 6 at 10; Tr. Vol. 11 at 69:17-70:12.

frequency of flooding or ponding, which means water is infiltrating the soil.[526] Even if there is a depression, water will infiltrate through subsurface to groundwater.[527] Dr. Rogers stated the site is not in an area conducive to forming playas, so it is not in a playa or inner-playa area.[528] Even though the soils are being excavated for the pits, he stated the areas around the pits will be exposed to waste during operations, and the soil will need to be appropriate to handle that situation because there is no liners or GCL in those areas.[529] Dr. Rogers reiterated that this is an active recharge zone.[530]

ii. Ogallala Aquifer

Dr. Darrell Brownlow is a geologist retained by the Mabee Protestants.[531] He was asked to evaluate the geologist characteristics of the site.[532] He has experience working as a geologist in aggregate mining working with and developing quarries, in environmental engineering performing environmental cleanups, site characterizations, and wastewater management; and working as a consultant on groundwater resources projects and regional water planning. As a consultant, he works extensively with mining operations and limestone quarries and caliche pits in West Texas.[533] He was accepted as an expert in geology, hydrogeology, subsurface evaluation and characterization, groundwater resources, clay mineralogy, and mining.[534]

Dr. Brownlow stated that the subsurface is a very porous caliche, with the water table for the Ogallala Aquifer at roughly 35 to 40 feet beneath the landfill location with no fat clays between the water table and bottom of the landfill.[535] The rock in the subsurface is fractured and contains conduits for potential fluid migration.[536] Dr. Brownlow testified that there are not confining layers.[537] He provided a report from the Texas Water Development Board showing the proposed landfill is located in an area where the Ogallala Aquifer is less than 1,000 milligrams per liter TDS.[538] Dr. Brownlow provided a map noting the Ogallala Aquifer is a major aquifer that outcrops at the location of the proposed site.[539] The outcrop is where precipitation falls to get into an aquifer.[540] The contact of the Dockum Formation below the Ogallala Formation represents the bottom of the Ogallala Aquifer.[541]

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[526] Mabee Ex. 6 at 10 and 11; Tr. Vol. 11 at 71:16-72:10.
[527] Tr. Vol. 11 at 72:14-19.
[528] Tr. Vol. 11 at 73:9-16.
[529] Tr. Vol. 11 at 73:23-74:11.
[530] Tr. Vol. 11 at 77:7-13.
[531] Tr. Vol. 11 at 129:7-10.
[532] Tr. Vol. 11 at 141:14-16.
[533] Tr. Vol. 11 at 129:7-136:3
[534] Tr. Vol. 11 at Pg.142:1-21.
[535] Tr. Vol. 11 at 147:24-148:8.
[536] Tr. Vol. 11 at 148:9-12.
[537] Tr. Vol. 11 at 148:21-24.
[538] Mabee Ex. 7 at 2, 3; Tr. Vol. 11 at 158:1-5.
[539] Mabee Ex. 7 at 4, 5; Tr. Vol. 11 at 154:4-8.
[540] Tr. Vol. 11 at 155:11-23.
[541] Tr. Vol. 11 at 159:7-18.

Dr. Brownlow provided a map with the location of water wells that have Driller's Reports submitted to the Texas Water Development Board.[542] He does not see any registered water wells within the proposed landfill location or in the immediate area.[543]

One of the nearby water wells, Well No. 26792, was drilled in September 2011 to a depth of 150 feet.[544] The water level in the well was recorded at 50 feet bgs.[545] The well is located less than 300 feet from the property line, on the side of the non-contact and contact stormwater ponds and drying pads.[546] Another nearby water well, Well No. 57362, is located near the entry of the property on the southeast corner where trucks will enter the facility.[547] This irrigation well was drilled in April 2005 with the depth of the well at 95 feet and the water level at 45 feet.[548] The report shows a well yield of 150 gallons per minute, and Dr. Brownlow testified that this demonstrates that it has encountered a "significant" water source.[549] Red beds were identified in both wells, in the first well from 145-150 feet and in the second well 90 to 95 feet.[550]

Dr. Brownlow provided data for a historical observation well, Well No. 2755301, which is "deemed important to the Water Development Board for mapping and cataloging regional water levels."[551] The well was drilled to a depth of 82 feet and is located across the highway to the east.[552] The well was mapped and monitored for decades by the Texas Water Development Board.[553] The Texas Water Development Board uses these wells for information for state water planning efforts to gauge historical levels of the aquifer.[554] The well is identified as being on the Ogallala Aquifer.[555] The data from this well dates back to 1947 and concludes in 1987. During that time, the water level has dropped from 35 feet bgs to between 45-50 feet bgs.[556] In 1987, the final measurement in the well was at 45 feet bgs.[557] Dr. Brownlow testified that water levels vary throughout the year due to seasonal changes, irrigation pumpage, and rainfall.[558]

Dr. Brownlow obtained water level data in 2019 to see if there are any differences between those water levels and water levels taken two years previously on the HR Martin site.[559] The water levels obtained by HR Martin in the seven groundwater monitor wells from March 2017 ranged from 57-64.83 feet below measuring point.[560] Dr. Brownlow took

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[542] Tr. Vol. 11 at 162:17-163:11.
[543] Tr. Vol. 11 at 164:1-6.
[544] Mabee Ex. 8 at 2.
[545] Mabee Ex. 8 at 2.
[546] Tr. Vol. 11 at 165:7-23.
[547] Tr. Vol. 11 at 167:14-24.
[548] Mabee Ex. 8 at 4.
[549] Tr. Vol. 11 at 168:7-20.
[550] Mabee Ex. 8 at 3, 5;
[551] Mabee Ex. 8 at 6; Tr. Vol. 11 at 171:2-11.
[552] Tr. Vol. 11 at 171:19-172:21.
[553] Tr. Vol. 11 at 171:12-19.
[554] Tr. Vol. 11 at 172:23-173:1-7.
[555] Mabee Ex. 8 at 7.
[556] Mabee Ex. 8 at 8, 9.
[557] Mabee Ex. 8, at 8, 9; Tr. Vol. 11 at 173:8-174:15.
[558] Tr. Vol. 11 at 177:3-7.
[559] Tr. Vol. 11 at 177:15-23.
[560] Mabee Ex. 9 at 1.

water level measurements in these wells in August 2019.[561] He testified that though these water levels did not change much between the sampling events, it shows that the water levels move in an unconfined aquifer.[562] Dr. Brownlow stated that there is no barrier above the water table to compress or confine the water, making the water level not static.[563]

Dr. Brownlow testified that he would have obtained water level and water quality information from the irrigation wells for a site characterization, but Trihydro did not evaluate the wells.[564]

iii. Site Characterization

Dr. Brownlow researched historical land usage at the site by reviewing historical aerial images and determined that from 2005 through 2016 the site was being utilized for agricultural purposes.[565]

Dr. Brownlow testified he does not approve of air rotary drilling for site characterization.[566] For the Mabee Protestants' borings, he utilized sonic drilling.[567] Sonic drilling extracts intact material without using water or air, and drills through the earth using sonic vibrations to extract physical material without manipulating moisture content or heat.[568]

Air rotary drilling was used in some of Trihydro's site characterization work. Air rotatory has a bit that spins and grinds up rock, then pressure is applied downhole to blow cuttings to the surface.[569] Dr. Brownlow testified that waste travels through hard rock through fractures and very fine spaces and the hardness does not correlate to water transmissivity through rock.[570] Dr. Brownlow testified "But the air rotary is not able to identify fractures or vugs or solution cavities or conduits for water because it's grinding the rock up."[571] Dr. Brownlow stated that in Trihydro's logs where air rotary drilling was utilized, the lithology descriptions of gravel do not provide enough information to characterize the rock.[572] Dr. Brownlow testified that there is the lack of site characterization information to understand the true lithology and nature of the material below this site based upon the drilling methodology."[573]

Dr. Brownlow testified that sonic drilling technology is best for obtaining data for site characterization.[574] Dr. Brownlow drilled two offset wells in November 2019 on the

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561 Tr. Vol. 11 at 182:22-182:3.
562 Tr. Vol. 11 at 183:12-22.
563 Tr. Vol. 11 at 185:6-10.
564 Tr. Vol. 11 at 189:10-190:5.
565 Mabee Ex. 9 at 3, 4; Tr. Vol. 11 at 188:22-189:9.
566 Tr. Vol. 11 at 145:1-146:10.
567 Tr. Vol. 11 at 145:1-146:10.
568 Tr. Vol. 11 at 146:11-20.
569 Tr. Vol. 11 at 204:18-205:12.
570 Tr. Vol. 11 at 206:19-25.
571 Tr. Vol. 11 at 207:1-3.
572 Tr. Vol. 11 at 208:18-209:19.
573 Tr. Vol. 11 at 211:4-8.
574 Tr. Vol. 12 at 45:15-46:2.

Mabee Ranch property directly across the property boundary from Trihydro's Groundwater Monitoring Well No. 4 ("GW-4") and Groundwater Monitoring Well No. 3 ("GW-3").[575] The Mabee Ranch Sonic 1 ("MR-S1") is directly across the property boundary of GW-4, and Mabee Ranch Sonic 2 ("MR-S2") is across the property boundary from GW-3.[576] The Mabee Ranch wells are approximately 50 to 75 feet away from the corresponding Trihydro wells.[577] Dr. Brownlow does not agree with Trihydro's assessment that there is an impermeable or confining unit that is separating the Ogallala Aquifer from the landfill.[578] He testified that GW-4 had the most significant changes between first observation of water during drilling as compared to the measurement after the well was completed, which he believes drove Trihydro's interpretation that the aquifer is confined.[579] Dr. Brownlow testified that many of the wells did not show significant change in water levels.[580]

Dr. Brownlow testified that the edge of the proposed facility and HR Martin's groundwater monitoring wells are right next the Mabee property boundary, and if contamination shows up in those monitoring wells, it is likely the contamination is already on the Mabee Ranch because there is no buffer between the edge of the facility, the monitor wells, and the property boundary.[581] Dr. Brownlow testified that the facility would have no buffer to identify a potential threat to groundwater contamination before it leaves HR Martin's property.[582]

According to the Trihydro site investigation and report, Trihydro found hard, dry caliche from approximately 10-70 feet bgs, and measured water at 75 feet bgs.[583] The water level in GW-4 rose to 57 feet bgs when it was measured again.[584] Dr. Brownlow testified that Trihydro's interpretation of this data was it has a confining layer of hard, dry, dense caliche.[585] He stated that the air rotary drilling uses compressed air at 400 to 500 psi and it pushes water out into the formation, so it does not come out while drilling.[586]

Dr. Brownlow testified that sonic drilling uses a 10 foot long core barrel that is 7.5 inches in diameter with 6-inch diameter core.[587] Rather than drilling through rock or using air, it cuts through rock using sonic vibrations at an extremely high frequency.[588] No air or water is introduced while drilling and 100 percent of the material that is drilled through gets collected.[589] Dr. Brownlow asserted that the percent recovery using sonic drilling is "roughly 100 percent." He indicated there is a small amount on the periphery as the sonic

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[575] Tr. Vol. 12 at 48:21-49:5.
[576] Tr. Vol. 12 at 48:21-49:5.
[577] Mabee Ex. 13 at 3.
[578] Applicant Ex. 25; Tr. Vol. 12 at 51:6-52:13.
[579] Tr. Vol. 12 at 52:20-53:2.
[580] Tr. Vol. 12 at 52:20-53:2.
[581] Tr. Vol. 12 at 62:14-63:6.
[582] Tr. Vol. 12 at 63:8-15.
[583] Tr. Vol. 12 at 53:20-54:2.
[584] Tr. Vol. 12 at 54:3-4.
[585] Tr. Vol. 12 at 54:5-11.
[586] Tr. Vol. 12 at 54:12-21.
[587] Tr. Vol. 12 at 66:1-7.
[588] Tr. Vol. 12 at 66:8-14.
[589] Tr. Vol. 12 at 67:5-9.

tube is driving down that is pulverized and ends up inside that barrel."[590] Dr. Brownlow was onsite the entire time the drilling was happening.[591] The sampling interval is 2 to 2.5 feet.[592] He stated, "During the drilling, once we get below about 50 feet, the water level in the boring is checked and recorded between each 5-foot run. So when they remove that core barrel and they're collecting samples, they set it aside, the hole is open."[593] After the boring is completed, the water level is measured every 15 minutes for the first hour, then after 24 hours, to determine where the water table is. The design of the monitoring well is based on the water level after 24 hours.[594] Dr. Brownlow claimed it is important to wait 24 hours to find the water table prior to installing the well, because the geology may vary and the rate water migrates into the hole may take time.[595]

Dr. Brownlow stated that the samples obtained from sonic drilling were divided into two parts, the natural state of material and washed material, and into two separate boxes.[596] Washing removes dust and fine-grained material generated by the sonic drilling process.[597] The caliche type materials tend to crumble and fall apart, even when the material is extremely hard.[598] Dr. Brownlow testified that the dust needs to be washed out so they can evaluate the lithology of the samples.[599]

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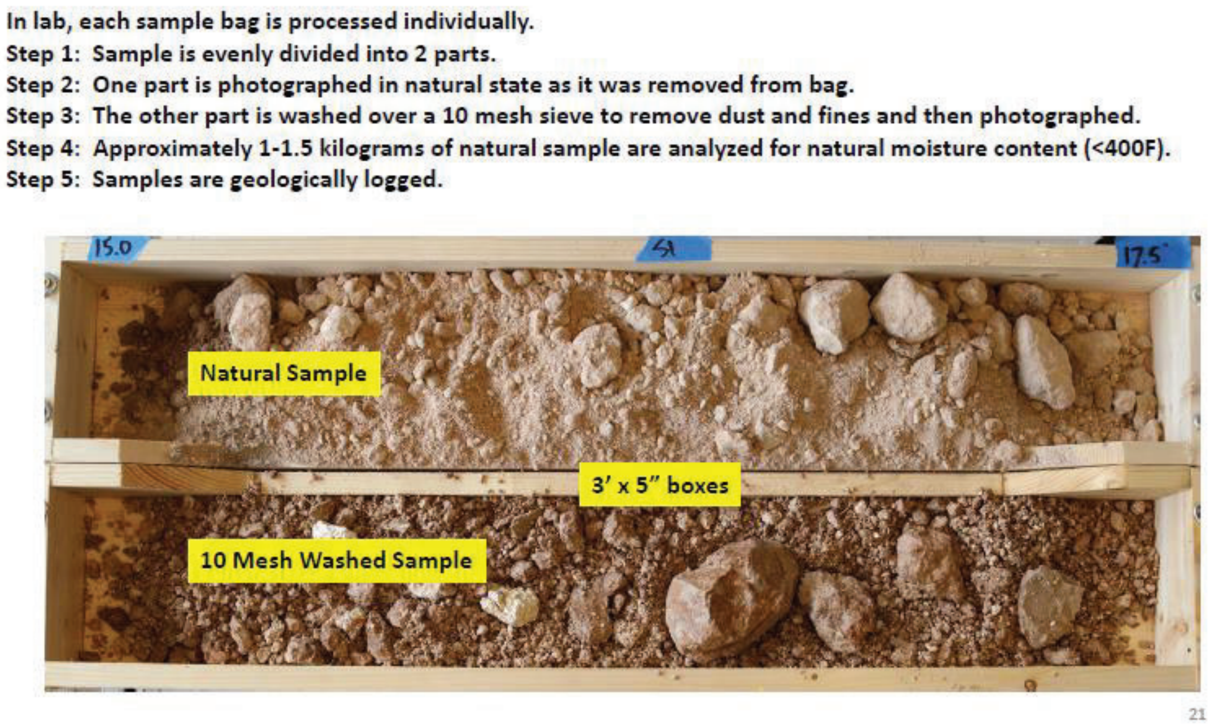
590 Tr. Vol. 12 at 67:19-68:5.
591 Tr. Vol. 12 at 68:13-19.
592 Tr. Vol. 12 at 69:5-9.
593 Tr. Vol. 12 at 71:6-13.
594 Tr. Vol. 12 at 71:18-72:1.
595 Tr. Vol. 12 at 72:6-12.
596 Tr. Vol. 12 at 74:2-19.
597 Tr. Vol. 12 at 74:2-19.
598 Tr. Vol. 12 at 74:20-75:2.
599 Tr. Vol. 12 at 75:3-8.

Image of the caliche samples collected from MR-S1.
One half of the sample is washed to remove fine grains.[600]



The siliceous gravels and dry white caliche is characteristic of the Ogallala Aquifer from 62 to 64 feet.[601] He found Gryphaea fossils from 66 to 68.5 feet which are a type fossil of the Ogallala Formation.[602] From 77.5 to 80 feet he encountered highly plastic, dark red, fat clay.[603] Dr. Brownlow asserts that the fat clay obtained from the sample has a hydraulic conductivity of at least 1x10^{-8} cm/sec.[604] Dr. Brownlow stated Trihydro classified the geology at the depth that Dr. Brownlow found the red beds as caliche.[605] The red beds encountered at 71 feet show a change in formation from Tertiary Ogallala formation to the Triassic Dockum formation.[606] The red beds are "a natural sealer."[607] Red beds are reported from 71 to 80 feet bgs.[608]

Dr. Brownlow testified the water table in MR-S1 is at 57.5 feet, but the aquifer level will vary over time and changes seasonally.[609] He asserts that based on the cuttings from the sonic boring process, the historical water table for the Ogallala is approximately 40 feet.[610] He stated that up to 40 feet is the historical zone of saturation based on material

[600] Mabee Ex. 13 at 21.
[601] Tr. Vol. 12 at 78:3-8.
[602] Tr. Vol. 12 at 78:9-79:7.
[603] Tr. Vol. 12 at 79:9-19.
[604] Tr. Vol. 12 at 80:24-81:9.
[605] Tr. Vol. 12 at 81:21-82:2.
[606] Tr. Vol. 12 at 82:6-13.
[607] Tr. Vol. 12 at 82:24-25.
[608] Tr. Vol. 12 at 85:1-7.
[609] Mabee Ex. 14; Tr. Vol. 12 at 87:23-88:10.
[610] Tr. Vol. 12 at 88:11-16.

collected and moisture content of the material. The observation of solution cavities and the porous nature of the rock shows where the water table has been.[611] Other wells in the area have shown historical water levels at 40-45 feet bgs.[612] Dr. Brownlow testified that based on regional water table information from the Texas Water Development Board website shows the water table near 40 feet.[613] The rock is porous from 40 feet to 57.5 feet, and the moisture content goes up.[614] Dr. Brownlow testified starting at 40 feet is a viable component of the aquifer.[615]

During sonic drilling, the water table in the hole dropped because the water was flowing into the hole, and the drilling occurred faster than the water coming into the hole; then it started to rise again to 58 feet which Dr. Brownlow stated is the final water table.[616] Sonic drilling enabled him to characterize the site, without grinding the rock or introducing air.[617] Dr. Brownlow claims Trihydro puts the top of the aquifer at 75 feet where there is saturated caliche below a confining layer, because Trihydro's first water is at 75 feet bgs, but red beds are not recorded in their boring. Dr. Brownlow testified that the depth where Trihydro has saturated caliche, Dr. Brownlow observed red beds.[618] Dr. Brownlow observed that where Trihydro identified low permeability, dry caliche is where the aquifer is, and where Trihydro interprets saturated caliche is where there are dry beds.[619] Dr. Brownlow observed Triassic Dockum red clays at 71 to 80 feet.[620] He stated the moisture content for the aquifer depths is around 10 percent, because gravel grains do not have permeability and do not absorb water so the measured moisture content would be low.[621]

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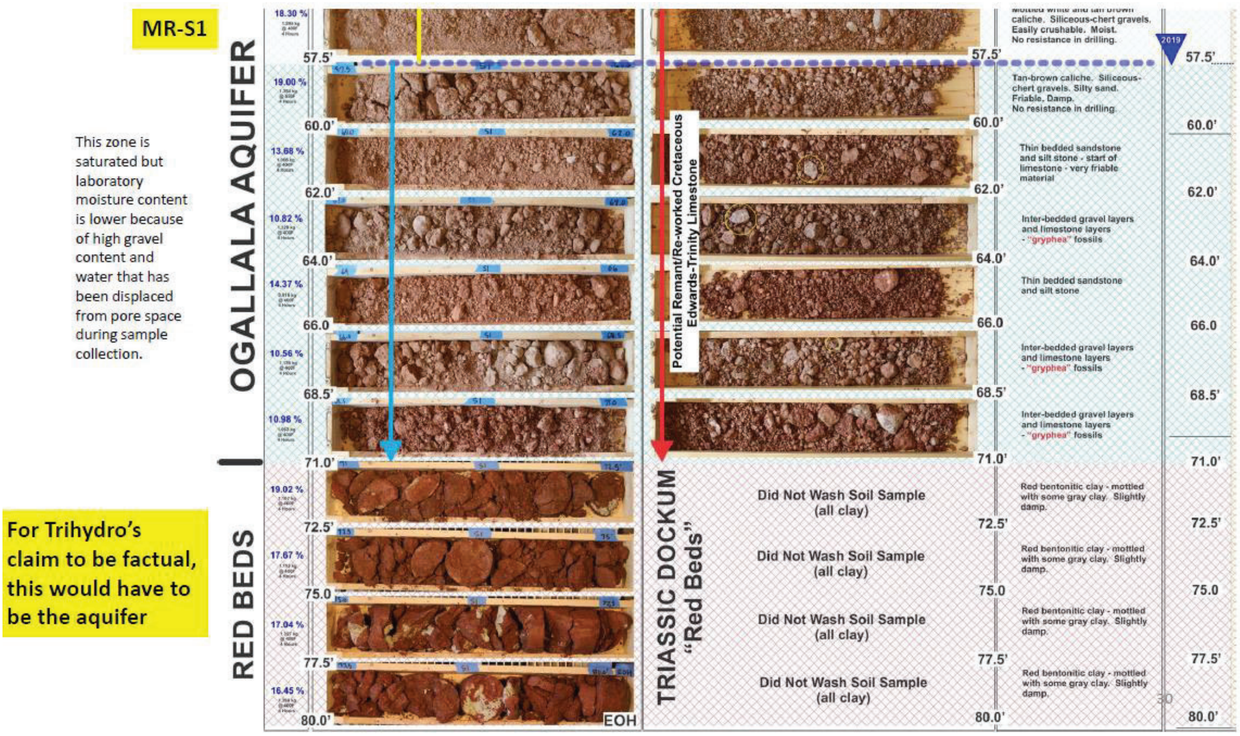
[611] Tr. Vol. 12 at 88:20-89:3.
[612] Tr. Vol. 12 at 89:4-15.
[613] Tr. Vol. 12 at 89:17-20.
[614] Tr. Vol. 12 at 90:7-13.
[615] Tr. Vol. 12 at 91:5-8.
[616] Tr. Vol. 12 at 93:18-94:8.
[617] Tr. Vol. 12 at 94:15-23.
[618] Tr. Vol. 12 at 96:7-98:6.
[619] Mabee Ex. 13, Slide 29, Tr. Vol. 12 at 98:8-13.
[620] Mabee Ex. 13, Slide 30; Tr. Vol. 12 at 98:23-99:2.
[621] Tr. Vol. 12 at 100:2-101:2.

Image of samples collected from sonic drilling process from MR-S1.
The samples are collected and described every 2.5 feet.
Red beds found from 71 to 80 feet bgs.[622]



Dr. Brownlow testified that it takes water a longer time to flow into a borehole at greater depths due to the greater pressure.[623] The nature of the rock such as permeability, porosity, and clay content affect how quickly water comes into a well.[624]

Dr. Brownlow testified the depth to water in an unconfined aquifer can vary, and the RRC requested the applicant leave 35 feet of separation between the bottom of the pits and groundwater, and with groundwater being as high as 40 feet, the current Application does not leave that amount of separation.[625] Dr. Brownlow testified that "There are no fat clays. There is nothing to retard migration of contaminating fluids, if a leak were to occur in this landfill, from entering the Ogallala Aquifer. This is porous caliche."[626]

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[622] Mabee Ex. 13, Slide 30.
[623] Tr. Vol. 12 at 103:2-12.
[624] Tr. Vol. 12 at 103:2-12.
[625] Mabee Ex. 13, Slide 31; Tr. Vol. 12 at 105:10-22.
[626] Tr. Vol. 12 at 107:18-22.

In MR-S2 samples were collected at 2.5 foot intervals down to 91 feet.[627] The water table was at approximately 67 feet.[628] Red beds were observed from 79 feet to 91 feet.[629] Very, hard caliche occurred from 17.5 feet to 44 feet, which Dr. Brownlow opined that this caliche would require blasting.[630]

The caliche is comparable to the quarry caliche observed in Mr. Mabee's pit 2.5 miles away.[631] Dr. Brownlow took pictures of all the samples.[632]

Surficial soil from 0 to 1 feet is very dry sandy loam with low moisture content.[633] The sandy loam from 1 to 2.5 feet has a higher moisture content.[634] Dr. Brownlow opined the dry sandy loam soil is a reason that playas do not exist in the area, because playas do not form in porous, free draining soil; if it were an inner-playa area, it would have more clay.[635] He stated precipitation in this area goes directly through soil and recharges the aquifer because it is porous.[636] From 2.5 to 4 feet is a sandy loam that is not a clay rich material.[637] From 7.5 to 10 feet the rock is friable, relative low density caliche.[638] Friable means the rocks will break apart in your hands and the rocks are not well lithified.[639] The rock is broken up in pieces in the core, because the vibrations from sonic drilling causes the rock to crumble; also fractures within the rock, and weakness planes are exacerbated.[640]

From 15 to 17.5 feet the density and moisture content in the samples increase.[641] The rock is getting denser, but there are solution cavities and small fractures all over the rock to suggest water movement and transport through it.[642] The interval is porous.[643]

From 20 to 22.5 feet, there is lower moisture content and higher density, but it is relatively porous.[644] Dr. Brownlow testified the rock is very hard and would require drilling and blasting to remove.[645] He further stated water is not being transported through the hard pieces of rock, but is going around the edges of the rocks using linear pathways.[646] He explained hardness has little to do with water migration.[647] He contended massive,

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[627] Tr. Vol. 12 at 112:1-9.
[628] Tr. Vol. 12 at 114:4-7.
[629] Tr. Vol. 12 at 114:8-21.
[630] Tr. Vol. 12 at 114:8-21.
[631] Tr. Vol. 12 at 114:8-115:2.
[632] Tr. Vol. 12 at 116:15-16.
[633] Tr. Vol. 12 at 119:8-12.
[634] Tr. Vol. 12 at 119:20-23.
[635] Tr. Vol. 12 at 121:9-122:3.
[636] Tr. Vol. 12 at 122:3-12.
[637] Tr. Vol. 12 at 122:15-23.
[638] Tr. Vol. 12 at 123:11-17.
[639] Tr. Vol. 12 at 123:22-124:5.
[640] Tr. Vol. 12 at 125:13-23.
[641] Tr. Vol. 12 at 125:24-126:7.
[642] Tr. Vol. 12 at 126:8-15.
[643] Tr. Vol. 12 at 126:16-20.
[644] Tr. Vol. 12 at 126:21-127:1.
[645] Tr. Vol. 12 at 127:6-11.
[646] Tr. Vol. 12 at 127:12-18.
[647] Tr. Vol. 12 at 127:19-22.

isolated boulders are in the caliche that are very hard lithified. The material would need to be drilled and blasted to excavate it.[648]

From 30 to 32 feet, Dr. Brownlow explained the pieces of very hard rock have small pore spaces, small cracks and fissures, that act as flow paths allowing water to move from the surface to the aquifer.[649] He said these rocks are in the recharge zone and are part of the Ogallala Aquifer itself.[650] According to him, material in the water is transmitted from surface to aquifer. [651]

From 48 to 50 feet bgs, Dr. Brownlow stated the material is within the historical water level zone; it has higher moisture content and is much more porous. Dr. Brownlow's interpretation is this zone has been within the active water table for the last couple of decades.[652]

The interval from 54 to 56 feet bgs has caliche that is very friable and has solution features. Precipitation from different calcium carbonates and small solution features, according to Dr. Brownlow, is evidence of historical rising and lowering of water.[653]

From 57.5 to 58 feet bgs, there is a fine sand silty layer and an interval of damp, moist silty sand with a water content of 30 percent.[654]

From 60 to 62 feet bgs, Dr. Brownlow testified that he can start seeing big pieces of chert gravel with a 19 percent moisture content.[655] It is porous sandstone with quartz grains and pebbles that he stated is clearly within the Ogallala Aquifer.[656] He explained the chert is part of the granites that are the parent material of the Ogallala Formation and is not something that would form by chemical precipitation.[657]

Dr. Brownlow testified from 68 to 70 feet bgs, there is a saturated portion of the aquifer with chert gravel.[658] He opined this is very near the bottom of the Ogallala Aquifer where most of the gravel occurs.[659]

From 70 to 72 feet bgs, the partially cemented and relatively porous Ogallala conglomerate has pebbles and holds water throughout.[660]

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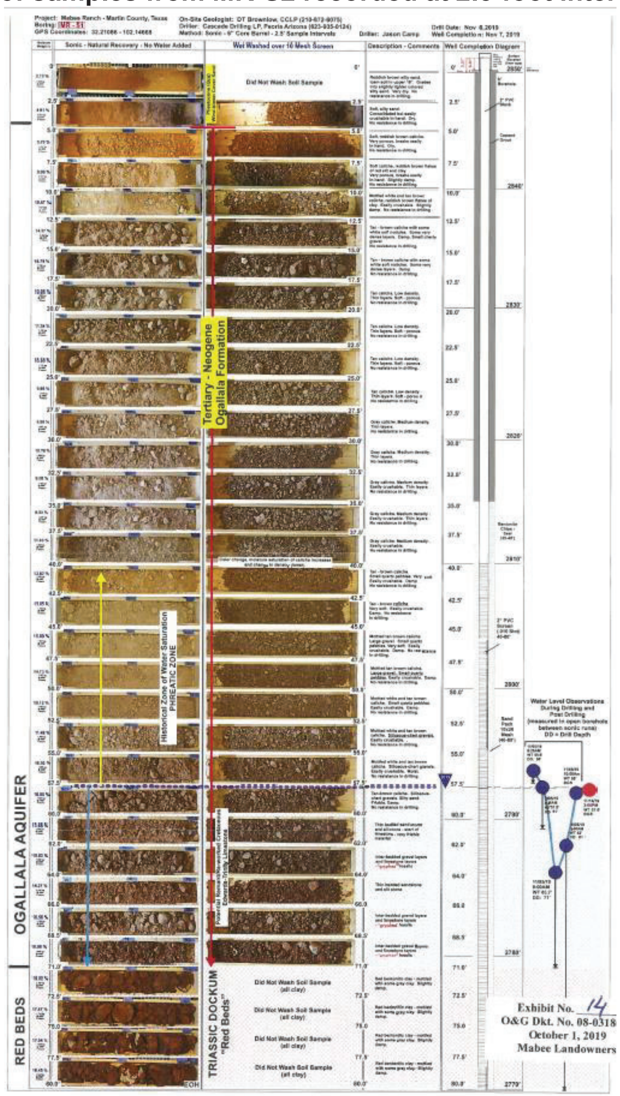
[648] Tr. Vol. 12 at 128:17-25.
[649] Tr. Vol. 12 at 129:6-20.
[650] Tr. Vol. 12 at 129:21-130:3.
[651] Tr. Vol. 12 at 129:21-130:3.
[652] Tr. Vol. 12 at 130:6-18.
[653] Tr. Vol. 12 at 131:8-19.
[654] Tr. Vol. 12 at 131:19-132:9.
[655] Tr. Vol. 12 at 132:10-15.
[656] Tr. Vol. 12 at 132:16-24.
[657] Tr. Vol. 12 at 133:3-15.
[658] Tr. Vol. 12 at 133:19-134:2.
[659] Tr. Vol. 12 at 134:21-25.
[660] Tr. Vol. 12 at 135:7-14.

From 80 to 82 feet bgs is the fat clay red beds down to the bottom of the well.[661] In MR-S1, Dr. Brownlow encountered the Triassic red beds at 71 feet bgs and in MR-S2 the beds are at 80 to 82 feet, and the water table at MR-S2 is also ten feet lower.[662] The Trihydro log for the corresponding GW-3 well, has 20 percent recovery from 15 to 35 feet.[663] At the bottom of the boring from 70 to 75 feet bgs, the Trihydro log shows white, hard caliche, but the MR-S2 log shows sand and gravel of the saturated portion of the Ogallala Aquifer.[664]

Dr. Brownlow provided a large graphic showing clear representations of the samples at all depths, which was consistent with his testimony.[665]

Image of samples from MR-S2 recorded at 2.5-foot intervals.[666]



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661 Tr. Vol. 12 at 135:15-17.
662 Tr. Vol. 12 at 135:15-22; 136:13-16.
663 Mabee Ex. 25, Slide 35; Tr. Vol. 12 at 137:17-20.
664 Mabee Ex. 25, Slide 35; Tr. Vol. 12 at 138:13-24.
665 Mabee Ex. 14.
666 Mabee Ex. 14.

According to Dr. Brownlow, the moisture content varies throughout the soil profile due to variations of lithology. Material that is within the aquifer may have low moisture content due to the material not containing water due to porosity.[667] He stated the area above the aquifer from 40 to 44 feet down to 60 feet had a visible increasing moisture profile.[668] He opined this is an area of active water movement within the potentiometric surface of the water table. The area the water is transmitting through on its way to the groundwater, which is evidence of recharge.[669] Between 66 and 68 feet is the top of the water table in MR-S2.[670] The low moisture content in the saturated aquifer interval is due to the water running out of the chert and pebbles because they do not absorb water.[671]

Dr. Brownlow testified that there is no naturally occurring continuous barrier that would prevent recharge of the Ogallala.[672] He further stated there are pathways throughout the profile for water to travel.[673] He asserted that blasting operations used to construct the pits "would have the potential to exacerbate or create new fractures, and additional pathways."[674] He contended that the information in the Application was not sufficient to infer that there is a barrier such as a fat clay or other hydraulic barrier or confining zone that could prevent water that leaks from the facility from reaching the Ogallala Aquifer.[675]

Dr. Brownlow agrees with Dr. Roger's concern that the location poses a threat to groundwater should the liner system fail or the lack of liner system in the unlined areas that still have operations.[676] Dr. Brownlow concluded from the borings that there are no fat clays to provide a barrier between the waste and the aquifer. The fat clays exist beneath the aquifer.[677] Dr. Brownlow does not agree with Trihydro's assertions that there is a hard, cemented caliche barrier, and there is no recharge because the site is in an inner playa area.[678]

Dr. Brownlow clarified that 50 to 60 percent of land surface in the state of Texas is resting over an outcrop or recharge zone of an aquifer.[679] He stated that the Ogallala outcrop is a recharge zone that occupies a large area. This site has free draining surficial soil, no significant runoff, and water that would fall on the ground would recharge the aquifer.[680] When he obtained water levels in 2019, he did not see the groundwater gradient change direction, but did observe fluctuation in water table on the eastern side of the site up to a 2.5 foot drop, and in the west less than a 0.5 foot drop.[681]

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[667] Mabee Ex. 17; Tr. Vol. 12 at 140:10-24.
[668] Mabee Ex. 17; Tr. Vol. 12 at 141:8-10.
[669] Mabee Ex. 17; Tr. Vol. 12 at 141:11-23.
[670] Mabee Ex. 17; Tr. Vol. 12 at 142:23-143:12.
[671] Tr. Vol. 12 at 143:22-144:4.
[672] Tr. Vol. 12 at 145:7-14.
[673] Tr. Vol. 12 at 146:5-8.
[674] Tr. Vol. 12 at 146:9-13.
[675] Tr. Vol. 12 at 147:9-18.
[676] Tr. Vol. 12 at 148:8-24.
[677] Tr. Vol. 12 at 148:25-149:6.
[678] Tr. Vol. 12 at 149:7-14.
[679] Tr. Vol. 14 at 11:13-15.
[680] Tr. Vol. 14 at 13:18-14:12.
[681] Tr. Vol. 14 at 16:16-17:3.

Dr. Brownlow testified that air rotary can be used to install a water well, but sonic drilling is the best way to get site characterization data.[682] Hollow stem augers work well in clays and soft sand, but it cannot penetrate hard rock.[683]

Dr. Brownlow stated that the hardest material was from 14 feet bgs to approximately 40 feet bgs and was well cemented material.[684] Below 40 feet the material was much softer, more porous, with a higher moisture content, but still caliche.[685] Dr. Brownlow testified that even in hard rock, there was still evidence of fractures, broken rock and materials partings.[686] In the sidewalls of a nearby quarry, he observed solution features and fractures and lineations.[687] Dr. Brownlow testified that in the quarries, he observed microfractures and microporosity and larger fractures such as bedding planes and lineations that would enable water to flow.[688]

iv. Caliche

Dr. Brownlow reviewed Trihydro's boring logs and laboratory analysis and found that the gravel content was zero in the lab analysis, but gravels up to two-inches were observed in the boring logs.[689] The composite samples are from a 20 foot interval, and Dr. Brownlow questions if the samples are representative.[690] He testified that very hard caliche was described in each of the borings, but the findings in the geotechnical results only showed sand and clay, but no larger gravels or cobbles.[691] Dr. Brownlow questions how representative the sample is of the full 20 to 25 foot boring that was used to create the composite samples for each boring.[692] To determine the representativeness of the sample for the full 20 to 25 feet, Dr. Brownlow then sought to determine the percent recovery and to review field notes.[693] He determined from the field notes from Trihydro that some core samplers only had 10 to 20 percent recovery, which causes him to question the engineering report.[694] For instance, he stated, MW-5 was drilled with hollow stem auger, the boring log shows 5 to 10 feet as fine grained caliche with silty sand, and from 15 to 20 feet there is hard dry caliche.[695] The laboratory analysis for MW-5 shows 54 percent sand and 46 percent clay. That combined with the low recovery of the core and the method of compositing samples causes Dr. Brownlow to question the reliability of the data when comparing the analysis to the logs.[696] Dr. Brownlow testified that he looked for photographs of Trihydro's samples to determine how the percent recovery was

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682 Tr. Vol. 14 at 21:14-17.
683 Tr. Vol. 14 at 21:18-23.
684 Tr. Vol. 14 at 22:12-20.
685 Tr. Vol. 14 at 22:21-23:4.
686 Tr. Vol. 14 at 23:5-12.
687 Tr. Vol. 14 at 23:25-24:4.
688 Tr. Vol. 14 at 25:13-21.
689 Tr. Vol. 11 at 194:16-195:15.
690 Tr. Vol. 11 at 194:16-195:15.
691 Tr. Vol. 11 at 196:9-197:8.
692 Tr. Vol. 11 at 196:9-197:8.
693 Tr. Vol. 11 at 197:10-198:3.
694 Tr. Vol. 11 at 198:16-199:3.
695 Mabee Ex. 10 at 7; Tr. Vol. 11 at 200:18-201:2.
696 Mabee Ex. 10 at 2; Tr. Vol. 11 at 201:3-202:8.

determined and how the samples were collected, but photographs of the sampling were not provided.[697]

Dr. Brownlow visited a quarry on the Mabee Ranch approximately 2.75 miles southeast of the proposed landfill site.[698] The quarry is a caliche pit where materials are mined for construction purposes.[699] Dr. Brownlow stated that the quarry is representative of the landfill in depth of excavation, and provides the ability to look at the natural materials.[700] Based on his observations in the quarry, Dr. Brownlow testified that the quarry material contains boulders, rocks, layers, stratification, and is not just one solid dry hard caliche.[701] In the quarry, Dr. Brownlow identified both hard and soft rock with a large solution cavity.[702] He found linear features within the rock that represent pathways and conduits for water movement.[703]

Photo from Site Visit to Nearby Quarry Showing Lithology of the Caliche.[704]

Dr. Brownlow testified that the boulders in the caliche cannot be worked by a ripper or bulldozer, and though areas are rippable, boulders cannot be broken up with a ripper or bulldozer.[705] The quarry was drilled and blasted.[706] The quarries are 25 to 35 feet deep which are comparable to the depths of the proposed disposal pits.[707]

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[697] Tr. Vol. 11 at 202:9-203:5.
[698] Tr. Vol. 11 at 213:21-214:14.
[699] Tr. Vol. 11 at 215:1-5.
[700] Tr. Vol. 11 at 216:4-14.
[701] Tr. Vol. 11 at 217:2-13.
[702] Tr. Vol. 11 at 217:21-218:3.
[703] Tr. Vol. 11 at 218:4-9.
[704] Mabee Ex. 12 at 10.
[705] Tr. Vol. 11 at 219:8-19.
[706] Tr. Vol. 11 at 219:8-19.
[707] Tr. Vol. 11 at 219:20-220:6.

Dr. Brownlow asserted that the quarry has solution cavities and ledges which are pathways for water movement.[708] Caliche is hard then it dissolves and becomes more porous, then it is filled in. He stated it has solution cavities, fractures, plains, and seams that water will migrate through.[709]

Dr. Brownlow stated that the rock is highly dense, so there is no permeability and no voids, and water does not go through the rock, it goes around the hard rocks.[710] It goes through faults, fractures, and fissures.[711] The caliche is not uniform throughout the subsurface.[712] He found solution cavities and collapsed features in the quarry.[713] He stated the large boulders in the quarry cannot be characterized or identified with a single 5 to 6 inch hole being drilled by air rotary.[714] Dr. Brownlow testified that water does not flow through the large boulders, but flows around the structures.[715]

Dr. Brownlow testified that the quarry material on the Mabee Ranch is comparable to what exists at the proposed landfill site.[716] He testified that the material he observed at the Mabee Ranch quarry is about 10 percent clay, 50 percent sand, and 40 percent gravel, not the 30 percent clay and 70 percent sand as represented by Trihydro.[717] He also testified that the blasting needed for the landfill pits where water is 40 feet beneath the site would create pathways.[718] The blasting that would be needed to develop the landfill would create additional fractures in the substrata beneath the landfill.[719] He said that after blasting, the quarry floor is permeable and the water travels to the aquifer rapidly.[720]

c. Facility Design

Dr. Rogers testified that he has not used GCLs on his sites because of proximity to groundwater and the need to find fat clays.[721] He asserted that he has had a secondary natural barrier at the locations of his hazardous waste landfills.[722] Dr. Rogers stated that the site does not have a sensitive ecosystem, but it has a sensitive hydrosystem due to groundwater recharge.[723]

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[708] Mabee Ex. 12 at 3-7; Tr. Vol. 11 at 221:2-222:9.
[709] Mabee Ex. 12 at 3-7; Tr. Vol. 11 at 221:2-222:9.
[710] Tr. Vol. 11 at 223:5-15.
[711] Tr. Vol. 11 at 223:5-15.
[712] Tr. Vol. 11 at 224:8-13.
[713] Tr. Vol. 11 at 225:5-11.
[714] Mabee Ex. 12 at 9, 10; Tr. Vol. 11 at 225:25-226:4.
[715] Tr. Vol. 11 at 226:5-11.
[716] Tr. Vol. 11 at 227:6-10.
[717] Tr. Vol. 11 at 227:11-19.
[718] Tr. Vol. 11 at 230:11-16.
[719] Tr. Vol. 11 at 230:17-231:1.
[720] Tr. Vol. 11 at 232:23-233:7.
[721] Tr. Vol. 11 at 47:16-22.
[722] Tr. Vol. 11 at 48:9-12.
[723] Tr. Vol. 11 at 56:13-22.

Dr. Rogers testified that all liner systems leak even with the best quality assurance.[724] The action leakage rate allows for a certain amount of liquid to leak out the liner.[725] He stated that a landfill needs secondary containment in the form of natural clays to prevent a leak from reaching groundwater.[726] He further argued that the GCL does not have the same healing properties of ten feet of fat clay beneath a facility.[727] Ten feet of clay has the ability to swell and fill voids, and the GCL has some ability to do that as well, but if the liner and GCL are pulled apart in any way, it reduces the effectiveness of the liner system.[728] GCLs need to be hydrated appropriately, and if there is much calcium on the subsurface, like at this site, the operator needs to confirm the GCL is installed and hydrated correctly.[729]

Dr. Rogers testified that the liner that goes over the temporary berms in the interior of the landfill cells are only going to have only one liner.[730] He asserted if a liquid leaks through the liner system to the GCL, and the GCL ends at the edge of cell without going over the interior berms, the liquid will migrate on the top of the GCL and go to groundwater.[731] A slickenside feature would be created from the leak because the clays in the GCL will not expand properly, and will allow for preferential pathways for contaminants.[732] The GCL does not go over the interior berm, so liquids may flow over the GCL to groundwater.[733]

Dr. Rogers expressed concern that if the temporary berms do not have sufficient volume to contain runoff from the waste and the water overtops the berm, and the liner for the new cell is not built, the water would go directly through the subsurface to groundwater.[734] He testified that once the temporary berm is removed but the liner has not been installed, there is no containment.[735] He testified that no calculations have been presented to demonstrate if a 25-year 24-hour event can be contained in the berms, and he believes the volume calculation should be for 50-year or 100-year flood event.[736]

Dr. Rogers testified that even though the material passes the Paint Filter Test, it can still have a significant amount of moisture when it is being placed in the cells.[737] He states that the Paint Filter Test determines that the waste is not a free-flowing liquid.[738] The liquid content in the waste could be up to 20 percent.[739] Waste that passes the Paint

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[724] Tr. Vol. 11 at 78:5-79:8.
[725] Tr. Vol. 11 at 78:5-79:8.
[726] Tr. Vol. 11 at 79:4-16.
[727] Tr. Vol. 11 at 81:2-12.
[728] Tr. Vol. 11 at 81:15-22.
[729] Tr. Vol. 11 at 82:3-12.
[730] Applicant Ex. 4, C-40; Tr. Vol. 11 at 82:18-83:2.
[731] Tr. Vol. 11 at 83:18-84:8.
[732] Tr. Vol. 11 at 83:18-84:8.
[733] Tr. Vol. 11 at 83:18-84:8.
[734] Tr. Vol. 11 at 84:9-17.
[735] Tr. Vol. 11 at 84:20-85:3.
[736] Tr. Vol. 11 at 85:4-22.
[737] Tr. Vol. 11 at 86:17-21.
[738] Tr. Vol. 11 at 88:9-15.
[739] Tr. Vol. 11 at 88:24-89:2.

Filter Test still has water that leaks out of the waste, and if there is a rainfall event, water will collect at the bottom of the pit.[740]

Dr. Rogers discussed the fact that trucks will be exiting disposal pits and will be driving over unprotected areas.[741] Heavy equipment will be driving over the liner system and he opined that he would expect fabric to be placed over the liners for additional protection from heavy equipment.[742]

Dr. Rogers testified the hydration of a GCL is very important, and he has not seen the type of GCL HR Martin proposes to use or the hydration procedures.[743] The clay in the GCL can be displaced when driving over the top of it with heavy equipment.[744] The GCL will not be welded or connected like the HDPE liners and will terminate at the edge of the cell, and if waste is on the GCL, it could act as a preferential pathway to groundwater.[745]

Dr. Rogers claimed the GCL has sodium bentonite and the GCL should be tested to determine compatibility with the waste and the substrate the GCL would be in contact with.[746] A compatibility test of the GCL with the waste material and substrate has not been performed to determine if the GCL can maintain hydration.[747] Dr. Rogers maintained oil waste has the potential to create slickenside preferential pathways when using GCL liners.[748] The type of GCL whether powdered or granular will determine the GCL's effectiveness.[749]

Dr. Rogers expressed concern regarding the seaming and welding activities.[750] If the HDPE liner is not put down correctly and waste is placed on the liner, the liner could split at the seams.[751] If the liner has folds, the stress of the weight of the waste on the liner can cause holes.[752] He reviewed the leakage models used by HR Martin, and opined that the number of leaks HR Martin is assuming is optimistic. He further argued the amount of head in the model should be the 12 inches in the sump, and he is unsure if the GCL will maintain its hydraulic conductivity at pressure.[753] Dr. Rogers stated the 1.5 millimeter manufacturing defects is not realistic for the models.[754]

Dr. Roger argued the estimate of four ounces based on one 1.5 millimeter hole per an acre per day is unsupported.[755] The modeled leakage through the liner system,

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[740] Mabee Ex. 6 at 15; Tr. Vol. 11 at 90:9-91:3.
[741] Tr. Vol. 11 at 82:18-93:1.
[742] Tr. Vol. 11 at 93:20-94:14.
[743] Tr. Vol. 11 at 96:2-15.
[744] Tr. Vol. 11 at 96: 16-25.
[745] Tr. Vol. 11 at 97:9-98:11.
[746] Tr. Vol. 11 at 98:17-99:12.
[747] Tr. Vol. 11 at 98:17-99:12.
[748] Tr. Vol. 11 at 99:19-101:4.
[749] Tr. Vol. 11 at 102:12-103:11.
[750] Tr. Vol. 11 at 103:23-104:1.
[751] Tr. Vol. 11 at 104:8-22.
[752] Tr. Vol. 11 at 104:8-22.
[753] Tr. Vol. 11 at 109:2-111:9.
[754] Tr. Vol. 11 at 112:11-22.
[755] Tr. Vol. 11 at 120:4-9.

assumes 0.2 inches of head on a potential leak and only considers moisture from rain events, not moisture level in waste.[756] Dr. Rogers testified that Trihydro's leakage modeling did not account for the 15 to 20 percent moisture content in the waste itself.[757]

Dr. Rogers testified that the rainfall data used by Trihydro was from El Paso and not Midland, while the evaporation data was from Midland.[758] He further contended that modeling should include precipitation from the 50-year or 100-year rainfall event, not the 25-year, 24-hour rainfall event to ensure that runoff can be safely contained within the berms.[759]

d. West Texas Mud Case

Dr. Brownlow compared this case to case involving West Texas Mud Disposal, LLC, in which the landfill application was denied. He testified that both facilities are in West Texas, both are over major aquifers. He made various comparisons to the case to demonstrate the similarities. Dr. Brownlow agreed that a similar decision should be made for HR Martin's Application; it should be denied.[760]

C. Summary of the Kelton and Johnston Protestants' Position

Jeff Johnston, protestant, is an oil and gas attorney in Midland, Texas.[761] He resides with his wife, Sandra Johnston, and his son in western Martin County near the proposed location of the landfill.[762] He has lived in that location since 1992.[763] Their home is approximately 800 to 900 meters north of the northern boundary line of the proposed landfill. [764]

Mr. Johnston testified that the ownership of the tract north of the facility was not correctly reflected by the Applicant.[765] Rather, the 360-acre Kelton tract which is north of the landfill site was subdivided into six strips of land. Jeff Johnston described the subdivided tracts from north to south stating the Johnston family owns the northernmost tract. That track is also where the Johnston family homestead is located. The next tract is owned by the Rogers family. The next tract south is owned by Mr. Miller. The following track south is owned by Robert W. Kelton Jr. and his family. Mr. Gray owns approximately 60 acres of the subdivided 360-acre tract. Mr. Gray's tract is the fifth tract from the north. Mr. Gray has resided on the property for possibly 40 or more years. The final tract immediately adjacent to the proposed landfill site is the tract owned by the Edward Kelton

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[756] Mabee Ex. 6 at 18; Tr. Vol. 11 at 121:8-122:3.
[757] Tr. Vol. 11 at 122:11-23.
[758] Tr. Vol. 11 at 122:24-123:10.
[759] Tr. Vol. 11 at 124:10-125:4.
[760] Tr. Vol. 12 at 153:2 to 165:20; Mabee Ex. 3.
[761] Tr. Vol. 12 at 10:3 to 10:10.
[762] Tr. Vol. 12 at 10:17 to 10:24.
[763] Tr. Vol. 12 at 10:11.
[764] Tr. Vol. 12 at 11:10 to 11:15.
[765] Kelton and Johnston Ex. 1.

and his immediate family. Edward Kelton and Betty Howell's property runs the length of the landfill. [766]

Mr. Johnston testified they have a water well on their tract. Mr. Gray's home is 742 feet from the landfill facility.[767] The Johnston family well is a producing water which the Johnstons rely upon for domestic and livestock needs. The well was drilled at the same time the home was built approximately 50 years ago. The well is screened into the top of the Ogallala Aquifer formation. Johnston believes Mr. Gray is also relying on well water as that is the only realistic way to get water. There is no municipal water service within many miles of the area.[768]

Mr. Johnston testified that he understood the landfill would be a 160-acre tract and would be approximately twice as wide as the distance of the landfill location to the Johnston family property. He testified that he also understood that the site would be an active repository for oilfield waste for approximately 25 to 30 years. [769]

Mr. Johnston discussed his concerns about the types of waste that would be disposed of in the landfill. He stated that he understood the landfill would store tank bottoms, oilfield waste, RCRA exempt waste which could be hazardous. The Application discussed disposal of bottom sediments from tank bottoms which have volatile organic compounds. Additionally, there would be fracture stimulation flowback which also contains a lot of chemicals that would be disposed of at the facility.[770] Furthermore, heavy metals such as barium, selenium, and arsenic would be disposed of in the site along with possibly hundreds of thousands of barrels of petroleum hydrocarbons.[771]

Mr. Johnston testified that the evaporation of organic compounds is going to be part of the stabilization process and creates a cause for concern to his family. Furthermore, he expressed concern about the timeline proposed in that the entire 160-acre tract is not going to be constructed or excavated all at once. Rather it is going to be constructed piecemeal meaning continuous operation, excavation, and blasting for 30 years near where he lives. He does not believe the Application should be approved.[772]

Mr. Johnston testified that the human habitation, livestock, and agriculture in the area are all supported by the Ogallala Aquifer and that the landfill operation would be a risk to that groundwater.[773] He testified there have been instances in the Midland area where groundwater contamination has occurred which has destroyed the habitability of the land.[774]

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[766] Tr. Vol. 12 at 12:12 to 16:5.
[767] Tr. Vol. 12 at 17:17 to 18:21; Kelton and Johnston Ex. 4.
[768] Tr. Vol. 12 at 20:10 to 21:25.
[769] Tr. Vol. 12 at 23:6 to 24:25.
[770] Tr. Vol. 12 at 25:1 to 25:25.
[771] Tr. Vol. 12 at 26:1 to 26:10.
[772] Tr. Vol. 12 at 27:1 to 27:25.
[773] Tr. Vol. 12 at 28:5 to 28:25.
[774] Tr. Vol. 12 at 29:11 to 29:14.

Mr. Johnston testified that he was also concerned about the health impacts of dust and water contamination as well as truck traffic and noise which is going to be associated with the lease operations for the next 30 years.[775] Their quality of life would be affected due to the heavy earthmoving equipment and 18-wheeler truck traffic hauling waste.[776]

Mr. Johnston testified the area is fairly flat therefore, the proposed site of the landfill would be the singular visible object in the horizon in any direction.[777]

Mr. Johnston testified that he also had concerns regarding whether the caliche layer is an impermeable and impenetrable barrier between water on the surface of the ground and the Ogallala Aquifer. Additionally, the synthetic liner has not existed for long enough for him to "bet the farm." He argued the Johnston family will be the one suffering the consequences 30 years from now if the liner fails.[778]

Sandra Johnston, protestant, testified she has lived with her husband Jeff Johnston at the house north of the proposed landfill for 27 years.[779] Ms. Johnston stated she is bothered by how the landfill will change their lives.[780] She testified that their lives would be unalterably changed for the worse if the facility were to be built south of their house.[781]

She stated she agrees with all of the facts laid out in Mr. Johnston's testimony and with the technical concerns raised by the Mabee Protestants.[782] She testified she was concerned about water contamination and air quality issues and that there would be carcinogenic materials disposed of in the area. She stated she was scared about the health issues as a cancer survivor and a diagnosed asthmatic.[783] She stated she did not want to breathe the dust nor the evaporating toxic substances.[784]

V. Examiners' Analysis

The Examiners conclude that HR Martin failed to prove that groundwater will be protected from pollution, which is the permitting criteria required by Statewide Rule 8.

A. Geology

a. Soils

The soils on the Site are Midessa and Amarillo soils, which is described as a fine sandy loam. The soil borings show the soil is present to a depth of 10 feet bgs. The soils

[775] Tr. Vol. 12 at 30:1 to 31:25.
[776] Tr. Vol. 12 at 31:1 to 32:25.
[777] Tr. Vol. 12 at 34:1 to 35:25.
[778] Tr. Vol. 12 at 35:1 to 38:25.
[779] Tr. Vol. 12 at 39:14 to 39:22.
[780] Tr. Vol. 12 at 41:11 to 41:21.
[781] Tr. Vol. 12 at 42:14 to 42:21.
[782] Tr. Vol. 12 at 40:1 to 40:18.
[783] Tr. Vol. 12 at 40:23 to 41:10.
[784] Tr. Vol. 12 at 42:7 to 42:13.

will generally be removed during the construction of the landfill and the other pits. Mr. Rogers testified that the soil survey shows the soils on the Site have a high capacity to transmit water, meaning the soil is permeable.[785] Though the soils will be removed in the pit areas, the soil must be suitable for the transport and handling of waste over unlined portions of the facility. The Examiners find that the soil is well-drained and permeable and is not suitable for the proposed landfill activities.

b. Groundwater

The Examiners also find there are no naturally occurring impermeable layers below the pits and other operational areas of the proposed facility, between the bottom of the site and shallow groundwater. During the sampling events, water was encountered at approximately 63 to 70 feet bgs. Both parties provided evidence that the depth to groundwater was shallower in the past but has gotten deeper over time. Dr. Brownlow provided evidence that though water is detected presently between 65 to 70 feet bgs, the groundwater level may fluctuate seasonally. He stated that his borings found porosity and solution cavities demonstrating groundwater occurring at shallower depths. He testified that groundwater could be as shallow as 40 feet bgs. Mr. Schreuder argues that the GCL, double liner system, and LDS are sufficient to prevent contaminates from reaching groundwater, even if there is no naturally occurring impermeable layer between the bottom of the landfill and groundwater. The Examiner find the static water levels, though reasonably consistent, fluctuate over time.

c. Ogallala Aquifer Recharge

The proposed facility is in the recharge zone for the Ogallala Aquifer, and though there are no playas identified on the site, the Examiners conclude that the site provides recharge for the aquifer. The Ogallala Aquifer contains high-quality groundwater that is widely used by the residents of Martin County. HR Martin asserted that playas are the primary recharge feature in the area. In contrast, Dr. Rogers provided evidence that there are areas where playas can be formed, but those sites require clays in soils for playas to develop. He argues that the site does not have playas because it is in an area where playas do not develop due to a lack of clay in the soil. Rather than the site being in a playa or interplaya area, he contends the site is neither. Clays are not in the soil to facilitate runoff to playas, instead the onsite soils are sandy and well-draining allowing for precipitation to infiltrate directly into the subsurface providing recharge to the aquifer.

Topographic depressions are also required for the formation of playas. The site is sloping one percent from west to east. Neither party identified a topographic low on or around the site. Mr. Pekas testified that playas require clay in soils for playas to form and topographic depressions to collect water. Due to the well-draining sandy soil and a lack to topographic lows on the site, the Examiners find that the site is not in a playa forming area, and the site recharges the Ogallala Aquifer through precipitation infiltrating directly through the sandy soils into the subsurface.

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[785] Mabee Ex. 6, Pg. 11; Tr. Vol. 13 at Pg. 44:12-45:9.

d. Subsurface Geology

Both HR Martin and the Mabee Protestants state there are no fat clays between the bottom of the pits and the water table. HR Martin asserts that the caliche layer below the site is very hard and heavily cemented, therefore could impede the infiltration of liquids from the surface to groundwater. Mr. Pekas notes the water level in the groundwater monitor wells rose between the time when water was first encountered while drilling and the water level after monitor well completion. He asserts this is evidence of confinement. Dr. Brownlow provided the more compelling argument that the hard caliche is vulnerable to cracks, fractures, and fissures, and that the caliche fractures can act as conduits for fluid migration from the site to shallow groundwater. He stated that he does not find a confining layer and pointed to the water levels fluctuating between later sampling events. He also opined that the air rotary method Trihydro used pushed water into formation while drilling potentially causing inaccuracies in water level measurements.

The cracks and fractures in the caliche were observed in the photos of samples and photos of the caliche quarry pit presented during the hearing. Mr. Mabee and Dr. Brownlow both testified that the hardness of the caliche will require blasting to get to the pit depths described in the facility design plans. The cracks and fractures could be exacerbated by the blasting activities that may be utilized to excavate the pits at the facility, increasing the potential for water to infiltrate from the surface to groundwater.

The utilization of hollow stem augers and air rotary drilling in the site characterization did not provide adequate information to demonstrate that the caliche is impermeable and confining. Mr. Brownlow provided boring logs from wells he drilled using sonic drilling that demonstrated the variable nature of the caliche and the potential pathways for liquid to travel from the bottom of the pits to the aquifer. In the sonic drilling samples, he pointed out small scale fractures and solution cavities that act as conduits for fluid migration. Trihydro did not find this information during their site investigation because of their low recovery of samples and methods used to drill its borings.

The Examiners find the testimony and evidence provided by Mr. Brownlow regarding a visit to a quarry 2.5 miles away on the Mabee Ranch to be compelling. He presented pictures of the quarry during the hearing to show the fractured nature of the caliche. Though the material is hard and heavily cemented, there are larger grains and even boulder sized rocks randomly disbursed throughout the caliche. The water cannot penetrate these larger rocks within the caliche, but the water flows along the seams around the rocks down to shallow groundwater. Mr. Schreuder conceded during his testimony that he cannot conclude the caliche is consistently impermeable across the Site.

B. Site Characterization Methods

Trihydro utilized both hollow stem augers and air rotary drilling to perform its soil borings. Mr. Krembs and Ms. Harper both testified that the material was very hard and were only able to recover only up to 50 percent of the amount of each sample for site characterization.

Dr. Brownlow testified that air rotary is an inadequate method for sample collection because the air rotary drilling will pulverize the rock. He also stated that using hollow stem auger drilling is not appropriate for hard rock such as caliche. Dr. Brownlow presented samples from the sonic drilling method he used just across the property boundary on the Mabee Ranch. He testified that this method achieves nearly 100 percent sample recovery. Because this sonic drilling does not destroy the sample or add water or heat, the natural characteristics of the rock is visible, and can show the fractures and solution cavities within the sample.

The Examiners find Dr. Brownlow's sonic drilling method more persuasive than HR Martin's drilling methods for obtaining samples for site characterization. The sonic drilling method produced a sample recovery of nearly 100 percent and provided for more accurate evaluation of the site's subsurface characteristics.

C. Facility Design

The Examiners find the Applicant failed to demonstrate the liner system design and the phased approach of filling the landfill cells is adequate to prevent pollution from contaminating groundwater. The landfill will be built one cell at a time, and at the interior edge of the new cell, a temporary toe berm will be used to keep in waste and potential runoff from precipitation. While most of the pits are lined with a GCL and double liner leak detection system, only the secondary liner is placed over the temporary berm. The GCL, the primary liner, and LDS end on the side of the berm, and do not go over the top. There is only one liner on the interior slope of an open landfill cell, which is the area that is most likely to collect stormwater runoff and liquids from the waste.

a. Single Lined Temporary Toe Berm

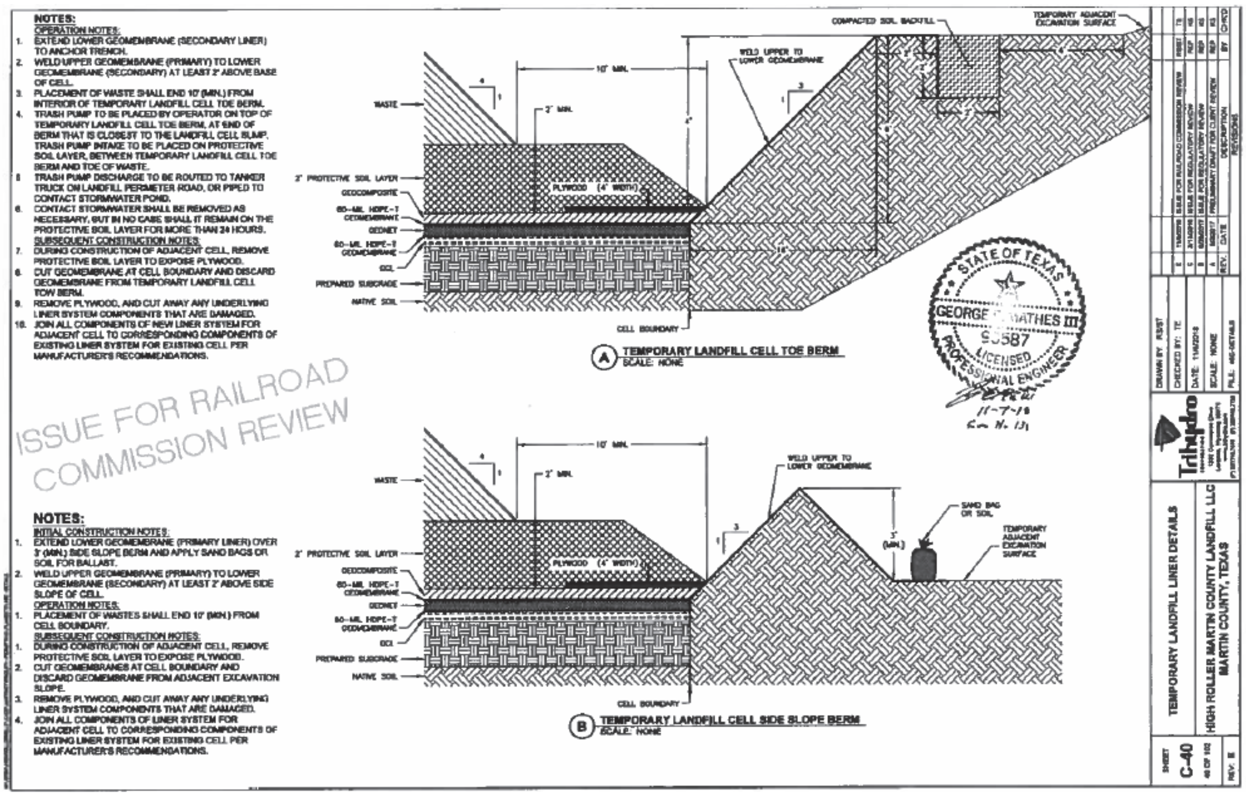
HR Martin presented only one liner goes over the top of the temporary landfill cell toe berm. The primary liner is welded to the secondary liner part of the way up the interior slope of the temporary berm but does not go over the top. There is no GCL or naturally impermeable layer below the secondary liner at the temporary toe berm that will be collecting contact stormwater.

With the single liner and no impermeable layer such as clays between bottom of the landfill and groundwater, the Examiners find this is an area with potential for the migration of contaminates to the aquifer.

The Applicant also stated that the temporary berms will be constructed of native soils and will not necessarily meet the standards of the perimeter berm in terms of moisture content and compaction. In the area of the pit where surface runoff will come directly off the waste and collect, there will only be a single liner that will not be up to same standards as other berms in the facility.

The GCL and double liner leak detection system end at the cell boundary. The primary liner will be welded to the secondary liner partially up the berm, but only a single liner goes over the top of the berm.

Design drawing of temporary toe berm detail.[786]



Mr. Schreuder stated that he did not calculate the berms volume capacity or determine if it can contain the volume of a 25 year, 24-hour rainfall event. He testified that the pumps would pump that water out before the water would overtop the berm. But if the pumps do not operate properly, and water overtops the berm, there is no liner, GCL, or naturally occurring impermeable layer to prevent the infiltration of contaminants to groundwater.

The temporary toe berm will be used on the interior slopes of the cells. At certain points during the life of the facility, up to four cells will be open at once, and these four cells will be utilizing the single lined temporary toe berms.

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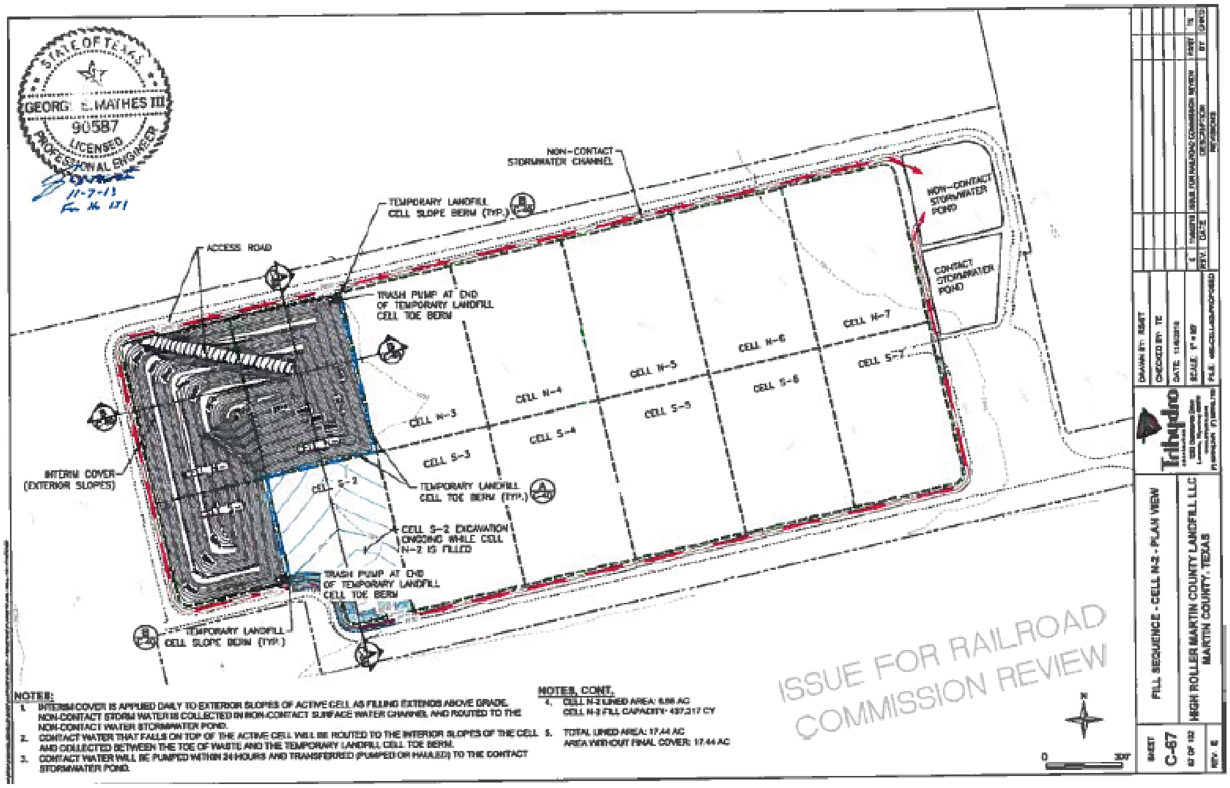
[786] Applicant Ex. 5 at C-40.

**Design drawing of Cells N-1, S-1, and N-2.
Cells are filled with interior slopes facing recently constructed Cell S-2.
The interior slopes are bordered by the single-lined temporary toe berm.**[787]



The waste material will be sloped inward towards the intersection of Cells N-1, S-1, and N-2. During rainfall events, the waste material stormwater runoff would be directed towards this intersection that is contained by a single-lined temporary landfill berm while Cell S-2 is being constructed. Due to the runoff being directed by the slope of the waste to this corner, more water will collect at this point within the temporary toe berm that is not underlain by GCL or double liner LDS. Only one liner will be protecting the temporary toe berm; the GCL and double liner LDS below the filled cells will terminate prior to reaching the temporary toe berm.[788]

Mr. Behling testified that he knows of no other facility that has as many as 14 cells, such as the proposed facility. He believes seven is the most he has seen. Some are as large as the proposed landfill but with fewer cells. He not seen permits with four cells open at once and has not been involved in any permit cell design like the proposed landfill, with four cells being open at a time and two exposed toe berms.[789]

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[787] Applicant Ex. 4 at C-57.
[788] In the Final Closing Statement of HR Martin County Landfill, LLC, HR Martin indicated, "HR would not consider it adverse if the permit included a condition that the liner system be extended along the interior side of the temporary berms, so that the liner system for the temporary berms matches the liner system for the entire disposal cell."
[789] Tr. Vol. 7 at 149:1 to 151:12.

b. GCL Effectiveness

HR Martin asserted that the GCL is the equivalent of having two feet of clay beneath the proposed landfill. The GCL is approximately 0.25 to 0.5 inches thick and has a hydraulic conductivity of 5×10^{-9} cm/sec as opposed to the 1×10^{-7} cm/sec hydraulic conductivity standard for clay liners listed in the Commission's Surface Waste Management Manual. The Examiners find that the GCL when installed correctly and is compatible with the waste and underlying material, the GCL can attain that permeability standard.

Below the truck wash pad, receiving pits, contact stormwater pond, and landfill cells, the operator will install a GCL below the liner system. The GCL will have a large load of waste on top of it, approximately 100 feet above grade, and while the cell is active heavy equipment will be moving on top of it. The large loads on top of the GCL may cause the clay within the GCL to be displaced and reduce the effectiveness of the GCL.

The landfill cells will be constructed one at a time over the life of the facility. The active landfill cells will have a GCL over the outer berms of the cell, but the GCL will end abruptly at the edge of the cell prior to reaching the temporary toe berm. Mr. Rogers expressed concern regarding the GCL ending at the cell boundary and does not go over temporary berm. Because the GCL ends at the edge of the cell, the conditions from the side of the GCL is not controlled, and could affect the GCL's ability to maintain hydration.

HR Martin did not provide the exact type and specification of the GCL that will be used at the facility during the hearing or in the Application. Therefore, it is unknown whether the GCL will be compatible with the type of waste at the facility or with the calcium rich excavated surface.[790]

The Mabee Protestants also argued that the life expectancy of the GCLs has not been fully researched and is still unknown. Given that the facility will permanently entomb waste over the Ogallala Aquifer without an impermeable clay layer below the site, they are concerned that the GCL will not be able to maintain its effectiveness. They argue fat clays have been used at similar facilities and have demonstrated that they can be effective long-term. Because GCLs have only been used for about 30 years, it is unknown if GCLs will remain impermeable in perpetuity.

The uncertainty of the type of GCL that will be used and the potential issues with installation, hydration, and longevity cause the Examiners to question the effectiveness of the GCL as the sole impermeable layer between the landfill and Ogallala Aquifer.

c. Drying Pads

The three drying pads are pits that are lined with a single eight-inch concrete liner over washed rock and prepared subgrade. The drying pads do not have a double liner

[790] In the Final Closing Statement of HR Martin County Landfill, LLC, HR Martin stated, "HR would not consider it adverse if the permit included a condition that the Commission would be required to approve the GCL specifications and type prior to installation."

system, LDS, or GCL. Mr. Schreuder testified that the drying pads are intended to only hold waste temporarily. Should any cracks develop in the concrete liner or a spill occur while handling waste, the Examiners find that there is not the additional protection of a GCL or a naturally occurring barrier in the subsurface to prevent contaminants from reaching the Ogallala Aquifer.

d. Unlined Operational Areas

The Examiners find the handling and transport of waste over unlined areas of the facility make groundwater vulnerable to contamination. The interior roads of the facility are unlined. The entrance to the facility is to the east, and the landfill cells will be constructed from west to east. When a truck enters the facility with waste, the truck must use the unlined road to access either the drying pads or the receiving pits, which are on the east side of the facility, or drive directly across the entire property until it reaches the active cell. During the early life of the facility, this could be across multiple acres that are unlined. The truck will then drive into the active disposal cell to unload waste. After driving in the cell, it will drive back across the unlined portion of the facility to the exit. The Applicant described the road as all weather.

Trucks carrying waste that passes the Paint Filter Test will be transporting the waste past the receiving pits all the way into the landfill cells. The Protestant provided the compelling argument that if there happens to be waste on the truck or on the tires, and that waste falls on the road and it rains, the water that comes off the roads over which trucks are carrying waste, will either infiltrate through the soils or will be collected and diverted to the non-contact stormwater pond which is unlined. With no liner and no naturally occurring geologic barriers, the contact stormwater from the roads could percolated through permeable substrate and into the Ogallala Aquifer.

Though HR Martin witnesses testified that in the areas of the pits, the sandy soils will be removed, there are areas of the facility that may contact waste where the soils will not be excavated. Sandy soils drain too well to prevent pollution. If waste gets released on any part of the facility that has not been excavated, the soils themselves do not have the capacity inhibit the flow down to groundwater.

The Mabee Protestants provided evidence that the onsite sandy soils are not well-suited for operational activities, and though the pits are lined, the areas where the waste is transported is not, further providing potential for groundwater contamination.

e. Leakage through Liners

HR Martin provided testimony on the leakage rate from the bottom of the landfill cells through the liner system into the subsurface. Though the leakage rate is reported to be less than a cup of coffee each day, waste is still getting through the liner system, and with no barriers between the bottom of the liner system and aquifer, the Examiners find that there is the potential to impact groundwater.

D. Administrative Denial

The HR Martin application was originally denied by Staff in December 2017. The denial letter states, "the proposed disposal facility is in an area that is unsuitable for the permanent internment of oil and gas waste."[791] The Examiners concur with the denial letter in that the site is located in the Ogallala Aquifer recharge zone with no naturally occurring impermeable barriers such as fat clays between the bottom of the landfill and groundwater to prevent the pollution of the aquifer. Furthermore, the Examiners find that the soils are well-drained and permeable, and therefore, not suited for oil and gas waste management and disposal activities. The Examiners do not agree with HR Martin that the liner system and GCL below the landfill cells and pits are adequate to protect shallow groundwater.

The Mabee Protestants provided testimony on the similarities between this case and the West Texas Mud Case Disposal, LLC case that was denied. The Mabee Protestants assert a similar decision should be made for HR Martin's Application. The Examiners note the similarities and differences between the two cases. The Examiners' decision for the proposed HR Martin landfill is based on the site-specific geologic information and unique design presented during this case, and not the content of previous cases.

After review and consideration of the evidentiary record and the parties' arguments, the Examiners recommend the Commission deny the application.

VI. Recommendation, Proposed Findings of Fact and Proposed Conclusions of Law

The Examiners recommend the Commission deny the Application and adopt the following findings of fact and conclusions of law.

Findings of Fact

1. HR Martin County Landfill, LLC ("Applicant" or "HR Martin"), Operator No. 407462, filed an application ("Application") for a permit to operate a commercial oil and gas waste stationary treatment facility (No. STF-0129) in Martin County, Texas under 16 Tex. Admin. Code § 3.8 ("Statewide Rule 8").

2. The Application includes separate pit applications for each of the following:

    a. Fourteen landfill cells (Nos. P012602A, P012602B, P012602C, P012602D, P012602E, P012602F, P012602G, P012603A, P012603B, P012603C, P012603D, P012603E, P012603F, P012603G)
    b. Three drying pads (Nos. P012655, P012656, P012657)
    c. Two receiving pits (Nos. P012752, and P012753)

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[791] HR Ex. 30.

d. One truck washout pad (No. P012654), and
e. Two contact stormwater ponds (Nos. P012604, P012605).

3. The Application was published in the Martin County Messenger for two weeks.

4. The initial application for the proposed facility was filed in October 2017; and the initial application was administratively denied by the Commission in December 2017.

5. HR Martin resubmitted the application in March 2018 with a revised facility design.

6. The Application is protested by John W. Mabee and Joseph “Guy” Mabee (“Mabee Protestants”), landowners of the Mabee Ranch adjacent to the proposed facility.

7. The Application is also protested by Edward Kelton, Betty Kelton Howell, Jeffrey M. Johnston, and Sandra K. Johnston (“Kelton and Johnston Protestants”), landowners near the proposed facility.

8. On May 21, 2019, the Hearings Division of the Commission sent a Notice of Hearing for the Application via first-class mail setting hearing dates of October 1, 2019 through October 8, 2019. The notice contained (1) a statement of the time, place and nature of the hearing; (2) a statement of the legal authority and jurisdiction under which the hearing is to be held; (3) a reference to the particular sections of the statutes and rules involved; and (4) a short and plain statement of the matters asserted. The hearing was held on October 1, 2019 through October 8, 2019, as noticed. The hearing was recessed at the end of the day on October 8, 2019 and resumed at the agreed date of January 23, 2020. The hearing was recessed at the end of the day on January 23, 2020 and resumed at the agreed dates February 3, 2020 through February 11, 2020. Consequently, all parties received more than 10 days’ notice. HR Martin, the Mabee Protestants, and the Kelton and Johnston Protestants appeared at the hearing and presented evidence.

9. HR Martin has an active organization report, Commission Form P-5, on file with the Commission.

10. HR Martin or one of its affiliate companies currently owns the 160.037-acre property in Martin County where the facility is to be located and has owned it for more than a year prior to filing the Application.

11. HR Martin plans to transfer the permit for the proposed facility to Milestone Environmental Services prior to construction and operation.

Proposed Pit Construction and Utilization

12. In the Application, the Applicant proposes a liner system for each pit in the proposed facility will be constructed as follows (from bottom to top):

a. The drying pads are proposed to be constructed with prepared subgrade, washed rock and an eight-inch concrete liner;
b. The receiving pits are proposed to be constructed with prepared subgrade, a geosynthetic clay liner ("GCL"), a 60-mil high density polyethylene ("HDPE") liner, a 200-mil geonet, and a 60-mil HDPE liner;
c. The truck wash pad are proposed to be constructed with prepared subgrade, a GCL, a 60-mil HDPE liner, an 8-ounce geotextile, and an eight-inch concrete liner;
d. The contact stormwater ponds are proposed to be constructed with prepared subgrade, a GCL, an HDPE liner, a 200-mil geonet, and a 60-mil HDPE liner; and
e. The landfill cells are proposed to be constructed with prepared subgrade, a GCL, a 60-mil HDPE liner, a 200-mil geonet, and a 60-mil HDPE liner.

13. According to the Application, the proposed facility would accept RCRA exempt and RCRA non-exempt oil and gas waste.

14. According to the Application, oil and gas waste that would be received by the proposed facility would be tested for free liquids by the Paint Filter Test.

15. Applicant proposes to use the drying pads and receiving pits for the temporary storage of oil and gas waste that does not pass the Paint Filer Test.

16. The landfill cells are proposed to be used only for the disposal of dry, solid waste that passes the Paint Filter Test.

17. According to HR Martin, the truck wash pad would be used to wash out trucks prior to leaving the facility.

18. Applicant proposes that contact stormwater will be pumped from the cells or other pits (drying pads, receiving pits, or truck washout) and trucked or piped to lined contact stormwater ponds.

19. The non-contact stormwater pond is unlined, and only designed for the storage of water that has not contacted waste in the facility.

Ogallala Aquifer

20. The proposed facility is located on an outcrop of the southern part of the Ogallala Aquifer, an aquifer that is widely used throughout the region.

21. The Ogallala Aquifer has a total dissolved solids concentration of 300 to 1,000 parts per million ("ppm") in the area near the proposed facility.

22. The Ogallala Aquifer contains usable quality groundwater.

23. Water levels in the Ogallala Aquifer have been tracked and are declining over time. US Geological Society data for a water well adjacent to the proposed landfill show the depths from surface to groundwater from 35 feet in 1952 to 48 feet in 1982.

24. Groundwater gradient is consistently west to east.

25. Static water levels in the seven groundwater monitor wells on the proposed facilities range 57.00-64.83 feet bgs in March 2017 to 57.78-66.45 feet August 2019. The variation in water level between the two sampling periods ranged from 0.44-2.20 feet bgs.

Recharge

26. Playas are closed, shallow basins that accumulate water. The water does not have an outlet from the playa. Playas are recharge features.

27. Playas require clays in soils and topographic depressions to form. If there is an insufficient amount of clay in soil or no topographic depressions, the conditions are unfavorable for playas to form.

28. The site has Midessa and Amarillo soils that the USDA describes as well-draining, fine sandy loam.

29. The lack of clay in the soil and lack of topographic depressions make the formation of playas unlikely.

30. The well-draining soils on the site allow for precipitation to infiltrate directly through the soil.

31. The well-draining soils on the site, which contain an insufficient amount of clay to form playas, are not conducive to allowing surface runoff.

32. There is recharge in the location of the proposed facility through direct infiltration of the soil.

33. The proposed facility is in the recharge zone for the Ogallala Aquifer, and the site provides recharge for the aquifer.

34. Due to the well-draining sandy soil and a lack of topographic lows on the site the site is not in a playa forming area, and the site recharges the Ogallala Aquifer through precipitation infiltrating directly through the sandy soils into the subsurface.

Caliche

35. Seven soil borings were installed around the perimeter of the site and three soil borings were installed in the central part of the site. The seven soil borings around the perimeter of the site were converted to groundwater monitor wells.

36. HR Martin used hollow stem auger drilling methods for five of the borings. The sixth boring was started with the hollow stem auger, but due to difficulties drilling through the caliche, it was completed with air rotary drilling. The remaining four borings were performed with air rotary drilling.

37. Soil thickness was approximately 0-10 feet below ground surface ("bgs") followed by caliche down to the termination of its soil borings at depths ranging from 70-80 feet bgs.

38. Dr. Darrell Brownlow, on behalf of the Mabee Protestants, performed two soil borings near the boundary of the proposed facility location using the sonic drilling method.

39. The caliche is very hard and dense.

40. The hollow stem auger and air rotary samples had low sample recovery.

41. Sonic drilling method samples had close to 100 percent sample recovery.

42. The sonic drilling method is a preferred method for determining lithology over hollow stem and/or air rotary samples.

43. Sonic drilling method samples demonstrated variable permeabilities, porosities, cementations, and grain sizes, in addition to showing fractures, fissures, and solution cavities within the caliche.

44. Larger scale fractures, fissures, solutions cavities, and variations in caliche characteristics such as size of rocks and cementation were observed at a quarry 2.5 miles from the proposed landfill site on the Mabee Ranch.

45. The caliche is not a naturally impermeable layer below the site, but a layer that contains fractures, fissures, cracks, and solutions cavities that allows the migration of fluids from the surface to groundwater.

46. The hard caliche is vulnerable to cracks, fractures, and fissures, and that the caliche fractures can act as conduits for fluid migration from the site to groundwater.

47. There are no naturally occurring impermeable layers below the pits and other operation areas of the facility, between the bottom of the site and shallow groundwater.

48. The hardness of the caliche will require blasting to get to the pit depths described in the facility design plans. The cracks and fractures could be exacerbated by the blasting activities that may be utilized to excavate the pits at the facility, increasing the potential for water to from the surface to groundwater.

Threat of Pollution

49. The soil is not suitable for the transport and handling of waste over unlined portions of the facility.

50. Soils are well-drained and permeable, therefore, not suited for oil and gas management and disposal activities.

51. There is no impermeable naturally occurring layer barrier such as fat clays between the bottom of the facility and the Ogallala Aquifer.

52. Operational activities will occur in areas that are not underlain by a GCL, are unlined, or have only one liner. Any spills or leaks occurring in these portions of the facility pose a pollution threat to groundwater.

53. The GCL must be compatible with waste material and the calcium rich underlying substratum. The type of the GCL and its compatibility with the activities at the proposed facility is unknown.

54. The three drying pads have a single concrete liner that is required to be inspected annually. There is no GCL below the liner. Cracks that develop in the concrete liner or spills will not have an impermeable layer protecting groundwater.

55. The landfill cells will be constructed one cell at a time. The active landfill cell will be bordered along the interior of the cell by a single-lined temporary toe berm. Only the secondary liner goes over the top of the temporary landfill cell toe berm. The primary liner is welded to the secondary liner part of the way up the interior slope of the temporary berm but does not go over the top. There is no GCL or naturally impermeable layer below the secondary liner at the temporary toe berm that will be collecting contact stormwater.

56. With the single liner and no impermeable layer such as clays between bottom of the landfill and groundwater, this is an area with potential for the migration of contaminates to the aquifer.

57. The temporary berms will be constructed of native soils and will not necessarily meet the standards of the perimeter berm in terms of moisture content and compaction. In the area of the pit where surface runoff will come directly off the waste and collect, there will only be a single liner that will not be up to same standards as other berms in the facility.

58. The temporary toe berm will be used on the interior slopes of the cells. At certain points during the life of the facility, up to four cells will be open at once, and these four cells will be utilizing the single lined temporary toe berms.

59. HR Martin did not calculate the berms volume capacity or determine if it can contain the volume of a 25 year, 24-hour rainfall event.

60. If water overtops a temporary berm, there is no liner, GCL, or naturally occurring impermeable layer to prevent the infiltration of contaminants to groundwater.

61. The waste material will be sloped inward towards the intersection of the active cells with temporary toe berms. During rainfall events, the waste material stormwater runoff would be directed towards theses intersection that is contained by a single-lined temporary landfill berm. Due to the runoff being directed by the slope of the waste to this corner, more water will collect at the intersection near the temporary toe berm, which is not underlain by GCL or double liner LDS.

62. Only one liner will be protecting the temporary toe berm; the GCL and double liner LDS below the filled cells will terminate prior to reaching the temporary toe berm.

63. HR Martin provided no evidence in the record of another facility with a phased construction and temporary toe berms in which four cells would be active during certain stages of construction.

64. Because GCLs have only been used for about 30 years, it is unknown if GCLs will remain impermeable in perpetuity.

65. The landfill design is 100 feet above grade.

66. The GCL will have a large load of waste on top of it, approximately 100 feet above grade, and while the cell is active heavy equipment will be moving on top of it. The large loads on top of the GCL may cause the clay within the GCL to be displaced and reduce the effectiveness of the GCL.

67. There is an estimated leakage rate for the bottom of the proposed landfill.

68. Though the leakage rate is reported to be less than a cup of coffee each day, waste will still get through the liner system, and with no barriers between the bottom of the liner system and aquifer.

69. The leaks anticipated by the calculated leakage rates have the potential to impact groundwater.

70. The Applicant failed to demonstrate the liner system design and the phased approach of filling the landfill cells are adequate to prevent pollution from contaminating groundwater.

71. HR Martin failed to demonstrate the proposed design and operation of the facility will protect groundwater from pollution.

Conclusions of Law

1. Resolution of the subject application is a matter committed to the jurisdiction of the Railroad Commission of Texas. Tex. Nat. Res. Code § 81.051.

2. Proper notice of hearing was timely issued to persons entitled to notice. *See, e.g.,* Tex. Gov't Code §§ 2001.051, .052; 16 Tex. Admin. Code §§ 1.41, 1.42, 1.45, 3.8(d)(6)(C), (D).

3. The application failed to demonstrate the proposed facilities will not result in the pollution of surface or subsurface water. *See, e.g.,* 16 Texas Admin. Code § 3.8(b), (d)(6)(A).

4. The application does not meet the requirements of Statewide Rule 8. *See, e.g.,* Tex. Admin. Code § 3.8.

Recommendations

The Examiners recommend the Commission deny approval of the Application.

Respectfully,

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Ashley Correll, P.G.
Technical Examiner

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