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March 15, 2022

Westford Planning Commission
Attn: Melissa Manka, Planning Coordinator
Westford Town Office
1713 VT Route 128
Westford, Vermont 05494

Stone Project No. 19-161
Subject: Hydrogeologic Evaluation of the Maple Shade (formerly Jackson Farm “Zone 3”) Disposal Site

Dear Melissa,

We are pleased to provide a summary of the evaluation of the hydrogeologic capacity of the Maple Shade community wastewater disposal site in Westford, Vermont conducted by Stone Environmental, Inc. (Stone). We also present updated system layouts completed by Green Mountain Engineering, Inc. (GME). Based on analysis of available data from several previous investigations at this site and collection of new subsurface information, we conclude:

1. There appears to be adequate capacity for design flows of up to 24,600 gallons per day (gpd).
2. Groundwater mounding will be less than 1.2 feet above the seasonal high water table and 9.4 feet or greater below ground surface within the proposed disposal field area.
3. The ground water flow away from the site is to the east and the unnamed stream, then north via the steep-sided bedrock valley towards the Browns River.
4. The Town may, at its discretion, direct Stone to request an updated Capacity Determination for a New Indirect Discharge of Sewage in accordance with Subsection 14-402 of the Indirect Discharge Rules.

1. Data Sources

Sources of information consulted to complete the analyses included:

- *Site Capacity Confirmation and Project Financing Options for a Community Wastewater System at the Jackson Farm Site, Westford, Vermont:* Letter report, maps, test pit logs, capacity calculations dated May 30, 2017 (and sources therein)
- *Preliminary Aquatic Permitting Criteria Compliance Assessment, Jackson Farm Community Wastewater Site, Westford, Vermont:* Letter report, maps, water quality sampling results and calculations dated January 10, 2019
- *Capacity Determination and Aquatic Permitting Criteria Assessment, Jackson Farm Site, Westford, Vermont:* Letter from Bryan Harrington, Vermont DEC Indirect Program, to Melissa Manka, Town of Westford, dated March 25, 2019

- *Westford Community Wastewater Disposal System Preliminary Engineering Report, State Loan RF1-267-1.0*, submitted December 29 2020 and updated May 2021
- Soil borings logged by Amy Macrellis of Stone, November 11-16, 2021
- Water level readings collected by Sarah Rathay and Lee Rosberg of Stone, November 24, 2021
- Hydraulic conductivity testing conducted by Sandra Walser and Lee Rosberg of Stone, Dec. 1, 2021
- *Westford Community Wastewater System – DEC meeting Summary and Disposal System Discussion*, technical memo dated February 18, 2022
- *Town of Westford, Vermont, Community Wastewater Disposal System Supplemental Preliminary Engineering Report, State Loan RF1-267-1*.0, submitted February, 2022

Test pit logs from previous site investigations of the Maple Shade disposal site are compiled in Attachment 1.

2. Project Background

Wastewater disposal alternatives developed for the *Westford Community Wastewater Disposal System Preliminary Engineering Report* were based on prior test pit evaluations, preliminary disposal field layouts, and the preliminary Capacity Determination issued by the Indirect Discharge Program concurring with design flows of 12,600 gpd. This capacity estimate was necessarily limited to the depths of test pit excavations. Soil borings were recommended to be advanced early in final design to confirm depths to limiting features, followed by adjustments to capacity estimates and disposal field layouts if and as warranted.

3. Soil Borings and Monitoring Wells

Four groundwater-level observation wells were installed at the Maple Shade site between November 11 and November 16, 2021. The locations of the monitoring wells, MW-1 through MW-4, are shown on the site plan (Figure 1). The wells were installed by New England Boring Inc. of Londonderry, New Hampshire under the supervision of Stone personnel. Boreholes for the monitoring wells were completed using 4 ½-inch OD solid stem augers.

Each of the boreholes was completed to refusal at bedrock or to a depth of at least 60 feet. Borings were generally sampled continuously using a 2-foot split spoon to a depth of 20 feet, and at five-foot intervals from 20 feet to the bottom of each boring. The soils are primarily sand to gravelly sands near the ground surface along the upslope, western portion of the site (Figure 2 and Figure 3). The surficial sandy material is underlain by lacustrine clay at depths of 6.5 to 13.5 feet below ground surface (bgs) in portions of the proposed disposal field area, but the clay layer is not continuous (Figure 4 and Figure 5). All soil borings encountered outwash material (very fine sand to gravelly coarse sand, often finely bedded) beneath the surficial sand or clay horizons. Three of the borings (MW-1, MW-2, and MW-3) encountered a firm glacial till horizon above bedrock at 34-54 feet bgs. MW-4 was advanced to 60 feet below ground surface near the eastern edge of the field but did not encounter bedrock. Soil boring logs are included in Attachment 2.

The monitoring wells were constructed of two-inch diameter PVC pipe with 10 to 20-foot sections of 0.010-inch slotted screen. The wells were installed into the open boreholes, and a filter pack of silica sand was poured into the annular space to a depth two feet above the top of the screen. A minimum two-foot bentonite seal was placed in the annular space above the silica sand, and native sandy material was placed into the remaining annular space. Concrete seals and metal protective casings were installed in the top foot of each monitoring well. Details of the individual monitoring wells' construction are included with the boring logs in Attachment 2. Monitoring well locations and top-of-casing elevations were estimated based on field GPS and VCGI Lidar data and will be surveyed during final design. Table 1 provides a summary of the monitoring well details.

Table 1. Monitoring Well Details

Monitoring Well ID	Total Depth (ft bgs)	Top of Casing Elevation (ft AMSL)	Depth to Limiting Feature (ft bgs)	Limiting Feature Elevation (ft AMSL)	Depth to Groundwater (ft) on December 1, 2021	Groundwater Elevation (ft AMSL)
MW-1	34.0	558.6	13.5 (lacustrine clay)	545.3	Dry at 33.6	Dry at 525.0
MW-2	34.0	547.5	29.0 (ESHGW)	518.7	30.8	516.7
MW-3	53.5	543.0	13.0 (ESHGW)	530.2	44.6	498.4
MW-4	59.0	522.8	1.0 (ESHGW, lacustrine clay)	521.8	38.8	484.0

Source: Stone field observations, 2021.
Notes: ft bgs – feet below ground surface; ft AMSL = feet above mean sea level; ESHGW = estimated seasonal high groundwater as determined by identification of redoximorphic features

Rising head and falling head slug tests were attempted in three of the monitoring wells (MW-2, MW-3, and MW-4), according to Stone standard operating procedures using a Solinst Levelogger 700 pressure transducer and Levelogger 5 Series instrument communication software. Slug test data were transformed and analyzed using the software application AquiferTest (Waterloo Hydrogeologic, Inc.) utilizing the Hvorslev (MW-2) and Bouwer and Rice (MW-3 and MW-4) analysis methods. Well MW-1 was dry.

Hydraulic conductivity estimates for the three wells ranged from 0.47 to 21.1 feet/day (Table 2). At MW-2 and MW-3, the saturated material consisted of till, resulting in relatively low hydraulic conductivity estimates (0.57-2.6 ft/day). At MW-4, saturated hydraulic conductivity was higher (21.1 feet/day) and consistent with the sandy aquifer material encountered. Analyses of all hydraulic conductivity tests completed to date are presented in Attachment 3.

Table 2. Saturated Zone Hydraulic Conductivity Estimates

Monitoring	Aquifer	Hydraulic Conductivity				
Well ID	Thickness (ft)	(ft/s)	(ft/min)	(ft/day)	(m/s)	Comments
MW-2	1.20	2.97E-05	1.78E-03	2.57	9.07E-06	Minimal saturated thickness; test likely conducted in till.
MW-3	6.87	5.46E-06	3.28E-04	0.472	1.67E-06	Saturated thickness consists of fine sand, silty clay, till, weathered bedrock.
MW-4	19.73	2.44E-04	1.47E-02	21.1	7.44E-05	Saturated thickness consists of very fine sand to gravelly coarse sand; finer material near top of aquifer.

Source: Stone field notes, 2021.
Notes: ft = feet; ft/s = feet per second; ft/min = feet per minute; ft/day = feet per day; m/s = meters per second.

4. Geology and Groundwater Flow Regime

A bedrock and groundwater contour map (Figure 1) and generalized hydrogeologic cross-sections (Figures 2-5) were developed based on Stone boring data, December 2021 groundwater elevation data, and previous test pit and site evaluations.

The soils within and near the proposed disposal fields are gravelly loamy sands near the ground surface. Beneath the surficial soils, gravelly fine to coarse sands were observed to depths of 6.5 to 13.5 feet bgs (Attachments 1-2 and Figures 2-5). A perched seasonal high groundwater condition exists across the area best suited to wastewater disposal at depths ranging from 6.5-13.5 feet bgs. This limiting condition consists of a combination of a lacustrine clay horizon (Figures 2, 3, and 4) and a potentially compact gravel horizon with indications of seasonal high groundwater (Figure 5). The well-drained sands, underlain by poorly drained silts and clays, are consistent with surficial geologic mapping in the vicinity, which shows glaciofluvial kame terrace deposits in the vicinity of the proposed disposal fields and glaciolacustrine deposits of clay and boulders located closer to Brookside Road.

Groundwater was encountered at approximately 31 to 45 feet bgs on December 1, 2021 (Figure 1 And Table 1). The saturated thickness of the water table aquifer was only 1.5-6.5 feet thick in the vicinity of MW-2 and MW-3. The water table aquifer is at least 20 feet thick at MW-4, although the aquifer is likely thicker in this area since the observation well was not drilled to refusal.

The bottom of the relatively high permeability sandy aquifer is apparently defined by a till and bedrock surface. Bedrock outcrops are apparent upslope of the western edge of the field, and borings MW-1, MW-2, and MW-3 encountered refusal that appeared to be bedrock (Attachment 2). These borings enabled a more detailed understanding of the bedrock surface topography. Bedrock elevations ranged from 540-485 feet AMSL beneath the disposal field area. The bedrock appears to form a buried valley with the lowest elevations occurring near the drainage channel and the unnamed stream headwaters east of the disposal site.

The groundwater contour data indicate that groundwater beneath the disposal field area flows west to east-northeast with a hydraulic gradient of 0.08 feet/foot (8%) until it reaches the unnamed stream. From there, it flows roughly from south to north towards the Town Common area and ultimately to the Browns River. The buried bedrock valley appears to control groundwater flow beneath the disposal site.

5. Revised Wastewater Capacity Analysis

After adjusting the previously identified disposal field area to account for the results described above and separations from areas of unsuitable soils, an area totaling approximately 1.96 acres is available for wastewater disposal (Figure 1). The area remains limited by the presence of slopes in excess of 20% in portions of the best-suited soils at the northern end of the field, as well as by limited areas of slope in excess of 20% along the western tree line.

In order to estimate the hydraulic capacity of this potential wastewater dispersal site, we revised the Darcy's Law calculations completed for our May 30, 2017 analysis and report.

This formula is represented as $Q = KiA$ where

Q = design flow (gallons/day) (gpd)
K = hydraulic conductivity (ft. /day)
i = hydraulic gradient (slope of water table)
A = transmitting soil cross-sectional area (square feet) = $D \times L$ where
    D = transmitting soil thickness (depth to impeding layer or water table, minus the required separation depth, minus the system depth) (feet)
    L = length of the disposal system in the estimated direction of groundwater flow (feet)

We used this formula to develop a series of hydraulic capacity estimates for each of the east-west cross-sections (Figures 2, 3, and 5). Full assumptions and calculations for each estimate are documented in Attachment 4. Two sets of disposal field design parameters were considered:

1. The system's design is in-ground absorption trenches with the bottom of the trench a maximum of 18 inches (1.5 feet) below the ground surface, consistent with the 2017 analysis and with the Alternative 4 design revision included in the February 2022 PER amendment submittal (Figure 6). The required separation distance to seasonal high groundwater is 3.0 feet, leaving a transmitting soil thickness of 4.1-9.0 feet between the induced groundwater mound and the bottom of the disposal trenches.
2. The system's design is a series of subsurface drip irrigation disposal fields with the bottom of the drip lines a maximum of 12 inches (1.0 feet) below the ground surface, consistent with the Alternative 5 design layout included in the February 2022 PER amendment submittal (Figure 7). The required separation distance to seasonal high groundwater is 3.0 feet, leaving varying transmitting soil thicknesses of 6.1-9.5 feet between the induced groundwater mound and the bottom of the drip systems.

The 2017 and 2021 revised capacity estimates are summarized in Table 3.

Table 3. Summary of Darcy's Law Wastewater Capacity Estimates

	2017 Results		2021 Results			
			Transmitting Soil Thickness (ft)		Hydraulic Capacity Estimate (gpd)	
Cross Section	Transmitting Soil Thickness (ft)	Hydraulic Capacity Estimate (gpd)	Trenches	Drip Disposal	Trenches	Drip Disposal
A-A′	6.2	38,975	9.0	9.5	53,900	56,900
B-B′	2.5	10,968	6.1	6.6	21,900	23,700
D-D′	n/a	n/a	8.5	9.0	82,500	87,400

Source: Stone field notes and calculations, 2017 and 2021.
Notes: ft = feet; gpd = gallons per day; n/a = not applicable

The hydraulic capacity available for wastewater disposal at the site ranges from 21,900-87,400 gallons per day, depending upon the portion of the disposal field evaluated and the disposal option modeled. The revised hydraulic capacity analysis confirms that the area required for layout of either wastewater disposal alternative is a greater limitation than the capacity of the underlying soil and surficial materials to accept and transmit renovated effluent.

6. Treatment and Disposal System Layouts and Design Criteria

Section II.A of the February 2022 Supplemental PER describes updates to the proposed system's initial year design flows and disposal field design criteria.

The design basis for treatment and disposal included in Alternative 4 is summarized in Table 4 and the conceptual disposal trench layout is provided in Figure 6. Treatment includes Advantex treatment pods to allow loading of the four proposed in-ground wastewater disposal trench fields at a wastewater loading rate of 1.5 gallons/day/square foot, for a total design capacity of 24,600 gallons/day. Each field is designed with inter-fingered trenches, half of which are proposed to be loaded on an annual basis.

Table 4. Alternative 4 Disposal Field Design Criteria

Disposal Field ID	Figure References	Design Dimensions	Adsorption Trench Area (sq. ft.)	Design Flow (gallons/day)
Field 1	Figure 5, D-D′	(20 trenches) x (4′ wide) x (100′ long)	8,000	6,000
Field 2	Figure 3, B-B′	(10 trenches) x (4′ wide) x (280′ long)	11,200	8,400
Field 3	Figure 2, A-A′	(10 trenches) x (4′ wide) x (210′ long)	8,400	6,300
Field 4	Figure 2, A-A′	(10 trenches) x (4′ wide) x (130′ long)	5,200	3,900
TOTAL			32,800	24,600

The design basis for treatment and disposal included in Alternative 5 is summarized in Table 5 and the conceptual subsurface drip zone layout is provided in Figure 7. Treatment includes primary treatment in septic tanks, followed by disposal in a series of subsurface drip disposal zones at a wastewater loading rate of 0.9 gallons/day/square foot, for a total design capacity of 24,300 gallons/day. Each of the five proposed drip disposal zones is designed to include 10,800 square feet of effective leaching area and is intended to be dosed as a single zone (so Zone 1A and 1B, etc. are dosed at the same time). Discussions with the subsurface drip disposal vendors' engineers indicate that annual rotation between zones, as would be required for adsorption trench systems under the IDRs, is not preferred for successful performance of the drip system (Attachment 5). The Alternative 5 conceptual disposal field layout provides full redundancy and is therefore conservative; preliminary discussions with DEC Wastewater Program staff indicate that full redundancy may ultimately not be required.

Table 5. Alternative 5 Disposal System Design Criteria

Drip Disposal Zone ID	Figure References	Design Dimensions	Effective Leaching Area (sq. ft.)	Design Capacity (gallons/day)	Design Flow (gallons/day)
Zone 1A	Figure 5, D-D'	100" wide x varies (46-64 feet long)	4,800	4,320	2,160
Zone 1B	Figure 5, D-D'	100' wide x 60' long	6,000	5,400	2,700
Zone 2	Figure 5, D-D'	300' wide x 36' long	10,800	9,720	4,680
Zone 3A	n/a	150' wide x 20' long	3,000	2,700	1,350
Zone 3B	Figure 3, B-B'	100' wide x 24' long	2,400	2,160	1,080
Zone 3C	Figure 3, B-B'	100' wide x 54' long	5,400	4,860	2,430
Zone 4A	Figure 3, B-B'	60' wide x 90' long	5,400	4,860	2,430
Zone 4B	Figure 2, A-A'	100' wide x 54' long	5,400	4,860	2,430
Zone 5	Figure 2, A-A'	150' wide x 72' long	10.800	9,720	4,860
TOTAL			54,000	48,600	24,300

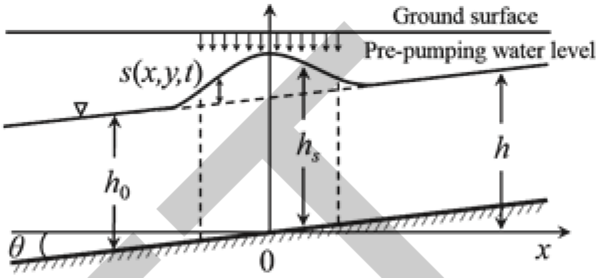
For Alternative 4, an in-ground system utilizing four-foot-wide trenches and using pre-treatment to increase the design loading rate and maximizing the available length along contour (~680 ft.) results in a linear loading rate of 24,600 gal/day / 680 ft. = 36 gallons/day/linear foot. For Alternative 5, pre-treatment is not utilized but the resulting linear loading rate is similar (24,300 gal/day / 680 ft. = 35.7 gallons/day/linear foot). Both linear loading rates are higher than 4.5 gallons per day per linear foot, and so if pre-treatment is desired in order to further increase the system's capacity, the state's Indirect Discharge Rules (Section 14-1010(d)(2)) require that a hydrogeologic analysis be completed to demonstrate:

- An unsaturated soil zone of at least 36 inches is maintained beneath the filtrate disposal system; and
- The mounded water table is at least one foot below grade at the downhill toe of the filtrate disposal system.

The required hydrogeological analysis was completed for Alternative 4 only, as described below.

7. Groundwater Mounding

Working with Green Mountain Engineering, Stone evaluated the degree of groundwater mounding that would result from loading each of the proposed disposal field designs at anticipated design capacities. The mounding of renovated effluent was evaluated for each disposal alternative along each of the three transects evaluated in the revised capacity analysis (Figures 2, 3, and 5). Mounding was determined using the Zlotnik et al. (2017) analytical model[1] to predict the rise of the water table that would be caused by long-term operation of each leachfield at the full design capacity. This analytical model is similar to Hantush (1967)[2] but allows prediction of transient or steady-state rise of the water table beneath a rectangular recharge source for unconfined, sloping aquifers.



Drawing 1. Cross section through water-table aquifer with sloping base along x axis of mapping coordinate system with $\gamma = 0$; $\phi = 0$; $i = \tan \vartheta$ *(from Zlotnik et al. 2017).*

As a conservative design scenario, the model was applied to predict elevations of the mounded water table starting on top of spring high water table conditions, consistent with the Darcy's Law capacity analysis assumptions described in Section 5. Results were evaluated to determine whether the induced groundwater elevations would meet the criteria of providing at least three feet of unsaturated soil beneath every trench in the leachfields, as required by §14-1401(a)(1)(E) of the IDRs.

The hydrogeologic evaluation also assessed the potential for effluent breakout downslope of the disposal fields, by determining the direction of groundwater flow from the leachfields and conservatively calculating the maximum acceptable water table rise at downslope model monitoring points. This assessment was based on ground surface topography, analysis of the groundwater contour maps, and assessment of the cross sections from the proposed leachfields to limiting features (in Figures 2-3) and at the downslope toe of the disposal field (Figure 5).

Details of the model results, conceptual cross-sections, and contour maps of predicted groundwater mounding for Alternative 4 are provided in Attachment 6.

The modeling analysis indicated that the required minimum three feet of unsaturated soil beneath the leachfields will be met at all times at the proposed 24,600 gpd design flow for Alternative 4 (Table 6). With the inter-fingered adsorption trenches as designed by Green Mountain Engineering, the depth of unsaturated soils between the infiltrative surface and the mounded seasonal high water table would be at least 4.9 feet at

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[1] http://www.aqtesolv.com/help/moundsolv/4/solutions.htm

[2] Hantush, M.S. 1967. Growth and Decay of Groundwater Mounds in Response to Uniform Percolation. Water Resources Research 3(1): 227-234. https://doi.org/10.1029/WR003i001p00227

cross section B-B’ (Figure 3), the most limited of the three cross-sections. Depth of unsaturated soils would be approximately 7 feet at the other two locations modeled – providing a substantial margin of safety. Based on the direction of groundwater flow and the extent of groundwater mounding that is predicted, the analysis also indicates that the leachfields will not cause effluent break-out at downslope locations beyond the toe of each disposal field (Table 6 and Attachment 6 model cross sections).

Table 6. Summary of Mounding Analysis Results, Alternative 4

Cross Section	Disposal Fields	Design Flow Applied (gallons/day)	Transmitting soil thickness before mounding (ft)	Maximum acceptable water table rise (ft)[1]	Maximum water table rise at disposal fields (ft)	Water table rise at downslope monitoring point (ft)	Comment
A-A’	Field 3, Field 4	10,200	9.0	2.50	0.99	0.82	Downslope monitoring point is TP-111
B-B’	Field 2	8,400	6.1	1.66	1.17	0.87	Downslope monitoring point is TP-123
D-D’	Field 1	6,000	8.5	8.00	0.48	0.46	Downslope monitoring point is downhill toe of Field 1

[1] Maximum acceptable water table rise is set conservatively by cross section to ensure that an unsaturated zone of at least 36" is maintained beneath the disposal system and that the mounded water table is at least one foot below grade at downhill toe of system.

Alternative 4 is more conservative than Alternative 5 in terms of loading rates and disposal system layout. The subsurface drip disposal zones proposed in Alternative 5 will disperse renovated effluent at a similar total design flow capacity, but using a lower loading rate (maximum 0.9 gallons/day/square foot versus the 1.5 gallons/day/square foot loading rate applied for Alternative 4) and utilizing a greater proportion of the suitable disposal area. Mounding analysis for the subsurface drip disposal system layout will generally result in smaller water table rises compared to the Alternative 4 layout, regardless of the final layout and dosing rotation (whether full redundancy, 150% of design flow, or other dosing regime to be determined in consultation with Oakson Inc., the project engineer, and VTDEC – see Attachment 5).

Given the substantial safety margins demonstrated for groundwater mounding under Alternative 4, and remaining uncertainty about details of subsurface drip disposal zone layout and dosing regime, we presume that Alternative 5 will also meet the requirements of §14-1401(a)(1)(E) of the IDRs. If further work is required to demonstrate compliance for Alternative 5 prior to or concurrent with a permit application for this *New Indirect Discharge of Sewage*, it will be completed during final design engineering.

Receiving Waters and Sensitive Receptors

The new data support previous conclusions that groundwater flow is toward the unnamed stream flowing north from the eastern boundary of the site towards the Browns River. Given the new bedrock and groundwater data and our current understanding of groundwater flow, renovated effluent recharging in the northern portion of the site will likely flow downslope and east along the surface of the lacustrine clay layer towards the unnamed stream (Figure 1). Renovated effluent recharging in the southern portion of the site will follow a similar flow path but may not encounter the lacustrine clay layer. Instead, it may encounter the surficial saturated sand aquifer and compact glacial till and flow east until it reaches the unnamed stream. Upon reaching the unnamed stream, flow is generally to the north and ultimately to the Browns River.

The lacustrine clay and compact glacial till layers present at the site, coupled with the hydrologic divide provided by the unnamed stream, provide reasonable protection and isolation for nearby and downgrade potable water supplies from the proposed new indirect discharge. There are up to nine private potable water supply wells that appear to be located within 1,000' of the proposed new indirect discharge, all of which are on the opposite side of the buried bedrock valley and the hydrologic divide marked by the unnamed stream. Further evaluation of these and other potential sensitive receptors will be completed, and mitigation measures identified if any are needed, prior to submittal of a permit application for this *New Indirect Discharge of Sewage*.

Conclusions

The site hydrogeology is suitable for an indirect discharge of up to 24,600 gpd. The groundwater flows in a steep-sided buried bedrock valley toward the north-northeast. The estimated groundwater mounding will result in a minimum of 4.9 feet of unsaturated soil. The determination of the Browns River as receiving water is reinforced by additional data.

Sincerely yours,

Amy Macrellis

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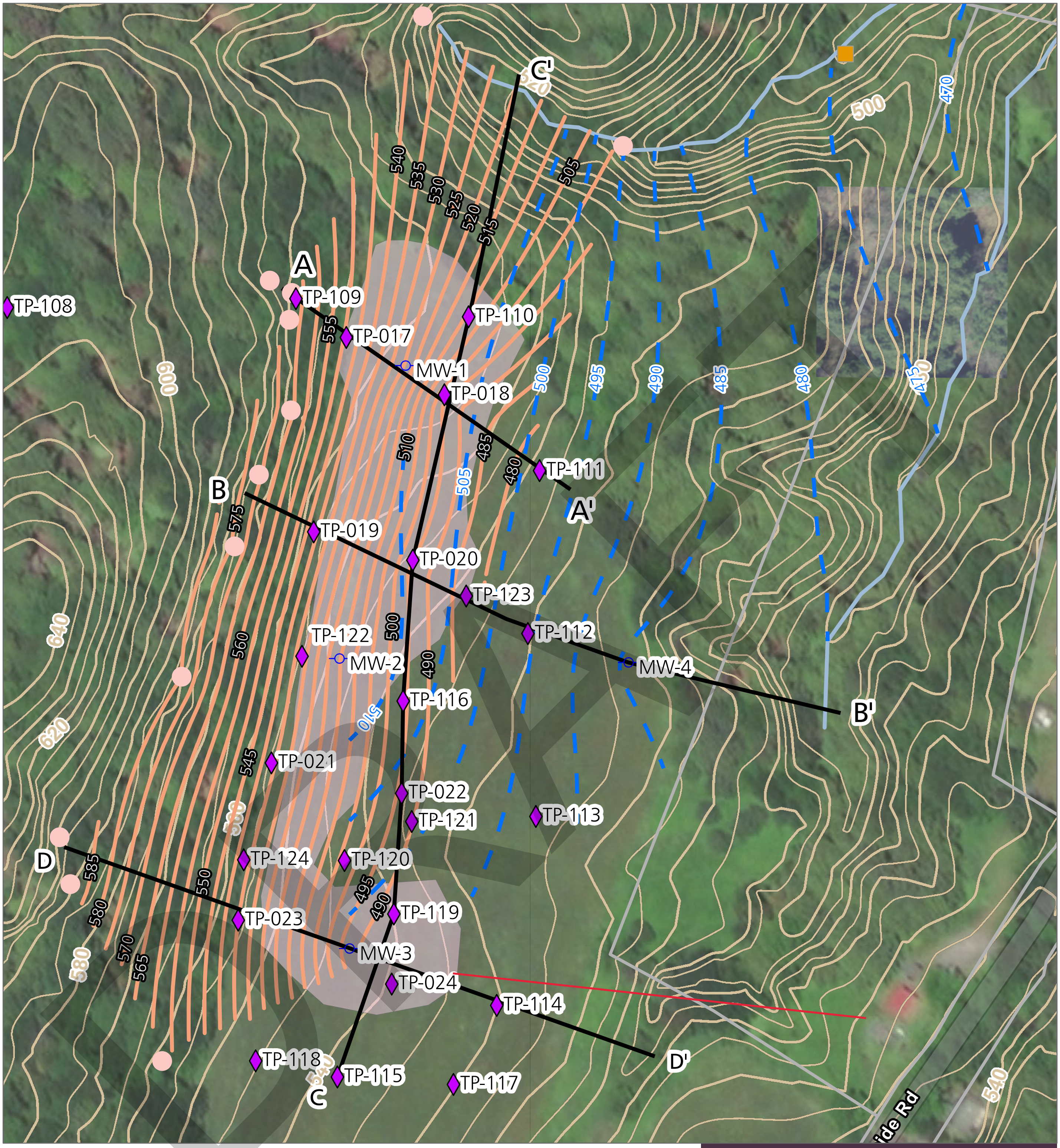
Encl.

Figures



LEGEND

- Soil boring / monitoring well
- Test pit
- Groundwater seep
- Surface bedrock
- Cross Section
- Groundwater Contours (feet, Dec. 2021)
- Bedrock Contours (feet)
- Stream
- Estimated disposal field area
- Parcel boundary (VCGI)

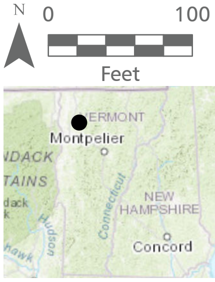


Figure 1. Hydrogeologic Site Plan

Westford Community Wastewater Disposal System

Prepared for the Town of Westford

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Path: Westford borings Site Map Exported: 3/2/2022 8:47 AM by amym

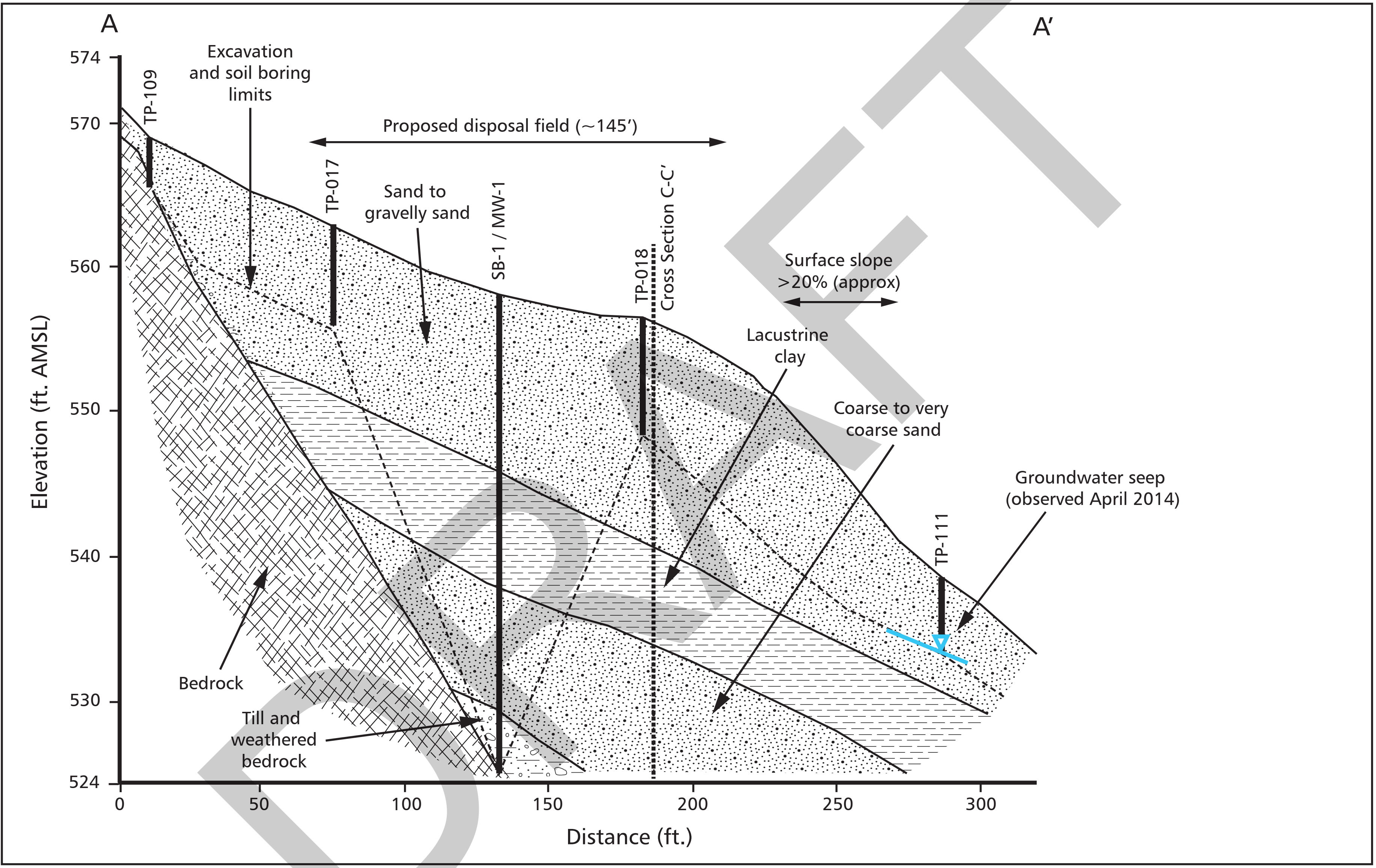

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Figure 2: Stratigraphic Cross Section A-A′ (West to East)

Westford Community Wastewater Disposal System, Maple Shade Disposal Site Hydrogeologic Investigation, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2021; GME topographic survey, 2015-2016; VCGI LiDAR, 2019.

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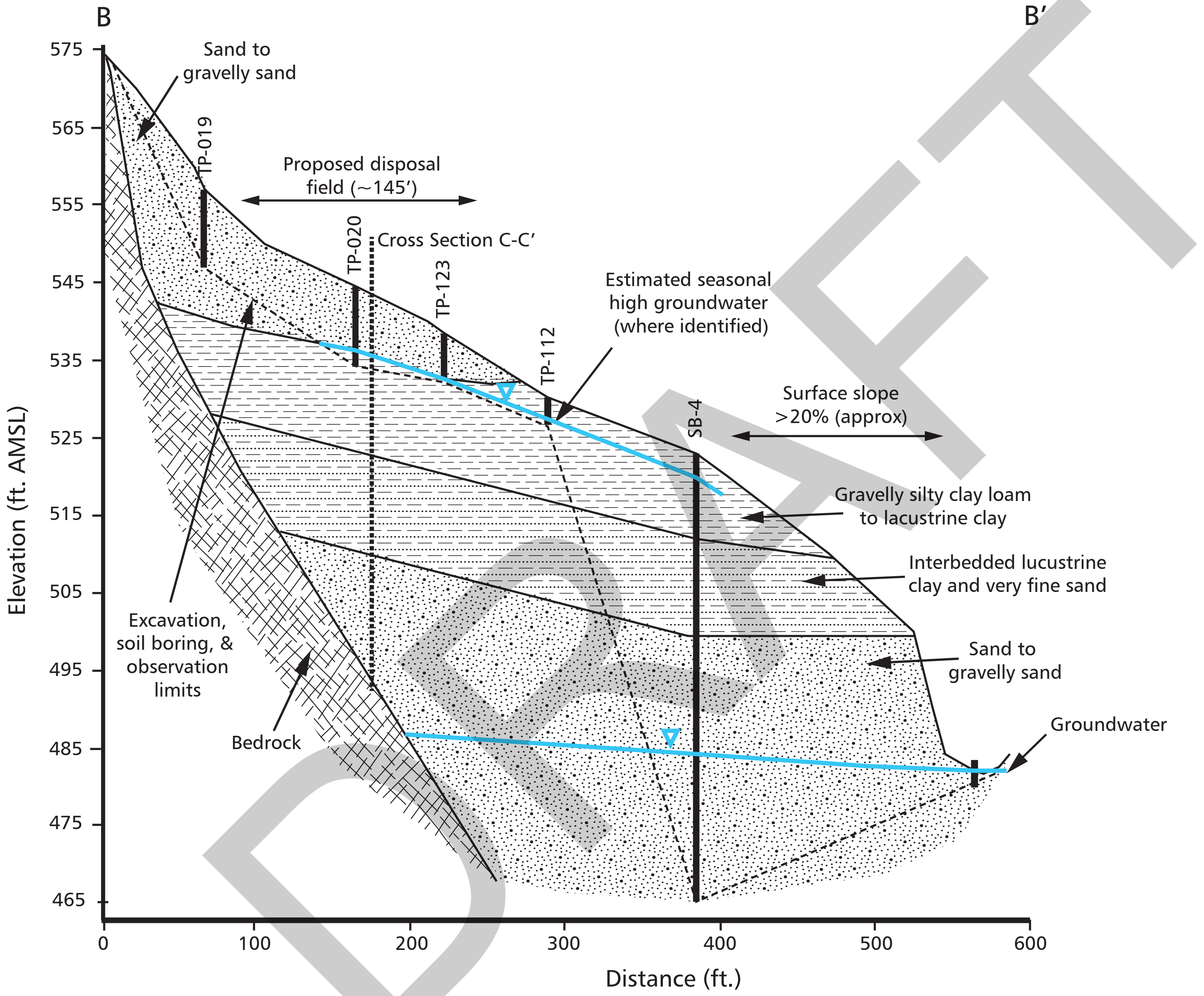

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Figure 3: Stratigraphic Cross Section B-B' (West to East)

Westford Community Wastewater Disposal System, Maple Shade Disposal Site Hydrogeologic Investigation, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2021; GME topographic survey, 2015-2016; VCGI LiDAR, 2019.

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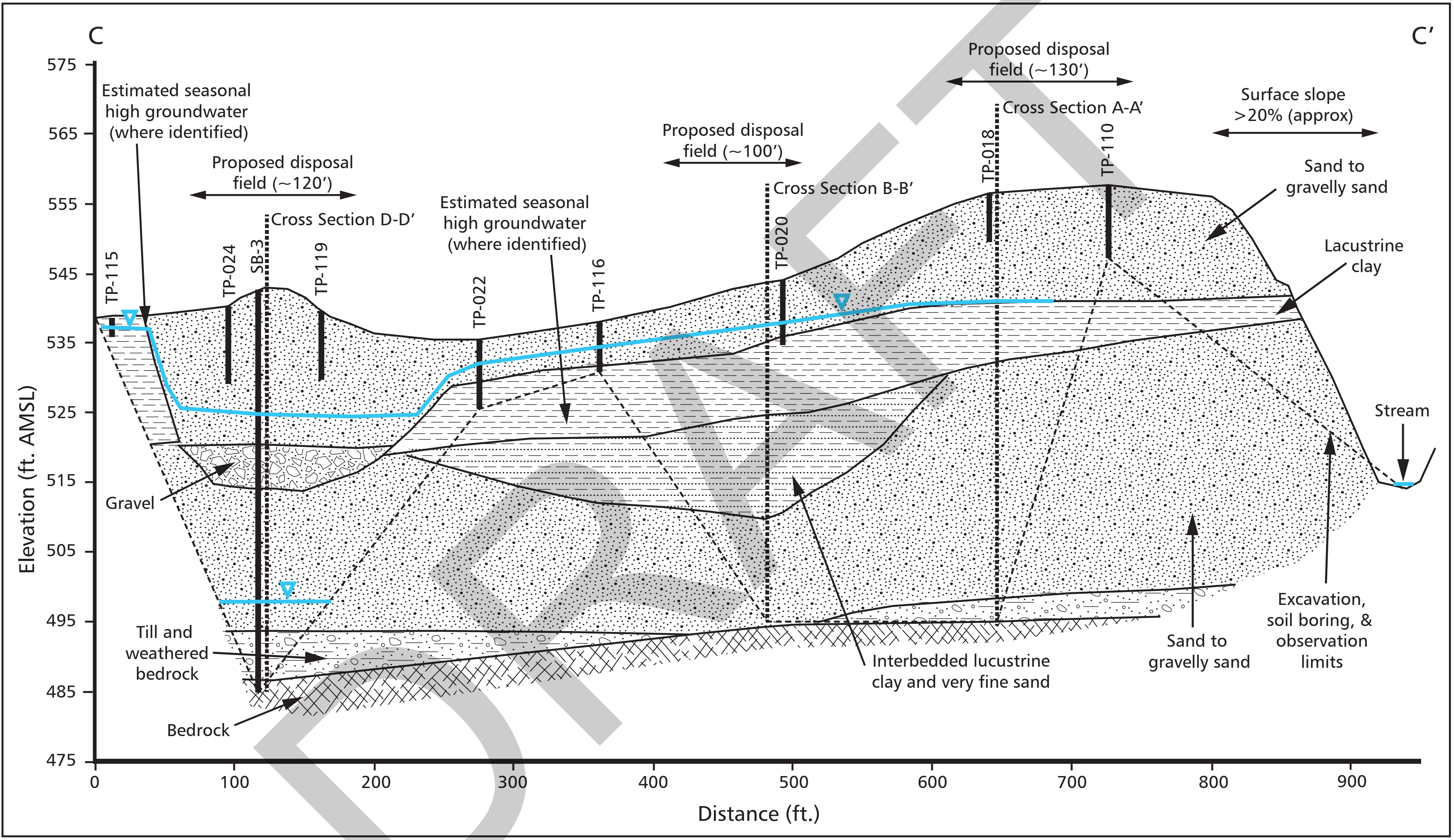

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Figure 4: Stratigraphic Cross Section C-C′ (South to North)

Westford Community Wastewater Disposal System, Maple Shade Disposal Site Hydrogeologic Investigation, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2021; GME topographic survey, 2015-2016; VCGI LiDAR, 2019.

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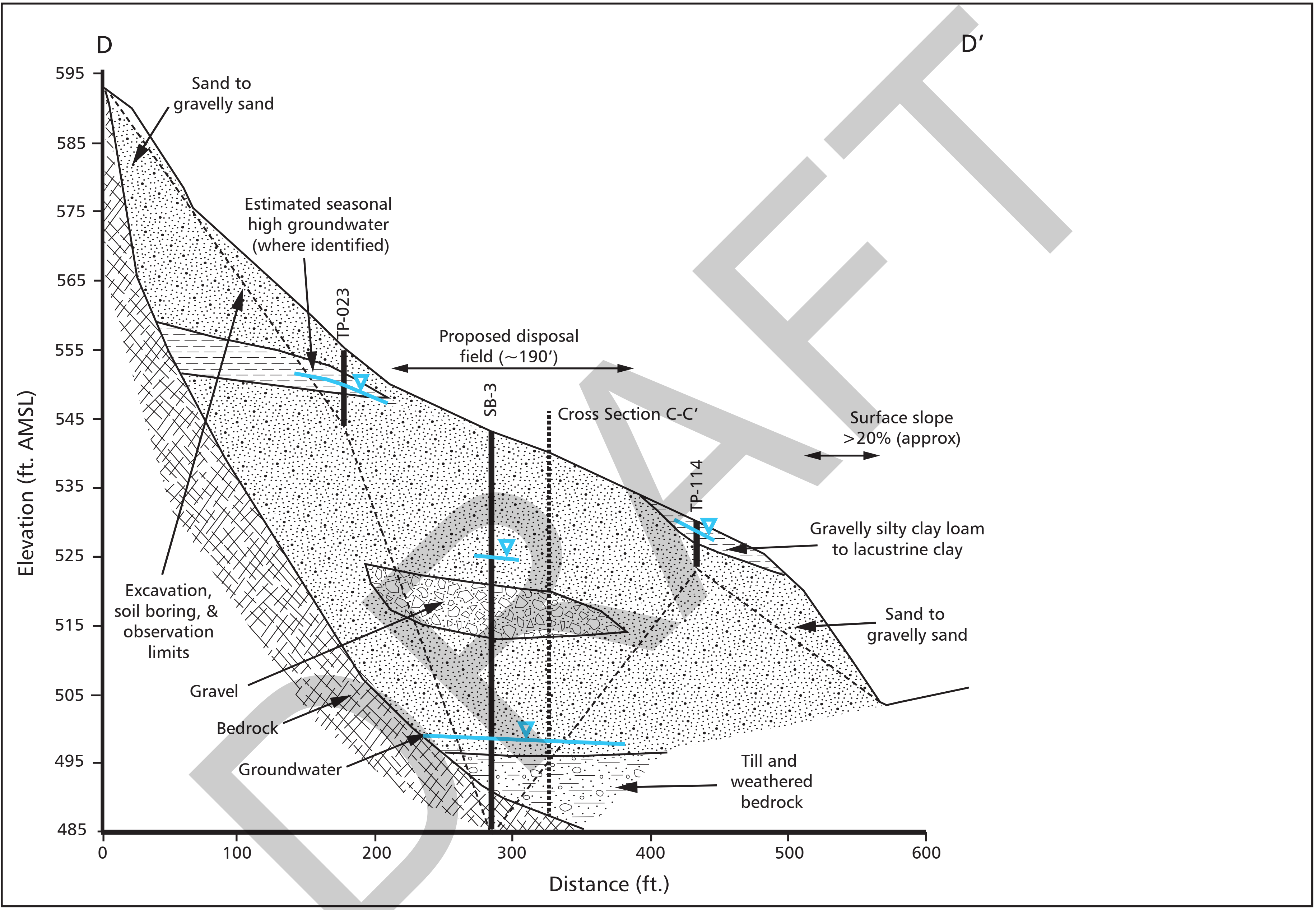
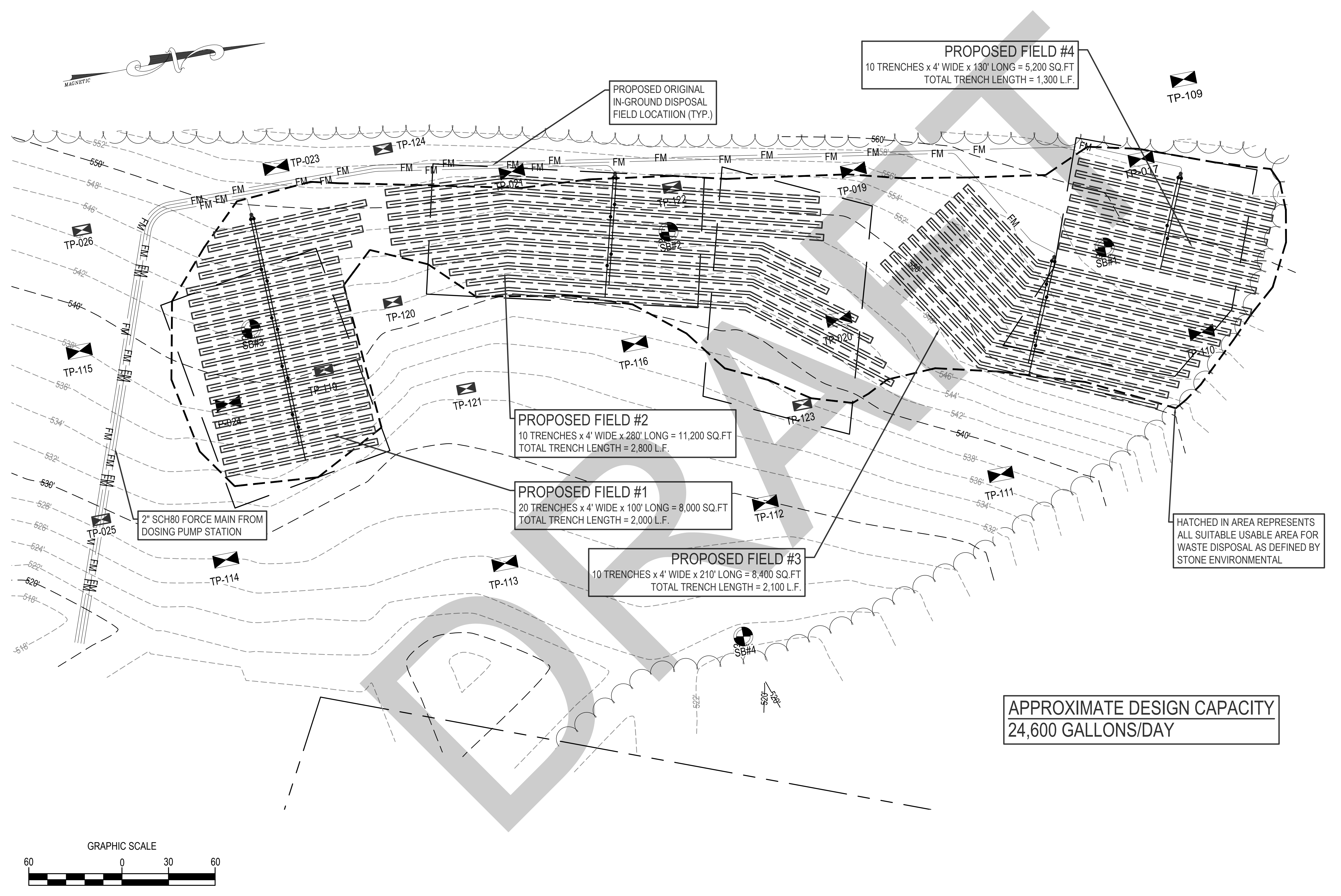


Figure 5: Stratigraphic Cross Section D-D’ (West to East)

Westford Community Wastewater Disposal System, Maple Shade Disposal Site Hydrogeologic Investigation, Westford, Vermont

Source: Hamlin Engineering field observations, 2014; Stone Environmental field observations, 2015-2021; GME topographic survey, 2015-2016; VCGI LiDAR, 2019.

Figure 6



PROPOSED ORIGINAL
IN-GROUND DISPOSAL
FIELD LOCATIION (TYP.)

PROPOSED FIELD #4
10 TRENCHES x 4' WIDE x 130' LONG = 5,200 SQ.FT
TOTAL TRENCH LENGTH = 1,300 L.F.

PROPOSED FIELD #2
10 TRENCHES x 4' WIDE x 280' LONG = 11,200 SQ.FT
TOTAL TRENCH LENGTH = 2,800 L.F.

PROPOSED FIELD #1
20 TRENCHES x 4' WIDE x 100' LONG = 8,000 SQ.FT
TOTAL TRENCH LENGTH = 2,000 L.F.

PROPOSED FIELD #3
10 TRENCHES x 4' WIDE x 210' LONG = 8,400 SQ.FT
TOTAL TRENCH LENGTH = 2,100 L.F.

2" SCH80 FORCE MAIN FROM
DOSING PUMP STATION

HATCHED IN AREA REPRESENTS
ALL SUITABLE USABLE AREA FOR
WASTE DISPOSAL AS DEFINED BY
STONE ENVIRONMENTAL

APPROXIMATE DESIGN CAPACITY
24,600 GALLONS/DAY

1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

GREEN MOUNTAIN ENGINEERING

CIVIL
WATER
WASTEWATER

DRAWING TITLE
ALTERNATIVE #4
IN-GROUND TRENCH DISPOSAL FIELD LAYOUT

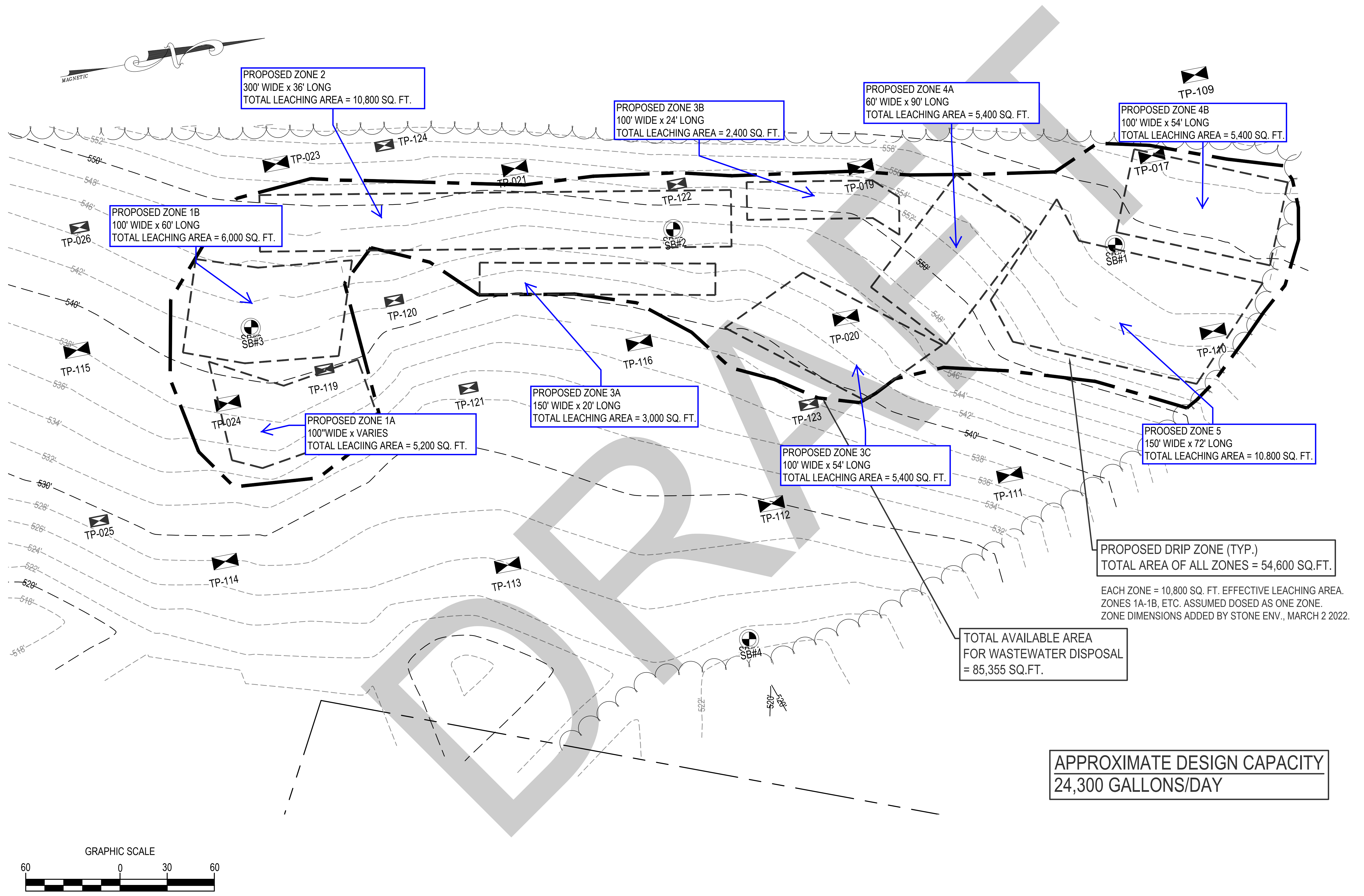
PROJECT
VILLAGE OF WESTFORD COMMUNITY
WASTEWATER DISPOSAL SYSTEM

CLIENT
TOWN OF WESTFORD, VERMONT

DESIGNED BW	PROJECT NO. 28-006
DRAWN BPC	
CHECKED BY AH	
PLOT DATE 2/16/22	EXHIBIT NO. 1
SCALE 1"=60'	
DATE FEB. 2022	1 OF 2

FILE: S:\GME PROJECT FILES\28-000\28-006 WESTFORD STUDY UPDATE\DRAWINGS\WESTFORD WW LAYOUT EXHIBITS.DWG

Figure 7



1438 SOUTH BROWNELL ROAD
WILLISTON, VERMONT 05495
PHONE: (802)862-5590
FAX: (802)862-7598

GREEN
MOUNTAIN
ENGINEERING

CIVIL
WATER
WASTEWATER

DRAWING TITLE
ALTERNATIVE #5
DRIP DISPERSAL FIELD LAYOUT

PROJECT
VILLAGE OF WESTFORD COMMUNITY
WASTEWATER DISPOSAL SYSTEM

CLIENT
TOWN OF WESTFORD, VERMONT

DESIGNED BW
DRAWN BPC
CHECKED BY AH
PLOT DATE 2/16/22
SCALE 1"=60'
DATE FEB. 2022

PROJECT NO.
28-006

EXHIBIT NO.
2
2 OF 2

FILE: S:\GME PROJECT FILES\28-000\28-006 WESTFORD STUDY UPDATE\DRAWINGS\WESTFORD WW LAYOUT EXHIBITS.DWG

Attachment 1: Compiled test pit logs from prior site evaluations

Donald L Hamlin Consulting Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **19** Project: **David Gauthier Soils** Project NO.: **14-420**

Date: **01/21/2015** Location: **Brookside Road, Westford** Equipment: **Backhoe**

Crew: **MLD** Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel) (L: Loam)
(Sa: Sand) (CL: Clay)
(SaL: Sandy Loam) (SiL: Silt Loam)
(SaCL: Sandy Clay Loam) (SiCL: Silt Clay Loam)
(SaC: Sandy Clay) (SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles______%) (2: Cobbles______%) (3: Boulders______%)
(4: Weathered Rock Fragments______%) (5: All Combined______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose) (VFB: Very Friable) (F: Friable)
(VFM: Very Firm) (EF: Extremely Firm)

STRUCTURE:

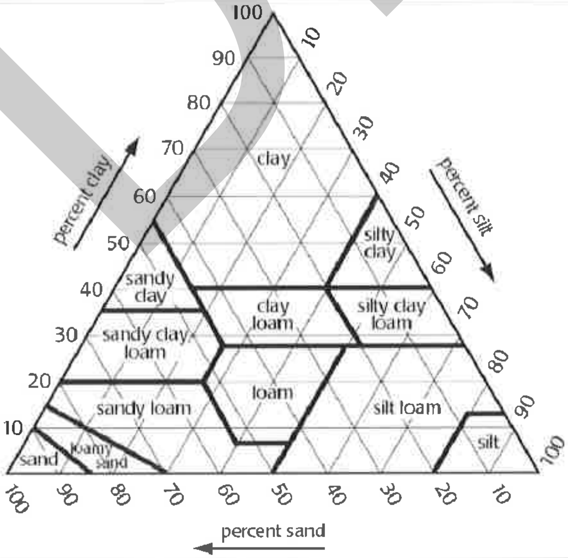
(Blocky) (Angular Blocky) (Sub Angular Blocky)
(Prismatic)

MOISTURE:

(Dry) (Damp) (Moist) (Wet) (Saturated)

MOTTLES:

Depth Interval: **NONE** FT to ________FT
(Few: <2%) (Common: 2-20%) (Many: >20%)
(Fine: < 5mm) (Medium: 5-15mm) (Coarse: >15mm)
(Faint) (Distinct) (Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- *Dry*
- *Frozen*
- *Sub-Angular Blocky*
- *Color: 7.5yr-3/3*

1.0 ft

Sa - Coarse
- *Dry*
- *Friable*
- *Single Grain*
- *15% Pebbles*
- *Color: 10yr-4/6*

2.0 ft

3.0 ft

G - Coarse Sand
- *Dry*
- *Loose*
- *Single Grain*
- *15% Pebbles, 15% to 20% Cobbles*
- *Color: 10yr-5/3*

4.0 ft

5.0 ft

6.0 ft

Sa - Coarse
- *Dry*
- *Loose*
- *Single Grain*
- *5% Pebbles*
- *Color: 2.5y-5/3*

7.0 ft

8.0 ft
10.0'

Bottom

Donald L Hamlin Consutling Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **20**
Project: **David Gauthier Soils**
Project NO.: **14-420**
Date: **01/21/2015**
Location: **Brookside Road, Westford**
Equipment: **Backhoe**
Crew: **MLD**
Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel)	(L: Loam)
(Sa: Sand)	(CL: Clay)
(SaL: Sandy Loam)	(SiL: Silt Loam)
(SaCL: Sandy Clay Loam)	(SiCL: Silt Clay Loam)
(SaC: Sandy Clay)	(SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles______%) (2: Cobbles______%) (3: Boulders______%)
(4: Weathered Rock Fragments______%) (5: All Combined______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose) (VFB: Very Friable) (F: Friable)
(VFM: Very Firm) (EF: Extremely Firm)

STRUCTURE:

(Blocky) (Angular Blocky) (Sub Angular Blocky)
(Prismatic)

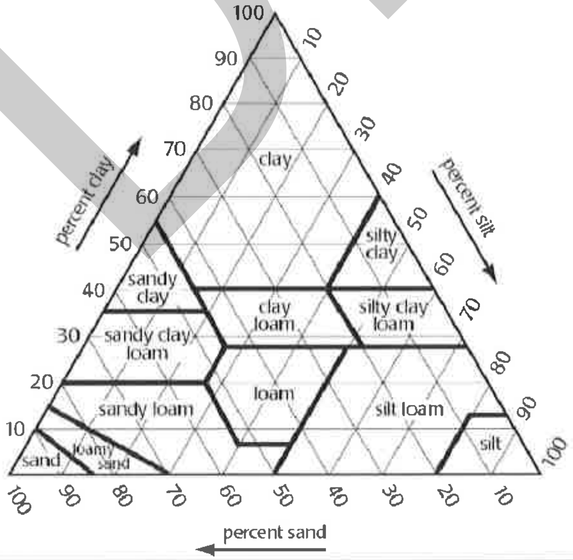
MOISTURE:

(Dry) (Damp) (Moist) (Wet) (Saturated)

MOTTLES:

Depth Interval: **6.2'** FT to **BOTTOM** FT

[✓ (Few: <2%)] (Common: 2-20%) (Many: >20%)
[✓ (Fine: < 5mm)] (Medium: 5-15mm) (Coarse: >15mm)
[✓ (Faint)] (Distinct) (Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- Dry
- Frozen
- Sub-Angular Blocky
- Color: 7.5yr-3/3

0.8'

1.0 ft

Sa - Coarse
- Dry
- Friable
- Single Grain
- 15% Pebbles
- Color: 10yr-4/6

2.0 ft

2.3'

G - Coarse Sand
- Dry
- Loose
- Single Grain
- 20% Pebbles, 5% Cobbles
- Color: 10yr-5/3

3.0 ft

4.0 ft

5.0 ft

6.0 ft

CL - Clay
- Moist
- Very Firm
- Platy
- Color: 2.5y-4/2

7.0 ft

WATER SEEP AT 9.4'

8.0 ft

9.5'

Bottom

Donald L Hamlin Consulting Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **21**　Project: **David Gauthier Soils**　Project NO.: **14-420**

Date: **01/21/2015**　Location: **Brookside Road, Westford**　Equipment: **Backhoe**

Crew: **MLD**　Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel)　(L: Loam)
(Sa: Sand)　(CL: Clay)
(SaL: Sandy Loam)　(SiL: Silt Loam)
(SaCL: Sandy Clay Loam)　(SiCL: Silt Clay Loam)
(SaC: Sandy Clay)　(SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles_______%)　(2: Cobbles_______%)　(3: Boulders_______%)
(4: Weathered Rock Fragments_______%)　(5: All Combined_______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose)　(VFB: Very Friable)　(F: Friable)
(VFM: Very Firm)　(EF: Extremely Firm)

STRUCTURE:

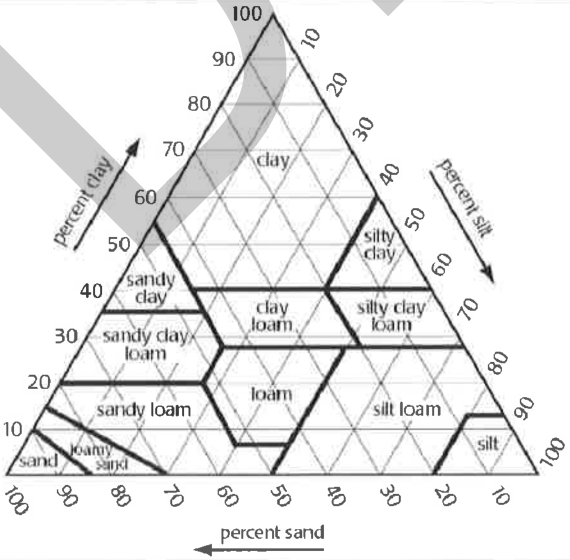
(Blocky)　(Angular Blocky)　(Sub Angular Blocky)
(Prismatic)

MOISTURE:

(Dry)　(Damp)　(Moist)　(Wet)　(Saturated)

MOTTLES:

Depth Interval: **NONE** FT to ________FT
(Few: <2%)　(Common: 2-20%)　(Many: >20%)
(Fine: < 5mm)　(Medium: 5-15mm)　(Coarse: >15mm)
(Faint)　(Distinct)　(Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- *Dry*
- *Frozen*
- *Sub-Angular Blocky*
- *Color: 7.5yr-3/3*

1.0 ft

Sa - Coarse
- *Dry*
- *Friable*
- *Single Grain*
- *15% Pebbles*
- *Color: 10yr-4/6*

2.0 ft

2.2'

G - Coarse Sand
- *Dry*
- *Friable*
- *Granular*
- *15% Pebbles, 10% Cobbles*
- *Color: 2.5y-4/4*

3.0 ft

4.0 ft

5.0 ft

G - Coarse Sand
- *Damp*
- *Loose*
- *Granular*
- *15% Pebbles, 10% Cobbles*
- *Color: 10yr-3/3*

6.0 ft

7.0 ft

Gravel - Clay Mixture
- *Damp*
- *Firm*
- *Granular*
- *10% Pebbles*
- *Color: 10yr-4/2*
- *Mixed Layers ranging from 1" to 4" alternating textures.*

8.0 ft

9.5'

Bottom

Donald L Hamlin Consutling Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **22**
Project: **David Gauthier Soils**
Project NO.: **14-420**
Date: **01/21/2015**
Location: **Brookside Road, Westford**
Equipment: **Backhoe**
Crew: **MLD**
Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel)
(Sa: Sand)
(SaL: Sandy Loam)
(SaCL: Sandy Clay Loam)
(SaC: Sandy Clay)
(L: Loam)
(CL: Clay)
(SiL: Silt Loam)
(SiCL: Silt Clay Loam)
(SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles_______%) (2: Cobbles_______%) (3: Boulders_______%)
(4: Weathered Rock Fragments_______%) (5: All Combined_______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose) (VFB: Very Friable) (F: Friable)
(VFM: Very Firm) (EF: Extremely Firm)

STRUCTURE:

(Blocky) (Angular Blocky) (Sub Angular Blocky)
(Prismatic)

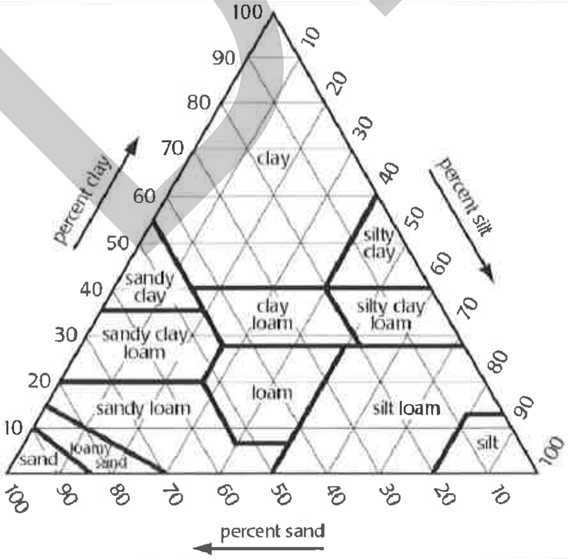
MOISTURE:

(Dry) (Damp) (Moist) (Wet) (Saturated)

MOTTLES:

Depth Interval: **3.0'** FT to **BOTTOM** FT

[✓ (Few: <2%)] (Common: 2-20%) (Many: >20%)
[✓ (Fine: < 5mm)] (Medium: 5-15mm) (Coarse: >15mm)
[✓ (Faint)] (Distinct) (Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- *Dry*
- *Frozen*
- *Sub-Angular Blocky*
- *Color: 10yr-2/1*

1.0 ft

Sa - Coarse
- *Dry*
- *Friable*
- *Single Grain*
- *15% Pebbles*
- *Color: 10yr-4/6*

2.0 ft

2.4'

SiCL
- *Dry*
- *Firm*
- *Sub-Angular Blocky*
- *5% Pebbles*
- *Color: 2.5y-4/4*

3.0 ft

4.0 ft

4.2'

G - Coarse Sand
- *Damp*
- *Loose*
- *Granular*
- *15% Pebbles, 20% Cobbles*
- *Color: 10yr-5/3*

5.0 ft

6.0 ft

CL - Clay
- *Moist*
- *Very Firm*
- *Platy*
- *Color: 2.5y-4/2*

7.0 ft

8.0 ft

10.0'

Bottom

Donald L Hamlin Consulting Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **23** Project: **David Gauthier Soils** Project NO.: **14-420**

Date: **01/21/2015** Location: **Brookside Road, Westford** Equipment: **Backhoe**

Crew: **MLD** Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel)	(L: Loam)
(Sa: Sand)	(CL: Clay)
(SaL: Sandy Loam)	(SiL: Silt Loam)
(SaCL: Sandy Clay Loam)	(SiCL: Silt Clay Loam)
(SaC: Sandy Clay)	(SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles______%) (2: Cobbles______%) (3: Boulders______%)

(4: Weathered Rock Fragments______%) (5: All Combined______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose) (VFB: Very Friable) (F: Friable)

(VFM: Very Firm) (EF: Extremely Firm)

STRUCTURE:

(Blocky) (Angular Blocky) (Sub Angular Blocky)

(Prismatic)

MOISTURE:

(Dry) (Damp) (Moist) (Wet) (Saturated)

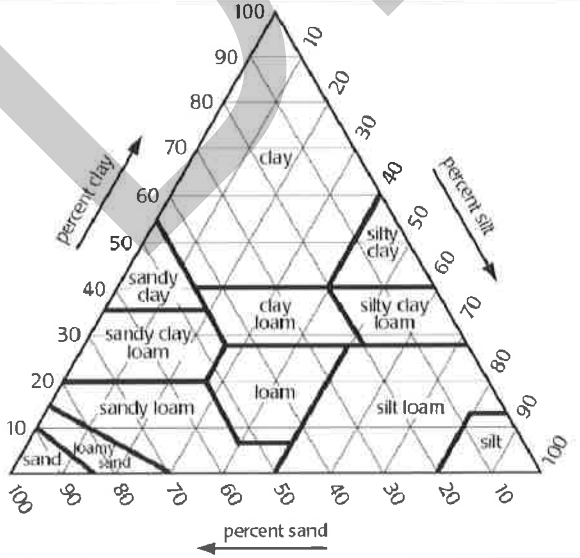
MOTTLES:

Depth Interval: **4.5'** FT to **BOTTOM** FT

[✓ (Few: <2%)] (Common: 2-20%) (Many: >20%)

(Fine: < 5mm) [✓ (Medium: 5-15mm)] (Coarse: >15mm)

[✓ (Faint)] (Distinct) (Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- Dry
- Frozen
- Sub-Angular Blocky
- Color: 7.5yr-3/3

1.0 ft

Sa - Coarse
- Dry
- Friable
- Single Grain
- 15% Pebbles
- Color: 10yr-4/6

2.0 ft

2.2'

CL - Clay
- Dry
- Very Firm
- Platy
- Color: 2.5y-5/3

3.0 ft

4.0 ft

5.0 ft

G - Coarse Sand
- Dry
- Loose
- Single Grain
- 15% Pebbles, 20% Cobbles
- Color: 10yr-5/3
- Becomes damp/moist @ 6.5'

6.0 ft

7.0 ft

8.0 ft

11.0'

Bottom

Donald L Hamlin Consutling Engineers, Inc., P.O. Box 9, Essex Juction, Vermont 05452

TEST PIT LOG

Test Pit NO.: **24**
Project: **David Gauthier Soils**
Project NO.: **14-420**
Date: **01/21/2015**
Location: **Brookside Road, Westford**
Equipment: **Backhoe**
Crew: **MLD**
Contractor: **David Gauthier**

SOIL CHARACTERISTICS

SOIL TEXTURE:

(G: Gravel)	(L: Loam)
(Sa: Sand)	(CL: Clay)
(SaL: Sandy Loam)	(SiL: Silt Loam)
(SaCL: Sandy Clay Loam)	(SiCL: Silt Clay Loam)
(SaC: Sandy Clay)	(SiC: Silty Clay)

ACCESSORY CONSTITUENTS:

(1: Pebbles_______%) (2: Cobbles_______%) (3: Boulders_______%)
(4: Weathered Rock Fragments_______%) (5: All Combined_______%)

COLOR: SEE MUNSELL SOIL COLOR CHARTS

DENSITY:

(LS: Loose) (VFB: Very Friable) (F: Friable)
(VFM: Very Firm) (EF: Extremely Firm)

STRUCTURE:

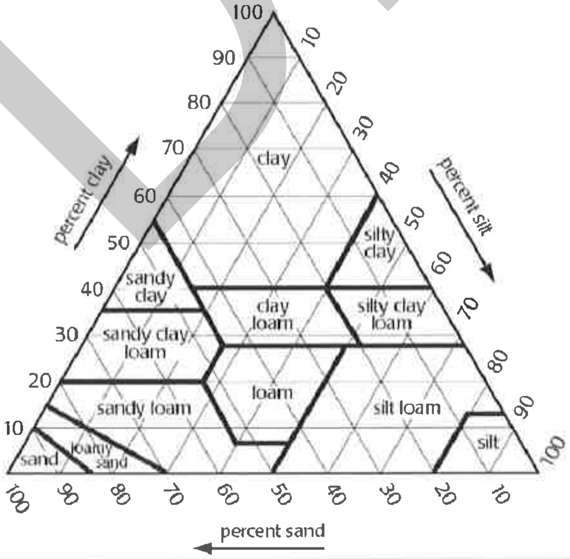
(Blocky) (Angular Blocky) (Sub Angular Blocky)
(Prismatic)

MOISTURE:

(Dry) (Damp) (Moist) (Wet) (Saturated)

MOTTLES:

Depth Interval: **NONE** FT to ________ FT
(Few: <2%) (Common: 2-20%) (Many: >20%)
(Fine: < 5mm) (Medium: 5-15mm) (Coarse: >15mm)
(Faint) (Distinct) (Prominent)



SOIL PROFILE

0.0 ft

SiL - Topsoil
- ***Dry***
- ***Frozen***
- ***Sub-Angular Blocky***
- ***Color: 7.5yr-3/3***

1.0 ft

Sa - Coarse
- ***Dry***
- ***Friable***
- ***Single Grain***
- ***10% Pebbles***
- ***Color: 10yr-4/6***

2.0 ft

2.2'

20% Pebbles

3.0 ft

5% Pebbles, Fine Sand

4.0 ft

40% Pebbles, Coarse Sand

5% Pebbles, Fine Sand

5.0 ft

6.0 ft

15% Pebbles, Fine Sand

7.0 ft

8.0 ft

10.5'

20% Pebbles, Coarse Sand

Bottom

Site Capacity and Opinion of Probable Cost of a Shared Wastewater System at the Jackson Farm Property, Westford, Vermont – Backhoe Test Pit Logs

Soils investigation conducted by Amy Macrellis of Stone Environmental, Inc. on August 4, 2015. Backhoe supplied by John Roberts of Roberts Excavation Inc. (operator Glenn). Others present during some or all of the investigation included David and Lynn Gauthier (property owners), Melissa Manka (Town of Westford Planning Coordinator), Kevin Camara (Green Mountain Engineering), Bryan Harrington (Vermont DEC, Indirect Discharge Permitting Program), Jessanne Wyman(Vermont DEC, Regional Engineer), and Mary Clark (Vermont DEC, Hydrogeologist).

Woodland Area West of "Zone 3" Hay Field

Test Pit TP-101

0" – 6"	Brown (7.5YR 5/2) fine sandy loam, weak subangular blocky structure, friable consistence, moist. Topsoil.
6" – 15"	Strong brown (7.5YR 4/6) fine sandy loam, weak subangular blocky structure, friable consistence, moist. Common tree roots.
15" – 24"	Brown (7.5YR 5/4) loamy fine sand, weak subangular blocky structure, loose consistence, moist.
24" – 72"	Light olive brown (2.5Y 5/3) sand, weak subangular blocky structure, loose consistence, moist.
72" – 80"	Brown (10YR 5/3) gravelly silt loam, moderate subangular blocky structure, very firm consistence, moist. Few fine faint mottles at 76". Very hard digging with hardpan and many cobbles.

No bedrock to depth. Seasonal high groundwater indicators at 76".

Test Pit TP-102

0" – 6"	Brown (7.5YR 4/2) fine sandy loam, granular structure, loose consistence, moist. Topsoil and duff.
6" – 19"	Strong brown (7.5YR 5/6) gravelly fine sandy loam, weak subangular blocky structure, friable consistence, moist. 10% gravel.
19" – 36"	Brown (10YR 5/3) gravelly silt loam, moderate subangular blocky structure, very firm consistence, dry. Till / hardpan. Mineralogy makes identification of redoximorphic features very difficult. Few fine faint mottles possible at 24".

No bedrock to depth. Possible seasonal high groundwater indicators at 24".

Test Pit TP-103

0" – 7"	Dark brown (7.5YR 3/3) fine sandy loam, weak subangular blocky structure, loose consistence, moist. Topsoil.
7" – 13"	Brown (7.5YR 4/4) very fine sandy loam, moderate angular blocky structure, friable consistence, moist.
13" – 22"	Dark reddish brown (5YR 3/4) loamy sand to loamy fine sand, weak angular blocky structure, friable consistence, moist.
22" – 46"	Olive brown (2.5Y 4/3) fine sand, weak subangular blocky structure, friable consistence, moist.
46" – 72"	Light olive brown (2.5Y 5/3) gravelly very fine sandy loam, moderate platy structure, firm consistence, moist. Few fine faint mottles at 48". Boulder in center of test pit at 54".

No bedrock to depth. Seasonal high groundwater indicators at 48".

Test Pit TP-104

0” – 7”	Black (7.5YR 2.5/1) silty clay loam, weak granular structure, loose consistence, moist. Topsoil.
7” – 16”	Brown (7.5YR 4/4) silty clay loam, moderate platy structure, loose consistence, moist.
16” – 28”	Olive brown (2.5Y 4/3) gravelly silty clay, moderate platy structure, firm consistence, moist. Many medium distinct mottles at 16”.

No bedrock to depth. Seasonal high groundwater indicators at 16”.

Test Pit TP-105

0” – 5”	Black (7.5YR 2.5/1) silty clay loam, weak granular structure, loose consistence, moist. Topsoil.
5” – 14”	Brown (7.5YR 4/4) very fine sandy loam, weak subangular blocky structure, loose consistence, moist.
14” – 23”	Brown (7.5YR 4/3) very fine sandy loam, weak subangular blocky structure, friable consistence, moist. VT DEC observed indications of seasonal high groundwater at 14”.
23” – 47”	Olive brown (2.5Y 4/3) very gravelly silt loam, moderate subangular blocky structure, firm consistence, moist to wet. Common medium prominent mottles beginning at 26”.

No bedrock to depth. Conservative estimate of seasonal high groundwater indicators at 14”; clear evidence at 26”.

Test Pit TP-106

0” – 5”	Black (7.5YR 2.5/1) gravelly very fine sandy loam, weak granular structure, loose consistence, moist. Duff/topsoil.
5” – 16”	Brown (7.5YR 4/4) very fine sandy loam, weak subangular blocky structure, loose consistence, moist.
16” – 27”	Brown (7.5YR 4/3) gravelly silt loam, weak subangular blocky structure, friable consistence, moist.
27” – 42”	Dark grayish brown (2.5Y 4/2) very gravelly very fine sandy loam, moderate subangular blocky structure, firm consistence, moist. Few small faint mottles beginning at 27”.

No bedrock to depth. Seasonal high groundwater indicators at 27”.

Test Pit TP-107

0” – 3”	Black (7.5YR 2.5/1) veryfine sandy loam, weak granular structure, loose consistence, moist. Duff, very rich organic material.
3” – 12”	Strong brown (7.5YR 4/6) gravelly fine sandy loam, weak granular structure, loose consistence, moist. 10% gravel.
12” – 18”	Strong brown (7.5YR 5/6) gravelly fine sandy loam, weak subangular blocky structure, friable consistence, moist. 15% gravel.
18” – 30”	Yellowish brown (10YR 5/4) gravelly very fine sandy loam, moderate subangular blocky structure, friable consistence, moist. 15% gravel.
30” – 40”	Light olive brown (2.5Y 5/3) Very gravelly fine sandy loam, weak subangular blocky structure, firm consistence, moist. 30% gravel.
40” – 84”	Light olive brown (2.5Y 5/3) Very gravelly loamy sand, weak granular structure, very firm consistence, moist to wet. Horizon coarsens downward, to very gravelly sand and coarse sand at 60”, but also becomes wetter. Few fine distinct mottles at 72”.

No bedrock to depth. Seasonal high groundwater indicators at 72”.

Test Pit TP-108

0" – 6"	Dark brown (7.5YR 3/2) sandy loam, weak granular structure, loose consistence, moist. Duff/topsoil.
6" – 13"	Strong brown (7.5YR 4/6) loamy sand to loamy coarse sand, weak granular structure, loose consistence, moist.
13" – 21"	Brown (7.5YR 4/4) sand, no structure (single grain), loose consistence, moist.
21" – 28"	Dark grayish brown (10YR 3/4) coarse sand, no structure (single grain), loose consistence, moist.
28" – 55"	Dark grayish brown (2.5Y 4/2) silty clay loam, moderate subangular blocky structure, firm consistence, moist. Common medium prominent mottles at 28". Upper boundary of this horizon is wavy – VT DEC measured depth to mottles at 24" in a different area of the pit, but at the same relative position in the soil profile.

No bedrock to depth. Seasonal high groundwater indicators at 28".

"Zone 3" Hay Field

Test Pit TP-109

0" – 7"	Very dark brown (7.5YR 2.5/2) fine sandy loam, weak granular structure, loose consistence, moist. Duff/topsoil.
7" – 16"	Strong brown (7.5YR 4/6) gravelly loamy fine sand, no structure (single grain), loose consistence, moist. 10-15% gravel.
16" – 28"	Brown (7.5YR 4/3) gravelly loamy sand, no structure (single grain), friable consistence, moist. 15% gravel.
28" – 45"	Brown (10YR 4/3) gravelly sand, no structure (single grain), friable consistence, moist. 15% gravel. Wavy bedrock boundary – 22" only in the northwestern portion of the pit, trending northeast and downward in the soil profile.

Bedrock at 22" in a portion of the pit. No seasonal high groundwater indicators to depth.

Test Pit TP-110

0" – 8"	Dark brown (7.5YR 3/4) very fine sandy loam, weak granular structure, loose consistence, dry. Topsoil.
8" – 16"	Strong brown (7.5YR 5/6) fine sandy loam, weak granular structure, loose consistence, dry.
16" – 32"	Strong brown (7.5YR 5/8) very gravelly loamy fine sand, no structure (single grain), loose consistence, dry. 40% gravel.
32" – 45"	Dark yellowish brown (10YR 4/6) gravelly fine sand, no structure (single grain), loose consistence, dry. 10% gravel, but less gravel deeper in this horizon.
45" – 128"	Dark grayish brown (2.5Y 4/2) gravelly coarse sand, no structure (single grain), loose consistence, dry. 10% gravel, but less gravel deeper in this horizon. Overdug pit from 64-128 inches, but did not enter. Sand to coarse sand present to depth.

No bedrock or seasonal high groundwater indicators to depth.
Hydraulic conductivity test completed at this location, 24-39" below ground surface.

Test Pit TP-111

0" – 6"	Dark brown (7.5YR 3/3) gravelly loamy sand, weak granular structure, loose consistence, moist. Topsoil/plow layer.
6" – 14"	Strong brown (7.5YR 4/6) very gravelly sand to coarse sand, no structure (single grain), loose consistence, moist. 40% gravel.
14" – 29"	Brown (7.5YR 4/4) very gravelly sand, no structure (single grain), loose consistence, moist. 30% gravel.
29" – 57"	Dark yellowish brown (2.5Y 4/4) gravelly coarse sand, no structure (single grain), loose consistence, moist. Wet at 54", seep that became standing water. At the down-slope end of the pit, measured distance to standing water was 41".

No bedrock or seasonal high groundwater indicators to depth.
Standing water at 54" (middle of pit) to 41" (down-slope end of pit).

Test Pit TP-112

0" – 10"	Dark brown (7.5YR 3/2) very fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
10" – 32"	Strong brown (7.5YR 4/6) very gravelly silt loam, weak subangular blocky structure, friable consistence, moist. 50% gravel.
32" – 44"	Dark grayish brown (2.5Y 4/2) gravelly silty clay loam, moderate angular blocky structure, firm consistence, moist. Common medium prominent mottles at 32".

No bedrock to depth. Seasonal high groundwater indicators at 32".

Test Pit TP-113

0" – 9"	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9" – 19"	Brown (7.5YR 4/4) gravelly silty clay loam, weak subangular blocky structure, friable consistence, moist. 10% gravel.
19" – 24"	Light olive brown (2.5Y 5/3) silty clay loam, moderate angular blocky structure, firm consistence, moist. Few medium faint mottles at 19".

No bedrock to depth. Seasonal high groundwater indicators at 19".

Test Pit TP-114

0" – 10"	Dark brown (7.5YR 3/2) very fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
10" – 18"	Brown (7.5YR 4/4) silt loam, weak granular structure, loose consistence, moist.
18" – 30"	Olive brown (2.5Y 4/3) very gravelly silty clay loam, moderate subangular blocky structure, very firm consistence, moist. 40% gravel. Many medium distinct mottles at 18-30".
30" – 68"	Dark olive brown (2.5Y 3/3) Gravelly coarse sand, no structure (single grain), friable consistence, moist. 20% gravel. No mottles in this horizon.

No bedrock to depth. Seasonal high groundwater indicators at 18".

Test Pit TP-115

0” – 8”	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
8” – 16”	Brown (7.5YR 4/4) gravelly silt loam, weak granular structure, friable consistence, moist.
16” – 25”	Olive brown (2.5Y 4/4) gravelly silty clay loam, moderate subangular blocky structure, firm consistence, moist. 40% gravel. Many medium distinct mottles at 16”.

No bedrock to depth. Seasonal high groundwater indicators at 16”.

Test Pit TP-116

0” – 9”	Dark brown (7.5YR 3/2) fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9” – 18”	Brown (7.5YR 4/4) loamy fine sand, no structure (single grain), loose consistence, moist.
18” – 28”	Dark yellowish brown (10YR 4/6) loamy sand, no structure (single grain), friable consistence, moist.
28” – 36”	Dark olive brown (2.5Y 3/3) very fine sand, moderate subangular blocky structure, firm consistence, moist. Many medium prominent mottles at 28-36”.
36” – 70”	Olive brown (2.5Y 4/3) sand, no structure (single grain), friable consistence, moist. No mottles in this horizon.
70” – 84”	Olive brown (2.5Y 4/3) gravelly clay loam, structure not recorded, firm consistence, moist. Many medium distinct mottles in this horizon.

No bedrock to depth. Seasonal high groundwater indicators at 28-36” and 70”.

O:\Proj-13\WRM\13-224 Westford WW Capacity Eval\Project Reports\Draft\Jackson Farm\Soil test pit logs 2014 08 04.docx

Site Capacity Confirmation and Project Financing Options for Community Wastewater System at the Jackson Farm Property, Westford, Vermont – Backhoe Test Pit Logs

Soils investigation conducted by Amy Macrellis of Stone Environmental, Inc. on November 17, 2016. Backhoe supplied by John Roberts of Roberts Excavation Inc. Others present during some or all of the investigation included David Gauthier (property owner), Melissa Manka (Town of Westford Planning Coordinator), Kevin Camara (Green Mountain Engineering), Mary Clark (Vermont DEC, Indirect Discharge Permitting Program), and Jessanne Wyman (Vermont DEC, Regional Engineer).

Test pits were located using survey-quality GPS prior to excavation, in order to precisely locate the new test pits relative to work completed previously on this property. The preliminary numbering system used on the day of testing included some numbers that duplicated the identification scheme previously used by Donald J. Hamlin Consulting Engineers in their early 2015 investigation of this area. Thus, the descriptions below include both the test pit numbering scheme used during the field investigation, and the final test pit numbering that eliminates duplicate IDs.

"Zone 3" Hay Field

Test Pit TP-117 (TP-025 on day of testing)

0" – 11"	Very dark brown (7.5YR 2.5/3) gravelly fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer. ~5% gravel.
11" – 18"	Strong brown (7.5YR 5/6) gravelly loamy fine sand, weak granular structure, loose consistence, moist.
18" – 27"	Yellowish brown (10YR 5/8) loamy fine sand, weak blocky structure, friable consistence, moist.
27" – 34"	Light olive brown (2.5Y 5/4) clay loam, weak platy structure, friable consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 27" (Stone determination); DEC representatives estimated seasonal high groundwater at 25".

Test Pit TP-118 (TP-026 on day of testing)

0" – 9"	Very dark brown (7.5YR 2.5/2) fine sandy loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9" – 14"	Light brown (7.5YR 6/3) gravelly very fine sandy loam, weak granular structure, friable consistence, moist.
14" – 18"	Strong brown (7.5YR 5/6) gravelly fine sand, weak blocky structure, friable consistence, moist. ~10% gravel.
18" – 32"	Yellowish brown (10YR 5/6) fine sand, single grain structure, friable consistence, moist. Gradually becomes stony and with firmer consistence between 26" and 32".
32" – 44"	Olive brown (2.5Y 4/4) clay loam, moderate platy structure, firm consistence, moist. Many medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 32" (Stone determination); DEC representatives estimated seasonal high groundwater at 29" in the northern end of the excavation.

Test Pit TP-119 (TP-027 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) fine sandy loam to silt loam, weak granular structure, loose consistence, moist. Topsoil.
8" – 16"	Brown (7.5YR 4/4) gravelly loamy fine sand, single grain structure, loose consistence, moist. 15-20% gravel.

16" – 69"	Brown (7.5YR 4/4) gravelly coarse sand to very coarse sand, single grain structure, loose consistence, moist. 15-20% gravel, 5% cobbles.
69" – 120"	Overdug pit, but did not enter. Sand to coarse sand present to depth.

No bedrock or seasonal high groundwater indicators to depth. A lens of light olive brown (2.5Y 5/4) clay loam was present at the north end of the excavation to approximately 18" below ground surface, but no indicators of seasonal high groundwater were present in this material.

Test Pit TP-120 (TP-028 on day of testing)

0" – 12"	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
12" – 17"	Strong brown (7.5YR 4/6) gravelly very fine sandy loam, weak blocky structure, friable consistence, moist.
17" – 31"	Light olive brown (2.5Y 5/4) silt loam, weak blocky structure, friable consistence, moist. Few fine faint mottles present at 24".
31" – 34"	Light olive brown (2.5Y 5/3) clay loam, moderate platy structure, firm consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 24".

Test Pit TP-121 (TP-029 on day of testing)

0" – 9"	Dark brown (7.5YR 3/3) silt loam, weak granular structure, loose consistence, moist. Topsoil/plow layer.
9" – 15"	Strong brown (7.5YR 4/6) gravelly sandy clay loam, weak blocky structure, friable consistence, moist.
15" – 24"	Light olive brown (2.5Y 5/4) silty clay loam, weak blocky structure, friable consistence, moist. Few fine faint mottles present at 20".
24" – 37"	Dark grayish brown (2.5Y 4/2) clay loam, moderate platy structure, firm consistence, moist. Few medium faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 20".

Test Pit TP-122 (TP-030 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) loamy fine sand, weak granular structure, loose consistence, moist. Topsoil.
8" – 24"	Brown (7.5YR 4/4) gravelly fine sand to sand, single grain structure, loose consistence, moist. ~5% gravel.
24" – 65"	Brown (2.5Y 5/2) gravelly sand to coarse sand, single grain structure, loose consistence, moist. 5-10% gravel and cobbles.
65" – 120"	Overdug pit, but did not enter. Coarse sand present to depth.

No bedrock or seasonal high groundwater indicators to depth.

Test Pit TP-123 (TP-031 on day of testing)

0" – 7"	Dark brown (7.5YR 3/3) gravelly loamy fine sand, weak granular structure, loose consistence, moist. Topsoil. ~5% gravel.
7" – 36"	Strong brown (7.5YR 4/6) gravelly coarse sand to very coarse sand, single grain structure, loose consistence, moist. ~5% gravel, few cobbles.
36" – 58"	Brown (7/5 YR 4/3) gravelly sand to coarse sand, single grain structure, loose consistence, moist. 5-10% gravel, increasing with depth.

58" – 64"	Olive brown (2.5Y 4/3) silty clay, weak platy structure, firm consistence, moist. Few fine faint mottles throughout the horizon.

No bedrock to depth. Seasonal high groundwater indicators at 58".

Test Pit TP-124 (TP-032 on day of testing)

0" – 8"	Dark brown (7.5YR 3/3) gravelly loamy sand, weak granular structure, loose consistence, moist. Topsoil with many roots.
8" – 24"	Brown (7.5YR 4/4) gravelly sand to coarse sand, single grain structure, loose consistence, moist. ~10% gravel and cobbles.
24" – 36"	Strong brown (7/5YR 5/6) gravelly fine sand, single grain structure, friable consistence, extremely dry. ~30% gravel.
36" – 84"	Light yellowish brown (2.5Y 6/3) very gravelly fine sand, single grain structure, friable to firm consistence, extremely dry. ~50% gravel.

No bedrock or seasonal high groundwater indicators to depth (96" at uphill/western end of the excavation).

Attachment 2: Soil Boring and Monitoring Well Logs

FIGURE NO

BORING ID SB-1 and MW-1

Maple Shade Wastewater

Date Drilled: 11/11/2021
COMPANY: New England Boring
DRILLER: Bub Thompson

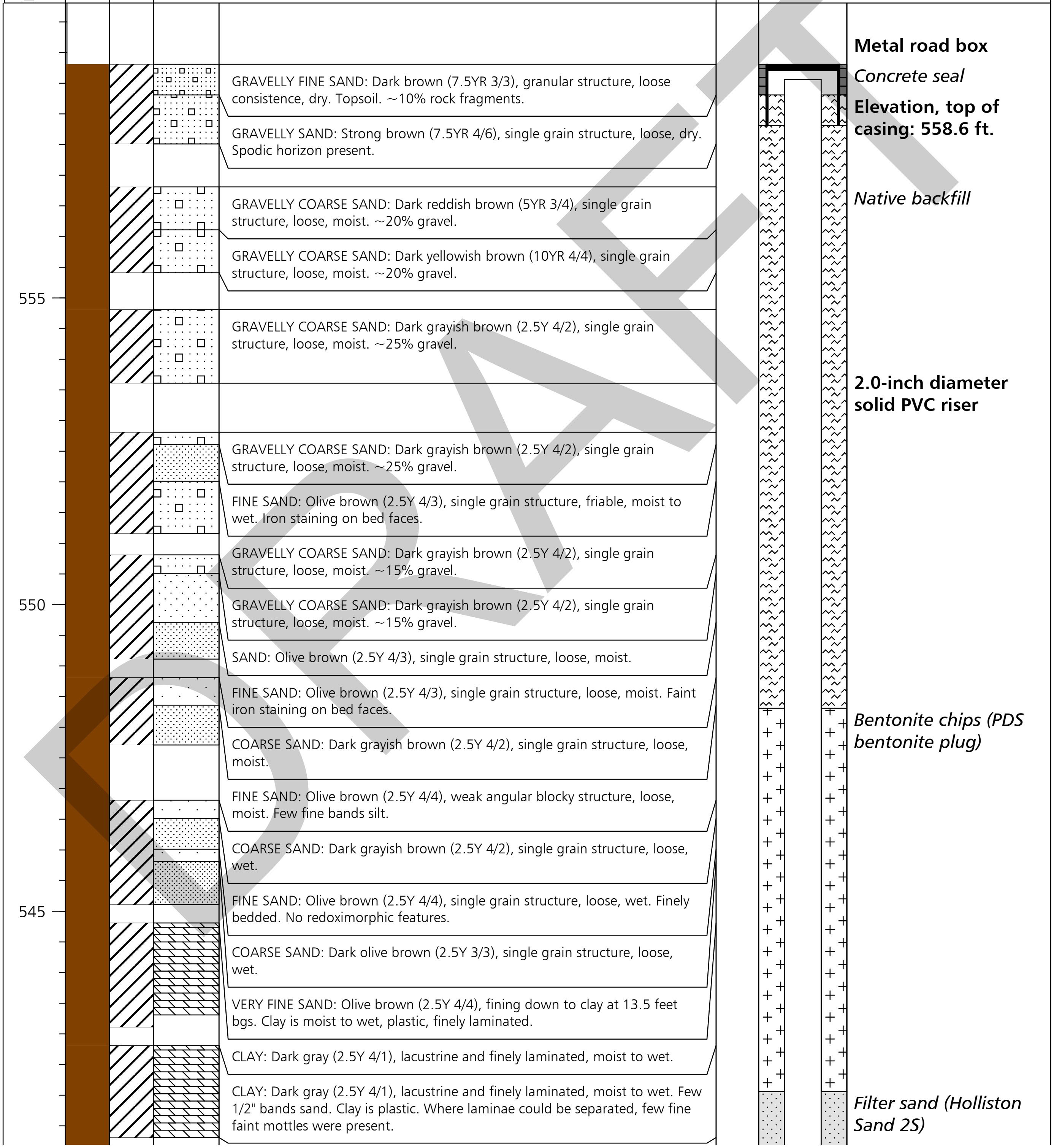
DRILLING METHOD: Solid stem auger
Logged by Amy Macrellis
Location:-73.01729928,44.61052559

COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations
REVISION DATE/INITIALS: 12/14/2021 anm
PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-1.dat

STONE ENVIRONMENTAL

ELEVATION (FEET)	SAMPLE INTERVAL	RECOVERY	LITHOLOGY / SOIL DESCRIPTION	Water Depth (ft)	WELL CONSTRUCTION *AND BACKFILL MATERIAL*



GRAVELLY FINE SAND: Dark brown (7.5YR 3/3), granular structure, loose consistence, dry. Topsoil. ~10% rock fragments.

GRAVELLY SAND: Strong brown (7.5YR 4/6), single grain structure, loose, dry. Spodic horizon present.

GRAVELLY COARSE SAND: Dark reddish brown (5YR 3/4), single grain structure, loose, moist. ~20% gravel.

GRAVELLY COARSE SAND: Dark yellowish brown (10YR 4/4), single grain structure, loose, moist. ~20% gravel.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist. ~25% gravel.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist. ~25% gravel.

FINE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, moist to wet. Iron staining on bed faces.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist. ~15% gravel.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist. ~15% gravel.

SAND: Olive brown (2.5Y 4/3), single grain structure, loose, moist.

FINE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, moist. Faint iron staining on bed faces.

COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist.

FINE SAND: Olive brown (2.5Y 4/4), weak angular blocky structure, loose, moist. Few fine bands silt.

COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, wet.

FINE SAND: Olive brown (2.5Y 4/4), single grain structure, loose, wet. Finely bedded. No redoximorphic features.

COARSE SAND: Dark olive brown (2.5Y 3/3), single grain structure, loose, wet.

VERY FINE SAND: Olive brown (2.5Y 4/4), fining down to clay at 13.5 feet bgs. Clay is moist to wet, plastic, finely laminated.

CLAY: Dark gray (2.5Y 4/1), lacustrine and finely laminated, moist to wet.

CLAY: Dark gray (2.5Y 4/1), lacustrine and finely laminated, moist to wet. Few 1/2" bands sand. Clay is plastic. Where laminae could be separated, few fine faint mottles were present.

FIGURE NO

BORING ID SB-1 and MW-1

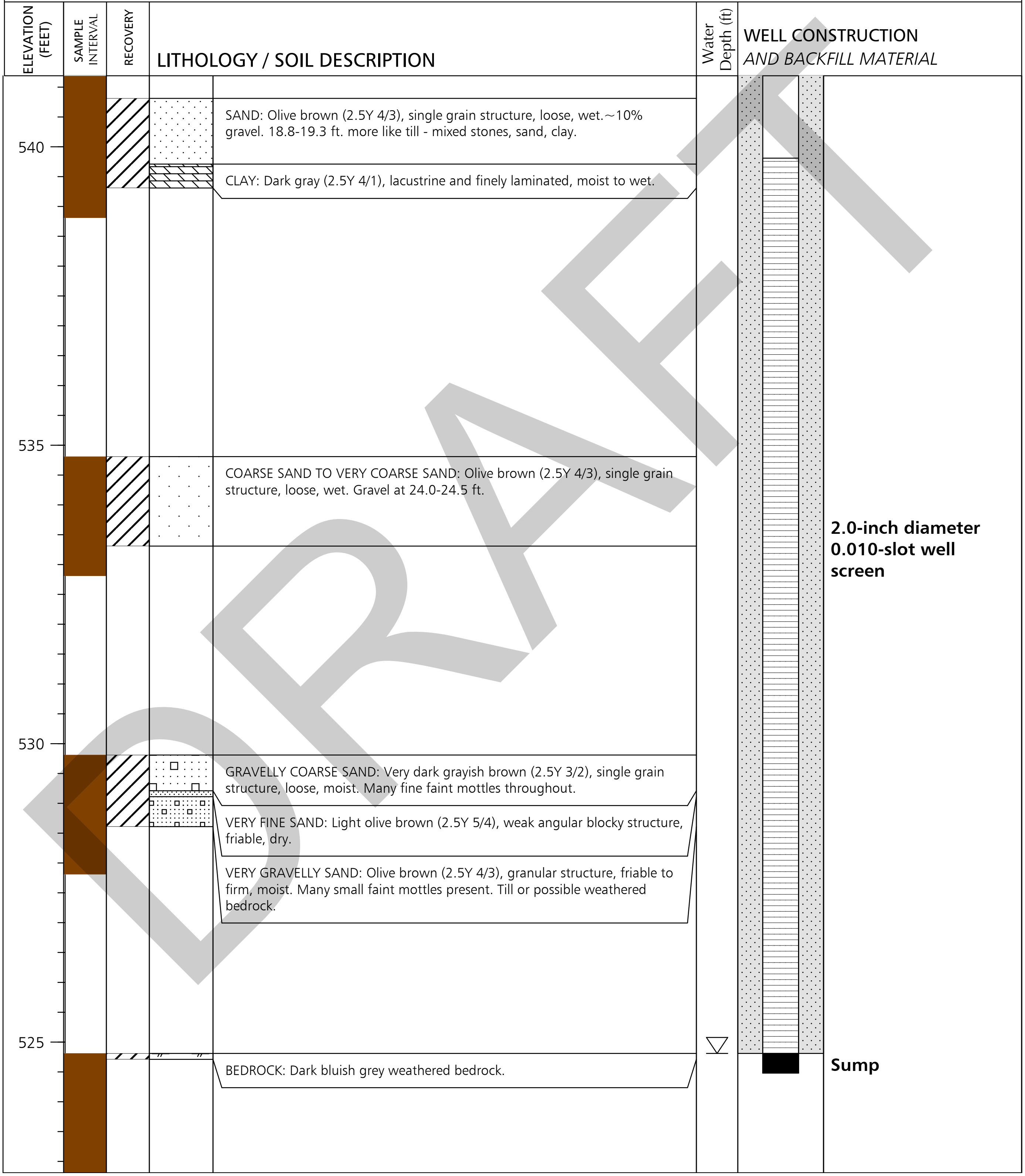
Maple Shade Wastewater

Date Drilled: 11/11/2021
COMPANY: New England Boring
DRILLER: Bub Thompson
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

DRILLING METHOD: Solid stem auger
Logged by Amy Macrellis
Location:-73.01729928,44.61052559

SOURCE: Stone Environmental field observations
REVISION DATE/INITIALS: 12/14/2021 anm
PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-1.dat

STONE ENVIRONMENTAL



SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet.~10% gravel. 18.8-19.3 ft. more like till - mixed stones, sand, clay.

CLAY: Dark gray (2.5Y 4/1), lacustrine and finely laminated, moist to wet.

COARSE SAND TO VERY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet. Gravel at 24.0-24.5 ft.

GRAVELLY COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, loose, moist. Many fine faint mottles throughout.

VERY FINE SAND: Light olive brown (2.5Y 5/4), weak angular blocky structure, friable, dry.

VERY GRAVELLY SAND: Olive brown (2.5Y 4/3), granular structure, friable to firm, moist. Many small faint mottles present. Till or possible weathered bedrock.

BEDROCK: Dark bluish grey weathered bedrock.

FIGURE NO

BORING ID SB-2 and MW-2

Maple Shade Wastewater

Date Drilled: 11/11/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:-73.01753035,44.6097726

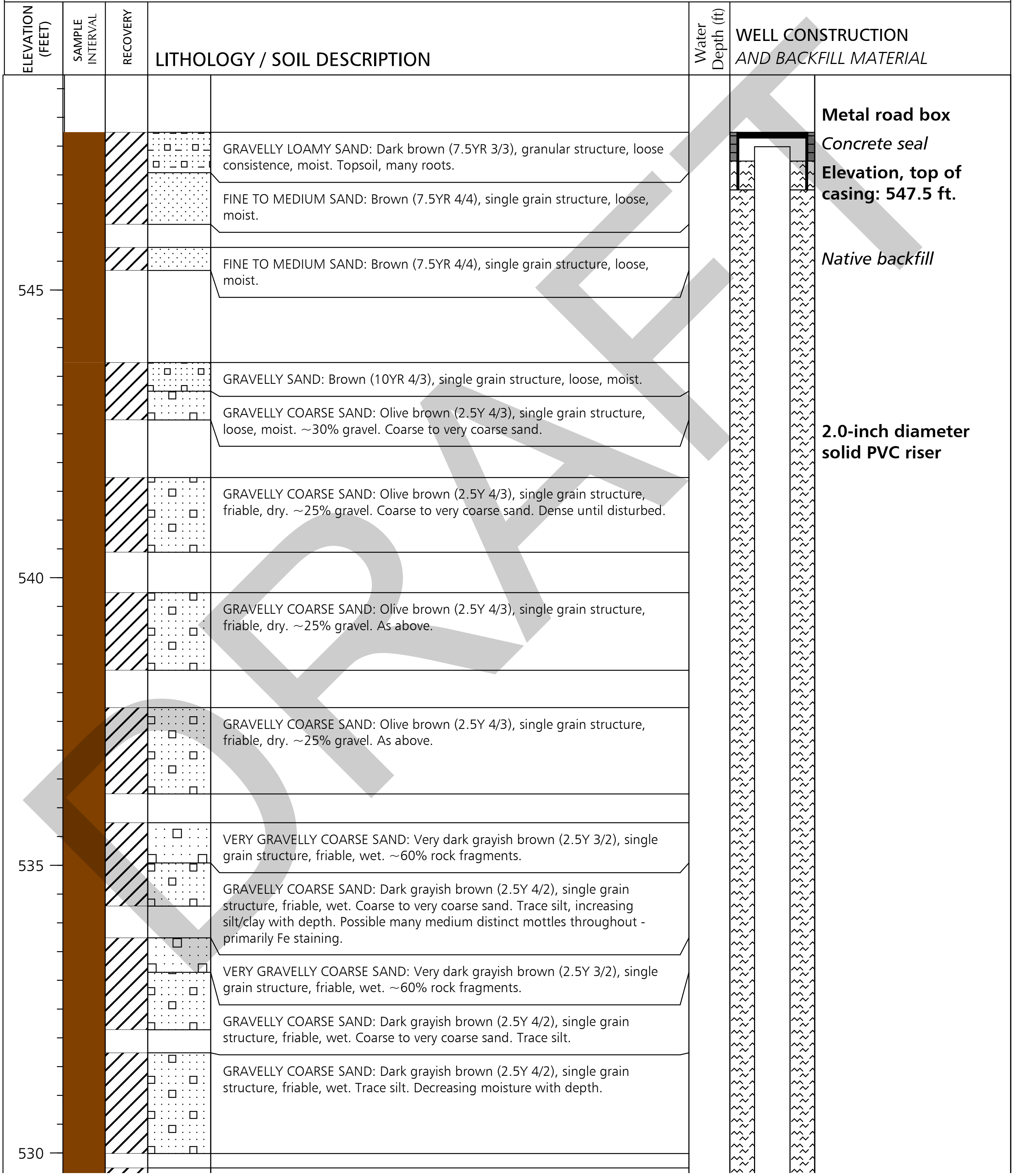
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/10/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-2.dat

STONE ENVIRONMENTAL



GRAVELLY LOAMY SAND: Dark brown (7.5YR 3/3), granular structure, loose consistence, moist. Topsoil, many roots.

FINE TO MEDIUM SAND: Brown (7.5YR 4/4), single grain structure, loose, moist.

FINE TO MEDIUM SAND: Brown (7.5YR 4/4), single grain structure, loose, moist.

GRAVELLY SAND: Brown (10YR 4/3), single grain structure, loose, moist.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, moist. ~30% gravel. Coarse to very coarse sand.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, dry. ~25% gravel. Coarse to very coarse sand. Dense until disturbed.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, dry. ~25% gravel. As above.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, dry. ~25% gravel. As above.

VERY GRAVELLY COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, friable, wet. ~60% rock fragments.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, friable, wet. Coarse to very coarse sand. Trace silt, increasing silt/clay with depth. Possible many medium distinct mottles throughout - primarily Fe staining.

VERY GRAVELLY COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, friable, wet. ~60% rock fragments.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, friable, wet. Coarse to very coarse sand. Trace silt.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, friable, wet. Trace silt. Decreasing moisture with depth.

FIGURE NO

BORING ID SB-2 and MW-2

Maple Shade Wastewater

Date Drilled: 11/11/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:-73.01753035,44.6097726

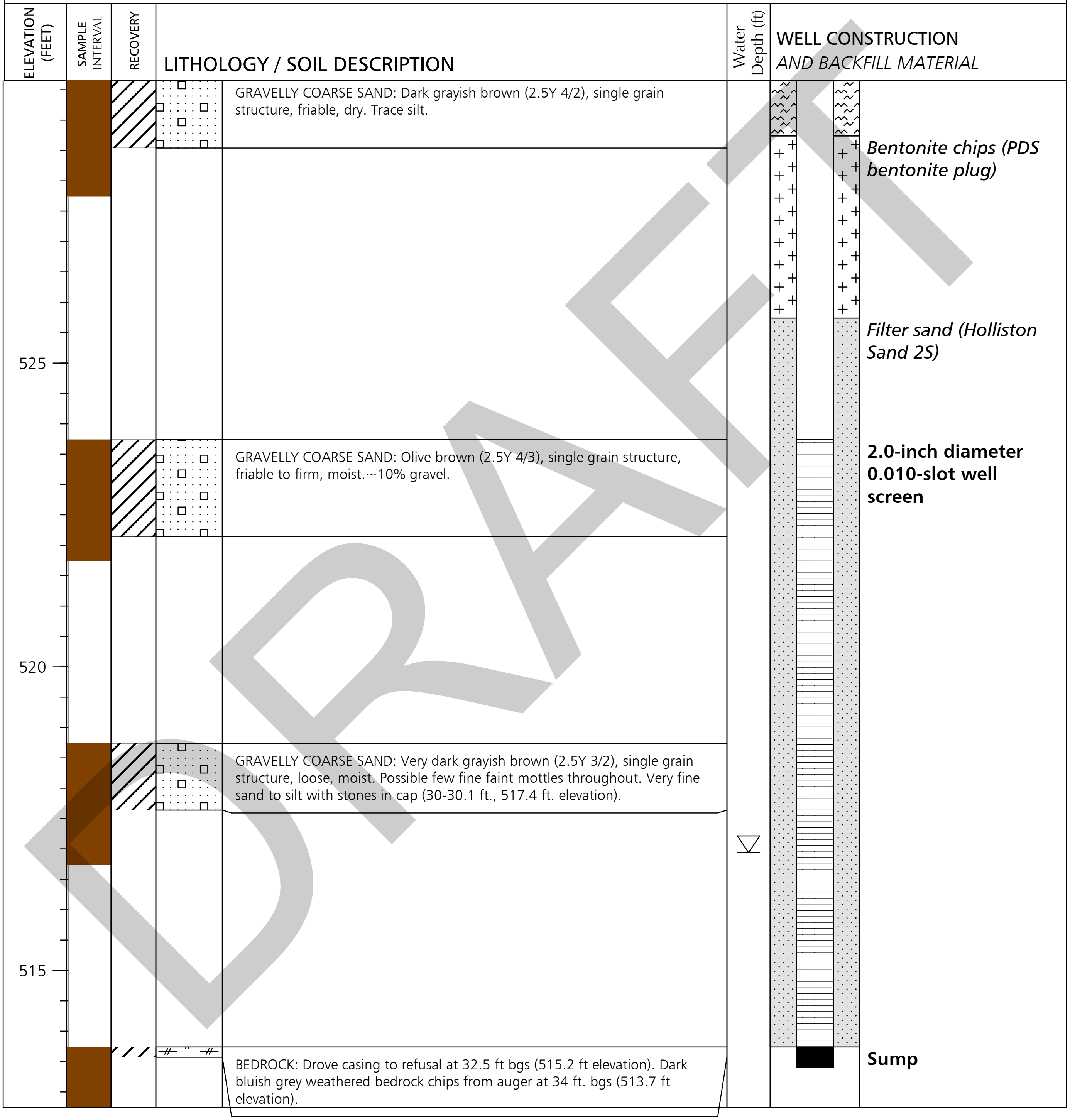
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/10/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-2.dat

STONE ENVIRONMENTAL



GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, friable, dry. Trace silt.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable to firm, moist.~10% gravel.

GRAVELLY COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, loose, moist. Possible few fine faint mottles throughout. Very fine sand to silt with stones in cap (30-30.1 ft., 517.4 ft. elevation).

BEDROCK: Drove casing to refusal at 32.5 ft bgs (515.2 ft elevation). Dark bluish grey weathered bedrock chips from auger at 34 ft. bgs (513.7 ft elevation).

FIGURE NO

BORING ID SB-3 and MW-3

Maple Shade Wastewater

Date Drilled: 11/12-15/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:-73.01748743,44.60902843

COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

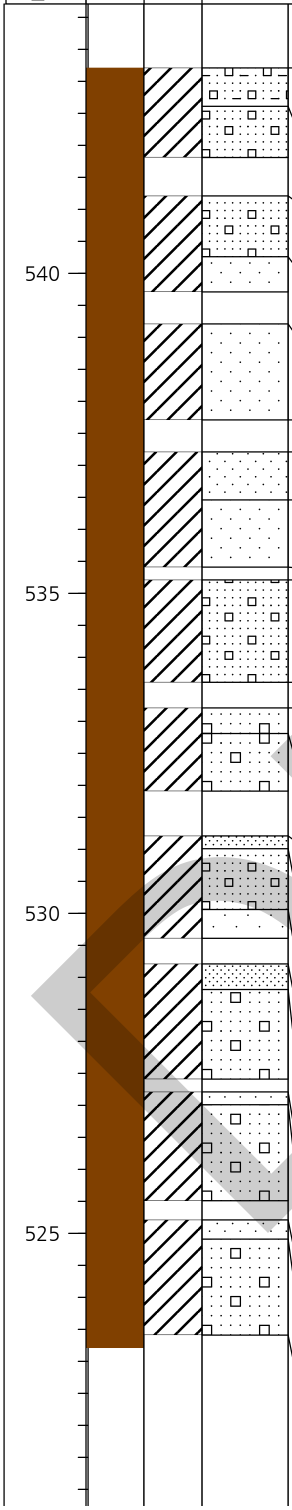
SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/10/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-3.dat

STONE ENVIRONMENTAL

ELEVATION (FEET) | SAMPLE INTERVAL | RECOVERY | LITHOLOGY / SOIL DESCRIPTION | Water Depth (ft) | WELL CONSTRUCTION *AND BACKFILL MATERIAL*



GRAVELLY LOAMY SAND: Dark brown (7.5YR 3/3), single grain structure, loose consistence, moist. Topsoil, many roots.

GRAVELLY SAND: Yellowish brown (10YR 5/4), single grain structure, loose, moist. Sand to coarse sand; ~5% gravel.

GRAVELLY SAND: Dark yellowish brown (10YR 4/6), single grain structure, loose, moist. Sand to coarse sand; ~5-10% gravel.

SAND TO COARSE SAND: Light olive brown (2.5Y 5/4), single grain structure, loose, moist.

SAND TO COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, loose, moist.

SAND: Light olive brown (2.5Y 5/4), single grain structure, loose, moist.

SAND TO COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, moist.

GRAVELLY SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, dry. ~5-10% gravel. Band of finely bedded fine sand at 9.4-9.5 ft bgs (533.8 ft. elevation).

GRAVELLY COARSE SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, friable consistence, moist. ~5% rock fragments.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose to friable, dry. ~5-10% gravel.

FINE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, moist (likely from drilling).

GRAVELLY SAND: Very dark grayish brown (2.5Y 3/2), single grain structure, friable consistence, dry. Sand to coarse sand. ~30% rock fragments.

COARSE SAND: Grayish brown (2.5Y 5/2), single grain structure, loose, dry.

FINE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, moist. Fine sand to sand.

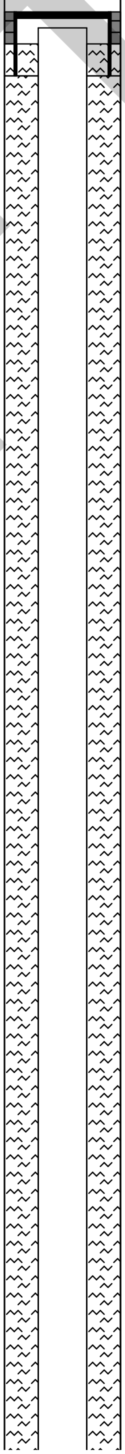
GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, dry. Sand to coarse sand. ~30% rock fragments. Iron staining.

SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet. Trace silt.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, moist to dry. Few fine distinct mottles throughout. Trace silt.

SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet. Trace silt.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, friable, moist to dry. Few fine distinct mottles throughout. Trace silt.



Metal road box

Concrete seal

Elevation, top of casing: 543.0 ft.

Native backfill

2.0-inch diameter solid PVC riser

FIGURE NO

BORING ID SB-3 and MW-3

Maple Shade Wastewater

Date Drilled: 11/12-15/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:-73.01748743,44.60902843

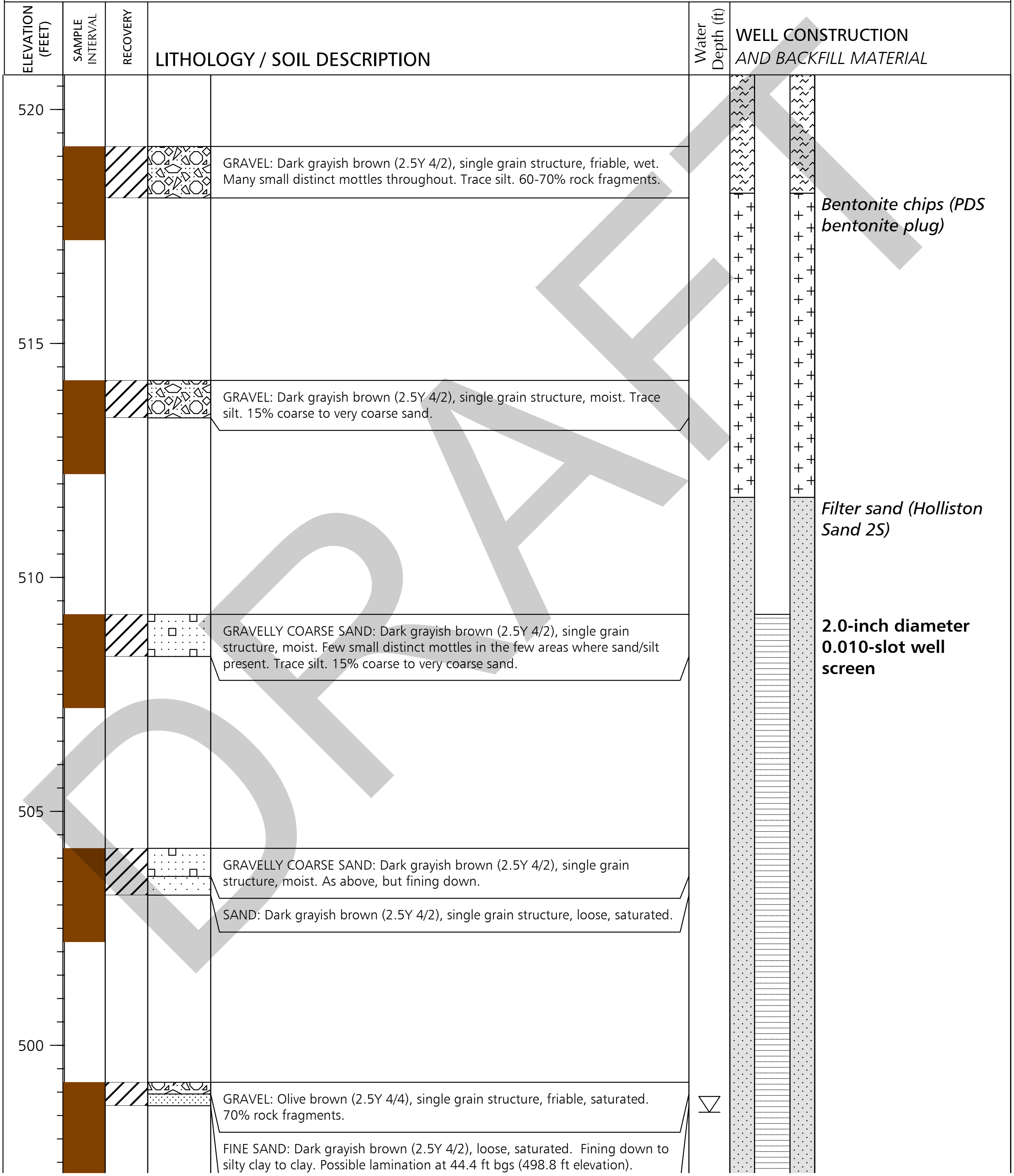
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/10/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-3.dat

STONE ENVIRONMENTAL



GRAVEL: Dark grayish brown (2.5Y 4/2), single grain structure, friable, wet. Many small distinct mottles throughout. Trace silt. 60-70% rock fragments.

GRAVEL: Dark grayish brown (2.5Y 4/2), single grain structure, moist. Trace silt. 15% coarse to very coarse sand.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, moist. Few small distinct mottles in the few areas where sand/silt present. Trace silt. 15% coarse to very coarse sand.

GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, moist. As above, but fining down.

SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, saturated.

GRAVEL: Olive brown (2.5Y 4/4), single grain structure, friable, saturated. 70% rock fragments.

FINE SAND: Dark grayish brown (2.5Y 4/2), loose, saturated. Fining down to silty clay to clay. Possible lamination at 44.4 ft bgs (498.8 ft elevation).

FIGURE NO

BORING ID SB-3 and MW-3

Maple Shade Wastewater

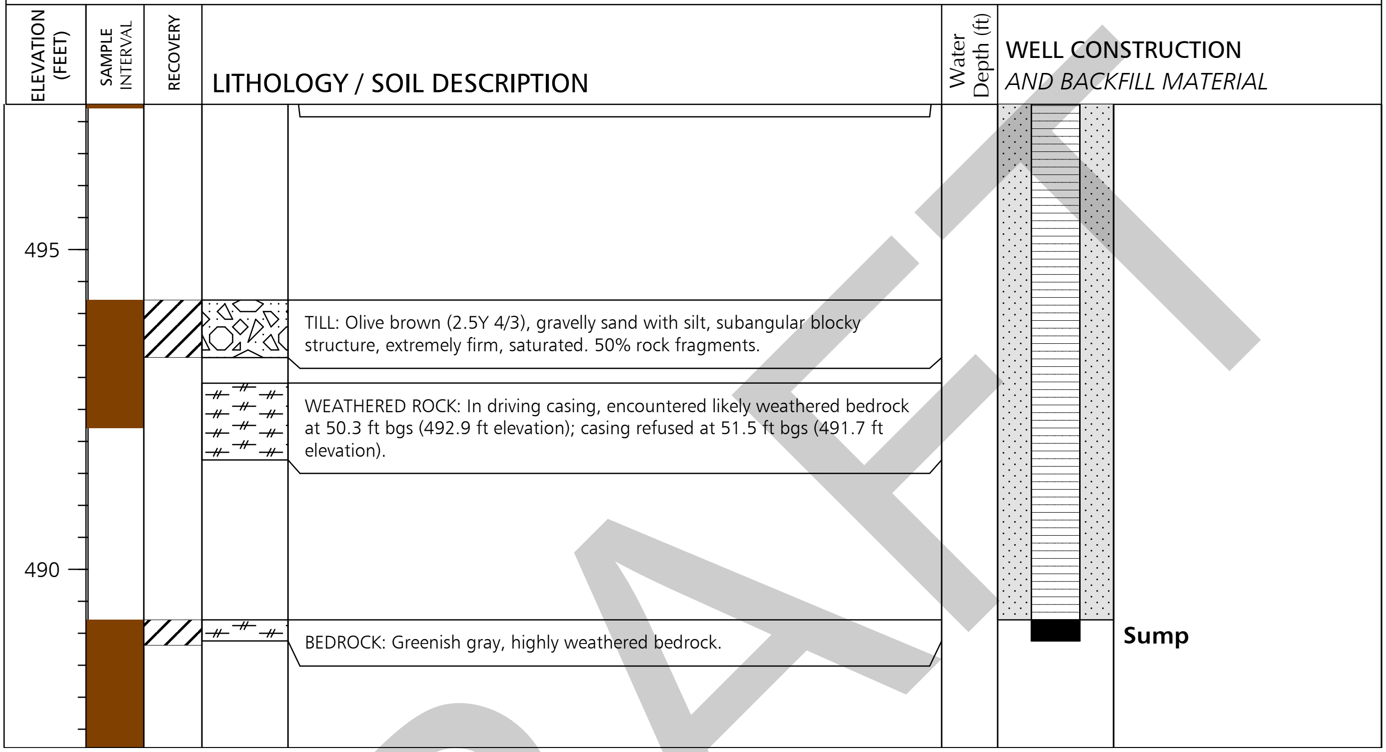
Date Drilled: 11/12-15/2021
COMPANY: New England Boring
DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger
Logged by Amy Macrellis
Location:-73.01748743,44.60902843

COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations
REVISION DATE/INITIALS: 12/10/2021 anm
PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-3.dat

STONE ENVIRONMENTAL



TILL: Olive brown (2.5Y 4/3), gravelly sand with silt, subangular blocky structure, extremely firm, saturated. 50% rock fragments.

WEATHERED ROCK: In driving casing, encountered likely weathered bedrock at 50.3 ft bgs (492.9 ft elevation); casing refused at 51.5 ft bgs (491.7 ft elevation).

BEDROCK: Greenish gray, highly weathered bedrock.

FIGURE NO

BORING ID SB-4 and MW-4

Maple Shade Wastewater

Date Drilled: 11/16/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:44.60976736,-73.01649102

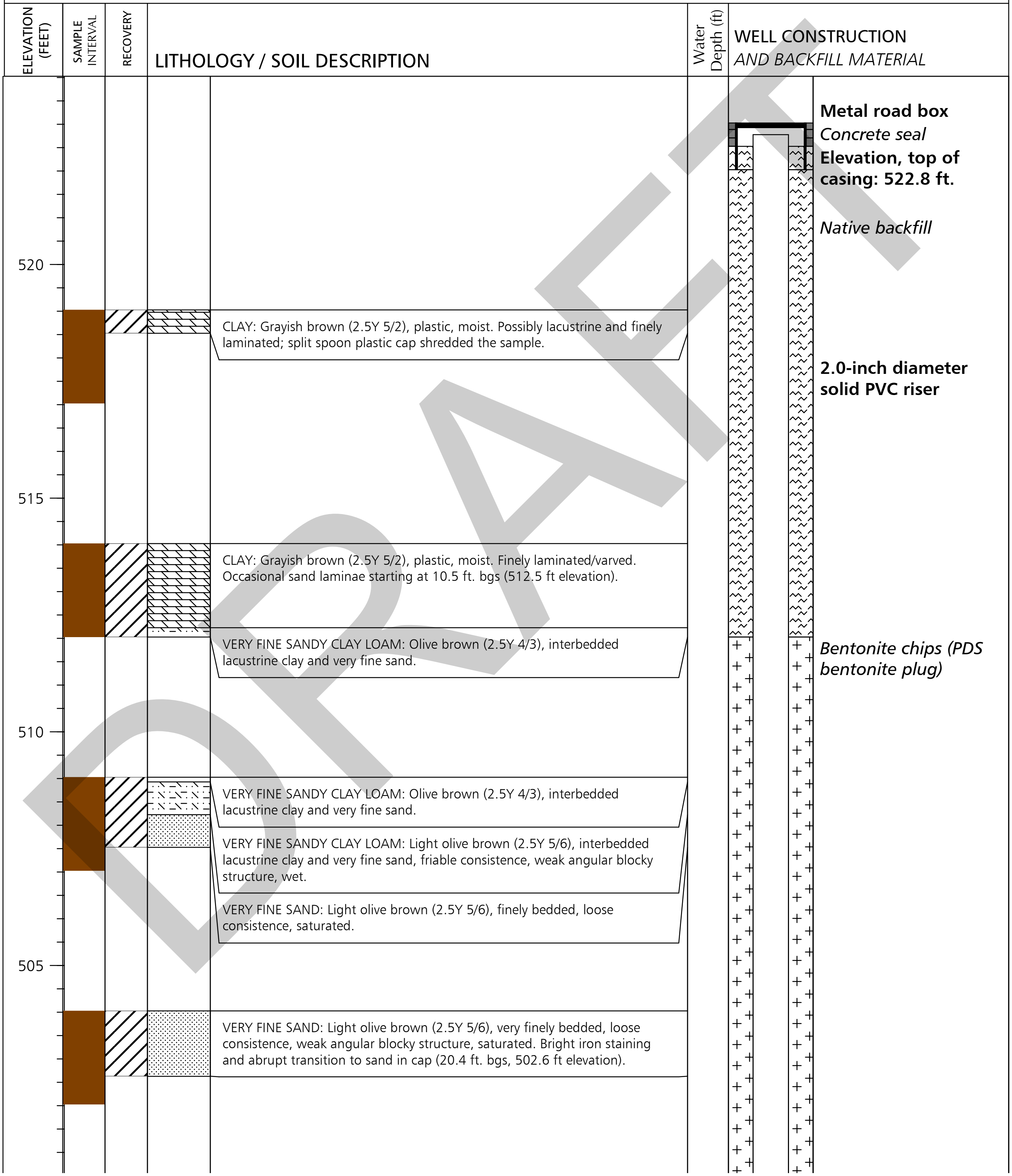
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/13/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-4.dat

STONE ENVIRONMENTAL



CLAY: Grayish brown (2.5Y 5/2), plastic, moist. Possibly lacustrine and finely laminated; split spoon plastic cap shredded the sample.

CLAY: Grayish brown (2.5Y 5/2), plastic, moist. Finely laminated/varved. Occasional sand laminae starting at 10.5 ft. bgs (512.5 ft elevation).

VERY FINE SANDY CLAY LOAM: Olive brown (2.5Y 4/3), interbedded lacustrine clay and very fine sand.

VERY FINE SANDY CLAY LOAM: Olive brown (2.5Y 4/3), interbedded lacustrine clay and very fine sand.

VERY FINE SANDY CLAY LOAM: Light olive brown (2.5Y 5/6), interbedded lacustrine clay and very fine sand, friable consistence, weak angular blocky structure, wet.

VERY FINE SAND: Light olive brown (2.5Y 5/6), finely bedded, loose consistence, saturated.

VERY FINE SAND: Light olive brown (2.5Y 5/6), very finely bedded, loose consistence, weak angular blocky structure, saturated. Bright iron staining and abrupt transition to sand in cap (20.4 ft. bgs, 502.6 ft elevation).

FIGURE NO

BORING ID SB-4 and MW-4

Maple Shade Wastewater

Date Drilled: 11/16/2021

COMPANY: New England Boring

DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger

Logged by Amy Macrellis

Location:44.60976736,-73.01649102

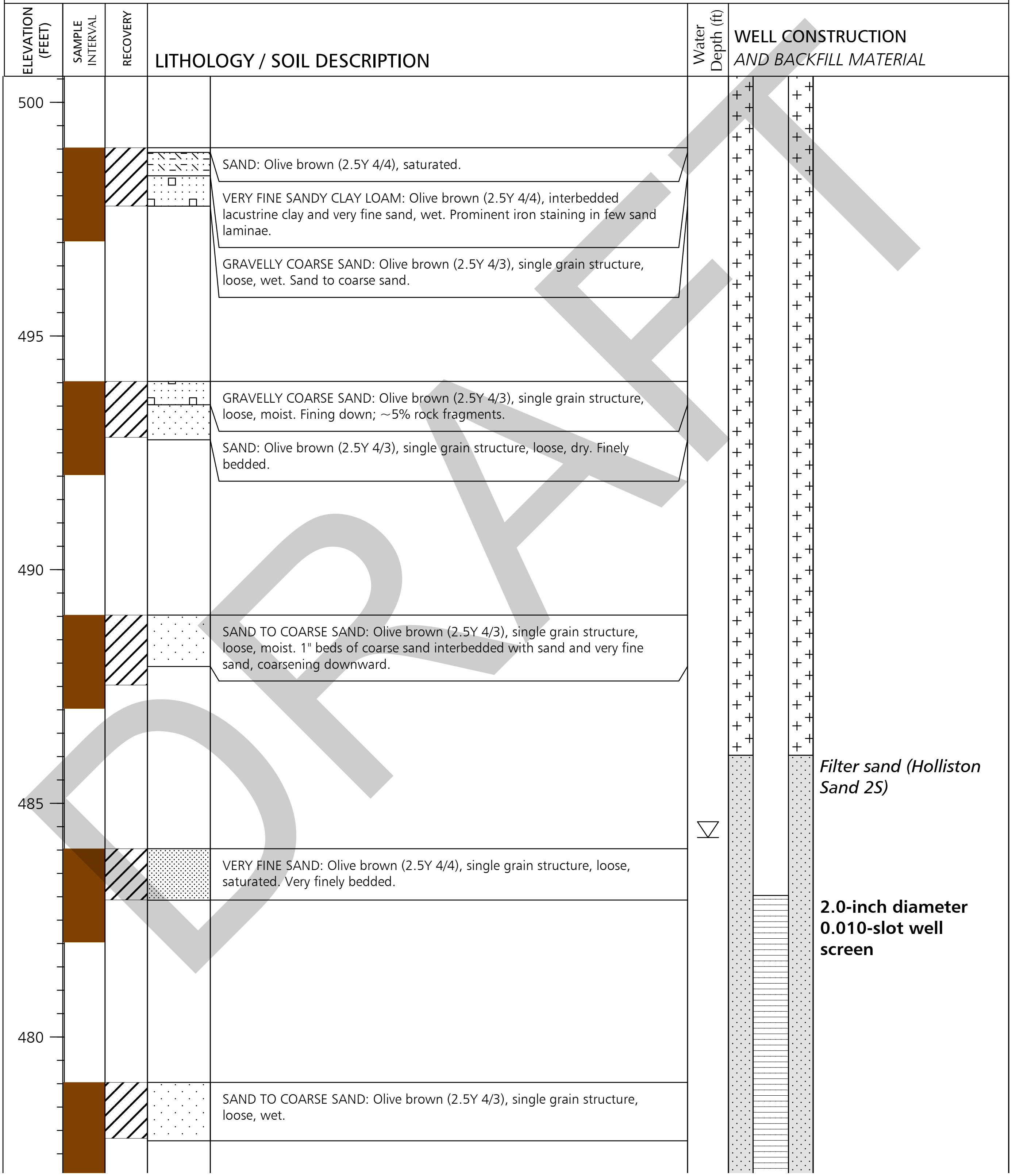
COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations

REVISION DATE/INITIALS: 12/13/2021 anm

PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-4.dat

STONE ENVIRONMENTAL



SAND: Olive brown (2.5Y 4/4), saturated.

VERY FINE SANDY CLAY LOAM: Olive brown (2.5Y 4/4), interbedded lacustrine clay and very fine sand, wet. Prominent iron staining in few sand laminae.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet. Sand to coarse sand.

GRAVELLY COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, moist. Fining down; ~5% rock fragments.

SAND: Olive brown (2.5Y 4/3), single grain structure, loose, dry. Finely bedded.

SAND TO COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, moist. 1" beds of coarse sand interbedded with sand and very fine sand, coarsening downward.

VERY FINE SAND: Olive brown (2.5Y 4/4), single grain structure, loose, saturated. Very finely bedded.

SAND TO COARSE SAND: Olive brown (2.5Y 4/3), single grain structure, loose, wet.

FIGURE NO

BORING ID SB-4 and MW-4

Maple Shade Wastewater

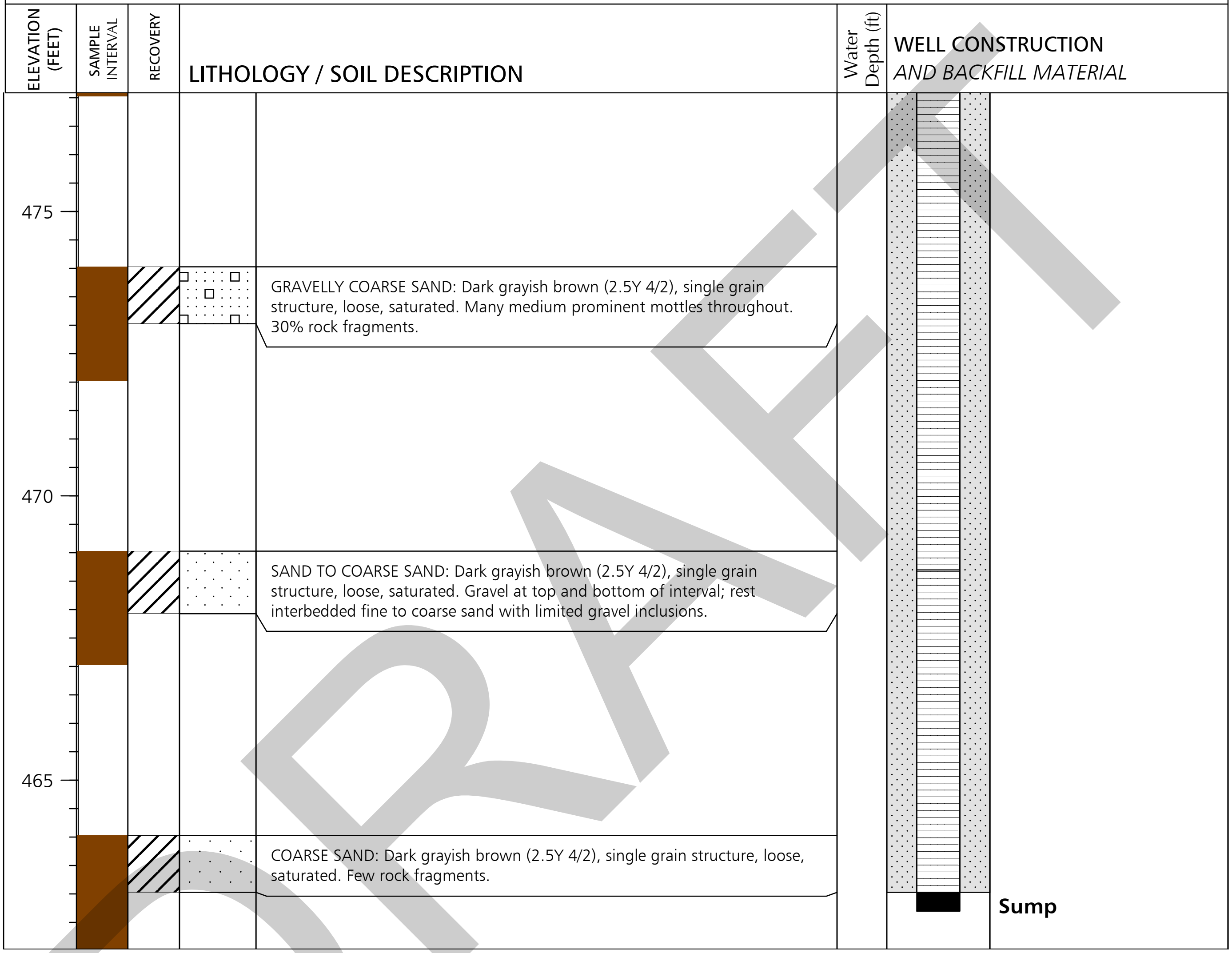
Date Drilled: 11/16/2021
COMPANY: New England Boring
DRILLER: Bub Thompson

DRILLING METHOD: Solid stem auger
Logged by Amy Macrellis
Location:44.60976736,-73.01649102

COMMENT: Ground elevation determined from GPS unit, draft pending topographic survey.

SOURCE: Stone Environmental field observations
REVISION DATE/INITIALS: 12/13/2021 anm
PATHNAME: O:\PROJ-19\WRM\19-161 Westford Comm WW System\Data\Soil borings and MWs\Soil boring and MW logs\MW-4.dat

STONE ENVIRONMENTAL



GRAVELLY COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, saturated. Many medium prominent mottles throughout. 30% rock fragments.

SAND TO COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, saturated. Gravel at top and bottom of interval; rest interbedded fine to coarse sand with limited gravel inclusions.

COARSE SAND: Dark grayish brown (2.5Y 4/2), single grain structure, loose, saturated. Few rock fragments.

Attachment 3: Hydraulic Conductivity Testing Results

Auger Hole Hydraulic Conductivity Measurement

Project Title: Westford Town Center Wastewater - Jackson Farm Evaluation
Stone Project #: 13-224
Date: 8/4/2015
Sampling Personnel: Amy Macrellis, David Gauthier, Melissa Manka
Backhoe test pit #: 110
Auger hole radius: 1.5" (3.8 cm)
Auger hole depth: 15" (38 cm) (test run at 24-39" below ground surface)

Field Measurements:

Run	Time (t) seconds	Δ t	Volume (v) Liters	Δ v	Flow Rate (Q_e) cm^3/sec
1	0		11		
	10	10	10	1	100
	23	13	9	1	77
	35	12	8	1	83
	50	15	7	1	67
	61	11	6	1	91
	72	11	5	1	91
	86	14	4	1	71
	100	14	3	1	71
2	159		14		
	165	6	13	1	167
	178	13	12	1	77
	190	12	11	1	83
	201	11	10	1	91
	214	13	9	1	77
	228	14	8	1	71
	241	13	7	1	77
	255	14	6	1	71
	268	13	5	1	77
	281	13	4	1	77
	293	12	3	1	83
3	346		15		
	360	14	14	1	71
	372	12	13	1	83
	386	14	12	1	71
	400	14	11	1	71
	413	13	10	1	77
	424	11	9	1	91
	438	14	8	1	71
	452	14	7	1	71
	466	14	6	1	71
	478	12	5	1	83
	492	14	4	1	71
	506	14	3	1	71

Calculations:

K = hydraulic conductivity (cm/sec)
L_w = wetted length of auger hole (cm)
r_w = radius of auger hole (cm)
S_i = vertical distance from bottom of auger hole to impeding layer (cm)
Q_e = equilibrium rate of water added (cm^3/sec) = average Δv/Δt for last run

$$K = \frac{Q_e}{2\Pi L_w^2}[\ln(\frac{L_w}{r_w} + \sqrt{(\frac{L_w^2}{r_w^2} - 1)}) - 1]$$

Assumption: Impermeable layer was not encountered; distance from bottom of auger hole to top of impermeable layer is more than 2x the wetted length (impermeable assumed at bottom of test pit, 128 inches bgs).

Results:

L_w = 38 cm
r_w = 3.8 cm
S_i = 226 cm
Q_e = 75 cm^3/sec

K = 0.0243 cm/sec
69 ft/day

Slug Test - Water Level Data Page 1 of 3

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT

Slug Test: SB-2 Slug Test

Test Well: SB-2

Test Conducted by: SYR

Test Date: 12/1/2021

Water level at t=0 [ft]: 30.99

Static Water Level [ft]: 30.80

Water level change at t=0 [ft]: 0.19

	Time [s]	Water Level [ft]	WL Change [ft]
1	0	30.803	0.001
2	0.251	30.805	0.003
3	0.501	30.803	0.001
4	0.882	30.803	0.001
5	1.005	30.80	-0.002
6	1.251	30.805	0.003
7	1.501	30.801	-0.001
8	1.845	30.802	0.00
9	2.001	30.801	-0.001
10	2.251	30.803	0.001
11	2.501	30.801	-0.001
12	2.751	30.805	0.003
13	3.001	30.803	0.001
14	3.251	30.802	0.00
15	3.501	30.803	0.001
16	3.751	30.80	-0.002
17	4.001	30.802	0.00
18	4.251	30.802	0.00
19	4.501	30.80	-0.002
20	4.751	30.804	0.002
21	5.001	30.804	0.002
22	5.251	30.803	0.001
23	5.501	30.801	-0.001
24	5.751	30.803	0.001
25	6.001	30.801	-0.001
26	6.361	30.804	0.002
27	6.721	30.801	-0.001
28	7.141	30.801	-0.001
29	7.561	30.80	-0.002
30	7.981	30.804	0.002
31	8.461	30.802	0.00
32	9.055	30.801	-0.001
33	9.481	30.80	-0.002
34	10.081	30.802	0.00
35	10.681	30.799	-0.003
36	11.281	30.804	0.002
37	11.94	30.801	-0.001
38	12.66	30.803	0.001
39	13.44	30.804	0.002
40	14.221	30.803	0.001
41	15.061	30.803	0.001
42	15.961	30.803	0.001
43	16.92	30.803	0.001
44	17.88	30.796	-0.006
45	19.089	30.799	-0.003
46	20.101	30.795	-0.007
47	21.301	30.371	-0.431
48	22.561	30.569	-0.233

Slug Test - Water Level Data

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
49	24.102	30.60	-0.202
50	25.321	30.607	-0.195
51	26.821	30.617	-0.185
52	28.38	30.63	-0.172
53	30.061	30.637	-0.165
54	31.86	30.647	-0.155
55	33.721	30.657	-0.145
56	35.761	30.668	-0.134
57	37.86	30.673	-0.129
58	40.08	30.682	-0.12
59	42.481	30.687	-0.115
60	45	30.692	-0.11
61	47.64	30.70	-0.102
62	50.461	30.704	-0.098
63	53.461	30.707	-0.095
64	56.64	30.714	-0.088
65	60	30.72	-0.082
66	63.6	30.726	-0.076
67	67.2	30.734	-0.068
68	71.4	30.735	-0.067
69	75.6	30.743	-0.059
70	79.8	30.746	-0.056
71	84.6	30.753	-0.049
72	90	30.758	-0.044
73	94.8	30.76	-0.042
74	100.8	30.766	-0.036
75	106.8	30.771	-0.031
76	112.8	30.773	-0.029
77	119.4	30.776	-0.026
78	126.6	30.782	-0.02
79	134.4	30.781	-0.021
80	142.2	30.785	-0.017
81	150.6	30.79	-0.012
82	159.6	30.793	-0.009
83	169.39	30.791	-0.011
84	178.8	30.793	-0.009
85	189.6	30.792	-0.01
86	201	30.796	-0.006
87	213	30.797	-0.005
88	225.6	30.799	-0.003
89	238.8	30.799	-0.003
90	253.2	30.803	0.001
91	268.2	30.801	-0.001
92	283.8	30.803	0.001
93	300.6	30.798	-0.004
94	318.6	30.803	0.001
95	337.2	30.80	-0.002
96	357.6	30.803	0.001
97	378.6	30.801	-0.001
98	400.8	30.802	0.00
99	424.8	30.991	0.189
100	450	30.926	0.124
101	476.4	30.883	0.081

Slug Test - Water Level Data Page 3 of 3

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
102	504.832	30.853	0.051
103	534.865	30.834	0.032
104	566.4	30.824	0.022
105	600	30.818	0.016
106	636	30.813	0.011
107	672	30.812	0.01
108	714	30.811	0.009
109	756	30.807	0.005
110	798	30.701	-0.101
111	846	30.757	-0.045
112	900	30.786	-0.016
113	948	30.796	-0.006
114	1008	30.80	-0.002
115	1068	30.801	-0.001
116	1128	30.80	-0.002
117	1188	30.939	0.137
118	1248	30.852	0.05
119	1308	30.818	0.016
120	1368	30.811	0.009
121	1428	30.806	0.004
122	1488	30.805	0.003
123	1548	30.804	0.002

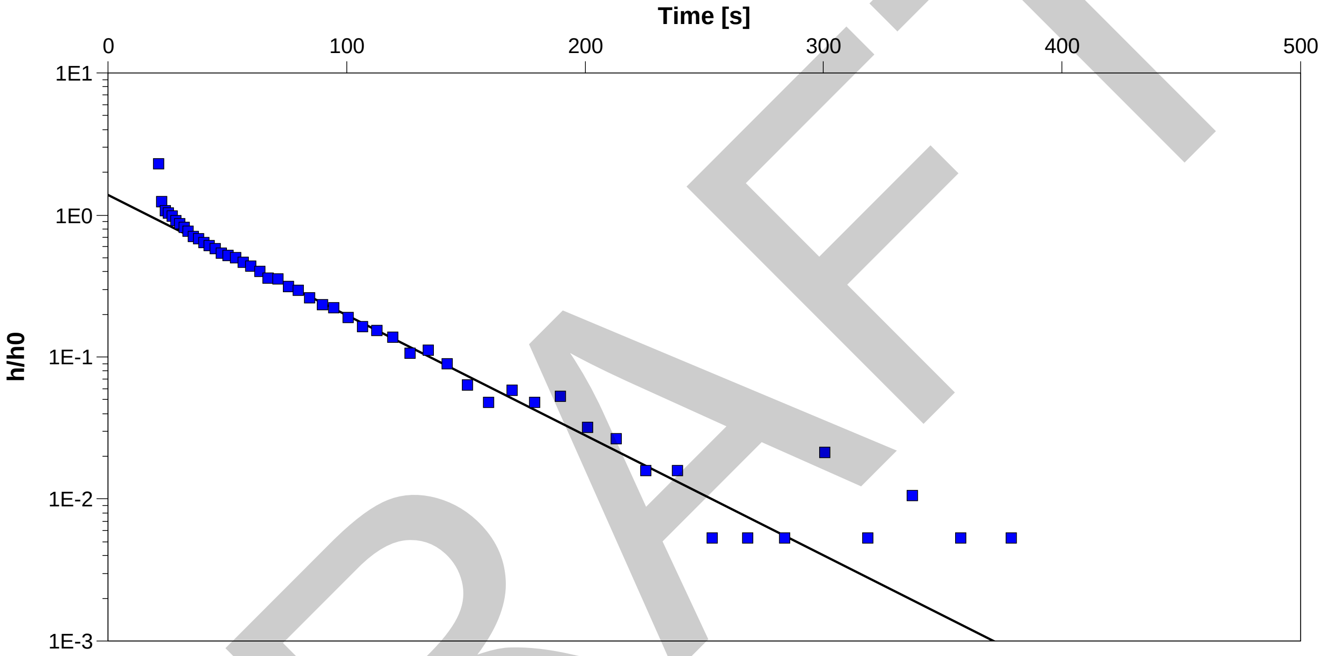
Slug Test Analysis Report

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT	Slug Test: SB-2 Slug Test	Test Well: SB-2
Test Conducted by: SYR		Test Date: 12/1/2021
Analysis Performed by: SYR	Hvorslev Analysis	Analysis Date: 12/3/2021
Aquifer Thickness: 1.20 ft		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [ft/d]
SB-2	2.57×10^0

Slug Test - Analyses Report

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT

Slug Test: SB-2 Slug Test

Test Well: SB-2

Test Conducted by: SYR

Test Date: 12/1/2021

Aquifer Thickness: 1.20 ft

	Analysis Name	Analysis Performed b	Analysis Date	Method name	Well	T [ft²/d]	K [ft/d]	S
1	Hvorslev Analysis	SYR	12/3/2021	Hvorslev	SB-2		2.57×10^{0}	

Slug Test - Water Level Data

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT

Slug Test: SB-3 Slug Test

Test Well: SB-3

Test Conducted by: SYR

Test Date: 12/1/2021

Water level at t=0 [ft]: 43.76

Static Water Level [ft]: 44.63

Water level change at t=0 [ft]: -0.87

	Time [s]	Water Level [ft]	WL Change [ft]
1	0	44.628	-0.002
2	0.251	44.627	-0.003
3	0.501	44.628	-0.002
4	0.863	44.631	0.001
5	1.001	44.632	0.002
6	1.251	44.626	-0.004
7	1.501	44.627	-0.003
8	1.751	44.628	-0.002
9	2.001	44.628	-0.002
10	2.251	44.626	-0.004
11	2.501	44.629	-0.001
12	2.751	44.631	0.001
13	3.001	44.627	-0.003
14	3.251	44.63	0.00
15	3.501	44.628	-0.002
16	3.751	44.627	-0.003
17	4.001	44.627	-0.003
18	4.251	44.63	0.00
19	4.501	44.625	-0.005
20	4.751	44.628	-0.002
21	5.001	44.629	-0.001
22	5.251	44.628	-0.002
23	5.501	44.631	0.001
24	5.751	44.629	-0.001
25	6.001	44.628	-0.002
26	6.361	44.627	-0.003
27	6.721	44.628	-0.002
28	7.141	44.628	-0.002
29	7.577	44.627	-0.003
30	7.981	44.628	-0.002
31	8.461	44.63	0.00
32	9	44.626	-0.004
33	9.481	44.629	-0.001
34	10.081	44.626	-0.004
35	10.681	44.626	-0.004
36	11.281	44.628	-0.002
37	11.94	44.628	-0.002
38	12.66	44.628	-0.002
39	13.44	44.629	-0.001
40	14.22	44.627	-0.003
41	15.061	44.625	-0.005
42	15.96	44.629	-0.001
43	16.92	44.623	-0.007
44	17.88	44.611	-0.019
45	18.96	43.761	-0.869
46	20.101	44.293	-0.337
47	21.301	44.37	-0.26
48	22.561	44.379	-0.251

Slug Test - Water Level Data

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
49	23.88	44.387	-0.243
50	25.321	44.39	-0.24
51	26.821	44.401	-0.229
52	28.38	44.395	-0.235
53	30.061	44.399	-0.231
54	31.86	44.409	-0.221
55	33.72	44.407	-0.223
56	35.76	44.411	-0.219
57	37.86	44.418	-0.212
58	40.08	44.419	-0.211
59	42.56	44.424	-0.206
60	45	44.428	-0.202
61	47.64	44.434	-0.196
62	50.46	44.436	-0.194
63	53.46	44.438	-0.192
64	56.64	44.444	-0.186
65	60	44.448	-0.182
66	63.6	44.454	-0.176
67	67.2	44.456	-0.174
68	71.4	44.461	-0.169
69	75.6	44.47	-0.16
70	79.8	44.474	-0.156
71	84.6	44.479	-0.151
72	90	44.485	-0.145
73	94.8	44.491	-0.139
74	100.8	44.495	-0.135
75	106.8	44.504	-0.126
76	112.8	44.509	-0.121
77	119.4	44.515	-0.115
78	126.6	44.524	-0.106
79	134.4	44.53	-0.10
80	142.2	44.532	-0.098
81	150.6	44.538	-0.092
82	159.6	44.545	-0.085
83	169.2	44.552	-0.078
84	178.8	44.559	-0.071
85	189.6	44.566	-0.064
86	201	44.569	-0.061
87	213	44.573	-0.057
88	225.6	44.577	-0.053
89	238.8	44.585	-0.045
90	253.2	44.586	-0.044
91	268.2	44.593	-0.037
92	283.8	44.595	-0.035
93	300.6	44.596	-0.034
94	318.6	44.598	-0.032
95	337.2	44.602	-0.028
96	357.6	44.605	-0.025
97	378.6	44.605	-0.025
98	400.814	44.608	-0.022
99	424.8	44.607	-0.023
100	450	44.608	-0.022
101	476.4	44.609	-0.021

Slug Test - Water Level Data

Project: Westford Comm WW System

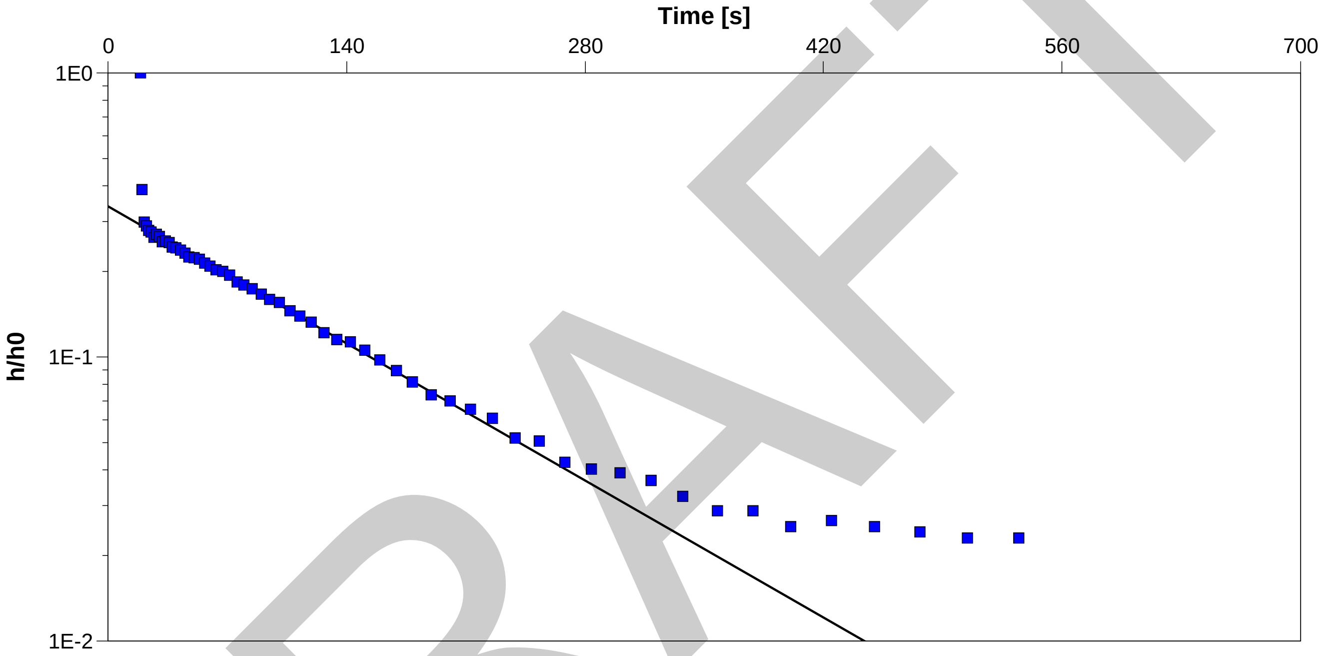
Number: 19-161

Client: Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
102	504.6	44.61	-0.02
103	534.6	44.61	-0.02
104	566.4	44.867	0.237
105	600	44.785	0.155
106	636	44.721	0.091
107	672	44.685	0.055
108	714	44.656	0.026
109	756	44.646	0.016
110	798	44.634	0.004
111	846	44.627	-0.003
112	900	44.622	-0.008
113	948	44.618	-0.012
114	1008	44.615	-0.015
115	1068	44.616	-0.014
116	1128	44.359	-0.271
117	1188	44.461	-0.169
118	1248	44.522	-0.108
119	1308	44.56	-0.07
120	1368	44.576	-0.054
121	1428	44.585	-0.045
122	1488	44.591	-0.039
123	1548	44.593	-0.037
124	1608	44.596	-0.034
125	1668	44.596	-0.034
126	1728	44.598	-0.032
127	1788	44.795	0.165
128	1848	44.688	0.058
129	1908	44.643	0.013
130	1968	44.62	-0.01
131	2028	44.607	-0.023
132	2088	44.606	-0.024
133	2148	44.602	-0.028

	Slug Test Analysis Report
	Project: Westford Comm WW System
	Number: 19-161
	Client: Town of Westford

Location: Westford, VT	Slug Test: SB-3 Slug Test	Test Well: SB-3
Test Conducted by: SYR		Test Date: 12/1/2021
Analysis Performed by: SYR	Bouwer & Rice Analysis	Analysis Date: 12/3/2021
Aquifer Thickness: 6.87 ft		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [ft/d]
SB-3	4.72×10^{-1}

Slug Test - Analyses Report

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT

Slug Test: SB-3 Slug Test

Test Well: SB-3

Test Conducted by: SYR

Test Date: 12/1/2021

Aquifer Thickness: 6.87 ft

	Analysis Name	Analysis Performed b	Analysis Date	Method name	Well	T [ft^2/d]	K [ft/d]	S
1	Bouwer & Rice Analy	SYR	12/3/2021	Bouwer & Rice	SB-3		4.72×10^{-1}	

Slug Test - Water Level Data Page 1 of 3

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT	Slug Test: SB-4 Slug Test	Test Well: SB-4
Test Conducted by: SYR	Test Date: 12/1/2021	
Water level at t=0 [ft]: 37.96	Static Water Level [ft]: 38.76	Water level change at t=0 [ft]: -0.80

	Time [s]	Water Level [ft]	WL Change [ft]
1	0	38.751	-0.009
2	0.251	38.751	-0.009
3	0.501	38.753	-0.007
4	0.751	38.753	-0.007
5	1.131	38.753	-0.007
6	1.254	38.754	-0.006
7	1.501	38.752	-0.008
8	1.751	38.755	-0.005
9	2.001	38.75	-0.01
10	2.251	38.754	-0.006
11	2.501	38.753	-0.007
12	2.751	38.752	-0.008
13	3.001	38.751	-0.009
14	3.251	38.751	-0.009
15	3.501	38.751	-0.009
16	3.751	38.752	-0.008
17	4.001	38.752	-0.008
18	4.251	38.754	-0.006
19	4.501	38.751	-0.009
20	4.751	38.752	-0.008
21	5.001	38.752	-0.008
22	5.251	38.751	-0.009
23	5.501	38.752	-0.008
24	5.751	38.752	-0.008
25	6.001	38.752	-0.008
26	6.361	38.753	-0.007
27	6.721	38.752	-0.008
28	7.141	38.754	-0.006
29	7.561	38.754	-0.006
30	7.981	38.751	-0.009
31	8.461	38.752	-0.008
32	9.001	38.755	-0.005
33	9.481	38.752	-0.008
34	10.081	38.75	-0.01
35	10.681	38.752	-0.008
36	11.281	38.753	-0.007
37	11.94	38.752	-0.008
38	12.66	38.752	-0.008
39	13.44	38.753	-0.007
40	14.221	38.75	-0.01
41	15.061	38.749	-0.011
42	15.96	38.753	-0.007
43	16.92	38.751	-0.009
44	17.88	38.751	-0.009
45	18.96	38.748	-0.012
46	20.101	38.376	-0.384
47	21.301	37.961	-0.799
48	22.561	38.238	-0.522

Slug Test - Water Level Data

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
49	23.88	38.444	-0.316
50	25.321	38.572	-0.188
51	26.821	38.642	-0.118
52	28.38	38.683	-0.077
53	30.061	38.711	-0.049
54	31.86	38.725	-0.035
55	33.721	38.73	-0.03
56	35.761	38.737	-0.023
57	37.86	38.741	-0.019
58	40.08	38.74	-0.02
59	42.481	38.74	-0.02
60	45	38.743	-0.017
61	47.64	38.743	-0.017
62	50.46	38.744	-0.016
63	53.46	38.744	-0.016
64	56.64	38.745	-0.015
65	60	38.748	-0.012
66	63.6	38.744	-0.016
67	67.2	38.746	-0.014
68	71.4	38.746	-0.014
69	75.6	38.745	-0.015
70	79.8	38.745	-0.015
71	84.749	38.743	-0.017
72	90	38.745	-0.015
73	94.801	38.741	-0.019
74	100.8	38.743	-0.017
75	106.8	38.743	-0.017
76	112.8	38.746	-0.014
77	119.4	38.744	-0.016
78	126.6	38.746	-0.014
79	134.4	38.745	-0.015
80	142.2	38.744	-0.016
81	150.6	38.744	-0.016
82	159.6	38.747	-0.013
83	169.2	38.744	-0.016
84	178.8	38.747	-0.013
85	189.6	38.747	-0.013
86	201	38.746	-0.014
87	213	38.745	-0.015
88	225.6	38.938	0.178
89	238.8	38.746	-0.014
90	253.2	38.743	-0.017
91	268.2	38.74	-0.02
92	283.8	38.744	-0.016
93	300.6	38.742	-0.018
94	318.6	38.743	-0.017
95	337.2	38.745	-0.015
96	357.6	38.745	-0.015
97	378.6	38.746	-0.014
98	400.8	38.743	-0.017
99	424.8	38.744	-0.016
100	450	38.684	-0.076
101	476.4	38.74	-0.02

Slug Test - Water Level Data	Page 3 of 3
Project:	Westford Comm WW System
Number:	19-161
Client:	Town of Westford

	Time [s]	Water Level [ft]	WL Change [ft]
102	504.6	38.742	-0.018
103	534.606	38.741	-0.019
104	566.4	38.74	-0.02
105	600	38.74	-0.02
106	636	38.74	-0.02
107	672	38.74	-0.02
108	714	38.738	-0.022
109	756.122	38.734	-0.026
110	798	38.737	-0.023
111	846.277	38.637	-0.123
112	900	38.735	-0.025
113	948	38.735	-0.025
114	1008	38.736	-0.024
115	1068	38.735	-0.025
116	1128	38.735	-0.025

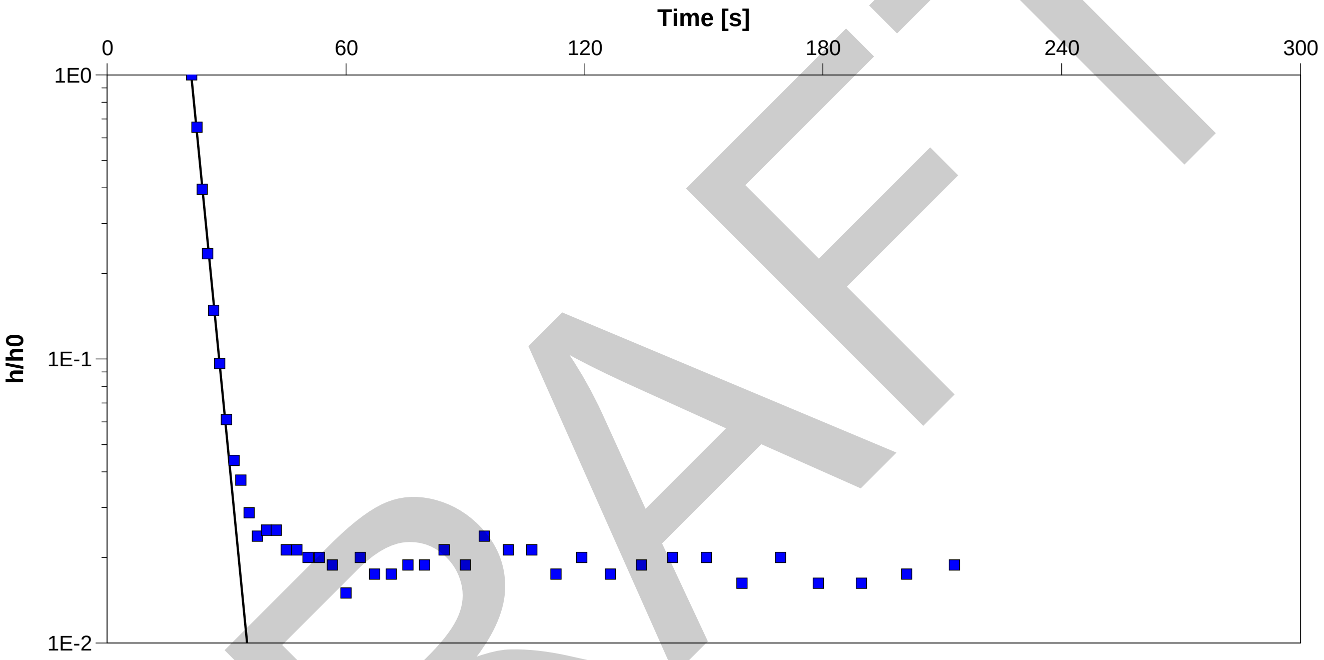
Slug Test Analysis Report

Project: Westford Comm WW System

Number: 19-161

Client: Town of Westford

Location: Westford, VT	Slug Test: SB-4 Slug Test	Test Well: SB-4
Test Conducted by: SYR		Test Date: 12/1/2021
Analysis Performed by: SYR	Bouwer & Rice Analysis	Analysis Date: 12/3/2021
Aquifer Thickness: 19.73 ft		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [ft/d]
SB-4	2.11×10^{1}

Slug Test - Analyses Report

Project: Westford Comm WW System
Number: 19-161
Client: Town of Westford

Location: Westford, VT
Slug Test: SB-4 Slug Test
Test Well: SB-4
Test Conducted by: SYR
Test Date: 12/1/2021
Aquifer Thickness: 19.73 ft

	Analysis Name	Analysis Performed b	Analysis Date	Method name	Well	T [ft²/d]	K [ft/d]	S
1	Bouwer & Rice Analy	SYR	12/3/2021	Bouwer & Rice	SB-4		2.11×10^1	

Attachment 4: 2021 Darcy's Law Capacity Calculations

Attachment 3-1: Revised Darcy's Law Capacity Analysis, A-A', Absorption Trenches

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA

Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
  D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1 Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2 Water table slope (i) is similar to ground surface slope and surface of lacustrine clay layer identifed in MW-1 and extrapolated to TP-111 along the A-A' cross section = 12/150 = 8.0%
3 Depth to limiting feature or bottom of pit - lacustrine clay encountered at 13.5 feet bgs in MW-1 assumed to occur at similar depths throughout the area leachfields would be sited
4 Design is for in-ground trenches with trench bottom located 1.5 feet below ground surface
5 Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6 System length (L) across slope (perpendicular to contours) = 145 feet (along A-A', from west of TP-107 to 25' setback from slope >20%, as presented in PER Alternatives 4 and 5

Calculations:

K = 69 ft/day
i = 0.080
L = 145 ft.
D = 9.00 ft. =13.5 ft. -1.5 ft. - 3.0 ft.

Q = 69 ft/day x 0.08 x (145 ft x 9 ft) x 7.48 gal/ft^3
Q = 53,900 gallons/day
(2017 = 38,975 gpd)

Attachment 3-2: Revised Darcy's Law Capacity Analysis, B-B', Absorption Trenches

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA
Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
    D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1. Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2. Water table slope (i) based on elevations of ESHGW at TP-19, TP-020 and TP-123 along the B-B' cross section as estimated from site survey and Lidar = 11'-230'= 4.8%
3. Depth to limiting feature or bottom of pit (ranges from 6.2 ft to 15.0 ft where leachfields would be sited; use average of TP-019 (revised 12/21) and TP-020 = 10.6 feet below ground surface)
4. Design is for in-ground trenches with trench bottom located 1.5 feet below ground surface
5. Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6. System length (L) across slope (perpendicular to contours) = 145 feet (along B-B', from Alternative 4 and Alternative 5 site plans; approximately from TP-019 to TP-123)

Calculations:

K = 69 ft/day
i = 0.048
L = 145 ft.
D = 6.10 ft. =10.6 ft. -1.5 ft. - 3.0 ft.

Q = 69 ft/day x 0.048 x (145 ft x 6.1 ft) x 7.48 gal/ft^3
Q = 21,900 gallons/day
(2017 = 10,968 gpd)

Attachment 3-3: Darcy's Law Capacity Analysis, D-D', Absorption Trenches

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA
Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
    D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1. Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2. Water table slope (i) based on ESHGW roughly follows ground surface slope in the proposed disposal field area along the D-D' as estimated from site survey and Lidar = 19'/192'= 9.9%
3. Depth to limiting feature - use shallowest instance of redoximorphic featrues in MW-3 at 13.0 feet below ground surface
4. Design is for in-ground trenches with trench bottom located 1.5 feet below ground surface
5. Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6. System length (L) across slope (perpendicular to contours) = 190 feet (along D-D', from Alternative 4 and Alternative 5 site plans; from east of TP-023 to west of TP-114)

Calculations:

K = 69 ft/day
i = 0.099
L = 190 ft.
D = 8.50 ft. =13.0 ft. -1.5 ft. - 3.0 ft.

Q = 69 ft/day x 0.099 x (190 ft x 8.5 ft) x 7.48 gal/ft^3
Q = 82,500 gallons/day

Attachment 3-4: Darcy's Law Capacity Analysis, A-A', Subsurface Drip Disposal

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA

Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
    D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1. Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2. Water table slope (i) is similar to ground surface slope and surface of lacustrine clay layer identifed in MW-1 and extrapolated to TP-111 along the A-A' cross section = 12/150 = 8.0%
3. Depth to limiting feature or bottom of pit - lacustrine clay encountered at 13.5 feet bgs in MW-1 assumed to occur at similar depths throughout the area leachfields would be sited
4. Design is for subsurface drip irrigation disposal system with bottom 1.0 feet below ground surface
5. Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6. System length (L) across slope (perpendicular to contours) = 145 feet (along A-A', from west of TP-107 to 25' setback from slope >20%, as presented in PER Alternatives 4 and 5

Calculations:

K = 69 ft/day
i = 0.080
L = 145 ft.
D = 9.50 ft. =13.5 ft. -1.0 ft. - 3.0 ft.

Q = 69 ft/day x 0.08 x (145 ft x 9.5 ft) x 7.48 gal/ft^3
Q = 56,900 gallons/day

Attachment 3-5: Darcy's Law Capacity Analysis, B-B', Subsurface Drip Disposal

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA
Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1. Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2. Water table slope (i) based on elevations of ESHGW at TP-19, TP-020 and TP-123 along the B-B' cross section as estimated from site survey and Lidar = 11'-230'= 4.8%
3. Depth to limiting feature or bottom of pit (ranges from 6.2 ft to 15.0 ft where leachfields would be sited; use average of TP-019 (revised 12/21) and TP-020 = 10.6 feet below ground surface)
4. Design is for subsurface drip irrigation disposal system with bottom 1.0 feet below ground surface
5. Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6. System length (L) across slope (perpendicular to contours) = 145 feet (along B-B', from Alternative 4 and Alternative 5 site plans; approximately from TP-019 to TP-123)

Calculations:

K = 69 ft/day
i = 0.048
L = 145 ft.
D = 6.60 ft. =10.6 ft. -1.0 ft. - 3.0 ft.

Q = 69 ft/day x 0.048 x (145 ft x 6.6 ft) x 7.48 gal/ft^3
Q = 23,700 gallons/day

Attachment 3-6: Darcy's Law Capacity Analysis, D-D', Subsurface Drip Disposal

Project Title: Westford Community Wastewater System, Hydrogeologic Analysis, Maple Shade Site
Stone Project No.: 19-161
Date: February 10, 2022
Prepared by: Amy Macrellis

Darcy's Law Calculations: Q = KiA

Q = design flow (gallons / day)
K = Hydraulic conductivity (feet / day)
i = Hydraulic gradient (slope of water table, unitless)
A = transmitting soil cross-sectional area (D) times length of disposal system (L) in square feet, where
    D = depth to impeding layer or water table, minus required vertical separation, minus system depth

Assumptions:

1 Hydraulic conductivity (K) = 69 feet/day (measured at TP-110)
2 Water table slope (i) based on ESHGW roughly follows ground surface slope in the proposed disposal field area along the D-D' as estimated from site survey and Lidar = 19'/192'= 9.9%
3 Depth to limiting feature - use shallowest instance of redoximorphic featrues in MW-3 at 13.0 feet below ground surface
4 Design is for subsurface drip irrigation disposal system with bottom 1.0 feet below ground surface
5 Required separation distance to seasonal high groundwater is 3.0 feet for septic tank effluent
6 System length (L) across slope (perpendicular to contours) = 190 feet (along D-D', from Alternative 4 and Alternative 5 site plans; from east of TP-023 to west of TP-114)

Calculations:

K = 69 ft/day
i = 0.099
L = 190 ft.
D = 9.00 ft. =13.0 ft. -1.0 ft. - 3.0 ft.

Q = 69 ft/day x 0.099 x (190 ft x 9 ft) x 7.48 gal/ft^3
Q = 87,400 gallons/day

Attachment 5: February 2022 Summary of GME-DEC Correspondence

GREEN MOUNTAIN ENGINEERING, INC.

MEMORANDUM

DATE: 02/18/2022

SUBJECT: Westford Community Wastewater System – DEC meeting Summary and Disposal System Discussion

TO: **Town of Westford**

FROM: Brad Washburn, P.E.

On February 03, Brad Washburn (GME), Bryan Harrington (IDR, VTDEC), Bruce Douglas (VT DEC) and Rob Sarmanian (Oakson) held a zoom meeting to discuss the design and permitting of a drip dispersal system for the proposed Town of Westford Community Wastewater Disposal System. The main discussion was regarding the replacement area requirements for drip disperal system for design capacities over 6,500 gallons per day as the current IDR rules do not directly address drip dispersal. The current IDR rules require dual alternating system for typical pressure distribution systems using septic tank effluent. GME's preliminary design discussions with Oakson have raised some questions to the resting of drip fields for extended periods of time and Oakson has indicated that they would rather utilize the entire disposal system, year-round at half of the application rate. Currently, Oakson has laid out a series of drip zones within the useable portion of disposal testing area.

The discussion concluded that DEC is aware that drip dispersal is not addressed in the IDR rules and are willing to look at proposed operational scenarios. The scenarios discussed included:

- Year-round use of the entire disposal system at a reduced loading rate
- The buildout of the system to 150% of the design flow (same as in-ground trench system)
- More frequent rotation of the online disposal fields. Monthly, quarterly etc.

Bruce and Bryan indicated that they were not able to commit to any scenario discussed during the meeting but were willing to work through a scenario that all parties are comfortable with. Bruce indicated that currently, there are no year-round drip dispersal system in the State with design flows over 6,500 gallon per day and that the revised IDR rules are currently being drafted which will address the drip dispersal requirements.

Overall, the meeting was positive, and it appears that with the appropriate supporting data, that there is a good chance that 100% full redundancy of the drip field will NOT be required.

GME will no longer be the design engineer for the system. Rob Sarmanian from Oakson wanted to pass along his offer to the town and new design team Oakson's services to provide technical information and first-hand accounts of what has been discussed so far.

Attachment 6: Mounding Analysis Results

MOUNDSOLV
GROUNDWATER MOUNDING ANALYSIS
FOR A SLOPING WATER-TABLE AQUIFER
ZLOTNIK ET AL. (2017) SOLUTION

Maple Shade Disposal Site, Alternative 4
Field 3 (Source 1) and Field 4 (Source 2)
A-A' Section, March 3, 2022

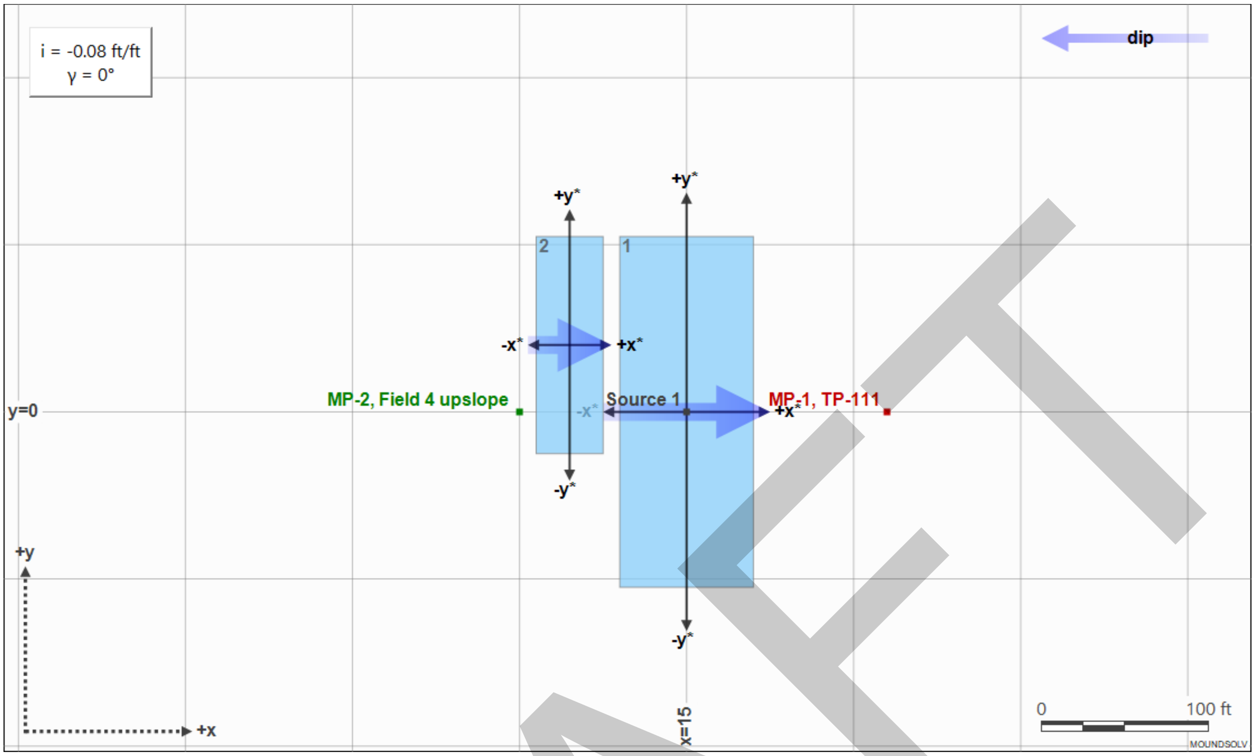
1. Solution Method

Zlotnik et al. (2017) steady-state solution for a rectangular source (linearization method 1)

2. Site Description

Aquifer Data	
Property	**Value**
Horizontal hydraulic conductivity, K (ft/d)	69
Initial saturated thickness, h_0 (ft)	2.5
Maximum allowable water-table rise, σ (ft)	3
Dip, i (ft/ft)	-0.08
Slope rotation from x axis, γ (°)	0

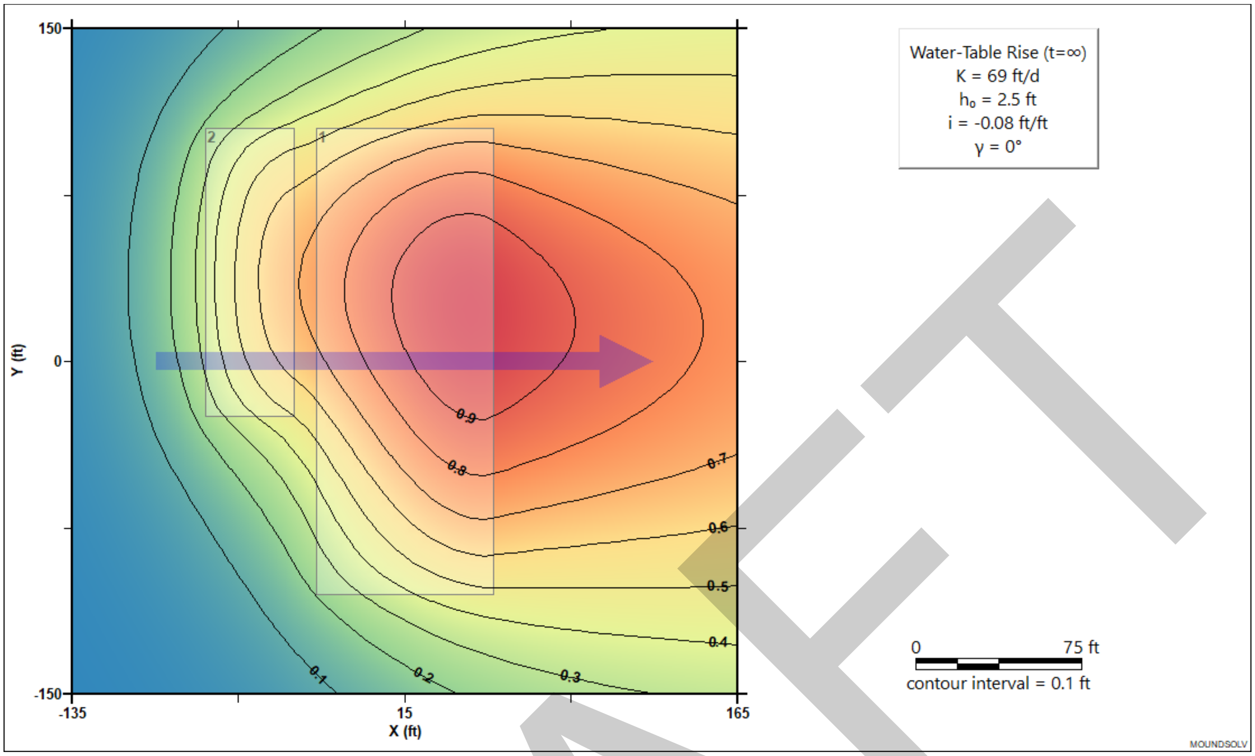
Recharge Sources		
Property	**Source 1**	**Source 2**
X coordinate at center, X (ft)	15	-55
Y coordinate at center, Y (ft)	0	40
Dimension along x* axis, L (ft)	80	40
Dimension along y* axis, W (ft)	210	130
Rotation from slope direction, ϕ (°)	0	0
Recharge rate, Q (ft^3/d)	842	521
Infiltration rate, q (ft/d)	0.05011904762	0.1001923077



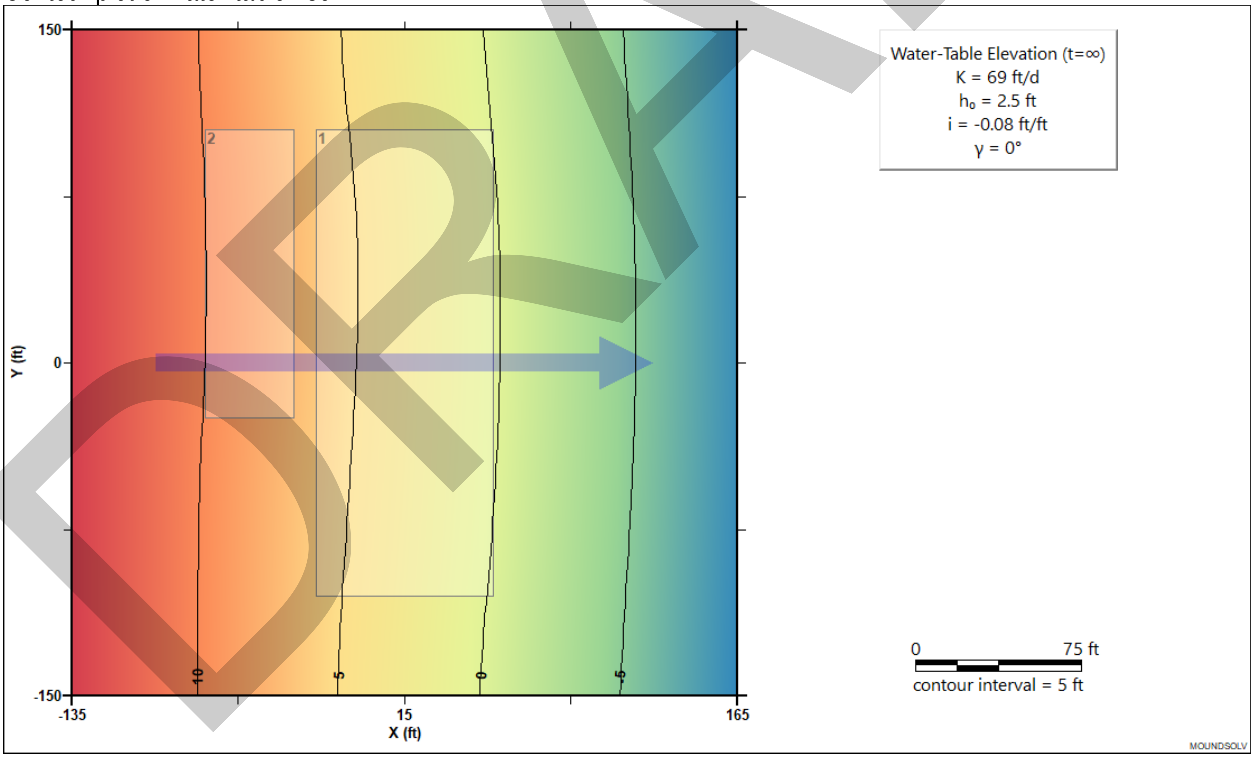
Map of recharge source.

3. Monitoring Points

Steady State					
Name	**x (ft)**	**y (ft)**	**s (ft)**	**h (ft)**	**z (ft)**
Source 1	15	0	0.8871	3.387	0
MP-1, TP-111	135	0	0.8155	-6.285	-9.6
MP-2, Field 4 upslope	-85	0	0.2159	10.72	8



Contour plot of water-table rise.



Contour plot of water-table elevation.

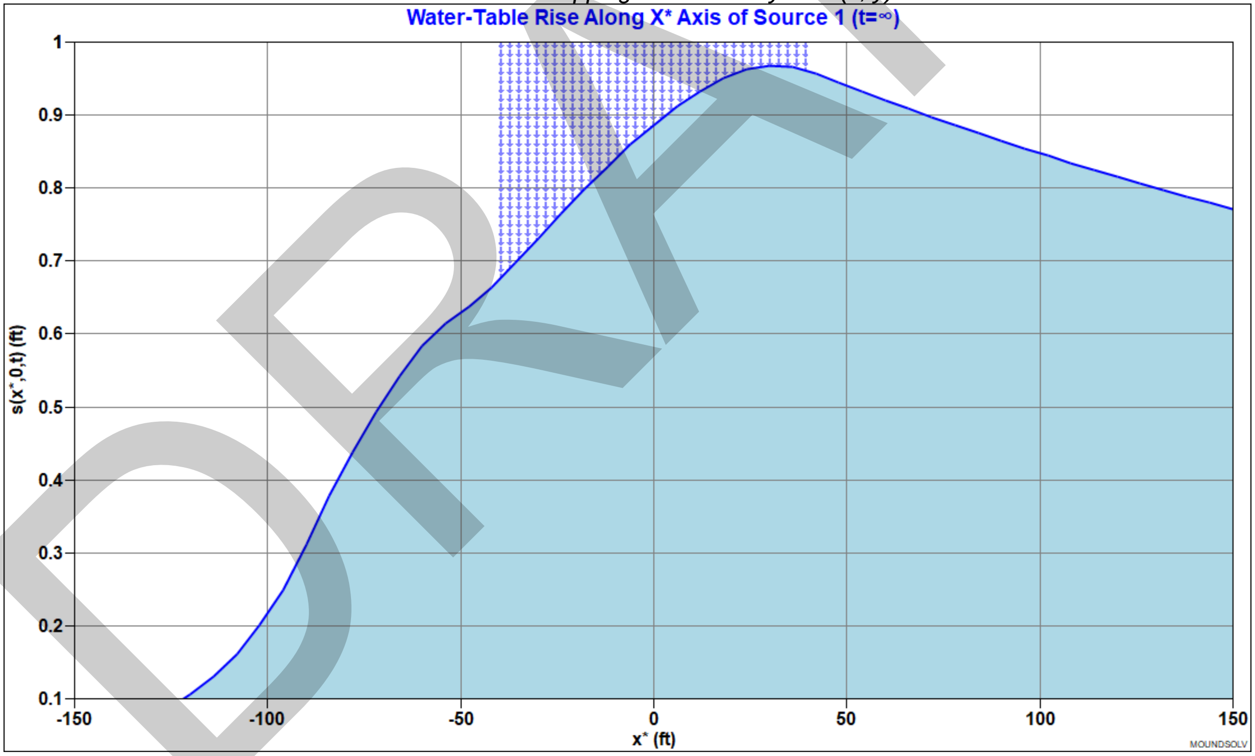
4. Profile Data

Profile Along X* Axis for Source 1 at Steady State

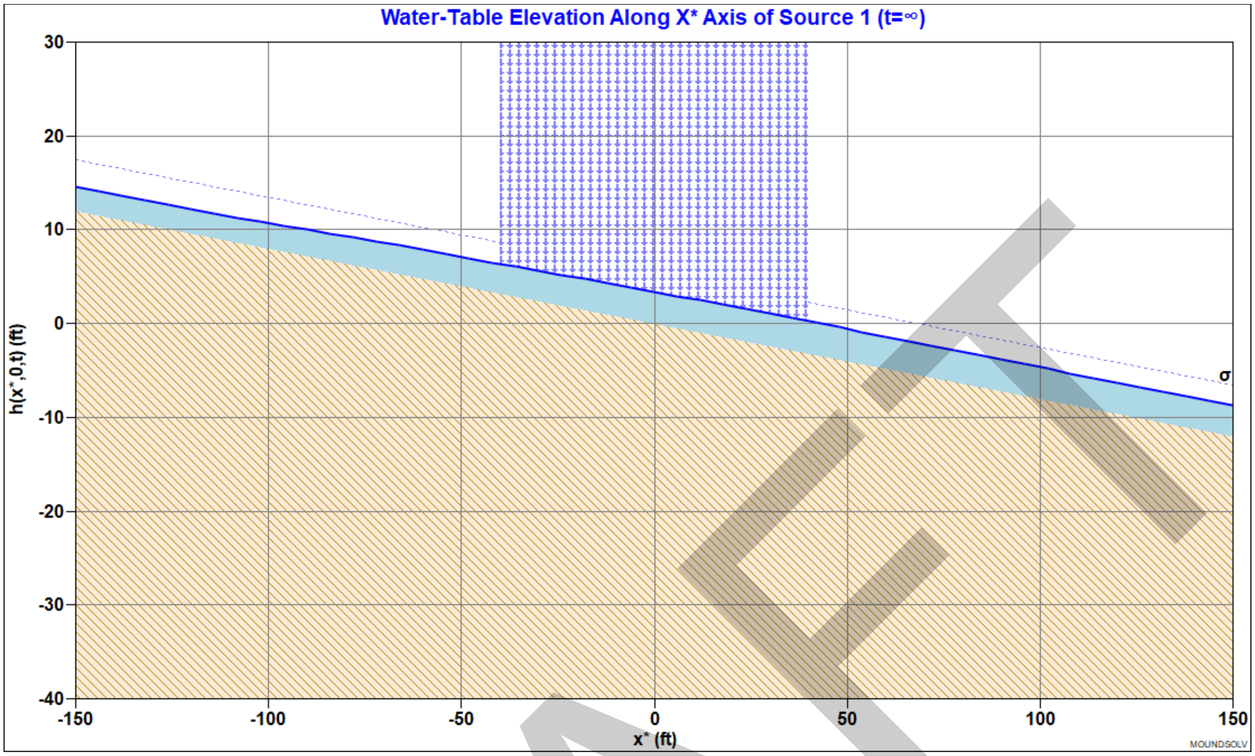
x* (ft)	s (ft)	h (ft)	z (ft)
-150	0.03684	14.54	12
-144	0.0454	14.07	11.52
-138	0.05598	13.6	11.04
-132	0.06908	13.13	10.56
-126	0.08531	12.67	10.08
-120	0.1055	12.21	9.6
-114	0.1305	11.75	9.12
-108	0.1617	11.3	8.64
-102	0.2008	10.86	8.16
-96	0.2497	10.43	7.68
-90	0.3112	10.01	7.2
-84	0.3775	9.598	6.72
-78	0.4385	9.178	6.24
-72	0.4936	8.754	5.76
-66	0.5422	8.322	5.28
-60	0.5832	7.883	4.8
-54	0.6152	7.435	4.32
-48	0.6373	6.977	3.84
-42	0.6636	6.524	3.36
-36	0.6975	6.077	2.88
-30	0.7317	5.632	2.4
-24	0.7655	5.185	1.92
-18	0.7983	4.738	1.44
-12	0.8298	4.29	0.96
-6	0.8596	3.84	0.48
0	0.8871	3.387	0
6	0.9118	2.932	-0.48
12	0.9332	2.473	-0.96
18	0.9503	2.01	-1.44
24	0.9624	1.542	-1.92
30	0.9683	1.068	-2.4
36	0.9667	0.5867	-2.88
42	0.9567	0.09667	-3.36
48	0.9445	-0.3955	-3.84
54	0.9326	-0.8874	-4.32
60	0.9208	-1.379	-4.8

66	0.9092	-1.871	-5.28
72	0.8978	-2.362	-5.76
78	0.8867	-2.853	-6.24
84	0.8758	-3.344	-6.72
90	0.8651	-3.835	-7.2
96	0.8547	-4.325	-7.68
102	0.8445	-4.815	-8.16
108	0.8346	-5.305	-8.64
114	0.8249	-5.795	-9.12
120	0.8155	-6.285	-9.6
126	0.8062	-6.774	-10.08
132	0.7973	-7.263	-10.56
138	0.7885	-7.751	-11.04
144	0.78	-8.24	-11.52
150	0.7717	-8.728	-12

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along x* axis of Source 1.



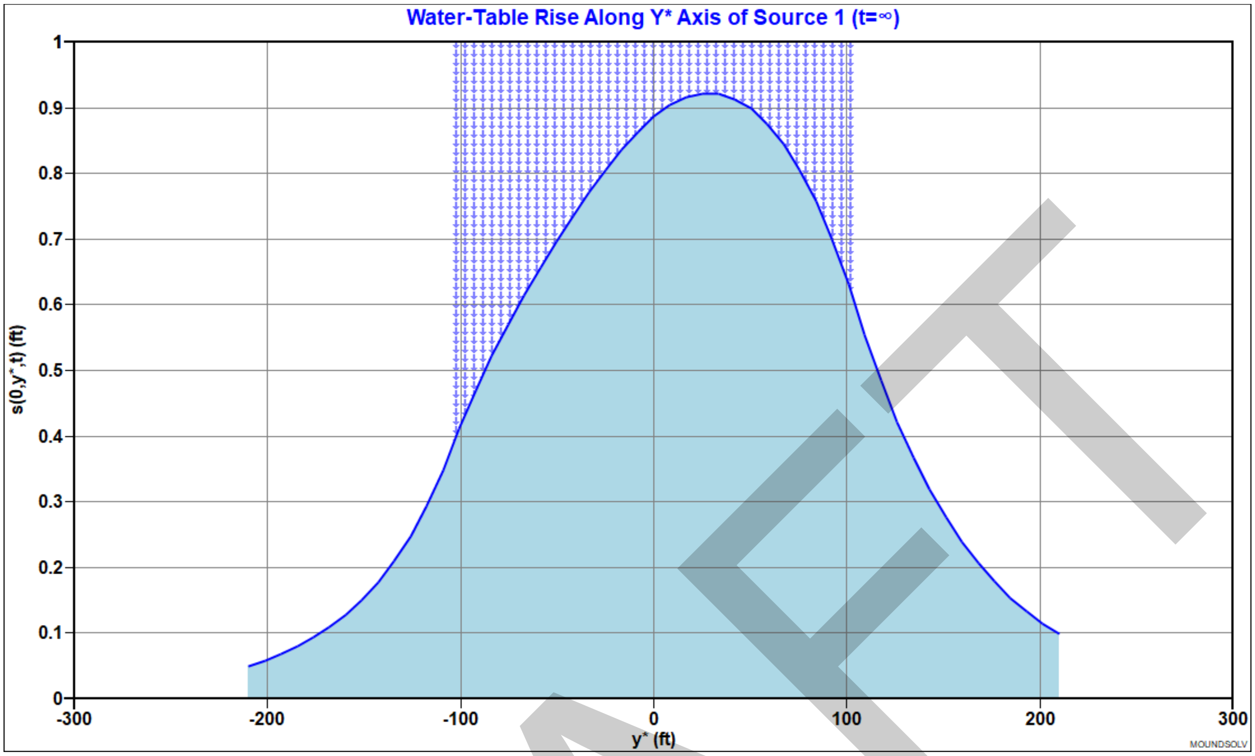
Profile of water-table elevation along x* axis of Source 1.

Profile Along Y* Axis for Source 1 at Steady State

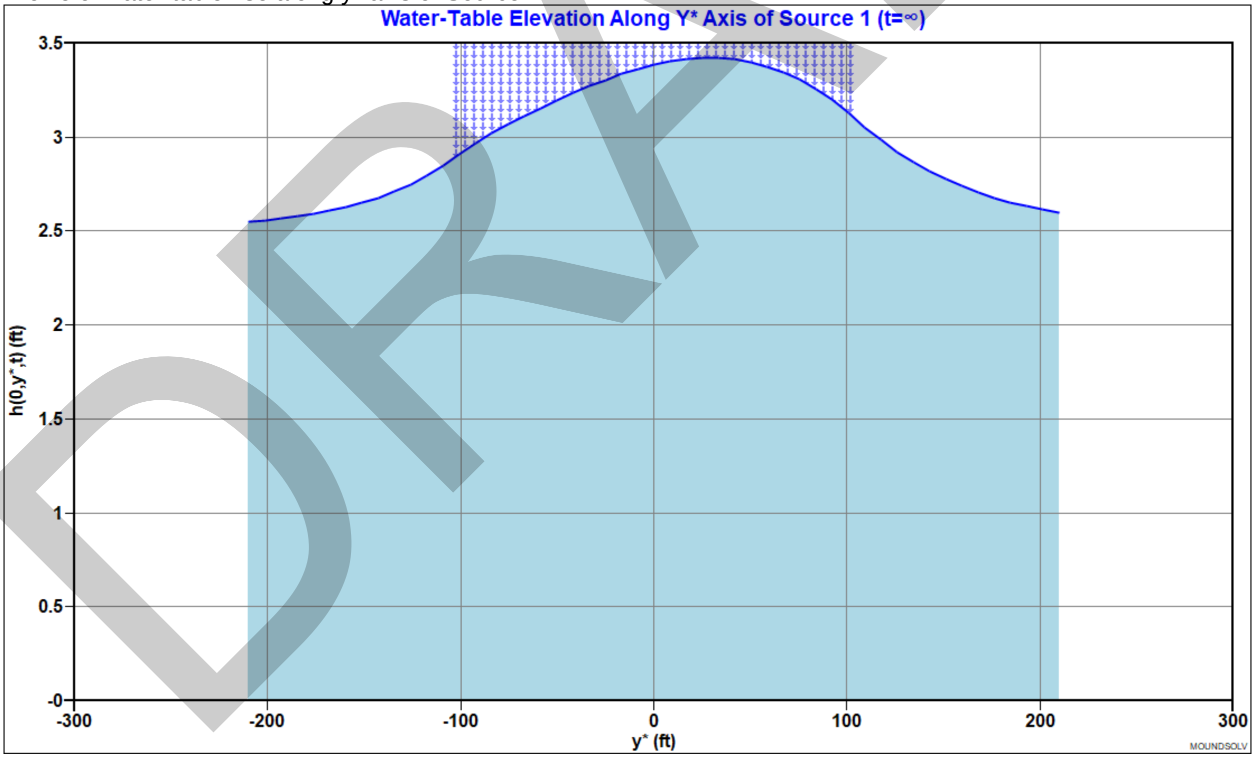
y* (ft)	s (ft)	h (ft)	z (ft)
-210	0.05002	2.55	0
-201.6	0.05834	2.558	0
-193.2	0.06812	2.568	0
-184.8	0.07963	2.58	0
-176.4	0.09318	2.593	0
-168	0.1092	2.609	0
-159.6	0.1281	2.628	0
-151.2	0.1506	2.651	0
-142.8	0.1773	2.677	0
-134.4	0.2092	2.709	0
-126	0.2473	2.747	0
-117.6	0.2931	2.793	0
-109.2	0.3481	2.848	0
-100.8	0.4115	2.912	0
-92.4	0.4698	2.97	0
-84	0.522	3.022	0
-75.6	0.5698	3.07	0
-67.2	0.6143	3.114	0
-58.8	0.6564	3.156	0

-50.4	0.6966	3.197	0
-42	0.735	3.235	0
-33.6	0.7716	3.272	0
-25.2	0.8058	3.306	0
-16.8	0.8369	3.337	0
-8.4	0.8643	3.364	0
0	0.8871	3.387	0
8.4	0.9047	3.405	0
16.8	0.9166	3.417	0
25.2	0.9223	3.422	0
33.6	0.9215	3.421	0
42	0.9137	3.414	0
50.4	0.8987	3.399	0
58.8	0.876	3.376	0
67.2	0.8453	3.345	0
75.6	0.806	3.306	0
84	0.7577	3.258	0
92.4	0.6997	3.2	0
100.8	0.6315	3.131	0
109.2	0.5548	3.055	0
117.6	0.4844	2.984	0
126	0.422	2.922	0
134.4	0.367	2.867	0
142.8	0.3185	2.819	0
151.2	0.2761	2.776	0
159.6	0.2391	2.739	0
168	0.2068	2.707	0
176.4	0.1787	2.679	0
184.8	0.1544	2.654	0
193.2	0.1334	2.633	0
201.6	0.1151	2.615	0
210	0.0994	2.599	0

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along y* axis of Source 1.



Profile of water-table elevation along y* axis of Source 1.

Notation

h is water-table elevation above datum[1]
h_0 is aquifer saturated thickness prior to mounding
i is dip of aquifer
K is horizontal hydraulic conductivity
L is dimension of recharge source parallel to x^* axis
q is infiltration rate (= Q / $L \cdot W$)
Q is recharge rate
s is water-table rise above static water table
W is dimension of recharge source parallel to y^* axis
x, y are mapping Cartesian coordinate axes
x^*, y^* are recharge source Cartesian coordinate axes
z is elevation above datum[1]
γ is angle between x axis and dip direction
ϕ is angle between dip direction and x^* axis of recharge source
σ is maximum acceptable water-table rise

[1] *Elevation datum is the base of aquifer beneath the center of primary recharge source*

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GROUNDWATER MOUNDING ANALYSIS
FOR A SLOPING WATER-TABLE AQUIFER
ZLOTNIK ET AL. (2017) SOLUTION

Maple Shade Disposal Site, Alternative 4
Field 2 (Source 1)
B-B' Section, March 8, 2022

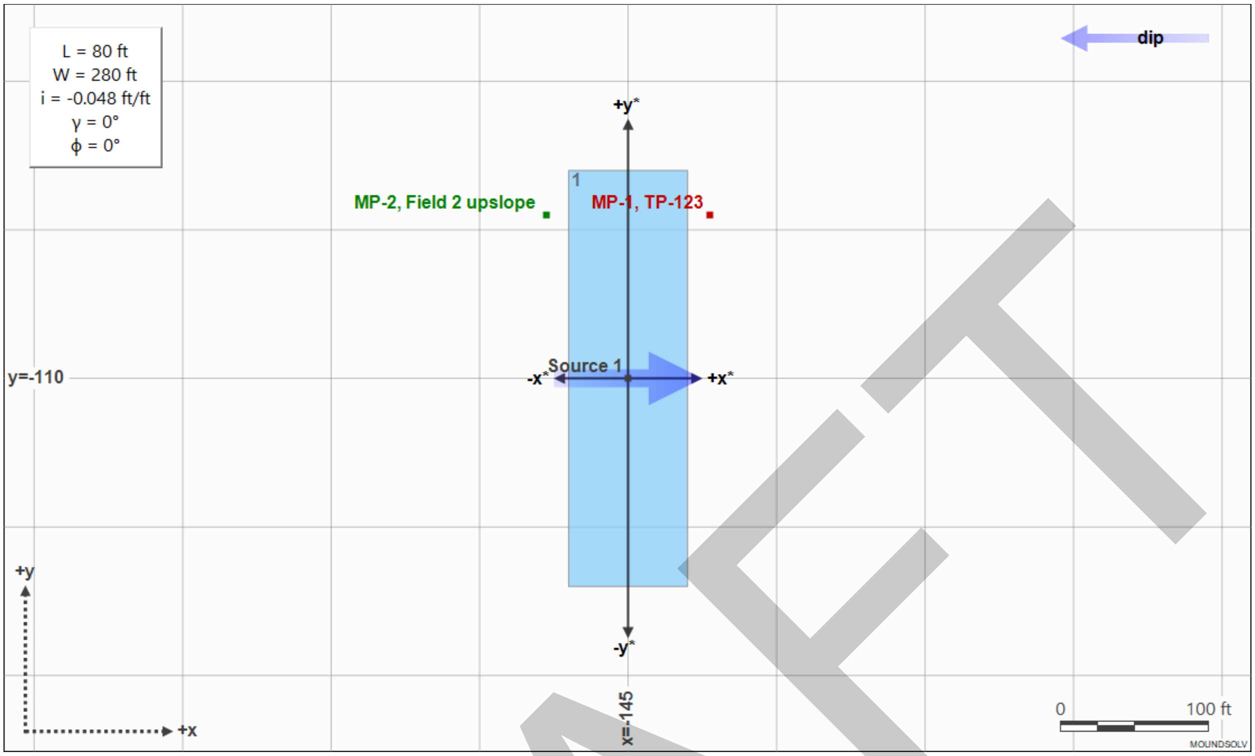
1. Solution Method

Zlotnik et al. (2017) steady-state solution for a rectangular source (linearization method 1)

2. Site Description

Aquifer Data	
Property	**Value**
Horizontal hydraulic conductivity, *K* (ft/d)	69
Initial saturated thickness, h_0 (ft)	1
Maximum allowable water-table rise, *σ* (ft)	1.66
Dip, *i* (ft/ft)	-0.048
Slope rotation from x axis, *γ* (°)	0

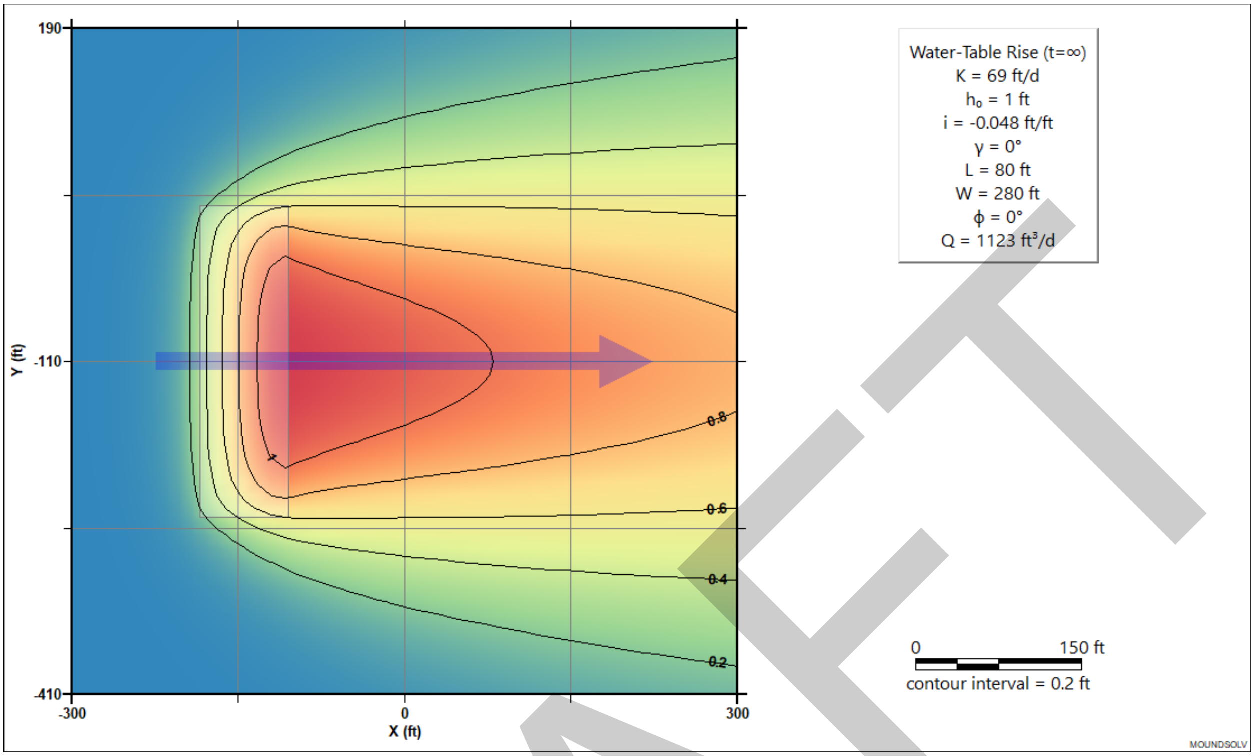
Recharge Sources	
Property	**Source 1**
X coordinate at center, *X* (ft)	-145
Y coordinate at center, *Y* (ft)	-110
Dimension along x* axis, *L* (ft)	80
Dimension along y* axis, *W* (ft)	280
Rotation from slope direction, *ϕ* (°)	0
Recharge rate, *Q* (ft^3/d)	1123
Infiltration rate, *q* (ft/d)	0.05013392857



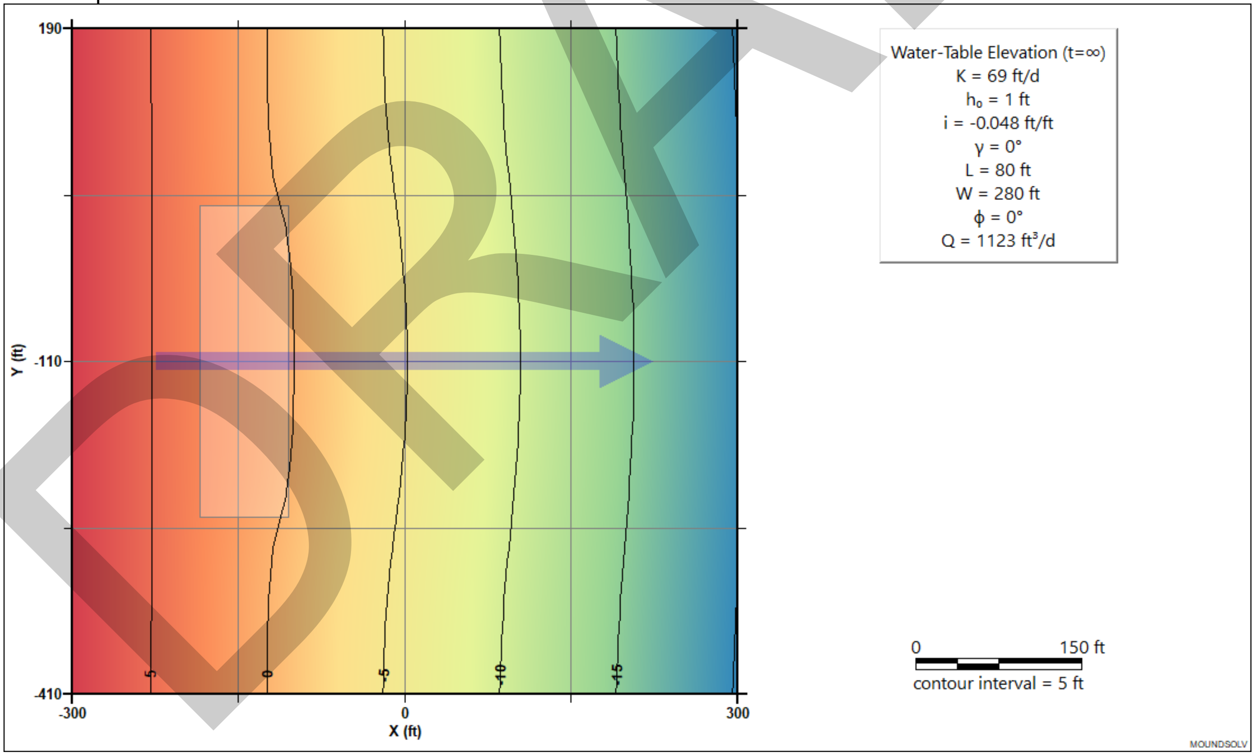
Map of recharge source.

3. Monitoring Points

Steady State					
Name	**x (ft)**	**y (ft)**	**s (ft)**	**h (ft)**	**z (ft)**
Source 1	-145	-110	0.857	1.857	0
MP-1, TP-123	-90	0	0.872	-0.768	-2.64
MP-2, Field 2 upslope	-200	0	0.1133	3.753	2.64



Contour plot of water-table rise.



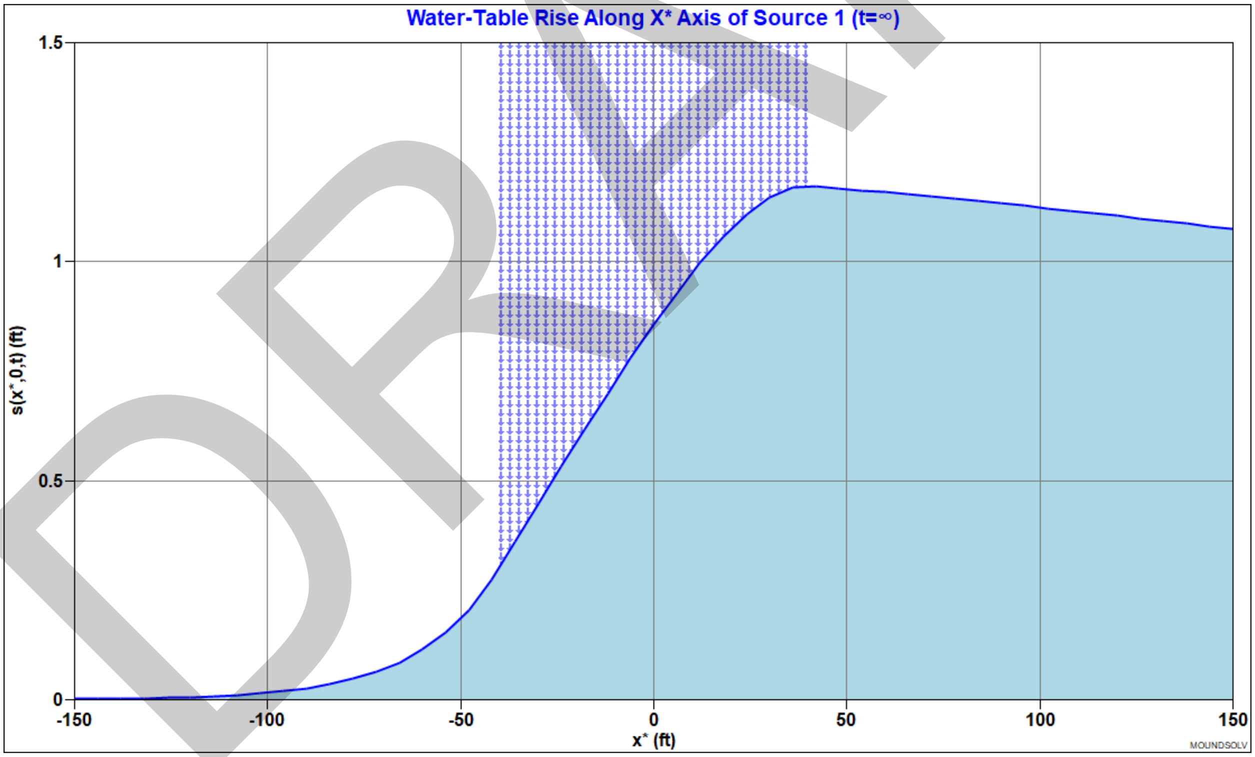
Contour plot of water-table elevation.

4. **Profile Data**

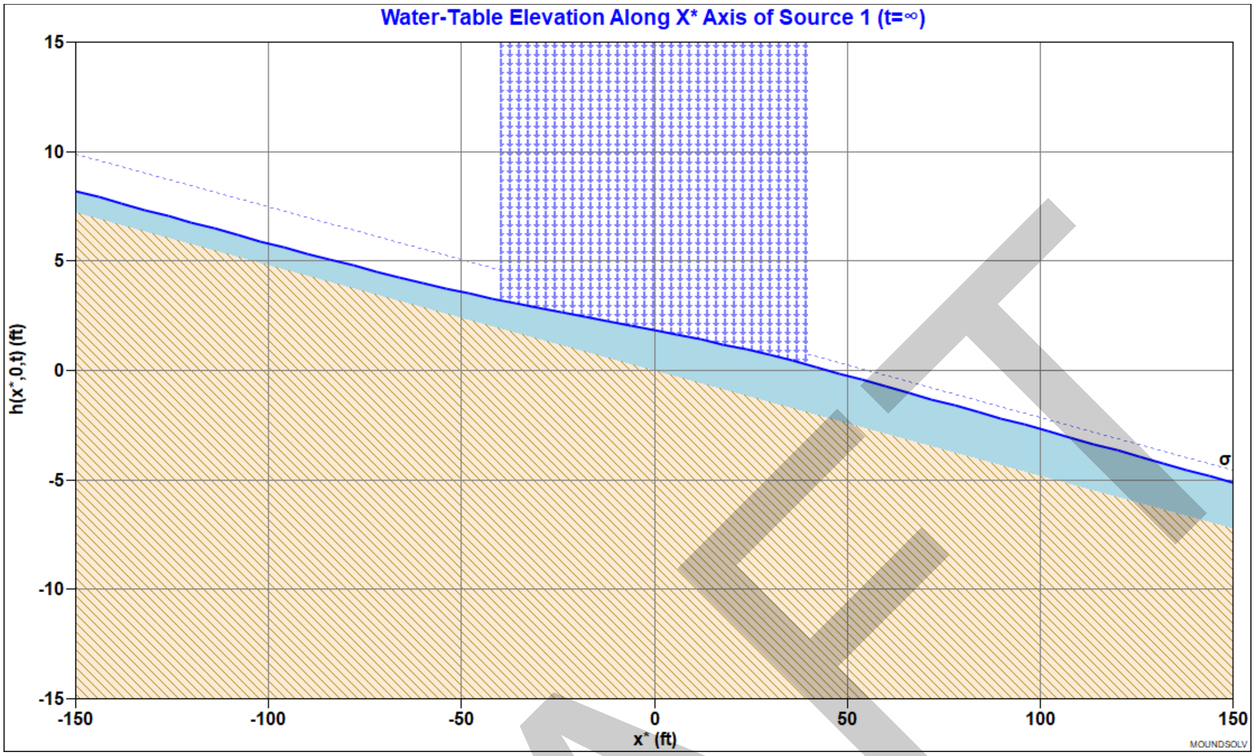
Profile Along X* Axis for Source 1 at Steady State			
x* (ft)	**s (ft)**	**h (ft)**	**z (ft)**
-150	0.001422	8.201	7.2
-144	0.001907	7.914	6.912
-138	0.002557	7.627	6.624
-132	0.003429	7.339	6.336
-126	0.004597	7.053	6.048
-120	0.006163	6.766	5.76
-114	0.008261	6.48	5.472
-108	0.01107	6.195	5.184
-102	0.01484	5.911	4.896
-96	0.01988	5.628	4.608
-90	0.02663	5.347	4.32
-84	0.03566	5.068	4.032
-78	0.04776	4.792	3.744
-72	0.06394	4.52	3.456
-66	0.08559	4.254	3.168
-60	0.1145	3.995	2.88
-54	0.1533	3.745	2.592
-48	0.205	3.509	2.304
-42	0.2742	3.29	2.016
-36	0.3605	3.088	1.728
-30	0.4473	2.887	1.44
-24	0.533	2.685	1.152
-18	0.6173	2.481	0.864
-12	0.6998	2.276	0.576
-6	0.78	2.068	0.288
0	0.857	1.857	0
6	0.9299	1.642	-0.288
12	0.9975	1.421	-0.576
18	1.058	1.194	-0.864
24	1.109	0.957	-1.152
30	1.148	0.7075	-1.44
36	1.17	0.4416	-1.728
42	1.171	0.1552	-2.016
48	1.167	-0.1369	-2.304
54	1.163	-0.4292	-2.592
60	1.158	-0.7217	-2.88

66	1.154	-1.014	-3.168
72	1.149	-1.307	-3.456
78	1.144	-1.6	-3.744
84	1.138	-1.894	-4.032
90	1.133	-2.187	-4.32
96	1.128	-2.48	-4.608
102	1.122	-2.774	-4.896
108	1.116	-3.068	-5.184
114	1.111	-3.361	-5.472
120	1.105	-3.655	-5.76
126	1.099	-3.949	-6.048
132	1.093	-4.243	-6.336
138	1.087	-4.537	-6.624
144	1.081	-4.831	-6.912
150	1.075	-5.125	-7.2

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along x* axis of Source 1.

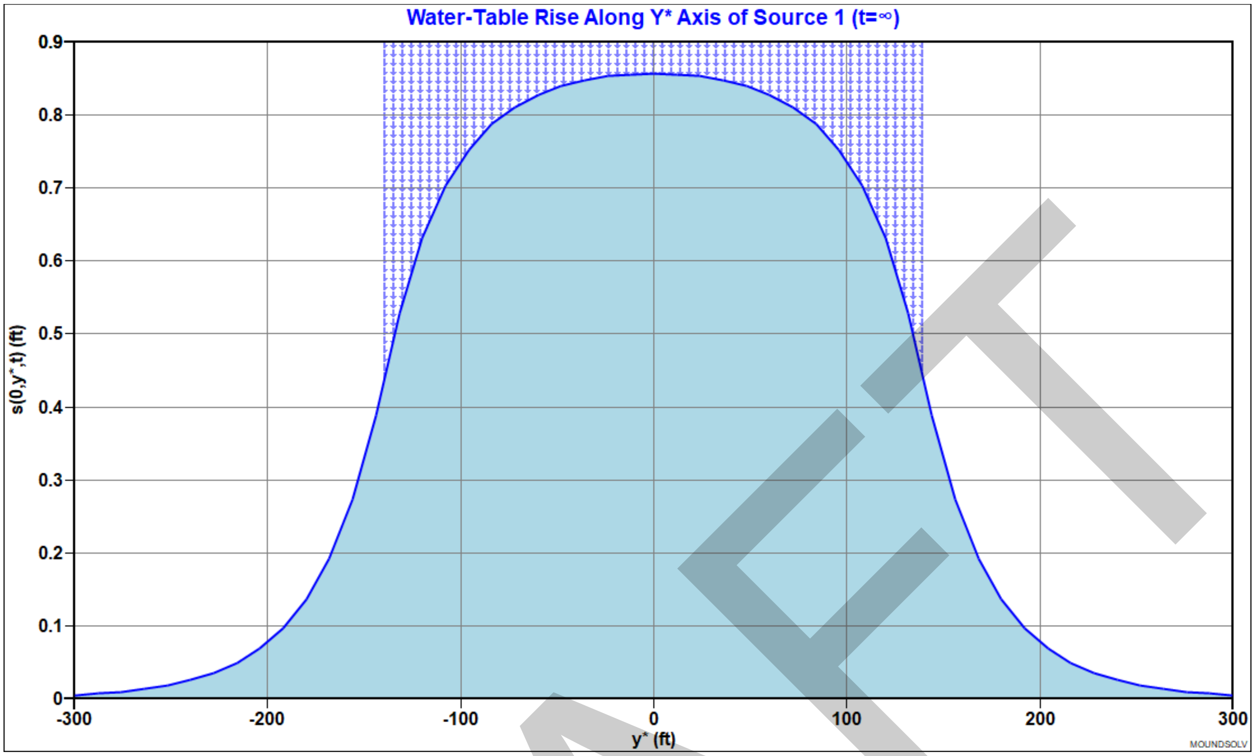


Profile of water-table elevation along x* axis of Source 1.

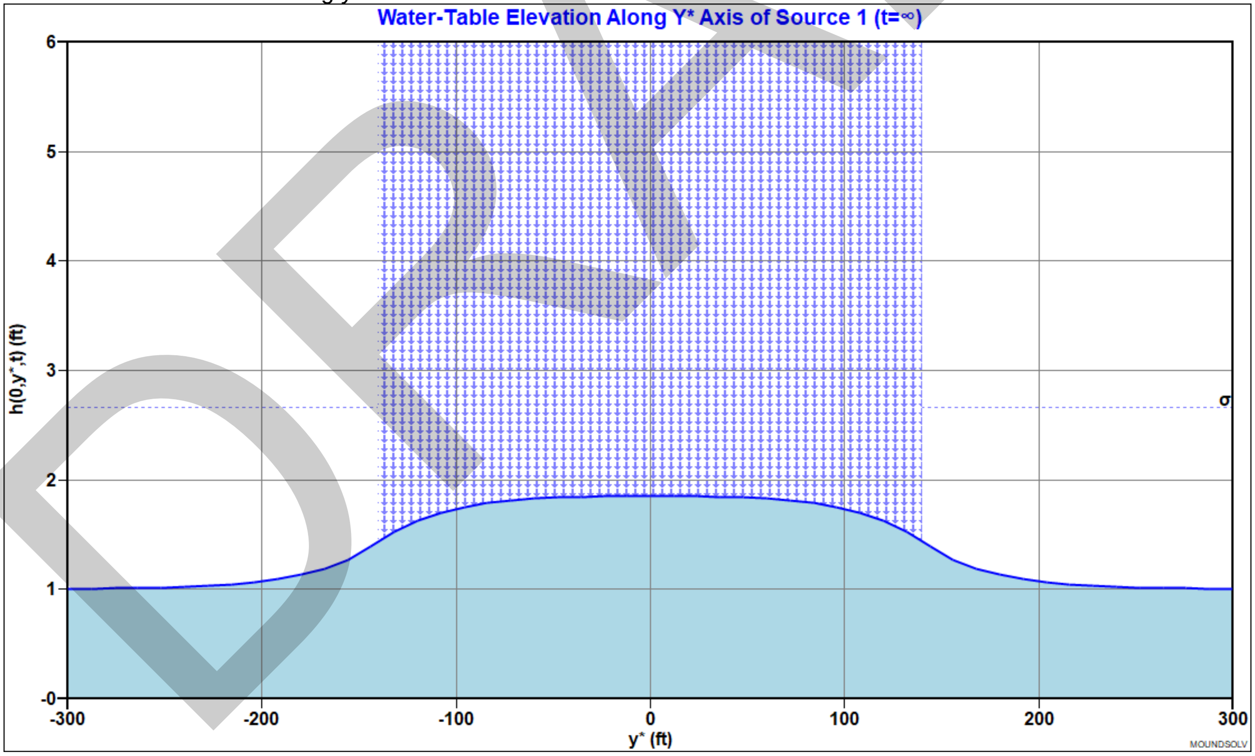
Profile Along Y* Axis for Source 1 at Steady State			
y* (ft)	**s (ft)**	**h (ft)**	**z (ft)**
-300	0.005199	1.005	0
-288	0.007129	1.007	0
-276	0.009792	1.01	0
-264	0.01347	1.013	0
-252	0.01858	1.019	0
-240	0.02568	1.026	0
-228	0.03559	1.036	0
-216	0.04948	1.049	0
-204	0.06902	1.069	0
-192	0.09667	1.097	0
-180	0.136	1.136	0
-168	0.1923	1.192	0
-156	0.273	1.273	0
-144	0.3886	1.389	0
-132	0.5287	1.529	0
-120	0.6313	1.631	0
-108	0.7027	1.703	0

-96	0.7525	1.752	0
-84	0.7872	1.787	0
-72	0.8115	1.811	0
-60	0.8284	1.828	0
-48	0.8402	1.84	0
-36	0.8481	1.848	0
-24	0.8532	1.853	0
-12	0.8561	1.856	0
0	0.857	1.857	0
12	0.8561	1.856	0
24	0.8532	1.853	0
36	0.8481	1.848	0
48	0.8402	1.84	0
60	0.8284	1.828	0
72	0.8115	1.811	0
84	0.7872	1.787	0
96	0.7525	1.752	0
108	0.7027	1.703	0
120	0.6313	1.631	0
132	0.5287	1.529	0
144	0.3886	1.389	0
156	0.273	1.273	0
168	0.1923	1.192	0
180	0.136	1.136	0
192	0.09667	1.097	0
204	0.06902	1.069	0
216	0.04948	1.049	0
228	0.03559	1.036	0
240	0.02568	1.026	0
252	0.01858	1.019	0
264	0.01347	1.013	0
276	0.009792	1.01	0
288	0.007129	1.007	0
300	0.005199	1.005	0

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along y* axis of Source 1.



Profile of water-table elevation along y* axis of Source 1.

Notation

h is water-table elevation above datum[1]

h_0 is aquifer saturated thickness prior to mounding

i is dip of aquifer

K is horizontal hydraulic conductivity

L is dimension of recharge source parallel to x^* axis

q is infiltration rate (= $Q / L \cdot W$)

Q is recharge rate

s is water-table rise above static water table

W is dimension of recharge source parallel to y^* axis

x, y are mapping Cartesian coordinate axes

x^*, y^* are recharge source Cartesian coordinate axes

z is elevation above datum[1]

γ is angle between x axis and dip direction

ϕ is angle between dip direction and x^* axis of recharge source

σ is maximum acceptable water-table rise

[1] *Elevation datum is the base of aquifer beneath the center of primary recharge source*

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MOUNDSOLV
GROUNDWATER MOUNDING ANALYSIS
FOR A SLOPING WATER-TABLE AQUIFER
ZLOTNIK ET AL. (2017) SOLUTION

ZLOTNIK ET AL. (2017) SOLUTION
Maple Shade Disposal Site, Alternative 4
Field 1 (Source 1)
D-D' Section, March 7, 2022

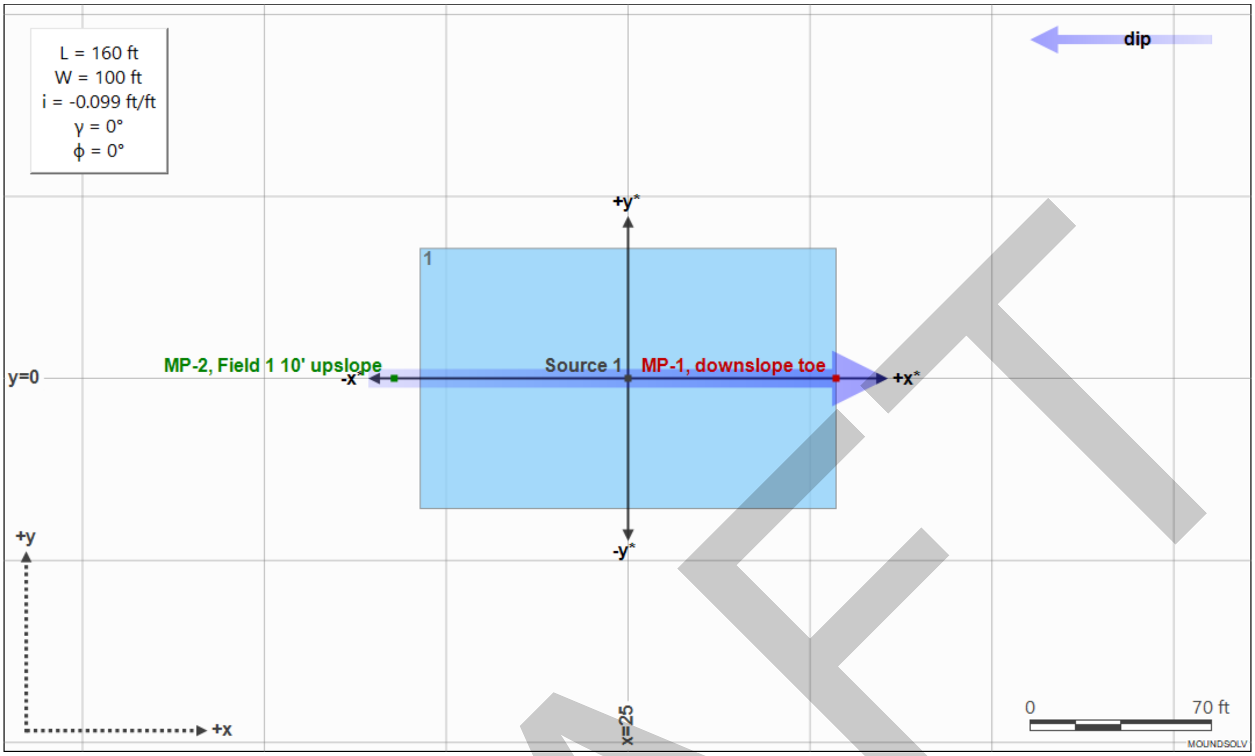
1. Solution Method

Zlotnik et al. (2017) steady-state solution for a rectangular source (linearization method 1)

2. Site Description

Aquifer Data	
Property	**Value**
Horizontal hydraulic conductivity, *K* (ft/d)	69
Initial saturated thickness, h_0 (ft)	5
Maximum allowable water-table rise, σ (ft)	8
Dip, *i* (ft/ft)	-0.099
Slope rotation from x axis, γ (°)	0

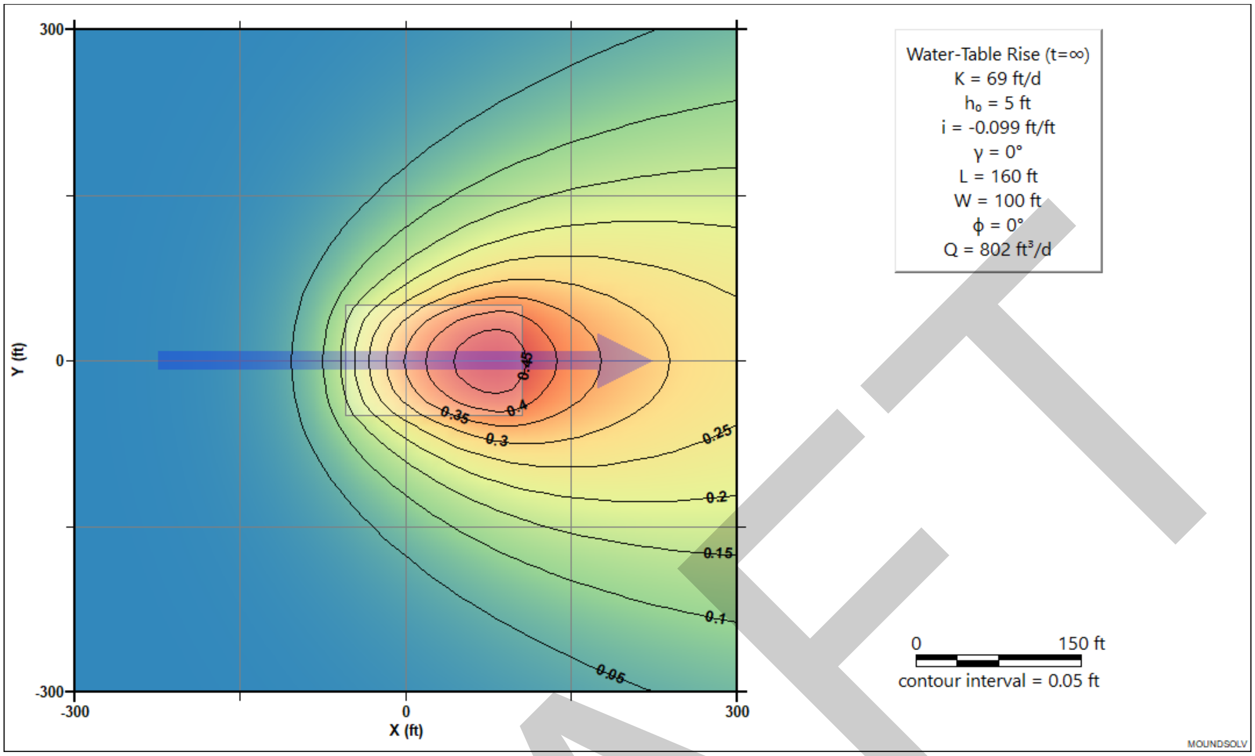
Recharge Sources	
Property	**Source 1**
X coordinate at center, *X* (ft)	25
Y coordinate at center, *Y* (ft)	0
Dimension along x* axis, *L* (ft)	160
Dimension along y* axis, *W* (ft)	100
Rotation from slope direction, ϕ (°)	0
Recharge rate, *Q* (ft^3/d)	802
Infiltration rate, *q* (ft/d)	0.050125



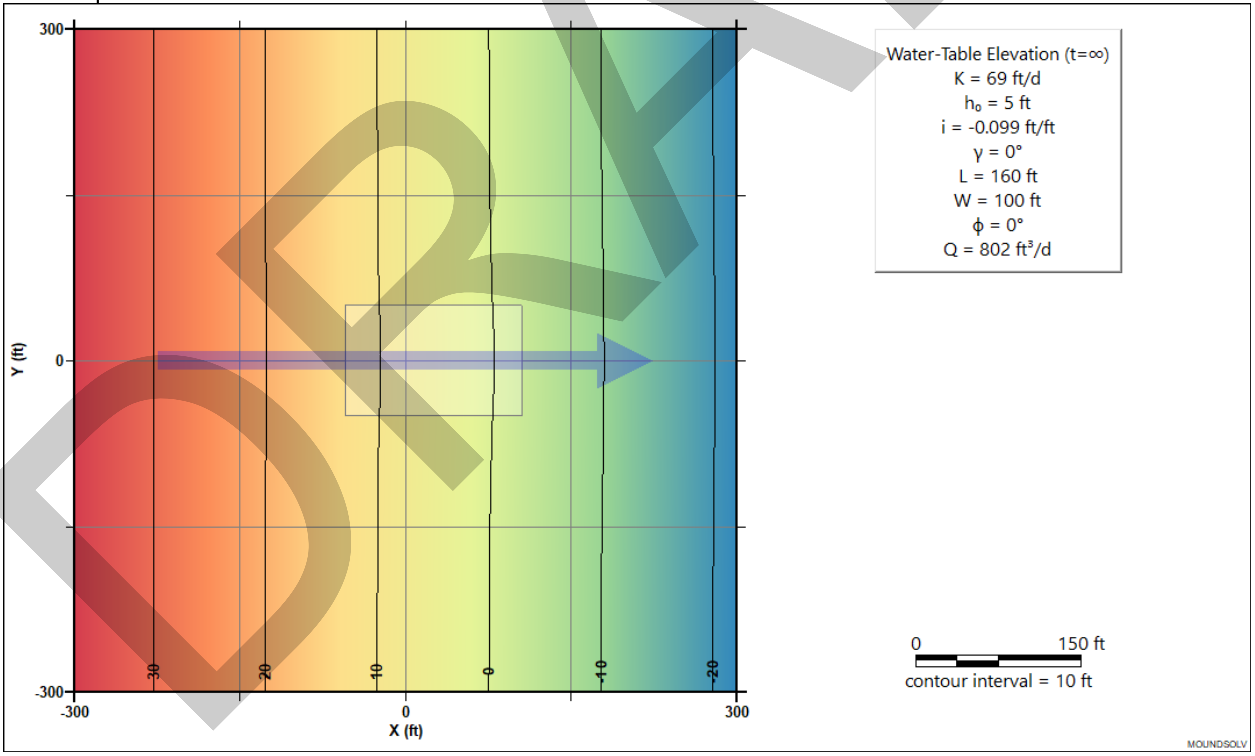
Map of recharge source.

3. Monitoring Points

Steady State					
Name	**x (ft)**	**y (ft)**	**s (ft)**	**h (ft)**	**z (ft)**
Source 1	25	0	0.4147	5.415	0
MP-1, downslope toe	105	0	0.4601	-2.46	-7.92
MP-2, Field 1 10' upslope	-65	0	0.1272	14.04	8.91



Contour plot of water-table rise.



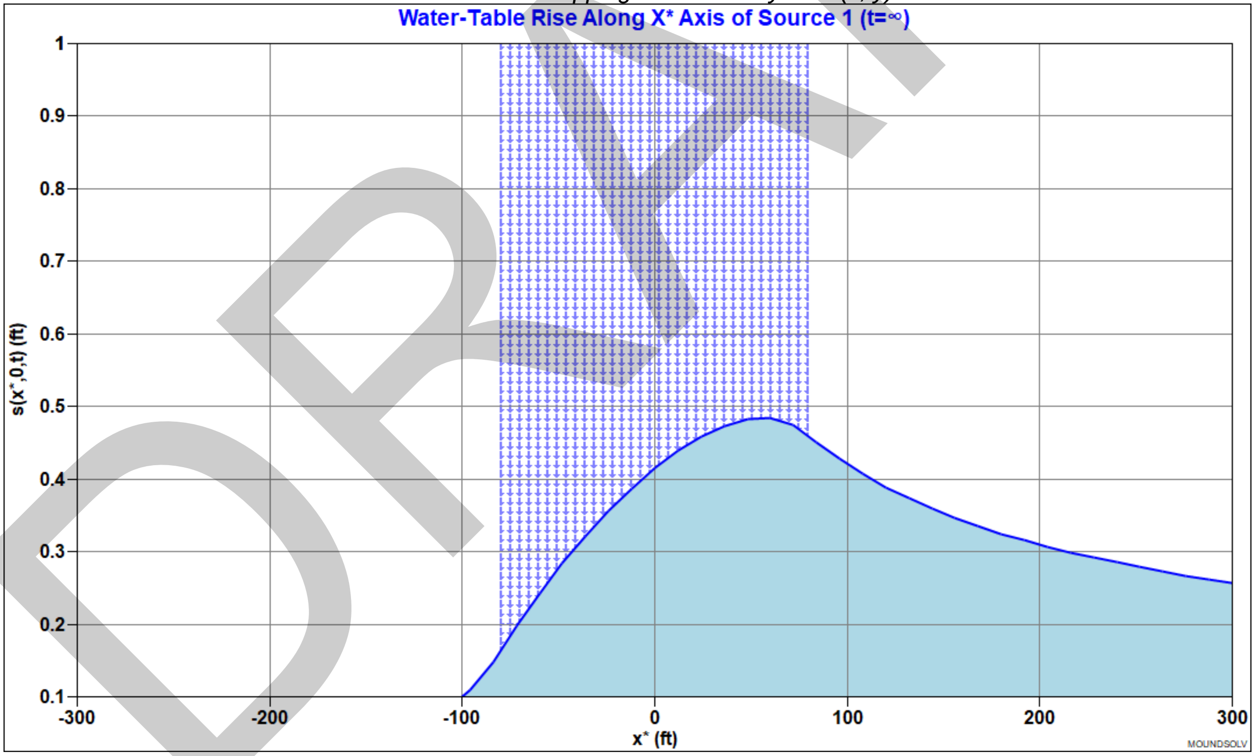
Contour plot of water-table elevation.

4. Profile Data

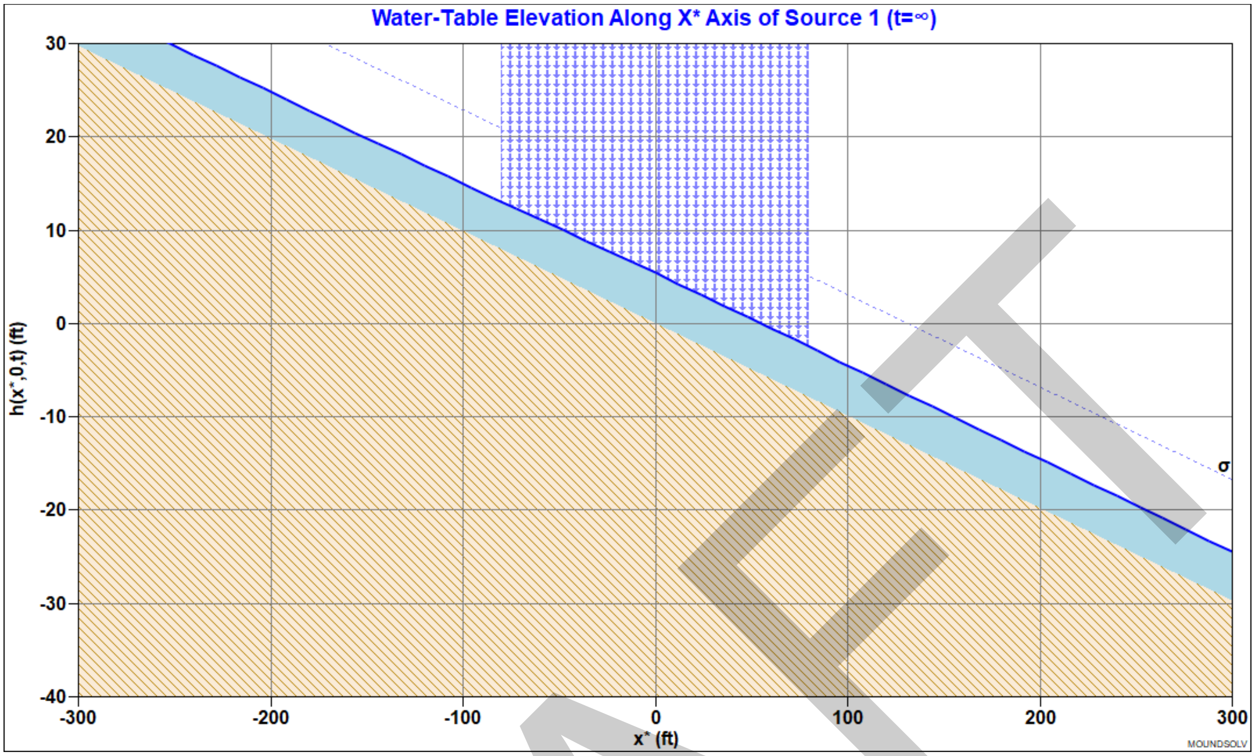
Profile Along X* Axis for Source 1 at Steady State			
x* (ft)	**s (ft)**	**h (ft)**	**z (ft)**
-300	0.001055	34.7	29.7
-288	0.001367	33.51	28.51
-276	0.001772	32.33	27.32
-264	0.0023	31.14	26.14
-252	0.002988	29.95	24.95
-240	0.003886	28.76	23.76
-228	0.005062	27.58	22.57
-216	0.006604	26.39	21.38
-204	0.008631	25.2	20.2
-192	0.0113	24.02	19.01
-180	0.01483	22.83	17.82
-168	0.01951	21.65	16.63
-156	0.02574	20.47	15.44
-144	0.03407	19.29	14.26
-132	0.04527	18.11	13.07
-120	0.06042	16.94	11.88
-108	0.08105	15.77	10.69
-96	0.1093	14.61	9.504
-84	0.1482	13.46	8.316
-72	0.197	12.32	7.128
-60	0.2425	11.18	5.94
-48	0.2839	10.04	4.752
-36	0.3217	8.886	3.564
-24	0.356	7.732	2.376
-12	0.3871	6.575	1.188
0	0.4147	5.415	0
12	0.4388	4.251	-1.188
24	0.4588	3.083	-2.376
36	0.4739	1.91	-3.564
48	0.4829	0.7309	-4.752
60	0.4839	-0.4561	-5.94
72	0.4742	-1.654	-7.128
84	0.4514	-2.865	-8.316
96	0.4277	-4.076	-9.504
108	0.407	-5.285	-10.69
120	0.389	-6.491	-11.88

132	0.3731	-7.695	-13.07
144	0.359	-8.897	-14.26
156	0.3464	-10.1	-15.44
168	0.3351	-11.3	-16.63
180	0.3249	-12.5	-17.82
192	0.3155	-13.69	-19.01
204	0.307	-14.89	-20.2
216	0.2991	-16.08	-21.38
228	0.2918	-17.28	-22.57
240	0.2851	-18.47	-23.76
252	0.2787	-19.67	-24.95
264	0.2728	-20.86	-26.14
276	0.2673	-22.06	-27.32
288	0.2621	-23.25	-28.51
300	0.2572	-24.44	-29.7

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along x* axis of Source 1.



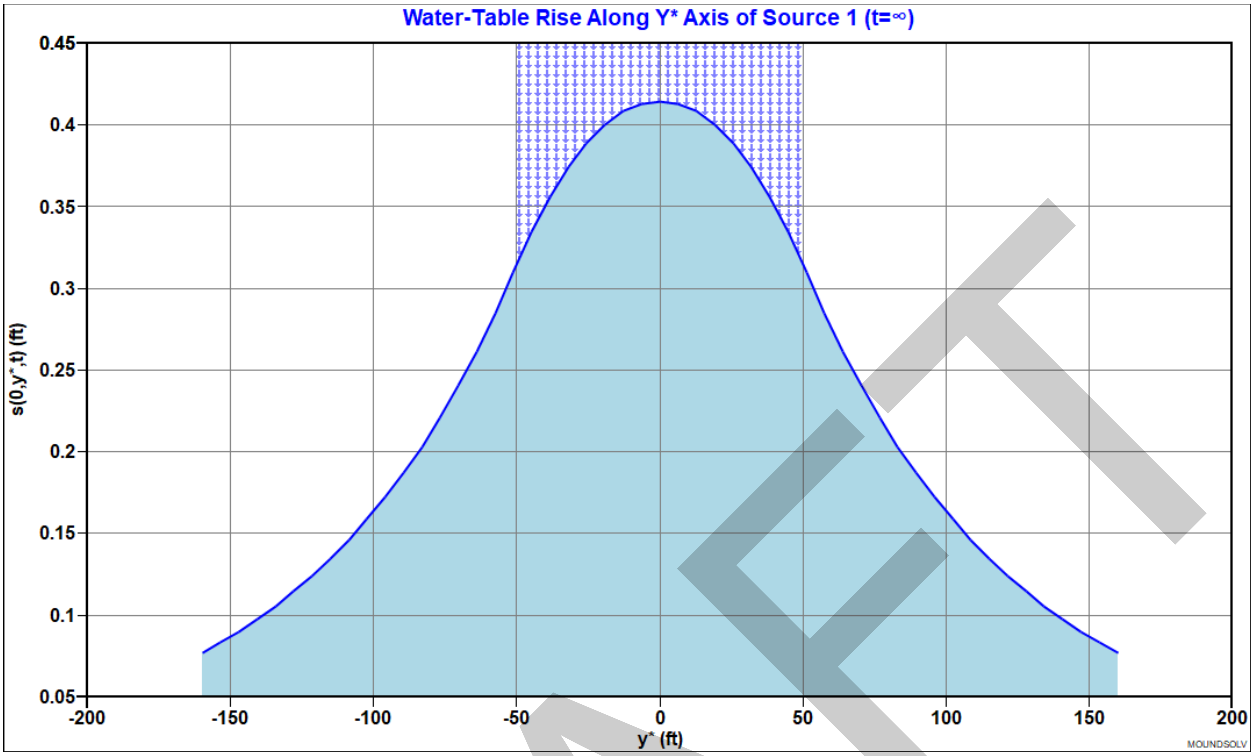
Profile of water-table elevation along x* axis of Source 1.

Profile Along Y* Axis for Source 1 at Steady State

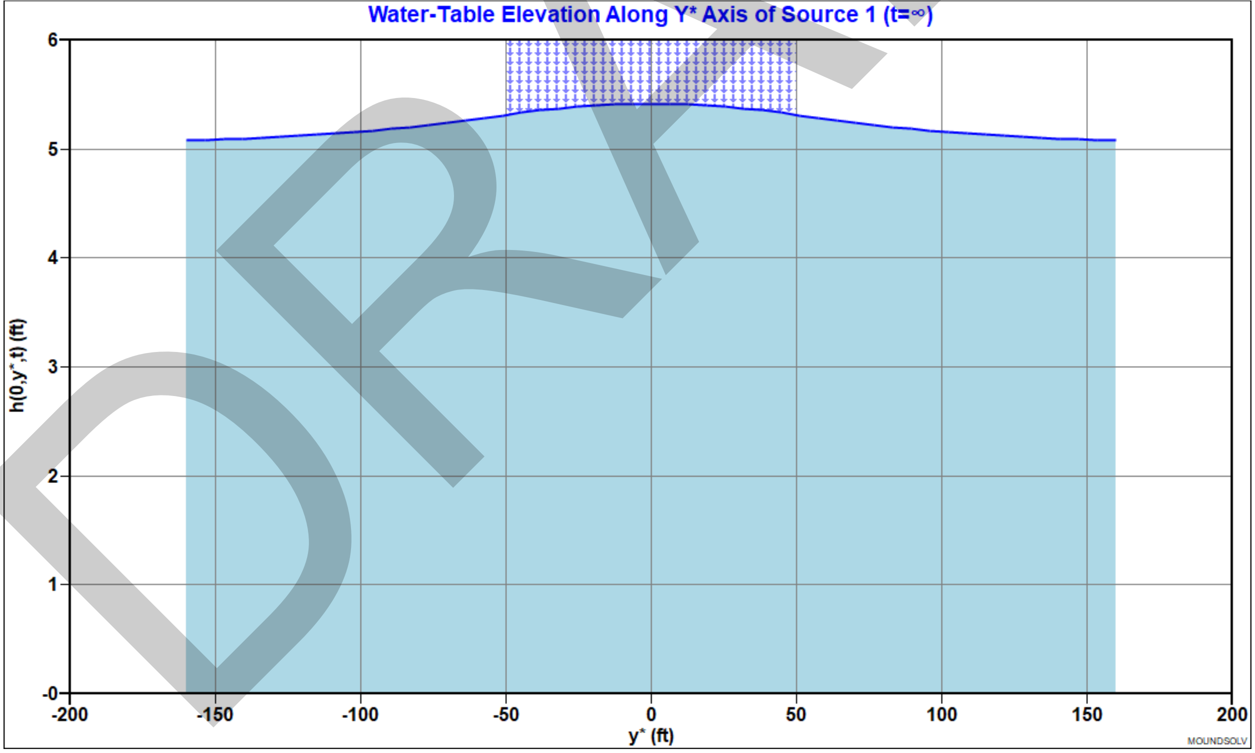
y* (ft)	s (ft)	h (ft)	z (ft)
-160	0.07705	5.077	0
-153.6	0.08335	5.083	0
-147.2	0.09019	5.09	0
-140.8	0.09764	5.098	0
-134.4	0.1057	5.106	0
-128	0.1146	5.115	0
-121.6	0.1242	5.124	0
-115.2	0.1347	5.135	0
-108.8	0.1461	5.146	0
-102.4	0.1586	5.159	0
-96	0.1722	5.172	0
-89.6	0.1871	5.187	0
-83.2	0.2034	5.203	0
-76.8	0.2211	5.221	0
-70.4	0.2404	5.24	0
-64	0.2615	5.262	0
-57.6	0.2845	5.285	0
-51.2	0.3095	5.31	0

-44.8	0.3347	5.335	0
-38.4	0.3564	5.356	0
-32	0.3744	5.374	0
-25.6	0.3891	5.389	0
-19.2	0.4004	5.4	0
-12.8	0.4084	5.408	0
-6.4	0.4132	5.413	0
0	0.4147	5.415	0
6.4	0.4132	5.413	0
12.8	0.4084	5.408	0
19.2	0.4004	5.4	0
25.6	0.3891	5.389	0
32	0.3744	5.374	0
38.4	0.3564	5.356	0
44.8	0.3347	5.335	0
51.2	0.3095	5.31	0
57.6	0.2845	5.285	0
64	0.2615	5.262	0
70.4	0.2404	5.24	0
76.8	0.2211	5.221	0
83.2	0.2034	5.203	0
89.6	0.1871	5.187	0
96	0.1722	5.172	0
102.4	0.1586	5.159	0
108.8	0.1461	5.146	0
115.2	0.1347	5.135	0
121.6	0.1242	5.124	0
128	0.1146	5.115	0
134.4	0.1057	5.106	0
140.8	0.09764	5.098	0
147.2	0.09019	5.09	0
153.6	0.08335	5.083	0
160	0.07705	5.077	0

The axes of Source 1 (x, y*) are rotated 0°*
from the axes of mapping coordinate system (x, y)



Profile of water-table rise along y* axis of Source 1.



Profile of water-table elevation along y* axis of Source 1.

Notation

h is water-table elevation above datum¹

h_0 is aquifer saturated thickness prior to mounding

i is dip of aquifer

K is horizontal hydraulic conductivity

L is dimension of recharge source parallel to x^* axis

q is infiltration rate (= Q / $L \cdot W$)

Q is recharge rate

s is water-table rise above static water table

W is dimension of recharge source parallel to y^* axis

x, y are mapping Cartesian coordinate axes

x^*, y^* are recharge source Cartesian coordinate axes

z is elevation above datum¹

γ is angle between x axis and dip direction

ϕ is angle between dip direction and x^* axis of recharge source

σ is maximum acceptable water-table rise

¹*Elevation datum is the base of aquifer beneath the center of primary recharge source*

Report generated by MOUNDSOLV v4.0 on 08 Mar 2022 at 14:25:25

MOUNDSOLV (www.aqtesolv.com)