WASTE MANAGEMENT

CROSSROADS LANDFILL

P.O. Box 629
357 Mercer Road
Norridgewock, ME 04957
(207) 634-2714
(207) 634-4519 Fax

23 September 2020

VIA Email and U.S. Mail
Ms. Linda Butler
Licensing and Compliance Specialist
Maine Department of Environmental Protection (MEDEP)
Division of Technical Services
Bureau of Remediation and Waste Management
17 State House Station
Augusta, Maine 04333-0017

RE: Supplemental Information in Support of Phase 14 Solid Waste Permit Application
License Application #S-010735-WD-YB-N
Crossroads Landfill - Norridgewock, Maine

Dear Ms. Butler:

In October 2019, Waste Management Disposal Services of Maine, Inc. (WMDSM) submitted a Solid Waste Permit Application for the Phase 14 Landfill at the Crossroads Landfill facility in Norridgewock, Maine (the "Application"). The MEDEP has provided several rounds of review comments on the Application and, most recently, provided review comments dated 9 September 2020. Enclosed please find WMDSM's response to the MEDEP's 9 September 2020 review comments. The response to review comments is provided in a table format with each comment listed on the left-hand side of the table and WMDSM's response to the right.

Comment 2 in the MEDEP's review comments requires WMDSM to request a variance from one of the restrictive siting criteria in the Solid Waste Management Rules (SWMRs). WMDSM believes it has demonstrated compliance with all the restrictive siting criteria, including SWMR Ch. 401.1C(3)(b). Specifically, as demonstrated in Section 5.2.2 of Volume III of the Application and Section 2.0 of Golder's 31 July 2020 *Supplemental Geologic and Hydrogeologic Report*, WMDSM has demonstrated that the in-situ undisturbed soils have a hydraulic conductivity less than or equal to 1×10^{-5} cm/s. Nonetheless, to the extent that MEDEP has concluded otherwise, WMDSM has included a request for a variance from this restrictive siting criterion as Attachment B to the enclosed Response to Comments. As reflected in the variance request, WMDSM is proposing specific methods to ensure that the Department is comfortable that soils underneath the landfill will have a hydraulic conductivity less than or equal to 1×10^{-5} cm/s.

Thank you for consideration of this additional information in support of the Application.

Sincerely,
Waste Management Disposal Services of Maine, Inc. – Crossroads Landfill

Sherwood McKenney

Sherwood McKenney
District Engineer

Enclosure: Response to 9 September 2020 MEDEP Comments

cc: R. LaBelle, Town of Norridgewock (w/ enclosure)
J. Browne, Verrill & Dana (w/ enclosure)
A. Macdonald, Golder Associates (w/ enclosure)
S. Luettich, Geosyntec Consultants (w/ enclosure)

TECHNICAL MEMORANDUM

DATE September 23, 2020 **Project No.** 20142671

TO Sherwood McKenney, District Engineer
Waste Management Disposal Services of Maine, Inc. (WMDSM)

FROM Alistair Macdonald, C.G. and Brendan Lennon, P.G.
Golder Associates Inc. (Golder)

RE: RESPONSE TO 9 SEPTEMBER 2020 MEDEP COMMENTS
PHASE 14 SOLID WASTE PERMIT APPLICATION # S-010735-WD-YB-N
CROSSROADS LANDFILL - NORRIDGEWOCK, MAINE

Dear Mr. McKenney:

The following table and attachments provide responses to comments issued by the Maine Department of Environmental Protection (MEDEP) on September 9, 2020.

Sincerely,

Brendan Lennon, PG
Senior Project Geologist

Alistair Macdonald, CPG
Senior Program Leader and Principal

Comment #	MEDEP Comment – September 9,2020	WMDSM Response
1	The above-mentioned document was prepared in response to our comments on the Geologic and Hydrogeologic Assessment. They completed a pumping test and re-evaluated the clay hydrogeology. The Department has concluded that, based upon the pumping test results as presented by Golder, rule requirement ch. 401.2C(2) has been satisfied and the minimum time of travel to the proposed sensitive receptors of greater than 6 years has been proven, as required in ch. 401.1C(c).	Comment noted.
THE FOLLOWING REQUIRE A RESPONSE FROM WMDSM:		
2	2.0 Presumpscot Clay. WMDSM is correct that during previous investigations of the other phases at Crossroads landfill fractures/fissures/joints were observed primarily in the stiff upper clay and not in the soft lower clay. We note, however, that there are areas of Phase 14 that are underlain only by the stiff clay and not the soft clay. Please propose a method or methods to address the areas of limited extent of the soft clay throughout the footprint of the proposed expansion, in accordance with ch. 401.1C(3)(b). WMDSM must request a variance to this rule requirement. Please reference the April 30, 2020 meeting notes of discussion with MDEP. Please submit the variance request together with supporting documentation as an addendum to the application for MEDEP review.	It is Golder's opinion that the natural geologic conditions within the Phase 14 solid waste boundary do meet the requirements of ch. 401.1C(3)(b) (i.e., that the soils with the proposed solid waste boundary "contain sufficient fines and clay-size particles to minimize infiltration of leachate" and that they have "an undisturbed hydraulic conductivity less than or equal to $1x10^{-5}$ cm/sec"). As we articulate in Section 2.0 of the Supplemental Geologic and Hydrogeologic Report (Golder July 31, 2020) and in the Response to Comments provided in Appendix A of the Supplemental Geologic and Hydrogeologic Report, Golder does not share the Department's concern regarding "the possibility that undetected fractures in the clay can allow rapid transport of contaminants to aquifers beneath the clay". As described in Section 5.2.2 of Volume III of the permit application, all hydraulic conductivity testing of the stiff upper clay conducted indicate that clays have a hydraulic conductivity of less than $1x10^{-5}$ cm/sec. The only exception is a slug test conducted in a piezometer (PZ-16M) that we believe has a compromised well seal (please see Response to Comment 18). As such, it is Golder's opinion that the requirement of ch. 401.1C(3)(b) is met in all locations, including locations where the soft lower clay is absent. To the extent the Department concludes otherwise, WMDSM has prepared a variance with supporting documentation for MEDEP review. The variance is included as Attachment B.
3	The uncertainty regarding fracturing in the clay, particularly in the stiff clay, would be alleviated by scarification of clays, expansion of the area of proposed fill and the addition of compacted clay in the northwestern part of Phase 14, as WMDSM proposed in the above referenced April meeting to satisfy rule requirement ch.401.2(D)(3).	Attachment B includes a discussion of additional measures such as scarification/recompaction of the stiff upper clay and the addition of silt-clay borrow in specific areas where the lower soft clay is absent.
4	6.1 Proposed groundwater water quality monitoring program. Based on the till equipotential contour lines (Figure 13a of volume III), the well MW14-04D is not downgradient of the likely discharge point, Ph14C, so MEDEP has indicated a new location for MW14-4D in the figure below. MEDEP considers that it is not necessary to install new upgradient wells for monitoring. WMDSM should be able to use the PZ-7 or PZ8 well clusters instead of installing new upgradient wells.	WMDSM has modified the proposed water quality monitoring plan (WQMP) to incorporate the new locations for MW14-04D as requested by MEDEP. WMDSM has also modified the proposed WQMP to use PZ-7M and PZ-7D as upgradient monitoring wells as suggested by MEDEP. Attachment A-1 includes revised Tables 6-1 and 6-2 that summarize the revised WQMP and Revised Figure 6-1 illustrating the proposed monitoring locations.
5	Follow-on response to Comment 16 of MEDEP memorandum dated June 22, 2020. MEDEP concurs that with weak vertical gradients, the transport of groundwater from the landfill to the bedrock would probably take a long time, but it would also mean that the water from the landfill would extend out from the landfill for a long distance before entering the bedrock and not intersect the existing bedrock wells. Some indication of this can be seen in the cross-section in Figure 15 of Volume III. There is no flow path from the landfill that intersects the screen of the downgradient bedrock well, MW14-04B. We concur that there appears to be a good hydraulic connection between the bedrock wells, but this does not tell us where the flow lines from the bottom of the landfill to the bedrock are. Two bedrock monitoring wells are required downgradient of Phase 14 so that groundwater released from the landfill is likely to be intercepted by the wells. MEDEP has indicated the locations of these wells in the figure below. Also, MW14-4D is not located downgradient of Ph 14C, the likely release point, and, like the bedrock well, MW14-4B, is not located far enough away for water from a release at Ph14C to intercept its screen, so we have indicated a new location. WMDSM must include two bedrock monitoring wells in its proposed water quality monitoring program that satisfy MEDEP concerns.	WMDSM has modified the proposed WQMP to incorporate the two bedrock monitoring well locations requested by MEDEP and the revised location for till monitoring well MW14-04D. Please see Attachment A-1 for revised Tables 6-1 and 6-2 that summarize the revised WQMP and Revised Figure 6-1 illustrating the proposed monitoring locations.
6	Follow-on response to Comment 29 of MEDEP memorandum dated June 22, 2020. MEDEP concurs that with weak vertical gradients, the transport of groundwater from the landfill to the bedrock would probably take a long time, but it would also mean that the water from the landfill would extend out from the landfill for a long distance before entering the bedrock and not intersect the existing bedrock wells. Some indication of this can be seen in the cross-section in Figure 15 of Volume III. There is no flow path from the landfill that intersects the screen of the downgradient bedrock well, MW14-04B. We concur that there appears to be a good hydraulic connection between the bedrock wells, but this does not tell us where the flow lines from the bottom of the landfill to the bedrock are. Two bedrock monitoring wells are required downgradient of Phase 14 so that groundwater released from the landfill is likely to be intercepted by the wells. MEDEP has indicated the locations of these wells in the figure below (end of document). Also, MW14-4D is not located downgradient of Ph 14C, the likely release point,	Please see Response to Comment 5.

Comment #	MEDEP Comment – September 9,2020	WMDSM Response
	and, like the bedrock well, MW14-4B, is not located far enough away for water from a release at Ph14C to intercept its screen, so we have indicated a new location.	
7	Given that a single geomembrane liner is proposed, the Department strongly recommends that WMDSM proposes to conduct an Electrical Leak Location Survey at the completion of each cell's construction to verify the integrity of the geomembrane liner following installation and prior to waste disposal, providing added post-construction quality control. The survey utilizes electrical conductivity techniques to detect leaks in the geomembrane. The survey will address the performance standards of ch. 401.1C(a) to ensure that the proposed landfill expansion does not contaminate groundwater outside the solid waste boundary.	WMDSM agrees to perform electric leak detection survey testing for each cell of the Phase 14 liner system. The testing will be performed in general accordance with ASTM D 7007 after construction of the liner and leachate collection system and before waste placement in each cell.
THE FOLLOWING ARE COMMENTS AND QUESTIONS OF CLARIFICATION THAT MEDEP REQUESTS A RESPONSE TO FOR THE RECORD:		
8	2.0 Presumpscot Clay, fifth paragraph. Does this limitation in the extent of the fissures/fractures/jointing refer to a vertical extent? Please clarify	Golder's review of the soil boring logs for the boreholes referenced by MEDEP (B-305, B-1001 to B-1044, B-103, B-310, B-614, B-615, B-617, B-618, B-620) and other borings in the Phase 11 and 12 (a total of 146 borings) identified only one observation of fissuring (B-305, sample for 5 to 6 ft bgs). Golder's statement refers to overall lack of observed fissuring.
9	3.7 Recovery Period, summary of key events. This section states that pumping of MW14-3B ceased pumping July 13, 14:00, but the data show the recovery starting July 10, 14:00. Please clarify	Pumping ceased at 2:00 p.m. (14:00 hours) on July 10, 2020 as indicated earlier in Section 3.7 of the Supplemental Geologic and Hydrogeologic Report. Reference to July 13 under "key events" is in error. Recovery monitoring ceased on July 13, 2020.
10	3.7 Recovery Period, summary of key events. This section states that a precipitation event occurred on July 11 from 4 pm to 9 pm, but because the response in PZ-16M starts around 7 am and is mostly over by 4 pm of July 11, should this be July 11 from 4 am to 9 am?	MEDEP is correct, based on available weather station data, the precipitation event occurred between approximately 4 am and 9 am on July 11.
11	3.7 Recovery Period, review of recovery data to confirm a response to pumping. How did WMDSM distinguish between a response of the wells to the July 10, 14:00 cessation of the pumping well from a response to the July 11, 4:00 precipitation event?	At some locations response to pumping cessation was clearly evident as a rapid rise in water levels shortly after pumping ended and prior to the rain event (e.g. pumping well MW-14-04B, bedrock observation wells MW14-02B and MW14-04B, and till wells MW14-03D and PZ-23D). At some of these locations the response to the precipitation event is evident in the form of a change in the shape of the recovery curve and increased water level rise (e.g., MW14-03D and MW14-04D). However, in these cases the response to the precipitation event is negligible relative to the response to pumping. In other cases, Golder observed a more modest rise in water levels shortly after cessation of pumping but also a response to the precipitation event (e.g., MW14-04D, PZ-13D and MW14-05D). Golder used the early-time (pre-precipitation event) recovery data as confirmation of pumping-period drawdown but did not attempt to quantify how much of the total observed head change during the recovery period was attributable to pumping cessation and how much was attributable to the precipitation event. Given the small amount of drawdown observed in the clay observation wells and piezometers, recovery due solely to cessation of pumping is really only evident at MW14-03M prior to the precipitation event. Recovery at the clay observation wells was typically well below 100% at most locations at the end of the recovery period, even with the precipitation event as indicated in Section 3.7 of the Supplemental Geologic and Hydrogeologic Report.
12	3.7 Recovery Period, bedrock wells. This paragraph states that MW14-2B recovered to within approximately 0.1 foot of the pre-pumping elevation, but then states that MW14-2B recovered to an elevation slightly higher than the pre-pumping level. Perhaps one of these statements refers to MW14-4B? Please clarify.	MEDEP is correct. MW14-04B recovered to a level slightly higher than the pre-pumping water level elevation.
13	3.9.2 Data adjustments. Please provide the actual calculations for the trends in the antecedent data that were removed from the drawdown period. Please provide the drawdown data that were used in the analysis	Appendix E-1 of the Supplemental Geologic and Hydrogeologic Report provided the adjusted corrected data that was used in the analysis. Attachment A-2 presents data plots of the field and corrected data to illustrate the effect of the data correction on the drawdown curves. Data corrections were completed with the assumption that the antecedent trend continued throughout the pumping test period and represents the natural variation of the hydrograph if no pumping occurred. The observed drawdown during the pumping test was corrected by removing the natural variation of water level to derive the pumping test drawdown, based on the following calculation: for a decreasing trend: $d_1' = d_1 - \Delta h_1$ for an increasing trend: $d_1' = d_1 + \Delta h_1$ where: d_1' = pumping drawdown, at a given time (t_1) d_1 = observed (measured) drawdown, at t_1 $\Delta h_1 = h_0 - h_1$, water level change due to natural variation, at t_1
14	3.9.3 Hantush Data Analysis. This section states that the Hantush method would derive vertical hydraulic conductivity from the pumping test, but if the pumping well is in the same unit as the monitoring wells, shouldn't it be deriving horizontal hydraulic conductivity (with the possible exception of MW14-3D)?	As a point of clarification, Section 3.9.3 of the Supplemental Geologic and Hydrogeologic Report states the Hantush analysis provides a vertical hydraulic conductivity for the aquitard, not the pumped aquifer. The Hantush method used in the analysis provides a value of transmissivity for the pumped aquifer. The hydraulic conductivity values presented in the report for the pumped aquifer were calculated by dividing the transmissivity by the aquifer thickness and are not directionally specific. The analytical method used also provides a value of vertical hydraulic conductivity for the overlying aquitard based on curve matching for wells/piezometers screened in the pumped aquifer. Drawdown curves for

Comment #	MEDEP Comment – September 9,2020	WMDSM Response
		wells screened in a "leaky" aquifer will differ from drawdown curves for wells screened in a "non-leaky" aquifer. Hantush developed type curves for leaky aquifers that incorporates leakance and its effect on the shape of drawdown curves. The amount of leakance is a function of the aquitard vertical hydraulic conductivity. Through matching of the Hantush type curves, a well function is derived, from which an aquitard hydraulic conductivity value can be calculated. There are other methods developed by Hantush that allow for calculation of a Kr (horizontal K) and Kz (vertical) ratio for the pumped aquifer when the test includes partially penetrating wells, but that was not the focus of this pumping test or analysis. The ratio of Kr/Kz in the till is expected to be close to one given the till lithology.
15	5.2.2 Presumpscot Clays, last paragraph. "…the Presumpscot clays impedes most meteoric recharge…" We noted that the response of the water levels in the background wells to the July 11 precipitation event indicated that the till responded quickly which might indicate rapid transmittal of the water across the clay. MW14-05D shows a very similar increase due to the precipitation that comes at virtually the same time as the clay well MW14-05M, further supporting rapid transmittal of water across the clay to the till. Please provide your thoughts on the response of till water to the precipitation event.	Evaluation of the recovery hydrographs for the background piezometers (Figure D-4a of the Supplemental Submittal) are useful for evaluating the relative response of the hydrostratigraphic units to precipitation. The response of the sand well (PZ-10S) to the precipitation event appears slightly delayed from the on-set of precipitation and of limited magnitude (approximately 0.1 ft). There was no observable response to precipitation in clay well PZ-10M to the precipitation event. The initial response in till well PZ-10D is almost simultaneous with the on-set of precipitation and of greater magnitude (approximately 0.2 ft) than the sand well. These observations suggest that the response of the till well to precipitation is independent of the response in the sand and clay (i.e., the magnitude of the response in the sand and clay to the precipitation is lower and occurs after the response in the till, therefore, they cannot be the cause of the response in the till). It is Golder's opinion that the response in the till is consistent with the expected response of a confined aquifer, where head changes are rapidly transmitted over long distances. The response to the precipitation is likely from recharge of the till in areas upgradient of Phase 14 where Presumpscot clays are absent. Attachment A-3 includes a hydrograph of recovery data for MW14-05D and MW14-05M plotted at the same scale. Golder notes that the apparent response to the precipitation event in the clay well MW14-05M is both temporally delayed and of significantly less magnitude than the response in till well MW14-05D. Furthermore, the clay well does not respond to the cessation of pumping in a similar manner as the till well, which indicates a lack of hydraulic communication between these two units. Similar to the background wells, it is Golder's opinion that the response in MW14-5D due to the precipitation event is not due to rapid transport through or across the clay.
16	5.2.3 Glacial till, second paragraph. The till in the Phase 14 area may be primarily recharged from the north, northeast (outside of Phase 14 area, we presume), but please explain the rapid response of water elevations to the rain event in several till wells.	Please see response to comment 15. It is Golder's opinion that the response in the till is consistent with the expected response of a confined aquifer. Recharge of the till primarily occurs in areas upgradient of Phase 14 where Presumpscot clays are absent. Head changes in response to precipitation are rapidly transmitted in confined units. Golder also notes that the July 11 precipitation event was a localized thunderstorm. The timing and intensity of the precipitation event in the till recharge area likely differed from timing and intensity of the precipitation in the immediate Phase 14 area.
17	Follow-on response to Comment 27 of MEDEP memorandum dated June 22, 2020. WMDSM's response states that they provide (in Section 4.0) a comparison of the current Phase 14 time-of-travel parameters to the parameters used in Gerber's 1996 groundwater model, but other than some discussion on porosity values (which weren't used in the original Phase 14 time-of-travel estimates), we could not find any comparison or evaluation of the 1996 model. Section 6.4 of Volume III uses the Gerber modeling results to justify the Phase 14 time-of-travel estimations, so it is appropriate to ask for confirmation of the applicability of the model. Could they be more specific on the location of the validation of using the 1996 model results to support Phase 14?	To clarify, Golder did not rely on the Gerber results to inform its analysis of the time of travel for the Phase 14 project. The Phase 14 time of travel analysis is independent of Gerber's results and based on the specific hydrogeologic conditions identified in the Phase 14 area. Golder noted that the results for Phase 14 were consistent with the prior results, but the intent of the comparison was to highlight the consistency of the results of the of the time of travel analyses completed by Golder and Gerber, not to "justify" or "validate" the Phase 14 analyses.
	THE FOLLOWING ARE ONLY COMMENTS OF NOTE:	
18	3.7 Recovery Period, response of clay wells to precipitation event. WMDSM concurs that a rapid response occurred in PZ-16M to the July 11 rain event and no other clay well responded this way. We concur that there may be a construction problem with this well. We note, however, that although the responses of the other clay wells are not as dramatic, many of them appeared to respond to the rain event (PZ-18M, MW14-4M, PZ-1M, MW14-2M, and MW14-5M) indicating the clay is recharged directly from precipitation. One can also see a response to the precipitation event in the till wells too, at PZ-10D, PZ-13D and possibly at MW14-04D and MW14-05D. This response in clay and till wells to precipitation events indicates that the till can be recharged directly from precipitation and the clay is not an impediment to recharge at all locations. Although not all the till and clay wells responded to the 7/11 precipitation event, there are locations were the till responded quickly, indicating that precipitation had to pass quickly through the clay to reach the till. The Conceptual Site Model should include possible recharge of the till through the clay.	Please see Response to Comment 16. It is Golder's opinion that the relative responses of till and clay wells is consistent with the conceptual site model as presented, and not indicative of rapid precipitation recharge through the clay.
19	3.8 Evaluation of total drawdown, Till. Although the elevations in MW14-5D are similar in shape to MW14-4D and PZ-13D, the start of the decrease in water levels at MW14-05E and PZ-13D does not support a conclusion that the decrease is related to the pumping of MW14-3B. Likewise, the increase in water levels at MW14-05D and PZ-13D are closer to the 7/11 rain event (that can be seen in the background till well, PZ-10D) and is probably not related to the pumping well. We only have confidence that three till	It is acknowledged that there is some uncertainty regarding the influence of pumping in the till and clay. However, Golder maintains the opinion that a sufficient stress (i.e., drawdown) was imparted on the till and bedrock to estimate hydraulic parameters (e.g., horizontal conductivity, storativity) in the bedrock and till, and to estimate vertical hydraulic conductivity in the Presumpscot clay aquitard.

Comment #	MEDEP Comment – September 9,2020	WMDSM Response
	wells (MW14-3D, MW14-4D, and PZ-13D) responded to the pumping test, with MW14-04D being the furthest away, and conclude that the radius of pumping influence is closer to 600 feet, than 1,500 feet.	
20	3.8 Evaluation of drawdown, Clay. We only have confidence that of the clay wells, MW14-3M, PZ-23M, and possibly PZ-22, responded to the pumping test, with PZ-23M being the furthest away, and conclude that the radius of pumping influence is closer to 30 feet, than 1,500 feet.	See response to comment 19.

<u>Attachments</u>
Attachment A-1: Revised Table 6-1, Table 6-2, and Figure 6-1
Attachment A-2: Pumping Period Data Correction Hydrographs (MW14-03M, PZ-22M, and PZ-23M)
Attachment A-3: MW14-05M and MW14-05D Response to Precipitation
Attachment B: Technical Information Supporting Variance for k ≤ 1×10-5 cm/s Restrictive Siting Criterion

Attachment A-1: Revised Table 6-1, Table 6-2, and Figure 6-1

Table 6-1: Proposed Groundwater and Surface Water Monitoring Locations

Location ID	Water Quality Monitoring Program	Water Level Monitoring Program
MW14-01S		x
MW14-01D	x	x
MW14-01B	x	x
MW14-02S		x
MW14-02M		x
MW14-02D		x
MW14-03S		x
MW14-03M	x	x
MW14-03D	x	x
MW14-04S		x
MW14-04M	x	x
MW14-04D		x
MW14-05S		x
MW14-05M	x	x
MW14-05D	x	x
MW14-06S		x
MW14-06M		x
MW14-06D		x
MW14-07M	x	x
MW14-07D	x	x
MW14-08M	x	x
MW14-08D	x	x
MW14-09D	x	x
MW14-09B	x	x
MW14-10B	x	x
MW14-11M	x	x
MW14-11D	x	x
PZ-8S		x
PZ-8D		x
PZ-9S		x
PZ-9D		x
PZ-10S		x
PZ-10M		x
PZ-10D		x
PZ-11S		x
PZ-11D		x
PZ-12S		x
PZ-12D		x
PZ-13S		x
PZ-13D		x
PZ-14S		x
PZ-14D		x
PZ-15M		x
PZ-15D		x
PZ-20S		x
S-1		x
S-3		x
S-4		x
S-6		x
SW14-02	x	x
SW14-05	x	x
SW14-07	x	x
SW14-08	x	x
VW-1S		x
VW-1D		x
VW-2S		x
VW-2D		x

Notes:
MW = groundwater monitoring well
PZ = groundwater piezometer
SW = surface water location
S = staff gauge
VW = vibrating wire piezometer

Created by: BDL
Checked by: AMC
Reviewed by: APTM

GOLDER

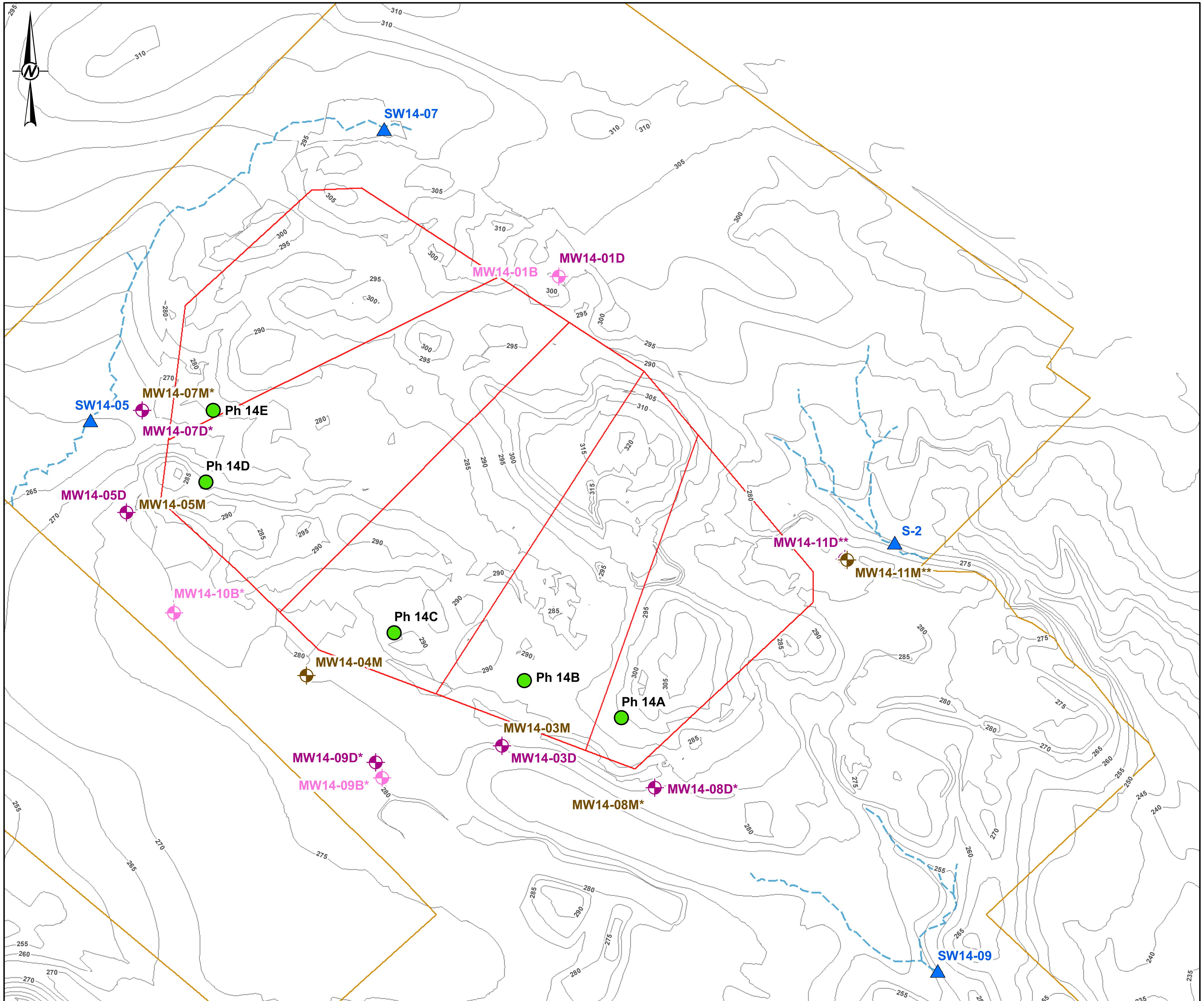
Table 6-2: Water Quality Program Sequence

		Location	MW14-01D	MW14-01B	MW14-11D	MW14-11M	MW14-03D	MW14-03M	MW14-04M	MW14-05D	MW14-05M	MW14-07D	MW14-07M	MW14-08D	MW14-08M	MW14-09D	MW14-09B	MW14-10B
Date	Activity	Unit	Till	Bedrock	Till	Phreatic	Till	Phreatic	Phreatic	Till	Phreatic	Till	Phreatic	Till	Phreatic	Till	Bedrock	Bedrock
		Cell	Upgradient	Upgradient	Upgradient	Upgradient	B	B	C	D	D	E	E	A	A	C	C	C
Winter/Spring 2021	Install Monitoring Wells											X	X	X	X	X	X	X
Spring 2021	Develop Monitoring Wells		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Summer 2021	**Begin Water Quality Sample Collection**																	
Summer 2021	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fall 2021	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring 2022	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Summer 2022	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fall 2022	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring 2023	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Summer 2023	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fall 2023	Water Quality Sample		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fall 2023	**Prepare Site Characterization Monitoring information**																	
2024+ (Triannial)	WQ Quality Sample		X		X	X	X	X	X	X	X	X	X	X	X	X		
Annually	**Submit Crossroads Annual WQ Report**																	

Note:

Dates and timeline are approximate, but are representative of the general sequence of events

Created by: BDL
Checked by: AMC
Reviewed by: APTM



LEGEND

- Clay Monitoring Well
- Till Monitoring Well
- Bedrock Monitoring Well
- Proposed Surface Water Quality Sampling Location
- Approximate Leachate Collection Sump Location
- Proposed 14 Waste Boundary
- Facility Site Boundary
- Ground Surface Topographic Contour
- Stream

0 350 700

1 " = 300 feet Feet

NOTE(S)

1. * MONITORING WELL TO BE INSTALLED.
2. ** LOCATION PREVIOUSLY IDENTIFIED AS PZ-7.

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 STATEPLANE MAINE WEST FIPS 1802 FEET
2. PROPOSED PHASE 14 WASTE BOUNDARY PROVIDED BY GEOSYNTEC CONSULTANTS ON JULY 23, 2019.
3. FACILITY SITE BOUNDARY PROVIDED BY GEOSYNTEC CONSULTANTS ON JULY 25, 2019 AND UPDATED WITH DATA PROVIDED BY BOYNTON & PICKETT LLC ON OCTOBER 18, 2019.
4. STREAMS LAYER FROM SHAPEFILE RECEIVED FROM NORMANDEAU ENVIRONMENTAL CONSULTANTS (NORMANDEAU) DATED MAY 3, 2019 AND GEOSYNTEC CONSULTANTS ON JULY 25, 2019.
5. PIEZOMETER AND SOIL BORING LOCATIONS SURVEYED BY BOYNTON & PICKETT AND PROVIDED ON 25 SEPTEMBER 2017 ("SURVEY INFROMATION"), OCTOBER 2018 ("WM MW CROSSROADS PIEZOMETER LOCATION OCT.2018), 17 APRIL 2019 ("WM MW PHASE 14 PZ GB MW LOCTIONS 04.17.2019").
6. EXISTING GROUND SURFACE WITHIN PHASE 14 AREA FROM CAD FILE "WM MAINE WEST PHASE 14 TOPO NOV 2017 (DELIVERABLE (2))".DWG CREATED BY BOYNTON AND PICKETT, AS PROVIDED BY GEOSYNTEC DATED 7 SEPTEMBER 2018. EXISTING GROUND SURFACE SURROUNDING PHASE 14 AREA FROM CAD FILE "BE0232 TOPO 09-2016 (SP)".DWG CREATED BY AERIAL SURVEY & PHOTO INC. AND BOYNTON & PICKETT, AS PROVIDED BY GEOSYNTEC DATED 7 SEPTEMBER 2018. EXISTING GROUND SURFACE CONTOUR DATA WERE MERGED.

CLIENT

WASTE MANAGEMENT DISPOSAL SERVICES OF MAINE, CROSSROADS LANDFILL, NORRIDGEWOCK, ME

PROJECT

PHASE 14 LANDFILL

TITLE

PROPOSED WATER QUALITY MONITORING PROGRAM

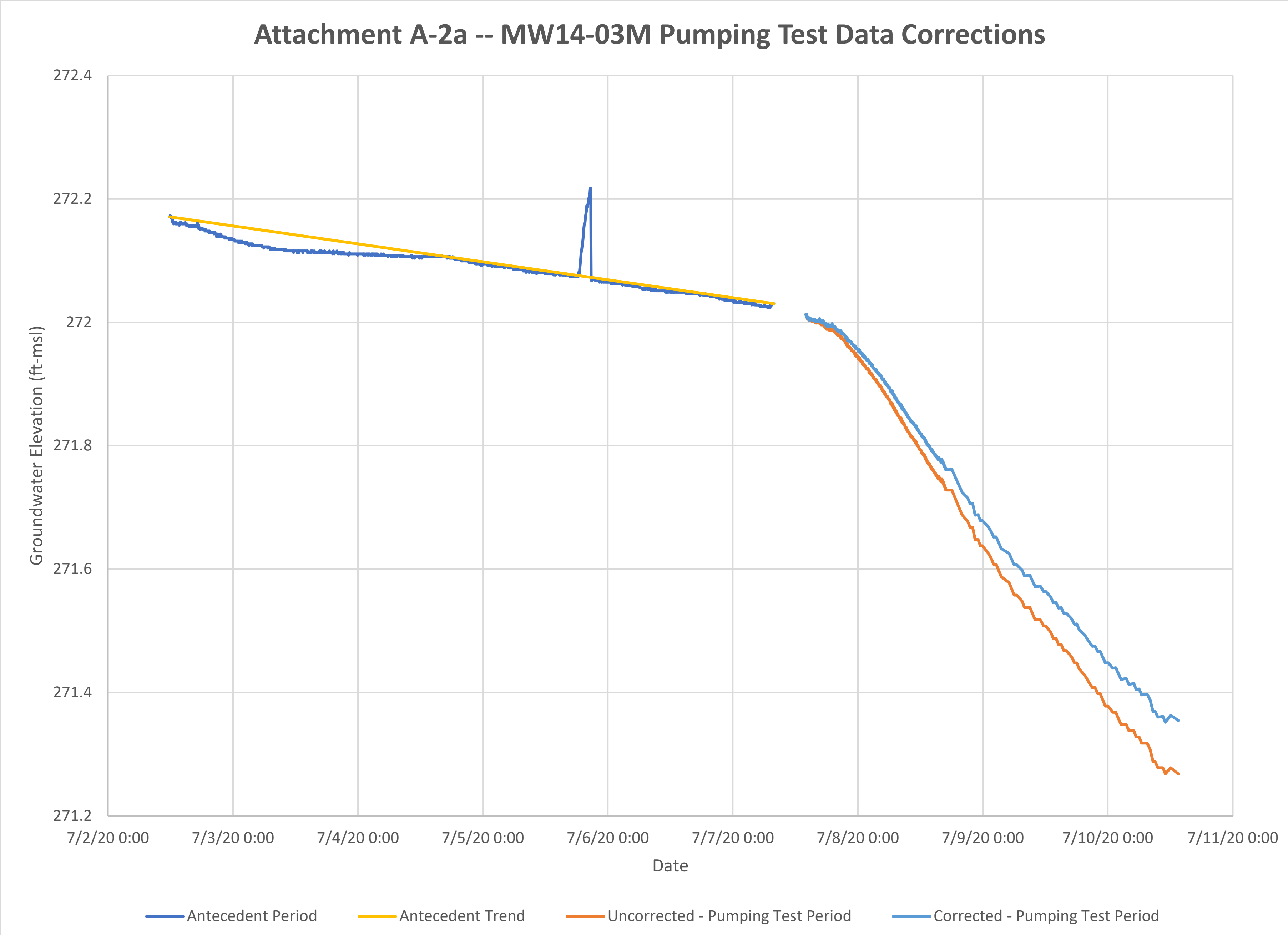
CONSULTANT

GOLDER

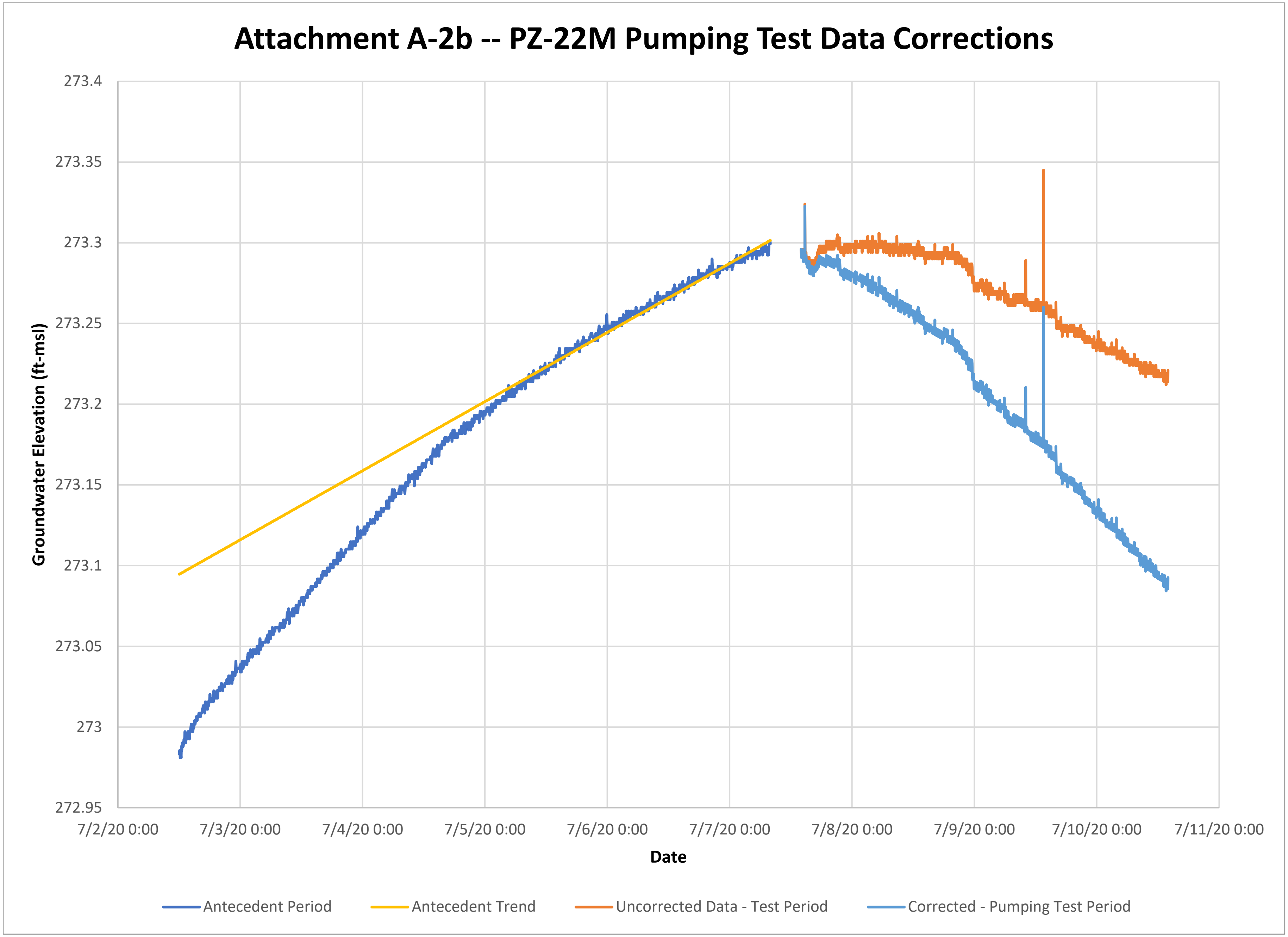
YYYY-MM-DD	9/23/2020
DESIGNED	JMB
PREPARED	SHL
REVIEWED	BDL
APPROVED	APTM

PROJECT NO.	CONTROL	REV.	FIGURE
2014267	-	-	6-1

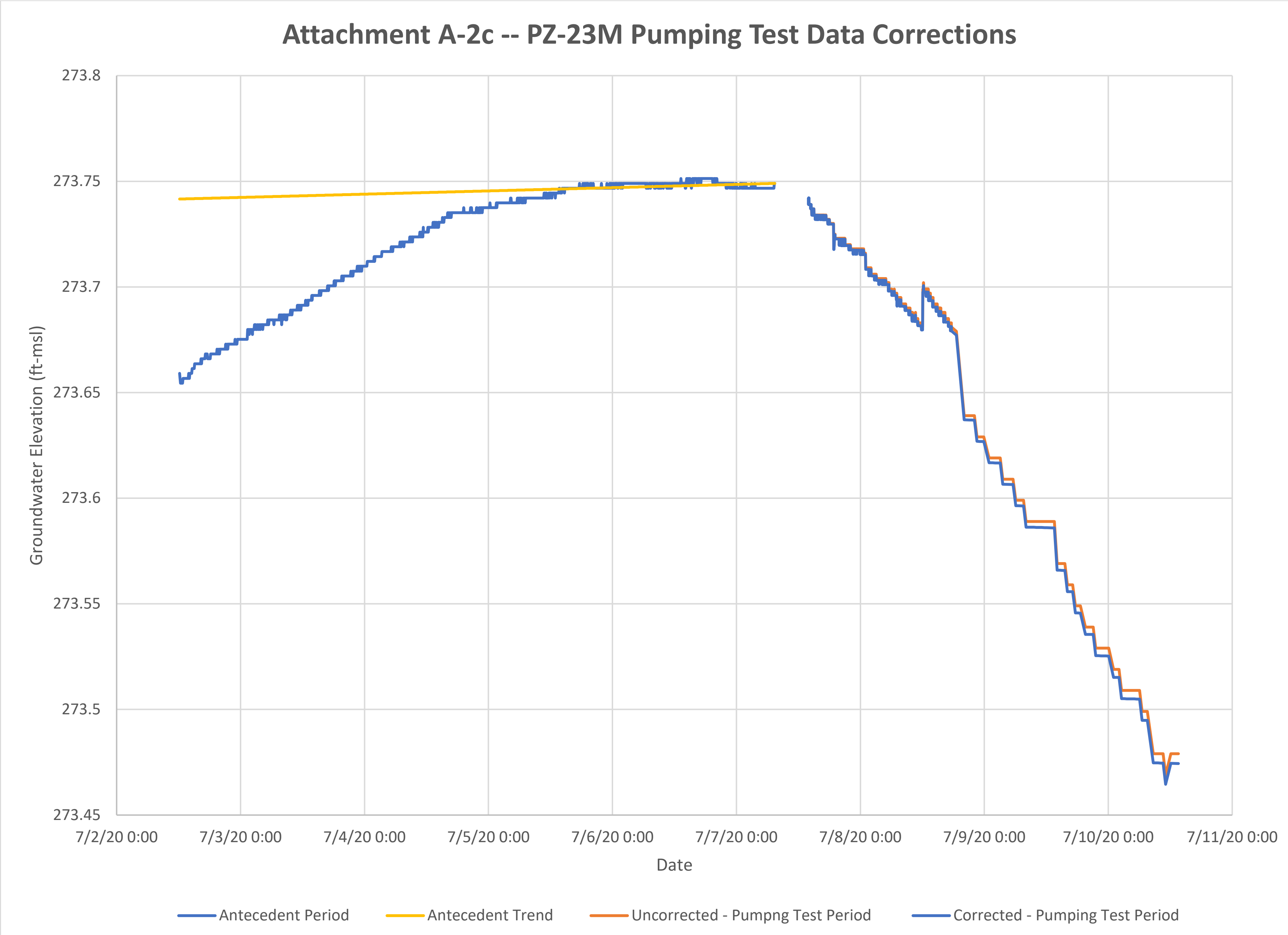
Attachment A-2: Pumping Period Data Correction Hydrographs (MW14-03M, PZ-22M, and PZ-23M)



Attachment A-2a -- MW14-03M Pumping Test Data Corrections
Groundwater Elevation (ft-msl)
272.4
272.2
272
271.8
271.6
271.4
271.2
7/2/20 0:00
7/3/20 0:00
7/4/20 0:00
7/5/20 0:00
7/6/20 0:00
7/7/20 0:00
7/8/20 0:00
7/9/20 0:00
7/10/20 0:00
7/11/20 0:00
Date
Antecedent Period
Antecedent Trend
Uncorrected - Pumping Test Period
Corrected - Pumping Test Period

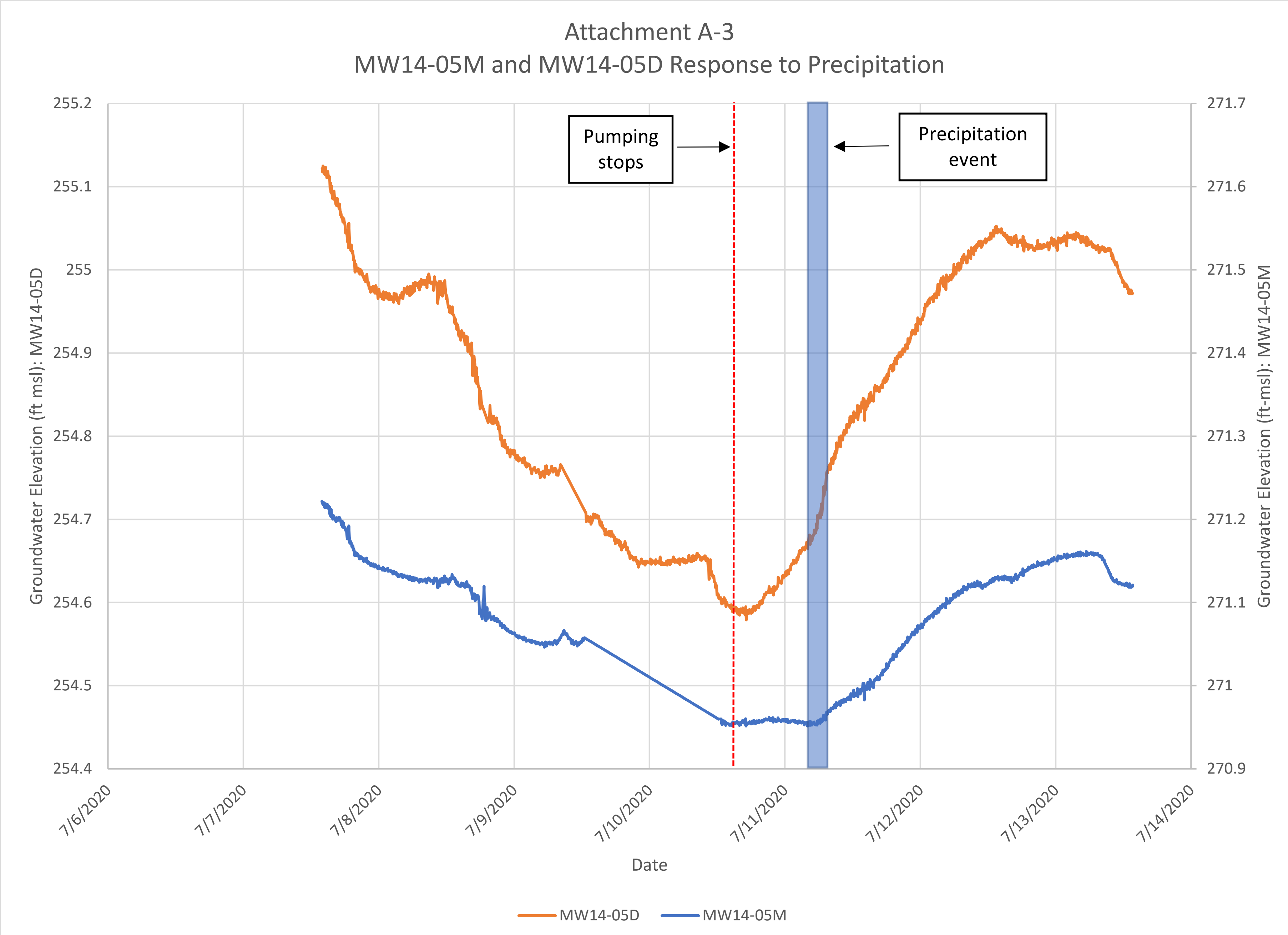


Attachment A-2b -- PZ-22M Pumping Test Data Corrections
Groundwater Elevation (ft-msl)
273.4
273.35
273.3
273.25
273.2
273.15
273.1
273.05
273
272.95
7/2/20 0:00
7/3/20 0:00
7/4/20 0:00
7/5/20 0:00
7/6/20 0:00
7/7/20 0:00
7/8/20 0:00
7/9/20 0:00
7/10/20 0:00
7/11/20 0:00
Date
Antecedent Period
Antecedent Trend
Uncorrected Data - Test Period
Corrected - Pumping Test Period



Attachment A-2c -- PZ-23M Pumping Test Data Corrections
273.8
273.75
273.7
273.65
273.6
273.55
273.5
273.45
Groundwater Elevation (ft-msl)
7/2/20 0:00
7/3/20 0:00
7/4/20 0:00
7/5/20 0:00
7/6/20 0:00
7/7/20 0:00
7/8/20 0:00
7/9/20 0:00
7/10/20 0:00
7/11/20 0:00
Date
Antecedent Period
Antecedent Trend
Uncorrected - Pumpng Test Period
Corrected - Pumping Test Period

Attachment A-3: MW14-05M and MW14-05D Response to Precipitation



Attachment A-3
MW14-05M and MW14-05D Response to Precipitation
Pumping stops
Precipitation event
255.2
255.1
255
254.9
254.8
254.7
254.6
254.5
254.4
271.7
271.6
271.5
271.4
271.3
271.2
271.1
271
270.9
Groundwater Elevation (ft msl): MW14-05D
Groundwater Elevation (ft-msl): MW14-05M
7/6/2020
7/7/2020
7/8/2020
7/9/2020
7/10/2020
7/11/2020
7/12/2020
7/13/2020
7/14/2020
Date
MW14-05D
MW14-05M

Attachment B: Technical Information Supporting Variance for $k \leq 1 \times 10^{-5}$ cm/s Restrictive Siting Criterion

Geosyntec consultants

289 Great Road Suite 202
Acton, Massachusetts 01720
Phone: 978.263.9588
www.geosyntec.com

ATTACHMENT B - Technical Memorandum

Date:	23 September 2020
To:	Sherwood McKenney, District Engineer Waste Management Disposal Services of Maine, Inc. (WMDSM)
From:	Nicholas J. Yafrate, P.E. Scott M. Luettich, P.E. Geosyntec Consultants (Geosyntec)
Subject:	Technical Information Supporting Variance for $k \leq 1\times10^{-5}$ cm/s Restrictive Siting Criterion Phase 14 Landfill License Application # S-010735-WD-YB-N Crossroads Landfill - Norridgewock, Maine

---

Introduction

This memorandum presents information supporting a variance which demonstrates that the Phase 14 site meets the intent of Maine Solid Waste Management Rule (SWMR) Chapter 401.1C(3)(b). The information presented herein is submitted pursuant to SWMR Chapter 400 13.C, and is organized as follows:

- Background Information
- Application Requirement
- Reasons for Variance
- Alternative Procedure / Design
- Construction Quality Assurance (CQA)
- Conclusions

References are listed and a figure depicting the concepts described herein is attached to the end of this technical memorandum.

Background Information

In October 2019, WMDSM submitted a Solid Waste Permit application to the Maine Department of Environmental Protection (MEDEP) for the Phase 14 Landfill at the Crossroads Landfill facility in Norridgewock, Maine. A *Geologic and Hydrogeologic Assessment* report, presented as Volume III of the permit application [Golder Associates, 2019], provided detailed information regarding the subsurface stratigraphy under the Phase 14 area, the profile of which can be summarized as follows (from top to bottom):

- Undifferentiated surficial soils (organic topsoil, stockpiled materials);
- Eolian silty fine sand ranging in thickness from zero ft in the central portion to 18 ft in the southeast portion of the Phase 14 footprint;
- Presumpscot Clay ranging in thickness from 2~3 ft in the northwest portion to 18 ft along the southwest and southeast perimeter of the Phase 14 footprint;
- Glacial Till ranging in thickness from 2 ft in the central portion to 16 ft in the western portion of the Phase 14 footprint; and
- Bedrock.

As explained in Section 4.2 of Golder's *Geologic and Hydrogeologic Assessment* report (i.e., Volume III), the Presumpscot Clay unit typically consists of two facies: (i) a Stiff Upper Clay Facies transitioning to and underlain by (ii) a Soft Lower Clay Facies. This is true in much of the Phase 14 area; however, as explained in Section 4.2 and shown in Figures 7a and 7b of Volume III, the clay stratum consists only of Stiff Upper Clay without Soft Lower Clay in the north-northwest portion of Phase 14 and in small isolated areas near the southwest end of Phase 14D and the south perimeter of Phase 14C.

As described in Section 2.1 of the *Landfill Engineering Report*, presented as Volume IV of the permit application [Geosyntec Consultants, 2019], earthwork for Phase 14 will involve excavating surficial soil stockpiles and the in-situ eolian sand stratum from the base of the landfill footprint and constructing a mechanically stabilized earth (MSE) berm to establish the perimeter of the lined area. And as shown on Sheet 4 of the Permit Drawings in Volume IV, in the areas where the eolian silty fine sand will be over-excavated from under the base portion of Phase 14, WMSDM will place compacted silt-clay backfill up to the liner subgrade elevations.

During its review of the October 2019 permit application, MEDEP asked questions about the possibility of post-depositional features in the Stiff Upper Clay that might increase the bulk hydraulic conductivity of this otherwise low hydraulic conductivity stratum. WMDSM provided responses to MEDEP's comments in which additional information was presented to support the conclusion that both the Soft Lower Clay Facies and the Stiff Upper Clay Facies meet the hydraulic conductivity $k \leq 1\times10^{-5}$ cm/s requirement of Chapter 4011C(3)(b). In response to MEDEP's request, WMDSM also conducted a groundwater pumping test to obtain additional information on the bulk hydraulic conductivity of the Phase 14 subsurface. On behalf of WMDSM, Golder submitted a Work Plan for the Pumping Test to MEDEP on 29 May 2020, and a Revised Work Plan was submitted on 4 June 2020 in which MEDEP's review comments were addressed. The groundwater pumping test was completed and a Supplemental Geologic and Hydrogeologic Report was submitted to MEDEP on 31 July 2020, which provided further confirmation that the bulk hydraulic conductivity of the in-situ clays is less than 1×10^{-5} cm/s.

MEDEP has continued to express a concern that the bulk hydraulic conductivity of the stiff upper clay might be greater than 1×10^{-5} cm/s. In its 9 September 2020 review comments, MEDEP requested that WMDSM identify measures to address the areas where the Lower Soft Clay is absent and required WMDSM to submit a variance request to address the possibility that the in-situ undisturbed soils in those locations might not meet the minimum hydraulic conductivity requirement of Chapter 401.1C(3)(b). As discussed in responses to those review comments, WMDSM believes the evidence demonstrates that the requirement of Chapter 401.1C(3)(b) is met in all locations of the Phase 14 landfill. Nonetheless, to the extent that MEDEP concludes otherwise and as required, WMDSM is submitting this variance request in accordance with Chapter 400.13.C.

<u>Ch 400.13.C(1) Applicable Requirement</u>

Chapter 401.1C(3)(b) states:

The area within the solid waste boundary must be located on soils that contain sufficient fines and clay-sized particles to minimize infiltration of leachate. The in-situ soils must have an undisturbed hydraulic conductivity less than or equal to 1×10^{-5} *cm/s.*

<u>Ch 400.13.C(3) Reasons for Variance</u>

The reason for this variance request is to fulfill the requirement set forth in the 9 September 2020 letter from Linda Butler of Maine Department of Environmental Protection (MEDEP) to Sherwood McKenney of WMDSM, in which MEDEP states that WMDSM must request a variance to the 1×10^{-5} cm/s criterion, and in which MEDEP specifically requests that WMDSM address areas of limited extent of the soft clay under Phase 14 footprint and describe how WMDSM will make liner subgrade improvements to meet the intent of Ch. 401.1C(3)(b).

<u>Ch 400.13.C(2) Alternative Procedure / Design</u>

The information presented herein describes how the construction of Phase 14 will be accomplished, specifically, the means and methods that will be used in areas where there is no Soft Lower Clay to improve the subgrade under the liner such that it meets the intent of Chapter 401.1C(3)(b).

The areas shown on Figure 1 colored green designate where there is no Soft Lower Clay and where excavation to the liner subgrade elevation will terminate within the Stiff Upper Clay. The excavation surface in these areas will be scarified to a depth of approximately 8 inches and recompacted using a pad-foot compactor to produce the kneading action that will result in a homogeneous low-permeability layer. Compaction criteria for the recompacted in-situ clay layer will be established based on pre-construction Proctor testing and permeability testing of remolded specimens (likely wet of optimum and to a density ≥ 90% of Proctor maximum dry density). Shelby tube samples from the recompacted layer will be obtained at a frequency of 1 tube per acre and sent to the Construction Quality Assurance (CQA) geotechnical laboratory for permeameter testing for additional confirmation that the 1×10^{-5} cm/s criterion has been achieved. After the confirmation testing is complete demonstrating that 1×10^{-5} cm/s criterion has been achieved, the 1-ft thick 1×10^{-7} cm/s compacted clay component of the liner system will be constructed directly on the recompacted in-situ clay surface.

Areas shown on Figure 1 colored blue designate where there is no Soft Lower Clay and where over-excavation will be performed to remove the eolian silty fine sand down to the surface of the Stiff Upper Clay. In these areas, the surface of the Stiff Upper Clay will be scarified prior to placement and compaction of silt-clay backfill up to the liner subgrade elevation. Compaction criteria for the clay backfill will be established by pre-construction Proctor testing and permeability testing of remolded specimens (likely targeted wet of optimum and to a density ≥ 90% of Proctor maximum dry density) to demonstrate the compacted silt-clay backfilled material has $k \leq 1\times10^{-5}$ cm/s. Shelby tube samples will be taken at a frequency of 1 tube per acre from the uppermost lift (the top 8 inches) of the silt-clay backfill and sent to a geotechnical lab for permeameter testing for additional confirmation/documentation that the 1×10^{-5} cm/s criterion has been achieved. After the confirmation testing is complete demonstrating that 1×10^{-5} cm/s criterion has been achieved, the 1-ft thick 1×10^{-7} cm/s compacted clay component of the liner system will then be constructed directly on the compacted clay backfill.

Areas shown on Figure 1 colored orange designate areas under the liner sideslopes where there is no Soft Lower Clay and where the liner subgrade will terminate in the in-situ eolian silty fine sand slope excavation and/or where the sideslope will be created by the inner structural fill slope of the MSE berm. WMDSM will remove an extra 1 ft of the sand and place a 1-ft thick compacted silt-clay layer on the excavated portion of the sideslope and/or will leave the inner fill sideslope of the MSE berm 1 ft low and will place an extra 1-ft thick compacted silt-clay layer on that portion of the sideslope as well. Compaction criteria for extra silt-clay layer will be established based on pre-construction Proctor testing and permeability testing of remolded specimens (likely wet of optimum and to a density ≥ 90% of Proctor maximum dry density). Shelby tube samples will be taken at a frequency of 1 test per acre and sent to lab for permeameter testing for additional confirmation the 1×10^{-5} cm/s criterion has been achieved. After the confirmation testing is complete demonstrating that 1×10^{-5} cm/s criterion has been achieved, the 1-ft thick 1×10^{-7} cm/s compacted clay component of the liner system on the sideslope will then be constructed directly on the silt-clay subgrade layer.

Construction Quality Assurance (CQA)

All pre-construction testing and CQA test results obtained during construction described herein will be submitted to MEDEP as part of the CQA program for each cell. Required compaction criteria for the upper surface of the Stiff Upper Clay, or the extra silt-clay backfill will be discussed during routine (typically weekly) construction meetings as set forth in the Quality Assurance Manual that was submitted in Volume VI of the October 2019 Solid Waste Permit Application [Geosyntec Consultants, 2019].

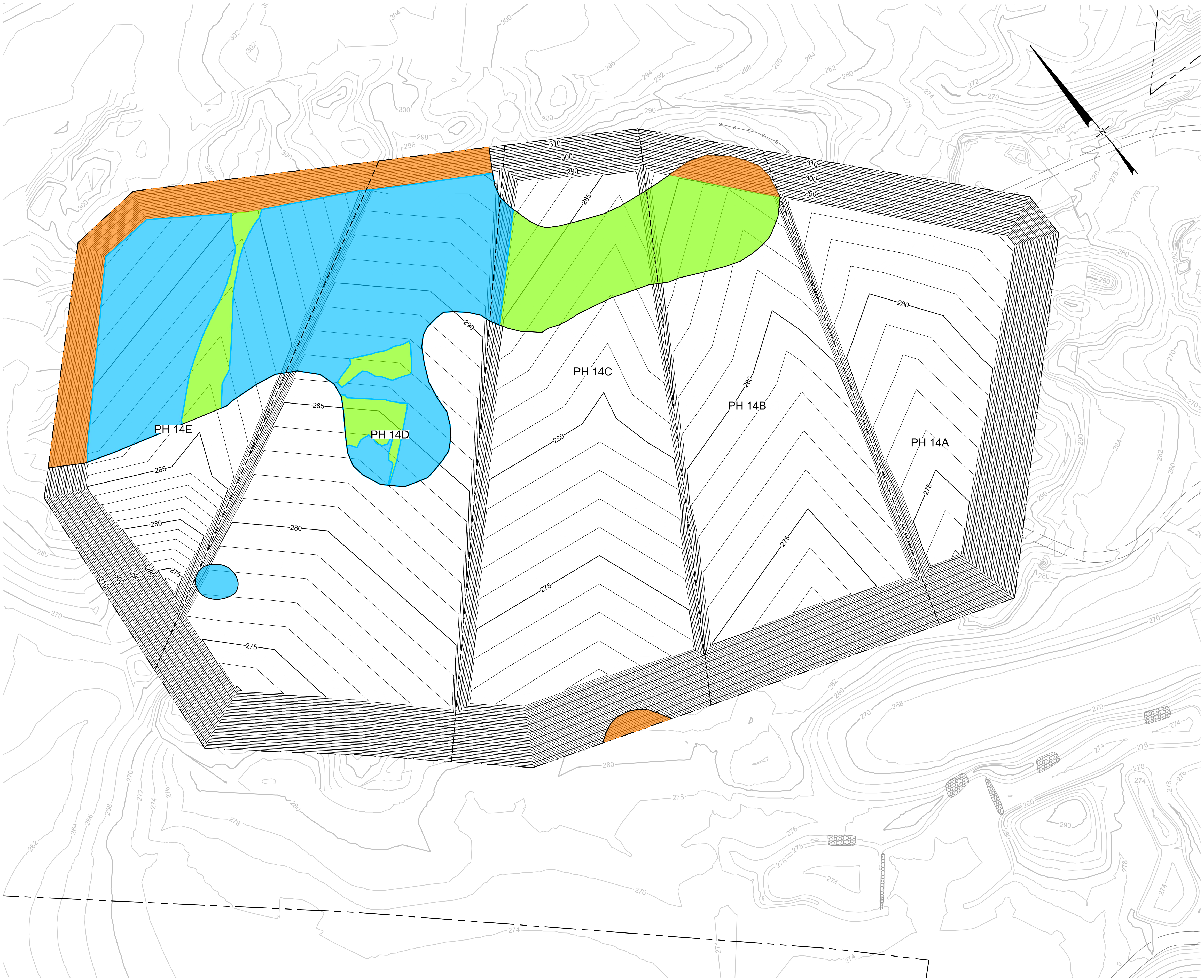
Conclusions

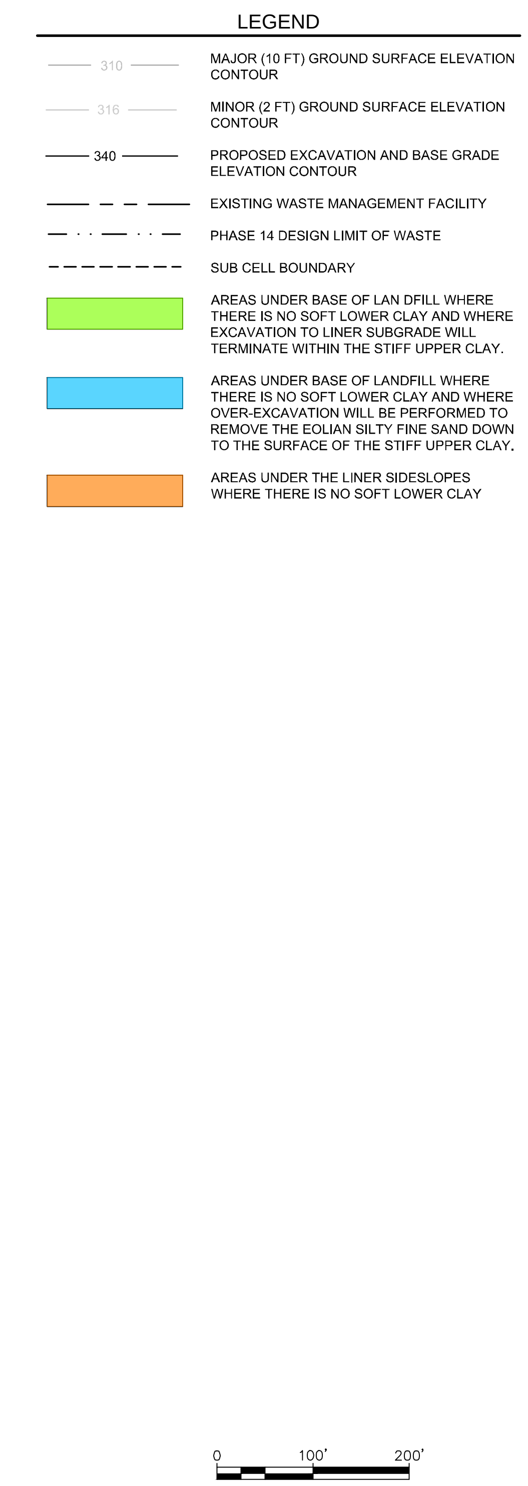
The purpose of the Ch. 401.1.C.(3)(b) is to ensure that the area within the solid waste boundary is located on soils that contain sufficient fines and clay-sized particles to minimize infiltration of leachate. Based on extensive information collected to date and set forth in Section 5.2.2 of the Geologic and Hydrogeologic Assessment (Golder, October 2019), and Section 2.0, Section 3.10, and Appendix A of the Supplemental Geologic and Hydrogeologic Report (Golder, July 2020), WMDSM believes the undisturbed in-situ soils, including areas where the Soft Lower Clay is absent, have a hydraulic conductivity of 1×10^{-5} cm/s or less. The additional measures described above support the conclusion that the subgrade conditions under Phase 14 will meet the intent of Chapter 401.1.C.(3)(b). Specifically, the area within the solid waste boundary will be located on soils that contain sufficient fines and clay-sized particles to minimize infiltration of leachate and will have hydraulic conductivity less than or equal to 1×10^{-5} cm/s. This will be confirmed and documented by CQA testing during construction as described herein and submitted to MEDEP in accordance with the Professional Engineering (PE) certification standard-of-practice in Maine.

* * * * *

REFERENCES

1. Golder Associates, *Phase 14 Solid Waste Permit Application, Geologic and Hydrogeologic Assessment,* Volume III of VI, October 2019.
2. Geosyntec Consultants, *Phase 14 Solid Waste Permit Application, Landfill Engineering Report,* Volume IV of VI, October 2019.
3. Golder Associates, *Work Plan – Phase 14 Pumping Test,* May 2020.
4. Golder Associates, *Revised Work Plan – Phase 14 Pumping Test,* June 2020
5. Golder Associates, *Supplemental Geologic and Hydrogeologic Report,* July 2020.





PHASE 14 PROPOSED AREAS OF LINER SUBGRADE IMPROVEMENTS IN LOCATIONS WITH NO SOFT LOWER CLAY

WASTE MANAGEMENT DISPOSAL SERVICES OF MAINE, INC.
CROSSROADS LANDFILL
NORRIDGEWOCK, MAINE

Geosyntec consultants

FIGURE 1

PROJECT NO: BE0232 | SEPTEMBER 2020

T:\PROJECTS_CADD\C\CROSSROADS LANDFILL\PHASE 14 EXPANSION\PERMIT\FIGURES\2020.09.18 SUBGRADE IMPROVMENTS FOR VARIANCE\BE0232 F1A-2B (EXCAV-CLAY LAYERS)