TECHNICAL MEMORANDUM

DATE May 24, 2018 **Project No.** 152030401.001

TO Travis Bennett
Holcim (US) Inc.

FROM Joseph Xi, Gary Zimmerman (Golder) **EMAIL** jxi@golder.com

RE: INTERCEPTOR TRENCH INVESTIGATION SUMMARY AND RECOMMENDATIONS

1.0 BACKGROUND

The location of the Ravensdale site is shown in Figure 1. In 2016 and 2017, subsurface investigations were conducted to determine the geologic materials and groundwater conditions along the proposed alignment of the interceptor trench extension. In portions of the Ravensdale site, perched groundwater flows within overburden soils along the top of bedrock. Investigations were completed in October 2016 and in December 2017, which consisted of drilling 16 boreholes between 10 to 30 feet in depth to determine the depth to bedrock and detect the presence of perched groundwater. Piezometers were installed in five of the boreholes in December 2017 to allow water level measurements and thereby determine the perched groundwater gradient and flow direction in the general area of the proposed alignment of the interceptor trench extension. Information collected from the October 2016 and December 2017 borehole drilling, piezometer installation, and subsequent water level measurements were used to evaluate a potential extension to the interceptor trench.

2.0 SUMMARY OF INVESTIGATIONS

2.1 October 2016 Investigation

Prior to conducting the 2016 investigation, the proposed alignment for the interceptor trench extension was to the north along the access road that borders the east side of the Lower Disposal Area (LDA). A limited test pit program in 2010 (Golder 2013[1]) had indicated bedrock or fill near the ground surface along this alignment. A work plan (Golder 2016[2]) was prepared describing the scope of the interceptor trench extension predesign investigation.

Drilling was performed by Cascade Drilling, L.P. (Cascade) using a model 100C track-mounted sonic drill rig. A total of 9 boreholes were drilled on October 25 and 26, 2016. The locations of the boreholes are shown on Figure 2.

Drilling began with borehole B-12 and proceeded north along the access road to boreholes B-13 through B-17 in numerical sequence. Because cement kiln dust (CKD) was unexpectedly encountered in several of these boreholes, additional boreholes B-19, B-19A, and B-20 were drilled in an attempt to delineate the eastern lateral

[1] Golder Associates Inc. (Golder). 2013. Lower Disposal Area Hydrogeological Investigations Report, Ravensdale Site, Ravensdale, Washington. June 11.

[2] Golder Associates Inc. (Golder). 2016. Interceptor Trench Extension Predesign Investigation Field Work Plan, Ravensdale Site, Ravensdale, Washington. October 12.

Golder Associates Inc.
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extent of the CKD. B-16 and B-17 were drilled to depths of 30 feet below ground surface (bgs) in an attempt to reach bedrock.

Fill overlying CKD was encountered in all boreholes except B-17, where no CKD was present, and B-16, where zones of CKD were interspersed with fill. Fill was encountered from the ground surface to depths of between 2 and 23 feet bgs, increasing in thickness to the north. The fill consisted predominantly of silty sand mine spoils, with clayey material and coal fragments, but also included debris. Underlying the fill, CKD was encountered to the depths explored, except in B-17, where material that was interpreted to be highly weathered siltstone/sandstone bedrock was encountered from 25 feet to the end of the hole at 30 feet bgs, and in B-16, where fill material was encountered beneath the CKD from a depth of 25 feet to the bottom of the borehole at 30 feet.

Boreholes B-19, B-19A, and B-20 were drilled as close as practicable to the toe of the slope east of the access road, which forms the hill upon which the Bonneville Power Administration (BPA) transmission line towers are founded. B-19A and B-20 were drilled at angles of 30 degrees and 10 degrees, respectively, to extend under the slope to determine if the CKD was present below the hill. In each of these borings, CKD was encountered below fill to the total depths of the boreholes.

Groundwater was encountered in all of the boreholes except B-13 and B-17. The depth to groundwater ranged from 8 to 18 feet bgs, but the water levels measured within short time periods after drilling do not necessarily represent the static water levels. Boreholes B-15, B-16, and B-19 were backfilled with sand and the upper 5 feet was plugged with bentonite chips, so that they could be easily re-drilled for piezometer installation in the future. All other 2016 boreholes were backfilled completely with bentonite chips in accordance with Washington State requirements. Groundwater was not encountered in boreholes installed north of borehole B-16, namely borehole B-17 and two previously installed boreholes B-9 and B-2 (Golder 2013). This indicates that any interceptor trench extension will not be required further north than B-16, as there is insufficient water to be intercepted.

The borehole information for both the 2016 and 2017 investigations are summarized in Table 1. Borehole logs are presented in Attachment A. A cross-section schematic of the 2016 investigation is shown in Figure 3A.

Results of this 2016 phase of the interceptor trench borehole investigation were summarized in the work plan (Golder 2017[3]) that presented the next phase of the investigation. A copy of this work plan is included with this letter as Attachment B.

2.2 December 2017 Investigation

Following the results from the 2016 investigation the proposed 2017 extension of the interceptor trench was moved further to the east, further uphill along the existing access road. Additional borings were located along this new proposed alignment to evaluate the extent of the CKD intercepted during the October 2016 borehole drilling, and to determine the geologic materials and presence of perched groundwater.

Drilling was performed by Cascade using a Terrasonic model 150 track-mounted sonic drill rig. A total of seven boreholes were drilled on December 11 and 12, 2017. The locations of the boreholes are shown on Figure 2. Three of these boreholes (B-21, B-24, and B-27) were converted to permanent piezometers on December 12 and 13, 2017. Two of the nine previously drilled boreholes from 2016 (B-12 and B-15) were also converted to

[3] Golder Associates Inc. (Golder). 2017. Lower Disposal Area Interceptor Trench Borehole Investigation Work Plan, Ravensdale Site, Ravensdale, Washington. September 18.

piezometers on December 13, 2017. All boreholes drilled in 2017 that were not converted to piezometers were backfilled with hydrated bentonite chips on December 13, 2017 in accordance with Washington State requirements.

Drilling for the 2017 investigation began with borehole B-21 and proceeded north along the access road to borehole B-26 in numerical sequence. Boring B-27 was subsequently drilled to fill a data gap between B-22 and B-23. Fill material was encountered from the ground surface to depths of between 7.5 and 17 feet bgs during the drilling. The fill consisted predominantly of silty sand mine spoils, with clayey material and coal fragments. No CKD was encountered in any of the seven boreholes.

Groundwater was encountered in all of the boreholes except B-22, and only minimally in boreholes B-25 and B-26. Wet soil cuttings in borehole B-22 were observed at around 11 feet bgs. Moist to wet soil was observed at around 7 feet bgs in B-25, and 3 feet bgs in B-26. Soil cores collected below these depths in B-25 and B-26 were dry, and did not indicate that perched groundwater was present at the top of the bedrock surface. Water was measured at approximately 24 feet bgs (1 foot of water in borehole) in B-25 at time of drilling, and at approximately 22 feet bgs (3 feet of water in borehole) in B-26 at time of drilling. The water measured in these boreholes was deeper than the top of the bedrock, and is interpreted to be water that entered from shallower depths. The water detected in these boreholes was likely caused by near-surface flow entering the boreholes during drilling rather than inflow of perched water on top of the bedrock. These observations indicate that perched groundwater may not be present in significant volumes north of borehole B-24, and extending the interceptor trench beyond this location may not be useful.

The depth to groundwater encountered during drilling ranged from 10 to 24 feet bgs, and five piezometers were installed at boreholes B-12, B-15, B-21, B-24, and B-27 in order to provide information on groundwater elevations. Boreholes B-12 and B-15 were previously drilled in October 2016 and converted to piezometers in December 2017. Piezometers were constructed of 2-inch Schedule 40 PVC pipe with at least 5 feet of 0.010-inch slotted screen. Each piezometer annulus was backfilled with 10/20 silica sand to approximately 2 feet above the slotted screen, and sealed from there to the ground surface with a hydrated bentonite seal. Finally, the piezometers were completed with flush-mounted steel monuments. The locations and elevations of the piezometers were surveyed by Encompass Engineering & Surveying on February 7, 2018, so that groundwater elevations could be accurately determined.

The 2017 borehole information is summarized in Table 1. Borehole logs are presented in Attachment A. A cross-section of the borehole profile for the December 2017 investigation is provided in Figure 3B.

3.0 GROUNDWATER GRADIENTS

Groundwater elevations were measured beginning in December 2017 from the piezometers installed during the December 2017 investigation and from a number of previously installed piezometers across the site. Groundwater elevations are presented in Table 2. This information was used to develop groundwater potentiometric maps, as shown in Figures 4A to 4F representing measurements taken at monthly intervals. Groundwater flow in a perched aquifer is dependent on numerous conditions, including the topography of the underlying bedrock, volumes of recent precipitation, and infiltration within various areas of the site. Groundwater gradients shown are based on groundwater elevation measurements at a given point in time, and do not necessarily represent the predominant groundwater flow across the entire site.

The information indicates that during the period of December 2017 to April 2018, static water level depths ranged from approximately 4 to 18 feet bgs (corresponding to elevations of approximately 780 to 800 feet above mean sea level) in the area of the proposed interceptor trench extension. The potentiometric maps show that the groundwater gradient is steep with a generally east northeast to west southwest direction in the immediate area of the proposed interceptor trench. This investigation indicates that an interceptor trench installed along the proposed alignment (as shown in Figure 2) would likely intercept and divert additional perched groundwater away from the LDA.

4.0 CONCLUSIONS

Based on the results of the investigations completed to date, extending the groundwater interceptor trench will potentially allow further interception and diversion of shallow groundwater before it enters the LDA, thereby reducing seepage from the LDA. The December 2017 investigation confirmed that CKD is not present along the revised alignment.

Groundwater elevations obtained from December 2017 to April 2018 indicate groundwater levels range from approximately 4 to 18 feet bgs in the areas of investigation, and locally the gradient is towards the west indicating potential flow into the LDA. Top of bedrock is intercepted at depths of approximately 10 to 25 feet bgs in this area. This information supports potentially extending the interceptor trench along the proposed alignment as shown on Figure 2.

However, before a final proposal can be made on installation of the interceptor trench extension, some additional data and evaluation are needed. Although the pH measured in the piezometers located along the proposed alignment is near neutral, water samples should be collected and analyzed from the piezometers to verify that water is this area is not impacted. Water level measurements and evaluation of gradients should continue into the drier seasons to evaluate seasonal changes. Following additional studies, if the conclusion is made that installation of an interceptor trench extension will effectively reduce the volume of water entering into the LDA, an engineering design report describing the proposed interceptor trench construction will be prepared and submitted for approval.

Joseph Xi, PE
Project Engineer

Gary Zimmerman
Principal

List of Attachments:

Tables

Table 1	Borehole Summary
Table 2	Groundwater Elevations

Figures

Figure 1	Vicinity Map
Figure 2	Investigation Site Plan (October 2016 and December 2017)
Figure 3A	Borehole Profile (October 2016)
Figure 3B	Borehole Profile (December 2017)
Figure 4A	Groundwater Potentiometric Map (December 19, 2017)

Figure 4B Groundwater Potentiometric Map (January 25, 2018)
Figure 4C Groundwater Potentiometric Map (February 6, 2018)
Figure 4D Groundwater Potentiometric Map (March 6, 2018)
Figure 4E Groundwater Potentiometric Map (March 27, 2018)
Figure 4F Groundwater Potentiometric Map (April 4, 2018)

Attachments
Attachment A Boring Logs
Attachment B 2017 Work Plan

JX/GLZ/sb

1520304-tm-rev0-final_interceptor trench field investigation-052418.docx

Tables

Table 1: Borehole Summary

Date of Borehole Installation	Borehole ID	Borehole Depth (ft)	Fill Depth (ft bgs)	CKD Depth (ft bgs)	Bedrock (?) Depth (ft bgs)	Depth to Water at Time of Drilling (ft bgs)	Converted to Piezometer?
10/25/2016	B-12	20	0-4.5	4.5-20	-	18	Yes
10/25/2016	B-13	20	0-3	3-20	-	-	No
10/25/2016	B-14	20	0-5, 8.5-11	5-8.5, 11-20	-	15	No
10/25/2016	B-15	15	0-14.5	14.5-15	-	8	Yes
10/26/2016	B-16	30	0-19, 20-22, 25-30	19-20, 22-25	-	Wet soil below 16	No
10/26/2016	B-17	30	0-25	-	25-30	-	No
10/26/2016	B-19	20	0-2	2-20	-	17	No
10/26/2016	B-19A (borehole angled 30 degrees from vertical toward the East)	10	0-2	2-10	-	Cannot determine (water from ditch water flowing into hole)	No
10/26/2016	B-20 (borehole angled 10 degrees from vertical toward the East)	20	0-12	12-20	-	Water present, but unable to measure depth due to angle of hole	No
12/11/2017	B-21	20	0-8	-	13-20	11	Yes
12/12/2017	B-22	20	0-11	-	11-20	Wet soil below 11	No
12/11/2017	B-23	25	0-11.5	-	-	19	No
12/11/2017	B-24	20	0-10	-	15	10	Yes
12/11/2017	B-25	25	0-7.5	-	18	24	No
12/12/2017	B-26	25	0-5	-	8	22	No
12/12/2017	B-27	25	0-17	-	22	14	Yes

Note: " - " Not Encountered

Table 2: Groundwater Elevations

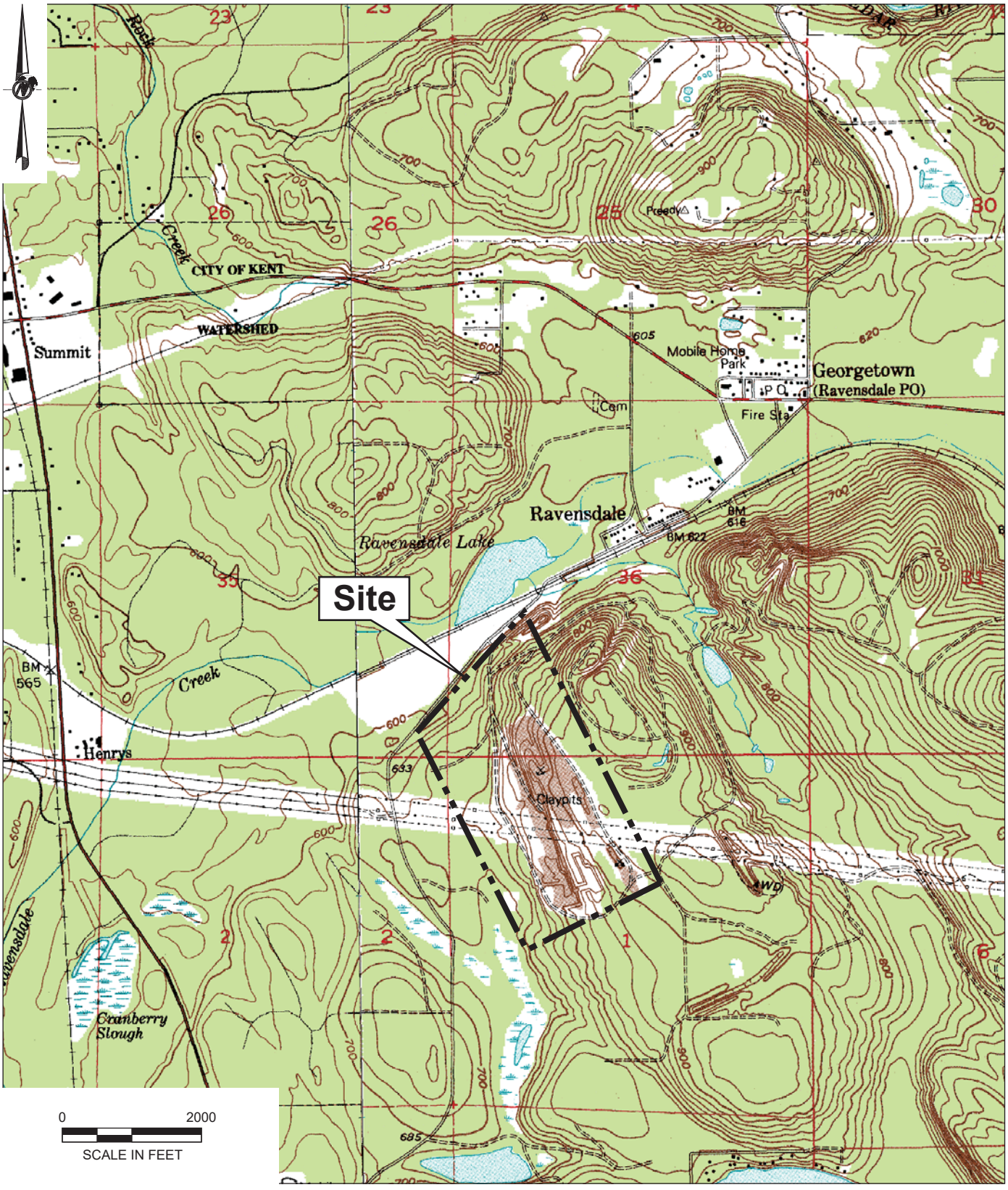
Well ID	TOC ELEV[1]	Date Measured	Depth to Water (feet below TOC)	Groundwater Elevation
P1	753.90	12/19/2017	23.44	730.46
		1/25/2018	22.39	731.51
		2/6/2018	22.11	731.79
		4/4/2018	21.72	732.18
P3	780.87	12/19/2017	40.82	740.05
		1/25/2018	36.71	744.16
		2/6/2018	35.35	745.52
		4/4/2018	40.06	740.81
P4B	734.81	12/19/2017	6.81	728.00
		1/25/2018	17.07	717.74
		2/6/2018	16.96	717.85
		4/4/2018	17.38	717.43
P5	769.70	12/19/2017	29.88	739.82
		1/25/2018	27.02	742.68
		2/6/2018	25.91	743.79
		4/4/2018	28.61	741.09
P9	742.18	12/19/2017	7.00	735.18
		1/25/2018	5.57	736.61
		2/6/2018	5.09	737.09
		4/4/2018	5.61	736.57
P11	735.09	12/19/2017	14.21	720.88
		1/25/2018	13.22	721.87
		2/6/2018	12.69	722.40
		4/4/2018	13.18	721.91
P12	757.07	12/19/2017	5.80	751.27
		1/25/2018	4.04	753.03
		2/6/2018	3.70	753.37
		4/4/2018	5.11	751.96
P13	804.63	12/19/2017	6.16	798.47
		1/25/2018	2.13	802.50
		2/6/2018	2.85	801.78
		4/4/2018	6.19	798.44
B12	758.71	12/19/2017	7.89	750.82
		12/20/2017	7.40	751.31
		1/25/2018	4.46	754.25
		2/6/2018	3.99	754.72
		3/6/2018	4.91	753.80
		3/27/2018	8.13	750.58
		4/4/2018	7.60	751.11
B15	775.41	12/19/2017	8.13	767.28
		12/20/2017	5.99	769.42
		1/25/2018	3.41	772.00
		2/6/2018	3.11	772.30
		3/6/2018	5.26	770.15
		3/27/2018	7.01	768.40
		4/4/2018	6.76	768.65

Table 2: Groundwater Elevations

Well ID	TOC ELEV[1]	Date Measured	Depth to Water (feet below TOC)	Groundwater Elevation
B21	783.00	12/19/2017	6.49	776.51
		12/20/2017	5.08	777.92
		1/25/2018	4.39	778.61
		2/6/2018	4.90	778.10
		3/6/2018	6.23	776.77
		3/27/2018	8.25	774.75
		4/4/2018	7.71	775.29
B24	809.76	12/19/2017	16.77	792.99
		12/20/2017	16.77	792.99
		1/25/2018	13.45	796.31
		2/6/2018	5.85	803.91
		3/6/2018	16.77	792.99
		3/27/2018	DRY	--
		4/4/2018	DRY	--
B27	803.40	12/19/2017	18.37	785.03
		12/20/2017	18.08	785.32
		1/25/2018	17.41	785.99
		2/6/2018	17.09	786.31
		3/6/2018	17.42	785.98
		3/27/2018	17.73	785.67
		4/4/2018	18.00	785.40

[1] Top of Casing Elevation surveyed 2016-2018

Figures



CLIENT

HOLCIM (US). INC.

CONSULTANT

GOLDER

YYYY-MM-DD	2018-03-22
PREPARED	REDMOND
DESIGN	
REVIEW	
APPROVED	

PROJECT

RAVENSDALE

TITLE

VICINITY MAP

PROJECT No.	Phase	Rev.	Figure
152030401	001	0	1

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NOTES

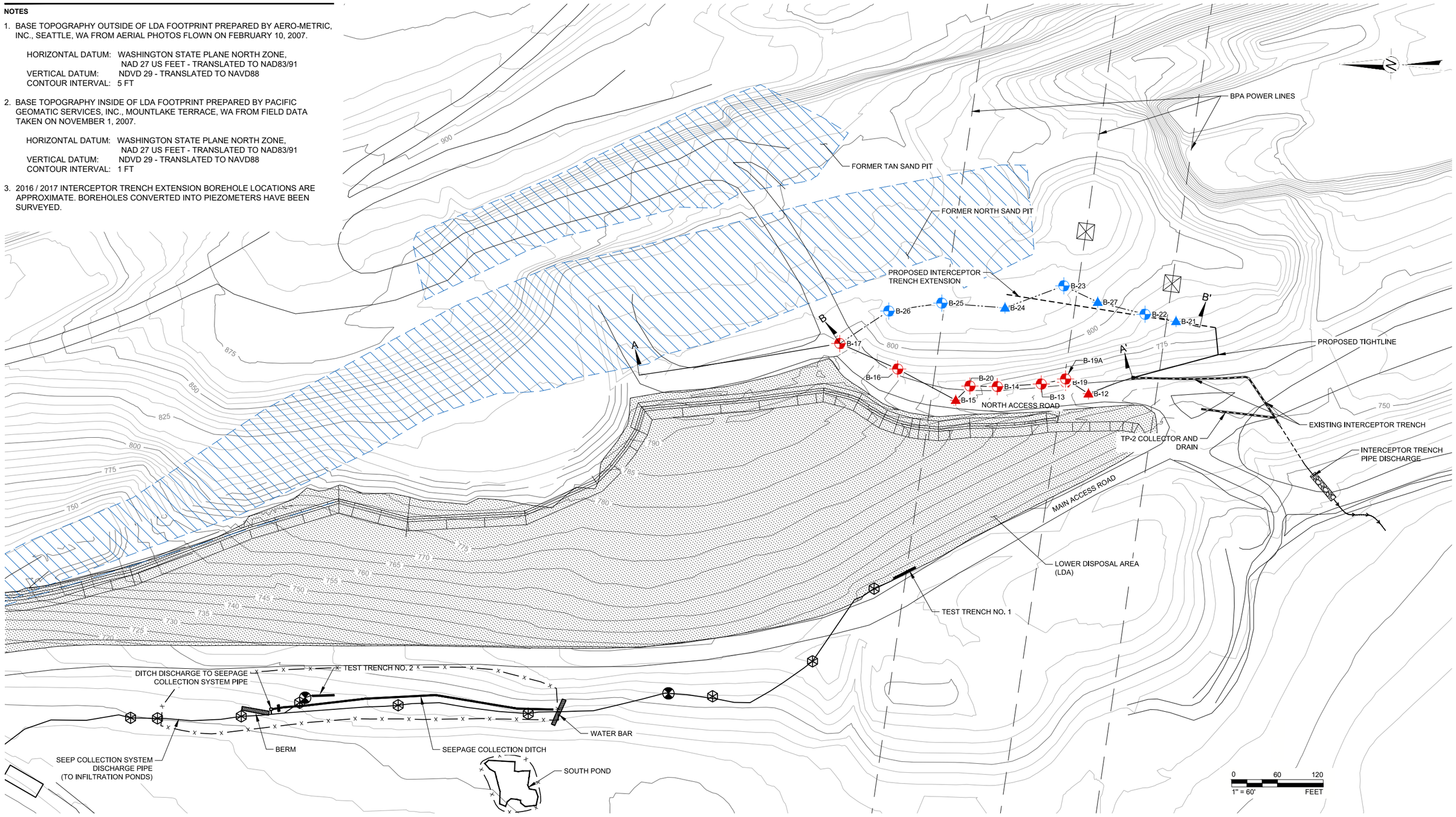
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. 2016 / 2017 INTERCEPTOR TRENCH EXTENSION BOREHOLE LOCATIONS ARE APPROXIMATE. BOREHOLES CONVERTED INTO PIEZOMETERS HAVE BEEN SURVEYED.



LEGEND

- 2017 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE
- 2017 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE CONVERTED INTO PIEZOMETER IN 2017
- 2016 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE
- 2016 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE CONVERTED INTO PIEZOMETER IN 2017
- A — A' CROSS SECTION ALIGNMENT

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

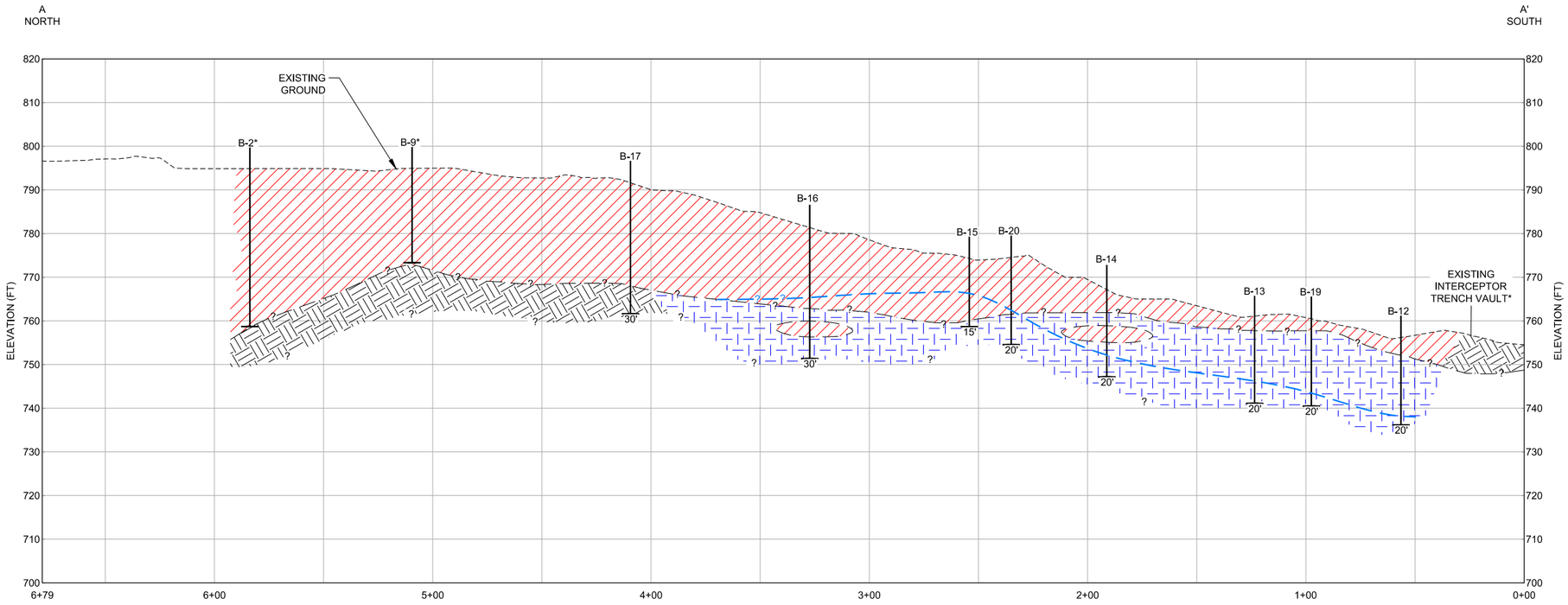
YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
2016 / 2017 INVESTIGATION SUMMARY

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	2

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



BOREHOLE PROFILE (OCTOBER 2016)

HORIZ. SCALE 1" = 30'
VERT. SCALE 1" = 15'

0 30 60
1" = 30' FEET

LEGEND

- FILL (NON-CKD)
- CKD
- BEDROCK
- * FROM 2013 INVESTIGATION - NOT SHOWN ON FIGURE 2
- APPROXIMATE WATER LEVEL AT TIME OF DRILLING
- 20' BORING (DEPTH)

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
BOREHOLE PROFILE (OCTOBER 2016)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	3A

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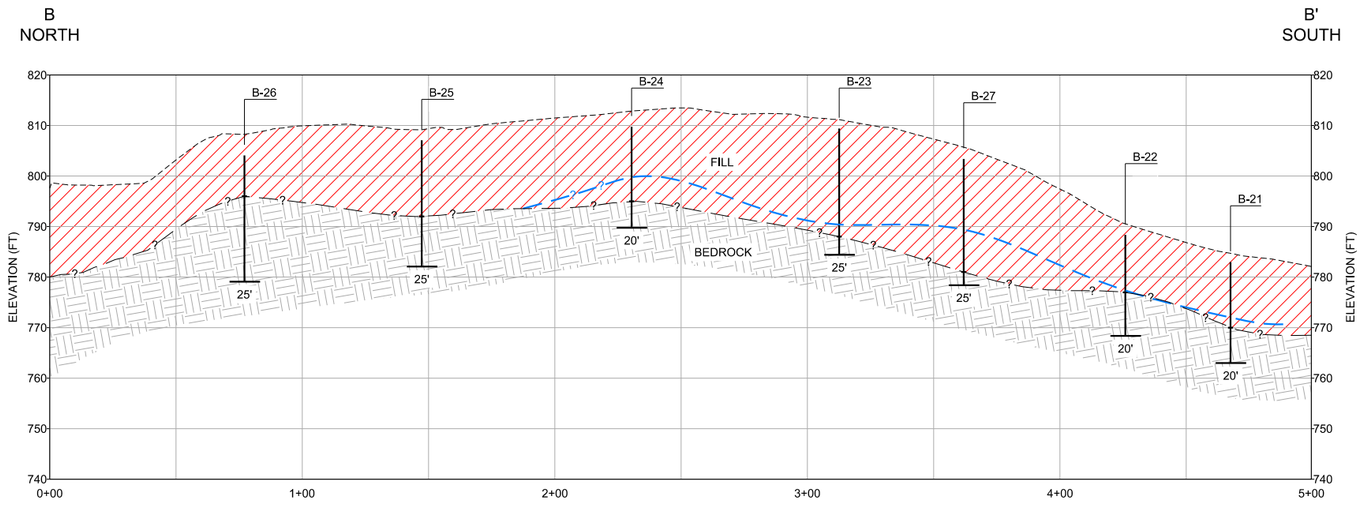


BOREHOLE PROFILE (DECEMBER 2017)

HORIZ. SCALE 1" = 30'
VERT. SCALE 1" = 15'

0 30 60
1" = 30' FEET

NOTE(S)

1. SURFICIAL PROFILE CREATED FROM BASE TOPOGRAPHY MAP 02/10/2007. BORING LOCATIONS SURVEYED ON 02/05/2018. ON SITE ACTIVITIES MAY HAVE ALTERED GROUND SURFACE BETWEEN SURVEYS.
2. MINIMAL WATER WAS ENCOUNTERED IN BOREHOLES B-25 AND B-26 DURING DRILLING. WATER LEVELS IN B-25 AND B-26 ARE NOT USED TO DETERMINE APPROXIMATE WATER LEVEL AT TIME OF DRILLING.

LEGEND

FILL (NON-CKD)

BEDROCK

APPROXIMATE WATER LEVEL AT TIME OF DRILLING

20' BORING (DEPTH)

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
BOREHOLE PROFILE (DECEMBER 2017)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	3B

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

NOTES

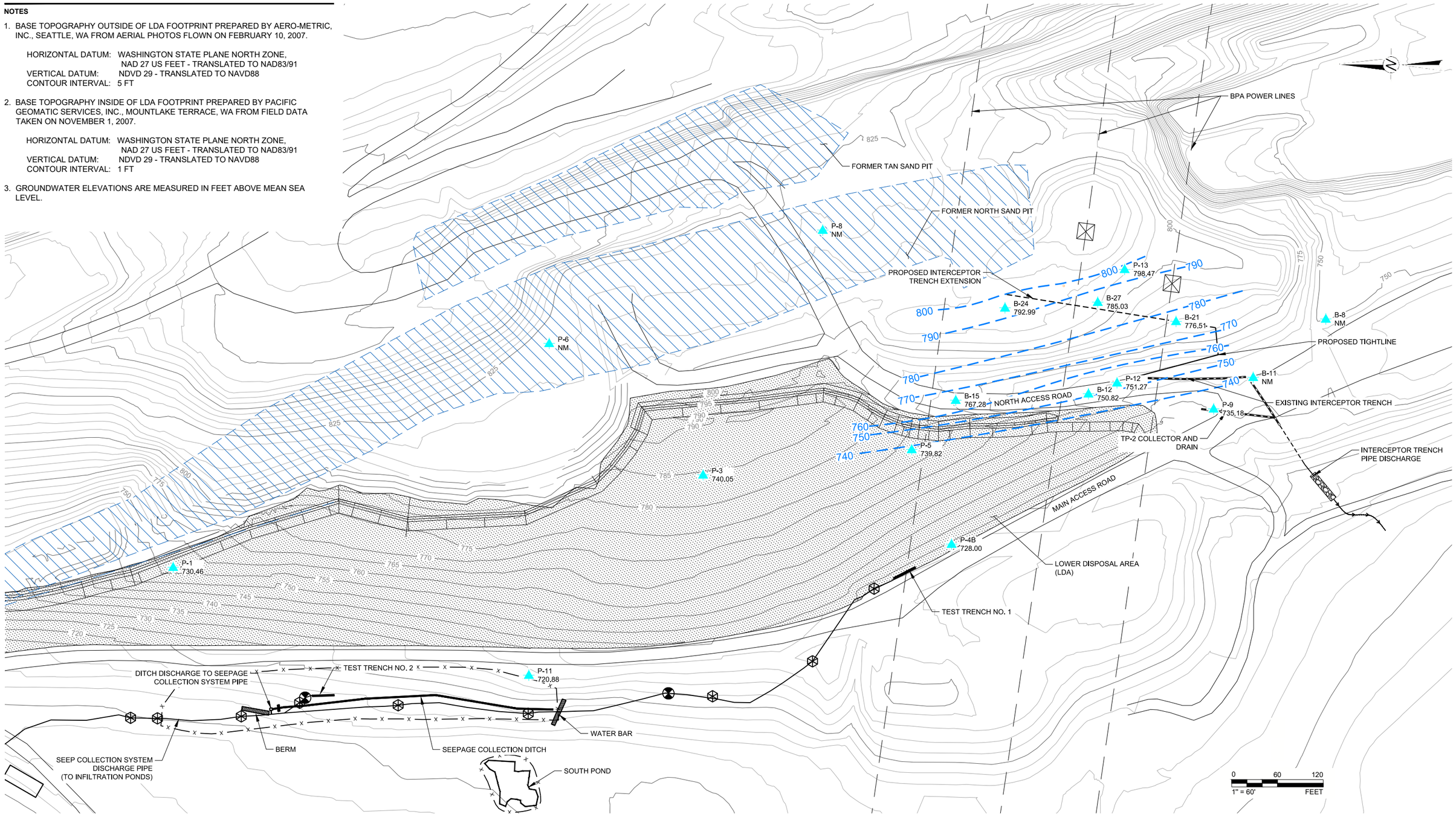
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET ABOVE MEAN SEA LEVEL.



LEGEND

B-27 785.03	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (DECEMBER 19TH, 2017)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4A

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NOTES

1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

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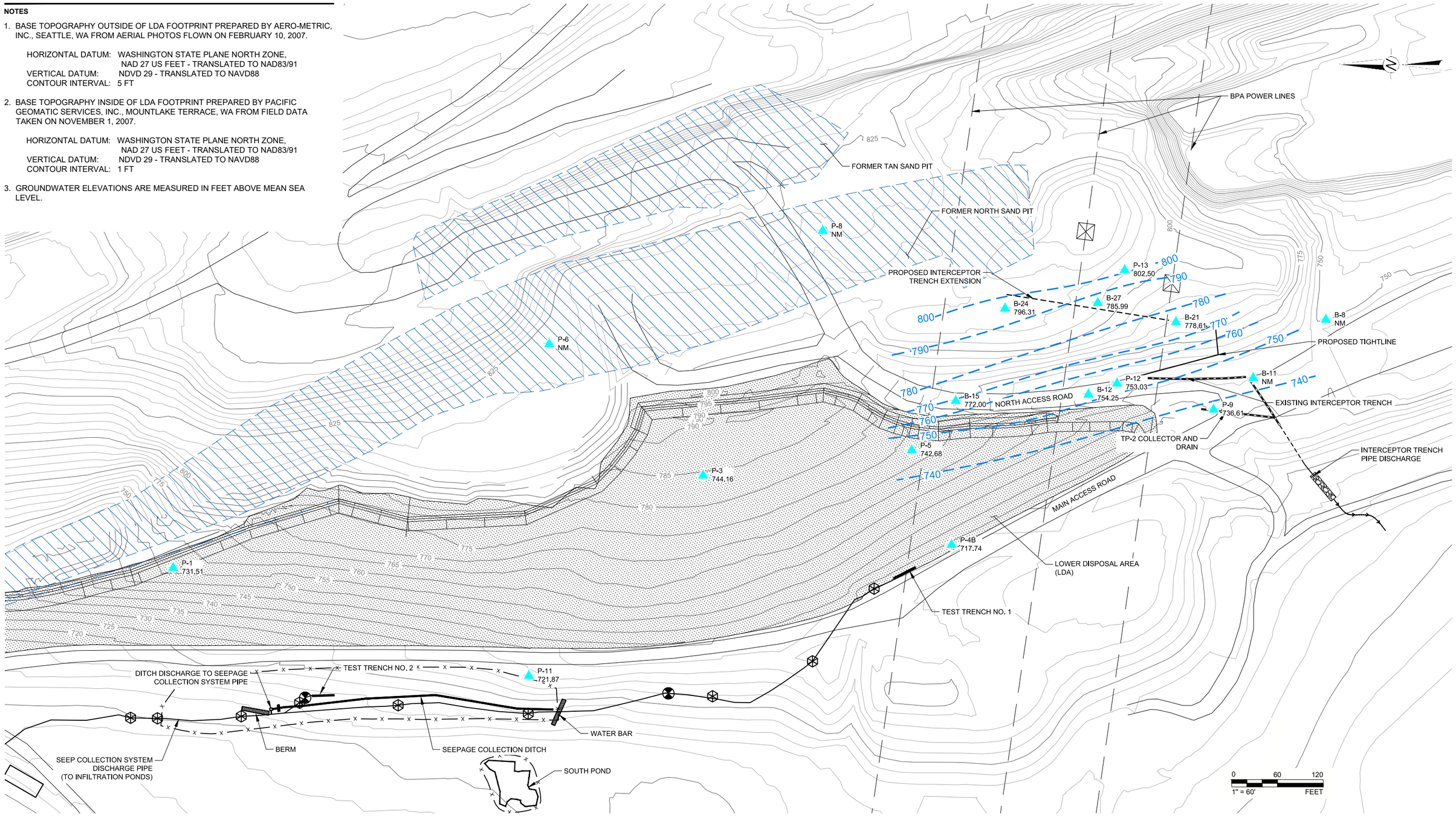


LEGEND

B-27 785.99	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (JANUARY 25TH, 2018)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4B

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

0 1 in

NOTES

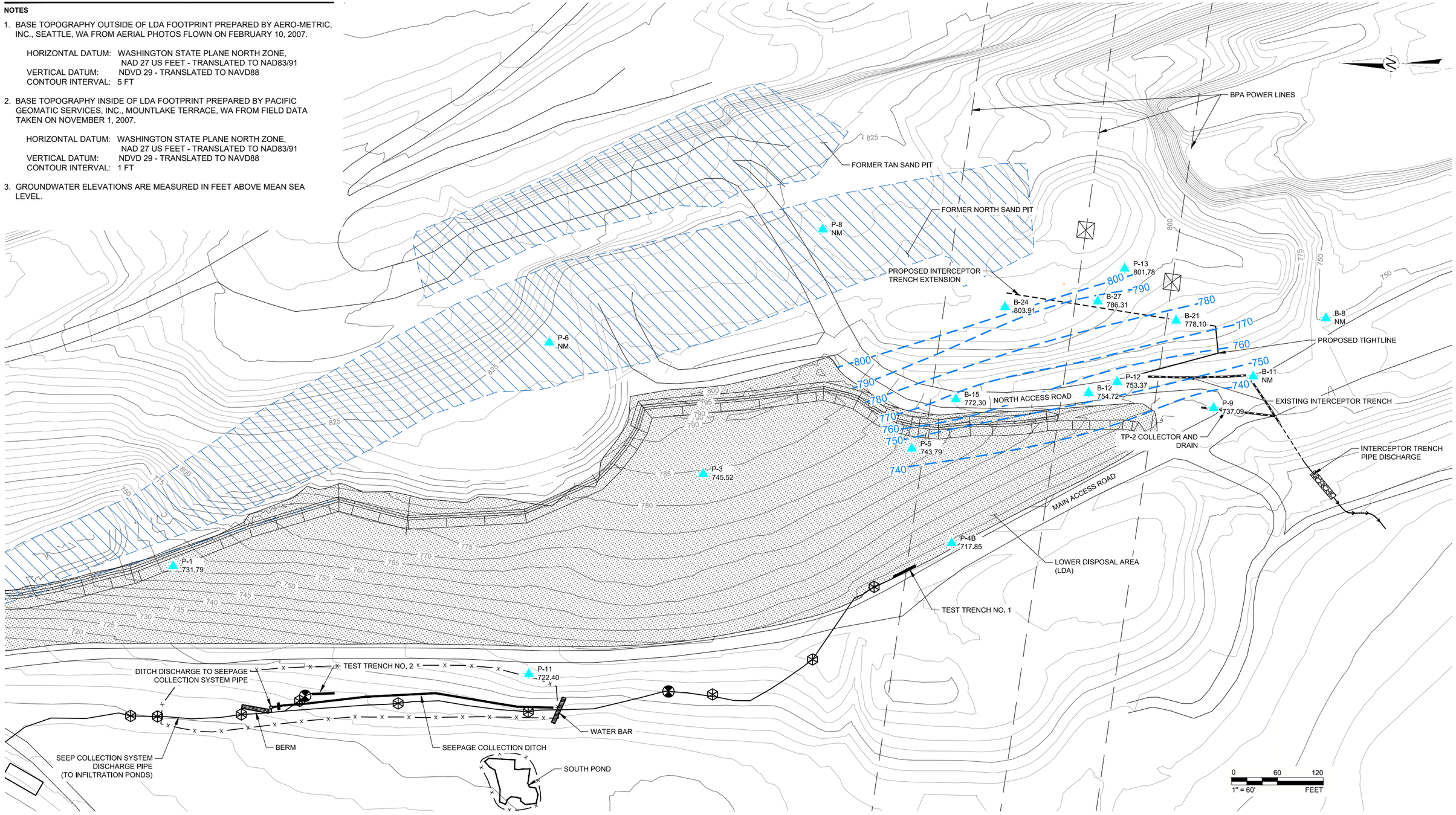
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET ABOVE MEAN SEA LEVEL.



LEGEND

B-27 786.31	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (FEBRUARY 6TH, 2018)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4C

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

0 1 in

Path: \\redmond\geomatic$\geomatic\HOLCIM\Ravensdale\99_PROJECTS\152030401_InterceptorTrenchExt001_PredesignInvestigation\02_PRODUCTION\DWG\ | File Name: 152030401_001_010.dwg | Last Edited By: tvbar Date: 2018-04-20 Time:9:50:49 AM | Printed By: TRybar Date: 2018-05-10 Time:9:48:11 AM

NOTES

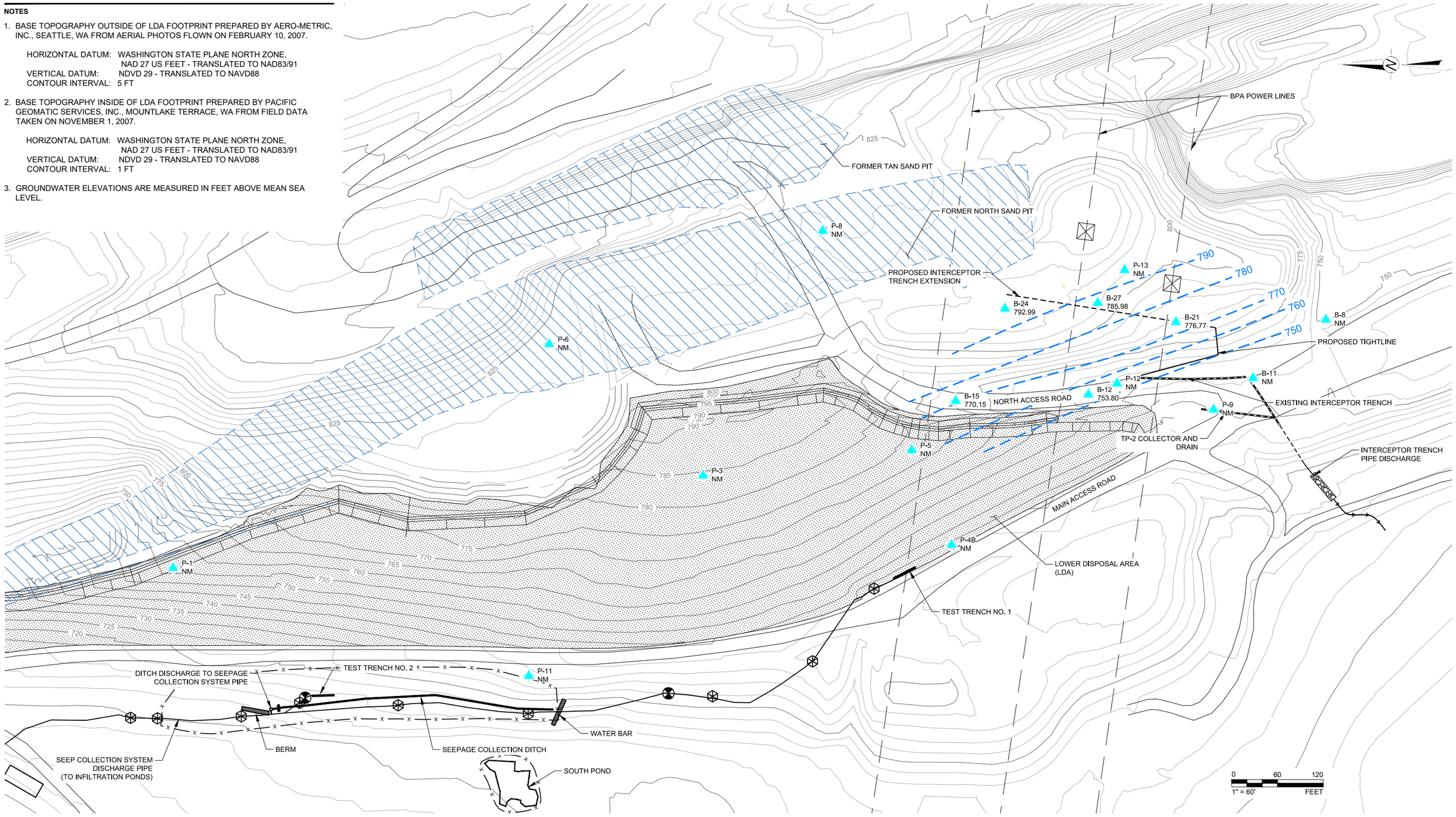
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET ABOVE MEAN SEA LEVEL.



LEGEND

B-27 785.98	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (MARCH 6TH, 2018)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4D

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

NOTES

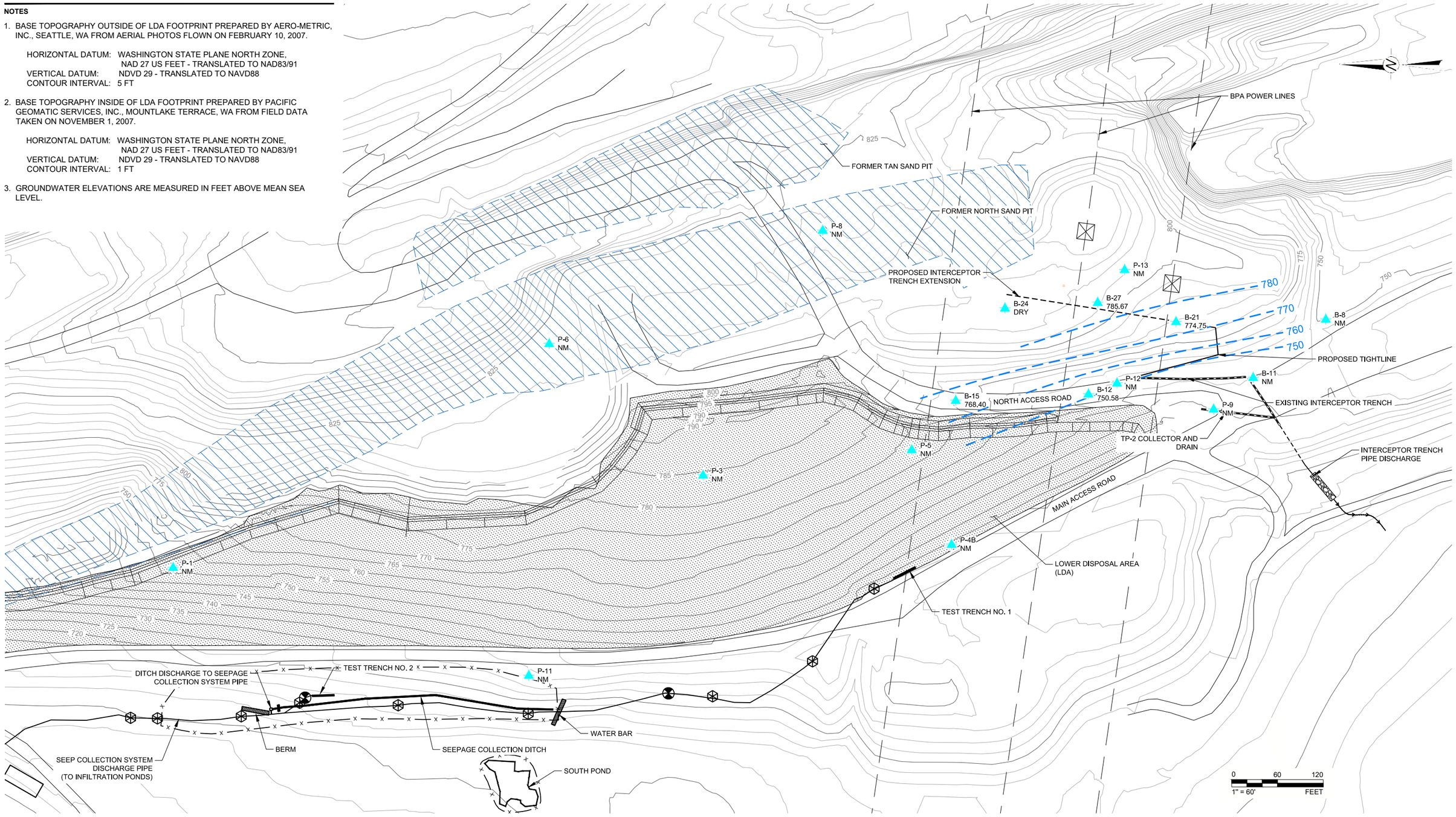
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET ABOVE MEAN SEA LEVEL.



LEGEND

B-27 785.67	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (MARCH 27TH, 2018)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4E

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

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NOTES

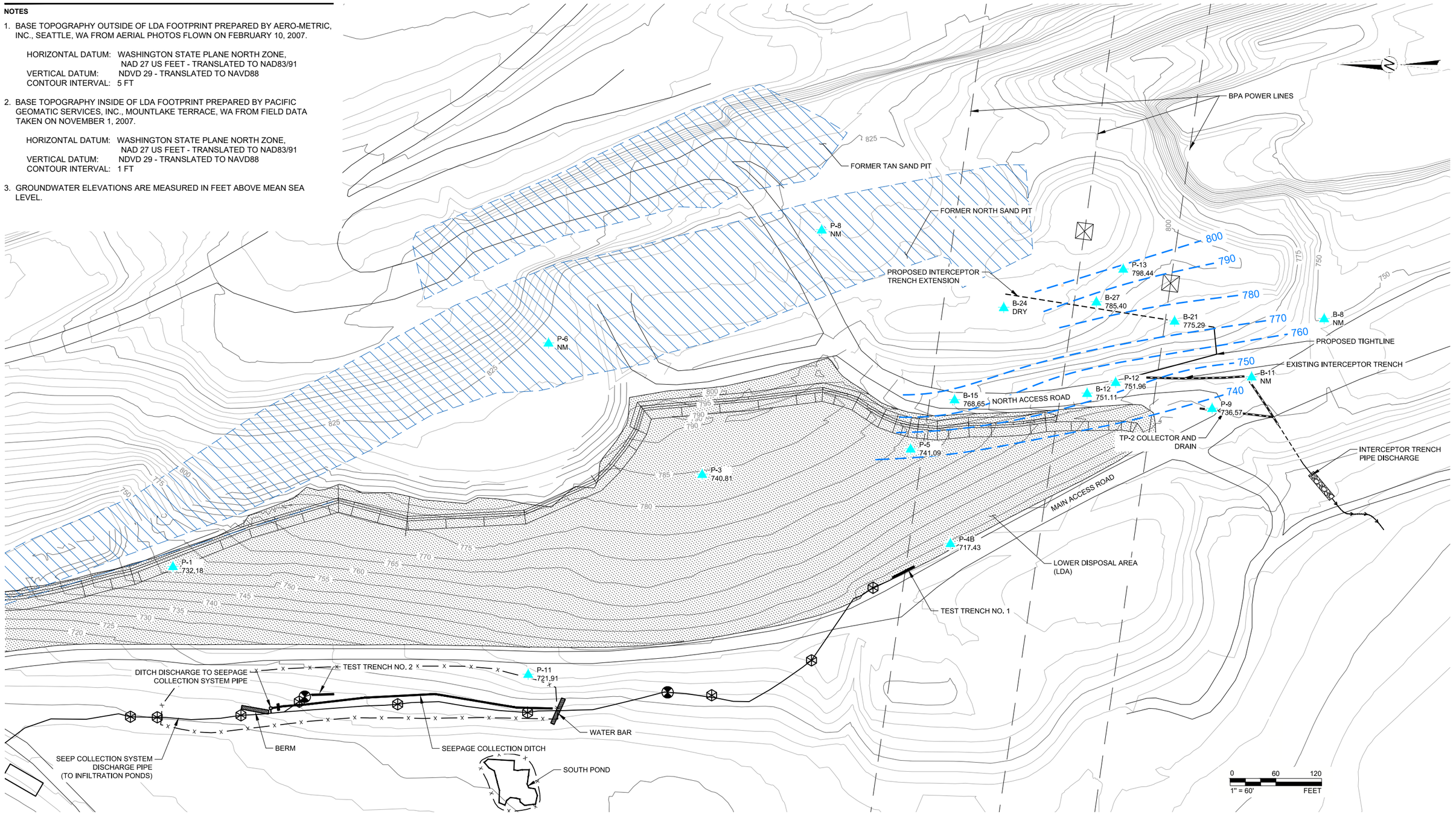
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91
   VERTICAL DATUM: NDVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET ABOVE MEAN SEA LEVEL.



LEGEND

B-27 785.40	GOLDER PIEZOMETER WITH MEASURED GROUNDWATER ELEVATION
730	GROUNDWATER CONTOUR WITH ELEVATION
NM	NOT MEASURED

NOTE(S)

1. GROUNDWATER FLOW IN A PERCHED AQUIFER IS DEPENDENT ON NUMEROUS CONDITIONS, INCLUDING THE TOPOGRAPHY OF THE UNDERLYING BEDROCK, VOLUMES OF RECENT PRECIPITATION, AND INFILTRATION WITHIN VARIOUS AREAS OF THE SITE. GROUNDWATER GRADIENTS SHOWN ARE BASED ON GROUNDWATER ELEVATION MEASUREMENTS AT A GIVEN POINT IN TIME, AND DO NOT NECESSARILY REPRESENT THE PREDOMINANT GROUNDWATER FLOW ACROSS THE ENTIRE SITE.

CLIENT
HOLCIM (US) INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-10
DESIGNED	JM
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
2017-2018 INVESTIGATION SUMMARY
RAVENSDALE, WA

TITLE
GROUNDWATER POTENTIOMETRIC MAP (APRIL 4TH, 2018)

PROJECT NO.	PHASE	REV.	FIGURE
152030401	001	0	4F

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

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ATTACHMENT A

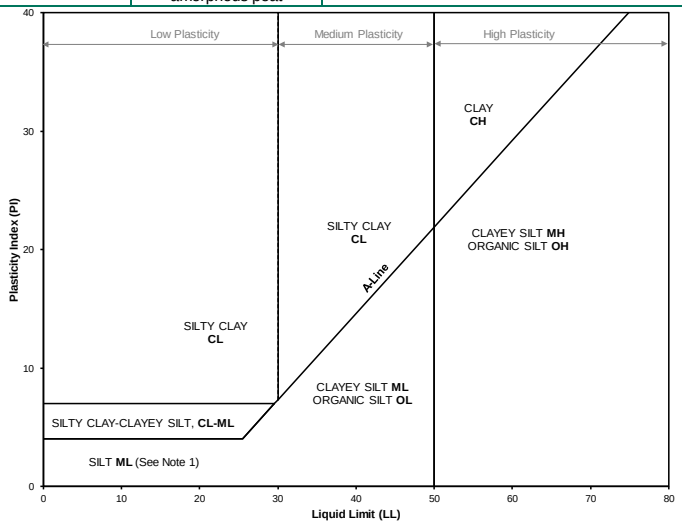
Boring Logs

METHOD OF SOIL CLASSIFICATION

The Golder Associates Inc. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content <30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with <12% * fines (by mass)	Poorly Graded	<4	≤1 or ≥3	<30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (>50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with <12% * fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content <30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3 mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3 mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3 mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2, below)	CL	SILTY CLAY
			Liquid Limit 30 to <50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CL	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous, or amorphous peat							75% to 100%		PEAT



Note 1 – Fine-grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are Non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics." For soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

* Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, and, CL-ML. For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel). For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see plasticity chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

METHOD OF SOIL CLASSIFICATION

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimeters	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	> 300	> 12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	< 0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
≤ 5	trace
> 5 to 12	some
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

N = the number of blows required to drive a 2 inch (50 mm) split-spoon sampler one foot (300 mm) using a 140 lb (63.5 kg) hammer falling 30 inches (760 mm) after an initial 6 inch (150 mm) seating (ASTM D1586).

Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a typical projected end area of 10 or 15 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically in real time during penetration. The seismic CPT (SCPT) adds measurement of shear wave velocity (V_S) to the standard CPT.

Dynamic Cone Penetration Test (DCP), N_d:

The penetration rate by an 8 kg (17.6 lb) hammer dropped 575 mm (22.6 in.) to drive uncased a 20 mm (0.79 in.) diameter, 60° cone attached to 16 mm (5/8 in.) drive rods (ASTM D6951). Other test methods exist for DCPs with different configurations and different correlations.

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO or DP	Drive open (SPT) or direct pushed tube sampler
DS	Denison type sample
FS	Foil sample
PS	Pitcher type sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

SOIL TESTS

M	water content
A	Atterberg limits (plastic and liquid limits)
G, H	grain size, hydrometer
UW	unit weight
Com	compaction
C	consolidation (oedometer) test
U	unconfined compression test
UU	unconsolidated undrained triaxial test
CD	consolidated isotropically drained triaxial test[1]
CU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D	direct shear test
V (FV)	field vane (LV-laboratory vane test)
SG	specific gravity
P	permeability
PD	pinhole dispersion
O	organic content test
PH	pH
CHEM	chemical analysis (refer to text)

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[1]

Term	SPT 'N' (blows/foot)[2]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.
2. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects. 'N'-values should be considered ONLY an approximate guide to consistency; for sensitive clays the 'N'-value approximation for consistency terms does not apply.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	Undrained Shear Strength (tsf)	SPT 'N'[1] (blows/foot)
Very Soft	<12	<0.12	0 to 2
Soft	12 to 25	0.12 to 0.25	2 to 4
Firm	25 to 50	0.25 to 0.5	4 to 8
Stiff	50 to 100	0.5 to 1	8 to 15
Very Stiff	100 to 200	1 to 2	15 to 30
Hard	>200	>2	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

RECORD OF BOREHOLE B-12

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 10/25/2016
DRILL RIG: DB 360
DATUM: NAD 88
COORDINATES: N: 126,354 E: 1,353,239
ELEVATION: 758.97
INCLINATION: -90
WELL TAG: BKH 464

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 2.0 FILL - MINE SPOILS, (GP-GM) GRAVEL, fine to coarse, some silt; brown; non-cohesive, moist, loose.			757.0							Flush Mount Monument
		2.0 - 4.5 FILL - MINE SPOILS, (SM) SILTY SAND, some gravel, fine; dark brown to brown, thin laminations; non-cohesive, moist, compact.			2.0 754.5							Medium (3/8") Bentonite Seal, 2" Schedule 40 PVC Riser
5		4.5 - 20.0 FILL - CEMENT KILN DUST, trace wood ash, trace coal fragments; light gray; non-cohesive, dry to moist, dense. 4.5 ft: Odor in core barrel, tested pH ~12 (mixture of DI water and soil)			4.5							
10												10/20 Silica Sand
15		15 ft: Hole staying open, sample sticking to core barrel										0.010-inch Slot Schedule 40 PVC Screen
20		Boring completed at 20.0 ft.			739.0 20.0							Depth to water at time of drilling
25												
30												
35												
40												

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-13

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 10/25/2016
DRILL RIG: DB 360
DATUM: NAD 88
COORDINATES: not surveyed
ELEVATION: 761
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS / GRAPHIC
0	Rotosonic	0.0 - 1.5 FILL - MINE SPOILS, (GP) GRAVEL, fine to coarse, some sand; brown, non-cohesive, moist, loose.	GP		759.5 1.5							
		1.5 - 3.0 FILL - MINE SPOILS, (CL) CLAY, some sand, some silt, trace gravel, trace coal fragments; brown; cohesive, moist, stiff. 1.5 ft to 3 ft: Trace shale, coal tailings/fill	CL		758.0 3.0							
5		3.0 - 10.0 FILL - CEMENT KILN DUST, some coal fragments; brown, mottled; non-cohesive, moist, dense. 3 ft: Trace sandstone (fine grained), brown tailings/fill 5 ft: pH ~12 (mixture of DI water and soil)										
10		10.0 - 20.0 FILL - CEMENT KILN DUST, trace coal fragments, trace wood fragments; gray; non-cohesive, moist, dense.			751.0 10.0							Backfilled with Medium (3/8") Bentonite Chips
15												
20		Boring completed at 20.0 ft.			741.0 20.0							
25												
30												
35												
40												

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-14

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 10/25/2016
DRILL RIG: DB 360
DATUM: NAD 88
COORDINATES: not surveyed
ELEVATION: 767
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 1.5 FILL - MINE SPOILS, (SP) SAND, some gravel, fine to coarse; brown to gray; non-cohesive, moist, loose.	SP		765.5						10 20 30 40 PL MC LL 20 40 60 80	
		1.5 - 4.0 FILL - MINE SPOILS, (SM) SILTY SAND, fine, some gravel, trace coal fragments; brown to gray; non-cohesive, moist, dense.	SM		1.5 763.0							
		4.0 - 5.0 FILL - MINE SPOILS, (ML) Sandy SILT, some clay; brown mottled gray; cohesive, m < PL, stiff.	ML		4.0 762.0							
5		5.0 - 8.5 FILL - CEMENT KILN DUST, trace clay, trace coal fragments; gray; non-cohesive, moist			5.0 758.5							
		8.5 - 11.0 FILL - MINE SPOILS, (SM) SILTY SAND, fine, trace coal fragments; orange-brown mottled gray, fine laminations; non-cohesive, moist, dense.			8.5 756.0							Backfilled with Medium (3/8") Bentonite Chips
10		11.0 - 20.0 FILL - CEMENT KILN DUST; gray, fine laminations; non-cohesive, moist, dense.			11.0							
15		15 ft to 20 ft: Trace coal fragments, last material in core barrel wet.										▼
20		Boring completed at 20.0 ft.			747.0 20.0							
25												
30												
35												
40												

Depth to water at time of drilling

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-15

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/25/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: N: 126,528 E: 1,353,232

ELEVATION: 775.83
INCLINATION: -90
WELL TAG: BKH 465

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 2.0 FILL - MINE SPOILS, (GP) GRAVEL, fine to coarse, some sand; brownish-gray; non-cohesive, dry, loose.	GP		773.8							Flush Mount Monument Medium (3/8") Bentonite Seal, 2" Schedule 40 PVC Riser 10/20 Silica Sand 0.010-inch Slot Schedule 40 PVC Screen
		2.0 - 4.0 FILL - MINE SPOILS, (SP) SAND, fine to medium, some gravel, fine; gray to brown; non-cohesive, moist, compact.	SP		2.0 771.8							
5		4.0 - 5.0 FILL - MINE SPOILS, (ML) Sandy SILT, trace gravel, trace coal fragments; brown, mottled; cohesive, m < PL, very stiff.	ML		4.0 770.8							
		5.0 - 7.0 FILL - MINE SPOILS, (SP) SAND, fine to coarse, trace silt, trace gravel; non-cohesive, moist, loose.	SP		5.0 768.8							
		7.0 - 10.0 FILL - MINE SPOILS, (SM) SILTY SAND, fine to medium, trace coal fragments, trace wood fragments; non-cohesive, moist, compact.	SM		7.0 765.8							
10		10.0 - 12.0 FILL - MINE SPOILS, (ML) Sandy SILT, trace coal fragments, trace fine gravel; olive gray mottled gray; cohesive, w < PL, stiff.	ML		10.0 763.8							
		12.0 - 13.0 FILL - MINE SPOILS, (ML) SILT, some sand, trace gravel; gray; cohesive, w < PL, firm.	ML		12.0 762.8							
		13.0 - 14.5	ML		13.0 761.3							
15		FILL - MINE SPOILS, (ML) Sandy SILT, trace gravel; orange-brown; cohesive, w < PL, firm.			760.8 15.0							
		14.5 - 15.0 FILL - CEMENT KILN DUST; gray; non-cohesive, moist, dense.										
		Boring completed at 15.0 ft.										
20												
25												
30												
35												
40												

Depth to water at time of drilling

1 in to 5 ft

DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-16

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/26/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: not surveyed

ELEVATION: 781
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 2.0 FILL - MINE SPOILS, (GP) GRAVEL, fine to coarse, some silt, trace cobble; brown; non-cohesive, moist, loose.	GP		779.0							
		2.0 - 5.0 FILL - MINE SPOILS, (SM) SILTY SAND, fine, some gravel, trace coal fragments, trace wood; gray to brown; non-cohesive, moist, compact.	SM		2.0 776.0							
5		5.0 - 10.0 FILL - MINE SPOILS, (SM) SILTY SAND, some coal fragments, trace gravel; dark brown mottled black; non-cohesive, moist, compact.	SM		5.0 771.0							
10		10.0 - 12.0 FILL - MINE SPOILS, (ML) Sandy SILT; dark brown mottled brown, fine laminations; cohesive, m < PL, soft.	ML		10.0 769.0							
		12.0 - 13.0 FILL - MINE SPOILS, (ML) SILTY, trace fine sand; gray; cohesive, moist, very stiff.	ML		12.0 768.0							
		13.0 - 15.0 FILL - MINE SPOILS, (SM) SILTY SAND, trace gravel, trace coal fragments; dark gray mottled brown; non-cohesive, moist, compact. 13 ft: pH 7 (mixture of DI water and soil)	SM		13.0 766.0							
15		15.0 - 17.0 FILL - MINE SPOILS, (ML) Sandy SILT, some coal fragments, trace gravel; dark brownish-gray; cohesive, firm.	ML		15.0 764.0							Backfilled with Medium (3/8") Bentonite Chips
		17.0 - 19.0 FILL - MINE SPOILS, (SP) SAND, some silt, trace gravel, trace coal; orange-brown; non-cohesive, moist	SP		17.0 762.0							
		19.0 - 20.0 FILL - CEMENT KILN DUST, trace coal fragments; gray; non-cohesive, moist	SM		19.0 761.0							
20		20.0 - 22.0 FILL - MINE SPOILS, (SP-SM) SAND, some silt; brownish gray, musty odor; non-cohesive, wet, loose.			20.0 759.0							
		22.0 - 25.0 FILL - CEMENT KILN DUST, some silt, some sand, trace gravel; gray, finely laminated; non-cohesive, moist.			22.0 756.0							
25		25.0 - 30.0 FILL - MINE SPOILS, (SM) SILTY SAND, trace gravel; fill debris (brick, asbestos); non-cohesive, moist, compact.	SM		25.0 751.0							
30		Boring completed at 30.0 ft.			30.0							
35												
40												

1 in to 5 ft

DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-17

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/26/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: not surveyed

ELEVATION: 792
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS / GRAPHIC
0	Rotosonic	0.0 - 5.0 FILL - MINE SPOILS, (GP) GRAVEL, fine to coarse, some sand, some silt, trace cobbles; brown to gray; non-cohesive, loose.	GP		787.0							
5		5.0 - 7.0 FILL - MINE SPOILS, (SM) SILTY SAND, fine, trace gravel; brown; non-cohesive, moist, loose.	SM		5.0 785.0							
		7.0 - 9.0 FILL - MINE SPOILS, (ML) Sandy SILT, trace gravel; dark brown mottled black; cohesive, firm.	ML		7.0 783.0							
		9.0 - 10.0 FILL - MINE SPOILS, (ML) SILT, trace sand; light gray; cohesive, m < PL, firm.	ML		9.0 782.0							
10		10.0 - 13.0 FILL - MINE SPOILS, (SP-SM) SAND, some silt, trace gravel; brown mottled gray; non-cohesive, compact	SP-SM		10.0 779.0							
		13.0 - 15.0 FILL - MINE SPOILS, (ML) SILT, some clay, trace sand, trace gravel; black to dark brown, finely laminated; cohesive, m < PL, stiff.	ML		13.0 777.0							
15		15.0 - 21.0 FILL - MINE SPOILS, (SM) SILTY SAND, trace gravel; dark brown; non-cohesive, moist, compact. 15 ft to 20 ft: Water in core barrel above sample	SM		15.0 771.0							Backfilled with Medium (3/8") Bentonite Chips
20		21.0 - 23.0 FILL - MINE SPOILS, (ML) Sandy SILT, some woody debris; brown mottled gray; non-cohesive, moist	ML		21.0 769.0							
		23.0 - 24.0 FILL - MINE SPOILS, (ML) SILT; gray; cohesive, firm.	ML		23.0 768.0							
		24.0 - 25.0 FILL - MINE SPOILS, (ML) SILT; black; cohesive, dry, soft.	ML		24.0 767.0							
25		25.0 - 29.0 (ML) Sandy SILT, trace gravel; reddish-brown, [BEDROCK?]; cohesive, w < PL, soft.	ML		25.0 763.0							
		29.0 - 30.0 (ML) Sandy SILT; gray with black specks, [BEDROCK?]; cohesive, w < PL, soft. 29 ft: pH 7 (mixture of DI water and soil) Boring completed at 30.0 ft.	ML		29.0 762.0 30.0							
30												
35												
40												

1 in to 5 ft

DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-19

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/26/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: not surveyed

ELEVATION: 760
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 2.0 FILL - MINE SPOILS, (ML) Sandy SILT, trace gravel; cohesive, moist, soft.	ML		758.0 2.0						10 20 30 40 PL MC LL 20 40 60 80	Backfilled with Medium (3/8") Bentonite Chips
5		2.0 - 20.0 FILL - CEMENT KILN DUST, trace coal fragments; gray; non-cohesive, moist, dense.										
10		10 ft to 15 ft: Putrid odor										
15												
20		Boring completed at 20.0 ft.			740.0 20.0							
25												
30												
35												
40												

Depth to water at time of drilling

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-19A

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/26/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: not surveyed

ELEVATION: 760
INCLINATION: -60
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS / GRAPHIC
0	Rotosonic	0.0 - 1.0 FILL - MINE SPOILS, (ML) Sandy SILT; wet.	ML		759.1 1.0						10 20 30 40 PL MC LL 20 40 60 80	
		1.0 - 10.0 FILL - CEMENT KILN DUST, trace coal fragments, trace silt, trace clay; gray; non-cohesive, moist, dense.										Backfilled with Medium (3/8") Bentonite Chips
10		Boring completed at 10.0 ft.			751.3 10.0							
15												
20												
25												
30												
35												
40												

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-20

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 10/26/2016
DRILL RIG: DB 360

DATUM: NAD 88
COORDINATES: not surveyed

ELEVATION: 775
INCLINATION: -80
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS per 6 in (140 lb hammer 30 inch drop)	SAMPLES N	SAMPLES REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 10.0 FILL - MINE SPOILS, (CL) CLAY, some silt, trace sand; brown to dark brown; cohesive, moist. 1" cobble caught in bit	CL		765.2							Backfilled with Medium (3/8") Bentonite Chips
10		10.0 - 12.0 FILL - MINE SPOILS, (ML) CLAYEY SILT, trace sand, trace gravel; cohesive, moist, stiff.	ML		10.0 763.2							
		12.0 - 20.0 FILL - CEMENT KILN DUST; gray; non-cohesive, moist, dense.			12.0							
20		Boring completed at 20.0 ft.			755.3 20.0							
25												
30												
35												
40												

PENETRATION RESISTANCE BLOWS / ft ◆: 10 20 30 40

PL MC LL: 20 40 60 80

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: S. Morgan
DATE: 11/21/2016

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-21

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 12/11/2017
DRILL RIG: Terrasonic 150
DATUM: NAD 88
COORDINATES: N: 126,239 E: 1,353,336
ELEVATION: 783.25
INCLINATION: -90
WELL TAG: BKH 466

DEPTH (Ft)	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40) PL MC LL (20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 1.0 Silty SAND (SM), Fine to Medium Sand, Few 6" Cobbles, Brown, Loose, Moist	SM		782.3 / 1.0							Flush Mount Monument
		1.0 - 8.0 Silty SAND (SM), Fine to Medium Sand, Trace Fine to Coarse Gravel, Brown, Compact, Moist	SM									Medium (3/8") Bentonite Seal, 2" Schedule 40 PVC Riser
5												
					775.3							
		8.0 - 13.0 Clayey SAND (SC), Fine to Medium Sand, Some Silt, Trace Fine Gravel, Brown, Compact, Moist			8.0							
10		-Becomes Wet	SC									10/20 Silica Sand
					770.3							0.010-inch Slot Schedule 40 PVC Screen
		13.0 - 20.0 SANDSTONE, Fine-grained with Silt, Weathered, Weak, Orange/Gray Mottled, Dry to Moist, Driller Note: Tough drilling at 13'	Sandstone		13.0							
15												
					763.3							
20		Boring completed at 20.0 ft.			20.0							
25												
30												
35												
40												

11.21' DTW after drilling

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-22

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 12/12/2017
DRILL RIG: Terrasonic 150
DATUM: NAD 88
COORDINATES: N: 126,280 E: 1,353,344
ELEVATION: 788.36
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 2.0 Silty SAND (SM), Fine to Coarse Sand, Trace Fine Gravel, Dark Brown, Loose, Moist	SM		786.4						10 20 30 40 PL MC LL 20 40 60 80	
		2.0 - 11.0 Silty SAND (SM), Fine Sand, Some Fine to Coarse Gravel, Rounded, Trace Cobbles, Trace Charcoal, Brown, Loose, Moist	SM		2.0							
10		- becomes wet			777.4							Backfilled with Medium (3/8") Bentonite Chips
		11.0 - 20.0 Fine Grained SANDSTONE, Some Silt, Weathered, Weak, Yellowish Brown, Moist	Sandstone		11.0							
15		- reddish-yellow, yellowish-brown, light gray mottled										
20		Boring completed at 20.0 ft.			768.4 20.0							
25												
30												
35												
40												

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-23

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 12/11/2017
DRILL RIG: Terrasonic 150
DATUM: NAD 88
COORDINATES: N: 126,387 E: 1,353,381
ELEVATION: 809.41
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 5.0 Silty SAND (SM), Fine to Coarse Sand, Some Fine Gravel, Compact, Dark Brown, Moist	SM		804.4							Backfilled with Medium (3/8") Bentonite Chips
5		5.0 - 10.0 Sandy SILT (ML), Fine to Coarse Sand, Some Fine to Coarse Gravel, Brown, Firm to Stiff, Moist 8.5 - 9.5 - wood fragments	ML		5.0 799.4							
10		10.0 - 11.5 Silty SAND (SM), Fine to Medium Sand, Trace Fine Gravel, Roots, Compact, Brown, Gray, Wet	SM		10.0 797.9							
		11.5 - 16.0 CLAY (CL), Blocky, Yellowish-Brown/Gray Mottled, Stiff, Dry 15.0 - 16.0 - increase Sand	CL		11.5 793.4							
15		16.0 - 19.0 COAL, Weak, Black, Dry	COAL		16.0 790.4							
20		19.0 - 21.0 CLAY (CL), Some Coal, Laminated, Yellowish-Brown, Stiff, Dry	CL		19.0 788.4							
		21.0 - 25.0 COAL, Weak, Black, Dry	COAL		21.0 784.4							
25		Boring completed at 25.0 ft.			25.0							
30												
35												
40												

18.95' DTW after drilling on 12/12/17

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-24

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 12/11/2017
DRILL RIG: Terrasonic 150

DATUM: NAD 88
COORDINATES: N: 126,464 E: 1,353,353

ELEVATION: 810.03
INCLINATION: -90
WELL TAG: BKH 467

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 10.0 Silty SAND (SM), Fine to Medium Sand, Some Fine Gravel, Trace Clay, Brown to Dark Brown, Compact, Moist	SM									Flush Mount Monument Medium (3/8") Bentonite Seal, 2" Schedule 40 PVC Riser
5												
10		-Trace Coal Clasts			800.0							
		10.0 - 12.0 Silty SAND (SM), Fine to Medium Sand, Trace Fine Gravel, Dark Gray, Loose, Moist to Wet	SM		10.0 798.0							10/20 Silica Sand 0.010-inch Slot Schedule 40 PVC Screen
		12.0 - 15.0 Poorly Graded SAND (SP), Some Silt, Yellowish Brown/Light Gray Mottled, Wet	SP		12.0 795.0							
15		15.0 - 20.0 Fine grained SANDSTONE, Weathered, Yellowish Brown/Light Gray Mottled, Weak, Moist	SS		15.0 790.0							
20		Boring completed at 20.0 ft.			20.0							
25												
30												
35												
40												

9.9' DTW After well installation

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-25

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 12/11/2017
DRILL RIG: Terrasonic 150

DATUM: NAD 88
COORDINATES: N: 126,546 E: 1,353,359

ELEVATION: 807.10
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 3.0 Silty SAND (SM), Fine to Coarse Sand, some Fine Gravel, Dark Gray, Compact, Dry	SM		804.1 3.0						10 20 30 40 PL MC LL 20 40 60 80	Backfilled with Medium (3/8") Bentonite Chips
5		3.0 - 7.5 Sandy SILT (ML), some Fine to Coarse Gravel, 7" Cobbles, Dense, Moist	ML		799.6							
10		7.5 - 18.0 COAL, Weak, Black, Dry	COAL		7.5							
15		- Drilling tough			789.1							
20		18.0 - 23.0 SHALE, some Coal, Friable, Weak, Black, Dry	Shale		18.0 784.1							
25		23.0 - 25.0 SHALE, some Coal, some Silt, Friable, Laminated, Weak, Black, Dark Gray, Dry	Shale		23.0 782.1							
30		Boring completed at 25.0 ft.			25.0							
35												
40												

23.6 DTW After Drilling on 12/12/17

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-26

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA
DRILLING METHOD: Rotosonic
DRILLING DATE: 12/12/2017
DRILL RIG: Terrasonic 150
DATUM: NAD 88
COORDINATES: N: 126,616 E: 1,353,348
ELEVATION: 804.08
INCLINATION: -90
WELL TAG:

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆	NOTES WATER LEVELS / GRAPHIC
0	Rotosonic	0.0 - 2.0 Silty SAND (SM), Fine to Coarse Sand, Trace Gravel, Brown/Black/Gray Mottled, Loose, Moist	SM		802.1						10 20 30 40 PL MC LL 20 40 60 80	
		2.0 - 5.0 Poorly Graded SAND with Silt (SP-SM), Fine Sand, Gray to Light Gray, Loose, Moist-Wet	SP-SM		2.0 799.1							
5		5.0 - 8.0 SILT (ML), Fine Laminations, Light Gray, Dry 7.0 - 8.0 pH 7- 8	ML		5.0 796.1							
		8.0 - 25.0 SILTSTONE, Trace Fine Sand, Laminated, <2mm Coal Beds, Gray, Dark Gray, Very Stiff, Dry	SILTSTONE		8.0							Backfilled with Medium (3/8") Bentonite Chips
10												
15		-Increase Shale, Trace Coal, Tight Drilling										
20		-becomes Hard										
		-Increase thickness of silt beds										
25		Boring completed at 25.0 ft.			779.1 25.0							
30												
35												
40												

22.00 DTW after drilling on 12/12/17

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider
LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

RECORD OF BOREHOLE B-27

SHEET 1 of 1

PROJECT: Ravensdale Trench Extension
PROJECT NUMBER: 1520304-01
LOCATION: Access Rd East of LDA

DRILLING METHOD: Rotosonic
DRILLING DATE: 12/12/2017
DRILL RIG: Terrasonic 150

DATUM: NAD 88
COORDINATES: N: 126,342 E: 1,353,360

ELEVATION: 803.64
INCLINATION: -90
WELL TAG: BKH 463

DEPTH (Ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (Ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ◆ (10 20 30 40; PL MC LL; 20 40 60 80)	NOTES WATER LEVELS GRAPHIC
0	Rotosonic	0.0 - 17.0 Silty SAND (SM), Fine to Coarse Sand, Trace Fine Gravel, Trace Wood Fragments, Trace Shale, Dark Brown/Yellow Brown Mottled, Loose, Moist (Fill)	SM		786.6							Flush Mount Monument
5												Medium (3/8") Bentonite Seal, 2" Schedule 40 PVC Riser
10		-Trace Coal										
15												
		17.0 - 22.0 Poorly Graded SAND (SP), Fine Sand, Trace Silt, Compact, Yellowish Brown, Wet	SP		17.0 781.6							10/20 Silica Sand 0.010-inch Slot Schedule 40 PVC Screen
20												
		22.0 - 25.0 Fine Grained SANDSTONE, Weak, Yellowish Brown, Dry	Sandstone		22.0 778.6							
25		Boring completed at 25.0 ft.			25.0							
30												
35												
40												

14.03' DTW After well installation 12/13/17

RECORD OF BOREHOLE 15-20304 HOLCIM RAVENSDALE BOREHOLE LOGS.GPJ SPARKLE_1.0_DATA_TEMPLATE.GDT 4/10/18

1 in to 5 ft
DRILLING CONTRACTOR: Cascade Drilling
DRILLER: D. Rider

LOGGED: J. Miller
CHECKED: G. Zimmerman
DATE: 4/5/2018

Golder Associates

ATTACHMENT B

2017 Work Plan

REPORT

LOWER DISPOSAL AREA INTERCEPTOR TRENCH BOREHOLE INVESTIGATION WORK PLAN

RAVENSDALE SITE, WASHINGTON

Submitted To: Holcim (US) Inc.
8677 Hwy 45 S Alt.
Artesia, MS 39736

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

Distribution: Seattle King County Public Health
Washington State Department of Ecology
Reserve Silica Corp.
Holcim (US) Inc.
Golder Associates Inc.

September 18, 2017 **Project No. 152030401.001**

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1.0 INTRODUCTION

1.1 Background

The Ravensdale site (site) is located at 28131 Ravensdale-Black Diamond Road in Ravensdale, Washington (Figure 1). Historically, sand and coal mining operations occurred on the site until 2007. The site is currently owned by the Reserve Silica Corporation (Reserve Silica). Reserve Silica is backfiling the remaining historical excavation areas under an inert waste landfill permit (Permit #PR0082027). Holcim (US) Inc. (Holcim) has entered into agreements with Reserve Silica for addressing environmental conditions associated with historic disposal of cement kiln dust (CKD) at the site by predecessor companies.

The Lower Disposal Area (LDA) is a former open pit sand mine that was backfilled by placing cement kiln dust CKD and other materials into the mine excavation from June 1979 to October 1982. The approximate location of the LDA is shown in Figure 2. Historically, high-pH seepage has surfaced along the down-slope area west of the LDA. The seeps are primarily located along the northern half of the western boundary of the LDA. The seepage historically drained through low-lying, marshy areas and commingled with stormwater before flowing to the infiltration ponds. Currently, the seepage is collected in a ditch and catch basin system and piped to the infiltration ponds at the northern end of the site.

Holcim is addressing the high-pH seepage from the LDA through two primary methods:

1. Reducing, to the extent practical, the amount of meteoric and groundwater entering the LDA and contacting the CKD, thereby reducing the volume of high pH seepage.

2. Capturing and directing the high pH seepage to a treatment system (scheduled for construction in the fall of 2017) for neutralization and removal of dissolved arsenic prior to discharge to the existing infiltration ponds.

1.2 Previous Remediation Activities

In September and October 2007, the soil cover on the LDA was upgraded to meet industry standards and to reduce infiltration that could contribute to high-pH seepage observed in this area. Specific activities included regrading the cover to provide positive surface water runoff at all locations, increasing the thickness of the low-permeability cover soil layer to a minimum of two feet at all locations, and constructing a surface water diversion ditch around the upslope boundary of the cover.

Qualitative observations after construction of the improved cover, however, did not indicate a significant reduction in seepage volume. On this basis, it was considered most likely that the primary cause of seepage is up-gradient shallow groundwater inflow into the LDA, rather than surface water or infiltration through the cover.

Under this interpretation, the most practical approach for reducing seepage would be to reduce the influx of groundwater to the LDA. Therefore, a comprehensive program of test pit excavations, borehole drilling, piezometer measurements, tracer tests, and geophysical investigations was performed during 2010 to 2012. The results of these investigations were summarized in the *Lower Disposal Area Hydrogeologic Investigation* report (Golder 2013), and strongly suggested that groundwater was entering the LDA from the southern end and flowing to the north, producing the observed high-pH seeps and shallow groundwater impacts.

A groundwater interceptor trench was constructed at the south end of the LDA during August through October of 2013 as a first phase of reducing groundwater inflow to the LDA. The trench is approximately 220 feet long and up to 20 feet deep. Only about 50 feet of the trench length extends up the east side of the LDA from the southern end. Figure 2 shows the location of the existing interceptor trench. The trench is filled with gravel with a perforated drainage pipe in the bottom that discharges diverted shallow groundwater via gravity drainage to a point on the hillside to the south of the LDA. Flows from this trench are clean (non-impacted) groundwater and generally range between about 0.5 and 2.5 gallons per minute (gpm), although flows of 5 gpm have been measured following periods of heavy rainfall. The attached Table 1 presents monthly measurements of clean water discharging from the existing interceptor trench during the period of August 2016 to August 2017. Since construction of this trench, seepage along the western side of the LDA has continued, although any volume changes have not been measured.

In September 2008 in order to evaluate remedial options for the seepage water along the western side of the LDA, two test trenches were installed to collect high-pH seepage from the LDA. One trench was located on the bench immediately to the west of the LDA, where several seeps (and resulting carbonate deposits) had been observed over the course of several years. The second trench was located at the toe of the cover slope near the south end of the LDA. The trenches themselves were backfilled with gravel and each included a perforated drain pipe and a standpipe system to measure flow rate. Collected seepage was discharged through a 4-inch tightline pipe installed from the trenches to the infiltration ponds. The purpose of this test program was to determine the effectiveness of gravel-filled trenches in collecting seepage, evaluate the construction methods used for the trenches and to provide data for estimating the quantity and chemical characteristics of the seepage. The last objective would, in turn, help to identify the most appropriate method for managing the seepage.

In February 2013, a collection ditch was excavated along the bench below the western seepage zone to collect seepage, and a drop inlet structure was installed to direct seepage into the tightline and convey it directly to the infiltration ponds, thereby reducing the volume that commingles with surface water. In 2015, the 4-inch tightline downstream of the drop inlet was replaced with a 10-inch pipe to reduce the required frequency of cleaning resulting from carbonate precipitation in the pipe. Table 2 presents monthly flow measurements of the collected seepage water discharging from the 10-inch pipe to the infiltration ponds

during the period of August 2016 to August 2017. The collection ditch proved effective in capturing and conveying seepage, and the discharge pipe will be re-routed to convey the collected seepage to a seepage water treatment system. The design, construction, and operation of the seepage collection treatment system are being submitted to the Washington State Department of Ecology (Ecology) and to the Public Health Seattle and King County department under separate cover.

Chain-link fencing with 3-strand barbed wire at the top has been placed around site areas where high pH surface water is present. The fenced areas include: the seepage area and seepage collection ditch located west of the LDA; the South Pond located west of the LDA; and the infiltration ponds that receive the collection trench water discharge via the tightline. In addition, minor seepage water exposures observed along the southwest toe of the LDA were covered with coarse rock to allow flow of the water into the collection ditch system, while preventing direct contact by humans or animals at the ground surface.

1.3 Purpose and Scope

The existing interceptor trench demonstrates that shallow groundwater flowing along the top of the bedrock at the south end LDA can be diverted around the LDA. The existing 220-foot-long interceptor trench, however, only extends approximately 50 feet along the southeast upgradient side of the LDA. The purpose of the proposed borehole investigation program is to determine if constructing an additional branch of the interceptor trench upgradient of the southeast side of the LDA could effectively divert additional shallow groundwater around the LDA, thus potentially reducing the volume of high pH seepage discharging from the downgradient side of the LDA.

The scope of the current investigation is to determine the depth to bedrock and to identify shallow groundwater flow zones on top of the bedrock in the area along the southeast, hydrologically upgradient, side of the LDA. If the initial borehole investigation indicates that constructing an additional branch of the interceptor trench is feasible, installation of additional groundwater piezometers/wells may be necessary to evaluate the effectiveness of the interceptor trench extension. An additional work plan would be prepared for if additional piezometers/wells they are considered necessary.

2.0 BOREHOLE INVESTIGATION ACTIVITIES

2.1 Preliminary Investigation

In October 2016, Golder performed a preliminary investigation along the southeast side of the LDA. A total of 9 boreholes were drilled to depths of between 10 and 30 feet below ground surface. As shown in Figure 3, the boreholes were located on a line that started near the end of the existing interceptor trench and extended along the southeast side of the LDA. In summary, fill material comprised of mine spoils and CKD was encountered in most of the boreholes, and the competent bedrock needed for effective installation of the interceptor trench was not detected along this line. Shallow groundwater was encountered in most of the boreholes.

Results of the preliminary investigation indicate that the interceptor trench extension alignment would need to be moved further to the east and constructed as a separate branch, connected to the existing interceptor trench, so as to be hydraulically upgradient of the fill and CKD material, and located in an area where competent bedrock and shallow groundwater are potentially present.

2.2 Proposed Field investigations

A targeted field investigation program will be performed to determine the depth to bedrock and to identify shallow groundwater flow zones in the area east of the preliminary borehole alignment. This activity will primarily involve drilling approximately 8 boreholes along or near the proposed interceptor trench extension alignment as shown on Figure 3. Figure 3 only shows the proposed location for 4 of the potential 8 boreholes included in this investigation. Following drilling of the first 4 boreholes, the additional boreholes will be located in the field in an adaptive and iterative approach. Data collected from each borehole(s) will be used to locate additional boreholes as necessary to collect data on the depth to bedrock and presence of shallow groundwater along the alignment of the proposed interceptor trench branch. Drilling will be conducted using a track-mounted sonic drill rig to provide better core recovery and less disturbance than other methods. Drilling will extend until bedrock is encountered or until 30 feet, whichever is less. Stratigraphic and groundwater data will be obtained, and if shallow groundwater is encountered, several of the holes may be completed as 2-inch diameter wells for measurement of water levels and potential additional hydraulic testing if necessary.

An investigation report will be prepared presenting the results of the field investigation and an assessment of the efficacy of adding a new branch to the existing interceptor trench. The report will be submitted to Ecology and Public Health.

3.0 SCHEDULE

In January 2011, an Easement Agreement involving Site Environmental Activities (Easement) was filed on record between Reserve Silica and Holcim (Reserve 2010). The areas covered by the Easement include both the DSP and LDA, access roads, monitoring wells, and the LDA leachate seepage areas and infiltrations ponds as shown in Exhibit A. The proposed borehole investigation area is just outside of the existing easement, and Holcim and Reserve Silica are working on an agreement to include the proposed drilling in this area. Additionally, the Bonneville Power Administration (BPA) requires permitting for drilling under their power lines and the presence of a qualified "safety watcher". The BPA permit has been obtained, but the availability of the safety watcher could also affect the schedule.

We would like to obtain regulatory approval to proceed, so the field investigation could occur upon finalization of the access agreement and scheduling of the BPA safety watcher.

4.0 CLOSING

The information presented in this work plan is intended solely for the purpose described herein and should not be used for any other purposes without written authorization from Golder Associates Inc.

GOLDER ASSOCIATES INC.

Frank S. Shuri, PE, LG, LEG
Principal

Gary L. Zimmerman
Principal

FS/GLZ/sb

5.0 REFERENCES

Golder Associates Inc. (Golder) 2013. *Lower Disposal Area Hydrogeological Investigations, Ravensdale Site*. Prepared for Holcim (US) Inc. June 11.

Golder 2014. Technical Memorandum: *Ravensdale Site Groundwater and Surface Water Statistical Characterization: Arsenic Background Level Evaluation.* Prepared for Holcim (US) Inc. January 3.

TABLES

Table 1: Monthly Flow Volumes of Clean Water Diverted Around the Lower Disposal Area by the Interceptor Trench

Location	Date	Time	Flow (ml/min)	Flow gpm	pH	Notes
Interceptor Trench	8/22/2016	11:00	312	0.08	7.8	measured with pH meter
Interceptor Trench	9/14/2016	9:15	262	0.07	8.0	measured with pH strip
Interceptor Trench	10/18/2016	12:13	7,966	2.07	7.0	measured with pH strip
Interceptor Trench	11/1/2016	14:40	8,900	2.31	8.2	measured with pH meter
Interceptor Trench	12/8/2016	11:55	8,200	2.13	7.0	measured with pH strip
Interceptor Trench	1/6/2017	9:05	5,817	1.51	7.0	measured with pH strip
Interceptor Trench	2/2/2017	9:25	7,933	2.06	7.6	measured with pH meter
Interceptor Trench	3/8/2017	12:15	10,033	2.61	7.2	measured with pH meter
Interceptor Trench	4/11/2017	8:40	5,167	1.34	7.7	measured with pH meter
Interceptor Trench	5/30/2017	15:45	4,000	1.04	7.3	measured with pH meter
Interceptor Trench	6/16/2017	7:38	19,333	5.03	6.9	>1" rain previous day pH measured with YSI multimeter
Interceptor Trench	7/21/2017	8:15	706	0.18	7.2	measured with pH meter
Interceptor Trench	8/18/2017	8:50	460	0.12	7.6	measured with pH meter

Table 2: Monthly Flow Volumes of Collected Seepage Water Discharged to the Infiltration Ponds

Location	Date	Time	Flow (ml/min)	Flow gpm	pH	Notes
Infiltration Discharge	8/23/2016	8:50	4,400	1.1	11.8	pH from sampling location
Infiltration Discharge	9/14/2016	8:25	4,467	1.2	12.0	measured with pH strip
Infiltration Discharge	10/18/2016	12:42	8,283	2.2	11-12	measured with pH strip
Infiltration Discharge	11/1/2016	11:00	24,800	6.4	13.0	measured with pH meter
Infiltration Discharge	12/8/2016	12:10	29,000	7.5	12.0	measured with pH strip
Infiltration Discharge	1/6/2017	8:18	27,333	7.1	13.0	measured with pH strip
Infiltration Discharge	2/1/2017	8:55	17,600	4.6	13.3	measured with pH meter
Infiltration Discharge	3/8/2017	12:35	32,667	8.5	13.2	measured with pH meter
Infiltration Discharge	4/11/2017	9:05	26,000	6.8	13.2	measured with pH meter
Infiltration Discharge	5/30/2017	10:22	21,000	5.5	13.0	measured with pH meter
Infiltration Discharge	6/16/2017	8:00	21,133	5.5	12.7	>1" rain previous day pH measured with YSI multimeter
Infiltration Discharge	7/21/2017	8:40	5,533	1.4	12.8	measured with pH meter
Infiltration Discharge	8/17/2017	9:20	2,540	0.7	11.9	measured with pH meter

FIGURES

NOTES

1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NGVD 29
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NGVD 29
   CONTOUR INTERVAL: 1 FT

3. BASE TOPOGRAPHY INSIDE OF DSP FOOTPRINT PREPARED BY PARAMETRIX, INC., BELLEVUE, WA FROM FIELD DATA TAKEN ON JULY 6, 2011.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NGVD 29
   CONTOUR INTERVAL: 1 FT

4. MONITORING INCLUDES ONLY WATER LEVELS AND FIELD PARAMETERS.

PROPERTY BOUNDARY
MWB-2DSP
MWB-6DSP
DALE STRIP PIT (DSP)
MWB-1SDSP
MWB-1DDSP
MWB-4SDSP
MWB-5DSP
POWER LINES AND TOWERS
LOWER DISPOSAL AREA (LDA)
INTERCEPTOR TRENCH DISCHARGE OUTLET
MWB-3LDA
SITE ENTRANCE
PORTAL
STILL WELL
MWB-2LDA
MWB-1LDA
CLEANOUT (TYP)
CONSTRUCTED WETLANDS
RAVENSDALE - BLACK DIAMOND RD
WEIR
MW-3A
MW-4A
MW-2A
MW-1A
MW-6A
MW-5A
SEEP COLLECTION SYSTEM DISCHARGE PIPE
SOUTH POND
TIGHTLINE DISCHARGE
INFILTRATION PONDS
INFILTRATION #1
PROPERTY BOUNDARY

LEGEND

- COVER AREA
- MW-1A — ALLUVIAL MONITORING WELL
- MWB-1DDSP — BEDROCK MONITORING WELL
- MWB-2DSP — BEDROCK MONITORING WELL (NOTE 4)
- LDA SURFACE WATER SAMPLING LOCATION
- DSP BEDROCK SAMPLING LOCATION (PORTAL)
- INTERCEPTOR TRENCH SAMPLING LOCATION

N

0 150 300
SCALE IN FEET

FIGURE 1
SITE PLAN
HOLCIM / RAVENSDALE PROJECT / WA

Golder Associates

NOTES

1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NDVD 29
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NDVD 29
   CONTOUR INTERVAL: 1 FT

3. FENCING COMPLETED 2017 LOCATIONS APPROXIMATED (NOT SURVEYED)

DALE STRIP PIT (DSP)
MWB-4DDSP
MWB-5DSP
DSP COVER (2010-2011)
BPA TRANSMISSION LINES
FORMER MINE PIT
BPA TRANSMISSION TOWER (TYP)
LDA COVER (2007)
LOWER DISPOSAL AREA (LDA)
MWB-3LDA
INTERCEPTOR TRENCH (2013)
TEST TRENCH NO. 1 (2008)
MONITORING STATION NO. 2
DITCH CHECK DAM
DITCH EARTHEN BERM
MWB-2LDA
DITCH WATER BAR
MWB-1LDA
DROP INLET (2013)
MONITORING STATION NO. 1
FENCE COMPLETION (2017)
SOUTH POND
MW-4A
CLEANOUT (TYP)
MW-3A
SEEPAGE COLLECTION DITCH (2013)
FENCE COMPLETION (2017)
SEEP COLLECTION SYSTEM DISCHARGE PIPE (2015)
TEST TRENCH NO. 2 (2008)
MW-1A
MW-2A
MW-5A
MW-6A
BLACK DIAMOND - RAVENSDALE RD
PROPERTY BOUNDARY (TYP)
INFILTRATION PONDS

N

0 100 200
SCALE IN FEET

LEGEND

COVER AREA
MWB-1LDA MONITORING WELL
SEEP COLLECTION SYSTEM MONITORING STATION
SEEP COLLECTION SYSTEM CLEANOUT

GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT: RAVENSDALE SITE

TITLE: LDA FACILITIES LAYOUT

PROJECT No.		1520304.350
FILE No.		AS SHOWN
REV. A	SCALE	AS SHOWN
DESIGN	SJM	07-21-16
CADD	VMN	07-21-16
CHECK	VMN	07-21-16
REVIEW	FSS	07-21-16

FIGURE 2

G:\HOLCIM\Ravensdale\99_PROJECTS\1520304_InterceptorTrenchExt350_LDAWorkPlan\02_PRODUCTION\DWG\1520304350_001.dwg | F01 | Mod: 07/21/2016, 18:26 | Plotted: 04/14/2017, 08:48 | Trybar

NOTES

1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NDVD 29
   CONTOUR INTERVAL: 5 FT

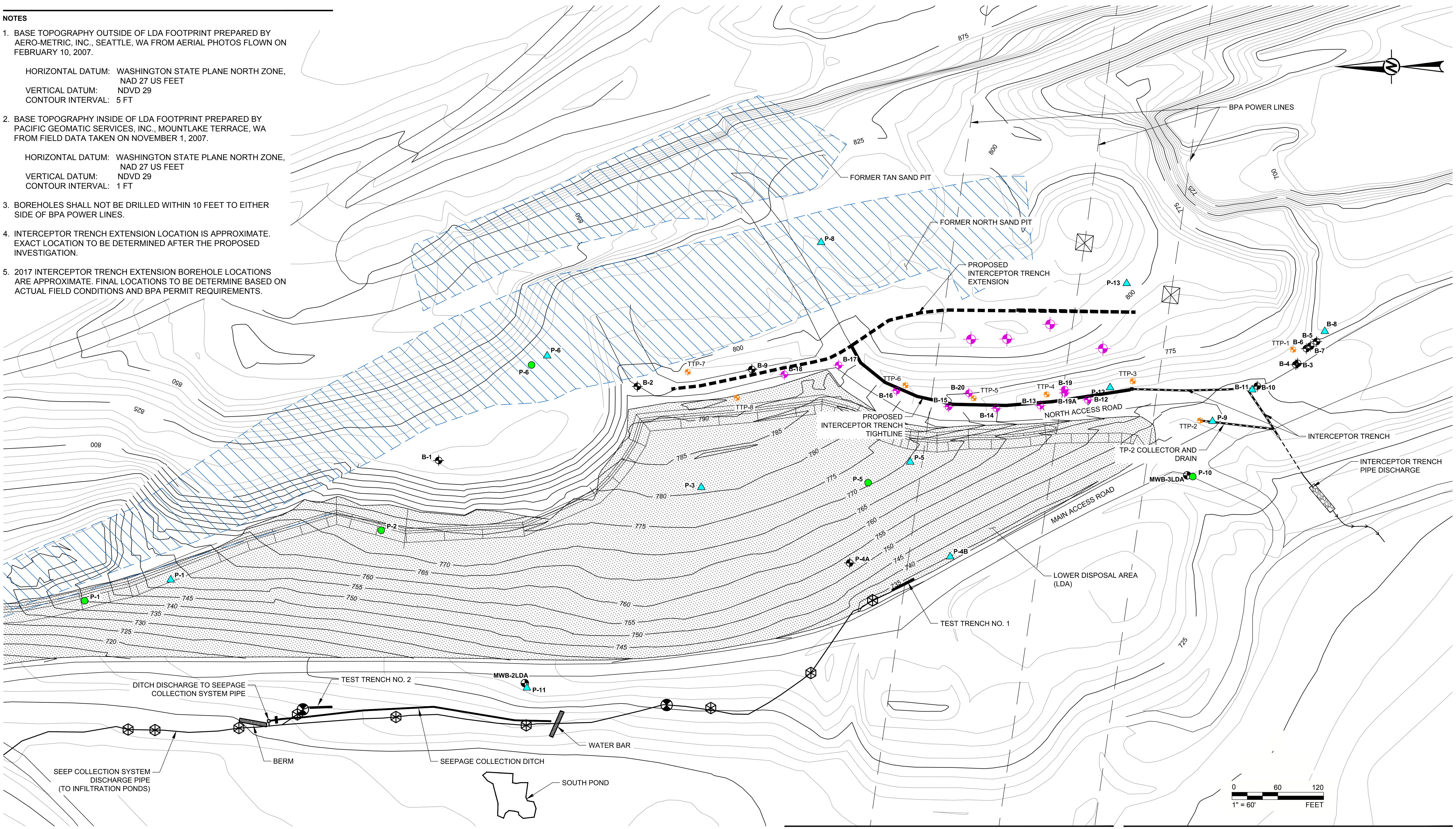
2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NDVD 29
   CONTOUR INTERVAL: 1 FT

3. BOREHOLES SHALL NOT BE DRILLED WITHIN 10 FEET TO EITHER SIDE OF BPA POWER LINES.

4. INTERCEPTOR TRENCH EXTENSION LOCATION IS APPROXIMATE. EXACT LOCATION TO BE DETERMINED AFTER THE PROPOSED INVESTIGATION.

5. 2017 INTERCEPTOR TRENCH EXTENSION BOREHOLE LOCATIONS ARE APPROXIMATE. FINAL LOCATIONS TO BE DETERMINE BASED ON ACTUAL FIELD CONDITIONS AND BPA PERMIT REQUIREMENTS.



LEGEND

- B-16 — 2016 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE
- MWB-1LDA — MONITORING WELL
- P-1 — GOLDER PIEZOMETER
- P-2 — GOLDER DIRECT PUSH PROBE
- B-1 — GOLDER EXPLORATORY BOREHOLE (BACKFILLED)
- TTP-1 — GOLDER TEST PIT (MAY, 2010)
- B-16 — 2017 GOLDER INTERCEPTOR TRENCH EXTENSION BOREHOLE

CLIENT
HOLCIM

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-04-14
DESIGNED	SJM
PREPARED	REDMOND
REVIEWED	FSS
APPROVED	GZ

PROJECT
RAVENSDALE
INTERCEPTOR TRENCH EXTENSION PREDESIGN INVESTIGATION

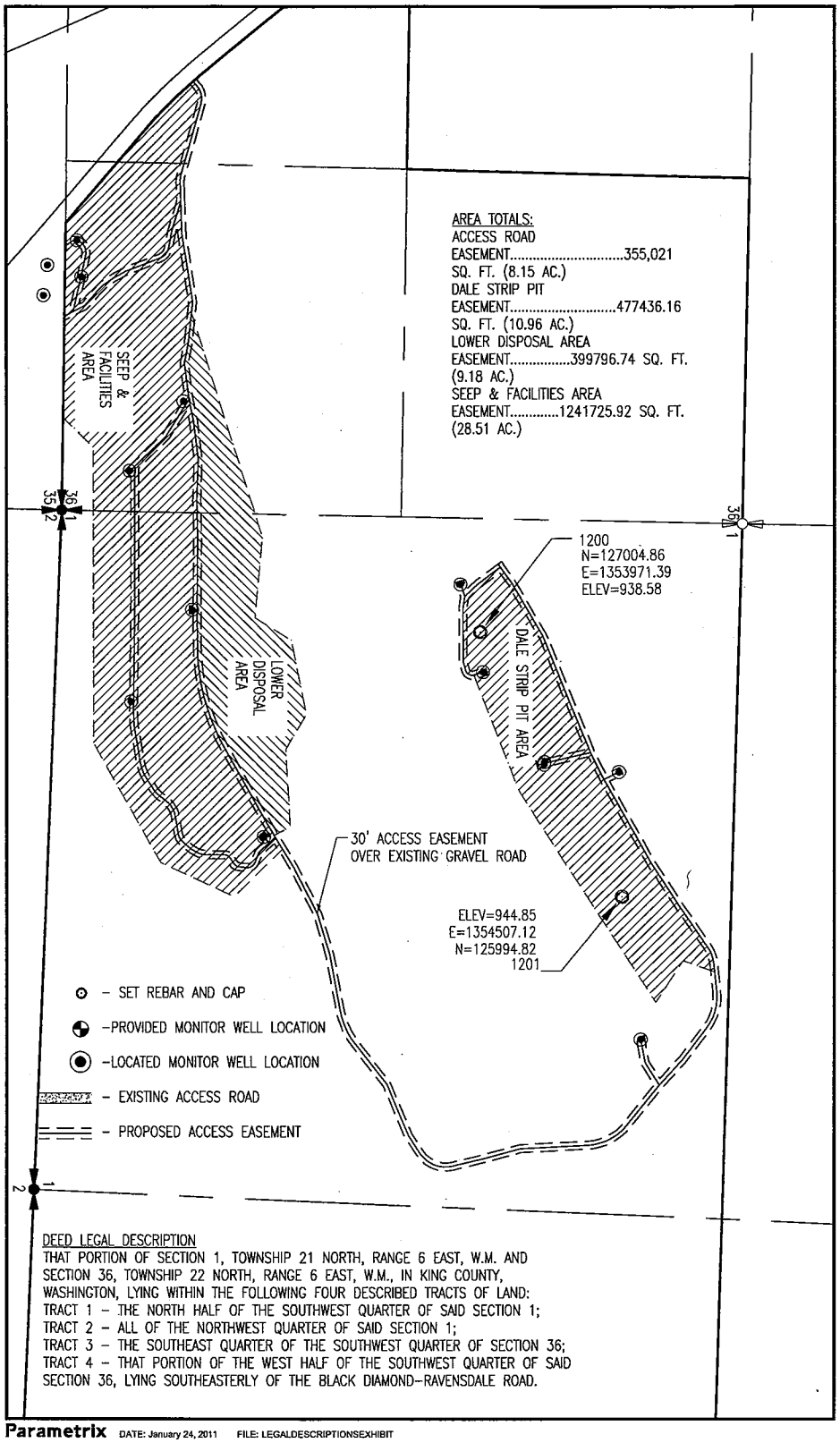
TITLE
PROPOSED 2017 INVESTIGATION SITE PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
152030401	100	A	3

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

Path: \\redmond.golder.gds\geomatt$\geomatics\Lakha\MeridianCleaners\02_DATA\DWG\ | File Name: 152030401_001_003a.dwg

EXHIBIT A



Parametrix DATE: January 24, 2011 FILE: LEGALDESCRIPTIONSEXHIBIT

N

0 500

1"=500'

NOTE
EASEMENT BOUNDARIES OF THE DALE STRIP PIT AREA, LOWER DISPOSAL AREA, AND SEEP & FACILITIES AREA RUN ALONG THE ROAD CENTERLINE WHEN THEY ARE COINCIDENT WITH THE ACCESS ROAD EASEMENT.

LEGAL DESCRIPTION EXHIBIT

EXHIBIT A: LDA LEACHATE SEEPAGE AREAS AND INFILTRATIONS PONDS

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity