REPORT

1,4-Dioxane Investigation Work Plan

Landsburg Mine Site

Submitted to:

Washington Department of Ecology
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Submitted by:

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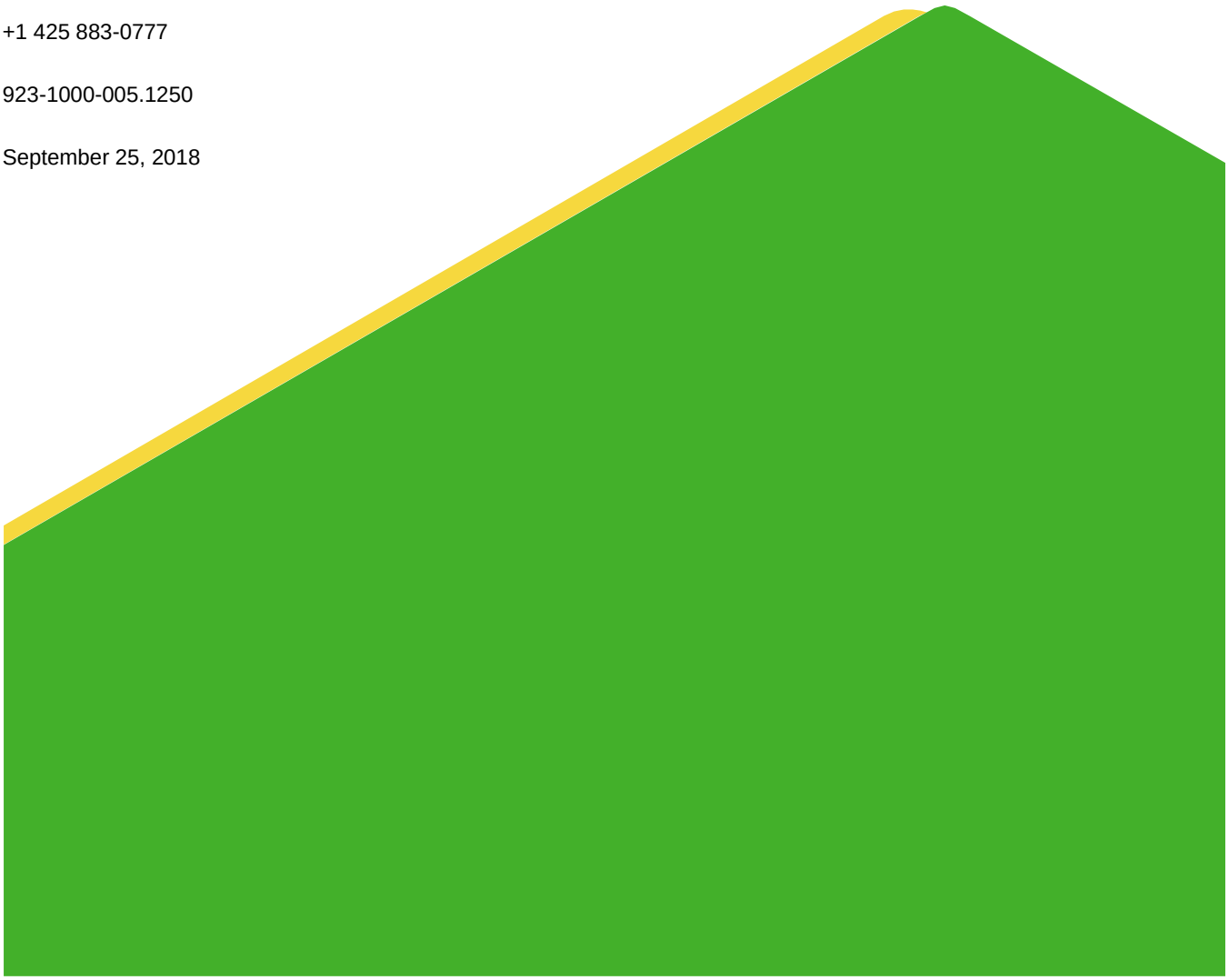
923-1000-005.1250

September 25, 2018



Distribution List

PLP Group - electronic copy

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1.0 INTRODUCTION

The Landsburg Mine Site (Site) is a Washington State Model Toxics Control Act (MTCA) listed site, administered by the Washington State Department of Ecology (Ecology). The history of the Site, summary of the remedial investigation (RI), feasibility study (FS) and additional environmental investigations completed at the Site, and the remedial actions selected by Ecology are detailed in the Final Cleanup Action Plan (CAP) (Ecology 2017a). Prior to the start of the selected remedial actions, low concentrations of 1,4-dioxane were detected in three Site groundwater monitoring wells located at the north end of the Site. Neither 1,4-dioxane nor any other contaminant of concern were detected at other Site wells. This Work Plan presents investigation activities that are proposed to continue the alternative source evaluation intended to help determine whether mine waste contaminants are the source of the recent detection of 1,4-dioxane.

1.1 Pre-Remedial Action Detection of 1,4-Dioxane

Quarterly groundwater monitoring was conducted during the RI starting in 1994, and interim groundwater monitoring was conducted periodically from 1995 to 2003, quarterly in 2004, and semiannually from 2005 to 2018. Interim groundwater monitoring is currently being conducted quarterly. The interim groundwater monitoring has been conducted to provide continued monitoring of the Site groundwater quality until the selected remedial actions and associated compliance monitoring are started as described in the CAP and Compliance Monitoring Plan (CMP) (Ecology 2017b). The interim groundwater monitoring has included laboratory testing for a comprehensive list of analytes; including: petroleum compounds, volatile (VOC) and semi-volatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCBs), and various metals. There were no detections of contaminants that are attributable to mine waste contaminants during the RI or during any of the interim groundwater monitoring events from 1994 to November 2017.

In response to comments received on the draft Cleanup Action Plan, Ecology added the compound 1,4-dioxane to the suite of analytes listed in the CMP that will be tested for during protection and confirmational monitoring at the Site. Although compliance monitoring will not commence until after the selected remedy is implemented, the Landsburg PLP Group elected to add 1,4-dioxane to the list of test analytes included in the current interim groundwater monitoring to be responsive to public comments received. 1,4-Dioxane was the only new compound added to the CMP, and starting in November 2017 was the only new compound added to the interim groundwater monitoring program. All other compounds included in the CMP have been tested for at the Site during the RI and during the interim groundwater monitoring conducted since 2003. 1,4-Dioxane is recognized for its use as a stabilizer in some solvents and for its use in many household consumer products such as laundry detergents, shampoos and cosmetics. The common use of 1,4-dioxane combined with its chemical property of high solubility and mobility in groundwater has resulted in low level detections of this compound in groundwater throughout the United States (EPA 2017). In recent years 1,4-dioxane is routinely being added to groundwater testing programs at municipal water systems and at environmental cleanup sites.

The November 2017 interim groundwater monitoring round included analysis for 1,4-dioxane for the first time. The analytical results for all test analytes during the November 2017 sampling event were consistent with results during the RI and with all the previous interim groundwater monitoring events conducted since 2003 except that 1,4-dioxane was detected in LMW-2 and LMW-4 at concentrations of 2.0 micrograms per liter (µg/L) and 2.3 µg/L, respectively. Since November 2017 was the first time 1,4-dioxane was tested for at the Site, its detection in LMW-2 and LMW-4 does not necessarily indicate a change in groundwater conditions. The compound 1,4-dioxane was not detected in any of the other groundwater monitoring wells or in either of the portal surface water

samples, including monitoring well LMW-10 and the north portal, which are located upgradient of LMW-2 and LMW-4.

LMW-2 and LMW-4 were resampled in February 2018 to confirm the November 2017 1,4-dioxane detections. 1,4-Dioxane was detected during the resampling at 2.1 µg/L and 2.3 µg/L in LMW-2 and LMW-4, respectively, similar to the results detected in the November 2017 groundwater monitoring. The Landsburg PLP Group notified Ecology after the November 2017 results were received and validated and after the February 2018 resampling results were received and validated.

1.2 Initial Alternative Source Evaluation

In response to the detection of the 1,4-dioxane in LMW-2 and LMW-4, the Landsburg PLP Group decided to expedite the installation of the four additional groundwater monitoring wells referred to as “sentinel wells” in the CAP. Sentinel wells are groundwater monitoring wells that are located between the waste disposal area and the compliance wells located at the north and south ends of the Site. The wells are referred to as sentinel wells because they will be used as an early warning for impacted groundwater migration. Two of the sentinel wells are located north of where the waste disposal occurred and two will be located south of the former waste disposal area. Figure 1 and the cross-section Figure 2 show the locations of the existing monitoring wells and the new sentinel wells.

In March 2018, a sentinel well installation work plan (Golder 2018a) was submitted to Ecology describing the details for installation of the four additional sentinel wells. Ecology approved the work plan, and the two north sentinel wells were installed during March through May 2018. The northern sentinel wells were installed first to provide data to help evaluate the potential source of the 1,4-dioxane detected in LMW-2 and LMW-4. The process of identifying the potential source of compounds detected in the Site groundwater monitoring wells is referred to in the CAP as “an alternative source evaluation” (CAP, page 46). As shown on Figure 2, the new shallow north sentinel well (LMW-12) was screened within the former mine workings from a depth of 15.5 to 25.5 feet below ground surface (ft. bgs). The new deeper north sentinel well (LMW-13R) was screened within the former mine workings at a depth of 115 to 140 ft. bgs. Existing north sentinel well LMW-10 is screened near the bottom of the coal seam at a depth of 267 to 287 ft. bgs. The attached Table 1 summarizes the groundwater monitoring well construction details. LMW-10, LMW-12, and LMW-13R are located upgradient of northern compliance wells LMW-2 and LMW-4 and downgradient of the former waste disposal area, as shown on Figure 2. If the 1,4-dioxane detected in LMW-2 and LMW-4 is a mine waste contaminant it would also be expected to be detected in LMW-12 and LMW-13R.

The two new north sentinel wells (LMW-12 and LMW-13R) were included in the May 2018 interim groundwater monitoring event. Full results from this monitoring event have been provided to Ecology in a groundwater monitoring report (Golder 2018b). During the May 2018 interim groundwater monitoring, 1,4-dixoane was detected in the new shallow north sentinel well LMW-12 at a concentration of 1.5 µg/L but was not detected in the new deeper north end sentinel well LMW-13R. The compound was also not detected in the existing deep north sentinel well LMW-10, or in any of the other Site groundwater monitoring wells except LMW-2 and LMW-4. During the May 2018 interim groundwater monitoring, 1,4-dioxane was detected in LMW-2 and LMW-4 at 1.8 and 1.5 µg/L; respectively, which is less than the concentrations that were detected in these wells in the initial sampling in November 2017 and lower than concentrations detected in the February 2018 resampling. Although these are only three distinct events over a six-month period of time, the data indicate the 1,4-dioxane concentrations are not increasing and may actually be decreasing.

The detection of 1,4-dioxane in the new shallow north sentinel well LMW-12 indicates that the 1,4-dioxane could possibly be coming from the former waste disposal area. However, the absence of detecting 1,4-dioxane in the new deeper north sentinel well LMW-13R does not support this determination. Only three rounds of sampling have been conducted of the new sentinel wells and additional evaluation of the detection of this new test compound is required as part of the alternative source evaluation.

Results of this initial alternative source evaluation and an assessment of any risk posed to human health or the environment from the 1,4-dioxane detections were presented to Ecology in a technical memorandum (tech memo) (Golder 2018d). The tech memo also proposed additional actions to address the 1,4-dioxane detection. The additional actions proposed included:

- Continue the alternative source evaluation as prescribed in the CAP. The closest private wells located northwest of the Site will be sampled as a precaution. Although the geology and hydrogeology of the Site and surrounding area indicate that groundwater from the Rogers mine discharges to the Cedar River and that groundwater would not flow towards the private wells located northwest of the Site, the Landsburg PLP Group will request access from the nearest private well owners to sample their wells. If access is provided, the wells will be sampled and analyzed for 1,4-dioxane. As indicated in the tech memo, 1,4-dioxane is present in many consumer products and has been found to enter groundwater through private septic system drain fields. The detection of 1,4-dioxane in any private well sample would not automatically indicate the groundwater from the Rogers seam is the source, but would indicate that additional evaluation of the potential source is required. The additional evaluation could include installation of groundwater monitoring wells north of the LMW-2 and LMW-4 to provide empirical data on the lateral extent of 1,4-dioxane in the groundwater downgradient of the Site.
- Complete the remedial actions as described in the CAP. If the 1,4-dioxane is a mine waste contaminant, backfilling and capping of the mine trench area where wastes were disposed will reduce the infiltration of rainwater and stormwater runoff currently entering the trench and subsequently reduce the flux of any 1,4-dioxane in soils to the groundwater within the mine workings. The capping will also reduce the total quantity of water that flows along the mine workings and ultimately discharges to the Cedar River.
- Increase the interim groundwater monitoring frequency of the groundwater monitoring wells located at the north end of the Site to quarterly. Sampling for 1,4-dioxane at the Site first occurred with the November 2017 interim semi-annual groundwater monitoring event. Although the concentrations detected in May 2018 were lower than detected in November 2017, it is not possible to evaluate the long-term concentration trends or seasonal trends with the limited amount of data currently available. The increased monitoring frequency will provide additional data to evaluate 1,4-dioxane concentration trends. Semi-annual interim groundwater monitoring will continue on all other Site groundwater monitoring wells, until compliance monitoring as described in the CMP starts.
- Expedite the installation of the south sentinel wells. The north sentinel wells have already been installed. The two southern sentinel wells required under the CAP will be installed during fall 2018. These wells will provide data on the groundwater quality and provide further clarification of the groundwater gradients.
- Install the south contingent treatment system infrastructure in 2019 versus 2020 as initially provided in the draft Engineering Design Report schedule.

Ecology provided a response letter to the tech memo (Ecology 2018) stating that "Ecology is largely in agreement with the descriptions of the contamination issue, its nature, and most of the proposed next steps." Ecology approved the proposal to increase frequency of interim groundwater monitoring and approved the plan to expedite installation of the south sentinel wells and south contingent system infrastructure. However, Ecology recommended additional groundwater investigation north of the Site prior to considering any sampling of private wells. The purpose of the additional investigation is to provide empirical groundwater data on nature and extent of the 1,4-dioxane directly hydraulically down gradient of the LMW-2 and LMW-4. The Landsburg Mine Site PLP Group concurs with Ecology's recommendation.

Ecology requested submittal of a work plan describing the proposed groundwater investigation, which would be conducted as part of the continued alternative source evaluation. The remainder of this Work Plan provides the details of the groundwater investigation to determine the nature and extent of the 1,4-dioxane detected at the north end of the Site.

2.0 PROPOSED ADDITIONAL INVESTIGATIONS

If the 1,4-dioxane detected at the northern portion of the Site is a mine waste contaminant, the lateral extent of the 1,4-dioxane would be expected to be limited to the width of the former Rogers seam. The coal seam itself is approximately 10 to 12 feet wide, but the collapsed width of the Rogers mine is about 15 feet. The geology and hydrogeology of the Site are described within the CAP (Ecology 2017a). On the northern end of the Site the coal seam and associated mine workings are oriented nearly vertically. Low permeability sandstone and shale of the Puget Group bedrock are located on the east and west sides of the Rogers coal seam and mine workings. The mined/backfilled Rogers seam is a highly conductive zone for groundwater flow. The fine-grained, vertically bedded Puget Group bedrock strata located to either side of the seam are several orders of magnitude less permeable than the mined-out seam. Groundwater flow within the mine flows horizontally to the north to northeast, along the strike through the highly permeable Rogers seam.

North of the Site, groundwater from the Rogers seam discharges to the Cedar River through the glacial sands and gravels that overlie the coal seam and underlie the Cedar River. The Cedar River is located approximately 600 feet north of LMW-2 and LMW-4. Figures 3 and 4 conceptually depict the coal seams, the low permeability Puget Group sandstone and siltstones located on either side of the coal seams, and the recessional outwash sands and gravel deposits beneath the Cedar River. There are currently no groundwater wells located between the north end of the Site and the Cedar River. To provide empirical data on the groundwater quality north of the Site installation of three additional groundwater monitoring wells is proposed. The three monitoring wells would include:

- LMW-20 – Will be installed along the strike of the Rogers coal seam and screened in the glacial soils overlying the Rogers coal seam. The monitoring well will provide data on the concentration of 1,4-dioxane in groundwater discharging from the Rogers coal seam to the glacial soils at a location downgradient of LMW-2 and LMW-4, prior to discharge to the Cedar River.
- LMW-21 – Will be installed east of LMW-20. As detailed in the tech memo (Golder 2018d), 1,4-dioxane use as a stabilizer in chlorinated solvents and in common commercial and household products has resulted in 1,4-dioxane being found in groundwater throughout the United States. LMW-21 will provide groundwater quality data at a location that is side gradient/upgradient of the Rogers seam and within the same glacial soils that LMW-20 and LMW-22 will be installed. LMW-21 will provide background groundwater quality data.

- LMW-22 – Will be installed west to northwest of LMW-20, between the Rogers coal seam and the closest private wells located to the northwest of the Site. Based on the geology noted in the private Water Well Reports filed with Ecology at the time of drilling, the nearest private wells located northwest of the Site are screened within the glacial soils overlying the bedrock similar to the proposed new Site monitoring wells. Groundwater discharging from the Rogers coal seam will travel north to northwest to the Cedar River. It is not anticipated that any of the water discharging from the Roger seam migrates in the direction of the private wells. LMW-22 will provide the empirical data on the presence or absence of 1,4-dioxane in groundwater between the Rogers coal seam and the closest private wells.

3.0 MONITORING WELL DRILLING AND INSTALLATION

The wells will be drilled and installed in accordance with Golder Technical Guidelines TG-1.2-12 *Monitoring Well Drilling and Installation* and TG-1.2 6 *Soil Description System*. Upon well completion, sampling and water level measurements will be conducted in accordance with the approved procedures detailed in the Compliance Monitoring Plan (CMP) (Ecology 2017b) and associated Quality Assurance Project Plan (QAPP). The Health and Safety Plan contained within the CMP will be augmented to address potential health and safety risks specific to drilling activities. Figures 3 and 4 show the approximate proposed well locations.

The boreholes will be drilled, by a Washington State licensed driller, using a roto-sonic drilling method. The borehole will be drilled at an 8-inch diameter cased hole. The roto-sonic drilling method collects continuous cores. A Golder geologist will inspect the cores to evaluate the soil lithology, create the borehole log, and evaluate the depth when groundwater is first encountered. Drilling will extend in each hole until the targeted depth is reached and the borehole is cleared to permit monitoring well construction. We anticipate the bedrock is approximately 30 feet below ground surface, and the intent is to install the screen interval of each well within the saturated portions of the glacial deposits that overlie the bedrock.

The wells will be constructed of 2-inch diameter polyvinyl chloride (PVC) screens and flush-threaded PVC riser casing. The anticipated screen length will be 10 feet (0.02-inch slot size). The screened intervals will be gravel packed with coarse silica sand properly sized for the screen slot size. The borehole annulus above each screen section will be sealed with bentonitic cement grout or a bentonite clay seal to land surface. A protective lockable steel monument will be installed for secured access at the well port. After development of the wells, each well will have a dedicated sampling pump installed for subsequent sampling efforts. Figure 5 illustrates a typical monitoring well construction.

A Washington State licensed land surveyor will conduct the geodetic survey. After installation, the wells will be surveyed for horizontal position (x- and y- coordinates) and elevation (z- coordinate) to the same benchmark established for the other Landsburg Mine Site monitoring wells. The horizontal survey will be in conformance with “Third-Order” accuracy and precision using differential Global Positioning System (GPS). Elevation survey will be to within 0.01-foot accuracy and precision using land surveying transects from existing Site groundwater monitoring wells.

Groundwater levels will be allowed to stabilize for at least one week before a measurement is obtained in the new wells and existing monitoring wells and piezometers in the vicinity of the Landsburg Mine. Groundwater levels will be measured using an electric water level tape. Water level measurements will be obtained in accordance with the procedures detailed in the approved CMP (Ecology 2017b).

The completed wells will be sampled in accordance with the procedures detailed in the approved CMP (Ecology 2017b). The samples will be analyzed for 1,4-dioxane by EPA Method 8270D and for VOCs by EPA Method 8260C in accordance with the QAPP.

A technical report will be prepared following completion of the monitoring well installation, water level measurements, data collection, and sample analysis. The report will contain the following:

- Summary of field investigations and data generated.
- Analysis and interpretation of the new data including but not limited to:
    1) Geologic log and well installation diagram
    2) Survey result
    3) Groundwater elevation
    4) Groundwater elevation maps and flow directions
    5) Groundwater quality results
    6) Preliminary conclusions regarding alternate source evaluation
    7) Identification of any additional data collection needs

4.0 SCHEDULE

Pending Ecology's approval of this Work Plan by October 5, drilling of the monitoring wells will start during the week of October 15. Drilling and installation of the three new northern monitoring wells is anticipated to take two weeks. Well development, surveying and sampling is anticipated to be completed during the month of November 2018. Laboratory results should be available within 30 days of sample collection. Based on this schedule, the technical report will be submitted to Ecology in January 2019. The need for additional evaluation on the nature and extent of the 1,4-dioxane detection, including additional data that may be needed to complete the alternate source evaluation, will be determined in consultation with Ecology, and will be dependent on the results of the groundwater analytical results from the three new wells combined with the continued quarterly monitoring of the existing Site groundwater monitoring wells.

Additional Site activities that are proceeding simultaneously with this 1,4-dioxane investigation include: continued quarterly groundwater monitoring; installation of the southern sentinel wells previously approved by Ecology; and preparation for implementing the Site remedial actions as detailed in the Final EDR (Golder 2018c).

Signature Page

Golder Associates Inc.

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Principal

Douglas J. Morell
Hydrogeologist

GLZ/DJM/sb

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5.0 REFERENCES

Golder Associates Inc. (Golder) 2018a. Draft Report. Sentinel Well Installation Work Plan. Prepared for the Washington State Department of Ecology. Redmond, Washington March 5.

Golder 2018b. Landsburg Mine Site Interim Groundwater Monitoring Results – May 2018. Prepared for the Landsburg PLP Steering Committee. Redmond, Washington. August 14.

Golder 2018c. Engineering Design Report Landsburg Mine Site. Prepared for the Washington State Department of Ecology. Redmond, Washington August 14.

Golder 2018d. Technical Memorandum. Pre-Remedial Action 1,4-Dioxane Detection at the Landsburg Mine Site Prepared for the Washington State Department of Ecology. Redmond, Washington. August 16.

U.S. Environmental Protection Agency (EPA). 2017. Technical Fact Sheet – 1,4-Dioxane November 2017. EPA 505-F-17-011. Washington DC.

Washington State Department of Ecology (Ecology). 2017a. Exhibit B of the Consent Decree - Final Cleanup Action Plan Landsburg Mine Site MTCA Remediation Project, Ravensdale, Washington. Prepared by Golder Associates Inc. June 7.

Ecology 2017b. Exhibit D of the Consent Decree – Compliance Monitoring Plan Landsburg Mine Site MTCA Remediation Project, Ravensdale, Washington. Prepared by Golder Associates Inc. June 7.

Ecology 2018. Letter from Ecology Providing Comments on the *Pre-Remedial Action 1,4-Dioxane Detection at the Landsburg Mine Site* Technical Memorandum (Golder 2018d). August 27.

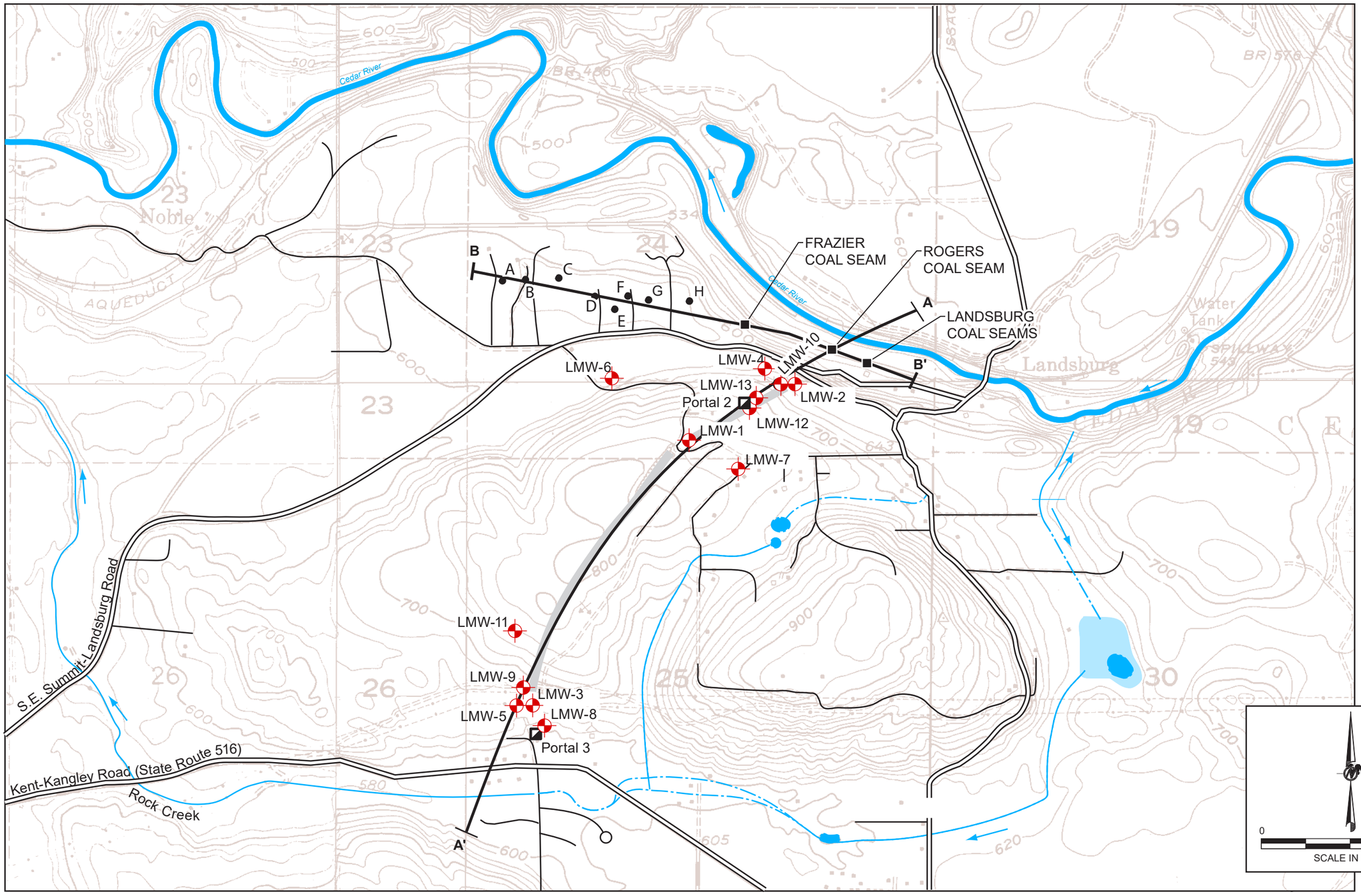
Tables

Table 1: Landsburg Mine Site Groundwater Monitoring Wells Construction Summary

Well ID	Coordinates		Installation Date	Measuring Point Elevation (ft)	Borehole Depth (ft)	Borehole Diameter (inches)	Well Casing Diameter (inches)	Well Materials	Depth to Top of Screen (ft)	Depth to Bottom of Screen (ft)	Screen Slot Size (inches)	Depth to Top of Filter Pack (ft)	Comments
	Northing	Easting											
LMW-1	138279.4	1354991.4	1/23/1994	765.36	180	8	4	Stainless/PVC	162	177	0.02	158	In area of gangway that connects mine fault off-set
LMW-1A	138322.87	1354997.2	2/7/1994	763.57	220	8	2	PVC	129	149	0.02	n/a	Only for water levels
LMW-2	139076.87	1355972.6	2/11/1994	617.79	46	8	4	Stainless/PVC	28	38	0.02	25	Shallow north compliance
LMW-3	135192.23	1353220.4	11/22/2004	656.75	76	8	4	Stainless/PVC	50	65	0.02	47	Shallow south compliance
LMW-4	139122.48	1355864.9	2/19/1994	619.27	233	8	4	Stainless/PVC	195	210	0.02	210	Deep north compliance
LMW-5	135206.05	1353141.3	12/8/2004	658.27	247	8	4	Stainless/PVC	232	242	0.02	232	Deep south compliance
LMW-6	138772.683	1714004.8	1/13/1994	632.33	106	8	4	Stainless/PVC	91	106	0.02	83	Frasier Coal Seam
LMW-7	138055.1	1355483.6	1/10/1994	771.51	254	8	4	Stainless/PVC	240	254	0.02	n/a	Landsburg Coal Seam
LMW-8	135074.898	1353229.4	4/7/2004	646.97	15	9	2	PVC	7.5	13	0.02	6	Representative of Portal #3 discharge
LMW-9	135727.33	1353324	4/14/2004	743.99	160	9	2	PVC	149	159	0.02	144	Southern Sentinel Well mid-depth
LMW-10	139054.3	1355787.9	5/11/2004	618.977	450	9	4	PVC	267	287	0.02	258	Deep, near bottom of mine, northern end
LMW-11	TBD	TBD	8/24/2005	801.87	707	9	4	Stainless/PVC	697	707	0.02	688	Deep, near bottom of mine, south end
P-2	135117.598	1353212.7	4/16/2004	651.37	70	9	2	PVC	39	44	0.02	*n/a	Temporary piezo into Portal #3
LMW-12	138923.92	1355721.8	3/14/2018	625.347	30	8	4	PVC	15.5	25.5	0.02	11	North Portal shallow Sentinel Well
LMW-13R	138932.43	1355728.9	5/15/2018	625.86	151	8	4	PVC	115	140	0.02	110	North Portal deep Sentinel Well

Note
* No filter pack was installed in P-2 due to the open mine shaft at 39 feet to 44 feet. The casing was removed, and the native material collapsed around the well to 15 feet below ground surface.
TBD = to be determined. Well coordinates and measuring point elevations will be determined by a professional surveyor.

Figures



BASE MAP FROM USGS 7.5' TOPOGRAPHIC QUADRANGLES "CUMBERLAND" AND "HOBART".

CLIENT	LANDSBURG MINE SITE PLP GROUP
CONSULTANT	GOLDER
YYYY-MM-DD	2018-08-03
PREPARED	REDMOND
DESIGN	
REVIEW	
APPROVED	
PROJECT	LANDSBURG MINE SITE
TITLE	**SITE FEATURES AND MAP VIEW FOR LANDSBURG CROSS-SECTION**
PROJECT No.	923-1000.005
PHASE	1000
FIGURE	1

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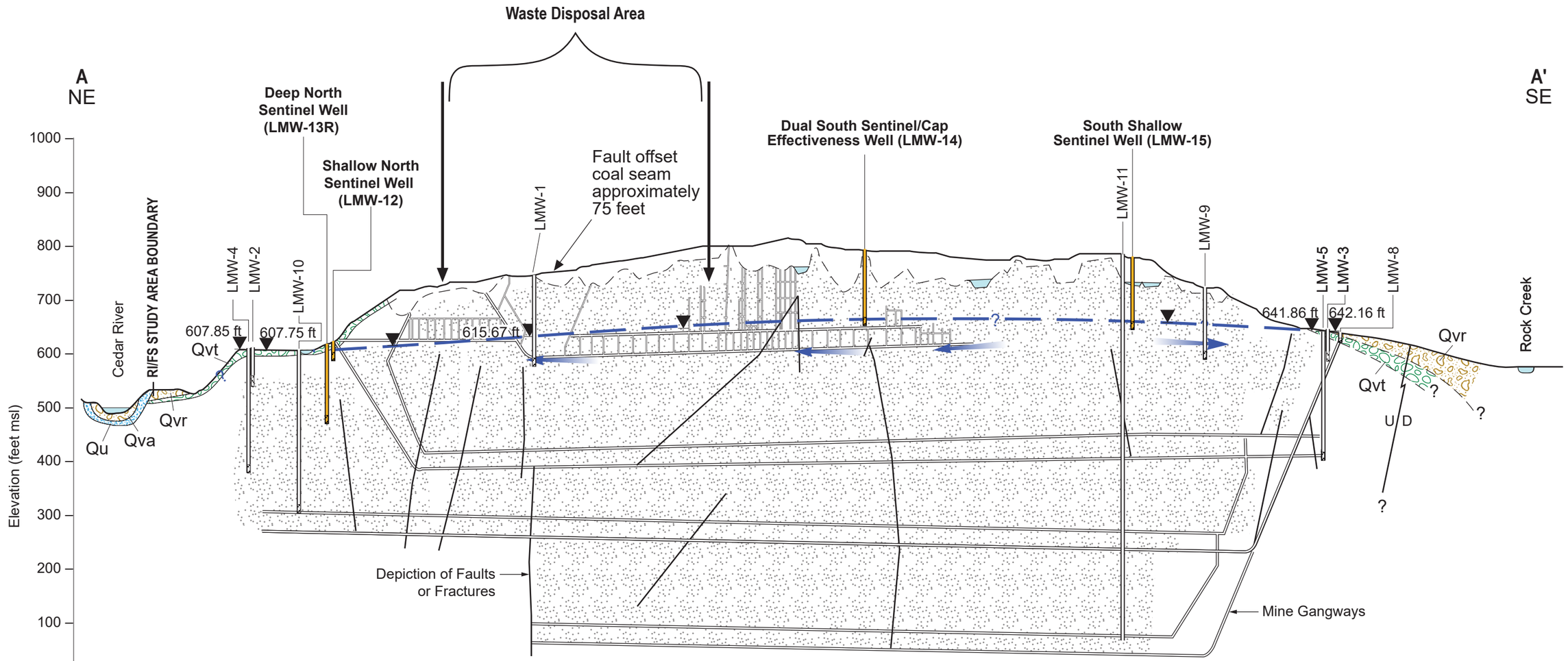

EXPLANATION

- Potentiometric surface
- Outline of trench bottom
- Water Level (ft. amsl) 2/23/94
- Qvt Till, compact mixture of gravel occasional boulders in clayey silty sand matrix
- Sandstone
- Surface water feature
- Anticipated collapsed zone within mine
- Qu Drift, till, fluvial sand and gravel, lacustrine sand, silt, clay and peat
- Qvr Recessional outwash, well sorted sand and pebble-cobble
- Qva Advanced outwash pebble-cobble gravel may include very fine sand
- Monitoring Interval
- Groundwater Flow Direction

0 500
FEET

Sources for the Geology and Mine Information:
J.E. Luzier 1969; surficial geology
State of Washington, Water Well reports
Mine Superintendant's Records
Landsburg Well Logs

NOTE: Vertical to horizontal scale ratio is 2.5:1
Wells are project normal into the strike of the Cross-Section A-A'

Assuming groundwater discharge at the north and south end of mine.

CLIENT	LANDSBURG MINE SITE PLP GROUP
CONSULTANT	GOLDER
YYYY-MM-DD	2018-08-03
PREPARED	REDMOND
DESIGN	
REVIEW	
APPROVED	
PROJECT	LANDSBURG MINE SITE
TITLE	CROSS-SECTION ALONG STRIKE AT COAL SEAM CROSS-SECTION A-A'
PROJECT No.	923-1000.005
PHASE	1000
FIGURE	2

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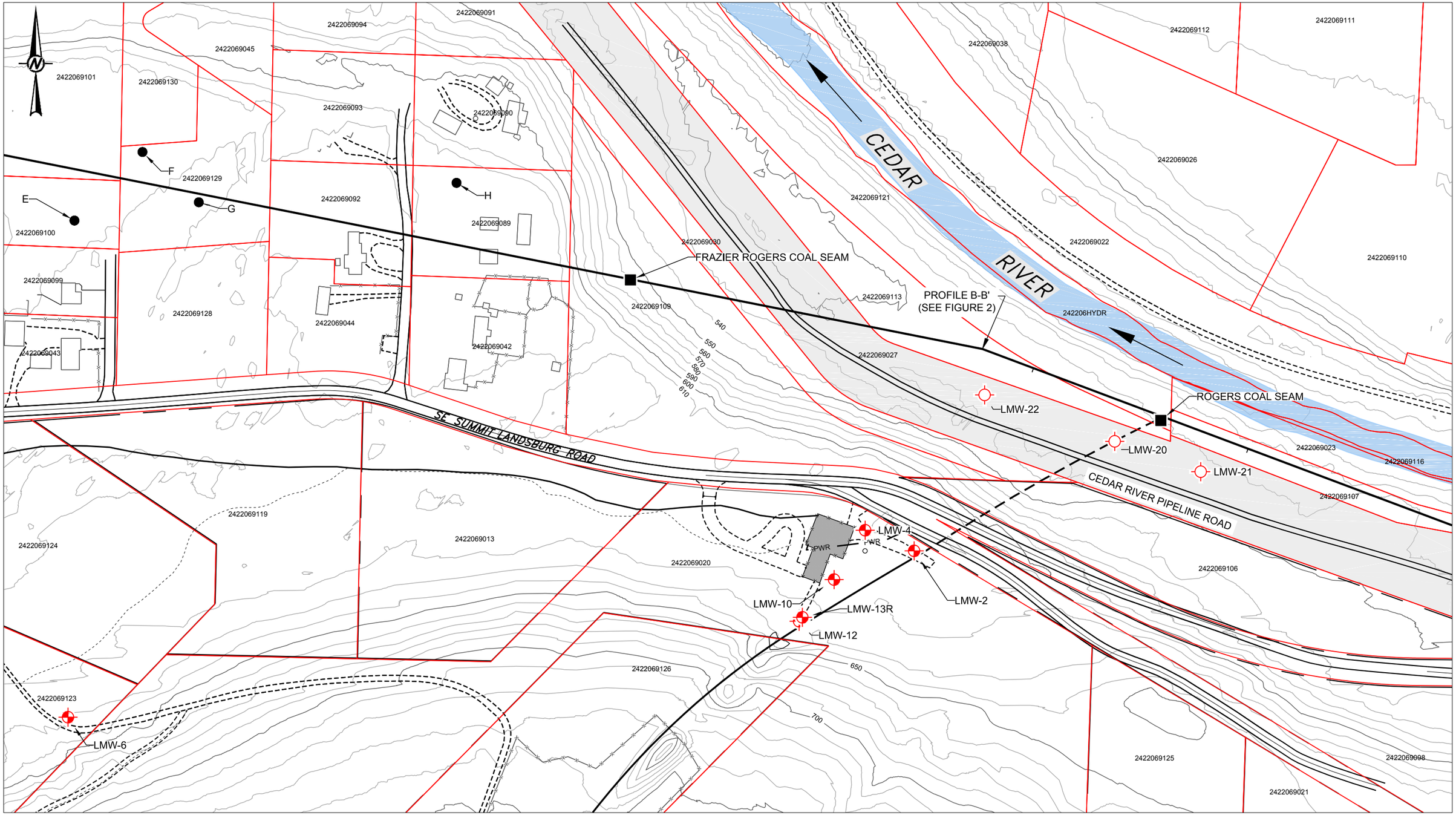

LEGEND

- PROPOSED MONITORING WELLS, APPROXIMATE LOCATIONS
- EXISTING MONITORING WELL LOCATIONS
- EXISTING PRIVATE WELL LOCATIONS

REFERENCE(S)

1. GROUND ELEVATION PROVIDED BY PUGET SOUND LiDAR CONSORTIUM, DATED 2016, DOWNLOADED IN SHAPEFILE FORMAT
2. SURVEY DRAWING PROVIDED BY TRIAD AND ASSOCIATES, DATED 2003, IN DWG FORMAT
3. PARCEL BOUNDARY PROVIDED BY KING COUNTY, DATED MARCH 2018, DOWNLOADED AS SHAPEFILE FORMAT

0 100 200
1" = 100' FEET

CLIENT
LANDSBURG MINE SITE PLP GROUP

CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-30
DESIGNED	N/A
PREPARED	NDC
REVIEWED	JSX
APPROVED	GZ

PROJECT
LANDSBURG MINE SITE
MTCA REMEDIAL ACTION

TITLE
SITE MAP, PROPOSED MONITORING WELL LOCATIONS NORTH OF THE SITE

PROJECT NO.	PHASE	REV.	SHEET
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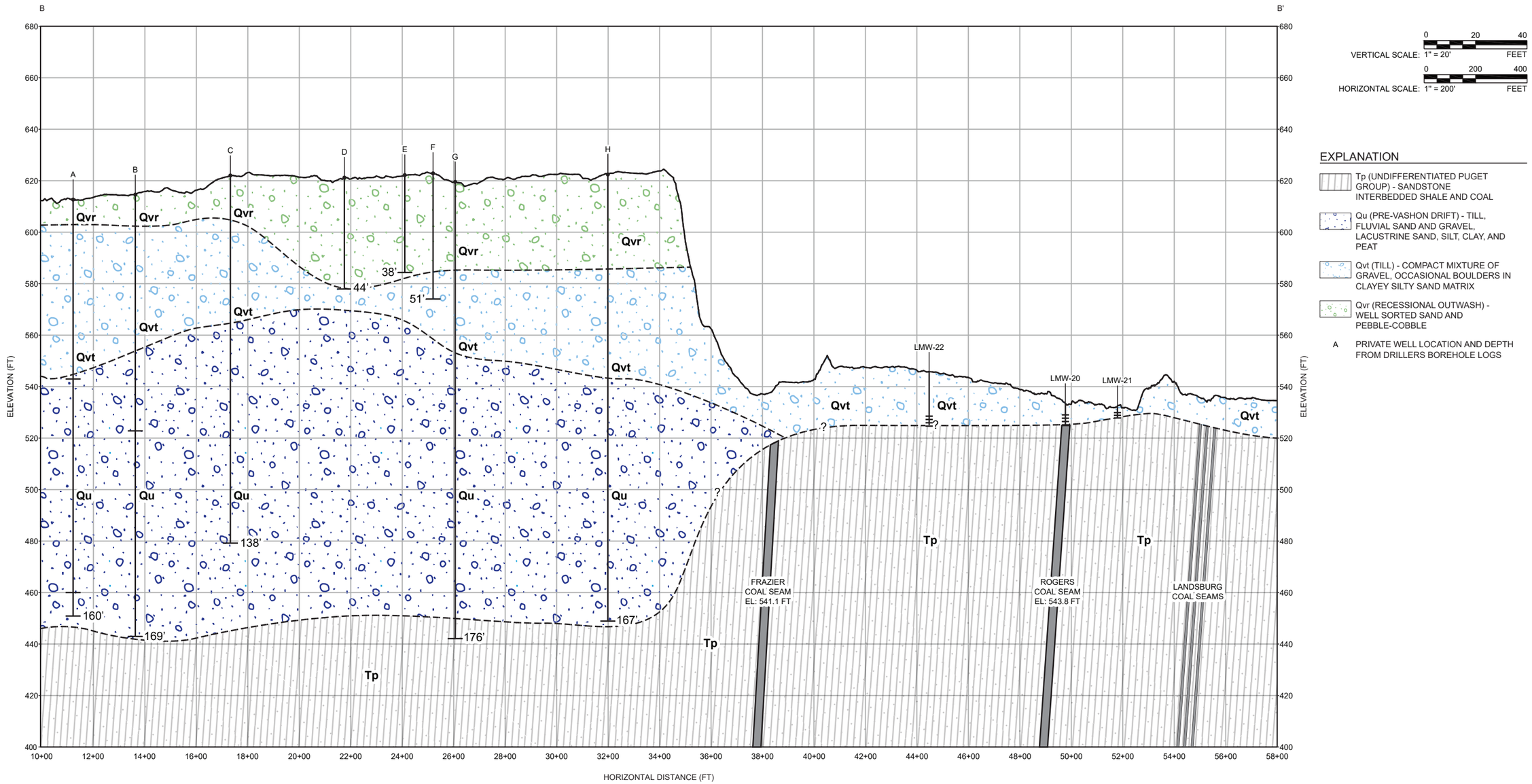

VERTICAL SCALE: 1" = 20' (0, 20, 40 FEET)

HORIZONTAL SCALE: 1" = 200' (0, 200, 400 FEET)

EXPLANATION

- Tp (UNDIFFERENTIATED PUGET GROUP) - SANDSTONE INTERBEDDED SHALE AND COAL
- Qu (PRE-VASHON DRIFT) - TILL, FLUVIAL SAND AND GRAVEL, LACUSTRINE SAND, SILT, CLAY, AND PEAT
- Qvt (TILL) - COMPACT MIXTURE OF GRAVEL, OCCASIONAL BOULDERS IN CLAYEY SILTY SAND MATRIX
- Qvr (RECESSIONAL OUTWASH) - WELL SORTED SAND AND PEBBLE-COBBLE
- A PRIVATE WELL LOCATION AND DEPTH FROM DRILLERS BOREHOLE LOGS

Sources for the Geology and Mine Information:

- J.E. Luzier 1969; surficial geology
- State of Washington, Water Well reports
- Landsburg Well Logs

NOTE:
Wells are projected normal into the strike of the Cross-Section C-C'.
Cross-sections are inferred from limited data and should be considered approximate.

CLIENT
LANDSBURG MINE SITE PLP GROUP

CONSULTANT
GOLDER

YYYY-MM-DD	2018-09-13
PREPARED	REDMOND
DESIGN	
REVIEW	
APPROVED	

PROJECT
LANDSBURG MINE SITE

TITLE
CROSS-SECTION B-B`

PROJECT No. 923-1000.005 | PHASE 1000 | FIGURE 4

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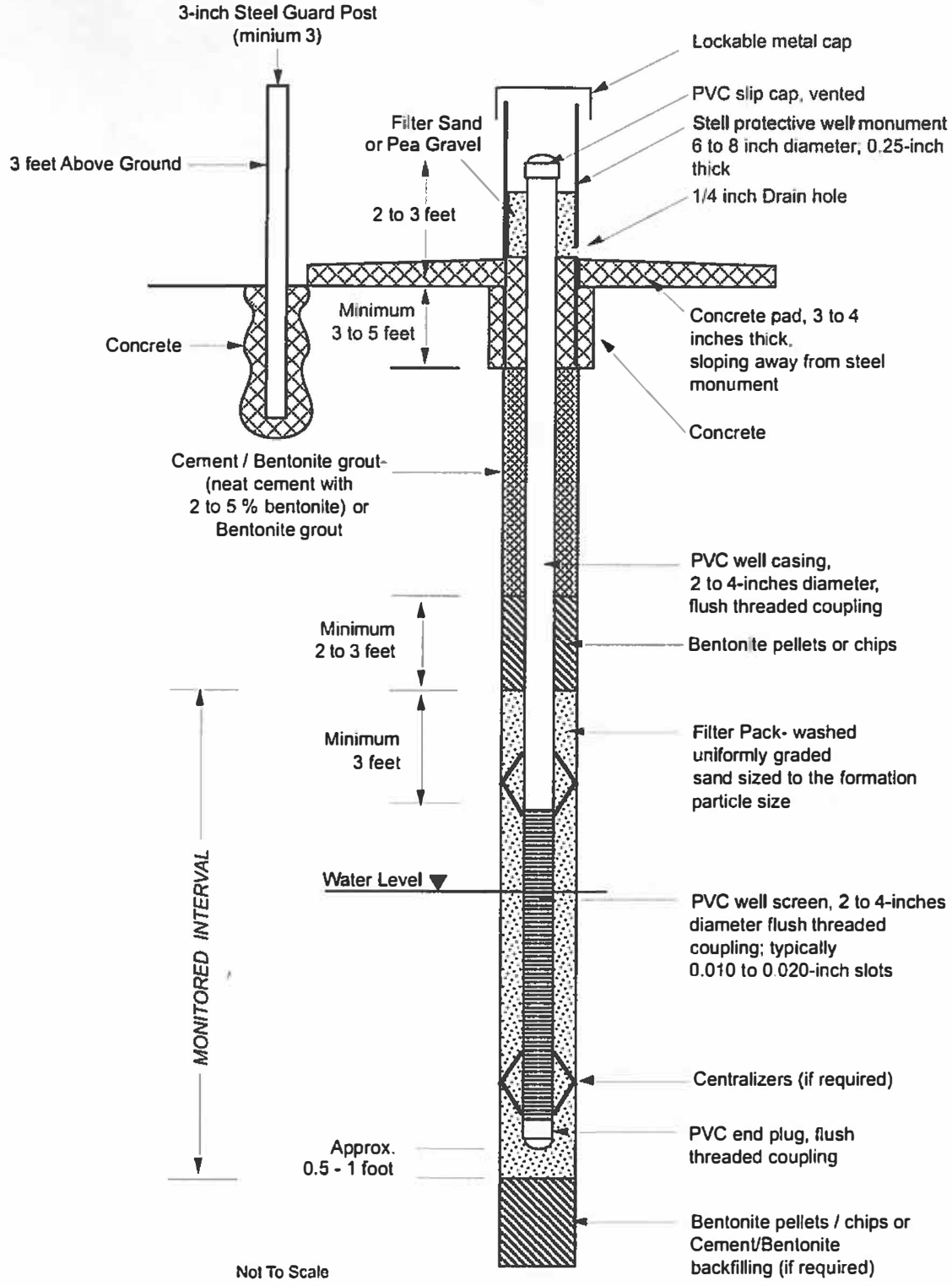
Above Ground Monument Installation



Not To Scale

CLIENT	PROJECT
PALMER COKING COAL COMPANY, LLP	LANDSBURG MINE SITE
CONSULTANT	TITLE
GOLDER	TYPICAL MONITORING WELL INSTALLATION
YYYY-MM-DD 2018-02-27	
PREPARED REDMOND	
DESIGN	
REVIEW	
APPROVED	
PROJECT No. 923-1000	PHASE 002
	FIGURE 5

G:\Palmer\CokingCoal\Coal\Landsburg\ArcMAP\9_PROJECTS\923\1000\002_Phase_Remediation\R154-02_PRODUCTION\MXD\923100_002_R154_001.mxd

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