STORMWATER MANAGEMENT REPORT

South Parcel Project

Prepared for: CalPortland

Project No. 040001-016-02 • February 23, 2021

earth + water

Aspect CONSULTING

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Contents

List of Tables

List of Figures

List of Appendices

Acronyms

Aspect	Aspect Consulting, LLC
BMP	best management practice
cf	cubic feet
cfs	cubic feet per second
DMC	City of DuPont Municipal Code
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
ft/day	feet per day
H:V	horizontal to vertical
NCRS	Natural Resources Conservation Service
NGVD 29	National Geodetic Vertical Datum of 1929
NPDES	National Pollution Discharge Elimination System
O&M	operation and maintenance
PGHS	pollution-generating hard surfaces
PGPS	pollution-generating pervious surfaces
SCS	Soil Conservation Service
sf	square feet
SWMMWW	Stormwater Management Manual for Western Washington
SWPPP	stormwater pollution prevention plan
WWHM2012	Western Washington Hydrology Model 2012

1 Project Overview

The Pioneer Aggregates South Parcel Project (hereinafter referred to as the "project") is an expansion of the existing mine operated by Glacier Northwest, Inc., doing business as CalPortland, in DuPont, Washington. The project includes horizontal expansion of mining into approximately 188 acres previously undisturbed by mining, and vertical expansion of approximately 125 acres where re-mining will deepen a portion of the existing mine. The project would extend mining at the current rate for approximately 14 additional years. This document describes the proposed stormwater management system for the project.

CalPortland is currently permitted to extract sand and gravel from a 497-acre area that includes the original mine permitted in 1997 (355 acres) and the North Parcel Expansion (142 acres), permitted in 2014. Activities on the existing site include extraction of sand and gravel, aggregate processing, concrete manufacture, and loading for transportation by barge and truck. Mining began in 1997, and the current mine has an estimated remaining life of 6 to 10 years. Mining is currently limited to 10 feet above groundwater.

The project would expand the mine area by 175 acres and allow deeper mining within portions of the existing mine. No changes are proposed to the processing area. The mine expansion would also include:

- Creation of a mitigation berm along a portion of the southern boundary to reduce noise and visual impacts.
- Creation of a wetland in the existing mine to mitigate for impacts to the Kettle Wetland.

Groundwater is present at shallow depths in the expansion area and the portion of the existing mine underlain by the Olympia beds (a lower permeability geologic unit below the glacial sand and gravels being mined). Mining in these areas requires constructing a temporary dewatering system consisting of a series of wells to draw down groundwater and allow mining to advance along the eastern perimeter of the expansion area. After removing the overlying sand and gravel, a drainage swale would be constructed in the underlying low permeability soils to intercept groundwater seepage and discharge it to a new mitigation wetland to be constructed on the bottom of the existing mine. Overflow from the mitigation wetland would flow to a new infiltration facility complete in the Steilacoom gravels on the bottom of the existing mine. Infiltrated water will join the sea level aquifer and ultimately flow into Puget Sound.

This report describes the proposed stormwater management system at completion of mining. These facilities would be constructed as mining advances and would also be used as the primary components of temporary stormwater management.

2 Summary of Minimum Requirements

The minimum requirements for stormwater management for new development and redevelopment are established in Chapters 22.01.200 and 22.01.090 of the City of DuPont Municipal Code (DMC), which collectively adopt the minimum requirements of the 2012 Washington State Department of Ecology's (Ecology) Stormwater Management Manual for Western Washington, as amended in 2014 (2014 SWMMWW; Ecology, 2014a) and as further amended by Appendix 1 of the National Pollution Discharge Elimination System (NPDES) Phase II general permit (Ecology, 2014b), which specifically addresses minimum requirements. This section describes how the proposed project complies with the nine minimum requirements identified in Appendix 1 of the Phase II NPDES permit.

As the project would disturb more than 7,000 square feet and would convert greater than 2.5 acres of native vegetation, all nine minimum requirements apply.

2.1 Minimum Requirement #1 – Preparation of Stormwater Site Plan

CalPortland will prepare a Stormwater Site Plan in accordance with Section 4.1 of Appendix 1 of the Phase II NPDES permit.

2.2 Minimum Requirement #2 – Construction Stormwater Pollution Prevention Plan

A Construction Stormwater Pollution Prevention Plan has been developed and is included as Appendix A. Much of the site will drain internally. Erosion and sediment control for the internally draining areas will generally be governed by the Sand and Gravel NPDES General Permit and the Reclamation Plan.

2.3 Minimum Requirement #3 – Source Control of Pollution

Source control best management practices (BMPs) will be implemented to prevent contamination of surface or ground waters.

2.4 Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls

The natural drainage pattern would be preserved with site development. Precipitation falling on the project site would be collected and infiltrated. From there it would join the sea-level aquifer and flow through subsurface to Puget Sound, as it does currently. There are no outfalls or other discharges of stormwater to surface water.

2.5 Minimum Requirement #5 – On-site Stormwater Management

All stormwater falling within the closed depression of the mine will be infiltrated, preserving the natural drainage pattern and retaining runoff on-site. The specific on-site stormwater management BMPs identified in List #2 of Section 4.5 of Appendix 1 of the Phase II NPDES permit are generally not applicable to the project as no hard surfaces will be created. Soil quality and depth will be managed in accordance with a Washington State Department of Natural Resources (DNR)-approved Reclamation Plan.

2.6 Minimum Requirement #6 – Runoff Treatment

Runoff treatment is required for sites that exceed minimum thresholds for pollution-generating pervious or hard surface areas as stated in Section 4.6 of Appendix 1 of the Phase II NPDES permit.

The proposed project exceeds the thresholds requiring treatment for pollution-generating surfaces. The type of treatment required is Basic Treatment as the project discharges to ground and the groundwater flows to a marine water. The site does not require Oil Control as the heavy vehicle and traffic loading does not meet the threshold for a "high-use" site.

Runoff treatment BMPs (two-celled wet ponds) are included upstream of proposed infiltration facilities. Treatment facility types were selected based on guidance in the 2014 SWMMWW. The facilities were sized to treat 91 percent of site runoff using the Western Washington Hydrology Model 2012 (WWHM2012).

2.7 Minimum Requirement #7 – Flow Control

Section 4.7 of Appendix 1 of the Phase II NPDES permit requires all projects that do not discharge to a flow control-exempt surface water to provide flow control to reduce the impacts of stormwater runoff. The proposed project meets this requirement by draining internally to infiltration ponds. Thus, the proposed surface flow leaving the site would be 0 cubic feet per second (cfs) for all storms; with sufficient infiltration capacity to infiltrate 100 percent of runoff simulated with WWHM2012.

2.8 Minimum Requirement #8 – Wetlands Protection

Additional water quality and flow control protections are required for stormwater discharges to wetlands. No stormwater will be discharged to any natural wetlands. Once reclaimed, stormwater from the eastern slope of the proposed mine expansion will be collected along with groundwater inflows and drain to a mitigation wetland to be constructed on the floor of the existing mine. There are no pollution generating hard surfaces (PGHS) or pervious surfaces (PGPS) within the drainage area tributary to the wetland.

2.9 Minimum Requirement #9 – Operation and Maintenance

An operation and maintenance (O&M) manual, consistent with Volume V of the 2014 SWMMWW will be provided for the proposed stormwater facilities and BMPs.

3 Existing Site Conditions

This section describes the existing site conditions within the active mine site and proposed project area. The existing site features and adjacent streams and wetlands are shown on Figure 1.

3.1 Site Geology

The geologic unit being mined is the Quaternary Vashon recessional outwash, predominantly comprised of sand and gravel. The first detailed study of the outwash sequence in the mine was conducted by CalPortland in 1988 and 1989 to evaluate the resource (Lonestar Northwest, 1989). At that time, borings were drilled through the sand and gravel and into the underlying silts on approximately 500-foot centers. Numerous subsequent studies were conducted for the specific area being proposed for mining in these plans, beginning largely in 1999 (CH2M Hill, 2000 and 2003; Aspect, 2004 and 2005a).

The sand and gravel outwash includes two generalized units in the area of the mine: the Steilacoom gravel, and an older Vashon outwash unit. The Steilacoom gravel is a highly permeable flood deposit that occurs at ground surface throughout the Sequalitchew Creek basin. Steilacoom gravel is the deposit that is currently being mined by CalPortland. It is estimated to be roughly 40 to 50 feet thick in the eastern expansion area.

Below the Steilacoom gravel is an older outwash deposit indicated by greater density, more silty layers, and lower hydraulic conductivity. This lower section of sand and gravel occurs in the eastern expansion area (Figure 2). It is approximately 30 to 40 feet thick.

Underlying the sand and gravel outwash are the Olympia Beds—a glacially overridden sequence of nonglacial, low-permeability silts and sands. This unit has been called the Kitsap Formation in geologic reports older than 1999 (Troost, 1999). The Olympia Beds occur at an elevation ranging from approximately 90 to 140 feet[1] in the planned mining area. This unit is estimated to be at least 40 feet thick in the project area and to occur to an elevation of 50 feet or lower (URS, Inc. and Pioneer Technologies Corporation, 2003).

Figure 2 presents a hydrogeologic cross section through the existing mine and the proposed expansion area. Depositional processes of the Steilacoom gravel eroded away the western end of the Olympia Beds and older outwash creating a discontinuity between the existing mine and the expansion area. In the eastern expansion area, the Olympia Beds hold groundwater elevations high by its relatively low permeability compared to the Steilacoom gravel to the west. The absence of Olympia Beds to the west creates a groundwater fall into the existing mine area. In this area, the

[1] All elevations presented in this report reference the National Geodetic Vertical Datum of 1929 (NGVD 29).

groundwater levels drop by over 100 feet in less than 500 feet (gradient between 0.1 and 0.2 feet/feet).

Appendix B provides more detailed descriptions of the expansion area geology and groundwater conditions.

3.1.1 Surficial Soils

According to the Natural Resource Conservation Service (NRCS) 2004 soil study for Pierce County, two surficial soil types are present in the planned mine area: Alderwood sandy gravelly loam and Spanaway sandy gravelly loam (NRCS, 2004). Both are typical of outwash gravels. The extent of these soils is shown on Figure 1. Both soils allow rapid infiltration of stormwater and their easy drainage encourages the establishment of plant communities that tolerate dry conditions.

3.2 Groundwater Conditions

Groundwater occurs at an average depth of approximately 10 to 15 feet below ground surface within the Steilacoom gravel. Groundwater levels fluctuate annually with precipitation and precipitation readily infiltrates the area soils. In the expansion area, groundwater levels are typically 7 feet higher in the winter/spring months than in summer/fall, ranging from approximately 197 to 190 feet elevation.

The aquifer is differentiated into an upper zone in the Steilacoom gravel, and a lower zone in the older outwash. The upper aquifer zone is more permeable with an estimated average hydraulic conductivity of 850 feet per day (ft/day). The lower zone is estimated to have an average hydraulic conductivity of 31 ft/day.

Four pumping tests were conducted in the aquifers beneath the site, with monitoring in both the upper and lower zones. Wells TW-1, TW-2, TW-3, and TW-4 (see Figure 1) were located and tested around the eastern boundary of the proposed expansion area. The 1- to 3-day tests provide good information on expected groundwater conditions during mining. These data, together with groundwater flow modeling and area-wide hydrology monitoring (Aspect, 2004, 2005b, 2007, and 2017b) have been used evaluate the groundwater system, and groundwater control during mining. The South Parcel Monitoring Plan (Appendix B) provides additional information on the predicted groundwater conditions during and following mining.

3.2.1 Sensitive Areas

Sensitive areas are present within the project site and would be impacted by the proposal. The following sections describe the wetlands, stream, and steep-slope sensitive areas present on-site and summarize any project activities within them.

3.2.2 Wetlands

One wetland, known as the Kettle wetland, is present within the proposed project area. It was delineated by Anchor QEA and is more thoroughly described and evaluated in their Kettle Wetland Delineation Report (Anchor QEA, 2020a).

The Kettle wetland is 1.78 acres of Category III wetland located near the eastern boundary of the existing lease area (Figure 1). The Kettle wetland would be dewatered shortly after the dewatering system is brought on line and subsequently removed by mining. The dewatering and subsequent removal would be mitigated via the construction of a mitigation wetland within the existing mine.

3.2.3 Stream

Sequalitchew Creek forms the southern boundary of the project area. In accordance with DMC 25.105.070 (4)(a), a 100-foot buffer measured from the stream bank is maintained along the stream corridor throughout the project area.

3.2.4 Steep Slopes

Steep slopes (greater than 40 percent) are present along the Sequalitchew Creek ravine and western slope facing Puget Sound. The boundary of steep slope areas was defined using ArcGIS and light detection and ranging (LiDAR) topographic data (which provides better resolution than aerial mapping in areas of dense vegetation).

In accordance with DMC 25.105.070(2), the project Geotechnical Report (Aspect, 2020) recommends maintaining at least a 50-foot buffer from the top of steep slopes. Consistent with the 2012 Settlement Agreement, the project includes a 100-foot buffer along the top of the slope along the Sequalitchew Creek ravine. The 100-foot buffer provides ample protection for steep slopes.

3.3 Site Hydrology

The existing site hydrology is dominated by evapotranspiration and infiltration. Surface soils are coarse, so precipitation falling on the site infiltrates and either is ultimately transpired by vegetation or flows in the subsurface to Puget Sound or to a lesser extent to Sequalitchew Creek (e.g., through the seeps in the ravine, such as the Seep wetland located near the proposed confluence).

The expansion area is generally flat and vegetated, with some cleared areas and gravel roads. Conifer forest, dominated by Douglas fir, covers 90 percent of the expansion area. A smaller clearing, approximately 13 acres in size in the northern portion of the expansion area, was once considered a prairie-type habitat, but is now dominated by Scot's broom. Surficial soils, shown on Figure 1, are classified by the NRCS Soil Survey (2004) as Spanaway gravelly sandy loam, which are characterized as "deep somewhat excessively drained soils formed in glacial outwash."

The Kettle wetland is the only surface water body within the existing mine or expansion area. The Kettle wetland is hydrologically connected to the Vashon aquifer. The Kettle wetland receives water primarily from groundwater inflows, but also from direct precipitation and any runoff generated within the kettle that surrounds it. The Kettle wetland does not have a surface discharge.

The active mine forms a closed depression so all stormwater generated within the mine either infiltrates or evaporates. Exposed soils within the existing mine consist of bare sand and gravel side slopes, where active mining is occurring, and compacted roads and equipment operating areas. Within the reclaimed portions of the mine the side slopes have been covered with topsoil and revegetated, and fine soil resulting from gravel washing (i.e., belt press fines) has been placed on the mine bottom. There have been no water quality or flooding problems associated with stormwater management within the active mine. There are no surface water discharges from the mine.

Several industrial warehouses, including Industrial Place and the Amazon Fulfillment Center, are located east of the project. These warehouses manage stormwater through infiltration, preceded by water quality treatment. There is no off-site run-on to the proposed project site.

Existing site stormwater conditions were not analyzed with a hydrologic model because there is no runoff currently occurring. As stormwater management for the mine will largely use infiltration, hydrologic model results for the existing condition are not important for correctly designing the water quality treatment and infiltration facilities.

4 Developed Site Conditions

The project would allow for the extraction of approximately 25 million cubic yards of sand and gravel from the expansion area and newly dewatered areas of the existing mine. Postmining conditions are shown on Figure 3. The project includes multiple two-cell stormwater treatment ponds and infiltration basins. The project also includes the following additional elements:

- A constructed wetland to mitigate impacts to the Kettle wetland. Groundwater emanating from the toe of the eastern mine slope of the South Parcel will be collected and conveyed to the wetland to be constructed within the existing mine.
- A berm along the southern boundary to mitigate noise and visual impacts.
- Grading for two future roads descending into the mine from the southwest corner. The road beds would be graded, but would not be paved as a component of this project.

4.1 Dewatering Plan

Dewatering will be required for control of groundwater during mining as outlined in the South Parcel Monitoring Plan (Monitoring Plan; Aspect, 2017a).

Mining of the South Parcel will proceed slowly from the north to the south over a period of 5 to 8 years, extracting gravel to create a broad trough along the eastern property boundary. Wells will be installed and pumped in advance of mining to intercept groundwater and dry out the gravels for mining. The purpose of mining a trough is to minimize the amount of time that active dewatering by pumping wells is required. Once mining of each section of trough is completed, the adjacent wells can be turned off, allowing groundwater to passively seep from the stable mine slope and flow by gravity to an infiltration facility on floor of the existing mine. After mining the trough along the perimeter, gravel will be extracted from the interior area.

The dewatering plan consists of four steps:

Step 1 – Initial Pumping Test. The initial step is a 60-day pumping test that is completely reversible (i.e., no gravel will be extracted during the test). The results of that test will be analyzed and evaluated, and plans adjusted as necessary prior to commencing the next phase.

Step 2 – Preparation for Mining/Dewatering Test. The second step involves installing and pumping additional dewatering wells to lower water levels in the first mine segment in preparation for mining. This step would last about 6 months and functions as a greatly expanded pumping test. As with the first step, it is also completely reversible.

Step 3 – Active Dewatering during Mining. This step involves mining the trough described above. Additional dewatering wells will be installed and pumped as mining progresses. Mining would begin at the location farthest from the Edmond Marsh and Sequalitchew Creek and proceed slowly south. Completing the trough would require 5 to 8 years depending on market conditions and the success in meeting predicted groundwater levels. The potential impact on groundwater levels builds slowly over time as wells are added and mining progresses south. This allows ample opportunity to monitor and adapt to the conditions observed before mining proceeds into each dewatered segment.

Step 4 – Cessation of Active Dewatering. The final step begins when mining of the trough is complete and the last dewatering well is turned off. Groundwater, no longer intercepted by wells, would form seeps at the toe of the eastern mine slope. It would flow by gravity through newly created wetlands and a vegetated swale to an infiltration pond located at the bottom of the existing mine. Groundwater discharge from the toe of the slope would continue in perpetuity. Once this step has begun, further mining activities in the interior of the South Parcel would not affect groundwater.

4.2 Mine Phasing

Mining activity has been divided into four segments, each consisting of two to four sequence areas. Sequence areas generally represent 1 to 2 years of mining, but the actual rate of mining will vary based on market conditions unforeseeable at this time. The mining sequence is shown on Sheet C3 of the Conditional Use Permit plan set.

Segment 1. Mining would begin from the bottom of the existing conveyor in the northeast corner of the existing permit area. Mining in Segment 1 involves excavating a deep, relatively narrow trough going south along the eastern property boundary. The trough would have a bottom width of about 200 feet, allowing room for a conveyor with access roads on each side, and toe ditches to convey stormwater and any intercepted groundwater.

The trough would begin in the existing mine area and would proceed to advance to the southeast, parallel to the conveyor, until reaching the eastern boundary of the expansion area. Mining would then turn to the south, advancing the trough along lease boundary for approximately 2,500 feet. From there, the trough would turn to the southwest and would be advanced about 2,000 feet and widened out

Segment 1 would be graded to drain to the north to a new water quality treatment pond and infiltration pond (Pond C) located in the existing mine.

Segment 2. Mining in Segment 2 would proceed to the northwest, ultimately connecting to the existing mine excavation. As the last sequence of Segment 2, mining would return to excavate the benches in the southeast corner of the expansion area.

Segments 3 and 4. Segments 3 and 4 involve extracting material from the center of the expansion area and existing mine. Mining would start at the southern portion of the trench and proceed west toward the existing mine. On reaching the existing mine, mining would start again from the trench in the next Segment to the north. The conveyor would be retracted as mining proceeds to the north.

4.3 Developed Site Hydrology

Site hydrology for developed conditions was evaluated using guidance provided in the 2014 SWMMWW. The WWHM2012 was used for sizing of the infiltration and water quality facilities per Ecology standards. Model input and out for WWHM2012 is included in Appendix C.

4.3.1 Basins

The site was divided into five drainage basins, labeled C, D, E1, E2, and E3[2]. These drainage basins were based on the proposed topography (Figure 4). A brief description of drainage patterns of each basin follows.

Basins C and D drain internally to infiltration ponds located in the existing mine and include about 390 acres of the existing mine and expansion area. When mining is completed, each basin will include mine side slopes, large areas of rolling terrain where sand and gravel will be excavated exposing the lower-permeability Olympia Beds, and a relatively flat area at elevation 25 to 50 feet in the bottom of the existing mine.

Basins E1, E2 and E3 consists of 92.6 acres of the mine side slopes and mitigation wetland which drain to the ditches designed to capture and convey groundwater emanating from the toe of the mined slope once active dewatering has ceased. Basin E1 consists of the slopes on the southern and southwestern corner of the mine as well as the mitigation wetland itself. Basin E1 drains to the mitigation wetland, then eventually infiltration pond E. . Basin E2 includes the western slopes that will drain to the ditch that conveys outflow from the wetland to the infiltration pond; it also includes infiltration pond E. Basin E3 consists of the eastern slopes that drain to the groundwater capture trench running along the toe of those slopes.

4.3.2 Land Types

Each basin was subdivided into smaller areas based on soil types, vegetative cover, and slope (Figure 4). The total areas calculated for each resulting land classification are presented in Table 1.

Table 1. Land Types by Basin in Acres

	Till Lawn			Outwash Lawn				Imperv.	
Basin	Flat	Mod.	Steep	Flat	Mod.	Steep	Wetland	Steep	Total
C	57.5	49.3	20.7	19.2	0.0	14.4	0.0	1.0	162.1
D	11.9	144.1	26.3	4.0	41.5	0.0	0.0	0.0	227.8
E1	2.2	0.0	0.0	0.0	0.0	34.1	4.3	0.0	40.6
E2	10.5	0.0	0.0	3.5	0.0	20.1	0.0	0.0	34.2
E3	0.0	0.0	0.0	0.0	0.0	17.9	0.0	0.0	17.9
Total	82.1	193.5	47.0	26.6	41.5	86.5	4.3	1.0	482.5

[2] Basins A and B are part of the North Parcel Mine Expansion (Aspect, 2012).

After the final phase of mining is complete, the developed site will be primarily composed of two types of pervious soils:

- Advance outwash and/or Steilacoom gravel deposits, which were modeled as outwash (Soil Conservation Service [SCS] soil type A/B), and
- Olympia Beds, which will be still covered by about 10 feet of gravel left in place after mining, but were conservatively modeled as till (SCS soil type C).

WWHM2012 uses three slope classifications: flat (0 to 5 percent slope), moderate (5 to 15 percent slope) and steep (greater than 15 percent slope). Vegetation categories are lawn, pasture, or forest, of which lawn generates the most runoff and is typically used to represent developed landscapes even if actual plantings will eventually more closely resemble a pasture or forest. As such, lawn was used as the vegetation for all land uses in the model.

The WWHM2012 categories were applied to different areas of the mine as follows:

- Till Lawn – Used for the Olympia Beds (even though overlain by 10 feet of gravel), areas of the existing mine where belt press fines have been placed (assumed to be 75 percent of the mine floor west of the edge of the Olympia Beds), and the mitigation berm.
- Outwash Lawn – Surfaces comprised of advance outwash and/or Steilacoom gravel, including mine side slopes, and the terraces in the southwest corner of the South Parcel. Twenty-five percent of the mine floor west of the edge of the Olympia Beds was assumed to be outwash lawn.
- Impervious – The surface of the compacted gravel access road in Basin C.

4.3.3 Incorporating Groundwater Inflow

Groundwater discharges were added to the WWHM2012 model for Basin E to ensure the infiltration pond has adequate capacity to infiltrate captured groundwater in the long-term.

A three-dimensional groundwater model was used to predict groundwater discharge at the toe of the mined slope after the cessation of active dewatering (i.e., in Step 4). The model results are documented in the Groundwater Model Update (Aspect, 2017b).

Groundwater discharge at the toe of the mine slope will vary from year to year and month to month. The maximum, average, and minimum groundwater discharges predicted by the model over the 12-year period simulated are shown on Figure 5. The maximum predicted groundwater discharge was 13.7 cfs, occurring in November, and the minimum was 4 cfs.

For design of infiltration pond E, groundwater inflow was conservatively assumed to be the maximum predicted by the model for each month (i.e., the blue line shown on Figure 5). A time series of the maximum monthly values was created and added as an inflow to the infiltration pond in WWHM2012. The maximum monthly values were used for all years in WWHM2012, regardless of the precipitation occurring in that year.

4.3.4 Peak Flows

Model-predicted peak flows for each basin are shown in Table 2. These flows represent the inflow to the infiltration ponds. The 15-minute time-step peak flows for the 100-year event ranged from 14.1 cfs for Basin E to 68.9 cfs for Basin C (Table 2).

Table 2. 15-Minute Peak Flows in cfs

Basin	Return Interval		
	2-year	**25-year**	**100-year**
C	7.2	31.8	55.9
D	9.5	42.8	75.7
E	14.2	16.3	17.1

5 Proposed Drainage System

This section describes the permanent drainage system that would be constructed as mining advances and would continue to operate after completion of mining and dewatering. The permanent system consists of water quality treatment facilities, infiltration ponds, and a network of open ditches to convey stormwater.

5.1 Water Quality Facilities

There are two water quality treatment facilities proposed for the project. The infiltration ponds in Basins C and D are preceded by two-cell wet ponds for solids settlement.

The volume of the water quality design storm for each basin was calculated using WWHM2012 (Table 3). Each water quality wet pond was designed to hold the BMP water quality volume determined by the model.

Table 3. Water Quality Design Volumes

Basin	Volume of Water Quality Storm in cf	Type of Settling Pond	Size Factor	Volume Required in cf
C	264,845	Basic Wet Pond	1	264,845
D	372,438	Basic Wet Pond	1	372,438

Notes: cf = cubic feet

The resulting wet-pond designs are summarized in Table 4. The ponds range in depth from 6 to 7 feet deep and each have 3:1 horizontal to vertical (H:V) side slopes. Two-celled ponds were designed to provide 30 percent of required storage in the first cell. Pond geometry was shaped to provide a flow path length to width ratio at least 3:1 at mid-depth. Each pond is equipped with 1 foot of freeboard and the upstream cell of each two-cell facility is designed to hold 1 foot of silt. The first cell of each wet pond would be lined with a compacted till layer a minimum 18 inches thick and compacted to 95 percent to retain water at all times, improving wet-pond function. The second cell would be unlined to promote infiltration.

Table 4. Wet Pond Dimensions

Pond	Cell	Depth in feet	Volume Provided in cf	Volume Required in cf
C	1	6	79,704	79,453
	2	7	187,614	185,391
D	1	6	111,816	111,731
	2	7	263,739	260,707

Notes: cf = cubic feet

5.2 Constructed Mitigation Wetland

As described in Section 3.2.1, above, the 1.78-acre Kettle wetland will be dewatered and ultimately removed by the proposed mining activities. To mitigate these wetland impacts, a constructed mitigation wetland is included in the proposed drainage system.

Groundwater discharges from the southern and southeastern mine slope and stormwater runoff from Basin E1 will provide the water source for the mitigation wetland. The groundwater source will provide a continuous inflow to the wetland throughout the year. Upon the completion of mining and revegetation, Basin E1 would not contain any PGPS and thus does not require water quality treatment.

5.3 Infiltration Studies

The three proposed infiltration ponds (C, D and E) will receive runoff from approximately 162, 228, and 93 acres, respectively. The ponds would be located on native outwash soils on the floor of the existing mine, as shown on Figure 3. These locations were evaluated and found suitable for the proposed facilities.

The infiltration ponds were designed to infiltrate all stormwater and groundwater generated within the mine. Key dimensions of the infiltration ponds are summarized in Table 5. The ponds were assumed to be rectangular with 3H:1V slopes, and a total depth of 6 feet (5 feet of active depth with 1 foot of freeboard).

The infiltration properties of soils in the pond areas were estimated using the methodology provided in Volume III, Chapter 3.3.6, Section 3 of the 2014 SWMMWW. This methodology relates infiltration rates to the grain-size characteristics of the soil. Grain-size information was obtained from CalPortland's gridded borings at the location and depth closest to the proposed pond locations (Lonestar Northwest, 1989). Data from the two borings closest to each infiltration pond, in the 168- to 188-foot depth range (which corresponds to the soils below the bottom of the infiltration ponds) were used to estimate infiltration rates. Conservative correction factors of CF_v = 0.33, CF_t = 0.40, and CF_m = 0.9 were applied.

The long-term infiltration rates corresponding with these grain-size results are 8.2, 8.1, and 8.2 inches per hour for Ponds C, D, and E, respectively. Calculations for the estimation of infiltration rates are presented in Appendix D.

The 'size infiltration pond' function in WWHM2012 was then used to determine the appropriate size of the infiltration pond, with preliminary dimensions being based on the amount of storage needed to fit the design volume simultaneously, and reducing it to account for infiltration, evaporation, and design storm hydrograph (Table 5). Infiltration Pond E also received groundwater inputs, as described above.

Table 5. Infiltration Pond Dimensions

Pond	Depth in feet (without freeboard)	Bottom Area in sf	Top Area at Max Water Level in sf	Side Slopes
C	5	50,762	66,748	3H:1V
D	5	37,655	68,755	3H:1V
E	6	57,807	82,120	3H:1V

Notes: sf = square feet

5.4 Conveyance

The conveyance system will consist of a network of open ditches that collect and route stormwater to the water quality facilities described above. In places where the slope is less than 2.5 percent, the ditches would be vegetated. Steeper ditches would require lining with cobbles for slopes up to 5 percent, or rip rap for steeper. The conveyance system was designed to convey the 25-year peak flow.

5.5 Dewatering System Flows and Discharges

The proposed dewatering system consists of two lines of wells located east and west of Segment 1 of mine excavation (Sheet C3 of Construction Plan Set). Groundwater pumped from these wells would be discharged to an infiltration pond on the floor of the existing mine.

The dewatering system would be constructed in phases ahead of the advancing mine excavation along the new creek corridor. Three phases are planned with each phase adding new pumping wells. As mining advances beyond the dewatering wells, the wells will be turned off, allowing groundwater to naturally discharge at the toe of the mined slope. The groundwater discharges will be collected in ditches and ponds and conveyed with the stormwater system into Pond E in the existing mine.

5.5.1 Groundwater Discharges to Stormwater System

Discharges to the infiltration ponds constructed for the stormwater system would include dewatering water from the wells located along the northern (DW-1 through DW-5) and west side of the Segment 1 mining area, and groundwater inflows to the base of the mine as mine sequences are completed and dewatering wells are turned off. Dewatering modeling results (Appendix A) indicate permanent discharges to the stormwater system, ultimately reaching Pond E, would reach a potential maximum of 13.7 cfs (Table 6).

Dewatering model results were incorporated into the WWHM2012 model by building a 15-minute time-step time-series flow file with the maximum monthly average groundwater inflow (in cfs) for each month. This time series uses the maximum average flow to produce a conservatively sized pond. The time series was inputted into infiltration Pond E along with stormwater runoff from watershed E, and the pond was sized based on those two inputs.

Table 6. Groundwater Discharges to Infiltration Pond E in cfs

Dewatering Step		Average Annual Pumping Rate	Average Wet Season Pumping Rate	Groundwater Inflow to Base of Mine
1	Initial Pumping Test	3.6	5.5	-
2	Preparation for Mining/Expanded Pumping Test	5.2	8.8	-
3	Active Dewatering during Mining	6.9	12.2	-
4	Cessation of Active Dewatering	-	-	6.6 - 13.7

Notes: cfs = cubic feet per second

Dewatering discharges would be conveyed to internal infiltration Pond E through a pipeline system. The pipeline would parallel the well alignment, starting along the expansion area lease boundary and running north, then curving in and downslope near the existing access road from the processing plant.

6 Off-site Analysis

A qualitative downstream analysis was conducted in accordance with Option Guidance #2 of the 2014 SWMMWW.

Relevant and available information on the study area was reviewed, including boring logs from on-site resource evaluation, WRIA 14 basin planning efforts, DNR Forest Practices Activity Map, wetland inventories, and groundwater studies from adjacent sites (Fort Lewis Landfill 5). The Kettle wetland is the only surface water body present on the site. No streams or drainage channels were identified on the project site on the DNR Forest Practice Activity Map for the area. There were no existing drainage problems identified.

The off-site analysis indicated that there would be no potential impacts from the proposed stormwater management approach of infiltrating all stormwater within the closed depression of the proposed mine.

6.1 Spills and Discharges of Priority Pollutants

Mining equipment primarily would operate within the closed depression of the mine, which reduces the potential for discharges to surface water. A stormwater pollution prevention plan (SWPPP) has been developed for mine as a component of complying with the Sand and Gravel General NPDES permit. The SWPPP BMPs for mobile fueling, vehicle and equipment maintenance, and spill prevention and response. However, due to the internally draining nature of the project, discharges to surface water are not expected.

6.2 Discharges to Groundwater Recharge Zones

The infiltration ponds would discharge to the unconfined aquifer that in turn flows to Puget Sound. The stormwater discharges would be treated to remove suspended sediments prior to discharge. As infiltrated stormwater is treated and vehicle activity is generally limited to a few pieces of equipment, there is little risk of contamination of the shallow aquifer. There are no water supply wells downgradient of the site, so the proposed activities will not affect local drinking water supplies.

7 Special Reports and Studies

The following special reports and studies have been prepared as a component of the South Parcel Mine Expansion:

- Groundwater Model Update (Aspect, 2017b)
- Geotechnical Report (Aspect, 2020)
- Kettle Wetland Delineation Report (Anchor QEA, 2020a)
- Critical Areas Report (Anchor QEA, 2020b)

8 Other Permits

This section provides a list of other permits and approvals required for the project that would include conditions that affect the drainage plan. Those permits and approvals are:

- Sand and Gravel General NPDES Permit, issued by Ecology.
- Surface Mine Reclamation Permit, issued by DNR.

9 References

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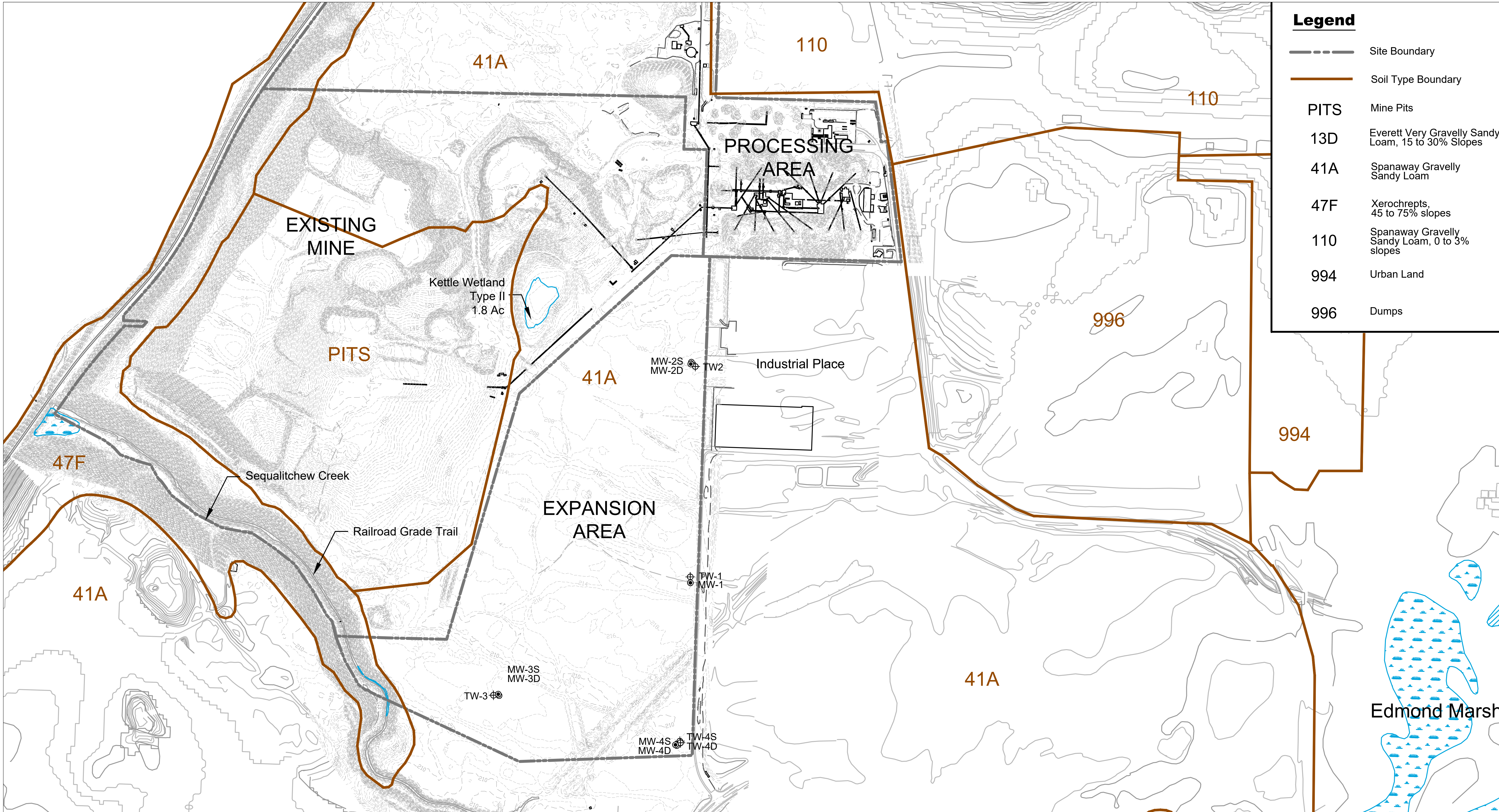
10 Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of CalPortland for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

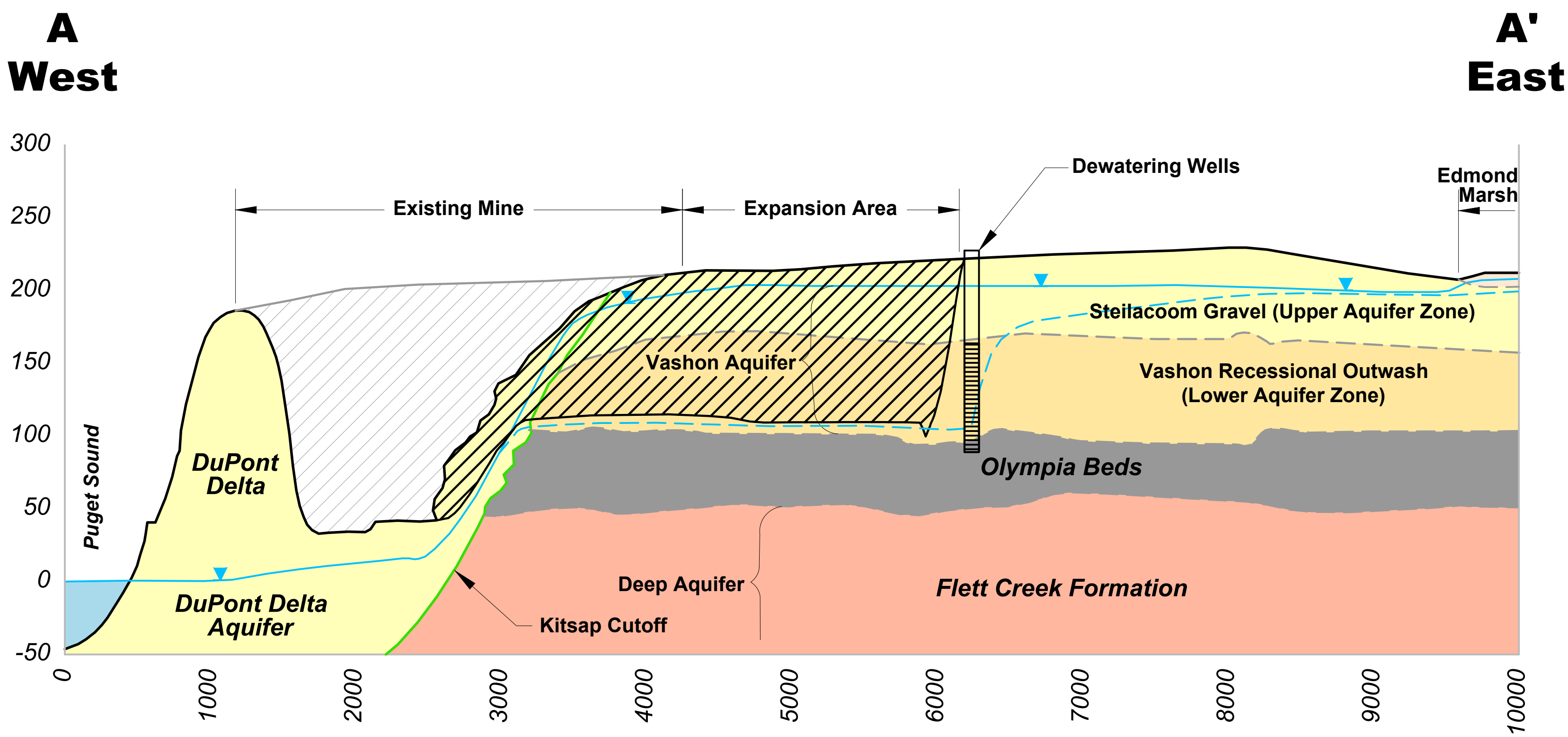
FIGURES



EXISTING CONDITIONS
DuPont Mine Expansion
CalPortland
DuPont, Washington

Aspect CONSULTING
Nov-2020
PROJECT NO. 040001
BY: BMG/CMV
REVISED BY: -
FIGURE NO. 1

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2020-11 SW Mgmt Report Figures\040001-01.dwg Figure 1 || Date Saved: Nov 25, 2020 4:17pm || User: cvanslyke



Note: Cross-Section from CH2M Hill, 2003, Figures 1-2 and 1-3.

Legend

Existing Water Table

Future Water Table

Area to be Mined

0 125 250 Feet

0 1250 2500 Feet

Horizontal Scale: 1" = 1250'
Vertical Scale: 1" = 125'
Vertical Exaggeration 10x

GENERALIZED GEOLOGIC CROSS-SECTION

DuPont Mine Expansion
CalPortland
DuPont, Washington

Aspect CONSULTING

Nov-2020	BY: BMG/CMV	FIGURE NO. 2	
PROJECT NO. 040001	REVISED BY: -		

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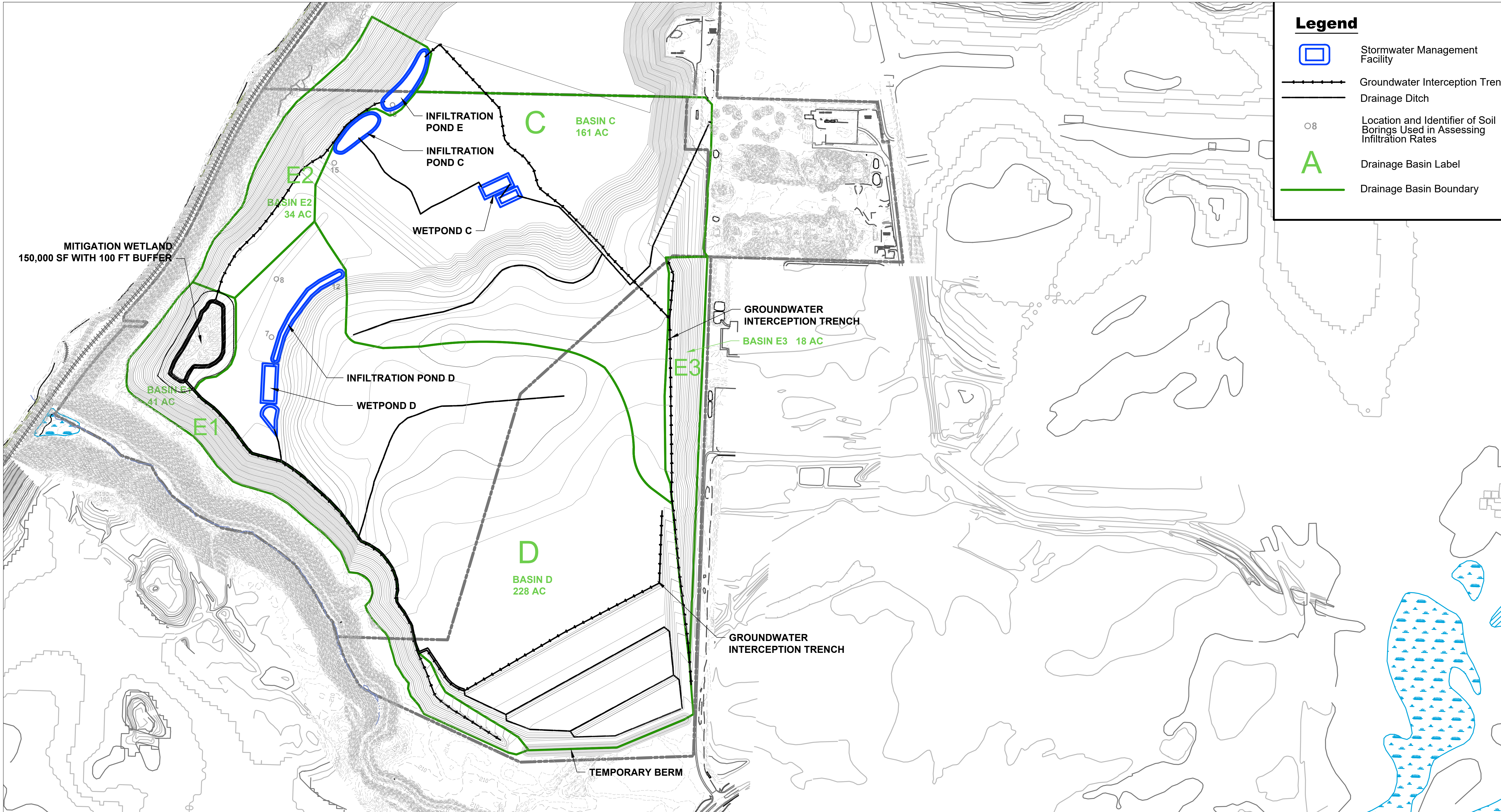
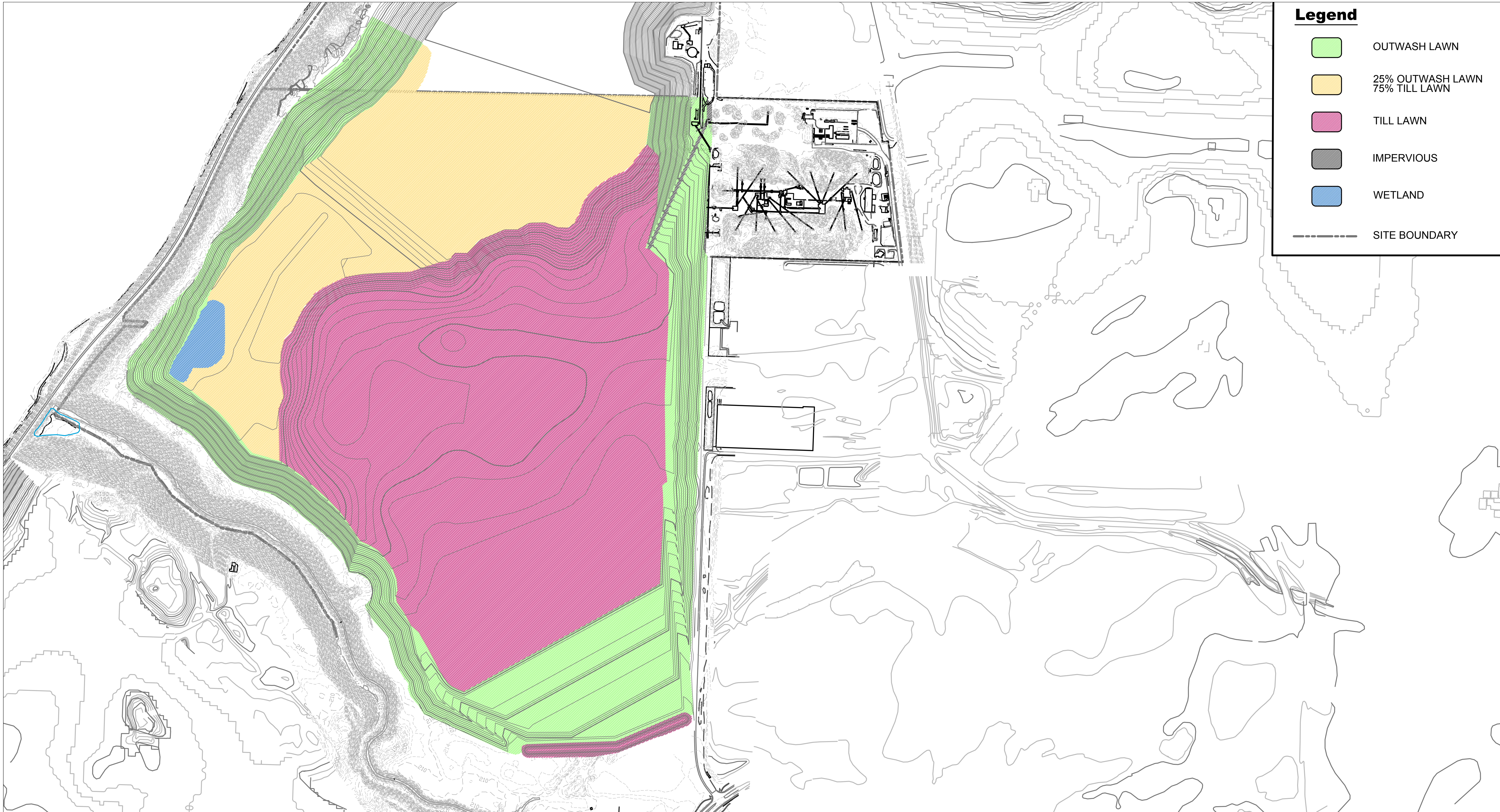


0 800 1600
Feet

PROPOSED CONDITIONS
CalPortland
Dupont, Washington

Aspect CONSULTING

Nov-2020	BY: BMG/CMV	FIGURE NO.
PROJECT NO. 040001	REVISED BY: -	3

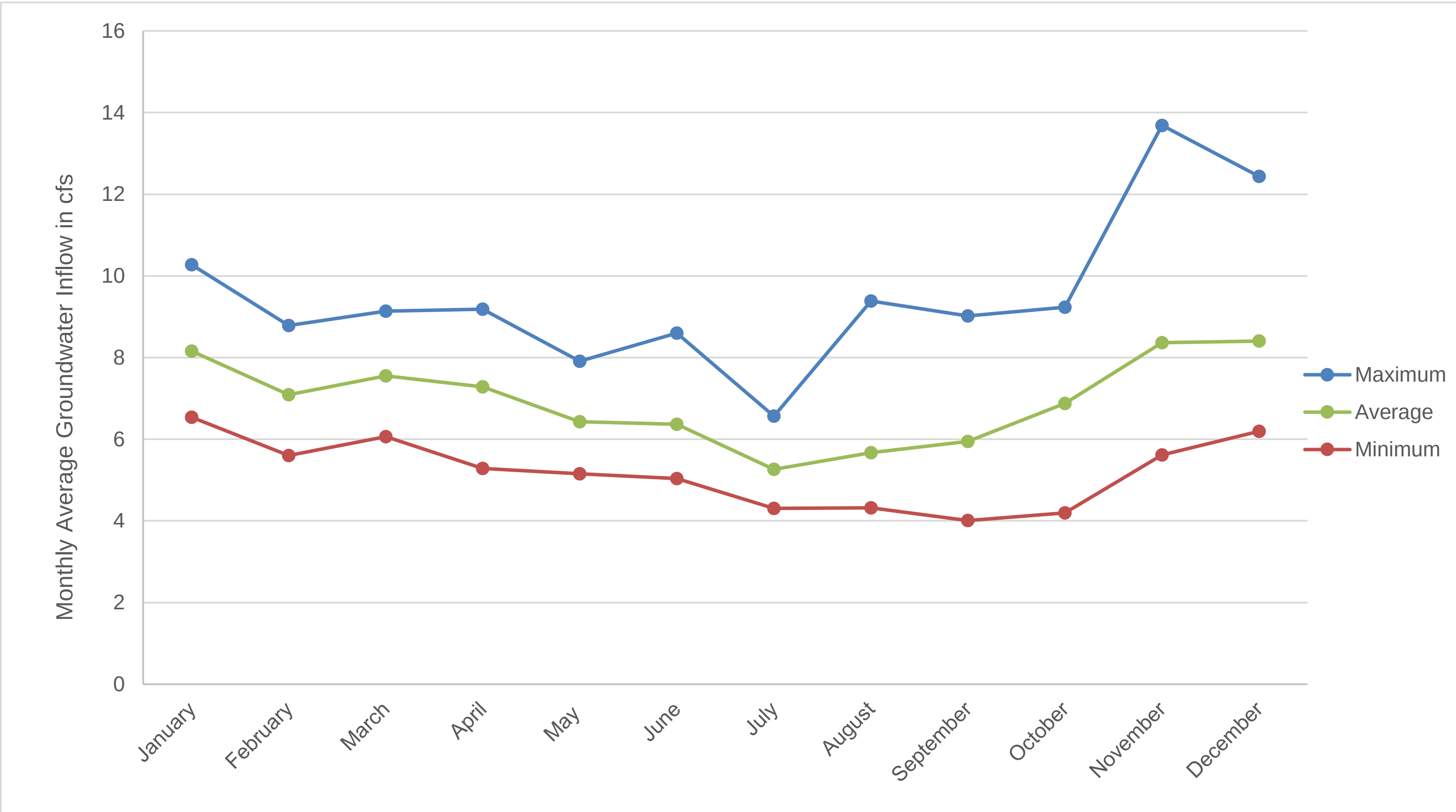


STORMWATER MODEL INPUT

DuPont Mine Expansion
CalPortland
DuPont, Washington

Aspect CONSULTING

Nov-2020	BY: BMG/CMV	FIGURE NO. 4
PROJECT NO. 040001	REVISED BY: -	



Aspect Consulting
02/23/2021
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Figure 5
Monthly Variation in Groundwater Inflows
Preliminary Stormwater Management Report
DuPont WA

APPENDIX A

Construction Stormwater Pollution Prevention Plan

CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

Pioneer Aggregates South Parcel Project

Prepared for: CalPortland

Project No. 040001-016 • February 23, 2021

earth + water

Aspect CONSULTING

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CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

Pioneer Aggregates South Parcel Project

Prepared for: CalPortland

Project No. 040001-016 • February 23, 2021

Aspect Consulting, LLC

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Contents

Introduction

This document describes the Construction Stormwater Pollution Prevention Plan (CSWPPP) for CalPortland's Pioneer Aggregates South Parcel Project (hereafter referred to as the project) in DuPont, Washington. The project includes a 188-acre expansion of the existing mine.

Throughout the project, the following basic principles will form the core of the approach to preventing erosion at the site:

- Design the project to drain internally.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of area exposed.
- Keep runoff velocities low by encouraging infiltration where possible.
- Retain sediment on the site.
- Thoroughly monitor the site and maintain erosion and sediment control (ESC) measures.

The site will drain internally, eliminating the risk of off-site sediment delivery from erosion. ESC measures will be governed by the Sand and Gravel NPDES Permit requirements and Reclamation Plan.

Minimum Requirements

City of DuPont Municipal Code 22.01.200 requires that all projects comply with the *2012 Stormwater Management Manual for Western Washington* as Amended in December 2014 (2014 SMMWW; Ecology, 2014). Minimum Requirement #2 states that all projects disturbing 7,000 square feet or more prepare a Construction Stormwater Pollution Prevention Plan (SWPPP). The SWPPP contains 15 erosion and sediment control element requirements. The requirements are described individually below, with the code requirement in italic bullets followed by a description of how that requirement has been addressed in the proposed project. The summary of code requirements is omitted for elements that are not applicable.

Element #1: Preserve Vegetation/Mark Clearing Limits

- *Before beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area.*
- *Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practical.*

Clearing limits for the mine will be marked with frequent and brightly colored flagging or posts. Given the size of the site, use of continuous clearing limit fencing would be economically and environmentally wasteful. The topsoil layer will be temporarily removed to facilitate mining, but those soils will be stockpiled on-site and used in mine reclamation in accordance with a Surface Mine Reclamation Permit from the Washington State Department of Natural Resources (DNR).

Element #2: Establish Construction Entrance

- *Limit construction vehicle access and exit to one route, if possible.*
- *Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent Best Management Plans (BMPs), to minimize tracking sediment onto roads.*
- *Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.*
- *If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or pick up and transport the sediment to a controlled sediment disposal area.*
- *Conduct street washing only after sediment is removed in accordance with the above bullet.*

- *Control street wash wastewater by pumping back on site or otherwise preventing it from discharging into systems tributary to waters of the State.*

All equipment and trucks, if leaving the property, will use the existing wheel wash in the Processing Area. No new construction entrances will be created.

Element #3: Control Flow Rates

- *Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site, as required by local plan approval authority.*
- *Where necessary to comply with the bullet above, construct stormwater retention or detention facilities as one of the first steps in grading. Assure that detention facilities function properly before constructing site improvements (e.g. impervious surfaces).*
- *If permanent infiltration ponds are used for flow control during construction, protect these facilities from siltation during the construction phase.*

The proposed site drains internally into the mine depression and, therefore, poses little risk of discharging sediment past project boundaries. Construction of infiltration ponds will be sequenced to avoid siltation from active mining.

Element #4: Install Sediment Controls

- *Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.*
- *Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.*
- *Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in Element #3, bullet #1.*
- *Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.*
- *Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal, and maximize stormwater infiltration, unless infeasible.*

- *Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.*

The proposed site drains internally and, therefore, poses little risk of discharging sediment from the construction site. All permanent infiltration ponds are preceded by water quality treatment BMPs to prevent clogging or reduction in long-term infiltration performance.

Element #5: Stabilize Soils

- *Stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base early on areas to be paved, and dust control.*
- *Control stormwater volume and velocity within the site to minimize soil erosion.*
- *Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.*
- *Soils must not remain exposed and unworked for more than the time periods set forth below to prevent erosion.*
  - *During the dry season (May 1 – Sept. 30): 7 days.*
  - *During the wet season (October 1 – April 30): 2 days.*
- *Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.*
- *Stabilize soil stockpiles from erosion, protect with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.*
- *Minimize the amount of soil exposed during construction activity.*
- *Minimize the disturbance of steep slopes.*
- *Minimize soil compaction and, unless infeasible, preserve topsoil.*

As the mine is internally draining, CalPortland proposes to comply with Element 5 by implementing the erosion control and reclamation requirements of their DNR Surface Mine Reclamation Permit.

Element #6: Protect Slopes

- *Design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).*

- *Divert off-site stormwater (run-on) or ground water away from slopes and disturbed areas with interceptor dikes, pipes, and/or swales. Off-site stormwater should be managed separately from stormwater generated on the site.*
- *At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion.*
    - *Temporary pipe slope drains must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped" area.*
- *Place excavated material on the uphill side of trenches, consistent with safety and space considerations.*
- *Place check dams at regular intervals within constructed channels that are cut down a slope.*

Mine cut slopes will be constructed by cutting to final grade, followed by topsoil, surface roughening, and reclamation planting according to established reclamation practices currently used in the existing mine. CalPortland’s mining technique leaves a series of ridges on the slope that helps prevent erosion prior to reclamation, by encouraging infiltration on the mine slopes.

Element #7: Protect Drain Inlets

Not applicable, no storm drain inlets are proposed.

Element #8: Stabilize Channels and Outfalls

- *Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the following expected peak flows:*
    - *Channels must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped area.*

- *Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches at the outlets of all conveyance systems.*

No temporary conveyance channels are proposed in areas with the potential to discharge off-site. CalPortland requests that the sizing and armoring requirements not apply within the internally draining portions of the mine. Current erosion control and mine reclamation practices within the existing mine have prevented erosion without requiring the use of armored drainage channels.

Element #9: Control Pollutants

- *Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.*
- *Handle and dispose of all pollutants, including waste materials and demolition debris that occur on-site in a manner that does not cause contamination of stormwater.*
- *Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.*
- *Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.*
- *Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed loop recirculation or upland land application, or to the sanitary sewer, with local sewer district approval.*

CalPortland manages other potential pollutants at the existing mine under the requirements of the Sand and Gravel General Permit. The site is managed under a SWPPP that includes BMPs for mobile fueling, vehicle maintenance, and the loading, unloading, storage, and containment for potential pollutants. The SWPPP also includes a Spill Control Plan.

With the proposed project, CalPortland would continue to manage potential pollutants using the existing established BMPs. No new potential pollutant sources would be created.

Element #10: Control Dewatering

- *Discharge foundation, vault, and trench dewatering water, which have characteristics similar to stormwater runoff at the site, into a controlled conveyance system before discharge to a sediment trap or sediment pond.*
- *Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems tributary to, or directly into surface waters of the State, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters or interfere with the operation of the system. Do not route clean dewatering water through stormwater sediment ponds. Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.*
- *Handle highly turbid or contaminated dewatering water separately from stormwater.*
- *Other treatment or disposal options may include:*
  1) *Infiltration.*
  2) *Transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.*
  3) *Ecology-approved on-site chemical treatment or other suitable treatment technologies.*
  4) *Sanitary or combined sewer discharge with local sewer district approval, if there is no other option.*
  5) *Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.*

Dewatering is a significant component of the proposed project. CalPortland intends to manage dewatering via the Groundwater Model Update (Aspect, 2017). This comprehensive plan includes a cyclical process of dewatering, disposal, and monitoring that requires design modifications should the requirements not be met. Further, all dewatering discharge will be disposed of internally into an infiltration basin that will return the water to the deep aquifer than flows to the Puget Sound. No dewatering water will flow off-site.

Element #11: Maintain BMPs

- *Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.*
- *Remove all temporary erosion and sediment control BMPs within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed.*

Maintenance would be performed according to the requirements of Ecology's 2014 SMMWW. Most of the ESC BMPs included in this plan are components of final site stabilization and would remain in place. However, if any Temporary Erosion and Sediment Control (TESC) measures are installed, they will be removed when no longer necessary.

Element #12: Manage the Project

- *Phase development projects to the maximum degree practicable and take into account seasonal work limits.*
- *Inspection and monitoring – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with the Construction Stormwater General Permit or local plan approval authority.*
- *Maintaining an updated construction SWPPP – Maintain, update, and implement the SWPPP in accordance with the Construction Stormwater General Permit.*

CalPortland will manage the proposed mining project in compliance with Element #12, the Sand and Gravel General Permit, and DNR Surface Mine Reclamation Permit. Routine inspections and maintenance of the SWPPP would be performed as required by the Sand and Gravel General Permit.

Financial Liability

Per City of Dupont Municipal Code 22.01.295:

> *Performance bonding, or other appropriate financial instruments shall be required as determined necessary by the City to ensure compliance with these standards.*

Under the Washington State Surface Mining Act, CalPortland is required to obtain a Reclamation Permit and provide the DNR sufficient performance security to reclaim the permitted mine. Because DNR will hold the performance security and exclusive authority to regulate reclamation under Chapter 78.44 Revised Code of Washington (RCW), CalPortland respectfully requests that the City of DuPont waive their performance bond requirement for the area covered by the Surface Mine Reclamation Permit.

ESC Measures

The mine area will be graded to drain internally to three infiltration facilities located on the floor of the mine. Two of the infiltration facilities would be preceded by water quality treatment to remove suspended sediments, enhancing long-term performance of the infiltration ponds. The third infiltration facility has no Pollution Generating Pervious or impervious surfaces draining to it.

ESC in the internally draining areas is generally governed by the Sand and Gravel NPDES Permit, and the Reclamation Plan, which establishes the plan for permanently stabilizing the site for the postmining condition. As portions of the site are mined, slopes will be stabilized and replanted using methods and practices prescribed in the Reclamation Plan approved by DNR.

Construction Sequence

Because this project includes ongoing operation and removal of materials, the CSWPPP is flexible to allow for adjustments in operation. In addition, a phased approach will be adopted. Some erosion control measures apply regardless of the phase of the project, while other measures are specific to certain phases as described in the previous section.

The following describes the general sequence of project actions as they pertain to erosion control measures.

1. Initial site preparation of the Expansion Area (clearing and removal of overburden).
2. Excavation of Sequence Areas 1–4.
    a. Grade and plant slopes as mining progresses.
    b. Clear and grub next mine area concurrently with mining.
3. Continued excavation of overburden, mining, and sequential reclamation of remaining phases of the mine development (Segments 1, 2, 3, and 4).
4. Removal of equipment from mine area and conveyor route.
5. Final stabilization of site.

References

Aspect Consulting, LLC (Aspect), 2017, Groundwater Model Update, DuPont Mine South Parcel Expansion Area, Prepared for CalPortland, June 29, 2017.

Washington State Department of Ecology (Ecology), 2014, Stormwater Management Manual for Western Washington. Publication No. 04-10-076. Water Quality Program, Washington State Department of Ecology, Olympia, WA.

Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of CalPortland for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

APPENDIX B

South Parcel Monitoring Plan

SOUTH PARCEL MONITORING PLAN

DuPont Mine South Parcel Expansion Area

Project No. 040001-014-02 • November 22, 2017

CONFIDENTIAL

This document is confidential, and is intended for the sole use of CalPortland and the Environmental Caucus (and their designated attorneys and consultants) for the purpose of effectuating the provisions of the 2012 Settlement Agreement. Any distribution of this document to any other party, or use of this document for any other purpose, is prohibited.

Aspect CONSULTING

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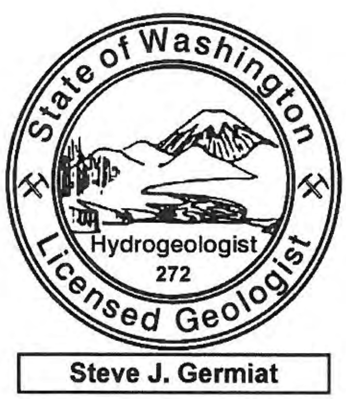
SOUTH PARCEL MONITORING PLAN

DuPont Mine South Parcel Expansion Area

Project No. 040001-014-02 • November 22, 2017

Aspect Consulting, LLC



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Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

This document presents the Monitoring Plan for dewatering of the South Parcel of CalPortland's DuPont Mine. The South Parcel is a 177-acre property located southeast of the existing mine, shown on Figure 1. CalPortland proposes to expand the existing mine by extracting sand and gravel from the South Parcel. Groundwater saturates the lower level of gravels that are proposed for extraction. For mining to occur, these gravels of the South Parcel would need to be dewatered by installing a series of pumping wells to capture groundwater. The dewatering activity would affect groundwater levels in the surrounding area.

In 2011, CalPortland, the City of DuPont, Washington State Department of Ecology (Ecology), and a group of seven environmental organizations collectively known as the Environmental Caucus entered into a Settlement Agreement to define the conditions under which mining of the South Parcel could occur. The Settlement Agreement requires the development and permitting of a Restoration Plan for the Sequalitchew Creek watershed. It also requires the development of a Monitoring Plan for ensuring that changes in groundwater levels resulting from dewatering are within expected (and agreed-upon) limits.

Section 7.3 of the 2011 Settlement Agreement specifies that the Monitoring Plan will *"…include a series of monitoring actions to allow a comparison of predicted and actual changes in groundwater draw-down levels, and a process for the Parties to meet and confer if groundwater monitoring results do not meet the criteria provided in the Monitoring Plan."* This document was developed to meet that requirement.

The aim of the Restoration Plan is to increase available habitat for aquatic species through the restoration and enhancement of creek flow from Sequalitchew Lake to the Puget Sound. The Restoration Plan includes the following restoration actions, among others: comprehensive beaver management to restore flow from Sequalitchew Lake to West Edmond Marsh, improvements to the outlet of Sequalitchew Lake to reduce barriers to flow down the creek system, rehabilitating fish passage through the DuPont Railroad Trail by replacing a section of trail that is built on fill with a pedestrian bridge, culvert evaluation and replacement, and habitat restoration in Sequalitchew Creek downstream of Edmond Marsh. Implementing these actions will involve changes to marsh water levels and increases in Sequalitchew Creek flows.

The Restoration Plan actions are intended to occur concurrently with South Parcel mining activities. Under the terms of the Settlement Agreement, mining of the South Parcel cannot commence until all necessary permits for the Restoration Plan have been obtained. The Restoration Plan will include a monitoring component aimed at measuring the success of restoration actions and adaptively responding if goals are not met.

As specified in the Settlement Agreement, this Monitoring Plan focuses on observing and responding to changes in groundwater levels. Marsh water levels and streamflows will also be monitored (as required by Section 7.2 of the Settlement Agreement), but they are not the focus of the adaptive management actions identified in the Monitoring Plan.

This Monitoring Plan consists of three components:

1) The main text, which outlines the framework for monitoring and decision making at a conceptual level.

2) A set of figures illustrating the performance thresholds for each month at each well in each dewatering step (Appendix A).

3) A sampling and analysis plan (SAP; Appendix B), which provides the specific details of monitoring, such as identification of monitoring locations, parameters, and frequency, as well as monitoring methods.

The parties acknowledge that the Monitoring Plan may be updated or amended by mutual agreement of the parties.

2 Goals and Objectives

This Monitoring Plan strives to monitor and respond to maintain groundwater at or above predicted levels beneath the marshes and Sequalitchew Creek, and manage groundwater to maintain conditions conducive to safe and efficient mining in the South Parcel.

Articulating the specific goals, objectives, and performance thresholds of a plan provides clarity in measuring the success of the actions taken and guidance for managing unanticipated circumstances. Goals are the overarching principles behind the Monitoring Plan. Objectives identify specific, measurable elements that are undertaken to meet the goal(s) of a project. They provide more detail on how the goals will be achieved, and criteria for determining when their achievement has occurred.

For each objective, a performance threshold is identified to measure success in meeting that objective. Failure to meet the performance threshold will trigger the adaptive management process and require iterative additional actions until it is met. If monitoring indicates that a performance threshold is not being met, additional action will be necessary and the adaptive management process (described in Section 4) will be used iteratively to identify and implement actions intended to improve conditions until the performance threshold has been met.

The goals, objectives, and thresholds of the Monitoring Plan are:

Goal 1. Maintain groundwater at or above predicted levels beneath Edmond Marsh and Sequalitchew Creek.

> **Objective 1A**. Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted levels.
>
> **Performance Threshold**: Monthly groundwater level measurements are at or above target levels established for each step of the dewatering process at each well and for each month of the year, based on statistical analysis of groundwater model predictions over a range of historical climate conditions. Initial target levels are included in Tables 4, 6, 8, and 10.

Goal 2. Maintain groundwater conditions conducive to safe and efficient mining and processing of the South Parcel aggregates.

> **Objective 2A**. Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.

3 Dewatering Plan Overview

The entire mining process will take many years and is designed to proceed slowly from areas of least potential impact toward areas of increasing potential impact, allowing time and opportunity to confirm predictions and adaptively manage the mining and dewatering effort before irreversible changes occur.

Mining of the South Parcel will proceed slowly from the north to the south over a period of 5 to 8 years, extracting gravel to create a broad trough along the eastern property boundary. Wells will be installed and pumped in advance of mining to intercept groundwater and dry out the gravels for mining. The purpose of mining a trough is to minimize the amount of time that active dewatering by pumping wells is required. Once mining of each section of trough is completed, the adjacent wells can be turned off, allowing groundwater to passively seep from the stable mine slope and flow by gravity to an infiltration facility on floor of the existing mine. After mining the trough along the perimeter, gravel will be extracted from the interior area.

The following section describes four steps of the dewatering plan, but it is important to recognize that these steps occur on very different time scales. Figure 2 provides an overview of the timeline for the four steps of dewatering, assuming that mining proceeds rapidly during the period of active dewatering (Step 3).

The initial step is a 60-day pumping test that is completely reversible (i.e., no gravel will be extracted during the test). The results of that test will be analyzed and evaluated, and plans adjusted as necessary prior to commencing the next phase.

The second step involves installing and pumping additional dewatering wells to lower water levels in the first mine segment in preparation for mining. This step would last about six months and functions as a greatly expanded pumping test. As with the first step, it is also completely reversible.

The third step—active dewatering during mining—involves mining the trough described above. Additional dewatering wells will be installed and pumped as mining progresses. Mining will begin at the location farthest from the Edmond Marsh and Sequalitchew Creek and proceed slowly south. Completing the trough would require 5 to 8 years depending on market conditions and the success in meeting predicted groundwater levels. The potential impact on groundwater levels builds slowly over time as wells are added and mining progresses south. This allows ample opportunity to monitor and adapt to the conditions observed before mining proceeds into each dewatered segment.

The final step—passive dewatering—begins when mining of the trough described above is complete and the last dewatering well is turned off. Passive dewatering represents the groundwater condition that will continue in perpetuity. Groundwater, no longer intercepted by wells, would form seeps at the toe of the eastern mine slope. It would flow by gravity through newly created wetlands and a vegetated swale to an infiltration pond located at the bottom of the existing mine. Once this step has begun, further mining activities in the interior of the South Parcel would not affect groundwater.

Additional detail about each of these steps is described in the following section.

3.1 Four Steps of Dewatering Plan

The dewatering necessary to accomplish the mine expansion will occur in four steps as outlined below to address the needs of the mining operations and to provide an opportunity for adaptive management, as described in Section 4. Figure 3 depicts locations of the wells planned for installation in each step. All water generated during dewatering will be infiltrated within the footprint of the current mine, west of the expansion area. Infiltrated water will travel vertically into the ground to the aquifer then flow westward and discharge as seeps to Puget Sound

Step 1. Initial Pumping Test: The first step is a 10-well pumping test, conducted for a minimum of 60 days, to validate model predictions of dewatering effectiveness in the local vicinity of the test wells and make any necessary changes to the model parameters and/or plans for subsequent dewatering and mining activities. The 10 wells will be located in the northeastern portion of the South Parcel as shown on Figure 3. Monitoring will be conducted throughout the test in the pumping wells and existing monitoring wells. The combined pumping rate during Step 1 is predicted to be approximately 3.5 cubic feet per second (cfs) on average, and up to approximately 5 cfs if pumping during the wet season. The model predicts that groundwater level changes will stabilize within approximately 60 days of the start of pumping. No mining will occur in the South Parcel during this step. Step 1 could occur at any time prior to mining; it is not anticipated that all permits for mining would need to be obtained before Step 1 could occur.

Step 2. Preparation for Mining/ Dewatering Test: Following completion of the initial pumping test, the next step of the dewatering plan involves expanding the dewatering well network along the eastern edge of the mine area with two purposes: 1) to evaluate model predictions across a wider extent (making any necessary changes to model parameters and/or to subsequent dewatering/mining activities); and 2) to dewater gravels for the first segment of mining. No mining will occur in the South Parcel before this step is completed.

During Step 2, an expected 14 additional dewatering wells will be installed along the South Parcel mine boundary, including wells located interior to the mine, as shown on Figure 3. The dewatering wells will be arranged in two lines on either side of the initial mine trough, including 19 boundary wells and 5 interior wells. Two additional monitoring wells will also be installed to measure drawdown within the mine interior. Step 2 is expected to last for up to 6 months,with the first two months being a second pumping test again lasting a minimum of 60 days, followed by an estimated four additional months of pumping to dry gravels in the Segment 1A in preparation for mining. The results from the first 60 days would be used to evaluate the model; this evaluation would occur concurrently with the continued dewatering in preparation for mining. The predicted total system pumping rate of approximately 5.1 cfs on average and up to approximately 8 cfs during the wet season.

Since a key component of Step 2 is preparation of the site for mining, pumping during Step 2 would only occur once mining and restoration permits have been obtained.

Step 3. Active Dewatering during Mining: Step 3 is active dewatering as mining begins to form a broad trough in the northeastern corner of the site. Over the next 5 to 8 years, mining will then proceed from north to south along eastern boundary of site. Step 3 dewatering is predicted to use 66 dewatering wells arranged in two lines on either side of the initial mine trough, with 54 boundary wells and 12 inner wells, as shown on Figure 3. The wells are installed and pumped ahead of the trough's southern progression; as mining of an area is completed, wells along that portion of the trough are shut off, allowing groundwater to begin seeping from the newly mined slope. Groundwater seeping into the mine will be collected in a vegetated swale and conveyed to the infiltration pond located at the bottom of the existing mine.

If all 66 dewatering wells were operating, the combined pumping rate is predicted to be approximately 6.8 cfs on average and up to approximately 11 cfs during the wet season. However, it is unlikely that all dewatering wells would need to be operated at any one time as wells will be phased off as mining progresses.

Step 4. Cessation of Active Dewatering: During Step 4, pumping from the dewatering well network will cease, and the post-mining groundwater flow condition will be established consistent with reclamation objectives. Once all dewatering wells are off, mining above the water table will continue in the interior of the South Parcel. Groundwater will flow from the toe of the newly mined slope on the eastern boundary of the property and be collected and conveyed to an infiltration pond in the bottom of the existing mine, from where it will continue its westward flow, ultimately entering Puget Sound. Groundwater levels will increase slightly following the cessation of active dewatering as they adjust to long-term equilibrium with the new spring locations that will form along the toe of the mined slope. Step 4 lasts through mining of the remaining interior areas and through the post-mining period.

3.2 Dewatering Well Construction

The dewatering wells are designed to accommodate large drawdowns (up to 70 feet), and operate under a wide range of flow rates against a wide range of heads. All dewatering wells will be screened to the depth of the Olympia Beds, with nominal 10-foot sumps installed into the top of the Olympia Beds. Expected well depths will range from about 75 to 115 feet to accommodate the variation in aquifer thickness (between ground surface and the Olympia Beds contact) and the 10-foot sump into the Olympia Beds. The dewatering wells will be screened across the lower zone and a portion of the upper aquifer zone (generally 40- to 50-foot screen lengths). Continuous slot, v-wire wrapped stainless-steel well screens will be used for maximum dewatering efficiency (low head loss). Anticipated well flows range from approximately 400 gallons per minute (gpm) initially to an average of approximately 50 to 200 gpm to maintain drawdown once storage is depleted.

3.3 Predicted Effects of Dewatering on Groundwater Levels

The effects of the four-step dewatering plan on groundwater levels have been evaluated using a numerical, three-dimensional, groundwater model developed specifically for the project (DuPont model). The model is transient, meaning that it simulates changes in groundwater levels over time, and runs on a monthly time step for a roughly 12-year period from March 2004 to December 2015 that includes wet and dry climate conditions.

This allows the model to be used to analyze the effects of the proposed dewatering plan over a range of weather conditions.

The model was developed using data from 2004 to 2010 and calibrated to observed water levels at 19 wells. The calibrated model achieved a “good fit” with a mean residual (difference between predicted and observed) of 1.7 feet or about 6 percent of the difference in minimum and maximum groundwater levels at the calibration targets. The model was validated over 2004 to 2015 (after a change in the precipitation data source) and the validation statistics were similar to the calibration with a mean residual of 1.87 feet providing confidence in its use to simulate groundwater conditions. Additional detail on groundwater model development, calibration, validation and predictive results is available in the Groundwater Model Update (Aspect, 2017).

The DuPont model was used to predict changes in groundwater conditions during the four sequential steps of proposed dewatering and mining activity in the South Parcel. These predictive runs used the same weather and boundary conditions as model calibration with the only change being the addition of pumping wells and changes in surface topography with mining. Dewatering Steps 1, 2, and 3 simulated 10, 24, and 66 active dewatering wells, respectively. Step 4 simulated the post-mining condition with pumping terminated and groundwater passively discharging at the toe of the newly mined slope.

Results of the predictive models are discussed below by dewatering step, in terms of predicted changes in groundwater levels. Baseline groundwater levels are sensitive to seasonal and longer-term precipitation patterns, and the model indicates that groundwater levels during the four dewatering steps will likewise remain sensitive to precipitation patterns. Monitoring well locations are shown on Figure 4.

In Step 1, the changes in groundwater levels are most evident at the monitoring wells closest to the pumping test (CHMW-2S and CHMW-2D). The maximum groundwater level change at CHMW-2D is predicted to be approximately 9 feet, whereas minimal groundwater level change (less than 0.5 foot) is predicted at monitoring wells in Edmond Marsh (MW-EM-1D and MW-EM-2D).

During Step 2, the maximum change in groundwater level is approximately 45 feet and would occur at CHMW-2D located on the northeastern edge of the South Parcel and within the dewatering well network. The maximum groundwater level changes in the closest monitoring wells in Edmond Marsh (MW-EM-1D and MW-EM-2D) are predicted to be approximately 1.3 feet and 0.2 feet, respectively.

During Step 3, maximum groundwater level changes of up to about 60 feet are predicted at wells within the mine area. The maximum groundwater level changes at MW-EM-1D and MW-EM-2D (Edmond Marsh) are predicted to be approximately 5.2 feet and 0.4 feet, respectively. The groundwater levels during Step 3 are predicted to be approximately 10 to 20 feet above the Olympia Beds along the mine trough.

During Step 4, following cessation of active pumping, the maximum change in groundwater levels along the eastern slope of the mine ranges from about 14 to 49 feet. The maximum groundwater level changes at the closest Edmond Marsh Wells (MW-EM-1D and MW-EM-2D) are predicted to be approximately 5.0 feet and 0.4 feet, respectively. A map of the predicted contours of groundwater drawdown after cessation of active pumping is shown on Figure 5. Solid drawdown contours on Figure 5 indicate areas of greater certainty closer to the monitoring well network and model calibration targets, dashed drawdown contours indicate areas of lesser certainty.

The groundwater model was used to develop performance thresholds for each well in each month during each dewatering step. The thresholds are based on the predicted range in water levels under seasonal and annual variation in climate. The performance thresholds were established at the lower 95th-percentile confidence interval for the predicted water levels.

As an example, Figure 6 provides the range of model predictions (groundwater elevation, and change from baseline water levels) over varying climate conditions for well CHMW-2D, located near the proposed location of the pumping test. The vertical lines in Figure 6 indicate the lower end of the predicted range. The bottom of the vertical line is the performance threshold. The performance threshold will change by well, by month (to account for annual seasonal patterns), and by dewatering steps. Similar figures have been prepared for each monitoring well and are presented in Appendix A.

4 Adaptive Management

This Monitoring Plan implements adaptive management to observe and respond to changes in groundwater levels occurring during mining of the South Parcel. This section first introduces the fundamental steps of effective adaptive management, then establishes key commitments by CalPortland to be met throughout the adaptive management process, and then walks through the detailed adaptive management plan, including the groundwater performance thresholds, for each dewatering step.

4.1 Process of Adaptive Management

Adaptive management has been described as "*a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs*" (Nyberg, 1999). Adaptive management typically consists of a monitoring system to identify changes in the environment coupled with a response system to adjust the activities in response to monitoring results. The adaptive management system proposed for implementation on this project was developed as a combination of the systems proposed by Ralph and Poole (2003) and Nyberg (1999). It consists of five key sequential elements, as illustrated on Figure 7:

A. **Assess:** Information is compiled from monitoring data, geologic investigations, groundwater modeling, and other available sources. The compiled information is used to identify issues, refine objectives, and screen potential alternative approaches. Predictions of the potential effects of the action on groundwater levels are developed.

B. **Design:** Based on the results of the assessment stage, design of the proposed action proceeds. Design will result in a specific plan of action, and supporting evaluations to ensure that the anticipated results are consistent with the identified objectives, the Monitoring Plan, and prior environmental assessments. Predictions of groundwater levels are refined as the design evolves. Analyses conducted during the design stage could result in an iterative process of assessment and design. Any required permitting is also included in the design stage.

C. **Implement and Monitor:** The approved plan is put into action, concurrently with monitoring focused on key indicators tied to the identified objectives. Monitoring data indicating conditions worse than forecasted are acted on rapidly, moving into the evaluation and adjustment stages.

D. **Evaluate:** Monitoring data are evaluated relative to the objectives and forecasted results developed in the assessment and design stages. Differences between forecasts and results are identified and the causes for those differences investigated.

E. **Adjust:** Information learned in previous steps is used to adjust the actions, if necessary. The Monitoring Plan provides an initial identification of potential adjustments in each dewatering step, but additional adjustments could be developed to fit specific situations.

The adaptive management process is iterative and would repeat until the mining project is completed. If an adjustment is identified, the process would begin again from the assessment and design stages, followed by implementation of the adjustment and associated monitoring, then evaluation and further response (if necessary). If an adjustment is not necessary, then the process still repeats. In this case, the assessment and design stages would largely rely on the previously approved plans, but there is still potential for more minor refinements based on the information learned.

Throughout the adaptive management process, status updates, monitoring data, and final reports will be shared with the Environmental Caucus. Should groundwater levels not meet the performance thresholds established in this plan, then CalPortland would notify the Environmental Caucus and plan and implement adjustments. If adjustments are unsuccessful in meeting predicted groundwater levels, CalPortland and the Environmental Caucus would initiate a technical review conference and, if necessary, meet and confer to share information and determine the appropriate additional steps.

4.2 Key Adaptive Management Commitments

This section establishes the commitments related to key components of adaptive management. First, an overview of the anticipated schedule for the four dewatering steps is presented. Then the commitments to the frequency that groundwater levels will be compared with the performance thresholds is established, followed by a summary of the notifications that will be provided if certain events occur (such as starting to pump new wells, or measurements of groundwater levels that are below performance thresholds). The next section summarizes the reports that will be provide throughout the process, ranging from relatively simple progress updates to detailed reports on the pumping tests. Then several overall limitations on advancement of mining and dewatering are established. Finally, the meet and confer process for resolving disputes is defined.

Additional detail about the adaptive management process as it applies to each dewatering Step is presented in Section 4.3.

4.2.1 Anticipated Schedule

Mining of the South Parcel will occur over many years, and the anticipated project schedule has been designed to include sufficient time for the adaptive management process to succeed in meeting performance thresholds before mining or dewatering advances. An overview of the anticipated schedule is presented on Figure 8; additional schedule detail is presented in the detailed adaptive management plan for each Step presented in Section 4.3.

Mining and dewatering activities would not begin until a series of conditions identified in Section 4.3 of the 2011 Settlement Agreement have been met. Those conditions include: 1) environmental review (SEPA) has been completed; 2) permits for the Restoration Plan have been issued [including the required authorizations and approvals from Joint Base Lewis-McChord (JBLM) for restoration activities on JBLM property], and applicable appeal periods have expired (except for federal permits); and 3) all necessary permits and approvals for South Parcel mining have been obtained. This paragraph is intended as a summary only; to the extent that it is inconsistent with the Settlement Agreement, the Settlement Agreement shall govern.

Step 1 is anticipated to require a year to complete from initial planning through reporting and discussion of the results and any resulting adjustments to the dewatering plan. Planning and well installation for Step 2 would overlap with completion of the reporting and review components of Step 1. Once Step 1 has been completed, the pumping test component of Step 2 would begin.

Step 2 is anticipated to require 6 months of active pumping—the first 2 months would be a larger-scale pumping test, and dewatering would continue over the subsequent 4 months in preparation for the start of mining. Reporting and review of results would be performed while dewatering continues.

Step 3 would only commence when groundwater levels are above the performance thresholds and water levels are at appropriately low levels for safe and efficient mining and processing. If groundwater levels meet performance thresholds, Step 2 would flow into Step 3 and the start of mining. Otherwise, Step 2 may require a longer period to perform the necessary adjustments to achieve sufficient dewatering for mining while maintaining groundwater levels consistent with the performance thresholds and prior environmental analyses, or update the environmental analyses, if necessary.

Mining would proceed south over a period of multiple years. The actual rate of mining depends on market demand. CalPortland expects that mining the first four segments (1A through 1D) would take 4 to 8 years and has committed (see Section 4.2.5) to completing those four segments in no less than 3 years total, or a minimum of 9 months for each segment. Figure 8 shows the timeline for mining of the South Parcel in the unlikely event that mining were to progress at this accelerated pace and the first four segments were to be completed in three years.

Step 4 will begin after active dewatering ceases. Depending on market demand for aggregate products, mining of the remainder of the South Parcel is expected to occur over 5 to 8 years after cessation of active dewatering.

4.2.2 Comparison of Groundwater Levels with Performance Thresholds

Success of the dewatering plan is evaluated by comparing groundwater levels with the performance thresholds.

A summary of the monitoring events where comparisons with the predicted ranges will be performed is provided in Table 1. The frequency of these comparisons will vary over time with more frequent evaluations at the start of each dewatering step or when changes to dewatering are made. If any of these monitoring results indicate groundwater levels are not above the performance thresholds, CalPortland will notify the Environmental Caucus according to the timelines described in Section 4.2.3, which vary by dewatering Step, and begin the adjustment process.

Table 1. Frequency of Comparison to Performance Thresholds

Dewatering Step	Frequency of Comparison
Step 1 – Initial Pumping Test	Changing frequency during test: hourly -> daily -> weekly
Step 2 – Preparation for Mining/ Dewatering Test	Changing frequency during first 2 months/ pumping test: daily -> weekly, then Weekly at key wells, Twice monthly at all others
Step 3 – Active Dewatering during Mining	For 3 months when new wells start pumping: weekly at key wells and twice monthly at all others, then Monthly.
Step 4 – Cessation of Active Dewatering	Monthly

Note: Key wells are the monitoring wells in the South Parcel (CHMW-1 through 4) and the closest marsh monitoring stations (EM-1 and -2), including both shallow and deep wells at those locations.

4.2.3 Notifications

Notifications are intended to alert the Environmental Caucus to the occurrence of an event. Routine reporting, including project status updates, data summaries, pumping test analyses, are described in the next section (Section 4.2.4).

CalPortland will inform the designated representative of the Environmental Caucus of each of the following types of events:

1) At the start of each dewatering step;
2) Major milestones within each step (such as addition of new pumping wells);
3) Upon collection of monitoring data indicating actual groundwater levels are lower than the performance thresholds; and
4) Implementation of response actions.

The Environmental Caucus will provide timely notice of any changes in its attorney, consultant, or designated representative or their contact information.

Notification points in each of the dewatering steps are summarized in Table 2, except for routine reporting milestones (which are summarized in Table 3). Notifications will be provided in writing by email, letter, or memorandum/report, as appropriate for the nature of the notification. It is anticipated that most notifications will be provided by email.

Groundwater monitoring data (including raw data) would be provided within 2 days of any notification that monitoring results are below performance thresholds.

Table 2. Summary of Notifications by Dewatering Step

Dewatering Step	Events Triggering Notification of Environmental Caucus	Timeline for Notification
Step 1 – Initial Pumping Test	Updates to pumping test plan	Within 3 days of updating plan
	Installation of pumping test wells	1 week prior to start of drilling
	Start of pumping test	1 week prior to start of pumping
	Monitoring results below performance thresholds	Within 24 hours of measurement
	Any adjustments implemented during pumping test	Within 24 hours of change
	End of pumping test	Within 24 hours
Step 2 – Preparation for Mining/ Dewatering Test	Updates to dewatering plan based on Step 1 results	Within 3 days of updating plan
	Installation of Step 2 dewatering wells	1 week prior to start of drilling
	Start of dewatering	1 week prior to start of pumping
	Monitoring results below performance thresholds	Within 48 hours of measurement
	Any adjustments implemented during dewatering	Within 24 hours of change
Step 3 – Active Dewatering during Mining	Commencement of mining in the South Parcel	1 month prior to start of mining
	Initiation of pumping at new wells	1 week prior to start of pumping
	Monitoring results below performance thresholds	Within 3 days of measurement
	Any adjustments implemented during dewatering	Within 3 days of change
	Cessation of active dewatering	Within 1 week of ceasing dewatering
Step 4 – Cessation of Active Dewatering	Monitoring results below predicted values	Within 3 days of measurement
	Completion of mining in South Parcel	Within 1 month of completion

The timeline for notification that monitoring results are below performance thresholds increases from 24 hours in Step 1 to 48 hours in Step 2 to 3 days in Steps 3 and 4 for four reasons:

1) the rate of change in groundwater levels will slow as mining progresses;

2) confidence increases over time as the number of wells pumping and set of successful groundwater measurements grows (mining and dewatering only advance when performance thresholds are met; see Section 4.2.5 for the specific limitations);

3) new wells begin pumping substantially in advance of mining both in time and space and dewatering proceeds from farthest away towards the creek and

marshes, which allows for the marginal impact of adding new wells to be reversible, even in during Step 3; and

4) Gravel would continue to be mined, but the volume that could be mined during the notification period is nominal compared with the volume of each mine segment, which are expected to require 1.5 to 2 years of mining to complete.

4.2.4 Routine Reporting

CalPortland will routinely share information about mining, dewatering, and the adaptive management process with the Environmental Caucus to achieve a variety of purposes, including sharing and interpreting monitoring data, documenting actions taken during a dewatering step, providing updated model predictions and analysis, and response actions, if necessary.

The specific reports required during each step of dewatering are summarized in Table 3. Additional detail about the individual reports and their role in the adaptive management process is presented in the Detailed Adaptive Management Plan in Section 4.3.

Table 3. Summary of Reporting by Dewatering Step

Dewatering Step	Reports	Minimum Frequency of Reporting
Step 1 – Initial Pumping Test	Pumping Test Design	One time
	Pumping Test Progress	Weekly during test
	Pumping Test Results	One time
Step 2 – Preparation for Mining/ Dewatering Test	Dewatering Plan for Step 2, if revised.	One time
	Pumping Test Progress	Weekly for first 2 months
	Pumping Test Results	One time – 4 months after start of Step 2
	Dewatering Summary Memos	Monthly
Step 3 – Active Dewatering during Mining	Dewatering Plan, Mining Plan, or SAP, if revised.	One time
	Dewatering Summary Memos,	Monthly for 3 months after each new set of dewatering wells, then quarterly
Step 4 – Cessation of Active Dewatering	Dewatering Summary Memos for first year	Quarterly for 2 years, then annually

The purpose and contents of each report are outlined below:

- Pumping Test Design/Dewatering Plans will provide the plan for performing the pumping tests and/or dewatering. These plans will include the proposed well pumping and observation well locations, depths, well construction, drilling methods, data collection, and timelines.

- Pumping Test Progress will provide a status update during the pumping test including an overview of progress toward completing the test, identifying which wells are pumping and pumping rates, locations and frequency of monitoring, any changes to the pumping test plan, and notes on how the test is proceeding.

- Pumping Test Results will present a detailed reporting of the execution of the pumping test, a summary of the data collected, including figures showing groundwater levels and pumping rates over time, comparisons of groundwater levels with performance thresholds, data analysis and results (estimates of key hydrogeologic parameters), and a comparison between model predictions and pumping test results for the purpose of model evaluation and validation.

- Dewatering Summary Memos will provide a summary of mining and dewatering progress, including information on any new wells installed, initiation of pumping at new wells, overview of wells that are pumping and pumping rates, cessation of pumping at wells, areas of active mining, and reclamation activities.

Reports will be prepared by a third-party consultant to be selected and paid for by CalPortland. The reports will be distributed to the Environmental Caucus electronically in protected documents, with hard copies available on request. Raw monitoring data will be provided with any groundwater measurement below a performance threshold, or when requested by the Environmental Caucus.

4.2.5 Limitations on Mining

In order to establish bounds on the pace and advancement of mining that will allow time for the adaptive management process to succeed, CalPortland commits to the following limitations on mining and dewatering activities in the South Parcel:

1) Mining associated with active dewatering (i.e., mining of the trough along the eastern boundary of the South Parcel; Figure 3) will last at least 3 years.

2) The mine trough has been divided into four segments (1A to 1D; Figure 3). Mining of each segment will last at least 9 months.

3) Mining will not advance into the next segment, unless groundwater levels meet performance thresholds.

4) Dewatering activity will not intensify through commencing pumping at new wells or increasing pumping rates at existing wells (except for normal seasonal changes in pumping rates), unless groundwater levels meet performance thresholds.

These limitations do not apply to operations of the existing mine and processing area, or extraction of gravel from areas west of the Olympia Bed truncation within the existing mine or North Parcel as these areas do not require dewatering.

4.2.6 Meet and Confer Process

Section 7.3 of the Settlement Agreement states that the Monitoring Plan will include a "process for the Parties to meet and confer if the groundwater levels do not meet the criteria provided in the Monitoring Plan." The process described below involves two steps for the parties (CalPortland and the Environmental Caucus) to follow with respect to groundwater information and data obtained during the monitoring process. The first step is for the parties' technical consultants to engage in one or more technical review conferences. If necessary, the second step would involve one or more meetings between the parties' designated representatives to discuss any differences of opinion or interpretation that the technical consultants are unable to resolve. Each of these two steps is discussed further below. This two-step process may be invoked at any time, including but not limited to the various specific points in the adaptive management process identified in Section 4.3 below.

Technical Review Conferences. The Environmental Caucus may initiate a request for a technical review conference of the parties' technical consultants at any time to discuss any questions or concerns it might have about any aspect of the groundwater monitoring data. The conferences may be in person or via conference call or other communications technology, and there may be multiple conferences to discuss any issues identified by the Environmental Caucus. The technical consultants would work in good faith during these review conferences to resolve any differences in interpretation of the groundwater monitoring data.

Party Representative Discussions. If the good-faith efforts of the technical consultants are unable to resolve any differences of opinion regarding the interpretation of the groundwater data, including but not limited to what the data shows regarding groundwater levels, either CalPortland or the Environmental Caucus may request a meeting of the parties' designated representatives or principals by providing notice to the other party of the desire to meet, and a brief explanation of the reasons for the request.

Once noticed is provided, CalPortland and the Environmental Caucus would work collaboratively to agree on a meeting format, date, time, and place to be held within 30 days of the request to hold a Technical Review Conference or a Party Representative Discussion. Meetings may be in person or via conference call or other communications technology, and there may be multiple meetings. This paragraph is intended to generally describe, but not constrain, the ways that the parties may choose to meet. Based on the issue raised, CalPortland would prepare and provide appropriate information summarizing the issue and current status of mining and dewatering activities, sharing related monitoring data (including raw data, if requested), and identifying potential responses.

Representatives of CalPortland and the Environmental Caucus will confer during the meeting on the most appropriate response with the goal of reaching consensus. If consensus cannot be reached, the parties would enter mediation, making good-faith efforts to hold a meeting with a mutually agreed-upon mediator within 45 days of the initiation of any request to the other party for mediation.

4.3 Detailed Adaptive Management Plan

This section is the core of the Monitoring Plan. It walks through each step of the dewatering plan providing conceptual details about how the stages of adaptive management would apply to that step. Specifically, this section establishes the objectives, provides an overview of monitoring activities, outlines an approximate schedule, summarizes the approach for data evaluation, and provides initial identification of potential response actions for each step of the dewatering plan.

Specific details of the monitoring activities (e.g., monitoring locations, frequency, and methods) are provided in the SAP in Appendix B.

Although the stages of adaptive management are presented sequentially in each step, it is important to recognize that the adaptive management process will be implemented iteratively within the step, particularly for Steps 2 and 3. For example, evaluation will be conducted each time monitoring data is collected, and that evaluation could trigger adjustment and looping back through the process during the same dewatering step. Alternately, if the monitoring data consistently indicate that performance thresholds are being met, the adaptive management process for a step could be completed without requiring iteration or adjustments.

4.3.1 Step 1 – Initial Pumping Test

Step 1 is envisioned as a 10-well pumping test, conducted for a minimum of 60 days, to validate model predictions of dewatering effectiveness in the local vicinity of the test wells, and make any necessary changes to the model parameters and/or to plans for subsequent dewatering and mining activities. No mining will occur in the South Parcel during Step 1.

The adaptive management process in Step 1 is illustrated on Figure 9.

A. Assess

The assessment stage for Step 1 will include compilation of existing monitoring data, geologic information, results from prior pumping tests conducted by CH2M Hill (2000), and the latest groundwater modeling simulations of the Step 1 pumping test. Monitoring data will continue to be collected and will be incorporated into the assessment for the pumping test.

Two initial objectives have been identified for the Step 1 pumping test:

1) Evaluate model predictions near the test wells.

2) Test dewatering design for meeting mining needs (i.e., achieving necessary drawdown), collecting information to refine the dewatering design, such as the number, screening, and spacing of wells.

B. Design

Based on the information collected during the assessment phase, CalPortland, and its consultants, will prepare a detailed plan for the pumping test. The plan will identify the number and location of pumping and observation wells, well drilling and construction, pumping rates, duration, monitoring locations, equipment, and frequency, etc.

The pumping test plan will be provided to the Environmental Caucus.

C. Implement and Monitor

CalPortland will install the pumping wells and any new observation wells, and conduct the pumping test. The minimum duration of pumping during the test will be 60 days.

Monitoring would consist of two components: 1) high-frequency automated monitoring at wells that are expected to be affected by the pumping test and at sensitive receptors, and 2) continuation of routine manual monitoring at other groundwater and surface water locations.

High-frequency monitoring using pressure transducers would be performed in observation wells near the pumping test location (CHMW-2D, -2S, and MW-D-3), and at wells located nearest to Sequalitchew Creek and West Edmond Marsh (CHMW-3S &-3D and MW-EM-1D). Typically, the frequency of data collection is programmed to vary throughout a pumping test with rapid data collection at the start tapering to less frequent as groundwater levels near stabilization.

Routine monitoring would continue to occur at the normal monitoring locations, including wetland, stream, and groundwater locations outside the area of influence of the pumping test. The streamflow monitoring stations are continuously recording. Manual measurements will be used at the wetland and groundwater locations not near the pumping test.

The Environmental Caucus will be notified of the installation of wells and the start and end of the pumping test. CalPortland will also provide weekly summaries of pumping test progress, and notification (within 24 hours) of any monitoring results below the performance thresholds. Routine reporting is summarized in Table 3 and notifications are outlined in Table 2.

D. Evaluate

Data will be screened as they are collected to determine if immediate action is required. In such an event, the Environmental Caucus would be notified within 24 hours, and the project would move immediately to the adjustment stage.

As monitoring data are collected, they also will be evaluated to see if the test is well-designed and the monitoring network is effective. If necessary, the project may enter the adjustment step to improve the pumping test to collect better information.

Once representative monitoring results are being collected, they will be screened against performance thresholds in Table 4 for the appropriate well and month. The performance thresholds were established at the lower 95^{th}-percentile confidence interval for the predicted water levels [see Section 3.3 and the Groundwater Model Update (Aspect, 2017)]. The frequency of screening will vary during the test beginning with hourly at the start and reducing to daily then weekly as the test progresses, as outlined in Table 1.

If the monitoring results indicate that groundwater levels near the marshes are lower than the performance thresholds, CalPortland would develop and implement appropriate adjustments during the pumping test.

If monitoring results indicate groundwater levels are lower than the performance thresholds in wells that are not near the marshes or other sensitive receptors (i.e., monitoring wells on the South Parcel), then the test would be completed as planned. These results would be evaluated and any anticipated adjustments for future steps identified.

Even if the observations made during the test are above the performance thresholds, they still may provide valuable information for refining the model, mine plan, and Monitoring Plan. Those observations will be considered during assessment and design for Step 2.

The evaluation will also include comparison of climate and water level conditions prior to the test with the range of conditions experienced during the model calibration and validation period.

E. Adjust

Adjustments during the pumping test could occur for two reasons:

1) The monitoring data indicate that data collected are not sufficient to achieve the objectives of the test; or

2) The monitoring data indicate that groundwater levels are below the performance thresholds.

Potential adjustments consist of modifying or terminating the pumping test, and are listed in Table 5. Since no mining below the pre-project groundwater elevation would occur during this dewatering step, any change in groundwater could be reversed by turning the dewatering wells off.

Table 5. Potential Response Actions during Step 1 – Initial Pumping Test

Modify pumping test:
Changing pumping rates
Changing the number of pumping wells
Changing the duration of pumping
Changing monitoring locations including installing new wells
Performing additional testing
Cease pumping test.

CalPortland will notify the Environmental Caucus of any adjustments to the pumping test within 24 hours of the change.

Reporting and Discussion

At the conclusion of the Step 1 pumping test, whether completed as planned, adjusted, or terminated, CalPortland will prepare an interpretative report documenting the pumping test, summarizing the monitoring data, comparing monitoring results with prior model predictions, and making recommendations for the assessment and design phases of the next step.

The report will be provided to the Environmental Caucus, with a 3-month period for review and discussion of the results. CalPortland commits to meeting with the Caucus as often as necessary during the review period to facilitate open communications and timely review. Should the Environmental Caucus and CalPortland have different interpretations of the dewatering test results, either party may request technical review conferences of the parties' technical consultants, followed by, if necessary, meetings of the parties' representatives, as described in Section 4.2.6 above.

Anticipated Schedule
The schedule for Step 1, in the context of the overall mining schedule, is illustrated in Figure 8. It is expected to require about a year to complete Step 1, with the following anticipated schedule:

- Planning the Pumping Test — 1 month
- Installing and Developing Wells — 2–3 months
- Performing the Pumping Test — 2 months
- Evaluating Results and Reporting — 2 months
- Model Updates (if necessary) — 2–3 months
- Review by and discussion with Environmental Caucus — 3 months

Incorporation of the results into the design of future steps could require additional time.

4.3.2 Step 2 – Preparation for Mining/ Dewatering Test

In Step 2, additional dewatering wells will be installed and will be pumped for several months to draw down groundwater until the gravel in the first mine segment of the South Parcel is dry enough to mine. If monitoring results are above performance thresholds during Step 2, the intent is to continue dewatering from those wells and transition smoothly into Step 3 – Active Dewatering during Mining. Step 3 would only commence when groundwater levels are above the performance thresholds.

The dewatering activity will also serve as a greatly expanded pumping test, the effects of which are completely reversible. The information collected in the first 60 days is most valuable as a pumping test, so evaluation and reporting on the test will focus on this period. The pumping test portion of Step 2 will occur for a minimum of 60 days.

The adaptive management plan for Step 2 is illustrated on Figure 10.

A. Assess
The planning for Step 2 will incorporate the results of Step 1, including any updates to the groundwater model, this Monitoring Plan, or mine plan resulting from Step 1.

In the assessment phase for Step 2, the results of the pumping test in Step 1 will be compared with the groundwater model. If they agree, then design would move forward as planned. If there are notable differences, the groundwater model would be evaluated and potentially modified.

The first level of model evaluation and modification would consist of updating the model to reflect the specific conditions of the Step 1 test (well locations, well construction, pumping rates, antecedent weather conditions, etc.) and developing a set of model predictions specific to the actual test conditions. These updates only modify the scenario for Step 1 and would not require recalibration of the model.

If the predictions from the updated model are notably inconsistent with the results of the pumping test, then the model parameters would be modified and calibrated to the observed data. Then, the full suite of predictive scenarios would be evaluated and compared with the groundwater levels included in the environmental analyses and permitting. If within the contemplated range, the project would move forward to the design phase with the revised model. If not, additional environmental analysis may be necessary.

The initially identified objectives for Step 2 are:

1) Evaluate whether groundwater levels at monitoring wells are above the performance thresholds; and,

2) Confirm that groundwater levels are low enough within the material to be mined to allow for safe and efficient mining and processing.

B. Design

Based on the results of the assessment step, the dewatering plan for Step 2 and the associated monitoring will be designed by CalPortland. Updates to the design will be simulated with the groundwater model and compared with prior environmental analyses as described above. If the model was updated in Step 1 or the assessment stage of Step 2, the predictive results from the updated model will be used to establish new performance thresholds.

Updates to the design and predictions of its impacts on groundwater will be provided to the Environmental Caucus.

C. Implement and Monitor

The additional dewatering wells for Step 2 will be installed and begin pumping. Pumped water will be discharged to an infiltration facility on the floor of existing mine. Pumping will occur for a minimum of 60 days to complete the dewatering test plus an estimated four additional months to dry gravels in Segment 1A sufficiently for mining.

Monitoring would consist of weekly monitoring at the key wells on the South Parcel in the portions of Edmond Marsh closest to the mine (key wells are defined in Table 1) and twice monthly monitoring at the other well, staff gage, and flow monitoring stations. Stations with continuously recording instrumentation, such as the flow monitoring stations, will be downloaded during these visits. Pressure transducers would also be installed to allow for continuous monitoring in key monitoring wells. Manual measurements will be collected from the other locations, such as staff gages and more distant wells.

The Environmental Caucus will be notified of the installation of wells and the start of dewatering. CalPortland will also provide weekly summaries of dewatering progress during the first two months, then monthly summaries. CalPortland will notify the Environmental Caucus (within 24 hours) of any monitoring results below the performance thresholds. Routine reporting is summarized in Table 3 and notifications are outlined in Table 2.

D. Evaluate

The evaluation stage in Step 2 is very similar to the evaluation stage of Step 1, as both actions are essentially pumping tests at different spatial scales.

Data will be screened as they are collected to determine if immediate action is required. In such an event, the Environmental Caucus would be notified and the project would move immediately to the adjustment stage.

Monitoring results will be screened against the performance thresholds in Table 6 for the appropriate well and month. The performance thresholds were established at the lower 95^{th}-percentile confidence interval for the predicted water levels [see Section 3.3 and the Groundwater Model Update (Aspect, 2017)]. If the monitoring results indicate that groundwater levels are lower than the performance thresholds, CalPortland will develop and implement appropriate adjustments.

Even if the groundwater levels are above the performance thresholds, they still may provide valuable information for refining the model, mine plan, and/or this Monitoring Plan. Those observations will be considered during assessment and design for the next dewatering step.

The evaluation will also consider the effect of conditions occurring at the time of monitoring (such as climate conditions, development, and Restoration Plan activities) with the range of conditions experienced during the model calibration and validation period, and include that information in the interpretation of results.

E. Adjust

Adjustment during the pumping test could occur for two reasons:

1) The monitoring data indicate that dewatering could cause groundwater drawdown beyond that previously contemplated and permitted; or

2) The monitoring data indicate that groundwater levels are not sufficiently low within the mine to allow for safe and efficient mining and processing in Step 3.

The first case would trigger rapid development and implementation of adjustments by CalPortland. If adjustments are not feasible or are exhausted without success, CalPortland would request to initiate the technical review conference of the parties' technical consultants, followed by, if necessary, meetings of the parties' representatives, as described in Section 4.2.6. The Environmental Caucus may also initiate this process.

In the second case, CalPortland would refine the dewatering plan while pumping continues. Potential adjustments include modifying or terminating the pumping test, and are listed in additional detail in Table 7. The list of adjustments provided in Table 7 is not intended to limit the range of potential responses.

CalPortland will notify the Environmental Caucus of any adjustments within 24 hours of the change.

Step 2 is completely reversible as no mining below the pre-project groundwater elevation would occur. Any change in groundwater could be reversed by ceasing to pump from the dewatering wells.

Table 7. Potential Response Actions during Step 2 – Preparation for Mining/Dewatering Test

Revise monitoring (change frequency of monitoring, or monitoring locations).
Install additional monitoring locations.
Change pumping rates.
Change pumping locations (adding or decommissioning) wells.
Modify the duration of pumping.
Cease dewatering.

Reporting and Discussion

In addition to the dewatering summaries described above, an interpretative report will be prepared in the third month of pumping for Step 2. The report will summarize the pumping-test portion of Step 2 by summarizing the first 2 months of data, comparing monitoring results with prior model predictions, documenting any response actions taken, and making recommendations for the assessment and design phases of the next step.

The report will be provided to the Environmental Caucus, with a 2-month period for review and discussion of the results. CalPortland commits to making its technical consultant available to meet with the Caucus's technical consultant as often as necessary during the review period to facilitate open communications and timely review. Should the parties' technical consultants be unable to resolve any difference in opinion in interpreting the dewatering test results, either party may request a meeting of the parties' designated representatives, as described in Section 4.2.6 above.

Anticipated Schedule

Step 2 is expected to require a about a year to complete, though the planning and well installation stages may overlap with the later reporting and discussions related to Step 1. The schedule for Step 2 and relationship with the Step 1 pumping test are shown on Figure 8. The anticipated schedule for key elements of Step 2, assuming performance thresholds are met, is:

Planning the Dewatering	2 months	
Installing and Developing Wells	2–3 months	
Performing the Pumping Test	2 months	
Evaluating Results and Reporting	2 month	Simultaneously: Continue Dewatering in Preparation for Mining
Update Model (if necessary)	1 month	
Review by and discussion with EC	2 months	4 months

If groundwater levels meet performance thresholds, Step 2 would flow into Step 3 and the start of mining. Otherwise, Step 2 may require a longer period to perform the necessary adjustments to achieve sufficient dewatering for mining while maintaining groundwater levels consistent with the performance thresholds and prior environmental analyses, or update the environmental analyses, if necessary.

Step 3 would only commence when groundwater levels are above the performance thresholds and water levels are at appropriately low levels for safe and efficient mining and processing.

4.3.3 Step 3 – Active Dewatering during Mining

During Step 3, mining will begin in the northeastern portion of the South Parcel and proceed south to mine a trough along the eastern boundary. Additional dewatering wells will be installed and pumped to dewater gravel in subsequent mine segments in the South Parcel. CalPortland would not start pumping additional dewatering wells until groundwater levels are at or above performance thresholds.

As mining is completed, reclamation of the eastern mined slope will begin. Pumping wells adjacent to mine segments that are under reclamation will be turned off incrementally to allow natural springs to form at the toe of the mined slope and vegetation to become established.

Steps 3 and 4 are different from the first two steps in that changes to groundwater in these steps are not as easily reversed. As such, the adaptive management plan is focused on identifying when adjustments are necessary.

The adaptive management plan for Step 3 is iterative, and activities would loop continuously through the adaptive management stages throughout implementation of Step 3. The adaptive management plan for Step 3 is illustrated on Figure 11.

A. Assess

The planning for Step 3 will begin prior to the completion of Step 2 to allow for a potentially smooth transition, if performance thresholds are being met. The planning stage will incorporate previously collected monitoring data as well as any updates to the groundwater model, monitoring plan, or dewatering and mining plans.

If monitoring data from prior steps meet the performance thresholds, the planning for Step 3 is expected to move forward in accordance with the mine plan.

Differences between monitoring results and predictions would result in re-evaluation of the groundwater model. The re-evaluation would first simulate the specific conditions of Step 2, then more broadly update the model if predictions still do not match observations. If significant model updates are required, the full suite of scenarios would be simulated and results compared with the prior environmental analyses and permitting. Only if model results are within the predicted range may the project move forward to the design phase with the revised model.

The initially identified objectives for Step 3 are:

1) Evaluate whether groundwater levels at monitoring wells are above the performance thresholds for the appropriate month; and

2) Confirm that groundwater levels are low enough within the material to be mined to allow for safe and efficient mining and processing.

B. Design

Based on the results of the prior steps and assessment for Step 3, the dewatering plan, mining plan, and the associated monitoring will be updated by CalPortland, if necessary. Updates to the design will be simulated with the groundwater model and compared with the performance thresholds. Updated documents will be provided to the Environmental Caucus.

C. Implement and Monitor

Mining will begin at the northern edge of the South Parcel in the area dewatered in Step 2. As mining progresses, additional dewatering wells will be installed to the south of the current wells and begin pumping. As mining is completed in an area, the nearby wells will be turned off, allowing groundwater to emerge from springs from the toe of the completed slope. Both pumped groundwater and spring flow will be conveyed to an infiltration pond installed on the floor of the existing mine.

Monitoring would continue at all normal well, wetland, and streamflow monitoring stations. Streamflow and select well monitoring stations would have continuous recording instruments installed. Other locations would use manual measurements.

The frequency of monitoring would vary during Step 3. In the 3 months after the start of pumping for each new group of monitoring wells, monitoring would be weekly at key wells (defined in Table 1) and twice monthly monitoring at the other well, staff gage, and flow monitoring stations. After that, monitoring will be performed monthly.

D. Evaluate

As with prior steps, monitoring results will be screened against performance thresholds for Step 3 (Table 8) for the appropriate well and month. The performance thresholds were established at the lower 95^{th}-percentile confidence interval for the predicted water levels [see Section 3.3 and the Groundwater Model Update (Aspect, 2017)]. If the model was previously updated, performance thresholds based on predictive results from the updated model will be used for the comparison. The evaluation will also consider the effect of conditions occurring at the time of monitoring (such as climate conditions, development, and Restoration Plan activities) with the range of conditions experienced during the baseline period.

If the monitoring results indicate that groundwater levels are lower than the performance thresholds, CalPortland would evaluate and implement appropriate adjustments.

Although the primary focus is on changes in groundwater levels, streamflow and surface water monitoring results will also be reviewed. By this point in the project, streamflow and surface water monitoring results will be affected by Restoration Plan activities, which are likely to have a larger effect than mining on the surface water bodies. The Restoration Plan will incorporate its own adaptive management process.

E. Adjust

Step 3 involves mining below the current aquifer level. As such, it is more difficult to reverse than prior steps; however, mining is designed to begin away from the marshes and Sequalitchew Creek and proceed southward toward them over a period of years. This will slowly change water levels beneath the marshes and creek and allow time for response actions should the monitoring data and evaluations indicate they are necessary.

If groundwater levels are below the performance thresholds, CalPortland would develop and implement adjustments. Unlike in the prior steps, re-examination of the groundwater model is not a first element of evaluating potential response actions in Step 3.

Either party may initiate a request for a technical review conference and, if necessary, meetings of the parties' representatives, as described under Section 4.2.6 above. If adjustments are not feasible or are exhausted without meeting performance thresholds, CalPortland would initiate the process to discuss alternative approaches and next steps.

Selection of potential response actions is shown in Table 9. The suite of appropriate response actions will change over time as mining progresses. For example, early in Step 3 there is more flexibility to alter the mine plan. As mining progresses further south, the ability for alterations to the mine plan to produce a meaningful change in groundwater levels is reduced.

Table 9. Potential Response Actions during Step 3 – Active Dewatering during Mining

Revise mine phasing to allow time for additional monitoring, analyses, testing, and planning.
Revise dewatering plan (number of wells, spacing, alignment, pumping duration).
Revise mining plan to change depth or extent of mining.
Install partial slurry cutoff wall.
Provide additional mitigation.
Cease dewatering and mining.

Reporting and Discussion

During Step 3, CalPortland will prepare summary memos providing comparison of observed groundwater levels over the past 3 months with model predictions, as well as an update on dewatering and mining status, and any response actions taken. The summary memos will be prepared monthly for 3 months after each new set of dewatering wells begins pumping, then quarterly. The memos will be provided to the Environmental Caucus.

Anticipated Schedule

Mining would proceed south over a period of years. Completion of Step 3 is expected to take 4 to 8 years. The mining schedule is, in part, driven by the market demand for aggregate. CalPortland has committed to complete Step 3 in no less than 3 years, or a minimum of 9 months per each of the first four segments (1A to 1D). The minimum timeline for completion of Step 3 is illustrated in Figure 8.

4.3.4 Step 4 – Cessation of Active Dewatering

This final step of dewatering commences once mining and reclamation advances to the point that the last dewatering wells installed in Step 3 have been turned off. At that point, groundwater will emerge from springs along the length of the toe of the mined (and reclaimed) slope along the eastern and a portion of the southern mine boundaries. Step 3 is expected to transition smoothly into Step 4, given the multiple-year duration of Step 3 and that ceasing to pump the dewatering wells will result in lower environmental impact.

Several steps of the adaptive management process (i.e., assess and design) are not as relevant in Step 4, because it is a largely passive step with respect to the effects on groundwater levels. Mining and reclamation activities will continue within the South Parcel, but those activities would no longer influence groundwater levels.

As such, this discussion focuses on ongoing monitoring, data evaluation, and potential response actions. The adaptive management plan for Step 4 is illustrated on Figure 12.

C. Monitoring

Monthly monitoring would continue for the duration of mining at the normal well, wetland, and streamflow monitoring stations. Continuous instrumentation will be maintained at streamflow monitoring stations. Staff gage and well monitoring locations will be manually measured.

D. Evaluate

Monitoring results would continue to be screened relative to the performance thresholds shown in Table 10, or as refined from the most recent groundwater model. The performance thresholds were established at the lower 95^{th}-percentile confidence interval for the predicted water levels [see Section 3.3 and the Groundwater Model Update (Aspect, 2017)]. It is unlikely that events will result in short-term changes in groundwater levels in Step 4. Therefore, the evaluation will focus on longer-term comparisons with model predictions and observations of changes in the marshes and Sequalitchew Creek.

E. Adjust

If groundwater levels persist lower than the performance thresholds, CalPortland and the Environmental Caucus would hold one or more technical review conferences of the parties' technical consultants and, if necessary, meetings of the parties' representatives (as described in Section 4.2.6). to discuss and select appropriate adjustments. Either party may initiate this process.

Reporting

Quarterly summary memos will be prepared for the first year after cessation of dewatering. Annual reports will be prepared for the remaining duration of mining of the South Parcel.

Anticipated Schedule

Step 4 will begin after active dewatering ceases. Depending on market demand for aggregate products, mining of the remainder of the South Parcel is expected to occur over 5 to 8 years after cessation of active dewatering. Active adaptive management during Step 4 would cease when the following conditions are met:

- Mining of the South Parcel is complete, and

- Measured groundwater levels have been met performance thresholds for at least 3 consecutive years.

5 Relationship of Adaptive Management Process to Sequalitchew Creek Restoration Plan

Mining of the South Parcel and the restoration of Sequalitchew Creek are separate, but interacting, projects. Each project has its own adaptive management process tailored to achieving the goals and objectives of that project. The interaction between the two adaptive management processes is three-fold: 1) project schedules that encourage restoration in advance of the potential impacts from mining; 2) development of performance thresholds for mining that support restoration based on prior technical studies, including the cumulative effects analysis prepared in 2016 (Aspect and Anchor, 2016); and 3) coordinated monitoring and open sharing of information.

Project Schedules. The mining and restoration projects have been designed to facilitate restoration occurring in advance of the potential impacts from mining. This relationship between the project schedules is founded in key elements of the settlement agreement:

1) The mining project cannot begin until all permits for restoration have been obtained and the required authorizations or approvals from JBLM needed to implement the restoration elements on JBLM have been obtained.
2) The first actions of the mining project are pumping and dewatering tests (i.e., Steps 1 and 2) and are expected to take about 1.5 to 2 years to complete and no less than 9 months[1], as described in Section 4.2.1. The effects of Steps 1 and 2 on groundwater are completely reversible.
3) The first South Parcel mining segment is located furthest from the wetlands and Sequalitchew Creek. Mining and dewatering proceed slowly toward the Creek over a period of not less than 3 years, and more likely 4 to 8 years.
4) There are no schedule constraints or limits imposed on the pace of restoration activities.

The Restoration Plan schedule is anticipated to begin with the elements that immediately restore flow through the system—specifically, beaver management and improvements at the outlet of Sequalitchew Lake. The actions will be followed by improvements that enhance flows (e.g., connections from Hamer Marsh) and make it easier to maintain flows (e.g., installation of the Railroad Trail bridge and sealing\restoration of the losing reach). Finally, habitat restoration, through culvert replacements and enhancement of wetland and stream habitats, is the final component of the Restoration Plan.

Although a detailed schedule has not been developed for implementation of the Restoration Plan, it is anticipated restoration activities will begin immediately shortly after Restoration Plan permits are obtained and it should require no more than 6 years to complete construction and implementation of all elements of the Restoration Plan. The

[1] Minimum durations for the pumping test and review and discussion stages of Steps 1 and 2 are established in Section 4.3. The specified timeframes add up to a minimum duration of 9 months, however this duration is unrealistically short as it does not include time for other key steps, like well installation or report writing.

flow restoration actions should be completed within two years from the start of the project, and followed by flow maintenance and enhancement, which may require 3 years to complete, but could overlap with the flow restoration actions. Finally, construction of habitat restoration improvements could be completed within 3 years and could overlap or dovetail with the related flow maintenance and enhancement elements.

A timeline relating the anticipated schedules for restoration and mining is presented on Figure 13. Restoration activities should be successful in restoring flows to Sequalitchew Creek within the first 2 years. During this time, the mining project would complete the second pumping test (Step 2) and, if groundwater levels meet performance thresholds and mining progresses at the fastest allowable pace, mine Segment 1A and advance into Segment 1B. The anticipated increase in flow is much greater than the potential impact from the mining project, and the full benefit in flow quantity may be achieved in these first 2 years; whereas the impact from mining is minimal at first and increases slowly over time. The impact from mining is expected to peak during mining of Segment 1C, when the greatest number of wells are pumping[2].

Even if mining is proceeding rapidly, CalPortland has committed that mining of Segment 1 would not be completed in less than 3 years, with each segment lasting at least 9 months. At this pace, the peak impact from mining could be expected around 2 to 3 years after the start of restoration. Even if delayed, the flow restoration action should have occurred by this time and only a fraction of flow restoration is necessary to offset the impacts from mining.

Performance Thresholds that are Supportive of Restoration. The cumulative effects analysis (Aspect and Anchor, 2016) found that the changes in the marshes would be dominated by the Restoration Project (which requires lowering marsh water levels to achieve flow from Sequalitchew Lake to the ravine), rather than increased infiltration resulting from lower groundwater levels. The marshes would have significantly more water flowing through them than under current conditions, resulting in consistent water levels year-round at the target levels established in the Restoration Plan, except for some periods in the driest years.

The cumulative effects analysis also concluded that the predominant cumulative effect on Sequalitchew Creek would be an increase in annual average flows by approximately 10 cfs, with abundant year-round flow most of the time. By comparison, the stream flow reductions from mining is expected to be less than 1 cfs, and only apparent during limited periods in atypical summers.

The anticipated benefits to streamflow from restoration are much larger than the potential impacts from mining. As a result, the success of the restoration project is not expected to be particularly sensitive to the groundwater levels resulting from mining. Monitoring during mining will ensure that groundwater levels remain within the expected range that will support the anticipated increases in stream flow from the restoration project. If

[2] To be conservative, the potential impacts of mining described in the cumulative effects analysis (Aspect and Anchor, 2016) were based on all wells pumping at the same time. In practice, this condition is unlikely to occur as initial wells would be phased off as mining progresses.

groundwater levels are not maintained within the expected range, corrective actions will be implemented in accordance with the adaptive management plan for mining.

Coordinated Monitoring and Information Sharing. To facilitate the coordinated collection and exchange of information, the two projects share an integrated SAP (Appendix B). The SAP outlines the collection of information on groundwater levels, surface water levels, streamflow, and surface water quality to support both plans. Each plan also outlines how information will be shared so that plan implementers have the data necessary to make informed management decisions.

6 References

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7 Limitations

Work for this project was performed for CalPortland (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting’s original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

TABLES

Table 4 - Performance Thresholds for Step 1 - Initial Dewatering Test

Project No. 040001-014-02, South Parcel, DuPont, Washington

Well	Performance Threshold = Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	203.6	202.4	202.9	202.2	202.3	201.4	200.4	200.4	199.5	199.5	202.1	202.9
MW-EM-1D	204.6	203.4	203.9	203.2	203.3	202.5	201.5	201.5	200.7	200.7	203.1	203.9
MW-EM-2S	210.6	210.3	210.4	210.3	210.2	210.0	209.7	209.6	209.3	209.5	210.2	210.4
MW-EM-2D	210.8	210.4	210.6	210.5	210.4	210.2	209.8	209.7	209.4	209.6	210.4	210.5
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.9
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	210.2	209.6	210.5	212.3	212.7
MW-BM-1	218.0	217.0	216.6	217.4	217.3	216.6	216.1	213.1	213.3	214.2	216.8	217.4
MW-HM-1	214.2	213.5	213.3	213.8	213.6	212.7	211.8	211.2	210.6	211.1	213.1	213.6
MW-PL-1	200.8	200.1	200.4	200.1	200.0	199.4	198.6	198.7	198.0	197.7	199.6	200.2
CHMW-1	191.3	189.9	190.4	189.6	189.7	189.0	188.1	188.0	187.4	187.5	190.0	190.7
CHMW-2S	184.6	183.3	183.7	183.0	183.0	182.5	181.7	181.6	181.2	181.4	183.5	184.0
CHMW-2D	183.4	181.8	182.4	181.4	181.5	180.8	179.8	179.7	179.3	179.4	182.1	182.7
CHMW-3S	193.3	191.7	192.4	191.3	191.5	190.6	189.6	189.5	188.7	188.8	191.7	192.6
CHMW-3D	193.2	191.5	192.2	191.1	191.3	190.4	189.2	189.1	188.3	188.4	191.5	192.5
CHMW-4S	196.1	194.7	195.3	194.4	194.6	193.7	192.7	192.6	191.9	191.9	194.6	195.5
CHMW-4D	194.3	192.9	193.5	192.6	192.7	191.9	190.9	190.8	190.1	190.1	192.8	193.6
MW-D-3	196.5	195.3	195.7	195.0	195.1	194.6	193.9	193.7	193.3	193.5	195.6	195.9
MW-93-MFS-C5-3	192.3	191.2	191.7	191.0	191.0	190.5	190.0	189.9	189.5	189.8	191.6	191.7

Table 6 - Performance Thresholds for Step 2 - Preparation for Mining/Expanded Dewatering Test

Project No. 040001-014-02, South Parcel, DuPont, Washington

Well	Performance Threshold = Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	202.3	201.1	201.6	200.9	201.1	200.1	199.1	199.2	198.4	198.3	200.8	201.5
MW-EM-1D	203.4	202.3	202.8	202.2	202.3	201.4	200.5	200.5	199.7	199.7	202.0	202.7
MW-EM-2S	210.6	210.2	210.3	210.2	210.1	210.0	209.6	209.5	209.2	209.4	210.1	210.3
MW-EM-2D	210.8	210.4	210.5	210.4	210.3	210.1	209.7	209.6	209.3	209.5	210.3	210.5
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.9
MW-SRC-2	213.2	212.4	212.6	212.6	212.8	212.0	211.4	210.2	209.5	210.5	212.0	212.7
MW-BM-1	218.0	217.0	216.5	217.3	217.2	216.6	216.1	213.0	213.3	214.1	216.8	217.3
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.2	210.5	211.1	213.0	213.6
MW-PL-1	200.4	199.7	200.1	199.8	199.8	199.1	198.2	198.4	197.7	197.4	199.2	199.8
CHMW-1	187.0	185.7	186.3	185.5	185.6	184.9	184.0	184.0	183.3	183.4	185.8	186.4
CHMW-2S	143.8	141.4	142.2	141.0	141.0	140.1	139.1	138.9	138.3	138.6	141.8	142.9
CHMW-2D	142.5	141.0	141.6	140.7	140.7	140.0	139.1	138.9	138.3	138.5	141.2	141.9
CHMW-3S	190.6	189.0	189.8	188.8	189.0	188.1	187.0	187.0	186.2	186.2	189.0	189.8
CHMW-3D	190.2	188.6	189.4	188.3	188.5	187.5	186.3	186.3	185.4	185.3	188.4	189.3
CHMW-4S	193.7	192.3	193.0	192.1	192.3	191.4	190.4	190.4	189.6	189.6	192.2	193.0
CHMW-4D	191.8	190.5	191.2	190.3	190.5	189.6	188.6	188.6	187.8	187.8	190.4	191.1
MW-D-3	193.7	192.5	193.0	192.3	192.3	191.9	191.2	191.1	190.7	190.9	192.9	193.4
MW-93-MFS-C5-3	190.8	189.8	190.3	189.6	189.6	189.1	188.7	188.5	188.2	188.5	190.2	190.5

Table 8 - Performance Thresholds for Step 3 - Active Dewatering during Mining

Project No. 040001-014-02, South Parcel, DuPont, Washington

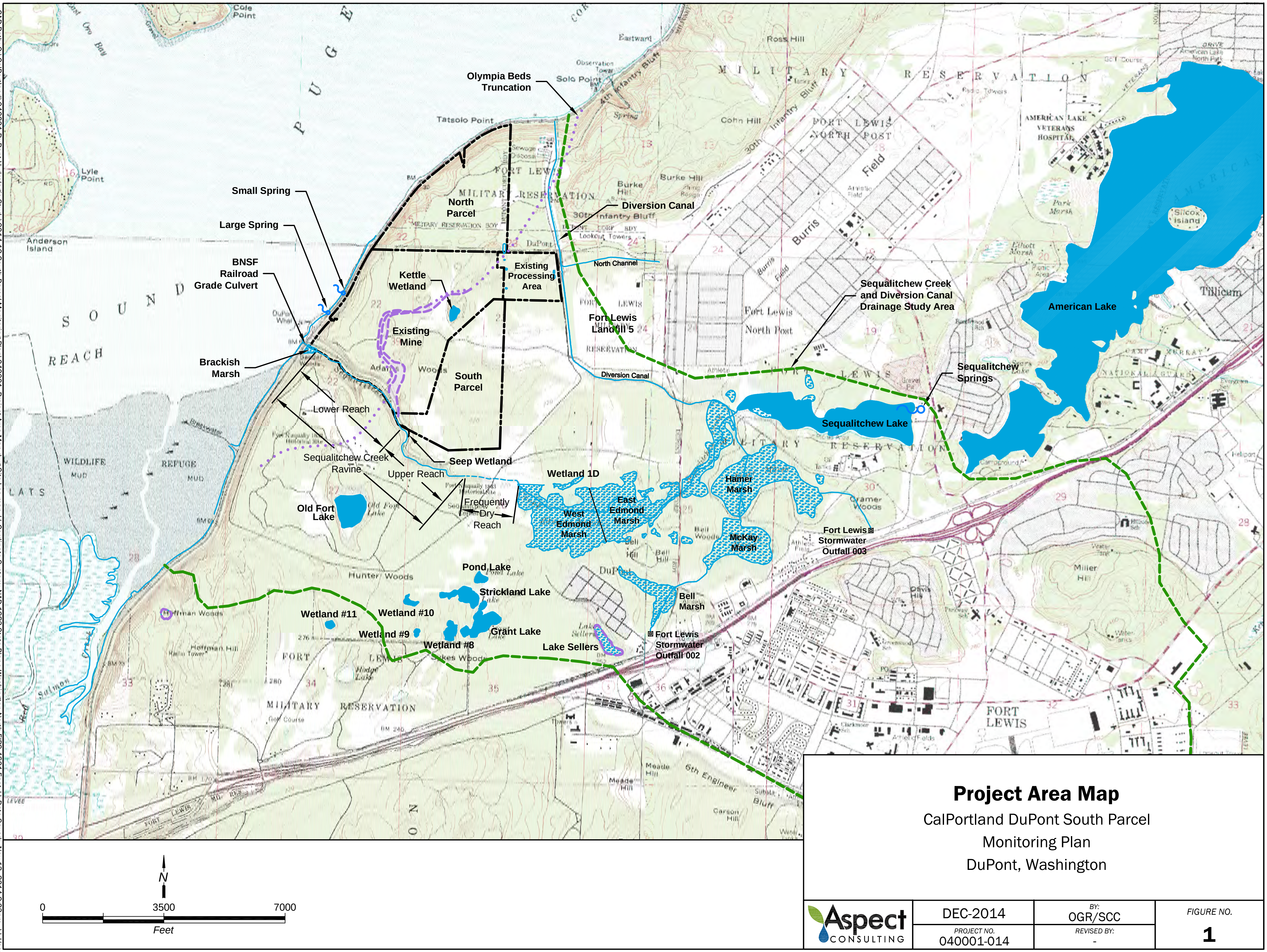
Well	Performance Threshold = Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	197.5	196.4	196.9	196.4	196.5	195.6	194.7	194.8	194.1	194.1	196.1	196.8
MW-EM-1D	199.4	198.4	198.9	198.3	198.4	197.6	196.8	196.9	196.2	196.2	198.1	198.7
MW-EM-2S	210.3	210.0	210.1	209.9	209.9	209.7	209.4	209.3	209.0	209.2	209.9	210.0
MW-EM-2D	210.5	210.1	210.3	210.1	210.0	209.8	209.5	209.4	209.1	209.3	210.0	210.2
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.8
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	210.2	209.5	210.5	212.0	212.7
MW-BM-1	217.8	216.8	216.4	217.2	217.1	216.4	215.9	212.8	213.1	213.9	216.7	217.2
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.2	210.4	211.1	213.0	213.6
MW-PL-1	199.4	198.7	199.0	198.8	198.7	198.0	197.1	197.3	196.6	196.2	198.1	198.8
CHMW-1	129.8	129.1	129.4	128.9	128.9	128.5	127.8	127.8	127.3	127.4	129.2	129.5
CHMW-2S	136.0	134.5	135.0	134.1	134.1	133.5	132.9	132.8	132.3	132.5	134.9	135.5
CHMW-2D	135.9	134.7	135.1	134.3	134.2	133.7	133.1	132.9	132.4	132.6	134.9	135.5
CHMW-3S	131.1	128.4	130.3	128.9	129.2	127.9	126.6	127.0	126.2	126.3	129.0	130.2
CHMW-3D	128.3	127.4	127.9	127.6	127.6	126.8	125.8	126.1	125.4	125.1	127.0	127.6
CHMW-4S	181.0	179.7	180.4	179.6	179.7	178.8	177.7	177.8	176.9	176.9	179.5	180.3
CHMW-4D	178.5	177.3	178.0	177.1	177.3	176.4	175.3	175.4	174.5	174.4	177.1	177.8
MW-D-3	189.9	188.6	189.1	188.4	188.4	187.9	187.4	187.3	186.9	187.3	189.1	189.6
MW-93-MFS-C5-3	189.5	188.5	189.0	188.4	188.3	187.9	187.5	187.4	187.2	187.5	189.0	189.3

Table 10 - Performance Thresholds for Step 4 - Cessation of Active Dewatering

Project No. 040001-014-02, South Parcel, DuPont, Washington

Well	Performance Threshold = Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	198.1	197.0	197.6	197.0	197.1	196.2	195.4	195.3	194.8	194.7	196.8	197.4
MW-EM-1D	199.9	198.9	199.4	198.8	199.0	198.2	197.3	197.3	196.7	196.7	198.7	199.3
MW-EM-2S	210.3	210.0	210.1	210.0	209.9	209.7	209.4	209.3	209.0	209.2	209.9	210.1
MW-EM-2D	210.5	210.2	210.3	210.1	210.1	209.9	209.5	209.4	209.1	209.3	210.1	210.2
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.8
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	209.9	209.4	210.4	212.0	212.7
MW-BM-1	217.9	216.9	216.4	217.2	217.1	216.5	216.0	212.3	213.0	213.8	216.7	217.2
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.0	210.3	211.1	213.0	213.6
MW-PL-1	199.5	198.8	199.2	198.9	198.9	198.2	197.3	197.5	196.8	196.4	198.2	198.9
CHMW-1	163.2	162.7	162.9	162.7	162.6	162.4	162.1	162.1	161.8	162.0	162.9	163.1
CHMW-2S	169.3	165.0	168.1	163.2	162.8	158.9	157.1	157.2	156.2	156.9	167.9	168.8
CHMW-2D	160.3	158.5	159.2	158.1	157.9	156.9	155.4	155.5	154.6	155.2	159.1	159.8
CHMW-3S	140.4	140.2	140.3	140.2	140.2	140.0	139.7	139.7	139.5	139.7	140.3	140.3
CHMW-3D	141.9	141.6	141.8	141.6	141.6	141.4	141.1	141.1	140.9	141.0	141.6	141.8
CHMW-4S	183.0	181.9	182.5	181.8	181.9	181.3	180.5	180.5	179.9	180.0	181.9	182.4
CHMW-4D	181.0	180.0	180.6	179.9	180.0	179.4	178.7	178.7	178.2	178.2	180.0	180.5
MW-D-3	191.4	190.2	190.7	190.0	189.9	189.5	188.9	188.8	188.5	188.9	190.7	191.1
MW-93-MFS-C5-3	190.1	189.1	189.5	188.9	188.8	188.4	187.9	187.9	187.6	188.0	189.6	189.9

FIGURES



Project Area Map

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	DEC-2014	BY: OGR/SCC	FIGURE NO. 1
	PROJECT NO. 040001-014	REVISED BY: -	

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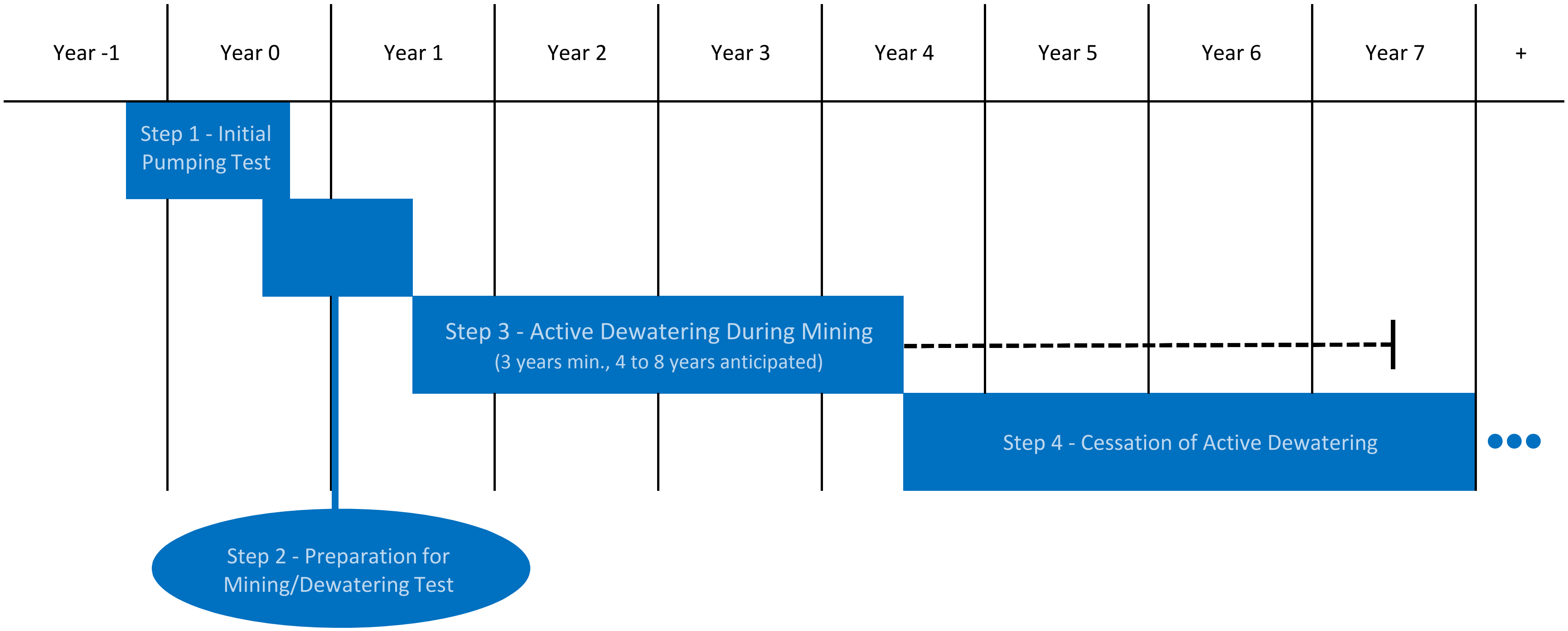
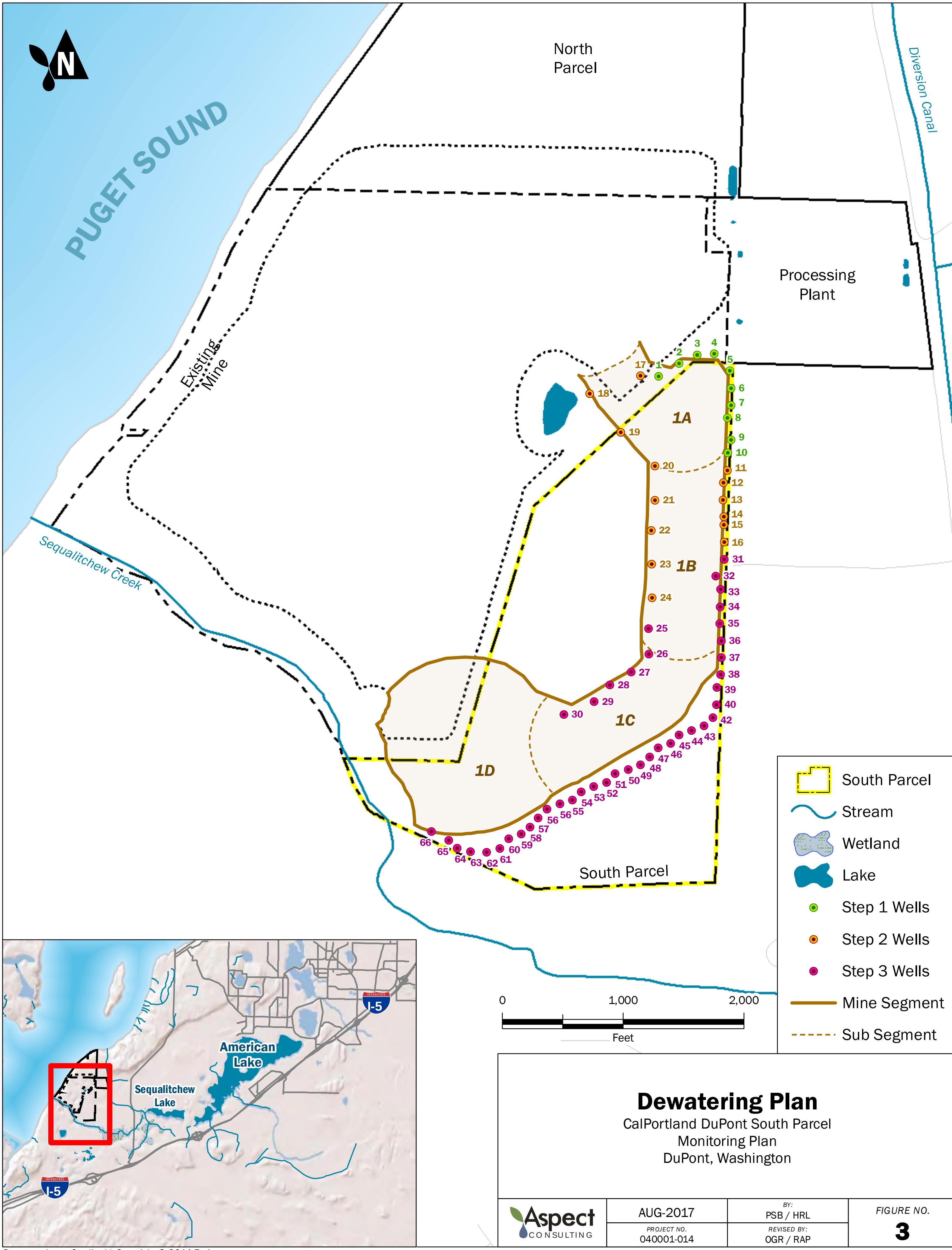


Notes:
1) Year 1 begins with the start of pumping in Step 2.
2) Timeline for Step 3 is based on CalPortland's commitment to a minimum duration of 3 years. The dashed line indicates the anticipated duration (6 years).

Aspect Consulting
September 2017
S:\CalPortland\DuPont\South Parcel\Report Drafts\Monitoring Plan\MonitoringPlanTables-Mining&Restoration.xlsx

Figure 2
Timeline of Dewatering Steps
South Parcel Monitoring Plan
DuPont, Washington



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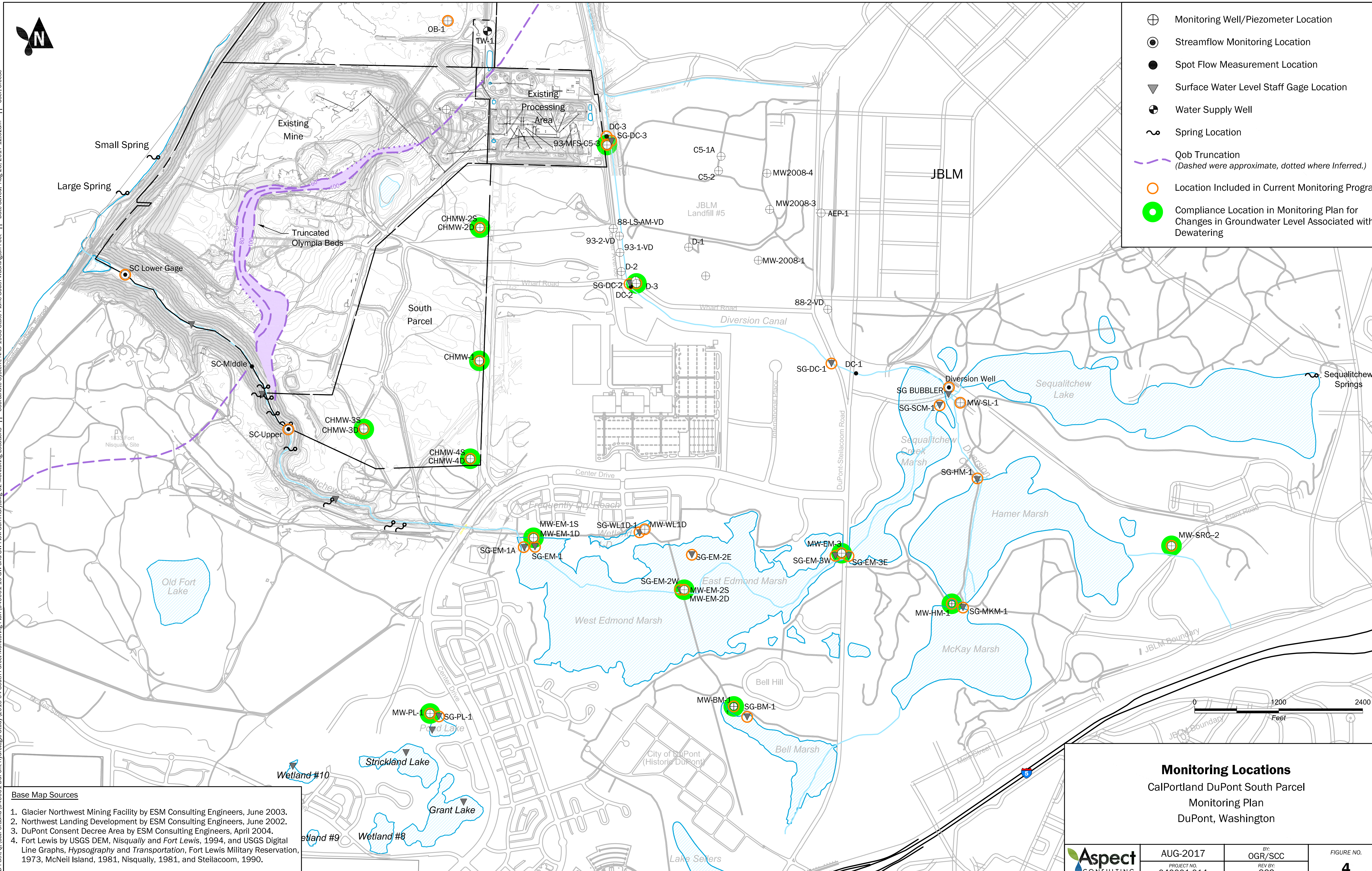
Dewatering Plan

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	AUG-2017	BY: PSB / HRL	FIGURE NO.
	PROJECT NO. 040001-014	REVISED BY: OGR / RAP	3



Base Map Sources

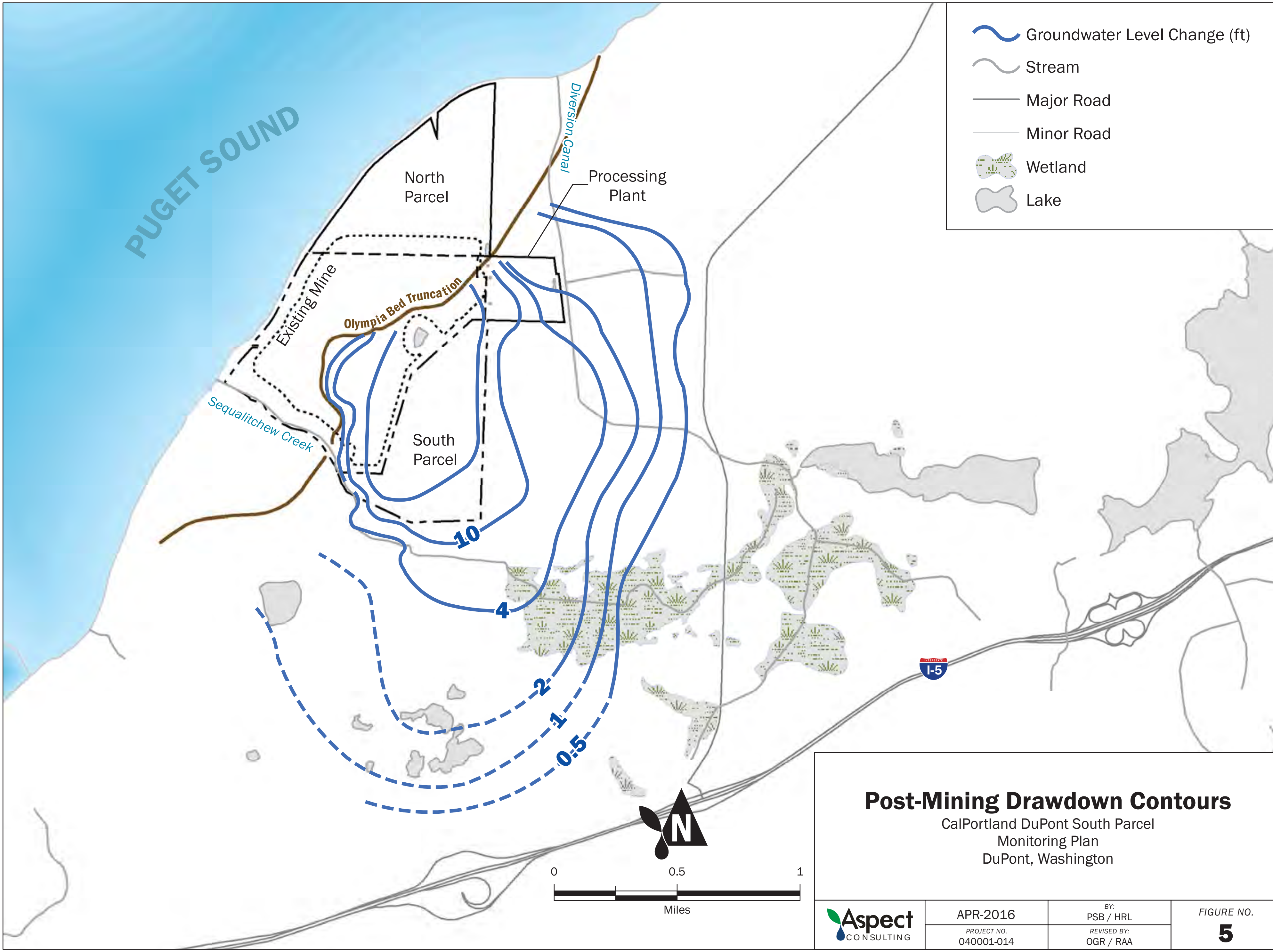
1. Glacier Northwest Mining Facility by ESM Consulting Engineers, June 2003.
2. Northwest Landing Development by ESM Consulting Engineers, June 2002.
3. DuPont Consent Decree Area by ESM Consulting Engineers, April 2004.
4. Fort Lewis by USGS DEM, *Nisqually* and *Fort Lewis*, 1994, and USGS Digital Line Graphs, *Hypsography* and *Transportation*, Fort Lewis Military Reservation, 1973, McNeil Island, 1981, Nisqually, 1981, and Steilacoom, 1990.

Monitoring Locations

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING

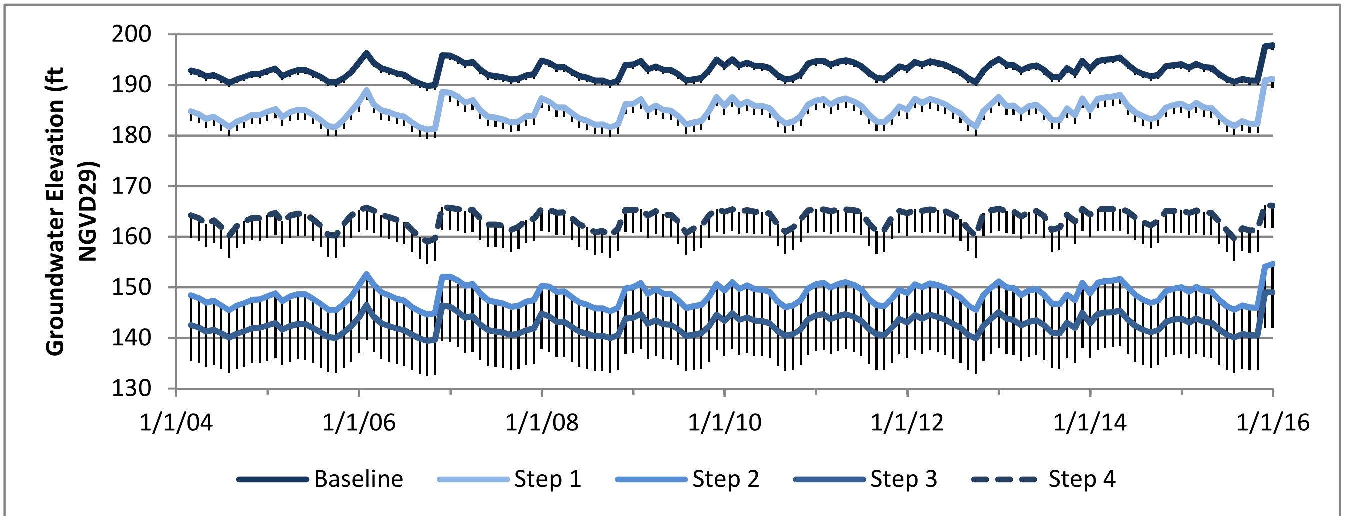
AUG-2017	BY: OGR/SCC	FIGURE NO.
PROJECT NO. 040001-014	REV BY: SCC	4

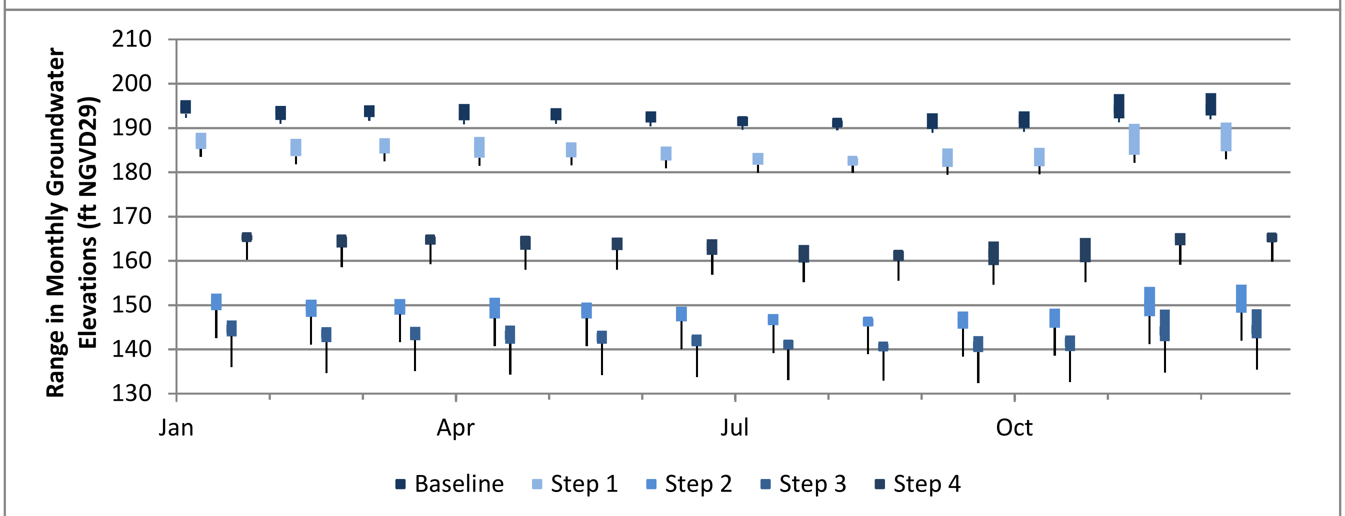


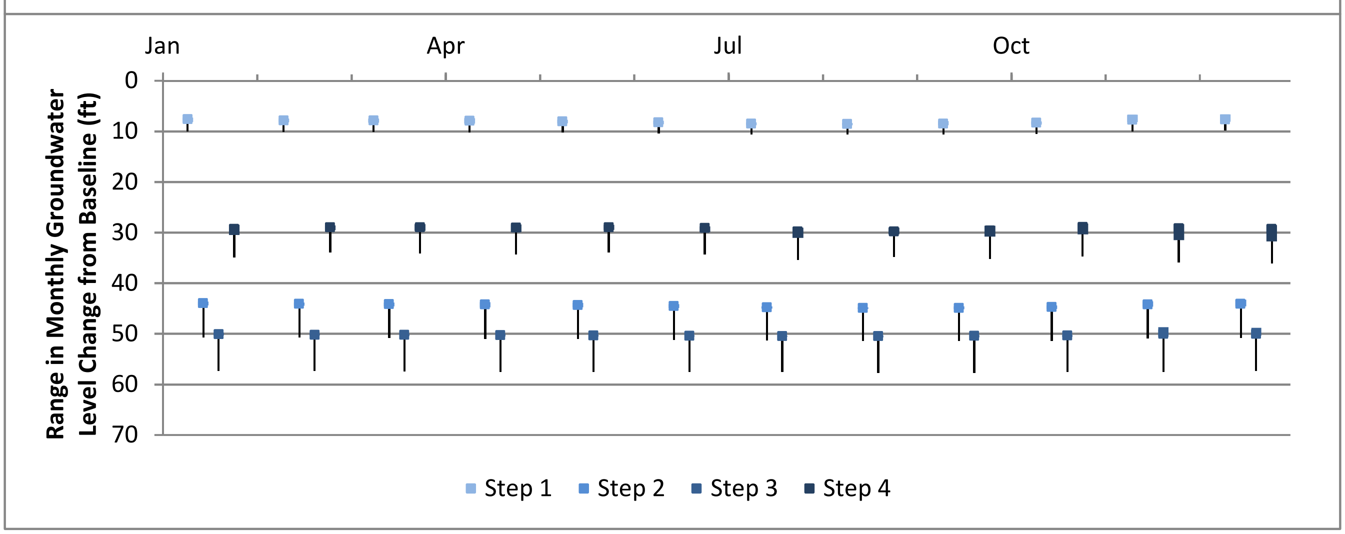
Post-Mining Drawdown Contours
CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	APR-2016	BY: PSB / HRL	FIGURE NO. 5
	PROJECT NO. 040001-014	REVISED BY: OGR / RAA	

CHMW-2D







Aspect Consulting, LLC
03/20/2017

Figure 6
Predicted Changes and Ranges in Groundwater Levels

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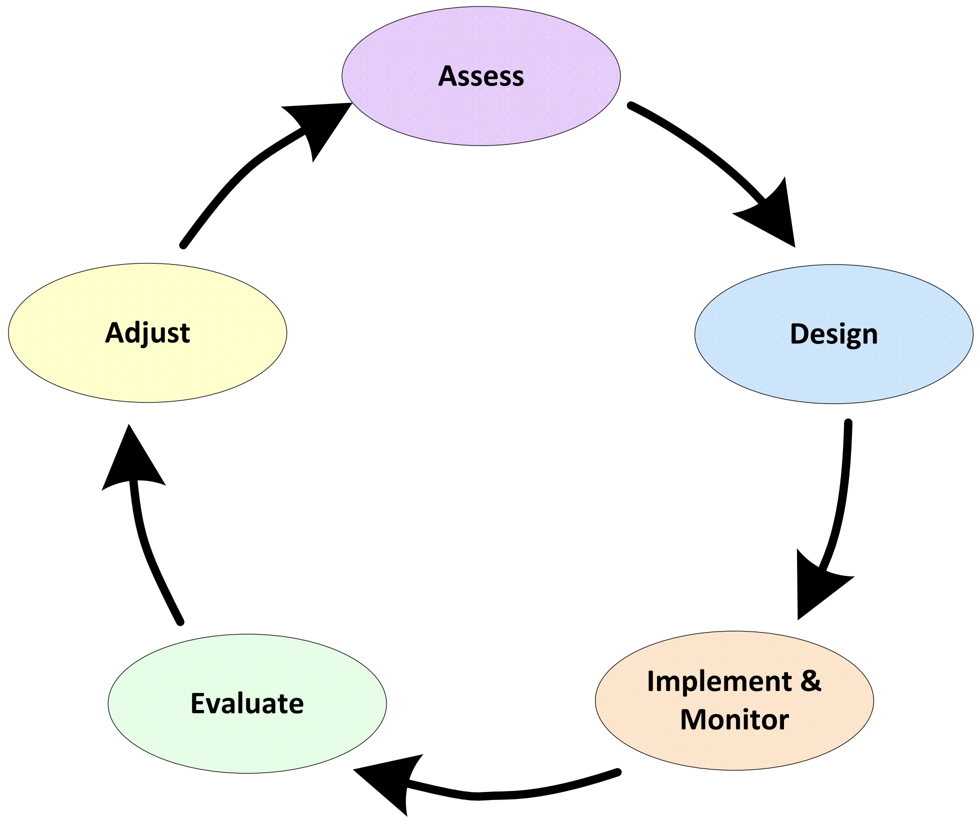

Adaptive Management Process

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, WA

Aspect CONSULTING	APR-2016	BY: OGR	FIGURE NO. 7
	PROJECT NO. 040001-014	REV BY: - - -	

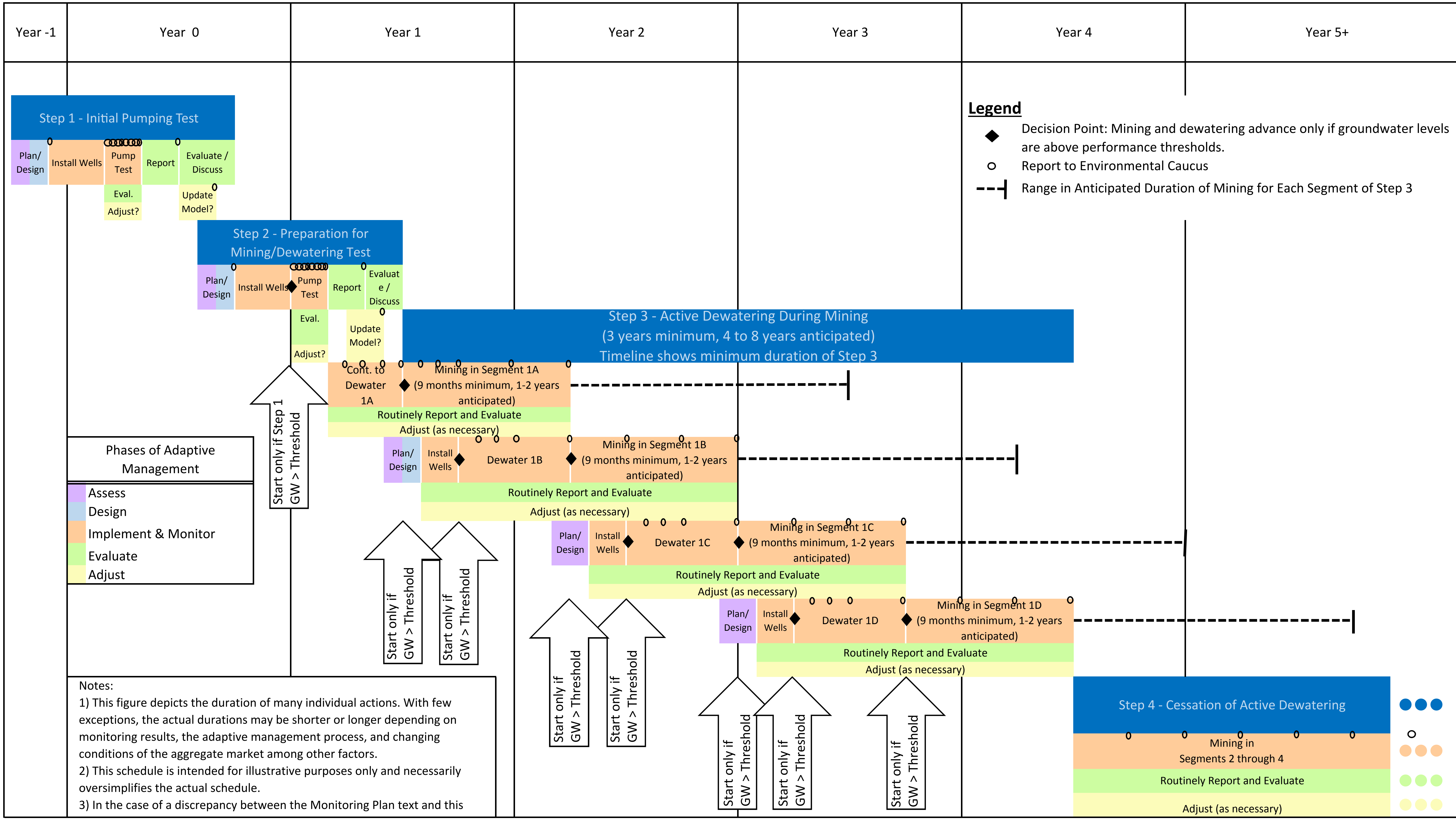

Figure 8

Timeline of Adaptive Management for South Parcel Mining

DuPont, Washington

Aspect Consulting

September 2017

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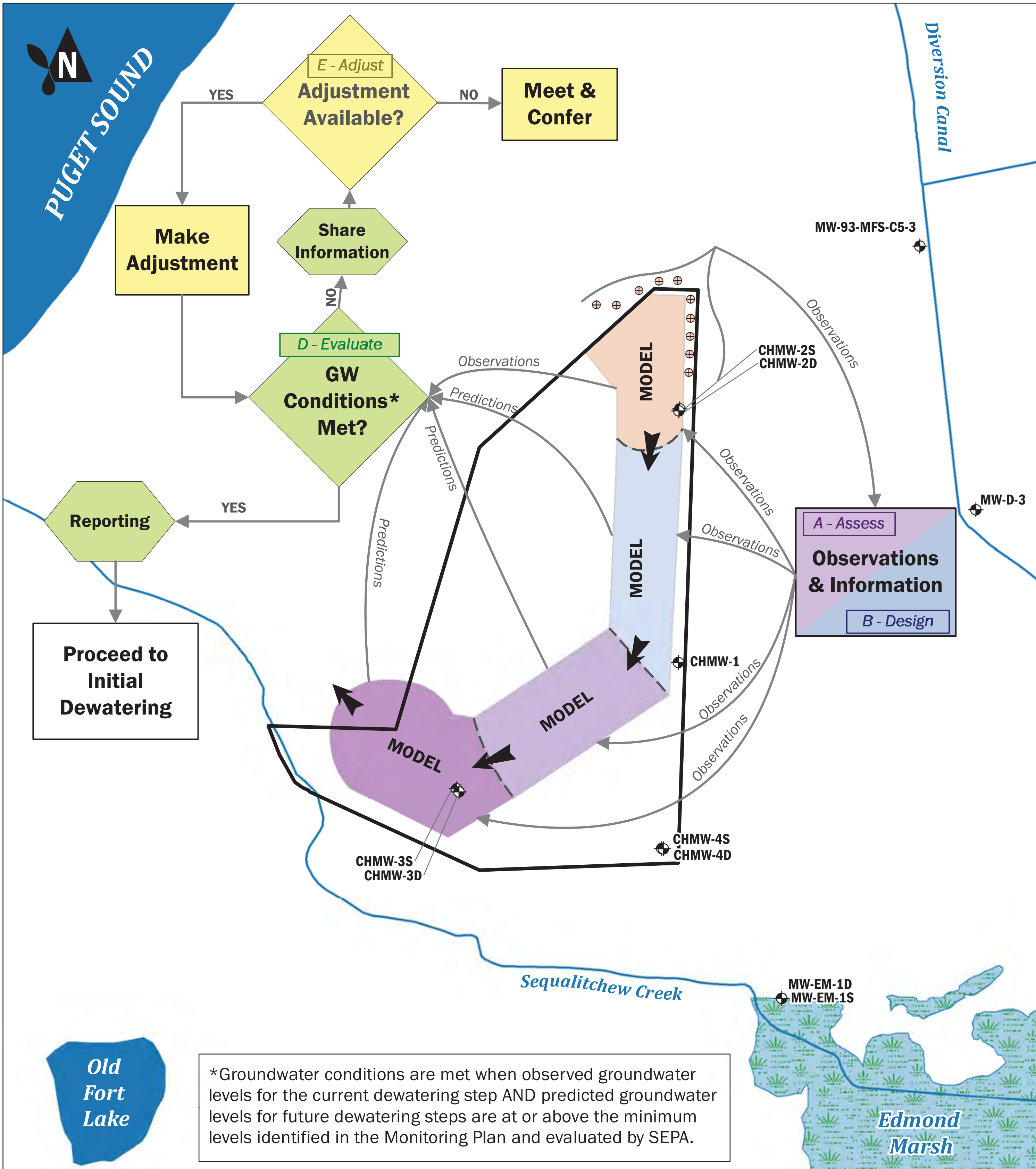


Monitoring Well | Wetland

Dewatering Well | Lake

0 | 1,000 | 2,000

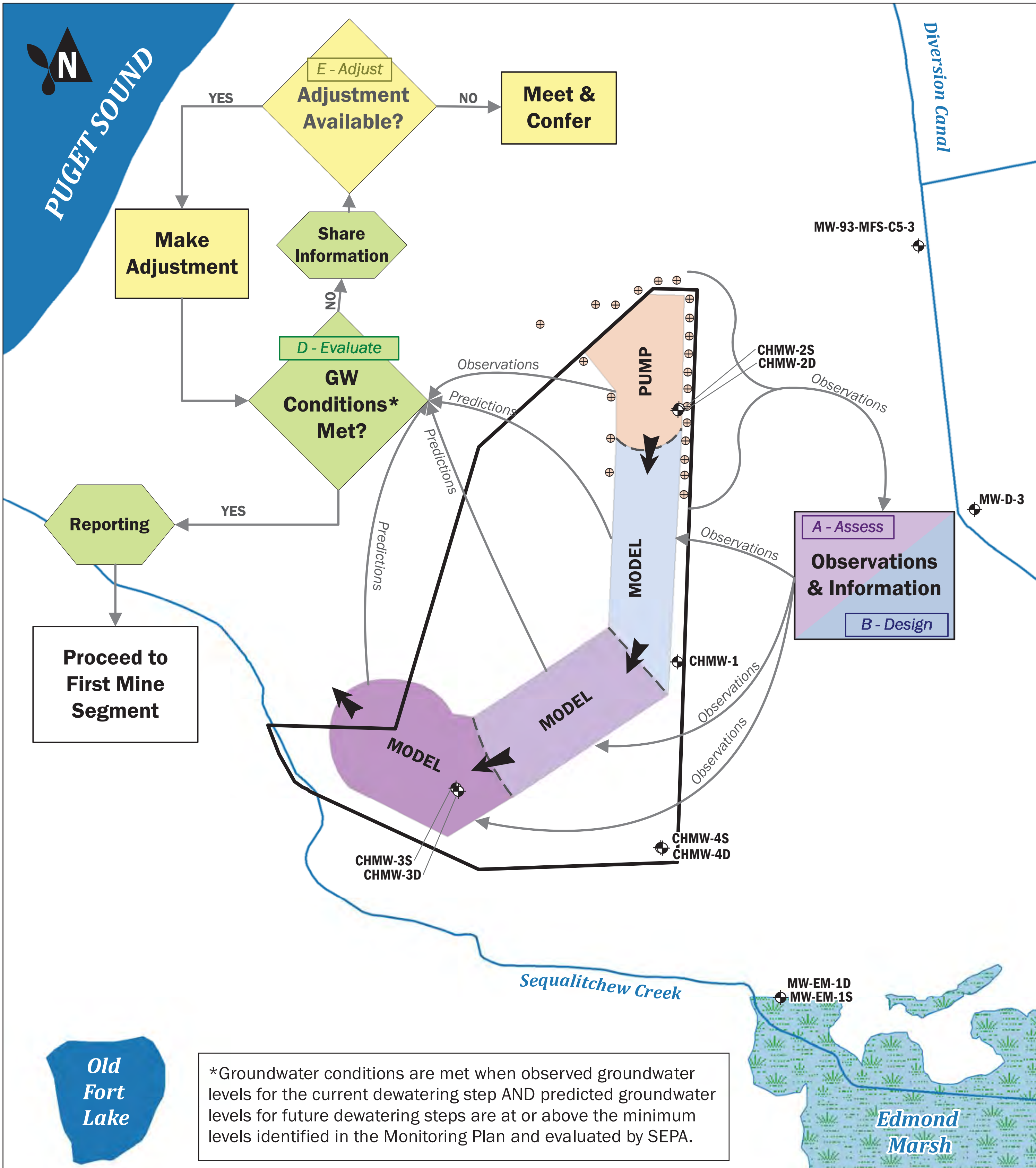
Feet

Adaptive Management Process During Step 1 - Initial Dewatering Test

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING

APR-2016	BY: OGR / RAP	FIGURE NO.
PROJECT NO. 040001-014	REVISED BY: - - -	9



*Groundwater conditions are met when observed groundwater levels for the current dewatering step AND predicted groundwater levels for future dewatering steps are at or above the minimum levels identified in the Monitoring Plan and evaluated by SEPA.

Monitoring Well
Wetland
Dewatering Well
Lake

0 1,000 2,000
Feet

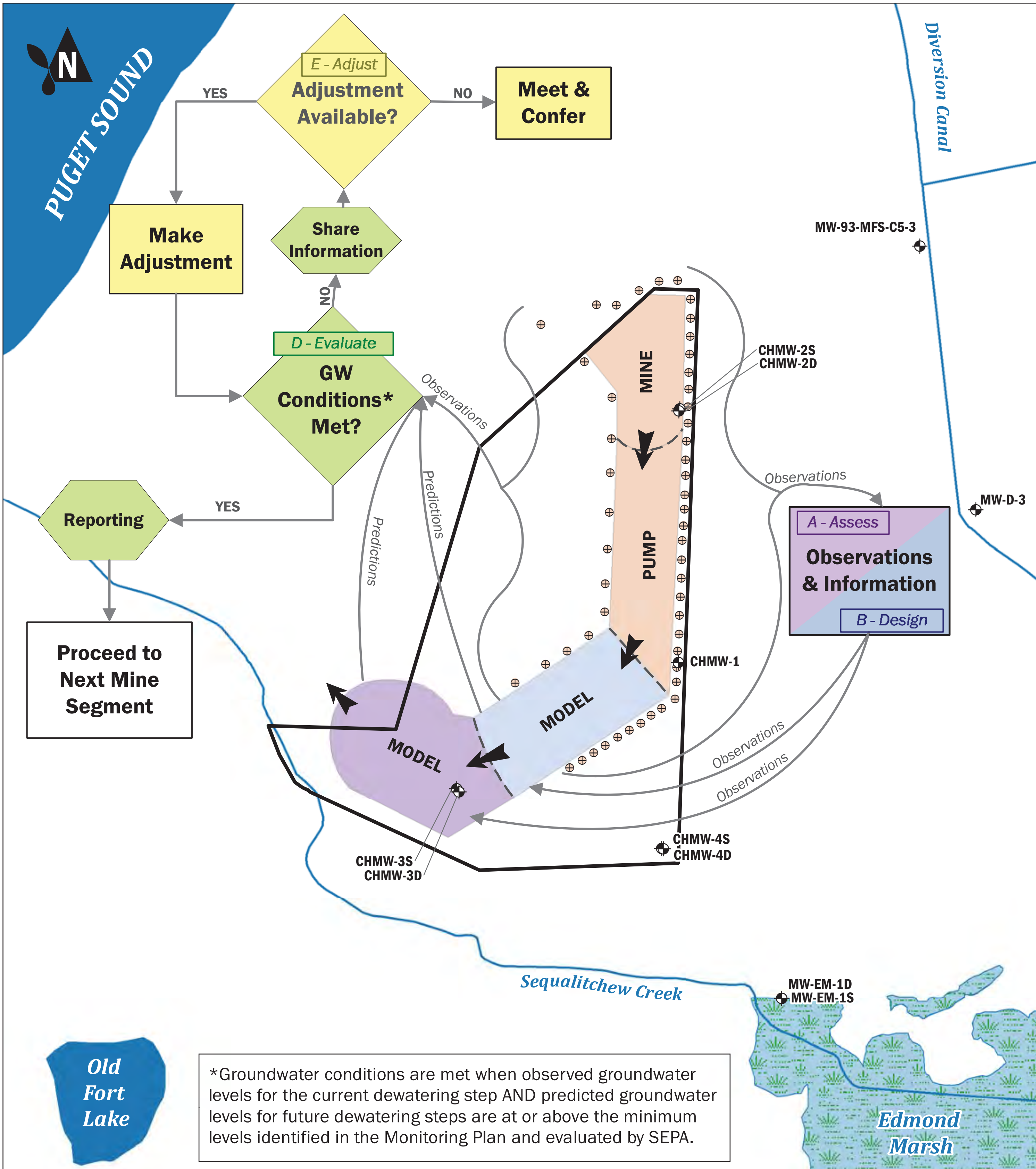
Adaptive Management Process During Step 2 - Preparation for Mining/ Dewatering Test

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING

APR-2016	BY: OGR / RAP	FIGURE NO. 10
PROJECT NO. 040001-014	REVISED BY: - - -	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Delivered\MonitoringPlan\11-AdaptiveManagementDuringStep2.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 4/6/2015 || User: rpepin



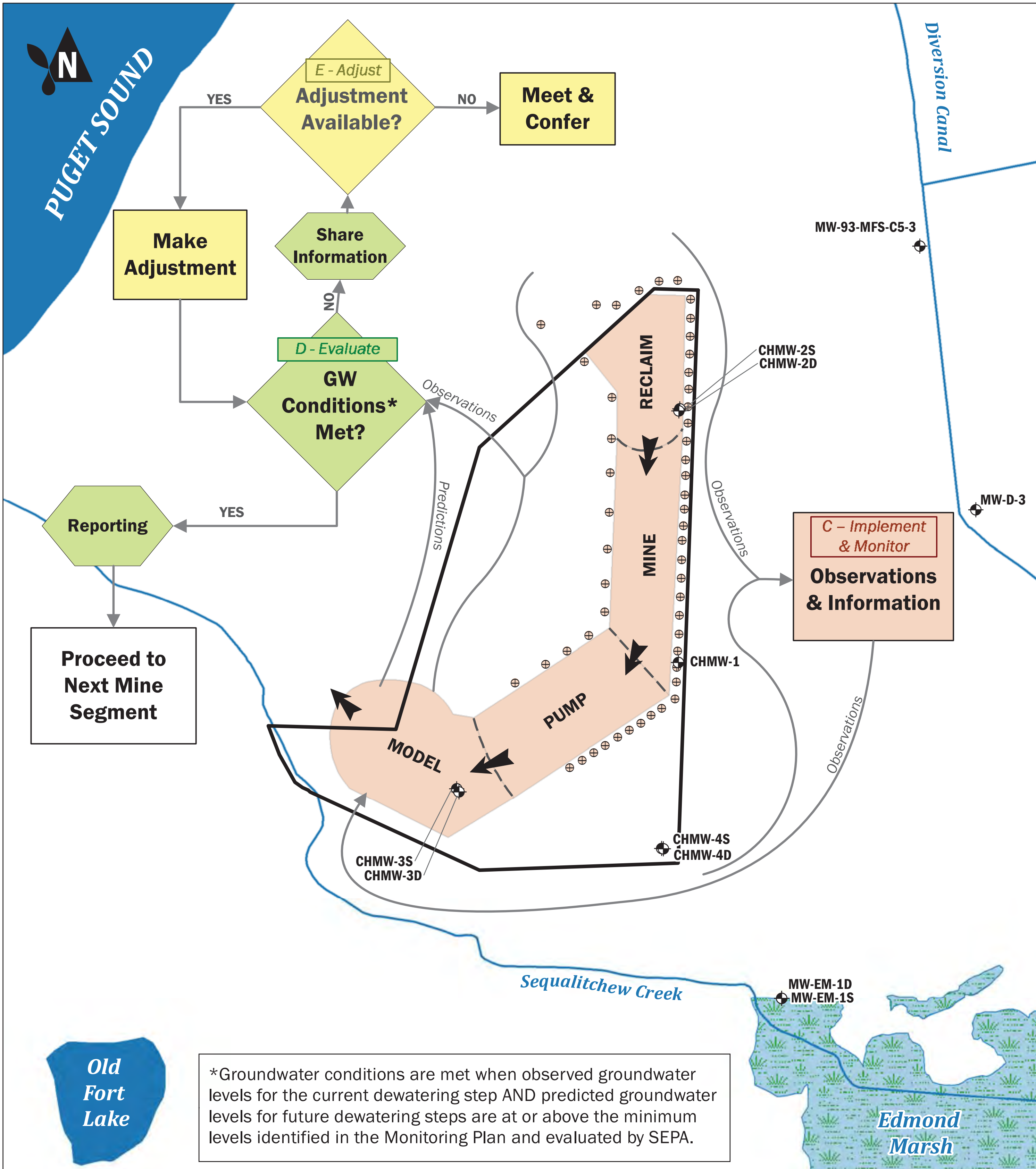
Monitoring Well
Wetland
Dewatering Well
Lake

0 1,000 2,000
Feet

Adaptive Management Process During Step 3 - Active Dewatering and Mining

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	APR-2016	BY: OGR / RAP	FIGURE NO.
	PROJECT NO. 040001-014	REVISED BY: - - -	11



*Groundwater conditions are met when observed groundwater levels for the current dewatering step AND predicted groundwater levels for future dewatering steps are at or above the minimum levels identified in the Monitoring Plan and evaluated by SEPA.

Monitoring Well
Dewatering Well
Wetland
Lake

0 1,000 2,000
Feet

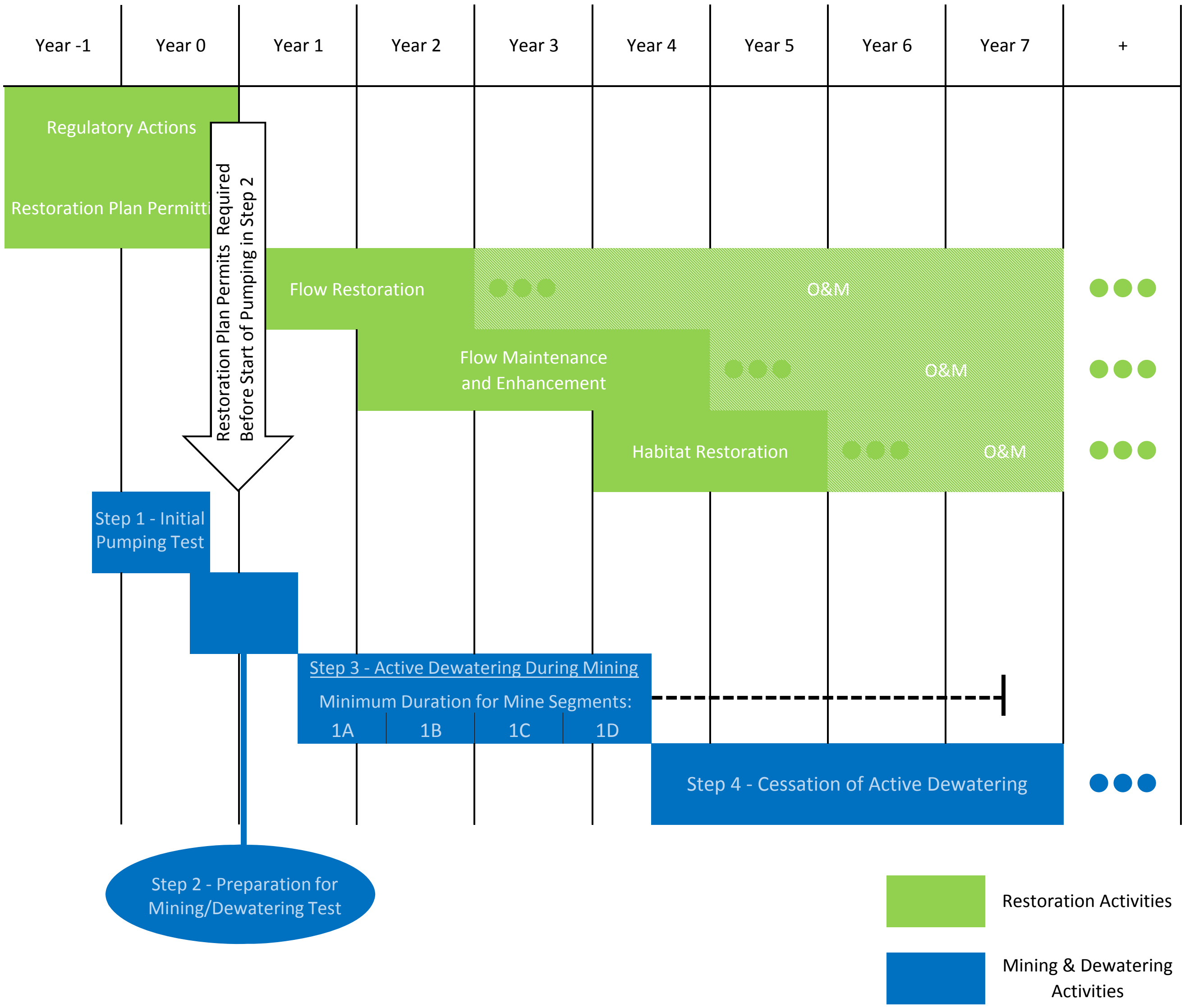
Adaptive Management Process During Step 4 - Cessation of Active Dewatering

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING

APR-2016	BY: OGR / RAP	FIGURE NO.
PROJECT NO. 040001-014	REVISED BY: - - -	12

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Delivered\MonitoringPlan\13-AdaptiveManagementDuringStep4.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 4/6/2015 || User: rpepin || Print Date: 4/6/2015

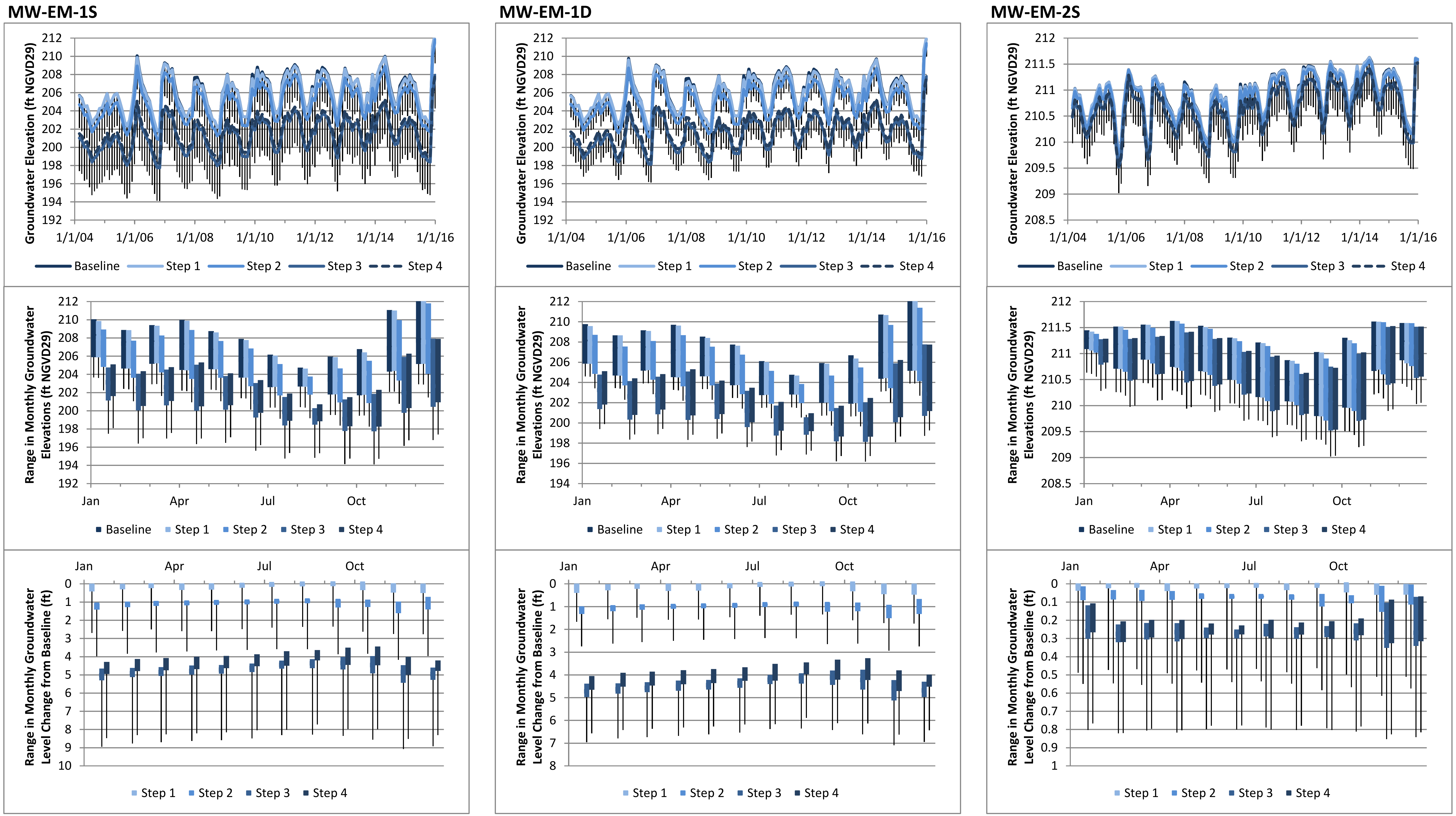


Notes:
1) Year 1 begins with the start of pumping in Step 2.
2) Mining timeline shown is based on the minimum duration of each mine segment in Step 3.
3) This figure depicts the duration of many individual actions. With few exceptions, the actual durations may be shorter or longer

Figure 13
Anticipated Timeline of Mining and Restoration Activities

APPENDIX A

Performance Thresholds: Predicted Changes and Ranges in Groundwater Levels



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan

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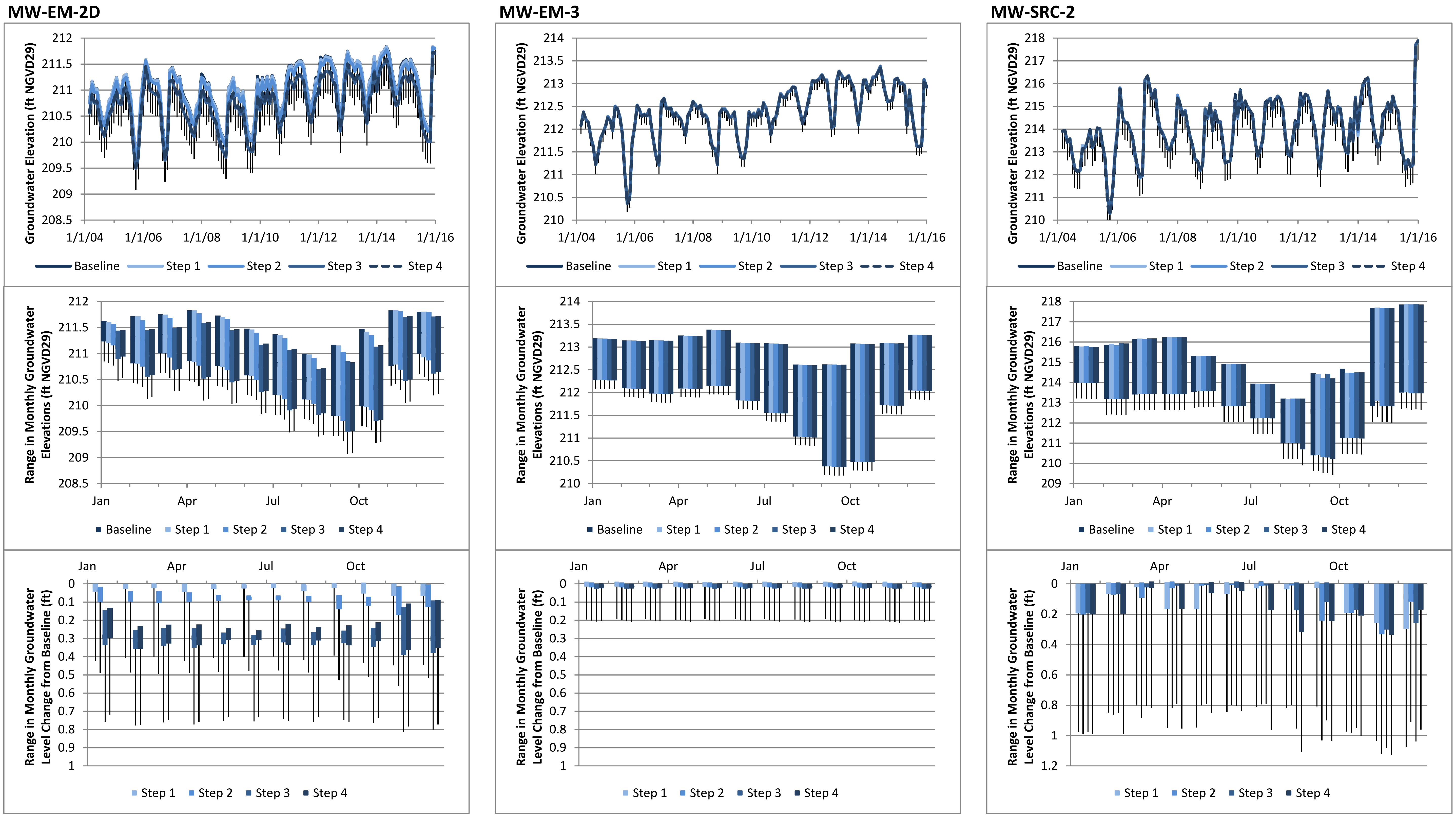
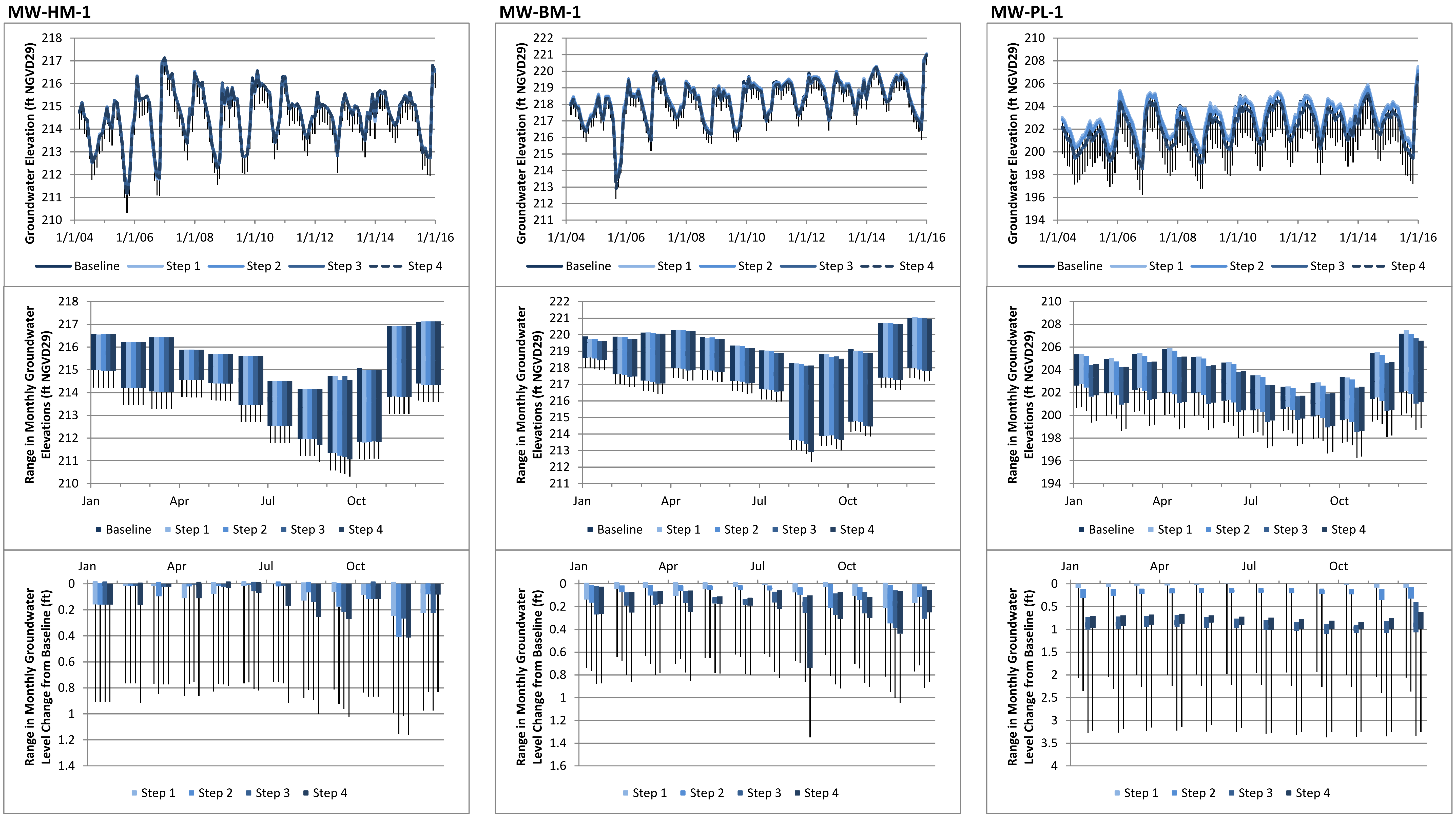


Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Aspect Consulting, LLC
November 2017
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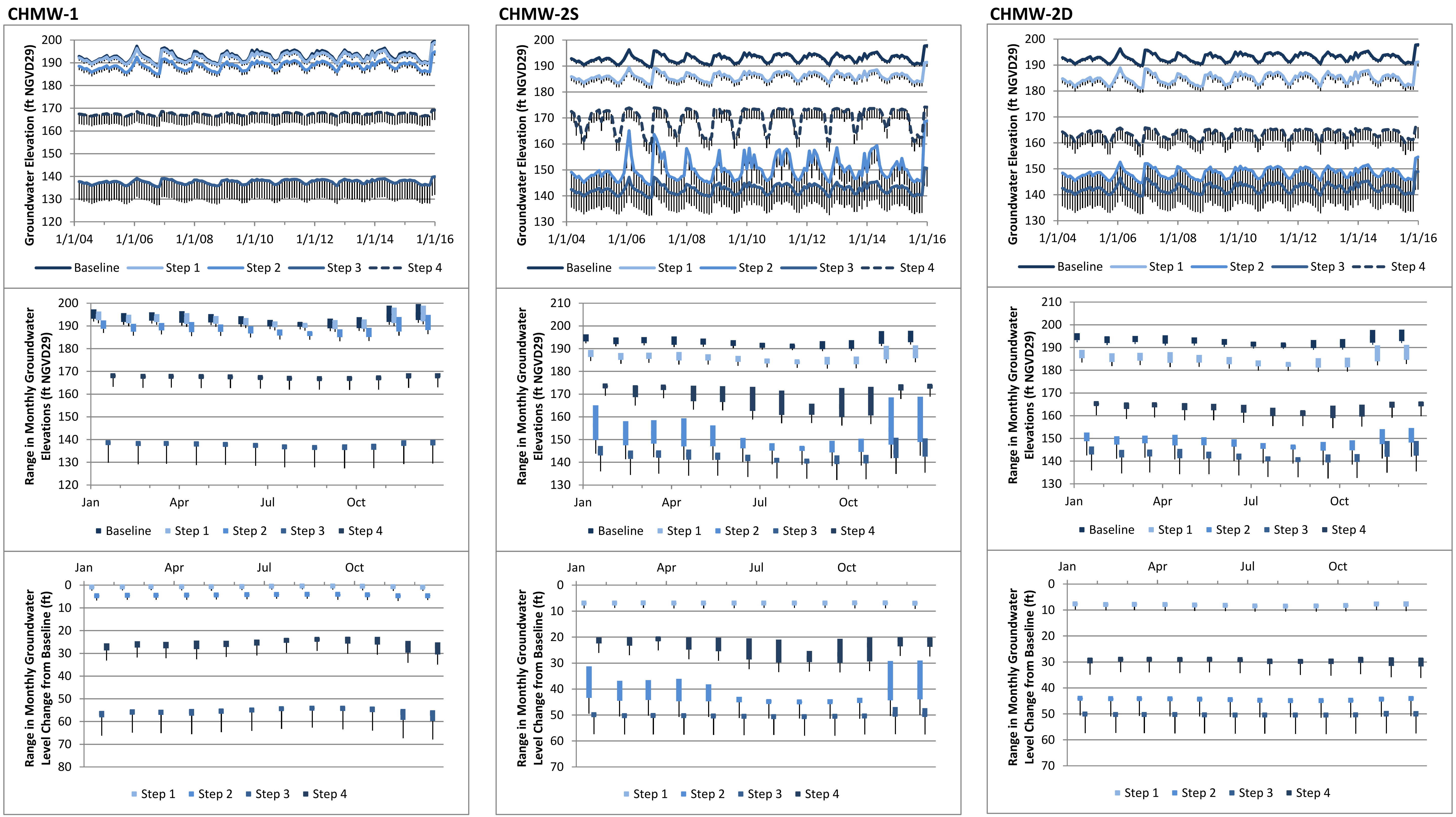
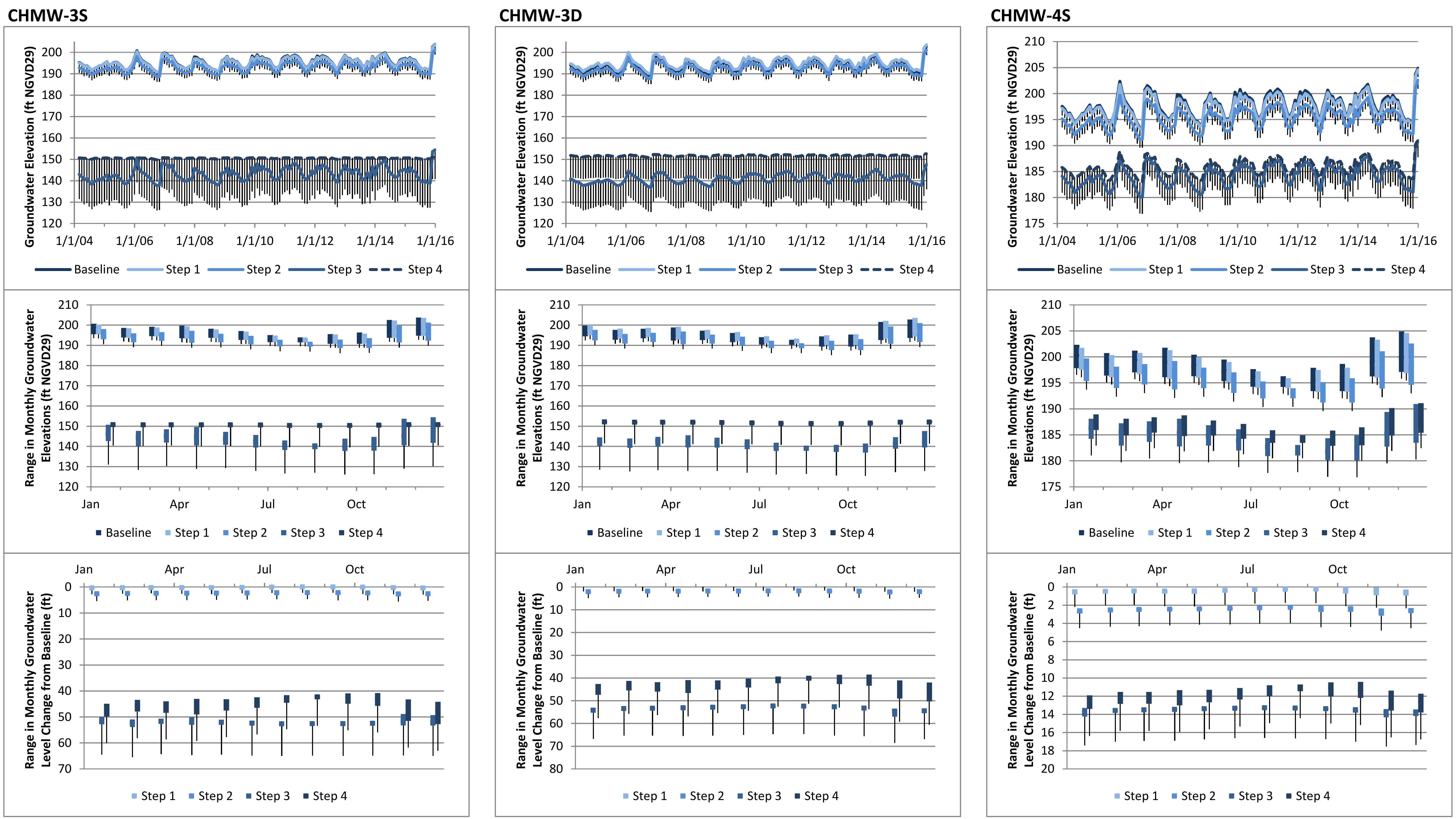
Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

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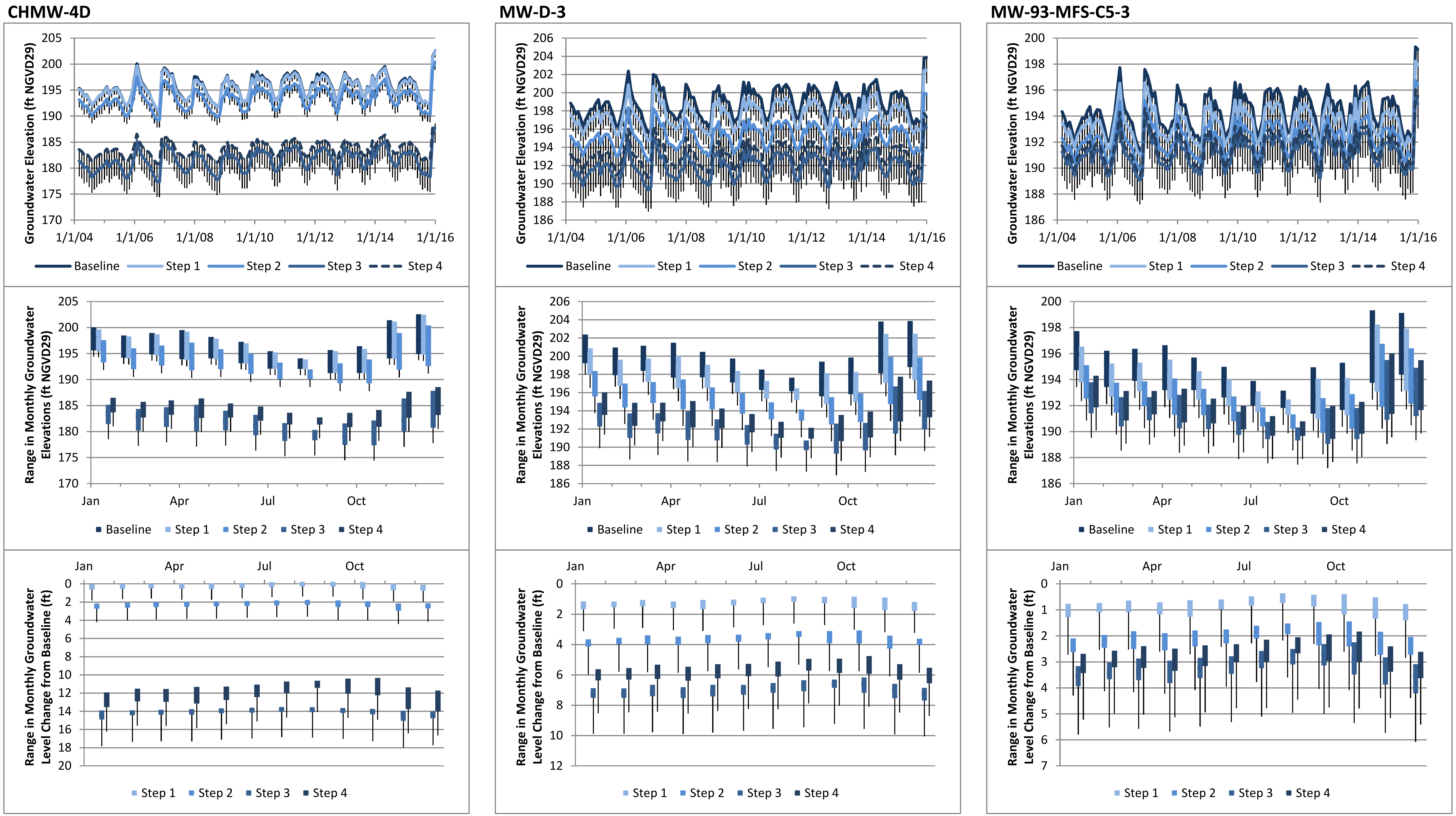
Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

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Figure A-1
Predicted Changes and Ranges in Groundwater Levels
Monitoring Plan

APPENDIX B

Sampling and Analysis Plan

Contents – Appendix B

List of Tables

List of Figures

List of Attachments

Sampling and Analysis Plan

A.1. Introduction

This document presents the Sampling and Analysis Plan (SAP) to collect the information necessary to support the adaptive management processes of the South Parcel Monitoring Plan and the Restoration Plan for the Sequalitchew Creek Watershed. This SAP is intended to direct collection, processing, and reporting of data by a single, reliable, and consistent source that will be used to inform both adaptive management plans.

A.2. Background

A.2.1. Baseline Monitoring Program

A baseline monitoring program of surface water and groundwater within the Sequalitchew Creek basin is currently conducted by CalPortland as a component of mine planning. The monitoring program generally consists of measuring water levels and flows on a monthly basis at multiple locations in Sequalitchew Creek and its related marshes. The hydrologic monitoring program has four basic elements:

- Groundwater elevation monitoring;
- Surface water elevation monitoring;
- Surface water streamflow monitoring; and
- Surface water quality monitoring (e.g., temperature, dissolved oxygen, and turbidity).

The monitoring program is summarized in Table 1, and monitoring locations are shown on Figure 1.

The baseline monitoring program began in 1999, then expanded significantly in 2003. Monitoring data has previously been presented in four reports (Aspect, 2004a, 2004b; Aspect and Anchor, 2007; and Appendix B of Anchor QEA and Aspect, 2010). The 2004 reports describe the surface water and groundwater systems of the Sequalitchew Creek basin and summarize the monitoring data collected through 2004. The 2007 report presents monitoring data collected in 2005 and 2006. The 2010 report provides summary hydrographs of streamflow and marsh levels, illustrating the data available at that time.

A.2.1.1. Groundwater Level Monitoring

In the baseline monitoring program, groundwater levels are monitored monthly at a network of 20 wells located throughout the watershed, including within the mine area, marshes, and upland areas:

- North Parcel mine area: OB-1
- South Parcel mine area: CHMW-1, CHMW-2S and -2D, CHMW-3S and -3D, and CHMW-4S and -4D
- Marshes and Lakes:
    - Edmond Marsh: MW-EM-1S and -1D, MW-EM-2S and -2D, and EM-3
    - Hamer and McKay Marshes: MW-HM-1
    - Sequalitchew Lake: MW-SL-1
    - Pond Lake: MW-PL-1
- Upland areas: D-3 (near Landfill #5) and SRC-MW-2 (east of Hamer Marsh)

Water levels are measured manually by measuring the depth to water from the top of the well casing. The top-of-casing elevation of each well has been surveyed relative to the National Geodetic Vertical Datum of 1929 (NGVD 29) to allow for calculation of groundwater elevations. Well logs for the existing monitoring wells are provided in Attachment A.

A.2.2. Surface Water Monitoring

A.2.2.1. Water Levels

The baseline monitoring program includes monthly measurement of surface water elevations at 15 locations in the Sequalitchew Creek watershed (Figure 1).

In many locations, staff gages are located close to monitoring wells to allow for coupled observations of surface water and groundwater levels. The following staff gages are included in the baseline monitoring program:

- Bell Marsh: SG-BM-1
- McKay Marsh: SG-MKM-1
- Hamer Marsh: SG-HM-1
- Sequalitchew Creek Marsh: SG-SCM-1 and SG-EM-3E
- East Edmond Marsh: SG-EM-3W and SG-EM-2E
- West Edmond Marsh: SG-EM-1/1A and SG-EM-2W
- Wetland 1D: SG-WL1D-1
- Pond Lake: SG-PL-1

- Diversion Canal: SG-DC-1, SG-DC-2, and SG-DC-3

The typical staff gage installed on this project is an enamel plate capable of measuring water levels in 0.01-foot increments over a 3.33-foot range. The staff gages at the west end of West Edmond Marsh (SG-EM-1/1A) are paired, with SG-EM-1 located near well MW- EM-1 and used to measure higher water levels in winter and SG-EM-1A located in a low spot behind the beaver dam at the outlet and used for measuring lower water levels in summer.

In addition, surface water levels are measured as a component of the three continuous flow monitoring stations described in Section A.2.2.3.

A.2.2.2. Water Quality

Beginning in 2009, surface water quality has been monitored monthly at three locations: the Diversion Weir, the outlet of Hamer Marsh, and the mid-ravine gage on Sequalitchew Creek. Monthly monitoring consists of field measurements of temperature, dissolved oxygen, specific conductance, oxidation reduction potential, and turbidity with a YSI Pro Plus and a Hach Turbidimeter. Several samples have been collected for laboratory analysis for select metals (iron, copper, and zinc) and total petroleum hydrocarbons.

A.2.2.3. Streamflow

The baseline streamflow monitoring program consists of continuous measurements at three stations, periodic measurements at three stations, and visual observations at five locations. The specific locations monitored are:

- Continuous streamflow monitoring at the Diversion Weir, and mid-ravine[1] and lower-ravine stations in Sequalitchew Creek.
- Periodic streamflow measurements at three locations in the Diversion Canal (SG-DC-1, SG-DC-2, SG-DC-3); and
- Visual estimates of flow at five locations:
    - Culvert from Hamer Marsh to Edmond Marsh,
    - Culvert from Sequalitchew Creek Marsh to Diversion Canal
    - Ditch at Plant Road flowing to Hamer Marsh,
    - Sequalitchew Creek at footbridge downstream of W. Edmond Marsh, and
    - Sequalitchew Creek under Center Drive.

Measurements of streamflow are made using the conventional current-meter method as described by the U.S. Geological Survey (USGS, 1982). Stream velocities are measured and discharges are calculated using a SonTek Flowtracker.

Discharge measurements are initially made at various stream stages to determine a relationship between stage and discharge. Discharge measurements are then made at

[1] The mid-ravine station was formerly known as the Upper gage or SC-Upper.

periodic intervals to verify the stage-discharge relationship or to define any change in the relationship caused by changes in channel geometry and/or channel roughness.

Rating curves, which relate water depth to flow in the channel, have been developed for each flow monitoring location based on a number of manual flow measurements collected over a range of different flows. These rating curves are used to convert observed water depths (stage) to flows.

Stream stage at each station is measured using a 4230 Bubble Flow Meter manufactured by Teledyne ISCO and powered by a 12-volt deep-cycle lead-acid battery. The meter uses an internal air compressor to force a metered amount of air through a bubble line submerged in the flow channel. The water level above the bubble line orifice is determined by measuring the pressure needed to force air bubbles out of the line. An internal data logger records the water level as bubbler pressure at 15-minute intervals. The water level is converted to a stage height by correlating the meter readings to manual measurements taken during monthly site visits from a staff gage that is installed at each station. The equipment for the stations is serviced once a month by replacing the batteries and downloading the data to a portable computer.

Flow over the Diversion Weir is monitored by continuously monitoring stage using an ISCO 4230 and calculating discharge with a standard weir equation for a fully contracted rectangular weir from the United States Bureau of Reclamation's (USBR) Water Measurement Manual (USBR, 2001). The weir equation is presented in Section A.5.4.1.

A.2.2.4. Habitat Monitoring

Wetland Habitat

Wetland monitoring conducted to date has been focused on documenting baseline (pre-project) conditions of three key variables in habitats: topography, hydrology, and vegetation. Major changes to the boundary of Edmond Marsh have been analyzed from high-resolution aerial photos, and compared to field-collected data. Twelve vegetation monitoring transects are located throughout the Sequalitchew Creek basin: in Edmond Marsh, Sequalitchew Creek Ravine, Wetland 1D, Pond Lake, and Brackish Marsh. Overall, patterns in species presence detected during the monitoring in the period from 2004–2015 have been documented by Anchor QEA (2016).

Stream Habitat

Anchor Environmental (Anchor; now Anchor QEA) has previously evaluated stream habitat in Sequalitchew Creek using toe-width and stage-discharge analysis methods as a component of the Fish Habitat Benefit Evaluation for Sequalitchew Creek (Anchor, 2004). Additional information on the methodology and background can be found in that document.

The **Toe-Width Method** applies information on active channel width to estimate the optimal flows (maximum habitat) for salmon spawning and rearing. Within Reach 2 and 3, transects were established in areas with fairly uniform depth over a gravel/cobble substrate (5 transects and 4 transects, respectively). Since Reach 1 was located in the estuary, no toe-width transects were established. Additional transects were established to represent riffle habitat in all three reaches.

The **Stage-Discharge Analysis** provides a more detailed evaluation of how habitat availability changes with incremental increases in flow by linking data on the physical relationship between water surface elevation (stage), velocity, and discharge with the biological habitat preferences of spawning and rearing salmon. Stage-discharge relationships in lower Sequalitchew Creek were developed at numerous transects that were selected to be representative of habitat conditions in the study area.

A.3. Roles and Responsibilities

The roles and responsibilities of all key members of the monitoring team are shown in Table 2 below. The monitoring team may be comprised of one or more qualified consulting firms, governmental agencies (e.g., USGS or Ecology), or nongovernmental organizations.

Table 2. Monitoring Team Roles and Responsibilities

Position	Roles and Responsibilities
Project Manager—Monitoring Team	Responsible for oversight of monitoring personnel, coordinating project tasks defined in the Consultant scope of work, tracking project progress and schedule relative to budget, and manage staff to complete project activities.
Principal-in-Charge—Monitoring Team	Responsible for oversight to project team to ensure that QC procedures are followed and project data quality objectives (DQOs) are being met. Oversight of development of project SAP, field audits, and project reports.
Data QC/Reporting Lead—Monitoring Team	Responsible for developing SAP, standard operating procedures (SOPs), and data QA/QC procedures for project. Responsible for managing project database, completing data QC on all project data, and reporting for individual events and the overall project.
Technology Lead—Hydrology/Water Quality	Responsible for the design of each monitoring station. Provide oversight for installation of each station’s monitoring system. Provide oversight for monitoring station maintenance and lead equipment troubleshooting activities.
Data Collection Lead—Hydrology/Water Quality	Manages and oversees monitoring and maintenance activities that are completed in the field for hydrology and water quality data collection.
Data Collection Lead—Habitat	Manages and oversees habitat monitoring activities.

A.4. Monitoring Approach

The monitoring conducted under this SAP will collect data necessary to assess whether activities associated with the South Parcel expansion and restoration of Sequalitchew Creek are achieving the objectives of the South Parcel Monitoring Plan and the Restoration Plan for the Sequalitchew Creek Watershed. The monitoring approach is targeted at the specific performance and aspirational thresholds identified in those plans.

The monitoring program includes six components that will be implemented at key locations within the watershed: groundwater level, surface water level, stream flow, surface water quality, habitat, and precipitation monitoring. Each of these components are described below. A cross walk between specific SAP elements and the objectives of the Monitoring Plan and Restoration Plan is provided in Table 3.

In addition to the main monitoring activities, stand-alone special studies will be implemented to address specific concerns of the mine expansion and watershed restoration. These special studies will be developed further as mining and restoration planning progresses, but are described generally in Section A.8.

A.4.1. Groundwater levels

Groundwater levels will be monitored primarily for comparison with the performance thresholds of the South Parcel Monitoring Plan.

Groundwater level monitoring will use the existing network of monitoring wells (described in Section A.2.1 and shown in Figure 1) and new dewatering wells and monitoring wells that will be installed specifically for this project. Water level monitoring will include a combination of spot measurements in active dewatering wells and adjacent temporary monitoring wells, continuous monitoring at key monitoring wells adjacent to the active dewatering area and beneath West Edmond Marsh, and routine monthly or semimonthly monitoring at other wells in the network.

As described in the Monitoring Plan, active dewatering of the South Parcel will occur in three sequential steps, involving progressively more dewatering wells, from 10 wells during Step 1, up to 66 wells during Step 3. Water levels will be measured periodically in the active dewatering wells, in new observation wells located adjacent to the active dewatering wells, and in several long-term monitoring wells installed in the interior of the South Parcel. Water level monitoring at these wells will be used to assess performance of the dewatering operation and, once mining operations commence in the South Parcel, will indicate if the moisture content of the mined aggregate is at appropriately low levels for safe, efficient mining and processing.

Outside of the South Parcel, groundwater level monitoring will consist of a combination of continuous monitoring and monthly or semimonthly manual measurements. During all Dewatering Steps, water levels will be monitored continuously in key wells located along the eastern boundary of the South parcel and in the western portion of Edmond Marsh. Specifically, the following key wells will be monitored continuously: CHMW-1, CHMW-2S and -2D, CHMW-3S and -3D, CHMW-4S and -4D. MW-EM-1S and -1D and MW-EM-2S and -2D. Water levels at all other groundwater monitoring wells will be measured monthly, except during Dewatering Step 2, when twice monthly measurements will occur, and Dewatering Step 3 when twice monthly measurements will occur for 3 months once new dewatering wells start pumping.

Monitoring wells are generally one- or two-inch-diameter PVC casings protected with a locking steel surface monument. Well depths vary from 5 feet for shallow piezometers to 85 feet for wells penetrating the Vashon Outwash gravels. Monitoring well logs are provided in Attachment A.

Continuous groundwater level monitoring will be conducted using a submersible pressure transducer connected to an aboveground data logger housed in a weather-resistant enclosure. Instruments will measure and record water level at 15-minute intervals. Data loggers will be downloaded by field staff at least weekly during Dewatering Steps 1 through 3 and once each month during Step 4.

A.4.2. Surface water levels

Surface water level monitoring data will primarily be used to compare the effects of restoration efforts with the performance and aspirational thresholds specified in the Restoration Plan. Surface water monitoring will occur at 12 stations as shown on Figure 1 and listed in Table 3 (station IDs have a “SG” prefix).

Continuous surface water monitoring will occur at SG-EM-1/1A and SG-EM-2E. Continuous water level data will be useful for assessing the water level response to precipitation. Water level will be measured manually once per month at the other stations; except during Dewatering Step 2, when twice-monthly measurements will occur. More frequent spot measurements will be made during specific restoration activities, such as the installation and adjustment of flexible levelers at beaver dams. New staff gage locations may be installed and added to the monitoring program as necessary to support adaptive management of the flexible levelers.

Surface water level monitoring at the seven locations in Sequalitchew Marsh, East Edmond Marsh, and West Edmond Marsh will provide feedback for efforts to increase westward flows in Sequalitchew Creek. Surface water level monitoring at SG-HM-1 in Hamer Marsh, in concert with groundwater level measurements at MW-HM-1 and MW-EM-3, will assess the increase in subsurface flow from Hamer Marsh to East Edmond Marsh following installation of the weir at Hamer Marsh outlet.

All surface water level monitoring stations are currently equipped with staff gages; either Stevens Style A or C porcelain-enameled iron plate. Style A gages are 3.33 feet long and 4 inches wide with graduated marks every 0.02 feet. Style C gages are also 3.33 feet long and are 2.5 inches wide with graduated marks every 0.01 foot. Water levels are measured to the nearest 0.01 foot. Water level is converted to surface water elevation by subtracting the staff gage height from the surveyed top-of-staff gage elevation and then adding the measured staff gage water level. At SG-EM-1 and SG-EM-2W, continuous water level monitoring will be conducted using a pressure transducer housed in a PVC stilling well that is mounted adjacent to the staff gage. The pressure transducer will be connected to the data logger used for continuous groundwater monitoring at the adjacent groundwater monitoring wells (MW-EM-1D for SG-EM-1/1A and MW-EM-2D for SG-EM-2W).

A.4.3. Streamflow

Streamflow monitoring will include:

- Continuous streamflow monitoring at five locations: the three existing streamflow monitoring stations (i.e., the Diversion Weir, and mid-ravine and lower stations in Sequalitchew Creek) and two new gaging stations on Sequalitchew Creek at the Lake Outlet and at Center Drive.

- Visual observations at the culvert from Hamer Marsh to Edmond Marsh.

At each continuous gaging station, water level will be measured and recorded every 15 minutes using a pressure transducer housed in a PVC stilling well and connected to a data logger that is housed in a weatherproof enclosure. Each continuous stream flow gaging station will include a Stevens Style A or C porcelain-enameled iron-plate staff gage, as described previous for the water level monitoring sites. Water level measured by the pressure transducer will be calibrated to the staff gage at the site. Field staff will service and download the data loggers at least monthly.

At the Diversion Weir, flow will be calculated using a standard discharge equation for a fully contracted rectangular weir as described above in Section A.5.4.1. At the other four gaging stations, stage-discharge or rating curves will need to be developed and maintained to calculate flow. Rating curves will be developed and maintained consistent with industry standard practices, as is currently done.

Flow through the culvert from Hamer Marsh to Edmond Marsh will be visually estimated monthly. Additional locations for visual flow estimates may be added at any time to respond to conditions observed in the field or adaptive management needs.

Following installation of the weir at the outlet of Hamer Marsh, outflow from Hamer Marsh to the Diversion Canal will be determined using the appropriate weir equation, based on water level observations at SG-HM-1, whose staff gage elevation relative the top of the weir will be established.

Continuous flow data from the Diversion Weir will be used to assess achievement of the Restoration Plan performance threshold to reduce flow to the Diversion Canal.

Continuous flow data from the Sequalitchew Lake Outlet and Center Drive gages will be used to assess achievement of the performance standard to match flows at those two locations.

Flow data at Center Drive, Upper Sequalitchew Creek, and Lower Sequalitchew Creek gages will be used to assess achievement of the performance standard to eliminate flow losses in the ravine.

Spot flow measurements at the Hamer Marsh Weir, at the culvert between Hamer Marsh and East Edmond Marsh, and in the ditch under Plant Road to Hamer Marsh, in concert with surface and shallow groundwater monitoring in and around Hamer Marsh, will be used to assess efforts to increase surface and groundwater flow from Hamer Marsh into East Edmond Marsh.

Going forward, the sampling program will no longer collect spot flow measurements in the Diversion Canal, since those data are not relevant to the objectives of the South Parcel Monitoring Plan or the Restoration Plan.

A.4.4. Surface Water Quality

The evaluation of habitat suitability will include monitoring water quality conditions in the watershed restoration area. In particular, stream temperature is predicted to increase in summer as a result of the restoration and mining projects for two reasons: 1) water temperatures in Sequalitchew Lake are warmer than the groundwater discharge that currently provides the flow in Sequalitchew Creek during summer, and 2) dewatering for mining will reduce the groundwater discharge. Prior monitoring indicates that Sequalitchew Lake temperatures can reach up to 21°C in summer, whereas Sequalitchew Creek is currently 12 to 13°C. This condition is largely natural resulting from solar radiation on the lake surface. However, it also represents the primary tradeoff of restoration—greatly increased flow and reconnection to the natural water source in exchange for higher temperatures in summer.

The water quality monitoring program has been designed to monitor for unintended consequences, primarily focused on temperature, resulting from the restoration and mining projects. Stream temperatures will be monitored continuously at the five locations in the Sequalitchew Creek watershed where flow is measured (Sequalitchew Lake Outlet, Diversion Weir, Center Drive, and mid-ravine and lower ravine Sequalitchew Creek stations), as well as at the continuous water level monitoring stations in East Edmond Marsh (SG-EM-1 and SG-EM-2). The pressure transducers used to monitor water levels will be equipped with temperature sensors and will record water temperature every 15 minutes. The monitoring data will allow for developing temperature profiles along Sequalitchew Creek from headwaters to near the mouth.

These monitoring data will inform the adaptive management components of the Restoration Plan. The Restoration Plan includes several restoration elements that either include specific components that would reduce temperatures, or include flexible elements that could be implemented adaptively in response to monitoring data that indicate unanticipated effects on stream temperature. Specifically, the following elements of the Restoration Plan have components related to temperature, beyond those aimed at increasing flow through the system:

> G – Losing Reach—restoration of riparian vegetation in the losing reach will benefit stream temperature through shading.

> J – Ravine Habitat—this element is intended to adapt to habitat conditions that emerge once flow is restored in the ravine. Envisioned as being used to enhance stream structure through large woody debris placement, it could also be used to address temperature issues by creating pools as refugia or shading through riparian plantings.

In addition to temperature, water quality monitoring will include periodic *in-situ* monitoring of temperature, dissolved oxygen, and turbidity at select surface water level monitoring locations.

Periodic *in-situ* water quality measurements of temperature, dissolved oxygen, and turbidity will be collected using portable water quality meters. Measurements will occur monthly, except during Dewatering Step 2, when measurements will be taken twice each month. These water quality data, used in conjunction with measurements of physical habitat characteristics, will inform the assessment of habitat conditions relative to performance thresholds in the Restoration Plan.

A special study of Hamer Marsh water quality will be developed and implemented separately as described in Section A.8.

A.4.5. Habitat

A.4.5.1. Wetland Habitat

The most important effect of the combined mining and restoration projects would be the restoration of a surface water and wetland community connection between the ravine and Edmond Marsh. Data collection discussed in this section is focused on detecting changes to vegetation and habitat structure. This will be used in conjunction with the collection of hydrology data (see section A.5.2) and topography to understand the effects of the project. Hydrology (water surface elevation) data will be used to further understand habitat changes:

- Changes in water surface elevations, particularly in East Edmond Marsh;
- Changes in the magnitude of seasonal fluctuation in water surface elevations;
- Changes in the location and amount of open-water habitat, specifically any loss of open-water habitat in East Edmond Marsh, or greater persistence (later in the growing season) of open water habitats in West Edmond Marsh; and
- The establishment of a surface water and wetland community connection between the ravine and Edmond Marsh.

The baseline wetland habitat monitoring approach (see Section A.2.2.4) will continue to be used to identify patterns in plant species presence, hydrology, and topography under changing conditions along these established transects for comparison and analysis with post-project conditions. New transects will be established between Edmond Marsh and Lower Sequalitchew Creek. Baseline data was not collected in this reach due to the lack of flow and wetland or riparian vegetation during the baseline period.

A.4.5.2. Stream Habitat

Stream habitat will be monitored by measuring physical habitat characteristics at consistent locations over time. Habitat monitoring stations will be established as cross sections of Sequalitchew Creek spaced 100 feet apart for 1,500 feet upstream of the BNSF culvert, then 200 feet apart upstream to the east end of Edmond Marsh. This will provide additional resolution in the area likely to be used for spawning by Chum.

At each section, the following physical parameters will be monitored: flow depth, velocity, substrate size and cover. Cross sections will be monitored in years 0, 1, 2, 3, 5, and 10 commencing prior to construction of the first Restoration Plan element.

Observations of fish presence and active erosion will be noted during the cross-section surveys. Surveys of large woody material will be conducted in years 5 and 10.

A.4.6. Precipitation

Precipitation will be continuously monitored with a tipping bucket rain gage to be located on or near the South Parcel (e.g., City Hall, Pioneer Middle School, or Chloe Clark Elementary). An on-site, program-operated rain gage will likely provide a more complete data set that is of known quality and will better represent precipitation occurring within the watershed than would data from the McMillin Reservoir rain gage, which has been used for prior monitoring efforts.

A continuous precipitation record will provide a context for evaluating short-term changes in surface water and shallow groundwater levels, stream flows, and water quality conditions monitored within the watershed in response to storm events. Observed seasonal precipitation patterns will be used in the analysis of seasonal groundwater and surface water levels, stream flows, and water quality conditions.

The rain gage will be installed at the top of a 1.5-inch-diameter steel pole, approximately 10 feet above the ground surface. The rain gage will be wired to a data logger that will record and totalize rainfall on a 15-minute interval. The data logger will be housed in a durable, weatherproof steel enclosure.

The rain gage will be maintained per manufacturer's recommendations (see Section A.5.7 for methods). The rain gage will be capable of measuring only liquid precipitation (i.e., rainfall or melted snow); it will not be a heated rain gage capable of melting snow. Alternate rain data from the McMillin Reservoir rain gage or PRISM estimates of gridded precipitation for the project area will be used should the project rain gage malfunction.

A.5. Monitoring Procedures

This section provides specific procedural guidelines regarding routine field measurement and maintenance activities pursuant to the monitoring objectives detailed in the previous section.

Campbell Scientific (CSI) pressure transducers and data loggers will be employed at groundwater, surface water, streamflow monitoring stations, which continually measure level and water temperature. A project rain gage will be installed at one of the central monitoring stations, and be recorded by the station data logger. Equipment specifications and installation guidelines for continual monitoring stations includes the following:

- Parameter data (e.g., level, temperature, precipitation) will be recorded at a minimum of 15-minute intervals.
- Transducers selected for each station will be designed with a PSI range and cable length that is appropriate for the range of water levels expected in the observation well or surface water environment.
- Transducer sensor diaphragms will be vented to the atmosphere; eliminating corrections regarding barometric pressure compensation.
- Groundwater pressure transducers will be suspended from a fixed reference point in each monitoring well, at a point below the lowest expected water level. Suspending

the transducer prevents corrosion/interference of benthic sediment, or level discrepancies/drift due to settling.

- Surface water pressure transducers will be installed at a fixed point within a PVC stilling well, adjacent to the station staff plate.
- All level and flow rate measurements will be reported in decimal-feet and cubic feet per second (cfs), respectively.

Water levels measurements at stations recording continuous data will be maintained within a 0.02-foot tolerance. If the difference between the level measured during site inspections and the data logger recorded level is greater than ± 0.02 feet, field personnel will calibrate the data logger recorded level during routine site inspections. Differences in level, as well as calibration points, will be recorded on field sheets. Level drift observed from either the pressure transducer, or movement of the suspension cable, will be corrected by linear interpolation within the project dataset.

A.5.1. Routine Station Inspections

Routine site inspections will occur at least monthly while the project is actively collecting water quality, level, and/or flow data. Field staff will complete a field data collection form, or electronic equivalent, when conducting station inspections (see example in Attachment B). During monthly inspections, all equipment will be maintained per manufacturer recommendation, and include the following tasks:

- Download data logger module records;
- Maintain station grounds for clear and safe access;
- Clean and maintain enclosures, sensors, and monitoring equipment;
- Change/charge station batteries; and
- Calibrate/verify the accuracy, precision, and operation of sampling and monitoring equipment.

All observed and recorded field measurements, as detailed below, will be updated within the project database following routine inspection activities.

A.5.2. Groundwater levels

Groundwater levels are measured in monitoring well stations using a 150- or 300-foot electronic water level indicator. Depth to water is measured from a black mark on the top of the well casing and recorded to the nearest 0.01 foot. The depth to water is converted to a groundwater elevation by subtracting the depth to water from the surveyed top of casing elevations. Groundwater level measurements will be conducted and recorded on field sheets, or electronic equivalents, during each routine site inspection.

The well casings are accessed by unlocking and removing the lids on the steel stick-up-style monuments protecting each well. MW-C5-3 is maintained by JBLM. A key to unlock MW-C5-3 is obtained from JBLM during each site visit.

A.5.3. Surface water levels

Surface water levels are visually observed/measured during routine site inspections from staff plate gages; measured to the nearest 0.01 foot. Water levels will be converted to surface water elevation by subtracting the staff gage height from the surveyed top-of-staff gage elevation and then adding the measured staff gage water level.

A.5.4. Streamflow

Streamflow monitoring for this project will be performed by continuously observing the water level in the stream and calculating flow using one of two methods: a standardized weir-discharge equation or a stage-discharge rating curve.

Stream water levels will be visually observed/measured during routine site inspections from staff plate gages. CSI pressure transducers at continuous-record streamflow stations will be calibrated to the correspond station staff-gage level. Spot level measurements and observations at all other stations will be recorded during routine inspections. All level measurements will be used to calculate and update discharge flow volumes from each station.

A.5.4.1. Weir-Discharge Equations

Streamflow at the Diversion Weir is calculated using a standard discharge equation for a fully contracted rectangular weir from the USBR’s Water Measurement Manual (USBR, 2001). The equation relates discharge (Q) to the length of the weir (l) and depth (d) of water over the weir as follows:

$$Q = 3.33*(l - 0.2*d)*d^{(3/2)}$$

It is imperative to maintain flow through weirs free from debris and obstructions, to ensure accurate level/flow measurements. Weir discharge equations will be incorporated into the project database, to ensure precision when field personnel transcribe field observations and measurements.

A.5.4.2. Stage-Discharge Rating Curve

Open-channel streamflow monitoring stations require the development of flow rating curves, which relate observed water depths (i.e., stage) to flow volumes. Rating curves will be developed for each flow monitoring location based on manual flow measurements collected over a range of different flows.

Measurements of streamflow (in cubic feet per second [cfs]) will be made using the conventional current-meter method as described by the USGS (1982). Stream velocities will be measured and discharges are calculated using a SonTek Flowtracker, or other similar velocity meter.

In accordance with the USGS current-meter method, observations of width, depth, and velocity will be made at approximately 10 to 15 intervals in a cross section by wading the stream. The average velocity of each subsection will be taken at 0.6 of the depth below the water surface. That velocity represents the average velocity for that stream subsection, whose cross-section area will be calculated from the corresponding width and depth measurements. A streamflow measurement is the sum of the flow in each subsection.

The recorded discharge measurements are plotted against corresponding stage heights. The stage-discharge rating (i.e., regression equation) is determined by plotting a best-fit line through a series of stage-discharge points.

Rating curves will be developed at streamflow monitoring stations during a minimum of three (3) different flow event regimes, including flows covering the low-, mid-, and high ranges of the depths expected in each channel. To measure flows at these ranges, field personnel will collect flow measurements during various intensity storm events, as well as baseflow conditions. For existing stations, the rating curves developed during baseline monitoring will be used initially.

Rating curves are evaluated by comparing sets of flow event measurements to determine if the average rating curve for each event graphs similarly on a stage-discharge plot. A change in curve shape or shift in location indicates a change in channel geomorphology and a new rating curve is developed and updated, as necessary. Manual streamflow measurements are made at periodic intervals to verify the rating curve and evaluate if there has been any change in the stage-discharge relationship caused by changes in channel geometry and/or channel roughness. Rating curves were previously developed and reported for the mid-ravine and lower Sequalitchew Creek stations (Aspect and Anchor, 2007), and have continued to evolve since. The rating curves from these stations will be evaluated against new flow-discharge measurements, to ensure updated and accurate rating curves are used.

A.5.5. Surface water quality

Surface water quality parameters, including temperature, dissolved oxygen, pH, and turbidity will be monitored at all surface water stations. Water quality parameters are measured with a YSI Pro Plus multiparameter meter and a Hach Turbidimeter or equivalent instruments.

Surface water temperature will be continually logged by integrated CSI pressure transducer temperature sensors or equivalent equipment (e.g., Onset Hobo/Tidbit© temperature loggers). Temperature sensors will have a minimum accuracy/precision range of +/- 0.2°C. Temperature sensors will be calibrated and maintained in accordance with Ecology’s (2015) Standard Operating Procedure (SOP) for Continuous Temperature Monitoring of Fresh Water Rivers and Streams (EAP080). Deployment techniques for temperature sensors/loggers will follow guidance and from Ecology’s SOP; however, may vary slightly based on alternative equipment specifications.

Table 4 summarizes the water quality parameters and standard methods that will be employed for the surface water quality monitoring objectives of this project.

Table 4. Water Quality Grab Sample Parameters and Methods

Sample Type	Field Collection Containers	Parameter	Holding Time	Method	Lab Sample Container	Preservative
Continuous	*In-situ* stream or surface water station	Temperature	N/A	Continually logged via CSI pressure transducer, or equivalent	*In situ* (n/a)	*In situ* (n/a)
Grab	1-liter poly	pH	15 minutes	EPA 150.1 via YSI	*In situ* (n/a)	*In situ* (n/a)
		Dissolved Oxygen	15 minutes	EPA 150.2 via YSI	*In situ* (n/a)	*In situ* (n/a)
		Turbidity	15 minutes	EPA 180.1 via YSI	*In situ* (n/a)	*In situ* (n/a)

Manual grab samples will be collected by directly filling sample bottles from the monitoring discharge point, using a “clean hands” approach. The principle of the “clean hands” technique is that field personnel wear appropriate noncontaminating, disposable, powderless gloves during the entire grab sample collection procedure; changing gloves frequently with each change in task.

In-situ measurements with the YSI multiparameter meter may be conducted by directly submerging the sensors into surface waters, so long as there is no interference from bottom sediments or debris.

A.5.5.1. Equipment maintenance

Monitoring equipment will be inspected and serviced as recommended by the manufacturer, or at least once preceding the deployment of temporary monitoring station setups. Generally, equipment maintenance includes: inspection, testing, calibration, and replacement of worn or missing components. Table 5 summarizes the water quality field equipment specifications for this project, including: parameters, decontamination, and calibration procedures.

Table 5. Field Monitoring Equipment Decontamination and Calibration Procedures

Equipment	Parameters	Decontamination Procedure	Calibration Procedures
YSI water quality multimeter, or equivalent	pH; dissolved oxygen	Rinse sensors thoroughly with DI water as needed Store sensors in KCl solution between uses.	Perform the following prior to each site inspection: • Three-point calibration of pH (4,7,10) • Dissolved oxygen using barometric pressure and/or saturation method
HACH Turbidimeter, or equivalent	Turbidity	Rinse sample vials thoroughly with DI water as needed.	Perform reference calibration before every sample period, in accordance with manufacturer specifications.
Continually logged via CSI pressure transducer, or equivalent	Temperature	Gently clean temperature loggers with a soft cloth or soft-bristled brush to remove any biofouling or sediment.	Record ten reference *in-situ* measurements using NIST field thermometer. Compare the mean absolute value of the NIST thermometer measurements against the continuous temperature logger for the same time period; ensure the mean difference isn't greater than 0.2°C.

A.5.5.2. Qualitative Observations

In addition to the quantitative observations of water quality described above, surface water stations will be qualitatively inspected for the following, where applicable:

- Channel conditions, including the presence/absence of beaver dams, downed trees, streambed composition, vegetation, and particularly fast or slow flow velocities.
- Water color, floating oil and grease, floating debris/scum, and materials that may be toxic or harmful to human or other life.

A.5.6. Habitat

Habitat data are collected for two purposes: 1) stream cross sections are measured for comparison with the performance and aspirational thresholds of Goal 2 of the Restoration Plan, and 2) wetland and additional stream habitat measurements are collected to understand the linkages between stream restoration activities and effects on habitat. The wetland and additional stream habitat measurements could inform decisions to employ additional adaptive management strategies or modify existing strategies to limit impacts and/or increase benefits. The supplemental data would not be applicable to the evaluation of performance or aspirational thresholds.

A.5.6.1. Wetland Habitat

Wetland habitat will be measured using established transects with surveyed topography that has been related to surface water monitoring stations. The protocols for point intercept methods for determination of the vegetation community will generally follow Heady et al., 1959. Vegetation data will be collected annually at the end of the growing season (September or October, typically). A tape measure will be strung between fixed points (T-stakes or rebar, typically) and all vegetation species present at each given interval (1-foot or 2-foot, depending on transect length) will be recorded along with the distance from the start of the transect for correlation to surveyed ground surface elevation and surface water elevation data collected throughout the growing season.

A.5.6.2. Stream Habitat

Habitat monitoring stations will be established as cross sections and marked with driven rebar, or similar, in the field. Stations will be spaced 100 feet apart for 1,500 feet upstream of the BNSF culvert, and will be spaced 200 feet apart upstream to the east end of Edmond Marsh. At each section, the following data will be collected, at the frequency indicated in Table 6.

Table 6. Stream Habitat Monitoring Parameters and Methods

Parameter	Method	Precision/ units	Frequency
Depth	Measured every 2 feet within the wetted width of the section using a stadia rod.	0.1 foot	Years 0,1,2,3,5,10
Velocity	Measured at least every 2 feet within the wetted width of the section with a minimum of five measurements using a current velocity meter (Swoffer 2100 or similar).	0.1 feet per second (fps) for velocities between 0.5 and 25 fps	Years 0,1,2,3,5,10
Substrate size	D50 of randomly chosen substrate at least every 2 feet within the wetted width of the section with a minimum of 10 measurements.	1 mm	Years 0,1,2,3,5,10
Cover	Densiometer	Intersects	Years 0,1,2,3,5,10

Additional observations will be collected along the creek and referenced by distance upstream from the BNSF culvert (by station), as shown in Table 7.

Table 7. Additional Habitat Observations

Parameter	Method	Precision/ units	Frequency
Large Woody Material	Repeat existing survey based on methodology by Fox and Boulton (2007).	Count	Years 5, 10
Fish Presence	Visual identification	Species/ size (approx.)/ behavior	0,1,2,3,5,10
Active erosion	Visual identification	Photo documentation with scale	0,1,2,3,5,10

All data, except large woody material, will be collected once per indicated year in November or December when flows are between 100 and 200 percent of mean monthly average flow (or as predicted during years 1 and 2). Data on large woody material can be collected at any time of year.

All data will be presented in an annual monitoring report, including summarization and analysis of the data in terms of the quantity of usable and optimal habitat for Chum spawning and salmonid rearing. Trends over monitoring years will be included along with adaptive management considerations regarding the project performance or this sampling methodology.

A.5.7. Precipitation

For this project, a Hydrological Services Model TB3, or similar, tipping bucket rain gage will be installed at the designated site on the South Parcel. This instrument measures rainfall at 0.01-inch increments. The rain gauge will be connected to a CSI data logger, recording rainfall data at 15-minute intervals. The rain gage will be downloaded at least once each month. Field staff will inspect the rain gage monthly and service as needed. Rain gage calibration checks will occur using the method and at the frequency recommended by the manufacturer.

A.6. Quality Control

This section presents the quality control (QC) requirements for field and laboratory activities associated with this project.

A.6.1. Field

Field measurement equipment, dataloggers, and pressure transducers will be maintained and calibrated every month, at a minimum, to help ensure proper monitoring station operation. Preventative maintenance of the pressure transducers and water quality multimeters will be performed as specified by the manufacturer. The pressure transducers and sensors will be calibrated to the manufacturer’s recommendations.

Original field records will be maintained in designated binders for all monitoring and field-related activities using project-specific forms, and guided by the procedures outlined in this SAP. Field documentation will include monthly inspection field sheets, maintenance/calibration logs, COC forms, and other required documentation. All entries in field notebooks will be written in pencil or waterproof ink. When errors are made, project staff cross-out the error and enter the correct information. All corrections will be initialed and dated. Electronic equivalents of field forms may be used.

Field personnel will employ the following additional field-sample collection QC procedures, as needed:

- Collect grab water quality samples in certified contaminant-free or properly decontaminated containers.
- Use “clean hands/dirty hands” sampling techniques (that is, one team member performs “dirty tasks,” while the other member performs “clean tasks,” such as handling sample collection bottles).
- Hold samples on ice in coolers during retrieval and delivery to analytical laboratory.
- Deliver samples to analytical laboratory with proper chain of custody, and within holding times.

A.6.2. Laboratory

An accredited laboratory will be contracted to complete additional analyses, as needed, by the inclusion of special studies. Analytical test methods will be standardized and in accordance with procedures approved under 40 Code of Federal Regulations (CFR) §136. The minimum laboratory QA/QC requirements shall also include, but may not necessarily be limited to the following:

- Calibration of analytical laboratory instruments within acceptable limits.
- Periodic inspection, maintenance/servicing, and analysis of quality indicator samples, as necessary, to determine the accuracy and precision of procedures, instruments, and operators.
- Statistical procedures, such as control charts to monitor the precision and accuracy of the analytical data and to establish acceptance ranges and control limits. These data shall be maintained with project records and available upon request or during an audit.
- A continuous review of results to identify and correct problems originating with the instrument, the methodology or the analyst.
- Thorough documentation of the performance of systems, procedures, and operators.
- Certify that electronic data deliverables will exactly match all hard copy data.
- Provide notification of all nonconforming events and conditions, including missed holding times and delays in turnaround time, potentially impacting sample analysis.

A summary of laboratory QA/QC procedures will be requested in the final analytical report deliverables.

A.7. Data Management

This section describes the data management procedures to be used for ensuring access to consistently reliable data. The data management procedure includes 1) recording measurements in the field, 2) downloading data from storage devices in the field, and 3) transferring these data into project databases. There are two separate databases, one for hydrologic data and managed by the hydrology/water quality consultant, and a second for storing vegetation information from the wetland transects and quadrats in the marshes and creek, managed by the habitat consultant. This section defines the structure, inputs, outputs, and quality assurance(QA) and quality control (QC) procedures for the hydrologic database. These data management procedures closely follow those used for current and prior monitoring activities.

A.7.1. Hydrologic Data Collection

Field measurements/observations will be recorded in the field notebook. The field notebook will include the following data sheets: field visit data sheets, field equipment calibration sheets, and the equipment maintenance activity log. Custom field data sheets will be developed for the actual equipment installed. Examples of field data sheets are in Attachment B. Electronic equivalents of field forms may be developed and used.

The Data Collection Lead is responsible for updating and storing the field notebook. The field notebook will be photocopied monthly, and the copy stored at the Consultant’s offices. Data loggers will be downloaded onto a project-designated field computer using applicable software and returned to the Consultant’s office for transfer to the project database, as described below. Information from field notebook is transcribed into the project database manually. The project data files and database are stored on the Consultant’s server, which is to be backed up for disaster recovery purposes at least once per week.

A.7.2. Hydrologic Database Structure

Hydrologic data are stored in an existing central Microsoft Access database created for the ongoing monitoring activities, and a set of specially formatted spreadsheets for ISCO datalogger data. The database will be used to assist with the analysis of groundwater and surface water conditions, and both consolidation and dissemination of information to other parties. The database provides a central storage area for ongoing data collected by Aspect Consulting, LLC and previous data sources, and allows data to be viewed in a uniform manner.

This database is structured such that, whenever possible, user input is validated using predefined formats and common terms making data input fast and simple, while ensuring that data can be accessed reliably through predefined queries. The data management tools in the database include:

- Task/field event setup for verifying completeness of data;
- Manual data entry;
- Querying and reporting tools; and

- Output of graphs and tabulated data.

Additional features designed to protect the integrity of the data and ensure smooth operation of the database include compact on close, tag data additions and modifications with date/time stamp and user id, and "*edit guard*" function that avoids inadvertent editing errors.

Due to the volume of ISCO bubbler data collected since 2004, it is currently managed as a set of Excel spreadsheets that combine to allow storage, correction, and graphing of the raw 15-minute stage data into final analysis and figures.

A.7.3. Database Inputs

Existing hydrologic data currently reside in the database. Data from planned monitoring described in this SAP will be routinely entered into the database as described below.

A.7.3.1. Existing Data

The following types of data were previously input for existing monitoring points:

- Survey coordinates and elevation data for staff gages and well top-of-casing elevations;
- Staff gage and well water level data;
- 15-minute continuous-record stream stage data;
- Stream stage-discharge rating equations for SC-Upper and SC-Lower;
- Standard weir equation for the Diversion Weir; and
- Spot flow measurements.

Existing water quality data is stored in an EQUIS database.

A.7.3.2. New Data

Data inputs from planned data collection include:

- Survey coordinates and elevation data for new staff gages (e.g., at SC-Center Drive gaging station and Sequalitchew Lake Outlet gaging station);
- New surface water staff gage measurements;
- Depth to groundwater measurements from wells;
- Monthly 15-minute stage-height data files for continuous flow and surface water monitoring stations;
- Monthly 15-minute groundwater level data files for continuous groundwater level monitoring stations;
- Monthly 15-minute precipitation data files from on-site rain gage;
- Water quality data;
- New manual streamflow flow measurements; and

- New stream stage-discharge rating equations, as necessary.

Staff gage, depth-to-groundwater, and spot water quality measurements are manually entered directly into the database using the manual data entry form following each field visit. The form includes fields for all monitoring data to help verify completeness.

Continuous stage height, groundwater level, temperature, and precipitation data files are loaded into the database and verified against manual measurements. Manual streamflow measurements and staff gage readings for the Sequalitchew Lake Outlet, SC-Center Drive, SC-Upper, and SC-Lower gaging stations are also entered into MS Excel to evaluate the appropriateness of the current rating curves for each station. When a new rating equation is necessary, it is entered manually into the database and applied to a specific date range for the station.

A.7.3.3. Back-up Precipitation Data

In the event the project rain gage malfunctions, precipitation data from the McMillin Reservoir weather station will be used to fill data gaps, as available. The McMillin Reservoir weather station is located about 20 miles northeast of the project area. This gage was selected as the most appropriate source of back-up precipitation data because it is the closest station with a lengthy period of record, and it receives similar monthly and annual precipitation amounts (Aspect, 2004a).

The precipitation data from McMillin Reservoir are collected as a part of the National Weather Service's (NWC) Cooperative Observer Program (COOP). Electronic files of daily precipitation can be downloaded from the COOP website and imported directly into the database using automated data import routines.

A.7.4. Database Outputs

Figures and tabulated data outputs are generated by an either automated output from the database, or generated via spreadsheet through Tableau. When new figures or tables are desired, water levels and flows are recalculated and printed from their appropriate software.

Water level elevations are calculated in the database, based on the supplied reference elevations for each point. The surveyed elevation of staff gages and monitoring wells is input in the database with a timestamp of when it was measured. Old water levels can be recalculated, based on resurveyed reference elevations when new ones become available.

Raw stage data from the continuous record stream gages is processed with the supplied stage-discharge ratings. Each station has a list of correlations that are applied over a specified time frame—typically for a given year or set of years. From the processed stage data, streamflow in either hourly or 15-minute data intervals is then averaged to mean daily flow for use in graphs and tables.

Precipitation data from the site rain gage is processed to calculate daily, monthly, and annual precipitation totals. Precipitation data at the appropriate time scale is exported to Excel for display on graphs and tables. The data export includes qualifiers indicating the quantity of missing data, if any.

Water quality data are stored and processed in the database. Continuous temperature data will be aggregated to calculate daily and monthly minimum and maximum temperatures as well as the 7-day average of daily maximum temperatures (7-DADMax), which has regulatory significance. Periodic water quality observations will also be output from the database.

A standard monthly report will be developed to assist with routine sharing of information during the mining and restoration projects. The report format will present a summary of observations for the prior month, and compare the observations with relevant performance and aspirational thresholds to determine if the adaptive management processes have been triggered.

A.7.5. QA/QC Protocol

QA/QC protocol for this project fall into three categories, based on which step of data collection and entry is taking place. Data QA/QC occurs during data collection in the field, data entry, and data reporting.

Key components of each QA/QC procedure are summarized below.

A.7.5.1. Data Collection

- The task/field event setup feature identifies all current monitoring points, and organizes them in the order that the data is typically collected on preprinted field forms. This feature helps ensure the completeness of data, especially in the event of field staff turnover.
- While measurements are being collected, the field staff quickly references the previous event's field form to verify the current measurement seems reasonable, and remeasures if necessary.

A.7.5.2. Data Entry

Manual data entry utilizes real-time data verification against defined valid values, acceptable data ranges, expected parameters, and standard data formats. Entries that fall outside these defined parameters will return an error message and reject the data.

A.7.5.3. Data Reporting

After each data entry event, data is reviewed in tabulated and graphical formats. This allows the user to readily identify data outliers and missing values. Data tables and figures will be inspected each month as a final step to verify the completeness and quality of monitoring data.

A.7.6. Data Archival (EIM)

To provide long-term data preservation by a neutral party, data collected under this SAP will be uploaded annually to Ecology's Environmental Information Management (EIM) database: http://www.ecy.wa.gov/eim/. Alternately, data collected by a governmental party with a similar, publicly accessible database (e.g., USGS's Nationwide Water Information System) may be stored in that database.

A.8. Special Studies

This SAP describes the routine monitoring approaches and methods for use in implementing the mining and restoration plans. Those plans also identify several special studies—notably the 60-day pumping test proposed as Step 1 of dewatering, and a study of water quality in Hamer Marsh to determine if it is adequate for improving the connection to Sequalitchew Creek. Specific plans will be developed for these studies, and others that may arise during implementation and adaptive management of the projects.

A.9. References

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TABLES

Table 1 - Summary of Baseline Monitoirng Program

Project No.: 040001-014-03, DuPont, Washington

Station ID	Summary of Monitoring					Description
	Surface Water	Streamflow	Water Quality	Groundwater Elevation		
				Shallow	Deep	
MW-BM-1				X		Bell Marsh - Monitoring Well
SG-BM-1	X					Bell Marsh - Stage Gage
SG-MKM-1	X					McKay Marsh - Stage Gage
MW-HM-1				X		Hamer Marsh - Monitoring Well
MW-SRC-2				X		Hamer Marsh - Monitoring Well
SG-HM-1	X		X			Hamer Marsh - Stage Gage
G-Diversion Weir	X	X	X			Diversion Canal - Continuous Stage Gage and Discharge Transect
SG-DC-1	X	X				Diversion Canal - Stage Gage and Discharge Transect
SG-DC-2	X	X				Diversion Canal - Stage Gage and Discharge Transect
SG-DC-3	X	X				Diversion Canal - Stage Gage and Discharge Transect
MW-D-3				X		Diversion Canal - Monitoring Well
IW-93-MFS-C5-3				X		Diversion Canal - Monitoring Well
MW-SL-1				X		Sequalitchew Lake Outlet - Monitoring Well
SG-SCM-1	X					Sequalitchew Creek Marsh - Stage Gage
SG-EM-3E	X					Edmond Marsh - Stage Gage
SG-EM-3W	X					Edmond Marsh - Stage Gage
MW-EM-3				X		Edmond Marsh - Monitoring Well
SG-EM-2E Island	X					Edmond Marsh - Stage Gage
G-EM-2W Culvert	X					Edmond Marsh - Stage Gage
MW-EM-2(D)					X	Edmond Marsh - Monitoring Well
MW-EM-2(S)				X		Edmond Marsh - Monitoring Well
SG-WL1D-1	X					Edmond Marsh - Stage Gage
MW-WL1D-1				X		Edmond Marsh - Monitoring Well
SG-EM-1	X					Edmond Marsh - Stage Gage
SG-EM-1A	X					Edmond Marsh - Stage Gage
MW-EM-1(D)					X	Edmond Marsh - Monitoring Well
MW-EM-1(S)				X		Edmond Marsh - Monitoring Well
MW-PL-1				X		Pond Lake - Monitoring Well
SG-PL-1	X					Pond Lake - Stage Gage
CHMW-1				X		Mine Area - Monitoring Well
CHMW-2-D					X	Mine Area - Monitoring Well
CHMW-2-S				X		Mine Area - Monitoring Well
CHMW-3-D					X	Mine Area - Monitoring Well
CHMW-3-S				X		Mine Area - Monitoring Well
CHMW-4-D					X	Mine Area - Monitoring Well
CHMW-4-S				X		Mine Area - Monitoring Well
OB-1				X		Mine Area - Monitoring Well
SG-SC-Lower		X				Sequalitchew Creek - Continous Stage Gage and Discharge Transect
SG-SC-Upper		X	X			Sequalitchew Creek - Continous Stage Gage and Discharge Transect

Table 3 - Relationship of Proposed Monitoring to Adaptive Management Thresholds

Project No. 040001-014-03, DuPont, Washington

Plan Objectives			Sampling and Analysis Plan Elements[1]				
			Precipitation	**Groundwater Level**			
			on-site rain gage	Dewatering Wells	Key Wells: CHMW-1, CHMW-2S&D, CHMW-3S&D, CHMW-4S&D, MW-EM-1S&D, MW-EM-2S&D	MW-BM-1, MW-HM-1, MW-D-3, MW-93-MFS-C5-3, MW-SRC-2, MW-SL-1, MW-EM-3, MW-WLD-1, MW-PL-1	Two new monitoring wells in mine interior
South Parcel Monitoring Plan Objectives	Step 1 - Initial Pumping Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	continuous		continuous	monthly	
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.	continuous	continuous			
	Step 2 - Prep for Mining/ Dewatering Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	continuous		continuous	twice monthly	
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.	continuous	continuous			as needed
	Step 3 - Active Dewatering During Mining	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	continuous		continuous	twice monthly for 3 months after new dewatering wells are brought on line, then monthly	
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.	continuous	as needed			as needed
	Step 4 - Cessation of Active Dewatering	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	continuous		continuous	monthly	
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.	continuous	as needed			as needed
Sequalitchew Creek Restoration Plan Objectives	After Elements B, C, and D,	Achieve year-round surface water flow in Sequalitchew Creek from Sequalitchew Lake to the mouth, as climate conditions allow.	continuous				
		Minimize the flow lost to the Diversion Canal.	continuous				
	After B, C, D, and G	Increase access to suitable spawning and rearing habitat in Sequalitchew Creek	continuous				

Notes:

1) additional monitoring locations may be added through adaptive management

* Continue routine monitoring of flow and surface water stations to aid in interpretation of groundwater measurements. Flow and surface water stations do not have Monitoring Plan performance thresholds.

Table 3 - Relationship of Proposed Monitoring to Adaptive Management Thresholds

Project No. 040001-014-03, DuPont, Washington

Plan Objectives			Sampling and Analysis Plan Elements*					
			Flow			Surface Water Level		
			Sequalitchew Lake Outlet	Diversion Weir	Sequalitchew Creek gages (Center Drive, mid-ravine, and SC-Lower)	West Edmond (SG-EM-1/1A and SG-EM-2W)	East Edmond and Sequalitchew Creek Marshes (SG-SCM-1, SG-EM-3E, SG-EM-3W, SG-EM-2E)	Hamer, McKay, and Bell Marshes (SG-HM-1, SG-MKM-1, SG-BM-1)
South Parcel Monitoring Plan Objectives	Step 1 - Initial Pumping Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	* continue routine monitoring			* continue routine monitoring		
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.						
	Step 2 - Prep for Mining/ Dewatering Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	* continue routine monitoring			* continue routine monitoring, but at twice monthly frequency		
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.						
	Step 3 - Active Dewatering During Mining	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	* continue routine monitoring			* continue routine monitoring, but at twice monthly for first three months after new dewatering wells are brought on line, then monthly		
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.						
	Step 4 - Cessation of Active Dewatering	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.	* continue routine monitoring			* continue routine monitoring		
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.						
Sequalitchew Creek Restoration Plan Objectives	After Elements B, C, and D,	Achieve year-round surface water flow in Sequalitchew Creek from Sequalitchew Lake to the mouth, as climate conditions allow.	continuous		continuous	continuous	monthly	monthly
		Minimize the flow lost to the Diversion Canal.		continuous				
	After B, C, D, and G	Increase access to suitable spawning and rearing habitat in Sequalitchew Creek			continuous	continuous	monthly	

Notes:

1) additional monitoring locations may be added through adaptive management

* Continue routine monitoring of flow and surface water stations to aid in interpretation of groundwater measurements. Flow and surface water stations do not have Monitoring Plan performance thresholds.

Table 3 - Relationship of Proposed Monitoring to Adaptive Management Thresholds

Project No. 040001-014-03, DuPont, Washington

DRAFT

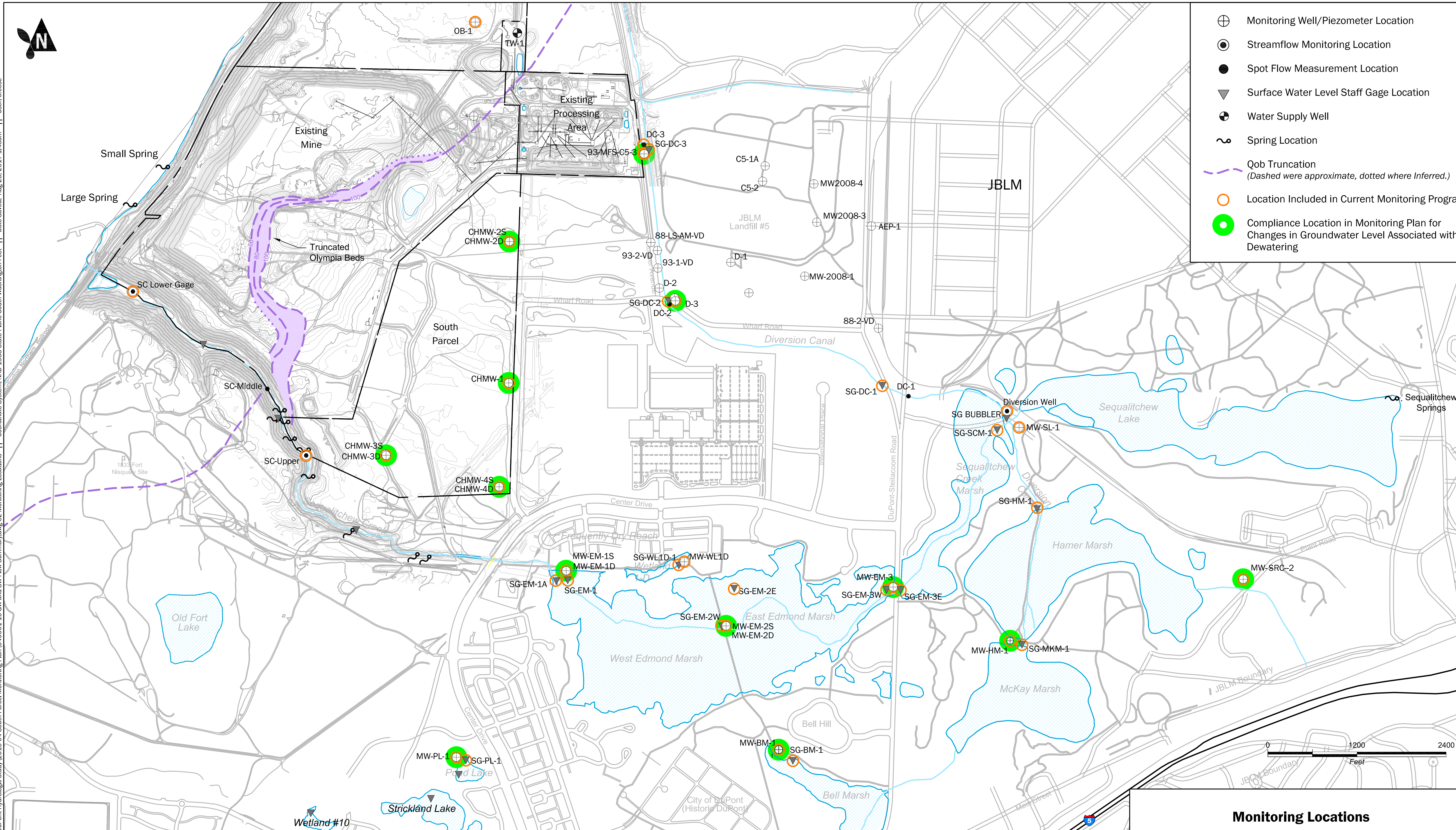
Plan Objectives			Sampling and Analysis Plan Elements*				
			Water Quality		Habitat		
			Temperature at SG-EM-1, SG-EM-2W, Diversion Weir, Sequalitchew Lake Outlet, SC-Center Drive, mid-ravine, SC-Lower	Water quality sampling for DO, turbidity, pH, Temperature at select surface water stations	Cross-section physical characteristics (depth, velocity, substrate,and cover)	Visual Observations (fish presence, active erosion)	Large Woody Material
South Parcel Monitoring Plan Objectives	Step 1 - Initial Pumping Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.					
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.					
	Step 2 - Prep for Mining/ Dewatering Test	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.					
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.					
	Step 3 - Active Dewatering During Mining	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.					
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.					
	Step 4 - Cessation of Active Dewatering	Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted, approved-upon levels.					
		Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.					
Sequalitchew Creek Restoration Plan Objectives	After Elements B, C, and D,	Achieve year-round surface water flow in Sequalitchew Creek from Sequalitchew Lake to the mouth, as climate conditions allow.					
		Minimize the flow lost to the Diversion Canal.					
	After B, C, D, and G	Increase access to suitable spawning and rearing habitat in Sequalitchew Creek	continuous	monthly	Years 0, 1, 2, 3, 5 and 10		Years 5 and 10

Notes:

1) additional monitoring locations may be added through adaptive management

* Continue routine monitoring of flow and surface water stations to aid in interpretation of groundwater measurements. Flow and surface water stations do not have Monitoring Plan performance thresholds.

FIGURE



Base Map Sources

1. Glacier Northwest Mining Facility by ESM Consulting Engineers, June 2003.
2. Northwest Landing Development by ESM Consulting Engineers, June 2002.
3. DuPont Consent Decree Area by ESM Consulting Engineers, April 2004.
4. Fort Lewis by USGS DEM, *Nisqually* and *Fort Lewis*, 1994, and USGS Digital Line Graphs, *Hypsography* and *Transportation*, Fort Lewis Military Reservation, 1973, McNeil Island, 1981, Nisqually, 1981, and Steilacoom, 1990.

Monitoring Locations

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	AUG-2017	BY: OGR/SCC	FIGURE NO.
	PROJECT NO. 040001-014	REV BY: SCC	1

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2015-04 South Parcel Monitoring Plan\040001-10 GW and SW Flow Summary.dwg 02-Monitoring Locations || Coordinate System: NAD 1983 State Plane South Washington Feet || Date Saved: Aug 23, 2017 1:45am || User: creese

APPENDIX A

Boring Logs

14P1

21 FEB 91

RESOURCE PROTECTION WELL REPORT

START CARD NO. 063977

PROJECT NAME: LONESTAR NW OBSERVATION WELL
WELL IDENTIFICATION NO. LONE STAR OB-1
DRILLING METHOD: REVERSE CIRCULATION ROTARY
DRILLER: DOUGLAS GRABOWSKI
FIRM: BECKER DRILLS INC.
SIGNATURE: William S. [signature]
CONSULTING FIRM: HART CROWSER
REPRESENTATIVE: TOM NOYES

COUNTY: PIERCE
LOCATION: SE 1/4 SW 1/4 Sec 14 Twn 19N R 1E
STREET ADDRESS OF WELL: NORTHWEST LANDING ANNEX DUPONT STIELACOOM ROAD DUPONT WASHINGTON
WATER LEVEL ELEVATION: 200 FT. STATIC
GROUND SURFACE ELEVATION: +210
INSTALLED: FEBRUARY 15, 1991
DEVELOPED:

AS-BUILT	WELL DATA	FORMATION DESCRIPTION
	3 EA. PROTECTIVE METAL POST	
SUBSURFACE STICK UP +2 FT. / PROTECTIVE METAL COVER	+2 1/2 PROTECTIVE COVER +6" RUNOFF PAD	+210' ABOVE SEA LEVEL
0'	0'	0' TO 25' FINE LIGHT BROWN SAND LARGE GRAVEL + SMALL COBBLES MULTI COLORED
STEEL SCH 80 1½" ID 1.9" OD WELL CASING +2' TO 210'		25' TO 50' LITTLE OR NO SAND, MOSTLY MEDIUM TO LARGE MULTI-COLORED GRAVELS
50' / 100' / 150'	0' TO 180' NEAT CEMENT PORTLAND TYPE III HIGH EARLY	50' TO 180' WELL UNIFORMED TAN MEDIUM SAND MIXED IN MEDIUM TO LARGE MULTI-COLORED GRAVELS
	180'	
	180' TO 190' WYOMING BENTONITE	180' LIGHT WATER + MEDIUM BROWN SAND
	190' TO 200' VOLCLAY ENVIRO SEAL	200' TO 240' MOVING WATER TABLE BROWN MEDIUM SAND MIXED WITH MEDIUM AND LARGE MULTI-COLORED GRAVELS
200' / 210' / 208.9 SCREEN TOP	200' SANDPACK END	
.015 SCREEN STAINLESS STEEL WIRE WOUND CONTINUOUS SLOT / 230'	8-12 COLORADO SILICA SAND	
240' / 10' TAILPIPE	SANDPACK END 240'	
250'		
239.5 = TAILPIPE END 229.3 = SCREEN BOTTOM 208.9 = SCREEN TOP	SCREEN MANUFACTURE = HOWARD SMITH .015 SLOT STAINLESS STEEL WIRE WOUND CONTINUOUS SLOT 1 3/8" ID 1 5/8" OD	

SCALE: 1" = 50 FEET

PAGE 1 OF 1

ECY 050-12 (Rev. 11/89)

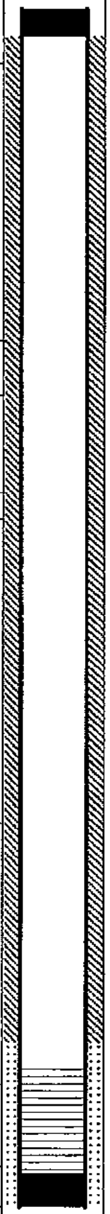
CH2MHILL

Well Number: CHMW-1

Sheet: 1 of 1

Driller: Hokkaido Drilling (Bill & Steve)
Client: Glacier NW
Drilling Method: Speedstar 15 Truck-Mounted Air Rotary
Project: N Sequalitchew Creek Aquifer Tests
Sampling Method: Sand pump (water added)
Location: DuPont, Washington
Logged by: driller
Project Number: 151973.A2.AT
Start/Finish Date: 9/23/99 - 9/24/99

Depth (ft)	Sample #	STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 217		Monument (not shown)-- Lockable 6" steel protective casing in concrete.
0				Ground Surface			
				Topsoil	2 / 210		
5				Sand and gravel with silt, dry, brown			
10							Casing - 2" sch 40 PVC pipe
15							
20					22 / 190		
				Brown silty gravel			
25					26 / 186		
				Brown gravel, like till			
30					33 / 179		
35				Brown silt			
				Light brown gravel, productive water-bearing zone			
40							
45							
50							
55					57 / 155		
				Dark brown gravel and sand. Note no "soupy sand" like in CHTW-1.			
60							Casing Seal - Hydrated medium bent
65							
70							Filter pack - 10-20 CSSI sand
75					76 / 136		Screen - 2" sch 40 PVC, 0.020-in slot
				Dark brown sand and gravel			
80					82 / 130		
				Gray-blue silty sand, sand and gravel.	85 / 127		
85							6" end cap



CH2MHILL

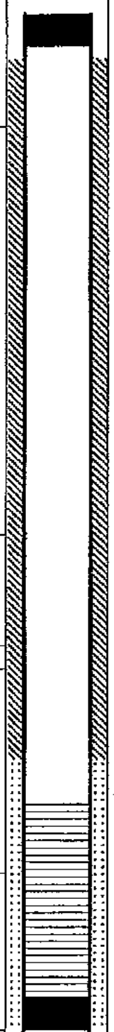
Well Number: CHMW-2(S)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Daryl & Tom)
Drilling Method: Star 71 cable tool, 8" steel casing
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/17/99 - 11/19/99

Depth (ft)	Sample #	STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 212		Monument (not shown)-- Lockable 6" steel protection casing in concrete.
0				Ground Surface			
				Topsoil and gravel	3		
5				Brown silty sand and gravel	204		
10							Casing - 2" sch. 40 PVC pipe
15							Casing seal - Hydrated medium bentc
20					21		
				Larger gravel and sand, slightly silty, very hard	186		
25					26		
				Brown silty sand _gravel	181		
				Sandier with gravel			
30							Sandy filterpack - 10-20 CSSI sand
35					36		Screen - 2 centralizers, 2" sch 40 PV(0.020-inch slot width
				Clean sand and gravel, water	171		
40					43		6" end cap
				End of Log	164		
45							
50							



CH2MHILL

Well Number: CHMW-2(D)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve & Tom)
Drilling Method: Speedstar 15 & Star 71 Cable Tool
Sampling Method: Sand pump (water added)
Logged by: Driller
Start/Finish Date: 11/12/99 - 11/18/99

Depth (ft)	Sample #	STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Construction Notes
-5					5 / 212	Monument (not shown): Lockable 6' steel protection casing in concrete
0				Ground Surface		
				Topsoil	4	
5				Brown silty gravel	203 / 9	
10				Brown gravel	198 / 15	Casing--2" sch 40 PVC pipe
15				Brown silty gravel, moist	192 / 24	
25				Hard till, brown	[illegible]	
				Loose sand and gravel, water	181 / 35	Casing Seal--Hydrated medium bentc
35				Brown till	172 / 48	
50				Loose sand and gravel, water	159 / 58	
60				Brown silt bound sand and gravel, tight	149 / 66	Screen - 2" sch 40 PVC, 0.020-in slot with centralizer
				no record	141 / 73	6" end cap
75				End of Log	134	

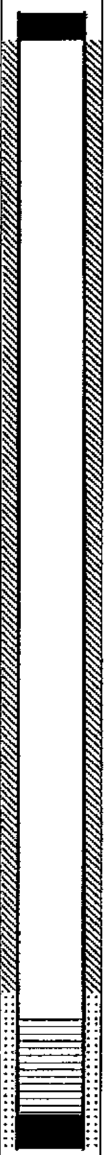
Well Number: CHMW-3(D)

CH2MHILL

Sheet: 1 of 1

Driller: Hokkaido Drilling (Steve)
Client: Glacier NW
Drilling Method: Speedstar 15 Air Rotary Drill Rig
Project: N Sequalitchew Creek Aquifer Tests
Sampling Method: Sand pump (water added)
Location: DuPont, Washington
Logged by: driller
Project Number: 151973.A2.AT
Start/Finish Date: 11/4/99 - 11/5/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 221		Monument (not shown): Lockable 6" steel protective casing in concrete
0				Ground Surface			
				Brown topsoil	2 / 214		
5				Loose brown gravel			
10							Casing - 2" sch 40 PVC pipe
15				Brown silty sand and gravel	16 / 200		
20							
25				Brown silty sand and gravel (moist)	26 / 190		Casing seal - hydrated medium bento
30				Brown sand and gravel, dirty, water	31 / 185		
35							
40				Brown till	41 / 175		
45				Sand and gravel, water	48 / 168		
50							
55				Brown till	54 / 162		
				Silt, sand and gravel, brown, wet			
60							
65				Clean sand and gravel	64 / 152		
70							Filter pack - 10-20 CSSI sand
75							Screen - 2" sch 40 PVC, 0.020-in slot
80							
85				End of Log	85 / 131		6" end cap
90							



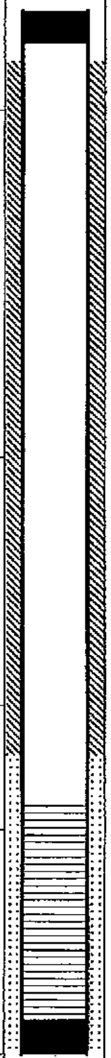
CH2MHILL

Well Number: CHMW-3(S)

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: Speedstar 15 Air Rotary Drill Rig
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/5/99

Depth (ft)	Sample #	STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 221		Monument (not shown): Lockable 6" steel protection casing in concrete
0				Ground Surface			
				Brown topsoil	2 / 214		
				Loose gravel			
5							
							Casing - 2" sch 40 PVC pipe
10							
15					16 / 200		Casing seal - Hydrated medium bentc
				Silty brown sand and gravel			
20							
25					26 / 190		
				Miost silty brown sand and gravel			Filter pack - 10-30 CSSI sand
30					31 / 185		Screen - 2" sch 40 PVC, 0.020-in slot
				Clean sand and gravel, water			
35							
40					40 / 176		6" end cap
				End of Log			
45							



CH2MHILL

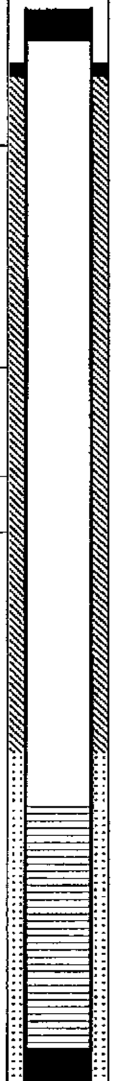
Well Number: CHMW-4(S)

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: air rotary
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/23/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Construction Notes
-5					5 / 219	Monument (not shown): Lockable 6" steel protective casing
0				Ground Surface		
				Topsoil with large gravel		
				Brown silty sand and gravel	3 / 211	
5						
10						Casing - 2" sch 40 pvc pipe w/ j-plug
				Brown silty sand and large boulders	11 / 203	
15				Sand and gravel with water	15 / 199	Casing seal - hydrated medium bento
				Brown silt with gravel	17 / 197	
20						
25						Filterpack - 10-20 CSSI sand
						Screen - 2" sch 40 pvc, 0.020-in slot v
30						
35						
					37 / 177	6" end cap
				End of Log		
40						

Well Drawing:



CH2MHILL

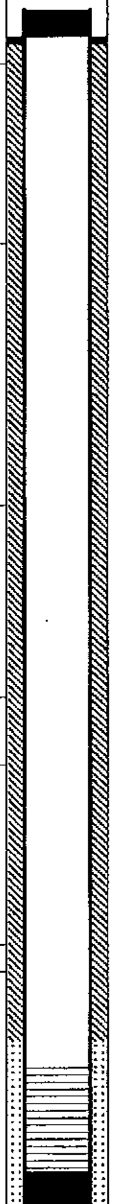
Well Number: CHMW-4(D)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: air rotary
Sampling Method: Sand pump (water added)
Logged by: diller
Start/Finish Date: 11/11/99

Depth (ft)	Sample info: Sample #	Sample info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 219		
0				Ground Surface			
				Topsoil	2 / 212		Monument: Lockable 6" steel protective casing in concrete
5				Brown gravel			
10							
15				Brown till	15 / 199		
20							
25							Casing - 2" sch 40 PVC pipe
30							
35				Sand, gravel, making water	34 / 180		Casing seal - hydrated medium bento
40							
45							
50				Brown till	48 / 166		
55				Sand, gravel, making water	53 / 161		
60							
65				Brownish orange silty gravel	66 / 148		
70				Sand, gravel, water			
75							Filter pack - 10-20 CSSI sand
							Screen - 2" sch 40 PVC, 0.020-in slot
80							
85					85 / 129		6" end cap



CH2MHILL

PROJECT NUMBER : 151973.A1.AT

WELL NUMBER : CHMW-1

SHEET 1 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT**

LOCATION : **50' S. OF CHTW-1**

WATER LEVELS : **21'6 3/4" ATD**

DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**

START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
0	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	0-2FT Topsoil
	2-22FT Sand/gravel w/silt (dry,brown)
5	
10	
15	
20	
	22-26FT Brown silty gravel
25	
	26-33FT Brown gravel (like till)
30	

CH2MHILL	PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-1 SHEET 2 OF 3
	WELL CONSTRUCTION/BORING LOG	

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' S. OF CHTW-1**
WATER LEVELS : **21'6 3/4" ATD**
DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**
START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	33-35FT Brown silt
35	35-57FT Lt.brown gravel, productive water-bearing zone
40	
45	
50	
55	
	57-59FT Dk.brown gravel & sand NOTE: No "soupy sand" at 50' like in CHTW
60	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT

WELL NUMBER : CHMW-1

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' S. OF CHTW-1**

WATER LEVELS : **21'6 3/4" ATD**

DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**

START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
65	
70	
75	
	76-82FT Dk.brown sand & gravel
80	
	82-83FT Gray silty sand & gravel
	83-85FT Blue sand & gravel
85	WELL: STICKUP=2' (2"sch 40 pvc) SCREEN=75'-84.5' (2"sch 40 pvc, 20-slot) 6" endcap 84.5 -85 fbgs ANNULUS=15 bags 10-20 cost sand (50lb. ea) 52 bags med. bentonite chips (50lbs ea) MONUMENT=6" steel protective casing in concrete
90	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(S) SHEET 1 OF 2

WELL CONSTRUCTION/BORING LOG

TOC elev = 209.39 Stickup = 1.45
grd = 207.94

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2(~15FT E.OF MW-2(D)**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **STAR 71 CABLE TOOL, 8" STEEL CASING**

START : **11/17/99** END : **11/19/99** LOGGER: **HOKKAIDO(DARYL & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
0	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	0-3FT Topsoil & gravels
	3-21FT Brown silty sand and gravels
5	
10	
15	
20	
	21-26FT Larger gravels & sand slightly silty, very hard
25	
	26-27FT Brown silty sand & gravel
	27-28FT Sandier w/gravel (gravel smaller)
30	

CH2MHILL	PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(S) SHEET 2 OF 2
	WELL CONSTRUCTION/BORING LOG	

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2(~15FT E.OF MW-2(D)**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **STAR 71 CABLE TOOL, 8" STEEL CASING**

START : **11/17/99** END : **11/19/99** LOGGER: **HOKKAIDO(DARYL & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
35	
	36-43FT Clean sand & gravel w/H20
	Total casing=46'-81/2"
	Well: Stickup=2' (2" sch 40 pvc) w/j-plug
40	Screen=33'-421/2' bgs w/2 centralizers & 6' end (2"sch 40 pvc, 20-slot) Annulus=13 50-lb bags 10-20 cgsi sand 18 50-lb bags medium bentonite chips Monument= 6"steel protecting casing in concrete (7 bags)
45	
50	
55	
60	

CH2MHILL	PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D) SHEET 1 OF 3
	WELL CONSTRUCTION/BORING LOG	

TOC elev = 209 Stickup = 1.8
grd = 207.2

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**

START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
0	0-4FT Dark brown topsoil
	4-9FT Brown silty gravel
5	
10	9-15FT Brown gravel
15	15-24FT Brown, silty gravel, moist
20	
25	24-26FT Hard till, brown
	26-35FT Loose sand & gravel H20
30	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D) SHEET 2 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**
WATER LEVELS :
DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**
START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
35	35-48FT Brown till
40	
45	
	48-58FT Loose sand & gravel H20
50	
55	
	58-66FT Brown tight Silt Bound sand & gravel
60	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D) SHEET 3 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**
WATER LEVELS :
DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**
START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
65	
	66-73FT NO RECORD
	Total Casing=72'-41/4"
	Well:
	Stickup=2' (2"sch 40 pvc) w/j plug
70	Screen= 63'-721/2' bgs (2" sch 40 pvc, 20-slot)
	w/centralizer 6"end cap 721/2-73 fbgs
	Annulus=13 50-lb bags 10-20 cssi sand
	34 50-lb bags medium bentonite chips
	Monument= 6" steel protectivecasing in concrete
75	
80	
85	
90	

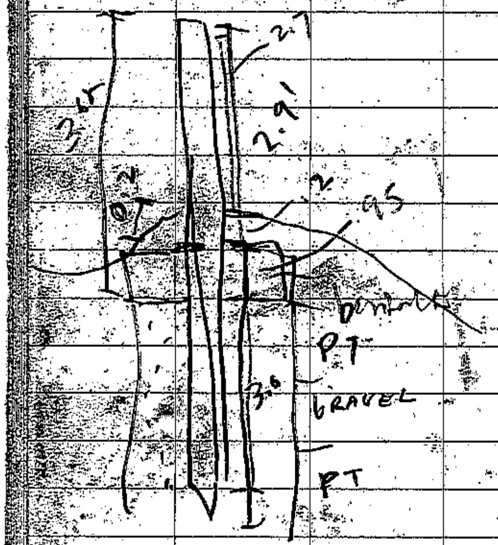
CHMW-4 (S) 18.42

4 (D) 20.81

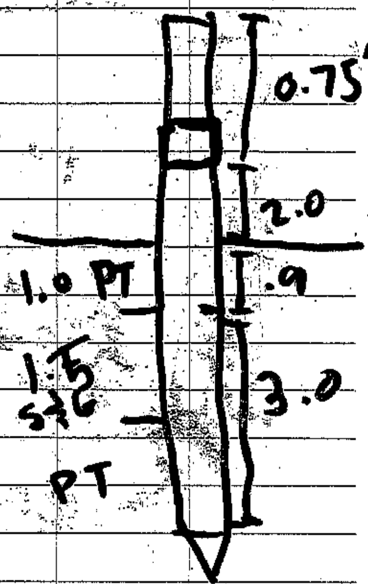
CHMW-1 19.40 14:21

July 06

WL10-1

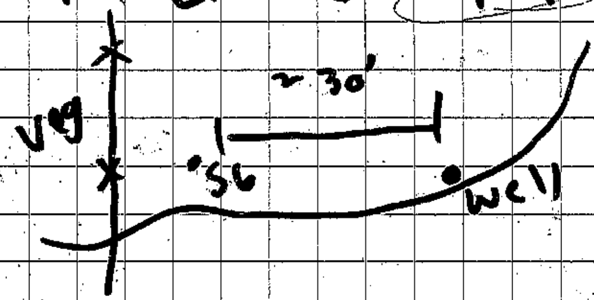


Pond Lake



Pond L. Well 2.95

Pond L. SG 1.07



BM-MW-1 14.23' 12:30

BM-SG-1 2.53' 12:32

EM-1A 3.69' 12:40

Top 6.65'

SG EM1 dry Tip 3.33

Aspect consulting IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	SL-1	1 of 1

Project Name: North Sequalichew Creek
Location: Fort Lewis, WA
Drilling Method: Hollow stem auger, 4" ID ; Holt Drilling
Sampling Method: 3" diameter D&M
Ground Elevation 214.94

Top of PVC Casing Elev. (ft mllw) 217.74
Depth to Water (ft BTC) 6.25
Start Date: March 11, 2004
Finish Date: March 11, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Description
	5" diameter steel monument, 3' stickup Concrete seal 0'-2'				Grass, duff FILL Gravel up to 1-1/2" diameter, to a depth of 8" below ground surface
		3/26/04 ▼	4 3 3	S-1	Medium stiff, moist to very moist, dark brown, gravelly SILT with SAND
5			3 3 4	S-2	•Very gravelly drilling, no recovery
			9 8 11	S-3	Medium dense, wet, gray, sandy GRAVEL; sand medium to coarse, gravel fine to coarse
			4 6 6	S-4	•Low recovery, trace gravel in sampler
10	Bentonite chips 2'-13'		7 7 7	S-5	RECESSIONAL OUTWASH Medium dense, wet, gray, very gravelly SAND; sand predominantly coarse
			7 7 9	S-6	Medium dense, wet, gray-brown, sandy GRAVEL; sand predominantly coarse
			6 7 12	S-7	
15			11 10 9	S-8	•Trace silt
	10/20 silica sand filter pack 13'-20'		10 7 7	S-9	•Trace silt
	20-slot screen 15'-20'; slip cap with SS screw 20'-20.3'		4 6 7	S-10	
20					Bottom of boring at 20 feet.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
▼ Water Level (ATD)
▽ Static Water Level

Logged by: RRH
Approved by: LJH
Figure No. B - 2

MW GEOLOG SEQUALICHEW CREEK.GPJ July 20, 2004

Aspect consulting — IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	HM-MW-1	1 of 1

Project Name: North Sequalitchew Creek
Location: DuPont, Washington
Drilling Method: Hollow Stem Auger - 4" ID ; Holt Drilling
Sampling Method: 3" Diameter D&M

Top of Casing Elev. (ft mllw): 221.06
Ground Surfave Elev. (ft): 217.75
Depth to Water (ft bgs): 5
Start Date: August 2, 2004
Finish Date: August 2, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Description
0–2.5	5" diameter steel monument, cement seal 0'-4'				Brown, slightly silty GRAVEL; gravel, predominantly coarse and cobbles (observed from drill action and cuttings) (GP)
2.5–5		18"/5"	3 27 30	2.5-4	Brown, moist, slightly silty to trace silt, sandy GRAVEL; sand medium to coarse; gravel fine to coarse, abundant cobbles, subangular to rounded (GW)
5–7.5	Bentonite Chips 4'-7.5'	8/2/04 (water level) 18"/8"	11 23 23	5-6.5	Brown to olive gray, wet, very sandy GRAVEL, trace silt; sand medium to coarse, predominantly medium; gravel fine to coarse with cobbles, subangular to subround; no apparent organization.
7.5–10		18"/11"	19 22 24	7.5-9	Color change to olive gray; grades to medium to coarse sand and predominantly fine gravel; increase in silt (still trace silt), less cobbles.
10–13.3	10/20 silica sand filter pack 7.5'-20.3'	18"/6" 18"/12"	22 28 32 21 30 35	10-11.5 12.5-14	Olive gray to gray-green, wet, SAND; trace gravel; sand medium to coarse, occasional zones of fine to medium; gravel fine (SP-SW)
13.3–15					Olive gray, wet, slightly silty, very sandy GRAVEL; gravel fine to coarse; with cobbles; sand predominantly medium to coarse (GW-GM)
15–16	20-slot screen 10'-20'; slip cap with SS screw 20'-20.3'	18"/10"	21 31 44	15-16.5	Gray-green to olive gray, wet, SAND, trace gravel; sand predominantly medium to coarse; gravel fine (SW)
16–17.5					Olive gray, wet, very sandy GRAVEL, trace silt, sand medium to coarse, occasional fine, predominantly coarse; gravel fine to coarse (GW)
17.5–18		18"/10"	26 50/6"	17.5-19	Gray-green, wet SAND; trace gravel; sand predominantly medium to coarse (SW)
18–20					Olive-gray, wet, very sandy GRAVEL, trace silt; gravel fine to coarse; sand predominantly medium to coarse (GW)
20–21.5		18"/11"	26 50/6"	20-21.5	Gray to olive gray, wet SAND; sand medium; homogenous (SP)
21.5–22.5					Olive gray to gray, wet, sandy GRAVEL, trace silt; gravel fine to coarse; subrounded to rounded; sand medium to coarse, predominantly medium (GW)
					Total depth = 20' drilled, 22.5' driven.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
- Water Level (ATD)
- Static Water Level

Logged by: ILE
Approved by: LJH
Figure No. A- 2

MW_GEOL S CRK.GPJ November 23, 2004

APPENDIX B

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	EM-3	1 of 1

Project Name: North Sequalichew Creek

Location: Fort Lewis, WA

Drilling Method: Hollow stem auger, 4" ID ; Holt Drilling

Sampling Method: 3" diameter D&M

Ground Elevation 214.63

Top of PVC Casing Elev. (ft mllw) 217.38

Depth to Water (ft BTC) 4.96

Start Date: March 11, 2004

Finish Date: March 11, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Description
0	5" diameter steel monument, 3' stickup; Concrete seal 0'-2'				Sod and dark brown organic soil
					FILL
					Gravel, some cobbles at 0.5'
		3/26/04 ▼	3 7 10	S-1	Medium dense, moist, dark brown, sandy GRAVEL with SILT and ORGANICS, trace wood
5			3 6 8	S-2	Medium dense, wet, gray SAND and GRAVEL
			6 2 1	S-3	
					MARSH DEPOSITS
		K Test K = $1x10^{-6}$ cm/s	1 1 9	S-4	Soft, wet, brown, slightly fibrous PEAT, trace gravel
					Medium dense, wet, brown, sandy GRAVEL to GRAVEL, trace silt
			8 12 14	S-5	
10	Bentonite chips 2'-13'				RECESSIONAL OUTWASH
			2 6 6	S-6	
			7 8 13	S-7	Medium dense, wet, gray SAND, trace gravel; sand fine to medium; 1/4" silt seam
			1 12 25	S-8	No recovery, coarse gravel in shoe of sampler
15			16 17 16	S-9	Dense, wet, brown, gravelly SAND to sandy GRAVEL
	10/20 silica sand filter pack 13'-20'		11 16 32	S-10	Dense, wet, sandy GRAVEL
	20-slot screen 15'-20'; slip cap with SS screw 20'-20.3'		15 25 35	S-11	
20					Bottom of boring at 20 feet.

Sampler Type (ST):

- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector

▼ Water Level (ATD)

▽ Static Water Level

Logged by: RRH

Approved by: LJH

Figure No. B - 1

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	BM-MW-1	1 of 1

Project Name	North Sequalitchew Creek	Top of Casing Elev. (ft mllw)	232.32
Location	DuPont, Washington	Ground Surfave Elev. (ft)	229.37
Drilling Method	Hollow Stem Auger - 4" ID ; Holt Drilling	Depth to Water (ft bgs)	12.5
Sampling Method	3" Diameter D&M	Start Date	August 3, 2004
		Finish Date	August 3, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Description
0–1.5	5" diameter steel monument, cement seal 0'-1.5'				Brown, dry, GRAVEL, trace silt; gravel fine to coarse, predominantly coarse; abundant cobbles, subrounded to rounded (GW)
1.5–5	Natural Fill 1.5'-5'				(Road fill)
5		18"/4"	11 12 10	5-6.5	Brown to tan, moist sandy GRAVEL, trace silt; gravel fine to coarse, subrounded to rounded; sand predominantly medium to coarse.
7.5	Bentonite Chips 5'-12'	18"/12"	4 10 16	7.5-9	Brown to reddish brown, moist, slightly gravelly SAND, trace silt; sand fine to coarse, predominantly medium; gravel fine, subangular to rounded (SP)
10		18"/5"	9 15 19	10-11.5	Occasional coarse gravel and grades medium to coarse sand.
12		8/3/04 ▼			
12.5	10/20 silica sand filter pack 12'-26.5'	18"/6"	8 14 15	12.5-14	Brown to red-brown, wet, gravelly SAND, trace silt; sand predominantly coarse; gravel fine to coarse, predominantly fine.
15		18"/10"	9 10 16	15-16.5	
16					Yellowish-green to brown, highly oxidized, wet, slightly to trace silt; sandy GRAVEL; gravel fine to coarse; sand predominantly coarse (GW-GM)
17.5		18"/8"	5 8 8	17.5-19	Yellow brown, highly oxidized, wet, slightly gravelly SAND, trace silt; sand medium to coarse, predominantly coarse; gravel predominantly fine (SP)
18.5					Grades to slightly silty and gravelly in shoe (SP-SM)
20	20-slot screen 15'-25'; slip cap with SS screw 25'-25.3'	18"/12"	9 11 13	20-21.5	Gray olive, wet, SAND; trace gravel; trace to no silt; sand predominantly medium to coarse (SP)
21					Gray green, wet, slightly silty to trace silt, sandy GRAVEL; gravel fine to coarse, subrounded to rounded; sand medium to coarse. (GP-GM)
22.5		18"/14"	13 25 24	22.5-24	Gray green, wet, SAND; sand medium (SP)
24					Gray olive, wet, sandy GRAVEL, trace silt; gravel fine to coarse, sand predominantly medium to coarse (GP)
25		18"/3"	28 19 17	25-26.5	Gray olive, wet, slightly silty sandy GRAVEL; gravel fine to coarse; sand medium to coarse (GP-GM)
26.5					Total depth = 25' drilled; 26.5' driven.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
- ▼ Water Level (ATD)
- ▽ Static Water Level

Logged by: ILE

Approved by: LJH

Figure No. A- 1

APPENDIX B

MW_GEOL S CRK SEQ CRK.GPJ November 23, 2004

CH2MHILL

GS elev= 212.1'

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2

Sheet: 1 of 3

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail

ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling

DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer

WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0'					Ground Surface	
		DM	12	2-5-5 (10)	SILTY SAND WITH ORGANICS (SM) Dark brown, moist, loose, fine grained sand, trace fine to medium round to subround gravel, est. 30-40% fines, 20% organics (TOPSOIL)	Two piezometers installed in separate monuments. EM-2(S) is the shallow piezometer, and EM-2(D) is the deep piezometer
		DM	6	5-6-6 (12)	SANDY SILTY GRAVEL (GM) Dark brown, moist to wet, medium dense, well graded round to subround gravel, est. 20% fines, 30-40% sand, trace organics (FILL)	3': Driller states in gravel and a little water
		DM	18	3-1-1 (2)	SILTY SAND WITH GRAVEL (SM) Light brown, moist, medium dense, fine to medium grained sand, fine to medium round to subround gravel, est. 15-20% gravel, 20% fines, trace organics (FILL)	
5		DM	18	6-16-18 (34)		5': Driller states drilling in gravel
					PEAT (PT) Dark brown, wet, very soft, fiberous	
					SANDY SILTY GRAVEL (GM) Gray, moist, medium dense, well graded round to subround gravel, fine to medium grained sand, est. 20% fines, 30% sand	8': Sampled, then loaded hole with water
		DM	12	18-21-15 (36)	SILTY SAND WITH GRAVEL (SM) Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 20-30% fines, 20-30% gravel, not compacted, soupy	
10						
		DM	12	18-22-18 (40)	GRAVELLY WELL GRADED SAND (SW) Gray, wet, medium dense, round to subround sand and gravel, fine to medium gravel, trace coarse gravel, est. <5% fines, 30-40% gravel	13': Driller states from 8-13' pretty sandy, not much gravel 14': Sampler wet
15						
		DM	10	44-50/6" (50/6")	GRAVELLY WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse grained sand, fine round to subround gravel, est. 30-35% gravel	18': Top of sample was heave
20						

PT

Qvl Gm/sm

Qvr

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		DM	12	24-26-30 (56)	GRAVELLY WELL GRADED SAND (GW) Gray, moist to wet, medium dense, fine to coarse grained sand, fine to coarse round to subround gravel, est. 30-40% gravel	20.5': Heave in sampler
		DM	12	34-50/6" (50/6")	SANDY WELL GRADED GRAVEL (GW) Gray, moist to wet, very dense, well graded sand, round to subround gravel, est. 30-35% sand	
25		DM	12	23-36-50/6" (86/12")	SANDY WELL GRADED GRAVEL (GW) -Similar to above, gray, moist to wet, dense to very dense, well graded sand, est. 30-40% sand, becomes siltier toward bottom of sample, est. up to 10% silt toward bottom of sample	25.5': Driller drained water out of samples before opening split spoon. Driller loads hole with water, difficult to determine if samples are wet from drilling water or groundwater. All heave in sample from 25.5'. Resampled.
		DM	12	32-40-50/6" (90/12")	GRAVELLY WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse grained sand, fine round to subround gravel, "clean"-little to no fines	
30		DM	12	36-44-50/6" (94/12")	GRAVELLY WELL GRADED SAND (SW) -Similar to above	
		DM	2	44-50/3" (50/3")	WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse round to subround sand	
35		DM	6	36-50/6" (50/6")	SANDY WELL GRADED GRAVEL (GW) Gray, moist to wet, very dense, well graded sand, round to subround gravel, est. 30-40% sand, est. 5% silt	
		DM	3	33-40-50/6" (90/12")	POORLY GRADED SAND WITH GRAVEL (SP). Gray, moist to wet, very dense, fine to medium grained sand, coarse round to subround gravel, est. 15-20% gravel	38': 3" of heave in sampler
40						

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
		DM	10	16-38-50/6" (88/12")	WELL GRAED SAND WITH GRAVEL (SW) Gray, moist to wet, very dense, fine round to subround gravel, "clean", grades to WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM) 42' Gray, moist to wet, very dense, fine round to subround gravel, est. 15% gravel, 10-15% silt
		DM	12	18-28-30 (58)	POORLY GRADED SAND (SP) Gray, moist to wet, fine to medium grained sand, trace fine to coarse round to subround gravel, est. 5% or less gravel
45					
		DM	12	29-36-42 (78)	POORLY GRADED SAND (SP) -Similar to above, some gravels have brown staining surrounding the gravel and within the fine grained sand, fine gravel
		DM	12	36-50/6" (50/6")	POORLY GRADED SAND WITH GRAVEL (SP) Gray, moist, very dense, fine to medium grained sand, fine to coarse round to subround gravel, gravel was packed in "tight", trace dark organics?, pockets/lenses of fine sand at 48'
50					
		DM	6	(100/6")	SILTY WELL GRADED SAND WITH GRAVEL (SM) Gray, moist to wet, very dense, some is compact where the sand is finer grained, est. 20-25% gravel
		SS	6	(100/8")	SILTY SAND WITH GRAVEL (SM) Gray, moist, very dense, fine grained sand, fine round to subround gravel, est. 20-25% gravel, compacted looking
55					BOTTOM OF BORING
60					

Qvr ↑ Qvt

COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

48': Driller states it felt more compacted

Bottom of boring at 51.7' at 1228 on 12-12-02

<u>Deep Piezometer Construction (EM-2(D))</u>
- +2.55-0' Steel riser, locking monument
- 0-2' Concrete
- 2-36' Quick grout
- 36-38' Bentonite chips
- 38-51.7' Lapis Lustre 2/12 silica sand
- 0-40' Blank pvc
- 40-50' 0.020 machine slot screen and cap

<u>Shallow Piezometer Construction (EM-2(S))</u>
Drilled and installed in a separate monument about 3 feet east of deep well
- 0-1' Concrete and riser
- 1-2' Bentonite chips
- 2-5' Lapis Lustre 2/12 silica sand
- 0-2.5' Blank pvc
- 2.5-5' 0.020 machine slot screen and cap

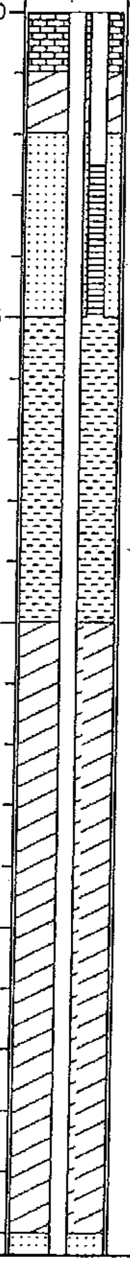
CH2MHILL

GS elev = 207.3

PROJECT NUMBER: 151973.A4.WL	BORING NUMBER: EM-1
	Sheet: 1 of 2

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 1544 **FINISH:** 12/11/02 1620 **LOGGER:** S. McGinnis



DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	Drilled down to 24 feet bgs before first sample. Two piezometers installed in one monument. EM-1(S) is the shallow piezometer, and EM-1(D) is the deep piezometer
						4': Driller states in gravel and a little water
5						
10						
						12': Sounded gravelley to 14' while drilling, rig stopped in gravel
						14': Loaded hole with water
15						14-16': Gravelly, smoother drilling below 16'
						17': Driller states cobbles about 4" in diameter, then smaller sized gravels below 17'
						17-24': Smooth drilling, loaded hole with water
20						

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1

Sheet: 2 of 2

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 1544 **FINISH:** 12/11/02 1620 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
25		DM	12	16-20-25 (45)	POORLY GRADED SAND WITH GRAVEL (SP) Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 15-20% gravel	
		DM	0	39-50/4" (50/4")	POORLY GRADED SAND WITH GRAVEL (SP) -similar to above but fine to medium gravel	Bottom of boring at 33.5' at 1620 on 12/11/02.
30		DM	12	34-35-35 (70)	No recovery -Slough	Measured groundwater at 6.10' (EM-1(S)) and 7.47' (EM-1 (D)) below top of steel on 12/11/02
		DM	6	50/6" (50/6")	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine to medium grained sand, fine to coarse gravel, gets siltier toward bottom of sample, grades to SILTY SAND WITH GRAVEL (SM) at 32' Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-20% silt, 20-25% gravel	Piezometer Construction (EM-1(S) and EM-1(D)) +3.65-0' Steel riser, locking monument 3.xx-2.5' Blank PVC (EM-1(S)) 3.xx-22' Blank PVC (EM-1(D)) 0-1' Concrete 1-2' Bentonite chips 2-5' Lapis Lustre 2/12 silica sand 2.5-5' 0.020 machine slot screen and cap (EM-1(S)) 5-10' Cuttings 10-20' Bentonite chips 20-33.5' Lapis Lustre 2/12 silica sand 22-32' 0.020 machine slot screen and cap (EM-1(D))
35					BOTTOM OF BORING	
40						Note: Both piezometers are in one steel, riser monument

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail

ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling

DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer

WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	
		DM	18	1/12"-1/6" (2)	ORGANICS Dark brown, moist, very soft	
		DM	18	5-7-12 (19)	PEAT (PT) Dark brown, moist, very soft, fiberous	
		DM	8	43-40-40 (80)	SANDY SILTY GRAVEL (SM) Light brown, wet, loose, fine to coarse grained sand, coarse round to subround gravel	3': Driller states in gravel and a little water
5		DM	8	35-37-39 (76)	PEAT (PT) Dark brown, moist, very soft, fiberous, trace gravel mixed in	4.5': Sampler very wet, large gravel/small cobble jammed in shoe
					SANDY SILTY GRAVEL (GM) -Similar to above, light brown, wet, dense, fine to coarse grained sand, coarse round to subround gravel	6': Drilled in gravel from 4.5-6'.
					SILTY SAND WITH GRAVEL (SM) Gray, wet, dense, fine to coarse grained sand, fine to coarse round to subround gravel, trace round cobbles (TILL-LIKE)	
10		DM	10	28-35-39 (74)	SILTY GRAVEL WITH SAND (SM) Gray, wet, dense, fine to coarse gravel, fine to coarse grained sand, est. 30% silt, 20% sand (TILL-LIKE) In shoe: SANDY SILT (ML) Gray, moist, hard, fine to medium grained sand, est. 20-30% sand	
15		DM	12	42-35-38 (73)	SANDY WELL GRADED GRAVEL WITH SILT (GW-GM) Gray, wet, medium dense, fine to coarse round to subround gravel, fine to coarse sand, est. 30% sand, 10-15% fines	14': Sampler wet 17': Driller states not as much rock, large gravel 19': Water poured out of sampler 19.5': Measured groundwater through augers at 1406 on 12/11/02. Augers may be acting as a barrier.
20		DM	4	21-25-27 (52)		

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland LOCATION: ~100' S. of Edmond Marsh Trail
ELEVATION: DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log START: 12/11/02 FINISH: 12/11/02 LOGGER: S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					GRAVELLY SAND (SW) Gray, wet, medium dense, fine to coarse grained sand, fine to coarse round to subround gravel, est. 30-40% gravel	
25		DM	10	42-33-30 (63)	POORLY GRADED SAND WITH GRAVEL (SP Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, trace fine cobbles, est. 15-20% gravel	
30		DM	12	24-35-38 (73)	WELL GRADED SAND WITH GRAVEL (SW) Gray, wet, medium dense, fine to coarse grained sand, fine to medium round to subround gravel, trace fines, increased fines toward bottom of sampler, est. 20-30% gravel	
35		DM	6	50/6" (50/6")	POORLY GRADED SAND WITH SILT AND GRAVEL TO SILTY SAND WITH GRAVEL (SP-SM/SM) Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-20% fines, 20-25% gravel (TILL??)	34': Driller states back into a few cobbles
40		DM	4	50/4" (50/4")		

Qvt
D of Boring

CH2MHILL

PROJECT NUMBER: 151973.A4.WL **BORING NUMBER:** EM-1A

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					<u>POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)</u> Gray, wet, very dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 10% fines, 10-15% gravel	
45		DM	4	50/5" (50/5")	<u>POORLY GRADED SAND (SP)</u> Gray, wet, very dense, fine to medium grained sand, trace fines	
50		DM	4	50/4" (50/4")	<u>GRAVELLY WELL GRADED SAND WITH SILT (SW-SM)</u> Gray, wet, very dense, fine to coarse round to subround gravel, est. 5-10% fines, 30-40% gravel	
55		DM	6	50/6" (50/6")	<u>POORLY GRADED SAND (SP)</u> Gray, wet, very dense, fine to medium grained sand	
60		DM	6	50/6" (50/6")		59': Driller states a little more gravel

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-15% fines, 5-10% gravel	
65		DM	5	50/5" (50/5")	WELL GRADED SAND WITH GRAVEL TO WELL GRADED SAND WITH SILT AND GRAVEL (SW/SW-SM) Gray, wet, very dense, fine to coarse grained sand, fine to medium round to subround gravel, est. 5-10% fines, 20-30% gravel	
70		DM	5	50/5" (50/5")	POORLY GRADED SAND (SP) Gray, wet, very dense, medium to coarse grained round to subround sand, fine to medium round to subround gravel, est. <5% fines, 5-10% gravel	
75		DM	6	50/6" (50/6")	WELL GRADED SAND WITH GRAVEL TO WELL GRADED SAND WITH SILT AND GRAVEL (SW/SW-SM) Gray, wet, very dense, fine to coarse grained sand, fine round to subround gravel, est. 5-10% fines, 10-15% gravel	
80		DM	5	50/5" (50/5")		

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland LOCATION: ~100' S. of Edmond Marsh Trail
ELEVATION: DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log START: 12/11/02 FINISH: 12/11/02 LOGGER: S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine grained sand, fine to medium round to subround gravel, est. 10-15% fines, 20-30% gravel	83': Driller states into silts
85 (Qtb)		DM	4	50/4" (50/4")	SILT (ML) Gray, moist to wet, hard	
90		DM	4	50/4" (50/4")	SILT (ML) -Similar to above, gray, moist to wet, hard, fine to medium sand seams BOTTOM OF BORING	Bottom of boring at 89.3' at 1300 on 12/11/02. Driller states not much heave while drilling Backfilled boring with grout. Could not install piezometer in this boring. Had to move 3' north and redrill to the bottom of the piezometer installation.
95						
100						

RESOURCE PROTECTION WELL REPORT

Close Demolition Waste Area - Ft. Lewis

START CARD NO. 17224

PROJECT NAME: Fort Lewis Public Works

WELL IDENTIFICATION NO. D-3

DRILLING METHOD: reverse circ. w/air

DRILLER: Charles E. Shorey, Jr.

FIRM: Layne Christensen Company

SIGNATURE:

CONSULTING FIRM: IMCO General Construction

REPRESENTATIVE: Roger Dudley

COUNTY: Pierce

LOCATION: ___ ¼ ___ ¼ SEC 26 TWN 19N R 1E

STREET ADDRESS OF WELL: Fort Lewis, WA 98433-9500

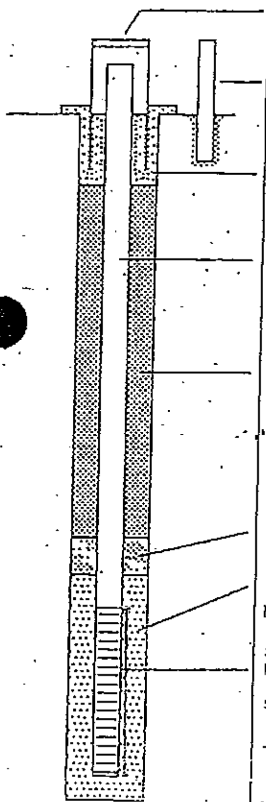
WATER LEVEL ELEVATION: 11' BGS

GROUND SURFACE ELEVATION: 216

DATE INSTALLED: 8-5-96

DATE DEVELOPED: 8-12-96, 8-14-96

AS-BUILT



OF BORING 24 FT.

WELL DATA

STEEL SURFACE MONUMENT W/LOCK 3 FT. ABOVE G.L.

PROTECTIVE POSTS no

CONCRETE SURFACE SEAL 2' TO +4" FT.

WELL CASING 14 TO +3 FT.

SCHEDULE 80 TFJ PVC 2"

ANNULAR SEALANT 8 TO 2 FT.
Material: Cement

SEAL 10 TO 8 FT.
Silica sand 12'-10'

FILTER PACK 24 TO 12 FT.
Material: 10-20 sand

SCREEN INTERVAL 24 TO 14 FT.

SCHEDULE 80 TFJ PVC 2"

.02 FACTORY SLOTTED

HOLE DIAMETER

9 IN. 24 TO 0 FT.

___ IN ___ TO ___ FT.

FORMATION DESCRIPTION

0'-5' Coarse sand with medium gravel, brown in color

5'-10' Coarse to medium sand, with large and medium cobbles

10'-15' Fine silty sand, wet, light brown

11' Static water level

15'-20' Fine, dense sand with silt and uniform cobbles

20'-24' Fine silty sand, dense with uniform cobbles

WELL DEVELOPMENT DATA

8-12-96 Bailed 15 gallons from well to remove sediments
Temperature: 60 degrees F
pH: 6.0 Very silty, brown

8-14-96 Pumped 150 gallons from well to stabilize.
Temperature: 60 degrees F
pH; 6.0 Clear, no sediment

WELL COMPLETION REPORT

Project CELL 5, LFS, FT. LEWIS
Completion date 2/25/93
Contractor ANDREW WELL DRILLING SERVICE
Rig INGERSOLL RAND T-4W
Operator BOB DEWILD/MATT GILBERT
Inspector RICHARD SMITH
Depth 35.0 Datum GROUND SURFACE

HOLE DATA
Size: 6" in. to 35' ft.
in. to ft.
in. to ft.

CASING
Type 6" DIAMETER, 6' LONG STEEL SURFACE CASING
Mfr.
Ht. above gnd. surf. 3.0'
Drive shoe NO
Size: 6" in. to 3' AGS ft.
6" in. to 3' BGS ft.
in. to ft.

SCREEN - 20'-30' (10') THREADED
Type PVC SCH 80 MONOFLEX 20 SLOT
Mfr. CAMPBELL
Composition PVC Dia. 2" ID

Fittings:	Length	Dia.
Riser	22.8'	2" ID
Tailpipe	0.2'	2" ID

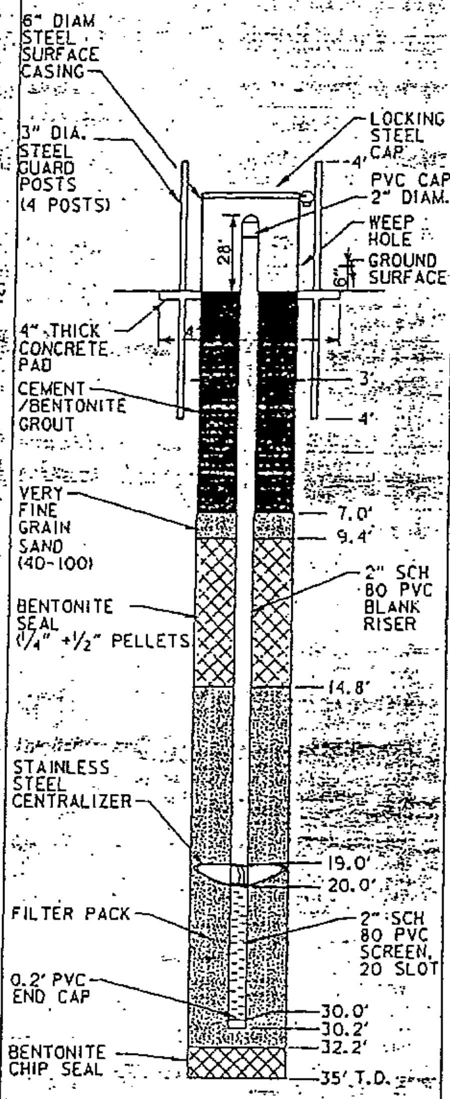
Centralizer- S.S., mounted on outside of PVC Riser 19'-20' BGS

FILTER
Source CSSI - ENVIRONMENTAL MEDIA
Composition SILICA SAND
Gradation 10-20
Inst. method POUR FROM SURFACE
Volume used 4 SACS (100 LB SAC)
Depth 14.8' to 32.2' ft.

GROUT
Composition CEMENT/BENT 5%/H20
Volume used 2-94 LBS BAGS CEMENT (12GAL)
Inst. method POUR DOWNHOLE W/BUCKET
Depth 0' to 7' ft.
to ft.

REMARKS: BOTTOM PLUG BENT. CHIPS 1/2, 50 LB BAG UPPER PLUG: BENT. PELLETS (3/8"), 2 - 50 LB BUCKETS. VERY FINE SAND: 1/2 - 50 LB BAG. FILLED CASING W/POTABLE WATER TO GROUND SURFACE PRIOR TO INSTALLATION TO PREVENT HEAVING AND AID IN PLACING BENT. PLUG.
GROUT RATIO: -1 SAC CEMENT (94 LBS)
6 GAL H20 - 5% BENT. BY WT

WELL DETAIL (AS BUILT)
93-MFS-C5-3



NOT TO SCALE

DATE AND TIME PLOTTED: 06-MAY-1993

DESIGN FILE: /cenps/projects/mic/ft/geotech/ftgeoc53.dgn

DRILLING LOG	DIVISION NPD	INSTALLATION FORT LEWIS	SHEET 1 OF 1 SHEETS

1. PROJECT RCRA WELLS, CS, LFS	10. SIZE AND TYPE OF BIT 6" ODEX/6" ID TEMP CASING
2. LOCATION (COORDINATES OR STATION) N 659,446.7 E 1,488,392.9	11. DATUM FOR ELEVATION SHOWN (TBM OR MSL) MSL
3. DRILLING AGENCY ANDREW WELL DRILLING SERVICE	12. MANUFACTURER'S DESIGNATION OF DRILL INGERSOLL RAND T-4W
4. HOLE NO. (AS SHOWN ON DRAWING TITLE AND FILE NUMBER) 93-MFS-CS-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7; UNDISTURBED -0-
5. NAME OF DRILLER BOB DEWILD, MATT GILBERT	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER 195.5
	16. DATE HOLE: STARTED 93OCT24; COMPLETED 93OCT24
7. THICKNESS OF OVERBURDEN +35'	17. ELEVATION TOP OF HOLE 216.9
8. DEPTH DRILLED INTO ROCK -0-	18. TOTAL CORE RECOVERY FOR BORING
9. TOTAL DEPTH OF HOLE 35'	19. NAME AND SIGNATURE OF INSPECTOR BILL GOSS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (DESCRIPTION) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (DRILLING TIME, WATER LOSS, DEPTH OF WEATHERING, ETC., IF SIGNIFICANT) g
	0		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, DRY, BROWN			DRILLED W/6: ODEX, 6" DRILLING CONCURRENT W/CASING, BIT LEADS CASING BY 6"
					A	SAMPLES TAKEN FROM DISCHARGE AT 5' INTERVALS
	10				B	AIR MONITORING WITH CGI AND PID - NO DETECT
					C	
	20		SWL 21.4'		D	
195.5			GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, WET, BROWN		E	
	30				F	
	35		T.D. 35'		G	

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71
SEP 90 MODIFIED FOR CADD BY CENPS

PROJECT RCRA WELLS, CS, LFS | HOLE NO. 93-MFS-CS-3

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 218.9 | Hole No. 93-MFS-CS-3

PROJECT RCRA WELLS, CS, LFS | INSTALLATION FT LEWIS | SHEET 2 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (DRILLING TIME, WATER LOSS, DEPTH OF WEATHERING, ETC., IF SIGNIFICANT)
	10		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND FINE -COARSE, ROUNDED GRAVEL TO 1", DRY, BROWN		(B)	SAMPLE B @ 10'
	11					AIR MONITORING 10-15' PID (-0.8) PPM CGI 20.8%, 0,0,0
	12					
	13					
	14					
	15		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND FINE -COARSE, ROUNDED GRAVEL TO 1½", DRY, TO SLT. MOIST, BROWN		(C)	SAMPLE C @ 15'
	16					AIR MONITORING 15'-17' PID (-0.8)PPM CGI 20.8,0,0,0 -1 9:25 -10:15 @ 17' WELD CASING AIR MONITORING 17'-20' PID (-0.4)PPM CGI 21.0,1,0,0
	17					
	18					
	19					
	20					

ENG FORM 1836-A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71
SEP 90 MODIFIED FOR CADD BY CENPS

PROJECT RCRA WELLS, CS, LFS | HOLE NO. 93-MFS-CS-3

DRILLING LOG	DIVISION NPD	INSTALLATION FORT LEWIS	SHEET 1 OF 4 SHEETS

1. PROJECT: RCRA WELLS, C5, LFS	10. SIZE AND TYPE OF BIT: 6" ODEX/6" ID TEMP. CASING
2. LOCATION (COORDINATES OR STATION): N 659,446.7 E 1,468,392.9	11. DATUM FOR ELEVATION SHOWN: MSL
3. DRILLING AGENCY: ANDREW WELL DRILLING SERVICE	12. MANUFACTURER'S DESIGNATION OF DRILL: INGERSOLL RAND T-4W
4. HOLE NO. (AS SHOWN ON DRAWING TITLE AND FILE NUMBER): 93-LFS-C5-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7; UNDISTURBED -0-
5. NAME OF DRILLER: BOB DEWILD, MATT GILBERT	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 195.5
	16. DATE HOLE: STARTED 93OCT24; COMPLETED 93OCT24
7. THICKNESS OF OVERBURDEN: 35'	17. ELEVATION TOP OF HOLE: 216.9
8. DEPTH DRILLED INTO ROCK: -0-	18. TOTAL CORE RECOVERY FOR BORING
9. TOTAL DEPTH OF HOLE: 35'	19. NAME AND SIGNATURE OF INSPECTOR: BILL GOSS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (DESCRIPTION) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (DRILLING TIME, WATER LOSS, DEPTH OF WEATHERING, ETC., IF SIGNIFICANT) g
	0		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED. SAND FINE -COARSE ROUNDED GRAVEL TO 3", DRY, BROWN, OCCASIONAL COBBLE TO 6"			DRILLED W/6" ODEX, 6" CASING CONCURRENT W/DRILLING, BIT LEADS CASING BY 6" SAMPLES TAKEN FROM DISCHARGE LINE AT 5' INTERVALS AIR MONITORING W/PID & CGI
	1					
	2					AIR MONITORING 0-5' PID 1-0.4PPM CGI 20.9,0,0,0
	3					
	4					
	5		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED. SAND FINE - COARSE, ROUNDED GRAVEL TO 1", SLT. MOIST, BROWN		(A)	SAMPLE (A) @ 5'
	6					
	7					
	8					
	9					
	10					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71 SEP 90 MODIFIED FOR CADD BY CENPS

PROJECT: RCRA WELLS, C5, LFS — HOLE NO. 93-LFS-C5-3

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 216.9 | Hole No. 93-MFS-C5-3

PROJECT RCRA WELLS, C5, LF5 | INSTALLATION FT LEWIS | SHEET 3 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (DRILLING TIME, WATER LOSS, DEPTH OF WEATHERING, ETC., IF SIGNIFICANT)
	20		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND FINE -COARSE, ROUNDED GRAVEL TO 1½", DRY, BROWN		(D)	SAMPLE D @ 20'
	21		@ 21' SAMPLE MOIST			AIR MONITORING 20'-25' PID (-0.4)PPM CGI 21, 1,0,0
195.5			SWL 21.4			
	22					
	23					
	24					
	25		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND FINE -COARSE, ROUNDED GRAVEL TO 1½", MOIST, BROWN		(E)	SAMPLE E @ 25' @ 25' ADD POTABLE WATER WHILE DRILLING APPROX. 2GPM. FOOTEM LOSE FROZEN HOSE THAW HOSE + ADD WATER
	26					
	27					AIR MONITORING 25'-30' PID (-1.0) PPM CGI 21,0,0,0.1
	28		GP: AS ABOVE W/SAND PREDOMINANTLY FINE GRAIN			
	29					
	30					

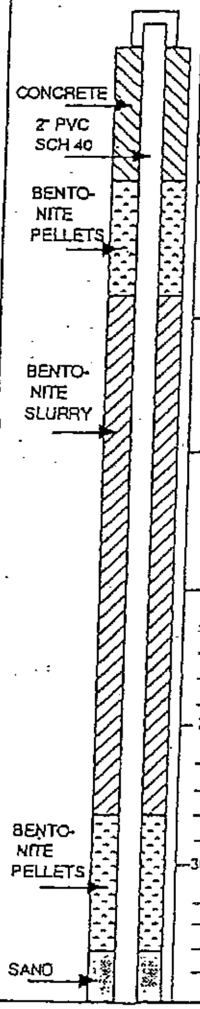
DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE 218.9		Hole No. 93-MFS-CS-3
PROJECT RCRA WELLS, CS, LFS	INSTALLATION FT LEWIS		SHEET 4 OF 4 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (DRILLING TIME, WATER LOSS, DEPTH OF WEATHERING, ETC., IF SIGNIFICANT)
	30		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND PREDOMINANTLY FINE GRAIN, ROUNDED GRAVEL TO 3 ", SATURATED, BROWN		(F)	SAMPLE F @ 30' ADDING WATER APPROX. 25 GPM
	31					
	32					AIR MONITORING 30'-35' PID (-1.2) PPM CGI 21.1, 0,0,0
	33					
	34		GP: POORLY GRADED SANDY GRAVEL; UNCONSOLIDATED, SAND PREDOMINANTLY FINE GRAIN, ROUNDED GRAVEL TO 3 ", SATURATED, BROWN		(G)	ADDING WATER APPROX. 25 GPM SAMPLE G @ 35'
	35		T.D. 35'			

ENG FORM 1836-A PREVIOUS EDITIONS ARE OBSOLETE. MAR 71
SEP 90 MODIFIED FOR CADD BY CENPS

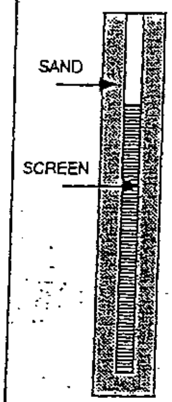
PROJECT RCRA WELLS, CS, LFS | HOLE NO. 93-MFS-CS-3

DRILLING LOG	PROJECT FT. LEWIS	PROJECT NUMBER 8820072A	SHEET 1 OF 2 SHEETS
LOCATION	LANDFILL #5	TOTAL NUMBER SAMPLES 0 (Sample Collected in Adjacent Hole)	
DRILLING AGENCY	HOLT	DEPTH TO WATER BELOW GRD SURFACE 22.06 FT	
HOLE NO.	88-2-VD	DATE HOLE STARTED 11/16/88	COMPLETED 11/17/88
NAME OF DRILLER	RANDY HOLT	ELEVATION AT REFERENCE POINT 220.03 FT	
TOTAL DEPTH OF HOLE	49.0 FT	SIGNATURE OF INSPECTOR	Warren Parkins William Deutsch



DPT (FT)	S T	B/FT	SAMP. NO.	% REC.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS	Gals water added
					Gravel with Sand		5, 5
5					Yellow-gray, angular fragments	Bailed Material	5, 5, 5, 5, 5
10					Yellow-gray, coarse sand with angular fragments, few 1-2" pebbles	Bailed Material	5
					Yellow-gray gravel with coarse sand fragments of some large cobbles to 5"	Bailed Material 11'10"	5
					Yellow-gray gravel with some pebbles, not as many angular fragments	Bailed Material	5
15					Yellow-gray pebbly gravel	Bailed Material	5
					Same as above, except more large angular fragments	Bailed Material	5
					As above, drilling harder at @ 18 ft similar to 88-1-SS	Bailed Material	
						Vashon Recessional Gravel	5
20					Sandy gravel, yellow-gray, few 3-4" rock fragments; no pebbles	Bailed Material	5
					Sandy gravel, some silt, still hard drilling	Bailed Material	5
					As above		5
25					Yellow-gray, sandy gravel, some silt; easier drilling	Water at 25' Bailed Material	5
					as above; drilling fairly hard	Bailed Material	2
					Yellow-gray, sandy gravel, angular fragments with some broken cobbles	Water bubbling into hole; drilling easier, able to drive casing ahead	
30						Vashon Till	7
					Yellow-gray angular fragments		
					as above	Bailed sample; bailer full of water	7
					Sand/gravel, some silt	Hole making some water, not a lot	10
					as above	Hole making a little water	5

DRILLING LOG (Cont. Sheet)	HOLE NO. 88-2-VD	
DIVISION	INSTALLATION FT. LEWIS	SHEET 2 OF 2 SHEETS



DPT (FT)	S T	B/FT	SAMP NO.	% REC.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
						Water coming into
40					Well rounded coarse sand and gravel Some silt and crushed cobbles	hole in good quantity Vashon Advance Gravel Bailed sample
45					Slow drilling, large cobbles; cuttings all pulverized	Water at 28' below ground
					Heaving sand bottom 1 foot	
50					TOTAL DEPTH = 49 FT	

APPENDIX B

Field Data Sheets

DuPont Sampling and Analysis Plan

CalPortland -- Dupont, WA

Project Site/Location:

Routine Station Maintenance			
Personnel:	Weather:		Arrival Date/Time:
Station Battery Voltage:		Battery Changed? (Y/N -- New Voltage)	
Data Logger Desiccant OK? (Y/N)		Sensor(s) Cleaned & Secure? (Y/N)	
Flow Meter Desiccant OK? (Y/N)		Staff Plate Cleaned & Secure? (Y/N)	
Data Downloaded? (Y/N)		Rain Gage Cleaned & Secure? (Y/N)	
Water Level & Flow		**Water Quality Measurements & Observations (*In-Situ*)**	
Flow Meter Battery Voltage:		Data Logger Recorded Temp (°C) :	
Battery Changed? (Y/N -- New Voltage)		YSI Measured Temp (°C) :	
Date/time correct? (Y/N)		DO (mg/l) :	
Data Logger(s) Desiccant OK? (Y/N)		DO (% saturation) :	
Flow Meter Data Downloaded? (Y/N)		Salinity (ppt) :	
Staff Plate/Well Level (decimal-feet):		pH :	
Data Logger/Meter Recorded Level:		Turbidity (NTU) :	
Velocity (feet per second):		Water Color? (e.g., yellow, brown, grey)	
Flow Rate (CFS):		Floating Oil/Grease? (Y/N)	
Level Calibrated? (Y/N)		Floating Debris/Scum? (Y/N)	
Level Offset (Post-Calibration)		Potentially Harmful Materials? (Y/N)	
Level Offset (Post-Calibration)			

Notes, observations, and maintenance items for future visits. Include observations regarding channel/site conditions, such as: presence/absence of beaver dams; downed trees; streambed composition (e.g., embedded with sediment); vegetation; and particularly fast or slow flow velocities.

DuPont Sampling and Analysis Plan

CalPortland -- Dupont, WA

YSI Professional Handheld Multimeter Calibration Record

CONDUCTIVITY and PH CALIBRATION*

1. Press the Cal key.
2. Highlight the parameter you wish to calibrate and press enter. For Conductivity, a second menu will offer the option of calibrating Specific Conductance, Conductivity, or Salinity. Calibrating one automatically calibrates the other two. An additional sub-menu will require you to select the calibration units. For pH, auto-buffer recognition will determine which buffer the sensor is in and it will allow you to calibrate up to 6 points.
3. Place the correct amount of calibration standard into a clean, dry or pre-rinsed container.
4. Immerse the probe into the solution, making sure the sensor and thermistor are adequately immersed. Allow at least one minute for temperature to stabilize.
5. For any of parameters, enter the calibration solution value by highlighting Calibration Value, pressing enter, and then using the alpha/numeric keypad to enter the known value. Once you have entered the value of the calibration standard, highlight <<<ENTER>>> and press enter.
6. Wait for the readings to stabilize, highlight Accept Calibration and press enter to calibrate.
7. For pH, continue with the next point by placing the probe in a second buffer and following the on-screen instructions or press Cal to complete the calibration.

DO CALIBRATION*

The Pro Plus offers four options for calibrating dissolved oxygen. The first is an air calibration method in % saturation. The second and third calibrates in mg/L or ppm to a solution with a known DO concentration (usually determined by a Winkler Titration). Calibration of any option (% or mg/L and ppm) will automatically calibrate the other. The fourth option is a zero calibration. If performing a zero calibration, you must perform a % or mg/L calibration following the zero calibration. For both ease of use and accuracy, YSI recommends performing the following 1-point DO % calibration:

1. Moisten the sponge in the cal/transport sleeve with a small amount of water and install it on the probe. The cal/transport sleeve ensures venting to the atmosphere. Disengage a thread or two to ensure atmospheric venting. Make sure the DO and temperature sensors are not immersed in the water.
2. Turn the instrument on.
3. Press the Cal key, highlight DO and press enter.
4. Highlight DO%, then press Enter.
5. Verify the barometric pressure and salinity displayed are accurate. Once DO and temperature are stable, highlight Accept Calibration and press enter.

*Additional calibration information can be found at: http://www.ysi.com/media/pdfs/605595-YSI-Pro-Plus-Quick-Start-Guide-RevB.pdf

Date:	
Time:	
Staff:	

pH		
7	Initial	
	Calibration	
	Final	
4	Initial	
	Calibration	
	Final	
10	Initial	
	Calibration	
	Final	

Conductivity (Includes Salinity)		
Initial (µS/cm)	Calibration (µS/cm)	Final (µS/cm)

Dissolved Oxygen (1-Point DO Saturation Method)		
Initial (%)	Calibration (%)	Final (%)

APPENDIX C

Hydrologic Calculations

Western Washington Hydrology Model 2012

WWHM2012
PROJECT REPORT

Project Name: Basins C D
Site Name: Pioneer Aggregates
Site Address: Pioneer Avenue
City : DuPont
Report Date: 11/25/2020
Gage : 38 IN CENTRAL
Data Start : 10/01/1901
Data End : 09/30/2059
(adjusted) **Precip Scale:** 0.00
Version Date: 2019/09/13
Version : 4.2.17

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

Low Flow Threshold for POC 2 : 50 Percent of the 2 Year

High Flow Threshold for POC 2: 50 year

PREDEVELOPED LAND USE

Name : Watershed C
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	19.2
A B, Lawn, Steep	14.4
C, Lawn, Flat	57.5
C, Lawn, Mod	49.3
C, Lawn, Steep	20.7

Pervious Total 161.1

Impervious Land Use	acre
DRIVEWAYS MOD	1

Impervious Total 1

Basin Total 162.1

Element Flows To:
Surface **Interflow** **Groundwater**

Name : Watershed D
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	4
A B, Lawn, Mod	41.5
C, Lawn, Flat	140
C, Lawn, Mod	15.9
C, Lawn, Steep	26.3

Pervious Total 227.7

Impervious Land Use	acre

Impervious Total 0

Basin Total 227.7

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin C
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	19.2
A B, Lawn, Steep	14.4
C, Lawn, Flat	57.5
C, Lawn, Mod	49.3
C, Lawn, Steep	20.7

Pervious Total 161.1

Impervious Land Use	acre
DRIVEWAYS MOD	1

Impervious Total 1

Basin Total 162.1

Element Flows To:

Surface	**Interflow**	**Groundwater**
Infilt Pond C	Infilt Pond C	

Name : Basin D
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
A B, Lawn, Flat	**4**
A B, Lawn, Mod	**41.5**
C, Lawn, Flat	**140**
C, Lawn, Mod	**15.9**
C, Lawn, Steep	**26.3**

Pervious Total **227.7**

Impervious Land Use	**acre**

Impervious Total **0**

Basin Total **227.7**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Infilt Pond D	Infilt Pond D	

Name : Infilt Pond C
Bottom Length: 450.00 ft.
Bottom Width: 113.00 ft.
Depth: 6 ft.
Volume at riser head: 6.8406 acre-feet.
Infiltration On
Infiltration rate: 8.1
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 22322.842
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 22322.842
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure

Riser Height: 5 ft.
Riser Diameter: 24 in.

Element Flows To:
Outlet 1 **Outlet 2**

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	1.167	0.000	0.000	0.000
0.0667	1.172	0.078	0.000	9.576
0.1333	1.177	0.156	0.000	9.618
0.2000	1.182	0.235	0.000	9.661
0.2667	1.188	0.314	0.000	9.703
0.3333	1.193	0.393	0.000	9.746
0.4000	1.198	0.473	0.000	9.788
0.4667	1.203	0.553	0.000	9.831
0.5333	1.208	0.633	0.000	9.874
0.6000	1.214	0.714	0.000	9.916
0.6667	1.219	0.795	0.000	9.959
0.7333	1.224	0.877	0.000	10.00
0.8000	1.229	0.958	0.000	10.04
0.8667	1.235	1.041	0.000	10.08
0.9333	1.240	1.123	0.000	10.13
1.0000	1.245	1.206	0.000	10.17
1.0667	1.251	1.289	0.000	10.21
1.1333	1.256	1.373	0.000	10.26
1.2000	1.261	1.457	0.000	10.30
1.2667	1.266	1.541	0.000	10.34
1.3333	1.272	1.626	0.000	10.39
1.4000	1.277	1.711	0.000	10.43
1.4667	1.282	1.796	0.000	10.47
1.5333	1.288	1.882	0.000	10.52
1.6000	1.293	1.968	0.000	10.56
1.6667	1.298	2.054	0.000	10.60
1.7333	1.304	2.141	0.000	10.65
1.8000	1.309	2.228	0.000	10.69
1.8667	1.315	2.316	0.000	10.74
1.9333	1.320	2.403	0.000	10.78
2.0000	1.325	2.492	0.000	10.82
2.0667	1.331	2.580	0.000	10.87
2.1333	1.336	2.669	0.000	10.91
2.2000	1.342	2.758	0.000	10.96
2.2667	1.347	2.848	0.000	11.00
2.3333	1.352	2.938	0.000	11.04
2.4000	1.358	3.028	0.000	11.09
2.4667	1.363	3.119	0.000	11.13
2.5333	1.369	3.210	0.000	11.18
2.6000	1.374	3.302	0.000	11.22
2.6667	1.380	3.393	0.000	11.27
2.7333	1.385	3.486	0.000	11.31
2.8000	1.391	3.578	0.000	11.36
2.8667	1.396	3.671	0.000	11.40
2.9333	1.401	3.764	0.000	11.45

3.0000	1.407	3.858	0.000	11.49
3.0667	1.412	3.952	0.000	11.54
3.1333	1.418	4.046	0.000	11.58
3.2000	1.424	4.141	0.000	11.63
3.2667	1.429	4.236	0.000	11.67
3.3333	1.435	4.332	0.000	11.72
3.4000	1.440	4.428	0.000	11.76
3.4667	1.446	4.524	0.000	11.81
3.5333	1.451	4.620	0.000	11.85
3.6000	1.457	4.717	0.000	11.90
3.6667	1.462	4.815	0.000	11.94
3.7333	1.468	4.912	0.000	11.99
3.8000	1.474	5.011	0.000	12.03
3.8667	1.479	5.109	0.000	12.08
3.9333	1.485	5.208	0.000	12.13
4.0000	1.490	5.307	0.000	12.17
4.0667	1.496	5.407	0.000	12.22
4.1333	1.502	5.507	0.000	12.26
4.2000	1.507	5.607	0.000	12.31
4.2667	1.513	5.708	0.000	12.36
4.3333	1.518	5.809	0.000	12.40
4.4000	1.524	5.910	0.000	12.45
4.4667	1.530	6.012	0.000	12.49
4.5333	1.535	6.114	0.000	12.54
4.6000	1.541	6.217	0.000	12.59
4.6667	1.547	6.320	0.000	12.63
4.7333	1.552	6.423	0.000	12.68
4.8000	1.558	6.527	0.000	12.73
4.8667	1.564	6.631	0.000	12.77
4.9333	1.570	6.735	0.000	12.82
5.0000	1.575	6.840	0.000	12.87
5.0667	1.581	6.945	0.365	12.91
5.1333	1.587	7.051	1.030	12.96
5.2000	1.593	7.157	1.886	13.01
5.2667	1.598	7.263	2.883	13.05
5.3333	1.604	7.370	3.979	13.10
5.4000	1.610	7.477	5.134	13.15
5.4667	1.616	7.585	6.307	13.19
5.5333	1.621	7.693	7.456	13.24
5.6000	1.627	7.801	8.540	13.29
5.6667	1.633	7.910	9.523	13.34
5.7333	1.639	8.019	10.37	13.38
5.8000	1.644	8.128	11.08	13.43
5.8667	1.650	8.238	11.65	13.48
5.9333	1.656	8.348	12.09	13.53
6.0000	1.662	8.459	12.46	13.57
6.0667	1.668	8.570	13.01	13.62

Name : Infilt Pond D
Bottom Length: 1000.00 ft.
Bottom Width: 37.70 ft.
Depth: 6 ft.
Volume at riser head: 6.1485 acre-feet.
Infiltration On
Infiltration rate: 8.2
Infiltration safety factor: 1

Wetted surface area On
Total Volume Infiltrated (ac-ft.): 31272.175
Total Volume Through Riser (ac-ft.): 1.011
Total Volume Through Facility (ac-ft.): 31273.186
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 5 ft.
Riser Diameter: 24 in.

Element Flows To:
Outlet 1 **Outlet 2**

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.865	0.000	0.000	0.000
0.0667	0.875	0.058	0.000	7.234
0.1333	0.884	0.116	0.000	7.313
0.2000	0.894	0.176	0.000	7.392
0.2667	0.903	0.235	0.000	7.471
0.3333	0.913	0.296	0.000	7.550
0.4000	0.922	0.357	0.000	7.629
0.4667	0.932	0.419	0.000	7.709
0.5333	0.941	0.482	0.000	7.788
0.6000	0.951	0.545	0.000	7.867
0.6667	0.961	0.608	0.000	7.946
0.7333	0.970	0.673	0.000	8.026
0.8000	0.980	0.738	0.000	8.105
0.8667	0.990	0.803	0.000	8.185
0.9333	0.999	0.870	0.000	8.265
1.0000	1.009	0.937	0.000	8.344
1.0667	1.018	1.004	0.000	8.424
1.1333	1.028	1.073	0.000	8.504
1.2000	1.038	1.142	0.000	8.584
1.2667	1.047	1.211	0.000	8.664
1.3333	1.057	1.281	0.000	8.743
1.4000	1.067	1.352	0.000	8.824
1.4667	1.076	1.424	0.000	8.904
1.5333	1.086	1.496	0.000	8.984
1.6000	1.096	1.568	0.000	9.064
1.6667	1.106	1.642	0.000	9.144
1.7333	1.115	1.716	0.000	9.225
1.8000	1.125	1.791	0.000	9.305
1.8667	1.135	1.866	0.000	9.385
1.9333	1.144	1.942	0.000	9.466
2.0000	1.154	2.019	0.000	9.547
2.0667	1.164	2.096	0.000	9.627
2.1333	1.174	2.174	0.000	9.708

2.2000	1.183	2.252	0.000	9.789
2.2667	1.193	2.332	0.000	9.869
2.3333	1.203	2.412	0.000	9.950
2.4000	1.213	2.492	0.000	10.03
2.4667	1.223	2.573	0.000	10.11
2.5333	1.232	2.655	0.000	10.19
2.6000	1.242	2.738	0.000	10.27
2.6667	1.252	2.821	0.000	10.35
2.7333	1.262	2.905	0.000	10.43
2.8000	1.272	2.989	0.000	10.51
2.8667	1.282	3.074	0.000	10.60
2.9333	1.291	3.160	0.000	10.68
3.0000	1.301	3.247	0.000	10.76
3.0667	1.311	3.334	0.000	10.84
3.1333	1.321	3.421	0.000	10.92
3.2000	1.331	3.510	0.000	11.00
3.2667	1.341	3.599	0.000	11.09
3.3333	1.351	3.689	0.000	11.17
3.4000	1.361	3.779	0.000	11.25
3.4667	1.370	3.870	0.000	11.33
3.5333	1.380	3.962	0.000	11.41
3.6000	1.390	4.054	0.000	11.49
3.6667	1.400	4.147	0.000	11.58
3.7333	1.410	4.241	0.000	11.66
3.8000	1.420	4.335	0.000	11.74
3.8667	1.430	4.430	0.000	11.82
3.9333	1.440	4.526	0.000	11.91
4.0000	1.450	4.623	0.000	11.99
4.0667	1.460	4.720	0.000	12.07
4.1333	1.470	4.817	0.000	12.15
4.2000	1.480	4.916	0.000	12.24
4.2667	1.490	5.015	0.000	12.32
4.3333	1.500	5.114	0.000	12.40
4.4000	1.510	5.215	0.000	12.48
4.4667	1.520	5.316	0.000	12.57
4.5333	1.530	5.417	0.000	12.65
4.6000	1.540	5.520	0.000	12.73
4.6667	1.550	5.623	0.000	12.82
4.7333	1.560	5.727	0.000	12.90
4.8000	1.570	5.831	0.000	12.98
4.8667	1.580	5.936	0.000	13.06
4.9333	1.590	6.042	0.000	13.15
5.0000	1.600	6.148	0.000	13.23
5.0667	1.610	6.255	0.365	13.31
5.1333	1.621	6.363	1.030	13.40
5.2000	1.631	6.471	1.886	13.48
5.2667	1.641	6.580	2.883	13.57
5.3333	1.651	6.690	3.979	13.65
5.4000	1.661	6.800	5.134	13.73
5.4667	1.671	6.912	6.307	13.82
5.5333	1.681	7.023	7.456	13.90
5.6000	1.691	7.136	8.540	13.98
5.6667	1.702	7.249	9.523	14.07
5.7333	1.712	7.363	10.37	14.15
5.8000	1.722	7.477	11.08	14.24
5.8667	1.732	7.592	11.65	14.32
5.9333	1.742	7.708	12.09	14.40

6.0000	1.752	7.825	12.46	14.49
6.0667	1.763	7.942	13.01	14.57

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:161.1
Total Impervious Area:1

Mitigated Landuse Totals for POC #1
Total Pervious Area:161.1
Total Impervious Area:1

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	7.15659
5 year	14.082833
10 year	20.66757
25 year	31.840733
50 year	42.64107
100 year	55.940025

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	4.799	0.000
1903	3.466	0.000
1904	25.520	0.000
1905	4.233	0.000
1906	1.571	0.000
1907	12.609	0.000
1908	5.300	0.000
1909	6.989	0.000
1910	14.200	0.000
1911	9.354	0.000
1912	55.963	0.000
1913	6.386	0.000
1914	39.323	0.000

1915	3.687	0.000
1916	8.055	0.000
1917	2.298	0.000
1918	4.539	0.000
1919	4.129	0.000
1920	9.261	0.000
1921	6.609	0.000
1922	17.117	0.000
1923	7.087	0.000
1924	3.338	0.000
1925	3.459	0.000
1926	6.149	0.000
1927	3.354	0.000
1928	4.887	0.000
1929	12.189	0.000
1930	4.365	0.000
1931	4.843	0.000
1932	5.332	0.000
1933	6.063	0.000
1934	20.863	0.000
1935	4.242	0.000
1936	6.076	0.000
1937	15.127	0.000
1938	5.018	0.000
1939	1.735	0.000
1940	6.513	0.000
1941	2.472	0.000
1942	13.789	0.000
1943	6.739	0.000
1944	19.359	0.000
1945	5.697	0.000
1946	10.648	0.000
1947	2.796	0.000
1948	10.617	0.000
1949	10.733	0.000
1950	3.312	0.000
1951	3.177	0.000
1952	36.522	0.000
1953	28.551	0.000
1954	5.398	0.000
1955	3.533	0.000
1956	2.073	0.000
1957	5.164	0.000
1958	19.341	0.000
1959	16.116	0.000
1960	3.516	0.000
1961	22.333	0.000
1962	5.470	0.000
1963	3.069	0.000
1964	31.433	0.000
1965	11.702	0.000
1966	3.930	0.000
1967	14.803	0.000
1968	5.405	0.000
1969	5.852	0.000
1970	12.098	0.000
1971	12.768	0.000

1972	52.820	0.000
1973	12.265	0.000
1974	12.727	0.000
1975	29.304	0.000
1976	21.674	0.000
1977	2.415	0.000
1978	19.844	0.000
1979	7.557	0.000
1980	15.201	0.000
1981	5.582	0.000
1982	3.596	0.000
1983	10.771	0.000
1984	11.121	0.000
1985	19.657	0.000
1986	5.284	0.000
1987	16.103	0.000
1988	5.029	0.000
1989	5.135	0.000
1990	7.297	0.000
1991	14.980	0.000
1992	11.209	0.000
1993	7.477	0.000
1994	11.829	0.000
1995	3.511	0.000
1996	14.451	0.000
1997	5.092	0.000
1998	11.456	0.000
1999	2.804	0.000
2000	6.273	0.000
2001	3.865	0.000
2002	28.697	0.000
2003	7.538	0.000
2004	9.171	0.000
2005	34.781	0.000
2006	3.283	0.000
2007	8.778	0.000
2008	6.181	0.000
2009	4.071	0.000
2010	4.942	0.000
2011	2.348	0.000
2012	6.803	0.000
2013	9.504	0.000
2014	5.199	0.000
2015	27.596	0.000
2016	2.758	0.000
2017	7.909	0.000
2018	18.018	0.000
2019	26.979	0.000
2020	12.928	0.000
2021	10.302	0.000
2022	8.336	0.000
2023	7.925	0.000
2024	45.967	0.000
2025	4.846	0.000
2026	7.863	0.000
2027	4.910	0.000
2028	2.945	0.000

2029	6.624	0.000
2030	15.307	0.000
2031	3.288	0.000
2032	2.451	0.000
2033	3.070	0.000
2034	4.192	0.000
2035	15.150	0.000
2036	6.795	0.000
2037	2.789	0.000
2038	15.705	0.000
2039	2.081	0.000
2040	4.681	0.000
2041	5.905	0.000
2042	13.736	0.000
2043	9.643	0.000
2044	9.191	0.000
2045	4.659	0.000
2046	5.399	0.000
2047	4.288	0.000
2048	5.191	0.000
2049	7.317	0.000
2050	7.509	0.000
2051	18.257	0.000
2052	3.570	0.000
2053	5.536	0.000
2054	32.862	0.000
2055	4.357	0.000
2056	2.675	0.000
2057	4.042	0.000
2058	4.312	0.000
2059	19.759	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	55.9628	0.0000
2	52.8202	0.0000
3	45.9668	0.0000
4	39.3227	0.0000
5	36.5224	0.0000
6	34.7813	0.0000
7	32.8623	0.0000
8	31.4326	0.0000
9	29.3037	0.0000
10	28.6966	0.0000
11	28.5509	0.0000
12	27.5956	0.0000
13	26.9794	0.0000
14	25.5195	0.0000
15	22.3329	0.0000
16	21.6736	0.0000
17	20.8633	0.0000
18	19.8441	0.0000
19	19.7590	0.0000
20	19.6570	0.0000
21	19.3587	0.0000

22	19.3413	0.0000
23	18.2573	0.0000
24	18.0179	0.0000
25	17.1166	0.0000
26	16.1156	0.0000
27	16.1032	0.0000
28	15.7052	0.0000
29	15.3068	0.0000
30	15.2014	0.0000
31	15.1501	0.0000
32	15.1265	0.0000
33	14.9802	0.0000
34	14.8030	0.0000
35	14.4510	0.0000
36	14.1996	0.0000
37	13.7890	0.0000
38	13.7363	0.0000
39	12.9282	0.0000
40	12.7680	0.0000
41	12.7266	0.0000
42	12.6087	0.0000
43	12.2648	0.0000
44	12.1890	0.0000
45	12.0982	0.0000
46	11.8294	0.0000
47	11.7016	0.0000
48	11.4560	0.0000
49	11.2090	0.0000
50	11.1213	0.0000
51	10.7712	0.0000
52	10.7328	0.0000
53	10.6481	0.0000
54	10.6173	0.0000
55	10.3024	0.0000
56	9.6433	0.0000
57	9.5038	0.0000
58	9.3535	0.0000
59	9.2609	0.0000
60	9.1913	0.0000
61	9.1712	0.0000
62	8.7780	0.0000
63	8.3359	0.0000
64	8.0547	0.0000
65	7.9255	0.0000
66	7.9088	0.0000
67	7.8633	0.0000
68	7.5570	0.0000
69	7.5383	0.0000
70	7.5089	0.0000
71	7.4765	0.0000
72	7.3171	0.0000
73	7.2970	0.0000
74	7.0873	0.0000
75	6.9892	0.0000
76	6.8032	0.0000
77	6.7951	0.0000
78	6.7392	0.0000

79	6.6238	0.0000
80	6.6086	0.0000
81	6.5127	0.0000
82	6.3864	0.0000
83	6.2726	0.0000
84	6.1810	0.0000
85	6.1495	0.0000
86	6.0758	0.0000
87	6.0626	0.0000
88	5.9047	0.0000
89	5.8516	0.0000
90	5.6973	0.0000
91	5.5818	0.0000
92	5.5361	0.0000
93	5.4705	0.0000
94	5.4054	0.0000
95	5.3989	0.0000
96	5.3978	0.0000
97	5.3317	0.0000
98	5.3001	0.0000
99	5.2844	0.0000
100	5.1989	0.0000
101	5.1912	0.0000
102	5.1638	0.0000
103	5.1346	0.0000
104	5.0924	0.0000
105	5.0292	0.0000
106	5.0183	0.0000
107	4.9417	0.0000
108	4.9104	0.0000
109	4.8875	0.0000
110	4.8459	0.0000
111	4.8429	0.0000
112	4.7986	0.0000
113	4.6807	0.0000
114	4.6594	0.0000
115	4.5394	0.0000
116	4.3648	0.0000
117	4.3568	0.0000
118	4.3121	0.0000
119	4.2875	0.0000
120	4.2417	0.0000
121	4.2333	0.0000
122	4.1918	0.0000
123	4.1287	0.0000
124	4.0712	0.0000
125	4.0416	0.0000
126	3.9304	0.0000
127	3.8653	0.0000
128	3.6866	0.0000
129	3.5958	0.0000
130	3.5696	0.0000
131	3.5328	0.0000
132	3.5163	0.0000
133	3.5109	0.0000
134	3.4661	0.0000
135	3.4587	0.0000

136	3.3542	0.0000
137	3.3382	0.0000
138	3.3115	0.0000
139	3.2884	0.0000
140	3.2832	0.0000
141	3.1770	0.0000
142	3.0697	0.0000
143	3.0686	0.0000
144	2.9449	0.0000
145	2.8037	0.0000
146	2.7957	0.0000
147	2.7891	0.0000
148	2.7581	0.0000
149	2.6753	0.0000
150	2.4716	0.0000
151	2.4511	0.0000
152	2.4155	0.0000
153	2.3485	0.0000
154	2.2981	0.0000
155	2.0808	0.0000
156	2.0730	0.0000
157	1.7348	0.0000
158	1.5711	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.5783	17484	0	0	Pass
3.9729	12565	0	0	Pass
4.3674	8897	0	0	Pass
4.7620	6343	0	0	Pass
5.1566	4656	0	0	Pass
5.5512	3562	0	0	Pass
5.9457	2785	0	0	Pass
6.3403	2182	0	0	Pass
6.7349	1561	0	0	Pass
7.1295	1210	0	0	Pass
7.5240	978	0	0	Pass
7.9186	780	0	0	Pass
8.3132	638	0	0	Pass
8.7078	535	0	0	Pass
9.1023	424	0	0	Pass
9.4969	343	0	0	Pass
9.8915	293	0	0	Pass
10.2860	261	0	0	Pass
10.6806	239	0	0	Pass
11.0752	223	0	0	Pass
11.4698	205	0	0	Pass
11.8643	193	0	0	Pass
12.2589	181	0	0	Pass
12.6535	170	0	0	Pass
13.0481	161	0	0	Pass

13.4426	152	0	0	Pass
13.8372	142	0	0	Pass
14.2318	133	0	0	Pass
14.6264	127	0	0	Pass
15.0209	116	0	0	Pass
15.4155	111	0	0	Pass
15.8101	108	0	0	Pass
16.2046	99	0	0	Pass
16.5992	97	0	0	Pass
16.9938	92	0	0	Pass
17.3884	88	0	0	Pass
17.7829	79	0	0	Pass
18.1775	73	0	0	Pass
18.5721	68	0	0	Pass
18.9667	66	0	0	Pass
19.3612	63	0	0	Pass
19.7558	60	0	0	Pass
20.1504	57	0	0	Pass
20.5450	55	0	0	Pass
20.9395	49	0	0	Pass
21.3341	46	0	0	Pass
21.7287	44	0	0	Pass
22.1232	44	0	0	Pass
22.5178	39	0	0	Pass
22.9124	39	0	0	Pass
23.3070	39	0	0	Pass
23.7015	38	0	0	Pass
24.0961	35	0	0	Pass
24.4907	34	0	0	Pass
24.8853	33	0	0	Pass
25.2798	31	0	0	Pass
25.6744	30	0	0	Pass
26.0690	30	0	0	Pass
26.4636	30	0	0	Pass
26.8581	29	0	0	Pass
27.2527	27	0	0	Pass
27.6473	26	0	0	Pass
28.0419	25	0	0	Pass
28.4364	24	0	0	Pass
28.8310	21	0	0	Pass
29.2256	21	0	0	Pass
29.6201	20	0	0	Pass
30.0147	20	0	0	Pass
30.4093	20	0	0	Pass
30.8039	20	0	0	Pass
31.1984	20	0	0	Pass
31.5930	18	0	0	Pass
31.9876	18	0	0	Pass
32.3822	18	0	0	Pass
32.7767	18	0	0	Pass
33.1713	16	0	0	Pass
33.5659	16	0	0	Pass
33.9605	16	0	0	Pass
34.3550	16	0	0	Pass
34.7496	16	0	0	Pass
35.1442	15	0	0	Pass
35.5387	15	0	0	Pass

35.9333	14	0	0	Pass
36.3279	14	0	0	Pass
36.7225	12	0	0	Pass
37.1170	12	0	0	Pass
37.5116	12	0	0	Pass
37.9062	12	0	0	Pass
38.3008	12	0	0	Pass
38.6953	12	0	0	Pass
39.0899	12	0	0	Pass
39.4845	11	0	0	Pass
39.8791	10	0	0	Pass
40.2736	10	0	0	Pass
40.6682	9	0	0	Pass
41.0628	9	0	0	Pass
41.4573	9	0	0	Pass
41.8519	9	0	0	Pass
42.2465	9	0	0	Pass
42.6411	9	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 6.0805 **acre-feet**
On-line facility target flow: 3.3931 **cfs.**
Adjusted for 15 min: 3.3931 **cfs.**
Off-line facility target flow: 1.9045 **cfs.**
Adjusted for 15 min: 1.9045 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Infilt Pond C POC	N	20313.78			N	100.00			
Total Volume Infiltrated		20313.78	0.00	0.00		100.00	0.00	0%	No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Passed

Stream Protection Duration

Predeveloped Landuse Totals for POC #2
Total Pervious Area:227.7
Total Impervious Area:0

Mitigated Landuse Totals for POC #2
Total Pervious Area:227.7
Total Impervious Area:0

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	Flow(cfs)
2 year	9.453983
5 year	18.751269
10 year	27.642348
25 year	42.801569
50 year	57.51558
100 year	75.693112

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #2

Year	Predeveloped	Mitigated
1902	6.246	0.000
1903	4.718	0.000
1904	33.939	0.000
1905	5.808	0.000
1906	2.062	0.000
1907	16.843	0.000
1908	6.764	0.000
1909	9.046	0.000
1910	19.255	0.000
1911	12.085	0.000
1912	77.843	1.755
1913	8.817	0.000
1914	50.844	0.000
1915	4.788	0.000
1916	10.048	0.000
1917	3.156	0.000
1918	6.084	0.000
1919	5.382	0.000
1920	12.020	0.000
1921	8.763	0.000
1922	22.619	0.000
1923	9.530	0.000
1924	4.652	0.000
1925	4.536	0.000
1926	8.035	0.000
1927	4.560	0.000
1928	6.400	0.000
1929	15.813	0.000
1930	5.877	0.000
1931	6.424	0.000
1932	6.832	0.000
1933	7.918	0.000
1934	27.707	0.000
1935	5.633	0.000

1936	7.878	0.000
1937	20.521	0.000
1938	6.479	0.000
1939	2.219	0.000
1940	8.440	0.000
1941	3.360	0.000
1942	18.130	0.000
1943	8.634	0.000
1944	25.406	0.000
1945	7.749	0.000
1946	14.041	0.000
1947	3.803	0.000
1948	14.258	0.000
1949	14.446	0.000
1950	4.515	0.000
1951	4.113	0.000
1952	50.783	7.074
1953	39.109	0.000
1954	6.849	0.000
1955	4.901	0.000
1956	2.873	0.000
1957	7.121	0.000
1958	26.457	0.000
1959	21.858	0.000
1960	4.398	0.000
1961	29.737	0.000
1962	7.022	0.000
1963	4.264	0.000
1964	42.383	0.000
1965	15.609	0.000
1966	4.977	0.000
1967	19.613	0.000
1968	7.449	0.000
1969	7.567	0.000
1970	15.844	0.000
1971	17.325	0.000
1972	71.605	0.000
1973	16.472	0.000
1974	17.212	0.000
1975	40.503	0.000
1976	28.810	0.000
1977	3.358	0.000
1978	27.189	0.000
1979	9.606	0.000
1980	19.926	0.000
1981	6.878	0.000
1982	4.449	0.000
1983	14.229	0.000
1984	14.551	0.000
1985	26.318	0.000
1986	6.950	0.000
1987	21.177	0.000
1988	6.670	0.000
1989	6.826	0.000
1990	9.281	0.000
1991	18.716	0.000
1992	14.449	0.000

1993	9.817	0.000
1994	15.884	0.000
1995	4.476	0.000
1996	19.610	0.000
1997	6.542	0.000
1998	15.149	0.000
1999	3.625	0.000
2000	8.159	0.000
2001	4.976	0.000
2002	38.857	0.000
2003	9.870	0.000
2004	11.896	0.000
2005	46.782	0.000
2006	4.233	0.000
2007	11.111	0.000
2008	8.046	0.000
2009	5.271	0.000
2010	6.874	0.000
2011	3.144	0.000
2012	9.224	0.000
2013	12.376	0.000
2014	6.602	0.000
2015	37.780	0.000
2016	3.159	0.000
2017	10.697	0.000
2018	25.208	0.000
2019	35.795	0.000
2020	17.250	0.000
2021	13.365	0.000
2022	9.977	0.000
2023	9.850	0.000
2024	64.683	0.000
2025	6.669	0.000
2026	10.472	0.000
2027	6.313	0.000
2028	4.045	0.000
2029	8.691	0.000
2030	20.644	0.000
2031	4.446	0.000
2032	3.072	0.000
2033	4.250	0.000
2034	5.863	0.000
2035	20.444	0.000
2036	9.044	0.000
2037	3.865	0.000
2038	20.483	0.000
2039	2.184	0.000
2040	5.955	0.000
2041	7.500	0.000
2042	18.567	0.000
2043	12.694	0.000
2044	12.165	0.000
2045	5.930	0.000
2046	7.032	0.000
2047	5.805	0.000
2048	7.202	0.000
2049	9.679	0.000

2050	9.773	0.000
2051	24.509	0.000
2052	4.830	0.000
2053	7.495	0.000
2054	44.017	0.000
2055	5.437	0.000
2056	3.707	0.000
2057	5.563	0.000
2058	5.827	0.000
2059	26.461	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	77.8432	7.0742
2	71.6051	1.7552
3	64.6825	0.0000
4	50.8441	0.0000
5	50.7834	0.0000
6	46.7818	0.0000
7	44.0168	0.0000
8	42.3826	0.0000
9	40.5026	0.0000
10	39.1091	0.0000
11	38.8567	0.0000
12	37.7802	0.0000
13	35.7950	0.0000
14	33.9390	0.0000
15	29.7370	0.0000
16	28.8097	0.0000
17	27.7067	0.0000
18	27.1888	0.0000
19	26.4609	0.0000
20	26.4572	0.0000
21	26.3176	0.0000
22	25.4058	0.0000
23	25.2078	0.0000
24	24.5093	0.0000
25	22.6185	0.0000
26	21.8582	0.0000
27	21.1771	0.0000
28	20.6440	0.0000
29	20.5208	0.0000
30	20.4827	0.0000
31	20.4438	0.0000
32	19.9258	0.0000
33	19.6128	0.0000
34	19.6103	0.0000
35	19.2545	0.0000
36	18.7158	0.0000
37	18.5671	0.0000
38	18.1296	0.0000
39	17.3248	0.0000
40	17.2504	0.0000
41	17.2121	0.0000
42	16.8432	0.0000

43	16.4715	0.0000
44	15.8843	0.0000
45	15.8442	0.0000
46	15.8125	0.0000
47	15.6093	0.0000
48	15.1494	0.0000
49	14.5511	0.0000
50	14.4486	0.0000
51	14.4460	0.0000
52	14.2582	0.0000
53	14.2287	0.0000
54	14.0408	0.0000
55	13.3653	0.0000
56	12.6935	0.0000
57	12.3759	0.0000
58	12.1649	0.0000
59	12.0851	0.0000
60	12.0203	0.0000
61	11.8959	0.0000
62	11.1114	0.0000
63	10.6974	0.0000
64	10.4724	0.0000
65	10.0477	0.0000
66	9.9772	0.0000
67	9.8699	0.0000
68	9.8497	0.0000
69	9.8169	0.0000
70	9.7728	0.0000
71	9.6795	0.0000
72	9.6063	0.0000
73	9.5297	0.0000
74	9.2813	0.0000
75	9.2245	0.0000
76	9.0458	0.0000
77	9.0442	0.0000
78	8.8167	0.0000
79	8.7634	0.0000
80	8.6914	0.0000
81	8.6343	0.0000
82	8.4400	0.0000
83	8.1594	0.0000
84	8.0462	0.0000
85	8.0351	0.0000
86	7.9177	0.0000
87	7.8778	0.0000
88	7.7495	0.0000
89	7.5670	0.0000
90	7.4996	0.0000
91	7.4949	0.0000
92	7.4485	0.0000
93	7.2023	0.0000
94	7.1209	0.0000
95	7.0316	0.0000
96	7.0221	0.0000
97	6.9501	0.0000
98	6.8783	0.0000
99	6.8739	0.0000

100	6.8494	0.0000
101	6.8321	0.0000
102	6.8264	0.0000
103	6.7636	0.0000
104	6.6703	0.0000
105	6.6692	0.0000
106	6.6022	0.0000
107	6.5422	0.0000
108	6.4785	0.0000
109	6.4237	0.0000
110	6.3999	0.0000
111	6.3135	0.0000
112	6.2460	0.0000
113	6.0841	0.0000
114	5.9555	0.0000
115	5.9305	0.0000
116	5.8765	0.0000
117	5.8631	0.0000
118	5.8265	0.0000
119	5.8080	0.0000
120	5.8054	0.0000
121	5.6331	0.0000
122	5.5632	0.0000
123	5.4370	0.0000
124	5.3821	0.0000
125	5.2706	0.0000
126	4.9766	0.0000
127	4.9760	0.0000
128	4.9015	0.0000
129	4.8297	0.0000
130	4.7881	0.0000
131	4.7176	0.0000
132	4.6524	0.0000
133	4.5602	0.0000
134	4.5358	0.0000
135	4.5146	0.0000
136	4.4764	0.0000
137	4.4486	0.0000
138	4.4460	0.0000
139	4.3984	0.0000
140	4.2645	0.0000
141	4.2498	0.0000
142	4.2333	0.0000
143	4.1134	0.0000
144	4.0452	0.0000
145	3.8650	0.0000
146	3.8025	0.0000
147	3.7072	0.0000
148	3.6252	0.0000
149	3.3602	0.0000
150	3.3581	0.0000
151	3.1587	0.0000
152	3.1562	0.0000
153	3.1436	0.0000
154	3.0717	0.0000
155	2.8726	0.0000
156	2.2190	0.0000

157	2.1836	0.0000
158	2.0622	0.0000

Stream Protection Duration
POC #2
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
4.7270	21074	5	0	Pass
5.2602	15174	3	0	Pass
5.7934	11041	3	0	Pass
6.3266	7806	2	0	Pass
6.8599	5656	1	0	Pass
7.3931	4265	0	0	Pass
7.9263	3345	0	0	Pass
8.4595	2653	0	0	Pass
8.9927	2048	0	0	Pass
9.5260	1494	0	0	Pass
10.0592	1178	0	0	Pass
10.5924	947	0	0	Pass
11.1256	758	0	0	Pass
11.6588	624	0	0	Pass
12.1920	508	0	0	Pass
12.7253	404	0	0	Pass
13.2585	331	0	0	Pass
13.7917	284	0	0	Pass
14.3249	245	0	0	Pass
14.8581	229	0	0	Pass
15.3914	210	0	0	Pass
15.9246	196	0	0	Pass
16.4578	187	0	0	Pass
16.9910	172	0	0	Pass
17.5242	157	0	0	Pass
18.0574	152	0	0	Pass
18.5907	145	0	0	Pass
19.1239	132	0	0	Pass
19.6571	125	0	0	Pass
20.1903	122	0	0	Pass
20.7235	114	0	0	Pass
21.2568	105	0	0	Pass
21.7900	100	0	0	Pass
22.3232	98	0	0	Pass
22.8564	93	0	0	Pass
23.3896	88	0	0	Pass
23.9228	85	0	0	Pass
24.4561	83	0	0	Pass
24.9893	73	0	0	Pass
25.5225	66	0	0	Pass
26.0557	64	0	0	Pass
26.5889	61	0	0	Pass
27.1222	57	0	0	Pass
27.6554	54	0	0	Pass
28.1886	51	0	0	Pass
28.7218	50	0	0	Pass

29.2550	45	0	0	Pass
29.7882	41	0	0	Pass
30.3215	40	0	0	Pass
30.8547	39	0	0	Pass
31.3879	38	0	0	Pass
31.9211	38	0	0	Pass
32.4543	38	0	0	Pass
32.9875	36	0	0	Pass
33.5208	34	0	0	Pass
34.0540	31	0	0	Pass
34.5872	30	0	0	Pass
35.1204	29	0	0	Pass
35.6536	29	0	0	Pass
36.1869	28	0	0	Pass
36.7201	28	0	0	Pass
37.2533	28	0	0	Pass
37.7865	28	0	0	Pass
38.3197	26	0	0	Pass
38.8529	26	0	0	Pass
39.3862	22	0	0	Pass
39.9194	22	0	0	Pass
40.4526	21	0	0	Pass
40.9858	19	0	0	Pass
41.5190	19	0	0	Pass
42.0523	19	0	0	Pass
42.5855	18	0	0	Pass
43.1187	18	0	0	Pass
43.6519	18	0	0	Pass
44.1851	16	0	0	Pass
44.7183	16	0	0	Pass
45.2516	16	0	0	Pass
45.7848	16	0	0	Pass
46.3180	16	0	0	Pass
46.8512	15	0	0	Pass
47.3844	15	0	0	Pass
47.9177	15	0	0	Pass
48.4509	15	0	0	Pass
48.9841	15	0	0	Pass
49.5173	15	0	0	Pass
50.0505	15	0	0	Pass
50.5837	15	0	0	Pass
51.1170	12	0	0	Pass
51.6502	12	0	0	Pass
52.1834	10	0	0	Pass
52.7166	10	0	0	Pass
53.2498	10	0	0	Pass
53.7831	10	0	0	Pass
54.3163	10	0	0	Pass
54.8495	10	0	0	Pass
55.3827	9	0	0	Pass
55.9159	9	0	0	Pass
56.4491	9	0	0	Pass
56.9824	9	0	0	Pass
57.5156	9	0	0	Pass

Water Quality BMP Flow and Volume for POC #2
On-line facility volume: 8.5564 **acre-feet**
On-line facility target flow: 4.7648 **cfs.**
Adjusted for 15 min: 4.7648 **cfs.**
Off-line facility target flow: 2.6759 **cfs.**
Adjusted for 15 min: 2.6759 **cfs.**

LID Report

LID Technique Used for Total Volume Volume Infiltration Cumulative
Percent Water Quality Percent Comment
Treatment? Needs Through Volume Volume
Volume Water Quality
Treatment Facility (ac-ft.) Infiltration
Infiltrated Treated
(ac-ft) (ac-ft) Credit

Infilt Pond D POC N 28458.60 N
100.00
Total Volume Infiltrated 28458.60 0.00 0.00
100.00 0.00 0% No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Passed

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.**Perlnd and Implnd Changes**
No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Basin E GW
Site Name: Pioneer Aggregates
Site Address: Pioneer Avenue
City : DuPont
Report Date: 11/25/2020
Gage : 38 IN CENTRAL
Data Start : 10/01/1901
Data End : 09/30/2059
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin E Pre
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	3.5
A B, Lawn, Steep	72.1
C, Lawn, Flat	12.7
SAT, Forest, Flat	4.3
Pervious Total	**92.6**

Impervious Land Use	acre
Impervious Total	**0**
Basin Total	**92.6**

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Watershed E
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
A B, Lawn, Flat	**3.5**
A B, Lawn, Steep	**72.1**
C, Lawn, Flat	**12.7**
SAT, Forest, Flat	**4.3**

Pervious Total **92.6**

Impervious Land Use	**acre**

Impervious Total **0**

Basin Total **92.6**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Trapezoidal Pond 3	Trapezoidal Pond 3	

Name : Trapezoidal Pond 3
Bottom Length: 600.00 ft.
Bottom Width: 96.00 ft.
Depth: 7 ft.
Volume at riser head: 9.8477 acre-feet.
Infiltration On
Infiltration rate: 8.1
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 1091797
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 1091797
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 6 ft.
Riser Diameter: 24 in.

Element Flows To:
Outlet 1 **Outlet 2**

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	1.322	0.000	0.000	0.000
0.0778	1.329	0.103	0.000	10.86
0.1556	1.337	0.206	0.000	10.92
0.2333	1.344	0.311	0.000	10.98
0.3111	1.352	0.416	0.000	11.04
0.3889	1.359	0.521	0.000	11.10
0.4667	1.367	0.627	0.000	11.16
0.5444	1.374	0.734	0.000	11.22
0.6222	1.382	0.841	0.000	11.29
0.7000	1.389	0.949	0.000	11.35
0.7778	1.397	1.057	0.000	11.41
0.8556	1.404	1.166	0.000	11.47
0.9333	1.412	1.276	0.000	11.53
1.0111	1.420	1.386	0.000	11.59
1.0889	1.427	1.497	0.000	11.66
1.1667	1.435	1.608	0.000	11.72
1.2444	1.442	1.720	0.000	11.78
1.3222	1.450	1.832	0.000	11.84
1.4000	1.458	1.945	0.000	11.90
1.4778	1.465	2.059	0.000	11.97
1.5556	1.473	2.174	0.000	12.03
1.6333	1.481	2.288	0.000	12.09
1.7111	1.488	2.404	0.000	12.16
1.7889	1.496	2.520	0.000	12.22
1.8667	1.504	2.637	0.000	12.28
1.9444	1.511	2.754	0.000	12.34
2.0222	1.519	2.872	0.000	12.41
2.1000	1.527	2.990	0.000	12.47
2.1778	1.535	3.109	0.000	12.53
2.2556	1.542	3.229	0.000	12.60
2.3333	1.550	3.349	0.000	12.66
2.4111	1.558	3.470	0.000	12.72
2.4889	1.566	3.592	0.000	12.79
2.5667	1.573	3.714	0.000	12.85
2.6444	1.581	3.837	0.000	12.91
2.7222	1.589	3.960	0.000	12.98
2.8000	1.597	4.084	0.000	13.04
2.8778	1.605	4.208	0.000	13.10
2.9556	1.612	4.334	0.000	13.17
3.0333	1.620	4.459	0.000	13.23
3.1111	1.628	4.586	0.000	13.30
3.1889	1.636	4.713	0.000	13.36
3.2667	1.644	4.840	0.000	13.43
3.3444	1.652	4.968	0.000	13.49
3.4222	1.660	5.097	0.000	13.55
3.5000	1.668	5.227	0.000	13.62
3.5778	1.675	5.357	0.000	13.68
3.6556	1.683	5.487	0.000	13.75
3.7333	1.691	5.619	0.000	13.81
3.8111	1.699	5.751	0.000	13.88
3.8889	1.707	5.883	0.000	13.94
3.9667	1.715	6.016	0.000	14.01
4.0444	1.723	6.150	0.000	14.07
4.1222	1.731	6.284	0.000	14.14
4.2000	1.739	6.419	0.000	14.20
4.2778	1.747	6.555	0.000	14.27

4.3556	1.755	6.691	0.000	14.33
4.4333	1.763	6.828	0.000	14.40
4.5111	1.771	6.965	0.000	14.47
4.5889	1.779	7.104	0.000	14.53
4.6667	1.787	7.242	0.000	14.60
4.7444	1.795	7.382	0.000	14.66
4.8222	1.803	7.522	0.000	14.73
4.9000	1.811	7.662	0.000	14.79
4.9778	1.820	7.803	0.000	14.86
5.0556	1.828	7.945	0.000	14.93
5.1333	1.836	8.088	0.000	14.99
5.2111	1.844	8.231	0.000	15.06
5.2889	1.852	8.375	0.000	15.13
5.3667	1.860	8.519	0.000	15.19
5.4444	1.868	8.664	0.000	15.26
5.5222	1.876	8.810	0.000	15.33
5.6000	1.885	8.956	0.000	15.39
5.6778	1.893	9.103	0.000	15.46
5.7556	1.901	9.251	0.000	15.53
5.8333	1.909	9.399	0.000	15.59
5.9111	1.917	9.548	0.000	15.66
5.9889	1.926	9.697	0.000	15.73
6.0667	1.934	9.847	0.365	15.79
6.1444	1.942	9.998	1.161	15.86
6.2222	1.950	10.15	2.205	15.93
6.3000	1.959	10.30	3.421	16.00
6.3778	1.967	10.45	4.745	16.06
6.4556	1.975	10.60	6.112	16.13
6.5333	1.983	10.76	7.456	16.20
6.6111	1.992	10.91	8.711	16.27
6.6889	2.000	11.07	9.823	16.33
6.7667	2.008	11.22	10.75	16.40
6.8444	2.017	11.38	11.48	16.47
6.9222	2.025	11.54	12.02	16.54
7.0000	2.033	11.69	12.46	16.61
7.0778	2.042	11.85	13.07	16.68

Name : Groundwater
Time Series number 400 is connected to:

Element Flows To:
Outlet 1 **Outlet 2**
Trapezoidal Pond 3

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:92.6

Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:92.6
Total Impervious Area:0

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.694472
5 year	1.66554
10 year	2.813589
25 year	5.188279
50 year	7.936065
100 year	11.870051

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	0.422	0.000
1903	0.344	0.000
1904	2.209	0.000
1905	0.399	0.000
1906	0.155	0.000
1907	1.106	0.000
1908	0.457	0.000
1909	0.639	0.000
1910	1.746	0.000
1911	0.792	0.000
1912	21.409	0.000
1913	0.870	0.000
1914	3.061	0.000
1915	0.347	0.000
1916	0.654	0.000
1917	0.215	0.000
1918	0.519	0.000
1919	0.392	0.000
1920	0.782	0.000
1921	0.601	0.000
1922	1.760	0.000
1923	0.892	0.000
1924	0.305	0.000
1925	0.344	0.000
1926	0.536	0.000
1927	0.323	0.000
1928	0.407	0.000

1929	2.441	0.000
1930	0.424	0.000
1931	0.436	0.000
1932	0.432	0.000
1933	0.512	0.000
1934	6.870	0.000
1935	0.403	0.000
1936	0.500	0.000
1937	1.364	0.000
1938	0.463	0.000
1939	0.161	0.000
1940	0.532	0.000
1941	0.249	0.000
1942	1.173	0.000
1943	0.548	0.000
1944	1.641	0.000
1945	0.514	0.000
1946	0.956	0.000
1947	0.253	0.000
1948	0.945	0.000
1949	0.947	0.000
1950	0.314	0.000
1951	0.307	0.000
1952	5.349	0.000
1953	3.215	0.000
1954	0.428	0.000
1955	0.335	0.000
1956	0.199	0.000
1957	0.541	0.000
1958	6.176	0.000
1959	5.202	0.000
1960	0.314	0.000
1961	3.901	0.000
1962	0.472	0.000
1963	0.284	0.000
1964	2.773	0.000
1965	3.175	0.000
1966	0.321	0.000
1967	1.279	0.000
1968	0.515	0.000
1969	0.479	0.000
1970	1.122	0.000
1971	1.544	0.000
1972	4.786	0.000
1973	1.154	0.000
1974	2.271	0.000
1975	3.088	0.000
1976	1.880	0.000
1977	0.219	0.000
1978	5.034	0.000
1979	0.600	0.000
1980	1.310	0.000
1981	0.430	0.000
1982	0.282	0.000
1983	0.920	0.000
1984	0.934	0.000
1985	1.721	0.000

1986	0.451	0.000
1987	1.370	0.000
1988	0.474	0.000
1989	0.476	0.000
1990	0.572	0.000
1991	1.181	0.000
1992	1.981	0.000
1993	1.047	0.000
1994	1.154	0.000
1995	0.296	0.000
1996	3.899	0.000
1997	0.422	0.000
1998	0.986	0.000
1999	0.289	0.000
2000	0.517	0.000
2001	0.314	0.000
2002	2.726	0.000
2003	0.648	0.000
2004	0.911	0.000
2005	8.312	0.000
2006	0.415	0.000
2007	0.681	0.000
2008	0.513	0.000
2009	0.335	0.000
2010	0.458	0.000
2011	0.229	0.000
2012	0.590	0.000
2013	0.800	0.000
2014	0.422	0.000
2015	2.610	0.000
2016	0.203	0.000
2017	0.955	0.000
2018	6.725	0.000
2019	4.625	0.000
2020	1.171	0.000
2021	1.569	0.000
2022	0.471	0.000
2023	0.769	0.000
2024	8.879	0.000
2025	0.456	0.000
2026	0.943	0.000
2027	0.402	0.000
2028	0.279	0.000
2029	0.789	0.000
2030	2.756	0.000
2031	0.302	0.000
2032	0.222	0.000
2033	0.291	0.000
2034	0.387	0.000
2035	1.379	0.000
2036	0.785	0.000
2037	0.253	0.000
2038	1.637	0.000
2039	0.152	0.000
2040	0.391	0.000
2041	0.478	0.000
2042	1.236	0.000

2043	1.078	0.000
2044	2.978	0.000
2045	0.461	0.000
2046	0.530	0.000
2047	0.428	0.000
2048	0.491	0.000
2049	0.625	0.000
2050	0.631	0.000
2051	1.624	0.000
2052	0.330	0.000
2053	0.486	0.000
2054	2.995	0.000
2055	0.346	0.000
2056	0.256	0.000
2057	0.394	0.000
2058	0.479	0.000
2059	4.711	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	21.4094	0.0000
2	8.8787	0.0000
3	8.3120	0.0000
4	6.8704	0.0000
5	6.7252	0.0000
6	6.1764	0.0000
7	5.3485	0.0000
8	5.2023	0.0000
9	5.0335	0.0000
10	4.7860	0.0000
11	4.7110	0.0000
12	4.6246	0.0000
13	3.9014	0.0000
14	3.8987	0.0000
15	3.2147	0.0000
16	3.1751	0.0000
17	3.0876	0.0000
18	3.0614	0.0000
19	2.9947	0.0000
20	2.9781	0.0000
21	2.7732	0.0000
22	2.7561	0.0000
23	2.7264	0.0000
24	2.6097	0.0000
25	2.4414	0.0000
26	2.2706	0.0000
27	2.2091	0.0000
28	1.9806	0.0000
29	1.8805	0.0000
30	1.7598	0.0000
31	1.7465	0.0000
32	1.7205	0.0000
33	1.6411	0.0000
34	1.6368	0.0000
35	1.6236	0.0000

36	1.5692	0.0000
37	1.5440	0.0000
38	1.3790	0.0000
39	1.3702	0.0000
40	1.3637	0.0000
41	1.3103	0.0000
42	1.2793	0.0000
43	1.2355	0.0000
44	1.1814	0.0000
45	1.1732	0.0000
46	1.1709	0.0000
47	1.1540	0.0000
48	1.1538	0.0000
49	1.1223	0.0000
50	1.1055	0.0000
51	1.0782	0.0000
52	1.0465	0.0000
53	0.9860	0.0000
54	0.9556	0.0000
55	0.9546	0.0000
56	0.9466	0.0000
57	0.9454	0.0000
58	0.9428	0.0000
59	0.9338	0.0000
60	0.9199	0.0000
61	0.9109	0.0000
62	0.8924	0.0000
63	0.8699	0.0000
64	0.8001	0.0000
65	0.7922	0.0000
66	0.7890	0.0000
67	0.7853	0.0000
68	0.7816	0.0000
69	0.7695	0.0000
70	0.6807	0.0000
71	0.6538	0.0000
72	0.6477	0.0000
73	0.6389	0.0000
74	0.6309	0.0000
75	0.6251	0.0000
76	0.6011	0.0000
77	0.5999	0.0000
78	0.5899	0.0000
79	0.5717	0.0000
80	0.5483	0.0000
81	0.5405	0.0000
82	0.5358	0.0000
83	0.5318	0.0000
84	0.5302	0.0000
85	0.5191	0.0000
86	0.5171	0.0000
87	0.5151	0.0000
88	0.5143	0.0000
89	0.5127	0.0000
90	0.5122	0.0000
91	0.4998	0.0000
92	0.4915	0.0000

93	0.4862	0.0000
94	0.4794	0.0000
95	0.4792	0.0000
96	0.4776	0.0000
97	0.4759	0.0000
98	0.4742	0.0000
99	0.4718	0.0000
100	0.4713	0.0000
101	0.4629	0.0000
102	0.4608	0.0000
103	0.4584	0.0000
104	0.4566	0.0000
105	0.4561	0.0000
106	0.4511	0.0000
107	0.4364	0.0000
108	0.4317	0.0000
109	0.4305	0.0000
110	0.4285	0.0000
111	0.4277	0.0000
112	0.4236	0.0000
113	0.4222	0.0000
114	0.4218	0.0000
115	0.4216	0.0000
116	0.4151	0.0000
117	0.4072	0.0000
118	0.4033	0.0000
119	0.4024	0.0000
120	0.3992	0.0000
121	0.3940	0.0000
122	0.3919	0.0000
123	0.3911	0.0000
124	0.3872	0.0000
125	0.3469	0.0000
126	0.3465	0.0000
127	0.3445	0.0000
128	0.3440	0.0000
129	0.3351	0.0000
130	0.3348	0.0000
131	0.3297	0.0000
132	0.3228	0.0000
133	0.3213	0.0000
134	0.3139	0.0000
135	0.3138	0.0000
136	0.3138	0.0000
137	0.3066	0.0000
138	0.3054	0.0000
139	0.3020	0.0000
140	0.2963	0.0000
141	0.2907	0.0000
142	0.2892	0.0000
143	0.2844	0.0000
144	0.2815	0.0000
145	0.2794	0.0000
146	0.2564	0.0000
147	0.2530	0.0000
148	0.2527	0.0000
149	0.2494	0.0000

150	0.2290	0.0000
151	0.2219	0.0000
152	0.2188	0.0000
153	0.2150	0.0000
154	0.2027	0.0000
155	0.1985	0.0000
156	0.1609	0.0000
157	0.1552	0.0000
158	0.1521	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	**Predev**	**Mit**	**Percentage**	**Pass/Fail**
0.3472	19041	0	0	Pass
0.4239	9872	0	0	Pass
0.5005	5518	0	0	Pass
0.5772	3457	0	0	Pass
0.6539	2213	0	0	Pass
0.7305	1451	0	0	Pass
0.8072	1034	0	0	Pass
0.8838	745	0	0	Pass
0.9605	558	0	0	Pass
1.0371	456	0	0	Pass
1.1138	381	0	0	Pass
1.1904	332	0	0	Pass
1.2671	306	0	0	Pass
1.3437	275	0	0	Pass
1.4204	253	0	0	Pass
1.4971	230	0	0	Pass
1.5737	213	0	0	Pass
1.6504	197	0	0	Pass
1.7270	178	0	0	Pass
1.8037	161	0	0	Pass
1.8803	155	0	0	Pass
1.9570	146	0	0	Pass
2.0336	138	0	0	Pass
2.1103	134	0	0	Pass
2.1870	126	0	0	Pass
2.2636	119	0	0	Pass
2.3403	110	0	0	Pass
2.4169	105	0	0	Pass
2.4936	99	0	0	Pass
2.5702	95	0	0	Pass
2.6469	91	0	0	Pass
2.7235	89	0	0	Pass
2.8002	84	0	0	Pass
2.8768	83	0	0	Pass
2.9535	81	0	0	Pass
3.0302	78	0	0	Pass
3.1068	76	0	0	Pass
3.1835	72	0	0	Pass
3.2601	68	0	0	Pass

3.3368	66	0	0	Pass
3.4134	65	0	0	Pass
3.4901	62	0	0	Pass
3.5667	61	0	0	Pass
3.6434	58	0	0	Pass
3.7200	55	0	0	Pass
3.7967	55	0	0	Pass
3.8734	55	0	0	Pass
3.9500	52	0	0	Pass
4.0267	51	0	0	Pass
4.1033	48	0	0	Pass
4.1800	46	0	0	Pass
4.2566	43	0	0	Pass
4.3333	41	0	0	Pass
4.4099	37	0	0	Pass
4.4866	37	0	0	Pass
4.5633	34	0	0	Pass
4.6399	31	0	0	Pass
4.7166	28	0	0	Pass
4.7932	26	0	0	Pass
4.8699	25	0	0	Pass
4.9465	24	0	0	Pass
5.0232	24	0	0	Pass
5.0998	22	0	0	Pass
5.1765	22	0	0	Pass
5.2531	21	0	0	Pass
5.3298	18	0	0	Pass
5.4065	17	0	0	Pass
5.4831	17	0	0	Pass
5.5598	17	0	0	Pass
5.6364	17	0	0	Pass
5.7131	17	0	0	Pass
5.7897	17	0	0	Pass
5.8664	17	0	0	Pass
5.9430	17	0	0	Pass
6.0197	15	0	0	Pass
6.0963	15	0	0	Pass
6.1730	14	0	0	Pass
6.2497	11	0	0	Pass
6.3263	11	0	0	Pass
6.4030	11	0	0	Pass
6.4796	11	0	0	Pass
6.5563	11	0	0	Pass
6.6329	11	0	0	Pass
6.7096	11	0	0	Pass
6.7862	9	0	0	Pass
6.8629	9	0	0	Pass
6.9396	8	0	0	Pass
7.0162	8	0	0	Pass
7.0929	8	0	0	Pass
7.1695	8	0	0	Pass
7.2462	8	0	0	Pass
7.3228	8	0	0	Pass
7.3995	8	0	0	Pass
7.4761	8	0	0	Pass
7.5528	8	0	0	Pass
7.6294	8	0	0	Pass

7.7061	8	0	0	Pass
7.7828	8	0	0	Pass
7.8594	8	0	0	Pass
7.9361	8	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 7.31 **acre-feet**
On-line facility target flow: 4.0677 **cfs.**
Adjusted for 15 min: 4.0677 **cfs.**
Off-line facility target flow: 2.2884 **cfs.**
Adjusted for 15 min: 2.2884 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 3 POC	N	993535.27			N	100.00			
Total Volume Infiltrated		993535.27	0.00	0.00		100.00	0.00	0%	No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Passed

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.**Perlnd and Implnd Changes**

No changes have been made.

APPENDIX D

Stormwater Design Calculations

Table 1. Wetpond Design Summary

Project No. 040010-016-01, CalPortland
Pioneer Aggregates South Parcel Project, DuPont, WA

Basin C WQ Pond

Required Pond Volume	6.08	ac-ft								
Required Pond Volume	264844.8	cu ft								
Number of Ponds Wanted:	1									
Total Volume Required Per Pond:	264,845	cu ft								
Pond Design Based on Number of Pond Wanted:										
% Total Volume for Cell 1	0.3									
Total Volume for Cell 1	79,453	cu ft								
Depth Cell 1	6	ft	Length to Width Ratio:	3	Length:	162 ft	Total Bottom Area:	8,748 sq ft		
Side Slopes XH:1V	3				Width:	54 ft	Total Top Area:	17,820 sq ft		
							Volume Calculated:	79,704	Good?	YES
Total Volume Required for Cell 2	185,391.4	cu ft								
Depth Cell 2	7	ft	Length to Width Ratio:	3.00	Length:	240 ft	Total Bottom Area:	19,200 sq ft		
Side Slopes XH:1V	3				Width:	80 ft	Total Top Area:	34,404 sq ft		
							Volume Calculated:	187,614	Good?	YES

Basin D WQ Pond

Required Pond Volume	8.55	ac-ft								
Required Pond Volume	372,438	cu ft								
Number of Ponds Wanted:	1									
Total Volume Required Per Pond:	372,438	cu ft								
Pond Design Based on Number of Pond Wanted:										
% Total Volume for Cell 1	0.3									
Total Volume for Cell 1	111,731	cu ft								
Depth Cell 1	6	ft	Length to Width Ratio:	3.03	Length:	200 ft	Total Bottom Area:	13,200 sq ft		
Side Slopes XH:1V	3				Width:	66.0 ft	Total Top Area:	24,072 sq ft		
							Volume Calculated:	111,816	Good?	YES
Total Volume Required for Cell 2	260,706.6	cu ft								
Depth Cell 2	7	ft	Length to Width Ratio:	3.16	Length:	300 ft	Total Bottom Area:	28,500 sq ft		
Side Slopes XH:1V	3				Width:	95 ft	Total Top Area:	46,854 sq ft		
							Volume Calculated:	263,739	Good?	YES

Notes

Yellow shading represents user input
Gray shading prepresents volume check for capacity
ac = acres, ac-ft = acre-feet, cu ft = cubic feet, ft = feet, sq ft = square feet

Table 2. Infiltration Calculations

Project No. 040010-016-01 CalPortland
Pioneer Aggregates South Parcel Project, DuPont,WA

Infiltration Pond C		Boring	15	15		18	18		
Original Ground Elevation	200	depth	168-178	178-188		168-778	178-188		
Existing Surface	25	D10	0.297	0.297		0.594	0.297		
Depth (bgs)	175	D60	12.7	9.525		12.7	4.75		
Analysis depth	12.5	D90	38.1	38.1		38.1	25.4		
		Fines	0.02	0.03		0.02	0.02		
	log (Ksat)		-1.35	-1.42		-0.79	-1.31		
	Ksat	cm/sec	0.04	0.04		0.16	0.05		
		in/hr	63.31	54.34		228.83	69.68		
			2.5 feet	10 feet		2.5	10		
		KsatAvg	55.92		KsatAvg		80.94		
	CFv	1	0.5	0.33	CFv	1	0.5	0.33	
	Correction Factor	0.36	0.18	0.1188		0.36	0.18	0.12	
	Ksat (in/hr)	20.132	10.066	6.644		29.140	14.570	9.62	8.13
								Ksat Final	8.1
Infiltration Pond D		Boring	8	8		7	7		
Original Ground Elevation	200	depth	168-178	178-188		168-180	180-185		
Existing Surface	25	D10	0.15	0.297		0.297	0.297		
Depth (bgs)	175	D60	4.75	12.7		9.525	12.7		
Analysis depth	12.5	D90	12.7	38.1		25.4	25.4		
		Fines	0.08	0.03		0.02	0.03		
	log (Ksat)		-1.53	-1.37		-1.23	-1.21		
	Ksat	cm/sec	0.03	0.04		0.06	0.06		
		in/hr	41.36	60.84		83.37	86.58		
		depth (ft)	2.5	10		5.0	7.5		
	KsatAvg	55.6033			KsatAvg		85.268		
	CFv	1	0.5	0.33	CFv	1	0.5	0.33	
	Correction Factor	0.36	0.18	0.1188		0.36	0.18	0.12	
	Ksat Design (in/hr)	20.02	10.01	6.61		30.70	15.35	10.13	8.37
								Ksat Final	8.2

Notes
Purple shading represents boring numbers
Pink shading represents Infiltration capacity calculations
bgs = below ground surface, cm/sec = centimeters per second, in/hr = inches per hour

Table 3. Infiltration Basin Design Summary

Project No. 040010-016-01, CalPortland
Pioneer Aggregates South Parcel Project, DuPont, WA

Basin C Designed Infiltration Pond:				
Length of bottom area (ft)	450			
Width of bottom area (ft)	113	Total Bottom Area:	50,762 sq ft	
Depth (ft)	5			
Side Slope X:1V	3	Total Top Area:	66,748 sq ft	(no freeboard - water surface)
Total Provided Volume (cu ft)	293,775			
Basin D Designed Infiltration Pond:				
Length of bottom area (ft)	1000			
Width of bottom area (ft)	37.7	Total Bottom Area:	37,655 sq ft	37655
Depth (ft)	5			
Side Slope X:1V	3	Total Top Area:	68,755 sq ft	(no freeboard - water surface)
Total Provided Volume (cu ft)	266,025			68755
Basin E Designed Infiltration Pond:				
Length of bottom area (ft)	600			
Width of bottom area (ft)	96.345	Total Bottom Area:	57,807 sq ft	
Depth (ft)	6			
Side Slope X:1V	3	Total Top Area:	82,120 sq ft	(no freeboard - water surface)
Total Provided Volume (cu ft)	419,781			