3.4 WATER RESOURCES - SURFACE WATER

This chapter of the DEIS describes surface water features — streams, lakes, the associated marsh system, and artificial channels – on the site and in the site vicinity. Potential impacts associated with the EIS Alternatives are evaluated and mitigation measures identified. This section is based on the *Earth and Water Resources Report* (May 2023), *Stormwater Management Report* (February 2021)*, Groundwater Model Update* (June 2017), and *South Parcel Monitoring Plan* (November 2017) all prepared by Aspect Consulting and peer reviewed by Mott MacDonald (see **Appendices B**, **D**, **E**, and **F**).

3.4.1 Affected Environment

Surface Water Hydrology

The surface water systems that are relevant to the site and Proposed Action include: Sequalitchew Lake, Sequalitchew Creek, the related marsh system, the Joint Base Lewis-McChord (JBLM) Stormwater Diversion Canal, on-site stormwater system, and the Kettle Wetland. In the Sequalitchew Creek watershed, the natural flow direction is westward from Sequalitchew Lake, through a portion of the marsh system, and into the Sequalitchew Creek ravine before discharging to Puget Sound. Construction of the Diversion Canal on JBLM created a secondary outlet for the water flowing out of Sequalitchew Lake, resulting in water no longer following the natural course to Sequalitchew Creek. Under current conditions, there is a segment of Sequalitchew Creek between the western margin of the marsh system and the steep ravine of the creek that does not typically have flowing surface water; this segment is referred to as the "dry reach" of Sequalitchew Creek. Relevant surface water bodies are depicted on **Figure 3.4-1**.

Sequalitchew Lake

Sequalitchew Lake is the headwaters of the Sequalitchew Creek watershed. It is an approximately 85-acre lake located on JBLM. The lake is fed by groundwater springs (Sequalitchew Springs)[1] at the east end of the lake and likely other groundwater discharges and minor surface water inputs. The normal water level of the lake is elevation 211.5 feet (ft) NGVD29.[2] The depth of the lake is approximately 6 ft on average and approximately 11.5 ft at maximum. The outlet of the lake is on the extreme west end of the lake.

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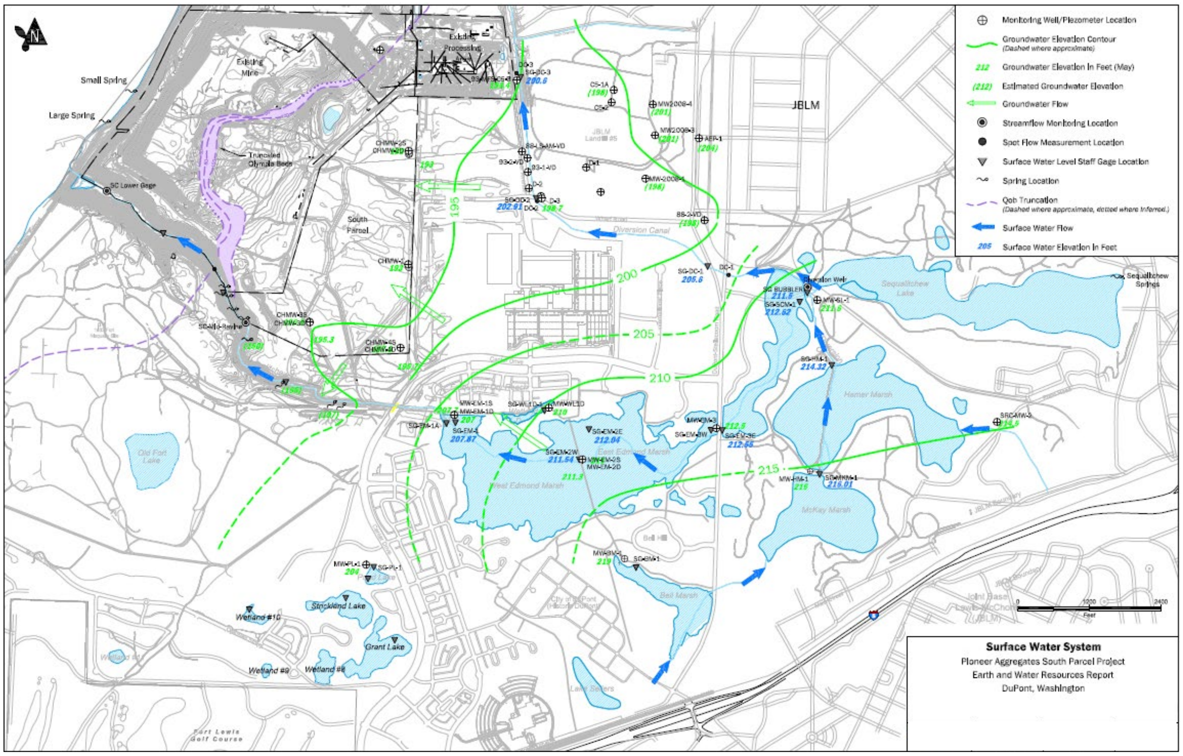
[1] *Sequalitchew Springs also provide the primary water supply for JBLM. Sequalitchew Springs represent a discharge from the groundwater system to the surface water system. Groundwater and surface water exchanges are complex and related to water level (or head) differences at any given location. Additional upgradient surface water bodies (e.g., American Lake) likely provide a source of water to the groundwater system that eventually discharges to Sequalitchew Lake.*

[2] *National Geodetic Vertical Datum of 1929.*

Figure 3.4-1
SEQUALITCHEW CREEK WATERSHED AND JBLM STORMWATER SURFACE WATER SYSTEM



Source: Aspect Consulting, 2022, Revised 2023.

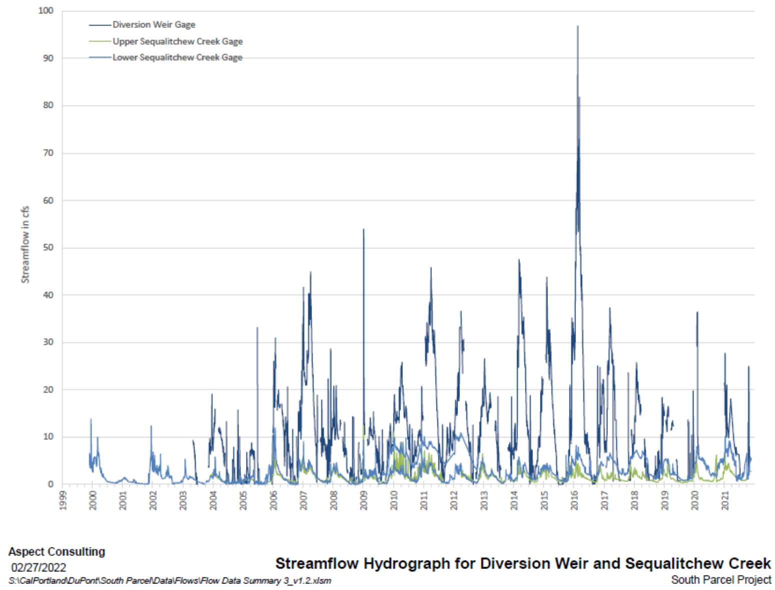
Historically, the lake outlet discharged primarily into Sequalitchew Creek and the associated marsh system to the southwest and west, eventually flowing into Puget Sound, though the flows through the marsh system were at times blocked due to beaver activity (i.e., dam-building). Washington Department of Fish and Wildlife (WDFW) operated a salmon rearing facility at the lake from 1976 to approximately 1997. In spring during that period, the fish would migrate out of the lake to Puget Sound via Sequalitchew Creek and the marsh system. To facilitate flows and a migration pathway for the outmigration, WDFW would remove beaver dams and heavy vegetation within the marsh system to create a flowing channel.

A culvert and weir system at the outlet of the lake was constructed in the 1950s to facilitate both outflow from the lake southwest toward Sequalitchew Creek and stormwater flow from JBLM northwest toward the Diversion Canal. Specifically, four 42-inch-diameter culverts—Sequalitchew Creek Culverts—connect the lake outlet with Sequalitchew Creek and were intended to convey the outflow of the lake southwest to the creek through the marsh system (i.e., to replicate historical conditions). Additionally, an 18-ft-wide concrete structure—Diversion Weir—with wooden stop logs was constructed at the lake outlet just upstream of the Sequalitchew Creek Culverts. The Diversion Weir was intended to control the water level of the lake (to protect JBLM's water supplies from Sequalitchew Springs) by directing water at high flow conditions to the Diversion Canal. Separately, three 48-inch-diameter culverts—Diversion Canal Culverts—cross under the Sequalitchew Creek Culverts to facilitate the northwest trending flows from Bell, McKay, and Hamer Marshes to the Diversion Canal. The flows from the Diversion Weir join the Diversion Canal just downstream (northwest) of the outlet of the Diversion Canal Culverts. As originally designed, the culvert and weir system would have conveyed the outflow from the lake toward the Sequalitchew Creek and marsh system and the stormwater flow from JBLM (and peak flows from the lake) into the Diversion Canal.

The culvert and weir system are currently in disrepair. Additionally, beaver dam construction within the marsh system increases surface water levels in the marsh to an elevation above the Sequalitchew Lake water level. The current disrepair of the system combined with nearby beaver dam construction within the marsh system results in the majority of outflow from the lake being routed to the JBLM Diversion Canal (i.e., the lake outflow bypasses the Sequalitchew Creek and marsh system). As such, discharges from the lake currently seldom flow into the creek and marsh system. There may be indirect discharges from the lake toward the creek and marsh system via groundwater but that has not been quantified.

Based on data recorded from 2003 to 2021, average monthly flows at the lake outlet weir vary from 2.4 cubic feet per second (cfs) in September to 21.5 cfs in March. During particularly dry years, there are periods during late summer or early fall when no flow is measured over the weir. No (or very low) flows over the diversion weir occur occasionally for limited periods (i.e., short periods in the summers of 2004, 2006, 2008, 2012, 2014, and 2016); extended periods of no-flow conditions occur in particularly dry years (i.e., in later summer and early fall of 2005 and 2015). Peak flows can reach approximately 40 to 50 cfs, with isolated occurrences of even greater flows (i.e., the maximum recorded flow over the diversion weir was approximately 97 cfs in early 2016). A hydrograph of flows measured at the Diversion Weir (representing outflow from Sequalitchew Lake) is shown on **Figure 3.4-2**. Monthly average flow rates recorded at the Diversion Weir from 2003 to 2021 are summarized in **Table 3.4-1**.

Figure 3.4-2
SEQUALITCHEW LAKE OUTFLOW (DIVERSION WEIR) AND SEQUALITCHEW CREEK STREAMFLOW MEASUREMENTS



Source: Aspect Consulting, 2022, Revised 2023.

Table 3.4-1
MONTHLY AVERAGE DIVERSION WEIR (SEQUALITCHEW LAKE OUTLET) AND SEQUALITCHEW CREEK FLOWS

Month	Average Flow in cfs				
	Diversion Weir	Mid-Sequalitchew Creek Ravine	Lower Sequalitchew Creek Ravine		
	2003 to 2021	2004 to 2021	1977 to 1978	1984 to 1987	1999 to 2021
January	15.6	2.5	9.7	5.9	4.0
February	19.6	2.6	12.8	8.5	4.2
March	21.5	2.2	12.2	8.7	3.8
April	19.8	2.0	0.7	9.4	3.2
May	12.7	1.6	1.6	7.8	2.7
June	7.4	1.2	1.5	3.7	1.9
July	3.2	0.9	0.2	1.3	1.3
August	2.8	0.8	0.1	1.0	1.1
September	2.4	0.8	0.1	1.0	1.1
October	3.7	0.8	0.1	1.4	1.4
November	7.1	1.3	2.4	3.7	2.6
December	10.9	1.9	10.5	5.1	3.5
Mean Annual Flow	10.5	1.6	4.3	4.8	2.7

Note: cfs = cubic feet per second

Source: Aspect Consulting, 2022, Revised 2023.

Sequalitchew Marsh System

The Sequalitchew Marsh system includes a complex series of marshes generally located between Sequalitchew Lake and the downstream portion of Sequalitchew Creek. Surface water flow from Bell, McKay, and Hamer Marshes is generally northward eventually draining to the JBLM Diversion Canal and from there into Puget Sound. Surface water flow from the East Edmond Marsh was historically westward to the West Edmond Marsh. At high flow conditions the West Edmond Marsh can discharge to Sequalitchew Creek and from there into Puget Sound. Due to beaver activity (e.g., dam building) in East Edmond Marsh, surface water now typically flows back eastward toward the Diversion Canal (i.e., does not follow its historical course down the creek). In addition, as described in Section 3.3, **Groundwater**, there are complex interactions between the marsh system and underlying groundwater. Namely, groundwater can discharge to surface water when groundwater levels are higher than surface water levels (i.e., in upward gradient conditions).

Conversely, surface water can discharge to groundwater when groundwater levels are lower than surface water levels (i.e., in downward gradient conditions). Indirect flow between the marshes via discharge to and from groundwater—from the south and east (Bell, McKay, Hamer Marshes) toward the west (East and West Edmond Marshes)—is inferred based on groundwater measurement contouring and marsh surface water level measurements. Based on the known surface water flow patterns and inferred groundwater-surface water interactions, Aspect (2022, Revised 2023) developed a spreadsheet-based water balance model of the marsh system, incorporating groundwater and surface water inflows/outflows, precipitation, and evapotranspiration. The water balance model can be used to estimate the hydraulic impact on certain elements of the system (e.g., water levels in the marshes or flows in Sequalitchew Creek) due to changes in other elements (e.g., lowered groundwater levels). The model provides a tool for assessing the interconnectedness of the groundwater and surface water systems and for predicting impacts to the surface water system from the Proposed Action and/or Sequalitchew Creek Restoration Plan.

East and West Edmond Marshes

East and West Edmond Marshes stretch from the outlet of Sequalitchew Lake to the dry reach of Sequalitchew Creek. East Edmond Marsh—including the eastern portion that is colloquially referred to as “Eastern East Edmond Marsh”—covers approximately 87 acres between the Sequalitchew Lake outlet and Robinson Trail (a former railroad grade converted to a public pedestrian trail). On the east end of Eastern East Edmond Marsh (just west of the Sequalitchew Lake outlet), a large beaver dam complex pools water in the marsh above that of the Sequalitchew Lake outlet, resulting in flow from the marsh eastward into the Diversion Canal (i.e., against the general—and historical—westward flow of water in the watershed). Eastern East Edmond Marsh is connected to East Edmond Marsh via a box culvert beneath DuPont-Steilacoom Road; water can flow east or west through the box culvert, depending on water levels in Eastern East and East Edmond

Marshes. Eastern East Edmond Marsh also receives some surface water flow from Hamer Marsh via a 12-inch culvert and likely shallow subsurface flows indirectly from Hamer Marsh via groundwater. According to the water balance model, East Edmond Marsh receives approximately 0.28 cfs, on average, as surface water inflows from Hamer Marsh and approximately 0.3 cfs, on average, from shallow groundwater inflow. East Edmond Marsh also loses water to groundwater outflow from other areas of the marsh at an estimated average rate of 0.5 cfs. The average water level in Eastern East Edmond Marsh is approximately 212.4 ft NGVD29 (or about 1 ft higher than the average Sequalitchew Lake level) and the average water level in East Edmond Marsh is approximately 212.2 to 212.4 ft NGVD29, indicating a slight westward gradient, on average. There is an open channel through East Edmond Marsh, which is likely the historical channel but may also have been excavated previously to facilitate flow (i.e., perhaps by WDFW for hatchery fish migration).

West Edmond Marsh covers approximately 80 acres between Robinson Trail and the dry reach of Sequalitchew Creek. West Edmond Marsh is hydraulically connected to East Edmond Marsh via a submerged culvert beneath Robinson Trail and likely subsurface flow beneath the trail. According to the water balance model, West Edmond Marsh receives approximately 0.17 cfs, on average, as surface water inflows from East Edmond Marsh (i.e., via the submerged culvert) and loses approximately 0.24 cfs, on average to groundwater outflow. Water levels in West Edmond Marsh vary and are controlled by several beaver dams. In the eastern portion of West Edmond Marsh, the average water level is approximately 211.4 ft NGVD29; in the western portion of West Edmond Marsh, the average water level is approximately 207.9 ft NGVD29. Sequalitchew Creek forms a channel along the northern margin of West Edmond Marsh. The western-most portion of West Edmond Marsh becomes dry in the summer of most years.

Bell, McKay, and Hamer Marshes

Bell, McKay, and Hamer Marshes cover approximately 18, 37, and 69 acres, respectively. While natural surface water bodies, they have been impacted by the construction of the Diversion Canal to facilitate drainage of stormwater from JBLM. The three marshes are in series, with surface water flows going from Bell to McKay to Hamer Marsh, facilitated by the Diversion Canal. The average water level in Bell Marsh is approximately 218.6 ft NGVD29. The average water level in McKay Marsh is approximately 215.4 ft NGVD29. The average water level in Hamer Marsh is approximately 214.0 ft NGVD29. The water levels in these three marshes are typically higher than those of East and West Edmond Marshes. As such, a portion of the water (estimated by the water balance model to be approximately 0.3 cfs on average) from Bell, McKay, and Hamer Marshes may infiltrate to ground and flow as groundwater to discharge to East and West Edmond Marshes. In addition, some surface water (estimated by the water balance model to be approximately 0.28 cfs on average) flows directly from Hamer Marsh to Eastern East Edmond Marsh via the 12-inch culvert connecting those two bodies.

Sequalitchew Creek

Sequalitchew Creek is approximately 3.3 miles long, starting from the eastern end of East Edmond Marsh, continuing as a channel through East and West Edmond Marshes as described above, exiting the marsh system on the western end of West Edmond Marsh into the dry reach of the creek between West Edmond Marsh and the steep creek ravine, then through the ravine section to discharge into Puget Sound. Historically, the creek began at Sequalitchew Lake; however, the construction of the Diversion Weir at the outlet of the lake and the beaver dams in the marsh system have largely restricted the direct surface water connection between the lake and the creek. Within East and West Edmond Marshes, the creek is low-gradient/low-velocity and appears as a channel of open water or a channel of less dense vegetation. Within the dry reach of the creek, flows exiting West Edmond Marsh typically infiltrate into ground, leaving the dry reach, including the portion of the creek that passes underneath Center Drive, grassy and without flow most of the time. West of the dry reach, the creek grade steepens into an approximately 1.3-mile-long ravine, where groundwater springs—discharging from the Steilacoom Gravel Member subunit of the Vashon Recessional Outwash aquifer—restore surface water flows to the creek. The creek continues westward through the incised ravine section, gaining flow from additional groundwater springs in the upper portion of the ravine. As the creek continues past the location of the Olympia Beds Truncation, about midway through the ravine section of the creek, west of which the aquitard is no longer present and groundwater levels are lower, additional observable groundwater spring discharges to the creek appear to cease. As the creek nears Puget Sound, the ravine section widens, and the gradient lessens. The creek discharges to Puget Sound via a 5-ft by 5-ft box culvert beneath an active railroad grade. The railroad grade culvert appears to limit the connection between the creek and Puget Sound, resulting in a brackish marsh immediately upstream of the culvert.

Average annual streamflow measured (for the period from 2004 to 2021) at a gaging station located approximately 3,900 ft upstream from Puget Sound is approximately 1.6 cfs (with peak flows typically between 5 and 8 cfs and with low flows of approximately 1 cfs or less). Average annual streamflow measured (for the same period) at a separate gaging station located approximately 700 ft upstream of Puget Sound just upstream of the brackish marsh at the mouth of the creek (the lower gage) is approximately 2.8 cfs (with peak flows typically between 5 and 10 cfs and with low flows of approximately 2 cfs or less).[3] Baseflow in the ravine section of the creek appears to vary from approximately 0.5 cfs in late summer to approximately 2.5 cfs in winter. Annual peak daily flow is typically between 5 and 10 cfs, with the maximum peak daily flow recorded as 13.8 cfs (in December 1999 at the lower gage). Hydrograph timeseries of Sequalitchew Creek flows are summarized in **Appendix E**.

[3] *The increase in streamflow from the mid-ravine gaging station to the lower gage can be attributed to groundwater inflows from springs and seeps between the mid-ravine station and the Olympia Beds Truncation, additional surface water inflows, and possibly other groundwater discharges adding flow to that section of the creek, potentially directly to the creek bed, which would be difficult to observe.*

Sequalitchew Creek and all tributaries (including Sequalitchew Lake) are closed to further consumptive appropriations (i.e., water right permitted diversions) by the Washington State Department of Ecology (Ecology), according to the instream flow rule of Chapter 173-512 Washington Administrative Code (WAC).

On-Site Stormwater

Due to the high permeability of site soils, precipitation falling on the site generally infiltrates at or near where it falls or is conveyed by ditches to small infiltration facilities distributed throughout the existing mine. Infiltration of stormwater on-site is facilitated by a combination of relatively permeable surficial soils (outwash material) remaining within the mined area as well as a depth to groundwater of approximately 10 to 14 ft below ground surface, which allows for a vertical gradient and downward flow. As such, on-site stormwater is contained within the existing mine. Furthermore, there are no documented streams or natural drainage channels conveying surface water to or from the site.

Kettle Wetland

The Kettle Wetland is an existing 1.78-acre natural wetland located in the Expansion Area of the site. The wetland is an example of a kettle lake, a common continental glacier feature that forms from a large block of isolated glacial ice that becomes surrounded by outwash sediments. When the ice melts, a topographic depression forms where water can collect. Based on the elevation of its bottom, the Kettle Wetland appears to be in direct hydraulic connection with the Vashon Aquifer (Steilacoom Gravel Member and/or Outwash).

Other Surface Water Features

There are numerous other surface water features in the vicinity of, but not directly connected by surface water flow to, Sequalitchew Creek. An example of other surface water features is Wetland 1-D, a small (2.1-acre) wetland immediately north of West Edmond Marsh. While Wetland 1-D is not connected to other wetlands or Sequalitchew Creek by surface water, it likely exchanges flow indirectly via groundwater.

Other isolated kettle wetland/lake formations include Pond, Strickland, Grant, and Old Fort Lakes, as well as Wetlands #8, #9, #10, and #11, all of which are located south of Sequalitchew Creek. The kettle wetland/lake formations are not directly connected to Sequalitchew Creek or marsh system by surface water and experience water level fluctuations similar to those of the groundwater system that exists south of Sequalitchew Creek.

Surface Water Quality

This section summarizes the known water quality information related to relevant surface water bodies onsite and within the Sequalitchew Creek watershed.

On-Site Kettle Wetland

Water quality data for the Kettle Wetland is not available. However, because the Kettle Wetland is likely in direct hydraulic connection with—and likely a reflection of—the Vashon Aquifer, the surface water quality of the wetland is likely similar to that of the groundwater.

Sequalitchew Creek Watershed

The relevant water quality standards for the Sequalitchew Creek watershed—including Sequalitchew Lake, East and West Edmond Marshes, and Sequalitchew Creek—are described in Chapter 173-201A WAC. Sequalitchew Lake and Sequalitchew Creek each have a designated aquatic life use of core summer salmonid habitat because they are tributary to Puget Sound, which is designated as an extraordinary aquatic life marine water, per WAC 173-201A-600(1)(a)(iv) and 173-201A-612. The current freshwater quality standards for core summer salmonid habitat, in accordance with WAC 173-201A-200, are summarized in **Table 3.4-2.**

Table 3.4-2
FRESH WATER QUALITY CRITERIA FOR CORE SUMMER SALMOND HABITAT

Parameter	Criterion	Allowable Change
Temperature (7-DADMax)	16.0°C	0.3°C when T ≥ 16.0°C or 28/(T+7) when T < 16.0°C
Dissolved Oxygen (1-Day Minimum)	10.0 mg/L or 95% Saturation	0.2 mg/L
Turbidity	N/A	5 NTU over background when ≤ 50 NTU; 10% increase when > 50 NTU
Total Dissolved Gas	110% of Saturation	--
pH	6.5 to 8.5 Standard Units	<0.2 Standard Units

Source: Chapter 173-201A WAC.
Notes:
°C = degrees Celsius
T = background temperature unaffected by project
mg/L = milligrams per liter
7-DADMax = 7-day average of daily maximum temperatures
NTU = nephelometric turbidity units

Sequalitchew Lake

The water quality in Sequalitchew Lake is generally good. Temperature varies seasonally from above 20 degrees Celsius (°C) in summer to below 6°C in winter. Dissolved oxygen concentrations are typically greater than 9 milligrams per liter (mg/L), pH is neutral, and turbidity is generally low.

Marsh System

The water quality of the marsh system is representative of a more stagnant, aquatic plant-rich environment. Temperatures in the marsh system vary more than in the lake, with summertime temperatures approximately 22°C (72°F) and wintertime temperatures approximately 3°C (37°F). Dissolved oxygen concentrations are relatively low, typically less than 4 mg/L, and pH is slightly acidic (median value of 6.5 Standard Units). Turbidity is relatively low, or less than 10 nephelometric turbidity units (NTU). Measured iron concentrations are relatively elevated (above 1 mg/L) in East and West Edmond Marshes, particularly near Robinson Trail (an old railroad grade) where groundwater seeps enter the marshes. Concentrations of other metals commonly associated with stormwater runoff (e.g., copper and zinc) are low in the marshes.

Sequalitchew Creek

The water quality of the ravine section of Sequalitchew Creek (west of the marshes and dry reach of the creek) is very good and relatively consistent, likely related to the primary source of surface water flow in the creek being the groundwater seeps. Temperatures in the creek are generally cool, less than 15°C (59°F). Dissolved oxygen concentrations are relatively high, typically greater than 9 mg/L. Turbidity is low, or less than 15 NTU. Metals concentrations in the creek are consistently low.

3.4.2 Impacts of the Alternatives

This section describes the anticipated impacts to the surface water system of the site and the Sequalitchew Creek watershed resulting from the two alternatives.

ALTERNATIVE 1 – PROPOSED ACTION

Under Alternative 1—the Proposed South Parcel Project (Proposed Action)—there would likely be impacts to surface water features both onsite and within the larger Sequalitchew Creek watershed. The impacts to surface water features would be primarily a result of the permanently lowered groundwater levels in the vicinity of the site due to long-term pumping and groundwater drainage at the site.

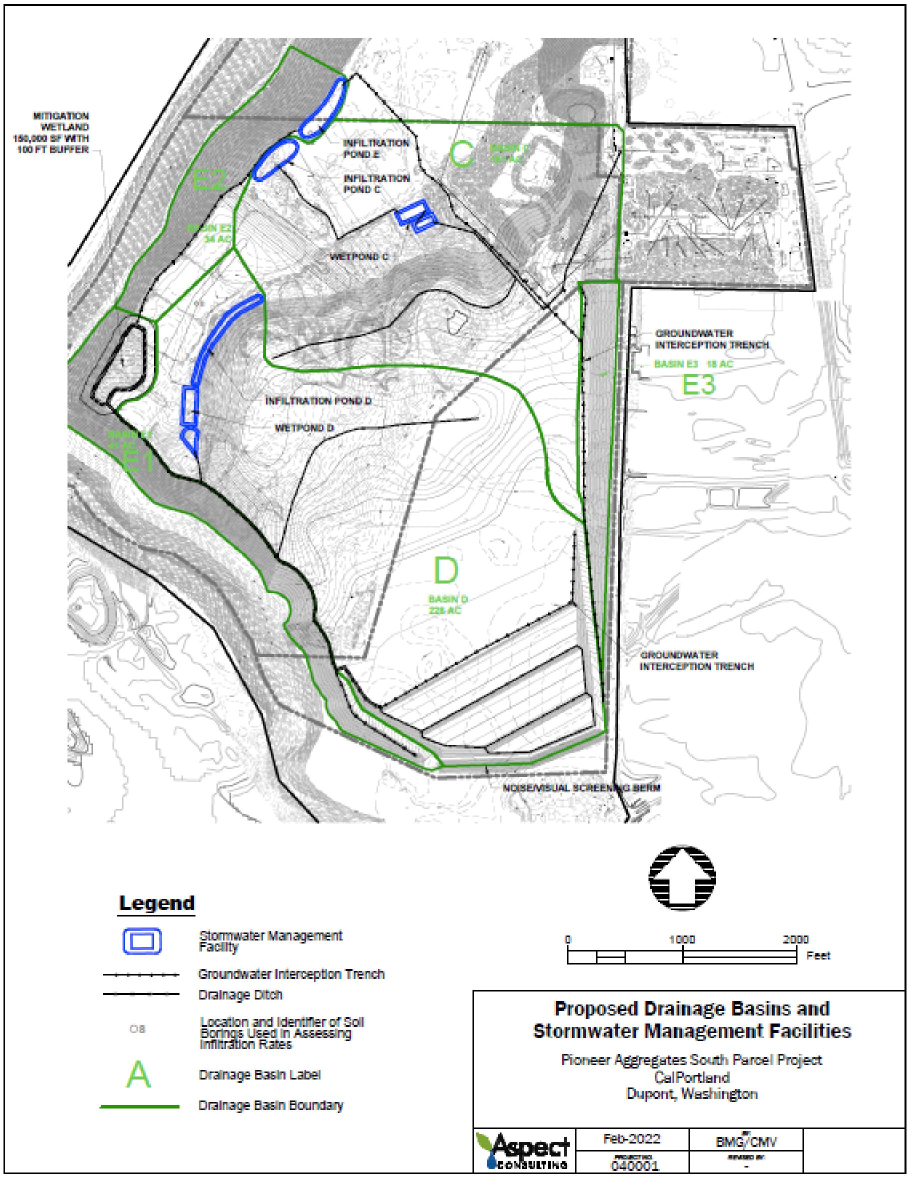
On an overall basis, changes in site grading would affect stormwater flows, but not the overall stormwater balance within the site. Primarily, changes in groundwater levels beneath the site resulting from proposed groundwater lowering are expected to affect flow in Sequalitchew Creek and surface water levels in the marsh system.

Stormwater Management

Under the Proposed Action, stormwater would continue to be managed and infiltrated on-site. As mining activities remove the permeable outwash materials and expose the underlying relatively impermeable Olympia Beds material, conveyance channels would be excavated to direct stormwater flows – and a significant amount of intercepted groundwater flows from the eastern slopes of the expanded mining area – toward three infiltration facilities in the lower (western) portion of the existing mine area of the site. For stormwater management planning purposes, the site has been divided into five contributing areas (or basins). Basins C and D would include 390 acres of the existing mine and expansion area. Basins E1, E2, and E3 would include a total of approximately 92.6 acres of the side slopes of the mined area (existing and expanded). All basins would contribute stormwater flows to be conveyed and infiltrated on-site. Flows from Basin E3 would also include the extracted groundwater from dewatering activities (while active dewatering is taking place) and intercepted groundwater (following active dewatering and mining activities) emanating from the eastern slope of the expanded mining area. A site water balance model was developed by Aspect (2022, Revised 2023) to quantify estimated stormwater and groundwater inflows and outflows from each basin.

Stormwater flows from Basins C and D would pass through one of two pairs of water quality treatment cells to reduce solids content in the water prior to entering the infiltration ponds designated for those basins (i.e., Infiltration Ponds C and D, respectively). Flows from Basin E1 would be conveyed to a constructed mitigation wetland (described below in the Mitigation Measures section and more fully in Section 3.6, **Plants and Animals**, and eventually to the third infiltration facility, Infiltration Pond E, which would also receive direct stormwater flows from Basins E2 and E3. The proposed stormwater basins and water quality and infiltration facilities are shown on **Figure 3.4-3.**

Figure 3.4-3
PROPOSED STORMWATER MANAGEMENT BASINS, WATER QUALITY TREATMENT, AND INFILTRATION FACILITIES



Source: Aspect Consulting, 2022, Revised 2023.

The water quality treatment and infiltration facilities would require performance monitoring and maintenance in order to retain their function. The project Stormwater Management Report (Aspect 2021) does not provide details regarding operation and maintenance (O&M) of the facilities; however, proper operation and maintenance (O&M) of the facilities would be a required element of the Sand and Gravel Permit coverage for the facility and an O&M plan would be developed during the permitting process.
Failure to maintain water quality treatment facilities, particularly for the interception of fine particles could result in particulates reducing the infiltration capacity of the system.

Reduced infiltration capacity of the system, if significant enough, could result in ponding of water in the lower portions of the reclaimed mine under severe storm events. Infiltration capacity could be restored through maintenance of the infiltration facilities or, in the worst case, establishing new infiltration facilities in the permeable gravels that remain on the floor of the existing mine.

Sequalitchew Creek Watershed Impacts

While no direct surface water diversions are proposed as part of the project, indirect impacts to surface waters will likely occur from the permanently lowered groundwater levels caused by dewatering, excavation, and groundwater seepage and stormwater diversion. Groundwater is in direct hydraulic connection with portions of the watershed surface water system; therefore, impacts to groundwater may also affect surface waters. The impact to surface waters will be more severe for those water bodies closer to the site.

Sequalitchew Lake

Sequalitchew Lake is located east of the area anticipated to be impacted by appreciable (i.e., greater than 0.5 ft) groundwater drawdown due to proposed dewatering. The primary water source to the lake is groundwater (spring) discharge at the far eastern end of the lake. The eastern end of the lake is relatively far removed from the anticipated appreciable groundwater drawdown area. In addition, the lake level is controlled artificially by the Diversion Weir. For these reasons, water levels in Sequalitchew Lake are not anticipated to be significantly impacted by the Proposed Action.

Marsh System

The anticipated impacts to water levels within the marsh system—including Bell-McKay-Hamer and East and West Edmond Marshes—were estimated using a spreadsheet-based water balance model of the marsh system (described above in the Sequalitchew Marsh System section of Affected Environment). The marsh water balance model is described in more detail by Aspect (2022, Revised 2023).

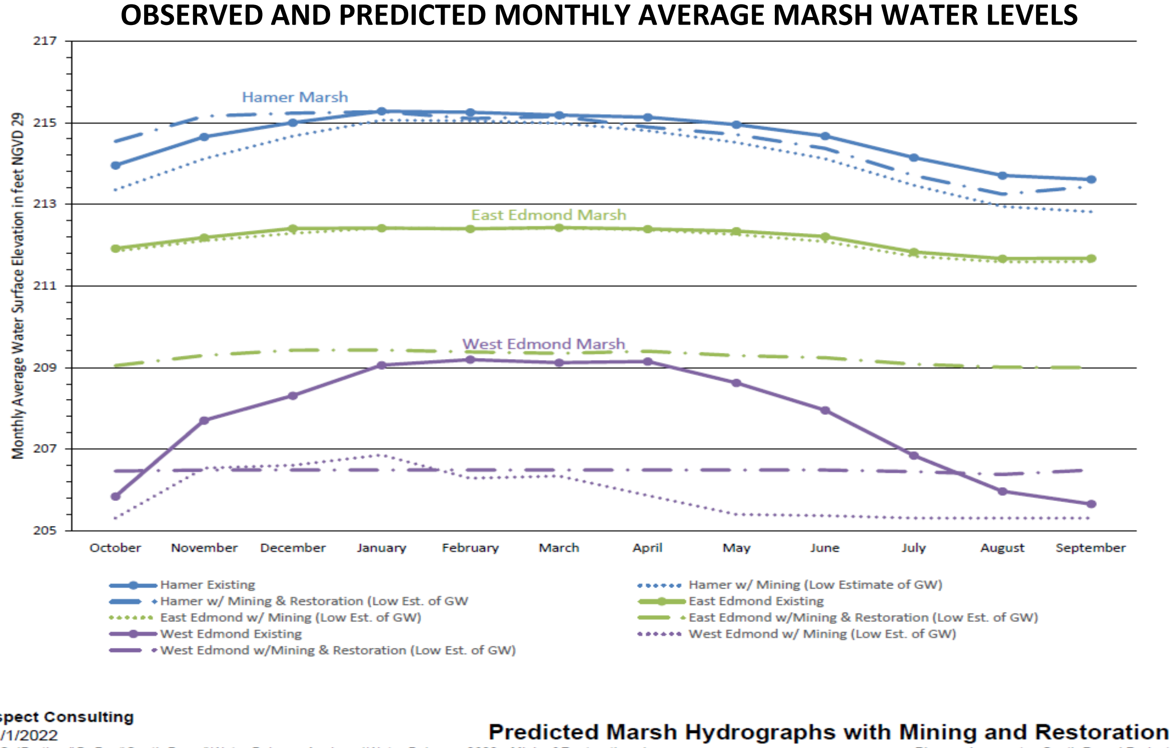
The calibrated marsh water balance model was used to predict the anticipated impact on average monthly marsh water levels due to proposed groundwater-level lowering at the site. The primary driver for the anticipated impacts to surface waters are estimated lowered groundwater levels beneath the marshes (as simulated by the groundwater model, described in Section 3.3, **Groundwater**, which would lead to increased groundwater recharge (or outflow) from the marshes. The results of the marsh water balance model indicate that water levels in the marsh would be expected to be lowered, compared to observed water levels during the simulated period, due to the proposed groundwater lowering. The effect on marsh water levels is anticipated to vary seasonally as well.
In West Edmond Marsh, located closest to the site, the decrease in water levels may vary between 0.35 ft (in late summer, when West Edmond Marsh is often dry under existing

conditions) and 3.0 ft (in spring). The average decline was calculated as 1.9 ft. Without mitigation, the projected lower water levels in West Edmond Marsh would likely result in reduced potential for outflows from the marsh system into the ravine section of Sequalitchew Creek; however, outflows from West Edmond Marsh do not commonly reach the ravine section of Sequalitchew Creek under existing conditions.

In East Edmond Marsh, the decrease in water levels may vary between 0.005 ft (in winter) and 0.13 ft (in early summer). The average decline was calculated as 0.1 ft. These projected lower water levels in East Edmond Marsh are small and would likely not have a significant impact on the potential for surface water outflows from the marsh system to the ravine section of Sequalitchew Creek.

In Bell-McKay-Hamer Marshes, the decrease in water levels may vary between 0.2 ft (in spring) and 0.8 ft (in late summer). The average decline was calculated as 0.3 ft. These projected lower water levels in Bell-McKay-Hamer Marshes would likely lead to less flow – groundwater and surface water – from those marshes to East Edmond Marsh. Hydrographs showing observed (solid line with circular symbols) and predicted (under Proposed Action only conditions; dotted line) monthly average water levels in the marsh system are presented on **Figure 3.4-4**. The dashed-dotted line showing predicted flows under Proposed Action and Streamflow Restoration alternative is discussed below in the Mitigation Measures section.

Figure 3.4-4
OBSERVED AND PREDICTED MONTHLY AVERAGE MARSH WATER LEVELS



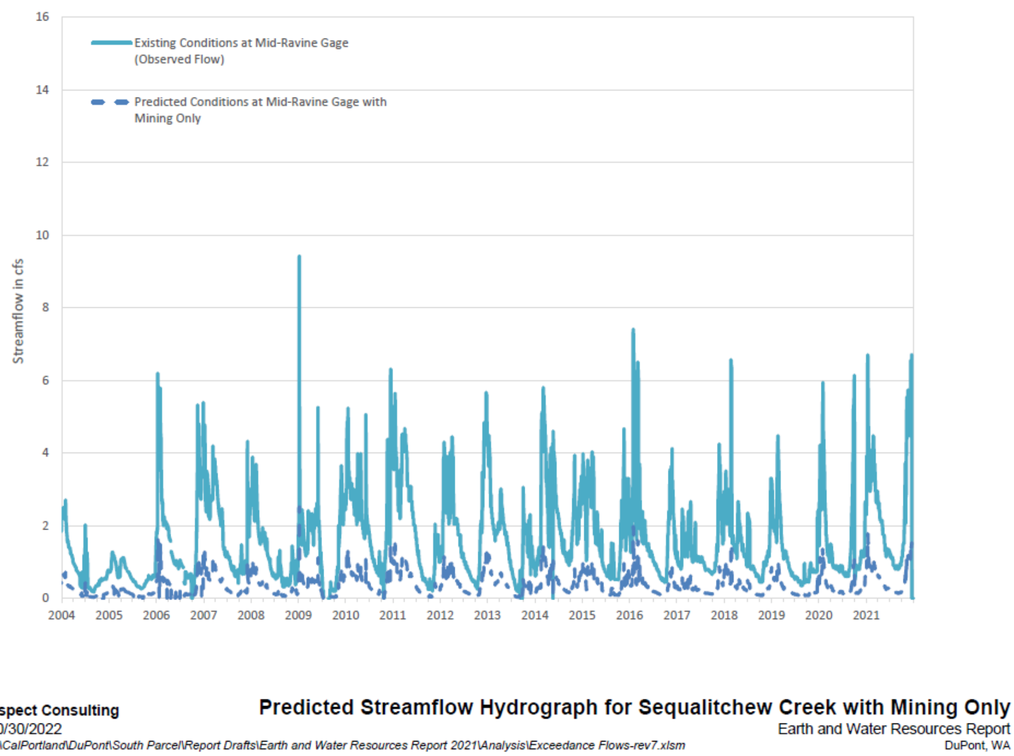
Source: Aspect Consulting, 2022, Revised 2023.

Sequalitchew Creek

The Proposed Action and associated groundwater-level lowering will decrease the number and flow rate of groundwater seeps and springs feeding Sequalitchew Creek within the ravine section. The impact to the groundwater springs and resulting Sequalitchew Creek flows was estimated using the numerical groundwater flow model, as described in Section **3.3, Groundwater**. Under long-term future proposed conditions (i.e., Step 4 of dewatering), reductions in spring flows leading to the creek are anticipated to occur throughout the entire year and to range from 76% (in January) to 86% (in summer). Base flow and peak flow in the creek are accordingly expected to be reduced. The annual average flow in Sequalitchew Creek is anticipated to be reduced from approximately 1.6 cfs to approximately 0.34 cfs. Hydrographs showing the observed and predicted flows in Sequalitchew Creek based on 2003 to 2021 data are shown on **Figure 3.4-5**.

While the Proposed Action is anticipated to negatively impact flows in Sequalitchew Creek, which is closed to further consumptive appropriations by the instream flow rule of Chapter 173-512 WAC, the Proposed Action does not require a water right from Ecology, as the pumped groundwater will not be withdrawn for the purpose of putting it to beneficial use.

Figure 3.4-5
OBSERVED AND PREDICTED SEQUALITCHEW CREEK FLOW HYDROGRAPHS



Source: Aspect Consulting, 2022, Revised 2023.

Other Surface Water Features

Other surface water bodies—including Wetland 1-D; Pond, Strickland, Grant, and Old Fort Lakes; and Wetlands #8, #9, #10, and #11—may be impacted by the proposed groundwater lowering , based on numerical groundwater flow model results. The magnitude of the impact is dependent on proximity to the proposed groundwater lowering activities at the site. Wetland 1-D water levels are anticipated to be reduced by approximately 3 ft, a relatively large impact, owing to its closer proximity to the site. Water levels in Pond Lake may be reduced by approximately 2 ft, resulting in the pond going dry earlier in the year (it typically goes dry currently in spring to mid-summer). Water levels in Wetlands #8, #9, #10, and #11 are anticipated to be reduced by approximately 1 ft. Old Fort Lake water levels may be reduced by approximately 0.5 ft. These water features and potential impacts to them are described in more detail in Section 3.5, **Fisheries**.

Kettle Wetland - The Kettle Wetland and its buffer would be cleared under the Proposed Action, and the entire wetland would be eliminated. The Kettle Wetland relies on groundwater to sustain wetland vegetation so even if the Kettle Wetland were to be left in place within the site, the change in groundwater levels would eventually alter the hydrology of the Kettle Wetland, converting the wetland vegetation to upland plant species. Proposed mitigation for these wetland impacts includes creation of a new wetland, as discussed in Sub-Section 3.5.3.

CUMULATIVE IMPACTS WITH PROPOSED ACTION AND SEQUALITCHEW CREEK RESTORATION PLAN

As described in Chapter 2 of this DEIS, the 2011 Settlement Agreement states permits for the Pioneer Aggregates South Parcel Project (Proposed Action) shall not be effective until permits for the Sequalitchew Creek Restoration Plan (Restoration Plan) are in place. The Restoration Plan will be evaluated as a separate but related action. The Restoration Plan seeks to restore and enhance streamflow and ecological functions from Sequalitchew Lake through Edmond Marsh into Sequalitchew Creek ravine by sequentially restoring diverted flows back to the creek, improving the sustainability of flows through the system, and restoring aquatic habitat.

It is assumed that CalPortland funding/implementation of projects associated with the Restoration Plan would be mitigation for certain environmental impacts identified in this DEIS and would be a condition of any City of DuPont approval of the Proposed Action.

The primary components of the Restoration Plan include:

- Improve hydraulic gradients so water discharges from Hamer and Bell Marshes flow into Edmond Marsh rather than into the Diversion Canal.

- Improve Sequalitchew Lake outlet and the Diversion Weir structure to allow significant flows from the lake into the Edmond Marsh complex to support a functional creek ecosystem and provide for the passage of migratory fish in the Sequalitchew Creek system.
- Rehabilitate East and West Edmond Marshes by removal of sufficient fill and other flow impediments to provide hydraulic gradients and capacity necessary to achieve and maintain adequate flows through the marsh system.
- Rehabilitate Sequalitchew Creek below West Edmond Marsh (i.e., the dry reach) to reduce seepage, improve fish habitat, and help restore year-round flows.
- Actively manage beaver activities (e.g., on-going beaver dam removal, installation and maintenance of beaver exclusion devices, etc.) to maintain hydraulic gradients that provide flows through Hamer, Bell, and Edmond Marshes.

The effectiveness of these elements depends on the independent modification of the diversion structure within JBLM which is proceeding as a separate federal project. JBLM entered a Memorandum of Agreement (MOA) with the Environmental Caucus, the South Puget Sound Salmon Enhancement Group and CalPortland describing the commitments each party is making to enhance flows down the creek. This includes substantial water utility repair and maintenance of the structures on JBLM. Congress has also indicated to the Army that the work on JBLM is a priority by including the following language in the Congressional Committee Report attached to the National Defense Authorization Act:

> "*The committee commends the Army for its work thus far in accomplishing needed environmental restoration projects related to Sequalitchew Creek and its associated canals. The committee notes that the Army made an important first step in this process by executing a memorandum of agreement with stakeholders. The committee encourages the Army to continue its work by following up with agreed-upon water utility repair and developing a maintenance plan per the memorandum of agreement.*"

The Settlement Agreement states that permits for the Restoration Plan must be in place before permits for the Proposed Action are effective. The plan identifies specific objectives and establishes performance thresholds and aspirational goals to be accomplished for each objective, along with an adaptive management plan to adapt to changing conditions and observations during plan implementation. Monitoring during mining is presumed to ensure that groundwater levels remain within the expected range. If groundwater levels are not maintained within the expected range it is specified that corrective actions will be implemented in accordance with the adaptive management plan for mining.

The anticipated combined effect on surface waters of the Proposed Action and the Restoration Plan is summarized in this section.

Marsh System

Water Levels

Water levels in the marsh system under the Proposed Action and Restoration Plan implementation were assessed with the marsh water balance model. The objectives and performance thresholds of the Restoration Plan were designed to improve flows and habitat to compensate for the impacts to the marsh system from drawdown of groundwater levels and subsequent effects on marsh water levels. Parameters established for the marsh system model to replicate combined effects of the Proposed Action and Restoration Plan included:

- Groundwater levels were lowered in accordance with a conservatively low estimate of simulated long-term groundwater conditions due to proposed groundwater dewatering and mining activity.
- Marsh surface level control structures in East and West Edmond Marshes and Hamer Marsh were assumed functional and effective with modification of the JBLM diversion and beaver management (e.g., selective removal of beaver dam structures and installation and maintenance of beaver exclusion devices). The target water levels were set to ensure east to west movement of water through the marsh system:
  - Eastern East Edmond Marsh: 210.5 ft NGVD29 (compared to the current average of 212.4 ft NGVD29)
  - East Edmond Marsh: 209 ft NGVD29 (compared to the current average of 212.2 to 212.4 ft NGVD29)
  - West Edmond Marsh: 206.5 ft NGVD29 (compared to the current average of 207.9 ft NGVD29 in the western portion of the marsh).
- Flows from Sequalitchew Lake were to be routed to Sequalitchew Creek via Eastern East Edmond Marsh (i.e., not diverted to the Diversion Canal).
- The dry reach of Sequalitchew Creek was assumed to be lined to prevent surface water flows leaving West Edmond Marsh from infiltrating to ground and, rather, continuing as surface water flows into the ravine section of the creek.

The results of the modeling indicate that the target water levels (which are significantly lower than they currently are) in the East and West Edmond Marshes could generally be achieved, resulting in continuous surface water flow from Sequalitchew Lake through to Sequalitchew Creek. The anticipated gradient across the marsh system from the Sequalitchew Lake outlet to the west end of West Edmond Marsh would be approximately 0.0006 feet per foot, or 0.06 feet per 100 feet. The East and West Edmond Marshes water levels are anticipated to be relatively consistent throughout the year. The predicted marsh system water levels under the Proposed Action and Restoration Plan scenario are shown earlier on **Figure 3.3-4.**

Table 3.4-3 provides a monthly summary of predicted flows from the lake to the marsh system, flows from the marsh system to the creek, and gain or loss from the marshes from or to groundwater, precipitation, and evapotranspiration. For comparison, monthly average flows from Sequalitchew Lake (to the Diversion Canal) based on existing observed data are also shown in **Table 3.4-3**.

Water Quality

In general, the water quality within East and West Edmond Marshes would be expected to be improved under the Proposed Action and Restoration Plan scenario, due to increased and consistent surface water inflows from Sequalitchew Lake and flushing out through Sequalitchew Creek. In particular, dissolved oxygen would likely increase and pH would likely become more neutral. Increased flows through the marsh system may also result in lower iron concentrations near Robinson Trail due to increased flushing.

Table 3.4-3
PREDICTED SURFACE WATER FLOWS TO AND FROM THE MARSH SYSTEM

Month	Existing Conditions	Predicted Conditions for Sequalitchew Marsh System			
	Average Outflow from Sequalitchew Lake (cfs)	Average Inflow from Sequalitchew Lake (cfs)	Average Outflow to Sequalitchew Creek (cfs)	Gain (+) or Loss (-) Flow (cfs)	Gain (+) or Loss (-) Percent (%)
January	15.6	15.8	18.5	2.7	17%
February	19.6	19.8	22.0	2.2	11%
March	21.5	22.2	24.3	2.1	9%
April	19.8	20.4	21.9	1.5	7%
May	12.7	13.4	14.6	1.2	9%
June	7.4	7.7	8.5	0.8	10%
July	3.2	3.4	3.5	0.1	3%
August	2.8	2.5	2.4	-0.1	-4%
September	2.4	2.2	2.4	0.2	9%
October	3.7	3.7	4.7	1.0	27%
November	7.1	7.1	8.8	1.7	24%
December	10.9	11.0	13.2	2.2	20%
Average:	**10.6**	**10.8**	**12.1**	**1.3**	**12%**

Note: cfs = cubic feet per second

Source: Adapted from Aspect Consulting, 2022, Revised 2023.

Sequalitchew Creek

Creek Flows

Under the Proposed Action and Restoration Plan scenario, flow rates and volumes delivered to – and flowing through – the dry reach segment of Sequalitchew Creek between West Edmond Marsh and the ravine section of the creek are generally expected to increase. Under this scenario, the predicted flows for the dry reach vary by month, from 2.4 cfs in August/September to 24.3 cfs in March, with an average annual flow of 12.1 cfs. Peak flows may reach as high as 65 cfs. Even with the Restoration Plan implemented, there may still be periods of dry, no-flow conditions in the dry reach of the creek, namely during dry periods when flow from Sequalitchew Lake through the Diversion Weir may not occur (i.e., in conditions similar to the low- or no-flow conditions, described in Section 3.3B.1, of the relatively dry years of 2004, 2005, 2006, 2008, 2012, 2014, 2015, and 2016).

Flows in the ravine section of Sequalitchew Creek were predicted based on the sum of predicted dry reach flows under the Proposed Action and Restoration Plan scenario and remaining groundwater discharges in the ravine.[4] The average monthly flows in the ravine section of the creek are predicted to range from 2.5 cfs in August to 26.3 cfs in March, with an average annual flow of 12.9 cfs (compared to the current 1.6 cfs average observed at the mid-ravine gage). Similar to predictions for the dry reach, there may be periods with reduced—or zero—flow in Sequalitchew Creek at the mid-ravine gage despite the Restoration Plan because of no outlet flows from Sequalitchew Lake. Flows in the creek may be lower than under existing conditions approximately 10% of the time. The number of no-flow days at the mid-ravine gage would be expected to increase under the Proposed Action and Restoration Plan scenario compared to existing conditions because of reduced or eliminated groundwater seepage to the ravine section of the creek that would no longer be present to add flows to the creek under low- or no-flow conditions upstream from Sequalitchew Lake. Periods with lower predicted flows in the creek compared to existing conditions are anticipated to occur typically in the period from July through October. The number of no-flow days at the mid-ravine gage also would be expected to increase under the Proposed Action and Restoration Plan scenario compared to existing conditions because of reduced or eliminated groundwater seepage to the ravine section of the creek that would no longer be present to add flows to the creek under low- or no-flow conditions upstream from Sequalitchew Lake. However, no flow days are rare under existing conditions (occurring approximately 0.13% of the time) and would remain rare (0.46% of the time) with the Proposed Action and Restoration Plan.

Potential impacts on fisheries resources are discussed in Section 3.6, **Plants and Animals**.

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[4] *The two components summed for this analysis represent: (a) the predicted surface water flows to Sequalitchew Creek from discharges from West Edmond Marsh as a result of the Restoration Plan implementation and (b) the predicted additional contributions to Sequalitchew Creek from remaining groundwater springs and seeps following the Proposed Action.*

Water Quality

The water quality effects in the ravine section of Sequalitchew Creek from the combined Proposed Project and Restoration Plan scenario would be primarily related to temperature. Flows in the creek, currently supplied primarily by consistently cool groundwater discharges, would instead be largely supplied by surface water flows originating in Sequalitchew Lake (which is relatively warm in summer and cold in winter) under this scenario. Temperatures in the creek in the winter are expected to fall to 5 or 6°C (41°F to 43°F). Creek temperatures in the summer—particularly June through August—are expected to rise to 21°C. Exceedances of the 16°C (61°F) 7-day average of daily maximums criterion of Chapter 173-201A WAC could be expected from May through September. These seasonal fluctuations in surface water temperatures in Sequalitchew Creek, however, may be more analogous to historical conditions in the creek prior to the construction of the Diversion Weir and Canal and re-routing of most of the Sequalitchew Lake outflows away from the creek and marsh system into the Diversion Canal. However, temperatures in the creek would be slightly higher than they were historically because of the reduction of groundwater seeps and springs providing groundwater flow to the ravine section of the creek resulting from the Proposed Action.

Other Surface Water Features

Because the other nearby surface water bodies—including Wetland 1-D; Pond, Strickland, Grant, and Old Fort Lakes; and Wetlands #8, #9, #10, and #11—would not benefit directly from the Restoration Plan implementation, they would be expected to be impacted by the proposed groundwater lowering in a similar manner as under the Proposed Action, as discussed above.

Stormwater Management

Because on-site stormwater flows and management would not be affected by implementation of the Restoration Plan, stormwater management would be performed in a similar manner as proposed under the Proposed Action, as discussed above.

ALTERNATIVE 2 - NO ACTION

Under Alternative 2, the No Action Alternative—either Scenario A Continuation of Existing Site Conditions or Scenario B Site Development under Existing Zoning—no significant impacts to surface water are expected. In either scenario, on-site stormwater would continue to be collected, conveyed, and infiltrated onsite (though onsite stormwater flow may increase due to increased impervious land coverage). The Kettle Wetland would remain intact. Flows and water quality in Sequalitchew Creek and surface water levels and water quality in the marsh system and Sequalitchew Lake would be expected to remain unaffected compared to current conditions.

Separate actions related to the Sequalitchew Creek Restoration Plan and JBLM Diversion Canal may or may not proceed without the Proposed South Parcel Project and CalPortland involvement.

3.4.3 Mitigation Measures

This section describes the measures that CalPortland has proposed to mitigate the impacts to surface water features resulting from the Proposed Action.

Proposed On-Site Impacts Mitigation

- Mitigation for the elimination of the Kettle Wetland will be accomplished by the creation of a new 3.4-acre constructed wetland in the southwest portion of the existing mine's bottom. The constructed wetland will be designed, constructed, maintained, and monitored in accordance with a detailed wetland mitigation plan (Anchor QEA, 2021). This is discussed in further detail in Section 3.6, **Plants and Animals**.

- On-site stormwater flow and groundwater seepage and the associated potential for increased erosion will be managed in accordance with a series of Mine Best Management Practices, as described in the *Preliminary Stormwater Management Report* (2021) and the *Earth and Water Resources Report* (Aspect 2022, Revised 2023).

Proposed Mitigation for Off-Site Resources

As described in **Chapter 2** of this DEIS, the 2011 Settlement Agreement states that permits for the Pioneer Aggregates South Parcel Project (Proposed Action) shall not be effective until permits for the Sequalitchew Creek Restoration Plan (Restoration Plan) are in place. The Restoration Plan will be evaluated as a separate but related action. The Restoration Plan seeks to restore and enhance streamflow and ecological functions from Sequalitchew Lake through Edmond Marsh into Sequalitchew Creek ravine by sequentially restoring diverted flows back to the creek, improving the sustainability of flows through the system, and restoring aquatic habitat.

The impacts of this mitigation measure are the same as described above in the subsection Cumulative Impacts with Proposed Action and Sequalitchew Creek Restoration Plan.

Other Possible Contingency Mitigation Measures

As an element of the approval conditions for the Proposed Action, the City of DuPont could require a Monitoring and Response Plan. The Monitoring and Response Plan could include, among other things, definition of monitoring methodology, establishment of performance thresholds, and identification of contingency response measures to the considered for implementation if monitoring indicates exceedance of a performance threshold. The Monitoring and Response Plan could incorporate elements of the adaptive management processes proposed to be established for the Proposed Action and the Sequalitchew Creek Restoration Plan.

The Sequalitchew Creek Restoration Plan is a separate but related action that is intended to be implemented in parallel with the Proposed Action. The mine and the stream restoration project each have their own adaptive management process tailored to achieving the goals and objectives of each specific project. The interaction between the two adaptive management processes could include: 1) project schedules that encourage restoration in advance of the potential impacts from mining; 2) development of performance thresholds for mining that support restoration and 3) coordinated monitoring and open sharing of information. The City, as the permitting authority for both projects would have a key role in assuring consistency between the two adaptive management plans.

The adaptive management process included in the Monitoring Plan (Aspect Consulting, 2017) includes, but is not limited to, the following potential mitigation actions if the impacts of dewatering on groundwater levels are greater than anticipated including: Installing additional monitoring locations; modifying the dewatering system or approach; revising the mining plan; and providing additional mitigation to impacted surface waters.

The Sequalitchew Creek Restoration Plan's adaptive management process similarly identifies examples of potential response actions to be implemented if restored flows do not meet the plans objectives that include, but are not limited to: removing beaver obstructions; installing additional beaver exclusion devices; escalating beaver management; installing additional flow paths through the former railroad grade that divides Edmond Marsh; sealing the losing reach; creating connections to Bell and/or McKay marshes; and expediting later elements of the Restoration Plan.

Other surface water contingency mitigation measures that could be implemented as part of the adaptive management process include:

- As described in Section 3.3, **Groundwater**, a possible contingency mitigation measure not considered in recent CalPortland documents – but discussed in the 2010 Final Feasibility Study (Anchor QEA 2010) – is to convey at least some of the intercepted groundwater seepage from the eastern slopes of the proposed mine expansion area to discharge to the ravine section of Sequalitchew Creek or West Edmond Marsh. Such mitigation has the potential to provide surface water flows in Sequalitchew Creek to offset the reduced groundwater seepage to the creek due to the Proposed Action and/or to make up for low- or no-flow periods in the creek and marsh system due to low or no flow discharges from Sequalitchew Lake under implementation of the Restoration Plan. If coupled with the Restoration Plan (including lining the dry reach section of the creek), the diversion of the groundwater seepage from the proposed expansion area to

West Edmond Marsh would provide flows to the dry reach as well as the ravine section of Sequalitchew Creek, while diversion to the ravine section of the creek would only provide flows to the ravine section (not the dry reach). Such mitigation could be adaptively managed, based on flow and temperature conditions in Sequalitchew Creek, and in such a way as to allow for some groundwater seepage from the proposed expansion area to be retained on-site and infiltrated to the Vashon-Sea Level Aquifer via the planned infiltration facilities in order to reduce negative impacts to the intertidal springs. Conveying groundwater from the mine expansion area to the ravine may require resolving conflicting provisions in the 2011 Settlement Agreement (see Chapter 2).

- Another possible additional mitigation measure that was considered in the 2010 Final Feasibility Study (Anchor QEA 2010) is raising the level of Sequalitchew Lake to increase the hydraulic gradient of Sequalitchew Creek through the East and West Edmond Marshes in order to better facilitate flows through the marsh system. With Restoration Plan implementation, the anticipated hydraulic gradient across the marsh system is approximately 0.0006 ft/ft. According to the 2010 Final Feasibility Study, the primary limitation to raising the lake level to induce a higher gradient is the protection of the Sequalitchew Springs located on the east end of Sequalitchew Lake. The Sequalitchew Springs are the drinking water source for JBLM and are protected behind a back-flow prevention weir. Reportedly, the lake level could potentially be raised (by modifying the outlet structure at the west end of the lake) by 0.56 ft with a moderate level of effort for modifications to the back-flow prevention weir at the springs. Raising the lake level higher than that is possible but would reportedly require a significant reconstruction of the facilities at the spring.

3.4.4 Significant Unavoidable Adverse Impacts

Under the Proposed Action with the Sequalitchew Creek Restoration Plan, unavoidable adverse impacts to the surface water system of the Sequalitchew Creek watershed would likely include:

- Increasing the surface water gradient between Sequalitchew Lake and the top of the ravine to restore the natural flow regime to the Sequalitchew Creek watershed, in combination with lower groundwater levels resulting from mining, would result in water levels in East and West Edmond Marshes being lowered by up to approximately 3 ft compared to existing conditions.

- Water levels in isolated lakes and kettle wetlands not directly connected by surface water to the Sequalitchew Creek system would be lowered due to lowered groundwater levels from the Proposed Action. The anticipated decrease in water levels would be approximately 3 ft for Wetland 1D; 2 ft for Pond Lake; 1 ft for Wetlands, #8, #9, #10, and #11; and 0.5 ft for Old Fort Lake. Implementation of the

Restoration Plan would likely not mitigate these impacts. These isolated wetlands have significant seasonal variability in water levels and are often dry during the summer. For these reasons, changes that result from changes in groundwater level may be difficult to observe.

Flows in the ravine section of Sequalitchew Creek would likely be lower than under existing conditions an estimated 10% of the time due to a reduction in groundwater seeps and spring discharges to the creek following groundwater lowering.

- Water temperatures in Sequalitchew Creek from April through September would likely be warmer than under existing conditions and could be expected to exceed 16°C (the 7-day average of daily maximum temperatures water quality criterion provided in WAC 173-201A-200) from May to September.

- The intent of the proposed mitigation measures described in 3.3B3, is to reduce these unavoidable adverse impacts to a non-significant status. If implementation of the proposed mitigation measures fails to mitigate these unavoidable adverse impacts, the City will consider implementing other possible contingency mitigation measures listed in 3.3.B3 as part of the adaptive management process.

If the contingency mitigation measure of conveying the intercepted groundwater from the eastern slopes of the proposed expansion area to Sequalitchew Creek and/or West Edmond Marsh is feasible and implemented as part of the adaptive management process for the Proposed Action and Restoration Plan Alternative, the flow and temperature impacts to Sequalitchew Creek would likely be at least partially reduced, if not eliminated, and may result in greater overall improvement of conditions within the creek.

Flows in the JBLM Diversion Canal would be reduced with the redirection of Sequalitchew Lake outlet flows to the historically natural drainage course through Sequalitchew Creek. Because the Diversion Canal was originally constructed to convey stormwater flows from JBLM and provide a watercourse for Sequalitchew Lake outlet flows, the reduced flows in the Diversion Canal are not considered an adverse impact.

Because on-site stormwater flows will be managed in a similar manner as existing conditions (i.e., on-site collection, conveyance, and infiltration) and because the removal of the Kettle Wetland will be mitigated by a new constructed wetland, no significant unavoidable adverse impacts to on-site surface waters are anticipated under the Proposed Action and Restoration Plan scenario.