3.6 WATER

3.6.1 Affected Environment

Water resources in the proposal area are discussed by physiographic provinces -- areas with characteristic climatic, geological, and topographical features that influence the timing, amount, and type of precipitation, which in turn influences hydrologic responses of surface water and groundwater. As indicated in Figure 3.6-1, the proposed pipeline would cross four physiographic provinces including the Puget Sound Lowlands, Western Cascade Mountains, Eastern Cascade Mountains, and the Columbia Plateau. Figure 3.6-2 illustrates the climatic and landform features of the four physiographic provinces and how they influence distinct streamflow responses.

3.6.1.1 Surface Waters

State stream channel and water quality classifications are indicators of the type and value of beneficial uses, or potential beneficial uses, of individual streams. The Washington Department of Natural Resources (WDNR) classifies individual stream channels as Types 1 through 5 as follows:

- # Type 1 - All waters within their ordinary high-water mark with "shorelines of the state" designations.

- # Type 2 - Segments of natural water which are not classified as Type 1 water, have a high use, and are important from a water quality standpoint for domestic water supplies, recreation, and fishery habitat.

- # Type 3 - Segments which are not classified as either Type 1 or 2 but have a moderate to slight use and are moderately important for the uses identified for Type 2 water.

- # Type 4 - Significant tributaries to Type 1, 2, or 3 waters that may be perennial or intermittent.

- # Type 5 - All other waters in natural watercourses with or without well-defined channels; areas of perennial or intermittent seepage, ponds, and natural sinks.

State water quality standards (WAC 173-201A) classify waters based on their beneficial uses (e.g., water supply, stock watering, fish and shellfish, wildlife habitat, recreation, and commerce and navigation). Specific water quality standards apply to the following classifications of water bodies: Class AA (extraordinary - must markedly and uniformly meet requirements for all or substantially all beneficial uses); Class A (excellent - must meet or exceed requirements for all or substantially all beneficial uses); Class B (good - must meet or exceed requirements of most beneficial uses); and Class C (fair - must meet or exceed requirements of selected beneficial uses). If waters of a specific classification fail to meet requirements, they are termed Awater quality limited@. The Washington Department of Ecology (Ecology) publishes a listing of water quality limited waters (Section 303(d) list) that require additional protection to prevent further degradation. Ecology also permits and enforces water rights for the protection of water use and maintenance of instream flows.

Water resources in the proposal area are discussed below by Water Resource Inventory Areas (WRIAs) within each physiographic province. WRIAs are basin-scale water management areas used by the State of Washington. Proposed stream crossing location numbers are in parentheses and can be cross-referenced to Appendix D and the map atlas in the ASC. Surface water characteristics along the pipeline corridor are summarized in Table 3.6-1.

Puget Sound Lowlands Province. Approximately 53 km (33 miles) of the pipeline corridor lies within the Puget Sound Lowlands Province. The Puget Sound Lowlands includes the Cedar-Sammamish Basin (WRIA 8) and a portion of the Snohomish River Basin (part of WRIA 7). Within the Puget Sound Lowlands Province, WRIA 8 includes crossings 1 to 5 and WRIA 7 includes crossings 7 to 37. There are 5 channel crossings in WRIA 8 and 29 crossings in WRIA 7 within the Puget Sound Lowlands Province. Crossings 6, 8, 21, 25 and 30 are wetlands and crossings 12 and 33 were avoided.

Precipitation in WRIA 8 falls primarily as rainfall and generates peak flows in late fall and winter. Mean annual precipitation ranges from 64 to 97 cm (25 to 38 inches). The corridor would cross Little Bear Creek (1) and four tributaries (2, 3, 4, and 5). Little Bear Creek, a Type 2 channel, is approximately 6 m (20 feet) wide with bank stability and sediment deposition concerns. It lies in a floodplain with dense alder, shrubs, and conifers. The corridor would intersect the 100-year floodplain for a distance of about 54 m (177 feet). Little Bear Creek is managed for Class AA waters; however, it is water quality limited due to high fecal coliform levels. Proposed crossing 4 is a 3 m (10-foot) wide, steep confined Type 3 stream; the others are Type 4 and Type 5 channels. Within WRIA 8, 18 water rights have been issued near the pipeline corridor, primarily from wells or small creeks. Little Bear Creek, however, is closed to consumptive appropriations.

Smaller watersheds generally west of North Bend in WRIA 7 are similar in their hydrologic character to WRIA 8. Precipitation increases to approximately 127 cm (50 inches), and storm runoff generates late fall and winter peak flows. The pipeline corridor would cross 26 channels with this flow regime in WRIA 7, including six Type 1 channels, one Type 2 channel, and seven Type 3 channels. The remaining channels are Type 4 and Type 5 waters.

The lower Snoqualmie River crossing (11) and the Tolt River crossings (26 and 27) are discussed in the following section because much of their watershed lies within the Western Cascade Province and is influenced by the annual hydrology in that province. Other Type 1 channels include Cherry Creek (20), Griffin Creek (28), and Tokul Creek (34). Cherry Creek (20) is 16 m (52.5 feet) wide with bank stability and steep sideslope concerns. Griffin Creek (28) is 4.9 m (15.7 feet) wide where the pipeline corridor would cross. Tokul Creek (34) is a high-gradient (6.7 percent) channel with stable banks at the proposed crossing. Harris Creek (22) is a Type 2 stream 7.9 m (25.6 feet) wide with moderately erodible banks.

Table 3.6-1. Surface Water Characteristics Along the Proposed Pipeline Corridor

		100-year Floodplains[3]		Water Quality Concerns[4]			Instream Flow Limitations[5]		Water Rights[6]
WRIA[1]	Physio Provences[2]	Name	Length (Feet)	Name	Rating	Limiting Factors	Name	Limitation	Permits Issued
8	PSL	Little Bear Cr (1)	177	Little Bear Cr (1)	AA	Fecal	Little Bear Cr (1)	Closed	18
7	PSL, WC	Snoq R (11)	498	Snoq R (11)	A	Temp, Fecal	Snoq R (11)	Min. low flow 800 cfs	149
		NF Cherry Cr (19)	337	Cherry Cr (20)	A	Fecal	NF Cherry Cr (19)	No diversion at flows < 1 cfs	
				Griffin Cr (28)	A	Fecal			
		Tolt R (26, 27)	1,165	Tokul Cr (34)	A	Temp	Cherry Cr (20)	Min. low flow 120 cfs; normal flows maintained	
		Snoq R (38)	257	Snoq R (38)	A	Fecal, D.O., Temp	Harris Cr (22)	Closed	
		SF Snoq R (42, 43)	No Data				Griffin Cr (28)	Closed	
							Snoq R (38)	Min. low flow 600 cfs	
39	EC	Keechelus Lake	No Data	Big Cr (127)	AA	Temp	None	Currently under adjudication	453
		Cabin Cr (117)	412	Yakima R (147)	A	Temp, D.O.			
		Big Cr (127)	535	Swauk Cr (151)	A	Temp			
		Little Cr (129)	763	Wilson Cr (187)	A	Temp, Fecal			
		Yakima R (147)	832	Cooke Cr (199)	A	Temp, D.O., Fecal			
		Swauk Cr (151)	467						
		Currier Cr (177, 180)	417						
		Wilson Cr (187)	147						
		Naneum Cr (190, 193)	125						
		Coleman Cr (196)	799						
		Cooke Cr (199)	720						
		Caribou Cr (200)	23						
		Parke Cr (201, 205, 206, 1-A)	1,810						
40	EC	Columbia R. (223)	1,150	None	n/a	n/a	Columbia R (223)	Min. low flow 10,000 cfs	6
41	CP	Lower Crab Cr (H26-C,D,E)	No Data	Lower Crab Cr (H26-C,D,E)	B	Temp, pH, pesticides	None	regulated for irrigation	61

WRIA[1]	Physio Provences[2]	100-year Floodplains[3]		Water Quality Concerns[4]			Instream Flow Limitations[5]		Water Rights[6]
		Name	Length (Feet)	Name	Rating	Limiting Factors	Name	Limitation	Permits Issued
				Crab Cr Lateral (237)	B	Temp			
36	CP	Esquatzel Coulee (284)	1,039	Esquatzel, Coulee and Canal (284, 283)	n/a	Temp, pH, D.O.	None	n/a	135
33	CP	None	n/a	None	n/a	n/a	None	n/a	26

Notes:

[1] Water Resource Inventory Areas (WRIAs) are displayed in Figure 3.6-1. Numbers represent management basins: Cedar-Sammamish River Basin (8); Snohomish River Basin (7); Upper Yakima River Basin (39); Alkali-Squilchuck Basin (40); Lower Crab Creek Basin (41); Esquatzel Coulee Basin (36); and the Lower Snake River Basin (33).

[2] Physiographic Provinces are displayed in Figure 3.6-1. Provinces are: Puget Sound Lowlands (PSL); Western Cascades (WC); Eastern Cascades (EC); and the Columbia Plateau (CP).

[3] Data from FEMA flood insurance maps and the ASC.

[4] Water quality ratings are described in 173-201A WAC and in the text. Impaired streams are identified in Ecology's 1996 303[d] list submitted to EPA.

[5] Instream flow limitations for WRIAs 7 and 8 are published in WAC 173-507 and WAC 173-508, respectively. A "Closed" limitation means the stream is closed to additional consumptive water diversion.

[6] Water rights permits issued by Ecology in the WRIAs *adjacent to the proposed pipeline alignment*. Permits may be for streams, springs, and wells and for a variety of beneficial uses.

All named streams in WRIA 7 in the Puget Sound Lowlands Province are managed for extraordinary (AA) or excellent (A) water quality. However, Cherry Creek (20), Griffin Creek (28), and Tokul Creek (34) are limited at the proposed crossings by fecal coliform or temperature exceedences, and are identified as impaired in the state's 1996 303(d) listing.

A 100-year floodplain is documented adjacent to the crossings of North Fork Cherry Creek. Small floodplains and floodprone areas may occur at some crossings and would need to be addressed during permitting.

Instream flow regulations limit withdrawals of surface water on North Fork Cherry, Cherry, Harris, and Griffin Creeks. Water rights holders along the pipeline corridor in this portion of WRIA 7 include the Cities of Carnation and Snoqualmie.

Western Cascade Mountains Province. From the second Snoqualmie River crossing (38) eastward to Snoqualmie Pass (just beyond crossing 84), 37 km (23 miles) of the pipeline corridor would lie in WRIA 7 and the Western Cascade Mountains Province. Precipitation in this province increases with elevation in the Cascade Mountains and western foothills. Mean annual precipitation in Snoqualmie Pass is approximately 267 cm (105 inches), but precipitation may reach 457 cm (180 inches) in adjacent watersheds draining westward from the divide. The annual hydrograph shows two peak flow seasons -- one in late fall from rainfall and one in spring from snowmelt. Because large portions of their watersheds lie within the Western Cascade Mountains Province, the lower Snoqualmie River crossing (11) and the two Tolt River crossings (26 and 27) are positioned within the Puget Sound Lowlands Province but retain this twice-seasonal peak flow characteristic. Rain-on-snow events can augment both runoff seasons with torrential flood events which scour channels in this province.

The pipeline corridor would intersect 51 channels in WRIA 7 which are in the Western Cascades Province (38 through 84). Three additional crossings reported in this province are actually wetlands (79, 80, 81) and one crossing is avoided (84). Six of the 51 channels (12 percent) are Type 1 and Type 2 streams. Type 3, Type 4, and Type 5 streams compose 24 percent, 33 percent, and 30 percent, respectively. Nine proposed channel crossings in this province (18 percent) have potential streambank and sediment deposition concerns. There are 32 steep confined and steep unconfined channels. Thirteen of these lie in or near areas with high mass wasting potential, underscoring the sideslope stability and deep scouring concerns associated with these channels.

The proposal would cross six channels in WRIA 7 with large, 100-year floodplains for a total corridor length in floodplains of approximately 0.8 km (0.5 mile). These include the Snoqualmie and South Fork Snoqualmie Rivers (11 and 38, and 42 and 43, respectively), and the Tolt River (26 and 27). Smaller floodplains and floodprone areas may occur adjacent to channels at some crossings and would need to be addressed during final project design.

All named streams in the portion of WRIA 7 where the pipeline would be located are managed for extraordinary (AA) or excellent (A) water quality. However, the downstream and upstream crossings of the Snoqualmie River are identified as impaired in the state's 1996 303(d) listing.

Instream flow regulations limit withdrawals of surface water from the Snoqualmie River, including near the two crossings. A total of 149 water rights have been issued in WRIA 7 adjacent to the pipeline corridor (including Western Cascade Mountains and Puget Sound Lowlands Provinces), including creek, spring, and well sources. North Bend is a municipal water rights holder in the Western Cascade Mountains Province.

Eastern Cascade Mountains Province. Sections of the pipeline corridor in the Upper Yakima River Basin (WRIA 39) and the Alkali-Squilchuck Basin (WRIA 40) fall within the Eastern Cascade Mountains Province. The pipeline corridor traverses nearly 147 km (92 miles) in this province, including 124 km (77 miles) of the Upper Yakima River Basin. There are 135 channel crossings in WRIA 39 (crossings 85 to 1-K) and 10 channel crossings in WRIA 40 (crossings 1-D to 23-A).

From Snoqualmie Pass (85) to Tillman Creek (133), near Cle Elum, the mean annual precipitation can exceed 254 cm (100 inches) and peak runoff occurs during fall rainstorm and spring snowmelt (similar to west slope conditions). Between Tillman Creek and Parke Creek (to crossing 1-K), mean annual precipitation declines to approximately 25 cm (10 inches). Peak flows in the larger channels in this portion of the basin correlate to spring snowmelt, and spring rain-on-snowmelt events in particular. However, the Yakima River is regulated by several reservoirs for irrigation, and the flow is shifted more into the summer months.

The pipeline corridor would cross 135 channels in the Upper Yakima River Basin. Mill (86), Cold (88), Roaring (97), and Meadow (99) Creeks and 11 other unnamed tributaries discharge to Keechelus Lake. All other streams that would be crossed, with the exception of 18 proposed irrigation canal crossings, flow into the Yakima River or its tributaries. Only six of the 135 channels (5 percent) in WRIA 39 are Type 1 and Type 2 streams, and 12 (8 percent) are Type 3 streams. The remaining streams are Type 4 and Type 5.

Low-gradient channels with potential streambank and sediment deposition concerns would be crossed at 25 locations (19 percent), including the Yakima River (crossing 147). Six of these meandering streams are braided or lie on alluvial fans where streambank disturbance can exacerbate lateral migration of the channel. There are eight steep confined channels, four of which have sideslope erosion and downcutting concerns.

Another 30 steep unconfined channels may be prone to channel avulsions and localized bed scouring. One-sixth to one-third of the 135 Upper Yakima River Basin channels are considered minor channels, generally less than 0.6 m (2 feet) in width and with flows that enable only incidental sediment and debris transport.

A total of 2.1 km (1.3 miles) of the pipeline corridor would be located within 100-year floodplains within WRIA 39. The longest of the 12 floodplains crossed would be adjacent to Parke Creek (crossings 201, 205, 206, and 1-A) and is about 0.55 km (0.34 mile) in length. The Yakima River floodplain contains about 254 m (832 feet) of the pipeline corridor. Smaller floodplains and floodprone areas may occur adjacent to channels at some crossings and would need to be addressed during final project design revisions.

All named streams along the pipeline corridor within the Upper Yakima River Basin are managed for extraordinary (AA) or excellent (A) water quality. Big Creek (127), Cooke Creek (199), Yakima River (147), Wilson Creek (187), and Swauk Creek (151) crossings are limited in the 1996 303(d) listing.

There are 453 water rights permits in WRIA 39 in the vicinity of the pipeline corridor, including all named streams. However, senior water rights and instream flow requirements are now under adjudication in WRIA 39 due to the over-allocation of available water. Kittitas County PUD and the City of Cle Elum hold water rights for municipal uses.

The Alkali-Squilchuck Basin (WRIA 40) lies within the Eastern Cascade Mountains Province as it transitions to the Columbia Plateau at the Columbia River. Approximately 23.4 km (14.5 miles) of the pipeline corridor would lie within this basin. Ten of the 11 streams crossed in this WRIA are small and intermittent, or they may be ephemeral, flowing only in response to storm events. Spring rains and snowmelt generate peak flows in early to mid-spring, earlier than in the upper Yakima River WRIA and later than in the Columbia Plateau Province. The Columbia River, which is also included within this WRIA discussion, functions as the Alkali-Squilchuck Basin's eastern boundary. The Columbia River (223), designated under shorelines of the state, is a Type 1 water. All other stream channels to be crossed within WRIA 40 are Type 4 or 5.

Most channels in this WRIA are incised in small to large canyons with little room for development of floodplains. The Columbia River is floodprone below an elevation of about 150 m (500 feet). Approximately 350 m (1,150 feet) of the pipeline would lie within the 100-year floodplain of the Columbia River (including Getty's Cove).

The Columbia River is managed for Class A water quality standards. All other surface waters that the pipeline would cross are not classified, and therefore Class A water quality standards would apply. None of the other channels has been identified as water quality limited.

There are six water rights permits issued within this WRIA adjacent to the pipeline corridor. These are groundwater rights used for water supply and irrigation. None of the surface waters have instream flow limitations, except the Columbia River, which has an instream flow requirement of at least 280 cubic meters per second (m^3/s) or 10,000 cubic feet per second (cfs). No municipalities obtain water from this portion of the Alkali-Squilchuck Basin.

Alternative alignments that have been identified at the Columbia River would cross primarily unnamed channels similar in structure and hydrology to those the proposed route would cross. Most are intermittent or ephemeral, Type 4 channels that could have some bank and sideslope stability concerns. None of these streams are classified by Ecology, thus they would be managed as Class A waters.

Columbia Plateau Province. Sections of the proposed and alternative alignments between the Columbia River and its terminus at the Snake River (crossings 224 to 285) are in the Columbia Plateau Province. About 133 km (82 miles) of the pipeline corridor would pass through the three WRIAs located in this province, including the Lower Crab Creek Basin (WRIA 41), Esquatzel Coulee Basin (WRIA 36), and Snake River Basin (WRIA 33).

Over 61 km (38 miles) of the pipeline corridor lies within the Lower Crab Creek Basin (WRIA 41). Mean annual precipitation is approximately 18 to 25 cm (7 to 10 inches) in this semi-arid region. Stream channels are sparse and usually intermittent. Peak flows occur in late winter or early spring in response to snowmelt or rain-on-snow events. Flow in lower Crab Creek is regulated by management of the Potholes Reservoir, and many upstream diversions exist for irrigation. Canals allow water transmission into and out of the basin across watershed divides. Much of the flow in lower Crab Creek is actually return flow from irrigated fields.

The pipeline corridor would cross 30 channels (crossings 224 to 254) in WRIA 41, nearly half of which are irrigation canals. Crab Creek, the primary natural drainage in this WRIA, is a sand-bedded, meandering channel. It is a Type 2 stream at each of its three proposed crossings (H-26C, H-26D, and H-26E). Most of the other 11 natural channels are Type 4 and Type 5 waters. Two of the channels lose their definition in wetlands at the pipeline corridor crossing. The canals are excluded from the state's stream typing system. Diversionary canals along the pipeline corridor include the Royal Branch Canal (233 and 235) and the Crab Creek Lateral (237).

Seven of the 14 proposed natural channel crossings are meandering streams; the remaining seven are minor streams. The three meandering lower Crab Creek crossings and two meandering tributaries (230 and 239) are generally well-vegetated and stable, but have high potential for bank and sideslope erosion because they are composed of sandy soils. Lower Crab Creek is managed for Class B water quality. The proposed pipeline corridor crossings, however, are located in water quality limited sections (temperature, pH, and pesticides) of the creek.

A total of 61 water rights have been issued in this WRIA adjacent to the pipeline corridor. Only six of these are for spring or creek withdrawals, however. Municipal water rights are held by Royal City and Grant County PUD.

Approximately 60 km (37.4 miles) of the pipeline corridor lies within the Esquatzel Coulee Basin (WRIA 36). Mean annual precipitation in this WRIA is 18 to 25 cm (7 to 10 inches). Streams are sparse and usually intermittent. Flow in the Esquatzel Coulee originates primarily as irrigation water diverted from the Columbia River at Grand Coulee Dam. In the vicinity of the pipeline corridor, Esquatzel Coulee carries irrigation return flows, much of which is diverted through the Esquatzel Diversion Channel and discharged back into the Columbia River upstream of Pasco. Peak flows in these irrigation channels occur between July and October. Approximately 317 m (1,039 feet) of the pipeline corridor lies within the 100-year floodplain of Esquatzel Coulee. Esquatzel Coulee and the Esquatzel Diversion Channel are managed as Class A waters. The Esquatzel Coulee and Canal are listed as water quality limited for temperature, pH, and dissolved oxygen.

The pipeline corridor would cross 30 channels within WRIA 36 (crossings 255 - 284), 25 of which are irrigation canals. A number of the canals are concrete-lined for at least a portion of their length. The Type 1 stream Esquatzel Coulee, which naturally meandered and downcut into the land before channelization, is concrete-lined at crossing 284. A Type 3 stream channel near Eagle Lakes is steep and confined with sideslope erosion concerns (262). Three other minor channels are Type 5 streams.

There are 135 water rights issued in this WRIA adjacent to the pipeline corridor. Most of these utilize well sources, including Basin City, the only municipal supplier with wells close to the pipeline corridor. No channels in the Esquatzel Coulee Basin have instream flow regulations to limit surface water withdrawals.

The pipeline corridor would lie within about 11 km (6.8 miles) of the Snake River Basin (WRIA 33). Mean annual precipitation in this area is approximately 15 cm (6 inches). Few channels develop in this semi-arid environment, and the pipeline corridor would cross only one -- an irrigation canal (285). The pipeline corridor terminates on the north bank of the Snake River, just upstream of its confluence with the Columbia River. The pipeline corridor would not cross any floodplains or water quality limited streams. However, the lower Snake River is currently on the state 303(d) list for pH limitations.

3.6.1.2 Groundwater

Groundwater quantity and quality are protected in the State of Washington. Groundwater quantities are protected by surface water and groundwater rights, and groundwater quality standards are defined in WAC 173-200. Groundwater is used for municipal, domestic, irrigation, and other uses along the entire pipeline corridor.

Groundwater conditions along the pipeline corridor are highly variable depending on the geology, hydrology, and climate. The occurrence and depth to groundwater is a function of climatic conditions and the permeability of overlying soils and geologic strata. Aquifers along the pipeline corridor occur in various geologic formations including recent alluvial deposits near large rivers and streams, glacial drift, fractured bedrock of the Cascade Mountains, and thick sequences of layered basalt and interbedded sediments in eastern Washington.

Groundwater recharge along the pipeline corridor is primarily by direct infiltration of precipitation and snowmelt. Groundwater recharge also occurs in floodplain areas during high water events. Recharge may also originate from small streams and water bodies that lose water to the underlying sediment. Groundwater recharge occurs at varying rates depending on the permeability of soil, climatic conditions, vegetation, slope, aspect, and degree of development.

The following discussion of groundwater conditions along the pipeline corridor highlights groundwater resources within the four principal physiographic regions and provides details of the Cross Valley Sole-Source Aquifer because of its regulatory status and importance as a resource. Characteristic groundwater regimes are described in Table 3.6-2. Refer to the map atlas in the ASC for specific locations of groundwater resources discussed in this section.

Cross Valley Sole-Source Aquifer. The Cross Valley Sole-Source Aquifer was designated by EPA in 1987. This sole-source aquifer, which supplies water for over 8,000 people, occupies an area of approximately 93 km^2 (36 square miles) in southcentral Snohomish County. The aquifer area is bounded on the east and north sides by bedrock, which is at or near land surface on the steep bluffs above the Snohomish and Snoqualmie Rivers, on the west by the North Creek Valley, and on the south by approximately the King/Snohomish County line.

Table 3.6-2. Aquifer Types and Associated Issues of Concern

Groundwater Regime	Soil Type	WRIA	Characteristics	Issues and Concerns	Monitoring/Mitigation*
I	Alluvium	7, 8, 33, 36, 39, 40, 41	Typically shallow water table associated with surface water bodies and floodplains. Well yields moderate to high, supporting public and domestic supplies. Variable sediment types. Provides baseflow to streams and rivers. Limited extent.	Shallow water table subject to contamination. Risk of contaminants spreading and entering surface water bodies and wells. Dewatering during construction may be necessary. Pipeline corrosion protection would be necessary.	Pipeline design features to minimize risk of leak (e.g., welded high-strength coated pipe, cathodic protection, block valves). Computerized leak detection system, regular visual inspections, internal inspections, and regular maintenance. ***Flow barriers of similar or lower permeability to surrounding soil should be located in the trench at stream crossings.***
II	Glacial Deposits	7, 8, 39	Variable water table depths. Multilayered aquifer, confined and unconfined conditions. Well yields can be substantial, supporting public and domestic supplies. Limited extent. Provides baseflows to rivers and streams.	Risk of contamination in shallow zones with subsequent spreading to water table and surface water. Dewatering may be necessary in areas of shallow groundwater.	Same as for alluvium where shallow groundwater is encountered.
III	Cascade Bedrock	7, 11, 39	Deep water table, often associated with fracture zones. Very limited in extent. Generally does not support water supplies.	Lower risk of contamination from spills; however, groundwater cleanup is impractical. Trench could serve as preferential pathway.	Flow barriers will be located in the trench at stream crossings and trench backfill will be of similar or lower permeability as the surrounding soils.
IV	Loess/Dune Deposits	33, 36, 39?, 40, 41	Variable water table depths; however, typically deep. Poor well yields generally do not support water supplies. Limited aquifer extent. Slow groundwater movement.	Same as above.	Same as above.
V	Outburst Flood Deposits	33, 36, 39, 40, 41	Water table generally shallow, although can be deeper in upland areas. Aquifers are associated with streams and rivers providing baseflows. Large yield supporting public and domestic supplies. Rapid transport. Limited extent.	Same as alluvium and glacial deposits.	Same as alluvium and glacial deposits.

Groundwater Regime	Soil Type	WRIA	Characteristics	Issues and Concerns	Monitoring/Mitigation*
VI	Lacustrine Deposits	7, 8, 39	Water table depth variable. Low yields to wells.	Risk of contamination and pipeline corrosion in shallow groundwater zones. Trench may serve as preferential pathway for groundwater movement. Dewatering during construction may be necessary.	Same as alluvium and glacial deposits.
VII	Columbia River Basalt	33, 36, 39, 40, 41	Aquifers typically deep, exhibiting confined (artesian) conditions. Aquifers are regionally extensive. Groundwater transport rapid. Groundwater supports public, domestic, and irrigation wells. Well yield can be high.	Risk of contamination through well bore holes possible during spills. Spread could be considerable.	Conduct surveys to determine proximity of wells to pipeline alignment. ***Place flow barriers in trench at stream crossings.***
VIII	Sole-Source Aquifers (Cross Valley Aquifer)	7, 8	Aquifer is located in a glacial-fluvial sand deposit, underlying glacial till ranging in thickness from 25 to 100 feet. The aquifer is recharged via infiltration through the capping till layers.	Risk of contamination from oil leaks.	Pipeline design features to minimize risk of leak (e.g., welded high-strength coated pipe, cathodic protection, block valves). Trench lining would be used in sensitive areas to direct spills toward a lower sensitivity area for capture and cleanup. Computerized leak detection system, regular visual inspections, internal inspections, and regular maintenance. If studies show additional measures are necessary, include extra pipe wall thickness, additional localized cathodic protection, additional pipe joint inspection prior to coating, and additional block valves.

* Items in regular typeface are based on OPL 1998, Application for Site Certification. Items in ***bold italic*** are additional mitigation suggested by the EIS team.

Source: OPL 1998 and work by EIS team.

The Cross Valley Aquifer is located within a regionally extensive, heterogeneous sand and gravel layer ranging in thickness from less than 7.6 m to greater than 30.5 m (25 to 100 feet). The aquifer is primarily composed of Vashon-aged advance outwash sand and gravel often referred to as the Esperance Sand. The formation is capped by as much as 30 m (100 feet) of low-permeability glacial till, averaging 15 m (50 feet) in thickness in most places (Newcomb 1952). The till is absent in a number of locations along the pipeline corridor.

The aquifer is recharged by precipitation that infiltrates through the till or directly into the aquifer where the till is absent. Recharge is slow through the till layer, with infiltration rates often less than 0.3 m (1 foot) per day. Some wetlands, ponds, and lakes on top of the till over the aquifer also provide recharge to the aquifer. Infiltration is much more rapid through the outwash deposits. Additionally, because the till layer has been eroded in the larger river valleys on the eastern edge of the aquifer, there is a direct hydraulic connection between the major rivers and streams and the aquifer.

The existing OPL product pipeline runs north-south for approximately 8 km (5 miles) through the western portion of the designated sole-source aquifer area. For this proposal, the Thrasher Pump Station would be constructed near Maltby Road in the southwest corner of the designated aquifer area; the pipeline would run directly east from the pump station, across the southern portion of the aquifer, and exit the aquifer area at approximately MP 8.

Approximately 83 percent (10.5 km or 6.5 miles) of the pipeline corridor that would cross the aquifer would be underlain by till soils with dense till below 1.8 m (6 feet); 13 percent (1.6 km or 1 mile) would be underlain by poorly drained soils located in depressions and in low-lying areas adjacent to streams and rivers; and 4 percent (0.5 km or 0.3 mile) would cross well drained permeable soils that are directly underlain by portions of the aquifer (SCS 1983). These soils are mapped by the Natural Resources Conservation Service (NRCS) as Everett soils, and they occur within the first several miles of the pipeline corridor in the Bear Creek drainage.

Appendix B of the Support Document for the EPA Designation of the Cross Valley Aquifer as a Sole-Source Aquifer (EPA 1987) determined that the Cross Valley Water Association had over 2,600 service connections serving an estimated population of 8,000 people. There were approximately 3,300 people obtaining water from individual wells, springs, and small community well supplies. Total groundwater use within the sole-source aquifer was estimated to be 1.7 million cubic meters (60.5 million cubic feet) in 1986. In 1987, the Cross Valley Aquifer provided almost 78 percent of the drinking water used in the aquifer area. The EPA found that the water quality from the shallow aquifer zone was of good quality, but the deeper wells were high in hydrogen sulfide gas and iron.

Puget Sound Lowlands Province. The primary aquifers in this province are located in glacial drift on the margins of the Snoqualmie Valley, alluvium along the Snoqualmie River floodplain, and bedrock in the Cascade Mountains. Groundwater west of the Snoqualmie River is found in the Interlake Drift Plain between Lake Washington and Lake Sammamish, and the Eastern Drift Plain located west of the Snoqualmie River in the Snohomish River Valley. In the drift plains, primary aquifers are within stratified Vashon-aged glacial deposits or the underlying pre-Vashon glacial deposits. These aquifers are widespread and are extensively developed as groundwater supplies for municipal, domestic, irrigation, and industrial uses. Alluvium is the primary aquifer in the larger stream valleys. Along the eastern margins of the plain, groundwater is obtained primarily from alluvial deposits and bedrock. These aquifers generally have lower yields than the drift plain aquifers to the west.

Groundwater development is extensive in the eastern and southern portions of the region. Most wells, especially those of higher yield used for public supplies, tap aquifers located in one or both of the drift plain deposits, although shallow dug wells utilize the limited perched groundwater in sand lenses within the overlying glacial till. The main aquifer in the Snoqualmie River Valley is located in the unconsolidated alluvial deposits associated with the river and the floodplain. Water quality in the alluvial aquifers generally is poorer, often high in iron compared to the water quality of the glacial aquifers.

Western Cascade Mountains Province. Along the pipeline corridor, aquifers in this region occur in the bedrock and in alluvial valleys of the larger tributaries to the Snoqualmie River. Groundwater flow in bedrock is primarily controlled by joints, bedding, and fractures. The groundwater table in these aquifers generally mimics topography and may be shallow or deep. Recharge occurs where weathered bedrock is exposed at outcrops, generally at higher elevations, and from percolation through overlying deposits and forest soils on slopes and lower elevations. Discharge from the aquifer occurs to streams and rivers at lower elevations.

Alluvial aquifers occur in the valleys of the larger streams. Generally, these are present where stream channel gradients are below 2 percent. These aquifers are limited in extent, restricted to the valley width, and are typically shallow in the Cascade Mountains. The aquifers are recharged from precipitation, from underlying bedrock aquifers, and from floodwaters in the associated stream. The aquifers provide baseflow to the associated stream or river.

Groundwater use in the Cascade Mountains east of North Bend is limited primarily to small individual domestic supplies and several small public supplies for campgrounds and ski resorts. The source of these groundwater supplies is typically bedrock, although groundwater in alluvial aquifers is used in the larger stream valleys.

Eastern Cascade Mountains Province. In the Eastern Cascade Mountains Province along the pipeline corridor, bedrock and small alluvial aquifers occur in the mountainous area, similar to the Western Cascade Mountains Province. In the foothills of the mountains, west of the Columbia River, basalt aquifers, terrace deposit aquifers, and larger alluvial aquifers are present. The primary aquifers in this region include alluvium within the Yakima River floodplain, sedimentary deposits in the Kittitas Valley area, and basalt in the high elevations on the east slopes of the Cascade Mountains.

Groundwater is extensively developed in the valleys of the Yakima River and its tributaries from alluvial and glacial deposits that are as much as 152 m (500 feet) thick. These deposits are hydraulically connected to the Yakima River and its tributaries, and are recharged by precipitation, as well as infiltration from streamflow and irrigation return flows. Recharge to the alluvial aquifer is from direct precipitation, from groundwater stored in surrounding terraces, and from floodwaters of the Yakima River and tributaries. The aquifer discharges primarily to the Yakima River. Surface water rights in the Yakima Valley are being adjudicated. The interconnected nature of the river with the alluvial aquifer in its valley renders these rights and groundwater rights inseparable in some cases.

Groundwater obtained from upland sedimentary rocks near the Yakima and Columbia River Valleys can be of low to moderate yields and is used for domestic uses, stock watering, and irrigation. Recharge is from direct precipitation and lateral flow from the Cascade Mountain uplands. Groundwater discharge is to deeper rock units and to the alluvial aquifers of the Yakima and Columbia River Valleys.

Volcanic rocks in the Cascade Mountains yield little or no water, whereas the Columbia River Basalt that is exposed along much of the eastern part of the province is a substantial water-bearing unit. The thick series of basalt flows has a wide range of both permeability and yield. Studies show that structural warping of the rocks has caused subsurface damming of the groundwater, which results in several essentially separate groundwater basins.

Columbia Plateau Province. Groundwater is generally available in large quantities in the Columbia Plateau Province from the basalt bedrock. Multiple basalt aquifers provide complexity to the groundwater situation and are generally known as the Columbia River Basalt Group. The basalt thickness varies near the older underlying rocks, but increases to the southeast and is more than 3,050 m (10,000 feet) thick near Pasco. The basalt surface is thinly mantled by loess, but in areas to the north, east, and southeast, much of the plateau was scoured by enormous floods of glacial meltwater, exposing wide belts of basalt within the channeled scabland.

The basalt is recharged mainly by precipitation. Aquifer recharge is through direct infiltration and by seepage from intermittent streams. Thin rocky scabland soils probably are more conducive to recharge than are the fine loess soils elsewhere. In the western part of the plateau and under much of the pipeline corridor, a substantial amount of recharge is derived from leakage of irrigation canals, artificial reservoirs, and irrigated land under the Columbia Irrigation Project. Seepage to the aquifers from the imported water has created increases in the water table of as much as 61 m (200 feet).

Groundwater movement in the province is generally to the southwest. Groundwater flow rates within the highly permeable interflow zones between individual basalt flows can be rapid in response to withdrawal, although they are generally slow under prevailing natural conditions due to low hydraulic gradients. Loess overlies the basalt and generally does not yield appreciable quantities of water to wells. Wells that tap coarse glacial outburst deposits can store and transmit large quantities of groundwater. The quality of the groundwater is generally good, ranging from soft to hard, although the water has high concentrations of dissolved iron in some locations.

Groundwater from the basalts is used extensively for irrigation, particularly in the Pasco area. In some areas, water levels are declining due to pumping, and well boreholes have interconnected the various layered basalt aquifers. These boreholes allow groundwater in upper layers to flow into deeper layers, commingling waters of different quality and providing a potential conduit for contaminant migration.

3.6.2 Environmental Consequences

3.6.2.1 Proposed Petroleum Product Pipeline

Construction Impacts - Surface Waters

Physical Disturbance of the Beds and Banks of Stream Channels. Bed and bank disturbance could result in short-term moderate impacts (lasting less than 3 years) in 60 percent of the channels that would be crossed, even with the design measures and BMPs proposed by OPL. Where multiple crossings of one channel or crossings of multiple channels within one watershed occur, the volume and duration of fine sediment on the streambed may increase relative to channels with single crossings, but impacts would remain moderate.

Stream crossing methods proposed by OPL are described in the ASC and are identified for each proposed channel crossing in Appendix D. Bridge, bore, horizontal directional drill, over-culvert, and under-culvert methods, in order of generally increasing potential water quality impacts, are considered Anon-invasive@ construction methods. By their design, these methods require little or no physical disturbance to the bed and banks of a channel, and thus would result in negligible impacts to bed and bank stability and resulting water quality. Any of the methods requiring physical trenching and disturbance to the streambed and streambanks are considered Ainvasive@ construction methods. These include, in increasing order of impact intensity, dry trench, flume and trench, divert and trench, and wet trench.

Trench construction involves excavation of the streambed and banks using a trackhoe situated on an adjacent bank. On channels wider than the reach of the trackhoe, the trackhoe or a trenching machine would operate from portable bridges or mats. The pipeline crossing would be as nearly perpendicular to the stream as possible. Disturbances of the streambed, streambank, and bank vegetation would be limited to the amount necessary to construct the pipeline (9 m [30 feet]). Streambed spoils would be temporarily stored in contained holding areas outside the riparian area on one or both sides of the channel. The location of larger boulders would be noted and these specifically set aside to be returned to the same or similar positions. Similarly, large woody debris (LWD) that is encountered at a crossing would be handled in a way that causes the least bed and bank disturbance possible -- left in place, removed whole, or cut and partially removed. All LWD at crossings would be stored, then returned and stabilized in the channel during restoration of the bed and banks. Stream beds and banks would be restored including contouring to pre-construction elevations and revegetating banks. More aggressive stabilization measures may be required at some crossings.

Using a number of state and federal data sources (e.g., WARIS by WDFW, Data96 by WDNR, and USFS GIS), the ASC identified that the pipeline would cross 293 channels on the preferred alignment. Of the 293 crossings, 127 utilize non-invasive methods, 161 utilize invasive methods, and at 5 crossings the method (invasive or non-invasive) of crossing is uncertain. Figure 3.6-3 indicates the distribution of crossing types by WRIA.

Despite efforts by OPL to identify all stream channels the pipeline corridor may cross, some Type 4 and Type 5 stream channels were probably missed. These smaller streams will be identified when the final centerline is established. Most unmapped channels are expected to be small, and intermittent or ephemeral in nature. Most would also be suitable for typical dry trench or flume and trench methods. With the implementation of construction BMPs (Appendix C), additional impacts at unmapped channels would be expected to be minor.

The pipeline corridor would cross some channels more than once, or have crossings of multiple tributaries upslope of the mainstem channel. These situations would occur in the following areas:

- Little Bear Creek (1) (WRIA 8), which is crossed in proximity at the mainstem and four moderate-gradient tributaries (2, 3, 4, and 5) ranging from 1 to 3 m (3 to 10 feet) in width. All four streams would be crossed using invasive methods.

- South Fork Snoqualmie River (WRIA 7) would be crossed twice by attaching the pipeline to bridges across the river (42 and 43). The pipeline corridor would parallel the South Fork on its left bank within the 100-year or 500-year floodplain (generally between 150 to 600 m [500 to 2,000 feet] from the river) for a distance of approximately 24 km (15 miles). OPL proposes to cross 44 tributary streams to the South Fork Snoqualmie River. Ten of these tributaries would be crossed using invasive methods including three wet trenched crossings (Hall, Mine, and Humpback Creeks).

- Numerous channel crossings would occur within the Yakima River Watershed (WRIA 39). The pipeline corridor would parallel the western shoreline of Keechelus Lake on the John Wayne Trail for a distance of approximately 9.5 km (6 miles). Within that section, OPL proposes to cross 15 tributaries to the lake, two of which would be crossed using invasive methods (Roaring [97], and Meadow [99] Creeks). The mainstem Yakima River would be crossed only once (147); however, a number of its tributaries would be crossed multiple times. Within the basin, Dry Creek would be crossed four times using invasive methods (156, 157, 160, and 161). Similarly, Jones Creek would be crossed three times (168, 169, and 170), Currier Creek two times (177 and 180), Naneum Creek two times (190 and 193), and Parke Creek four times (201, 205, 206, and 1-E) using invasive methods.

- The lower Crab Creek mainstem (WRIA 41) would be crossed three times (HD26-C, HD26-D, and HD26-E) using invasive methods. Five unnamed tributaries to the mainstem would also be crossed using invasive methods (230, 231, 238, 239, and 240).

Many of the situations include dry trench crossings of Type 4 or Type 5 streams. However, the potential cumulative impact to the channel conditions and water quality downstream of these multiple crossings would be increased relative to single channel crossings.

OPL notes that use of explosives could be required to obtain adequate burial depths in streams with a high percentage of bedrock and large boulders in their beds. The need to use explosives would be determined during the final design phase of the project. If blasting is required, shock waves could weaken residual bed material and unconsolidated bank material, increasing their susceptibility to scouring and debris flow processes when saturated or at high flows.

It is possible that streambeds could experience preferential scouring and sorting of the backfilled trench during the next bankfull or larger event. If an extremely large event were to occur, scouring may be accelerated and the maximum scour depth attained. Surface water bodies most vulnerable to this type of impact include steep, confined channels with banks and beds composed of easily erodible unconsolidated sediments. Sediments can be entrained and subsequently deposited in sensitive downstream reaches. Silts and clays can remain in suspension and result in turbid conditions in downstream water bodies.

Removal of Riparian Vegetation. The proposal would result in minor impacts from riparian vegetation removal. Riparian and streamside vegetation would be removed at proposed crossings to create a total corridor width of 9 m (30 feet). The impacts of removing this vegetation could create potentially minor impacts on bank stability, shade and stream temperatures, LWD, and erosion just upslope of streambanks.

OPL alignment revisions and crossing method selection have minimized many of the potential impacts associated with riparian vegetation removal. Trees would be removed at 22 of the crossings. Grasses and other ground flora dominate the riparian area at 32 of the crossings. At the remaining crossings, construction would involve minor or no riparian vegetation disturbance because the crossing method is non-invasive or the crossing location lacks natural riparian vegetation.

The small amount of vegetation disturbance required at the stream crossings would reduce the impacts. However, bank stability could decline at crossings where vegetation would be removed at localized reaches 9 m (30 feet) long. Revegetation BMPs, including replanting native shrubs, use of an approved seed mixture for erosion control and monitoring, and a contingency plan, would mitigate much of the risk. However, some bank instability may persist (also see Section 3.4, Botanical Resources). The corridor would be allowed to revegetate with the exception of a maintained 3 m (10-foot) wide access trail.

Temperature impacts could include minor, very localized, and short-term temperature increases where shrubs and trees are cleared as part of crossing construction. Woody debris recruitment would be reduced by tree removal at about 22 crossings. The actual effect of this is unknown, but would be expected to be minor because in all cases the wood removed would be very small relative to the remaining volume along those streams. OPL would remove and store any LWD found in each stream crossing corridor, and replace it as part of crossing construction. Replacement of LWD would occur as close to the original configuration as possible.

Erosion and Sedimentation. Construction would generate minor to potentially major sediment-related water quality impacts despite its temporary effect. EFSEC may authorize a short-term variance for water quality as long as mitigation and application of all known, available, and reasonable methods of prevention are implemented. Federal agencies may include mitigation requirements as part of their approval process for the project.

During the construction phase, the primary impact would be increased erosion and sedimentation effects on water quality and channel conditions. The largest source of sediment would be the sand, silt, and clay released from the streambed and entrained in streamflow during construction of crossings using the invasive methods described above. Non-invasive methods substantially reduce the risk of impacts to water quality by avoiding in-channel excavation.

The magnitude of the actual impact at any crossing would vary widely based on the amount of fine material in the streambed, channel gradient, number and type of channel obstructions, crossing method, season, depth and velocity of streamflow, the effectiveness of BMPs, and the beneficial uses of the channel. Subsequent impacts may include deposition of transported sediments downstream. Silts and clays could remain in suspension and result in turbid conditions downstream.

BMPs to be used with these proposed crossing methods (see Appendix C) are usually not completely effective at preventing erosion and prohibiting offsite sediment transport. They are, however, effective in minimizing impacts by reducing the volume of sediment generated, restricting the distance that it moves downstream, and decreasing the rate at which it moves there. Nevertheless, impacts would occur where invasive methods would be used. Turbidity of the stream would likely exceed water quality standards during construction of crossings, particularly when water is released from flumes or diversions and generates a pulse of turbidity lasting for a relatively short period of time. Highly turbid water may negatively affect fish, fish habitat, and domestic and irrigation water supplies and equipment. These effects, however, would generally be temporary (lasting hours) and localized, and would diminish downstream. Similar effects occur in streams in disturbed watersheds whenever there are storm events.

Accidental Spill from Directional Drilling. The potential for a loss of drilling muds to the Columbia River from the proposed drilled crossing of the river (crossing 223) is relatively high due to subsurface geological conditions (see Section 3.2, Geology, Soils, and Seismicity). Potential secondary impacts could range from major to minor depending on the point of release to the streambed, the volume released, and the flow conditions at the time of release. Assuming a drilled crossing is feasible, a number of measures proposed by OPL and additional mitigation suggested in Section 3.2 would minimize the potential for this impact.

Accidental Spill of Hazardous Materials Associated with Construction Equipment. Small accidental spills of construction-related materials would generally result in negligible to minor impacts because of (1) the small volume of such spills, (2) the length of the corridor where such spills might occur, and (3) the use of BMPs. However, if releases occur immediately upslope of lower gradient channels with high-value fish or fish habitat, major impacts would be possible. Accidental leaks and spills resulting from equipment operation and fuel storage along the pipeline corridor may affect water quality where instream or near-stream construction occurs, or where slopes drain to watercourses.

OPL would implement a number of BMPs to avoid and minimize the volume of petroleum products introduced to the environment (see Appendix C). These can be enforced through the EFSEC Site Certification or the BLM Plan of Development Approval. Most releases would probably be small volumes with temporary, localized effects on water quality. Major impacts could be possible where larger or multiple releases occur in a localized area.

Discharge of Hydrostatic Test Water. Discharge of hydrostatic test water to streams would result in a minor impact to water quality. The pipeline at each water crossing would be hydrostatically tested at least twice. The pipe would be constructed, tested, placed in the trench, backfilled, and then tested again. Many crossings would again be tested as part of the testing of 10 longer pipeline segments once they are completed. The tests confirm the integrity of the materials and pipeline, and therefore minimize the potential for operational leaks and spills of petroleum products.

Water for tests at individual crossings would be obtained from the stream itself, or from water transported to the site. The relatively small volume of water used to test the pipeline individual crossings would be discharged to a filtration area (using straw bales or filter fence) and allowed to drain back to the stream channel without additional testing or treatment. The test water would be discharged to the stream at a rate that does not dominate the streamflow. Hydrostatic testing of individual stream crossing sections would be expected to result in negligible to minor impacts because of the small volumes of water used.

Exhaust water from testing larger sections of the pipeline would be discharged to the ground at the Stampede Pump Station (infiltration and evaporation), to the ground at the Kittitas Terminal or to the Cascade Irrigation Canal near the terminal, and to the Snake River indirectly (through filtration) near the pipeline terminus at Pasco. The discharge of the exhaust water can have water quality impacts on receiving waters. The test water should not introduce toxic materials to receiving waters, nor should it alter the physical and chemical characteristics of the receiving stream.

To minimize water quality impacts, a hydrostatic test water grab sample would be obtained prior to discharge from the pipe and analyzed for total suspended solids (TSS), oil and grease, and pH. If a pH adjustment is anticipated, the water would be treated as it is loaded into the test segment. If filtering is needed to reduce TSS or oil and grease to acceptable levels, it would be done as the water is discharged, through the use of a mechanical filter designed to collect solids or oil and grease. Water would discharge to the Snake River using straw bales or filter fence for erosion control. It could also be discharged to the Kittitas stormflow containment system (or to bare soil) for evaporation or infiltration. Discharge to the channels would be regulated to ensure that it does not dominate the flow of the receiving water body, even during low-flow conditions.

The storage tanks at the Kittitas Terminal would be similarly hydrostatically tested. Water supplies would be obtained from the Cascade Canal District. Discharge water would be drained into the ground onsite or to the stormflow containment system at the facility.

Impacts from test water releases would be short term and confined to relatively short reaches. No chemical additives would be added to the test water, with the possible exception of a buffer to moderate pH. Lab tests would characterize the water quality during final testing prior to discharge.

Impacts to Senior Water Rights from Water Quality Degradation. If construction resulted in water quality degradation in the Yakima River, potential impacts on the City of Cle Elum and the Kittitas County PUD could result by temporarily decreasing water availability or by increasing treatment costs to remove sediments. Increased turbidity and sediment load could impact senior surface water rights downstream, if the introduced sediment impairs the use at the time the water is needed. The Kittitas County PUD obtains water from the Yakima River for domestic and industrial use with intakes downstream of 18 crossings where invasive methods would be used. Sediment-laden water could damage pumps and supply lines, delay use, and/or increase treatment costs. Potential impacts to municipal water rights are considered major, though actual impacts may be avoided through cooperative planning between OPL and the local governments.

OPL plans to trench several unlined irrigation canals in the lower Crab Creek drainage which could impact senior water rights in that area for the same reasons cited above. The proposal would involve boring under lined irrigation canals crossed by the pipeline corridor, thus avoiding similar water quality and water rights concerns.

Construction Impacts - Groundwater. Groundwater in the vicinity of the pipeline corridor is a major source of water for domestic and public supplies; groundwater also provides baseflow to streams and rivers. Potential impacts during construction, other than the effects of localized dewatering and small fuel spills from fuel storage and equipment operation, are considered low due to the short duration of construction relative to the movement of groundwater.

The sensitivity of groundwater quality and quantity to potential impacts during construction depends on the hydrogeologic regime the pipeline corridor would cross. Potential impacts to groundwater during construction are discussed below.

Erosion. Erosion and uncontrolled discharge could increase groundwater turbidity. However, OPL plans to use erosion control measures in all areas where soils are exposed during construction to minimize transport of sediment to water (see Appendix C for discussion of BMPs).

Spill of Hazardous Material Associated with Construction Equipment. As discussed earlier for surface water, impacts to groundwater from construction can occur as a result of small spills associated with refueling and maintenance of construction equipment. Minor spills would be contained and cleaned up by construction crews as part of their operating guidelines.

Excavation. Excavation of previously contaminated soils during construction and trenching could mobilize contaminants into a previously uncontaminated groundwater body. During trenching, there is the possibility of encountering historically contaminated soil as well as buried structures such as wells and underground storage tanks. Abandoned or Aorphaned@ wells could provide a direct pathway for contaminants to flow to an underlying aquifer. In these circumstances, proper disposal procedures would be implemented based on the type and quantity of contaminants, and the pipe would be rerouted to avoid contaminated soils discovered during construction. State regulation requires reporting of both circumstances. In the case of contamination, compliance with WAC 173-340 (The Model Toxics Control Act) is required. Chapter 173-160 WAC, Minimum Standards for Construction and Maintenance of Wells, includes procedures for proper well abandonment and would be followed upon encountering orphan wells.

Dewatering. Shallow groundwater may be encountered during trenching along stretches of the pipeline corridor. Laterally extensive shallow aquifers with seasonal groundwater levels within trenching depths are likely to be found in alluvial sediments and near major drainages. Perched or shallow groundwater zones may be encountered at various places along the pipeline corridor including the plateau areas of Puget Sound, the Upper Yakima Basin, Kittitas Valley, and lower Crab Creek areas, and other areas associated with lakes, ponds, wetlands, and small drainages. In these areas, localized dewatering may be necessary. In areas where groundwater conditions could necessitate dewatering in large volumes, rerouting of the pipeline would be considered. In areas where dewatering would be necessary, it would be performed only for the period required to place and backfill the pipeline.

Where shallow groundwater is encountered in coarse sediments, the dewatering operation would likely require pumping and discharge of relatively large volumes of water. The dewatering process would depress the water table in the immediate vicinity of the excavation, causing a temporary alteration in the local groundwater surface. This could affect the ability of nearby wells to collect groundwater. After the excavation is backfilled, water levels would recover.

Interruption of Groundwater Flow Paths. Trench backfill, in most cases, would consist of excavated native soils. In areas where the native soils are consolidated, such as compacted till, the more loosely compacted backfill could result in a preferential groundwater pathway along the pipeline trench.

In areas where low-permeability soils occur at or near the surface, the trenching may cut through low-permeability soils and intercept higher permeability materials underneath. This could allow water to drain more quickly into underlying soils, allowing for preferential infiltration. In these areas, identified as part of the advance geotechnical evaluation along the pipeline corridor, the backfill would be compacted to match the native overlying soils, and if necessary, the bottom of the trench would be lined with a low-permeability material.

Although these impacts might be minor with regard to the groundwater resource, they could be more substantial for a receiving stream or other surface water body such as a wetland or lake.

Construction Impacts - Columbia River Approach Options. Impacts to water quality resulting from construction of either of the YTC corridor segment options would be similar to those resulting from construction of the proposed route, and would be negligible to minor. Streams crossed by these segment options are intermittent and construction would be performed only when they are dry.

Construction Impacts - Columbia River Crossing Options. In addition to the proposed Columbia River crossing method (horizontally drill a crossing downstream of Wanapum Dam), OPL has identified four alternative Columbia River crossing routes: dredging a crossing north of I-90, attaching the pipeline to the I-90 Bridge, placing the pipeline on Wanapum Dam, or attaching the pipeline to the Burlington Northern Beverly Railroad Bridge. There are also various approach routes to the alternative crossing sites.

The alternate routes for the dredged and I-90 Bridge crossings continue east on the north side of I-90, cross the river, and continue south along the east side of the Columbia River, rejoining the proposed pipeline corridor approximately 25 km (4 miles) east of Wanapum Dam. With the exception of the Columbia River and Ryegrass Coulee, streams crossed by these two alternative routes (crossings 24a to 24c) are intermittent and would be crossed when they are dry. Ryegrass Coulee would be a bored crossing.

There would be negligible impacts to water quality if the pipeline crossed the Columbia River via the I-90 Bridge, the railroad bridge, or Wanapum Dam. Impacts to water quality from crossing the Columbia River via a dredged crossing would be greater than the proposed drilling crossing, and could be moderate to major. Dredging the Columbia River would result in resuspension of sediments, temporarily increasing turbidity and possibly pollutant concentrations.

There are also several alternative approach routes which originate at the YTC segment option north of I-90 and extend to the proposed crossing location (crossing 223) and the Burlington Northern Railroad Bridge crossing. This includes 14 crossings in the Park Creek (208 - 215), Sagebrush Springs (216 - 217), Canyon Creek (218 - 219), and Johnson Creek (220 - 221) drainages which would be flumed or trenched when dry, resulting in minor impacts.

Operational Impacts - Surface Waters

Long-Term Channel Changes Expose Pipeline. If stream erosion or migration exposes the pipeline during the lifetime of the project, the risk of damage to the pipeline, and subsequent release of product to water, could result in a potentially major impact to water quality. The pipeline could be exposed to abrasion by sediment transport on the streambed. Steep, confined channel forms are expected to have the greatest susceptibility to exposure from vertical scouring, but alluvial fans and meandering channels could be subject to exposure by lateral migration.

If the pipeline were exposed by scouring at river and stream crossings, damage to the pipeline might occur. To anticipate and address this issue, OPL would locate the pipeline 0.6 m (2 feet) below the maximum scour depth identified for each channel for the full width of the floodplain that could be occupied by a laterally migrating stream channel. Burial at this depth would prevent exposure that might otherwise occur through channel degradation (downcutting). In addition, thicker gauge pipe would be used and the pipe would be coated with concrete or river weights used to reduce the potential buoyancy under the channel. In this fashion, the risk of pipeline exposure, damage, and subsequent loss of oil from damage would be much reduced.

The actual methodology to identify the maximum scour depth on a site-specific basis is currently under review. The final methodology used to determine maximum scour depth would be agreed on by all federal and state agencies involved.

Water Quality Degradation from a Leak or Spill. The greatest potential impact to water quality during pipeline operations would be associated with a leak or accidental release of product, which would have major detrimental impacts on water quality and subsequent beneficial uses. Refer to Section 3.18, Health and Safety, and Appendix A for assessment of pipeline spill risk.

Design and construction features and post-construction BMPs proposed by OPL are described in Appendix C. Key features that would ensure minimal impacts during operation include the following:

- OPL preparation of a Spill Response Plan before project implementation that addresses containment and cleanup issues.

- Inclusion of block valves at spacings sufficient to reduce the number of potential large oil releases, and placement of trench plugs in the pipeline trench upslope of each bank of a crossing (to prevent small leakages from entering a stream via the trench fill). A block valve damaged by a slide may not function.

- Long-term monitoring of:

  - erosion conditions to prevent potential pipeline exposure;
  - corrosion at crossings (and in areas of shallow groundwater) to prevent weakening of the pipeline; and
  - leaks and spills to provide adequate lead time for prevention and cleanup actions.

Conflicts with Senior Water Rights. A spill or leak of any size would have a major potential impact on permitted senior water rights. A spill could contaminate water supplies and/or damage equipment. Impacts to senior water rights could occur if a spill or leak of oil from the pipeline entered a stream or river and impaired the beneficial use of the resource. The Spill Response Plan, discussed earlier, would include coordination with state and local agencies, municipalities, and communities, to address compensation as well as spill containment and cleanup issues. The plan would be WRIA-specific, and would be of particular concern in WRIA 39, Upper Yakima River, due to ongoing adjudication in that watershed.

In the event of a spill, all downstream surface water (and groundwater) right holders would be notified of the spill and an assessment made as to the degree and quantity of impaired use. Water right holders would be compensated for loss or impairment of water uses for the duration of the impact.

Operational Impacts - Groundwater

Releases of Petroleum Product. The potential for substantial impacts to groundwater would occur primarily during operation of the pipeline if a release of petroleum product occurs. Existing and senior groundwater right holders may be impacted if a spill or leak were to occur, and the product reached the groundwater table and migrated to a downgradient well or spring. Pipeline releases can be associated with leaks, rupture due to seismic shakings, ground rupture from faulting or landsliding, human-caused events, or damage of the pipeline by corrosion.

A sensitivity and potential impact rating has been developed to assess which aquifers are the most critical and where additional protective measures and monitoring are needed to prevent and/or minimize impacts (Table 3.6-3). The rating system ranks the sensitivity of groundwater regimes to potential impacts from the proposal, primarily leaks or spills. The impact rating considers the value

Table 3.6-3. Groundwater Sensitivity and Potential Impact Rating Criteria

Index Parameters	Parameter Description and Justification	Sensitivity Rating Values	Relative Rating Value Description
Groundwater Regime*	The groundwater regime that the pipeline segment is located in is an indicator of the resource value (i.e., potential yield to wells and connection to surface water resources), and potential to transport contamination if a pipeline leak should occur.	1 = Groundwater Regimes III, IV and VI 2 = Groundwater Regimes II and V 3 = Groundwater Regimes I and VII 4 = Groundwater Regime VIII	The lowest sensitivity rating for regimes III, IV and VI reflects the low permeability, transport potential, and potential well yield that these groundwater zones exhibit. Groundwater regimes II and V exhibit potentially high well yields but may not be directly associated with surface water bodies, and are typically heterogeneous, limiting transport potential. Groundwater regimes I and VII exhibit the largest potential for contaminant transport, and impact to surface waters (via irrigation pumping from regime VII and direct baseflow from regime I). The greatest sensitivity is assigned to regime VIII, sole-source aquifer, due to the importance of protecting the aquifer.
Groundwater Use	The groundwater use index characterizes the current value of the resource to human users within the groundwater regime along the pipeline segment.	0 = unknown minor uses 1 = domestic, limited public, irrigation and industrial 2 = public The rating value is the sum of each of the use index values assigned to each segment.	Public supply use is given the largest sensitivity rating due to the potential impacts to a large number of users. Domestic, irrigation and industrial uses are assigned a lesser sensitivity rating value because they are not subject to a public distribution system and in the case of irrigation and industrial, are not a source of drinking water.
Depth to Groundwater	The depth to groundwater, or separation distance, is the vertical distance from the pipeline to the aquifer beneath the pipeline segment. The aquifer is considered to be the uppermost groundwater zone that can provide usable quantities of groundwater to wells and which supplies baseflow to streams. This parameter does not include near-surface soil water or extremely limited perched groundwater zones.	1 = >100 feet below surface 2 = 50 - 100 feet below surface 3 = 0 - 50 feet below surface	The sensitivity values for depth to groundwater are somewhat arbitrary, and are selected to represent the range of aquifer depths that occur along the alignment. Additionally, in sediments with permeabilities generally sufficient to yield water to a public supply well (100 gpm or greater), leaked product could migrate up to 50 feet within a 24-hour period, which is assumed to be a reasonable response time if a leak should occur.

Index Parameters	Parameter Description and Justification	Sensitivity Rating Values	Relative Rating Value Description
Separation Sediments	The characteristics of the sediment that separate and occur between the proposed pipeline and the uppermost aquifer are critical to assessing the risk of potential contamination from the pipeline if a leak were to occur. Low-permeability sediments would minimize downward migration of leaked product, containing the spill within the immediate vicinity. Permeable sediments would allow for relatively quick percolation of leaked product to the uppermost aquifer.	1 = glacial till, loess, competent bedrock, clay or other confining material. 2 = low permeability or heterogeneous transmissible sediments including fine to medium sand and well graded sand, silt, and gravel. 3 = permeable poorly graded sediments including sand and gravel and highly fractured bedrock.	The lowest permeability capping materials are rated with the lowest sensitivity, and the highest permeability materials are rated with the highest sensitivity. The selected sediment categories represent the range of materials found along the alignment.

* See Table 3.6-2 for description of groundwater regimes.

of the aquifer resource, soil permeability, and the depth of the water table and water-bearing unit underneath the pipeline.

Table 3.6-4 provides the milepost segment for separate groundwater regimes (or aquifer types) found along the pipeline corridor, as defined in Table 3.6-2, along with a description of the groundwater uses in each segment, typical depth to groundwater, and the impact sensitivity rating for each segment. The impact sensitivity rating for each groundwater regime segment along the pipeline corridor is a relative indicator of the value and environmental sensitivity of that segment to a potential leak or spill from the pipeline.

The mean impact sensitivity rating for all the segments along the pipeline corridor is 7.8, with a standard deviation of 1.6. Ratings of 10 or greater can be considered significantly more sensitive than the mean or typical conditions found along the pipeline corridor. These more sensitive aquifer segments are those used for public supplies and/or are susceptible to relatively rapid spread of product if a spill were to occur. Such sensitive segments underlie 117 km (73 miles) or approximately 32 percent of the pipeline corridor. The majority of the sensitive segments occur in the Puget Sound Lowland region, west of the Snoqualmie Tunnel.

The potential for leaks and spills from the pipeline during operation is a function of the integrity of the pipe and associated facilities. All facilities and the pipeline would be tested hydraulically to ensure integrity prior to operation and introduction of product. A potential for leaks and spills exists at valves and pumping stations where mechanical failures could occur. These spill volumes are considered to be less than those that could occur from a leak or breach in the pipe; therefore, block valves would be used to contain large spills by isolating large segments of the pipeline.

Pipe rupture can occur from damage by corrosion, unauthorized excavation within the pipeline corridor, or by the effects of water forces at stream crossings if the pipeline becomes exposed or placed under differential buoyant forces, creating stresses in the pipe. Corrosion of the pipeline metal can occur, particularly where fluctuating shallow groundwater levels periodically inundate the pipe or where the pipe is submerged in corrosive waters. Corrosion would be monitored periodically along the entire pipeline corridor and more intensively in the areas of higher risk. Cathodic protection would be employed where needed in areas of high water table and at stream crossings and in floodplains.

Preventing corrosion and impacts from potential leaks and spills would be a function of initial design, but also a function of effective monitoring. Monitoring for pipeline integrity and corrosion, and monitoring the mechanical conditions of valves and pump stations on a regular basis, would ensure low probability of failure and leakage. Routine pipeline inspections and pressure sensing in the pipe would provide early detection of spills. Early spill detection would prevent a substantial leak and allow for rapid cleanup before significant spread of product. In addition to line monitoring, equipment used to inspect the pipe=s interior (a Asmart pig@) would be used periodically to detect areas of pipeline weakness. In the most sensitive pipeline segments (Table 3.6-4), increased inspection and line monitoring would be employed relative to other less sensitive sections of the pipe.

Table 3.6-4. Groundwater Conditions along Proposed Pipeline Corridor

Pipeline Segment (milepost)	Groundwater Regime[a]	Known Groundwater Uses Downgradient of Alignment[b]	Estimated Water Table Depth Below Surface (feet)	Vulnerability/Impact Rating (Scale of 4-12)[c]	Specific Recommendations/ Comments[d]	Federal Owner
0 - 8.15	II & VIII	PUB, IRR, DOM	~100	10	For Cross Valley Sole-Source Aquifer, coordinate spill response w/ Cross Valley Aquifer Association; ***place block valve east of Echo Lake wetland; provide special trench design to impede leakage from trench***	
8.15 - 9.3	I	DOM	~20	9	Low yield/poor water quality	
9.3 - 11.9	II	limited DOM	~100	7		
11.9 - 16	III	limited DOM	20-50	7		
16 - 33.7	II	PUB, DOM, IRR	10-50	10	Coordinate spill response w/ City of Carnation	
33.7 - 41.05	I	IND, PUB, IRR, DOM	10 - 15	11	Coordinate spill response w/ Cities of Snoqualmie and North Bend	
41.05 - 56.2	I & II	DOM, limited PUB	10 - 15	10	Tinkham & other state park campgrounds present	USFS
56.2 - 59	III	DOM, possible limited PUB	Variable, generally >100	5	Commercial and ski areas present @ MP 58	USFS
59 - 64	I & II	possible limited DOM	40	9		USFS
64 - 73.35	II	possible limited DOM	~90	7		USFS
73.35 - 75.8	III	DOM, limited PUB	Variable, generally >100	5	Town of Easton, Easton Lake State Park @ MP 74-75	USFS
75.8 - 77.8	I	unknown, possible limited DOM	~70	8		
77.8 - 98.9	II	DOM, IRR	100->300	6	Indian John rest area @ MP 93	
98.9 - 112.4	I	DOM, IRR	20-60	10		
112.4 - 114.9	VII	DOM, possible IRR	~100	9	Impact rating assumes basalt bedrock is permeable from the	

Pipeline Segment (milepost)	Groundwater Regime[a]	Known Groundwater Uses Downgradient of Alignment[b]	Estimated Water Table Depth Below Surface (feet)	Vulnerability/Impact Rating (Scale of 4-12)[c]	Specific Recommendations/ Comments[d]	Federal Owner
					surface to water table	
114.9 - 126.4	VII	IRR, DOM, PUB	60-100	10	Overlain by 50+ feet alluvium, City of Ellensburg	
126.4 - 129.4	VII	Unknown, possible limited DOM	~100	8		
129.4 - 131.4	VII	Unknown, possible limited DOM	Variable, generally >100	7	Overlain by 50+ feet alluvium	
131.4 - 147.4	VII	Unknown, possible limited DOM	~100	8		
147.4 - 153.4	VII	DOM	300	8	Overlain by 50+ feet outburst flood deposits, may be shallow sources within deposits	
153.4 - 163.9	VII	DOM, IRR	400	8	Overlain by 50+ feet lacustrine deposits	
163.9 - 171.4	VII	IRR, IND, DOM	200	8		
171.4 - 177.4	VII	IRR, DOM	100	9	Overlain by ~50 feet outburst flood deposits, may be shallow sources within deposits	
177.4 - 181.9	VII	Unknown	200	6	Overlain by 50 feet of alluvial deposits (landslide)	
181.9 - 183.4	VII	IRR, DOM	400	6	Overlain by <50 feet loess	
183.4 - 187.9	VII	IRR, DOM	400	6	Overlain by ~50 feet lacustrine deposits	
187.9 - 190.9	VII	IRR, DOM	500	6	Overlain by >100 feet loess and lacustrine deposits	
190.9 - 191.9	VII	IRR	500	6	Overlain by ~50 feet lacustrine deposits	
191.9 - 193.9	VII	IRR	300	6	Overlain by >100 feet loess and lacustrine deposits	
193.9 - 199.4	VII	IRR, DOM	300	8	Overlain by ~100 feet outburst	

Pipeline Segment (milepost)	Groundwater Regime[a]	Known Groundwater Uses Downgradient of Alignment[b]	Estimated Water Table Depth Below Surface (feet)	Vulnerability/Impact Rating (Scale of 4-12)[c]	Specific Recommendations/ Comments[d]	Federal Owner
					flood and lacustrine deposits	
199.4 - 202.9	VII	IND, IRR	100	9		
202.9 - 206.9	VII	IRR, DOM	200	8	Overlain by ~100 feet outburst flood and lacustrine deposits	
206.9 - 208.4	VII	IRR, DOM	300	7	Overlain by ~100 feet outburst flood deposits, may be shallow sources within deposits	
208.4 - 213.4	VII	IRR, DOM, IND	250	6	Overlain by ~100 feet lacustrine deposits	
213.4 - 219.9	VII	IRR, DOM	200	6	Overlain by >100 feet loess	
219.9 - 221.4	VII	IRR, DOM	100	9	Overlain by >100 feet outburst flood deposits, may be shallow sources within deposits	
221.4 - 228.9	VII	IRR, IND, DOM, PUB	100	9	Overlain by >100 feet loess, City of Pasco	
228.9 - 230.7	VII	IRR, IND, DOM	50	10	Overlain by <100 feet outburst flood deposits, may be shallow sources within deposits	

Note: Mileposts shown are approximate and subject to change.

[a] I - Alluvium
II - Glacial-Fluvial Deposits
III - Cascade Mountain Bedrock
IV - Loess/Dune Deposits
V - Outburst Flood Deposits
VI - Lacustrine Deposits
VII - Columbia River Basalts
VIII - Sole-Source Aquifer

[b] PUB - Public Supply
IRR - Irrigation
DOM - Domestic
IND - Industrial

[c] Rating is the sum of the Sensitivity Rating Values in Table 3.6-3. Ratings of 10 or greater are significantly more sensitive than the typical conditions along the pipeline corridor.

[d] Items in regular typeface are from OPL 1998, Application for Site Certification. Items in ***bold italic*** are additional mitigation suggested by the EIS team.

Interruption of Groundwater Flow Paths. The presence of the proposed facilities could impact groundwater movement and water levels at the Kittitas Terminal by reducing infiltration in areas where compacted soils or impermeable liners are placed and where stormwater collection systems are operated. However, due to the relatively small area covered by these facilities, these impacts would be minor.

Water Rights. As mentioned earlier, senior groundwater right holders might be impacted by operation if a spill or leak were to occur, and the product reached the groundwater table, migrating to a downgradient well or spring. As part of the proposal, OPL would develop a compensation plan worked out with the communities, state and local agencies on a WRIA basis. A separate agreement would also be established with the Cross Valley Aquifer Association to protect the Cross Valley Aquifer (see next subsection). There are no other sole-source aquifers or other groundwater areas that are being comprehensively managed (i.e., no wellhead protection programs) along the pipeline corridor.

Cross Valley Aquifer. There is one designated sole-source aquifer in the vicinity of the pipeline corridor. The Cross Valley Sole-Source Aquifer is located in south Snohomish County. The pipeline corridor would cross the aquifer from approximately MP 0 to MP 8. The existing Olympic pipeline has been in this location for 30 years, even before the designation of the aquifer as sole source. There are no restrictions limiting uses or construction practices over the aquifer.

The majority of historic releases from the existing pipeline system have been at the pump stations or block valves. OPL would construct one pump station (Thrasher) over the sole-source aquifer. The pump station would be electronically equipped to detect leaks and would be located on an upland area underlain by till. A valve would be placed to minimize spill volumes in case damage to the pipeline occurs.

Due to the importance of the aquifer as a sole source for drinking water, a specific monitoring plan with increased line monitoring, pigging, and groundwater monitoring would be developed in conjunction with the Cross Valley Aquifer Association to ensure adequate response time if a spill should occur.

The pipeline corridor across this sole-source aquifer is generally underlain by low permeability till in most places. In these areas, a leak or spill would generally be contained to within the upper 1.8 m (6 feet) of soil. As previously discussed, well-drained soils with hydraulic connection to the aquifer occur in limited sections along the pipeline corridor. In these areas, trench lining would be employed that would prevent oil from escaping the trench, and would direct the oil toward a lower sensitivity area for capture and cleanup. The exact locations and lining techniques would be developed in conjunction with the Cross Valley Aquifer Association.

Operational Impacts - Columbia River Approach Options. Under normal operating conditions, operation of the pipeline would not result in impacts to water quality. If a spill occurred, it could result in minor to major impacts to water quality depending on the location, timing, and volume of the spill. Impacts of a spill along YTC segment options would not be substantially different from a spill along the proposed pipeline corridor in terms of water quality.

Operational Impacts - Columbia River Crossing Options. Impacts to water quality from normal operation of the pipeline are not expected for any of the crossing options. If product were to spill into the Columbia River, minor to major impacts to water quality could occur, depending on the timing and the volume of the spill. Impacts would be similar to those described in the Columbia River spill scenario in the spill analysis section of the ASC.

Cumulative Impacts. Increased risk of negative cumulative effects to watersheds during construction could result within watersheds with harvested and roaded areas upstream; multiple pipeline crossings (discussed earlier in this section); disturbances by wildlife; heavy winter applications of sand and gravel to highways and roads; other near-stream ground disturbing activities; and others. Turbidity of the water column would result in temporary impacts, even on a cumulative basis. Deposition of sediment from multiple sources in low-gradient stream reaches could result in streambeds with fine sediment increasing faster than peak flows can remove and transport it. Cumulative effects could be more pronounced in basins that would contain numerous invasive crossings of streams (e.g., South Fork Snoqualmie River), where sediment from several tributaries would be transported to a mainstem system. High fine sediment concentrations in the streambed often have negative implications for aquatic ecology.

Quantifying the actual sediment release from each stream crossing and estimating the ultimate portion of that release which might reach the principal river in a watershed is beyond the scope and capability of this EIS. To be useful, the analysis would have to include all other existing and planned timber harvest activities, and such analysis is attempted in various timber harvest plans. It can be assumed that some sediment release may reach the mainstem from each pipeline crossing, and the less effective revegetation and sediment control measures are, the more sediment may reach the mainstem. While construction across rivers in logged watersheds may increase sedimentation in rivers already subject to greater flow fluctuations and sedimentation, vegetation removal for the project in such areas would be relatively minor. To minimize any potential cumulative impacts, sediment and erosion control must be aggressively managed, especially at crossings that are a short distance from the river into which they flow.

After construction, and after revegetation and other stabilization measures are in place, no cumulative impacts are anticipated. Hydrostatic test water intake and discharge is not significant and not a cumulative impact; it would occur over different watersheds at different times.

3.6.2.2 No Action

Surface Water. The No Action Alternative would result in no impacts associated with OPL=s proposal. However, the risk of other oil spill-related impacts from trucks would not decrease but instead may increase (see spill analyses section of ASC). Potential impacts from barge activities and transfer operations on the Columbia River would continue.

Assuming a travel corridor using I-90, I-82, and other roadways, many of the trucks carrying product that is not carried by the existing north-south pipeline would cross many of the same stream channels as the proposed pipeline. For example, the South Fork Snoqualmie River would be crossed four times by a truck route (compare two times for the pipeline corridor) and is paralleled by I-90 for a distance greater than the proposed pipeline corridor. The Yakima River is crossed five times by the interstate highways (compare one time for the pipeline corridor) and is paralleled for a much greater distance than the proposed pipeline. The Columbia River, like the pipeline corridor, is crossed at I-90. The risk of oil loss to the environment would increase through time with the increased risk of tanker truck accidents. The cleanup of oil spills on roads could be easier to contain (relative to a buried pipeline) if the spill could be contained on impervious surfaces; such a situation depends on the circumstances of the spill.

The ASC indicates that barge traffic in the Pacific Ocean along the Washington coast and on the Columbia River from the Pacific Ocean to Pasco probably would also increase without implementation of the proposal (OPL 1998). Columbia River traffic could increase over 50 percent in the next 23 years to over one trip per day. The corresponding risk of oil spills and potential impacts to the Columbia and Snake Rivers increases with increased barge use. However, the expanding use of double-hulled barges reduces the risk of barge-related oil spills. See Section 3.18, Health and Safety, for further discussion of spills associated with the proposal and the No Action Alternative.

Groundwater. Little or no impact to groundwater is expected from No Action. A truck spill onto soils overlying a shallow groundwater table would have impacts similar to a pipeline. However, cleanup may be easier as a result of response access, lower volumes, and the fact that trucks would be on highways and not directly over an aquifer. Spills leaving roadways and entering ditches could create some groundwater risk.

3.6.3 Additional Proposed Mitigation Measures

This section presents mitigation measures beyond those identified by OPL in the ASC that can further reduce the risk of impacts on water resources.

3.6.3.1 Construction Mitigation and Subsequent Impacts

Stream Channel Bed and Banks

OPL has indicated that undersized culverts that are identified would be replaced (see Appendix C). To ensure all undersized culverts are identified, OPL should meet with all land owners and/or entities with easements or ROW where under- or over-culvert crossings are planned (e.g., USFS, State Parks, etc.), and identify culverts whose future maintenance or replacement may be restricted by the pipeline; survey culvert conditions and assess their capacity to pass flows from a 100-year storm event; and identify inadequate culverts needing replacement and record design criteria for replacement structures (all culverts on crossings in the Wenatchee National Forest may be undersized). Culvert replacement would improve fish passage and reduce erosion.

Monitor culvert and channel conditions at all replaced culverts 1 and 3 years after construction for desired fish passage and erosion concerns. Take corrective actions as

necessary. Add any new structures to the long-term monitoring plan for all stream crossings. Replacement of culverts would require additional instream construction activities that could result in additional temporary impacts to water quality during the construction period, including increases in turbidity and sediment transport. However, these potential impacts would be less substantial than impacts resulting from a failure of an undersized or degraded culvert.

Streamside Vegetation

Consider leaving some of the larger trees which are cut down in the riparian area. Where possible, these trees may be pushed over so that the root wad stays attached. This measure would enhance long-term LWD recruitment. LWD could also be used for crossing stabilization or fish enhancement, taking care that placement would not generate scour of backfill materials in the streambed that are not fully stabilized.

Consult wildland hydrologists or fisheries habitat managers prior to replacement of LWD removed from the stream or riparian area during construction. LWD should be partially buried and anchored. This mitigation would ensure LWD stability during high streamflows and maximize the benefits for fish habitat.

Floodplains

To ensure adequate burial depth of the pipeline for crossings identified as highly vulnerable to water quality and fisheries impacts, including those with FEMA-identified 100-year floodplains, utilize water surface profile model(s) as well as FEMA flood-elevations and field indicators to identify the 100-year flood boundary.

On all crossings, consult a hydrologist or geomorphologist to assist in identification of floodplain boundaries in the field.

Bury the pipeline 0.6 m (2 feet) below maximum scour depth throughout the entire floodplain.

These mitigations would further reduce the potential for exposure of the pipeline.

Water Quality. It is not possible to totally eliminate all water quality impacts, such as erosion/sedimentation, and it will always be possible for a pipeline leak to occur. However, to reduce potential impacts as much as possible, the following additional measures are recommended:

OPL has indicated they would provide long-term monitoring to detect erosion and prevent potential pipeline exposure (see Appendix C). The most sensitive stream crossings should be monitored more frequently and more intensively.

During the design phase of the project, develop detailed stream crossing plans and specifications for the sensitive stream crossings (high resource value or difficult site conditions), including site-specific scour depth and width estimates, site-specific sediment

and drainage control plans, site-specific streambank and bed restoration plans, site-specific stabilization plans, site-specific stream crossing construction plans with phasing and sequencing, and site-specific monitoring plans. Adapt these plans in the field for application to all of the crossings.

- Consider the use of a polymer in place of bentonite for drilling. Select a polymer that begins to break down naturally after a few days in the environment, similar to polymers used in drilling water wells.

- To protect water quality in the Columbia River, ensure that design and construction of horizontally drilled crossing of the Columbia River minimize the potential for discharge of drilling muds to the river. (See specific discussion of additional mitigation measures in the AConstruction Mitigation and Subsequent Impacts@ subsection in Section 3.2, Geology, Soils and Seismicity of this EIS).

- Monitor water quality downstream of trenched or drilled crossings, including the presence of sheens and scums, during equipment operation in and near channels known or suspected to contain salmonids. If a problem is detected, discontinue construction until it is rectified.

- Trench plugs should be installed at changes in pipeline slope in areas of shallow groundwater tables.

Water Rights

- Coordinate timing of invasive crossing construction upslope of Cle Elum and Kittitas PUD water intakes with these entities. Construct crossings under low-flow conditions to minimize sediment transported in the Yakima River wash load.

- Provide additional measures to protect against sediment at water intakes, including measures to filter sediment suspended in the water column.

3.6.3.2 Operational Mitigation and Subsequent Impacts

- At each crossing site, and especially those using invasive crossing methods, survey both of the elevations of the installed pipeline and the reconstructed streambed and banks. Install and survey a benchmark and a second reference point near each crossing. Then monitor cross-sectional morphology at each crossing at 1, 3, and 5 years after construction by repeated level surveys. Repeat monitoring after every storm event that substantially exceeds the peak storm observed in each WRIA during the first 5-year interval. Whenever the depth of the pipeline is halved relative to the original burial depth, notify appropriate agencies and assess whether stabilization measures are appropriate. If the bed elevation ever reaches the original maximum scour depth of the channel, OPL should meet with the appropriate agencies and identify and modify stabilization and spill prevention measures, including pipeline closure, if necessary. These measures would greatly reduce but not eliminate the potential for exposure and subsequent breakage of the pipeline.

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