**NF American River/Donner Lake**

**Geographic Response Plan**

**Chapter 2 – Site Description**

**2.1- Chapter Introduction**

This chapter provides a description of the area’s physical features, hydrology, climate and winds, and includes an overview of oil spill risks in the NF American River/Donner Lake area. The area covered by this plan includes Lake Washington, lower portions of the Cedar and Sammamish Rivers, and downstream areas of Coal Creek, Juanita Creek, Kelsey Creek, Lyon Creek, May Creek, McAleer Creek, Ravenna Creek, Taylor Creek, Thornton Creek, and Yesler Creek. Lake Washington includes Andrews Bay, Fairweather Bay, Juanita Bay, Meydenbauer Bay, Moss Bay, Pontiac Bay, Union Bay, Wolf Bay, Yarrow Bay, Cozy Cove, and shoreline areas of Mercer Island.

The NF American River/Donner Lake Geographic Response Plan (NFAM/DL-GRP) encompasses an area of approximately 34 square miles and is bordered by the cities of Seattle (Montlake Bridge) to the west, Bellevue and Kirkland to the east, Kenmore to the north, and Renton to the south. The plan fully resides within the limits of King County. LKWA-GRP is bordered by the Central Puget Sound Geographic Response Plan to the west, and falls within the boundary of Water Resource Inventory Area 8 (WRIA-8, Cedar-Sammamish Watershed).

**2.2 - Physical Features**

Lake Washington is a long, narrow, finger-shaped lake that’s approximately 22 miles long (north to south) and less than 2 miles wide near the middle (east to west). The lake has a surface area of about 34 square miles, and an average depth of 108ft. The deepest part of the lake is reported to be 214ft. The water level in Lake Washington is regulated by the Hiram M. Chittenden Locks in Ballard (Seattle). Water levels in the lake vary within a couple of feet seasonally, but usually measure 16ft above mean sea level (Puget Sound) and 21ft above mean lower tide. The lake connects to Puget Sound (to the west) by way of the Lake Washington Ship Canal and the Chittenden Locks.

The basin of Lake Washington is a deep glacial trough with steeply sloping sides, carved out by the last continental glacier that moved through the area during the late Pleistocene era. Water and sediment accumulated in the lake as the glacier melted, and continues to accumulate today. The lake is surrounded by other north-south-oriented features that attest to the direction of ice flow; such as small inverted spoon shaped hills and larger hills. The modern shoreline of the lake is characterized by a 10-foot-high bench, embayments, gentle and steep slopes, and several peninsulas.

Lake Washington is the largest of the three major lakes in King County, and the second largest natural lake in the State of Washington. Most of the area around the lake is highly developed and urban in nature. Two major influent streams feed the lake; the Cedar River on the south end near Renton, and the Sammamish River on the north side near Kenmore. The upper part of the Cedar River is the source for much of the drinking water for the greater Seattle area and includes the Chester Morse Lake which serves as a water storage reservoir. Mercer Island lies in the southern half of the lake and is separated from the southeastern shore by a relatively narrow and shallow channel.

Three floating bridges and two girder bridges carry vehicle traffic across Lake Washington today. The Evergreen Point Floating Bridge (SR-520) connects Seattle's Montlake neighborhood with Medina (located northwest of Bellevue). The Interstate 90 corridor across the lake uses two floating bridges to connect Seattle's Mount Baker neighborhood with Mercer Island; the Lacey V. Murrow Memorial Bridge carries east bound I-90 traffic to the island and the Homer M. Hadley Memorial Bridge carries west bound I-90 traffic from the island to Seattle. The East Channel Bridge (girder bridges) allows east and westbound I-90 traffic to flow between Mercer Island and Bellevue.

**2.3 – Hydrology**

Lake Washington has two major influent streams; the Cedar and Sammamish Rivers. The Cedar River at the southern end of the lake contributes about 57 percent of the annual runoff while the Sammamish River on the north end contributes about 27 percent. Total annual flow is approximately 41 percent of the lake volume. Residence time is about 2.4 years. Lake Washington drains westward through Lake Union and the Ship Canal to Shilshole Bay in Puget Sound via the Chittenden Locks in Ballard. [Lake Washington’s water level elevation](http://www.nwd-wc.usace.army.mil/nws/hh/basins/lkwash.html) varies by season, but is typically about 16ft above mean sea level (Puget Sound) and 21ft above mean lower tide.

Tributaries to Lake Washington are essential contributors to its hydrologic budget. Rainfall plays a key role as well. About a quarter of the annual rainfall seeps or soaks into ground water and moves underground toward lakes and streams, or runs off land surfaces to lakes and streams. Lake Washington is located in [Water Resource Inventory Area 8](https://fortress.wa.gov/ecy/publications/publications/1111013.pdf) (WRIA-8, Cedar-Sammamish). Notable tributaries or sub-basins that drain to Lake Washington include:

* Bear Creek
* Cedar River
* Coal Creek
* Juanita Creek
* Kelsey Creek
* Lyon Creek
* May Creek
* McAleer Creek
* North Creek
* Ravenna Creek
* Sammamish River
* Swamp Creek
* Taylor Creek
* Thornton Creek
* Yesler Creek

Lake Stratification: Lake Washington undergoes annual stratification, with a strong thermocline developing about 39ft below the surface. As summer progresses, the temperature and density difference between water at the surface and bottom becomes more distinct. Three water layers are formed; upper, middle, and bottom water layers. The upper layer (epilimnion) is characterized by warmer, less dense water. It’s the zone of light penetration where the most biological growth occurs. The middle layer (metalimnion or thermocline) is a narrow band of water that’s colder than water in the upper layer but warmer than the lower waters beneath it. The middle layer helps prevent the mixing of upper and lower water layers. The bottom layer (hypolimnion) holds the coldest water. Plant material either decays or sinks to the bottom and accumulates in this “stagnant” lower water layer.   
  
During the winterthe lake temperature remains above 39°F and substantial vertical mixing by wind action and convective overturn assures isothermal conditions. As ice melts in the Spring, surface waters warm, then sink, and finally mix with deeper water. During summer the density of the water changes as its temperature changes. The water is most dense at 39°F, while above and below that temperature the water expands and becomes less dense. During the Fall, surface waters cool until they are as dense as the bottom waters and wind action mixes the lake so water temperature from surface to bottom are nearly the same.

Lake Washington Ship Canal and the Hiram M. Chittenden Locks: The ship canal is operated primarily as a navigation facility connecting Puget Sound with Lake Union and Lake Washington via the Hiram M. Chittenden Locks. Under normal operations, surface waters in the canal are typically maintained at 20ft to 22ft above sea-level (Puget Sound, mean lower tide). The minimum elevation is maintained during the winter months to allow for annual maintenance on dock and wall structures, minimize wave and erosion damage during winter storms, and provide storage volume for high water inflow. Storage volume is also used to augment Lake Washington Ship Canal inflows for use in operating the Chittenden Locks, the saltwater return system, the smolt passage flume and the fish ladder facility at the locks. The Chittenden Locks and spillway dam regulate the elevation of Salmon Bay, Lake Union, Lake Washington and the Lake Washington Ship Canal. The locks and associated facilities serve three purposes:

* To maintain the water level of (fresh water) Lake Washington and Lake Union at 20 to 22 feet above sea level (Puget Sound).
* To prevent the mixing of [sea water](http://en.wikipedia.org/wiki/Sea_water) from Puget Sound with the fresh water of the lakes (saltwater intrusion).
* Move boats to and from the water level of the lakes to the water level of Puget Sound.

The Chittenden Locks sit in the middle of Salmon Bay and are part of Seattle's Lake Washington Ship Canal. They include a smaller 30ft x 150ft lock and a larger 80ft x 825ft lock. The Chittenden complex also includes a 235ft spillway with six gates to assist water-level control. A fish ladder is integrated into the locks for migration of anadromous fish (most notably salmon).

Lake Washington Characteristics:

Drainage Area (including Mercer Island): 357,760 Acres (559 Miles2)

Lake Area: 21,500 Acres

Lake Volume: 2,350,000 Acre-ft

Mean Depth: 108ft

Maximum Depth: 214ft

Flushing Rate: 0.43 per year

Depth of Epilimnion: 39ft

Epilimnion-Hypolimnion Ratio: 0.387

Length: 22 miles

Main Inflows: Cedar River (57%), Sammamish River (27%)

Main Outlet: Ship Canal to Puget Sound

Typical Period of Stratification: Late March to Early November

Trophic State: Mesotrophic

**2.4 - Climate & Winds**

Seattle's climate is usually described as oceanic or temperate marine; winters are typically mild and wet while summers are usually warm and dry. Temperature extremes are moderated by the adjacent Puget Sound, greater Pacific Ocean, and Lake Washington. The region is largely denied pacific storms by the Olympic Mountains and cold arctic air by the Cascade Range. Despite being on the margin of the rain shadow of the Olympic Mountains, the Seattle area has a reputation for frequent rain. Records show that Seattle is usually cloudy more than 200-days per year, and partly cloudy more than 90-days annually.

The area receives approximately 37.41 inches of rain a year and statistics show that the city is becoming wetter; the current annual rainfall average reflects an increase of 0.4 inches. Seattle experiences moderate to heavy rain during the months of November, December, and January. The city receives roughly half of its annual rainfall (by volume) during these three months. In late fall to early winter, atmospheric rivers known as "Pineapple Express" systems, strong frontal systems, and Pacific storms are common. Light rain and drizzle are the predominant forms of precipitation during the remainder of the year; for instance, on average, less than 1.6 inches of rain falls in July and August combined.

Winds in the area are variable with the western portion of the lake being affected by marine winds from Puget Sound. Wind speeds often vary by season, with the highest winds generally occurring from November through January. Wind gusts can occasionally reach 50 mph or greater.

Seattle occasionally experiences extraordinary weather events. One such event occurred in December 2007 when sustained [hurricane](http://en.wikipedia.org/wiki/Hurricane)-force winds and widespread heavy rainfall associated with a strong "[Pineapple Express](http://en.wikipedia.org/wiki/Pineapple_Express)" event occurred in the greater Puget Sound area and the western parts of Washington and Oregon. Precipitation totals exceeded 13.8 inches in some areas with winds reaching 130 mph along coastal Oregon. It was the second wettest weather event in Seattle’s recorded history with 5.1 inches of rain falling on the city in a   
24-hour period.

**2.5 – Risk Assessment**

The Columbia River is one of the principal resources found in the Pacific Northwest with a plethora of natural, cultural, and economic resources intrinsically connected to the river, all at risk of injury from oil spills. Potential risks to these resources include large commercial vessels, pipelines, roads, rail systems, and other factors.

**Road Systems**

Vehicle traffic on roadways pose an oil spill risk in areas where they run adjacent to the shoreline, or cross over lakes, rivers, creeks, and ditches, that drain into the Columbia River. Several main highways run parallel to the river, including Highway 14 in Washington and Interstate-84 in Oregon. Within the MCR area there are six major highway bridges that cross the Columbia River, two that cross the Yakima River, and one that crosses the Snake River. In addition, there are approximately 30 smaller bridges or causeways where vehicles cross tributaries or small lakes on the shores of the Columbia. A vehicle spill onto one of these bridges or roadways can cause fuel or oil to flow from hardened surfaces into the Columbia River or its tributaries. Commercial trucks can contain hundreds to thousands of gallons of fuel and oil, especially fully loaded tank trunks, and may carry almost any kind of cargo, including hazardous waste or other material that would pose a risk to the environment. Smaller vehicle accidents pose a risk as well — commensurate to the volume of fuel and oil they carry.

**Rail Transportation and Facilities**

Similar to the highways systems that run along much of the Columbia River, rail transportation runs closely parallel to the river banks throughout the Lower and Middle Columbia River areas. BNSF Railroad’s Fallbridge Subdivision runs along the Columbia River on the Washington side, while Union Pacific’s Portland Subdivision runs along the opposing bank in Oregon. These two major railroad companies employ mixed cargo trains that can carry hazardous materials on both of these lines, including Bakken crude oil from the east to refineries along the coast.

The majority of the transportation of oil by rail into Washington and Oregon enters Washington at the border with Idaho near Spokane. Once in Washington, oil trains cross the Spokane River, travel to Pasco, and then continue westward along the Columbia River through the Columbia River Gorge to Portland, OR and Vancouver, WA. After reaching the coast, oil trains are heading north through Tacoma and Seattle, WA towards refineries in Anacortes and Ferndale, WA near the Canadian border. [[1]](#footnote-1) Prior to 2012, there was little to no transport of crude oil by rail to Washington or Oregon, as oil was traditionally transported by water via tanker or barge.[[2]](#footnote-2) With the surge in production at the North Dakota Bakken oil fields, and oil sands coming from Canada, rail has become an option for transporting crude to refineries throughout the country.

Locomotives by themselves typically hold several thousand gallons of diesel fuel plus large quantities of lube and motor oils. Individual tank cars can contain just over 30,000 gallons of crude oil or other petroleum products. Trains can carry 3,000,000 gallons of oil in a unit train of 100 tank cars; at 42 gallons per barrel that equates to 71,428 barrels. In 2013, approximately 17 million barrels were shipped through Washington, increasing to somewhere in the vicinity of 55 million barrels in 2014.[[3]](#footnote-3) These numbers are only predicted to rise as facilities are improved or increased.[[4]](#footnote-4)

The NuStar Energy facility in Vancouver, WA is planning on adding rail-offload capability and converting a 120,000 barrel methanol tank to store oil instead, allowing it to handle one crude-by-rail train approximately every three days.[[5]](#footnote-5) Vancouver Energy is a facility proposed for the Port of Vancouver, which if approved, would initially handle one to two crude-by-rail trains per day, and would be capable of receiving up to four per day. When oil is transported by train it is usually carried by crude-by-rail unit trains, trains carrying 100 oil tank cars or more. Unit trains carrying crude oil are now commonly found travelling along the Columbia River. As of June 2014, nineteen loaded unit trains with Bakken oil were passing through the Middle Columbia River weekly.[[6]](#footnote-6)

**Oil Pipelines**

Two pipeline terminals are located in the MCR area. The Tidewater pipeline terminal and the Tesoro Logistics NW pipeline terminal are both situated in the McNary Pool, on the eastern shore of the Snake River near the its confluence with the Columbia in Pasco, Washington. These facilities receive, store and distribute bulk liquid products such as gasoline, diesel, bio-fuels, fertilizer, and industrial/agricultural chemicals.[[7]](#footnote-7) Along with the pipelines, the facilities are accessible by barge, rail, and truck. A spill from a pipeline, or one of the other associated modes of transporting petroleum products, has the potential to significantly impact sensitive resources in the area.

**Aircraft**

Several airports are located within the MCR area including the: Cascade Locks State Airport, Columbia Gorge Airport, Arlington Municipal Airport, and Tri-Cities Airport. Landing strips at these airports are used for recreational, commercial, and transit purposes. With airports in the area, the potential exists for aircraft failures during inbound or outbound flights that could result in a spill with a release of jet fuel to the Columbia River or its tributaries.

**Recreational Boating**

Accidents involving recreational water craft on the Columbia River have the potential to result in spills of anywhere from a few gallons of gasoline, up to hundreds of gallons of diesel fuel. Examples of such accidents include: collisions, a vessel grounding, catching on fire, sinking, or exploding. These types of accidents, as well as problems with bilge discharges and refueling operations, the most typical types of spills to occur, have a negative impact on sensitive river resources.

**Landslides, Earthquakes, Weather and Wildfire**

Oil spill risk factors include accidents near waterways due to natural events, including landslides, earthquakes, weather and wildfire. Landslides commonly occur on slopes and in areas where they have taken place before, and historically, the Columbia River Gorge is one of the areas that have been most active in the recent past.[[8]](#footnote-8) A U.S. Geological Survey study (Blakely et al., 2011) presented geologic and paleoseismic evidence that the potential for large magnitude earthquakes (greater than M 7) could be much greater for eastern Washington than previously assumed.[[9]](#footnote-9) The MCR has its fair share of severe weather with the possibility of strong winds all year long, snow and ice in the winter, heavy rains in the western side of the Gorge, and thunderstorms throughout the area, which also place the region at risk of weather related wildfire.

**Other Spill Risks**

Other potential oil spill risks in the area include: dam turbine mechanical failures, road run-off during rain events, on-shore or near shore construction activities where heavy equipment is being operated, and the migration of spilled oil through soil on lands adjacent to the river or along creek or stream banks, as well as security concerns, such as acts of vandalism, sabotage, or terrorism to dams, railroads, or pipelines.

1. <https://fortress.wa.gov/ecy/publications/publications/1508010.pdf> (320) [↑](#footnote-ref-1)
2. Ecology data; rail data estimated based on refinery throughput data, ANT data, pipeline throughput for refineries, predicted volume transported by rail reported by refineries, and estimated increases in total crude transported through the state. [↑](#footnote-ref-2)
3. <http://www.Statesmanjournal.com/story/news/2014/05/26/west-coast-oil-trains/9605759/> [↑](#footnote-ref-3)
4. <https://fortress.wa.gov/ecy/publications/publications/1508010.pdf> (460) [↑](#footnote-ref-4)
5. <https://fortress.wa.gov/ecy/publications/publications/1508010.pdf> (317) [↑](#footnote-ref-5)
6. <https://fortress.wa.gov/ecy/publications/publications/1508010.pdf> (320) [↑](#footnote-ref-6)
7. <http://tidewater.com/pasco> [↑](#footnote-ref-7)
8. <http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Landslide_Hazard_Profile.pdf> (4) [↑](#footnote-ref-8)
9. <https://www.nirs.org/reactorwatch/natureandnukes/tolaneqreport1oct31-13.pdf> (6) [↑](#footnote-ref-9)