STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

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TO: Kerry Graber, HWTR

FROM: Charles San Juan, LHG, TCP-HQ *Charles San Juan*

SUBJECT: Groundwater Non-Potability Designation, former Occidental Chemical (OCC) Site, Tacoma.

Summary

This transmittal provides both the legal framework and technical justification for designating the Occidental site groundwater as non-potable (unfit for human consumption). Briefly, this non-potability designation is based on two components within MTCA Section 720. First, Ecology has determined that site groundwater is not a current source or future source of drinking water. Second, Ecology, as well as CRA (2014), have determined that site groundwater contains naturally occurring saltwater levels, which renders it unfit for human consumption. Lastly, Ecology (1995) has completed a Comprehensive Ground Water Protection Program (CGWPP). If a state has completed a CGWPP, then the EPA remediation program may defer to the state for groundwater current / future use designations (EPA, 1997). This means that Ecology now has jurisdiction for this current / future use designation, per prior agreement with EPA.

Conceptual Site Model

The groundwater non-potability designation means the human ingestion of groundwater exposure pathway does not apply to this site. Therefore, the final cleanup remedy for this site will be based on two exposure pathways: 1) groundwater discharge to surface water, which includes marine sediments /aquatic life and 2) vapor intrusion (human inhalation of indoor air).

Organization of this Transmittal

There are four parts to this document. A brief synopsis of each part is as follows:

- Part I contains background information (site description, land use, geology / hydrogeology, etc).
- Part II provides information on the MTCA Section 720 criteria for designating non-potable groundwater. Part II also contains an analysis of current fresh / saltwater conditions.
- Part III provides information on the EPA guidelines / criteria for groundwater non-potability.

- Part IV provides a conclusion and summary observations.

Part I – Background Information

Site Description

The Occidental Chemical (OCC) property (605 and 709 Alexander Avenue) is located within a man-made peninsula of land that extends roughly 0.8 miles northwest into Commencement Bay (Figure 1). The Port of Tacoma (POT) is the primary owner / operator for this area. The Occidental "site" (where hazardous substances are located, MTCA Section 200) is part of the EPA Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site. An affiliate of OCC (Mariana Properties), now owns the 605 Alexander Avenue parcel. The 709 Alexander parcel has also been conveyed to Mariana Properties (CRA, 2014).

Historical OCC Operations

Chlorinated solvents (TCE / PCE), were manufactured at the OCC facility from approximately 1947 – 1973. Historical solvent releases from former OCC operations have impacted the peninsula soil, groundwater and adjoining Hylebos Waterway sediment (CRA, 2014).

Land Use / History

Historical transcontinental railroad traffic to Commencement Bay resulted in the need for rail to sea transport. However, the flat tidal mud flats were not suitable for deep draft vessels. Consequently, to accommodate shipping traffic, five man-made peninsulas were constructed (from tidal mud flats dredge / fill). The former OCC site is located on the peninsula that intersects both the Blair and Hylebos waterways.

Site Geology / Hydrogeology

The former OCC site is located at the mouth of the Puyallup River valley, which empties to Commencement Bay. Several creeks also discharge to Commencement Bay (Ruston, Mason, Asarco, Puget, Hylebos and Wapato). Historically, the hydrogeology of this area was tidal marsh / estuary, as well as Puyallup River deltaic deposits. A key point is that the OCC site is located on land reclaimed from the sea. Therefore, the natural state (or occurrence) of underlying groundwater has probably always been more of a fresh / saltwater mix (brackish).

Part II – MTCA Section 720 Criteria

Groundwater Non-Potability Criteria

Non-potable groundwater is defined in MTCA Section 720 (Chapter 173-340 WAC). Groundwater may be deemed non-potable if it is demonstrated that it is not a current or future drinking water source. There are several criteria for non-potability. A brief description of key criteria as well as whether it applies to this OCC site is provided herein.

Yield

If the groundwater yield is less than 0.5 gpm on a "sustainable" basis, then it can be assumed that the groundwater is non-potable. This criteria is not met at the Occidental Site because yields greater than 0.5 are routinely observed in groundwater extraction wells and in groundwater monitoring wells.

Natural Background Concentrations

If there are naturally occurring substances that render groundwater non-potable, then the aquifer can be designated as non-potable. The OCC site groundwater has been impacted by salinity intrusion from the surrounding waterways. Therefore, this site does qualify for the natural background (salinity) non-potability designation. The remainder of this section speaks to two substances that were used to quantify naturally occurring salinity levels: total dissolved solids (TDS) and bromide.

Total Dissolved Solids

Per the Section 720 regulations, groundwater with naturally occurring total dissolved solids (TDS) levels > 10,000 mg/L may be deemed non-potable. TDS measures minerals and salts dissolved in water. TDS are typically those compounds that cannot be removed by traditional water filters. The EPA secondary drinking water standard for TDS is 500 mg/L.

As part of a salinity intrusion study (CRA, 2013), groundwater TDS levels were measured. Most of the groundwater TDS data is from the 2012-13 sampling events, however, some of the wells have historical TDS levels as well (CRA "e-dat" database). A query of the 2012-13 groundwater TDS data resulted in 361 records, from wells with depths from 0 to -175 ft elevation.

However, OCC did use salt (sodium chloride) to produce chlorine gas and caustic soda (CRA, 2014). This salt was stored on a 1.6 acre salt pad (land surface). This historical chlorine gas / soda production has resulted in a significant groundwater caustic plume, with pH levels in the 11-12 range. This in turn has resulted in what has come to be known as the anthropogenic density plume (ADP). This ADP is a mixture of caustic soda, lime sludge and solvent residue (CRA, 2014).

Therefore, given that sodium chloride was used in historical OCC operations, TDS may not be a reliable measure of what is truly "naturally occurring". However, for 2012-13, there are wells with higher TDS levels (> 10,000 mg/L) that are located outside the pH / ADP footprint. As a footnote, OCC's manufacturing operations were from 1929 – 2002 (CRA, 2014). Therefore, the 2012-13 groundwater TDS data was collected ten years after OCC ceased operations. Consequently, some fraction of the 2012-13 groundwater TDS data set is thought to be suitable for a non-potability designation.

Thus, data from what is thought to be non-impacted (i.e. background) wells was used to assess salinity (from TDS). The following methods were used to filter / process the 2012-13 groundwater TDS data:

- Reduce the data to those wells west and south of the former OCC plant. This results in 100 data records, from wells ranging in depth from 0 to -150 ft elevation.

- Subdivide the data into 25 ft thick intervals (layers) and sort the data by elevation (e.g. 0 to -25, -25 to -50 ft, etc). The was done to accommodate various wells screened over different depths (elevations).

- Calculate the average groundwater TDS level for each 25 ft interval.

The resulting overall average groundwater TDS level is 10,600 mg/L (100 records). Spatially, it appeared that there were higher TDS levels more to the west (along the Blair Waterway; Figure 2). TDS levels did increase over depth (elevation). Specifically, the average groundwater TDS level from 0 to -50 ft elevation was < 5,000 mg/L. However, the average TDS level from -50 to -150 ft elevation was between ~20,000 and 25,000 mg/L (Table 1; Figure 3 TDS v. depth plot; Figure 4 interval / box plots). This suggests that there is a freshwater lens from roughly 0 to -50 ft elevation, with denser seawater from -50 to -150 ft elevation.

A conclusion that can be derived from this evaluation is that peninsula groundwater contains naturally high TDS levels (> 10,000 mg/L), which makes it unfit for human consumption. Ideal drinking water has 0 – 50 mg/L TDS and hard to marginally-acceptable water has 200 – 400 mg/L TDS. For this data set (2012-13), about 80% of the levels exceeded the EPA secondary MCL of 500 mg/L. Likewise, 40% of the data set was greater than 10,000 mg/L TDS. Historical OCC operations (pH / ADP plume) may have biased some of these TDS levels. However, again, this data set was filtered / reduced to account for potential anthropogenic impacts. Therefore, the weight of evidence points to groundwater with naturally occurring salinity levels that are unfit for human consumption.

Percent Seawater

In 2013, a site salt / freshwater equilibrium study was conducted (CRA, 2013). The objective of this study was to determine natural saltwater / freshwater equilibrium conditions. For this study, ten common seawater ions (boron, bromide, calcium, chloride, iodide, magnesium, potassium, sodium, strontium, and sulfate) were measured. Of these ten, it was determined that several were used in historical OCC operations (e.g. calcium, iodide and magnesium) and were therefore unsuitable for the salinity intrusion analysis. In the end, bromide was used to assess fresh / saltwater equilibrium.

Percent seawater levels were calculated using a mixing equation with estimated background concentrations for bromide in freshwater and in saltwater. As with the TDS data, average percent seawater levels were calculated from 25 ft elevation intervals (from 0 to -175 ft). Average saltwater levels based on the observed bromide concentrations range from roughly 10 to 50% over depth (Table 2). Like TDS, average percent seawater levels increased over depth and again, like TDS, percent seawater levels peaked at -50 to -75 ft (Figure 5). The -50 to -75 elevation peak was then followed by a gradual decline in percent levels to -175 ft elevation. Percent seawater interval and box plots are also provided in Figure 6.

To better understand percent seawater levels over depth (elevation), the data were spatially mapped (using kernel smoothing and filled contours; Figure 7). Results are as follows:

- 0 to -25 ft – predominantly freshwater across the peninsula, with smaller seawater lenses both northeast and southeast of the former OCC property.

- -25 to -50 ft – more salinity intrusion along the northeast tip of the peninsula as well as a freshwater lens that sort of centers (or follows) Alexander Avenue.

- -50 to -75 ft – most of the peninsula is now predominantly seawater, however, there is freshwater lens that centers beneath the former OCC property.

- -75 to -100 ft – most of the peninsula is predominantly seawater, however, there is freshwater lens more to the west (towards the Blair Waterway).

- -100 to -125 ft – most of the peninsula is predominantly seawater, however, there is a freshwater from the OCC property trending northwest.

- -125 to -150 ft – most of the peninsula is predominantly seawater, however, the northwest trending freshwater lens (from the OCC property) is more pronounced.

- -150 to -175 ft – there's really not enough data points (only 5) to draw any meaningful conclusion. However, what you observe is a freshwater lens along the north tip of the peninsula.

In summary, as with the TDS data, it appears that there is a freshwater lens within the middle of the peninsula, from about 0 to -50 ft elevation. However, below -50 ft elevation, saltwater levels gradually increased and then declined.

From this evaluation, it can be concluded that in its natural state, the peninsula groundwater is a mix of both fresh / seawater. There are higher freshwater levels near land surface, however, seawater levels increase over depth. Consequently, in its natural state (high salinity), this groundwater is unfit for human consumption.

Effect of Pumping on the Distribution of Saltwater

The distribution of saltwater and freshwater at the Occidental site inferred from the TDS and bromide data consists of a relatively thin freshwater lens that is underlain and surrounded laterally by saltwater. The lateral extent of the shallow freshwater lens is constrained by saltwater from Commencement Bay to the north, the Blair Waterway to the west, and the Hylebos Waterway to the east. The aquifer that contains the freshwater lens is an unconfined aquifer comprised of fluvial and deltaic deposits. There are no stratigraphic layers or boundaries to separate the freshwater lens from the surrounding saltwater. Pumping fresh groundwater at the site will cause additional saltwater intrusion from both lateral boundaries and from underlying saltwater zones. Zones of freshwater that might be considered for water supply would be highly susceptible to saltwater contamination from surrounding and underlying areas.

Fresh / Saltwater Equilibrium Summary

Both TDS and percent seawater increase significantly at elevations below roughly -50 ft. This is consistent with the site conceptual model for fresh / saltwater conditions. Specifically, CRA (2014) has previously defined fresh / saltwater conditions as follows: less dense freshwater (from precipitation recharge) near land surface, followed by denser seawater over depth. Prior tidal studies (CRA, 2014) have found that peninsula groundwater at depths greater than 25 ft is tidally influenced. However, groundwater at depths less than15 ft is not generally tidally influenced. Again, this points to a freshwater lens near land surface, with denser seawater over depth. Also, the bottom of the Hylebos Waterway is -35 ft MLLW (-47 ft NGVD;. The bottom of the Hylebos is at approximately -50 ft elevation (CRA, 2014), which is where TDS and percent seawater levels generally increase. However, there is deeper submarine groundwater discharge, from the east side of the Hylebos Waterway (i.e. the "bluffs" area, CRA, 2014). This deeper recharge is fresh groundwater, from upland areas at higher elevations. Prior to the peninsula construction, the natural state of the discharging groundwater was likely brackish. The increased TDS and percent seawater levels over depth support this historical model.

Other MTCA Non-Potability Criteria

Aside from yield and naturally occurring substances, there are several other criteria that may be used to designate groundwater non-potable. A brief discussion is as follows:

- Groundwater is located at a depth that makes it technically impracticable for use. This criteria would not apply as the groundwater table is < 25 ft from land surface. A groundwater treatment / extraction system has also been operating for nearly 20 years now.

- It is unlikely that hazardous substances will be transported from the site to a drinking water source. This criteria would apply as the peninsula is bounded by marine water. The closest public supply well (City of Tacoma tideflats well ACN703; 775 feet deep) is roughly 0.6 miles southeast (and up-gradient) of the former OCC property.

- The site is located near or within close proximity to surface water, i.e. the "Harbor Island" rule exemption. If a site is near or abuts a marine waterway, then you may conclude that there is an "extremely low probability" of future human consumption of groundwater. As a footnote, the rule does not provide any criteria as to how this decision is made. However, Harbor Island (Duwamish River estuary) is used as an example and this OCC site matches that type of scenario. Therefore, this OCC site does qualify for the Harbor Island rule exemption.

Part III – EPA Criteria

Underground Source of Drinking Water (USDW)

Like Ecology, EPA also uses the TDS 10,000 mg/L threshold to define what is an "underground source of drinking water" (USDW; 40 CFR) Section 144.3). Per federal regulations, you may also create or designate "exempted aquifers" (40 CFR Section 146.4). The criteria for exempted aquifers is similar to Ecology's MTCA Section 720. As a footnote, EPA's criteria for exempted aquifers is groundwater with TDS levels > 3,000 and < 10,000 mg/L ("freshwater" is TDS < 3,000 mg/L). Lastly, the USDW criteria has also been incorporated into EPA's Underground Injection Control (UIC) program. For example, EPA Region V has published guidance on how to apply USDW criteria to states with UIC programs (e.g. Michigan, Indiana, etc.).

Comprehensive State Groundwater Protection Program (CGWPP)

Both Ecology / EPA have jurisdiction for this former OCC site cleanup. This is a federal EPA superfund site; therefore, the CERCLA provisions do apply. However, if a state has a Comprehensive State Groundwater Protection Plan (CGWPP), then EPA may defer to the state for determinations of current / future groundwater use (EPA, 1997). A State of Washington CGWPP was completed by Ecology (1995). This CGWPP was endorsed by EPA (2002).Therefore, per these directives, Ecology now has the authority to determine groundwater current / future use. In this case, Ecology has decided that the former OCC site groundwater is not a current or potential source of drinking water.

Part IV – Conclusion

Based on the weight of evidence, this peninsula groundwater (former OCC plant) is unfit for human consumption. Although there is a freshwater lens near land surface, the underlying and surrounding groundwater has much higher salinity levels. These salinity levels do vary over depth. However, for the most part, levels exceed drinking water standards (e.g. TDS > 500 mg/L). From a practical standpoint, no one would ever drill a well and use this peninsula groundwater for drinking water. If this were to occur, then the groundwater would have to be treated (desalinization). This would be very costly and seems impracticable from a future use standpoint. For that matter, the historical natural state of groundwater entering (or discharging to) Commencement Bay was likely always brackish. Therefore, this peninsula groundwater does meet the MTCA Section 720 non-potability criteria.

.References

CRA (2013). Salt Water / Freshwater Evaluation Results. CRA technical memorandum (Michael Mateyk and Jody Vaillancourt, CRA to Clint Babcock; March 8th, 2013.

CRA (2014). Site Characterization Report (SCR). Groundwater and Sediment Remediation, Occidental Chemical Corporation, Tacoma, Washington. August-2014, 007843, Report No. 128

Ecology (1995). Washington State Ground Water Protection Program Core Program Assessment Document (July, 1995). Note: this document published prior to advent (or use) of Ecology publication numbers.

EPA (1997). The Role of CSGWPPs in EPA Remediation Programs (memorandum from Timothy Fields to Region I – X administrators; April 4th, 1997). OSWER Directive 9283.1-09

EPA (2002). Endorsement of State of Washington Core Comprehensive Ground Water Protection Program (letter from John Iani, EPA Region X to Kirk Cook, Ecology; February 1st, 2002).

Table 1 – Average Groundwater TDS Levels (2012-13) Over Depth (Elevation).

Layer	Elevation	Elevation	n	Average TDS
	ft	ft		mg/L
1	0	-25	36	1,481
2	-25	-50	26	4,656
3	-50	-75	11	22,873
4	-75	-100	11	22,214
5	-100	-125	8	25,050
6	-125	-150	8	23,684
			100	

Table 2 – Average Percent Seawater (2012-13) Over Depth (Elevation).

Layer	Elevation	Elevation	n	Average Percent Seawater
	ft	ft		%
1	0	-25	79	8.5%
2	-25	-50	76	26.1%
3	-50	-75	40	53.9%
4	-75	-100	45	48.7%
5	-100	-125	32	42.0%
6	-125	-150	26	45.2%
7	-150	-175	6	38.1%
			304	

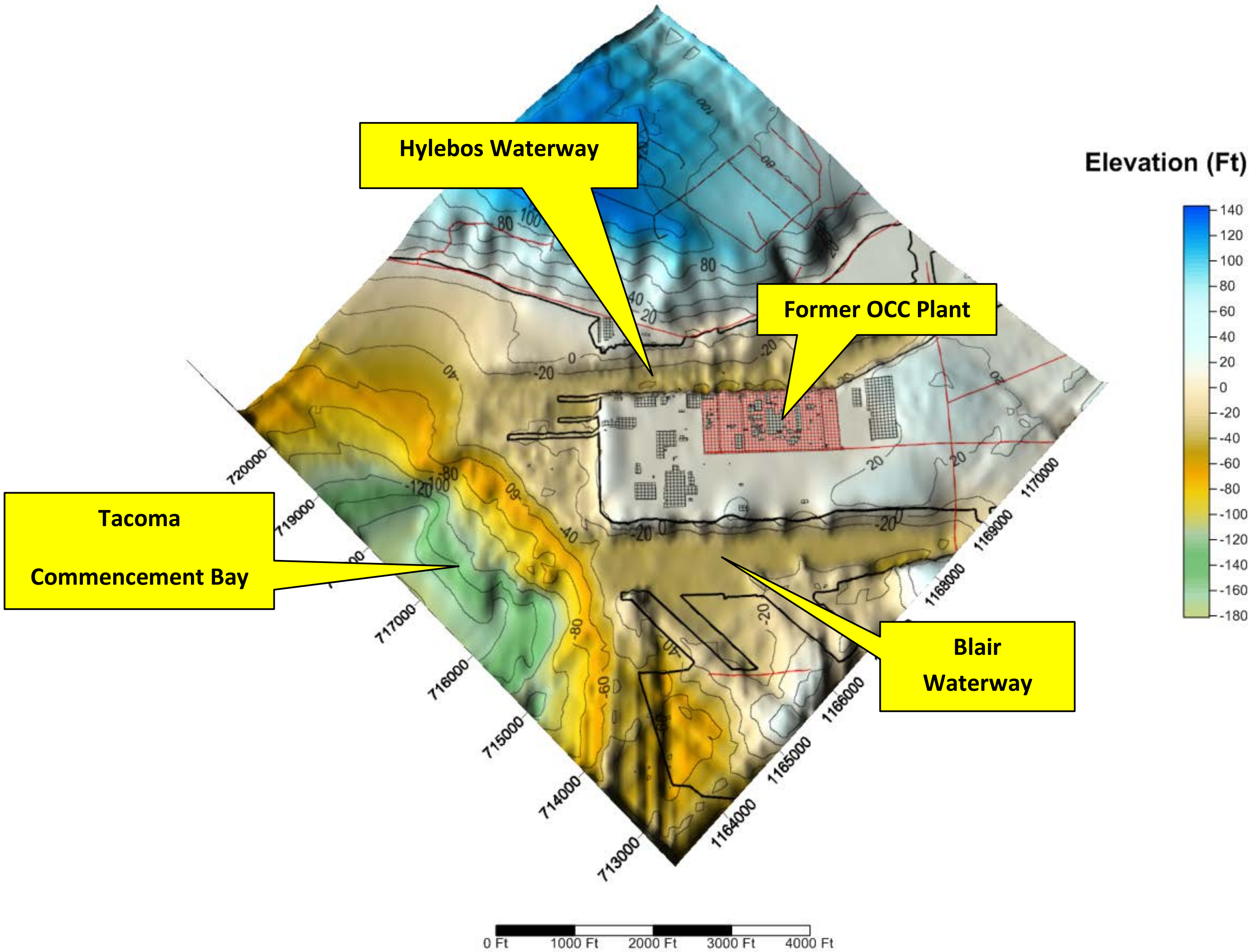


Figure 1 – 3D Land Surface and Bathymetry (Commencement Bay, Tacoma).

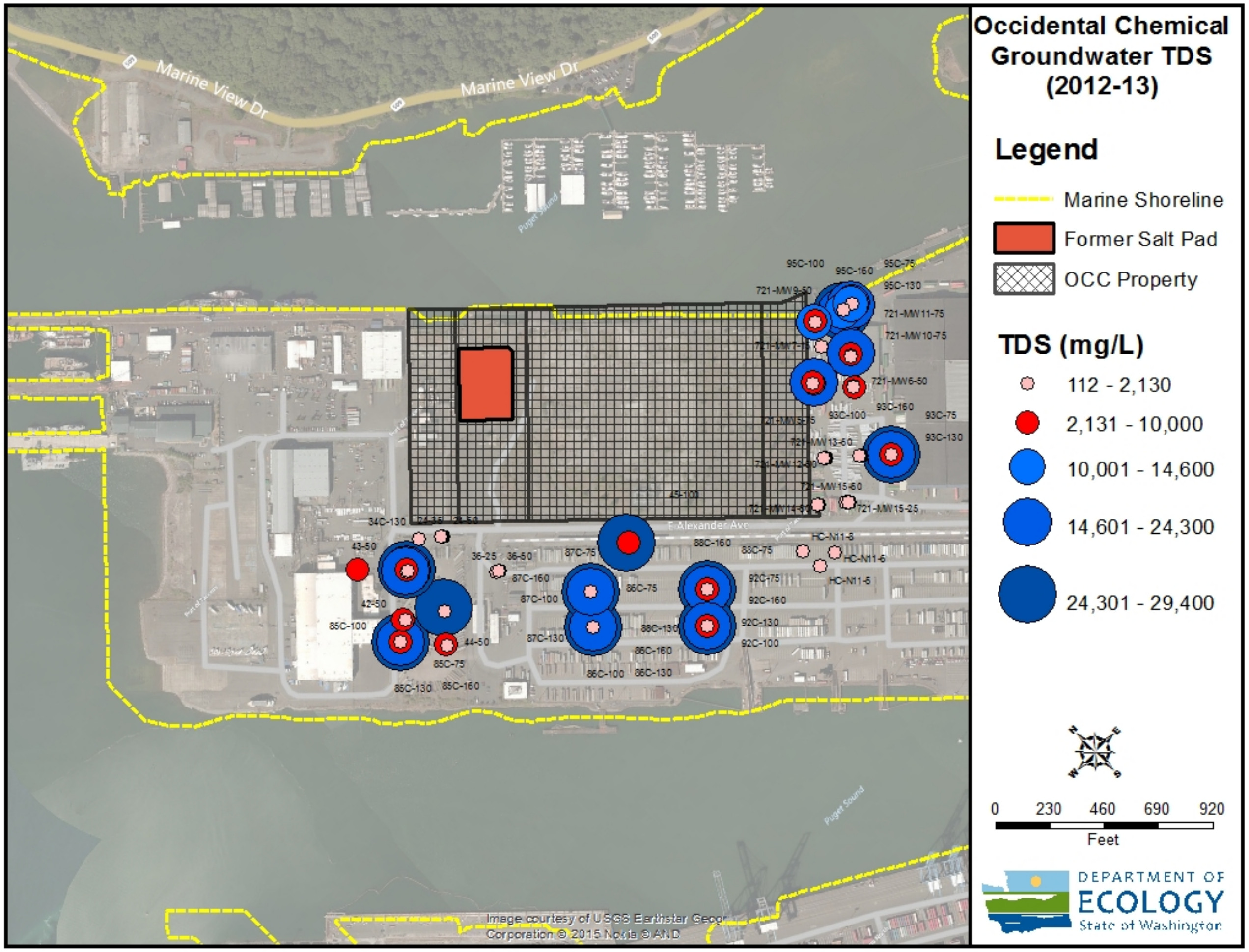


Figure 2 – Groundwater TDS Levels (2012-13).

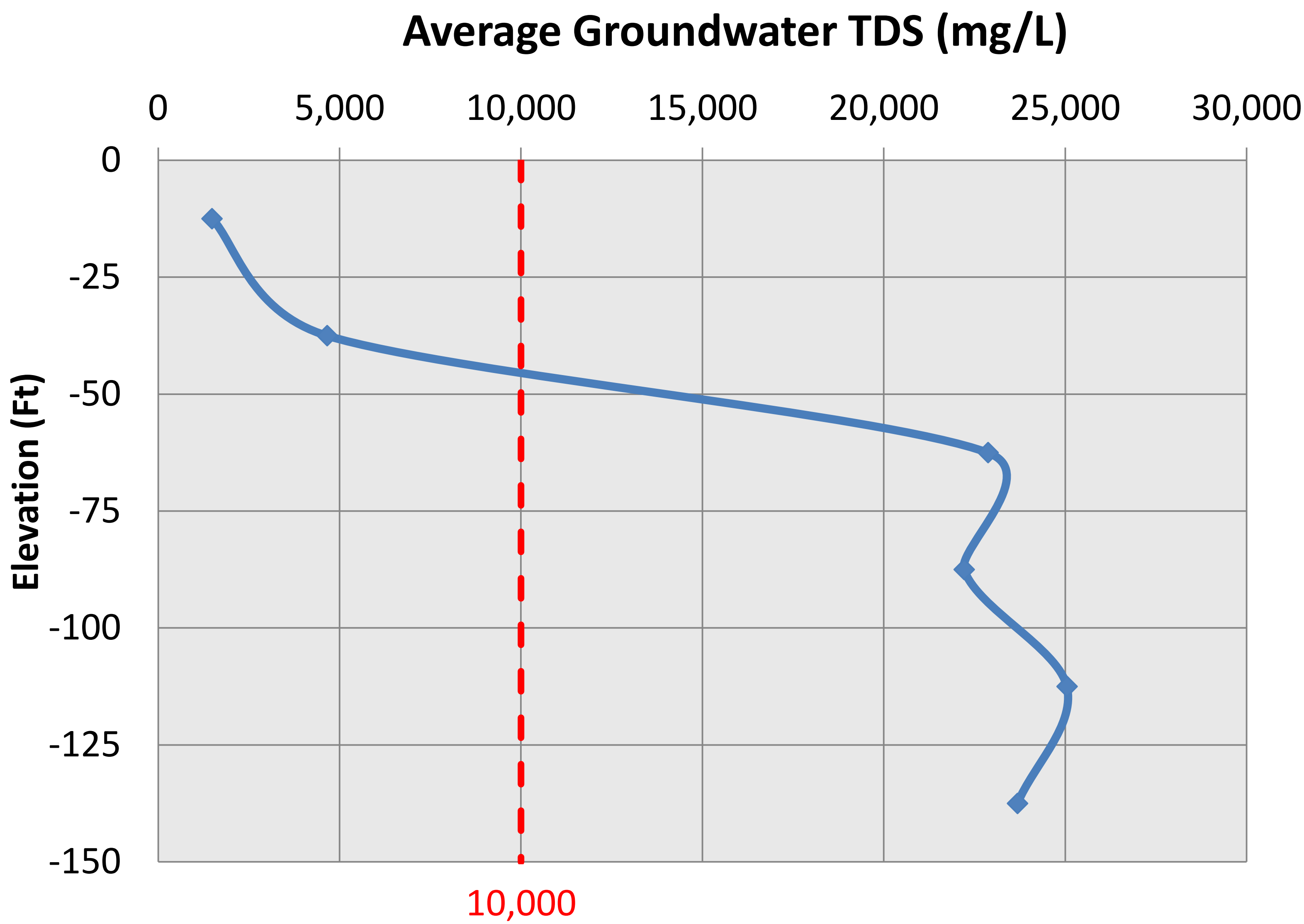
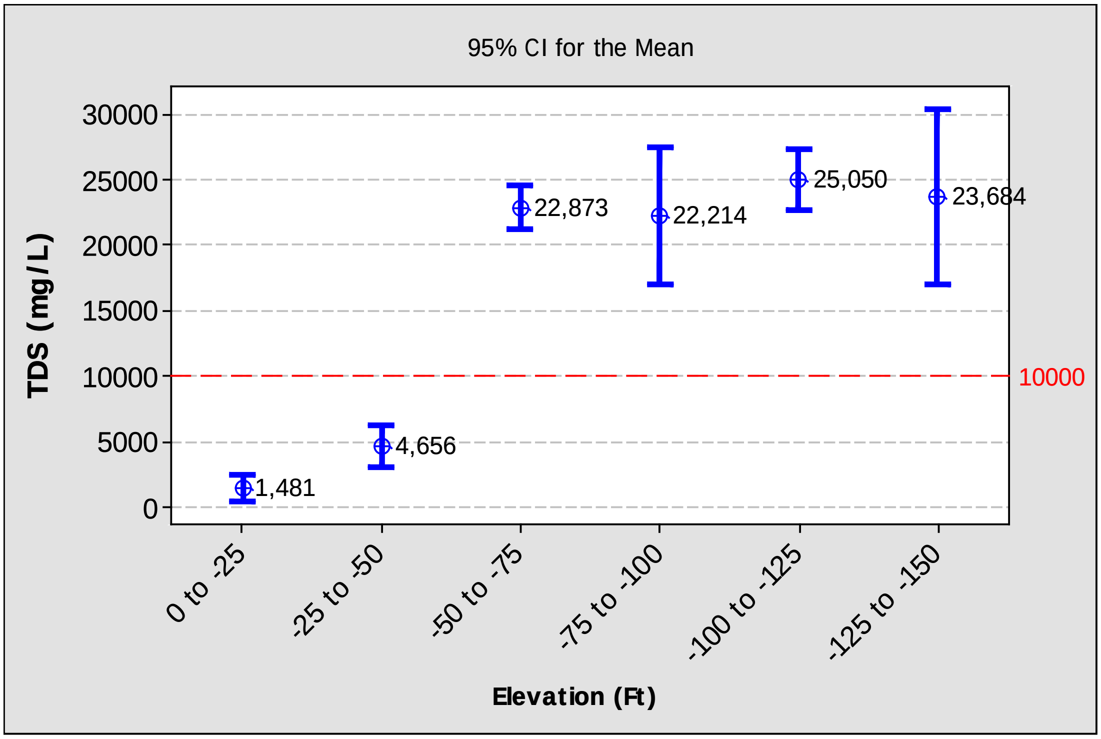


Figure 3 – Groundwater TDS Levels v. Depth (Elevation).

Interval Plot (with Average Values Labeled)



Box Plot (with Median Values Labeled)

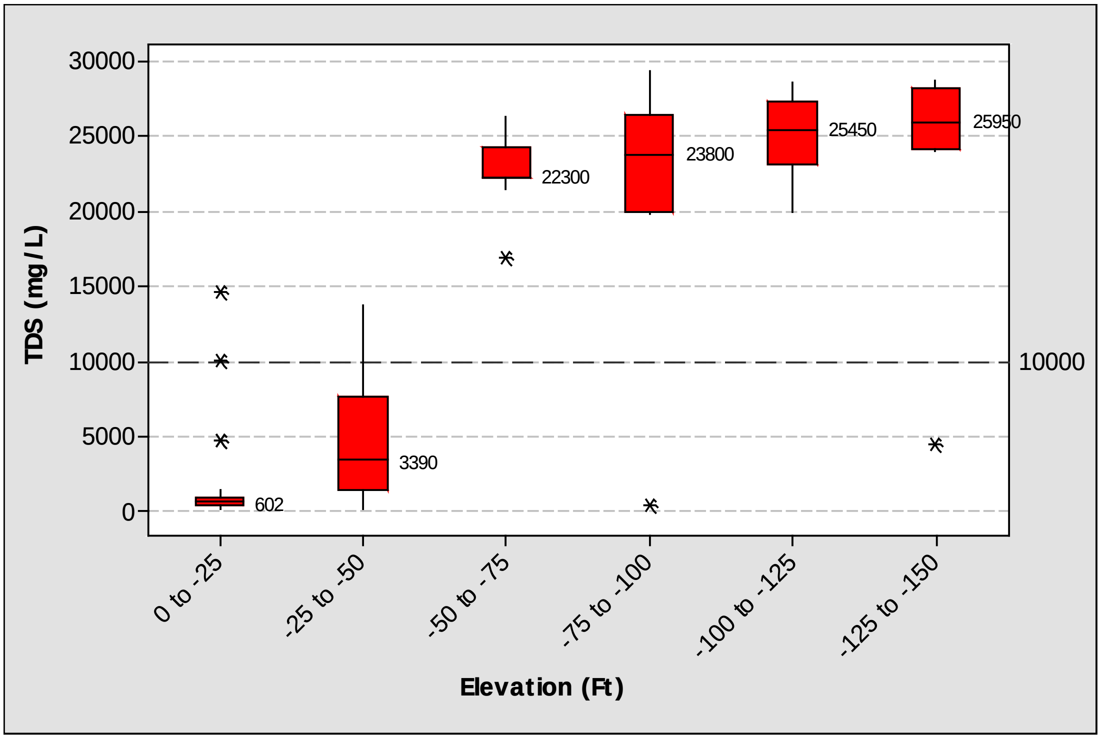


Figure 4 – Groundwater TDS Histogram and Box Plot (2012-13 Data).

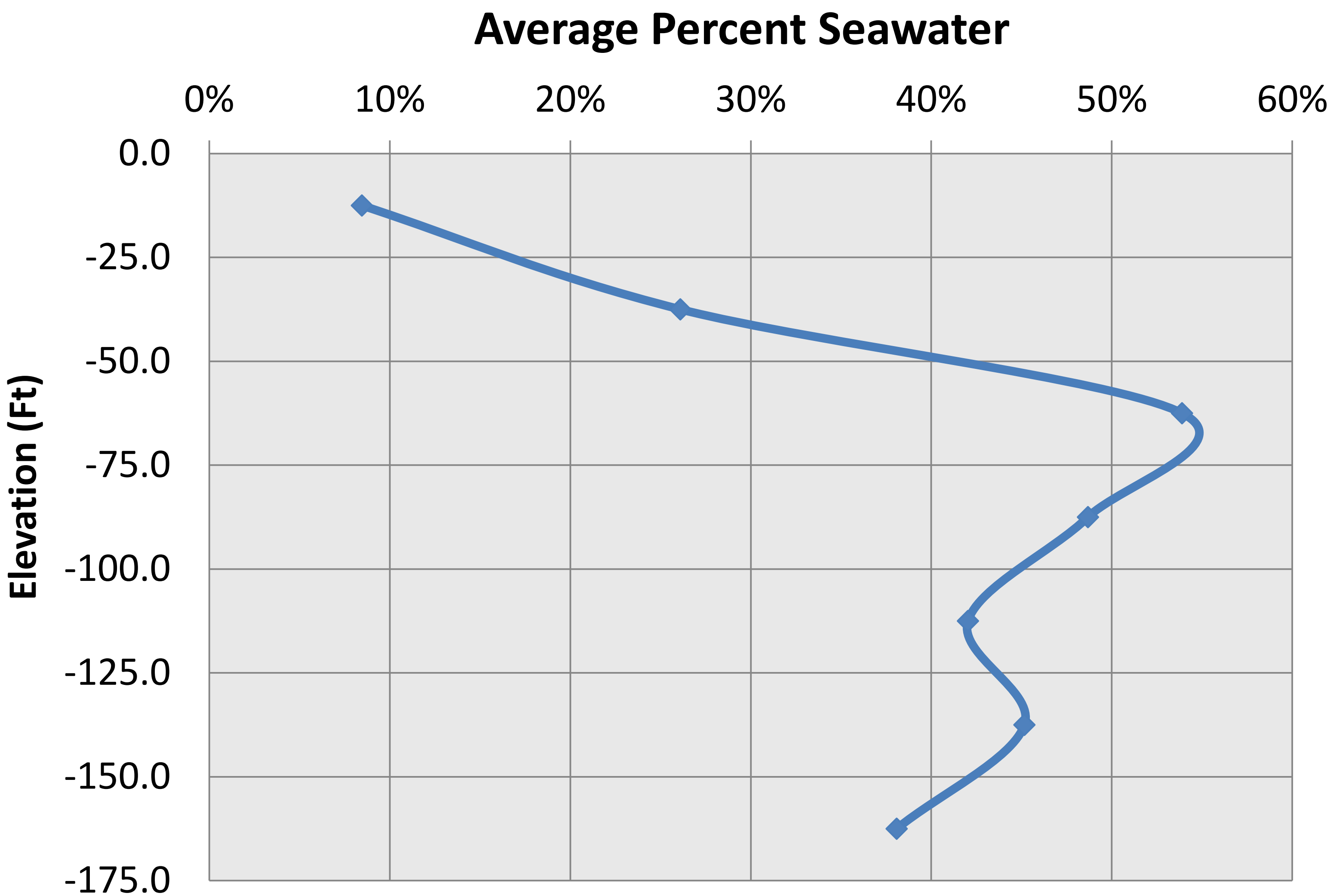
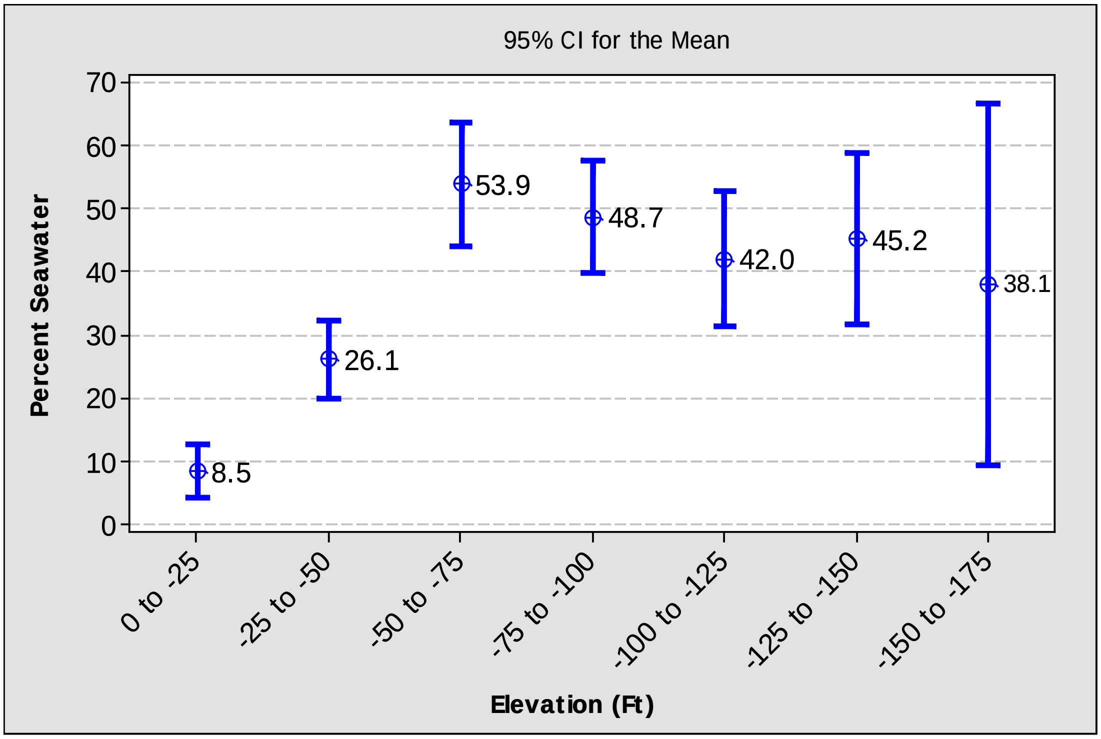


Figure 5 – Average Percent Seawater v. Depth (Elevation).

Interval Plot (with Average Values Labeled)



Box Plot (with Median Values Labeled)

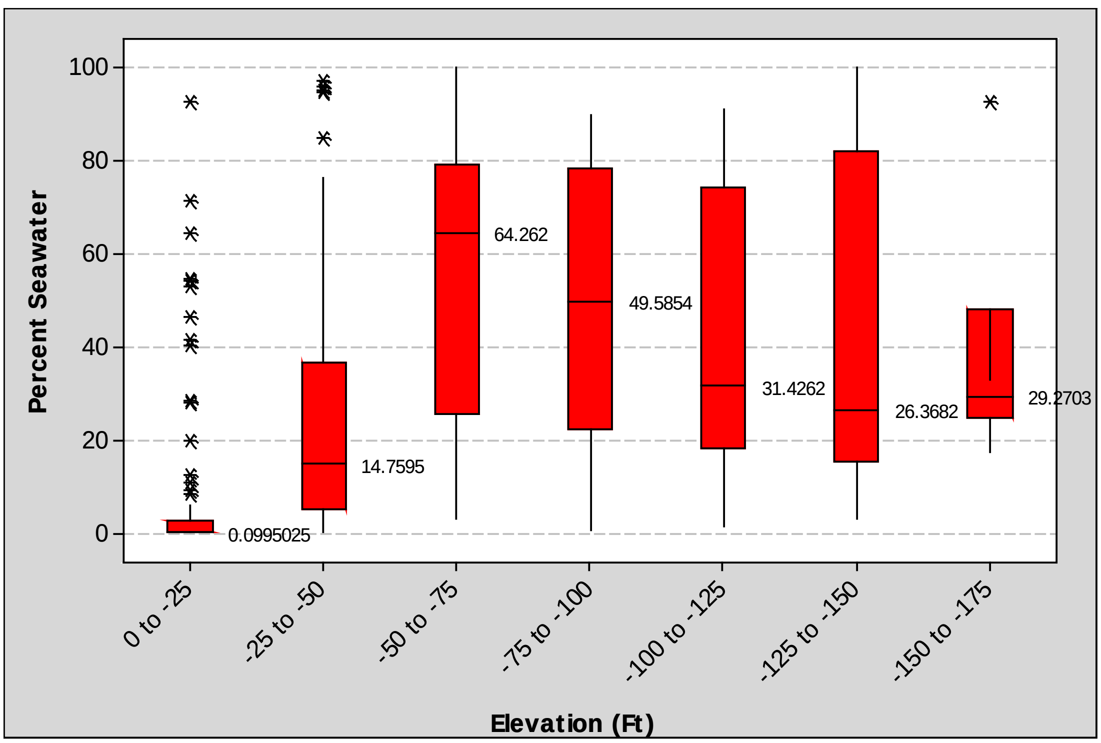
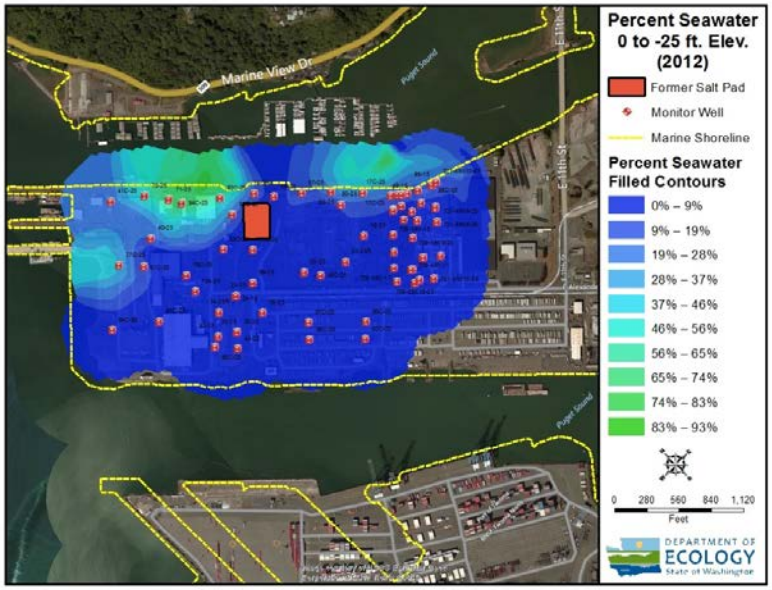
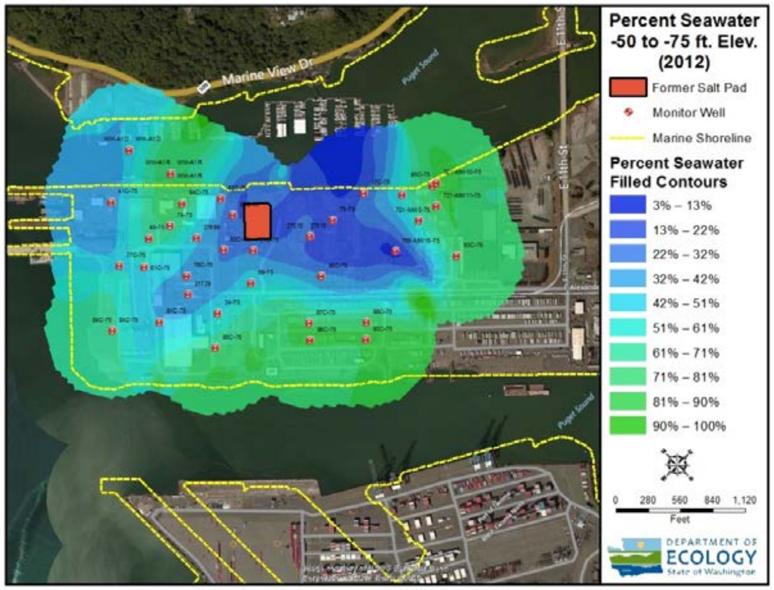


Figure 6 – Percent Seawater Interval and Box Plots.

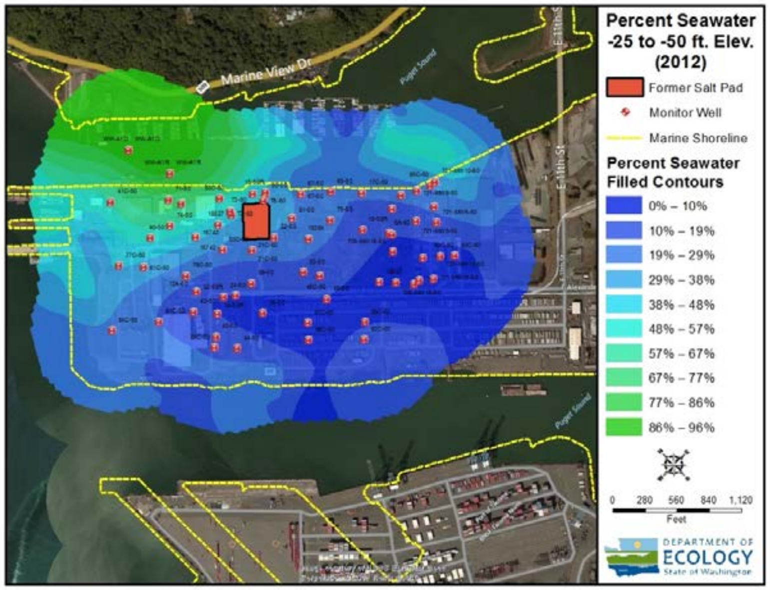
0 to -25 Ft Elevation



-50 to -75 Ft Elevation



-25 to -50 Ft Elevation



-75 to -100 Ft Elevation

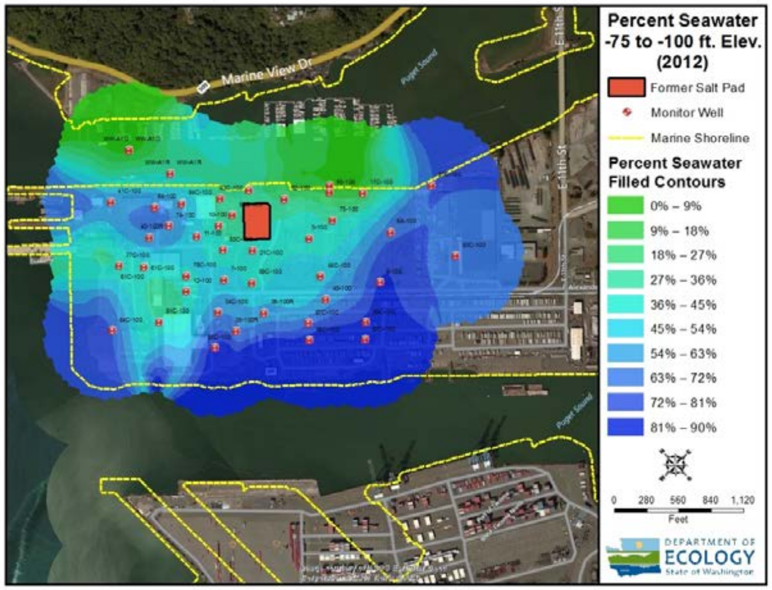
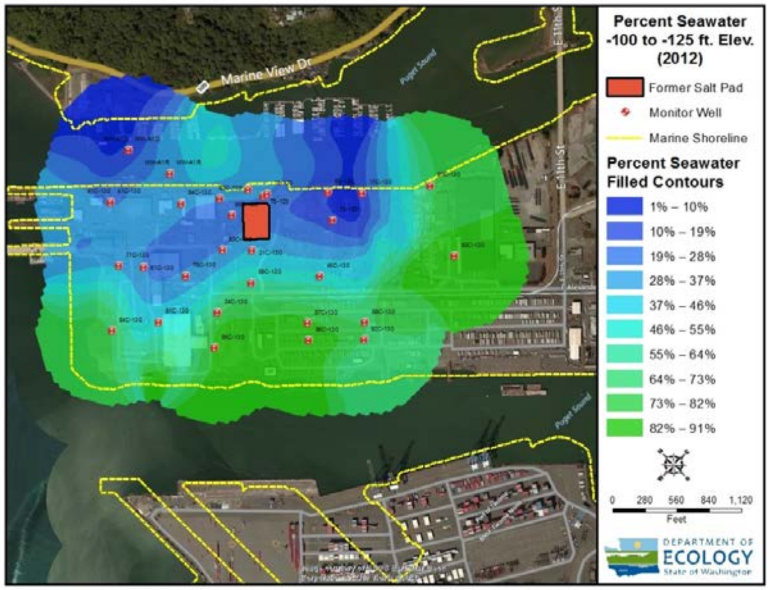
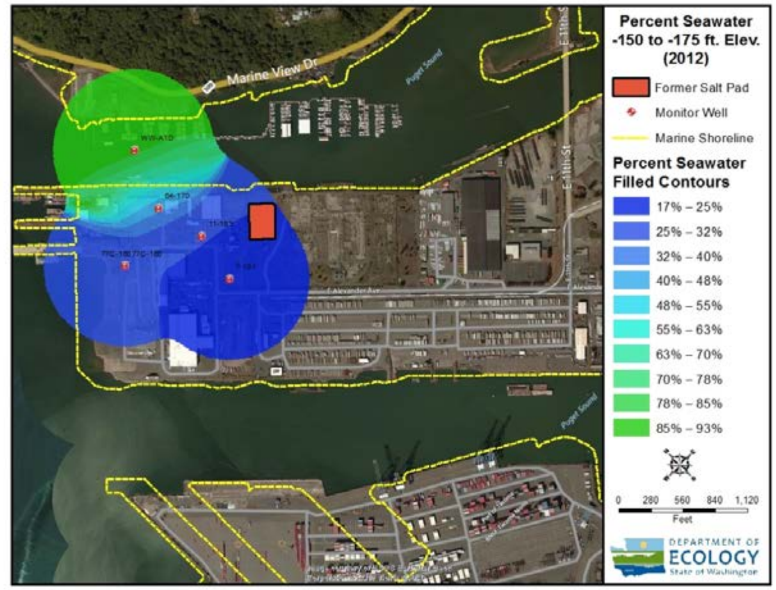


Figure 7 – Percent Seawater Levels Over Depth (Elevation, Ft).

-100 to -125 Ft Elevation



-150 to -175 Ft Elevation



-125 to -150 Ft Elevation

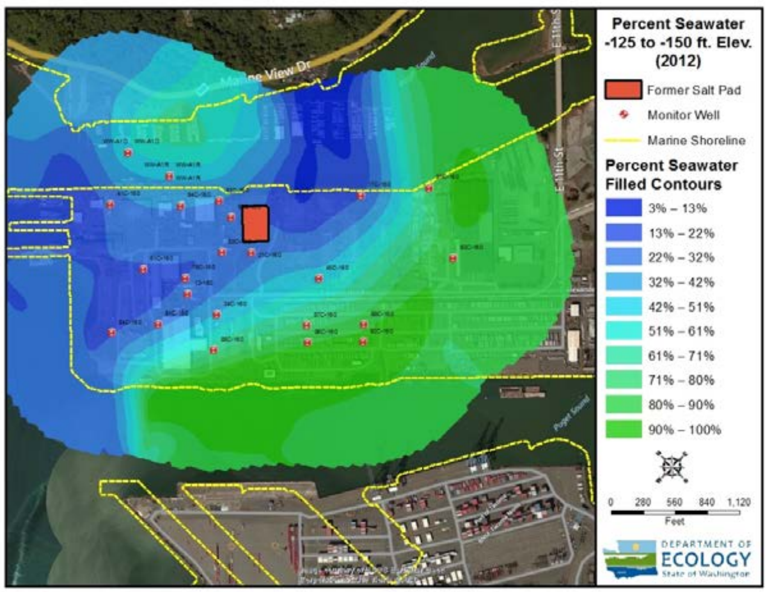


Figure 7 (Cont.)