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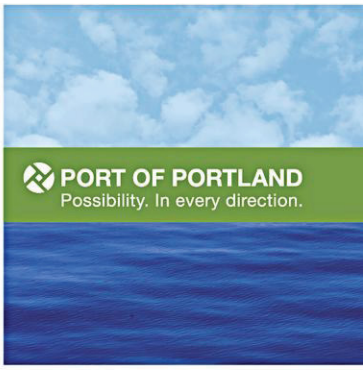


March 26, 2013

To: Portland Planning and Sustainability Commission; Eric Engstrom, Bureau of Planning and Sustainability and Mike Rosen, Bureau of Environmental Services

From: Greg Theisen, Port of Portland

Re: West Hayden Island - Comments regarding floodplain mitigation

The attached paper discusses current proposals from BPS and BES to address floodplain mitigation for impacts to WHI as a result of future development of marine terminal facilities as described in the City's WorleyParsons Conceptual Development Plan. The Port, in consultation with Tangent Services, has undertaken an evaluation of the floodplain function on WHI and offers this information in service to the WHI annexation project.

Thank you for your consideration

Greg Theisen

Comments on West Hayden Island Floodplain Mitigation

This paper presents comments and analysis on potential floodplain mitigation for proposed terminal development on West Hayden Island (WHI). It assesses proposed mitigation levels and makes a recommendation that accounts for ecosystem function specific to floodplains and wetlands. The recommendation further ties floodplain/wetland mitigation to the suite of ecosystem functions provided by those areas within the proposed development footprint.

In preparing the paper, I reviewed a City of Portland Bureau of Environmental Services (BES) memorandum outlining floodplain mitigation alternatives, a City of Portland Bureau of Planning and Sustainability (BPS) email providing additional information on these alternatives, and studies by Entrix, ECONorthwest, and WorleyParsons. I also performed a hydrological analysis to assess potential flood impacts on the WHI development footprint.

This paper presents my thoughts on the WHI floodplain topic by attempting to answer the following questions:

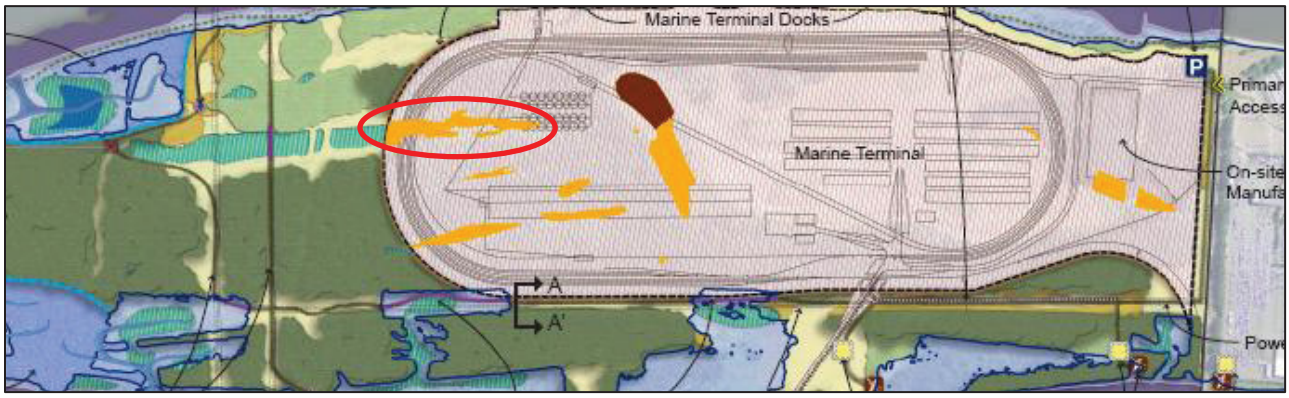
- How much of the development footprint is subject to occasional inundation?
- How frequently does flooding occur within the development footprint?
- How much benefit does the development footprint offer in terms of flood regulation?
- How much benefit does the development footprint offer in terms of floodplain-related wildlife habitat?
- Is 180 acres the right number for floodplain mitigation?
- Which of the floodplain mitigation alternatives offered by BES is most appropriate?

How much of the development footprint is subject to occasional inundation?

For the purposes of this analysis, occasional high water events are defined as events exceeding 14 feet.[1] There are approximately five acres in the development footprint that could flood during occasional high water events.[2] The five-acre area, which is shown as a wetland in the City's Natural Resource Inventory and on the WorleyParsons concept plan, is shown in the red circle on Figure 1.[3] This area is physically connected to the river via Benson Pond and a culvert that is extant under the WHI access road. Most of the five-acre area ranges between 14 and 18 feet in elevation, indicating that, if the river connection via Benson Pond were unobstructed, a portion of this area would be subject to river intrusion when the level of the Columbia River equals or exceeds about 14 feet.[4]

[1] All river level data in this analysis are converted from Columbia River Datum (CRD) to NGVD29 datum by adding 1.82' to CRD.
[2] Five acres is a rough approximation; the actual number of affected acres is likely much lower than this.
[3] The five-acre area circled in Figure 1 is included in the approximately 10.2 acres of wetlands in the development footprint, which include a 2.3-acre wetland mitigation area.
[4] Please also see Attachment 1 which shows WHI at 17.8 feet. This illustration is consistent with the five-acre approximation.

Figure 1: WHI Development Map



Source: WHI Base Plan Concept, WorleyParsons, March 2012.

It is important to reiterate that the area circled on Figure 1 would be classified a riverine wetland under the HGM wetland classification system and would be regulated by the U.S. Army Corps of Engineers and the Oregon Department of State Lands. Its function as such is already included in the existing package of proposed wetland mitigation.

There are also other areas within the development footprint that are designated as wetlands by the City and WorleyParsons and included in the existing package of proposed wetland mitigation. All these areas are marked as wetlands on the project development map (in orange, Figure 1). These additional wetland areas are not physically connected to the river; seasonal ponding here is likely due to precipitation and the water table level. River flooding of these other wetlands would occur only during rare high water events (see hydrological analysis below).

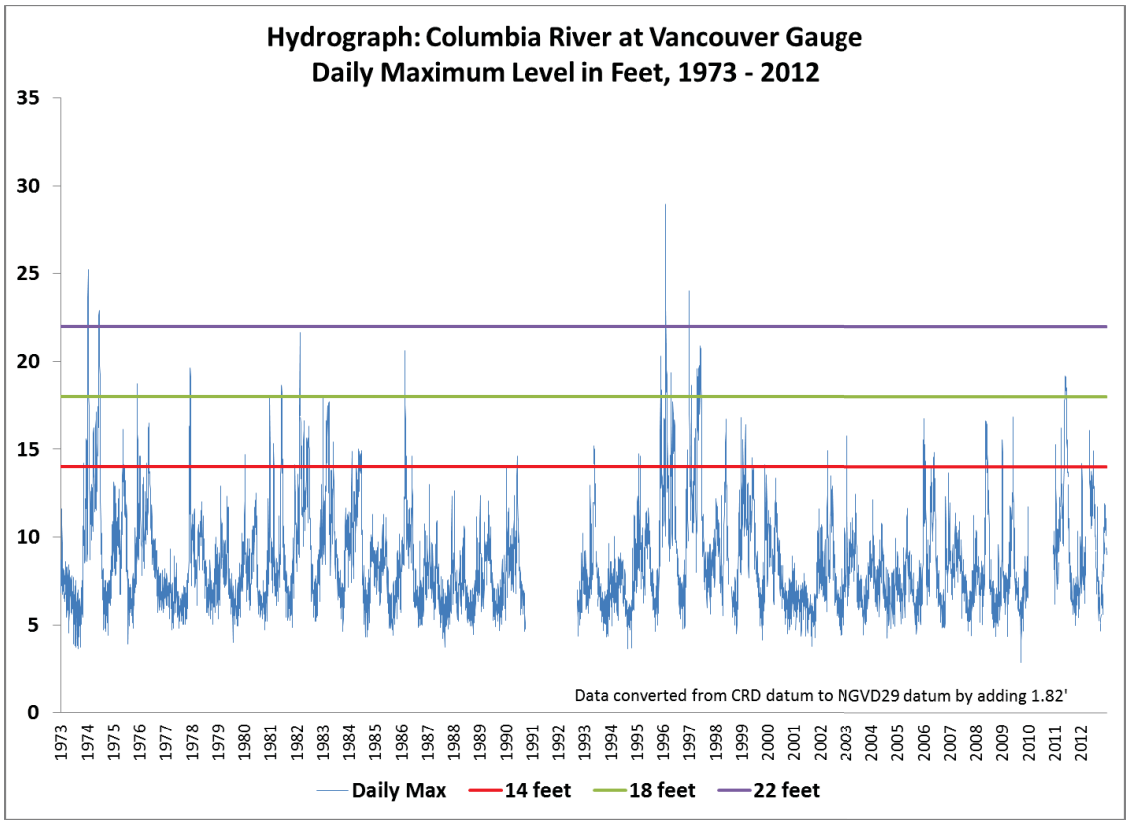
How frequently does flooding occur within the development footprint?

The hydrograph below shows the daily maximum highs on the Vancouver gauge from 1973 through 2012, a 40-year period (Figure 2).[5] Three horizontal lines mark specific river levels: 14 feet (red line), which is the approximate stage at which the river may occasionally inundate the five-acre wetland shown on Figure 1; 18 feet (green line), which is the approximate ordinary high water mark; and 22 feet (purple line), the approximate point at which a more substantial portion of the development footprint could flood.[6]

[5] There are missing daily readings during the 40-year period, likely the result of times when the gauge was broken. These missing data appear as blanks on the Figure 2 chart.

[6] It would appear that most of the development footprint is above 22 foot elevation. A more detailed topographic analysis could determine what percentage of the footprint was above certain elevations, e.g., XX% is above 20 feet, XX% is above 22 feet, etc.

Figure 2: Historical Columbia River Levels



A statistical analysis of the river level data shows that during the 40-year period:

- There were 57 high water events that equaled or exceeded 14 feet. These events occurred in 23 of the 40 years. During the 40-year period, the daily maximum reached or exceeded 14 feet on 5.9 percent of all days (786 of 13,314 readings).

- There were 16 high water events that equaled or exceeded 18 feet (the approximate ordinary high water). These events occurred in 11 of the 40 years. During the 40-year period, the daily maximum reached or exceeded 18 feet on 1.3 percent of all days (167 of 13,314 readings).

- There were 4 high water events that equaled or exceeded 22 feet. These events occurred in 3 of the 40 years (two in 1974, one in 1996, and one in 1997). During the 40-year period, the daily maximum reached or exceeded 22 feet on 0.2 percent of all days (23 of 13,314 readings).

Based on the data, it would appear that 22-foot flood events are very rare, occurring perhaps every ten years or less frequently. The frequency of 18-foot events is approximately once every four years. The 14-foot events occur a little more than once a year on average, but typically occur more than once during specific high-water years. Thus, 14-foot events typically occur about every two years, but in those years there are, on average, 2.5 events (e.g., in 1996 there were four 14-foot events).

How much benefit does the development footprint offer in terms of flood regulation?

The BES memorandum (by Mike Rosen, dated February 22, 2013) cites flood storage as a beneficial function of the WHI floodplain. There is good reason for the Port to challenge this assertion. As noted above, portions of the 200-acre development footprint do occasionally flood, but these inundation events are almost always restricted to a small area of five acres or less. Floods that cover more substantial areas of the development footprint are historically rare occurrences.

For this and other reasons, WHI offers little in the way of flood regulation and storage benefit. According to the ECONorthwest *West Hayden Island Public Cost/Benefit Analysis* (2012), the benefit of WHI with respect to the water-related benefit of flood storage, water temperature, and water quality is likely small:

> "As stated in the 2010 Entrix Report, however, these values in the context of WHI and the Columbia River Basin likely are small (with the exception of water-related benefits associated with wetlands). Dams along the Columbia River are managed, in part, to control flooding in the Lower Columbia River. Furthermore, flood storage capacity on WHI is small relative to the size of the river, which means the potential value derived from flood regulation likely is small. Similarly, due to the size of the basin and the volume of water that runs through it, the marginal impact of forests and woodlands on water quality and water temperature likely is small. So, while these are prevalent functions on WHI, their marginal contribution (in monetary terms) in the context of the entire Columbia River Basin likely are small."[7]

The Entrix *WHI Environmental Foundation Study* (2010) concludes the value of WHI flood storage is expected to be minimal:

> "Due to the low relative volume of water that can be stored or conveyed at WHI, the avoided cost associated with natural flood control at WHI is expected to be minimal. As noted above, the U.S. Army Corps of Engineers (ACOE) manages the Columbia River dams to control flooding in the lower Columbia River. Interviews with ACOE confirm that the flood storage capacity in WHI relative to the size of the river and the volume of flood waters in the Columbia River, and that operation of the dams would not differ based on changes in flood water storage and conveyance on WHI."[8]

The Entrix study does not assign an ecosystem value to the WHI flood regulation, noting there will be "Likely No Change" in the development scenario.[9]

[7] ECONorthwest, 2012, p. 3-22
[8] Entrix, 2010, p. ES-22
[9] Entrix, 2010, Table ES-5, p. ES-23

How much benefit does the development footprint offer in terms of floodplain-related wildlife habitat?

A BES memorandum also cites off-channel salmonid habitat as a function of the development footprint floodplain. It is difficult to put a value on this benefit partially due to lack of information in the memorandum and elsewhere. While the wetlands function of WHI has been valued and is included in the ECONorthwest cost-benefit analysis, I could not find any specific analysis of the off-channel salmonid habitat function.

The projected benefit of the off-channel salmonid habitat, whatever it may be, needs to be scaled to the size of the potential habitat area, which is, at most, five wetland acres. As noted above, this five-acre area is only occasionally inundated by the river, potentially providing salmonid habitat function less than 6 percent of all days over 40 years. The remaining 200-plus acres of the development footprint either do not have a direct connection to the river or are at an elevation that makes flooding a very rare occurrence.

Is 180 acres the right number for floodplain mitigation?

The BES memorandum notes that hydrological modeling is needed to determine intervals at which the floodplain is inundated by the river. In lieu of that modeling, it assumes that 200 acres would be required to achieve floodplain mitigation since the entire footprint was inundated during the 1996 flood. In the March 20, 2013 email to the Port, the City's Bureau of Planning and Sustainability (BPS) revises the floodplain mitigation area to 180 acres.

The hydrological analysis provided in this paper suggests that 180 acres is too high of an assumption. The actual area within the development footprint that is occasionally inundated by the river is only five acres or less of existing riverine wetlands. The scale of floodplain mitigation should be focused on this smaller, five-acre area, particularly as it pertains to salmonid habitat.

Which of the floodplain mitigation alternatives offered by BES is most appropriate?

The BES memorandum offers three mitigation alternatives (see Table 1). Alternative #1, WHI culvert replacement, and Alternative #2, off-site floodgate retrofit, are in addition to the current slate of mitigation options. Alternative #3 proposes to both achieve floodplain mitigation and to replace substantial portions of the existing mitigation for shallow water, wetlands, and forests.

Table 1: Floodplain Mitigation Alternatives from BES Memorandum

Table 1. WHI Floodplain Mitigation: Alternative Mitigation Packages			
Mitigation Category	**Alternative #1**	**Alternative #2**	**Alternative #3**
Floodplain	WHI culvert replacement	off-site Floodgate Retrofit 200 acre	off-site Levee Breach ≥ 200 acre Reclaim floodplain reconnection
Floodplain Functions Replaced	None replaced; some existing function enhanced	*hydrology only* replaced at 1:1 ratio off-site	*hydrology & habitat* replace floodplain at 1:1 ratio off-site replaced habitat at ≥ 1:1 ratio off-site
Floodplain Project Construction Cost	$45,000 - $100,000 per structure	$50,000 - $178,000 per structure	$24,000 - $313,000 per acre = $4.8M - $62.6M
shallow water	WHI on-site ($5M)	WHI on-site ($5M)	achieved with off-site floodplain reconnection
wetlands	WHI on-site ($3.5M)	WHI on-site ($3.5M)	achieved with off-site floodplain reconnection
forests	WHI & Gov Is. ($15-25M[1])	WHI & Gov Is. ($15-25M[1])	WHI on-site ($2.7M[1]) & off-site floodplain reconnection ($5.2M[1])
grasslands	off-site grant ($1.5M)	off-site grant ($1.5M)	off-site grant ($1.5M)
total relative cost	$25.1 – $35.1M	$25.1M - $35.2M	$14.2M - $72M

The BPS email (from Mindy Brooks, dated March 20, 2013) revises Alternative #3 to 180 acres and leaves the existing SWH, wetlands, and forest mitigation program in place. It puts the floodplain mitigation cost at $18 million and the "all-in" mitigation cost at $44 million.

Alternative #1

This analysis indicates that Alternative #1 may be the most appropriate mitigation. Its cost ($100,000) seems proportional to the potential loss of the highest value yet infrequent floodplain function. According to the BES memorandum, this alternative provides a "simple solution" to fish passage into the floodplain habitat.

Alternative #2

Alternative #2 appears appropriate from a cost ($178,000) relative to floodplain function perspective. However, according to the BES memorandum, this alternative provides flood storage benefit but no habitat benefit. To the extent that floodplain mitigation is needed, it should be focused on habitat function rather than flood storage function. For this reason, Alternative #2 is less desirable then #1.

Alternative #3

Alternative #3, as revised by the BPS email, is the most aggressive of the three alternatives offered, proposing to re-establish a 180-acre floodplain at another location. Alternative #3 is the most costly floodplain mitigation alternative proposed by a factor of 100. It adds $18 million to the existing mitigation package, upping the total cost from $26.5 million to $44.5 million, an increase of 68 percent.

This level of mitigation investment, given the potential increment of ecosystem function it offers, seems wholly unwarranted.

1. As stated by the Entrix study, the development footprint offers little or no function with respect to flood storage and regulation.

2. The potential habitat function of the development footprint, with respect to flooding, is restricted to a small area that is already designated wetlands. This riverine wetland area, which is five acres or less, is subject to only occasional river inundation.

3. Importantly, the existing mitigation package includes mitigation for 35 acres of shallow water habitat (SWH) and wetlands at a cost of $10.1 million. The development footprint area affected by flooding is already included in this SWH/wetland mitigation. The proposed floodplain mitigation is thus largely duplicative. If this area offers an additional increment of ecosystem services function, it must be very small compared to the SWH/wetland function that is already considered.

The Alternative #3 mitigation approach is therefore unjustified in three fundamental ways. First, it mitigates for 180 acres when the greatest potential floodplain function of the development footprint is constrained to a much smaller area. Second, it proposes a very expansive and costly mitigation alternative that will result in only a small increment of ecosystem services functional improvement. Third, it largely duplicates for functions already accounted for in proposed wetland and shallow water mitigation.

In sum, to the extent that floodplain mitigation may be justified, Alternative #1 appears to be the most appropriate of the options presented by BES.

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March 25, 2013

Sources:

Brooks, Mindy, Email to Greg Theisen, "RE: WHI Flood Storage and Diminishing Returns," *City of Portland Bureau of Planning and Sustainability*, March 20, 2013.

ECONorthwest, "West Hayden Island Public Cost / Benefit Analysis," June 2012.

Entrix, "WHI Environmental Foundation Study," July 2010.

NOAA, river level data retrieved from the NOAA web site at http://water.weather.gov/ahps2/hydrograph.php?wfo=pqr&gage=vapw1 on March 19, 2013. The CRD datum used is converted to NGVD29.

Rosen, Mike, Memorandum, "West Hayden Island – Floodplain Mitigation," *City of Portland Bureau of Environmental Services*, February 22, 2013.

WorleyParsons, "West Hayden Island, Final Report," March 2, 2012

Attachment 1: WHI at 17.8 ft. (NGVD29) River Level