BEFORE THE STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of: Application No. 2013-01	CASE NO. 15-001
TESORO SAVAGE, LLC	PRE-FILED TESTIMONY OF CHRISTOPHER J. EARLE, Ph.D.
VANCOUVER ENERGY DISTRIBUTION TERMINAL	OFFERED BY THE PORT OF VANCOUVER USA

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
Pacwest Center
1211 SW 5th Ave., Suite 1900
Portland, OR 97204
Telephone: 503.222.9981

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ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of: Application No. 2013-01 TESORO SAVAGE, LLC VANCOUVER ENERGY DISTRIBUTION TERMINAL	Case No. 15-001 DECLARATION OF CHRISTOPHER J. EARLE, Ph.D. OFFERED BY THE PORT OF VANCOUVER USA

I, CHRISTOPHER J. EARLE, Ph.D., certify and state as follows:

1. I am over eighteen years of age, have personal knowledge of the matters herein, and am competent to testify regarding all matters set forth herein.

2. I am writing as an employee of ICF International, Inc. ("ICF"). My office is located at 711 South Capitol Way, Suite 605, Olympia, WA 98501.

3. This declaration comments on the topic of deep-draft vessel impacts that would result from increased tanker traffic on the lower Columbia River ("LCR"), if the Tesoro Savage Vancouver Energy Distribution Terminal Facility ("Vancouver Energy Project") were to be constructed and operated as proposed in the Draft Environmental Impact Statement ("DEIS") for the facility. Topics treated below include the current effects associated with deep-draft vessel traffic on the river, and the changes that would result from the Vancouver Energy Project, with particular regard to the effects of vessel wakes relative

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SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

to potential stranding of juvenile salmon, modification of riverine vegetation, and erosion of shoreline sediments containing archeological deposits.

My Work Experience

4. ICF employs me full time as a consulting ecologist. I have a 1979 BA in biology, a 1986 MS in geology, and a 1993 Ph.D. in forest ecology. Since 1993, I have worked with a series of environmental consulting firms; I have been with ICF or its predecessor, Jones & Stokes, since 1999. Since 1993, my practice has focused on Pacific salmon and the Endangered Species Act ("ESA"), although the full breadth of my work (shown in Ex1002 attached hereto, my résumé) is quite a bit more diverse, including geographies extending far beyond the Pacific Northwest and addressing varied species, habitats, and types of projects, ranging from pure research to large industrial projects, to large government programs, to ecological restoration work. Mostly, I assist clients with preparation of documents (environmental impact assessments, biological assessments, habitat conservation plans, critical areas ordinances, etc.) needed to secure compliance with environmental regulations. A large part of my work consists of helping clients to achieve minimal environmental impact and optimum environmental benefit in association with their proposed projects or programs.

5. About 90% of my work is for federal, state, or local governmental entities, primarily, entities charged with natural resource protection and management. Much of my work is on highly controversial projects. ICF has a reputation among our clients for being able to present fair, unbiased, scientifically objective analyses that stand up under highly adversarial review. For instance, ICF is currently preparing several environmental impact statements for the Washington Department of Ecology, evaluating proposals to site oil and coal export terminals in western Washington; ICF was chosen for this work in large measure for its past performance regarding the rigorous application of principles of "best available science" to other highly controversial proposals. I have done very little work on the

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

Department of Ecology projects, but have been involved with comparably controversial analyses; examples include a tar sands development in Alberta, a proposed strategic oil repository in Mississippi, a very large water project in California, and a proposed liquefied natural gas terminal on the LCR. Many of these projects have faced critical reviews. The sound science used in ICF's reviews, including my work, has been relied upon by regulators and courts in making their determinations.

6. My work with ports includes (in chronological sequence) two major development projects for the Ports of Los Angeles and Long Beach (constructed), the proposed Columbia Gateway development at the Port of Vancouver USA (not constructed), two additional rail-plus-port development projects at the Port of Vancouver USA (constructed), a proposed liquefied natural gas facility at Bradwood Landing on the LCR (not constructed), and a proposed gravel mine facility and marine terminal in Puget Sound (not constructed). Besides these projects, I have also worked on a good number of other projects in nearshore marine and estuarine waters of the Pacific Northwest. I have been working on LCR projects intermittently since 2004, with an active project in the area in about 7 of those years. The Columbia Gateway and Bradwood Landing projects were most relevant to the issues treated in this declaration; on both projects, the issues of river impacts due to deep-draft vessel traffic were central, requiring substantial analysis, particularly with regard to the effects of vessel wakes.

Summary of this Declaration

7. The LCR has been subjected to numerous engineered modifications during the history of its development as a navigational corridor. These modifications have placed fill, installed rip-rap, and otherwise modified a large portion of the river corridor, substantially reducing the portion of the river where native vegetation or prehistoric sediments potentially containing archeological material may occur. Much of what remains of these resource areas

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SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

is on the island margins that do not face the navigation channel, or along secondary channels distant from the navigation channel.

8. Ship wake effects are only significant in close proximity to the shipping channel. With increasing distance from the channel, wake effects are rapidly overwhelmed by the effects of wave energy derived from natural sources, principally tides and wind-generated waves. Even at sites in close proximity to the shipping channel, wake effects are only observed where there is a very low-angle beach, and where other topographic effects provide full exposure to the impact of any ship wakes. Such sites comprise a very small fraction of the LCR; for example, wake stranding of salmonids is only observable at three-to-eight sites.

9. Thus, a limited distribution of sensitive resources is paired with a risk factor that only has a limited spatial distribution. The result is that impacts from vessel wakes are and, under the Vancouver Energy Project would remain, uncommon and minor. These impacts would not significantly affect the status of the sensitive resources represented by juvenile salmon, native vegetation communities, and archeological sites.

Current Conditions on the Lower Columbia River

10. Substantial human alteration of landforms and associated processes on the LCR began as soon as technology had enabled such changes. By 1950, these changes included: (a) construction of jetties at the mouth of the river; (b) extensive filling of wetlands for construction of varied industrial facilities along the river; (c) construction of railroad embankments along much of the riverbank; (d) construction of flood-control facilities (levees) on many parts of the river floodplain and banks; (e) construction of highways on the floodplain and, in many cases, on the banks of the river; (f) dredging of a navigational channel enabling passage of deep-draft vessels as far upstream as Portland; and (g) placement of that dredged material nearby, either on the shoreline or within the river channel. Additional changes resulted from the 1938 completion of Bonneville Dam, which

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

shut off the principal source of sediment input to the lower river channel. Since that time, the LCR has experienced a net loss of sand-sized sediment in most years, and is currently losing that sediment at the rate of about 4.6 million tons per year (Templeton and Jay 2013), which is larger than the river's entire sand-sized sediment load; thus, the total amount of sand in the LCR corridor is decreasing on a year-over-year basis, resulting in ongoing erosion. This information provides context for assessment of effects of both existing and prospective human activity on the LCR; most of the existing landforms and processes on the river are not consistent with presettlement conditions and are artificial, produced by intentional human alteration of the landscape. Most of that alteration was not originally performed in the context of any meaningful environmental regulation, and much of the altered environment represents a substantial impairment of habitat for natural wildlife, vegetation, and fisheries. It also has implications for resources treated in this analysis, in that new deposits (dredged materials, wetland fill, levees, etc.) cannot contain archeological deposits and may in fact protect such deposits from other types of impact; also, these many constructed features generally do not support valued natural vegetation communities. Example photographs depicting sites along the LCR where wake stranding of fish has been observed by prior investigators are shown in Ex1003 attached hereto (source: Ackerman 2002).

11. This declaration addresses deep-draft vessel impacts upon three types of sensitive natural resources: salmon, vegetation, and archeological sites.

12. Four species[1] of Pacific salmon live in the LCR, along with several species[2] of trout and char (collectively, "salmonids"). Most of these are protected under the federal ESA. Vertebrate species listed under the ESA may be listed as "distinct population

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[1] A fifth species, pink salmon, occasionally appears in the river but does not breed there.

[2] Not all are protected.

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

segments" ("DPS"),[3] which is an infraspecific taxonomic rank; the LCR includes fourteen DPS of salmonids, as well as one species of smelt and one of sturgeon (*Table 1*). The vast majority of the work on wake stranding from vessel traffic has focused on impacts to salmonids, so smelt and sturgeon effects are not further addressed in this declaration, except to note that smelt do use the shallow river margins and are of similar size to juvenile salmon, so they likely do experience some stranding risk. Sturgeon (even juvenile sturgeon) are larger fish that remain near the river bottom, so they likely experience negligible stranding risk.

Table 1. ESA-Listed Fish Species in the LCR.

Type	Distinct Population Segment
Salmon	Upper Willamette River Chinook salmon Snake River Spring/Summer-run Chinook salmon Snake River Fall-run Chinook salmon Lower Columbia River Chinook salmon Upper Columbia River Spring-run Chinook salmon Lower Columbia River chum salmon Lower Columbia/Southwest Washington Coho salmon Snake River sockeye salmon
Trout or Char	Upper Columbia River steelhead Snake River Basin steelhead Middle Columbia River steelhead Upper Willamette River steelhead Lower Columbia River steelhead Bull trout
Smelt	Southern DPS Pacific Eulachon
Sturgeon	Southern DPS Green sturgeon

13. Vegetation along the LCR includes a wide variety of vegetation communities. During presettlement time, native vegetation along the LCR included primarily coniferous upland forests, primarily hardwood floodplain forests, extensive floodplain and riverine wetlands dominated by diverse shrub and herb communities, and primarily herbaceous shallow-water aquatic vegetation. The modern river retains these vegetation types, but there are also extensive areas of ruderal vegetation, meaning vegetation associated with frequent

[3] The National Marine Fisheries Service has chosen to use the term "evolutionarily significant unit" ("ESU") rather than the term "distinct population segment"; the two terms are equivalent, but the latter term is used in the ESA.

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

human disturbance on degraded sites (such as roadsides, levee margins, and old industrial sites); and all of the native vegetation communities now contain a substantial number of non-native, often invasive, species. Few plant species along the river are regarded as rare or sensitive.

14. Although there are some known archeological sites along the LCR, such as shell midden sites, I assume for the purposes of this discussion that sites that are not comprised of historically recent fill material may hold undocumented archeological resources.

Current Vessel Traffic on the Lower Columbia River

15. The Columbia River navigational channel is maintained through dredging performed by the U.S. Army Corps of Engineers. For many years, the channel was dredged to a depth of 40 feet; in 2010, the channel was deepened to a depth of 43 feet, enabling somewhat larger vessels to use the river and, more importantly, to allow deep-draft vessels to use the river over a wider range of tidal and flow stages. Channel deepening occurred in the context of modern environmental regulation and, in consequence, a wealth of studies were performed evaluating the environment impacts of the deepening and the resulting changes in shipping; Pearson et al. (2006) is one example of that work.

16. O'Mara and Matuszak (2016) present a detailed analysis of current vessel traffic on the LCR. Their analysis of 2014 vessel transits found 925 deep-draft vessel transits to Vancouver (850 cargo/carrier vessel transits and 75 tanker transits at Vancouver; few other vessels were thought to represent deep-draft vessel traffic). There were 2,762 deep-draft vessel transits recorded at Astoria, indicating that about a third of the deep-draft vessel traffic in 2014 came upriver as far as Vancouver. For comparison, data from 2004 identified 877 deep-draft vessel transits at Vancouver and 1659 transits on the lower river. The highest deep-draft vessel traffic recorded on the river was in 1995, with 2,413 ship calls on the LCR and, since that time, there has been a persistent, long-term decrease in deep-draft vessel

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

traffic on the river. There is also a significant amount of year-to-year variation (Meira 2016, Wainwright 2016). An example of this variability is given in *Table 2*.

Table 2. Example of Variability in Baseline Vessel Traffic on the LCR (Source: Wainwright 2016).

Cargo type	Year				
	2000	**2005**	**2010**	**2013**	**2015**
Autos	285	268	170	164	191
Containers	278	93	87	105	19
Grain	431	421	490	370	424
Logs	103	67	110	133	106
Petroleum tankers	206	51	57	32	30
Steel products	150	90	61	67	67
Totals	**1453**	**990**	**975**	**871**	**837**
Note: Wainwright (2016) does not specify where on the LCR these data are applicable, but the figures are consistent with an estimate of vessels coming upriver as far as Vancouver or Portland.					

Characterization of Vessel Impacts

17. Past work to evaluate the environmental impacts caused by deep-draft vessels has been focused on the vessels themselves, as physical objects, regardless of the type of cargo they happen to carry. Ackerman (2002), for instance, recorded a variety of different deep-draft vessel types passing fish stranding sites, but singled out deep-draft vessels as a cause of concern, partly because the next smaller class of vessels, tugs and tug/barge combinations, produced wakes less than a third as large as deep-draft vessel wakes. This result, and similar results from other studies on the river, all show that deep-draft vessels are the principal players in vessel wake effects on the Lower Columbia River, regardless of what type of cargo they carry.

18. Past studies of vessel wake effects on the Lower Columbia River are also united in showing that the location and types of impact related to deep-draft vessel passage are extremely variable. For example, very few vessel transits have been observed to cause any stranding, as shown by *Figure 1* below. The earliest published work on biological effects of ship wakes on the river (Bauersfeld 1977) found only eight locations of concern along the Lower Columbia River. The NOAA researchers Hinton and Emmett (1994)

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

reexamined those eight sites and concluded that "various physical factors such as river-surface elevation, beach slope, vessel design and speed, and the distance between the passing vessel and the beach, and biological factors such as fish condition, may need to interact for stranding of juvenile salmonids to occur." They found substantial risk of fish stranding at only three sites (see *Figure 2* below, and Ex1004 (Coleman 2016) attached hereto) and, even then, concluded that, "stranding of juvenile salmonids is not presently a significant cause of juvenile salmonid mortality in the lower Columbia River." Ackerman (2002), examining wake stranding of the three sites studied by Hinton and Emmett (1994), stated, "We found that wake amplitude was related to distance of vessel from shore, vessel draft and vessel length." He found little evidence of actual effects attributable to wake action. Pearson et al. (2006; Pearson and Skalski 2010) confined their analysis to the same three sites identified by Hinton and Emmett (1994) and performed statistical modeling based on an extensive data set describing fish stranding observed at these sites. Pearson et al. found that site, tidal stage, abundance of juvenile salmon, and kinetic energy (a derivative term base on vessel size and speed) were the primary determinants of fish stranding risk, and that risk still varied considerably between the three study sites.

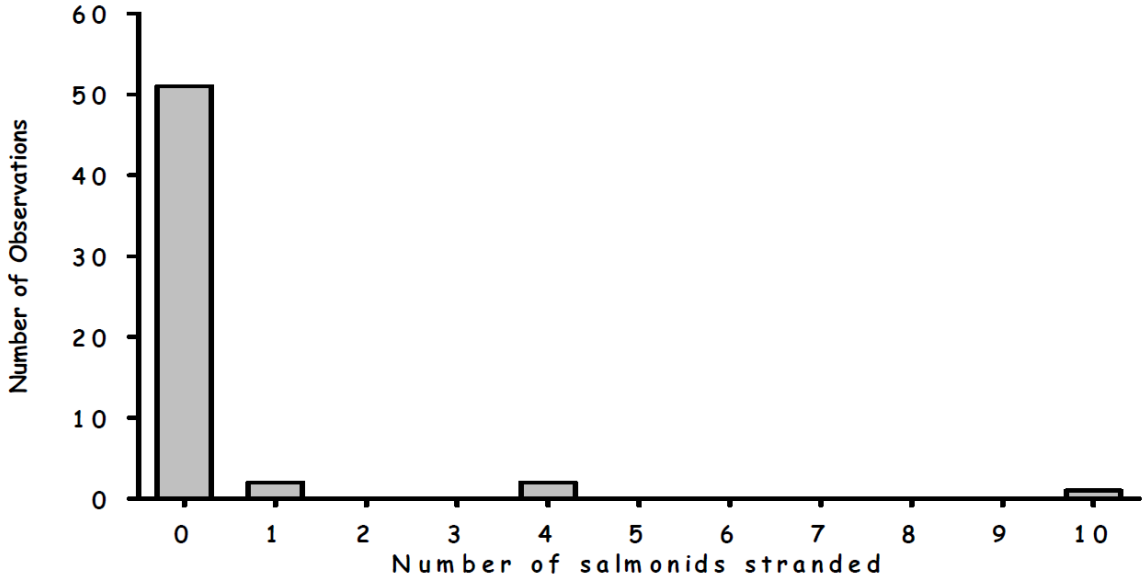

Figure 1. Stranding Incidence Observed at Sites Evaluated by Ackerman (2002) (figure from Ackerman [2002]).

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

Figure 2. Locations of the three wake stranding sites investigated by Hinton and Emmett (1994), Ackerman (2002), Pearson et al. (2006), and Entrix (2008). Source: Ackerman (2002).

19. MacDonald (2003) developed the theory of deep-draft vessel wake generation, demonstrating the importance not only of vessel size and speed but also of channel geometry and distance to shoreline. Maynord (2004) developed the theory of wake effects on shorelines along navigational channels, which enables quantitative evaluation of the potential for effects such as shoreline erosion. ENTRIX (2008) synthesized this information to develop a list of criteria that determine potential wake effects as a function of vessel characteristics and channel geometry, information that could be used to develop detailed maps of potential vessel wake impacts in the LCR. This review produced

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

geomorphic indicators of stranding risk based on analysis of bathymetry for the various stranding sites identified in the earlier studies. ENTRIX (2008) identified the importance of blocking features (stranding sites must be located on an uninterrupted path to the source of the vessel wake), proximity to the sailing line (wake height and stranding risk decreases rapidly with distance from the vessel; *Table 3*), and the importance of a shallow (less than 10%) slope to a beach.[4] Application of these criteria to the LCR showed that about 33 miles of the 208 miles of shoreline frontage on the LCR below Vancouver is susceptible to stranding, with the highest risk (which included the known stranding sites identified by earlier investigators) limited to about 8 miles of shoreline.

Table 3. Change in Wake Height with Distance from a Deep Draft Vessel (Reproduced from Entrix 2008)

Distance from Sailing Line (m)	Wake Height (cm)
1	200
50	23
75	19
100	16
150	13
200	11
250	10
300	9
350	8
400	7
450	7
500	7
550	6
600	6
650	6

20. Pearson and Skalski (2010) observed actual stranding events at the three stranding sites on the LCR that had been identified by previous investigators (Bauersfeld 1977, Hinton and Emmett 1994, Ackerman 2002, Pearson et al. 2006, and Entrix 2008).

[4] Steeply sloped beaches rapidly dissipate wave energy (Coast and Harbor Engineering 2016), so they pose little risk with regard to either stranding or other wake-related effects on the shoreline.

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

They found that the great majority (86%) of stranded fish were subyearling Chinook salmon. A more detailed analysis of salmon DPS susceptibility (Grette Associates 2016) showed that the vulnerability of subyearling Chinook salmon is partly due to their low swimming speed, relative to other salmonids, but also occurs because they are more likely to be found in shallow nearshore waters where stranding is a risk. Nearly all (91%) of the susceptible fish are Lower Columbia River Chinook Salmon, which is listed as threatened under the ESA (Grette Associates 2016, citing genetic analyses by Roegner et al. [2012, 2013]). Subyearling Chinook salmon can occur within the tidal freshwater region year-round, but their presence in the shallow river margin, where they are vulnerable to stranding, is limited largely to the spring, with low relative abundance in the winter and summer (Grette Associates 2016).

21. Although no studies have been performed specifically addressing vessel wake impacts on vegetation or archeological sites, the fish stranding studies also cast light on this potential, as does a study of vessel wakes in Grays Harbor, Washington (Osborne 2003). The Grays Harbor study considered the effects of wakes from deep-draft vessels in the Grays Harbor Navigation Channel where it passes the Whitcomb Flat Natural Area Preserve, the site of several nesting seabird colonies. The analysis clearly demonstrated that tides and winds were, by far, the primary influence on transport and deposition of sediment around Whitcomb Flats; the amount of energy created by vessel wakes was negligible, as shown by the size of the wakes (only slightly larger than the average size of waves in the harbor) and by their brief duration relative to natural processes. Both concepts are equally applicable on the LCR. Like Grays Harbor, the LCR is subject to substantial naturally-caused waves associated with winds and tides. Also, most of the LCR shorelines are far enough from the ship channel that wakes are of a size smaller than, or comparable to, wind- and tide-generated waves. Thus, vessel wakes could result in erosion and, thereby, could affect vegetation or archeological resources, only at sites that meet all of the following criteria:

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

(a) Sites are exposed to the direct effects of vessel wakes;

(b) Sites are subject to vessel wakes that are larger than naturally-occurring waves, *i.e.*, sites are generally within 100 meters of the navigational channel (per *Table 3*); and

(c) Sites are vulnerable: (1) for fish impacts to occur, they must have shallow beach slopes; (2) for vegetation impacts to occur, they must support functionally valuable native vegetation communities; or (3) for archeological impacts to occur, they must have sediments that have remained undisturbed by fill placement, substantial excavation or extensive erosion since early historical or presettlement times.

22. Analyses have not been performed to quantify each of these variables. However, work by Entrix (2008) indicates that, of 208 miles of shoreline on the LCR, no more than 33 miles (16%) meets the first criterion. Work by Entrix also examined shoreline characteristics of many of the sites that they evaluated, and indicates that most sites were beach or rip-rap and, thereby, did not meet the second two criteria. In consideration of this, it is likely that only a very small percentage of the LCR may have native vegetation or exposed sediments old enough to contain archeological material; to date, no evidence has been found documenting actual effects of vessel wakes upon such resources.

Impacts of the Vancouver Energy Project on the LCR

23. Vessels proposed to serve the Vancouver Energy Project do not differ in size from deep-draft vessels currently navigating the LCR; about 80% will be Handymax-sized, which are typical of vessels that have long been transiting the Columbia River. Larger vessels (Aframax and Suezmax vessels) could be used, but would be partially loaded due to depth restrictions. Indeed, vessels cannot be substantially bigger than they are under current conditions; the size of vessels serving ports on the LCR is constrained by the physical parameters of the navigational channel. The hull shapes and the speed of the proposed vessels would likewise be within the normal range of variation for deep-draft vessels

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

currently using the river. The vessels would be transiting the river at the same times, *i.e.*, year-round, with no particular seasonal dependencies. Therefore, these vessels would have the same impacts as the vessels that currently use the river, and impacts would be expected to increase in direct proportion to the change in the numbers of vessels transiting the river. The proposed action includes up to 365 tanker transits per year. Relative to the 2014 data cited earlier (2,762 deep-draft vessel transits to Astoria; 925 to Vancouver), this represents a 13% increase in traffic at Astoria and a 39% increase at Vancouver. Absent any other changes in traffic on the river, vessel traffic impacts would increase proportionally. It remains to ask, would this be a significant impact?

24. Factors that weigh into this determination include the following:

(a) How real is the proportional increase, *i.e.*, how would the baseline condition change if the Port of Vancouver were to lease the site of the proposed Vancouver Energy Project to some other tenant?

(b) How large is the absolute impact, *i.e.* is there a material impact under baseline conditions, which would be proportionally increased?

(c) How could the impact be minimized or mitigated?

25. The question of proportional increase is somewhat speculative. For example, total container vessel traffic on the LCR has decreased by 82% in the past two years due to the loss of Hanjin and Maersk container traffic from the Port of Portland (Wainwright 2016). Deep draft vessel traffic on the LCR is not limited by the capacity of the shipping channel, but by economic factors, and ports all along the river are seeking to attract more business from deep-draft vessels. Recent expansion and development at the ports of Kalama, Longview, and Portland, all attest to this phenomenon. The Port of Vancouver has recently developed the site proposed for the Vancouver Energy Project and, should Vancouver Energy not use that site, the Port can reasonably be expected to locate an alternative tenant. It is not possible to predict how heavily that tenant might use the site; in general, the logistics

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

of loading or unloading a deep-draft vessel would suggest that the tenant might account for fewer than 365 vessel transits per year, but it would be speculative to state how many fewer. Nonetheless, it remains likely that at least a portion of the vessel transits performed to serve the Vancouver Energy Project would still be performed if any other facility were permitted at the site.

26. The question of absolute impact was addressed in the foregoing discussion of existing conditions. To recapitulate, wake effects upon the shoreline environment have only been observed at a very few sites along the LCR, which are characterized by close proximity of the shoreline to the navigational channel, and presence of a very low beach slope that allows the wakes to propagate far up onto the shoreline. No impacts to vegetation or archeological resources have been documented, and the number of salmon affected is very small. It is also reasonable to propose that regulation and, if needed, mitigation of ESA impacts, is the responsibility of the U.S. Army Corps of Engineers, which created and maintains the navigational channel, and the U.S. Coast Guard, which regulates the operation of vessels using the channel. These federal agencies are charged with evaluating and minimizing their impacts to species protected under the ESA. For the purposes of the Vancouver Energy Project, the magnitude of the absolute impact of vessel wakes upon sensitive fish, vegetation communicates, and archeological resources, does not appear significant.

27. Finally, there is the question of minimization or mitigation of impacts. As noted above, the U.S. Army Corps of Engineers created and maintains the navigational channel, and the U.S. Coast Guard regulates the operation of vessels using the channel. The vessel operators do not have the option of traveling farther from the shoreline, which would minimize wake effects. They do not have the option of deviating from operational constraints imposed by U.S. Coast Guard regulations, which might enable lower wake heights.

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SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

Thus, operational changes do not offer the potential to further minimize impacts. In the absence of a clear significant impact, there is no apparent need for mitigation.

Conclusions

28. The LCR has been subjected to numerous engineered modifications during the history of its development as a navigational corridor. These modifications have placed fill, installed rip-rap, and otherwise modified, a large portion of the river corridor, substantially reducing the portion of the river where native vegetation or prehistoric sediments potentially containing archeological material may occur. Much of what remains of these resource areas is on the island margins that do not face the navigation channel, or along secondary channels distant from the navigation channel.

29. Ship wake effects are only significant in close proximity to the shipping channel. With increasing distance from the channel, wake effects are rapidly overwhelmed by the effects of wave energy derived from natural sources, principally tides and wind-generated waves. Even at sites in close proximity to the shipping channel, wake effects are only observed where there is a very low-angle beach, and where other topographic effects provide full exposure to the impact of any ship wakes. Such sites comprise a very small fraction of the LCR; for example, wake stranding of salmonids is only observable at three-to-eight sites.

30. Thus, a limited distribution of sensitive resources is paired with a risk factor that only has a limited spatial distribution. The result is that, impacts from vessel wakes are and, under the Vancouver Energy Project would remain, uncommon and minor. These impacts would not significantly affect the status of the sensitive resources represented by juvenile salmon, native vegetation communities, and archeological sites.

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SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

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SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711

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I DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF WASHINGTON THAT THE FOREGOING IS TRUE AND CORRECT.

Dated this 29th day of April, 2016 at Olympia, Washington.

CHRISTOPHER J. EARLE, Ph.D.

SCHWABE, WILLIAMSON & WYATT, P.C.
Attorneys at Law
1420 5th Avenue, Suite 3400
Seattle, WA 98101-4010
Telephone: 206.622.1711