Appendix A. Alphabetical list of birds observed at the Elliott Bay/Duwamish Restoration Program sites on the Duwamish River and their associated reference sites from 1997 to 2005.

Common Name	Scientific Name
American Coot	*Fulica americana*
American Goldfinch	*Carduelis tristis*
American Robin	*Turdus migratorius*
American Wigeon	*Anas Americana*
Anna's Hummingbird	*Calypte anna*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Swallow	*Hirundo rustica*
Barrow's Goldeneye	*Bucephala islandica*
Belted Kingfisher	*Ceryle alcyon*
Bewick's Wren	*Thryomanes bewickii*
Black-capped Chickadee	*Poecile atricapillus*
Brown-headed Cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Bushtit	*Psaltriparus minimus*
Cackling Goose	*Branta hutchinsii*
California Gull	*Larus californicus*
California Quail	*Callipepla californica*
Canada Goose	*Branta Canadensis*
Canvasback	*Aythya valisineria*
Caspian Tern	*Hydroprogne caspia*
Cedar Waxwing	*Bombycilla cedrorum*
Cinnamon Teal	*Anas cyanoptera*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Common Snipe	*Gallinago gallinago*
Common Yellowthroat	*Geothlypis trichas*

Common Name	Scientific Name
Cooper's Hawk	*Accipiter cooperii*
Dark-eyed Junco	*Junco hyemalis*
Domestic Duck	*Anas sp.*
Domestic Goose	*Anser sp.*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpine*
Eared Grebe	*Podiceps nigricollis*
European Starling	*Sturnus vulgaris*
Fox Sparrow	*Passerella iliaca*
Gadwall	*Anas strepera*
Glaucous-winged Gull	*Larus glaucescens*
Golden-crowned Kinglet	*Regulus satrapa*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Great Blue Heron	*Ardea herodias*
Greater Yellowlegs	*Tringa melanoleuca*
Green Heron	*Butorides virescens*
Green-winged Teal	*Anas crecca*
Heermann's Gull	*Larus heermanni*
Herring Gull	*Larus argentatus*
Hooded Merganser	*Lophodytes cucullatus*
Horned Grebe	*Podiceps auritus*
Common Name	*Scientific Name*
House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferous*

Common Name	Scientific Name
Lesser Yellowlegs	*Tringa flavipes*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Mallard	*Anas platyrhynchos*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mew Gull	*Larus canus*
Northern Flicker	*Colaptes auritus*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern Shrike	*Lanius excubitor*
Northwestern Crow	*Corvus caurinus*
Orange-crowned Warbler	*Vermivora celata*
Oregon Junco	*Junco h. oregonus*
Osprey	*Pandion haliaetus*
Pacific Loon	*Gavia pacifica*
Pied-billed Grebe	*Podilymbus podiceps*
Pigeon Guillemot	*Cepphus columba*
Pine Siskin	*Carduelis pinus*
Purple Finch	*Carpodacus purpureus*
Purple Martin	*Progne subis*
Red-breasted Merganser	*Mergus serrator*
	Podiceps grisegena
Red-tailed Hawk	*Buteo jamaicensis*
Red-throated Loon	*Gavia stellata*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-billed Gull	*Larus delawarensis*
Rock Pigeon	*Columba livia*
Ruby-crowned Kinglet	*Regulus calendula*
Rufous Hummingbird	*Selasphorus rufus*
Rufous-crowned Sparrow	*Aimophila ruficeps*
Rufous-sided Towhee	*Pipilo maculatus/erythr.*
Sanderling	*Calidris alba*

Common Name	Scientific Name
Savannah Sparrow	*Passerculus sandwichensis*
Sharp-shinned Hawk	*Accipiter striatus*
Song Sparrow	*Melospiza melodia*
Spotted Sandpiper	*Actitis macularius*
Swainson's Hawk	*Buteo swainsoni*
Swainson's Thrush	*Catharus ustulatus*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Western Grebe	*Aechmophorus occidentalis*
Western Sandpiper	*Calidris mauri*
White-crowned Sparrow	*Zonotrichia leucophrys*
Winter Wren	*Troglodytes troglodytes*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler	*Dendroica coronata*

Appendix B. Examples of Duwamish Restoration Projects Completed from Earlier NRDA Settlements

Herring's House

This restoration project is located at River Mile two of the Duwamish Waterway at the site of the former Seaboard Lumber Mill, which operated from around 1929 until the early 1980s. The site is in the vicinity of Kellogg Island and on the last remaining oxbow of the Duwamish River system. The site contains 5.7 acres of upland and 10 acres of tidelands. Historically, the upland site was a marsh/channel of the Duwamish River. Developed as an industrial site, the area was filled with waste-bearing fill material consisting of silt, sand, and gravel mixtures with broken asphalt, rock, concrete, brick, wood, and metal debris. Investigations revealed soils with concentrations of Total Petroleum Hydrocarbons (TPH), lead, mercury, and polycyclic aromatic hydrocarbons (PAHs) that exceeded Washington State Model Toxics Control Act cleanup criteria.

Design Objectives

- Restore intertidal habitat from areas that have been filled for use by juvenile salmonids.
- Create a protective low-energy environment with backwater pools to provide refuge and food sources.
- Establish areas of high intertidal salt marsh vegetation with a protective perimeter buffer of upland riparian vegetation.
- Remove and contain contaminated upland soils and industrial debris.
- Protect the site for natural resources in perpetuity.
- Provide opportunities for passive public access and environmental education.

Restoration Activities

In 1999, a protective outer berm was constructed, armoring and modifying the shoreline. The armor layer consists of 8 to 9 inches of quarry stone with voids filled with fish rock (fine/medium gravel and course sand to three-eighths of an inch). Parts of the berm serve to contain low-level industrial contaminants which has been monitored. Project construction was completed in 2000 and consisted of several primary activities:

- Structures associated with the mill operation were demolished; a 9,200 square foot shoreline dock structure was removed, including 248 creosoted wooden supporting piles, concrete foundations, areas of paving, and partially buried railroad spurs.
- Highly contaminated upland soil was removed.
- Low level TPH-contaminated soil was contained by covering with a minimum of two feet of clean soil with erosion control features to ensure containment.
- A 1.8-acre intertidal bay was excavated with a curvilinear edge to elevations between +6 to +12 feet MLLW, protected by two armored spits forming a mouth opening to the Duwamish River.
- On-site soil was amended with a mixture of silts and clays with a high organic content distributed to a depth of 18 inches over the basin.
- Slopes of the intertidal area were planted with emergent marsh plants at various elevations, and transitional scrub/shrub habitat between the intertidal marsh, upland meadow, and forested habitat.
- Intertidal habitat was monitored for a ten-year period.

Turning Basin no. 3

This project is located on the former Kenco Marine Services property at the western upstream boundary of the maintained navigation channel (Turning Basin No. 3) where the Duwamish Waterway is formed from the Duwamish River. The upland portion of the site was composed of fill material and was covered with asphalt and concrete pads, in addition to an office/warehouse structure, small storage sheds, and a house. A commercial pier extended 125 feet into the Turning Basin. Barges and other vessels moored in the intertidal and subtidal area.

Other portions of the Turning Basin have been restored to natural wetlands by federal agencies, including NOAA, the U.S. Fish and Wildlife Service, and the Port of Seattle, under various programs. The Panel partially funded the purchase of additional land to increase estuarine habitat, to be held under the trusteeship of the Muckleshoot Tribe. Over one acre of mudflats were “daylighted” by the removal of derelict vessels at the site. The commercial pier and shoreside structures were removed and the area was recontoured and revegetated to provide an enhanced intertidal wetland area.

Design Objectives

- “Daylight” intertidal and subtidal areas by removing vessels.
- Reduce pollution potential by curtailing commercial activity.
- Remove existing commercial upland and in-water structures.
- Recontour bank to create three intertidal and riparian habitat benches.
- Reestablish native intertidal and riparian vegetation.
- Increase food sources for trust resources.
- Protect the site in perpetuity for natural resources.

Restoration Activities

- Vessels and commercial activities were removed from the pier.
- Former commercial structures, concrete foundations and paved areas were removed, including the dock structure and creosoted wooden supporting piles.
- The area was recontoured and planted to create an enhanced intertidal wetland area consisting of three habitat benches at various elevations:
    - A "lower bench” at +2 to +6 feet at a 10:1 slope of sand over 3/4 inch gravel substrate to create 6,500 square feet of habitat. Bank stabilization will be accomplished by using “soft” substrates (wood) in lieu of riprap at the transition to the emergent zone bench.
    - An “emergent zone bench” at +9.5 to +11 feet at 20:1 slope planted with native intertidal vegetation and random rock placement will create 6,050 square feet of habitat.
    - A “groundcover and shrub zone bench” at elevation +14 to +17 feet at a 3:1 slope planted with native riparian vegetation to create 1,850 square feet of habitat.
- Future moorage of barges and other vessels was prohibited at the site, allowing 18,000 square feet of intertidal and subtidal mudflats to become permanently exposed.
- Intertidal habitat was monitored for success over a ten-year period under the Elliott Bay/Duwamish Restoration Program’s monitoring plan

North Wind’s Weir

The North Wind’s Weir project is on a 3.1-acre parcel of King County’s Cecil B. Moses Park on the free-flowing Duwamish River about a mile upstream of Turning Basin #3. The Elliott Bay/Duwamish Restoration Program purchased 1.03 acres of the park to construct an intertidal basin. The site was developed in the 1930s and 1940s for single-family residential housing. All dwellings were removed. A steep bank along the river right-of-way sloped downward (almost vertical) approximately 20 feet to the riverbed where the shoreline was poorly protected by riprap and debris in the lower intertidal to subtidal areas.

Design Objectives

- Create an intertidal basin for use by juvenile salmon.
- Shoreline protection improvements.
- Provide native intertidal and riparian vegetation.
- Improve habitat for out-migrating salmonid acclimation to salt water at a critical location in the Duwamish River.
- Provide refuge and food sources for trust resources.
- Protect the site in perpetuity for natural resources.

Restoration Activities

A 0.3-acre intertidal basin was constructed by excavating from an elevation of +6 to +15 feet MLLW. A curvilinear edge creates a more natural appearance and maximizes habitat diversity at the zone edge. The northeast end of the property connects to the Duwamish River via natural bank slopes stabilized with vegetation. Upland edges were revegetated with native trees and shrubs to form a riparian buffer designed to incorporate as many mature trees and native shrubs present on the site as possible and to restrict human access from the surrounding park. Monitoring for intertidal habitat success was conducted for a period of ten years under the Elliott Bay/Duwamish Restoration Program's restoration monitoring plan.

APPENDIX C: DEFINING INJURIES TO NATURAL RESOURCES IN THE LOWER DUWAMISH RIVER

(Adapted from Appendix D of March 14, 2002 Hylebos Waterway Natural Resource Damage Settlement Proposal Report)

Introduction

The Lower Duwamish River (LDR) Habitat Equivalency Analysis (HEA) evaluates and quantifies natural resource injuries in areas where surface sediments contain Substances of Concern (SOCs) at or above threshold concentrations defined for natural resource injury. The HEA also quantifies how much restoration is required to compensate for these injuries. This appendix describes how injuries are defined and how increasing concentrations of SOCs cause greater injury. It also explains how percent service loss is used in the injury calculations for estimating natural resource damages in the LDR.

Cacela *et al.* (2005) thoroughly discusses the concept of percent service loss. The focus in this appendix is on how service loss supports the HEA, what information is used to determine service loss and how service losses are estimated.[1] All of the processes and results described represent a means to establish groundwork for dialog for reaching NRDA settlements.

Associating Ecosystem Service Loss with Sediment Contamination

The concept of *service* is central to HEA. What is needed is a clear understanding of what service is being evaluated or modeled and how reductions in services are determined (Cacela *et al.,* 2005). Habitats typically provide many and varied types of ecological services (Strange *et al*, 2002) and promote a sustainable ecosystem through complex interactions among plants and animals and their habitat (Holmlund and Hammer, 1999). Examples of ecological services include providing places for shelter, feeding and resting for fish and birds. In addition, human use services include consumptive and non-consumptive uses such as fishing, nature photography, education, etc. Although some human use services are easy to evaluate, for example recreational beach use, others are not. It is difficult to connect services associated with human use with ecological services. Because of this, in the LDR HEA, only ecological services were used to estimate injury.

Ecological service is a term that may embrace several different structural or functional attributes of an ecosystem. In the context of HEA, ecological services are used as an exchange rate for determining how much habitat must be restored to compensate for harm to the environment. Injured and restored habitat is equated by comparing the services provided by each habitat. Although the injured and restored habitats may include human use services as well as ecological services, it is assumed that a focus on restoring ecological services will also support restoring human use services.

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[1] Services (or natural resource services) mean the functions performed by a natural resource for the benefit of another natural resource and/or the public. Examples include ecological services such as provision of food, protection from predation, nesting habitat, as well as human services such as fishing, hunting, education, etc.

It is important to consider how an ecological service is lost, how much is lost, and how that loss can be represented. For the purposes of the LDR HEA, ecological services are considered lost when organisms are adversely affected by the presence of a specified concentration of an SOC. Adverse effects can be non-lethal, such as causing changes within the cells of an organism, or lethal (causing the death of the animal or plant). In terms of service losses, these effects would range from small to large. Death may impact the species' population, however it is very difficult to quantify effects at the population level. Consequently, we focus on effects to sample groups of organisms, individual organisms, and processes within an organism.

Organisms live on a finite energy budget. Because energy is limited, any stressor that occurs in addition to natural stressors (i.e., not human-caused) is detrimental to that organism. Organisms must redirect energy to counteract the effects of the stressor (Rowe *et al.,* 1998). Examples of energy redirection induced by stress include fighting any toxicity associated with the stressor and using additional energy to move to avoid unsuitable habitat (Cacela *et al.* 2005). Redirecting energy for these activities comes at the expense of other biological processes, such as growth, reproduction, and avoiding predation. If a particular habitat is more stressful than a reference site, it provides less service, meaning some portions of the habitat's services are lost. The lost portion of service is an injury. Because of the functional role that ecological services play in HEA, service reductions are expressed on a percentage basis. The ecological service index of a unit of habitat is reduced by a fractional amount that reflects the difference in habitat quality at the injured site relative to an uninjured reference location.

One way to evaluate service loss within a habitat is to identify the extent and types of injuries to resources using that habitat. This information is found in scientific literature; however, the breadth of information on injuries varies greatly between chemicals. Two examples of this are described for Hexachlorobenzene (HCB) and Polycyclic Aromatic Hydrocarbons (PAHs). Following the discussion of each of these SOCs is information about other SOCs that are handled in a similar manner.

HCB Injuries and the use of Apparent Effects Thresholds

The only data sets used to evaluate injuries from HCB and several other SOCs are benthic community analyses and bioassay information from the State of Washington's Sediment Management Standards (SMS, Chapter 173-204 WAC, revised 12/95). The State of Washington Department of Ecology maintains a database that determines the apparent effects of particular contaminants to specific organisms. These effects are listed in the Apparent Effects Thresholds[2] (AETs) and are associated with invertebrate bioassays and benthic community data. There are seven AETs considered in this appendix. Five AETs address invertebrate groups and two address the benthic community (Table C1). These include a benthic community analysis and bioassay results for an echinoderm, Microtox™, amphipod, *Neanthes* (*polychaete worm*), "bivalve", and oyster. The bivalve AET is used only when oyster data are not available, because the oyster AET has been more extensively reviewed.

The lowest AET establishes Marine Sediment Quality Standards (MSQS) for Puget Sound that "correspond to a sediment quality that will result in no adverse effects on biological resources…".

[2] An Apparent Effects Threshold is defined as the concentration of a single chemical (or chemical class) in sediments above which a particular biological effect has always been observed in a particular biological test.

Table C 1. Apparent Effects Thresholds (AETs) for a variety of substances of concern. These AETs are derived from data used to promulgate State of Washington (Marine) Sediment Management Standards. All concentrations are expressed at dry weight values.

SUBSTANCES OF CONCERN	***Amphipod Bioassay*** **[1994]**	***Benthic Community Analysis*** **[PSEP, 1988]**	***Bivalve Bioassay*** ***[1994]***
Metals (mg/kg or ppm)			
Arsenic	450	57	35
Cadmium	14	5.1	3.6
Chromium	>1,100	260	63.5
Copper	1,300	530	298
Lead	1,200	450	336
Mercury	2.3	2.1	1.7
Silver	6.1	>6.1	3.0
Tributyltin	>180	na	na
Zinc	3,800	410	839
Nonionizable organic compounds (ug/kg or ppb)			
Total LPAHs	29,000	13,000	3,825
2-Methylnaphthalene	1,900	1,400	120
Acenaphthene	2,000	730	660
Acenaphthylene	1,300	1,300	150
Anthracene	13,000	4,400	1,500
Fluorene	3,600	1,000	500
Naphthalene	2,400	2,700	180
Phenanthrene	21,000	5,400	2,000
High molecular weight PAHs (ug/kg or ppb)			
Total HPAHs	69,000	69,000	13,080
Benz[a]anthracene	5,100	5,100	1,100
Benzo[a]pyrene	3,500	3,600	1,000
Benzo[ghi]perylene	3,200	2,600	640
Total benzofluoranthenes	9,100	9,900	na
Chrysene	21,000	9,200	1,600
Dibenzo[a,h]anthracene	1,900	970	250
Fluoranthene	30,000	24,000	3,300
Indeno[1,2,3-cd]pyrene	4,400	2,600	590

SUBSTANCES OF CONCERN	*Amphipod Bioassay* [1994]	*Benthic Community Analysis* [PSEP, 1988]	*Bivalve Bioassay [1994]*
Pyrene	16,000	16,000	4,100
Chlorinated organic compounds (ug/kg or ppb)			
1,2,4-Trichlorobenzene	51	na	10
1,2-Dichlorobenzene	>110	50	6
1,4-Dichlorobenzene	120	110	97
Hexachlorobenzene	130	22	6

For our analyses, the MSQS for HCB is defined as our threshold for injury (22 parts per billion (ppb)). Within the State's database, all tested sediment samples containing more than 22 ppb of HCB show an adverse effect on benthic communities. This means that *all* analyses indicate a significant reduction in invertebrate population abundance and/or species diversity when compared to a reference location. The initial injury level is defined as relatively insignificant and is estimated as 5% of the ecological service value for any form of marine habitat.[3] In situations where contamination exceeds the threshold level, more AETs are exceeded, resulting in greater injury and greater service loss. We chose three additional injury levels for HCB (and other SOCs where only Washington SMS data are available): a 10% reduction in ecological service value or service loss when at least half of the AETs are exceeded, a 15% service loss when three-quarters of the AETs are exceeded, and a 20% service loss when all invertebrate AETs are exceeded. These additional injury levels are associated with HCB concentrations of 70, 130, and 230 ppb (Table C2).

A 20% service loss is the maximum injury level assigned to HCB because no data were available to indicate effects on biota other than invertebrates. Some may argue that assigning this level of service loss to marine sediments is too low if all tested invertebrate groups are adversely affected. This criticism results from several factors, such as:

[3] Habitats used in the LDR HEA include: marsh, intertidal areas (12 feet (ft) above to 4 ft below Mean Lower Low Water (MLLW); shallow subtidal areas (4 ft below to 14 ft below MLLW); and deep subtidal areas (depths more than 14 ft below MLLW).

- By definition, AETs reflect the *minimum* concentration at which an effect is observed in *ALL* tests. AETs are continually evolving; with associated concentrations usually moving higher simply because all you need to change the AET is to identify a test that shows no effect at that concentration.
- Marine AETs often measure mortality and frequently focus on a 10-day acute test. This usually does not reflect sublethal effects (effects that cause impairment but do not kill the organism). Hence, these AETs are a coarse measure of an organism's ability to survive in contaminated sediment.
- Some AETs only focus on the adult life stage, a period in the life cycle that is often less sensitive to chemical effects.
- None are life cycle tests that determine whether an animal can live, grow, reproduce and maintain their population.
- An invertebrate may ingest, but not metabolize chemicals. Though the invertebrate itself may not be injured, the 'body burden' of the contaminant may provide a source of contamination to predators that eat them, causing impacts to higher level organisms in the food web. For example, a fish may experience injury at a lower concentration than an invertebrate AET (see PCBs).

Although no information is available on HCB effects on animal groups other than invertebrates, mortality to invertebrates and diminished benthic community abundance or diversity should adversely impact higher -level organisms. This would result from diminished quantity or quality of food, requiring animals to expend greater amounts of their limited energy budget to find alternate food resources.

Table C 2. Concentrations of chlorobenzenes estimated to cause injuries to natural resources in Duwamish Waterway, based on Washington State SQS and AET values, expressed in dry weight.

SOC	BIOASSAY	CONCENTRATION	INJURY
Hexachlorobenzene (HCB)			
	"Bivalve" AET	6	(Not used)[1]
	Echinoderm AET	--	
	Benthic Community	22	5% Service Loss
	Microtox AET	70	10% Service Loss
	Amphipod AET	130	15% Service Loss
	Neanthes AET	>120	
	Oyster AET	230	20% Service Loss

SOC	BIOASSAY	CONCENTRATION	INJURY
1,2-dichlorobenzene (oDCB)			
	"Bivalve" AET	6	(Not used)[1]
	Echinoderm AET	na	
	Neanthes AET	na	
	Microtox AET	35	5% Service Loss
	Benthic Community	50	
	Oyster AET	50	20% Service Loss
	Amphipod AET	>110	
1,4-dichlorobenzene (pDCB)			
	"Bivalve" AET	97	(Not used)[1]
	Benthic Community	110	10% Service Loss
	Microtox AET	110	
	Echinoderm AET	--	
	Oyster AET	120	20% Service Loss
	Neanthes AET	--	
	Amphipod AET	120	
1,2,4-trichlorobenzene (TCB)			
	Echinoderm AET	>4.8	
	"Bivalve" AET	10	(Not used)[1]
	Benthic Community	--	
	Microtox AET	31	5% Service Loss
	Amphipod AET	51	10% Service Loss
	Oyster AET	64	20% Service Loss
	Neanthes AET	--	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Although there are arguments to suggest a 20% Service Loss is either insufficient or too excessive, based on current information the service losses assigned to invertebrate bioassay data represent an appropriate level without overstating injury.

Injuries for Other SOCs Based Solely on Washington SMS Information—

For several other SOCs only benthic and bioassay data is available from the Washington Department of Ecology. In most instances, *four or more AETs* are present in our analytical database. In those cases, service loss is established in a manner identical to that used for HCB. SOCs in this category include:

Metals	**Phenols**	**Phthalates**	**Other SOCs**
Arsenic	4-methyl phenol	Butylbenzyl phthalate	Hexachlorobutadiene
Cadmium	2,4-dimethyl phenol		
Copper			
Lead			
Mercury			
Silver			
Zinc			

In some instances fewer than four AETs are available, and we identify service loss per SOC based on the following method: *when only three AETs* are available, the lowest concentration is identified as a 5% Service Loss, the second lowest is defined as a 10% Service Loss, and the third is defined as 20% Service Loss (all available AETs are exceeded). For Di-n-butyl phthalate, all three AETs have the same concentration: 1,400 ppb dw. In this instance, only one service loss level (20%) is assigned (Table C5). SOCs in this category include:

Metals	**Phenols**	**Phthalates**	**Other SOCs**
Chromium	Phenol	bis (2-ethylhexyl) phthalate	1,2,4-trichlorobenzene
		Dimethylphthalate	
		Di-n-butyl phthalate	

When *only two AETs* are available, the lowest is identified as a 5% Service Loss, and the highest as a 20% Service Loss. SOCs in this category include the following

Metals	**Chlorobenzenes**	**Phthalates**	**Other SOCs**
None	1,2-dichlorobenzene	Di-n-octyl phthalate	none
	1,4-dichlorobenzene		

Service losses associated with various concentrations of metals are presented in Table C3, and service losses associated with concentrations of phenols, phthalates, and Hexachlorobutadiene are presented in Tables C4, C5, and C6, respectively.

Table C 3. Concentrations of metals estimated to cause injuries to natural resources in Duwamish Waterway, based on State of Washington Sediment Quality Standards and AET values, expressed in parts per million dry weight.

SOC	BIOASSAY	CONCENTRATION (ppm)	INJURY
Arsenic (As)			
	"Bivalve" AET	35	(Not used)[1]
	Benthic Community	57	5% Service Loss
	Neanthes AET	63	
	Echinoderm AET	130	10% Service Loss
	Amphipod AET	450	15% Service Loss
	Microtox AET	700	
	Oyster AET	700	20% Service Loss
Cadmium (Cd)			
	"Bivalve" AET	3.6	(Not used)[1]
	Echinoderm AET	2.7	5% Service Loss
	Neanthes AET	3.0	
	Benthic Community	5.1	10% Service Loss
	Microtox AET	9.6	
	Oyster AET	9.6	15% Service Loss
	Amphipod AET	14	20% Service Loss
Chromium (Cr)			
	"Bivalve" AET	63.5	5% Service Loss
	Neanthes AET	94	10% Service Loss
	Microtox AET	--	
	Echinoderm AET	>96	
	Benthic Community	260	20% Service Loss
	Oyster AET	--	
	Amphipod AET	>110	
Copper (Cu)			
	Neanthes AET	270	5% Service Loss
	"Bivalve" AET	298	(Not used)[1]
	Oyster AET	390	
	Echinoderm AET	390	10% Service Loss
	Microtox AET	390	

SOC	BIOASSAY	CONCENTRATION (ppm)	INJURY
	Benthic Community	530	15% Service Loss
	Amphipod AET	1,300	20% Service Loss
Lead (Pb)			
	"Bivalve" AET	336	(Not used)[1]
	Neanthes AET	360	5% Service Loss
	Echinoderm AET	430	
	Benthic Community	450	10% Service Loss
	Microtox AET	530	15% Service Loss
	Oyster AET	660	
	Amphipod AET	1,200	20% Service Loss
Mercury (Hg)			
	Microtox AET	0.41	5% Service Loss
	Oyster AET	0.59	
	Neanthes AET	1.3	10% Service Loss
	Echinoderm AET	1.4	15% Service Loss
	"Bivalve" AET	1.7	(Not used)[1]
	Benthic Community	2.1	
	Amphipod AET	2.3	20% Service Loss
Silver (Ag)			
	"Bivalve" AET	3.0	5% Service Loss
	Microtox AET	>0.56	
	Oyster AET	>0.56	
	Neanthes AET	3.3	10% Service Loss
	Amphipod AET	6.1	15% Service Loss
	Benthic Community	>6.1	
	Echinoderm AET	8.4	20% Service Loss
Zinc (Zn)			
	Benthic Community	410	5% Service Loss
	Echinoderm AET	460	
	Neanthes AET	530	10% Service Loss
	"Bivalve" AET	839	(Not used)[1]
	Microtox AET	1,600	15% Service Loss
	Oyster AET	1,600	
	Amphipod AET	3,800	20% Service Loss

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 4. Concentrations of phenols estimated to cause injuries to natural resources in Duwamish Waterway Injuries are based on State of Washington Sediment Quality Standards and AET values, expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
4-methyl phenol (MP4)			
	"Bivalve" AET	100	(Not used)[1]
	Echinoderm AET	110	5% Service Loss
	Oyster AET	670	
	Microtox AET	670	10% Service Loss
	Neanthes AET	880	
	Benthic Community	1,800	15% Service Loss
	Amphipod AET	3,600	20% Service Loss
2,4-dimethyl phenol (DMP)			
	"Bivalve" AET	--	(Not used)[1]
	Oyster AET	29	5% Service Loss
	Microtox AET	29	
	Echinoderm AET	55	10% Service Loss
	Neanthes AET	--	
	Amphipod AET	77	15% Service Loss
	Benthic Community	210	20% Service Loss
Phenol			
	"Bivalve" AET	160	(Not used)[1]
	Neanthes AET	180	5% Service Loss
	Echinoderm AET	>220	
	Oyster AET	420	10% Service Loss
	Microtox AET	1,200	
	Amphipod AET	1,200	
	Benthic Community	1,200	20% Service Loss

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 5. Concentrations of phthalates estimated to cause injuries to natural resources in Duwamish Waterway. Injuries are based on State of Washington Sediment Quality Standards and AET values, expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
bis [2-Ethylhexyl] phthalate (bEPH)			
	Benthic Community	1,300	5% Service Loss
	Echinoderm AET	1,700	
	Microtox AET	1,900	10% Service Loss
	Oyster AET	1,900	
	Neanthes AET	2,000	20% Service Loss
	"Bivalve" AET	2,200	(Not used)[1]
	Amphipod AET	>8,300	
Butylbenzyl phthalate (BBPH)			
	Microtox AET	63	5% Service Loss
	"Bivalve" AET	100	
	Echinoderm AET	200	10% Service Loss
	Oyster AET	>470	
	Neanthes AET	>580	
	Benthic Community	900	15% Service Loss
	Amphipod AET	970	20% Service Loss
Di-n-butyl-phthalate (DnBPH)			
	"Bivalve" AET	58	(Not used)[1]
	Microtox AET	1,400	20% Service Loss
	Neanthes AET	na	
	Echinoderm AET	>31	
	Oyster AET	1,400	
	Amphipod AET	1,400	
	Benthic Community	>5,100	
Di-n-octyl phthalate (DOPH)			
	"Bivalve" AET	61	5% Service Loss
	Microtox AET	na	
	Neanthes AET	na	
	Echinoderm AET	>98	
	Oyster AET	>420	

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
	Amphipod AET	>2,100	
	Benthic Community	6,200 ←	20% Service Loss
dimethylphthalate (DMPH)			
	"Bivalve" AET	6	(Not used)[1]
	Microtox AET	71 ←	5% Service Loss
	Echinoderm AET	85 ←	10% Service Loss
	Neanthes AET	--	
	Oyster AET	160 ←	20% Service Loss
	Benthic Community	>1,400	
	Amphipod AET	>1,400	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 6. Concentrations of hexachlorobutadiene estimated to cause injuries to natural resources in the LDR. Injuries are based on State of Washington Sediment Quality Standards and AET values expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
Hexachlorobutadiene (HCBD)			
	"Bivalve" AET	6	(Not used)[1]
	Benthic Community	11	5% Service Loss
	Microtox AET	120	10% Service Loss
	Amphipod AET	180	15% Service Loss
	Echinoderm AET	1.3 [2]	
	Oyster AET	270	20% Service Loss
	Neanthes AET	--	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

[2] There is some question about the validity of this number; therefore, it was not used.

PAH Injuries to Vertebrates and Invertebrates

Information on injuries from PAH contamination is more extensive than that for HCB, including effects data for both invertebrates and fishes. Our analysis includes two types of information: biological effects of PAHs on English sole *Pleuronectes vetulu, and AET invertebrate data* from the Washington Sediment Management Standards database.

PAH effects on English Sole are compiled from studies performed by the NOAA Northwest Fisheries Science Center by Johnson et al. (2002). These studies use Total PAHs, a combination of numerous high and low molecular weight PAHs that are listed in Table C7. PAH AETs do not provide a total PAH concentration, only total high molecular weight PAHs (Total HPAHs) and total low molecular weight PAHs (Total LPAHs). The Total HPAHs concentrations are used in this report for effects comparisons between the flatfish and invertebrates. These concentrations are chosen because they represent higher AETs than for LPAHs, and consequently are considered not to overstate injuries.

Table C 7. Polycyclic aromatic hydrocarbons (PAHs) combined to represent Total PAHs in NOAA Northwest Fisheries Science Center studies of PAH effects on English Sole.

Low Molecular Weight PAHs	**High Molecular Weight PAHs**
2-Methylnaphthalene	Benz[a]anthracene
Acenaphthene	Benzo[a]pyrene
Acenaphthylene	Benzo[ghi]perylene
Anthracene	benzofluoranthenes (b+k)
Fluorene	Chrysene
Naphthalene	Dibenzo[a,h]anthracene
Phenanthrene	Fluoranthene
	Indeno[1,2,3-cd]pyrene
	Pyrene

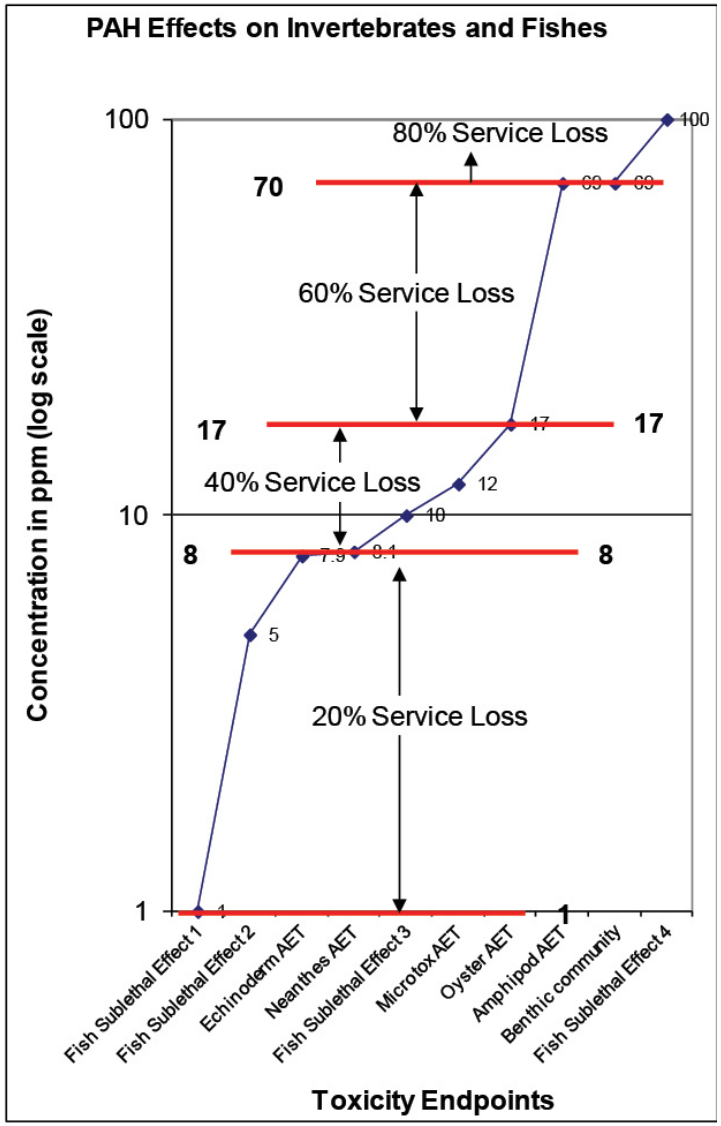
English sole continues to be one of the most extensively studied fish species in pollution monitoring research. Because it is a shallow-water bottom-dwelling flatfish and occurs in urban and non-urban environments along the Pacific Coast of North America, it is particularly likely to take up contaminants in sediment, through direct contact with sediments and through its diet. Since this species is relatively sedentary and spends most of its life in a small area, biological effects in English sole are an accurate reflection of PAH exposure at sites where they are collected. Numerous studies show that English sole from PAH-contaminated areas are highly susceptible to the development of liver cancer and related lesions, and are prone to several other adverse health effects, such as reproductive abnormalities, immune dysfunction, and alterations in growth and development (Myers *et al.* 1994, 1998; Arkoosh *et al.* 1996; and Johnson *et al.* 1998).

Based on a review of the English sole studies and the State of Washington SMS information, the following can be stated about PAH injuries to natural resources. (All PAH concentrations mentioned refer to levels of sediment contamination):

- The first sign of reproductive effects of PAHs on English sole in Puget Sound occurs at about 1 ppm dry weight, and cancerous or pre-cancerous lesions are found fairly frequently. At that concentration, nearly 10% of English sole studied contain 1 or more of a variety of toxicopathic lesions in soft body tissue and nearly 5% of adult females are infertile when compared to female populations in relatively uncontaminated areas.
- By 5 ppm, the number of individuals with lesions has increased three-fold and female infertility has increased to 17% above baseline. By 7.9 ppm, invertebrates also begin to be affected (Table C1).
- By 10 ppm, over 40% of all English sole studied have one or more lesions, nearly 25% of adult females are infertile, and between 10 and 69 ppm, more than half of the invertebrate bioassays show adverse effects.
- By 100 ppm, over 70% of all English sole studied in Puget Sound have some form of toxicopathic lesions, and for adult females, over half have inhibited reproduction capability, over two-thirds do not participate in spawning, and more than three-quarters are infertile. All invertebrate AETs are exceeded.

Information in the previous paragraph describes a significant range of injuries to natural resources from exposure to PAHs in marine sediments. This suggests that a significant range of service losses is associated with these varied injuries. Initial impacts to vertebrates are reported by Johnson et al. (2002) to begin at sediment concentrations as low as 54 ppb, and the variety and extent of injuries to English sole increase markedly with rising PAH concentrations. While this information is from studies focusing on direct exposure to contaminated sediments, these fish indirectly suffer substantial additional exposure through ingestion of invertebrate prey residing in contaminated sediment (Rice *et al.* 1999). In turn, the prey is directly affected by sediment concentrations of PAHs, as low as 7.9 ppm.

To map PAH injuries and identify a range of service losses, impacts on English sole and invertebrate AETs are graphed against PAH concentrations in sediments (Figure C1). The PAH concentrations are represented on the y-axis in (base 10) logarithmic form to permit observing effects details at low concentrations as well as evaluate effects at very high concentrations on the same scale. A 20% threshold service loss is assigned at 1ppm dry weight, with a general grouping of additional flatfish injuries and an invertebrate AET between 1 ppm and 8.1 ppm. This initial service loss is much higher than that assigned for HCB (discussed previously) because it impacts other members of the biological community through the food web.



References	Toxicity Endpoint	Concentration ppm dw
4	Fish Sublethal Effect [1]	1
4	Fish Sublethal Effect [2]	5
1	Echinoderm AET	7.9
1	Neanthes AET	8.1
4	Fish Sublethal Effect [3]	10
1	Microtox AET	12
1	Oyster AET	17
1	Amphipod AET	69
1	Benthic community	69
4	Fish Sublethal Effect [4]	100

References

1 Washington Department of Ecology

4 Johnson et al. 2002

Flatfish Injuries	
Sublethal 1	initial effects on fecundity and occurrence of lesions in soft tissue
Sublethal 2	significant increases lesion occurrence (>30%) and reduced fecundity (>15%)
Sublethal 3	>40% of all individuals with lesions and fecundity reduced by ~25%
Sublethal 4	~75% occurrence of lesions and fecundity reduced by ~50%.

80% Service Loss >70 ppm dry weight	All tested invertebrates affected; flatfish injuries include ~50% reduction in fecundity and ~75% occurrence of at least one lesion/fish
60% Service Loss 17 to 70 ppm	All tested invertebrates affected.
40% Service Loss 8 to 17 ppm	One-half of tested invertebrates affected; significant injuries to flatfish include ~25% reduction in fecundity & 31% occurrence of lesions
20% Service Loss 1 to 8 ppm	Begin to see effects on invertebrates and fishes. Flatfish fecundity reduced by ~5% and up to 10% of all fish with some form of lesion.

Figure C1. Information used to determine injury threshold concentrations for total PAHs and their associated percent Service Losses.

A 40% service loss is assigned to the range of 8 to 17 ppm because both the extent of biological effects on fish and the number of invertebrate AETs that are exceeded at these concentrations. A 60% service loss is assigned to the range of 17 to 70 ppm because of continued substantial increases of biological effects and the incorporation of all invertebrate AETs. Finally, an 80% service loss is assigned to PAH sediment concentrations above 70 ppm.

Other SOCs Handled Similarly to PAHs

Injuries from polychlorinated biphenyls (PCBs), p,p'DDT, p,p'DDE, and p,p'DDD are evaluated in a similar manner. In addition to the Washington SMS data, numerous studies were reviewed for PCBs and the various DDT congeners (forms of DDT that result from the breakdown of the original chemical) (MacDonald 1994). Data from research on PCB effects on several salmonid species were also included (Meador et al. (2002b). As with PAHs, a graph of toxic endpoints and associated concentrations was developed for each SOC. Higher service losses are assigned at points on the graph where there is a notable increase in effect concentration.

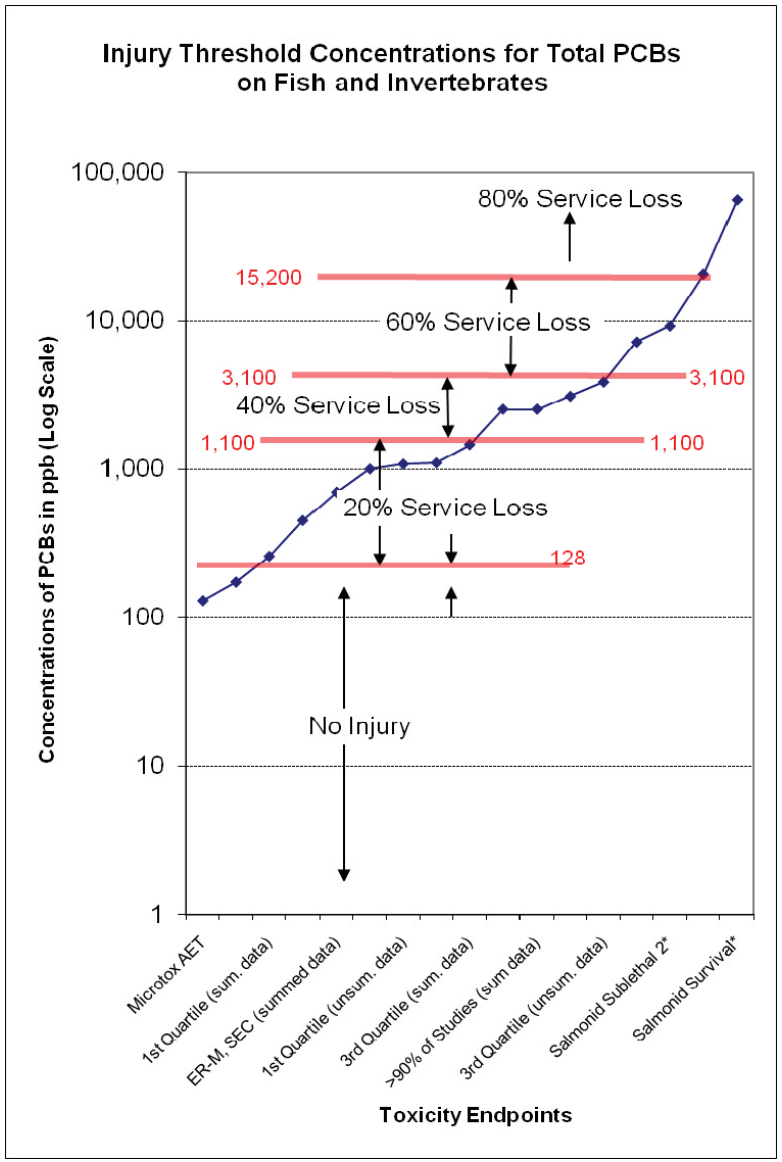
PCBs—The first threshold for PCBs in the LDR HEA was set by the "Sediment Effect Threshold" of "SET" described in Meador et al. (2002b). Since it represents a bioaccumulative effect, it is assigned a 20% service loss. The Trustees used a slightly different total organic carbon (TOC) value to derive the first PCB threshold than the TOC value used by Meador et al. The Trustees calculated an area-weighted average TOC value of 1.7%, based on a more comprehensive set of Duwamish sediment data. Meador et al. used 1.5%. The result is that where Meador et al shows a value of 113 ppb dry weight, the Trustees calculate 128 ppb dry weight. The value of 128 ppb dry weight corresponds to the Washington State Sediment Management Standards Lowest Apparent Effects Threshold, which is 130 ppb dry weight.

PCB injury thresholds are represented by 20-40-60-and 80% Service Losses for four concentration ranges of 128-1,100 ppb (20% Service Loss), 1,100-3,100 ppb (40% Service Loss), 3,100-15,200 ppb (60% Service Loss), and greater than 15,200 ppb (80% Service Loss (Figure C2).

DDT Congeners--DDTs are assigned 10-20-30-40% service losses. These SOCs are assigned a lower service loss range than PAHs and PCBs as most studies only describe injuries to invertebrates. A summary graph and table of service loss information for p,p' DDT is found in Figure C3. It identifies injury ranges as 12-34 ppb (10% Service Loss), 34-340 ppb (20% Service Loss), 340-1,500 ppb (30% Service Loss) and concentrations greater than 1,500 ppb (40% Service Loss).

Figure C4 summarizes toxic endpoint information for p,p' DDE. It identifies injury ranges as 9-65 ppb (10% Service Loss), 65-5,200 ppb (20% Service Loss), 5,200-16,300 ppb (30% Service Loss) and concentrations greater than 16,300 ppb (40% Service Loss).

Figure C5 summarizes toxic endpoint information for p,p' DDD. It identifies injury ranges as 16-70 ppb (10% Service Loss), 70-1,100 ppb (20% Service Loss), 1,100-2,600 ppb (30% Service Loss) and concentrations greater than 2,600 ppb (40% Service Loss).



Reference	Toxicity Endpoint	Concentration ppb dw
1	Microtox AET	96
3	Chinook SEC1*	128
2	1st Quartile (sum. data)	191
1	Echinoderm AET	333
2	ER-M, SEC (summed data)	517
1	Benthic Community	739
2	1st Quartile (unsum. data)	798
1	Oyster AET	813
2	3rd Quartile (sum. data)	1,084
2	ER-M (unsum data)	1,870
2	>90% of Studies (sum data)	1,870
1	Amphipod AET	2,291
2	3rd Quartile (unsum. data)	2,856
2	>90% of Studies (unsum)	5,321
4	Salmonid Sublethal 2*	6,800
4	Salmonid Growth*	15,226
4	Salmonid Survival*	47,970

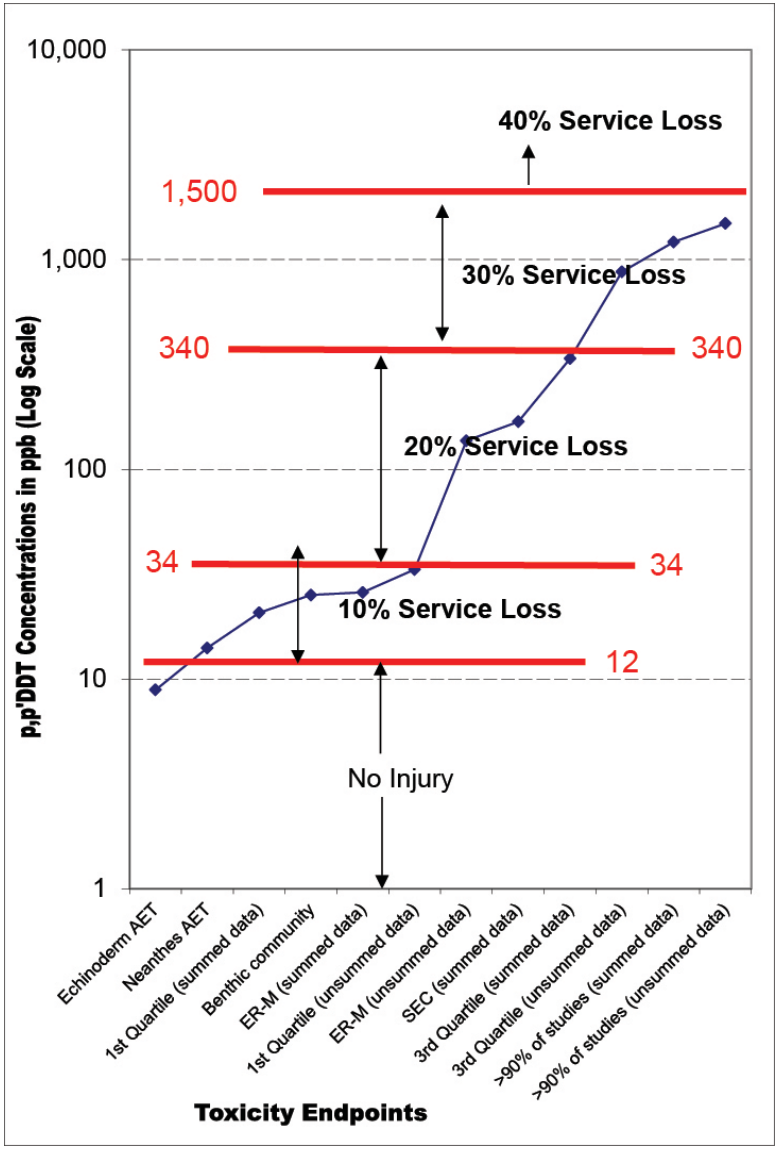
[1]--SEC = Sediments Effects Concentration
[2]--ER-M = Effects Range-Median
* concentrations based on 1.7% TOC

References

1 Washington Department of Ecology
2 MacDonald 1994
3 Meador et al. 2002 (b)
4 NOAA, 2001

80% Service Loss > 15.2 ppm dry weight	All tested invertebrates affected and salmonid growth and survival are affected
60% Service Loss 3.1 to 15.2 ppm	All invertebrates affected and sublethal effects on salmonids such as changes in immuno-suppression and P450 induction
40% Service Loss 1.1 to 3.1 ppm	Most tested invertebrates affected
20% Service Loss 0.128 to 1.1 ppm	First signs of cellular compromise in Chinook salmon; several invertebrates affected

Figure C2. Information used to determine injury threshold concentrations for total PCBs and their associated percent Service Losses.



Ref.	Toxicity Endpoint	Concentration (ppb dw)*
1	Echinoderm AET	9
1	Neanthes AET	14
3	1st Quartile (summed data)	21
1	Benthic community	25
3	ER-M (summed data)	26
3	1st Quartile (unsummed data)	33
3	ER-M (unsummed data)	137
3	SEC (summed data)	169
3	3rd Quartile (summed data)	337
3	3rd Quartile (unsummed data)	874
3	>90% of studies (summed data)	1,214
3	>90% of studies (unsummed data)	1,487

* Concentrations based on 1.7% TOC

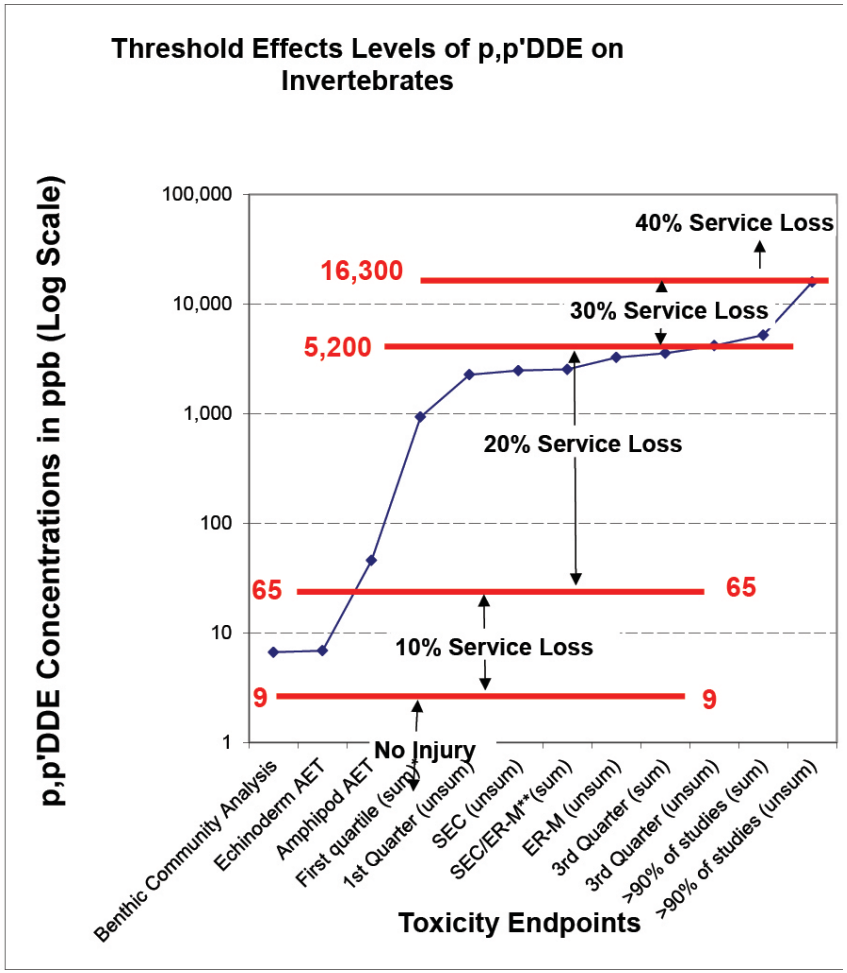
References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >1,500 ppb dw	All bioassays show effects.
30% Service Loss 340 to 1,500 ppb	Over 90% of studies reported by MacDonald 1994 show effects by this range.
20% Service Loss 34 to 340 ppb	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range
10% Service Loss 12 to 34 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C3. Information used to determine injury threshold concentrations for p,p' DDT and their associated percent Service Losses.



Reference	Toxicity Endpoint	Concentration (ppb dw)
1	Benthic Community Analysis	7
1	Echinoderm AET	7
1	Amphipod AET	46
3	First quartile (sum)*	931
3	1st Quarter (unsum)	2,267
3	SEC (unsum)	2,473
3	SEC/ER-M**(sum)	2,531
3	ER-M (unsum)	3,254
3	3rd Quarter (sum)	3,554
3	3rd Quarter (unsum)	4,166
3	>90% of studies (sum)	5,196
3	>90% of studies (unsum)	15,899

* Concentrations for MacDonald (1994) data based on 1.7% TOC
** Effects Range-Median Sediment Effects Concentration

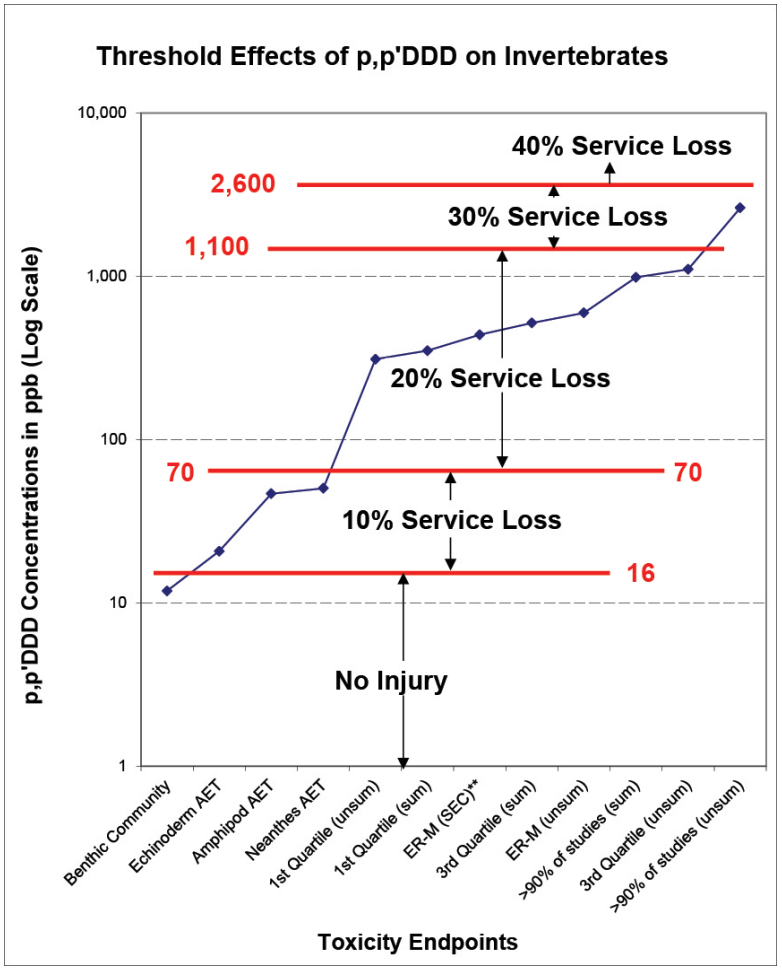
References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >16,300 ppb dw	All bioassays show effects.
30% Service Loss 5,200 to 16,300	Over 90% of studies examined by MacDonald 1994 show effects by this range.
20% Service Loss 65 to 5,200	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range.
10% Service Loss 9 to 65 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C4. Information used to determine injury threshold concentrations for DDE and their associated percent Service Losses.



Reference	Toxicity Endpoint	Concentration (ppb dw)*
1	Benthic Community	12
1	Echinoderm AET	21
1	Amphipod AET	47
1	Neanthes AET	50
3	1st Quartile (unsum)	310
3	1st Quartile (sum)	350
3	ER-M (SEC)**	438
3	3rd Quartile (sum)	517
3	ER-M (unsum)	597
3	>90% of studies (sum)	986
3	3rd Quartile (unsum)	1,104
3	>90% of studies (unsum)	2,626

* Concentrations for MacDonald (1994) data based on 1.7% TOC

** Effects Range-Median Sediment Effects Concentration

References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >2,600 ppb dw	All bioassays show effects.
30% Service Loss 1,100 to 2,600 ppb	Over 90% of studies reported by MacDonald 1994 show effects by this range.
20% Service Loss 70 to 1,100 ppb	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range
10% Service Loss 16 to 70 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C5. Information used to determine injury threshold concentrations for DDD and their associated percent Service Losses.

Tributyltin Service Losses—There is no MSQS associated with tributyltin (TBT), and more recent AET information is minimal. Consequently, we rely on information compiled from studies elsewhere and the analysis by Meador et al. (2002a) that supports a sediment quality threshold for TBT in Puget Sound to protect prey species for juvenile salmonids that are listed by the Endangered Species Act. In this document, he calculates an effects level of 6,000 ppb OC; a median concentration for all sublethal effects studies which is primarily growth impairment). With a calculated average TOC for the LDR of 1.7%, the previously stated carbon normalized number would translate to 102 ppb dry weight.

For specific studies, TBT concentrations associated with adverse effects range from 100 ppb to 1000 ppb dry weight. Meador (1997) indicates that 329 ppb is a concentration in a range needed to produce a lethal response for a sensitive invertebrate such as the amphipod, *Eohaustorius washingtonianus*. Bryan and Langston (1992), Langston and Burt (1991) and Meador et al. (2002a) have suggested that some populations of bivalves in United Kingdom waters have disappeared in locations with TBT sediment concentrations over 700 ppb. Fent and Hunn (1995) (from ibid) noted that clams have disappeared in other areas where sediment TBT exceeds 800 ppb. Lastly, Meador and Rice (2001) report severe reductions in growth of the polychaete, *Armandia brevis,* for sediment concentrations in the range of 100 to 1,000 ppb.

Based on the above TBT information, the threshold value for injuries from TBT is assigned at 102 ppb dry weight (Table C8). A 5% service loss is associated with this threshold value. A 20% service loss is assigned to concentrations greater than 1,000 ppb.

Table C 8. Concentrations of Tributyltin considered to cause injuries to natural resources in the LDR

SOC	BIOASSAY	Concentration in ppb	INJURY
Tributyltin (TBT)			
Tributyltin (TBT)	NMFS threshold[1]	102	5% Service Loss
	Bivalve abundance[2]	>800	
	Bivalve abundance[3]	>700	
	Polychaete growth[4]	1,000	20% Service Loss

[1] Meador et al.*(2002a*) proposes that a concentration of 6,000 ppb per gram Carbon would be protective for many, but not all prey species. For the average TOC for Duwamish stations, this would translate as 138 ppb DW (average TOC = 1.7%).

[2] Disappearance of clams in areas where TBT exceeded 800 ppb DW, reported by Fent and Hunn 1995.

[3] Populations of bivalves *Macoma balthica* and *Scrobicularia plana* have disappeared in locations with concentrations over 700 ppb--reported by Bryan and Langston (1992) and Langston and Burt (1991).

[4] Severe reductions in growth of *Armandia brevis* for sediment concentrations in the range of 100 - 1,000 ng/g (ppb), reported by Meador and Rice (2001).

Summary

This appendix assigns threshold sediment concentrations for injuries to natural resources from various SOCs. The ecological service losses assigned to each threshold and higher are based on the variety and extent of injuries caused by each SOC. If only invertebrate AET information is used to estimate injury thresholds, the maximum service loss value is determined to be 20%. If information from reports on injuries to fishes is incorporated into our analysis along with the AETs, both initial and maximum service losses are higher, with thresholds at 10-20% and maximum values up to 80%.

REFERENCES

Arkoosh, M. A., E. Clemons, P. Huffman. H. R. Sandborn, E. Casillas, and J. E. Stein. 1996. Leukoproliferative response of splenic leukocytes from English sole (*Pleuronectes vetulus*), exposed to chemical contaminants. Environ. Toxicol. Chem., 15:1154-1162.

Bryan, G. W. and W. J. Langston. 1992. Bioavailability, accumulation, and effects of heavy metals in sediments with special reference to United Kingdom estuaries: a review. Environ. Pollut. 76:89-131.

Cacela, D., J. Lipton, D. Beltman, J. Hansen, and R. Wolotira. 2005. Associating Ecosystem Service Losses with Indicators of Toxicity in Habitat Equivalency Analysis. Environmental Management 35(3): 343-351.

Fent K, Hunn J. 1995. Organotins in freshwater harbors and rivers: temporal distribution, annual trends and fate. Environ Toxicol Chem 14(7):1123–1132.

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: Part II. Incubating downstream from weathered Exxon Valdez crude oil caused increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos. Environ. Toxicol Chem 18: 494-503

Holmlund, C. M., and M. Hammer. 1999. Ecosystem services generated by fish populations. Ecological Economics 29:253-268.

Johnson, L. Collier, T. K. and J. E. Stein. 2002. An analysis in support of sediment thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. Aquatic Conservation: Marine and Freshwater Ecosystems, 12:517-538.

Johnson, L. L., J. T. Landahl, L. A. Kubin, B. H. Horness, M. S. Myers, T. K. Collier, and J. E. Stein. 1998. Assessing the effects of anthropogenic stressors on Puget Sound flatfish populations. Neth. J. Sea Res. 39:125-137.

Langston, W. J. and G. R. Burt. 1991. Bioavailability and effects of sediment-bound TBT in deposit feeding clams, *Scrobicularia plana.* Mar. Environ. Res. 32:61-77.

MacDonald, D. D. 1994. Sediment Injury in the Southern California Bight: Review of the Toxic Effects of DDTs and PCBs in Sediments. Prepared for NOAA, August, 1994, by MacDonald Environmental Sciences Ltd. Ladysmith, B.C., V0R 2E0. 96 pp. + Appendices.

Meador, J. P. 1997. Comparative toxicokinetics of tributyltin in five marine species and its utility in predicting bioaccumulation and toxicity. Aquatic Toxicol. 37:307-326.

Meador, J. P., T. K. Collier, J. E. Stein. 2002a. Determination of a tissue and sediment threshold for tributyltin to protect prey species for juvenile salmonids listed by the U. S. Endangered Species Act. Aquatic Conservation: Marine and Freshwater Ecosystems, 12:539-551.

Meador, J. P., T. K. Collier, J. E. Stein. 2002b. Use of tissue and sediment-based threshold concentrations of polychlorinated biphenyls (PCBs) to protect juvenile salmonids listed under the U.S. Endangered Species Act. Aquatic Conservation: Marine and Freshwater Ecosystems, 12:493-516.

Meador, J.P. 2000. Predicting the fate and effects of tributyltin in marine systems. Rev. Environ. Contam. Toxicol. 166:1-48.

Meador, J.P. and C.A.Rice. 2001. Impaired growth in the polychaete *Armandia brevis* exposed to tributyltin in sediment. Mar. Environ. Res. 51:113-129

Myers, M. S., C. M. Stehr, O. P. Olson, L. L. Johnson, B. B. McCain, S-L. Chan, and U. Varanasi. 1994. Relationships between toxicopathic hepatic lesions and exposure to chemical contaminants in English sole (*Pleuronectes vetulus*), starry flounder (*Platichthys stellatus*), and white croaker (*Genyonemus lineatus*) from selected marine sites on the Pacific Coast, U.S.A. Environ. Health Perspect. 102: 200-215.

Myers, M. S., L. L. Johnson, T. Hom, T. K. Collier, J. E. Stein, and U. Varanasi. 1998. Toxicopathic hepatic lesions in subadult English sole (*Pleuronectes vetulus*), from Puget Sound Washington, U.S.A.: Relationships with other biomarkers of contaminant exposure. Mar. Environ. Res. 45:47-67.

NOAA Damage Assessment Center. 2001. Associating Ecosystem Service Loss with indicators of Toxicity in Habitat Equivalency Analysis. National Oceanic and Atmospheric Administration, Seattle, WA.

Puget Sound Estuary Program (PSEP). 1988. Sediment Quality Values Refinement: Volume 1, 1988 Update and Evaluation of Puget Sound AET. Prepared for the U.S. EPA, Region 10 B Office of Puget Sound, Seattle, WA.

Rowe, C. L., O. M. Kinney, R. D. Nagle, and J. D. Congdon. 1998. Elevated Maintenance costs in the Anuran (*Rana catesbeiana*) Exposed to a Mixture of Trace Elements during the Embryonic and Early Larval Periods. Physiol. Zool. 71(1):27-35.

Strange, E., H. Galbraith, S. Bickel, D. Mills, D. Beltman, and J. Lipton. 2002. Determining ecological equivalence in service-to-service scaling of salt marsh restoration. Environmental Management. Environmental Management 29(2): 290-300.

Washington Department of Ecology. 1996. Progress Re-evaluating Puget Sound Apparent Effects Thresholds (AETs). Volume 1: 1994 Amphipod and Echinoderm Larval AETs. Prepared for the Puget Sound Dredged Disposal Analysis (PSDDA) Agencies.

APPENDIX D: HABITAT VALUATION IN THE LOWER DUWAMISH RIVER AND DETERMINATION OF TIME TO SUSTAINED FUNCTION

(Adapted from Appendix C of March 14, 2002 Hylebos Waterway Natural Resource Damage Settlement Proposal Report)

Habitat Valuation Introduction

For the purposes of the Lower Duwamish River Habitat Equivalency Analysis (HEA), habitats are valued by how well they support juvenile Chinook salmon, four bird assemblages that are representative of avian species occurring in the area, and juvenile English sole. These values are based on a habitat's potential to provide attributes that support feeding and refuge needs of these species and groups. Habitats are ranked according to their functional importance as relative rather than absolute values, similar to the concept in the Habitat Suitability Indices (HSI) used with the U.S. Fish and Wildlife Service Habitat Evaluation Procedures (USFWS, 1980).

Representative Species

Fifty three species of resident and non-resident fish were captured in recent remedial studies on the Lower Duwamish River (Lower Duwamish Waterway Group, 2010), including eight species of anadromous salmonids (Kerwin & Nelson, 2000). Chinook, coho, chum, and steelhead are common. Pink salmon, sockeye, sea-run cutthroat trout and bull trout are rare. Juvenile Chinook salmon and juvenile English sole are used as representative fish species to assess the value of habitat to fish. This is because juvenile Chinook salmon and juvenile English sole have feeding modes, behavioral characteristics, and habitat requirements that sufficiently overlap those of similar species found in the LDR so as to consider them appropriate surrogates for fish in LDR.

Bird assemblages rather than individual species are used to assess habitat value to birds along the LDR. The bird assemblages are grouped as a function of their foraging behavior and include both resident and migratory species found in the river. Because birds use similar habitat types as juvenile Chinook salmon and are linked with them through their food webs, habitat value for birds is linked to habitat value for juvenile Chinook salmon.

Scores are assigned to habitat types based on their value to each of these species. These scores are then used to quantify potential injuries to the habitat and to assess the relative value of restoration projects in the manner described below.

LDR Species Specific Habitat and Habitat Values

The LDR is an estuarine waterway. There is considerable information on the utilization of estuarine environments by anadromous salmonids, flatfishes, and birds. However, much of the

information is qualitative and while it is useful in identifying what constitutes essential habitat, it is of less value in determining how specific habitat attributes relate to habitat value.

Habitat for Chinook salmon

Estuaries are particularly important to juvenile Chinook salmon, which may have the longest estuarine residence time of juvenile salmonids. Estuarine habitats are used as refuge from predators, foraging, and temporary residence during physiological transition for seawater acclimation (Simenstad et al., 1982). There is considerable information regarding the value of estuaries to juvenile salmon but much of it is qualitative, describing generalized relationships and attributes, rather than providing value measurements. The few quantitative data sets that exist are not in formats amenable to developing habitat-species relationships or adequately defining the relative value of different habitat types. The Trustees reviewed available information and assigned relative values of habitat for juvenile Chinook salmon based on the reasons set forth below.

Chinook salmon in the LDR consist primarily of summer/fall run fish. Spring Chinook are found occasionally in the Green River, which feeds upstream into the LDR, but it is not known if these fish constitute a self-sustaining run. Chinook in the LDR are a mixture of natural spawning and hatchery fish. Natural spawners are classified as ocean type fish because they typically spend little time in fresh water after emerging from eggs laid in the gravel. It is believed juvenile Chinook migrate from the LDR to the ocean from January through August; however, the complete migratory time period for juvenile Duwamish/Green River fall Chinook is not currently known (Kerwin & Nelson, 2000). Juveniles have been found in the Lower Duwamish through September, and may remain in the estuary even longer. Naturally spawning summer/fall Chinook juveniles generally remain in upstream areas for two to three months following emergence from eggs. They then begin their migration to the estuarine areas of the LDR (Williams et al., 1975, Kerwin & Nelson, 2000). Typically, the Green/Duwamish river basin summer/fall Chinook migrate within their first year of life.

Because of their extended estuarine residence, and the diversity of size classes, juvenile Chinook consume a diversity of prey and use a variety of estuarine habitats, shifting to reflect changes in food habits as they grow (Simenstad et al., 1982). Estuaries provide a diverse array of prey organisms, often in large populations, which allows juvenile salmon to sustain relatively high growth rates while occupying a refuge from predators. Chinook occupy three main zones of the LDR. Smaller individual Chinook occur primarily in the freshwater transition zone in the upper portion of the LDR where they feed on larval and adult aquatic insects, terrestrial insects, and epibenthic organisms. Larger subyearling fish move to tidal flats, gravel-cobble shorelines, and other shallow water habitats where they feed on epibenthic crustaceans such as *gammarid* amphipods, *mysids*, and *cumaceans*. Yearling Chinook occupy the open water habitat of the lower estuary, and may prefer habitats within confined embayments, where they feed on small nekton, insects, mysids, larval fish, and nuestonic drift organisms. Sampling in the LDR in 2005 documented the presence of the various life and transitional stages within the LDR as well as the importance of each of these three estuarine zones for juvenile Chinook salmon (Ruggerone et al, 2006).

Growth of juvenile Chinook while in the LDR may help increase their survival rates by narrowing the window of vulnerability to predators once they enter the ocean. Residence time in the estuary is related to foraging success and growth in the ocean, increasing marine survival. This suggests that the distribution and abundance of principal habitat types and the availability of prey for Chinook may be a reflection of salmon populations migrating through the system.

Thus, estuarine habitat is a critical factor in the life history of Chinook salmon, but there are no models available that describe the relationship between habitat types and species utilization. For the purpose of this appendix, relative values are assigned to habitat types using available information on the feeding and refuge functions of different habitats for juvenile Chinook salmon, the functional rarity of habitats in the LDR (e.g., tidal marshes, an important habitat for Chinook, are virtually nonexistent), and best professional judgment. References consulted included not only literature on juvenile salmonid habitat utilization and feeding preferences, but also information on the frequency of occurrence of preferred food organisms (Beauchamp et al., 1983; Northcote et al., 1976; Seliskar et al., 1983; Simenstad et al., 1982; Simenstad, 1982; Simenstad et al., 1985; Simenstad et al., 1991; Simenstad et al., 1993). Values were based on uncontaminated habitats.

Three estuarine habitat types, based on tidal elevation, are used in the LDR injury assessment: intertidal, shallow subtidal and deep subtidal. In addition, other habitats are identified for use in valuing potential restoration projects: marsh (intertidal habitat containing aquatic vascular plants), vegetated buffer (an upland zone adjacent to the aquatic habitat consisting of native floodplain vegetation with trees and shrubs), upland greenbelt (a vegetated zone landward of the vegetated buffer and outside of the shoreline zone, with trees and shrubs) and rip-rap (rock armor placed along shorelines to protect against erosion).

Chinook Habitat Values

Habitat values are unit-less numbers, based on relative, rather than absolute values, similar to the concept used in the Habitat Suitability Index (HIS) (USFWS 1980). LDR habitat types are assigned values for juvenile Chinook salmon using data from sediment composition and water depth surveys.

Habitat values were assigned to estuarine habitats, ranging from one (optimal conditions) to zero (unsuitable conditions). Each habitat value is relative to the value given to marsh with an associated vegetated buffer which is considered to be the best habitat available for the representative species in the LDR. The reason marsh with a vegetated buffer is considered the optimal habitat, and thus given the highest value is based on several factors. Marsh vegetation provides an environment that increases epibenthic and benthic production and available food for Chinook salmon. It provides an important refuge from predators-and is a scarce habitat type in the LDR estuary.

Habitat values related to elevation (referenced to mean lower low water (MLLW) are assigned, from highest to lowest, to marsh (+ 6 to + 12 ft), intertidal (-4 to +12 ft), shallow subtidal (-4 to -14 ft), and deep subtidal (<-14 ft) (Table D1). These are based on larger number of species and greater populations of food for Chinook and on primary productivity and habitat

use (Northcote et al., 1976; Simenstad et al, 1993). With depth, available light decreases, which results in fewer salmonid prey species and hence, a lower habitat value).

Benthic community structure is affected by a variety of conditions. Different species colonize different substrate types, and mixed substrates (sand, gravel, and cobble) can provide abundant prey species and suitable refuge habitat for juvenile salmonids. In this analysis, habitat classifications are based only on depth and silt, sand, coarse sand, and fine gravel substrates are combined. Shallow, low gradient, unconsolidated sediments are assumed to provide more prey organisms consumed by juvenile salmonids and are thus assigned higher values than structurally complex sediments such as riprap. Deep subtidal habitats (-14 ft and deeper) provide fewer prey organisms and are not preferred habitats of juvenile salmon, and are assigned a minimal value.

Birds

Birds utilizing estuarine areas may be classified into four assemblages based on their foraging behavior (Simenstad, 1983):

(1) Shallow-probing and surface searching shorebirds (e.g. sandpiper, dunlin, plover) that feed on benthic organisms.

(2) Waders, which prey on similar, though somewhat deeper benthic organisms than those that prey on the surface and shallow water (e.g. Greater yellowlegs), or prey on small fishes and crustaceans (e.g. Great blue heron).

(3) Surface and diving water birds, which include birds that find prey in deeper waters (e.g. Western grebe, Common merganser, mallard).

(4) Aerial searchers, which include omnivores and carnivores that find prey in all habitats (e.g. Osprey, belted kingfisher, Glaucous-winged gull).

Different types of estuarine birds use different foraging behaviors and thus, require diverse habitats for feeding and resting. Since certain bird species from these assemblages share common habitats and prey items with juvenile salmon, the value of habitat for salmon is related to its value for birds.

Shallow-probing and surface searching shorebirds, some waders, and some surface and diving birds feed on benthic macroinvertebrates in intertidal habitats. Shorebirds feed in exposed areas, however, they are restricted to the high intertidal area and the part of the lower intertidal area exposed at low tide. Tidal fluctuations affect habitat utilization by waders that feed on benthic organisms and by surface and diving waterbirds. Some waders, surface and diving waterbirds and aerial searchers feed on juvenile salmon and other fish species with similar habitat requirements. For the purposes of the LDR HEA, we assume that the value of a particular habitat type to estuarine birds is the same as the habitat value assigned to salmon (Table D2).

English sole

The model presented in "Habitat Suitability Index Models: Juvenile English Sole" (Toole et al., 1987) is used to quantify the habitat value for English sole. The model applies to juvenile English sole in estuaries and coastal lagoons year-round. It is based on the assumption that any environmental variable that has an impact on the growth, survival, distribution, or abundance of juvenile English sole can be expected to have an impact on the capacity of the habitat to support the species (Figure D1). Habitat Suitability Indices (HSI) are calculated based on Suitability Indices (SI) from either the Food or Water Quality component of the model. An HSI value of one indicates optimal conditions, and a value of zero indicates unsuitable conditions. The HSI is based on the concept of limiting factors. A limiting factor is a component of an organisms' environment that can affect its growth, reproduction, or distribution. The availability of food, shelter or predation pressure, are examples of factors that could be limiting for an organism. Using this concept, the HIS is set at the value of the lowest limiting factor. Habitat values for English sole in the LDR are expressed in terms of HSI. There are two components in the model: water quality, with habitat variables related to bottom salinity, dissolved oxygen, and bottom water temperature; and food, with habitat variables related to the hydrodynamic regime and dominant sediment type.

Because of the river flow and tidal exchange in the LDR, the Water Quality variables (bottom water temperature, mean salinity, and dissolved oxygen concentration) fall primarily in the high suitability value ranges (1.0). Since HSI defaults to the limiting factor, in this situation the SI calculation defaults to use of the Food Component. The Food Component is related to hydrodynamic regime and dominant sediment type, therefore, the HSI value of the habitat is whichever has the lower SI value, that of the hydrodynamic regime or the substrate. Within the hydrodynamic regime model, there are three SI values: 0.2 for high energy areas of rapid erosion and deposition, 1.0 for areas of intermediate energy with stable substrates, and 0.3 for low energy areas with limited tidal exchange. The LDR fits best into the category of intermediate energy with stable substrates and was assigned a hydrodynamic regime value of 1.0. Therefore, the HSI value for LDR habitats is calculated based on dominant substrate.

Substrate SI values are based on data relating density and stomach fullness of English sole to substrate type. Fine substrate provides the best habitat for feeding sole, but sediment with as much as 20% gravel (>2 mm in diameter) are suitable. Values are low where gravel and rocks are the dominant substrate type; however, even 100% gravel is assumed to provide some food for English sole. Depth and cover do not affect habitat value. Intertidal, subtidal, and deep water habitats are used by sole at different life stages (Lassuy, 1989). Sole that have recently metamorphosed and juveniles in the 50 - 68 mm size range are found in intertidal and shallow subtidal areas where they feed primarily on small epibenthic crustaceans. As they grow, they move into deeper water, where prey items shift to polychaetes, mollusks and other infaunal organisms. The existing literature does not identify cover as an important factor influencing abundance or predation. The variable related to the substrate SI value is dependent upon the percentage of the substrate that is made of particles >2 mm in diameter.

Five substrate composition categories are presented in the HSI model, based on the percentage of substrate >2 mm. SI values for these categories are interpolated from the substrate composition suitability graph (Toole et al., 1987) with values ranging from 1.0 for

substrate with less than 20% particles greater than 2 mm in diameter to 0.15 for substrate with less than 50% particles, smaller than two 2 mm in diameter (Table D3). The predominant substrate in the LDR consists of sand/silt, therefore a value of 1.0 is used to value habitats for English sole living in the LDR.

Combined Habitat Values

Seven habitat types were identified for use in this analysis for injury determination and for restoration planning. For restoration, habitats that provide the most benefit to the injured resource may not necessarily be those habitats that are injured, so habitats are included that may not have been injured in the LDR, but may provide considerable restoration benefit.

All habitats provide some value for all three representative species. In order to reduce some steps in the HEA, a single weighted value combining all three species for each habitat type was used in the calculation, rather than calculating the value for each species individually and adding the individual weighted values. There is no difference mathematically. The combined value does not weight the species equally. Chinook salmon in Puget Sound are a high profile species, listed as threatened under the Endangered Species Act. There is considerable regional interest in their restoration, and so they were given a higher weighting in the calculation of a combined habitat value. Species weighting in the final combined value was: 50% juvenile Chinook salmon, 25% juvenile English sole, and 25% birds. Individual and combined values for the habitat types are shown in Table D4.

Value adjustments associated with environmental conditions

Habitat values identified for the HEA are used both in quantifying loss of functional value associated with injuries and in assessing benefits associated with restoration project development. The LDR is in an urban/industrial/commercial setting, with extensive shoreline development. There are only remnant marshes and few upland areas that could be classified as functioning vegetated buffer habitat (TerraLogic GIS, Inc. & Landau Associates, 2004). We created value adjustment categories of “fully functional” and “baseline adjusted” to apply to marsh, intertidal, and shallow subtidal habitats. The “fully functional” category was based primarily on the premise that the presence of adjacent desirable habitat results in an ecological complex that enhances overall production. Habitats considered “baseline adjusted,” have no adjacent habitat to enhance their value. As an example, the presence of insect and organic matter is increased when it is placed adjacent to a vegetated buffer. Also, created marsh habitats provide benefits that increase the value of adjacent habitats. Thus, the creation of a habitat that increases invertebrate recruitment and subsequent juvenile salmonid use of a intertidal area bordered by a marsh or vegetated buffer zone make it more valuable (fully functional) than one that does not have the benefits from these adjacent habitats (baseline adjusted). In restoration planning, adjustments to habitat values are beneficial in identifying habitat mixes to provide maximum benefits (e.g. an intertidal area created in association with a marsh or vegetated buffer area would have more value than one that is created as an isolated habitat).

All of the intertidal and shallow subtidal habitats in the LDR are considered "baseline adjusted," with little to no adjacent habitat to enhance their value. This provides for the values of 0.75 for intertidal and 0.55 for shallow subtidal. For purposes of restoration planning, an enhancement of 0.15 is added to intertidal and shallow subtidal habitats constructed in association with a vegetated buffer or a fully functioning marsh. Therefore, fully functional values for intertidal and shallow subtidal habitats in LDR are 0.9 and 0.7, respectively (Table D5).

The premise for a fully functional classification in the LDR is that habitat complexes (e.g. a mix of marsh, mudflat and riparian) are necessary for proper ecosystem functioning. Marsh habitat alone and in optimal condition was assigned a value of 1.0. A marsh associated with a vegetated buffer likely has more ecological value than one that does not. Therefore, for a marsh to be considered fully functional, it must have an adjacent vegetated buffer. Marshes without a vegetated buffer are considered baseline adjusted, and do not receive the 0.15 enhancement and are consequently assigned a maximum value of 0.85 rather than 1.0.

In summary, for restoration planning in the LDR, fully functional value is given to the following:

- a marsh must be associated with an adjacent vegetated buffer habitat;
- an intertidal habitat must be associated with an adjacent vegetated buffer or an adjacent fully functioning marsh;
- a shallow subtidal habitat must be associated with an adjacent fully functioning intertidal habitat.

LDR restoration projects involving the creation of each of these habitats will be considered fully functional and valued as such (Table D5). All other types of restoration projects involving less complex habitats will be considered baseline with a lower value relative to the fully functional value.

Development in the LDR has resulted in facilities and activities that physically degrade habitat quality. The presence of large over-water structures such as piers, aprons and buildings creates conditions that limit the use of affected habitats by species considered in this analysis. This situation called for another category to represent these conditions and a "degraded" classification of reduced value (0.1) was created to decrease the value of habitats that are severely impacted by physical obstructions.

Potential impacts associated with severe physical habitat degradation warrant application of a lower habitat value in certain situations. Examples of physical habitat degradation that result in lower values are reduced light and disruption of migration and feeding behavior. There are gradations of impact from overwater structures related to their height over the water, piling type and density, orientation, type of structure, water depth and habitat type beneath them. However, there was no attempt to identify sub-classifications based on these gradations to cover the range of impacts. The degraded classification is applied narrowly and only to situations causing severe physical impacts.

Overwater structures include permanent and semi-permanent structures such as piers, aprons, buildings, boathouses, and houseboats. Because a juvenile salmonids' visual ability to

adapt from bright to subdued-light conditions proceeds slowly (Ali, 1959), they are reluctant to pass beneath structures where there is a high contrast between bright and low light levels. Smaller juvenile salmonids are shoreline and shallow water oriented. Over-water structures that produce sharp light contrasts may interfere with their feeding and migratory movements. The subdued light conditions found along the periphery of piers are often preferred over bright sunlight; however, lower light levels may also interfere with feeding. Moreover, structures covering intertidal and shallow subtidal habitat limit the available light to bottom substrates in the productive near-shore photic zone and have more impact on epibenthic production than those in deeper water. As a result, with all other factors being equal, only habitats under structures that extend directly from and are contiguous with the shoreline are assigned the degraded habitat value of 0.1.

Piers and docks that have the major pier structure away from the shore, and have a narrow overpass perpendicular to the shore (e.g. T-docks) usually have the major over-water portion in deeper water, and have less shoreline and near shore shading. They have less of an impact than structures extending from the shoreline, and are consequently not placed in the degraded category. Habitat beneath them is included in the baseline adjusted value, dependent on habitat type. Marinas with docks and boat houses are generally in deeper water, and the shoreline connections are usually narrow. They have an adverse impact, but not enough to be included in the degraded category. Habitat beneath them is assigned the baseline adjusted value.

The foregoing guidelines are not intended to represent acceptance or rejection of particular types of structures or activities. All of the in-water/over-water structures mentioned above can have an adverse impact on aquatic habitat and there are exceptions to each situation that could mitigate or exacerbate the expected impact. However, the decision to include or not include particular over-water structures is made in a general sense based on an evaluation of biological information on potential effects to representative species selected for the LDR. It is to be used for the sole purpose of classifying habitat values for the LDR HEA in as simple and as equitable of a manner as possible. Value adjustments associated with environmental conditions are shown in Table D5.

TIME TO SUSTAINED VALUE

Introduction

The assumption that environmental injury or habitat loss can be compensated by ecological restoration is based on the premise that restored habitat should provide the same values as the natural ecosystem (Pacific Estuarine Research Laboratory 1990). This restoration has been termed ecological equivalence, referring to the capacity of a restored, created, or enhanced habitat to reproduce the ecological structures and functions equivalent to an injured or lost habitat (Kentula et al. 1992). Determining the value of a restoration project depends not only on the level of function expected from the habitat, but also the time it takes for the habitat to reach and sustain this level of function. A created, restored, or enhanced habitat goes through natural successional patterns, gradually increasing in value from its initial condition over a period of time until it reaches some assumed endpoint, with a sustained functional value. There are two components to this function, the shape of the curve and the time to maturation.

Shape of the Curve

The shape of the curve means how the recovery appears when graphed and allows for a picture of the rate of increase in a habitat's recovery. The shape of the recovery curve will likely vary with habitat types. It may follow an "S" shaped curve, increasing gradually at first, rapidly approaching a stable maximum, then falling off as the final level of function is achieved; or it may follow some other pattern. A study on the use of different curves to describe the increase in wetland functions as created wetlands develop found that, for the purposes of evaluating restoration, the shape of the curve was not important and resulted in minimal percentage differences in the amount of restoration required (King et al., 1993). Growth rate or population dynamics data from existing restoration projects in the Pacific Northwest are not consistent enough to define specific recovery curves, and for the sake of simplicity, it is assumed that an ecological function will increase along a linear path until sustained value is achieved.

The number of years after construction when the restoration project is expected to achieve sustained value varies with habitat type (Strange et al. 1999). In restored salt marshes on the East coast, vegetative cover was similar to that of a natural marsh within 5 years; however, development of other physical and chemical properties necessary to support fish and shellfish production took 25-30 years. Estimates of time to sustained value for use in this assessment are based on observations made at similar restoration projects in Puget Sound, the scientific literature, unpublished research in the "gray" literature, and best professional judgment of the natural resource trustees. In determining time to sustained value for the various habitat types, the focus is on biological processes that generate and maintain food and habitat for the representative biota, such as benthic and epibenthic invertebrates, number of species present, abundance of individuals, and preferred prey species. Habitats considered are those that may be included in restoration projects: intertidal habitat, shallow subtidal habitat, marsh, vegetated buffer, upland greenbelt and degraded habitats.

Assumptions

The scientific literature suggests that replicating the services provided by a natural habitat with a created one is extremely difficult. Even restoration sites that are essentially identical in physical features to natural habitats may not provide the same ecological functions (Kusler and Kentula, 1990). However, for the purpose of this analysis, a 1:1 productivity ratio is assumed for the level of ecological services provided by created habitats relative to natural habitats. This implies that restored habitats will be as productive as natural habitats in terms of all associated services. There is uncertainty associated with the outcome of restoration projects. Certain types of habitats carry more risk of failure than others. Restoration project implementation in the Pacific Northwest commonly incorporates monitoring, success criteria, and mid-course corrective actions to increase the probability of success (Commencement Bay Natural Resource Trustees, 2000; Elliott Bay/Duwamish Restoration Program, 2000). Actions that can assist natural processes to achieve successful restoration projects include: developing and amending soil, transplanting plants, controlling weeds, including invasive and non-native species and other eco-engineering methods. For the purposes of this analysis, risk of failure is not incorporated. Habitats are assumed to achieve the expected function within the time identified.

Intertidal and shallow subtidal habitats

Achieving the expected sequence of invertebrate recruitment and subsequent use by juvenile salmon, juvenile English sole, and birds is related to the initial condition of the habitat. The farther initial conditions are from a mature steady state, the longer a habitat will take to approach a self-sustaining level (Mitsch and Wilson, 1996). Monitoring data from restoration projects in the Puget Sound area indicate that habitat functions associated with intertidal and subtidal sand/silt and gravel/cobble substrates develop rapidly. Many of these projects used excavation, regrading or filling to create intertidal or shallow subtidal habitats. Some sites showed rapid development of a diverse and abundant assemblage of benthic and epibenthic organisms, achieving within 50-100% of their long term trends within 1 - 2 years after construction, e.g. Milwaukee Habitat Area (Parametrix, 1998). The data indicate that newly placed, newly exposed, and sometimes, newly wetted materials require time to develop the natural processes necessary to support benthic and epibenthic production.

The rate of development of a stable community is related to substrate, slope, elevation, exposure, and salinity. Although the numbers of epibenthic invertebrates were often highly variable from year to year, by years three to four, benthic and epibenthic production at many restoration sites in the Puget Sound area approached long- term production levels and population structure and taxa richness comparable to reference areas. For a newly created LDR habitat, four years is assumed to be an appropriate time to reach sustained value for baseline adjusted intertidal and shallow subtidal habitats (0.75 and 0.55, respectively). Time to sustained value for fully functional intertidal and shallow subtidal habitats (0.9 and 0.7, respectively) is related to the time to sustained value of the adjacent habitat. This is generally eight years for vegetated buffer habitat.[1]

Marsh habitats

Marsh habitat is assumed to include both dendritic and fringing marshes. Success in creating estuarine habitats that support aquatic vascular plants has been mixed in the Puget Sound area. In other regions where salt marshes have been created, it is still unclear how well they actually replicate the ecological functions of natural marshes. The report Strange et al. (1999) investigated maturity rates and recovery of particular ecological structures and processes in salt marsh restoration and found that conclusions regarding success were dependent upon the metric used to measure it. If vegetative structure alone is assessed, a restoration project may be considered to have achieved equivalence to a natural marsh within five years. When the metric is community and ecosystem function, recovery was slower and was generally in excess of 15 years. Development of the physical and chemical properties of soils needed to support infaunal development and the production of higher order consumers, can take decades to become fully equivalent to a natural salt marsh. There is some thought in the ecological community that creation of a marsh that duplicates a natural marsh is not possible (Kusler and Kentula, 1990). This is because of the complexity and variation in natural marshes, and the subtle relationships

[1] See Part 1, Value adjustments associated with environmental conditions, for a description of “baseline adjusted” and “fully functional” habitats.

among hydrology, soils, vegetation, nutrients, and animal life. In this assessment, the marsh habitat is not assumed to duplicate a natural estuarine marsh. However, it is considered a habitat that has the structural characteristics to generate and maintain food and habitat for the representative biota within 15 years. Therefore, after this time, it is assumed to be a fully functional marsh with a value of 1.0 or a baseline adjusted marsh with a value of 0.85.

In the LDR, marsh habitat may be created in sand/silt substrates in the + 6 to + 12 ft elevation range. Depending on location, substrate, and salinity, low marsh (+ 6 to + 10 ft) and/or high marsh (+ 10 to + 12 ft) could be expected. This elevation range is included in intertidal habitat (- 4 to + 12 ft). The curve for fully functional marsh habitat is shaped as a stepped function. A newly created habitat intended to reach a marsh endpoint goes through natural successional stages, first becoming an intertidal mudflat, then gradually transforming into a marsh over a period of years as vegetation develops. The value increases in a straight line from its initial state to the value for a fully functional intertidal habitat (having a value of 0.9) in years zero through eight, then increases more gradually to the marsh value of 1.0 between years eight and 15. A baseline adjusted marsh is valued the same as baseline adjusted intertidal habitat with a value of 0.75 through year four, when it then increases gradually to its sustained marsh value of 0.85 between years five and 15.

Vegetated buffer and upland greenbelt

There is considerable information on the value and size requirements of vegetated buffers but much less on rates of development. Planting riparian buffer is part of several restoration projects in the Puget Sound area, e.g. Middle Waterway Shore Restoration Project in Commencement Bay Sitcum Waterway Remediation Project), but there is, as yet, insufficient data upon which to draw conclusions about how long it takes them to become fully functional. Related information is available to infer how fast a vegetated buffer will develop, and whether development follows a straight line or stepped trajectory. Monitoring guidelines for restoration projects include success criteria. Success criteria are defined generally as those measures used to evaluate whether the requirements for functional replacement have been met - if the criteria are met, the project is successful, and functional replacement is achieved.

The supposition used in this assessment is that if these monitoring guidelines are providing a measure of functional replacement, they should provide some determinant of the time frame within which success, in terms of functional habitat replacement, may be expected. This is based on guidance on the selection of functional performance objectives indicating that they should be: 1) known or likely benchmarks of success and 2) achievable on the site within the designated monitoring period (Ossinger, 1999)

In the U.S. Army Corps of Engineers' "Examples of Performance Standards for Wetland Creation and Restoration in Section 404 Permits and an Approach to Developing Performance Standards" (USACOE 1999) most monitoring programs for vegetated buffers (riparian, shrub-scrub, and woody vegetation) extend for five years. Specific project information is not provided for the examples in the document, but expectations as a measure of success for shrub-scrub and forested buffers from temperate zone areas are:

- California - 75% cover by native riparian species by year five
- Maryland - 85% of site vegetated by planted species and/or naturally regenerated vegetation by year five
- Maryland - 85% herbaceous cover, 75% areal cover by planted woody species by year two
- Alaska - vegetative cover equal to 75% of test plot cover in five years
- Washington - 60% cover by native shrub species by year five

An example of Seattle District ACOE 1994 monitoring guidelines for freshwater wetlands required 80% cover of native shrub/scrub species after five years and 40% canopy cover of native species forest vegetation after 20 years (USACOE, 1999). Ossinger et al. (1999), reported on findings of the "Success Standards Work Group," a group of wetland professionals from state, federal and private sectors convened to provide practical guidelines for mitigation planning. This report suggests benchmark values for herbaceous vegetation as 80% cover by year three, and 90% cover by year five. For woody cover (wetland buffer/forested zone) they suggest 50% cover by year five.

Developing guidelines for King County, Mockler (1998) suggested that buffers, defined as dense vegetation that will protect wetland from human encroachment and provide wildlife habitat, should have 60% emergent cover by year one, 80% by year three, and 90% by year five. Shrub or sapling tree cover should be >60% by year three.

A success criterion for establishing riparian vegetation in a recent monitoring program proposal specific to the area (Elliott Bay/Duwamish Restoration Program, 2000; Commencement Bay Natural Resource Trustees, 2000) specifies native trees and shrubs at the end of year five, the shrub layer is expected to be >50% and the tree layer >40 percent. Both native trees and shrubs should cover at least 90% of the upland vegetated area at the end of 10 years. Monitoring data from the Puget Sound area are sparse, but there are some that contribute to an understanding of the rate of development of buffer areas and functions provided. The Gog-Li-Hi-Te wetland system, created in 1986, included a mix of upland and wetland habitats. The 5-year monitoring report (Thom et al., 1991) shows that upland trees increased from 725 m^2 to approximately 1500 m^2. The data also show that the transitional zone between the intertidal and upland habitats was rapidly colonized by willow and alder, which increased from 0.4% of the area (160 m^2) in 1986 to approximately 4.3% (1,650 m^2) in 1990. The riparian vegetation increases are from natural recovery, as planting of these species was not included in the project design.

Duwamish River Coastal America sites included planted upland riparian vegetation, and monitored three years post-construction. Though there was no data provided on the post-construction monitoring (Cordell et al. 1999), insect production and juvenile salmon diets were reported. At the T-105 and Turning Basin sites, there was a shift in species composition of insect populations captured in fallout traps from 1996 to 1997. Insects with aquatic immature stages (shore flies, midges, biting midges) shifted to terrestrial insects and the authors conclude that this was probably due to the large increase in riparian and emergent vegetation at these sites between 1996 and 1997. This change also occurred in the juvenile Chinook salmon diets. The makeup of insects consumed was different between 1996 and 1997. The findings suggested that

within three years after construction, the riparian area developed to the point that insects dependent on riparian plants were beginning to be produced and were utilized as a food source by juvenile salmonids. In 1999, there was a shift back to the insects dominant in 1996, leading the authors to speculate that the vegetation assemblages that support the insects might not yet be stable (Cordell et al, 2001). However, the study reported that although survival and expansion of riparian areas were not monitored, they appeared to have become established successfully.

Monitoring results for riparian vegetation coverage from LDR restoration projects constructed via the Elliott Bay Panel do not provide a good measure of natural succession over time due to complications associated with routine maintenance to remove debris, invasive and non-native species and replanting. The year five goals of >50% tree cover and >40% shrub cover were met at Herring's House, Hamm Creek, and North Winds Weir (USFWS, 2008).

The current definition for a vegetated buffer is native floodplain vegetation, with tree, shrub, and herbaceous layers. Buffers provide a range of functions, from minimizing human disturbance to filtering sediments from surrounding areas and moderating temperatures. In this assessment, buffers are important not only for the typical benefits they provide, but also for the value they add to adjacent habitats. In that regard, the most important benefits are providing organic matter in the form of leaves and litter, providing insects from riparian vegetation, and providing wildlife habitat. Mitigation monitoring guidelines suggest that significant growth and plant cover in vegetated buffer areas can be achieved in five years. Data from the Gog-Li-Hi-Te wetland site in Commencement Bay, WA, show significant increases in riparian vegetative growth within five years. Data from the Coastal America Sites on the Duwamish River show development of riparian vegetation and associated insect production within five years. Mitigation monitoring guidelines specific to Washington State indicate that 90% herbaceous cover may be expected by year five. Woody vegetation/shrub cover ranges from 50% to 80% by year five, to 90% by year ten. By assuming that full plant cover equals sustained ecological value, and by averaging projections of time to full plant cover for woody shrubs, then the time to sustained value for vegetated buffer habitats is about eight years. This eight year time frame is based on monitoring guidelines, which determine the time required for "success" in terms of functional replacement; and inferences from two studies (Gog-Li-Hi-Te wetland and Duwamish Coastal America sites). Upland greenbelts may consist of different species mixes but should be predominately native trees, shrubs, grasses and forbs (flowering plants that are not grasses). The time to sustained value for upland greenbelts is also assumed to be eight years.

Degraded habitat classification

As noted above, intertidal and shallow subtidal areas adversely affected by overwater structures are classified as degraded, so removal of structures and conditions adversely affecting these habitats could restore their habitat value, making them candidates for restoration projects.

Time to sustained value for intertidal and shallow subtidal habitats is four years, based on data from restoration projects in Puget Sound. The projects reviewed were habitat creation projects involving excavating, re-grading, or filling to create intertidal or shallow subtidal habitats. The expected sequence of invertebrate recruitment followed by juvenile salmonid use

is related to initial conditions at the site. The degraded classification applies only to intertidal or shallow subtidal habitats. Prior to the introduction of the physical impairment, these areas likely provided the functions associated with their habitat type. Overwater structures limit production by shading the habitat; removal of this impact should allow the habitat to return to near natural production quickly. A literature review found no data addressing the effects of removing overwater structures. However, based on inferences drawn from studies on the impacts of shading, a time to sustained value following removal of overwater structures was assigned.

The low light environments under overwater structures affect juvenile salmonids by disrupting their behavioral and feeding patterns. Their reluctance to pass beneath piers and aprons and alteration of migratory behavior when encountering piers has been observed (Weitkamp, 1982, Pentec, 1997). The ability of juvenile salmonids to see and capture their prey is also reduced in low light situations. Removal of the overwater structure will eliminate this impact.

Evaluation of epibenthic zooplankton production at pier apron sites in Commencement Bay (Parametrix, 1991) showed that in areas having similar substrates, salmonid prey epibenthos at shaded apron stations was about 83% of the abundance at non-apron stations. One distinct difference was in the occurrence of the harpacticoid copepods *Harpacticus* and *Tisbe*, which are very important prey items for small juvenile salmon entering the estuary. *Tisbe* are found where there is abundant detrital vegetation, and there were no significant differences in abundance of *Tisbe* between apron and non-apron stations. However, in this study, *Harpacticus* is primarily epiphytic on growing algae and eelgrass, and was rarely found under aprons. Investigations on the effect of shading on eelgrass may also be helpful in determining the recovery time associated with removal of overwater structures. Pentilla and Doty (1990) reported that fixed dock structures reduced eelgrass density to zero, even when light attenuation did not approach full darkness. A floating dock site, which moved with the tide and did not cast a continuous shadow over the bottom, did not have negative impacts on eelgrass density. Studies associated with impacts from the Anacortes Ferry terminal showed eelgrass presence related primarily to the height of the docks, which affected the level of shading (Parametrix and Battelle, 1996). Fresh et al. (1995) evaluated dock structures and found measurable declines in eelgrass density under and adjacent to docks in Puget Sound, except for ones that moved up and down and side to side with tidal fluctuations, eliminating constant shading. The investigations all considered sites with similar substrates in areas with homogenous eelgrass coverage, eliminating variables other than shading. While we do not expect there to be eelgrass in the LDR, it is logical to assume that shading would similarly reduce primary production of benthic diatoms and other algae.

Shading appears to be the primary factor impacting primary and secondary production under overwater structures; therefore, the effect of shading on juvenile salmonid behavior will be eliminated immediately upon removal of the structure. The limited data that exist indicate that epibenthic production occurs under piers but at a level lower than unshaded sites. A 1991 study (Parametrix, 1991) linked the absence of particular epibenthic zooplankers under pier aprons to the absence of eelgrass and algae under the aprons, a condition related to the lack of light. Studies on the effects of shading on eelgrass indicate that within a particular substrate type, eelgrass distribution is limited only by the level of shading Pentilla and Doty (1990), Parametrix and Battelle, (1996), Fresh et al. (1995). With the foregoing information, it is

reasonable to expect that once light becomes available to natural intertidal and shallow subtidal habitats currently shaded by overwater structures, algal and vegetative production necessary to support the functions normally provided by these habitats can be achieved quickly, possibly in as little as one year. Time to sustained value for various habitat types is provided in Table D6.

REFERENCES CITED

Beauchamp, D.A., Shepard, M.F., and B.B. Pauley. 1983. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Coast): Chinook Salmon. Prepared for Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Mississippi. FWS/OBS-82/11.6. 15 pp.

Commencement Bay Natural Resource Trustees. 2000. Commencement Bay Natural Resource Damage Assessment Restoration Monitoring Plan. Prepared by the National Oceanic and Atmospheric Administration, the U.S. Dept. of the Interior, and the State of Washington.

Cordell, J.R., Tear, L.M., Jensen, K. and H.A. Higgins. 1999. Duwamish River Coastal America Restoration and Reference Sites: Results from 1997 Monitoring Studies. FRI-UW-9903. Fisheries Research Institute, University of Washington, Seattle, WA.

Cordell, J.R., Tear, L.M., Jensen, K. 2001. Biological Monitoring at Duwamish River Coastal America Restoration and Reference Sites: A Seven-Year Retrospective. SAFS-UW-0108. Wetland Ecosystem Team. University of Washington, Seattle, WA.

Elliott Bay/Duwamish Restoration Program. March 2000. Intertidal Habitat Projects Monitoring Program, Panel Publication 23. Prepared for the Elliott Bay Restoration Panel by C.D. Tanner, U.S. Fish and Wildlife Service.

Fresh, K.L., B. Williams, and D. Pentilla. 1995. Overwater Structures and Impacts on Eelgrass in Puget Sound, Washington. Puget Sound Research, 1995 Proceedings. (abstract).

Kentula, M.E., Brooks, R.P., Gwin, S.E., Holland, C.C., Sherman, A.D., and J.C. Sifneos. 1992. An Approach to Improving Decision Making in Wetland Restoration and Creation. Edited by A.J. Hairston. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Kerwin, John and Nelson, Tom S. (Eds.). 2000. "Habitat Limiting Factors and Reconnaissance Assessment Report, Green/Duwamish and Central Puget Sound Watersheds (WRIA 9 and Vashon Island)." Washington Conservation Commission and the King County Department of Natural Resources.

King, D.M., Bohlen, C.C., and K. Adler. 1993. Appendix C. Watershed Management and Wetland Mitigation: A Framework for Determining Compensation Ratios. *In* King, D. and C. Bohlen. 1995. The Cost of Wetland Creation and Restoration. Final Report prepared under contract No. DE-AC22-02MT92006, U.S. Dept. of Energy, Bartlesville, Oklahoma. 107 pp.

Kusler, J.A. and M.E. Kentula (eds) 1990. Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, D.C. Lower Duwamish Waterway Group. 2007. Lower Duwamish Waterway Remedial Investigation. Phase 2 Remedial Investigation Report. Appendix A: Baseline Ecological Risk Assessment.

Lassuy, D.R. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest): English Sole. Prepared for Waterways Experiment Station, U.S. Army Corps of Engineers. Vicksburg, Mississippi. Biological Report 82(11.101). 17 pp.

Lower Duwamish Waterway Group. 2010. Draft Final Feasibility Study – Lower Duwamish Waterway, Seattle Washington. 43 p.

Mitsch, W.J., and Wilson, R.F. 1996. Improving the success of wetland restoration with know-how, time, and self-design, Ecol. Appl. 6, 77-83. *In:* Simenstad, C.A. and J.R. Cordell.2000. Ecological assessment criteria for restoring anadromous salmonid habitat in Pacific Northwest estuaries. Ecological Engineering 15 (2000)283-302.

Mockler, A. 1998. Sensitive Area Mitigation Guidelines. King County Dept. of Development and Environmental Services. Renton, WA. 14 pp.

Northcote, T.G., N.T. Johnston, and K. Tsumura. 1976. Benthic, epibenthic and drift fauna of the lower Fraser River. Tech. Rep. 11, Westwat. Res. Cent., Univ. Brit. Col., Vancouver, Canada, 227 pp. *In* Simenstad, C.A. 1983. The Ecology of Estuarine Channels of the Pacific Northwest Coast: A Community Profile. U.S. Dept. of the Interior, Fish and Wildlife Service Report FWS/OBS-83/05. 181 pp.

Ossinger, M. (principal author) 1999. Success standards for Wetland Mitigation Projects - a Guideline. Washington State Dept. of Transportation. 31 pp.

Pacific Estuarine Research Laboratory. 1990. A manual for assessing restored and natural coastal wetlands with examples from southern California. California Sea Grant Report No. T-CSGCP-021. La Jolla, California. 105 pp.

Parametrix, Inc. 1991. Epibenthic Zooplankton Production and Fish Distribution at Selected Pier Apron and Adjacent Non-Apron Sites in Commencement Bay, Washington. Report Prepared for Port of Tacoma, Tacoma, Washington.

Parametrix, Inc. 1998. Sitcum Waterway Remediation Project: Milwaukee Habitat Area Monitoring Report, 1996. October 1998.

Parametrix, Inc. and Battelle Marine Sciences Laboratory. 1996. Anacortes Ferry Terminal eelgrass, macroalgae, and macrofauna survey report. Report for Sverdrup Civil, Inc. and WSDOT. 12 pp.

Pentec Environmental, Inc. 1997. Movement of Juvenile Salmon through Industrialized Everett Harbor. Report to Port of Everett. (abstract)

Pentilla, D. and D. Doty. 1990. Progress Report. Results of 1989 Eelgrass Shading Studies in Puget Sound. Washington Dept. of Fisheries, Marine Fish Habitat Investigations Division.

Ruggerone, G.T., Nelson, T.S., Hall, J., & E. Jeanes. 2006. Habitat Utilization, Migration Timing, Growth, and Diet of Juvenile Chinook Salmon in the Duwamish River and Estuary. Prepared for: WRIA 9 Technical Committee, WRIA 9 Steering Committee.

Seliskar, D.M., and Gallagher, J.L. 1983. The Ecology of Tidal Marshes of the Pacific Northwest: A Community Profile. U.S. Dept. of the Interior, Fish and Wildlife Service Report FWS/OBS-82/32. 65 pp.

Simenstad, C.A. 1983. The Ecology of Estuarine Channels of the Pacific Northwest Coast: A Community Profile. U.S. Dept. of the Interior, Fish and Wildlife Service Report FWS/OBS-83/05. 181 pp.

Simenstad., C.A., Fresh, K.L., and E.O. Salo. 1982. The Role of Puget Sound and Washington Coastal Estuaries in the Life history of Pacific Salmon: An Unappreciated Function. p. 343-364, *In* V.S. Kennedy (ed.), Estuarine Comparisons. Academic Press, New York.

Simenstad, C.A., Cordell, J.R., Milward, D.M., and E.O. Salo. 1985. Diet composition of juvenile salmon (*Oncorhynchus spp.)* in an urbanized estuary: results of three years studies in Commencement Bay, Puget Sound, Washington. Final report to the Port of Tacoma, Tacoma, Washington. 71 pp.

Simenstad, C.A., Tanner, C.D., Thom, R.M., and L.L. Conquest. 1991. Estuarine Habitat Assessment Protocol. Report prepared for U.S. Environmental Protection Agency, Region 10, Seattle, WA. EPA 910/9-91-037. 201 pp.

Simenstad., C.A. H.B. Anderson, J.R. Cordell, and L. Hallum. 1993. Analysis of Changes in Benthic and Epibenthic Communities in Commencement Bay, Washington. Final Report to U.S. Army Corps of Engineers - Seattle District, Contract No. DACW67-90-D-0008. January 26, 1993. 88 pp + attachments.

Strange, E., Galbraith, H., Bickel, S., Mills, D., Beltman, D., and J. Lipton. 1999. Determining Ecological Equivalence in Service-To-Service Scaling of Salt Marsh Restoration. Stratus Consulting, Inc., Boulder, Colorado. 44 pp (unpublished)

TerraLogic GIS, Inc. & Landau Associates. 2004. Final Lower Duwamish Inventory Report. Prepared for WRIA 9 Steering Committee and Seattle Public Utilities.

Thom, R.M., Simenstad, C.A., Cordell, J.R., and L. Hamilton. 1991. The Gog-Li-Hi-Te Wetland System in the Puyallup River Estuary, Washington: Phase V Report: Five Year Monitoring, January-December 1990. Final Report to Port of Tacoma. Fisheries Research Institute, University of Washington, Seattle.

Toole, C.L., Barnhart, R.A., and C.P. Onuf. 1987. Habitat Suitability Index Models: Juvenile English Sole. U.S. Dept. of the Interior, Fish and Wildlife Service Biological Report 82(10.133) February 1987.

U.S. Fish and Wildlife Service. 1980. Habitat Evaluation Procedures. ESM 102. Fish Wildl. Serv., Div. Ecol., Washington, D.C.

U.S. Fish and wildlife Service. 2008. Elliott Bay/Duwamish Restoration Program: Intertidal Habitat Projects Monitoring Report. Prepared for the Elliott Bay/Duwamish Restoration Program Panel.

U.S. Army Corps of Engineers (1999) "Examples of Performance Standards for Wetland Creation and Restoration in Section 404 Permits and an Approach to Developing Performance Standards" WRP Technical Note WG-RS-3.3, January 1999. 14 pp.

Weitkamp, D.E. 1982. Juvenile chum and Chinook salmon behavior at Terminal 91, Seattle, Washington. Report by Parametrix Inc. to Port of Seattle, Washington. 21 pp.

Williams, R.Q., R.M. Laramie, and J.J. Ames. 1975. A Catalog of Washington Streams and Salmon Utilization - Volume 1, Puget Sound. WA Dept. of Fisheries.

Table D 1. Habitat classifications used in the HEA.

Habitat Type	**Elevation ft. (MLLW)**
Marsh (aquatic vascular vegetation)	+6 to +12
Intertidal	-4 to +12
Shallow Subtidal	-14 to -4
Deep Subtidal	< -14

Table D 2. Relative habitat values for juvenile Chinook salmon (and bird assemblages).

Habitat Type	**Relative Habitat Value for Juvenile Chinook Salmon (and Bird Assemblages)**
Estuarine habitats	
Marsh	1.0
Intertidal	0.67
Shallow Subtidal	0.40
Deep Subtidal	0.05
Rip-rap	0.10
Buffer Habitats	
Vegetated Buffer	0.50
Upland Greenbelt	0.20

Table D 3. Relative habitat values for English sole based on substrate composition.

Substrate composition: percentage by weight of substrate particle size greater than 2mm in diameter	**Relative habitat value**
<20	1.0
21 - 30	0.86
31 - 40	0.60
41 - 50	0.33
> 50	0.15

Table D 4. Relative habitat values for juvenile Chinook salmon, birds, and juvenile English sole; and species' combined habitat values.

Habitat Type	**Relative Value for Salmon**	**Relative Value for Birds**	**Relative Value for English sole**	**Relative Combined Value for all Species**
Intertidal	0.67	0.67	1.00	0.75
Shallow Subtidal	0.40	0.40	1.00	0.55
Deep Subtidal	0.05	0.05	1.00	0.29
Marsh	1.00	1.00	1.00	1.00
Rip-rap	0.10	0.10	0.15	0.11
Vegetated buffer	0.50	0.50	0.00	0.38
Upland Greenbelt	0.20	0.20	0.00	0.15

Table D 5. LDR habitat classifications and values applied in the HEA.

Habitat	**Value**		
	Fully Functioning	**Baseline Adjusted**	**Degraded**
Estuarine Marsh	1.0	0.85	NA
Intertidal	0.9	0.75	0.1
Shallow Subtidal	0.7	0.55	0.1
Deep Subtidal	0.3	0.3	0.1
Rip-rap	NA	NA	0.1

Table D 6. Restoration project habitat values and time to sustained value for fully functional (FF) and baseline adjusted (BA) habitats.

Habitat	**final value and percent of final value (%) at end of year**			
	1	4	8	15
Habitats formed through excavation, regrading, or material placement.				
Marsh	not applicable	0.825 (82.5%) FF 0.75 (88.2%) BA	0.936 (93.6%) FF 0.786 (92.4%)BA	1.0 (100%) FF 0.85 (100%) BA
Intertidal	not applicable	0.825 (91.6%) FF 0.75 (100%) BA	0.9 (100%) FF no change	no change
Shallow Subtidal	not applicable	0.63 (90.0%) FF 0.55 (100%) BA	0.7 (100%) FF no change	no change
Existing FF or BA habitats restored by over water structure removal				
Intertidal	0.9 (100%) FF 0.75 (100%) BA	no change	no change	no change
Shallow Subtidal	0.7 (100%) FF 0.55 (100%) BA	no change	no change	no change
Existing Fully Functional (FF) or Baseline Adjusted (BA) habitats restored by removal or log rafts or wood waste				
Intertidal	not applicable	0.825 (91.6%) FF 0.75 (100%) BA	0.9 (100%) FF no change	no change
Shallow Subtidal	not applicable	0.63 (90.0%) FF 0.55 (100%) BA	0.7 (100%) FF no change	no change

Habitat	**final value and percent of final value (%) at end of year**			
	1	4	8	15
Other				
Vegetated Buffer	not applicable	0.2 (50%)	0.4 (100%)	no change
Upland Greenbelt	not applicable	0.075 (50%)	0.15 (100%)	no change

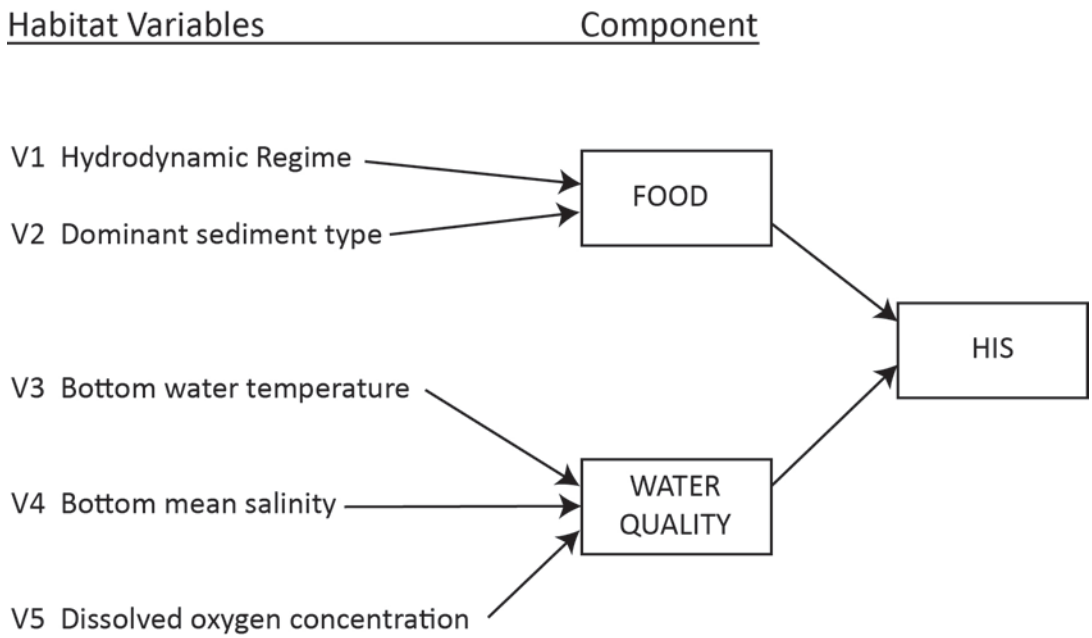


Figure D 1. The relationship of habitat variables, life requisite components, and the habitat suitability index (HIS) for juvenile English sole in estuaries and coastal lagoons. (Toole, C.L., Barnhart, R.A., and C.P. Onuf. 1987. Habitat Suitability Index Models: Juvenile English Sole. U.S. Dept. of the Interior, Fish and Wildlife Service Biological Report 82(10.133) February 1987.)

APPENDIX E: RECOMMENDATIONS FOR SELECTING & VALUING RESTORATION PROJECTS ON THE LOWER DUWAMISH RIVER: A COMPILATION OF RESULTS FROM THE FEBRUARY 19-20, 2004 EXPERT PANEL MEETING CONVENED BY THE Elliott Bay Trustee Council

(Adapted from a document prepared by the Elliott Bay Trustee Council March, 26, 2010)

Introduction

The Lower Duwamish River is an industrialized watercourse that has been polluted by a wide variety of contaminants over many years. The Elliott Bay Trustee Council[1] (Trustees) has begun to evaluate the extent of injuries resulting from past and ongoing contaminant releases to the waterway's natural resources. In order to offset injuries in the Lower Duwamish River (LDR), restoration actions must be designed and constructed to provide compensatory benefits to those injured natural resources. The Trustees developed methods to value certain attributes of habitat actions, such as the type of habitat to be created and its square footage. The Trustees sought outside, expert guidance to develop relative valuation factors for other attributes of restoration, including relative size, shape, and location within the river. On 19-20 February 2004 the Trustees convened a panel of experts to help determine how ecological attributes associated with various types of restoration may be valued.[2] Panel participants included Mr. Kurt Fresh of the National Marine Fisheries Service, Mr. Charles Simenstad of the University of Washington, and Dr. Ronald Thom of Battelle Pacific Northwest Marine Sciences, with Dr. Pete Peterson of the University of North Carolina serving as chair.

Trustees charged the panel with identifying and making recommendations on how to value key ecological attributes associated with potential restoration projects along the LDR. In particular, the panel was asked to focus on ecological attributes that: (a) were not captured by the Trustees' current methodology and that (b) might increase the ecological value of a project—i.e., characteristics that might result in a particular project deserving more credit than would normally have been given using current methodology. Guidelines based on these characteristics could be used to compare and evaluate potential LDR restoration projects.

The panel emphasized that its opinions and proposed quantification of the identified attributes were site-specific to the LDR. For example, the panelists based part of their approach on the potential value of restoration projects to the species groups evaluated in the LDR injury evaluation: juvenile Chinook salmon, English sole, and bird assemblages. A similar exercise for other sites might focus on the potential benefit to different species and result in different values.

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[1] National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service representing the Department of the Interior, Muckleshoot Indian Tribe, Suquamish Tribe, and State of Washington.

[2] This meeting was preceded by a pre-meeting and several less formal discussions, which laid the groundwork for the February meeting.

The overall guiding principle for the exercise was to provide more credit for larger, more integrated projects that sustainably restore or enhance ecosystem processes. This approach reflects two values. First, larger, more integrated projects are likely to support a more diverse ecosystem, one that is more similar to the historic ecosystem. Second, larger and more integrated projects are more likely to be sustainable and are more likely to endure for longer periods of time without active maintenance. The panel members identified a number of project attributes and restoration project credit guidelines, to encourage projects that are consistent with this approach. The remainder of this memorandum describes the general project attributes identified by the panel and the specific guidelines it developed for the LDR.

Key project attributes identified by the panel include the following:

- *Size.* The panel considered the question of whether one large project or several smaller projects totaling the same area would be preferable.[3] The panel generally felt that a single larger project would be superior, both because (up to a point) larger projects allow more diversity to develop and allow easier access by animals. Furthermore, a single, larger project would probably be more resistant to stressors and be more resilient following disturbances. The panel also pointed out that data is sparse in terms of the quantitative relationships between size and various functional attributes.
- *Shape.* A project of a given size could have its longest dimension oriented parallel to the waterway, perpendicular to the waterway, or anywhere in between. In general, the panel felt that both the parallel and perpendicular dimensions[4] are important to sustainability.
- *Habitat type.* The panel recognized the desirability of restoring the specific types of habitats that contribute to marine and aquatic resource services lost as a consequence of contamination in the waterway. Thus, for example, marsh and mudflat areas were generally provided with more credit per acre of project size than were upland vegetated areas. In addition, the panel recognized that different habitats provide services to different groups of organisms. If specific organisms or groups of organisms are identified as key, the habitat types of special importance to those groups might be granted more restoration credits than other habitat types. Similarly, if some habitat types are locally limiting (i.e., acting as a bottleneck) to the population of a key species group, these habitats could also be especially valuable.
- *Diversity provided by project*. The panel considered projects that sustainably[5] provide increased diversity to be preferable –in terms of number of ecological niches and numbers of supported species. Thus, the panel developed some guidelines to encourage the creation of projects that specifically create multiple kinds of habitat, as these are more likely to support a wider array of species.

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[3] This question is analogous to the SLOSS (Single Large or Several Small) debate amongst conservation biologists.

[4] In this document, the length of a habitat refers the dimension that is parallel to the adjacent watercourse, while the width of a habitat refers to the dimension that is perpendicular to the watercourse.

[5] Although diversity is desirable, the panel pointed out the risk of trying fit too many habitat types, or too much diversity, into a project of a given size, as this may reduce sustainability of the project as a whole.

- *Siting - historic locations and the probability of success.* Restoration siting is commonly directed by history—i.e., a project tries to return an area to its baseline condition, based on the assumption that if the habitat was present at a particular location historically, it could presumably be sustained there again. However, historic locations are not as relevant for the LDR because of the extensive physical changes to the watershed and waterway since historic times (the hydrology, channel form, and wetland habitats of the LDR have been drastically altered due to industrial development and urbanization). The panel reviewed current ecosystem processes in the LDR to develop specific guidelines for appropriately choosing sites for projects to maximize their chances for success.
- *Siting - organism access and use*. Depending on the key species of interest, the specific location chosen for a project may affect the ability of key species groups to use it. Location, in this context, has three spatial dimensions: linear position along the waterway's length, distance from the waterway's edge, and elevation (e.g., height relative to mean lower low water). All three spatial dimensions are relevant. For instance, different locations along the waterway's length are subject to different salinity regimes, which may be more or less appropriate for different species groups. Variations in distance from the shoreline will also affect accessibility of the habitat to organisms, as will elevation. One specific example is provided by juvenile Chinook salmon. During its seaward migration, this species may spend a considerable period of time in the estuary and requires reasonably-spaced, sheltered areas for foraging, refuge from predation, and physiological transition for seawater acclimation. Not only should these areas be spaced appropriately along the river to account for this species' needs, they also need to be situated in shallow, protected areas, preferably in side channels. The panel considered the lifecycle requirements of key species groups and developed guidelines to provide extra credit for projects that reflect these benefits.
- *Siting - societal/cultural factors*. The panel recognized that a variety of societal and cultural factors might cause certain projects to be more or less desirable, depending on their location. Some projects, especially those near residential areas, might provide increased recreational opportunities or may enhance the well-being of local residents. On the other hand, access of these areas to people might increase the level of disturbance and discourage use by wildlife, or might ultimately degrade the restored habitat by overuse. Native American cultural considerations are also key: respecting any culturally important tribal sites is a fundamental requirement of any restoration project.
- *Siting - potential for contamination*. The panel was concerned about the potential for residual on-site or off-site contamination to prevent the successful re-establishment of a functioning ecosystem at project locations.
- *Siting - adjacency*. Projects that create a given habitat type will generally provide more ecological services if they are located immediately adjacent to existing habitat of the same or a different type. For instance, a marsh project that is located next to existing marsh is likely to be more sustainable, as the adjacent aquatic vegetation would serve as a seed source for the new marsh area. In addition, the new marsh would likely resist stressors better than it would if unconnected. Similarly, a marsh project fronted by a mudflat would be better protected from boat wakes, while one backed by a vegetated buffer could better support birds, which could use the upland buffer for roosting and/or nesting while feeding in the nearby marsh. In general, connectivity among habitats enhances the flow of materials and energy throughout the ecosystem, and provides corridors for animals to travel from location to location.

- *Landscape connectivity*. The remaining green space near the LDR lies within an urbanized/industrialized corridor and is fragmented. Furthermore, a significant amount of formerly-present freshwater inflow to the waterway has been diverted, reducing the availability of brackish areas, which are valued by juvenile Chinook salmon. Reconnecting existing green space drainage to the waterway, and increasing the total area of green space that could provide clean freshwater drainage (not storm water) to the waterway are important restoration goals. Restoring these connections would also enhance the transportation of organic materials and insects to the main channel.

After identifying the above set of attributes, the panel began to consider how best to value the attributes in the context of potential restoration projects. First, they determined that some attributes could not be quantified. For these attributes, the panel formulated general guiding principles or binary pass/fail criteria.

Second, the panel determined that many of the identified attributes are highly inter-related. For instance, a wider marsh is likely to be necessary along the main channel of the LDR, while a narrower marsh would be acceptable if along a side channel sheltered from boat wakes, where the physical energy regime is less rigorous. The panel chose to develop guidelines that simultaneously reflect two or more of the attributes listed above because it made the most ecological sense.

Third, although the panel relied on the best available science for northwest estuarine systems, in some cases, empirical data were not available to specify with certainty all parameters that relate to each guideline. In these cases, the panel used best professional judgment, while acknowledging that there is uncertainty in the selected values.

Subject to these caveats, Table E1 displays the panel's proposed guidelines for ecological value, organized approximately into the attribute categories noted above (see the shaded gray rows). The first column (Habitat) indicates the habitat or habitats to which the guideline applies. To assist the Trustees in defining these habitats, this first column may also contain a proposed definition of the habitat type. The second column (Guidelines) lists the guideline applicable to the particular habitat–e.g., thresholds for width ranges for high-elevation marsh. Particular habitat types are shown in order of increasing ecological value – e.g., for high elevation marsh, value increases as width increases over 10 m. The third column (Rationale/Notes) presents the panel's rationale for providing the proposed credit.

Application of Factors to Proposed Projects

The panel's emphasis was to provide recommendations that would most naturally support the target resources, and that would be sustainable. Because the ecosystem is so heavily altered, the panel acknowledged that options for ecosystem recovery were constrained. Overall, the panelists were relatively certain that implementation of the recommendations would result in significantly improved ecosystem conditions. Monitoring was strongly recommended in order to determine both the site specific and system-wide effects of multiple restoration projects.

The factors listed in Table E1 are intended to be used either alone or in conjunction with one another. To explore the total set of factors that might result from projects that take advantage of the guidelines set forth in these tables, the panel examined a variety of theoretical projects. These projects and the values related to habitat associations that should be considered are set forth in Table E2.

The most value would be achieved in a project that creates a high elevation marsh, over 50 meters in width and at least 5 acres in size, plus a fringe of low marsh at least two meters in width. The project would be located at a side-channel site between First Avenue Bridge and Hamm Creek, adjacent to an existing freshwater flow that enters the waterway. If the project also reconnected an existing freshwater flow to the waterway, additional value should be considered.

Altogether, the panel felt that it was able to meet its charge, and that it successfully identified ecological attributes that were: (a) not captured in the current methodology and that (b) may have a positive effect on the value of a project—i.e., characteristics that might result in a particular project receiving more credit than would normally have been calculated using the current methodology. These were determined within the context of the urbanized and industrialized nature of the river and alterations to the watershed.

Table E1. Value Considerations for LOWER DUWAMISH RIVER Restoration Projects.

(guidelines for each habitat presented in order of increasing ecological value)

Habitat	Guideline [a, b]	Rationale/Notes
	Shape and Habitat	
High elevation marsh (Occurs upland of channels, approx. 11-13 feet above mean lower low water (MLLW)[c]. Supports a more diverse complex of species, such as *Deschampsia*, *Atriplex*, *Distichlis*, and *Potentilla*.)	**Main channel** 10 m minimum width for additional value 10-50 m wide (channels begin, maybe at ~30 m widths) >50 m wide (>1st order channels form naturally) Project must be at least 10 m in length. **Side channel** 3 m minimum width for additional value 3-50 m wide (channels begin to form naturally) >50 m wide (>1st order channels form naturally) Project must be at least 10 m in length.	Wider marshes are significantly more likely to be sustainable and are more likely to develop higher order channel systems. Higher-order systems (especially tertiary channels and higher) provide substantially more edge area, which is where fish feed. They also allow fish to stay in channels for significantly longer, and fish are not forced out by lower tides as frequently. Side channel marshes are more likely to be protected from boat wakes and related disturbances; a smaller minimum width The additional values are applicable only to marsh projects of 10 m in length (measured parallel to the adjacent waterway).

Habitat	Guideline [a, b]	Rationale/Notes
	Shape and Habitat	
Low elevation marsh (Occurs surrounding channels – primarily *Carex* species, approx. 5.5-9.5 feet above MLLW.) [c]	**Main channel** 4 m minimum width for additional value 4 to 10 m wide > 10 m wide Project must be at least 10 m in length. **Side channel** 2 m minimum width for additional value 2 to 5 m wide >5 m (safe from destruction by geese) Project must be at least 10 m in length.	Wider marshes are significantly more likely to be sustainable and are more likely to develop higher order channel systems. Higher-order systems (especially tertiary channels and higher) provide substantially more edge area, which is where fish feed. They also allow fish to stay in channels for significantly longer, and fish are not forced out by lower tides as frequently. Side channel marshes are more likely to be protected from boat wakes and related disturbances; a smaller minimum width The additional values are applicable only to marsh projects of 10 m in length (measured parallel to the adjacent waterway).
Intertidal habitat (excluding mudflats)	No extra credit for width (or total size).	Few additional species diversity or other benefits are expected as a function of increasing size.
Vegetated buffer (Mixed scrub/shrub and trees, with an elevation +13 feet relative to MLLW. Must be contiguous with another habitat that is adjacent to water (marsh, mudflat, etc.)	< 5 m wide 5 to 30 m wide >30 m wide	Vegetated buffer provides habitat complexity and enhances flows of materials and energy between habitat types. It aids in the sustainability of adjacent habitats and encourages diversity, e.g., by providing roosting areas for birds. Buffers also dampen noise and can reduce contaminated runoff from uplands to aquatic systems. Additional width is important to protect the integrity of the stand; extra credit is therefore provided for wider buffers.

Habitat	Guideline [a, b]	Rationale/Notes
Total Size/Adjacency to Existing Habitats of Same Type		
Marsh and mudflats	<2 acres 2 to 5 acres >5 acres	The key issue here is total size, including size of the project itself and also the total area of laterally-contiguous habitat if a project is sited next to existing habitat of the same type. Larger areas are more robust towards disturbances, and (up to a point) provide more niches and enhance biodiversity. Further, connecting a new project to existing habitats allows the new project to tap into an existing source of propagules, providing a higher likelihood of success and faster recovery trajectory. Extra credit should be given for larger project size and for siting projects next to laterally contiguous areas of the same habitat type. Marsh and mudflats are productive habitats and are especially important for juvenile Chinook salmon. They also provided key foraging opportunities for birds. The higher credit factors for these areas reflect this extra value, relative to upland locations.

Habitat	Guideline [a, b]	Rationale/Notes
Total Size/Adjacency to Existing Habitats of Same Type		
Upland	<2 acres 2 to 5 acres >5 acres	The key issue here is total size, including size of the project itself and also the total area of laterally-contiguous habitat if a project is sited next to existing habitat of the same type. Larger areas are more robust towards disturbances, and (up to a point) provide more niches and enhance biodiversity. Further, connecting a new project to existing habitats allows the new project to tap into an existing source of propagules, providing a higher likelihood of success and faster recovery trajectory. Extra credit should be given for larger project size and for siting projects next to laterally contiguous areas of the same habitat type. Marsh and mudflats are productive habitats and are especially important for juvenile Chinook salmon. They also provided key foraging opportunities for birds. The higher credit factors for these areas reflect this extra value, relative to upland locations.
Adjacency to Existing Habitat of Another Type (Buffering)		
Any (except vegetated buffer projects)	Applicable for project creating new habitat adjacent to existing vegetated buffer.	The HEA currently allows an area to be fully functional only if the project includes a vegetated buffer. In the case of restoration projects, choosing a site adjacent to an existing buffer results in a faster time to full recovery because it doesn't depend on the development of new upland areas.

Habitat	Guideline [a, b]	Rationale/Notes
Diversity		
Marsh	Apply the factor if the maximum width threshold for one marsh type is exceeded, and a second type of marsh that meets its minimum threshold value is added. The factor is then applied to the entire created marsh area.	Two types of marsh provide more diversity than a marsh of only one type; the variety also enhances sustainability.
Siting – Organism Access/Use		
Mudflat (Intertidal habitat with a grade of less than 2 percent, a fine sand to silt/clay substrate, lacking macrophyte vegetation, and having a width in excess of 5 meters.)	Main channel Side channel	Mudflats have special value for juvenile Chinook salmon and so are given some extra credit relative to other intertidal habitats, wherever they are created. Mudflats on side channels serve as potential way stations for juvenile Chinook and as such receive additional credit.
Mudflat	Northern tip of Kellogg Island downstream	Mudflat habitat is most appropriate in higher salinity areas and in these areas is especially beneficial to English sole, a marine species. This credit is intended to be applied in addition to the above credit for mudflat habitat created either on the main channel or a side channel.

Habitat	Guideline [a, b]	Rationale/Notes
Siting – Organism Access/Use		
Marsh	Side channel location between First Avenue Bridge and Hamm Creek Side channel location between Turning Basin and upstream extent of injured area	In certain significant stretches (e.g., between the First Avenue Bridge and Hamm Creek), there are few opportunities for juvenile Chinook to get out of main channel and rest, which salmon prefer to do after traveling for about a day. Creating appropriate juvenile Chinook resting habitat in areas where little such habitat exists therefore receives extra credit. The area upstream of the Turning Basin is also important for juvenile Chinook: it is probably the local area of the most value in terms of providing brackish/ oligohaline habitat. (This region used to occur much lower in estuary but does no longer, since the river(s) flow has been reduced.) For the habitat to meet the juvenile Chinook's needs, the project must be in a protected area (i.e., a side channels). If no side channel exists at an appropriate location in the specified reach, the channel would have to be created, as well as the specified habitat type. The panel notes that the mudflat credit provided in the most northern reach (see "Siting—Historic Considerations/Probability of Success" section of table below) has special benefit to English sole and is not repeated here.

Habitat	Guideline [a, b]	Rationale/Notes
Siting – Contamination Avoidance		
All habitats	No site should be built without first ensuring adequate on-site source control. The potential for future contamination from off-site is a primary consideration in site selection. Monitoring, prior to and during project construction, is essential to evaluate and minimize the potential for on-site and off-site recontamination. Avoid project construction in areas likely to be adversely affected by boat traffic/wakes.	Restoration projects are less likely to be sustainable and less likely to support a full range of organisms if they are subject to significant ongoing or future contamination, whether from on-site or off-site sources.
Siting – Historic Considerations/Probability of Success		
Marsh	Low marsh is more appropriate in upstream portions of waterway near the Turning Basin, as compared to lower reaches near Kellogg Island. The panel encourages restoration or preservation programs upstream of the primary area of consideration.	Restoration efforts are commonly directed by history—i.e., a project tries to return an area to its baseline condition, based on the assumption that if the habitat was present at a particular location historically, it could presumably be sustained there again. However, historic locations are not as relevant for the LDR because of the extensive physical changes to the waterway since historic times (in hydrology, sediment transportation, etc.). These guidelines therefore focus only on important habitat types previously present in the area. For instance, based on salinity and elevation considerations low marshes are most likely to thrive in the more upstream parts of the waterway near the Turning Basin.

Habitat	Guideline [a, b]	Rationale/Notes
Siting – Social/Cultural Considerations		
All habitats	Avoid impacting human cultural or heritage sites.	Representatives of the Suquamish and Muckleshoot Tribes are co-Trustees for the LDR. Respecting any culturally important tribal sites is a fundamental requirement of any restoration project.
All habitats	Projects adjacent to residential communities	The First Avenue Bridge/Hamm Creek stretch also includes the sole residential area along the waterway; actions in this area might have human services as well in terms of recreation, wildlife viewing, etc. On the other hand, enhancing access for humans might detract from the ecological value of the site in that the increased presence of humans might discourage some organisms from making use of the area.

Habitat	Guideline [a, b]	Rationale/Notes
	Landscape Connectivity	
Marsh and Mudflat	Add freshwater flow via reconnection (minimum of 50 green space acres, maximum of 100 acres) Add freshwater flow via green space creation directly next to an existing freshwater flow into the Duwamish [d] Project involving both of the above	Historically, the LDR was connected to a wider variety of freshwater sources. The panel feels that increasing clean flows to the waterway (and thereby increasing the number/size of brackish areas) would enhance access of the waterway to juvenile Chinook salmon. Increasing freshwater flow also enhances the transfer of organic materials and insects to the main channel. The panel points out that there are three conceptual ways in which freshwater flows to the LDR could be increased in a given project: (a) reconnecting neighboring freshwater flows to the LDR (e.g., Puget Creek), (b) creating additional green space habitat adjacent to existing freshwater inflows (e.g., Hamm Creek), (c) doing both of the above. For (a), the panel proposes providing additional value based on the total area of green space drained by the newly-formed connection. To provide a significant amount of new flow, the panel determined that flow from a minimum of 50 acres of green space must be added to receive this credit. For (b), credit is based on the size of the newly-created habitat. Option (c) is the sum of (a) and (b). The panel also noted that any new flows should meet relevant water quality standards.

Habitat	Guideline [a, b]	Rationale/Notes

Notes:

a. Unless otherwise indicated, the basis for the specified guidelines is professional judgment.

b. Size and shape thresholds for each habitat are listed in order of increasing ecological value: e.g. for a high marsh in a side channel, 3 m is the minimum width for which additional value is considered, value increases linearly as the width increases from 3 m to 50 m, and a marsh > 50 m in width is given the greatest value.

c. Elevations of these marshes are based on data from the WET monitoring of the Coastal America reference sites.

d. The panel notes that the added green space areas will probably be narrow, in order to keep the streams deeper, to allow access to the juvenile Chinook. Therefore, this additional value consideration probably would not be found in combination with credits for project size.

TABLE E2. VALUE CONSIDERATIONS FOR HABITAT/ATTRIBUTE ASSOCIATIONS [a]

(X indicates additional value should be considered for this attribute)

Habitat Type and Width	Width (on/off main channel)	Mudflat Siting (mudflat only, on/ off main channel)	Diversity (marsh only)	Total Size, Connectivity	Buffering	Adjacent to Freshwater Flow [b]	Habitat Siting
Vegetative buffer >30 m wide	(on or off) X	N/A	N/A	(>5 acres) X	N/A	N/A	N/A
Mudflat	N/A	X (on)	N/A	(>5 acres) X	Reduce time to full functionality	N/A	(downstream)[c] X
Mudflat	N/A	X (off)	N/A	(>5 acres) X	Reduce time to full functionality	X	(downstream)[c] X
Low Marsh >10 m wide	X (on)	N/A	(+ high marsh) X	(>5 acres) X	Reduce time to full functionality	N/A	(midreach)[d] X
Low Marsh > 5 m wide	X (off)	N/A	(+ high marsh) X	(>5 acres) X	Reduce time to full functionality	X	(midreach)[d] X
High Marsh > 50 m wide	X (on)	N/A	(+ low marsh) X	(>5 acres) X	Reduce time to full functionality	N/A	(midreach)[d] X
High Marsh > 50 m wide	X (off)	N/A	(+ low marsh) X	(>5 acres) X	Reduce time to full functionality	X	(midreach)[d] X

Habitat Type and Width	Width (on/off main channel)	Mudflat Siting (mudflat only, on/ off main channel)	Diversity (marsh only)	Total Size, Connectivity	Buffering	Adjacent to Freshwater Flow [b]	Habitat Siting

Notes:

[a] The factors shown in this table are meant to demonstrate the combined ecological values, by habitat type, that might result for a given project. Therefore, not all factors included in Table E1 are listed in this table.

[b] This credit is for creating the project adjacent to an existing freshwater flow into the LDR. The panel notes that green space projects added adjacent to existing (side channel) freshwater flows will probably be narrow, in order to keep streams deeper to allow access for the juvenile Chinook. Therefore, receiving the "Adjacent to Freshwater Flow" credit in addition to the Width credit, as done in this table, is unlikely.

[c] Northern tip of Kellogg Island downstream

[d] Between First Avenue Bridge and Hamm Creek

APPENDIX F: ALLOCATION PROCESS IN THE LOWER DUWAMISH RIVER NATURAL RESOURCE DAMAGE ASSESSMENT

Each site that contributed to contamination in Lower Duwamish River (LDR) sediments was allocated a percentage of the natural resource liability based on specified criteria and decision rules. Allocations were made to specific land parcels, called 'sites' and not to Potentially Responsible Parties (PRPs). A site is defined as a group of contiguous tax parcels that contributed chemicals responsible for natural resource damages in the LDR. Our approach allocates only to the current property owner and does not attempt to allocate damages among historical and current owners, tenants, operators, generators or transporters. This convention is not intended to limit the liability of any party involved with these sites. Many sites have had numerous owners and tenants over the past several decades and current owners are encouraged to engage with these entities as part of settlement negotiations.

Allocations are based on data from Washington Department of Ecology (ECY), the U.S. Environmental Protection Agency (EPA) and other publically available reports produced over the last several decades. While available data are extensive, it is possible that other data exist that might influence the allocations. If parties identify additional data that that could impact proposed allocations, these can be incorporated into the analysis.

This allocation apportions responsibility for contamination in sediment in the Lower Duwamish River using footprint maps created for 27 Substances of Concern (SOCs). Each footprint delineates sediment concentrations that exceed threshold levels for injury to aquatic resources. The thresholds for determining injury reflect Washington State Sediment Standards and Effects Thresholds established in the scientific literature (See Appendix D for additional information). Footprint maps were constructed using sediment contamination data from 1991 to 2008 for 27 substances of concern, including but not limited to PAHs, PCBs, metals, and chlorobenzenes. A contaminant footprint map was developed for each substance of concern, reflecting the degree of contamination relative to threshold concentrations.

The impact of the SOC footprints was quantified using a Habitat Equivalency Analysis (HEA), producing Discounted Service Acre Year (DSAY) values for each footprint. The HEA is described in detail in Chapter 2 of this document. Sites that were potential contributors to contamination were identified using King County tax parcel data: (http://www.kingcounty.gov/operations/GIS/PropResearch/ParcelViewer.aspx). We considered all parcels of land adjacent to the LDR and all non-residential properties between the main roadways parallel to the LDR (East Marginal Way and West Marginal Way). King County International Airport and Boeing Field parcels were also included because they are known to drain directly to the LDR. In addition to properties, the allocation also included public storm drains and combined sewer outfalls (SDs/CSOs) that discharge into the LDR. Residential parcels were not included, because releases of SOCs from residential properties were expected to be low and would likely be part of the contributions from CSOs and storm drains.

This initial identification process resulted in the designation of 458 non-residential sites for evaluation. In many cases, contiguous tax parcels were combined by owners or operators to

support a common set of activities. For example, the King County International Airport encompasses five tax parcels. For allocation purposes, tax parcels used to support a common set of activities are grouped together and considered a single site. The combined parcels are assumed to share a consistent SOC discharge profile.

While sites further inland contribute to contaminant loads in LDR sediments, their effects are assumed to be captured through storm drains (SDs) and combined sewer overflows (CSOs) in the drainage basin. The discharges from these drains were considered as a potential source of SOCs separate from the adjacent tax parcels.

For parcels adjacent to the river, information from EPA and ECY on activities occurring on the site, substances used or stored on site, wastewater, soil, groundwater and other sampling data, reports of spills and releases and other factors were incorporated into the allocation.

Based on the footprint maps, tax parcel information and data from EPA and ECY files, responsibility for contamination was allocated using a tiered, hybrid approach. Wherever possible, individual footprints were allocated to specific parcels, small groups of parcels, or SDs and CSOs. In general, a parcel allocated responsibility in this way is adjacent to a footprint and is known to have stored, used and/or released the substance of concern on site. We also considered patterns in the gradient of contamination such as shown in Figure F1. Here, highest concentrations are seen near the presumed source on land, and concentrations decrease with distance from the source. A footprint was assigned to a storm drain or CSO if the associated SOC is known to be a common component of storm drains or CSOs and the associated footprint exhibited a spatial pattern consistent with nearby contaminant releases from the drain (Figure F1).

The allocation process requires the use of professional judgment, largely to address variability in the amount, type and quality of data available for each site. Sites are allocated responsibility only if there is a link (called a 'nexus' in the CERCLA regulations) between the site and contamination found in the LDR (Table F1). For each site and substance of concern, we examine three criteria:

1. Is there a pathway for the contamination to travel from the site to the LDR?
2. Is it more likely than not that the SOC was used or generated at the site or were actions conducted at the site which could result in the transfer of the substance of concern to the LDR?
3. Is the chemical found in the LDR adjacent to the site, on-site groundwater, on-site surface water, an NPDES discharge, or potentially erodible soil or sediment?

Figure F1. Hypothetical injury footprint showing a gradient of contamination emanating from a land-based source.

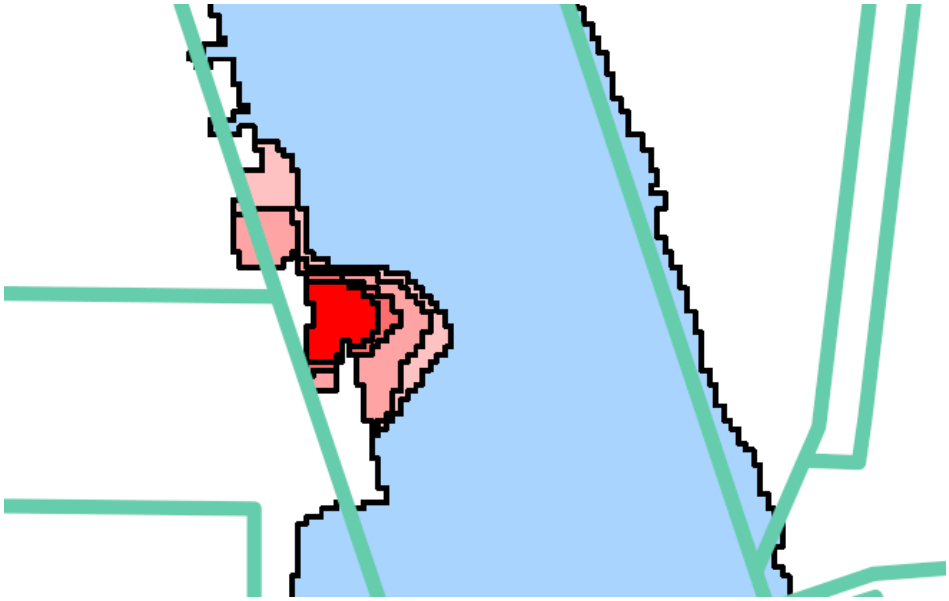

Table F1. Factors Considered to Trigger Allocation to a Site

1. Pathway. Is there a pathway for process water, surface water, groundwater, or sediment to travel from the site to the Duwamish Waterway?	Yes/No
2. Activity. Was an activity conducted at the site that is a likely source of an SOC or which resulted in the release of a chemical likely to exacerbate the impact of an SOC?	Yes/No
3. Evidence of Contamination	
a. NPDES violations	Yes/No
b. Surface water contamination	Yes/No
c. Groundwater contamination	Yes/No
d. Soil or sediment contamination	Yes/No
e. Sediment "footprint" in very close proximity to site.	Yes/No
To trigger continuation in the allocation process, the answers to 1, 2 and at least one component of 3 must be "**Yes**".	

A site is considered to be a source of the SOC if (and only if) the answer to all three questions is yes. First, a pathway must exist for process water[1], surface water, groundwater, or sediment to travel from the site to the LDR. Because sites identified for this allocation border or drain directly to the LDR, it is reasonable to assume the existence of a viable pathway for SOC transport at every site. Groundwater is very shallow along the LDR (5-10 feet below the soil surface), so contamination in soils can easily leach into the groundwater. Second, there must be evidence of on-site activities that could be a source of one or more SOCs or result in the release of substances that mobilized or otherwise exacerbated the release of one or more SOCs to the LDR. For example, the transport of lead from lead-painted surfaces would not be considered a potential release to the LDR. However, sandblasting of lead-painted surfaces to the adjacent ground would be considered a potential source of lead to the LDR, because of the deposition of waste grit material in shipways and other areas susceptible to stormwater or erosional transport.

Finally, we require evidence that one or more SOCs were present in site wastewater, discharges, soil, surface water and/or groundwater. Information used to make this determination included records of NPDES violations and contamination measured in surface water, ground water, soil or sediment.

Establishing the potential for an SOC release to the LDR depends on the amount of information available for each site. If site records are incomplete and therefore insufficient to satisfy the criteria discussed above, the site is not included in the allocation. As a result, the allocations may exclude viable contributors of SOCs to the LDR for which there are no publicly available data. Our evaluation process systematically and objectively used all data available at the time of the analysis. If additional information is made available it can be incorporated into the allocation at a later date.

The sequential steps and decision junctions in the allocation process are shown in Figure F2. This methodology produces a separate allocation for each of the 27 SOCs. For many of these SOCs, individual footprints could be linked to specific parcels. For others, we relied on a combination of footprint-specific and mass balance approaches. For example, some stretches of the LDR are broadly contaminated with a substance of concern potentially attributable to a large number of parcels. In addition, some discrete footprints are located in places that potentially implicate several sites and/or SDs/CSOs. In these cases, the allocation relied on a mass-balance approach. Sites in close proximity to the footprint that used, stored and/or released the substance of concern were given partial responsibility for the footprint, taking into account contamination gradients and likely contaminant transport dynamics. Estimates of each sites' relative contribution of the substance of concern were derived from EPA and ECY data and general reference information from the scientific literature. For Polycyclic aromatic hydrocarbons (PAH), the allocation relied solely on the mass balance approach, because PAH contamination is pervasive throughout the LDR at concentrations above injury thresholds. This was the only SOC treated in this manner.

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[1] Process water is water used in a manufacturing or treatment process or in the actual product manufactured. Examples would include water used for washing, rinsing, direct contact, cooling, solution make-up, chemical reactions, and gas scrubbing in industrial and food processing applications.

A small set of footprints could not be allocated using either methodology. "Type I" unallocated footprints are those that could not be linked to a particular site, group of sites, or SD/CSO. "Type II" unallocated footprints are those that appear to be linked to a particular site, group of sites, or SD/CSO, but available data is not sufficient to trigger an allocation. However, a methodology was developed to allocate these footprints to parcels with a history of use of the particular SOCs.

Allocation by Unique Footprint

Under this approach, individual footprints were allocated to specific sites or SDs/CSOs. In general, the site allocated responsibility in this way is adjacent to the associated footprint, is known to have stored, used and/or released the substance of concern on site, and exhibits contamination gradients consistent with nearby contaminant release and LDR transport dynamics. In the case of CSOs or SDs, if the footprint is located next to the CSO or SD discharge to the river, and is a commonly detected contaminant in storm water discharge, then the footprint was assigned to the CSO or SD.

In assigning footprints to individual sites or SDs/CSOs, the following criteria were used:

- The footprint must be within or immediately adjacent to the tax parcel boundary of the "paired" site and no other site; or at the approximate point of discharge of a SD or CSO and not shared with a site, and
- The paired site must have an activity that could potentially result in the release of the SOC in question; or the contaminant must be commonly detected in storm water if the footprint is associated with a SD or CSO.

This approach reflects the common sense notion that discrete, elevated concentrations of SOCs found in sediments bordering a site should be attributed to that site when activities that used those SOCs took place. There is a possibility that these footprints received minor contributions from other sources. However, when a spatial and causal link between a footprint and a bordering site is apparent, we presume that impact diminishes with distance and thus rely on the likelihood that sources closer to the footprint dominate. The "Allocation by Unique Footprint" approach was the default allocation methodology used in the analysis. If a particular footprint did not meet the criteria listed above, the "Allocation by Mass Loading" approach was applied.

Allocation by Mass Loading

In some cases, SOC contamination is so widespread and diffuse that contamination footprints blend together and are not readily linked to specific sites. Footprints potentially associated with several sites are best allocated using a mass loading approach. The mass loading allocation is based on establishing the total loading of an SOC to the LDR from each site.

When the data are available, the most direct method to determine the mass released to the LDR is based on 'Flux'. The term flux applies to the time rate of release: for example, pounds per day. If the rate is multiplied by the duration (e.g., in days), total loadings released to the LDR can

be calculated and relative contributions assessed through comparisons of loadings estimates. Unfortunately, in almost all cases, information was not sufficient to estimate SOC flux.

In most cases, the approach used assumed that the SOC mass released to the LDR will be a function of the type of activity, the scale and duration of the activity, and the fate and transport mechanisms for the contaminant. Under this 'Activity Ratings' approach, the scale and duration of the activity generally can be quantified (e.g. acres and years). While it is difficult to quantify the amount of an SOC potentially released by different activities, the absolute quantity of a release is less important than the relative quantity compared to other sources of the same SOC. Relative amounts can be estimated from information in the general literature and by analyzing site-specific information (e.g., groundwater and surface water data). The fate and transport mechanisms depend on the physical and chemical characteristics of the SOC and the location of the site and pathways by which the SOC could reach the LDR. In some cases the footprints for certain SOCs can be used to estimate the releases of other SOCs with less clearly defined footprints.

Table F2. Mass Loading Allocation Method for Shared Footprints (not PAH). For each Substance of Concern choose the best method – depending on data:

Allocation Index = (Duration Index) x (Flux)

Allocation Index = (Size Index) x (Duration Index) x (Activity Index)

Allocation to Site A = Allocation Index for Site A / $\sum$ Allocation Indices in Segment

Size and Duration Indices:

Size Index: Use the size of the site, or area of activity, in acres. If the size has changed, use the weighted size (weighted by years of different size)

Duration Index: Years from start of activity to present for on-going activities, termination of activity (for activities leaving no residual upland or groundwater contamination) or final cleanup. Use the same weighting for pre-1981 and post-1981 (it is assumed that waste generated prior to 1981 could lead to post-1981 releases).

Ultimately, both mass balance approaches (Activity Ratings and Flux) generate allocation indices that become the basis for apportioning responsibility for contamination between multiple sites. The Flux approach is used when sufficient data are available to quantify actual releases from the sites subject to a mass loading allocation. When such data were not available, the Activity Ratings approach was used to assign index values based on the type, duration, and size of activities that took place on site and are associated with relevant SOCs. Table F2 summarizes the Flux and Activity Ratings approaches for mass loading. Table F3 describes the Activity Ratings in greater detail. These methods require consideration of the fate and transport properties listed in Table F4, particularly when:

- The flux or release is measured at a significant distance from the LDR.
- The activity takes place at some distance from the LDR.
- Releases involving different pathways (surface water, groundwater, and soil/sediment erosion) are being added together or compared.

One SOC (PAH) was allocated solely through use of the mass loading approach because the contaminant concentrations were widely diffused throughout the LDR. Concentration gradients were discernable, but footprints were not readily defined. Thus, allocation to each site within the entire LDR was determined by mass loading, taking into account various sources of PAH to the Lower Duwamish River.

For all other SOCs, if a footprint was associated with more than one site, then the mass loading approach was used for allocation among sites. If one or more CSOs or SDs was located in the vicinity of a footprint and no site triggered within that area, then the footprint was assigned to the CSO and/or SD.

Unallocated Footprints

Some footprints could not be allocated using any of the methods described above. These unallocated footprints fit one of the following two categories:

- **Type I Unallocated:** The SOC footprints are not clearly adjacent to or otherwise linked to specific sites.
- **Type II Unallocated:** The SOC footprints abut or are adjacent to an individual site according to the criteria outlined above but no documentation exists to establish that activities at the site represent a likely source of the SOC in question.

To allocate the unallocated footprints we developed an approach based on a site's share of the particular SOC allocated by the abovementioned methods. The total allocated and unallocated DSAYs in the study area were determined for each SOC. For each site that had DSAYs allocated for a particular SOC, the percentage of the total allocated DSAYs for that SOC was determined. Then, the site's share of the unallocated DSAYs was calculated by multiplying the total unallocated DSAYs for a particular SOC by the site's percentage of the allocated DSAYs for that SOC.

Here is a hypothetical example that illustrates the process described above:

- The HEA calculates a total of 200 DSAYs for contaminant A for the entire study area.
- Of the 200 DSAYs, 180 are allocated to multiple sites, 20 are from unallocated footprints.
- Site X, one of the sites responsible for contaminant A, is allocated 45 of the 180 DSAYs, or 25% of the total allocated DSAYs (45/180 = 25%).
- Site X's share of the DSAYs associated with the unallocated footprints for contaminant A is, therefore, 25%.
- Site X receives five additional DSAYs for contaminant A as their share of the unallocated footprints (20 unallocated footprint DSAYs * 0.25 = 5).
- Site X's total allocation for contaminant A is 50 DSAYs (45 allocated + 5 unallocated share).

Table F3. Activity Ratings

This table is intended to represent an initial screening of the relative ranking of activities with respect to their potential to release PCBs. Thus, all other things being equal (e.g. size, duration, degree of case, fate and transport, chemical concentrations, etc.) an activity near the top of the list is expected to result in the release of a greater mass of SOCs than an activity near the bottom of the list. However, where things are not equal the actual mass contribution could be much different than that implied by the order noted in the table.

PCBs	
Activity	**Activity Index**
PCB transformer recycling	High
PCB contaminated oil spill	
Recycling waste oil	
PCB transformer use	
Ship dismantling	
Vehicle recycling	
PCB use in oils and fluids for machining	
PCB use in paints, resins, sealants, and adhesives	
Ship maintenance	
Solvent mobilization of PCB's in the environment	Low

Table F4. Fate and Transport Considerations

Surface Water

Flow path to the Waterway (e.g., distance, velocity)

Presence of free product

Chemical concentration

Potential for volatilization and degradation

Adsorption to sediments

Groundwater

Flow path to the Waterway (e.g., distance, gradient)

Transmissivity of aquifer

Floating or sinking free product

Chemical concentration

Potential for adsorption by aquifer soil

Potential for volatilization and degradation

Mobilization by other chemicals

Mobilization of natural substances

Adsorption to sediments

Sediments

Proximity to ditch, swale, or waterway

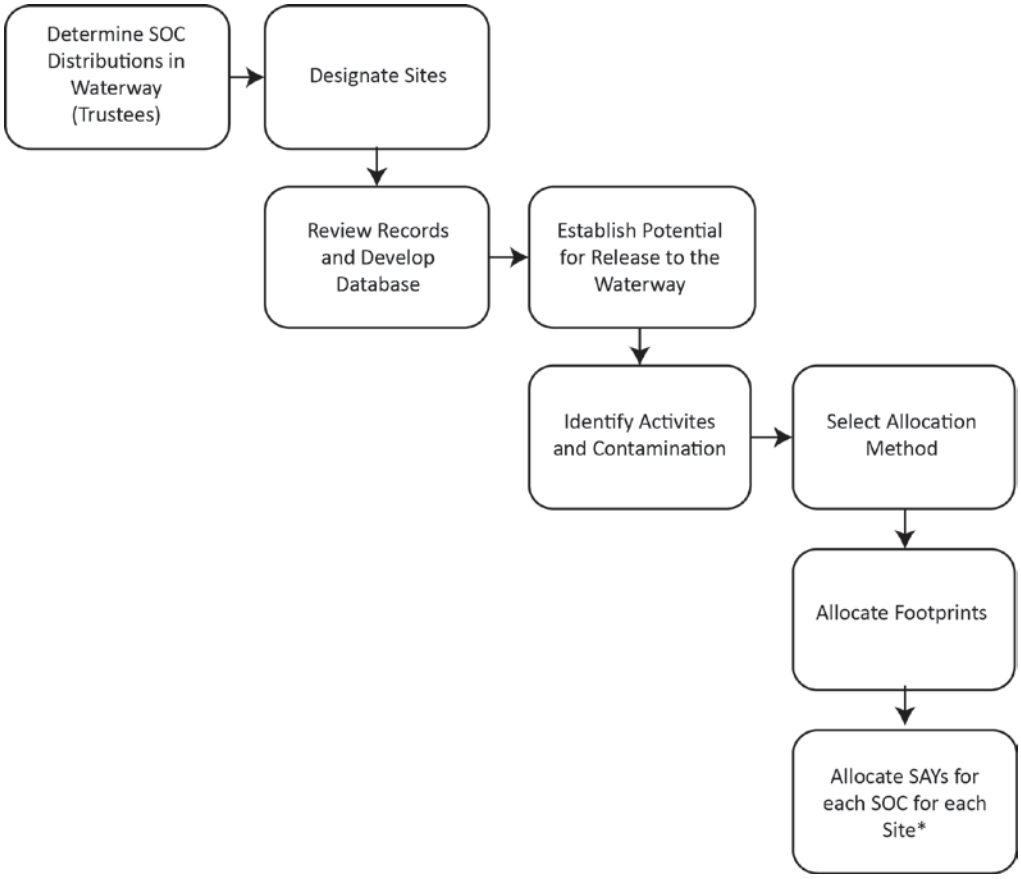
Covered or uncovered

Velocity of eroding water

Particle size

Potential to settle before reaching Waterway

Figure F2. Overview of Allocation Steps



Note: this step does not include allocation to individual parties, but rather allocates contaminants to physical sites (or land parcels). Each site may have multiple owners and/or operators.

APPENDIX G: 2009 RESPONSE TO COMMENTS

Presented below are the comments received on the Draft Recovery Plan (RP) and Programmatic Environmental Impact Statement (PEIS) released for public review in 2009. NOAA and the other Trustees have prepared responses to the concerns and issues raised in these comments, also provided below. Eight stakeholders provided comments: Boyer Logistics (M.C. Halvorsen), King County Department of Natural Resources and Parks (KC), U.S. EPA region 10 (USEPA), Duwamish River Cleanup Coalition (DRCC), People for Puget Sound (PFPS), Water Resource Inventory Area 9 Watershed Ecosystem Forum (WRIA 9), City of Seattle Public Utilities (Seattle), and the Port of the Seattle (POS). The stakeholder comments are paraphrased and/or quoted directly and are written in italics with the commenters identified in parentheses, the actual comments are included in the last pages of this document.

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Preferred Alternative

Several commenters support the preferred alternative. (KC) (USEPA) (DRCC) (PFPS) (WRIA 9)

Response: Support noted.

The description of typical kinds of restoration actions under the preferred alternative is well stated and consistent with recent practical experience in the Duwamish Waterway. (POS)

Response: Comment noted.

What is planted in the banks will die. The dead material would accumulate on the bed of the river, which would be excessive, which in turn would cause the algae to grow, which in turn would suck the oxygen out of the river. This plan will surely kill the river. (M.C. Halvorsen)

Response: Riparian vegetation has been successfully established at several locations along the Lower Duwamish River (LDR). Because the benefits of riparian vegetation to river systems are widely recognized, the Trustees believe that planting riparian vegetation as part of restoration projects will only benefit the river.

Habitat Focus Areas (HFA)

Commenters support HFA approach that gives highest priority to HFA1 that benefit all injured species. (DRCC) (WRIA 9)(Seattle)

Response: Support noted.

Commenter encourages Trustees to only modestly discount the value of projects in HFA3 compared to HFA1 because there is great ecological benefit from projects throughout the Upper Duwamish. (WRIA 9)

Response: The Trustees appreciate the ecological benefit from projects in HFA3, but are discounting the value of projects in this HFA for the purpose of Natural Resource Damage Assessment (NRDA) restoration because restoration there will provide relatively little benefit to the marine and largely estuarine aquatic species injured in the LDR.

The upstream 1.5 miles of HFA1 is not straightened and developed as the rest of HFA1 is, and so should be included in HFA3 rather than HFA1. (M.C. Halvorsen)

Response: The Trustees disagree with this comment and have kept the farthest upstream 1.5 miles in HFA1. The designation of the HFAs is based on the environmental conditions and importance to the injured natural resources, not the state of development. HFA1 includes the portion of the Duwamish River below the North Winds Weir and has mixed salinity. HFA3 is above the influence of marine water and is entirely influenced by freshwater.

If the restoration work is intended to focus on the transition zone for juvenile salmon, the areas upstream of river mile 3.5 (measured from the mouth of the Duwamish River) in HFA1 and areas in HFA3 should be the focus because areas downstream have high salinity. (KC)

Response: The restoration effort is not focused on the transition zone for juvenile salmon exclusively, but on benefiting the suite of resources injured in the LDR, including areas downstream of river mile 3.5. Incorporating parts of HFA3 into HFA1 is not appropriate, as conducting restoration in HFA3 will not

benefit the entire suite of injured natural resources; some of the injured species would not be expected to be present in HFA3. Habitat restoration in HFA3 would provide less direct benefit to those species compared to projects in HFA1.

Commenter objects to conducting any restoration outside of the LDR and Elliott Bay. (PFPS)

Response: The Trustees are prioritizing restoration within the LDR (HFA1) and will require settlements with Potentially Responsible Parties (PRPs) to provide for some restoration within HFA1 as part of any package, because projects in this area have the greatest potential to benefit the entire suite of resources injured as a result of hazardous substance releases. Inner Elliott Bay (HFA2) is the next highest priority for restoration. However, we will consider restoration in the other HFAs as part of a proposed settlement or for implementation by Trustees as a lower priority. Projects in these HFAs will address at least some of the injured resources, and thus there is a nexus between natural resource injuries and restoration in HFA3 and HFA4. Additionally, the Trustees recognize that practical restoration opportunities within the LDR itself may not be sufficient to provide full compensation.

Restored Habitat: Types, Characteristics, Priorities

Commenter concurs with the primary focus of restoration being on the creation of mudflat, marsh, and riparian habitat, as these habitat types are most needed to restore the estuarine ecology of the Duwamish and of greatest benefit as salmonid habitat. (WRIA 9)

Response: Support noted.

Commenter supports the general approach presented in the restoration plan identifying the types of all-purpose habitat that should be developed. (KC)

Response: Support noted.

Commenter supports the importance given to landscape connectivity in the plan. (KC)

Response: Support noted.

In an area as devoid of upland vegetation as the Duwamish, some greater emphasis on riparian habitat is important and with encouragement it will be possible to integrate this type of habitat into many of the industrial sites. (Seattle)

Response: The Trustees recognize the importance of riparian habitat and believe that our approach provides an appropriate value for riparian habitat. Not only does created riparian habitat get restoration credit based on the area of riparian habitat created, it can also provide an increase in value for associated marsh and mudflat habitats from a baseline adjusted to a fully functional value. This is discussed in detail in the additional material provided in the Supplement to the draft RP/PEIS.

The language describing the goal of the restoration effort in the draft RP/PEIS ("restore injured natural resources to baseline by helping improve the ecosystem of the Lower Duwamish River to a more acceptable condition that can support both natural resources and human use of the system") is inadequate and high-quality, not "acceptable," habitat is needed. (PFPS)

Response: The commenter is confusing the goal of making the LDR ecosystem better as a whole through the creation of habitat projects, with the goal of individual projects being of high quality. The restoration projects themselves will create high-quality habitat. The addition of more acreage of high-quality habitat as provided by the restoration projects will help improve the entire ecosystem of the LDR, in which very little habitat is not degraded. It is the creation of such high-quality habitat projects that will improve the functioning of the LDR ecosystem ("to a more acceptable condition"), thus restoring the injured natural resources that will benefit from this new high-quality habitat.

Clams and other shellfish are historical traditional tribal foods and should be a high priority for habitat recovery along with salmon. (DRCC)

Response: The Trustees agree that restoration of shellfish resources is important in achieving restoration in the LDR. Restoration projects implemented under the RP/PEIS will provide clean areas of intertidal and shallow subtidal sediment, which will provide good habitat for shellfish.

High priority should be given to projects that integrate habitat restoration and public access. (DRCC)

Response: The Trustees will seek to integrate public access with habitat restoration at some of the restoration projects. This will not be possible at all sites; for example, projects built by PRPs on their own property would likely not include public access. Where public access is provided, it would be designed to minimize any impact on use by natural resources. The Herring's House restoration project, implemented by the Elliott Bay Panel, is a good example of integrating restoration projects and public access.

Habitat Valuation

Commenter concurs with the use of juvenile Chinook salmon as one of the two fish species used to assess value of habitat in the restoration effort. (WRIA 9)

Response: Support noted.

Commenters support integration of different habitats within restoration projects and giving them additional value. (DRCC) (PFPS)

Response: Support noted.

Commenter disagrees that created habitats should have the same level of ecological services as natural habitats (i.e., 1:1) because some percentage of the created habitat will fail and that the time factor in

development of habitat service provision in created habitats should be incorporated into replacement ratio requirements. (PFPS)

Response: The Trustees recognize that it is virtually inevitable that some of the created habitat will not provide all the ecological services expected, despite the Trustees' efforts in monitoring, long-term stewardship, and adaptive management. For projects implemented by PRPs as part of a settlement, we try to minimize this risk through the terms of the settlement that will require evaluation of adaptive management measures when monitoring indicates that a project's development is not matching expectations. Although some projects are likely to underperform, it is not possible to identify those projects in advance, and we do not believe it is appropriate to require more restoration from all PRPs simply because some of their projects may fail to meet predictions. Based on experience gained from other projects, the habitat most likely not to provide full function is marsh habitat, due to failure of marsh vegetation to become established. Under these circumstances, a failed intertidal marsh would instead function as mudflat (unvegetated intertidal) and would have a relative value of 0.9 instead of 1.0. The Trustees recognize that the ecological services from created habitats develop gradually as the project matures and account for this in the Habitat Equivalency Analysis (HEA) approach, which incorporates this factor in the determination of the size of that habitat needed to compensate for the injury. In this approach, restoration projects are not given full credit until they are mature.

The draft plan does not indicate that the Trustees are willing to recognize the time value of habitat by giving greater consideration to habitat created earlier as opposed to habitat that may be created 10 years later, although the Trustees have indicated this verbally, and it should be noted in the PEIS. (Seattle)

Response: The HEA method used accounts for when restoration projects are constructed, and a project built earlier will provide more restoration credits. As noted in response to another comment, additional information on HEA was added to the Supplement to the RP/PEIS, and the new material explains how timing is incorporated in the analysis.

Commenter requested that additional information on the valuation approach for restoration projects be included as an appendix to the plan. (PFPS)

Response: Extensive information on habitat valuation in the LDR was provided in Appendix D of the Supplement to the RP/PEIS.

The WRIA 9 plan discussed in the section Summary of Other Restoration Plans did state there is no scientific evidence that docks and other structures over water harm or interfere with the fish run. (M.C. Halvorsen)

Response: In contrast to this statement, the referenced WRIA 9 plan specifically identifies overwater structures as one of the "Factors of Decline" for salmonids in Table 3-1.[1] As discussed in Appendix D, the

[1] Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area. 2005. *Salmon Habitat Plan: Making our Watershed Fit for a King*. Seattle. Available online at http://www.govlink.org/watersheds/9/plan-implementation/HabitatPlan.aspx#download.

Trustees treat areas under overwater structures as degraded, which means that removal of overwater structures, as part of a restoration project, will provide restoration credits. It also means that the amount of injury estimated for an area under an overwater structure would be less than for a similar area with exactly the same levels of contaminants that is not shaded by any overwater structures.

Please state which bird assemblages were used to assess habitat value to birds. (KC)

Response: The requested information was added to the Supplement to the draft RP/PEIS.

Please present more information on how the potential loss of natural resources in terms of fish and bird habitat were evaluated. (KC)

Response: The Trustees' authority under NRDA statutes regarding loss of habitat is limited to addressing losses caused directly by response actions (unless addressed under mitigation requirements) and by the contamination in the habitats resulting in a reduction of ecological services. Loss of habitat due to development or other factors is not within the purview of the Trustees under NRDA. However, the Trustees recognize that loss of habitat has impacted many species and the habitat restoration implemented under this plan will help address those impacts.

Coordination

Commenter supports the objective of coordinating restoration efforts with other planning and regulatory activities, to maximize habitat restoration. (KC)

Response: Support noted.

NOAA and the Duwamish Trustees should ensure a robust public involvement and review process for each NRDA restoration project under consideration. (DRCC)

Response: Although the public will have the opportunity to review and provide comments on all restoration projects, the extent to which the Trustees can involve the public in the development process for any specific restoration project will vary depending on the circumstances for that project. For example, if a PRP or group of PRPs were to propose a restoration project to the Trustees as part of settlement negotiations, the public would be able to review and comment on projects the Trustees believe are acceptable when the proposed settlement is out for public review. For projects implemented by the Trustees themselves, there would be more opportunity for public involvement during the development of the project.

Comment that local governments are identified in CERCLA and OPA as having trustee responsibilities and should be consulted in the development of restoration plans and related decisions. (KC)

Response: Under relevant NRDA statutes, including CERCLA and Oil Pollution Act (OPA), local governments do not have authority to participate as trustees in NRDAs unless so designated by the

governor of the state. The Trustees recognize that local governments have valuable knowledge, and they intend to continue seeking input from local governments throughout the restoration process.

Encourage coordination with other parties that have developed habitat plans in the Green/Duwamish watershed. (KC)

Response: The Trustees recognize the value of coordinating with others interested in habitat restoration and will continue to do so.

Industry, particularly the maritime industry, should be among those helping to identify restoration sites. (M.C. Halvorsen)

Response: The Trustees welcome suggestions from industry as well as from other interested parties for potential restoration project sites.

The Trustees should pursue opportunities to include private property of businesses who are not PRPs but whose property is adjacent to NRDA restoration sites to increase habitat size and functionality. (DRCC)

Response: The Trustees will pursue such opportunities.

Commenter questions whether the guidance for habitat laid out in the Coordination and Consultation section of the document has been determined to adequately address concerns of the federal agencies required for consultation under various federal agencies, and suggests it would promote implementation of the restoration plan if this point was clarified and the document more clearly identified requirements for individual projects regarding compliance with specific regulations or orders. (KC)

Response: This section presents a review of potentially applicable laws and regulations that may be applicable to projects. Many of the consultations and coordination are conducted as part of the process of obtaining necessary permits. Which specific requirements are applicable to any given project depends on a number of factors unique to that project, and it is not feasible to pre-identify requirements for hypothetical projects to be constructed in the future. The relevant consultations and coordination will be made for each project based on the specific details of the project.

Emphasis should be given to the goals developed by the Green-Duwamish Fish Habitat Enhancement Group/WRIA 9 Steering Committee. (DRCC)

Response: Although the goals of the Trustees extend beyond those of WRIA 9—in that additional injured natural resources besides salmonids need to be restored as part of the NRDA restoration process—we believe our efforts will help address the goals developed by WRIA 9.

Project Planning and Implementation Issues

Commenters supported integrating habitat restoration with clean-up actions where feasible; WRIA 9 requested that more specificity be included about when and how decisions about integrating clean-up with restoration will be coordinated with USEPA, the Washington Department of Ecology, and PRPs. (DRCC) (PFPS)(POS) (WRIA 9)(Seattle)

Response: Support for integration of restoration and remediation is noted; additional information regarding coordination with clean-up agencies and PRPs was added to the Supplement to the draft RP/PEIS.

Commenter indicates that the list of potential construction actions necessary for restoration is well done, but notes that excavation entails removal of fill materials, active or inactive structures, shoreline armoring, and debris, and that these materials often present unanticipated project implementation challenges. (POS)

Response: The Trustees are well aware of the challenges faced in constructing restoration projects in the LDR as a result of the restoration projects undertaken by the Elliott Bay Panel. Implementing restoration in this highly modified system is indeed challenging, and unexpected discoveries often result in increased costs and sometimes require modification of the project to accommodate these discoveries, especially if historical or culturally significant discoveries are made.

It would be useful in the section on Adaptive Management to note that future work would benefit from incorporating successful designs and techniques used in the LDR and avoiding unsuccessful past practices. (POS)

Response: This suggestion was adopted in the Supplement to the draft RP/PEIS.

The Stewardship Model section should acknowledge the need to provide temporary irrigation and control of Canada geese grazing as essential to successful establishment of riparian and marsh vegetation. (POS)

Response: This suggestion was adopted in the Supplement to the draft RP/PEIS.

It would be difficult to overstate the importance of the need for adequate source control to prevent recontamination of restoration sites. (POS)

Response: Comment noted. The Trustees agree that adequate source control is extremely important in the development of restoration projects that provide all the ecological services provided.

Commenter requested additional information supporting dimensions of restoration projects in the sections on creation of mudflat and marsh habitats, suggested the importance of uncovering relic sediment layers in former locations of marsh as a guide in planning restoration, and noted that the list of plant species in the section on riparian restoration does not include all appropriate native riparian plant species. (POS)

Response: Additional information regarding the dimension of restoration projects is included in Appendix E to the Supplement to the draft RP/PEIS. The discussion regarding habitat creation in the draft RP/PEIS was not intended to be exhaustive, but rather to provide basic information sufficient to help readers evaluate the alternatives. For any specific project, the presence of relic marsh platforms will be considered during project development, as will evaluation of other appropriate native plant species beyond those listed in the document.

Commenter suggested that emphasis be given to local business and workforce in restoration planning, implementation, and monitoring. (DRCC)

Response: The Trustees will need to follow federal, state, or tribal contracting requirements if one of the Trustees implements a project, and therefore have limited ability to follow the commenter's suggestion.

Commenter is supportive of restoration in the Duwamish, which thoughtfully co-exists with the important manufacturing and industrial base along the LDR. (Seattle)

Response: Comment noted.

Commenter supports more rigorous timelines for completion of the individual restoration plans and for the overall river-wide restoration. (DRCC)

Response: The Trustees are seeking to speed restoration of natural resources in the LDR through negotiations with PRPs for early settlement based on the Trustees' approach to estimating injuries with existing data, as discussed in the Supplement to the RP/PEIS. However, negotiations are often time-consuming and unpredictable, so setting a rigorous timeline for individual restoration projects or the overall restoration is not possible. Additionally, some PRPs may choose not to settle early, and litigation may be required in order to obtain settlements resulting in funds for restoration. So it will take many years to complete the overall river-wide NRDA restoration, despite the efforts of the Trustees to accomplish restoration as quickly as possible.

Some of the restoration plan would need to be done on private property, which cannot be taken for restoration purposes. (M.C. Halvorsen)

Response: The Trustees cannot take property for restoration, but instead will rely on property being made available by PRPs who wish to build restoration projects or provide property for others to build restoration projects, public entities that would like to see habitat restoration on their property, third parties who undertake a project for restoration banking purposes, and landowners who willingly sell property to the Trustees for restoration purposes.

The restoration process—including land acquisition, design, permitting, construction, and potential litigation—could take a decade or more, and the document should describe how the length of this process would affect the potential success of the alternatives. (KC)

Response: Although it is likely to take many years to complete NRDA restoration in the LDR, it is likely that many PRPs will want to settle with the Trustees before conducting further assessment activities and the costs associated with those activities, and so restoration will occur gradually over time. Boeing has already reached a NRDA settlement to address natural resource injuries from some of their properties and restoration actions have begun. Additional early settlements are anticipated. The most likely potential impact from a drawn-out restoration process is that land availability for restoration within HFA1 may change. If the amount of land available for restoration in HFA1 decreases, a larger proportion of restoration would need to be constructed in other HFAs under the preferred alternative or for habitat or other types of projects under the species-specific alternative. Alternatively, it is possible that additional land may be available in the future, so it is difficult to predict what impacts might result from an extended restoration process.

Priority should be given for restoration efforts that show a clear plan that the site will be able to adapt with climate change impacts. (PFPS)

Response: The Trustees share the commenter's concern about the potential for effects of climate change to impact the restoration effort, and will consider this potential in designing restoration projects.

Commenter supports giving small restoration projects more priority than is proposed, and suggests it is unnecessary in this system to give higher priority to large projects. (PFPS)

Response: When developing the valuation approach, the Trustees consulted with experts from academia and NOAA on factors that would provide higher value for restoration projects in the LDR. One of the factors identified as influencing the value of projects was size, with larger projects having more value than smaller projects with otherwise similar features. Therefore the Trustees believe that giving additional value to larger projects is appropriate. However, because there are relatively few opportunities within the LDR for large projects, many small projects will be part of the restoration effort in the LDR despite their lower value.

Commenter would like to see greater emphasis given to habitat in areas of the Duwamish where little habitat exists, suggesting a goal of having habitat sites within each of a fixed length of linear shoreline (specific length of shoreline desired is not specified in the comment). (Seattle)

Response: The Trustees recognize the value of having habitat areas throughout the length of the LDR and will try to spread restoration throughout the LDR so as to not have large gaps without habitat (existing and/or restored). We believe that all reasonable potential locations to conduct restoration in the LDR will need to be used in order to meet restoration goals. These locations include property where PRPs or third parties interested in NRDA restoration banking are willing to build restoration projects, public property made available for restoration by the Trustees or others, and property that can be purchased by the Trustees with settlement funds for restoration.

Impacts Analysis

The analysis of impacts should include a statement relating to potential greenhouse gas emissions. (POS)

Response: Comment adopted in the Supplement to the draft RP/PEIS.

Commenter believes that both action alternatives would have short-term impacts on energy and natural resources in contrast to description in the draft RP/PEIS that no impacts would be expected. (KC)

Response: The referenced section in the draft PEIS (8.2.1.3) addresses the issue of whether the alternatives would impact the **development** of energy or natural resources. The analysis of impacts expected from the action alternatives on natural resources themselves is discussed elsewhere in the document, and the potential for short-term impacts is noted. Although implementing either action alternative would use energy (fuel for construction equipment, electricity, etc.), by any reasonable standard this would be so negligible that no measurable impact to energy supplies or prices would be expected.

Commenter expresses concerns about the safety of recreational uses, such as boating and fishing, of the LDR. (M.C. Halvorsen)

Response: The LDR is already used by the public for recreation, and the creation of habitat restoration projects will not affect the safety of such activities. Instead, habitat restoration should enhance the quality of recreational uses of the LDR.

Placement of large woody debris is not feasible and would be dangerous to boats. (M.C. Halvorsen)

Response: Large woody debris has been used safely in restoration projects in the LDR. Wood can be anchored when necessary to prevent danger to navigation. All such restoration projects in the LDR require a permit from the USACE, and safety to navigation is one of the factors considered in the permit review process.

The banks of the lower 5.5 miles of the Duwamish River are made up of fill or are otherwise altered, plants will not grow there, and creation of marsh, mudflat, or riparian habitat in a working commercial waterway is impossible as it would interfere with navigation. (M.C. Halvorsen)

Response: Several successful restoration projects have been implemented within the lower 5.5 miles of the LDR. These projects have not negatively affected navigation, and projects implemented consistent with this plan will be designed so as to not interfere with navigation. These projects generally involve removal of artificial fill, pulling back and contouring the banks, and planting native vegetation.

Chinook salmon return to the Duwamish River in greater numbers than any other river in Puget Sound, Chinook salmon "like" industry, and the Trustees' plans may reduce the amount of returning Chinook salmon; birds like the industry in the river. (M.C. Halvorsen)

Response: The Trustees disagree with the contention that industrial development and activities along the LDR benefit either Chinook salmon or birds. It is widely recognized that loss of habitat, especially within the transition zone, is a factor in the reduction of Chinook salmon populations in Puget Sound, and therefore the Trustees believe that increasing the amount of habitat within the LDR will positively affect Chinook salmon runs in the Duwamish. We believe that creation of additional habitat will similarly benefit birds. Finally, a number of habitat restoration projects have been constructed in the LDR by the Port of Seattle and others, including between Kellogg Island and Turning Basin #3.

The discussion of land and shoreline use in the draft RP/PEIS should include a discussion of impacts caused by the conversion of shoreline properties from their current designated use. (KC)

Response: Additional language has been added to this discussion that property conversion to habitat would remove land from commercial use (in addition to the existing discussion related to economic impacts in that section). As discussed in the document, the Trustees do not believe that significant amounts of property would be available for the Trustees to purchase, so the impacts of such conversion would be slight. Many projects on commercial property could be done without affecting current uses (as will be the case for the two habitat restoration projects Boeing has agreed to build in their NRDA settlement) or could be built on public property made available for habitat work.

NRDA Process, Injury Assessment Issues

Section 2.1 of the draft RP/PEIS ("Affected Environment") would be clearer if information describing the timeline for compensatory restoration decision making is added. (POS)

Response: This section is intended to be a description of the LDR and surrounding environment as they exist today, and it would be confusing to include a discussion related to timelines for aspects of the NRDA process here. As discussed elsewhere in the response to comments, it is not possible to develop a specific timeline for restoration decisions or actions given the uncertainty of how different PRPs might decide to be involved in the process. Decisions about compensatory restoration actions will be made gradually over time as the Trustees engage with PRPs in settlement negotiations on projects to resolve their liability, obtain settlement funds in which to implement restoration ourselves, and after any litigation is concluded for non-settling PRPs.

The discussion under Restoration Goals and elsewhere confuses injured natural resources with the effects of past physical alterations, and how this relates to baseline is not clear. (POS)

Response: Changes were made in the text to help clarify that the goal of the NRDA in the LDR is to restore injuries resulting from releases of hazardous substances, not from past physical alterations of the LDR. The past physical alterations are considered as part of the baseline conditions at the site.

Under CERCLA, there is liability for clean-up of oil spills but not for natural resource damages, and this is contrary to the Equal Protection Clause of the 14th amendment. (M.C. Halvorsen)

Response: Liability for injury to natural resources resulting from oil spills is covered under OPA, and the Trustees include injuries resulting from releases of oil in our approach toward estimating injury in the LDR.

Commenter requested additional details on the injury assessment process. (PFPS)

Response: Extensive information on the injury estimation approach for early settlement in the LDR was provided in Appendix C of the Supplement to the RP/PEIS.

It would be helpful to include reference materials on economic analyses that are noted as part of the damage assessment process in Section 1.6.2 ("Injury Assessment/Restoration Planning"). (POS)

Response: Additional information regarding potential approaches for injury assessment was included in the Supplement to the RP/PEIS. However, it is important to stress that this section was included in an overview of the NRDA process in general. The HEA approach used by the Trustees to develop the estimates of injury for early settlement does not include any economic analyses. Such analyses could be conducted as part of future assessment work for those PRPs who choose not to seek settlement based on the Trustees' early settlement approach.

The interaction of groundwater with the system in the LDR has been poorly characterized to date and should be included in the evaluations. (PFPS)

Response: The Trustees are evaluating available information from the state and USEPA efforts in the LDR on groundwater as a pathway for contamination in developing our estimates of injury in our early settlement process. The Trustees may conduct investigations of groundwater in future assessment work to evaluate injury for PRPs that have not reached settlement with the Trustees as part of the early settlement process. However, the Trustees believe that the current method for estimating injury for early settlement in the LDR is the best approach to getting significant early restoration in the LDR and do not intend to conduct additional investigations of groundwater at this time.

The LDR has been extensively altered, is a commercial working waterway, and restoring conditions to the historical state is not possible; information is not available on pre-development conditions as a standard to compare with today's conditions. (M.C. Halvorsen)

Response: The Trustees believe the text makes clear that the goal of the restoration is not to attempt to restore conditions to a pre-development state and that restoration to address injured natural resources resulting from the release of hazardous substances needs to co-exist with the existing commercial activities along the LDR. Several restoration projects have been implemented by the Trustees, as well as others including the Port of Seattle, without affecting navigation. The consideration of baseline conditions in the Duwamish incorporates existing development and is not based on conditions existing prior to development.

The damage assessment process is ill-defined in Sections 1.1 and 1.2 and needs appropriate detail. (POS)

Response: The Trustees feel that the discussion of the damage assessment process (discussed in more detail in later sections of the document) is sufficient to provide the necessary background to evaluate the different alternatives for restoration. Readers who want additional information on the NRDA process can find more information in the references cited.

Commenter requests that documentation of injuries be provided and to clarify any intended difference between descriptions of injuries in the Duwamish in the subsections "Trust Natural Resources and Services" and "Need for Restoration Planning." (KC)

Response: The basis for the Trustees' determination that injuries have occurred is discussed in more detail in the Supplement to the RP/PEIS. As explained in the document, a full damage assessment has not been undertaken at this time, but there is evidence that injuries have occurred. Further information regarding injuries to natural resources is available in the Pre-Assessment Screen Determination (EBTC, 2009).

The description of injuries in the subsection "Trust Natural Resources and Services" provides a broad description of the injuries that have occurred and/or potentially occurred in the LDR. The description in the subsection "Need for Restoration Planning" describes the approach of using sediment contamination as the basis for estimating injury for the purpose of early settlement. The Trustees would decide which among the suite of potential injuries provided in the subsection "Trust Natural Resources and Services" would be pursued in any injury assessment for PRPs that do not choose to settle based on the early settlement approach.

The discussion on air quality should link air quality concerns from the river corridor to natural resources covered by the restoration plan. (KC)

Response: The discussion on air quality is included in the description of the affected environment, and was not intended to address potential impacts to natural resources due to air quality issues. At this time the Trustees have not tried to evaluate potential impacts to natural resources from air pollution, and have focused instead on impacts related to contaminated sediments.

Monitoring and Stewardship

Commenter encourages specific metrics for measuring salmon, wildlife, and habitat recovery so we will know when natural resource services are recovered. (DRCC)

Response: The Trustees will monitor the performance of the habitat created at each project in order to ensure that the habitats are providing the ecological services expected. However, it is not feasible to try to monitor salmon or other wildlife populations as a metric for performance of individual NRDA restoration projects or for the NRDA restoration projects as a whole. Using salmon as an example, it would require an enormous effort over many years to try to identify the effect that a restoration project or group of projects is having on salmon populations because there are so many other critical factors for salmon, including ocean conditions, quantity and timing of river flows, harvest, etc.

Commenters supported requiring long-term stewardship as part of every project and one suggested that programs being developed by the Commencement Bay Trustees and the Elliott Bay/Duwamish Restoration Program could serve as models. (KC) (DRCC) (PFPS)(WRIA 9)

Response: The Trustees will require that long-term stewardship be a component of every project and will look to those stewardship programs as potential models. Although the exact mechanism for performing long-term stewardship may differ depending on the circumstances of individual projects, the Trustees recognize that long-term stewardship is necessary for restoration projects to achieve their goals.

Commenter suggested that whoever is doing the environmental monitoring of restoration projects would be prejudiced, and that more than one person and industry should be present. (M.C. Halvorsen)

Response: Monitoring of projects will be done by environmental firms with appropriate qualifications to undertake this work. In the case of PRP-implemented projects, the PRP could choose the environmental firm with Trustee concurrence.

Conditions change so protection of habitat restoration projects in perpetuity should be changed to "as long as these conditions remain." (M.C. Halvorsen)

Response: The Trustees recognize that conditions change and that some of the restored habitats may be affected. However, ecological services will still be provided by habitats as they adjust to changing conditions and adaptive management actions can be performed to mitigate such change; therefore, habitat restoration projects should be protected in perpetuity.

Requests for Clarification and Additional Information

Commenter requests an explanation of whether the intent of the plan is to include the Harbor Island and Lockheed West Superfund sites in addition to the Lower Duwamish Waterway Superfund site, and asks if the Lockheed West site is included whether the plan should include the affected portion of Elliott Bay. (POS)

Response: The Trustees are approaching the LDR as a single "site" for the purpose of NRDA restoration planning, and all injuries resulting from releases of hazardous substances into the LDR—wherever they originate—are included in this planning effort. As part of the estimation of injury, the area under consideration for injury assessment includes the near shoreline area of Elliott Bay fronting the Lockheed West and Harbor Island Superfund sites.

Commenter noted that the plan indicates that the Harbor Island site is included for the purpose of covering compensatory mitigation, but wanted clarification as to whether this includes the East Waterway Operable Unit. (Seattle)

Response: As noted previously, the Trustees are evaluating injuries in the entire LDR, which includes the East Waterway Operable Unit.

Services provided by natural resources are discussed but not defined clearly. (POS)

Response: A definition for the services provided by natural resources—"ecological services"—was added to the Supplement to the RP/PEIS.

The discussion about primary and compensatory restoration does not clearly distinguish them, particularly regarding implementation of "timely and efficient remedial restoration actions." (POS)

Response: Additional discussion was added in the Supplement to the draft RP/PEIS on primary restoration. Information regarding the HEA approach, and how the timing of remedial actions is factored in the determination of compensatory restoration requirements, was also added to this Supplement.

Commenter suggested specific additional references be included regarding water quality, fish species, contamination, and progress on remediation. (KC)

Response: The requested references were added to the Supplement to the RP/PEIS.

Commenter requested more information on the types of risk faced by the resources listed in the document; for example, habitat loss and impacts to food resources. (KC)

Response: The RP/PEIS addresses restoration for injuries to natural resources resulting from releases of hazardous substances. Other risks are not within the purview of the Trustees under NRDA statutes. However, the restoration actions taken under this plan will help address impacts to resources from habitat loss, by creation of new habitat which will increase the availability food resources.

The document does not provide enough detail to fully assess the species-specific restoration alternative and the PEIS from Commencement Bay which discusses this, and other alternatives should be added as an appendix. (KC)

Response: Additional information was provided in the Supplement to the draft RP/PEIS rather than adding the Commencement Bay PEIS as an Appendix. It is difficult to be specific about potential species-specific restoration projects because the approach taken by the Trustees to estimate injury for settlement purposes is based on lost services from habitats and not on direct injury to various species. The types of projects that could be included in a species-specific restoration approach are described generally, as injuries to individual species have not been quantified at this time.

Commenter requested more information related to the injuries in the LDR in order to better evaluate the preferred alternative and the nexus between the restoration and the injuries. (KC)

Response: The Trustees have not conducted a formal damage assessment at this time, so it is not possible to provide detailed information concerning impacts to species in the LDR. A description of the types of resources that were potentially injured is provided in the document. Information on how injury has been estimated for the purpose of early settlement was added in Appendix C and on how habitat restoration is valued was added in Appendix D in the Supplement to the RP/PEIS. The approach used is based on a "lost ecological services" approach due to contaminated sediments, and not on estimating injury to

individual species. The Trustees believe that the approach toward restoring injuries can be evaluated without having conducted a damage assessment and fully quantified injuries. However, further information regarding injuries to natural resources is available in the Pre-Assessment Screen Determination, available online at:
http://www.darrp.noaa.gov/northwest/lowerduwamishriver/pdf/Final_Pre-Assessment_Screen_for_the_Lower_Duwamish_River._Elliot_Bay_Trustee_Council,_December_2,_2009.pdf

There is no mention of the cfs that were diverted to Lake Washington or Lake Union in the Section on Biological Resources (Section2.3 of first draft). (M.C. Halvorsen)

Response: The modifications of the Duwamish River are discussed in Section 3.2 of the RP/PEIS, and the Trustees believe that this discussion is sufficient to inform the reader.

Interstate shipping commerce generates 70,000 jobs for the Seattle area and this is not mentioned in the plan. (M.C. Halvorsen)

Response: A 2009 estimate from the Port of Seattle that the seaport generates 56,000 jobs was added to the Supplement to the RP/PEIS.

Commenter requests additional information on injuries such as recreational services or non-consumptive uses. (KC)

Response: The consumption advisory for resident fish in the LDR is a recreational service loss that results from releases of hazardous substances in the LDR. Non-consumptive uses are described in the subsection "Alternate Methods for Injury Assessment" in the Supplement to the RP/PEIS. A more detailed description of injuries is provided in the Pre-Assessment Screen for the LDR.

Commenters requested additional information regarding restoration projects at the mouths of tributaries to HFA1. (KC) (POS)

Response: Restoration projects located near the mouths of tributaries in HFA1 are expected to provide similar benefits to the injured natural resources as projects located along the LDR itself. The extent to which projects can extend up into the tributaries will depend on the specific details of the project, since fewer of the injured resources would benefit directly as a project extends up into the tributary. The project would need to benefit aquatic habitat used by injured natural resources.

Commenter requests that information be provided about the number of projects identified in the 1994 EBDRP concept document and those specifically in the LDR. (KC)

Response: This information was added to the final document.

Commenter requested that additional information be included on baseline water quality contamination levels, source control, and bank stability. (USEPA)

Response: The Trustees believe that the level of detail provided in the RP/PEIS is sufficient to provide a background to review the alternatives and have provided references (incorporated by reference) where additional information can be found.

Clarify if the term "wetland" in Section 2.1.3, page 13 of the draft RP/PEIS refers to emergent plants and marsh. (POS)

Response: The reference to wetlands was meant to refer to marsh in this section.

Commenter requested clarification about language related to increased sediment and pollution inputs from riparian and marsh habitats. (KC)

Response: The final document clarifies that the loss of riparian and marsh habitats increases sediment and pollution inputs due to reduction in filtration and other attributes of these habitats.

Editorial Comments

The first sentence in Section 1.8.2 does not reflect present environmental decision-making and overstates the ability to alter aquatic area resources without directly linked compensatory mitigation actions. (POS)

Response: The sentence was rewritten in the Supplement to the RP/PEIS to more clearly identify that the loss of habitat that has occurred is significant, and that the Trustees' proposed approach will help address the lack of habitat.

Section 2.0 ("Environmental Setting/Affected Environment") and subsections of the draft RP/PEIS could be improved. (POS)

Response: A number of modifications were made in response to suggestions to improve this section in the Supplement to the RP/PEIS (Section 3.0).

The abstract does not adequately convey the specifics of this plan and is too generic. (PFPS)

Response: The abstract was rewritten and details were added to the Supplement to the RP/PEIS.

The discussion of the role of sediment contamination in the Trustees' injury estimation process does not belong in the section on "Need for Restoration Planning" and should be relocated to a section discussing injury assessment. (KC)

Response: This recommendation was adopted in the Supplement to the draft RP/PEIS.

Commenter recommends adding a subsection on sediment quality in addition to the subsections on air quality, water quality, and climate change. (KC)

Response: Requested subsection was added to the Supplement to the RP/PEIS.

Commenter suggests using the term "rock revetments" instead of "rock breakwaters" and moving the last sentence in the second paragraph in the subsection "Physical Environment." (KC)

Response: Comments adopted.

The Executive Summary would be improved if additional details were included. (POS)

Response: Additional detail was added to the Executive Summary in the Supplement to the RP/PEIS.

Commenter suggested that the EIS provide details about the communities affected by past contamination and industrial activities and how their concerns are being addressed. (USEPA)

Response: The Trustees believe that a more detailed discussion of how past industrial activities have affected local communities is not necessary for assessing the impacts of the restoration alternatives, and they direct those interested in these details to the USEPA website for the Lower Duwamish Superfund Site. The Trustees have held public meetings in the local area to facilitate public participation by the affected community in the process, and are prioritizing restoration within the LDR (HFA1) as part of the restoration effort. The Trustees believe this not only is best for restoring natural resources injured by the releases of hazardous substances, but it is also consistent with our understanding of the desire of the community to do restoration within the affected area.

Actual Comments from the Public from 2009

To: Rebecca Hoff, NOAA

From: M.C. Halvorsen

Subj.: Draft Lower Duwamish River Restoration Plan

Date: June 19, 2009

Fax: 206-526-6665

10002 Aurora Ave. N., #5546
Seattle, WA 98133
June 19, 2009

Roberta Hoff, NOAA
NOAA Damage Assessment and Restoration Center NW
7600 Sand Point Way N.E., Building 1
Seattle, WA 98115

Re: Draft Lower Duwamish River
Restoration Plan

Dear Roberta Hoff:

It was good to talk with you by telephone yesterday afternoon. As promised I am sending you my comments regarding the above-referenced plan. I will comment generally first and then specifically with reference to specific pages and specific sections. As I told you, I am concerned with the 5.5 miles from the north tip of Harbor Island to Turning Basin 3 (and boats still turn around in Turning Basin 3) as that is a working, industrial, commercial, federal waterway and is not acknowledged as such in the Plan.

Because that area has had more alteration than the other areas included in the plan, the industrial, commercial waterway should be treated separately. Instead NOAA has designated HFA 1 as extending up to the North Wind Weir, a distance of 7 miles. The last mile and a half were never straightened and should more properly be included with HFA 3. The Plan is very fuzzy that indeed the first 5.5miles is a working industrial commercial waterway; that the banks of that stretch are fill and trying to plant anything there is like trying to grow flowers in cement. The bank cannot be removed because that would cause the river to return to its winding channel thereby wiping out the industrial, commercial area, which incidentally generates 70,000 jobs. This is unconstitutional as it would interfere with the commerce clause of the U.S. Constitution. It should be explicitly stated that the industrial, commercial waterway has certain alterations that cannot be undone.

In two cases dealing with commercial waterways, United States v. Chandler-Dunbar Water Power Co. 229 U.S. 53, 33 S.Ct. 667, 57 L.Ed 1063) 1913) and United States v. River Rogue Improvement Co., 269 U.S. 411, 46 S.Ct 144, 70 L.ed 339 (1923), the United States Supreme Court, the final arbiter of what the law is in the United States, declared that the primary purpose of a commercial waterway is navigation. It is not fish. There are many more cases dealing in general with navigable bodies of water that state the same thing. The Court has been consistent on this issue all the way down to 2003. I haven't checked past that year and it may be to the present time.

The Chinook return in greater numbers to the Duwamish River than any other rivers in Puget Sound, a fact never mentioned in NOAA's plan. Maybe what the other rivers need is a little industry. The Chinook certainly like it. NOAA plans to change the river. What effect will this have on the Chinook? NOAA and everyone else just assumes the Chinook will adapt. That is an assumption, not science. It could very well be that the Chinook don't like the changes and won't return. If that happens and NOAA ruins the Chinook run, then more harm than good has been done.

Specifically, I have the following comments:

1.7 Goals. P.7, para. 1: Restoring to historical (pre 1911s) conditions is not possible in the first 5.5 miles of the Duwamish Commercial Waterway because it has undergone such a high level of alteration and and they should be clearly stated.

1.8 Need for Restoration Planning. P.8-9, para. 4 on P.8 and para. 1 on P. 9. It is ignored that 5.5 miles of the river is a commercial industrial waterway and cannot be accomplished here. Again, this reads as if that area is just a country stream.

1..8.1 Purpose of Restoration Planning. P 10 in Perpetuity. Conditions change. Perpetuity should be changed to as long as these conditions remain.

2.2 Physical Environment. P. 14, para. 3:The Duwamish River, as were other rivers throughout the country, straightened between 1911-1916 to be a commercial, industrial waterway and it still is in the first 5.5 miles from the north tip of Harbor Island to Turning Basin 3. The banks are fill, not dirt and nothing will grow in them.

2.3 Biological Resources. P.15, para. 1: In discussing the cfs, there is no mention that some of the original cfs were diverted to Lake Washington or Lake Union. This is not really a complete picture.

Birds. P.16, para. 2: Kellogg Island, near Harbor Island, close to the mouth of the Duwamish, is a nature preserve. The next bird area is upland at Turning Basin 3 at Hamm Creek, 5.5 miles distant. Like the Chinook, the birds like the industry in the river. Anyone reading this would never know that an industrial area existed.

Chinook Salmon. P. 17, both paras: See my general comments, P. 1, para. 4. See the legal definition of what is the primary purpose of a commercial waterway.

2.4 Socioeconomic/Cultural Resources. P. 20, para. 20. The interstate shipping commerce in the Duwamish Commercial Waterway generates 70,000 jobs for the Seattle area. There is no mention of that in this plan and in any paragraph muchless this one. I consider the failure to include the maritime industry when listing the jobs in King County as downright underhanded and misleading.

3.2 Public Participation. I have a summer place in B.C., Canada and usually leave for the property in April and return in October. Consequently, I never know of these meetings. The only meeting I heard of and attended was one where NOAA stated, very vindictively , that NOAA was going to punish polluters again after EPA already punished them once for polluting. It sounded like double jeopardy, which is unconstitutional as it violates the 5th amendment to the U.S. Constitution. However, since neither I nor members of my family were polluters, I did not pay further attention to NOAA. Nothing was said about a restoration plan, for if it had been mentioned, I would have paid close attention. Further, I did not subscribe to the Seattle Times. I preferred the now defunct Post-Intelligencer. I am here this year because I hurt my back and am undergoing physical therapy.

4.2 Responsible Party Liability. P. 26, para. 1: CERCLA 42 U.S.C. 9601 et seq. holds oil spills liable only for cleanup and exempts them from natural resource responsibility. (I know because I spent 50 hours in the University of Washington Law Library studying that law.) To me, it violates the Equal Protection clause of the 14th amendment to the U.S. Constitution because oil companies are more equal than the rest of us.

5.1 Description of Preferred Alternative. P.27, line 6: Creation of marshes and mudflats in a working industrial, commercial waterway such as the first 5.5 miles of the Duwamish from the north tip of Harbor Island to Turning Basin 3 is impossible as it would interfere with navigation. It is ludicrous to pretend that such things can be done.

5.2 Restoration of Injured Natural Resources and Services. P. 27. When the 5.5 miles of the Duwamish River was straightened between 1911-1916, fill was placed to create the banks. No assessment to natural resources occurred; thus there is no standard to compare today's existing situation with what was there in 1916. Any comparison would be complete guesswork.

5.3 Key Duwamish Habitats. P. 27 and 28: It is impossible to restore marshes, intertidal mudflats, and shallow subtidal in a working industrial, commercial waterway. I wonder if someone is fantasizing. This is ridiculous. As to riparian habitat, the land in question is private property and cannot be taken for buffers. Riparian Habitat. P.28, para. 4: The property beyond mean high water is privately owned. NOAA cannot take property for the proposed purposes without paying just compensation. Again, this is another hopeless proposal.

5.5 Restoration Process and Objectives. P. 29, last para.: Generally stated these objective sound fine. The problem is it won't work in a working, commercial industrial waterway. I don't like to sound like a broken record but I reiterate: the primary purpose of a commercial waterway is navigation. It isn't fish. Interfering with navigation is unconstitutional and violates U.S. Supreme Court rulings. The banks are fill, 10 ft. deep and trying to grow anything there is like trying to grow flowers in cement.

There is no recognition in this plan that the Chinook return in greater numbers to the Duwamish River that any other river in Puget Sound. See my general remarks, paragraph 4.

In this 5.5 miles, only Hamm Creek is a tributary and enters the Duwamish just south of Turning Basin3, where boats still turn around. I was unaware that hazardous substances were released south of Turning Basin 3. All of the property in the 5.5 miles is used. It is not vacant land. Exactly where does NOAA plan to have permanently wetted areas at appropriate elevations? Incidentally, Mean High Water is 8 feet, not 13.

5.6 Habitat Focus Areas, HFA 1. P. 31, last para., P. 32-33, all: I object to including past 5.5 miles as that has a different history with different effects. The proposed plan for the Lower Duwamish River first surfaced 10 years ago and was discarded as unworkable. The scientists told us that the banks of the river are fill and nothing will grow with them; that there are exactly 7 "spots", some on private property, that do have dirt but that they are not connected. What is planted in the banks will die. The dead material would accumulate on the bed of the river, which would be excessive, which in turn would cause the algae to grow which in turn would suck the oxygen out of the river. This plan will surely kill the river. This is the third time this plan has been dredged up and I cannot for the life of me understand why.

HFA 1The Lower Duwamish River. P.31, last para. nd continues to P.32 Again, this designation including the 5.5 miles of the industrial, commercial waterway of the Duwamish River and extending it another mile and a half is unnatural. The areas have different histories and different characteristics. It is like comparing apples and oranges. The commercial, industrial 5.5 miles of the Duwamish River should be considered separately and the other area should be placed with HFA 3. I don't know if this designation is to camouflage what is being planned but I suspect it is. Obviously, in a commercial waterway weirs cannot exist as ships and boats cannot navigate around them.

HFA 2 Inner Elliott Bay Shoreline. P.32: Again, much of this property is privately owned. The harbor is a busy harbor, not just Port shipping but privately owned interstate vessels, ferries, sightseeing boats and recreational boats. I do not see how this could possibly work.

HFA 3and HFA 4 The Duwamish River Reach and The Green River Reach, respectively, P.32: These areas are not commercialized as the first two areas but much of that land is privately owned and the property owners have riparian rights. NOAA cannot go upon private land without just compensation and cannot abolish anyone's rights, which is what NOAA would be doing.

6. RESTORATION TYPES. 5 Locations in the River P. 35, last para., P. 36, para. 1,2, 3: It is totally ludicrous to try to restore the Lower Duwamish River, a working industrial, commercial waterway to its historical habitat condition, and talking about marshes and mudflats therein is ridiculous.

6. Landscape connectivity. P.36, last para.: In the commercial waterway off-channels and side channels are used by boats to navigate the channel. Any interference with navigation is unconstitutional. I cannot understand why anyone at the Seattle Office of NOAA would seriously propose this. It is totally not feasible and downright ridiculous.

6.1 Desired Types of Restoration. P.37, last para.: Again marshes and mudflats in the industrial, commercial waterway cannot be achieved. This is not a country stream. Furthermore, these plans would interfere with riparian rights of upland owners. Riparian rights, the free use of water in rivers, lakes and streams by the upland owner, can be traced to the Middle Ages. They came to this country from England and are in all 50 states. NOAA cannot abolish rights as that is unconstitutional.

6.1.1 Creation of intertidal Mudflats and 6.1.2 Creation of Marsh. P. 38: my comments are the same as for 6.1. I begin to wonder if people are hallucinating.

P.39, last para.: The placement of large woody debris is not only not feasible but also dangerous to boats. Such debris could become entwined in the propellers of boats and damage them. This is another silly idea.

6.1.3 Creation of Riparian Habitat. P.40, para. 1,2,3: This gives a false picture of where riparian habitats occur. Kellogg Island, near Harbor Island, at the north tip of Harbor Island, is a nature preserve. For 5.5 miles up to Turning Basin 3 there is very little habitat. This is the highly industrialized, commercial waterway whose upland is privately owned and this is where the banks of the river are fill. It is a fantasy to talk of planting Willows, Sitka Spruce, Hemlocks, Douglas Firs, Salal and Oregon grapes. Nothing will grow in the 10' fill. As it is privately owned, NOAA cannot go upon the private property. Mean High Water in the Duwamish River, according to the line drawn up by the Coast and Geodetic Survey, is 8'.

Paras. 2 and 3 are fantasies also. When the Washington State Derelict Vessel Department informed us that this was the lowest priority with them and it would take years to get to them, Boyer Towing, Inc., an adjacent property owner, in front of whose property there is no pollution, decided to obtain the necessary permits and remove the derelict vessels at their own expense. Removal can only be done at certain times of the year because of the Chinook run.

In the lower Duwamish River, Hamm Creek is the only Creek in that 5.5 mile stretch of the river and it has already been reconnected.

Planting on adjacent lands on private property is the taking of property without due process of law.

6.2 Types of Restoration Not Desired. P.41, whole para.: This whole plan for the 5.5 mile stretch of the Lower Duwamish River is a type not desired. It won't work. As I said I spent 50 hours in the University of Washington Law Library studying CERCLA. It does not give NOAA or anyone else the right to destroy the interstate commerce industry in the name of making the public and environment whole again (which cannot be accomplished with this plan). This proposed plan for the Lower Duwamish River is totally misleading, unrealistic and unobtainable.

6.3 Restoration Project Monitoring and Performance Criteria. 6.3.1 Performance Criteria. P.42: This is too vague to comment on.

6.3.2 Adaptive Management. P. 42: This is too vague to comment on.

6.3.3 Monitoring Parameters. P.43, whole section: I agree monitoring should take place for 10 years but I would be concerned that whoever is doing the monitoring would be prejudiced. Therefore, it should be

more than one person and industry should be present or eve be a member of the persons doing the monitoring in the Lower Duwamish River.

6.4 Stewardship Model. P.44, whole section: There is no way that the Lower Duwamish River can be restored to its 1911 condition. Instead a new plan, focusing on the 5.5 miles comprising the working industrial, commercial waterway separately, that realistically evaluates what can be done without interfering with interstate commerce and private property owners' rights should be undertaken.

7. PROJECT SELECTION. 7.1 Summary of Other Restoration Plans. P.45, last para.: WRIA 9 was very general but did state there is no scientific evidence that docks and other structures over the water harm or interferes with the fish run.

The Port of Seattle's Plan, having been discarded 10 years ago and dredged up this year, was not adopted. It was sent back for further scientific scrutiny. I know it won't stand up to such scrutiny because 10 years ago the scientists told us it wouldn't. However, with all these flawed plans out there, there is no need for another restoration plan.

Duwamish Valley Vision Map is another fantasy.

7.2 Selection Criteria. P.46: The Lower Duwamish River(5.5 miles) is not included with those identifying the sites. Industry should particularly include representatives from the maritime industry.
Tier 1 Screening. P.45: Again, a new plan should be drawn up realistically assessing the Lower Duwamish River as it is today and realistic standards should be based on that.

Future Management. P.47: Under no circumstances would I agree to a conservation easement on my properties. One is in the industrial, commercial waterway and I lease to a man who operates a marina there. The other is residential and when I replaced my bulkhead I was asked to plant native species. I did. They died. The banks are fill. It was a waste of money.

Examples of Restoration Projects from Previous Settlements. Appendix C sites Kellogg Island, near the mouth of the Duwamish River and Turning Basin 3. There are none in the 5.5 mile industrial, commercial waterways which separates these two sites.

8. Restoration Alternative Analysis. P.49, para.3: The point that is lost on NOAA is that the damages done by releases of hazardous substances cannot be determined since no assessment of the damages done to natural resources was undertaken as a result of the 1911-1916 straightening. We cannot go back to 1911 which is what this proposal for the lower Duwamish River is. It is completely unrealistic.

8.1 Analysis of the Alternatives for the Purposes of Restoration. 8.1.1. P. 50: The problem here is that is seems that the point is lost on NOAA that it is impossible to return to 1911; that no assessment was taken in 1916 as to what would constitute a baseline for natural resources; and that it is not still occurring. I have owned property on the Duwamish River since 1967 and the river is cleaner now than it was then precisely because people have been stopped from dumping anything they please in the river. CERCLA provides for the restoration of natural resources and services that were injured or lost as a result of the release of hazardous substances. It does not provide for restoration of natural resources and services lost by the straightening of the river. Herein is the fallacy of this plan.

The rest of section 8 to 8.2 is meaningless for the Lower Duwamish River. I cannot comment on other areas.

8.2.1.2 Economic Impacts. P. 55: The economic impact on the 5.5 miles of the working commercial, industrial Duwamish Commercial waterway would be catastrophic as it would destroy the interstate commercial shipping.

8.2.1.5 Recreation and Education. P. 56:The banks of the Lower Duwamish River are fill, 10 feet deep. There is no way NOAA could remove hard armoring without the river reverting to its original winding course thereby destroying the industrial, commercial industry that incidentally provides 70,000 jobs. Kayaking and boating may not be desirable in such a busy waterway. Homeland Security and the Coast Guard do not want such activity because it isn't safe around ships, tugs and large barges. It is not possible to have any more parks in the 5.5 mile area that comprises the working industrial, commercial waterway. Parks in an industrial area are used by prostitutes, drug dealers and transients. The Police Department cannot patrol them and the Fire Department is adamantly opposed to them. This particular paragraph reads like something out of Alice-in-Wonderland where people pretend the working industrial, commercial waterway is just a country stream.

8.2.1.6 Land and Shoreline. P 56: This is private property and cannot be used the way NOAA proposes.

8.2.1.8 Wetlands. P.57: There is no way to have wetlands in the 5.5 miles of the working industrial, commercial Lower Duwamish River.

8.2.2.3 Floorplain and Floor Control . P.58: Off-channels in the Lower Duwamish River are used by ships, tugs and barges to reach the channel. It is not possible for NOAA to place off-channel habitat there as it would interfere with navigation, which is unconstitutional.

8.2.3 Unique Characteristics of the Geographic Area in Which the Alternatives Would be implemented [40 CFR 1508.27 (B) (3)]. P.58, last para.: The Chinook salmon return in greater numbers to the Duwamish River than any other river in Puget Sound. Maybe what the other rivers need is a little industry. The Chinook certainly like it. However, it is obvious the Chinook like the river the way it is. NOAA proposes to change the river. What fish biologist did you talk to who told NOAA it would not hurt the Chinook, possibly destroying the run altogether? Assuming that the fish will adjust is an assumption/ not science.

Ten years ago, when a plan for the 5,5 miles of the Lower Duwamish River first surfaced, very similar to the plan NOAA is putting forth here, scientists old us it would not work. The banks of the river are fill and nothing will grow in them. It is like trying to grow flowers in cement. Therefore, the plantings will die, causing excess dead material on the riverbed, causing in turn the algae to grow, causing in further turn for the oxygen to be sucked out of the river. That would surely kill every living thing in the river and do more harm than good.

I have no way of knowing if the environmentalists do not know of this scientific evidence; whether the environmentalists cannot admit of this scientific evidence; or whether they think no one will remember ten years ago.

In addition, this plan is unconstitutional as it would abolish the riparian rights of the upland owners and would ignore the rulings of the U.S. Supreme that navigation is the primary purpose of a commercial waterway.

8.2.4 Controversial Aspects of the Alternates. P.59: It is highly controversial in the 5.5 miles that comprise the working industrial, commercial waterway as it would completely destroy the industrial shipping industry. Unfortunately, no one cares about the 70,000 job loss generated by that industry or the resultant tax loss in addition to the job loss.

8.2.6 Precedential Effect of the Alternatives. P.59: This paragraph totally ignores the character of the 5.5 miles comprising the working industrial, commercial waterway and pretends NOAA is dealing with a county stream. It is totally unrealistic.

I am not commenting on the plans on pages 60-64 as I do not know how it would affect the areas other than the Lower Duwamish River. It will not work in the 5.5 miles of the working industrial, commercial Duwamish River. My only other observation is that Elliott Bay is a very busy harbor and I have serious doubts that it will work there either. However, I have not studied Elliott Bay and just pass my observation along.

9. COORDINATION AND CONSULTATION, Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), etc. P. 65: As I said before, I spent 50 hours in the University of Washington Law Library studying 42 USC 9601 et seq., and I am very familiar with it. Damage to natural resources is specifically for damage caused by the dumping of hazardous material. The Duwamish Waterway was straightened between 1911-1916. In 1916 no assessment was done to determine what natural resources suffered damage. There is no way to return to 1911; thus baseline conditions must be as of 1916. NOAA has no standard against which to measure what damage was done by the hazardous materials subsequently dumped in the river. The 5.5 mile work industrial, commercial waterway should be treated separately because only that area was straightened and has different factors affecting it.

Oil pollution Act of 1990 (OPA) 33 USCNo. 2701 et seq. P. 65: This act is later than CERCLA but the two laws say different things. CERCLA holds the oil companies responsible for the oil spill only for the cleanup and specifically exempts them from natural resources damage..

Rivers and Harbors Act, 33 USC 401 et seq., P.66: I am familiar with this act as I had occasion to read it in 2005. I am delighted to see that NOAA acknowledges the prohibition of unauthorized obstruction or alteration of navigable waters. This proposed plan, insofar as the 5.5 mile working industrial commercial Duwamish Waterway would do just that. Therefore, NOAA is prohibited from breaking the law.

Magnuson-Stevens Act (MSA)…16 USC No. 1801 et seq.,50 CFR Part 600. P.67: This act did not say that fisheries is the most important industry and that all other industries are subservient to it. Indeed, it could not do so. Where the U.S. Supreme Court had ruled that navigation is the primary purpose of a commercial Waterway, Congress cannot overturn that body.

Executive Order 11988 Floorplain Management. P. 67: This really does not pertain to commercial, industrial waterways.

Executive Order 11990 Protection of Wetlands. P.68: This is in regard to new wetlands. It does not give NOAA the right to interfere with navigation in rivers.

Executive Order 12898 Environmental Justice, as amended. P. 68: This is not applicable to an industrial, commercial waterway as the first 5.5 miles of the Duwamish River are.

Executive Order 11514 (35 Fed. Reg. 4247) – Protection and Enhancement of Environmental Quality. P 68 I cannot see that Order gives NOAA the right to interfere with navigation in navigable bodies of water; nor the right to take private property for whatever purposes; nor the right to rearrange a commercial waterway, all of which this plan would do.

Executive Order 12962 (^) Fed. Reg. 30, 769) – Recreational Fisheries. P. 69: This Order does not give NOAA the right to develop recreational fisheries along a busy working industrial, commercial waterway

such as the Duwamish Commercial Waterway. No one seems concerned with safety. Such fisheries would not be safe the recreational users nor for those engaged in interstate commercial shipping. I have no objection to recreational fisheries as long as they are not in an industrial area.

10. REFERENCES

Blomberg, G., C. Simenstad, and P. Hickey. Changes in Duwamish River Estuary Habitat Over the Past 15 Years. P.71: George Blomberg, a Port of Seattle employee, is an environmentalist, not a fish biologist. He has an agenda of his own and needs to be taken with a grain of salt.

Duwamish River Cleanup Coalition. Duwamish Valley Vision Map and Report, 2009. P. 71: This is a fantasy.

Port of Seattle, Lower River Habitat Restoration Plan: An Inventory of Port of Seattle Properties, by AHBL, Seaport Planning Group. January 13, 2009. I am not familiar with this document. I do know that the Port of Seattle, Lower River Restoration Plan itself was not adopted by the Commissioners of the Port of Seattle but was referred to further scientific scrutiny.

In general, many references pertain to pre-establishment of the straightening of the river and are not applicable to the Lower Duwamish River as a basis of restoration. No reference pertains to the straightening of the river itself and the creation of the working industrial, commercial waterway that became the Duwamish Commercial Waterway. I find them slanted leading to bias.

11. Glossary. P.79

Baseline Condition. P.79: I could not find this in any dictionary that I looked in, so I am assuming NNOAA is creating a new condition. However, it is not clear which year NOAA is using. Indeed, different parts of Puget Sound have different years. At least you know a Baseline is a measuring.

Primary Restoration. P. 81: I disagree with your interpretation of CERCLA.

Appendix C Examples of Restoration Projects Completed from Earlier NRDA Settlements. Turning Basin 3. P. 95: Boats still turn around in Turning Basin 3. It is afterall still a part of the working industrial commercial waterway that is know as the Duwamish Commercial Waterway.

My conclusions are as follows:

1. The proposed plan, as regards the Lower Duwamish River, will not work and should be discarded.

2. The 5.5 mile working industrial, commercial Duwamish Waterway should be a separate unit that is studied separately. South of Turning Basin 3 to the North Wind Weir should be included in HFA 3.

3. A new plan should be formulated for the Duwamish Commercial Waterway establishing that it is a working industrial, commercial waterway and stating that restoration is limited. The extent of damage from pollution cannot be determined because the River was straightened and no evaluation was undertaken to determine damage from the straightening, thus no basis exists from which to compare present day damage.

Thank you for your attention to this matter.

Very truly yours,

M. C. Halvorsen

M. C. Halvorsen

cc: Patricia Montanio, NOAA
Dir. Eduardo Ribas, NOAA
Acting Chrmn, FMC
Senator Patty Murray
Senator Maria Cantwell
Representative Jay Inslee
Ken Brunner, ACOE
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July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River Natural Resource Damage Assessment (NRDA) Programmatic Restoration Plan and Programmatic Environmental Impact Statement (RP/PEIS). King County's Wastewater Treatment Division and Water and Land Resources Division offer the following comments.

General Comments

1) We support the general approach laid out in the draft restoration plan identifying the basic types of all-purpose habitat that should be developed to help facilitate the development of future projects. By targeting the restoration or enhancement of ecosystem functions typical to the system, the likelihood of developing sustainable habitat is increased. We feel this is a sound approach to removing barriers for parties that have some liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Oil Pollution Act of 1990 (OPA).

2) We encourage coordination with the other existing entities that have developed habitat plans in the Green/Duwamish watershed, listed in Section 7, to take advantage of the prioritization work already accomplished. A process to ensure that parties pursuing individual projects work with these entities should help maximize their habitat value.

3) Other NRDA work conducted by the Trustees referred to in this document is often central to positions stated and conclusions drawn. Without the ability to see these documents, which are only available for review at the National Oceanic and Atmospheric Administration (NOAA), it is difficult to determine if the statements made are appropriate and the conclusions drawn acceptable. At a minimum, the relevant documents should be clearly referenced in the document so that reviewers have some idea what material is the basis for statements presented. It is preferred that relevant materials be included as appendices to the Programmatic Environmental Impact Statement (PEIS) so that reviewers have access to all relevant material for their review. Specifically, the lack of adequate documentation creates the following problems:

   -- The preferred restoration alternative is difficult to evaluate without understanding more about the species that are injured and the degree of injury. It would be helpful to have more information on the types of injuries NOAA determined has occurred. For example, are there injuries to species' habitat, food resources or directly to the species of concern?

-- It was difficult to assess Alternative 2 (Species-specific) versus Alternative 3 (Integrated Habitat) because of the lack of information presented for Alternative 2. The report refers the reader to the Commencement Bay PEIS for various aspects of the evaluation. We recommend that summaries of the Commencement Bay PEIS findings be included to facilitate the evaluation of the alternatives. However, this is not to say we disagree with the preferred approach (see Comments 34 and 35). It would be easier to evaluate the alternatives if more information was presented with regards to references to the Commencement Bay PEIS.

4) The document should address impacts associated with the length of time it would take to implement each alternative. Land acquisition, funding, design, permitting, and construction of habitat restoration projects could take a decade or longer. Litigation could add more time. How will implementation timeframes impact the alternatives' potential for success?

Specific Comments

5) Section 1.8, pages 7-8: It would be helpful to understand the types of risk faced by the resources listed, for example, habitat loss and impacts to food resources.

6) Section 1.8, page 9: The paragraph beginning "Because of the central role that sediments ..." does not seem to fit the discussion under this section heading, "Need for Restoration Planning." We suggest this paragraph be moved to a section that includes discussion of injury assessment.

7) Section 1.8, page 9: Please state which bird assemblages were used to assess the value of habitat to birds, similar to how specific fish species were listed. Also, present more information on how NOAA evaluated the potential loss of natural resources in terms of fish and bird habitat.

8) Section 2.1, page 11: Please add the Draft Feasibility Study for Lower Duwamish Waterway to the list of documents detailing contamination and progress on remediation *(AECOM 2009. Draft Feasibility Study for Lower Duwamish Waterway. Prepared for US EPA and Department of Ecology by AECOM, Seattle, WA)*. Also include the East Waterway Operable Unit Existing Information Summary Report (*Anchor Environmental and Windward Environmental 2008. East Waterway Operable Unit Existing Information Summary Report. Prepared for US EPA by Anchor Environmental and Windward Environmental, Seattle, WA*).

9) Section 2.1.1, pages 11-12: In general, air quality concerns include a broader area and source than the Lower Duwamish River corridor. If air quality is included, the text should link air quality concerns from the river corridor to natural resources covered by the restoration plan.

10) Section 2.1.2, page 12: The King County report cited did not evaluate water quality conditions on the majority of the Lower Duwamish River. It focused on the very upstream segment as well as tributaries to the Duwamish River. King County's Water Quality Assessment of the Duwamish River and Elliott Bay would be a better source of water quality evaluation for the Duwamish River (*King County Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay. King County Department of Natural Resources, Seattle, WA, 1999*). The Lower Duwamish Waterway Remedial Investigation would be another source of water quality information (*Windward 2007. Lower Duwamish Waterway Remedial Investigation Report; draft. Prepared for the USEPA and Washington DOE, Seattle, WA*).

11) Section 2.1: We recommend adding a subsection that discusses sediment quality to make Section 2.1 complete, in addition to the existing subsections that address air quality, water quality, and climate change.

12) Section 2.2, page 14: In the first paragraph of this Section, the term "rock breakwaters" should be replaced with "rock revetments."

13) Section 2.2, page 14: The last sentence of the second paragraph is not appropriate in this section. Please delete it or move it to a more appropriate section.

14) Section 2.3, pages 15-16: Additional information on fish species found in the river can be obtained from the Lower Duwamish Waterway Remedial Investigation (RI). A number of fish trawls were conducted and the results of these are summarized in the RI.

15) Section 4.1, page 25: The explanation of Federal Trustee responsibilities in the second paragraph does not acknowledge the role of local governments and their responsibilities related to Trust Resources. Local governments are clearly identified in CERCLA and OPA ("the Acts") among the entities with resources "belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by…" Local government responsibilities include: (a) Metro (now King County), under state legislation, is responsible for water quality in the central Puget Sound region in portions of Water Resource Inventory Areas 7, 8, and 9; (b) Local governments regulate land use, which is key to the ability to protect and restore natural resources defined under the Acts; (c) Under the Growth Management Act (GMA), local governments have the responsibility to protect critical areas including the lower Duwamish River; (d) King County and other jurisdictions own, manage, and hold in trust various resource lands and critical habitat in the Habitat Focus Areas; and (e) As general purpose governments, local governments have the responsibility to protect the health and welfare of the public, which includes public resources such as air, water, and land. Local governments have trustee responsibilities and should be consulted in the development of restoration plans and related decisions.

16) Section 4.1, page 25: The third paragraph in Section 4.1 states "Injuries have been documented…" Please list all of these documents. Also clarify any intended difference between the statement in the last sentence of the paragraph and the discussion of injuries presented in Section 1.8.

17) Section 5.2, page 27, first sentence: Please provide citations for where the Trustees have documented key natural resources in the lower Duwamish River as well as injuries to those resources. This information is needed to determine the appropriateness of the restoration plan and adequacy of the PEIS.

18) Section 5.2, page 27, first paragraph: Please provide more specific information on the services the Trustees believe may have been injured, for example, what recreational services or non-consumptive may have been injured?

19) Section 5.2, page 27: The last sentence discusses how marsh vegetation increases productivity of animals and plants living in and on sediments. Please note that marsh vegetation also increases productivity of salmonids and resident fish species.

20) Section 5.5, objective 1: We agree with this objective but find it difficult to assess the nexus without more documentation being provided in the document.

21) Section 5.5, objective 4: We strongly support this objective and request meaningful coordination with local governments, as they have both trustee and regulatory responsibilities.

22) Section 5.5, objective 4, fourth bullet: This flexibility will be the key to the long-term success of the restoration plan and we strongly support allowing all these options. See later comments on concerns with long-term stewardship needs, Comments 23 and 31.

23) Section 5.5, objective 5, third bullet: While we understand the need for long-term commitment and public involvement for the success of these types of programs, we feel a more formal approach is needed to ensure that long-term stewardship is maintained. Without such commitment, the efforts and expense of restoration have very low probability of achieving the designed functions. We suggest that long-term stewardship plans be required as part of every project. Those funds could then be coordinated into a single stewardship program that can coordinate with the public and non-profit organizations to provide the site work needed over time to ensure that restoration projects develop into fully functioning habitat. Programs being developed by the Elliott Bay/Duwamish Restoration Program (EBDRP) and Commencement Bay can be used as models.

24) Section 5.6, page 31: The first paragraph of Section 5.6 should include a reference to the Lower Duwamish Waterway Remedial Investigation Report. The reference cited in the document does not cover most of the Duwamish River.

25) Section 5.6, page 31: Habitat Focus Area1 (HFA) is defined as the Lower Duwamish River from the northern tip of Harbor Island to North Winds Weir. The document describes this area as the heart of the transition zone for juvenile salmon. The transition zone is described as the area where fresh and salt water mix and where juvenile salmon osmoregulate. Based on data and modeling described in the Draft Lower Duwamish Waterway Remedial Investigation Report, the transition zone would not include the entire HFA1, but a portion of it. The movement of the saltwater wedge in the Duwamish River begins at approximately river mile 3.5 (if River Mile 0 begins at the northern tip of Harbor Island). The area downstream of this point consists of marine water with only a thin freshwater lens along the surface of the river. Therefore, it seems if the restoration work is to focus on the transition zone for juvenile salmon, the areas upstream of river mile 3.5 in HFA1 and areas in HFA3 would be the focus.

26) Section 5.6, page 32, HFA1: Please clarify the last sentence in this section as this particular situation is not discussed under habitat types.

27) Section 5.6, page 32: HFA2 refers to areas of higher salinity as not being part of the transition zone for juvenile salmon; higher salinity is also found in approximately the last 3-4 miles of HFA1.

28) Section 6, page 36, first paragraph: An additional reason why the transition zone has moved further upstream is that the deeper navigation channel dug in the waterway allows saltwater to intrude further than would natural river bathymetry.

29) Section 6, page 36: We strongly encourage that landscape connectivity is highly valued as a habitat function. Particularly in an urban system, it is critical to the habitat value, especially to the terrestrial species targeted under the restoration plan.

30) Section 6.4, page 44: The fourth sentence in the first paragraph currently says that riparian and marsh habitats have increased sediment and pollution inputs. Please explain how the lack of riparian and marsh habitats have increased sediment and pollution inputs. We assume it is because of the lack of natural filtration and other attributes these habitats provide to reduce pollution from entering a river system.

31) Section 6.4, page 44: It is unclear exactly what is required for stewardship in the restoration plan. We support development of a permanent long-term stewardship program that is sustained by required contributions from each project. Once proponents meet short-term survivorship commitments, there is little incentive to continue to provide the long-term stewardship required to develop sites into fully functioning habitat. Both the EBDRP and Commencement Bay have viable models for such a program and we suggest coordinating the stewardship needed for these projects with those programs for efficiency and certainty.

32) Section 7.1, page 45: Please list the number of projects identified in the 1994 EBDRP concept document and those specifically in the lower Duwamish River.

33) Section 8, page 49: The PEIS that reviewed potential restoration approaches in Commencement Bay is key to this document and should be included as an appendix.

34) Section 8.1.2, page 51: The discussion of Alternative 2 includes statements about a broad range of affected species. However, the case has not been presented in this document to determine which species these may be or how they may be affected. Without this information, it is not possible to determine if this alternative is feasible and potentially more appropriate. Because this document does not clearly identify what species-specific injuries have occurred, we cannot determine if appropriate specific restorations could target those needs as effectively as the general habitat approach. We believe this information should be provided and assume it will clearly demonstrate that the conclusions presented in the document are supported.

35) Section 8.1.3, page 53: We support this alternative as the preferred alternative. This alternative meets the needs of the resources and provides the most realistic implementation.

36) Section 8.2.1.3, page 55: We believe that both action alternatives would have short-term impacts on energy and natural resources.

37) Section 8.2.1.6, page 56: We believe that both action alternatives would impact land and shoreline use. Land use of the areas converted to habitat would effectively be removed from their current designated use. In particular, sites in the waterway would remove industrial land from the land use inventory. In many cases it would be relatively minor, but as the GMA has identified, industrial land use is limited and is to be protected. Such impacts should be identified in the document.

38) Section 9, page 65: It is not clear in this section if the guidance for habitat laid out in this document has been determined to adequately address concerns of the federal agencies required for consultation under the Endangered Species Act, Magnuson-Stevens Act, Fish and Wildlife Coordination Act, and relevant Executive Orders. It would promote implementation of the restoration plan if this point was clarified and the document more clearly defined requirements for individual projects with regards to compliance with specific regulations or orders.

Thank you for the opportunity to comment. Please contact Sue Meyer, Environmental Planner, King County Wastewater Treatment Division, at 206-684-1171 or sue.meyer@kingcounty.gov with any questions and future opportunities to comment on the Lower Duwamish River RP/PEIS.

Sincerely,

Christie True
Director
King County Wastewater Treatment Division

Mark Isaacson
Director
King County Water and Land Resources Division

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OFFICE OF
ECOSYSTEMS, TRIBAL AND
PUBLIC AFFAIRS

July 28, 2009

Ms. Rebecca Hoff
NOAA
Damage Assessment and Restoration Center NW
7600 Sand Point Way NE, Building 1
Seattle, WA 98155

Subject: Draft Lower Duwamish River NRDA Programmatic Plan and Environmental Impact Statement. EPA Project number 07-023-NOA

Dear Ms. Hoff:

The U.S. Environmental Protection Agency (EPA) has reviewed the draft Environmental Impact Statement (EIS) for the **Duwamish River NRDA Programmatic Restoration Plan and Programmatic EIS** (EPA Project Number 07-023-NOA) in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309, independent of NEPA, specifically directs EPA to review and comment in writing on the environmental impacts associated with all major federal actions. Under our policies and procedures we evaluate the document's adequacy in meeting NEPA requirements.

The EIS is being developed to provide guidance to the Lower Duwamish River Natural Resource Trustees (Trustees) in their decision to implement restoration of natural resources that have been impacted by hazardous substance releases. The Trustees include NOAA; US Fish and Wildlife Service; the Bureau of Indian Affairs; Washington State Departments of Ecology, Fish and Wildlife Service, and Natural Resources; the Muckleshoot Indian Tribe; and the Suquamish Indian Tribe. The Duwamish River has undergone widespread contamination with numerous potentially responsible parties (PRPs) and therefore, this EIS is also intended to keep the public and PRPs informed of restoration planning and the decision making process.

We appreciate the coordination with EPA staff involved in clean up activities through our Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority. We believe that the EIS comprehensively describes the restoration strategy, restoration objectives, and monitoring criteria. We have assigned a rating of Lack of Objection (LO) to the draft EIS. This rating and a summary of our comments will be published in the Federal Register.

While we support the project, we have suggestions we believe would strengthen the document. In our comments on the preliminary draft EIS, we recommended inclusion of additional detail on baseline water quality. We acknowledge that this is a broad scale

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programmatic EIS and that more detail will be provided as restoration proposals are submitted to NOAA and Environmental Assessments are developed. However, we believe that the programmatic EIS should also provide data and a discussion of current water quality contamination levels, details about sources impacting water quality and potential restoration effectiveness (e.g. non point source, storm water outfalls, invasive species), and bank stability.

The EIS includes good references to other restoration plans that exist for the Duwamish River. We are glad to see that the Duwamish River Cleanup Coalition Visioning Report was included in this list. This report is a great resource that helps readers understand the perspective of the impacted community. Their main concerns are about health and environmental impacts from multiple sources of pollution and they look forward to a cleaned up Duwamish River Valley. Although the EIS includes a section on public participation, and a section on cultural resources and Tribal resources that have been impacted, the EIS should provide more detail about coordination with communities of concern and how restoration proposals can address their issues. We recommend that the EIS provide some detail about the communities affected by the past contamination and industrial activities, what their concerns or ideas are with restoration projects, and how these concerns are being addressed.

Thank you for the opportunity to comment on this draft EIS. If you would like to discuss our comments further, please contact Lynne McWhorter of my staff at (206) 553-0205.

Sincerely,

Christine B. Reichgott

Christine Reichgott, Manager
Environmental Review and Sediment Management Unit

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Duwamish River Cleanup Coalition

Community Coalition for Environmental Justice • The Duwamish Tribe• Georgetown Community Council • IM-A-PAL • ECOSS • People for Puget Sound • Puget Soundkeeper Alliance • South Park Neighborhood Association • Washington Toxics Coalition • Waste Action Project

Rebecca Hoff, NOAA
NOAA Damage Assessment and Restoration Center NW
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Email: Rebecca.Hoff@noaa.gov

July 28, 2009

Dear Ms. Hoff,

RE: Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

The Duwamish River Cleanup Coalition is the Community Advisory Group for the Lower Duwamish River Superfund Site. We represent ten stakeholder organizations, including the Duwamish Tribe, Environmental Coalition of South Seattle, South Park Neighborhood Association, Georgetown Community Council, People for Puget Sound, Puget Soundkeeper Alliance, Community Coalition for Environmental Justice, IM-A-PAL Foundation, Washington Toxics Coalition and Waste Action Project. DRCC attended the previous scoping Meetings for the Lower Duwamish River Restoration Plan and Programmatic Environmental Impact Statement and the May, 2009 presentation on the Plan

Overall Restoration Strategy. DRCC strongly supports the restoration project evaluation utilizing an ecosystem based approach rather than a single species.

Integrated habitat Restoration. We support Integrated Habitat Restoration and agree that restoration that can integrate intertidal mudflats, shallow subtidal, marsh and riparian habitat is of high value and more natural resource credits be awarded to those areas.

Coordinated Restoration and Cleanup. Emphasis on restoration projects that are coupled with site cleanup and treatment to minimize impacts to the river, fish, wildlife and human communities .

Long-term Monitoring, stewardship and site maintenance. DRCC supports the commitment to long term monitoring, ongoing stewardship and maintenance. NOAA and the trustees should specify what range of mechanisms "will be established by the Trustees to ensure long-tem stewardship of NRDA sites."

Partnerships Opportunities. Opportunities to include private property of businesses that are not classified as PRP's but are adjacent to NRDA restoration sites should be pursued in order to increase size and functionality of habitats.

Inclusion of public in restoration planning, implementation and monitoring. Emphasis should be given to local business and workforce including utilizing local educational and training institutions toward that end.

Marine fish, shellfish, birds, juvenile salmonids. DRCC support the "highest priority for Habitat Focus Areas are assigned to HFAs that provide habitat for all the injured groups of species identified by the Trustees (marine fish and shellfish, birds, juvenile salmonids)." Clams and other shellfish are historical traditional tribal foods and should continue to be a high priority for habitat recovery along with salmon, both adult and juvenile.

WRIA 9. Emphasis should continue to be given to the fish habitat needs and goals developed by the Green-Duwamish Fish Habitat Enhancement Group/WRIA 9 Steering Committee.

Integration of Restoration with Cleanup. DRCC strongly supports integration of habitat restoration with the EPA riverwide cleanup the Department of Ecology Source Control efforts. This will reduce cost, encourage cleanup that is habitat restoration focused from the onset and reduce the impact on the surrounding communities by a prolonged clean up and restoration process.

Public Access. DRCC would like to see a high priority for projects that integrate habitat restoration and public access. long term public access to the river ensures long term support for monitoring and stewardship.

Public Involvement. The RI/FS for the Lower Duwamish Waterway is carried out under an enhanced Public Participation Plan. The Duwamish River Valley Residents have come to expect that level of public. DRCC encourages public involvement including outreach to immigrant, Latino and Pacific-Islander populations. NOAA and the Duwamish Trustees should ensure a robust public involvement and review process for each NRDA restoration project under consideration.

Timelines and Metrics for Recovery. DRCC supports more rigorous timelines for completion of the individual restoration plans and for the overall riverwide restoration. In addition, we encourage specific metrics for measuring salmon, wildlife and habitat recovery. i.e. How will we know when populations and natural resource services are recovered?

Lower Duwamish River. DRCC supports a strong emphasis on projects in the Lower Waterway. Projects outside the waterway are a low priority.

Thank you for the opportunity to review the Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement.

Thea Levkovitz
Duwamish River Cleanup Coalition
thea@duwamishcleanup.org

PEOPLE FOR PUGET SOUND

pugetsound.org

July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way NE
Seattle, WA 98115
Via email: DuwamishPEIS.DARRP@noaa.gov

RE: Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

Dear Ms. Hoff,

Thank you for the opportunity to comment on the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*, dated May 22, 2009.

People For Puget Sound is a nonprofit, citizens' organization whose mission is to protect and restore the health of Puget Sound and the Northwest Straits.

Background: CERCLA allows trustees to seek damages for injury to, destruction of, loss of, or loss of use of natural resources. The process that must be used for restoration uses selection criteria (extent of restoring resources that have been impacts, likelihood of success, risk of collateral injury, and effect on public health and safety, and cost). Responsible parties and third parties can do the work.

The NRDA process relates to the multiple Superfund cleanups in the Duwamish/Elliott system (Lower Duwamish, Harbor Island and Lockheed W and RCRA sites). Technical approach will be the same as Commencement Bay.

The programmatic EIS is designed to be general for the whole program but more specific efforts will accompany each project.

Our specific comments follow:

1. **Overall approach.** People For Puget Sound agrees with the ecosystem approach selected in this plan, specifically the Integrated Habitat Restoration Approach (rather than a species-specific approach). This will integrate habitats to maximize ecological function, looks to long-term sustainability and includes a commitment to stewardship. We agree that the highest priority (as identified by the WRIA effort) is marsh and mudflat, followed by riparian buffers.

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2. **Integration of restoration with cleanup.** Integration of restoration with cleanup is an excellent idea. We believe that this should be a high priority and these projects should be given an incentive. Not only will it be more cost effective, it will also help push cleanup efforts to be more habitat-friendly from the start.

3. **Scope.** We object to allowing any projects outside of the Duwamish Elliott geographic area. The damage occurred in this area and the restoration needs to also occur here. There are plenty of needs within the lower river and the bay.

4. **Goal too low.** A goal of "restore injured natural resources to baseline by helping improve the ecosystem of the Lower Duwamish River to a more acceptable condition that can support both natural resources and human use of the system." is too low a bar. We need high quality habitat, not "acceptable" habitat.

5. **Groundwater.** Groundwater – its interaction with the system – has been poorly characterized in the lower watershed to date. This should be included in evaluations.

6. **Climate change.** We believe that priority should be given for restoration efforts that show a clear plan that the site will be able to adapt with Climate Change impacts, such as sea level rise or significantly changed hydrologic regimes.

7. **Long-term stewardship**. We strongly support long-term stewardship as this ensures that our dollar investment is protected. The draft plan needs to more clearly require this (on page 31). The term "encourage" is not adequate.

8. **Size of restoration projects**. We support giving small projects more priority rather than what is proposed. Linear and small, frequent projects in this constrained watershed can make sense and improve the corridor function of extant habitats. It seems unnecessary in this system to give more priority to large projects.

9. **Technical valuation.** This is a significant deficit in this document as the omission of the technical valuation approach hampers public understanding of the program. The specific technical approach should be included as an appendix to this plan. It is difficult for the public to determine that the habitat will be valued in a transparent way for this area. A highly detailed description is not needed but a basic overview, basically a 2-4 page overview of the approach, the types of factors taken into consideration, a referral to the Commencement Bay documents (specifically Appendix C), representative species, habitat values (and general range of these), species weighting, what qualifies as "fully functional," "baseline adjusted," and "degraded" and values associated, habitat polygon determination, time period for recovery. In addition, the injury assessment process should be included.

10. **Production ratio.** In the Commencement Bay process "a 1:1 productivity ratio is assumed for the level of ecological services provided by created relative to natural habitats. This implies that restored habitats will be as productive as natural habitats in terms of all associated services. There is uncertainty associated with the outcome of restoration projects…" We disagree that 1:1 is adequate because a certain percentage of the habitat WILL fail. The Trustees are asking us to take it on faith that monitoring, etc. will ensure 100% habitat and this is unreasonable. In addition, as an entity responsible for several restoration projects in the Duwamish, we can vouch for the considerable long term effort needed to control invasive species until plant succession

creates an adequate riparian canopy. The temporal loss of habitat function while this succession is taking place should be incorporated into replacement ratio requirements. Washington Department of Ecology provides guidance on this issue.

Document style:

1. **Abstract**. The abstract needs to be improved. As written, it doesn't really convey the facts of the document and therefore does not stand alone. We suggest that it be rewritten to be more specific to the specific situation of this plan rather than a generic abstract that could apply to any site.

Thank you for your consideration. If you have any questions, please contact me at (206) 382-7007/htrim@pugetsound.org.

Sincerely,

Heather Trim
Urban Bays and Toxics Program Manager

Port of Seattle

DATE: July 28, 2009

TO: Rebecca Hoff
NOAA Office of Response and Restoration

FROM: Kathy Bahnick, Geo. Blomberg
Seaport Environmental Programs

SUBJECT: Comments—Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

Please find below comments and notes regarding the 5-22-09 draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement. The port is grateful for the opportunity to see the draft EIS take shape. In addition, the port is pleased for the contributions your office made to the port's recently completed Lower Duwamish River Habitat Restoration Plan (final document dated 7-7-09). The ability to collaborate in planning, and potentially implementing, habitat improvements in south Elliott Bay and the Duwamish Waterway is an essential element of successful fish and wildlife restoration.

Executive Summary:

The executive summary derives from the body of the draft EIS, however, several of the summary statements would benefit from using descriptions presented in Chapter One and Chapter Five. In particular, discussion of habitat focus areas, use of an integrated habitat restoration approach, restoration goals, and restoration planning is expertly evaluated in sections 1.7, 1.8, and 5.1 through 5.6. The executive summary would be improved using more similar statements and evaluations.

Discussion under Restoration Goals confuses injured natural resources with the effects of past physical alteration of south Elliott Bay and the Duwamish River estuary. It is important to clearly distinguish between CERCLA decision-making, subsequent natural resource damage determinations, and derivative fish and wildlife habitat restoration actions. The latter may be based on appropriate environmental planning, recognizing the context of past changes, however, natural resource damages are linked with specific applicable laws and more recent timeframes.

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Item (2), under Trustees' Primary Objective, notes that the trustees seek a net gain of habitat function beyond existing conditions. It is important that readers understand that this objective is based on CERCLA (and other applicable laws) NRD determinations, distinct from past environmental changes.

The para under Desired Types of Restoration clearly summarizes the hierarchy of restoration goals. The statements refer to aquatic resources and services lost due to the effects of contamination. Natural resources service is not well defined in the body of the EIS and using the term in the summary statement is confusing.

DEIS comments listed by section

Sections 1.1 and 1.2, refer to the decision-making sequence linking CERCLA, the Elliott Bay Trustee Council, and the damage assessment process. The objective of the trustees is outlined, however, the damage assessment process is ill-defined and it would be helpful to clarify and outline the process. The link between planning and the damage assessment process needs appropriate detail. The term "services" is also used, without sufficient definition. "Services" are described indirectly in Section 4.1.

Section 1.3, last para, includes an excellent description of the integrated habitat restoration approach suggested by the DEIS. This would be helpful in the executive summary, noting the need to describe "associated services".

Section 1.5, notes the benefit of integrating restoration and remediation work. The port agrees with this approach and hopes to work with your office in this respect regarding future fish and wildlife habitat restoration and enhancement actions. Discussion in this section seeks to distinguish between primary restoration and compensatory restoration. The distinction is unclear and, although the DEIS pertains to compensatory actions, later statements are not entirely clear regarding primary in contrast with compensatory restoration, particularly regarding implementation of timely and efficient remedial restoration actions

Section 1.6.2 notes economic analyses important to natural resource damage assessments. It would be helpful to include reference materials in this instance. This section uses "natural resources and services" throughout, without any definition.

Section 1.7 is unclear regarding the distinction between CERCLA-related damages and

past physical development in the area of evaluation, particularly relating to baseline conditions. Items (1) and (3) are clear, while item (2) is not sufficiently analyzed or evaluated in order to link the statement with the body of the DEIS. Finally, the last sentence must be clear regarding compensatory actions based on a stated baseline.

Section 1.8, provides important context and background. It is important to note that by 1920 approximately 75 percent of the habitat features emphasized in the DEIS as restoration objectives had been lost due to physical changes, with approximately 15 percent additional change prior to 1940. This simply notes that the scope of change that shaped the present in urban/industrial waterway took place more than 60 years ago. It is important to refer to resident and migratory marine fish, mammals, and birds, as well as anadromous fish. The LDW superfund site includes 4.6 miles of the 5.2 mile long Duwamish Waterway. This section also mixes Harbor Island and Lockheed West superfund decision-making with the lower Duwamish context. Is the intent of the DEIS to cover resource damages from all three superfund sites? If the Lockheed West superfund site is included in restoration planning, should the plan include the affected portion of Elliott Bay as an appropriate focus area? Later DEIS statement indicate the rationale for extending restoration decision-making from the north margin of Harbor Island to approximate river mile six (total of seven river miles), however, including these additional CERCLA matters requires explanation.

Sections 1.8.1 and 1.8.2 include very useful statements indicating "what" the restoration plan will do and the "benefits" of restoration planning. However, the first sentence in Section 1.8.2 does not reflect present environmental decision-making and over-states the ability to alter aquatic area resources without directly linked compensatory mitigation actions.

Section 2.0 can be improved. Seven miles separate the north end of the West Waterway from North Winds Weir. The Duwamish Waterway is 5.2 miles in length, with the West Waterway approximately 0.9 miles long.

Section 2.1 would be more clear with the addition of information describing the timeline for compensatory restoration decision making.

Section 2.1.3, page 13, third para: Clarify if term "wetland" refers to emergent plants and marsh.

Section 2.3 includes a very useful summary of biological resources. In light of subsequent statements relating to native vegetation and riparian environments, including off-channel areas and large woody debris, it would be useful to describe forested wetland/tidal swamp in context. Terminal 30 no longer supports nesting glaucous-winged gulls. It would be useful to refer to river mile or study mile for some of the features noted. For example, Kellogg Island is located at approximately river mile 1.3.

Section 4.1, last para, includes a well written description of the relationship between injured resources and cleanup remedies.

Section 5.1 repeats the potential for confusing CERCLA-related natural resource damages in the lower Duwamish River with the historic scope of physical change in the Duwamish estuary.

The statement in second para, Section 5.2, firmly establishes the link between habitat restoration and injured resources.

Section, 5.3, describes key habitats in concise statements. As with later text (page 39) it would be useful to emphasize export of detritus from emergent plants. The inter-tidal mudflat description overlooks the relative abundance of existing deep inter-tidal and shallow sub-tidal, low-slope mudflat area in the Duwamish Waterway. Riparian habitat discussion could be improved with more description of the benefits of forested wetland plant communities

Section 5.4 is another example of the need to distinguish between CERCLA related NRD actions and resource functions lost due to dredging, building or dikes, and shoreline armoring.

The discussion of process and objectives in Section 5.5 is well done.

The Section 5.6 discussion of habitat focus areas is clear, however, HFA1 abruptly introduces "mouths of tributaries" and does not clarify the insertion. This requires clarification and supporting evaluation.

Section 6 and the discussion of restoration types is well done and logical. More support

of the dimensions noted in 6.1.1 and 6.1.2 is required, however. Section 6.2.1 should note the importance of uncovering relic sediment layers, in the location of former marsh areas, as a guide to planning restoration site dimensions. Section 6.1.3 includes a list of riparian trees and shrubs. Recent experience with riparian restoration in the Duwamish Waterway includes a more extensive list of appropriate native riparian vegetation trees and shrubs.

Section 6.1.4 describes potential construction actions necessary for restoration actions. It should be noted that in all cases, excavation would entail removal of previously placed fill materials, active or in-active structures, shoreline armoring and debris. These materials often present significant un-anticipated project implementation challenges. The list is well done.

Section 6.3.2 describes adaptive management regarding fish and wildlife restoration site design, construction, and implementation. It would be useful to note that future work would benefit from incorporating successful designs and techniques used recently in the Duwamish Waterway, while avoiding past practices that did not create useful conditions or provide the most environmental resources possible.

Section 6.4 should acknowledge the need to provide temporary irrigation and control of Canada geese grazing as essential to successful establishment of riparian and marsh vegetation.

Section 7.2, Tier 2 screening, refers to the need for adequate source control to prevent re-contamination of restoration sites. It would be difficult to over-state the importance of this matter. Construction of relatively large habitat focus sites, connected with more modest habitat corridor improvements requires confidence that past sources of sediment and water column contamination are controlled. Recent experience with habitat restoration in light of superfund re-contamination oversight has required substantial negotiation and commitment of resources.

The description of typical kinds of restoration actions included in Section 8.1.3, the preferred alternative, is well stated and consistent with recent practical experience in the Duwamish Waterway.

Section 8.2.1, and the following discussion of anticipated effects, is concise and consistent with recent SEPA analysis prepared by the port's Lower Duwamish River

Habitat Restoration Plan. The analysis should include a statement relating to potential greenhouse gas emissions.

The port would be pleased to provide clarification and additional information regarding the above at your convenience.

WATER RESOURCE INVENTORY AREA 9 (WRIA 9) WATERSHED ECOSYSTEM FORUM

GREEN / DUWAMISH AND CENTRAL PUGET SOUND WATERSHED

Algona
Auburn
Black Diamond
Burien
Covington
Des Moines
Enumclaw
Federal Way
Kent
King County
Maple Valley
Normandy Park
Renton
SeaTac
Seattle
Tukwila

King Conservation District
Vashon/Maury Island Community Council
Covington Water District
Port of Seattle
Tacoma Public Utilities
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington Department of Natural Resources
U.S. Army Corps of Engineers

Washington Environmental Council
Green/Duwamish Watershed Alliance
Trout Unlimited/Mid-Sound Fisheries Enhancement Group
Save Habitat and Diversity of Wetlands (SHADOW)

The Boeing Company
Master Builders Association
King County Agricultural Commission

July 23, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Re: Comments on Draft Lower Duwamish River Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS)

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) for the Lower Duwamish River.

The following comments are offered on behalf of the WRIA 9 Watershed Ecosystem Forum, a broad-based partnership of governments, businesses, and non-profit groups working on watershed health and salmon habitat recovery in the Green/Duwamish and Central Puget Sound Watershed. These comments are intended to complement the comments that may be provided by WRIA 9 partner jurisdictions such as Seattle, Tukwila, and King County.

1) Thank you for your responsiveness to comments provided during the scoping process in the July 31, 2007 letter from WRIA 9 Watershed Coordinator Doug Osterman. Most of the comments in that letter were acted on in the draft RP/PEIS. As a corollary, we appreciate the use in the RP/PEIS of recommendations from the 2005 WRIA 9 Salmon Habitat Plan: Making Our Watershed Fit for a King.
2) We concur with the policy of integrating restoration with the sediment cleanup effort under the Lower Duwamish Superfund process. The WRIA 9 Salmon Habitat Plan includes a policy (DU2 on page 7-78) supporting concurrent cleanup and restoration. We ask the Trustees to be more specific about when and how they expect to coordinate decisions about integrated cleanup/restoration with the Environmental Protection Agency, Department of Ecology, and potentially responsible parties. Greater clarity on this matter will increase the likelihood that restoration occurs sooner rather than later, which in turn will generate greater ecological value.

Financial support provided by signers of Watershed Planning Interlocal Agreement for WRIA 9 including: Algona, Auburn, Black Diamond, Burien, Covington, Des Moines, Enumclaw, Federal Way, Kent, King County, Maple Valley, Normandy Park, Renton, SeaTac, Seattle, Tacoma, Tukwila

3) We concur with the primary focus on creation of mudflats, marshes, and riparian habitats. These are the habitat types most needed to restore/rehabilitate the estuarine ecology of the Duwamish and thus of greatest benefit in terms of salmonid habitat. We appreciate the recognition given to the importance of transition zone habitat to juvenile Chinook salmon.

4) We concur with the use of juvenile Chinook salmon as one of two fish species used to assess the value of restored/rehabilitated habitat to fish.

5) We concur with the Trustees' preferred restoration alternative: Alternative 3: Integrated Habitat Restoration. WRIA 9 partners are working to restore the ecological health of the Green/Duwamish and Central Puget Sound Watershed as a means toward recovering habitat used by Chinook and other salmonids. The proposed ecological approach, informed by the needs of juvenile Chinook as a surrogate species for other fish species, is consistent with our approach.

6) We concur with the approach of using Habitat Focus Areas to prioritize restoration/rehabilitation and support directing as much restoration/rehabilitation as possible into Habitat Focus Area 1, the Lower Duwamish. The WRIA 9 Salmon Habitat Plan, in fact, is counting on the success of the Restoration Program in the Lower Duwamish to complement habitat restoration work done upstream and in the marine nearshore. We encourage the Trustees to only modestly discount the value of any projects done in Habitat Focus Area 3 (the Duwamish from North Wind's Weir [RM 6.3] to Black River [RM 11]) as compared to projects done in HFA 1. While the Salmon Habitat Plan identifies the known transition zone as extending to RM 7.0, there is great ecological benefit from projects throughout the Upper Duwamish.

7) We strongly support the recommended use of a mechanism that funds and arranges for long-term stewardship of the restored/rehabilitated sites.

Thank you for the opportunity to comment. Please contact WRIA 9 staff Dennis Clark, 206-296-1909, dennis.clark@kingcounty.gov with any questions and regarding future comment opportunities.

Sincerely,

Dow Constantine, Co-Chair
Councilmember, King County

Bill Peloza, Co-Chair
Councilmember, City of Auburn

Cc: WEF Members

City of Seattle
Gregory J. Nickels, Mayor

Seattle Public Utilities
Ray Hoffman, Acting Director

July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Re: Comments on Draft Lower Duwamish River Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS)

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) for the Lower Duwamish River.

The City is glad to see a preference for habitat in focus area 1—the Lower Duwamish. We understand that this area is both the most habitat poor area and the most difficult to find opportunities to bring in habitat. Thus we agree it is important to discount to some degree habitat proposals elsewhere in order to encourage Lower Duwamish proposals.

The manufacturing and industrial base located along the Lower Duwamish is important locally, regionally, and globally. Therefore the City of Seattle is supportive of restoration in the Duwamish which thoughtfully co-exists with these important economic resources.

We note that the Trustees' document recognizes that there are areas of the Duwamish with little or no habitat at all (p. 29) and supports restoration in those areas. However follow-up on that recognition is not apparent (see notable absence of "underserved" areas as a consideration on p. 35,#5). The City would like to see greater emphasis given to habitat in areas where no other habitat exists. A parallel is the City's goal of having a City park within specified distance of all residential areas. Here we might strive for habitat sites of some sort in every x mile of lineal shoreline.

The plan, in its draft form, does not indicate that the Trustees are willing to recognize the time value of habitat by giving greater consideration to habitat created earlier, as opposed to that habitat that may be created 10 years hence. Although I have heard verbally that such consideration is built

into the valuation process, I think it should also be noted in the PEIS. This is as important to the potential environmental impact of the plan as the designation of primary habitat focus areas.

P. 4 in the draft PEIS indicates that the plan is to cover compensatory mitigation for the Harbor Island site. I assume this then also covers the East Waterway site as a Operable Unit of the Harbor Island site.

The City would like to encourage the Trustees to reflect on the value of diversity of upland vegetation related to insect production, and the consequent value to the target species which the plan addresses. In an area as devoid of upland vegetation as the Duwamish, some greater emphasis on riparian habitat is important. With some encouragement we believe it is possible to integrate this type of habitat into many of the industrial sites.

Lastly, the City would like to encourage the Trustees to quickly tackle the thorny problem of integrating habitat into remediation sites. While the plan does encourage such integration, the process for doing so in a way that assures recognition of credit by the Trustees does not appear to have been worked out. Conversations with EPA and Ecology to work through the bureaucratic aspects of this dilemma are clearly needed in order to reap the promise that the plan puts forward.

Again, thank you for seeking our comments. We look forward to continual engagement on this issue.

Sincerely,

Judith Noble

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APPENDIX H: 2012 RESPONSE TO PUBLIC COMMENTS

Presented below are the major issues that capture the substantive concerns raised in the comments received on the Supplement to the Draft Restoration Plan (RP) and Programmatic Environmental Impact Statement (PEIS). The Trustees' responses to the concerns are provided below. Three stakeholders provided comments: EPA region 10, the Port of Seattle, and Vigor Industrial. The EPA assigned the document a Lack of Objection (LO) rating, while the Port of Seattle and Vigor commented on each issue with identical analyses prepared by Windward Environmental. The comments are re-written in italics and the page number and the document source are located at the end of each comment in parentheses. The actual comments are included in the last pages of this document. For references mentioned in the italicized comments, please see the last pages of this document (the actual public comments) for a complete reference citation. Because the EPA supports the proposal, their only comment was a continued suggestion that additional environmental conditions be considered in the analysis to support restoration decisions. The Trustees will follow the guidance of the EPA suggestion as restoration decisions are made.

All of the comments received from the Port of Seattle and Vigor Industrial concern Appendix C and Appendix F of the Supplement to the Draft RP/PEIS. It is important to note that these appendices describe different aspects of the approach used by the Trustees in estimating injury and assigning liability for the purpose of reaching early settlement with those Potentially Responsible Parties (PRPs) interested in settling with the Trustees early to facilitate integration of remedial and restoration actions and/or to avoid having to pay for future assessment costs that non-settling PRPs will share. The Trustees' approach for estimating injury for the purpose of early settlement relies on published scientific literature on the effects of contaminants, data collected by the Trustees and by the various parties who have been doing remedial investigations within the Lower Duwamish River (LDR), and sediment quality standards such as Apparent Effects Thresholds (AETs). It is generally consistent with the approach used successfully at other hazardous waste sites, such as Commencement Bay, Washington, and Lavaca Bay, Texas. There is some uncertainty associated with developing injury estimates using any approach, and the Trustees have been careful to develop a balanced approach in which assumptions used do not predominantly favor either an over- or under-estimate of likely injury. Although the damage assessment is not complete, the Trustees believe they have sufficient information and data available to frame a settlement proposal that would adequately compensate the public for natural resource damages associated with the LDR.

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Appendix C – Defining Injuries to Natural Resources in the Lower Duwamish River

Category A –GENERAL CONCERNS

A1 - Ecological Risk Assessment (ERA) vs. Natural Resource Damage Assessment (NRDA)

In general, we believe that the analysis provided in Appendix C (NOAA and USFWS 2009) is inappropriately based entirely on literature toxicity values and state screening values, ignoring the extensive dataset associated with the Lower Duwamish Waterway (LDW) remedial investigation (RI), including sediment bioassay testing and tissue concentrations, and the assessment of ecological risk in the LDW ecological risk assessment (ERA). (Page 1, Windward Memo)

*In general, the selected values are well below the toxicity reference values used to evaluate these chemicals in the LDW RI; and for PAHs and PCBs, threshold values were established based on biomarkers of exposure that cannot be definitively associated with an effect that would result in a service loss. (*Page 2, Windward Memo*)*

The high hazardous substance concentrations that demonstrably result in meaningful effects on the species present in the Duwamish are simply not found at many locations, resulting in low ecological risk. (Page 3, Port letter)

<u>RESPONSE</u>: The Trustees interpreted the above comments to assert that the Ecological Risk Assessment (ERA) should be used to formulate the natural resource damages. The Trustees determined they cannot base the Natural Resource Damage Assessment (NRDA) on the conclusions of the ERA because the two processes have different programmatic objectives and different statutory and regulatory requirements that result in different data requirements and analytical approaches (Gala et al., 2009). ERAs are not designed to gather data appropriate for a NRDA although, with appropriate coordination, data collected may sometimes be useful to both ERA and NRDA (US EPA, 1992).

For an ERA to serve the needs of a NRDA, the ERA endpoints "need to include natural resource services valued by the natural resource trustees as well as endpoints of concern to the regulators" (Bascietto et al., 1993). One of the major differences between NRDA and ERA approaches is the focus of the assessment effort. ERAs incorporate tests and studies to estimate community or population level effects (US EPA, 1999; Suter et al., 2005; Gala et al., 2009). In contrast, NRDAs commonly include biological responses at the sub-organismal level, such as enzyme induction and physiological changes, and at the organism level (Cacela et al., 2005; Gouguet, 2005; Gala et al., 2009). The U.S. Department of the Interior (DOI) NRDA regulations specifically include a number of suborganism and organism biological responses as injuries (see, for example, 43 CFR §11.62(f)(1)(i)).

Studies have shown that biochemical alterations in response to contaminants can lead to effects such as impaired behavior in predators, leading to population alterations (e.g., Weis et al, 2001). Biochemical and physiological effects are useful in evaluating contamination because of their sensitivity and relationship to populations and communities (e.g., Adams et al., 2000). The ERAs performed for the Lower Duwamish Waterway Superfund site and the East Waterway Operable Unit of the Harbor Island Superfund site specifically excluded biomarker, histological, and behavioral endpoints (LDWG, 2007; Port of Seattle, 2012). The Trustees did use these types of endpoints in estimating injury, as was done in the Commencement Bay NRDA and consistent with the definition of injury in the DOI regulations.

The Commenters suggest that the results of the site-specific toxicity tests should be used in the development of injury thresholds, rather than using AETs to establish such thresholds. The appropriateness of the use of AETs to develop injury thresholds is discussed more specifically in response C1 of this document—Use of AETs for determining injury thresholds. Under the recently revised Washington State Sediment Management Standards (SMS) program, toxicity tests are one method used to delineate and screen areas for future cleanup in addition to other applications. Other criteria are also considered in addition to toxicity tests under SMS. While they are sometimes used to determine injury, toxicity tests are based on short term exposures of a small number of organisms, which limits their applicability. . If site-specific biological data were to be used as part of the Habitat Equivalency Analysis (HEA) process in the LDR, more comprehensive data collection would be needed to identify actual injury thresholds.It is illustrative to show how the results of site specific toxicity testing from an ERA were considered in the NRDA process at Lavaca Bay, Texas. At that site, the ERA included sediment quality triad (SQT) sampling to examine the risk from mercury in the sediments. Those tests did not indicate a significant adverse effect with mercury levels in the sediment from 0.3 to 4.6 mg/kg (a range encompassing both the AET and NOAA Effects-Range Median or ERM values), yet in recognition that sublethal toxicological endpoints were not measured in the SQT approach, the trustees and PRP agreed to use the NOAA ERM value of 0.71 mg/kg as the initial threshold for injury to the benthos and assigned a 10% service loss to that level (Gouguet, 2005). The approach taken by the Trustees in developing injury estimates for the purpose of early settlement is therefore consistent with the approach used in Lavaca Bay in not relying on the results of sediment toxicity tests conducted for the ERA to determine initial thresholds for injury, given that the endpoints utilized do not take into account many potential injuries that could occur.

Another difference between ERA and NRDA that makes using the ERA results in the Lower Duwamish River difficult, is that where ERAs and NRDAs are prospective (related to the future) or current, only NRDAs are also retrospective – evaluating injuries that occurred in the past (Gala et al., 2009). The ERAs conducted in the Duwamish River

did not consider past conditions, and were conducted after some dredging and other response actions were undertaken. Therefore, the ERAs are not reflective of conditions that existed in the decades prior to the ERA studies. Even if the ERA had incorporated the Trustees' recommendations concerning endpoints and studies, the results of the ERAs would not quantify the entire injury, because response actions and source control measures have improved conditions in LDR habitats. This means that past injuries would not be accounted for. In their analysis, the Trustees have combined recent sediment contaminant data with older data (when contaminant levels were higher).

The Trustees' approach toward estimating injury in the LDR is based on ecological service reductions provided by contaminated areas of habitat, in this case intertidal and subtidal habitat within the LDR. The Commenter's statement that English sole have expansive home ranges and thus have only a low exposure to contamination is irrelevant to the injury estimation approach used in the LDR that is described in Appendix C. While the Trustees do not agree with Commenters analysis concerning English sole (see comment PAH B1b), the Commenters' assertion ignores the fact that the contaminated areas **themselves** are injured. Specifically, the ecological service of providing clean food is reduced when contaminant levels exceed those that would cause adverse effects to organisms feeding within that area.

The LDR is important in serving as the transition zone for salmonids where they spend time adjusting to higher salinities that they will encounter in the ocean environment, so the services provided by the small amount of remaining habitat in the LDR is critical and has a high value. The importance of small areas of injury is recognized by EPA in its ERA guidance, acknowledging that the "ecological function" can be "more important than its size" (US EPA, 1999). In conclusion, though the Trustees provided input into the development of the ERAs for the LDW and East Waterway investigations, many of these recommendations were not adopted. The decision not to include many of the Trustees' recommendations has severely limited the value of the ERAs for the purpose of estimating natural resource injuries in and proximate to the LDR which, for natural resource purposes includes Harbor Island and Lockheed West Superfund Sites. Unfortunately the ERAs conducted in the LDR do not include consideration of assessment endpoints that reflect ecosystem services, as has been recommended by Munns et al. (2009) to improve the value of ERA data to the NRDA process.

A2 - Data from the EPA Remedial Investigation (RI) and Ecological Risk Assessment (ERA) is not used, haven't incorporated newer datasets

NOAA should…take into account the mountain of new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early-to mid-1990s. (Page 2, Port letter)

In general, we believe that the analysis provided in Appendix C…ignoring the extensive dataset associated with the Lower Duwamish Waterway remedial investigation (RI) (Page 1, Windward Memo)

RESPONSE: The Trustees used all available surface sediment data that meet criteria for use in the Habitat Equivalency Analysis. Only surface sediment data are used, as these represent the biologically active zone that would most directly impact benthic organisms, fish and wildlife. Datasets collected by the Lower Duwamish Waterway Group (LDWG) under the auspices of the EPA Remedial Investigation comprise the bulk of the available data. In addition, any pre-remedial samples that are not located in a dredge footprint (that represent the historical record of contamination in the LDR) are included as they become available and go through a quality assurance process. For a discussion on issues related to use of toxicity test data and the EPA- ERA, please see comment A1.

A3 - Measurement Precision and Service Loss Levels Overlap (e.g. phthalates, dichlorobenzenes)

For many of the chemicals discussed in Appendix C, the AET values that are used to represent different levels of injury are not analytically distinct concentrations. (Page 7, Windward Memo)

RESPONSE: Since the Trustees have chosen at this stage of early settlement to rely on data previously collected under the auspices of the EPA-led Remedial Investigation, we do not control the precision of these data. Unfortunately, for some Substances of Concern (SOCs), detection limits are higher than would be ideal. For non-detect values where the detection limit exceeds the service loss levels, no injury is assigned and the concentration is assumed to be close to zero for purposes of the geographic interpolation. Use of this assumption may result in an underestimation of injury, and illustrates the care taken by Trustees to minimize the likelihood of overestimating injury.

Category B - INJURY THRESHOLDS FOR PAHS, TBT AND PCBS

B1 – PAH Injury Assessment

B1a: Liver disease & injury

The two studies that were cited in Appendix C to support the assessment of injury to fish by PAHs in sediment are Johnson et al. (2002) and Rice et al. (2000). The values selected from these studies to assess injury to fish overpredict injury by assigning injury based on physiological indicators of exposure and reversible suborganismal effects. The data underlying the effects thresholds overestimate the potential for adverse effects. The sediment effects thresholds for liver disease from Johnson et al. 2002 were biased low because all lesion types were assumed to cause disease in affected fish, whereas only a fraction of the lesion types were frank lesions indicative of disease. (Page 2, Windward Memo)

RESPONSE: The Trustees do not agree with the Commenters' conclusion. The federal regulations for NRDAs list seven types of injuries to biological resources that are defined as adverse effects on the organisms and that have been shown to be caused by exposure to hazardous substances: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), and physical deformations 43 C.F.R. § 11.62(f)(i). In addition, a biological resource is injured if the concentration of a hazardous substance is present in the edible tissue of the organisms at concentrations that exceed an action or tolerance level established by the U.S. Food and Drug Administration (FDA), or a concentration resulting in a consumption limit or ban issued by a state health agency Id. §11.62(f)(ii),(iii).

Fish are particularly sensitive to PAH toxicity because they metabolize PAHs to toxic and mutagenic intermediates, something that does not occur in invertebrates, or only to a very limited extent (Meador et al., 1995a). Thus fish are susceptible to carcinogenic and mutagenic effects of PAHs, which can occur even at relatively low exposure concentrations (Varanasi et al., 1987). Numerous studies have shown that English sole exhibit biological effects from exposure to PAHs in sediments, including liver cancer and related lesions, reproductive abnormalities, immune dysfunction, and alterations in growth and development (Myers et al., 1994, 1998, 2003; Arkoosh et al., 1996; Johnson et al., 1998).

Physiological indicators of exposure are not the same as liver lesions which equal injury. In fact, all the lesions referred to in the comment are measures of disease, and their presence indicates injury in fish, causing compromised condition that can lead to a reduced ability to survive in the wild. Typically, all pre-neoplastic focal lesions have the potential to progress to neoplasms (tumors), and although not all of them do, it is not correct in the terminology of pathology to call these pre-neoplastic lesions reversible.

Some lesions or other effects may theoretically be reversible (though not neoplasms, or pre-neoplastic focal lesion or foci of cellular alteration) *if the exposure to PAH is eliminated* and the lesions can then heal. The lesion-causing substance or condition MUST be removed to potentially achieve positive outcome. Even if all exposure to harmful levels of PAH stopped—something that will only occur in the LDR after a successful clean up—injury would still take place through reduced fitness, less growth resulting in smaller sized adults and impaired reproduction (Johnson et al., 1988, 1998; Meador et al., 2006; Myers et al., 2008). The Habitat Equivalency Analysis includes a function that accounts for recovery of natural resources once remediation has taken place and the habitat has returned to full function.

B1b: English Sole Ranges

Furthermore, the co-located sediment and tissue data used to develop the hockey stick regression underestimated the PAH concentrations to which English sole were likely

exposed prior to sampling. Stern et al. (2003) conducted a re-analysis of the hockey stick regression using the same lesion data as that used in Johnson et al. (2002) and a larger sediment dataset. Instead of using co-located data from trawls, Stern et al. (2003) used spatially weighted average sediment PAH concentrations from the trawl area collected over realistic home range. This re-analysis resulted in an effects threshold for lesions that is four times higher than that presented in Johnson et al. (2002). (Page 2-3, Windward Memo)

RESPONSE: The Stern et al. (2003) presentation contains a number of biases. Unlike Johnson et al. (2002), Stern et al. (2003) was not published in a scientific journal that requires a rigorous scientific review process. (The Stern study is part of the Puget Sound Research Conference 2003, Vancouver B.C., proceedings.) The Trustees question several of Stern's assumptions. In the Johnson study, the sediment chemistry was paired with fish samples collected within the trawl track, which were then translated into threshold exposure values linked to certain biological effects such as liver lesions. Sediment samples were collected at the same time or within one year of the fish samples. In this way, the authors determined that fish were present in the area where the sediment samples were measured.

In contrast, Stern's sediment data were not paired directly with the fish samples. Stern used data from a variety of sources and many data points were separated in time by 3 to 4 years. An arbitrarily determined "home range" was defined as 1 km^2, and it was assumed that a sole will use that entire range. However, it is incorrect to assume homogeneity of habitat over a species' entire range. Different types of habitat (preferred and not-preferred) can occur within the larger assumed range.

The Trustees are concerned that the Stern samples are not truly unbiased. The Stern analysis did not account for remediation and restoration actions that were taking place during the time period when the samples were selected, which would have impacted the PAH sediment concentrations. The Johnson et al. scientists also do not believe that several of the areas where Stern chose sediment samples are used by English sole as habitat (Johnson, pers. comm., 2012). Stern assumed that English sole uniformly used the entire area of their defined "home range." Tagging studies conducted on English sole (Moser et al., 2005) in Eagle Harbor provide solid data on English sole movements and suggest that their home range is quite a bit smaller than 1 km^2, and in fact is more in the vicinity of 0.2 km^2.

At Eagle Harbor the tagged fish did not use the shallow nearshore area, which is where the highest PAH concentrations are found. Stern's analysis included these high PAH concentrations in developing thresholds, even though there is no evidence that sole use those areas. Sole migrate into deeper waters at night, but they do not feed at night. During

the day they stay within a relatively small area, which could range from 0.2 km^2 – 0.7 km^2 (Moser et al., 2005; Myers, pers. comm., 2012).

B1c: Reproductive Effects- threshold levels and inflection points

The sediment effects thresholds for reproductive dysfunction from Johnson et al. (2002) are highly uncertain. The statistical analysis relied on estimates of the background level of reproductive dysfunction and the inflection point (i.e., the concentration at which effects begin to be elevated above background) because insufficient data were available to calculate these parameters. (Page 3, Windward Memo)

RESPONSE: As shown in Figure C1, threshold levels for service losses are established using a weight of evidence approach based on research with as many different types of organisms and effects from the contaminant of concern as are available. There is an abundance of data on PAH effects to benthic organisms and fish in the Lower Duwamish River. The service loss values and threshold levels for PAH were established using a variety of data showing impacts to fish, including liver lesions, reduced fecundity, and several kinds of reproductive effects. In addition, AETs for echinoderm and Neanthes represent impacts to the benthic community. This weight of evidence of multiple effects from PAH to many ecosystem levels support the service loss levels used in the Habitat Equivalency Analysis.

B1d: Reproductive Effects-Casillas et al. 1991 study

Furthermore, the causal relationship between observed reproductive effects and sediment PAH concentration is unclear. For example, in one study, (Casillas et al. 1991) that underlies the Johnson et al. (2002) relationship for gonadal growth, PAH concentrations accounted only for 34% of the variance in ovarian development, indicating that other factors may be causative. Differences in ovarian development could be due to natural variation in maturation timing among English sole subpopulations in Puget Sound or to exposure to other environmental stressors. (Page 3, Windward Memo)

RESPONSE: It is not clear on what Windward based its 34% assertion for variance in ovarian development in Casillas et al. (1991). However, considering the many possible parameters that could affect gonad development in English Sole, having one parameter (PAH contamination) account for approximately one third of the variance is considered evidence of a highly significant relationship. The authors in Casillas et al. say that natural variability is unlikely to be a major contributor to the effects measured, because of the careful timing of the sampling conducted for the study. Johnson et al. (2002) data indicated that PAH are a major cause of these effects. Another study on the causal relationship between liver neoplasms and other neoplasia-related liver lesions in English sole as related to PAH exposure published in the *Journal of Human and Ecological Risk Assessment* (Myers et al., 2003) corroborated these results with their finding that 54% of

the variation in the prevalence of toxicopathic liver lesions in English sole from Puget Sound was explained by PAH concentrations in sediment (Myers et al., 2003).

PAH exposure is identified as a major risk factor for inhibited ovarian development in adult English sole (Johnson et al., 1988). In addition, English sole from areas contaminated with PAH experience inhibited spawning ability and reduced viability of eggs and larvae.

B1e: Creosote / Growth

The sediment effect threshold for growth from Rice et al. (2000) is also uncertain…The major chemical contaminants present at Eagle Harbor were associated with creosote, which is used as a wood preservative. The major creosote-related chemicals generally associated with toxicity are PAHs, phenols, and cresols (ATSDR 2002). About 300 chemicals have been identified in coal tar creosote, but as many as 10,000 other chemicals may also be in this mixture (ATSDR 2002). (Page 3, Windward Memo)

RESPONSE: Sixty-three percent of the creosote from Eagle Harbor is comprised of PAHs, with other components constituting a minor contribution. Therefore, PAHs are likely to be the major contributor to any effects from this creosote.

B1f: Growth Effects

Rice et al. (2000) showed that in one experimental trial, fish exposed to contaminated worms that contained a total PAH concentration of 11.3 parts per million (ppm) dry weight (dw) had a lower daily growth rate than did the controls. In a second trial of the experiment, a similar trend was observed, but the effect was not statistically significant. (Page 3, Windward)

RESPONSE: Rice et al. (2000) found a severe impact to growth at a total PAH concentration of 11.3 ppm dry weight in prey (polychaete worms) fed to English sole. This would equal a prey whole-body concentration of approximately 2.2 ppm wet weight. The total PAH concentration in the test sediments for prey exposure were 3.1 and 3.6 ppm dry wt. Rice et al. (2000) conducted two experiments with very similar results producing severe growth impairment. One experiment was highly significant and the other was not, even though the mean percent change in fish weight was 24 times lower (1.2% per day increase for the control versus 0.05% per day for the treatment) for the non-significant test. Because the first test was highly significant and the second test supported those results, these data strongly implicate total PAHs as a growth inhibitor. As the authors (Rice et al., 2000) admit, these tests had low statistical power, making these results even more striking. There is no doubt that if the power was higher, the second test would have also been statistically significant. Even though this study was conducted with field contaminated sediment, it was diluted with clean sediment, producing a concentration that was only 0.1% of the fully contaminated sediment. The predominant

contaminants at Eagle Harbor are PAHs and the main source is creosote. The only other contaminants of note at Eagle Harbor are elevated PCBs (up to 2.5 ppm dry wt. in sediment) (Misitano et al., 1994). For the diluted sediment of 0.1% (used in Rice et al., 2000), the concentration of PCBs in the polychaetes would be extremely low due to an equivalent test sediment concentration of only 2.5 ppb. The expected PCB concentration in these worms would have likely been in the 10–20 ppb range, which is far below any toxic threshold for this class of toxicants.

B1g: Evaluating PAH impacts to sole

The exposure of highly motile organisms such as English sole is integrated over the entirety of their home range and cannot be evaluated on a point basis. (Page 4, Windward Memo)

RESPONSE: The comment misses the point that, as explained in A1, the Trustees are basing their approach to estimating injury on the reduction in ecological services provided by the habitat. In addition, areas of sediment with contaminant concentrations above those that could cause injury to organisms feeding within those areas are themselves injured. Moreover, contrary to the Commenters' assertion, it *is* possible to directly measure PAH exposure in fish. This can be done with metabolites from fish bile, which have been shown to be strongly correlated with sediment PAH values and dietary dose (Collier et al., 1993, as seen in Meador et al., 1995b; Meador et al., 2008). Also see comment B1b which discusses issues related to English sole home range size and feeding habits.

B2 – TBT Injury Assessment

B2a: Use of Armandia Brevis

The development of TBT injury threshold values is based on work that evaluated the effect of TBT on the marine polychaete Armandia brevis (Meador and Rice, 2001) and bioaccumulation modeling based on relatively few datasets, including the A. brevis data (Meador et al., 2002). There is a significant amount of literature on the effects of TBT on benthic organisms that is not represented. The bioaccumulation potential for TBT has been shown to be highly species specific (Meador et al., 1997). Further justification should be provided to support setting injury thresholds based on a polychaete species that has not been observed in the Lower Duwamish River. (Page 4, Windward Memo)

RESPONSE: Meador (2011) summarized information from several studies on the occurrence of organotins in the tissues of fish and invertebrates and their toxicological significance. The information from nine studies dealt with a variety of adverse effects from TBT exposure (e.g., behavior, imposex, growth impairment, reproductive impairment, and mortality) and listed five mean critical body residues with values between 13 and 85 ppb. Regarding the statement questioning the appropriateness of using

A. brevis data for the injury threshold analysis, that species is a commonly occurring marine polychaete in Puget Sound. Schoch and Dethier (2001) indicated *A. brevis* was encountered at over 80% of stations sampled within six miles of the mouth of the Duwamish River during their intertidal surveys in 1999 and 2000. This information strongly suggests that *A. brevis* is a very appropriate candidate for injury assessment. If *A. brevis* is not currently present in the LDR, it could very well be because contamination levels in the river sediment prevent them from surviving there.

B2b: TBT and EPA Ecological Risk Assessment (ERA)

TBT was not identified as a risk driver in the ERA conducted for the LDW Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) evaluation based on the evaluation of imposex in benthic organisms collected throughout the site and the evaluation of chemical concentrations in tissue collected from throughout the site and compared with tissue effect concentrations. The data collected from the site is not consistent with the level of injury that would be predicted by the proposed injury threshold values. (Page 4, Windward Memo)

RESPONSE: See comment A1 clarifying the differences between the objectives for ERA and NRDA. While TBT was not identified as a risk driver in the LDW ERA, it *was* included as a risk driver in the East Waterway ERA, based on recommendations and rationale presented by NOAA.

Meador et al. (2002b) concluded that protection against severe adverse sublethal effects for many salmonid prey species should be achieved with a TBT sediment concentration of 6,000 ng/g OC (organic carbon). For the Lower Duwamish River (average TOC = 1.7%) this would equal 102 ng/g dry wt. The Trustees assigned the lowest injury (service loss) level (5%) to this concentration. However, it should be noted that Meador (2002b) further mentioned that many of the sublethal responses reported for TBT exposure would eventually lead to death of the organism in the environment. A later publication (Meador, 2011) listed several additional studies of fish species with low threshold levels that would further diminish the Duwamish TBT threshold, should the Trustees re-evaluate TBT injury thresholds utilizing these new studies. Based on these new studies, the current TBT injury thresholds used by the Trustees cannot reasonably be said to overestimate injury.

B3 – PCB Injury Assessment

B3a: Estimated parameters in Meador 2002a

The relationships between sediment concentrations and adverse effects reported in Meador et al. (2002) rely on several assumptions that are highly uncertain. Meador et al. (2002) estimated organic carbon-normalized sediment effect thresholds from lipid-normalized PCB concentrations in salmon that were associated with various effects. In each of the 15 studies underlying this relationship, some data critical to the analysis (e.g.,

tissue PCB concentrations, tissue lipid concentrations) were not reported but were instead estimated based on uncertain assumptions… (Page 4, Windward Memo)

RESPONSE: Meador et al. (2002a) did not use uncertain assumptions. Meador reviewed numerous studies on PCB effects to salmonids. From the larger pool of published studies, 15 were selected using rigorous screening criteria (Meador et al., 2002a). These 15 studies used different methodologies and measured different types of PCB effects, therefore it was necessary to standardize the results based on appropriate scientific methodology. Because PCB effects on individual fish are greatly affected by the lipid content of the fish, Meador developed lipid values to lipid normalize the results. The lipid values used in Meador et al. (2002a) were taken from literature studies that actually measured (not estimated) lipid levels. Meador et al. (2002, Table 1) shows the extensive dataset used to develop the lipid values incorporated into the PCB threshold values. Data from 18 different studies including adult and juvenile fish were examined with sample sizes ranging from 3 to 180 individual fish.

B3b: Tissue residue concentrations

Based on these assumptions, Meador et al. (2002) calculated a PCB tissue residue of 1.7 ug/g lipid as the effect threshold. A later report… by (Melancon et al. 1989) suggested that such effects occur at a muscle concentration of approximately 0.3 ug/g wet weight (ww) which, using the assumptions from Meador et al. (2002) would correspond to 3.3 ug/g lipid. Similar assumptions made for the other 14 studies are more likely to underestimate rather than overestimate the tissue concentration at which the effect is likely to occur. Consequently, the sediment effects thresholds are more likely to underestimate than overestimate realistic effect thresholds and result in an overprediction of injury. (Page 5, Windward Memo)

RESPONSE: The sediment effect thresholds do not underestimate realistic effect thresholds and do not result in over-prediction of injury. Meador et al. (2002) used a Melancon study (Melancon et al., 1989) which suggested an effects level of 1.7 ug/g lipid. The overall effect threshold recommended by Meador for all the studies considered is 2.4 ug/g lipid. For PCBs, muscle concentrations are usually lower than whole body concentrations. Using measurements in muscle ignores the PCBs in the rest of the fish. Additionally, lipid concentrations in muscle are not comparable to whole-body lipid levels and should not be used interchangeably, as assumed here by Windward when they converted the wet weight concentration in muscle to a lipid normalized value. Meador et al. (2002) cites a number of studies that demonstrate how PCB levels in fish differ between muscle and other organs, and how PCB levels will re-distribute themselves within the fish depending on its life stage, energy content, and availability of food.

B3c: Physiological indicators of exposure

…many of the effects included in Meador et al. (2002) are physiological indicators of exposure and reversible suborganismal effects. Examples included altered levels of hormones, changes in enzyme activity, or decreases in the synthesis of vitellogenin. The effects associated with a 60% service loss from NOAA (2001) are also biomarkers (i.e. immune suppression and cytochrome P450 induction). The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown. (Page 5, Windward Memo)

RESPONSE: The statement that consequences of alterations in biochemical processes on fish health are unknown is misinformed. This is another reiteration of the commenters' assertion that a reversible or sublethal effect does not cause injury, which is simply untrue. The commenters assert that altered hormone levels, increased enzyme activity, and disease susceptibility are not 'injuries.' Individual salmon must undergo complex physiological processes that allow them to make the transition from freshwater to the marine environment. Throughout the transition, they need to be able to resist disease, mature normally and successfully complete their lifecycle (Meador et al., 2002). Thus, the physiological indicators noted in Meador et al. (2002) and NOAA (2001) indicate alteration in the biochemical processes that negatively impact salmon. These sublethal impacts caused by PCBs adversely impact these processes by reducing the fitness of the salmon. Impairment of vital functions may also affect a fishes' ability to tolerate normal environmental fluctuations, including smoltification. These impacts are discussed in more detail in Meador et al. (2002).

Even if the studies showing P450 induction were removed from the list of studies supporting the service losses for PCBs, the result would not change. Immune suppression and reduction in growth are both well-defined indicators of injury (Meador, pers. comm., 2012). Furthermore, vitellogenin is a precursor for many yolk proteins necessary to provide nutrients during early development of vertebrates, and so a reduction in vitellogenin production would be expected to impact reproductive success.

Published studies using disease challenge have shown the effects of immune suppression, which leads to death of fish.

Category C – USE OF AETS IN INJURY ASSESSMENT

C1 - Use of AETs for determining injury thresholds

"For chemicals other than PCBs, PAHs, and TBT, apparent effects thresholds (AET) values are used to calculate service losses. This use of AETs is not consistent with their intended use as screening values that most accurately identify sediment for which no

biological effects would be expected. The exceedance of an AET may or may not indicate the presence of biological effects." (Page 2, Windward Memo)

AET values were developed as screening concentrations and are inherently conservative values that will overestimate biological effects. (Page 5, Windward Memo)

The sediment used in the development of AETs contained a variety of chemicals with a range of concentrations. (Page 6, Windward Memo)

AETs are inherently conservative values and are most useful as screening benchmarks. There is no basis for using AET values as the threshold concentrations at which a particular hazardous substance causes damage to natural resources because AETs do not establish a causal relationship between biological effects and a chemical of concern. (Page 5, Windward Memo)

RESPONSE: Sediment quality guidelines such as AETs, are frequently used as thresholds for injury in settlements of natural resource damages across the country. Using sediment quality guidelines by the Trustees for the purpose of developing estimates of injury for settlement in the LDR is built on this established practice. Though the commenters suggest that AETs *over*estimate biological effects, AETs may actually *under*estimate injury because they incorporate effects only on benthic invertebrates and then measure very few potential adverse effects to those organisms (such as mortality).. Neither do AETs take into consideration effects of contaminants on fish or bioaccumulative effects in higher trophic levels.

The approach used by Trustees in the LDR uses AETs to establish the initial threshold for injury for most contaminants. A recent paper discussing the use of Sediment Quality Guidelines in NRDAs recommends that a "reasonably conservative threshold" near the Lowest Observed Adverse Effects Level (LOAEL) should be used for the "onset of injury" and "less conservative" sediment quality guidelines, such as AETs, be used to represent an increased level of severity of injury in damage assessments (Gouguet, 2005). This was how an AET was used in the NRDA at the Lavaca Bay, Texas Superfund Site.[1] The use of AETs to set the initial threshold for injury by the Trustees in the LDR is therefore less conservative than this recommendation, and not likely to overestimate injury.

[1] ***The approach taken in the LDR NRDA may underestimate injury compared to the approach used in Lavaca Bay since the benthic AET for mercury of 2.1 mg/kg was used there as recommended in Gouguet (2005) as an indicator of an increased level of severity of injury, and was assigned a 25% service loss, whereas the approach used by trustees in the LDR uses AETs as the initial threshold for injury for most contaminants and assigns only a 5% service loss. Additionally, injury to fish due to mercury contamination of habitats was evaluated separately and added to the injury from contamination of habitat to benthic organisms in Lavaca Bay (Trustees, 2000), resulting in much higher service loss estimates than would have been developed using the approach utilized by Trustees in the LDR with the same data.***

The Trustees recognize that AETs were developed from field data which contained a variety of different chemicals. This reflects the actual situation in the LDR, which also contains a mixture of contaminants. This approach takes into account the synergistic effects of mixtures that commonly exist in Puget Sound sediments that influenced results of the toxicity tests used to derive AETs.

The Trustees' methodology for estimating injury for purposes of early settlement is based solely on ecological losses and does not attempt to quantify or recover human use losses and other economic damages; therefore, it cannot be reasonably viewed as overstating the extent of the damages resulting from releases of hazardous substances to the LDR. Rather, the Trustees may be understating their natural resource damage claim. Human use losses and other economic damages may be evaluated for inclusion in any damage assessment process moving forward for those non-settling parties along with further assessment of ecological damages that may be necessary to support all natural resource injuries.

C2 – Injury Ramps

… the "injury ramp" for butyl benzyl phthalate (BBP) is presented in Table 1. No effort was made to evaluate the available sediment bioassay data for the Lower Duwamish River to determine the relevance of the AET thresholds for the mixture of contaminants at these sites. Increasing levels of injury are assigned based on the exceedance of multiple AET values. No justification is provided for increasing service loss percentages when multiple AET values are exceeded. (Page 5, Windward Memo)

<u>RESPONSE</u>: Justification is provided for increasing service loss percentages when multiple AET values are exceeded in Appendix C, which provides a detailed explanation of how different levels of service loss were estimated. The basic approach advocated by Gouguet (2005) is utilized: higher levels of service loss are assumed as the number of sediment quality guidelines exceeded increases. For most SOCs, there is insufficient information to establish sediment thresholds that are protective of fish. Therefore, the only injury thresholds used are those to protect the benthic community, largely AETs. For all of these chemicals, the minimum injury threshold is 5%, and the maximum is 20%--based solely on effects to invertebrates. Appendix C includes a detailed discussion of why assigning only a 20% loss of service when all invertebrate AETs are exceeded can be criticized as being too low, using HCB as an example. These chemicals may actually affect fish and other higher trophic levels as well, and most likely a higher service loss would be applied if the data were sufficient to make these determinations. On the other hand, for PAHs, there are known effects on fish as well as on benthic organisms. Therefore, a higher service level loss is applied. Although PAHs are metabolized by fish,

it is during this very process that harmful effects occur. Since this HEA is directly oriented toward protection of living marine resources (versus human uses), known effects on fish at the minimum injury threshold, as well as known effects on benthic organisms, justifies a higher service loss than SOCs for which there are only known benthic effects. It is the difference in the available data regarding the effects of contaminants, rather than a subjective view of a contaminant's importance, that leads to the difference in assignment of service level losses.

C3 - Case Study: Evaluation of Effects Predicted by AETs Compared with Effects Measured in Lower Duwamish Waterway (LDW) and East Waterway (EW) Sediment

In order to evaluate the predictive power of AETs in the Lower Duwamish River, a dataset of 101 sediment samples collected from the LDW and East Waterway (EW) of Harbor Island was evaluated…The reliability of the chemical concentrations above the AETs as indicators of biological effects, as measured by the sediment bioassays, was evaluated…However, for the 95 samples that exceeded at least one of the AET values, the exceedance of the AET did not necessarily accurately predict the biological effects associated with the bioassay results. In 54% of these samples, the chemical exceedence of the AET was consistent with a bioassay result, which also exceeded the SQS threshold. However, in 46% of the samples, no toxicity was observed in the three sediment bioassay results for a sample. (Page 10-11). *These results suggest that the exceedance of an AET value should not be used as a reliable indicator of certain biological effects. AETs may function well as screening levels, but they are clearly not a reliable indicator of biological effect as demonstrated by the LDW and EW sediment bioassay results.* (Page 7, Windward Memo)

Finally, the LDW data was examined to determine whether the exceedance of multiple AETs increased the predictive power of the AET evaluation….This analysis would suggest that predictive power of the AETs is not improved when multiple AET exceedances are present. (Page 7, Windward Memo)

RESPONSE: The commenters assert that the Trustees' assessment is flawed because it relies on AETs and does not consider the results of toxicity tests performed as part of the ERAs for the Lower Duwamish Waterway (LDW) superfund site and the East Waterway Operable Unit of the Harbor Island Superfund site. As discussed in section A1, ERA for remedial purposes and NRDA are structured to address very different objectives. The toxicity tests performed as part of the ERA were intended to help inform what remedial actions should be performed, and did not include important sublethal endpoints that would be important in determining injury. Furthermore, the results of the analyses conducted by Windward are biased by the way samples were chosen for toxicity testing for the ERA. The ERA toxicity tests from the LDW intentionally excluded samples that were highly contaminated, under the assumption that these samples would be toxic (LDWG, 2007). If this assumption is true, (i.e. that the excluded samples are toxic), then

the reliability of AETs to predict adverse biological effects in the LDW would be far greater than is suggested in the comment. Despite this, for more than half of the 95 samples included in the commenters' analysis, the chemical exceedance of the AET was consistent with the bioassay result. This is also true of the Windward analysis of multiple AET exceedances, which suffers from the same bias in the selection of samples- over 50% of the samples matched the predictions.

An independent evaluation of the ability of AETs to predict adverse biological effects using data from 13 Puget Sound embayments indicated that adverse effects were not found for samples with contaminant concentrations below the AET but were found for samples exceeding the AET in over 85% of the samples (Barrick et al., 1988). This means that approximately 85% of samples were in accordance with the predictions. A more recent evaluation of AETs found that reliability of the AETs in predicting adverse effects was 84% (Gries and Waldow, 1996). The results of these two studies, using unbiased samples, support the reliability of AETs in Puget Sound as predictors of adverse effects. Given that the AETs are based only on a few potential endpoints with a few receptors, ignoring other receptors and other endpoints indicative of other potential types of injuries, the use of AETs in the Trustees' injury estimation approach is very unlikely to result in an *over*estimate of the ecological injuries.

Appendix F - Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment

Category D – TEXT IS TOO GENERAL, NOT SITE-SPECIFIC, AND ALLOCATION IS ARBITRARY

D1 - General allocation - liability allocation methodology is arbitrary

…arbitrary allocation methodology…certain public and private entities are unjustifiably assigned vast amounts of natural resource damages liability, with other parties that have been responsible for significant releases apparently being assigned little or no such liability. (Page 1, Port cover letter)

RESPONSE: This is a vague and conclusory statement for which the Port does not provide any documentation or other evidence. Moreover, the allocated liability for each potentially responsible party is not publicly available as such discussions are legally protected as settlement negotiations pursuant to the Federal Rules of Evidence; therefore, it is unclear as to how the Port reached this conclusion. The Trustees disagree with the Port's assertion. This is not an arbitrary allocation methodology and no entities were unjustifiably assigned vast amounts of natural resource damages liability. Allocations of liability for the purposes of early settlement are based on publicly available records and follow the specific parameters outlined in Table F1 in Appendix F. To the extent the Port has any additional information that the Trustees have not considered relating to significant releases by other PRPs, the Trustees will review and consider such information. In the event a PRP resolves their liability through a settlement, the Trustees must show the court a fair and equitable basis as to the liability and resolution of any PRP's liability. An existing example is the Boeing Consent Decree.

D2 - Allocation does not take advantage of available information

In general, the process provided here is overly simplistic and does not take advantage of the extensive chemistry dataset and current and historical source control documentation that is available for use in the allocation model. (Page 2, Windward Memo App. F)

RESPONSE: Trustees considered all of the sediment chemistry and current and historical source control information available to them at the time the allocation was done. When the process was first undertaken in 2001, source control information in the LDR was limited, and incomplete for some areas. As the Washington Department of Ecology and US EPA have completed additional source control studies for properties along the LDR, the Trustees continue to incorporate this data into the allocation at regular intervals. For example, in 2011, the Trustees updated the allocation of PAH liability and revised the analysis using current scientific research and new data.

D3 - Allocation of overlapping contaminant footprints

In cases where a plume that originates at one parcel overlaps onto adjacent parcels, liability has been allocated to multiple parcels rather than to the single parcel that is the likely source. In cases where sufficient information is available to identify the unique sources, the Trustees should allocate liability to the specific source rather than simply allocating liability to all adjacent properties. (Page 2, Windward Memo, App. F)

RESPONSE: The Trustees allocate liability to the specific source to the extent there is evidence that the use of a SOC could be associated with an activity on that property, and a pathway is established. Specifically, when an injury footprint for an individual SOC touches more than one property, each property is examined for a possible connection to that contaminant. Allocations of liability for the purposes of early settlement are based on publicly available records and follow the specific parameters outlined in Table F1 in Appendix F.

For all parcels where the criteria noted in Table F1are answered in the affirmative, liability is assigned for the SOC in question. In some instances, a large footprint is shared among several parcels, and in other cases, a single parcel will receive the full allocation for the footprint, depending on the results of the decision tree in F1. If the Port or other parties have access to information not in the public domain that they feel would contribute to the allocation decision process, and are willing to share such information with the Trustees, the Trustees would include any viable evidence in the allocation process.

D4 - Unfair to Allocate Only to Current Property Owners

…the approach to liability allocation used by NOAA, as described in Appendix F, that results in current shoreline property owners being assigned essentially all site NRD liability, including liability for activities that occurred in the distant past that current shoreline property owners had no role in, and liability for hazardous substance releases that clearly originated from other parties. (Page 1, Port Cover Letter)

RESPONSE: Each person's allocated liability is attributable to publicly available information showing releases of hazardous substances from each identified property. In general, current owners are strictly liable for any on-going releases from their property and as such are liable for such releases. To the extent that any current owner is able to bring evidence that another person is responsible for specific contamination on their property and which contributed to injury to the natural resources in the LDR, the Trustees remain open to allocate such liability, in whole or in part, to the prior owners and/or operators. As noted above, in the event a PRP resolves their liability through a settlement, the Trustees must show the court a fair and equitable basis as to the liability and resolution of any PRP's liability.

Category E – DOCUMENT DOES NOT CONSIDER SOURCES WITHIN THE PIPESHED

E1 – Allocation of Pipeshed Sources

The approach does not adequately consider sources within the pipeshed for storm or combined overflows; …characterization of the chemical loads used for this purpose was not provided. (Page 2, Windward Memo, App. F)

RESPONSE: The allocation methodology does consider the sources within the pipeshed for both storm drains and combined overflows. Trustees accounted for contaminant inputs to the river via combined sewer outflows (CSO) and storm drains using the same methodology used to assign liability to properties. If a contaminant footprint was closely associated with an outfall, if available data showed a contaminant was known to occur in storm drains or CSOs, and if there was no other source of that contaminant on adjacent properties, then the footprint liability was assigned to the CSO or storm drain. The basins that drain into each CSO or public storm drain are large, covering hundreds of acres and properties. It is unlikely that quantification of these large basins and storm drains is readily available or likely to be obtained at a reasonable cost.

E2 - Allocation doesn't include parcels that are not adjacent to the LDR

The document fails to address parcels that do not abut the Lower Duwamish River but are associated with current and historical activities that may have resulted in the release of contaminants in to the Lower Duwamish River (Page 1, Windward Memo App. F)

RESPONSE: Trustees included all properties within the designated area of the NRDA that are adjacent to the LDR as well as those that have a documented connection to the LDR (See page F-1). Initially, 458 parcels were reviewed. In addition, storm drains and CSOs that drain large areas beyond the river were included in the allocation.

If the Commenters have knowledge of and can document other sources that have contributed contaminants to the LDR, the Trustees request that the Commenters submit such for review and analysis.

Category F – PAH ALLOCATION ISSUES

F1 - Mass balance approach for PAHs is incomplete, concerns related to creosote pilings

The mass balance approach used for polycyclic aromatic hydrocarbons (PAHs) is not fully explained in this document. The information that has been provided on the calculation of PAH release rates for marine pilings suggests that the release of PAH from creosoted marine pilings has been greatly overestimated. (Page 1, Windward Memo, App. F)

RESPONSE: The Trustees do not agree that releases of PAH from creosoted marine pilings has been greatly overestimated. Estimates of PAH releases from creosote-treated marine pilings were derived using information published in a 2007 study of PAH sources to the New York/New Jersey Harbor (Valle, 2007) and a 2011 report by the Washington Department of Ecology (ECY) regarding sources of contamination to the Puget Sound basin (ECY 2011).

Using the size of pilings removed as reported in the Washington Department of Transportations' (WSDOT) Creosote Removal Initiative for state ferry terminals and PAH leaching rates as reported by Valle, ECY reported that 0.062 Kg of PAH per pile per year is released to the air and 0.48 Kg PAH/pile/year is released to the water. As shown in Figure F1, it was assumed that 10% of the pile was exposed to air, 60% to water, and 30% to the sediments. Since ECY only reported values for air and water, it was assumed that the 0.48 Kg PAH/pile/year included both the portion of the piling exposed to the water column and the portion embedded in the sediment.

The assumption was made that pilings used in the LDR would be of lesser length and smaller diameter than those used by the ferry system, so only 75% of the 0.48 Kg PAH/pile/year value was used to represent the release from smaller pilings. This result (0.36 Kg PAH/pile/year) was then multiplied by 0.3 to represent the 30% of the piling exposed to the sediment (0.11 Kg PAH/piling/year), and then by 0.2 (on-site diminution factor) which results in the assumption that only 6% of the area of the piling is contributing PAH to the sediments biologically active zone (0.022 kg PAH/piling/year). Although there is evidence in the literature that some portion of the PAH released to the air and water does contribute to the PAH levels in the sediment, these releases were not included in the NRDA PAH assessment. Other creosote-treated elements associated with the pilings (cross-beams, ties, planking, etc.) were also not included, although PAH contribution would also be expected from both releases to the air and from rainwater leaching. These exclusions provide a buffer that compensates for potential differences in the leaching rate (reported by Valle and ECY) when salinity, temperature, flow rate, and other factors specific to conditions in the LDR are considered.

As shown in Figure F1, two different Diminution Factors were applied to the 0.11 Kg PAH/pile/year value. First, an on-site factor of 0.2 was applied. The on-site Diminution Factor addresses the portion of the PAH that was likely to impact the biologically active zone. The following mechanisms for migration to the biologically active zone were considered: direct leaching from the pile and spreading caused by scour; direct leaching to the sediments within the zone of disturbance caused by ship operations (this zone was assumed to be up to two feet thick at the face of the piers with a lesser thickness below the piers); convective migrations in the pore water; migration in preferred seepage paths along the piles caused, in part, by pile movement; and loss of treated wood resulting from ship impact and pile aging.

Next, the in-river Diminution Factor of 0.5 was applied. This is based on the assumption that approximately half of the PAH released to the sediment would remain in the same general area after being adsorbed or absorbed.

The product of the two Diminution Factors is 0.1. Essentially, after application the two Diminution Factors, only 10% of the 0.11 Kg PAH/pile/year was included when impacts to the waterway sediments were quantified: a final value of 0.011 Kg PAH/pile/year.

Google maps and United States Army Corps of Engineers Report No. 36 (USACE 2002) were then used to determine the size of pile-supported structures such as docks, causeways, dolphins, etc. Where dock dimension data were incomplete, the length was assumed to be 71% of the property length (the average for known sites) and the width perpendicular to the waterway was assumed to be 60 feet. A 10-foot pile spacing was assumed based on the USACE guidelines.

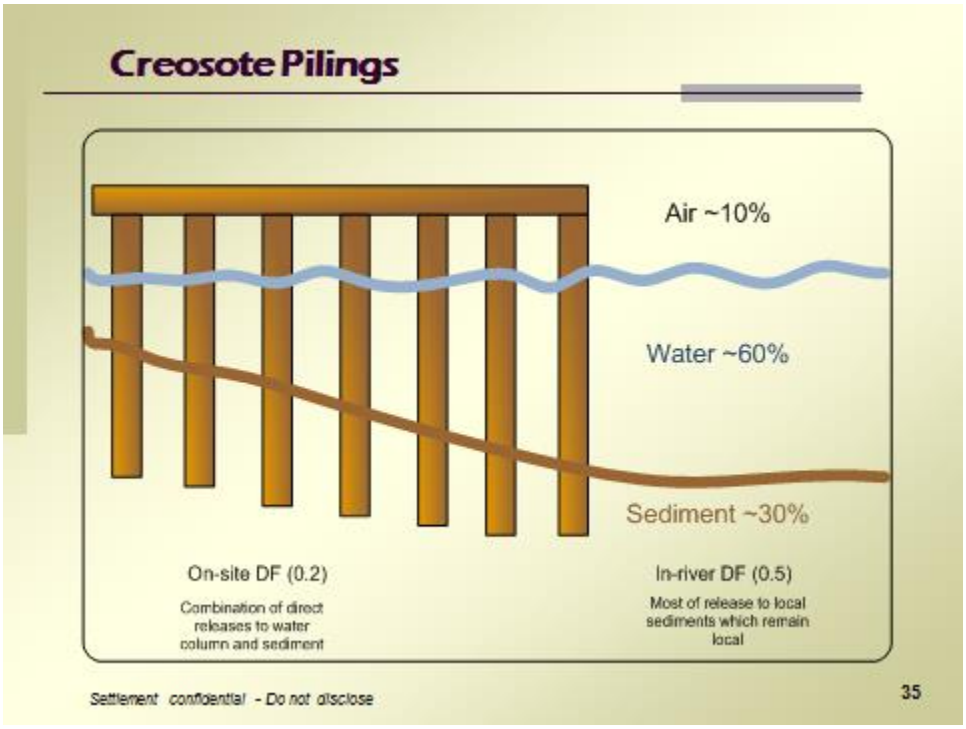

Figure F1. Schematic showing how creosote pilings were treated in the PAH NRDA analysis.

F2- Release rates for creosote pilings are overestimated; concerns about the leaching rate from the Valle and Ecology reports; effects of temperature and salinity

The desorption rate is based on freshwater exposure…has been shown to be strongly temperature dependent… (Page 3, Windward Memo, App. F)

The leaching rate of PAHs was observed only at the surface (1mm) of the treated piling…therefore, only a small volume of creosote is available to function as a source of PAHs due to leaching. (Page 3, Windward Memo, App. F)

PAH desorption rates decline exponentially following the placement of freshly treated wood. (Page 3-4, Windward Memo, App. F)

…the rate of PAH release derived by Valle et al. (2007) is an overestimation of the release of PAHs from the pilings into the water column in Puget Sound waters… (Page 4, Windward Memo, App. F)

<u>RESPONSE</u>: Both Valle et al. (2007) and Washington Department of Ecology (2011) agree that there is a level of uncertainty associated with the leaching rate. In Valle et al. 2007, leaching rates from two reports (Ingram et al., 1982; Bestari et al., 1998) were reviewed and used to calculate leach rates using four different methods (Valle, Table 3.5). The authors selected the average value (23% loss of PAH over 30 years) as the leach rate for the New York/New Jersey harbor. This same rate was used in the Ecology report and the NRDA PAH analysis.

A number of authors have attempted to produce a model which quantifies the PAH leach rates from a creosote-treated pilings. In a 2006 report prepared by Stratus Consulting and Duke University *2006*), the leaching models from twelve different researchers were reviewed to determine the relative strengths and weaknesses of each approach. The Stratus report did not identify any leach rate model as a preferred or definitive approach.

For the NRDA PAH analysis, it was necessary to estimate the amount of PAH in the waterway sediments that originated from creosote-treated pilings. Due to the differences in the leach rate models discussed in the literature and the uncertainty about the inputs to the models, the relatively straight-forward model proposed in Valle et al. 2007 (and also used in ECY 2011) was used as the leaching rate.

The assumption that the leach rate continues to decrease with time has been contradicted in the literature. For example, a more recent report by Kang et al. (2005) shows that after about a week at a very high leach rate, the leach rate reached a lower steady state. Also, as pilings age, other factors such as crumbling and abrasions (from ship traffic, debris, etc.) would expose fresh creosote that would leach at a rate closer to the much higher initial rate.

It is understood that this analysis is based on data generated from warmer and less saline waters, and if the analysis was re-run using conditions similar to those found in the Duwamish waterway, a lower value might be calculated. Other studies show that leaching rates increase with increased water velocity. However, since our analysis uses diminution factors that reduce the amount of PAH so that only 3% of the estimated PAH

leached is considered to have contributed to sediment contamination, we believe our approach compensates for uncertainty in the leaching rates.

Additional assumptions in the PAH loading estimate from creosote pilings:

- No contribution from the portion exposed to the water column is included. Using the ECY example and applying the same factors as were used for the portion exposed to the sediment, an additional 0.022 Kg PAH/pile/year would be allotted for the portion exposed to the water.

- No contribution from the portion exposed to the air is included, although some research indicates that when creosote-treated wood is warmed by sunlight, micro-droplets of creosote are exuded from the wood, fall into the water and directly impact the sediments (Goyette and Brooks, 1998). Using the ECY example and applying the same factors, an additional 0.005 Kg PAH/pile/year would be allotted for the portion exposed to the air.

- No contribution was included from other materials such as cross-ties, planking, etc., which would leach PAH into the water from both rainfall and from micro-droplets.

- It was assumed that pilings only leach for 30 years, even though pilings often remain in the water for up to 70-90 years and continue to leach during that time frame.

In summary, there is some uncertainty in creosote leach rates and these may be influenced by site-specific factors such as temperature, salinity, velocity and age and condition of the pilings. The leach rate calculated here is based on the available scientific literature and is applied to the loading estimate with diminution factors so that only 3% of the PAH estimated to leach from a piling over 30 years is considered to contribute to PAH sediment contamination. The use of diminution factors accounts for uncertainty in the leach rates and provides a conservative estimate of creosote pilings contribution to PAH in sediments.

F3- Inappropriateness of relating PAHs with sandblast grit

"The association of PAHs with sandblast grit is inaccurate and results in an inappropriate assignment of discounted service acre years (dSAYs) to non-contributing parcels." (Page 1, Appendix F)

"…the rationale for associating PAHs with sandblast grit is not known." (Page 6, Appendix F)

"Metals and tributyltin are the primary chemicals associated with sandblast (also known as abrasive grit blast [AGB])…For the …CERCLA sediment remediation project implemented at Todd Pacific Shipyards…constituents of AGB were analyzed, and a definition of AGB in sediment was prepared and approved by the US …EPA…Copper, arsenic, and zinc, as well as grain size, were considered diagnostic of AGB, not PAHs." (Page 6, Appendix F)

"PAHs are not constituents present in sandblast grit, and the manufacturers do not analyze for PAHs. Based on the above information, the correlation between sandblast grit and PAHs is inaccurate and should be removed." (Page 6, Appendix F)

RESPONSE: The Commenter contends that metals (copper, arsenic, and zinc) and TBT are the primary chemicals associated with sandblast grit, which they refer to as abrasive grit blast. The USEPA definition referred to in the comment is published in USEPA (2003), related to the sediment remedial action at Todd Shipyards. The purpose of the definition was to provide guidelines to determine whether abrasive grit blast was present, and not to state what may be present in *spent (used)* abrasive grit blast. Specifically, the definition states that abrasive grit blast is present if it is visually identified, *or* if copper, arsenic, or zinc is present above certain concentrations and the material is coarse (0.15 – 2.0 mm in size).

The purpose of this definition was solely to identify abrasive grit blast that needed to be removed as part of the remedial action, which was to lower the levels of lead. The EPA states "the abrasive grit blast definition is a generic definition developed solely for the TSSOU" (operable unit at Todd Shipyards).

The Commenter also contends that there is no correlation between sandblast grit and PAH, based on a review of the constituents of grit from three different manufacturers (Kleen Blast, Tuf-Kut, and Green Diamond). The Trustees agree that it is unlikely that PAH would be present in clean (unused) sandblast grit when the product is received from the manufacturer. *Used* sandblast grit, however, will contain elevated levels of contaminants based on the surfaces that were sandblasted and the general cleanliness of the sandblast areas in the shipyards.

Historical and recent data analysis from shipyard sites in the Lower Duwamish River support the conclusion that spent sandblast grit can contain significant levels of PAH, along with other contaminants (McLaren Hart, 1992; Duwamish Shipyard Inc., 2011).

REFERENCES

Adams, S., Greeley, Jr., M., and M. Ryon. 2000. Evaluating effects of contaminants on fish health at multiple levels of biological organization: exrapolating from lower to higher levels. Human and Ecological Risk Assessment 6:15–27.

Arkoosh, M.R., E. Clemons, P. Huffman, H.R. Sanborn, E. Casillas, and J. E. Stein. 1996. Leukoproliferative response of splenocytes from English sole (*Pleuronectes vetulus*) exposed to chemical contaminants. Env. Tox & Chem (15):1154–1162.

Barrick, R., S. Becker, L.Brown, H. Beller, and R. Pastorok. 1988. Sediment Quality Values Refinement Volume I: 1988 Update and Evaluation of Puget Sound AET. September 1988 report to the Puget Sound Estuary Program. 193 pp.

Bascietto, J., R. Dunford, F. Sharples, and G. Suter II. 1993. Integrating Natural Resource Damage Assessment and Restoration Activities at DOE Facilities. Paper presented at Federal Environmental Restoration Conference, Washington, DC, May 25–27, 1993.

Bestari, K.T.J., R.D. Robinson, K.R. Solomon, T.S. Steele, K.E. Day, and P. K. Sibley. 1998. Distribution and composition of polycyclic aromatic hydrocarbons within experimental microcosms treated with creosote-impregnated Douglas fir pilings. Environ. Toxicol. Chem. 17:2369–2377.

Cacela, D., J. Lipton, D. Beltman, J. Hansen, and R. Wolotira. 2005. Associating ecosytem service losses with indicators of toxicity in habitat equivalency analysis. Environmental Management 35:343–351.

Casillas, E., D.A. Misitano, L.L. Johnson, L.D. Rhodes, T.K. Collier, J.E. Stein, B.B. McCain, and U. Varanasi. 1991. Inducibility of spawning and reproductive success of female English sole (*Parophrys vetulus*) from urban and nonurban areas of Puget Sound, Washington. Mar. Environ. Res. 31:99–122.

Collier, T.K., J.E. Stein, A. Goksoyr, M.S. Myers, J.W. Gooch, R.J. Huggett, and U. Varanasi. (1993). Biomarkers of PAH exposure and effects in oyster toadfish (Opsanis tau) from the Elizabeth River, Virginia. Environ Sci. 2:161–177.

Duwamish Shipyard Inc. 2011. Phase I Remedial Investigation Duwamish Shipyard, Inc. Site, September 2011. Prepared by Anchor QEA. 308 pp.

ECY. 2011. See: Washington Department of Ecology, 2011.

Gala, W., J. Lipton, P. Cernera, T. Ginn, R. Haddad, M. Henning, K. Jahn, W. Landis, E. Mancini, J. Nicoll, V. Peters, and J. Peterson. 2009. Ecological risk assessment and natural resource assessment: synthesis of assessment procedures. Integrated Environmental Assessment and Management 5:515–522.

Gouguet, R. 2005. Use of sediment quality guidelines in damage assessment and restoration at contaminated sites in the U.S. In Wenning, R., G. Batley, C. Ingersoll, and D. Moore, eds. Use of Sediment Quality Guidelines and Related Tools for the Assessment of Contaminated Sediments, pp. 589–606. Pensacola,FL): SETAC Press.

Goyette, D., and K.M.Brooks. 1998. Creosote Evaluation: Phase II, Sooke Basin Study – Baseline to 535 Days Post Construction, 1995-1996. Prepared for Creosote Evaluation Steering Committee, Regional Program Report PR98-04, December 1998: http://www.wwpinstitute.org/documents/sookebasinstudy/Main%20Report/01Creosote98.pdf

Gries, T., and K. Waldow. 1996. Progress Re-evaluating Puget Sound Apparent Effects Thresholds (AETs). Volume I: 1994 Amphipod and Echinoderm AETs. Draft report for Puget Sound Dredged Disposal Analysis. April 1996. 75 pp.

Ingram, L.L., G.D. McGinnis, L.R. Gjovik, and G. Roberson. 1982. Migration of creosote and its components from treated piling sections in a marine environment. American Wood-Preservers' Association. 78:120-128.

Johnson, L.L.,E. Casillas, T.K. Collier, B.B. McCain, and U. Varanasi. 1988. Contaminant effects on ovarian development in English sole (*Parophrys vetulus*) from Puget Sound, Washington. Can. J. Fish. Aquat. Sci. 45:2133–2146.

Johnson, L.L., J.T. Landahl, L.A. Kubin, B.H. Horness, M.S. Myers, T.K. Collier, and J.E. Stein. 1998. Assessing the effects of anthropogenic stressors on Puget Sound flatfish populations. J. Sea Res. (39):125–137.

Johnson, L.L., T. K. Collier, and J. E. Stein. 2002. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. Aquat. Cons: Marine and Freshwater Ecosystems 12:517–538.

Johnson, L., personal communication, 2012.

Kang, S., J.J. Morrell, J. Simonsen, and S. Lebow. 2005. Creosote movement from treated wood immersed in fresh water. Forest Products Journal 55:42–46.

Lower Duwamish Waterway Group (LDWG). 2007. Baseline Ecological Risk Assessment (Appendix A to Lower Duwamish Waterway Phase 2 Remedial Investigation Report).Submitted to US EPA and Washington Department of Ecology.

McLaren Hart. 1992. Preliminary Site Characterization Summary Phase I Remedial Investigation/Feasibility Study Lockheed Shipbuilding Yard 1, Seattle, Washington. Rev. January 1992, Vol. 1–3.

Meador, J.P., J.E. Stein, W.L. Reichert, and U. Varanasi. 1995a. A review of bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of Environmental Contamination and Toxicology 143:79–165.

Meador, J.P., E. Casillas, C.A. Sloan, and U. Varanasi. 1995b. Comparative bioaccumulation of polycyclic aromatic hydrocarbons from sediment by two infaunal invertebrates. Mar. Ecol. Prog. Ser. (123):107–124.

Meador, J.P., T.K. Collier, and J.E. Stein. 2002a. Use of tissue and sediment based threshold concentrations of polychlorinated biphenyls (PCBs) to protect juvenile salmonids listed under the U.S. endangered species act. Aquat. Conserv. Mar. Fresh. Ecosyst. 12:493–516.

Meador, J.P., T.K. Collier, and J.E. Stein. 2002b. Determination of a tissue and sediment threshold for tributyltin to protect prey species of juvenile salmonids listed under the US Endangered Species Act. Aquat. Conserv. Mar. Fresh. Ecosyst. 12:539-551.

Meador, J.P., F.C. Sommers, G.M. Ylitalo, and C.A. Sloan. 2006. Altered growth and related physiological responses in juvenile Chinook salmon (Oncorhynchus tshawytscha) from dietary exposure to polycyclic aromatic hydrocabons (PAHs). Can. J. Fish. Aquat. Sci. 63:2364–2376.

Meador, J.P., J. Buzitis, and C. Bravo. 2008. Using fluorescent aromatic compounds (FACs) in bile from juvenile salmonids to determine exposure to polycyclic aromatic hydrocarbons. Environmental Toxicology and Chemistry 27:845–853.

Meador, J.P. 2011. Organotins in aquatic biota, occurrence in tissue and toxicological significance. Chapter 7 in Beyer, W.N., and J.P. Meador, eds. Environmental Contaminants in Biota: Interpreting Tissue Concentrations, pp. 255–284. Boca Raton, FL: Taylor and Francis. 751 pp.

Meador, J. Personal communication, 2012.

Meador JP, Rice CA. 2001. Impaired growth in the polychaete *Armandia brevis* exposed to tributyltin in sediment. Mar Environ Res 51:113-129.

Melancon, M.J., K.A. Turnquist, and J.J. Lech. 1989. Relation of hepatic microsomal monooxygenase activity to tissue PCBs in rainbow trout *(Salmo gairdneri)* injected with 14C PCBs. Environ. Toxicol. Chem. 8(9):777–782.

Misitano, D.A., E. Casillas, and C.R. Haley. 1994. Effects of contaminated sediment on viability, length, DNA and protein content of larval surf smelt, *Hypomesus pretiosus*. Marine Environmental Research 37:1–21.

Moser, M., M.S. Myers, S.L. Katz, S.M. O'Neill, S.R. Quinnell, and J.E. West. 2005. Using ccoustic telemetry to document English sole movements: application to management of contaminated sediments. In Report of the National Marine Fisheries Service Workshop on Advancing Electronic Tag Technologies and Their Use in Stock Assessments, August 23–25, 2005. NOAA Technical Memorandum NMFS-F/SPO-82, pp. 9–10.

Munns, W., R. Helm, W. Adams, W. Clements, M. Cramer, M. Curry, L. Dipinto, D. Johns, R. Seiler, L. Williams, and D. Young. 2009. Translating ecological risk to ecosystem service loss. Integrated Environmental Assessment and Management 5:500–514.

Myers, M.S., C.M. Stehr, O.P. Olson, L.L. Johnson, B.B. McCain, S. Chan, and U. Varanasi. 1994. Relationships between toxicopathic hepatic lesions and exposure to chemical contaminants in English sole (*Pleuronectes vetulus*), starry flounder (*Platichthys stallatus*) and white croaker (*Genyonemus lineatus*) from selected marine sites on the Pacific Coast USA. Environ. Health Perspect. 102:200–215.

Myers, M.S., L.L. Johnson, T.Hom, T.K. Collier, J. E. Stein and U. Varanasi. 1998. Toxicopathic hepatic lesions in subadult English sole (*Pleuronectes vetulus*) from Puget Sound, Washington, USA: relationships with other biomarkers of contaminant exposure. Mar. Envion. Res. 45:47–67.

Myers, M.S., L.L. Johnson, and T.K. Collier. 2003. Establishing the causal relationship between polycyclic aromatic hydrocarbon (PAH) exposure and hepatic neoplasms and neoplasia-related liver lesions in English sole (*Pleuronectes vetulus*). Human and Ecological Risk Assessment 9:67–94.

Myers, M.S., B.F. Anulacion, B.L. French, W.L. Reichert, C.A. Laetz, J. Buzitis, O.P. Olson, S. Sol, and T. K. Collier. 2008. Improved flatfish health following remediation of a PAH-contaminated site in Eagle Harbor, Washington. Aquatic Toxicology 88:277–288.

Myers, M. Personal communication, 2012.

Port of Seattle. 2012. Baseline Ecological Risk Assessment (Appendix A to East Waterway Supplemental Remedial Investigation/Feasibility Study). Submitted to US EPA.

Rice, C.A., M.S. Myers, M.L. Willis, B.L. French, and E. Casillas. (2000). From sediment bioassay to fish biomarker—connecting the dots using simple trophic relationships. Mar. Environ. Res. 50:527–533.

Schoch, G.C., and M. Dethier. 2001. The Intertidal Biota of Puget Sound Gravel Beaches, Part 1: Spatial and Temporal Compositions between 1999 and 2000. A Report for the Washington State Department of Natural Resources, Nearshore Habitat Program.

Stern, J.H., D.P. Hennessy, and C.R. Patmont. 2003. Improving estimates of contaminant exposure for mobile organisms: an assessment of area-weighted home range exposure estimates applied to the relationship between sediment chemistry and liver lesions in English sole. Puget Sound Research Conference 2003, Vancouver, BC.

Stratus Consulting Inc. and Duke University. 2006. Creosote-Treated Wood in Aquatic Environments: Technical Review and Use Recommendations. Prepared for NOAA Fisheries Southwest Division, December 31, 2006. http://swr.nmfs.noaa.gov/wood/creosote_report-final.pdf

Suter, G., S. Norton, and A. Fairbrother. 2005. Individuals versus organisms versus populations in the definition of ecological assessment endpoints. Integrated Environmental Assessment and Management 1:397–400.

U.S. Army Corps of Engineers (USACE). 2002. ACOE Institute for Water Resources Navigation Data Center, Port Series No. 36.

U.S. Environmental Protection Agency (US EPA). 1992. The Role of Natural Resource Trustees in the Superfund Process. Publication 9345.0-051.

US EPA. 1999. Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites. OSWER Directive 9285.7-28 P.

US EPA. 2003. Explanation of Significant Differences to the Harbor Island – Shipyard Sediment Operable Unit, Todd Shipyards Sediments, Seattle, WA. Publication EPA/EDS/R10-03/010.

Valle, S., M.A. Panero, and L. Shor. 2007. Pollution Prevention and Management Strategies for Polycyclic Aromatic Hydrocarbons in the New York/New Jersey Harbor. New York: New York Academy of Sciences. 171 pp.

Varanasi, U., J.E. Stein, M. Nishimoto, W.L. Reichert, and T.K. Collier. 1987. Chemical carcinogenesis in feral fish—uptake, activation and detoxication of organic xenobiotics. Environmental Health Perspectives 71:155–170.

Washington State Department of Ecology. 2011. Control of Toxic Chemicals in Puget Sound—Phase 3: Primary Sources of Selected Toxic Chemicals and Quantities Released in the Puget Sound Basin. Publication No. 11-03-024.

Weis, J., G. Smith, T. Zhou, C. Santiago-Bass, and P. Weis. 2001. Effects of contaminants on behavior: biochemical mechanisms and ecological consequences. BioScience 51:209–217.

Actual Comments from the Public from 2012

Port of Seattle

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October 10, 2012

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point WayNE
Seattle, WA 98115

Re: Port of Seattle Comments on Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement

Dear Ms. Hoff:

The Port of Seattle is submitting the enclosed comments on NOAA's Supplement to the Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) issued July 27, 2012. Included in our comments are analyses prepared by Windward Environmental on behalf of the Port and the Puget Sound Commerce Center, Inc. (formerly Todd Shipyards) concerning RP/PEIS Appendix C (Defining Injuries to Natural Resources in the Lower Duwamish River) and Appendix F (Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment).

The Port is very concerned that NOAA has greatly overestimated damages to natural resources in the Lower Duwamish River and the Harbor Island Waterways by relying on unsupported assumptions and an overly simplistic approach to what must necessarily be a complex damage assessment analysis. The Port is also concerned with the approach to liability allocation used by NOAA, as described in Appendix F, that results in current shoreline property owners being assigned essentially all site NRD liability, including liability for activities that occurred in the distant past that current shoreline property owners had no role in, and liability for hazardous substance releases that clearly originated from other parties. This approach to damage assessment does not meet NOAA's burden of demonstrating that a party's natural resource damages debit "result[s] from" hazardous substance releases associated with that party. 42 U.S.C. 9607(a)(4)(C).

The result of the approach to damage assessment and the arbitrary allocation methodology documented in RP/PEIS Appendices C and F is that certain public and private entities are unjustifiably assigned vast amounts of natural resource damages liability, with other parties that have been responsible for significant releases apparently being assigned little or no such liability. Substantially overestimating natural resource damages, and then unfairly allocating the purported liability, has unfortunate consequences for both the environment and the current shoreline property owners along the Duwamish and Harbor Island Waterways. Without a reasonable and defensible damage assessment and liability allocation, parties assigned large shares of liability

will be unwilling to enter into agreements to restore habitat and provide needed environmental improvements. Many Duwamish corridor parties, including the Port, are both willing and eager to participate in habitat restoration projects and to resolve issues associated with the natural resource damages for which they can legitimately be held liable. However, the approaches used by NOAA for damage assessment and liability allocation have stood as an impediment to moving forward for many years, resulting in very few substantial settlements.

As documented in the attached comments, NOAA should revisit its assessment of damages to take into account the mountain of new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early- to mid-1990s. The Port and other parties have spent tens of millions of dollars in the characterization of the sediments at those sites and the evaluation of their potential impacts on human health and the environment. Rather than focusing on that wealth of new and more reliable information, NOAA has chosen for most hazardous substances to use screening levels taken from a more limited, and much older, dataset. NOAA has taken the screening levels calculated from that limited dataset and misapplied them based on the faulty assumption that those values represent the concentrations at which significant injuries to biota begin to occur. Instead, as explained in the Windward comments, the calculated screening levels are conservative values most appropriately used as thresholds for determining when damage to biota is *not* occurring due to a particular hazardous substance rather than values that show the onset of damage.

Further, for a limited set of substances, NOAA has rejected the screening values taken from the old dataset and used a small set of highly questionable studies to derive even lower thresholds for damages. The values derived by NOAA from those studies are inconsistent with the results of numerous other studies and with generally accepted reference toxicity values of the type used for the Duwamish and East Waterway Ecological Risk Assessments. For example, the PAH thresholds used in Appendix C were derived based on an assumption that the sampled fish had lifetime exposures to the concentrations ofPAHs found immediately adjacent to where the fish were caught. However, the highly mobile fish involved range over a larger area. When the same analysis is performed using average concentrations across a more realistic home range area, the threshold concentrations go up four fold.

NOAA's mistake in assuming that exposure indications for mobile species can be validly correlated to point concentrations of contaminants is compounded by the assumption that any indication of exposure, such as the presence of biomarkers, represents an actual injury. In reality, biomarkers and other exposure indicators are just that-mere indications that exposure has occurred and that the species in question has reacted to that exposure by, e.g., producing more of the enzyme needed to metabolize a certain compound. An indication of exposure is the first step in evaluating whether an effect may be present, not the last.

Finally, NOAA's damage assessment mistakes are compounded yet again by simply assuming that substantial service losses occur at the extraordinarily low concentrations where NOAA believes exposure indications begin to appear. Although scientific studies exist demonstrating actual harm at much higher concentrations, meaning service losses at those concentrations could validly be estimated, NOAA has assigned very significant service losses to concentrations far

below those levels. By contrast, the Duwamish and East Waterway Ecological Risk Assessments, which were performed under the oversight of the U.S. Environmental Protection Agency and the Washington Department of Ecology, relied on more credible and accepted science and found relatively little ecological risk at these sites. The high hazardous substance concentrations that demonstrably result in meaningful effects on the species present in the Duwamish are simply not found at many locations, resulting in low ecological risk.

The unsupportable approaches to damage assessment and liability allocation presented in Appendices C and F demonstrate the need for NOAA to rework both its assessment of damages and its assignment of liability for those damages. This need not be a multi-year, multi-million dollar effort. A more streamlined, reasonable approach is possible using existing data and more defensible damage thresholds. Plumes can readily be defined based on the data that NOAA has to date chosen to ignore, and liability can proportionally be assigned to those parties that can clearly be shown to have caused significant releases of the hazardous substances involved.

Continuing to rely on an outdated and indefensible damage assessment and an arbitrary damages allocation will result in the continued waste of valuable public and private resources that could be better spent actually restoring habitat. The Port urges NOAA to apply a more reasoned approach to damage assessment and liability allocation. An approach of that type will avoid the situation where some parties are assigned huge amounts of liability, while other genuinely liable parties are assigned virtually none, or are ignored altogether. The "winners" in the game that NOAA is currently playing will, of course, consider moving forward with settlements, but little new habitat will be created because their assigned liability is minimal. The "losers" will not be willing to settle based on the damage assessment and liability allocation as it is currently structured, as their liability has been dramatically overestimated. The result is that the habitat that could have been created by settlements with those parties will have to wait, as it already has for the 20 years following NOAA's settlement with the City and County. NOAA should turn away from this lose/lose approach that has stymied habitat creation in the Duwamish for two decades and move forward with a more defensible, streamlined approach.

Thank you for considering the Port's comments. We would be happy to discuss the issues raised by our comments at any time.

Very truly yours,

S

Senior Port Counsel
Tel: (206) 787-3416
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Enclosure

cc: Stephanie Jones Stebbins

October 10, 2012

VIGOR
INDUSTRIAL

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way NE
Seattle, WA 98115

Re: Puget Sound Commerce Center, Inc. (f/k/a Todd Shipyards Corporation) Comments on Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement

Dear Ms. Hoff:

Puget Sound Commerce Center, Inc. (f/k/a Todd Shipyards Corporation) ("Todd") is submitting the enclosed comments on NOAA's Supplement to the Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) issued July 27, 2012. Included in our comments are analyses prepared by Windward Environmental on behalf of the Port and Todd concerning RP/PEIS Appendix C (Defining Injuries to Natural Resources in the Lower Duwamish River) and Appendix F (Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment).

Todd is concerned that NOAA has greatly overestimated damages to natural resources in the Lower Duwamish River and the Harbor Island Waterways by relying on questionable assumptions and a simplistic approach. As documented in the attached comments, we urge NOAA, in performing its assessment of damages, to utilize the extensive new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early- to mid-1990s. NOAA's assumptions of significant service losses at extremely low concentrations is in direct contrast to the Duwamish and East Waterway Ecological Risk Assessments, which were performed under the oversight of the U.S. Environmental Protection Agency and the Washington Department of Ecology, which found relatively little ecological risk at these sites.

Todd believes that the assessment of damages and assignment of liability presented in Appendices C and F need to be revised. This need not be a multi-year, multi-million dollar effort. A more streamlined, reasonable approach is possible using existing data and more defensible damage thresholds.

Thank you for considering our comments. Please let me know if you would like to discuss our comments in more detail.

Very truly yours,

T. Alan Sprott
Vice President, Environmental Affairs

Enclosure

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MEMORANDUM

To: Jon Sloan, Port of Seattle, and Alan Sprott, Puget Sound Commerce Center, Inc. (fka Todd Pacific Shipyards)

From: Ron Gouguet and Susan McGroddy, Windward Environmental LLC

Subject: Review of Appendix C, Defining Injuries to Natural Resources in the Lower Duwamish River, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*

Date: October 9, 2012

The natural resource trustees (Trustees) for the Duwamish River published a draft update to their *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement* (NOAA and USFWS 2009). The document attempts to explain how the Trustees intend to adapt the damage assessment approach used to scale injury in the Hylebos Waterway to conduct a damage assessment for the Lower Duwamish River. We have reviewed Appendix C, Defining Injuries to Natural Resources in the Lower Duwamish River, and have the following comments.

In general, we believe that the analysis provided in Appendix C (NOAA and USFWS 2009) is inappropriately based entirely on literature toxicity values and state screening values, ignoring the extensive dataset associated with the Lower Duwamish Waterway (LDW) remedial investigation (RI), including sediment bioassay testing and tissue concentrations, and the assessment of ecological risk in the LDW ecological risk assessment (ERA). Furthermore, the use of literature toxicity values and sediment guidelines to calculate service loss rather than site-specific data results in an overly conservative assessment of injury. In many cases, the sediment concentration associated with a given service loss is associated with a threshold for the induction of biomarkers of organism exposure that are not causally linked to measurable effects on populations or communities that would constitute a service loss. For polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and tributyltin (TBT), service loss threshold concentrations have been identified based on a small number of studies that do not provide sufficient justification in support of the values used in Appendix C. Specific concerns regarding the values for each of these chemicals are identified below.

For chemicals other than PCBs, PAHs, and TBT, apparent effects threshold (AET) values are used to calculate service losses. This use of AETs is not consistent with their intended use as screening values that most accurately identify sediment for which no biological effects would be expected. The exceedance of an AET may or may not indicate the presence of biological effects. In the following sections, specific issues associated with the analysis presented in Appendix C (NOAA and USFWS 2009) are discussed, followed by an evaluation of AETs as predictors of biological effects conducted using sediment collected within the Lower Duwamish River.

Finally, there is no discussion provided in Appendix C (NOAA and USFWS 2009) to support the service loss percentages assigned to each threshold concentration. The lowest threshold concentration for every chemical is consistently associated with 5% service loss; and for all chemicals other than PAHs, PCBs, and dichlorodiphenyltrichloroethane (DDT) isomers, the highest threshold concentration is associated with a 20% service loss. The highest level of service loss for PAHs and PCBs was 80%; and for DDT isomers, the highest level of service loss was 40%. There is no explanation provided for the different levels of service loss assigned to different chemicals or to justify the levels of service loss associated with the threshold values for each chemical.

1 INJURY THRESHOLDS FOR PAHS, TBT AND PCBS

For most chemicals, AETs are used in Appendix C (NOAA and USFWS 2009) as the basis for determining whether damage to natural resources from hazardous substance releases has occurred. However, injury thresholds for PAHs, TBT, PCB, and DDT isomers were not calculated based solely on Washington State AET values. For these chemicals, a combination of AETs and a small number of literature studies were used to establish injury thresholds. Very little detail is provided in Appendix C to support the threshold values that have been identified for these chemicals. In general, the selected values are well below the toxicity reference values used to evaluate these chemicals in the LDW RI; and for PAHs and PCBs, threshold values were established based on biomarkers of exposure that cannot be definitively associated with an effect that would result in a service loss.

1.1 PAH Injury Assessment

The two studies that were cited in Appendix C (NOAA and USFWS 2009) to support the assessment of injury to fish by PAHs in sediment are Johnson et al. (2002) and Rice et al. (2000). The values selected from these studies to assess injury to fish overpredict injury by assigning injury based on physiological indicators of exposure and reversible suborganismal effects.

The data underlying the effects thresholds overestimate the potential for adverse effects. The sediment effects thresholds for liver disease from Johnson et al. (2002) were biased low because all lesion types were assumed to cause disease in affected fish, whereas only a fraction of the lesion types were frank lesions indicative of disease. Furthermore,

the co-located sediment and tissue data used to develop the hockey stick regression underestimated the PAH concentrations to which English sole were likely exposed prior to sampling. Stern et al. (2003) conducted a re-analysis of the hockey stick regression using the same lesion data as that used in Johnson et al. (2002) and a larger sediment dataset. Instead of using co-located sediment data from trawls, Stern et al. (2003) used spatially weighted average sediment PAH concentrations from the trawl area collected over realistic home range. This re-analysis resulted in an effects threshold for lesions that is four times higher than that presented in Johnson et al. (2002).

The sediment effects thresholds for reproductive dysfunction from Johnson et al. (2002) are highly uncertain. The statistical analysis relied on estimates of the background level of reproductive dysfunction and the inflection point (i.e., the concentration at which effects begin to be elevated above background) because insufficient data were available to calculate these parameters. In addition, as described above, for liver disease, the sediment concentrations to which English sole were exposed prior to sampling were likely to be underestimated. Furthermore, the causal relationship between observed reproductive effects and sediment PAH concentrations is unclear. For example, in one study (Casillas et al. 1991) that underlies the Johnson et al. (2002) relationship for gonadal growth, PAH concentrations accounted only for 34% of the variance in ovarian development, indicating that other factors may be causative. Differences in ovarian development could be due to natural variation in maturation timing among English sole subpopulations in Puget Sound or to exposure to other environmental stressors.

The sediment effect threshold for growth from Rice et al. (2000) is also uncertain. In this study, juvenile English sole were fed polychaete worms that had previously been exposed in the laboratory to 0.1% sediment from the Eagle Harbor, Washington, Superfund site mixed with 99.9% sediment from a reference site. PAH concentrations were reported for the sediment and worm tissue; other uncharacterized chemicals may also have been present but were not analyzed.[1] The major chemical contaminants present at Eagle Harbor were associated with creosote, which is used as a wood preservative. The major creosote-related chemicals generally associated with toxicity are PAHs, phenols, and cresols (ATSDR 2002). About 300 chemicals have been identified in coal tar creosote, but as many as 10,000 other chemicals may also be in this mixture (ATSDR 2002). Rice et al. (2000) showed that in one experimental trial, fish exposed to contaminated worms that contained a total PAH concentration of 11.3 parts per million (ppm) dry weight (dw) had a lower daily growth rate than did the controls. In a second trial of the experiment, a similar trend was observed, but the effect was not statistically significant.

There is no discussion in Appendix C (NOAA and USFWS 2009) of how the results of the toxicity studies (Johnson et al. (2002) and Rice et al. (2000) support the establishment

[1] Concentrations were reported as low-molecular-weight PAHs (LPAHs) and HPAHs; the specific individual PAHs quantitated were not reported.

of 20 and 40% service losses for invertebrates and fish, respectively, at a total PAH concentration of 1 ppm in individual sediment samples. The exposure of highly motile organisms such as English sole is integrated over the entirety of their home range and cannot be evaluated on a point basis. The development of these thresholds has been shown to be highly sensitive to the sediment data selected as the exposure concentration. The assumption that a concentration at a point located proximate to the trawl line represents the lifetime exposure of a highly mobile fish is not logical. Furthermore, the 1-ppm concentration is associated with the presence of lesions that are reversible suborganismal effects. The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown. They are not clearly linked to effects on populations or communities that constitute a measurable ecological service loss. It should also be noted that the 1 ppm total PAH concentration is much lower than the AET of 69 ppm for high-molecular-weight PAHs (HPAHs). Finally, PAHs were evaluated in the LDW ERA for potential risk to English sole; and based on an evaluation of the prey items collected throughout the LDW, no risk to English sole from exposure to PAH concentrations in the LDW was identified.

1.2 TBT Injury Assessment

The development of TBT injury threshold values is based on work that evaluated the effect of TBT on the marine polychaete *Armandia brevis* (Meador and Rice 2001) and bioaccumulation modeling based on relatively few datasets, including the *A. brevis* data (Meador et al. 2002). There is a significant amount of literature on the effects of TBT on benthic organisms that is not represented. The bioaccumulation potential for TBT has been shown to be highly species specific (Meador et al. 1997). Further justification should be provided to support setting injury thresholds based on a polychaete species that has not been observed in the Lower Duwamish River.

TBT was not identified as a risk driver in the ERA conducted for the LDW Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation based on the evaluation of imposex in benthic organisms collected throughout the site and the evaluation of chemical concentrations in tissue collected from throughout the site and compared with tissue effect concentrations. The data collected from the site is not consistent with the level of injury that would be predicted by the proposed injury threshold values.

1.3 PCB Injury Assessment

The assessment of service losses due to the exposure of benthos to PCBs is based on total PCB AET values. The assessment of injury to fish is based on work done by Meador et al. (2002) and NOAA (2001), which evaluate effects of PCB exposure on juvenile Chinook salmon. Meador et al. (2002) is cited as the source of the values used as thresholds for the 20 and 60% service losses. The relationships between sediment concentrations and adverse effects reported in Meador et al. (2002) rely on several assumptions that are highly uncertain. Meador et al. (2002) estimated organic carbon-normalized sediment effects thresholds from lipid-normalized PCB concentrations in

salmon that were associated with various effects. In each of the 15 studies underlying this relationship, some data critical to the analysis (e.g., tissue PCB concentrations, tissue lipid concentrations) were not reported but were instead estimated based on uncertain assumptions. For example, in the study associated with the lowest effects threshold, Melancon and Lech (1983) reported increased levels of a biomarker of chemical exposure (hepatic mono-oxygenase activity [ethoxyresorufin-O-deethylase (EROD)]) in juvenile rainbow trout associated with the injection of PCBs into their body cavity. Melancon and Lech (1983) did not report the tissue concentration of PCBs in the trout, so Meador et al. (2002) assumed that 75% of the injected dose was absorbed into the tissue. In addition, Melancon and Lech (1983) did not report the lipid content of the trout so Meador et al. assumed 9% lipid based on estimates for adult fish. Based on these assumptions, Meador et al. (2002) calculated a PCB tissue residue of 1.7 µg/g lipid as the effect threshold. A later report by the authors of the original study (Melancon et al. 1989) suggested that such effects occur at a muscle concentration of approximately 0.3 µg/g wet weight (ww), which, using the assumptions from Meador et al. (2002), would correspond to 3.3 µg/g lipid. Similar assumptions made for the other 14 studies are more likely to underestimate rather than overestimate the tissue concentration at which the effect is likely to occur. Consequently, the sediment effects thresholds are more likely to underestimate than overestimate realistic effect thresholds and result in an overprediction of injury.

Furthermore, as is the case for PAHs, many of the effects included in Meador et al. (2002) are physiological indicators of exposure and reversible suborganismal effects. Examples included altered levels of hormones, changes in enzyme activity, or decreases in the synthensis of vitellogenin (a precursor protein of egg yolks). The effects associated with a 60% service loss from NOAA (2001) are also biomarkers (i.e., immune suppression and cytochrome P450 induction). The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown.

2.0 USE OF AETS IN INJURY ASSESSMENT

For all chemicals other than PAHs, TBT, PCBs, and DDT congeners, Washington State AETs were used to identify threshold concentrations for service losses. AET values were developed as screening concentrations and are inherently conservative values that will overestimate biological effects. In the following sections, the development of AETs is described, and the use of AETs in the Hylebos Model is examined. Finally, the predictive power of AETs is tested with a dataset that includes sediment chemical concentrations and bioassay results from the LDW and East Waterway (EW).

2.1 Development of Apparent Effects Thresholds

In Washington State, AETs have been developed for several biological endpoints, including field measures of benthic infaunal abundance, results of laboratory toxicity tests using marine benthic invertebrate organisms (i.e., amphipods [survival] and oysters [percent abnormal development of oyster larvae]), and results of laboratory

toxicity tests using bacteria (Microtox® [decreases in luminescence from the bacteria *Vibrio fisheri*]). For each hazardous substance, the AET is the chemical concentration in sediment above which statistically significant biological effects are always expected for one or more biological effects indicators.

The sediment used in the development of AETs contained a variety of chemicals with a range of concentrations. These complex mixtures present issues when interpreting the cause of any observed biological effects because it is difficult to identify the chemical or chemicals that are responsible for the biological effects or toxicity. If, for example, a particular chemical consistently co-occurred with a more toxic chemical in sediment sampled for the calculation of AETs, the AET value for the less toxic chemical could be much lower than the "true" toxic threshold for the chemical based on exposure to the chemical alone.

In addition to the complexity of the chemical mixture, other confounding factors that can affect the bioassay result are geochemical (e.g., organic carbon, sulfides, ammonia) and physical properties (e.g., grain size, porosity) of the sediment. These confounding factors can result in significant organism mortality, or other observed effects, resulting in the attribution of effects to chemical concentrations that are not causing the effects. Because effects associated with co-occurring chemical and other confounding factors are not taken into account when AETs are calculated using field sediment. AETs are inherently conservative values and are most useful as screening benchmarks. There is no basis for using AET values as the threshold concentrations at which a particular hazardous substance causes damage to natural resources because AETs do not establish a causal relationship between biological effects and a chemical of concern.

The Washington State Sediment Management Standards (SMS) recognize the uncertainty associated with the use of the AET values and allow for the use of sediment bioassay results as the direct measure of the biological effects to supersede the chemical exceedances of AET thresholds in the characterization of sediment. The SMS use AET values as a screening tool that can be superseded by bioassay results, which provide a direct measurement of sediment toxicity and are recognized as a more reliable predictor of sediment quality.

2.2 Use of AETs in the Hylebos Model

AET values in conjunction with the Hylebos Model are used to predict benthic effects presented in Appendix C (NOAA and USFWS 2009). Sediment with a chemical concentration above an AET value is assigned a specific level of injury. As an example, the "injury ramp" for butyl benzyl phthalate (BBP) is presented in Table 1. No effort was made to evaluate the available sediment bioassay data for the Lower Duwamish River to determine the relevance of the AET thresholds for the mixture of contaminants at these sites. Increasing levels of injury are assigned based on the exceedance of multiple AET values. No justification is provided for increasing service loss percentages when multiple AET values are exceeded.

Table 1. Hylebos/Commencement Bay damage assessment injury ramp for butyl benzyl phthalate

Endpoint	AET	% Service Loss
Microtox	63	5
Bivalve	100	na
Echinoderm	200	10
Oyster	> 470	na
Neanthes	> 580	na
Benthic community	900	15
Amphipod	970	20

Source: Table C-5 of Appendix C (2009)
AET – apparent effects concentration
na – not available

For many of the chemicals discussed in Appendix C (NOAA and USFWS 2009), the AET values that are used to represent different levels of injury are not analytically distinct concentrations. For example, in Table 1, a butyl benzyl phthalate sediment concentration of 900 µg/kg is associated with a 15% service loss, and a sediment concentration of 970 µg/kg is associated with a 20% service loss. The standard allowable analytical precision for the measurement of butyl benzyl phthalate in sediment is ± 50% of the measured concentration. The difference between the two AET values is less than 10% and is well within the allowable analytical precision for this chemical, which means that the duplicate analysis of a sediment sample that yielded 900 and 970 µg/kg would represent acceptable accuracy for the analysis. Other chemicals for which there are AETs associated with variable injury levels that are clearly within the analytical precision of the measurements are 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, cadmium, lead, mercury, silver, bis(2-ethylhexyl) phthalate, and dimethylphthalate.

2.3 Case Study: Evaluation of Effects Predicted by AETs Compared with Effects Measured in LDW and EW Sediment

In order to evaluate the predictive power of AETs in the Lower Duwamish River, a dataset of 101 sediment samples collected from the LDW and East Waterway (EW) of Harbor Island was evaluated. All of these samples were submitted for chemical analysis and sediment bioassays for the LDW or EW CERCLA remedial investigations. The reliability of the chemical concentrations above the AETs as indicators of biological effects, as measured by the sediment bioassays, was evaluated.

For the purpose of this evaluation, the degree of chemical or bioassay exceedance was not considered; the only consideration was whether or not the chemistry and bioassay results exceeded the AET threshold for chemistry or the sediment quality standards (SQS) threshold for the bioassay results.

However, for the 95 samples that exceeded at least one of the AET values, the exceedance of the AET did not necessarily accurately predict the biological effects associated with the bioassay results. In 54% of these samples, the chemical exceedance of the AET was consistent with a bioassay result, which also exceeded the SQS threshold. However, in 46% of the samples, no toxicity was observed in the three sediment bioassay results for the sample. For this dataset, the AETs have functioned as intended, as a conservative screening tool with a strong tendency to overpredict toxicity in order to ensure that sediment classified as non-toxic on the basis of the chemistry results were reliably confirmed as non-toxic by the bioassay results.

These results suggest that the exceedance of an AET value should not be used as a reliable indicator of certain biological effects. AETs may function well as screening levels, but they are clearly not a reliable indicator of biological effect as demonstrated by the LDW and EW sediment bioassay results.

Finally, the LDW data was examined to determine whether the exceedance of multiple AETs increased the predictive power of the AET evaluation. The sediment concentrations in the LDW sediment were compared with six AET values. Of the 95 samples that exceeded at least one AET value, 48 samples exceeded 1 to 3 AET values, and 47 samples exceeded 4 to 6 AET values. Of the 48 samples that exceeded 1 to 3 AET values, 24 samples (50%) showed that there were no significant biological effects associated with the sediment bioassays. Of the 47 samples that exceeded 4 to 6 AET values, 20 samples (42%) showed that there were no significant biological effect associated with the sediment bioassays. This analysis would suggest that predictive power of the AETs is not improved when multiple AET exceedances are present. These results further suggest that it is not accurate to ascribe a greater level of effect or injury on the basis of the number of AET values exceeded.

In conclusion, our analysis of LDW sediment data does not support the assessment of benthic injury provided in Appendix C of the programmatic environmental impact statement (PEIS) (NOAA and USFWS 2009). Specifically, the exceedance of an AET value does not appear to predict benthic effects as represented by sediment bioassays undertaken using the same sediment to which the Appendix C evaluations were applied. Half of the sediment samples that exceeded at least one AET value did not exhibit significant biological effects in the sediment bioassays. Finally, it was determined that the exceedance of multiple AET values did not appear to improve the predictive power of the AET analysis and do not support the idea that the exceedance of greater numbers of AETs represents a greater injury or service loss as presented in Appendix C.

REFERENCES

ATSDR. 2002. Public health statement: creosote. Agency for Toxic Substances and Disease Registry, Atlanta, GA.

Casillas E, Misitano D, Johnson LL, Rhodes LD, Collier TK, Stein JE, McCain BB, Varanasi U. 1991. Inducibility of spawning and reproductive success of female English sole (*Paraphrys vetulus*) from urban and nonurban areas of Puget Sound, Washington. Mar Environ Res 31:99-122.

Johnson LL, Collier TK, Stein JE. 2002. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. Aquat Conserv Mar Freshw Ecosys 12(5):517-538.

Meador JP, Rice CA. 2001. Impaired growth in the polychaete *Armandia brevis* exposed to tributyltin in sediment. Mar Environ Res 51:113-129.

Meador JP, Krone CA, Dyer DW, Varanasi U. 1997. Toxicity of sediment-associated tributyltin to infaunal invertebrates: species comparison and the role of organic carbon. Mar Environ Res (43):219-241.

Meador JP, Collier TK, Stein JE. 2002. Determination of a tissue and sediment threshold for tributyltin to protect prey species of juvenile salmonids listed under the US Endangered Species Act. Aquat Conserv Mar Freshw Ecosys 12:539-551.

Melancon MJ, Lech JJ. 1983. Dose-effect relationship for induction of hepatic monooxygenase activity in rainbow trout and carp by Aroclor 1254. Toxicology 4:51-61.

Melancon MJ, Turnquist KA, Lech JJ. 1989. Relation of hepatic microsomal monooxygenase activity to tissue PCBs in rainbow trout (*Salmo gairdneri*) injected with $_{14}$C PCBs. Environ Toxicol Chem 8(9):777-782.

NOAA. 2001. Associating ecosystem service loss with indicators of toxicity in habitat equivalency analysis. National Oceanic and Atmospheric Administration, Seattle, WA.

NOAA, USFWS. 2009. DRAFT Lower Duwamish River NRDA programmatic restoration plan & programmatic environmental impact statement. Prepared for the Elliott Bay Natural Resource Trustee Council. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Rice CA, Myers MS, Willis ML, French BL, Casillas E. 2000. From sediment bioassay to fish biomarker – connecting the dots using simple trophic relationships. Mar Environ Res 50:527-533.

Stern JH, Hennessy DP, Patmont CR. 2003. Improving estimates of contaminant exposure for mobile organisms: an assessment of area-weighted home range exposure estimates applied to the relationship between sediment chemistry and liver lesions in English sole. Puget Sound Research Conference 2003, Vancouver, BC.

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MEMORANDUM

To: Jon Sloan, Port of Seattle, and Alan Sprott, Puget Sound Commerce Center, Inc. (fka Todd Pacific Shipyards)

From: Ron Gouguet and Susan McGroddy, Windward Environmental LLC

Subject: Review of Appendix F, Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*

Date: October 9, 2012

The natural resource trustees (Trustees) have developed a set of highly conservative screening-level assessment tools to help the Trustees provide an opportunity for early settlement of claims for alleged natural resource damages in the Lower Duwamish River. This is the step in the process where the total service losses estimated by the Trustees are apportioned to a subset of the parties that contributed contamination, as identified by the Trustees. We reviewed Appendix F, Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement* (NOAA and USFWS 2009) and have the following comments.

GENERAL COMMENTS

- The text provided in Appendix F (NOAA and USFWS 2009) is very general, with virtually no information specific to the Lower Duwamish River, which does not allow for a thorough review of the proposed Lower Duwamish River allocation.
- The approach does not adequately consider sources within the pipeshed for storm or combined overflows; and although the Trustees say that this was accounted for in the pipe discharges, the characterization of the chemical loads used for this purpose was not provided. The document fails to address parcels that do not abut the Lower Duwamish River but are associated with current and historical activities that may have resulted in the release of contaminants in to the Lower Duwamish River.
- The mass balance approach used for polycyclic aromatic hydrocarbons (PAHs) is not fully explained in this document. The information that has been provided on

the calculation of PAH release rates for marine pilings suggests that the release of PAH from creosoted marine pilings has been greatly overestimated.

- The association of PAHs with sandblast grit is inaccurate and results in an inappropriate assignment of discounted service acre years (dSAYs) to non-contributing parcels.

ALLOCATION BY UNIQUE FOOTPRINT

The Trustees applied the gradient analysis technique to provide an indication of the locations of sources potentially responsible for a portion of the contaminants in sediment. This technique assumes that maximum concentrations occur near sources and decline with distance. Appendix F, Figure F1 (NOAA and USFWS 2009), is a hypothetical injury footprint showing a gradient of contamination emanating from a land-based source with a resulting sediment plume.

In cases where a plume that originates at one parcel overlaps onto adjacent parcels, liability has been allocated to multiple parcels rather than to the single parcel that is the likely source. In cases where sufficient information is available to identify the unique sources, the Trustees should allocate liability to the specific source rather than simply allocating liability to all adjacent properties.

Additional information, such as co-occurrence of chemicals, grain size, bathymetry, and historical marine development, can allow for a better understanding of a plume and assist in the assignment of responsibility for portions of a plume. More-sophisticated fingerprinting methods could be used to develop source signatures for unique plumes and could assist in a more rigorous allocation process. In general, the process provided here is overly simplistic and does not take advantage of the extensive chemistry dataset and current and historical source control documentation that is available for use in the allocation model.

ALLOCATION BY MASS LOADING

One substance of concern (SOC) (i.e., PAH) was allocated solely through the use of the mass loading approach because the contaminant concentrations were widely diffused throughout the Lower Duwamish River. Concentration gradients were discernible, but footprints were not readily definable. Thus, allocation to each site within the entire Lower Duwamish River was determined through mass loading, taking into account various sources of PAH to the Lower Duwamish River.

PAH MASS BALANCE ALLOCATION APPROACH

The Trustees chose to use a so-called "mass balance" approach to the allocation of PAH (the major injury driver in the Lower Duwamish River) as a substitute for the site-specific footprint approach used for all other chemicals. The details of the mass balance calculations conducted for PAHs are not provided in Appendix F. There is insufficient

information provided Appendix F (NOAA and USFWS 2009) to justify the use of an alternative allocation approach for this important class of chemicals.

The use of the mass balance approach has resulted in a gross overestimation of the contribution of PAHs from marine pilings. In discussions with the Trustees, we have learned that the leaching rate used to characterize the loss of PAHs from marine pilings was 23%, which is the rate calculated by Valle et al. (2007) based on the release of PAHs from pilings into the water column. This rate is based on work by Ingram et al. (1982) and Bestari et al. (1998). In their work, the authors provided empirical observations on variables that control the rate at which PAHs leach from creosoted pilings, including the fact that PAH release rates are higher at higher temperatures, and PAH release rates in fresh water are twice the release rates in marine water. Although these uncertainties were noted by Valle et al. (2007) and Ecology (2012), they were not taken into account when site-specific release rates were calculated. Instead, Ecology (2012) and Valle et al. (2007) used a release rate based on freshwater releases at elevated temperatures to characterize the contribution of PAHs from pilings in the colder, marine waters of Puget Sound and other marine water of Washington State (Ecology and WDOH 2012). Based on the controlling factors identified by Ingram et al. (1982) and Bestari et al. (1998), a reliance on release rates obtained from warm fresh water greatly overestimates the contribution from creosote pilings to the waters in Washington State, including the Lower Duwamish River. The primary uncertainties associated with the PAH leaching rate are:

- The desorption rate is based on freshwater exposure. Results by Ingram et al. (1982) indicated that PAH release rates in salt water are half the rates reported in Bestari et al. (1998).
- The desorption rate of PAHs from pilings has been shown to be strongly temperature dependent. The laboratory experiments carried out by Ingram et al. (1982) were conducted at temperatures ranging from 20 to 40 °C, and the mesocosm experiments carried out by Bestari et al. (1998) were conducted outdoors in August with a water depth of 1 m. The temperature data were not reported, but the shallow water depth likely involved temperatures that were higher than the cooler water temperatures found in Puget Sound and other Washington State marine waters. Based on the analysis of temperature presented in Xiao et al. (2002), it appears that the PAH release rate at 20 °C is approximately twice the PAH release rate at 10 °C.
- The leaching of PAHs was observed only at the surface (1 mm) of the treated piling; no loss was observed from the deeper regions of the piling (Bestari et al. 1998). Therefore, only a small volume of creosote is available to function as a source of PAHs due to leaching.
- PAH desorption rates decline exponentially following the placement of freshly treated wood. The rate calculated by Bestari et al. (1998) was based on the

placement of treated wood in a mesocosm for 84 days, during which an exponential decline in PAH releases was measured.

> "In this study, total water column PAHs increased steadily to a maximum concentration at 7 d post-treatment, followed by an exponential decline to approximately background levels by 84 d" (Bestari et al. 1998).

The application of this rate to the 30-year lifespan of a piling is not supported by the research because it does not account for the fact that significant releases of PAHs only occur following the installation of the piling.

- Other important variables that have been shown to affect the release of PAHs but have not been accounted for in this analysis include creosote composition, the type of wood, the method of creosote application, water temperature, and flow rates.

It is our understanding that the rate of PAH release from marine pilings into the water column was applied to the portion of the marine piling in the sediment in order to estimate the contribution of the piling to the sediment PAH concentration. The many reasons why the rate of PAH release derived by Valle et al. (2007) is an overestimation of the release of PAHs from the pilings into the water column in Puget Sound waters are provided above. If this rate was applied to the portion of the piling buried in the sediment, then the release of PAHs from pilings has been greatly overestimated. There is no reason to assume that the rate of PAH release in the water column represents the rate of PAH release in the sediment. The physical and chemical properties of PAHs suggest that there is a strong thermodynamic tendency for PAHs to remain associated with the hydrophobic organic matrix of the creosote. Furthermore, there is no viable transport mechanism to move PAHs released into sediment 10 to 40 ft below the sediment surface upward into the biologically active zone where there is a potential for biological uptake.

IMPACTS ASSOCIATED WITH PAH LEACHING FROM PILINGS

Numerous studies have been conducted in an effort to quantify the effects of PAHs released from creosote-treated pilings in terms of increased PAH concentrations in the water column, sediment, and biota in the vicinity of these pilings. The conclusions of a variety of studies are summarized below. Very few impacts have been observed in the immediate vicinity of the pilings during the time period that immediately follows the placement of the pilings.

Ingram et al. (1982) conducted laboratory desorption experiments and concluded that:

> "The amount of creosote that migrates from creosote-treated marine piling is extremely small…. This small annual loss, plus the fact that PAHs apparently are rapidly broken down in sea water, indicates that the PAHs

> that migrate from creosote piling should have a negligible effect on the environment."

Bestari et al. (1998) conducted mesocosm studies in which changes in water column and sediment PAH concentrations were monitored over a period of months and concluded that there were no significant impacts from the leaching of PAHs in creosote from pilings:

> "The loss of PAHs from the water was not reflected as an increase in the sediments although an increase in PVC-bound PAHs was observed. Thus, it appears that the majority of PAHs leached into the water from the pilings is lost via natural physical (volatility, photodegradation) and biological (microbial degradation) pathways. In this sense, environmental impacts associated with loss of creosote from impregnated wood structures are most likely to occur during the initial periods following their placement in aquatic environments. Further, relatively low concentrations were recorded in this study so any impacts that do occur may be chronic, rather than acute, in nature."

A long-term *in situ* study carried out by Goyette and Brooks (1998) was conducted in Sooke Bay on Vancouver Island, British Columbia, Canada. This study is particularly relevant to Washington State marine waters because of the similarity in the conditions of exposure. This study included the placement of creosoted pilings and 4 years of monitoring of the chemical and biological impacts of the pilings. According to Goyette and Brooks (1998):

> "This study has shown that under worst case conditions, significant PAH contamination was restricted to an area within 7.5 meters from the perimeter of a significant structure. The response of an extensive infaunal community analysis and laboratory bioassays indicates that significant adverse biological effects were found within a distance of approximately 0.65 meters from the perimeter of the structure. Slight adverse effects were observed to a distance of 2.0m."

Finally, the Stratus report prepared for NOAA (Stratus 2006) is a compilation and critical review of the available literature that describes the release of PAHs from creosote-treated wood structures. The authors concluded that the impacts associated with PAHs released from pilings are likely to be small in both temporal and spatial scales.

> "Overall, the laboratory and field studies described above indicate that treated wood structures can leach PAHs and other toxic compounds into the environment. However, the degree of PAH accumulation to sediment associated with these structures appears to be relatively minor in many settings, particularly in well-circulated waters and over time. PAH accumulation also appears to be relatively limited spatially (within approximately 10 m of the structure) and has not generally been

> associated with measured, significant, biological effects except in close proximity to the structures. The duration of any biological effects also appears to become attenuated within several months of construction (the time period when leaching rates are likely to be highest)."

The conclusions of these studies would suggest that the injury resulting from the release of PAHs from pilings should not be large. However, it is our understanding from discussions with the Trustees that the preponderance of the PAH injury has, in fact, been allocated to releases from marine pilings.

ASSOCIATION OF PAHS WITH SANDBLAST GRIT

In addition, the Trustees have asserted that PAHs are associated with sandblast grit. This assertion has not been supported and is inappropriate. At a February 16, 2012, Trustee presentation regarding the natural resource damage assessment, the Elliot Bay Trustee Council listed "sandblasting grit" as a site-specific activity related to PAHs, along with asphalt production, creosote pilings, and vehicle washing. The Trustees stated that using their methodology, sandblast grit is associated with 18% of the total mass of PAHs released. However, the rationale for associating PAHs with sandblast grit is not known.

Metals and tributyltin are the primary chemicals associated with sandblast (also known as abrasive grit blast [AGB]). For the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sediment remediation project implemented at Todd Pacific Shipyards (now known as Puget Sound Commerce Center, Inc.), constituents of AGB were analyzed, and a definition of AGB in sediment was prepared and approved by the US Environmental Protection Agency (EPA). Copper, arsenic, and zinc, as well as grain size, were considered diagnostic of AGB, not PAHs. These metals plus grain size and/or a visual assessment allowed for the identification of AGB. PAHs were never associated with AGB nor used to identify AGB releases to the sediment.

In addition, as part of the source control work required by EPA for the CERCLA process at Todd Pacific Shipyards, the historical use and constituents of sandblast grit were evaluated. Kleen Blast, a vitreous copper smelter slag grit, and Tuf-Kut and Green Diamond, nickel slag grits, were evaluated. Kleen Blast grit contains moderate to trace levels of copper, lead, arsenic, and zinc, with copper occurring in highest concentration. PAHs are not constituents present in sandblast grit, and the manufacturers do not analyze for PAHs. Based on the above information, the correlation between sandblast grit and PAHs is inaccurate and should be removed.

UNALLOCATED FOOTPRINTS

The hypothetical example that illustrates the process described in Appendix F (NOAA and USFWS 2009) is not useful. It provides percent allocation figures as if there were a precise basis for them and explains the arithmetic of the calculation.

It is not clear why the Trustees included Table F3, activity ratings for polychlorinated biphenyls (PCBs) in Appendix F (NOAA and USFWS 2009). The explanation provided in Appendix F follows:

> "This table is intended to represent an initial screening of the relative ranking of activities with respect to their potential to release PCBs. Thus, all other things being equal (e.g., size, duration, degree of case, fate and transport, chemical concentrations) an **activity near the top of the list is expected to result in the release of a greater mass of SOCs than an activity near the bottom of the list. However, where things are not equal the actual mass contribution could be much different than that implied by the order noted in the table**."

The bold text is confusing and does not provide a clear explanation as to how this information was used in the allocation process.

CONCLUSIONS

The screening exercise described in Appendix F (NOAA and USFWS 2009) provides a brief and cursory description of the process that has been used to determine who is likely responsible for hazardous substance contamination and resulting injury in the Lower Duwamish River. The description of the approach employed by the Trustees does not provide enough information to allow for a full evaluation of the decision process that has been developed for this site.

The Trustees state that "The allocation process requires the use of professional judgment, largely to address variability in the amount, type and quality of data available for each site." The professional judgment that has been used for this site has not been sufficiently described in Appendix F. Furthermore, the results of the allocation process must be released in order to allow for a full understanding of the implications of the allocation process.

REFERENCES

Bestari KTJ, Robinson RT, Solomon KR, Steele TS, Day KE, Sibley PK. 1998. Distribution and composition of polycyclic aromatic hydrocarbons within experimental microcosms treated with creosote-impregnated Douglas fir pilings. Environ Toxicol Chem 17(12):2369-2377.

Ecology, WDOH. 2012. Draft PAH chemical action plan. Publication no. 12-08-038. Washington State Department of Ecology and Washington State Department of Health, Olympia, WA.

Goyette D, Brooks KM. 1998. Creosote evaluation: Phase II Sooke Basin Study - Baseline to 535 days post construction, 1995-1996. Environment Canada, Pacific and Yukon Region, North Vancouver, BC.

Ingram LL, McGinnis GD, Gjovik LR, Roberson G. 1982. Migration of creosote and its components from treated piling sections in a marine environment. Seventy-

eighth Annual Meeting of the American Wood-Preservers' Association, May 2-5, 1982, Bethesda, MD. American Wood-Preservers' Association, pp 120-128.

NOAA, USFWS. 2009. DRAFT Lower Duwamish River NRDA programmatic restoration plan & programmatic environmental impact statement. Prepared for the Elliott Bay Natural Resource Trustee Council. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Stratus. 2006. Creosote-treated wood in aquatic environments: technical review and use recommendations. Prepared for NOAA Fisheries, Santa Rosa, CA. Stratus Consulting Inc., Boulder, CO.

Valle S, Panero MA, Shor L. 2007. Pollution prevention and management strategies for polycyclic aromatic hydrocarbons in the New York/New Jersey Harbor. New York Academy of Sciences, New York, NY.

Xiao Y, Simonsen J, Morrell JJ. 2002. Effect of water flow rate and temperature on leaching from creosote-treated wook. Research note FPL-RN-0286. Forest Products Laboratory, Forest Service, US Department of Agriculture, Madison, WI.