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