Sheldon & Associates, February 15, 2001

1. Movement of water through the fill and MSE wall has been properly analyzed. Several studies and technical memoranda have been prepared detailing how water will flow through embankment fill to recharge groundwater or be collected and transmitted through the MSE wall to maintain the hydrology of downslope wetlands. Documents that describe and substantiate that the hydrology of the wetlands located downslope of the embankment and wall will be maintained include:

- *Sea-Tac Runway Fill Hydrologic Studies Report* (Pacific Groundwater Group 2000). This report was funded by the Washington State Department of Ecology
- *Geotechnical Report* (Hart Crowser 1999)
- *Wetland Functional Assessment and Impact Report* (Parametrix, Inc. 2000)
- *Seattle-Tacoma Airport Master Plan Update-Low Streamflow Analysis* (Pacific Groundwater Group 2000)

Wetlands located downslope of the embankment are maintained by groundwater discharge seeps located beneath then and at their margins, seasonal periods of shallow interflow, and (in the case of Wetland 18, 37, and 44 some channelized flow).

2. The primary purpose of the drainage layer at the base of the embankment fill is to prevent the build-up of excess pore pressures in the overlying fill material by preventing the development of fully saturated conditions at the base of the fill. It does this by providing a high-permeability pathway that allows drainage to occur to the toe of the embankment if the rate of infiltration and seepage through the embankment exceeds the permeability of the underlying native soils.

The primary hydrologic source for the wetlands (groundwater discharging through a shallow aquifer) will remain in place. Groundwater will continue to recharge the shallow aquifer located beneath and east of the embankment and pass beneath the embankment before discharging to the wetlands. The weight of the embankment on the aquifer will result in some compression of the soil structure beneath it, the resulting reductions in porosity, void ratio, and permeability are conservatively estimated to be less than 5% under the maximum height of the fill *(Sea-Tac Third Runway-Aquifer Compaction*, letter, to Port of Seattle from Hart Crowser, December 9, 1998) and so the groundwater flow will continue largely unimpeded.

Most of the wetlands that will remain downslope of the embankment are fed by groundwater flow from the shallow aquifer, which surfaces as seeps in these wetland areas. The groundwater flow in the shallow aquifer is sustained from the area to the east (primarily the areas east of the Third Runway), and currently flows through the subsurface materials that will form the foundation for the embankment. These soils will almost entirely remain undisturbed by construction. Only limited areas where low-permeability wetland soils are present will excavation occur. In these areas, soils will be replaced (typically 1 to 3 feet below existing ground surface) with more permeable drain material.

A secondary hydrologic source for downslope wetlands is interflow from the existing slopes above the wetlands. The interflow component supporting wetland hydrology lost due to embankment construction will be replaced by collecting seepage water from the underdrain conveying it to the outer swale and downslope wetlands. Recharge calculations show that more water will be available from this source than is currently the case under existing conditions, and that it will occur for a longer duration than currently. Both these factors are expected to extend the hydroperiod of the wetland, and improve rather than detract from the current condition of the ·tland.

Another function of the drainage layer is to prevent the build-up of excess pore pressures in the overlying fill material, by preventing the development of fully saturated conditions at the base of the fill. It does this by providing a high-permeability pathway that allows water to flow to the toe of the embankment if the rate of infiltration and seepage through the embankment exceeds the permeability of the underlying native soils. The drainage layer also allows existing channelized surface and seepage flow to be collected and directed to downslope wetlands.

3. **The System is Designed to Prevent Rock Underdrain Clogging.** The underdrain is designed and constructed in a manner that expressly avoids the build-up of particulates within the drain rock. The grain-size distribution of the Group 1A material that are specified for drain construction meets the standard civil engineering requirements for performance as a filter medium (i.e., it is designed not to clog when exposed to seepage from the proposed embankment soils). Part of the design requirement for this layer is to avoid clogging if exposed to the invasion of soil particles into the filter medium. Filters of this type have been used successfully for more than 50 years, and are specified for a wide range of civil engineering (Soil Mechanics in Engineering Practice, Terzaghi & Peck, 1948; ibid, 3rd Edition Terzaghi, Peck, & Mesri, 1996).

The material placed in the backfill zone behind the MSE wall will be granular Group 1A or 1B material that will be relatively free-draining and will therefore allow water to drain from behind the engineered wall without build-up of excess pore pressures. Design requirements for the embankment address the invasion of soil particles into the filter medium, as discussed above, and groundwater movement would not move particles to the extent that the drainage layer would clog.

.. **Fill Infiltration.** (See Northwest Hydraulics, Response #34 to Comment #13)

5. **Constantly Saturated Underdrain.** There will not be a constantly saturated underdrain beneath the embankment or MSE wall. The capacity of the underdrain to transmit lateral flow substantially exceeds the ability of fill to convey flow into the drain and the volume of water that would be directed to it. Therefore, the drain would not be constantly saturated, except in places where it is picking up subsurface seeps from below the embankment. This may occur in limited areas, typically where there are existing seeps and wetlands that will be buried beneath the fill. The drainage layer will be thickened in these areas to further reduce the likelihood of saturation. A key purpose of the drain is to prevent the build-up of positive pore pressures in the embankment. This could occur if the base of the fill was allowed to become saturated; the drain is designed to prevent this from happening, and thus to avoid potential instability.

6. **Shallow Groundwater Flow to Wetlands.** As explained above, the embankment design will allow shallow groundwater flow to downslope wetlands to continue. The lateral groundwater flow regime in the existing subsurface shallow aquifer will not be affected by the wall or the underdrain since, as the commenter correctly observes, the drain will be largely constructed on the natural ground surface, well above the underlying groundwater (except where the embankment is constructed over wetlands and seeps). Subgrade improvements will rely on free-draining backfill or gravel and will not impede groundwater flow, as discussed in Appendix L of the Port's SMP. The primary hydrologic source to the existing wetlands and Miller Creek – i.e., shallow groundwater flow – will therefore be maintained. PGG and Hart Crowser both predict that the hydrologic source to the existing wetlands and Miller Creek will be enhanced by the increased time of travel for water infiltrating into and passing through the through the embankment fill prior to moving into existing soil layers.

see comment on previous page

7. **Uniform Fill Blanket.** The embankment design includes a drainage layer for its full length and width. The drawings (e.g., as shown in the Port's Phase 4 construction drawings) show that the underdrain will be placed as a continuous layer (minimum thickness: 3 feet) of Group 1A material beneath the base of the embankment. Groundwater from upland areas will continue to flow (as it does now) thorough the existing soils beneath the embankment. As a result, the presumed interruption to the hydrology of the wetlands and Miller Creek the commenter has posited will not occur.

8. **Reintroduction of Water.** While the Port plans to use infiltration facilities for the disposal of stormwater as part of the SMP, it is largely groundwater seepage water from the underdrain (as observed in Phases 1 and 2 of embankment construction) that will be collected by the replacement drainage swale for dispersal to the wetlands. This relatively steady flow will in fact enhance the wetland hydrology because it will increase the length and duration of the hydroperiod, potentially improving the condition and function of downstream wetlands.

The adequacy of plans showing the distribution of water to from drainage channels to wetlands is addressed in response #13 below.

9. Existing wetlands located west of the embankment already receive channelized flow (see descriptions of channels in the *Wetland Delineation Report, Wetland Functional Assessment and Impact Analysis, Natural Resource Mitigation Plan*, and letter to Eric Stockdale (21 September 2000)). The channels, in part, convey water from Wetlands 19 and 20 to Wetlands 18 and 37. Ditches along 12th Avenue South also convey channelized flow to Wetlands 18 and 37. Channelized flow also occurs in Wetland 39, 44, R9, where runoff is concentrated by topography, streets, driveways, or culverts. The purpose of the replacement drainage channels is to maintain this existing hydrologic condition, including the channelized flow to Wetland 18, 37,and 44. The channels also provide contingency options to augment wetland hydrology if monitoring demonstrates the wetland hydrology must be supplemented elsewhere.

As demonstrated in the above responses, groundwater required to maintain seep wetlands located west of the embankment will continue and a collection system to collect interflow and channelized flow will further maintain wetland conditions. This drainage system is designed to maintain existing hydrologic conditions, and includes new channels that will convey existing surface flows and replace existing channels. The replacement channels will disperse flow over a broader area than the existing ditches and culverts that they replace, so increase in channelization would not occur. The maintenance of these varying sources of hydrology will maintain seep areas in the wetlands, and assure that reductions in the size of these wetlands do not occur.

The existing ground surface below the embankment will be left largely undisturbed prior to fill placement. Shallow interflow seeps, expressed where perching layers surface on the slope, will continue to discharge into the underdrain, or will continue to flow downslope within the subsurface soils below the underdrain. Areas of soft soils that need to be removed to provide embankment foundation support will be backfilled with free-draining sand and gravel hydraulically connected to the underdrain. In this way, existing seepage into the wetlands that are filled will continue to be available as seepage through the underdrain. This water will flow down gradient to the west, and eventually reach downslope wetlands and Miller Creek. If reduced wetland hydrology is observed during construction and/or post-construction monitoring, contingency actions including additional flow dispersion, and would be implemented adaptive management techniques would be implemented to ensure downslope wetlands maintain the appropriate hydroperiod required to maintain existing functions. The 10-year monitoring plan and adaptive management approach will be instrumental in assuring maintenance of the wetland hydrology.

Because hydrologic conditions will be maintained in downslope wetlands (i.e. the wetlands will continue to receive groundwater seepage and channelized flow) nutrient dynamic in the wetlands following construction will be similar to current conditions. The removal of pollution generating surfaces and incorporating the wetlands located west of the embankment within the Miller Creek Wetland and Riparian Buffer Area will reduce anthropogenic sources of nutrients to the wetlands. Removing non-point pollution sources from lawns, parking areas, septic systems, fertilizers, and other sources will enhance wetlands and uplands in the Lora Lake/Vacca Farm area. Additionally, planting native trees and shrubs, removing areas of invasive non-native plant species, and monitoring the success of the enhancement will enhance the area.. For example, the wetlands at the Vacca Farm site will shift from a wetland dominated by bare ground, Himalayan blackberry, and soft rush to a native shrub-dominated wetlands with areas of cedar trees. This shift in plant communities will increase sediment trapping, and organic matter input from the wetland complex to the creek.

As described in Appendix B of the *Wetland Functional Assessment and Impact Analysis* (Parametrix, Inc. 2000), subgrade improvements will be composed of permeable soils (mostly gravels) and will act like outwash soils, not till. Subgrade improvements also include stone columns, which will be installed to strengthen the native soils beneath parts of the embankment. The stone columns that will be installed to strengthen the native soils beneath parts of the embankment will also act like outwash soils.

10. As explained above, no "complete change in the hydroperiod of the wetlands" is expected to occur. The plan does not require water to be "metered from a storm pond outfall into an infiltration trench".[1]

The embankment design and its potential impacts to wetland hydrology have been the subject of independent reviews. These evaluations, summarized in the *Wetland Functional Assessment and Impact Analysis* report, have found that the delay in water movement through the embankment would extend the period of groundwater discharge from the area and that this could benefit low flow conditions in Miller Creek and downslope wetlands.

11. Appendices A and B of the *Wetland Functional Assessment and Impact Analysis* report identifies the design and purpose of the TESC swales and the inner collection swale. The Appendices show that portions of the TESC swale, following construction, are incorporated into the replacement drainage channels. These swales will serve to collect and direct construction runoff to sedimentation ponds. Water from these ponds will be pumped to stormwater treatment and detention ponds and discharged to Miller Creek at existing outfalls.

The inner collection swale will serve to collect water from the embankment, MSE wall, and security road. Water from this inner collection swale will be conveyed under the security road to the replacement drainage channels, and ultimately to the wetlands located west of the project area.

The paved security road located west of the embankment will have limited use (approximately one vehicle per hour) and is thus not classified as a pollution-generating surface according to

[1]For Wetland 39, potential impacts to the uppermost portion of the wetland (0.02 acres) are mitigated using hydrology from a stormwater detention pond.

King County Stormwater Management standards. Therefore, runoff from the road that reaches either the inner collection swale or the replacement drainage channels is expected to meet water quality criteria. No anticipated impact is expected to occur as a result of mixing runoff from the embankment, the Perimeter Road, or the MSE wall with ground water collected by the replacement drainage channel.

The replacement drainage channels will be located west of the MSE wall, embankment, and security road. These channels will serve to collect seepage diverted from the inner collection swale or seeps from the embankment underdrain. Water within these channels will be directed to wetlands to help maintain their hydrology.

12. Wetlands not linked to the replacement drainage channels will continue to receive water via shallow groundwater that will be recharged as water infiltrates through the embankment and into the existing subsoils that will remain. Additionally, riparian wetlands not associated with the replacement drainage channels will continue to receive water through overbank flow from Miller Creek. The changes in the hydrologic conditions related to the embankment are discussed in detail above.

ask KC how much will go into the underdrain & how much into the existing subsoil.

13. The design sheets illustrate the required information regarding project mitigation. As the reviewer has correctly determined, Segment C and Segment D of the replacement drainage channels are north flowing. Segment C conveys water to Wetland 37, Segment D conveys water to Wetland R9 and A13. The swale located upslope of these areas continues to Pond D, but this segment is not part of the *Natural Resource Mitigation Plan*, as identified in the documents.

The swale shown in Pond D on Sheet C6 is the TESC swale that will be constructed prior to the construction of stormwater Pond D. This TESC swale will be used only during initial construction and construction staging. Prior to completion of the project, Pond D will be constructed in the footprint shown on this sheet. When this pond is constructed, the portion of the swale in its ultimate boundaries will be removed. The finished grading plan for Pond D is shown in Appendix I of the *Wetland Functional Assessment and Impact Analysis Report*.

What percentage of water is infiltrated or caught in the underdrain vs. amount going to storm pond & then directly discharged to the creek.

The drainage channel segments identified in the *Natural Resource Mitigation Plan* mitigation are the minimum channel lengths required to replace channel lengths being impacted. The remainder of the channels shown on plan sheets with buffers may also collect seepage water from the embankment or the inner collection swale and are also part of the mitigation. The additional lengths of channel provide flexibility in how and where the seepage water is discharged to the wetlands and Miller Creek, if redirection is deemed warranted during the monitoring program.

The 1-foot contours provided on the design drawings show that the replacement drainage channel depths are 0-3 feet in depth. The relationship of the swales to the downslope wetlands can also be determined from the grading plan. Where the swale crosses wetlands, the west side of the swale is shown to be at the elevation of the wetland. Thus, water collected by the swale can disperse into the downslope wetland. The distribution of water o the wetlands from the drainage channels will occur over a broader area than is found where culverts currently concentrate flows, and increases in channelization in the remaining wetlands are not expected.

The drainage swales located upslope of the mitigation channels are not part of the project mitigation. These channels are located in areas that generally lacked seeps and wetlands; thus they are expected to be dry much of the time.

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14. As discussed above, the project will not transform "downslope wetlands from seep driven ;land systems (groundwater discharge zones) to wetlands that are driven by surface water ...put."

There are no infiltration swales shown in the *Natural Resource Mitigation Plan* design drawings and no infiltration swales are planned or required to maintain wetland hydrology. Sheet C8 of Appendix D to the *Natural Resource Mitigation Plan* shows flow dispersal trenches. The flow dispersal trenches are not designed for infiltration. They are designed to allow water to disperse over broad areas into wetlands, and they are designed to avoid concentrating water in wetlands.

All wetlands impacts identified in the *Wetland Functional Assessment and Impact Analysis* (Parametrix, Inc. 2000) have been properly calculated. These calculations include all construction activities in wetlands, including the impact of the replacement drainage channels. Appendix D (Sheets C5 and C6) of the *Natural Resource Mitigation Plan* identify the impacts of these channels to wetlands.

15. The mitigation does not depend on a constructed infiltration system to maintain proper hydrology in wetlands located west of the embankment. Saturation of the soils at the flow dispersal facilities will demonstrate that the reintroduction of water is occurring as planned and the water transmission capacity of the soil has been reached. This condition will be beneficial to downslope wetlands, and may even cause an increase in the size and improvement in condition of the affected wetlands. This saturation is expected to continue well into the dry summer months, due to the buffering effect of the thick vadose zone created by the embankment.

16. Significant technical details required to understand how mitigation will be constructed included in the *Natural Resource Mitigation Plan*, Appendices, and associated reports.

17. The design drawings in Appendix A show that the relocated segment of Miller Creek will be lined with geotextile fabric. The use of geotextile fabric as part of the relocation project is also identified in the *Natural Resource Mitigation Plan* text (Figure 5.1-3, and page 5-14).

18. The proposed geotextile fabric is highly permeable, and is designed to permit groundwater exchange[2]. Because the geotextile fabric will be permeable-the stream will not be hydrologically isolated from the high groundwater table or the underlying peat soils. The geotextile will facilitate constructability of the channel in the peat soils.

There is no concern regarding the disappearance of water into organic soils, as monitoring reported in the *Natural Resource Mitigation Plan* demonstrates that a high water table is present on the site and that the elevation of the stream channel will be very close to the elevation of the groundwater.

An "open water pond" would not occur on the site (except during flood events) because existing and proposed grades allow surface water drainage of area through the south end of the Vacca Farm area.

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[2]Geotextile liners are by definition permeable, unless identified as "impermeable geomembrane liner". The geotextile's permeability of 60 to110 gallons per minute per square foot is much greater than that of the derlying peat.

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19. The following discussion responds to the commenter's concerns regarding the function of the Vacca Farm Restoration project as a natural floodplain. During floods greater than the mean annual flood, the low channel bank that defines the west side of the stream channel (Sheet C5, Appendix A) will be overtopped by flood flows. At these times, floodwaters would move from the channel laterally across the floodplain, submerging low-lying areas of the floodplain located to the west. In addition to overbank flooding from the creek, "backwater" flooding could occur by floodwater overtopping the existing creek banks downstream of the relocated segment. Backwater flooding is a natural condition that is present along many large and small stream systems (another example is shown in Figure 7.2-4 of the *Natural Resource Mitigation Plan* that maps the backwater floodplain area near the off-site mitigation). During flood events smaller that the 1-year flood, much of the floodplain would flood as a result of a backwater condition. As correctly pointed out, the floodplain area is designed to drain freely to the south following flood events. Thus, floodwaters flow through the entire floodplain and wetland restoration area.

Chapter 5, Section 5.1.1.6 describes the estimated flooding frequency. The channel has been designed to overtop its banks at flows greater than 40 cfs, which occur approximately once a year during annual peak flows. This frequency of flood event is not an 'extreme event' and the design provides a direct hydrologic connection between the wetland floodplain and the stream channel.

The function of the creek channel, and whether or not it is lined, are independent from the design of the adjacent floodplain. The post-construction topography will allow floodwater to pond until the flow in the creek recedes, thereby providing a direct connection to the floodplain and channel.

Also see Comment Number 24 of NW Hydraulic Letter.

20. The Miller Creek relocation has been designed using appropriate and current standard engineering practices for topographic, geologic, hydrologic, and ecological conditions found in the Vacca Farm area. Because of the unique characteristics of the site, general conclusions about other sites, which have different site conditions, design approaches, and permit standards are not directly applicable to the Miller Creek design.

The creek relocation project on North Creek in Bothell was recently examined by the Port (March 15, 2001) during a rainstorm (about 0.7 inches measured in nearby Redmond). The creek was observed overtopping the channel banks in several locations within the mitigation site, flooding portions of the adjacent wetlands. Based on examination of pre-project aerial photographs and the recent site conditions, it appears that this project has successfully enhanced a previously ditched stream channel by creating floodplain wetlands and natural channel conditions. The site differs from that planned by the Port in that it the North Creek site includes flood control levees, which are not part of the Port's proposal.

21. The Miller Creek relocation site design responds to existing site specific hydrologic, geologic, ecological, and topographical conditions of the area. The project design meets requirements to maintain a creek channel with fish habitat, replace lost floodplain area, restore wetlands, and provide water quality benefits.

22. Design and establishment of the creek channel and floodplain on the Vacca Farm site has been substantiated during the development of the mitigation plan. The bearing strength of peat, potential erodability of peat, other soil conditions, groundwater conditions, and channel hydraulics have been considered in the Miller Creek design, and the design approach with the geotextile liner is determined to be stable, without adversely affecting groundwater movement. Because the Vacca Farm floodplain already floods in a backwater condition, and the relocation

project will not alter this feature, even if the relocated creek section failed to overtop its bank, the :ural flood storage functions of the restored wetland would be realized.

Currently, there is no direct surface water connection between the Miller Creek stream channel or associated wetlands and floodplain. The stream is channelized and currently overflows its banks with at least a 2-year frequency. The new channel will be designed to allow the creek to overtop its banks with approximately 1-year frequency, thus improving the hydrologic connection to the floodplain. Additionally, the current design will create a forested and shrub riparian buffer, which will increase shade to the creek, decrease temperatures, and provide an increase in organic material.

The Miller Creek floodplain has a high groundwater table. Excavation in the floodplain soil will enhance groundwater saturation throughout the upper soil horizon within the floodplain, thus improving wetland hydrology. Supporting data on groundwater elevation in this area are provided in the *Natural Resource Mitigation Plan*.

23. The reviewer correctly identifies that the installation of logs will involve cutting of the geotextile fabric. However, since the geotextile fabric is permeable (see above), there are no design, operational, or reliability consequences to this approach. All geotextile fabric used during stream construction will be permeable, therefore, there will be a direct connection with the groundwater and "springing a leak" is not a concern.

24. The flood frequency of the wetland is described above, as is the ability of the permeable geotextile fabric to permit groundwater movement. The wetland and areas of high groundwater west of the stream are currently and will continue to be maintained by high groundwater nditions. Maintenance of wetlands in this area is not dependent upon floodwater, and peat soils would not be expected to form in wetlands that were maintained solely by floodwater.

The stream will flood its banks in less than an extreme 100-year flood event. The proposed channel will convey flows as indicated in the *Natural Resource Mitigation Plan*, and spill over to the floodplain with flows in excess 40 cfs, which is less than the mean annual flow (See page 5-12 and Table 5.4-1). The relocated channel and the floodplain "swale" are connected at the south end of the new creek, which is the point that will control the water surface level in the floodplain. The area draining to this point also includes drainage from Des Moines Memorial Drive, Lora Lake, as well as overflow from the new channel.

The 100-year flood elevation in the vicinity of the relocated channel currently forms a broad shallow backwater area rather than simply fringing the creek channel.

25. Geotextile fabric will be permeable; as a result, groundwater will be able to seep into the stream channel and supplement stream flow during low flow periods.

26. The *Natural Resource Mitigation Plan* identifies temporary impacts to wetlands in areas where wetlands can be avoided by the finished project, yet, to accommodate facilities to manage construction stormwater during the initial construction phase, they will be temporarily modified. Because these impacts are temporary, they are not classified as permanent. Upon completion of construction, the wetland areas will be restored to pre-construction conditions. Chapter 2 of the *Wetland Functional Assessment and Impact Analysis* (Parametrix, Inc. 2000) describes how these impacts were calculated and explains them in detail (see especially Section 2 and Section 4.2). 'dditionally, Chapter 5 Section 5.2.4 of the *Natural Resource Mitigation Plan* describes the .mporary construction related impacts of the third runway embankment and how those impacts

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were calculated. The temporary construction related impacts located outside the project footprint are identified in the Technical Memorandum *Temporary Impacts to Wetlands during Third Runway Embankment Construction* (HNTB 1999) (Appendix A of the *Wetland Functional Assessment and Impact Analysis* (Parametrix, Inc. 2000)).

Where temporary fill in wetlands results in small fragments of remaining wetlands, the remaining wetland area has been considered permanently impacted, and tabulated in Table 3.1-1. This includes Wetlands A5, A6, A8, 35, A18, portions of Wetland 18, and portions of Wetland A12. Where, following construction, the impacted wetlands could be restored and integrated into adjacent wetland areas or buffer mitigation, impacts were considered temporary because, in these areas, the full suite of existing wetland functions could be restored.

27. The evaluation of temporary sediment control ponds as a temporary impact is appropriate. These facilities are temporary, are not a permanent feature of the project, and will not cause permanent impacts to downstream wetlands. The temporary stormwater ponds are located at critical elevations relative to project construction activities, as explained in Appendix A of the *Wetland Functional Assessment and Impact Analysis*. The stormwater pond locations are at the very lowest elevations adjacent to the embankment so construction runoff from the all upslope areas can be collected and treated. Where located in wetlands (i.e. Wetlands 18, 37, and 44) the collection ponds will collect construction runoff prior to it being pumping upslope to the treatment systems. One benefit of this approach is to reduce the area of temporary impacts. The conveyance of runoff to these systems is in part via the TESC swale shown on plan sheets, with additional conveyances from the embankment itself likely.

The designed footprint of temporary ponds is shown on Figure 5.2-14, Figure 5.2-17 and Appendix D (Sheet C5 and C7) of the *Natural Resource Mitigation Plan*. The temporary ponds will not be excavated to 10 feet below the ground surface of adjacent wetlands, because this would cause the excavation to simply fill with groundwater.[3] There is no need or desire to collect groundwater and pump it upslope for treatment. The ponds will be lined, to prevent any movement of water from the pond into the wetlands. However, even lined ponds must be located at the ground surface, since high soil groundwater would cause the liner to "float", resulting in a loss of storage function of the ponds. The ponds have been designed so that the combination of storage volume and pump capacity provides the ability to collect and transfer at least twice the anticipated stormwater volume to the upstream treatment ponds.

28. Two sedimentation ponds (Ponds A and E) will be installed within a portion of Wetlands 18 and 37, and the restoration of these areas is described in detail in the *Natural Resource Mitigation Plan* (See Section 5.2.4, and Appendix D). The temporary ponds are to be constructed in areas of groundwater discharge, and not where wetlands occur on impervious perching layers. Since groundwater discharge maintains the wetlands in these areas, maintaining interflow during or after construction will not be required (in these groundwater discharge areas, soils saturated to the surface throughout the rainy season prevent interflow). For this reason, and because no significant excavation will occur during pond construction, there is no need to recreate impervious subsurface layers.

Wetlands18 and 37 will be restored to pre-construction topography by removing fill used to create berms and backfilling the pond with native soil that is similar in texture to the soil removed during excavation. The requirements for treating soils during restoration of these areas are

[3]Minor changes to the ground surface elevations could occur due to clearing and grubbing of vegetation and surface roots.

identified in Section 5.2.4.6 of the *Natural Resource Mitigation Plan*. If the disturbed areas are used as described, soil conditions will be suitable for the growth of wetland plants and sufficiently friable and permeable to allow groundwater discharges to continue.

29. The information the commenter has requested is part of the Public Notice. The potential impact of permanent stormwater detention ponds on the hydrology of downslope wetlands has been analyzed in the *Wetland Functional Assessment and Impact Analysis* report (See Section 4.3.2.12 and Appendix I). Groundwater data for this area, in relation to the ground elevation is shown in Appendix I and discussed in the *Wetland Functional Assessment and Impact Analysis* report. Because of the excavation, a small indirect impact to the uppermost section of Wetland 39 could occur where the pond is excavated below the elevation of the wetland. Because Pond D has been designed to infiltrate water into the soil, and with an additional orifice to discharge treated stormwater to the wetland, the potential indirect impact may not occur.

30. Permanent wetland impacts were assumed for the portion of Wetland A12 that is crossed by the TESC swale. The area where the swale runs through Wetland A12 was calculated as a permanent impact (0.08 acre).The area west of the swale (0.03 acre) will remain a wetland because of groundwater seepage and the replacement drainage channel that conveys water to the remaining portion of the wetland. Additionally, this wetland area will be enhanced through planting native trees and shrubs thus maintaining the primary functions of this wetland.

The *Natural Resource Mitigation Plan* describes and illustrates how water will be discharged to the downslope wetlands. The replacement drainage channels are described in Section 5.2.3 of the *Natural Resource Mitigation Plan*. Design details showing the channel grades, cross sections and flow dispersal trenches are shown in Appendix D (Sheet C8) of the *Natural Resource Mitigation Plan*. Additionally, page 28 in Appendix B of the *Wetland Functional Assessment and Impact Analysis* (Parametrix, Inc. 2000) describes facilities to maintain water supplies to wetlands located downslope of the embankment and MSE wall that assure the function of the downslope wetlands and mitigation.

As described in the *Wetland Functional Assessment and Impact Analysis* report, temporary wetland impacts will not occur for the duration of the project. Section 4.2.3 of the *Wetland Functional Assessment and Impact Analysis* report states that "these temporary impacts will be approximately one to two construction seasons". Appendix A of this report also describes the type of temporary impacts and that, for Wetland 37, they will be during a 1-2 years timeframe (see page 4, *Temporary Construction Impacts to Wetlands)*. Similar timeframes will occur for other temporary impacts, but the exact timing depends on the time of year construction is started, weather conditions, and other factors.

31. Based on hydrogeologic findings and field observations, the remaining wetlands downslope of the embankment are located in areas where groundwater discharge is occurring and they are not fed by shallow interflow. Numerous geotechnical explorations have been conducted for this project and these explorations are sufficient to design the permanent stormwater ponds and assess downstream impacts. Appendix I of the *Wetland Functional Assessment and Impact Analysis* report (Parametrix, Inc. 2000) show cross sections of the permanent stormwater ponds in relation to groundwater and ground surface elevations. Section 4.3.2.12 of this report evaluates the potential impact of the embankment on downslope wetlands.

32. The grading plans that are part of Appendix D (Sheet C8) of the *Natural Resource Mitigation Plan* show the TESC swale to be 2-3 feet deep in upland portions adjacent to Wetland 18 and 37. This swale is about 1 foot deep where it crosses Wetland 18 and 37. The swale is

designed to be as shallow as possible where it crosses wetlands. By using a shallow swale across wetlands, the amount of groundwater collected in the stormwater ponds during the winter months will be minimized, as are potential impacts to downslope wetlands.

As described in the *Natural Resource Mitigation Plan*, the temporary ponds will be restored the pre-construction topography by regrading and backfilling with soil similar to those excavated. Shallow groundwater and seeps that feed Wetland 18 and 37 will be maintained through construction of the underdrain, collection swales, and replacement drainage channels.

33. The replacement drainage channel is considered to be a temporary impact, except where the design drawings indicate the impact is permanent (Appendix D of the *Natural Resource Mitigation Plan*). The channel is designed to be nearly flat, shallow, and broad where it enters Wetlands 18 and 37. For these reasons, and the emergent and shrub vegetation planted in and near it, the channel will replace the wetland functions that will be temporarily lost during construction.

34. All wetland impacts are accounted for in the above-referenced documents. The calculation of permanent, temporary, and indirect wetland impacts are discussed above and in responses to Azous (2-16-01) comment letter.

35. Post-construction groundwater monitoring data is not necessary to establish hydrology performance standards and to evaluate potential impacts to the wetlands located downslope of the project. As described in the *Natural Resource Mitigation Plan* in Section 5.2.3 the Port will monitor the hydrology in downslope wetlands on a monthly basis during years 0 through 5, year 7, year 9, and year and 10. Within these wetlands, the depth from the ground surface to the static water table will be measured. The data will be used to determine if wetland areas downslope of the embankment continue to experience wetland hydrology, and if present, whether the duration of soil saturation is sufficient to maintain the existing wetland plant communities and the existing hydric soil conditions observed at various locations in the wetland.

This is a scientifically valid monitoring approach. The data collected from hydrologic observations can be related to the wetland indicator status of wetland plants, the information on vegetation tolerance of various hydrologic regimes, and the intensity of reducing soil conditions (i.e. iron reduction (creating mottled and gleyed soil colors) or organic matter accumulation). This analysis provides insight into the long-term hydrologic regime that the wetland has developed under, and will provide an objective methodology for determining whether the post-construction hydrology observed through monitoring can reasonably be expected to continue to support the wetland soils and vegetation observed.

The evaluation parameters used in this monitoring approach are superior to pre-construction groundwater monitoring because the criteria based on vegetation and soil conditions are free of short-term variation and aberrant conditions. For example, if preexisting groundwater data existed for two years, the implication is that adequate information is available to establish a performance standard for ground water elevation. However, in reality, since precipitation is different each year, there is no real way to relate a change in ground water elevation to a precipitation trend or a project impact. Relying solely upon hydrologic data to determine whether the wetland is functioning is problematic because hydrologic data is not always conclusive and can be misleading. For example, hydroperiod within a particular wetland is not the same each year and can vary statistically according to climate and antecedent conditions.[4]

Mitsch, William J. and James G. Gosselink. 1993. *Wetlands*. Van Nostrand Reinhold, New York.

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Baseline wetland hydrology data have been gathered were during wetland delineations, during geotechnical explorations, and during periodic site investigations. Performance standards for downslope wetlands have been developed based upon existing wetland hydrology and observations of soil types (see page 5-108 of the *Natural Resource Mitigation Plan* for complete performance standards). The monitoring standards proposed for the areas are as follows:

- Flowing water will be present in the lower portions of the replacement drainage channels from December to June in years of normal rainfall.
- Wetland areas with predominantly organic soils (Portions of Wetland 18, 37a, R14a, A14b, and 44a) will have soils saturated in the upper part to mid-June in years of normal rainfall.
- Other wetlands with predominantly mineral soils will have soils saturated in the upper part to mid-April in years of normal rainfall.

Using these performance standards, as well as data gathered after standard groundwater monitoring wells are installed, it will be possible to identify if the drainage channel features or shallow groundwater is not supporting the downslope wetlands as anticipated.

If the results of the hydrologic monitoring reveals that wetlands located downslope of the embankment are not exhibiting wetland hydrology during the growing season (in years of normal rainfall) then the reason for the absence of anticipated wetland hydrology will be determined and contingency measures employed.

Due to the land acquisition process between the Port of Seattle and the private landowners within the acquisition area, property access to the wetlands of concern has been sporadic throughout delineation process. Access to some property began in the spring of 1998, but most areas were not available until late 1998 or early 1999. Several landowners refused entry to the Port or their representatives until the property was sold (e.g. Parcel 177 sold 12/14/1999). Others allowed the Port access only for the short period of time required to delineate wetlands on the parcel (e.g. Parcel 302 and 303). Therefore, consistent and repetitive hydrological measurements within all wetlands were not possible until recently.

36. See response to Comment #35.

37. The Port is following applicable regulations and procedures to assure that no net loss of wetland area or function occurs. Many of the mitigation projects evaluated in the King County study failed to meet performance standards because the wetlands had inadequate hydrology; did not contain appropriate plants adapted site conditions; were planted with non-native plants; were not maintained; or because the mitigation plans were not properly implemented. In many cases there was a lack of proper weed management or there was a failure to monitor the wetland mitigation site. Some mitigation sites were never built.

To ensure that the Port's mitigation is successful, each mitigation project has been carefully planned to avoid the problems listed above. The projects also incorporate many of the recommendations of the King County study. For example, the Port has obtained over four years of hydrologic data at the Auburn site. This data, as well as other detailed analysis contained in the *Auburn Mitigation Site Draft Hydrologic Report* (Parametrix 1997) provides the necessary information to construct the wetland mitigation site and obtain the desired water levels. This approach is consistent with the findings by King County that adequate hydrology is one of the most important aspect of wetland creation. As a contingency, if optimal water levels are not obtained, simple modifications (i.e., adjustments of outlet control structures) may be made to adjust water levels to desired depths. These weirs provide flexibility to ensure that water levels match the ecological requirements of the proposed plantings.

Following recommendations of the King County Study, a temporary irrigation system will be installed at mitigation sites (Auburn, Vacca Farm, portions of the Miller Creek buffer, and Tyee Valley Golf Course) to enhance survivability and growth during the first two years following planting.

As recommended by the King County study, plants to be installed at the mitigation sites are native and have been selected based upon their tolerance to the hydrologic regime for the mitigation site. For instance, Oregon white ash, red alder, black cottonwood and western red cedar have been chosen to be components of the mitigation areas because they can tolerate the seasonally saturated soils that occur or will be established on mitigation sites.

Following the findings of the King County study, the Port has planned a top soil mix at the mitigation sites that is appropriate for the planned vegetation communities. For example, as described in the *Natural Resource Mitigation Plan* (Parametrix, Inc. 2000), the top layer of soil would be mixed with compost to provide rich soil to promote rapid plant establishment. In addition, soils that may be compacted during construction would be amended and/or scarified to provide a friable soil structure suitable for plant establishment.

As required by Ecology and the Corps, the Port has prepared and will implement detailed monitoring plans to determine if the mitigation is successful. Monitoring will continue for ten years (five years longer than the monitoring period recommend by King County). The Port will extend this monitoring period if, after ten years, the performance standards for the mitigation sites are not met.

Also, in accordance with the King County recommendations, the Port has made pre-project topographic surveys of the mitigation areas. Post-construction topographic surveys will be made to ensure that the planned topography was achieved.

The *Natural Resource Mitigation Plan* (Parametrix, Inc. 2000) identifies that a site specific weed management strategy will be implemented. These strategies would be used to reduce the percentage of non-native invasive plant species colonizing the planted areas to ensure the survivability of the planted species.

The King County report identifies, that with incorporation of some of the above planning and design methods into mitigation projects, wetland mitigation success would increase. Since the Port has already implemented the significant recommendations made by King County and involved Ecology, Corps, EPA, and USF&WS experts in the mitigation design process, a high probability of success exists for the mitigation projects.

A number of wetland and stream mitigation projects have been successfully planned, implemented, and monitored in the Puget Sound area. The following projects are similar to the mitigation the Port is proposing and demonstrate that wetland mitigation can be successful:

- Metro West Point Wastewater treatment facility (wetland creation)
- Emerald Downs wetland mitigation in Kent (wetland and stream restoration)
- U.W. Branch Campus-Bothell (wetland creation and stream restoration)

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- Metro wastewater treatment facility in Kent (wetland creation)
- Paine Field (wetland creation)
- Boeing Long Acres (wetland creation)

38. Plans submitted by the Port contain the requisite technical information needed by the reviewing agencies to reach a permit decision.

Comment noted.

The evaluation of permanent, temporary, and indirect impacts is described in detail in project report, responses provided above, and in response to the Azous letter (02-16-01).

The proposed plan and permit application sufficiently mitigates the identified impacts.

39. The documents submitted by the Port and its consultants provide sufficient data and analysis for reviewing staff to evaluate the project impacts and the adequacy of the mitigation to offset them. Plan submittals show detailed mitigation designs and explanations and provide sufficient information to support the conclusion that the stream and wetland mitigation should function to meet the design goals. The plans also provide detailed monitoring plans that are based on evaluating enforceable contingency standards. For each mitigation element, a variety of contingency actions are provided, so that corrective action alternatives can be immediately implemented in the unlikely event that the desired wetland functions are not achieved by the initial mitigation plan a particular site.