Port of Seattle

July 23, 2001

Ann E. Kenny
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

Dear Ms. Kenny:

SUBJECT: Low Streamflow Analysis, Summer Low Flow Impact Offset Facility Proposal, Seattle–Tacoma International Airport

This letter summarizes the Port of Seattle's evaluation of summer low streamflow impacts in Des Moines, Miller, and Walker Creeks calculated to result from proposed airport Master Plan Update projects. This letter also summarizes the Port's proposal to offset these impacts to maintain existing summer low streamflow conditions in these creeks post project. The methodology used to determine the effects and the plan to offset the impacts was developed and discussed in a series of meetings between the Port of Seattle (Port), Department of Ecology (Ecology), and King County, with staff from Floyd Snider McCarthy, Inc., acting as facilitators.

The evaluation and low streamflow impact offset proposal is final, subject to potential conditions associated with your review during 401 permit deliberations. The Port plans to submit final documentation of the low streamflow evaluation and operational plan for mitigation facilities in the form of a detailed Low Streamflow Analysis Report and Summer Low Flow Impact Offset Facility Operational Plan, outlines of which are included as an attachment to this letter.

Summary

The Port's proposal is to detain stormwater in underground vaults and release the detained water continuously into each creek during the summer low streamflow period at a rate equal to the calculated summer low streamflow impact to that creek from planned Port projects. The summer low streamflow impacts in each creek were determined through detailed modeling analysis. The summer low streamflow periods were determined through statistical analyses of modeled streamflow from the calibrated HSPF models and discussions with biologists on the effects of low streamflow periods on stream biology. Details of the analysis used to arrive at the proposed summer low streamflow offset periods, low streamflow magnitudes, impacts to summer low streamflows from Port projects, and sizing of the vaults are included as attachments to this letter A summary of the calculated summer low streamflow impacts and flow impact-offset proposal is listed below:

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	Des Moines Creek	Miller Creek	Walker Creek
Summer low flow period	July 24-October 24	August 1-October 31	August 1-October 31
2-year 7-day low flow (1994)	0.35 cfs	0.74 cfs	0.79 cfs
Port impact on streamflow[1]	0.10 cfs	0.13 cfs	0.09 cfs
Vault size needed	12.2 acre-feet	18.8 acre-feet	15.0 acre-feet
Maximum vault fill time	32 days[2]	58[3] days	282 days[3]

1 Difference between 1994 and 2006 2-year, 7-day low flow, including non-hydrologic impacts.
2 Vault filling starts January 1.
3 Vault starts filling November 30.

Vaults to detain stormwater for release during summer low streamflow periods were sized based on the duration within which summer low streamflows have historically occurred (generally +/- 90 days from late July through late October), the modeled impact to streamflow in each creek, and an allowance for precipitation events during the summer low streamflow periods that will partially refill the vaults. The resulting storage volumes (12.2 acre-feet in Des Moines Creek, 18.8 acre-feet in Miller Creek, 15.0 acre-feet in Walker Creek) will provide enough water every year to offset the impacts to streamflow throughout the historic summer low streamflow period. For two years within the period of record (1977 and 1979), the Walker Creek vault does not fill up entirely by the start of the summer low streamflow period. However, in these two years, rainfall that occurs during the summer low streamflow period provides enough water so that offset flows are provided throughout the entire summer low streamflow period. The vaults will include features (both structural and operational) for managing water quality to ensure there are no adverse impacts from discharges from the flow impact offset facility. Additional details on all these issues are presented in this letter.

Determination of the Duration of Summer Low Streamflow Periods

Determination of the summer low streamflow period for each creek was done by analyzing modeled streamflow from the calibrated HSPF model for each creek, which used 1994 (existing) land use conditions. The HSPF models for each watershed were calibrated by comparing model output with streamgauge data and adjusting model parameters until a satisfactory match was obtained. Additional low streamflow calibration information is provided in the attachments. Assumptions of model parameters (land use, basin delineations, impervious areas, etc.) are the same as detailed in the Comprehensive Stormwater Management Plan. The seven-day low flow period for each year (using 1994 flow conditions) in the 47-year period (1949-1995) for each creek was determined at points of compliance near the airport (200th Street in Des Moines Creek, SR 509 in Miller Creek, and at the outlet of the wetland near Des Moines Memorial Drive in Walker Creek). The seven-day low flow was selected as an indicator of persistent dry season flow. For example, a longer low streamflow would have the same or higher flow, since flows tend to have a downward trend (flows become gradually lower) before a storm increases flow. In addition, summer low streamflows tend to decrease gradually, therefore, a shorter low streamflow period is unlikely to result in significantly lower average flows or target flows. Finally, consultation with biologists concludes that summer low flows with durations of less than two weeks do not affect the carrying capacity of the creeks or cause behavioral changes to salmonids (see attachment).

The occurrences of the annual seven-day low flow periods were plotted and a histogram showing the distribution of the summer low flow periods was developed for each creek. The summer low streamflow period for each creek was selected to include all the historical seven-day low flow occurrences, with the exception of three specific occurrences during the forty-seven year record that occurred during November and December – periods typically associated with two of the three wettest months of the rainy season. The summer low streamflow periods for each creek are:

Des Moines Creek	July 24 through October 24
Miller Creek	August 1 through October 31
Walker Creek	August 1 through October 31

The Port's proposal is to provide water to offset the impacts to summer low streamflows throughout these time periods in each creek.

Determination of Streamflow Magnitudes (Target Streamflows)

The magnitude of existing summer low streamflow (target streamflow) in each creek was determined through analysis of the seven-day low flow periods under existing (1994) conditions described above. The annual seven-day low flows for each creek were ranked and recurrence intervals were determined based on this ranking. The seven-day low flow with a two-year (50 percent) recurrence interval was selected as the streamflow target in each creek. The two-year seven-day low flow was selected because the magnitude of the estimated impact to seven-day low flows decreases with greater recurrence interval; i.e., the estimated reduction in the seven-day two-year frequency low flow rate is greater than that for the seven-day, ten-year frequency low flow rate. Therefore, providing mitigation equivalent to the seven-day, two-year frequency impact will provide mitigation sufficient to mitigate all of the more extreme summer low streamflow events. Based on this analysis, the existing summer low streamflows (two-year, seven-day pre-project conditions) are determined to be:

Des Moines Creek	0.35 cfs
Miller Creek	0.74 cfs
Walker Creek	0.79 cfs

Determination of Impacts to Streamflow

The effects to flow during the summer low streamflow periods were determined by comparing modeled streamflows before project construction to modeled streamflows after project construction. Each creek has different post-development conditions that potentially affect low streamflow; therefore each has a different approach for determining impacts. In Des Moines Creek, 2006 land use conditions ("post-project") were modeled for the full 1949-1995 period of record. The seven-day low flow for each year was selected, ranked, and the streamflow with a two-year recurrence interval was determined. In Des Moines Creek, the two-year post project summer low streamflow is 0.25 cfs. The impact to streamflow from proposed Port projects is the difference between this flow and the existing pre-project summer low streamflow described above, as determined from the modeled 1994 ("existing") land use conditions (0.35 cfs). Therefore, the impact to summer low streamflows in Des Moines Creek from proposed Port

projects is the difference between the post project and existing condition flows, or 0.10 cfs. The flow rate is the magnitude of offset that will be provided during the summer low streamflow period for Des Moines Creek described above (July 24 through October 24).

In Miller Creek, a different approach was applied because of the need to model the effect of the proposed runway embankment on streamflows. In areas where the embankment is proposed, recharge entering the embankment was calculated using the post-project HSPF model. The recharge was then input to the Hydrus-2D model, which simulated the spreading of recharge fronts through the unsaturated zone of the embankment fill. Output from the Hydrus-2D model were input to the "slice" model, which is a finite-difference groundwater model used to simulate flow through the proposed embankment underdrain layer. Output from the "slice" model was then input back into the HSPF model to determine the quantity and timing of discharge from the embankment, and the groundwater effects on Miller Creek. This approach was selected to accurately simulate the flow of groundwater through the proposed embankment. The analysis was a more discrete application of the Hydrus-2D and "slice" modeling approaches used in the Runway Fill Hydrologic Studies Report (Pacific Groundwater Group, June 19, 2000), prepared for Ecology.

For the post-project conditions in Miller Creek, the four-year period from 1991 through 1994 was modeled. This period was chosen as a representative dry period in the precipitation record. Output from the HSPF model was analyzed to determine the annual seven-day low streamflows for each of the four years. To determine the impact between 1994 (existing) low streamflow and 2006 (post-project) flows, the impact during 1991 was used. This year was selected because it was the only year in the four years of detailed embankment flow analysis that low streamflows were greater than the two-year flow. In Miller Creek, the estimated summer low streamflow impact due to the project is 0.11 cfs.

In addition to hydrologic impacts in Miller Creek, additional impacts, both positive and negative, will result from removal of septic tank flows (negative impact) and cessation of water uses for residential and agricultural uses (positive impact). The impact of these "non-hydrologic" changes in Miller Creek is an additional net -0.02 cfs (-0.08 cfs for septic tanks which is then adjusted by 0.7 for loss to DEEPFR; water use withdrawals are +0.04 cfs). The total Miller Creek impact (both hydrologic and non-hydrologic) is 0.13 cfs.

For the post-project conditions in Walker Creek, the entire record from 1949 through 1995 was used. To determine hydrologic impacts, it was assumed in the post-project (2006) model that new impervious areas and new fill area is simply removed from the model and can no longer contribute to low streamflow. This is a conservative assumption, since some precipitation will undoubtedly contribute to groundwater flow. This approach was chosen to allow for the largest impervious area possible to refill the Walker Creek low streamflow vault. The Port proposes to line the filter strips with impermeable material to collect infiltrated stormwater that will be directed to the low streamflow vault. The lined area (approximately six acres) does not exceed the effective impervious area used in the Comprehensive Stormwater Management Plan.

In Walker Creek, much of the groundwater that supports summer low streamflows comes from areas where surface water drains to Des Moines Creek or Miller Creek. Under existing (1994)

conditions, approximately 630 acres of pervious land is included in the Walker Creek groundwater basin, which contributes to Walker Creek summer streamflows. Thirty-eight acres of new impervious area is proposed in the approximate area of the 630 acres pervious acre area. The thirty-eight acre area is adjusted (multiplied) by 0.86 to reduce the area to effective impervious area. The result (32.7 acres) is deducted from the 630-acre pervious area in the existing conditions model to determine the post project (2006) contribution to the Walker Creek groundwater basin.

To determine the magnitude of the hydrologic impact in Walker Creek, the seven-day low flow for each year was selected, ranked, and the streamflow with a two-year recurrence interval was determined for existing (1994) and post-project (2006) conditions. The two-year 1994 seven-day low streamflow is 0.79 cfs; the 2006 summer low streamflow is 0.71 cfs. Therefore, the impact to summer low streamflow in Walker creek from proposed Port projects is the difference between the post-project and existing conditions flow, or 0.08 cfs.

In addition to hydrologic impacts in Walker creek, additional impacts will result from the removal of septic tanks. The impact of this change in Walker Creek is an additional 0.01 cfs (0.014 cfs for septic tanks which is then adjusted by 0.7 for loss to DEEPFR). The total Walker Creek impact (both hydrologic and non-hydrologic) is 0.09cfs.

Based on the analyses described above, total net summer low streamflow impacts that the Port proposes to offset throughout the summer low streamflow periods in each creek are:

Des Moines Creek	0.10 cfs
Miller Creek	0.13 cfs
Walker Creek	0.09 cfs

Sizing/Filling of Vaults and Vault Release

Several of the stormwater vaults proposed in the Comprehensive Stormwater Management Plan will have storage areas sized and designed to detain the volume of water needed to continuously release a flow equivalent to the calculated summer low streamflow impacts throughout the summer low streamflow duration in each creek. The vault sizes were calculated in the following manner: the offset flow rate was multiplied by the duration of the summer low streamflow period. Analysis of precipitation records show that some amount of rainfall always occurs during the summer low streamflow period. Rainfall amounts during the summer low streamflow period from the worst (driest) year on record were converted into a volume based on the amount of impervious area that drains to each vault. This water was subtracted from the total volume to arrive at the final volume. These calculations were done on a daily basis to account for the dynamics of filling and draining the vaults throughout the summer low streamflow period in each creek. This conservative approach assures that the volume of water needed to offset the impacts to summer low streamflow will be available in a range of extreme conditions such as those found in the 47-year period of record. The net storage volumes of water needed for each creek are:

Des Moines Creek	12.2 acre-feet
Miller Creek	18.8 acre-feet
Walker Creek	15.0 acre-feet

The vaults will be filled each year during the winter, by closing the flow offset discharge outlet no later than January 1 each year, allowing stormwater to accumulate in the vaults. Analysis of historical rainfall records and the amount of impervious area that drains to each vault were used to determine the length of time required to fill the vaults. This length of time was applied to the beginning of the summer low streamflow period in each creek (the date the flow impact offset would start each year) to determine when to begin accumulating water. Based on this analysis, the maximum time needed to fill the vaults during the period of record are:

Creek	Closure Date	Longest Fill Time in Record
Des Moines Creek	January 1	32 days
Miller Creek	January 1	58 days
Walker Creek	December 1	282 days

The impervious area in each basin used to fill the vaults is as follows:

Des Moines Creek	234 acres impervious area
Miller Creek	82 acres impervious area
Walker Creek	3.5 acres impervious area
	6 acres lined pervious area
	2 acres Pond F cover

It is important to note that using the period of record (except for the worst (driest) year on record), the vaults will always have water remaining in them at the end of the summer low streamflow period. The Port proposes to continue releasing this water at the determined flow rate for as long as possible before the vault outlets are actually closed (after the end of the summer low streamflow periods). The operational plan will call for the vaults' outlets to be closed no later than January 1 each year to allow the filling of the vaults to take place when precipitation is generally most abundant.

Water Quality Considerations

The Summer Low Streamflow Impact Offset Facilities will be designed and operated to avoid in-stream water quality violations. Class AA water quality standards are used as the applicable in-stream standards. Water quality parameters of concern include dissolved oxygen, temperature, turbidity, copper, lead, and zinc. A variety of best management practices (BMPs), facility designs, and monitoring programs are proposed (or already in place) to ensure that in-stream water quality violations will not result from operation of the flow offset facility.

Structural features of the vaults include sediment traps, settling areas, and special placement of inflow and outflow pipes to reduce turbidity, vents to allow air circulation to enhance aeration, placement of inlets to facilitate periodic flushing with "fresh" stormwater, and discharge pipes configured to enhance passive aeration. The underground configuration of the vaults will facilitate temperature management. Provisions are included to allow for additional filtration and aeration of discharges, as needed. BMPs in place in the drainage areas on the airfield will minimize the amount of sediment that will enter the vaults. An extensive water quality monitoring program is proposed to characterize the water discharged from the offset facility, and

to ensure that the facilities can be managed and operated without causing in-stream water quality violations.

Operational Plan

A detailed operation, maintenance, and monitoring plan will be completed for the summer low streamflow impact offset facilities. The operational plan proposes an annual schedule of activities to ensure that the facilities are meeting performance goals. An adaptive management system is proposed to allow the operation of the facilities to be refined as experience is gained. The vaults will be monitored as they are filled and as water is released. Periodic monitoring of water quality will be completed, both of the discharge water and in the creeks, to ensure that water quality criteria are not violated in the creeks. Biological monitoring is proposed as part of the Natural Resources Mitigation Plan. This monitoring will evaluate changes in the Benthic Index of Biotic Integrity (BIBI) over a ten-year period.

Information provided for review attached to this letter include:

- Outline of Summer Low Streamflow Flow Analysis and Summer Low Streamflow Impact Offset Facility Operations Plan
- Selected Draft sections of Summer Low Streamflow Impact Offset Facility Operations Plan
- Technical backup material for low flow impact evaluation and impact offset proposal including the following
  - Des Moines Creek
  - Miller Creek
  - Walker Creek
  - Stream Biology Information
  - Embankment Modeling Information
  - Non-Hydrologic Analysis
    - Methodology
    - Data (electronic only)
  - Daily Average Creek Flows (electronic only)

In addition, selected model data files have been electronically sent to Kelly Whiting for his review.

Please contact me at 206/988-5528 if you have any questions.

Sincerely,

Keith R. Smith
Water Resources Manager

C: Kelly Whiting, KCDNR