Review Comments on the Low Flow Impact Analysis - Flow Impact Offset Facility Proposal, July 2001

Review Scope and Limitations

The July 2001 Low Flow Analysis Flow Impact Offset Facility Proposal (Low Flow Report) has been reviewed for consistency in hydrologic modeling and for consistency in meeting the performance objectives identified by the Department of Ecology (Ecology) and Port of Seattle (Port). The Low Flow Report supplements the Port's Comprehensive Stormwater Management Plan (SMP). While the 1998 King County Surface Water Design Manual (KCSWDM) does not include performance standards for low flow mitigations, the following comments do include some references to KCSWDM design criteria. This review summary concludes that the low flow report proposes substantial mitigations for offsetting low flow impacts annually during the timeperiod when most low flow events occur. There are, however, some significant gaps in the documentation of the analyses performed and the associated mitigations. This enclosure summarizes key findings and recommendations generated from this review. These comments include a substantial amount of commentary as to the reviewer's understanding of the analyses performed.

Review has been limited to the HSPF hydrologic modeling, the impact assessment, and the conceptual design of the associated facilities. With the exception of the hydrologic inputs and outputs, the review of specific aspects of the embankment modeling used in Miller Creek was performed by Ecology staff with expertise in that area.

Review of a stormwater management plan is primarily a review of design concepts and assumptions to determine if the proposed mitigations demonstrate a feasible approach to comply with the identified performance goals. As the proposed Master Plan Update (MPU) development projects move from the planning stages to development of construction plans, the proposed low-flow mitigations may need to be updated to reflect any change in conditions. Prior to construction of specific projects, additional review and approval of the final construction drawings and associated technical information report is typically required. Oversight and monitoring are key elements to successful implementation of any stormwater management plan. It is recommended that Ecology and the Port develop a plan to oversee and monitor compliance with the mitigations set forth in the Stormwater Management Plan and Low Flow Report. One option is to create an Ecology "Compliance Team", representing the necessary disciplines, to work with the Port to achieve compliance with the goals and objectives laid out in the SMP and related documents.

General Comments-

Certification:
The final low flow study should be stamped by a professional civil engineer. The engineering work included in the report should be performed by, or under the supervision of, a licensed civil engineer.

Non-Hydrologic Effects on Low Stream Flows:
The proposed low flow mitigation includes flow augmentation for identified non-hydrologic changes effecting low stream flows. These changes include the removal of septic systems in Walker and Miller creek basins, and the relinquishment of water withdrawal rights in Miller Creek. The water withdrawal numbers have been refined from early SMP drafts. The septic system numbers have also been revised since the 12/00 low flow report. The net effect of these changes is a relatively small additional reduction in calculated future low stream flows (0.01 cfs in Walker, 0.02 cfs in Miller). The Port is proposing to provide additional flow augmentation to offset these non-hydrologic changes during the proposed 3 month mitigation period. Additional water quality benefits are expected associated with the removal of 277 septic tanks from the former residential areas adjacent to Miller and Walker creeks.

While some of the comments below address how the non-hydrologic changes were handled in the low-flow statistics, none are meant to question the appropriateness of the quantity or duration of the proposed non-hydrologic mitigations.

Calibration Accuracy:
The low flow analyses used the same HSPF calibration files used in the SMP to define the existing baseline low flow conditions. This calibration has been accepted for stormwater design and therefore the low flow analysis and mitigations will be consistent. The final low flow report needs to include a discussion of the accuracy of the calibrations in predicting low flows at upper stream gauges, and a statement of adequacy of the calibrations for the purpose of low flow simulation.

Biological Conclusions:
The flow frequency plots of ranked annual low flow events show substantially complete mitigation of the annual minimum low-flow events by providing augmentation during the timeperiod when streams are at their historically lowest flow levels (August-October). Inspection of the 1991 through 1994 hydrographs shows that June-July baseflows will also be reduced by a similar amount. The flow frequency analyses generally predict an increase in number of annual low flow periods occurring in July under the augmentation plan. The low flow report's biological assessment concludes that this change in timing of low flow events will not have an adverse impact on salmonids or their habitat.

The late spring and early summer periods are when fish typically grow at the greatest rate. It is difficult to put these early summer hydrologic changes into perspective without an evaluation of what these flow reductions will look like in-stream. Will fish be forced into pools at times they currently are not? Will the number of available pools be reduced? Will this change the spatial distribution of fish? Will juvenile fish be subject to increased predation? Will there be impacts to invertebrate diversity and/or abundance? Will there be shifts in timing and duration of insect hatches?

- The final low flow study should put these spring-early summer low flow periods into perspective through a quantitative assessment of the effects of flow reductions on representative stream channel cross-sections.

- A monitoring program should be developed to verify the biological findings of no adverse impact to stream biology. This monitoring should begin as soon as possible so that baseline data can be obtained prior to substantial development changes.

- A monitoring program should be developed to ensure adequate water quality of reserve stormwater prior to discharge to stream.

Documentation:
The report should clearly document and narrate the analyses used to generate the results used to determine the impact and develop proposed mitigations. Presentation (including narrative) of alternatives considered is appropriate. Likewise, if electronic files are provided they should be limited to those files which correspond to the results presented in the report. A readme.txt file (or text in the report) should detail specifically which electronic files are provided and what information they contain. There should only be one CDROM. In the event additional files are needed, an entire replacement CDROM should be provided. The analyses and information are complicated enough without insufficient documentation (narrative) and superfluous supporting documents creating unneeded confusion.

Conceptual Drawings:
Conceptual drawings of the reserve storage facilities were received July 31. They show reserve vault locations and size for all of the proposed low flow vaults. The Low Flow Report needs to include details on how constant discharge will be maintained in a reservoir with variable hydraulic head pressures. Specific Comments provided below.

The reserve vault inlets and outlet should be configured so that water is added/discharged from the middle of the reserve storage depth. This will help avoid disturbing sediments and/or floatables which could be present in the reserve vault. Some drawings have notes indicating that internal piping will be used to promote circulation and flushing of stored water. A similar note would be applicable to situations like SDS3 vault where the inlet pipe is located 12.9 feet above the reserve storage.

To help keep the retained water well aerated, reserve storage vaults should include open ventilation consistent with KCSWDM wetvaults. Mechanical aeration may be needed if grating is not feasible (e.g., vaults considerably below grade). At conceptual stage, a note to this effect would suffice.

Des Moines Creek -

Overview

Point of Evaluation: S 200th Street, near golf course weir.

Existing conditions: represented by the SMP 1994 Calibration HSPF input file.

Future conditions: represented by the SMP 2006 Future HSPF input file.

Target flow condition: 1994 landcover, 2-year 7-day low flow = 0.35 cfs

2006 flow condition: 2006 landcover, 2-year 7-day low flow = 0.25 cfs

Hydrologic change: 0.10 cfs

Additional Non-Hydrologic mitigation: 0.00 cfs

Total Low Flow Augmentation: 0.10 cfs

Low Flow Augmentation Period: July 24 - October 24; 91 days

Reserve Storage Volume: 12.2 acre-feet

Start of Filling: January 1

Duration of Reserve Storage Filling (maximum): 32 days (vault filled by February 2)

Comments

Calibration Documentation:
No data was found in the low flow report, or the accompanying three CDROMs, comparing the existing condition simulation of low flows against the Tyee Golf Course weir gauge data. Provide representative hydrographs, associated discussion and statement of adequacy of the calibration for simulating low flows.

Low Flow Statistics:
The proposed augmentation period starts on July 24 due to a large number of late July low flow events in the 2006+ augmentation record which occurred prior to an August 1 start date. (note: these low flow events before or after the mitigation window are less severe than would occur during the late summer if no low flow augmentation was provided.) However, there remains 11 annual low flow events (out of the 47 year record) which occur outside of the mitigation window, six starting around July 15. The reserve storage filling analysis determined that there will be at least 36 days (lowest of the 47 year record) worth of flow augmentation remaining in the vaults at the end of the proposed augmentation period (October 24). The vault storage volume remaining was not known when the July 24 and July 15 start dates were discussed previously. It is recommended that the reserve storage be evaluated with a July 8-15 start date to see if the filling analysis continues to show enough remaining storage to continue mitigation through October. Provided the final operations plan includes the provision to continue discharging any available water during

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the month of November, or until substantial rains occur, the flow frequency analysis would be consistent to assume events within this extended period of water availability to be augmented.

The flow frequency plots of ranked annual low flow events show substantially complete mitigation of the annual minimum low-flow events. The proposal provides augmentation during the period when streams are at their lowest flow levels. Inspection of the 1991 through 1994 hydrographs show that June-July baseflows will also be reduced by approximately the same 0.10 cfs. The flow frequency analyses predicts an increase in number of annual low flow periods occurring in July under the augmentation plan. The low flow report's biological assessment concludes that this change in timing of low flow events will not have an adverse impact on salmonids or stream habitat.

The late spring and early summer periods are when fish typically grow at the greatest rate. It is difficult to put these early summer hydrologic changes into perspective without an evaluation of what these flow reductions will look like in-stream. Will fish be forced into pools at times they currently are not? Will the number of available pools be reduced? Will this change the spatial distribution of fish? Will juvenile fish be subject to increased predation? Will there be impacts to invertebrate diversity and/or abundance? Will there be shifts in timing and duration of insect hatches?

- The final low flow study should put these spring-early summer low flow periods into perspective through a quantitative assessment of the effects of flow reductions on representative channel cross-sections.

- A monitoring program should be developed to verify the biological findings of no adverse impact to stream biology. This monitoring should begin as soon as possible so that baseline data can be obtained prior to substantial development changes.

- A monitoring program should be developed to ensure adequate water quality of reserve stormwater prior to discharge to stream.

Conceptual Designs:

- Conceptual designs should include details on how constant discharge will be achieved with variable head pressures.

- SDS4 vault: The vault inlet pipe will need to be reconfigured at a lower elevation. A note similar to the one found on exhibit C131 should be included here.

- SDS3 vault: not all inlet pipes are tributary to the reserve storage vault. The effects of having a reduced tributary area should be factored into the vault filling calculations.

Des Moines Creek Conclusions:

1. The proposed Des Moines Creek low flow augmentation has increased from 0.08 cfs to 0.10 cfs in the current proposal. The proposal to augment low flows for 3 months constitutes a substantial amount of mitigation.
2. The Low Flow Report needs to include evaluation of the accuracy of calibration for predicting upper stream low flows, a discussion of the evaluation, and a statement of adequacy.
3. Consideration should be given to moving the start date earlier (July 8-15) because of the large amount of reserve storage available at end of augmentation period, and the presence of several low flow events occurring in July.
4. It is recommended that the Low Flow Report include complete conceptual drawings for the proposed reserve storage vault and revised site design which includes the proposed reserve storage release structure to maintain constant discharge.
5. The SDS3 vault includes bypassing some inflows around the reserve storage. It is unclear whether this has been accounted for in the reserve storage filling calculations.
6. The SDS4 vault release rate will need to be only 0.015 cfs. It would be preferable if the reserve storage could be achieved with SDS3 facility alone.

Walker Creek -

Overview

Point of Evaluation: Des Moines Memorial Drive (~Gauge 42C).

Existing conditions: represented by the Calibration HSPF input files.

Future conditions: represented by modified 2006 HSPF input file. 8.05 acres removed from SDW2 subbasin. Embankment flows not included.

Target flow condition: 1994 landcover, 2-year 7-day low flow = 0.79 cfs

2006 flow condition: 2006 landcover, 2-year 7-day low flow = 0.71 cfs

Hydrologic change: 0.08 cfs

Additional Non-Hydrologic mitigation: 0.01 cfs

Total Low Flow Augmentation: 0.09 cfs

Low Flow Augmentation Period: August 1 - October 31; 92 days

Reserve Storage Volume: 15.0 acre-feet

Start of Filling: December 1

Duration of Reserve Storage Filling (average year): 102 days (vault filled by Mid March)

Comments

Low Flow Statistics:
It appears that the low-flow statistics provided for 1994 and 2006 conditions do not account for the non-hydrologic changes, while the 2006+ augmentation includes the additional augmentation proposed for non-hydrologic changes. If this observation is true, the benefits of the proposed mitigation are slightly overstated. This could be done by raising the 1994 curve by 0.01 cfs or by lowering the future condition curves by 0.01 cfs. Either way, it does not change the calculations for the amount of augmentation proposed. Non-hydrologic changes and low flow events occur outside the proposed augmentation window, so it would not be accurate to simply remove the augmentation associated with the proposed non-hydrologic mitigations.

The third CDROM provided, dated 7/26/01, includes timeseries for non-hydrologic adjustments. These timeseries have not been reviewed as there is no indication they were used in the current analysis.

Embankment Modeling:
The low flow study report indicates that the hydrologic contributions from the embankment were not included in the results of the 2006 conditions, nor in the 2006+ augmentation models. However, the low flow report includes information on the Walker Creek fill embankment, which raise the following comments:

- It appears that a significant portion of the modeled Walker Creek embankment is located within in Des Moines Creek surface water basin (SDS7). The embankment analysis found 2250 linear feet of embankment south of the Miller/Walker basin divide. This appears to include the entire length of the 3rd runway outside of the Miller Creek Basin. In comparing against the SMP Grading and Drainage plans, it appears that approximately the southern 1300 feet of the runway either does not have any embankment fill or the embankment drainage would not be tributary to Walker Creek.

See email
~ 11/1/01 which
Clarified this comment.
Comment is partially
inaccurate.

- On Figure 1 of the 6/25 PGG memo, the southernmost green area representing fill depths over 40 feet appears to be in an area shown on the SMP grading plans to be in an area identified to be a 40 foot cut (elevation 390 reduced to elevation 350). It is indicated in the low flow report that Walker Creek post-project conditions assume that the embankment fill provides no discharge during summer low flow statistics. This is shown in Walker Creek HSPF input file (wcnofill.inp) received via e-mail attachment on 7/24/01. This is the input file reported to have been used to generate the 2006 low flow statistics. The input file includes the removal of 8.05 acres of till grass, embankment fill, and impervious. The stated purpose for the removal of the PGG embankment flows was "...to allow for the largest impervious area possible to refill the Walker Creek low streamflow vault." This philosophy raises concerns in that simply not modeling the embankment does not change the expected runoff response of the embankment fill.

Non-Hydrologic Evaluation:
The Walker Creek drainage area reportedly includes the removal of 41 septic systems. The low flow impact associated with this removal of water is 0.014 cfs. This is approximately equal to 210 gallons per septic system per day. This is consistent with commonly used numbers for domestic water use.

Reserve Storage Collection:
To facilitate the collection of enough stormwater in the SDW2 surface water subbasin, the low flow report indicates that water will be collected from an impervious cover over Pond F, and by placing liners under some of the infield areas (filter strips) to keep stormwater in the surface collections system for conveyance to the reserve storage vault. The July 25, 2001 letter from Keith Smith, Port, indicates that 3.5 acres of infield area is proposed to be lined with impervious surface underlying the grass lined filter strips. The liner is to offset the 3.5 acres of runway assumed to 100% infiltrate into the embankment in the low flow models. Additionally, the SMP proposes to cover the pond with an impervious cover and to collect stormwater from the cover. Adding impervious surfaces not anticipated in the SMP creates inconsistencies with the assumptions used to size and evaluate the surface water facilities, as well as creating inconsistencies in the amount of water assumed to recharge groundwater and adjacent wetlands.

The SMP hydrologic models have assumed that all airport impervious areas are 100% effectively connected to the downstream drainage system. Therefore, the modeled impervious areas equal the total impervious areas. This assumption was used consistently in the HSPF models for all 3 stream basins for the calibration, future and predeveloped (meaningful where use of an effective impervious fraction would result in less than 10% effective impervious) landcover assumptions. For the facilities serving the embankment area effective impervious (less than total) was used for release rates and total impervious was used for future conditions. Per the June 2000 PGG report, this is a conservative assumption since the embankment fill specifications should result in a much more permeable embankment. However, since it is not possible to verify the future condition of the embankment, the SMP has not changed the original embankment permeability or effective imperious assumptions. The proposed approach for Walker Creek is to consider 3.5 acres of the proposed runway is 0% effective and therefore lining 3.5 acres of infield areas produces no net increase in impervious cover. Comments include,

- Adding impervious surfaces for the sake of mitigation feasibility is a counter-productive strategy for attaining resource protection goals.
- If lining the embankment area, the amount of embankment water available for downstream wetlands will change (likely decrease).
- If lining other pervious areas in Walker Creek (either till grass or outwash grass) this will have a larger effect on the flow control performance than lining embankment area.
- While filling the reserve storage vault the winter hydrology of Wetland 44A will be altered. In an average year the vault filling will take 102 days (mid March), but in drier years filling will extend through Spring and Summer. While filling, the runoff volumes which would have been discharged to the wetlands will be stored (15 ac-ft) and introduced to wetlands during late summer.

If the runway areas draining to the embankments are assumed to be zero percent effective impervious for purposes of designing flow control facilities, infiltration related BMPs such as raised rims on conveyance inlets, or perforated stubouts on the outlets from conveyance inlets should be provided. Unless measures are taken to ensure that runway areas draining to the embankment will be fully infiltrated, the flow control facility performance should be reevaluated to determine the feasibility of meeting stormwater standards using modeling assumptions consistent with the SMP. Performance verification may be possible using the existing proposed facility. Successful demonstration of maintaining flow control performance goals may, in part, be contingent on what portion of SDW2 subbasin is proposed to be lined. Due to the hydrologic response assumptions for the fill in the SMP, it would be advantageous to line an area of embankment fill. However, see Wetland 44A discussion below.

This proposal to add additional impervious surfaces is significant enough (total impervious will increase from 9.5 to 13.0 acres) that the areas to be lined should be provided in a figure to show how it will look either on the grading plans or as a separate figure. It is also necessary to know whether the liner will be located over the embankment or other soils. It should also show any infiltration BMPs, if proposed.

Wetland Hydrology:
Wetland 44A is located at the toe of the Walker Creek embankment. The northern arm of the wetlands receives flows from the outlet swale. The outlet swale serves as the conveyance system for discharges from the detention pond, reserve vault, and possibly serves to collect discharges from the embankment drain. Note: The NRMP indicates that this swale is to be removed after construction which is inconsistent with the SMP that shows the swale as a permanent stormwater conveyance system.

The low flow proposal includes the collection and retention of 11.5 acres of impervious surfaces into the reserve storage vault. The period of filling will average 102 days starting on November 30 (ending around mid-March in average year). During this time there will be almost zero surface inflows/discharges from the detention pond. In less than average years of precipitation, the time period needed for vault filling can extend considerably (in two years of the modeling record the vault did not completely fill). During these periods of filling the wetlands will receive only water from the embankment drains (assuming they are not intercepted into the vault also). This includes about 8 acres of pervious and impervious surfaces in the Walker Creek subbasin. The low flow proposal includes lining of 3.5 acres of pervious area, either on the embankment or east of the embankment. If the liner is located on the embankment, there will be a reduction in the amount of embankment recharge to the northern arm of Wetland 44A. The retained volumes (15 acre-feet) will be introduced to the wetlands as constant low flow augmentation between August 1 and October 31.

The NRMP shows the outfall from a channel located south of the southern arm of Wetland 44A, which is not shown on the SMP grading and drainage plans. The channel is assumed to convey flows from approximately 200 linear feet of embankment located south of wetland 44A. Since this portion of the runway is located in the Des Moines surface water basin, it is not expected that the proposed lining of the embankment will occur here.

The proposal to add additional impervious surfaces to facilitate stormwater mitigation is not supported by the reviewer. Alternatives recommended for evaluation include: 1) collection of the winter runoff from the 69 acres of impervious being added in the Walker Creek non-contiguous groundwater basin, or 2) the collection of a percentage of water at the toe of the Walker Creek embankment, 3) divert some winter runoff from adjacent SDW1B drainage system.

1. The 69 acres of impervious surface being added in the Walker Creek groundwater basin is likely responsible for most of the mitigation need. A portion of the rain water that would be intercepted by these impervious areas is currently flowing as groundwater to Walker creek. The collection of January runoff from some or all of these new impervious areas (or equivalent) would be unlikely to have an adverse affect on Des Moines Creek winter flows.

2. It is understood that the storm water at the toe embankment has been identified as providing hydrologic mitigation to wetlands 44A. It is not known whether there is sufficient water in the embankment to provide enough runoff volume for both purposes. A portion of the embankment north of the SDW2 pond could likely be directed into the vault by gravity drain.

3. Taking water from SDW1B would be similar to getting water from the non-contiguous groundwater area, except that it would more clearly be a diversion of flows under the KCSWDM. However, the diversion of flows is sometimes approved when determined to have beneficial results. It appears that this would have beneficial results, and that the reduced winter flows from SDW1B would have no negative impact on Miller Creek.

Conceptual Designs:
Conceptual designs need to include details on how constant discharge will be achieved at variable head pressures.

Walker Creek Conclusions:
1. The proposed Walker Creek low flow augmentation has increased substantially from previous conclusions which indicated improvements to base flows, or zero impact. The proposal to augment low flows by 0.09 cfs from August 1 - October 31 constitutes a substantial amount of mitigation.
2. The augmentation proposed assumes no contribution from the embankment fill, perhaps due to what appears to be an overestimation in the size of the Walker Creek embankment. If future updates to the low-flow report include the reinstatement of the embankment model, the true size of the fill embankment tributary to Walker Creek needs to be verified and modeled accordingly.
3. The proposed addition of new impervious surfaces as part of the low-flow augmentation is not recommended. Whether the other 3.5 acres of runway will truly be zero percent effective (entirely infiltrate into the embankment) is not known. If it is not 100% infiltrated, then the flow control facility may not be adequately sized. It appears that treated stormwater needs to be collected from an alternate location to avoid impacts to Wetland 44A and to ensure reliable filling of the reserve storage without extending through Spring and early Summer.
4. The embankment drainage is already intended to provide hydrologic contribution to Wetland 44A. It appears that the quantity of embankment drainage will be approximately half of that indicated in the current embankment model even without the addition of 3.5 more acres of impervious surface. 15 acre-feet of runoff which would have flowed to this wetland will be intercepted and stored for release to the wetlands and stream during August-October.
5. It is recommended that the low flow report include complete conceptual drawings for the proposed reserve storage vault and revised site design which includes the proposed reserve storage release structure to maintain constant 0.09 cfs discharge, the proposal to line a portion of SDW2, and the cover and rainwater collection system being proposed for the SDW2 pond.

Miller Creek -

Overview

Point of Evaluation: SR509 crossing (COPY 55).

Existing conditions: represented by the Calibration HSPF input files.

Future conditions: represented by modified 2006 HSPF input file.

Target flow condition: 1994 landcover, 1991 (~2-year) 7-day low flow = 0.79 cfs

2006 flow condition: 2006 landcover, 1991 (~2-year) 7-day low flow = 0.67 cfs

Hydrologic change: 0.11 cfs (why not 0.12 cfs? See below)

Additional Non-Hydrologic mitigation: 0.02 cfs

Total Low Flow Augmentation: 0.13 cfs

Low Flow Augmentation Period: August 1 - October 31; 92 days

Reserve Storage Volume: 18.8 acre-feet

Start of Filling: January 1

Duration of Reserve Storage Filling (maximum): 58 days (vault filled by March)

Summary of 2006 HSPF PERLND Adjustments (units = acres)

Subbasin	PERLND 26 Removed	PERLND 45 Removed	IMPLND Removed	PERLND 80 Added	PERLND 45 Remaining
SDN3x		0.29		0.29	23.48
SDN3AI			5.69	5.69	
SDN3AO		15.72	2.19	17.91	6.4
SDW1AO	0.67	18.66	0.93	20.26	13.78
SDN1AI			13.07	13.07	
SDW1B	0.54	36.05	22.41	59.00	10.21
SDN2X					0.86
SDN4					0.99
SDN4X					8.31
IWS NSMPS					0.01
TOTALS	1.21	70.72	44.29	116.22	64.04
PGG MODEL 6/25 memo		69.6	42.1	111.7 total PGG	
Difference	-1.21	-1.12	-2.19	-4.52	

Review shows that more area was removed from HSPF stream model than was simulated in the PGG models. Unclear why non-fill PERLND 26 was removed, or why there is an additional 64 acres of embankment fill remaining in the HSPF stream model. These issues would tend to have no effect or a slightly conservative effect on the analysis.

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Summary of other 2006 HSPF input file modifications

- WDM DSN7000 timeseries applied to RCHRES 35 (miller creek). DSN includes the embankment model output for water conveyed to toe of embankment via underdrain. DSN units are cubic-feet per day. Scalar converts to acre-feet per timestep.
- WDM DSN7001 timeseries applied to PERLND 80 AGWLI (active groundwater). DSN includes the embankment model output for water lost through bottom of underdrain. DSN units are cubic-feet per day. Scalar converts to inches per timestep per acre of PERLND80. Note: PERLND 80 is not rained on or evaporated from.
- PERLNDS 47 and 57 turned off. Infiltrated water (SDW1A and SDW1B) is not sent to active groundwater. As there remains tributary area in these subbasins after the removal of embankment areas, this would be a conservative assumption.

COMMENTS:

Low Flow Statistics:

It appears that the low-flow statistics provided for 1994 and 2006 conditions do not include the non-hydrologic changes, while the 2006+ augmentation includes the additional mitigation proposed for non-hydrologic changes. If this observation is true, the benefits of the proposed mitigation are somewhat overstated. This could be done by raising the 1994 curve by 0.02 cfs or by lowering the future condition curves by 0.02 cfs. Either way, it does not change the calculations for the amount of augmentation proposed. Non-hydrologic changes and low flow events occur outside the proposed augmentation window, so it would not be accurate to simply remove the augmentation associated with the proposed non-hydrologic mitigations.

The third CDROM provided, dated 7/26/01, includes timeseries for non-hydrologic adjustments. These timeseries have not been reviewed as there is no indication they were used in the current analysis.

The 1993 annual low occurs outside the stated augmentation window, but the reserve storage filling analysis shows that even in the driest year there were 20 days of flow augmentation volume remaining in the vault. Provided the final operations plan includes the provision to continue discharging any available water through the month of November, or until substantial rains occur, the analysis is consistent to assume this event mitigated.

The original 12/00 Low Flow study reportedly used the same input file (1994 calibration input file hasn't changed since 12/00 SMP and Low Flow study) that is currently being used (per Response to Public Comments, Parametrix 2001). There was some confusion over what file was actually used. A set of input files were provided by Parametrix on 4/19/01, but discussions on 4/22/01 indicated uncertainty as to what input files were used in the 12/00 analysis. The 4/19/01 input files appear to be 2006 subbasins with 1994 landcover. This may explain why the existing condition 2-year 7-day low flow dropped from 0.79 cfs to 0.74 cfs in this latest draft of the low flow report. Although the existing 2-year low flow was reduced, the calculated hydrologic impact (including embankment flows), now based on 1991 low flows, increased from 0.06 cfs to 0.11 cfs in this report.

Should the 1991 7-day impact number be 0.12 cfs? All of the data in the provided spreadsheets show 2 decimal places and the difference in 0.12 cfs. The table entitled "Comparison of 7-day Low Flow by Rank" calculates the hydrologic change at 0.12 cfs also. The only place found that uses 0.11 cfs was in the cover letter.

- In the electronic file (7/23/01 CDROM) named: millerdailyaverageflow.xls a check of 7-day low flows for 1991 was performed. This spreadsheet includes daily average flows for the full 47 year period of record and therefore is assumed to be the 2006 conditions with no embankment contribution. The numbers in that spreadsheet would indicate the hydrologic impact to be 0.14 or 0.15, depending on rounding preference. The difference is that the 2006 daily timeseries has a low 7 day average of 0.64, rather than the 0.67 shown in the summary tables. This analysis indicates that if the expected infiltration rates into the embankment are not achieved and maintained, 0.14-0.15 cfs would be the low flow offset for hydrologic changes (0.16-0.17 cfs including non-hydrologic mitigations).

- Discussion with modeler on 7/30/01, resulted in the finding that an outdated electronic file was provided for "Low Flow Miller 91-94.xls". Reportedly, the 2006 future conditions column had been updated and the correct results should have a future condition 1991 7-day low flow of 0.67 cfs (not 0.69 cfs calculated in the provided electronic file). No backup data was found on CDROMs which produce a future 1991 7-day low flow of 0.67 cfs, which is the flow indicated by the modeler to be the correct value.

- Additionally, the existing (1994) condition 1991 low flow was consistently calculated in the electronic files to be 0.784 cfs (not 0.79 cfs indicated in all tables). The difference (impact) is reportedly 0.114 cfs, consistent with the low flow report cover letter (0.13 cfs total flow reduction with non-hydrologic changes included).

Reserve Storage:
The drainage area for the existing NEPL vault was probably not intended to be included in vault filling calculations. The NEPL vaults are not in series and retrofitting of the existing vault is not proposed. NEPL new vault serves 26.29 acres of impervious (miller 2006 HSPF model), rather than the assumed 32.31. The % of reserve storage in each vault could be updated to maintain similar depths and/or fill times in the facilities.

The NEPL site design provides water quality treatment downstream of the vaults. The Cargo site also uses biofiltration swales, but it appears that biofiltration is proposed upstream of the Cargo vault. Both sites are subject to motor vehicle use. The draft partial operational plan was written assuming collection of treated runway runoff receiving water quality pre-treatment, and details additional water quality concerns with runoff from areas subject to regular motor vehicle use. NEPL is currently proposed to provide 40% of the total augmentation water. The Cargo site provides an additional 10%. The current low flow plan does not clearly demonstrate whether it is feasible to collect reserve water in these locations. The final proposed vault locations should be evaluated for feasibility and any special design considerations (e.g.., upstream spill control, oil controls, downstream compost filters, etc.) identified for the final low flow plan.

With a large number of reserve vaults, it means that the discharge rates must be proportioned. This will result in individual vault discharges as low as 0.013 cfs. For perspective, the minimum orifice size allowed by KCSWDM is 0.5 inches which produces a calculated discharge of 0.012 cfs with 3 feet of head. The actual discharge will be dependent on factors not considered by the standard orifice equations and will be susceptible to maintenance difficulties. The final low flow report should consider reducing the number of facilities to reduce the maintenance and monitoring needs. This will also allow for larger releases from individual vaults which would be easier to design, and less prone to plugging. The final low flow report needs to include design details on how the constant discharge releases will be achieved.

The low flow report assumes that essentially all runoff from impervious surfaces on the embankment will fully infiltrate into the embankment. Therefore, runoff from these impervious areas will not be available to fill the reserve storage vaults, which has led to the proposal for reserve storage vaults in other subbasins within the Miller Creek drainage area. Although contributing to the low flow condition, some of these subbasins are not located adjacent to Miller Creek. In late summer it may be difficult to deliver the augmentation water to the stream. The outfall locations upstream of the regional detention facility may result in losing the water to the soil rather than delivering it to stream. However this is where much of the impervious surfaces are being added under future conditions. It would certainly be preferred to find appropriate places for infiltration to occur which would offset the low flows without large reserve storage vaults. Investigations into infiltration feasibility have been negative in most areas evaluated. Perhaps approaching the investigation by asking where on the site infiltration would be feasible might be more productive.

Embankment Modeling: (Description of Process, no recommended action items)
The inflow to the PGG embankment models was generated from file Millalt1.inp. The embankment surface was modeled consistent with a typical parameters for flat sloped grass cover on outwash soils. This

was consistent with the embankment characterization in Ecology's June 2000 PGG report. During facilitated meetings, it was originally agreed that the precipitation would be scaled to account for the "run-on" of stormwater from runways and taxiways onto the in-field areas for infiltration. However, the approach used was to scale up the pervious AGWO flows as tributary inflows into the embankment model. Figure 2 of the 6/25 PGG report, shows the different results between the two approaches. Alternative 1 was the approach used, which is shown to provide less water available to the embankment. It is therefore accepted as more conservative than the approach originally agreed to. It was also expected that the normal 1 hour timestep would be used to simulate the embankment inflows and then the results would be aggregated to daily values for input into the embankment model. Discussions with the modeler indicated that using hourly timesteps for Alternative 2 would have lowered the values shown in Figure 2 slightly, but they would remain greater than the approach used, Alternative 1.

The PGG embankment models were reviewed by others at Ecology. As we provided no review of this model, no comments are provided.

The PGG embankment model produced two outflow timeseries. Discharge at the toe of the embankment, and water lost downward from the underdrain, assumed to go to active groundwater. For the four year embankment simulation period these values were added into the HSPF stream model using the 2006 HSPF model with the embankment areas removed. The initial results were run for only the 4 year simulation period. There were significant differences in the low flow statistics (existing conditions) when the model was run for only the 4 years of embankment data (1991 existing condition low flow was 0.79 cfs in full simulation and 0.69 cfs when run for only the 4 years). Reviewer did not support the approach of starting out with a completely "dry" model at the start of the embankment period of simulation, especially when the hydrologic impact is being based on the results of the 1st year. The modeler proposed to "wet up" both models using the calibration model. This approach seems reasonable (and resulted in slight increase in the amount of mitigation proposed). The analysis is consistent with expectations that the largest difference in annual 7-day low flows would be used to assess the hydrologic impact (see above comments).

Infiltration of impervious surface runoff through filter strips is typically assumed not to occur in site designs. However, the current modeling approach is consistent with Ecology's June 2000 PGG report. The infield areas on the embankment typically exceed the standard filter strip lengths which will provide additional opportunity for infiltration to occur. Over time it may become necessary to take corrective actions to maintain the surface infiltration needed to recharge the embankment (e.g., poking holes to ensure good water contact with permeable soils).

To help ensure infiltration into the embankment, there are some simple BMPs which could be introduced to the collection and conveyance system. Raising the rim on the catchbasin inlets 1-2 inches would provide conveyance for high flows while encouraging infiltration of smaller events. Another idea would be to provide 5-10 feet of perforated pipe just downstream of the catchbasin inlets. Note, these proposed BMPs were previously rejected due to concerns over ponding and cost, respectively.

From evaluation of the electronic file provided (MillerDailyAverageFlow.xls) it appears that in the event that embankment infiltration rates are not achieved the total low flow augmentation would increase to a maximum of 0.16-0.17, including both hydrologic and non-hydrologic changes to low flows, assuming no low flow contribution from the embankment. Monitoring should be performed to determine the effectiveness of the embankment to infiltrate and at the embankment drain collection system for verification of the embankment model.

Collection and Conveyance of Embankment Drainage:
Grading and Drainage plans show the collection swale at the toe of embankment in the vicinity of the SDN3A pond. Sheet 129 shows the collection swale flowing northerly to the break-line for Sheet 130. Sheet 130 shows a ditchline flowing in the opposite direction (south) to the same break line. It is not clear where this water is intended to go.

Similarly, there is a ditchline below where the airport security road traverses the slope on Sheet 130. The ditch is located on the up-slope side of 154th St. The ditchline may be collecting a majority of the embankment drainage at the north-end of the runway. The ditchline disappears at the breakline between Sheets 130 and 129. It is not clear where this water is intended to go.

Conceptual Designs:
Conceptual designs need to include details on how constant discharge will be achieved at variable heads.

Special considerations may be needed with the NEPL reserve storage vault. The inflow water will not have water quality pre-treatment and therefore it is reasonable to assume it will have relatively high TSS and possibly oils. A proposal to deal with the water quality concerns is needed at the conceptual design stage, particularly because NEPL is providing 40% of the reserve storage water.

Special considerations may be needed for Cargo reserve storage water quality. This also may affect the conceptual design.

Miller Creek Conclusions:

1. The proposed Miller Creek low flow augmentation has increased 0.10 to 0.13 cfs in the current proposal. The proposal to augment low flows by 0.13 cfs from August 1 - October 31 constitutes a substantial amount of mitigation.
2. The large number of facilities proposed to provide reserve storage volume will be problematic in terms of maintenance, operation, monitoring, and design. Proportioning the storage also implies proportioning the release rates. The release rates in some vaults may be less than can be reliably achieved using the KCSWDM minimum orifice size.
3. There are water quality concerns at NEPL and Cargo due to collection of runoff from regularly used vehicle access areas. The current operations plan needs to be updated to reflect this change. An evaluation as to feasibility of providing reserve storage of adequate water quality is recommended.
4. Clarification is needed as to where the outfall is located for the embankment toe collection swale in the vicinity of the SDN3A pond.
5. It is recommended that some infiltration type BMPs be included to help ensure that the levels of infiltration expected are achieved.
6. It is recommended that the low flow report include complete conceptual drawings for the proposed reserve storage vault and revised site design that includes the proposed reserve storage release structure to maintain constant discharge, and any structural water quality pre-treatment proposed for NEPL and Cargo to help ensure adequate water quality for the reserve storage.