2. LOW STREAMFLOW ANALYSIS

2.1 APPROACH

2.1.1 Introduction

The low-streamflow analysis approach included the determination of the critical low-streamflow periods for each stream, determination of existing streamflow magnitudes (target streamflows), and the determination of impacts to each stream resulting from construction projects in the Master Plan Update for STIA. The evaluations of the summer low-streamflow periods and rates are described in Sections 2.1.2 and 2.1.3. A detailed modeling analysis was used to determine the impacts to streamflows during the summer low-streamflow periods. Modeling tools used include the calibrated Hydrologic Simulation Program – FORTRAN (HSPF; EPA 1997) models for Miller, Walker, and Des Moines Creeks. HSPF model calibration is described in Section 2.2, and detailed HSPF model and calibration information is contained in Appendices A and B (Volumes 2 and 3) of the SMP (Parametrix 2000a, 2001a). The impacts of the proposed third runway embankment were modeled using a combination of Hydrus (Simunek et al. 1999) and Slice models. The embankment modeling is described in Section 2.3, and the complete embankment modeling report (Pacific Groundwater Group 2001) is contained in Appendix B. Non-hydrologic impacts, including cessation of water withdrawals and removal of septic tank discharges, are described in Section 2.4. The total net summer low-streamflow impacts are summarized in Section 2.5.

2.1.2 Determination of Summer Low-Streamflow Period

Determination of the low-streamflow period for each stream was done by analyzing modeled streamflow from the calibrated HSPF model for each stream, which used 1994 (existing) land use conditions. This determination is summarized below, and supporting information is provided in Appendix I.

The 7-day low-flow period for each year (using 1994 flow conditions) in the 47-year period of record (1949 to 1995) for each stream 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 7-day low flow was selected as an indicator of persistent dry season flow. For example, 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. In addition, consultation with biologists concluded that summer low flows with durations of less than 2 weeks do not affect the carrying capacity of the streams or cause behavioral changes in salmonids (Appendix H).

The occurrences of the annual 7-day low-flow periods were plotted and a bar graph showing the distribution of the summer low-flow periods by date was developed for each stream. The summer low-streamflow period for each stream was selected to include all the historical 7-day low-flow occurrences.

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2.1.3 Existing Summer Low Streamflows

The magnitude of existing summer low streamflow (target streamflow) in each stream was determined through analysis of the 7-day low-flow periods under existing (1994) conditions described above. The annual 7-day low flows for each stream were ranked, and recurrence intervals were determined based on this ranking using a cumulative density function (see Appendix I for supporting information). The 7-day low flow with a 2-year (50 percent) recurrence interval was selected as the streamflow target in each stream. The 2-year, 7-day low flow was selected because the magnitude of the estimated impact to 7-day low flows generally decreases with greater recurrence interval (i.e., the estimated reduction in the 7-day, 2-year-frequency low-flow rate is greater than that for the 7-day, 10-year-frequency low-flow rate). Therefore, providing mitigation equivalent to the 7-day, 2-year-frequency impact will provide mitigation sufficient to mitigate the more extreme summer low-streamflow events. Based on this analysis, the existing summer low streamflows (target streamflows) (7-day, 2-year frequency) were determined to be 0.33 cfs for Des Moines Creek, 0.77 cfs for Walker Creek, and 0.73 cfs for Miller Creek.

2.2 HSPF MODEL CALIBRATION

2.2.1 Overall Model

The computer program HSPF was used to simulate continuous watershed hydrology and to design stormwater detention facilities for the Port's Master Plan Update at STIA. Because the airport encompasses three watersheds, separate HSPF models for Miller, Walker, and Des Moines Creeks were developed. Hydrological modeling using HSPF requires the calibration of many parameters that describe the different hydrologic processes. These processes include:

- Rainfall runoff from pervious and impervious surfaces.
- Infiltration of rainfall to soils.
- Soil moisture accounting.
- Flow of groundwater from soils to streams.
- Loss of groundwater to deep aquifers.

Each of these physical processes is controlled by several parameters. The calibration process adjusts model parameters to achieve a close match between recorded streamflows and simulated streamflows for a period when streamflow data are available. Calibration of the HSPF models used for Miller, Walker, and Des Moines Creek watersheds is described in detail in Appendix B (Volume 3) of the SMP (Parametrix 2000a, 2001a).

2.2.2 Low-Flow Review

The overall HSPF model calibration effort did not focus specifically on low-streamflow periods. The low-flow analysis consisted of review of data from water-years 1991 through 1996, with the low-flow period considered to be June through November. This section summarizes the results of the overall HSPF model calibration for Miller, Walker, and Des Moines Creek watersheds as related to the low-flow analysis. Detailed information on the low-flow calibration review is provided in Appendix A.

2.2.2.1 Miller Creek Low Streamflow

Two streamflow gages located in the Miller Creek watershed were used in the low-streamflow analysis calibration review (Figure 2-1). One of these streamflow gages was located near the mouth of Miller Creek, and the other was located further upstream at the Miller Creek detention facility.

Average simulated and observed streamflows for each 7-day low-flow period during 1991 through 1996 are listed in Table 2-1 for the gage near the mouth and Table 2-2 for the gage at the Miller Creek detention facility. In general, the observed 7-day low flows exceeded the predicted 7-day low flows at both gages, particularly for the gage located at the Miller Creek detention facility.

Table 2-1. Miller Creek at the mouth, 7-day low flows for water-years 1991 through 1996.

Water-Year	Observed Average Flow (cfs)	Calibrated Average Flow (cfs)	Difference (cfs)
1991	1.348	1.749	-0.401
1992	1.457	1.390	0.067
1993	1.639	1.300	0.339
1994	1.361	1.100	0.261
1995	1.500	1.661	-0.161
1996	2.762	2.138	0.624
Average Difference	**2.517**	**2.335**	**0.182**

Table 2-2. Miller Creek at the detention facility, 7-day low flows for water-years 1991 through 1996.

Water-Year	Observed Average Flow (cfs)	Calibrated Average Flow (cfs)	Difference (cfs)
1991	0.400	0.150	0.250
1992	0.127	0.124	0.004
1993	0.190	0.110	0.080
1994	0.000	0.090	-0.090
1995	0.183	0.137	0.045
1996	0.263	0.189	0.074
Average Difference	**0.291**	**0.200**	**0.091**

2.2.2.2 Walker Creek Low Streamflow

Two streamflow gages located in the Walker Creek watershed were used in the low-streamflow calibration review (see Figure 2-1). One of these streamflow gages was located near the mouth of Walker Creek, and the other was located further upstream near a wetland.