



Fraser River  
Estuary  
Management  
Program

**Fraser River Estuary Management Program (FREMP)**

**Sediment Budget**

**&**

**Dredging Activities**

**Annual Report**

**For the Fiscal Year**

**April 1, 2005 to March 31, 2006**

**Prepared by FREMP**

## 2005/06 SEDIMENT BUDGET AND DREDGING ACTIVITIES ANNUAL REPORT

### ***1. INTRODUCTION***

The Fraser River Estuary Management Program (FREMP) is a partnership among federal, provincial and regional government agencies to foster co-ordinated and sustainable activities in the Fraser River estuary. FREMP is guided by its Estuary Management Plan (EMP). Developed through a multi-stakeholder consensus process in 1994 and updated in 2003, the EMP outlines a shared vision, goals and an action plan for a sustainable estuary. A key target in the EMP is to manage the removal of sediment from the Fraser River while maintaining the sediment regime of the river in balance. FREMP developed a tool called the “Sediment Budget”, which allows FREMP partners to deliver on this key target.

The report is organized as follows:

- Section 2 presents background on the FREMP Sediment Budget;
- Section 3 provides the 2005-2006 Sediment Budget numbers;
- Section 4 provides information on dredging activities and volumes removed over the year;
- Section 5 contains the summary numbers for maintenance dredging volumes over the past nine years since the Sediment Budget was developed; and
- Section 6 summarizes related dredging activities and studies completed during the year.

### ***2. THE FREMP SEDIMENT BUDGET***

The FREMP Sediment Budget is used to ensure that the average amount of sediment removed over a five- to ten-year period does not change the shape of the riverbed. This “averaging” approach acknowledges two factors:

- The amount of sediment deposited by the Fraser River’s annual spring flood fluctuates widely from year to year.
- Even in years where a relatively low amount of sediment flows into the estuary, water action may form underwater sandbars that need to be removed to prevent grounding of ships using the Fraser River. Conversely, in years where large amounts of sediment may enter the estuary, not all of it will pose a navigational hazard, and therefore, all of it may not need to be removed.

**The FREMP Sediment Budget covers sand-sized sediment in the estuary as far upstream as Mission.** For the purposes of the Budget, “sand” is any material that has a grain size between 0.177mm and 2.000mm. All other materials are not considered in the Budget. Thus, the Sediment Budget represents the amount of sand within that range that needs to be removed from the estuary in order to maintain a balanced riverbed from year to year.

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**The Sediment Budget is calculated annually for what is called the “freshet” year.** Generally, the dredging period runs from August of one calendar year to March of the next calendar year. The Budget is derived from a mathematical model which is described in detail in a report entitled “Lower Fraser River Sediment Budget Analysis” prepared for FREMP in 1999 by Northwest Hydraulic Consultants. This report concluded that a **preliminary** estimate of the upcoming annual Sediment Budget, accurate to within 25% of actual values, can be made by April 1<sup>st</sup> each year, using snow pack prediction data. The report also concluded that a **revised** estimate, accurate to within 15% of actual values, can be made by August 1<sup>st</sup> each year, using peak river flow data collected at Mission. The latter formula requires data for two separate variables concerning river volume:

- 1) the freshet volume between April and September at Hope<sup>1</sup>; and
- 2) the annual peak discharge at Mission.<sup>2</sup>

Following on a FREMP commitment to evaluate the predictive ability of the equation every five years, the model was reviewed in the 2002 by Northwest Hydraulic Consultants (NHC). NHC concluded that a sediment surplus has accumulated since 1996, and that the original target dredging figure of 70% of incoming bed material load is still appropriate and applies to grain sizes greater than 0.177mm. The report also noted that the Fraser River appears to be a stable “transport reach” between Mission and Douglas Island, and recommended that FREMP consider maintaining the sediment balance over the long term (10 years) as there is less need for concern about individual years.

The Sediment Budget equation may not perform well in years where freshet volumes are very low, as was the case in 2003 and 2004. Bathymetric analysis undertaken by Fraser River Port Authority for the main navigation channel provides additional information on sediment in-fill and further guidance for dredging activities in the river. Nonetheless, the Sediment Budget remains a useful calculation in looking at the *long-term* stability of the riverbed.

### ***3. THE 2005/06 BUDGET***

For the 2005/06 freshet, these respective values measured 63,200 million cubic metres and 7,720 cubic metres per second. **Placing these values into the Sediment Budget formula gave an estimate that the incoming sediment bed load would be approximately 0.99 million cubic metres during the period April 1, 2005 to March 31, 2006<sup>3</sup>.** While 2003/04 and 2004/05 were both classified as extremely low inflow years, the 2005/06 inflow was classified as moderately high inflow year.

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<sup>1</sup> Forecast volume for the Fraser River at Hope from April 1 to September 30, 2006 as noted in Seasonal Runoff Volume Forecast available at <http://www.env.gov.bc.ca/rfc/index.htm> (go to Archives).

<sup>2</sup> Peak flow at Mission as noted in preliminary peak discharge data available from Environment Canada, <http://scitech.pyr.ec.gc.ca/waterweb/selectProvince.asp>.

<sup>3</sup> This figure represents the refined FREMP Sediment Budget calculated in September 2005.

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### 4. ***DREDGING ACTIVITIES IN 2005/06***

During the period April 2005 to March 2006, 2.54 million cubic metres of sand-sized sediment were removed from the navigation channel of the Fraser River. Thus, dredging managers were above the Sediment Budget in the 2005/06 dredging year. Note, however, that the re-evaluation of the Sediment Budget equation illustrated the need for a long-term equilibrium compared to individual years.

*Sediment was removed as follows:*

Amount of sediment removed from the river and taken to upland sites (A):	<b>1.75 million m<sup>3</sup></b>
Amount of sediment removed from the river and disposed in ocean (B):	<b>0.79 million m<sup>3</sup></b>

Total removed from River = (A) + (B) = **2.54 million m<sup>3</sup>**

**Thus, a total of 2.54 million cubic meters of sediment were removed from the navigation channel in 2005-2006.** The map attached to the end of this report shows the locations where sediment was dredged for maintenance purposes during 2005/06, and for comparison purposes, where sediment was dredged during 2004/05.

This amount excludes approved capital dredging undertaken to deepen the navigation channel. Capital dredging began in 2001 to allow larger ships entry into the port; environmental and hydraulic reviews were carried out to approve the channel deepening. Because the purpose of the FREMP Sediment Budget is to calculate sediment removal that will maintain the riverbed at an equilibrium, and capital dredging is a decision made to change the morphology and create a new equilibrium, capital dredging volumes over the period 2001-2006 have been removed from the summary provided below, although details and volumes are noted. The resulting numbers therefore reflect the sediment volumes that have been removed through maintenance dredging with respect to the Sediment Budget (70% of the total Sediment Forecast). Note that capital dredging volumes will be reflected in future reviews of long-term changes to the channel.

### 5. ***OVERALL SEDIMENT BUDGET BALANCE DURING PAST NINE YEARS***

2005/06 marks the ninth year that FREMP has forecasted the sediment (size between 0.177 mm and 2.000 mm) that enters the Lower Fraser River. The table below summarizes the annual Sediment Budget forecasts (in millions of cubic metres) and the actual amount of sediment removed from the River by dredging (in millions of cubic metres) during the past nine years.

The data shown below for the Sediment Forecast and Budget are taken from past FREMP Dredging Annual Reports<sup>4</sup>. Note that a comparison of forecast versus hindcast (actual) volumetric sediment loads in the NHC report showed that forecast loads are generally quite close to actual loads.

<sup>4</sup> Previous FREMP Dredging Annual Reports reported a maximum of cubic meters that could be removed without changing the shape of the riverbed. This represented the 70% level of the Sediment Forecast.

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Data for “Actual Removed from the River” has been updated based on the December 2002 Northwest Hydraulics report. Where previous Annual Reports included in this column dredging totals for all particle sizes, the numbers below for “Actual Removed from River” now reflect net removal of sediment greater than 0.177 mm. As noted above, capital dredging volumes for grain sizes greater than 0.177mm over the period 2001-2005 have been netted out in the summary provided below. The resulting numbers therefore reflect the volumes that have been removed with respect to the Sediment Budget (70% of the Sediment Forecast).

“Net Infill” compares “Actual Removed from River” against the “70% of Sediment Forecast” (i.e. what is still available to be dredged in keeping with sustainable sediment removal).

“Percentage of Forecast Removed” compares actual removed against the sediment bed load forecast.

### SEDIMENT FORECAST VS REMOVALS 1997-2006 (all values in millions of cubic metres)

Year	Sediment Forecast (0.177mm to 2.000mm)	70% of Sediment Forecast	Actual Removed From River (>0.177mm)	Actual Removed Less Capital Dredging (>0.177mm)	Net Infill Or (Net Removal)	% of Forecast Removed
1997/98	4.70	3.30	1.32	1.32	1.98	28.1%
1998/99	1.11	0.78	1.00	1.00	(0.22)	90.1%
1999/00	4.50	3.15	1.85	1.85	1.30	41.1%
2000/01	1.70	1.19	1.20	1.20	(0.01)	70.6%
2001/02	0.72	0.50	0.76	0.55	(0.05)	76.4%
2002/03	2.98	2.09	2.79	2.31	(0.22)	77.5%
2003/04	0.61	0.43	1.61	1.45	(1.02)	237.7%
2004/05	0.55	0.39	1.96	1.67	(1.28)	303.6%
2005/06	0.99	0.70	3.22	2.54	(1.84)	185.8%
<b>1997/98 to 2005/06</b>	<b>17.86</b>	<b>12.53</b>	<b>15.71</b>	<b>13.89</b>	<b>(1.36)</b>	<b>77.7%</b>

The 1999 report by Northwest Hydraulic Consultants stated that “using the results of the Sediment Budget, an approximate long-term equilibrium can be maintained if the net dredging volumes are maintained at about 70% of the incoming bed material load”. During the past nine years, the volume of dredged material amounts to 77.7% of the forecasted bed material load. Thus, there has been a **net removal from the navigation channel during the past nine years that is estimated to be 1,360,000 cubic metres.**<sup>5</sup>

<sup>5</sup> Numbers used in the table are taken from FREMP Dredging Annual Reports, and so represent sediment forecasts based on preliminary discharge data. The NHC Report (2002) included findings based on actual sediment loads.

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While this is the first year that a cumulative net removal is evident, it should be noted that maintenance dredging volumes have remained relatively constant in recent years. When combined with the low freshets of recent years, particularly in 2003 and 2004, the result is a net removal from the river.

### **6. OTHER DREDGING-RELATED ACTIVITIES DURING 2005/06**

#### ***FREMP Environmental Management Strategy for Dredging in the Fraser River Estuary***

In 2002, in response to ongoing issues around the need for biological impact studies relating to dredging applications in the river, the BIEAP-FREMP Management Committee requested that a Comprehensive Dredge Management Strategy be developed to help resolve questions around dredging impacts and data gaps. The need to develop a Dredging Strategy for the estuary was captured in the updated Estuary Management Plan, 2003.

As a step towards the Dredge Management Strategy, in 2004 WLUC completed a study of data gaps for the biological impacts of dredging in the estuary. Work on the Comprehensive Dredge Management Strategy began at that time and continued into 2005-2006. The draft document was reframed as an 'environmental management strategy' to reflect the document's focus on biophysical and environmental issues. In January 2006, the *Environmental Management Strategy for Dredging* was approved by the BIEAP-FREMP Management Committee.

The Environmental Management Strategy is a practical, decision-making tool for the FREMP partners, proponents and the FREMP Environmental Review Committee regarding dredging applications in the estuary, in particular to identify where additional biological impact studies may be required. The Strategy is based on the channel segments of the river, and identifies port and dredge management activities as well as environmental knowledge and specific biological impact data gaps for each channel segment. Recently completed dredging impact studies have been analyzed for possible extrapolation to other parts of the estuary. Background information on river use and dynamics, ecology and food web, and navigation is also provided.

#### ***Revised FREMP Dredge Management Guidelines (2005)***

FREMP Dredge Management Guidelines were developed in 2000 and contain useful information to dredging applicants on the FREMP Sediment Budget, dredging registry and the Coordinated Project Review process.

In 2005, FREMP updated the Dredge Management Guidelines and made them available on the FREMP website at <http://www.bieapfremf.org/fremf/publications/current.html>. Revisions included minor housekeeping issues and revised maps showing the Fraser River Port Authority and North Fraser Port Authority navigation channels. Appendices have been brought up to date to reflect current information, including upland disposal requirements and updates to the BIEAP-FREMP Coordinated Project Review process.

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### ***Dredging Impact Assessment – Sand Heads***

Fraser River Port Authority funded a study to assess dredging impacts on benthic communities in the Sand Heads and Steveston segment of the estuary, as part of a channel deepening project. Sampling occurred in February and April 2004, with dredging taking place in March 2004. The Sand Heads environmental impact study was completed in April 2005.

The study focused on Pacific sand lance, an abundant marine fish in the estuary that is important as forage for salmon, sea birds, and marine mammals. It is vulnerable to entrainment by dredging given its habit of seeking cover by burrowing in the sand substrate, mainly at night. The catch rate of sand lance and density of other benthos was also compared between habitat in un-dredged segments of the shipping channel and habitat of shallower water over mud flats of Roberts Bank, south of the shipping channel. This latter task was used to determine the relative importance of the shipping channel as habitat for benthic fish.

The study found that despite the removal of organisms by entrainment, no effect of dredging on catch rate of sand lance, other fish species (mainly starry flounder and staghorn sculpin) or density of benthic invertebrates (mainly true shrimp, crab, nematodes, amphipods and polychaetes) was found. These results suggest that sand lance and other benthic fish and invertebrate communities in the outer Fraser River estuary are highly resilient to disturbance, at least at the scale associated with the channel deepening project.

The study authors hypothesize that resiliency of the benthic community is linked to constant organism recruitment with the daily tidal influx, dune movement, or combinations thereof. Tidal flux may re-sort benthic communities on a daily basis, causing rapid recruitment of sand surfaces, not by voluntary animal movement, but more by entrainment of organisms in mass water and sand movements. Hence, some of the benthic community in a given area of river bed, particularly that in the troughs of the dunes, may remain in place even after direct passage of the dredge. After dredging, these organisms will be naturally mobilized as dunes reform and continue to migrate, contributing to quick recruitment of substrates within a dredged area.

The authors concluded that while the deepening is a major physical disturbance to the river bottom that does remove organisms, it did not affect benthic invertebrate density and diversity within the time scales tested in this project. This comparison illustrates that the freshet is of primary importance in modifying benthic communities in the outer estuary.

### ***Fraser Basin Council – Lower Fraser River Hydraulic Model Development***

A related project of note is being facilitated by the Fraser Basin Council. The primary purpose of this project is to provide an up-to-date evaluation of the design flood profile for the lower Fraser River based on simulating a re-occurrence of the 1894 Fraser River flood of record, considering current river and floodplain conditions. Specific objectives include a better understanding of the effects of sedimentation and dredging on the dike design profile. Fraser River Port Authority and FREMP are members of the Advisory Committee for this project, for which a final report from consultants is expected in fall 2006.

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### ***7. MEMBERS OF WATER AND LAND USE COMMITTEE***

The following agencies are represented on the FREMP Water and Land Use Committee (WLUC) and provide input and expertise with respect to dredging matters:

Fisheries and Oceans Canada

- Oceans, Habitat and Enhancement Branch
- Canadian Coast Guard

North Fraser Port Authority

Public Works and Government Services  
Canada

Environment Canada

BC Ministry of Environment

Fraser River Port Authority

### ***8. FOR FURTHER INFORMATION***

For further information on FREMP, the Sediment Budget, or this Annual Report, please contact:

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