



Fraser River
Estuary
Management
Program

Fraser River Estuary Management Program (FREMP)

Sediment Budget

&

Dredging Activities

Annual Report

For the Fiscal Year

April 1, 2006 to March 31, 2007

Prepared by FREMP

2006/07 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 2006-2007 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 1st 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 1st 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 Hope¹; and
- 2) the annual peak discharge at Mission.²

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 2006/07 BUDGET

For the 2006/07 freshet, the freshet volume estimate measured 54,100 million cubic metres and the annual peak discharge at Mission was 8,360 cubic metres per second. **Placing these values into the Sediment Budget formula gave an estimate that the incoming sediment bed load would be approximately 0.79 million cubic metres during the period April 1, 2006 to March 31, 2007.** While 2005/06 was classified as moderately high inflow year, the 2006/07 inflow was classified as moderate inflow year.

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

² Peak flow at Mission as noted in preliminary peak discharge data available from Environment Canada, <http://scitech.pyr.ec.gc.ca/waterweb/selectProvince.asp>. Peak discharge was reached on May 27, 2006.

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4. DREDGING ACTIVITIES IN 2006/07

During the period April 2006 to March 2007, 3.18 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 2006/07 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):	2.56 million m³
Amount of sediment removed from the river and disposed in ocean (B):	0.62 million m³

Total removed from River = (A) + (B) = **3.18 million m³**

Thus, a total of 3.18 million cubic meters of sediment were removed from the navigation channel in 2006-2007, with approximately 80% of the removed material used as sand for pre-load and other developments, and less than 20% ocean disposed. The map attached to the end of this report shows the locations where sediment was dredged for maintenance purposes during 2006/07, and for comparison purposes, where sediment was dredged during 2005/06.

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

2006/07 marks the tenth 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 Reports³. 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.

³ 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 1997-2007 (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%
2006/07	0.79	0.55	3.18	2.44	(1.89)	308.9%
1997/98 to 2006/07	18.65	13.08	18.89	16.33	(3.25)	87.6%

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 ten years, the volume of dredged material amounts to [87.6%] of the forecasted bed material load. **Thus, there has been**

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a net removal from the navigation channel during the past 10 years that is estimated to be [3,250,000] cubic metres.⁴

The Sediment Budget equation is less predictable in years with unusually high or low freshets. Over the past ten years, there have been extreme flow conditions (both high and low); consequently there is greater uncertainty of the model results.

Due to an increase in vessel size, the Fraser River Port Authority's management objectives have changed in recent years from maintaining to deepening the river channel. Increased deepening will result in increased sedimentation; therefore more sediment will need to be removed on an annual basis.

The FREMP Navigation and Dredging Working Group is in the process of investigating ways to improve the Sediment Budget model and its predictive capability; however this will require increased financial support.

6. OTHER DREDGING-RELATED ACTIVITIES DURING 2006/07

FREMP Dredging Registry

Developed in 2002, the FREMP dredging registry acts as a long-term record of dredging volumes and will assist in reviews of the FREMP Sediment Budget. In its current form, the FREMP office maintains an Access database of dredging removals from the estuary. Data for this comes from the Fraser River Port Authority and includes various grain sizes as well as information on disposal sites (e.g., in-river disposal, transfer pits) and volumes. In 2006, FREMP updated the dredging registry with data from 2002 through to 2006.

Fraser Basin Council – Lower Fraser River Hydraulic Model

A related project of note was facilitated by the Fraser Basin Council. In September 2005, the Fraser Basin Council (FBC) retained Northwest Hydraulic Consultants Ltd (nhc) to undertake a program of one-dimensional hydraulic modeling on the lower Fraser River using MIKE11 software. The overall objective was to generate an up-to-date design flood profile for the lower Fraser River based on two scenarios:

- The estimated flow during the 1894 Fraser River flood combined with high spring tide conditions.
- The 200 year winter storm surge with high tide combined with a Fraser River winter flood.

The two profiles were then overlaid and the higher of the two values was used to develop an overall design flood profile for the river. The hydraulic model was developed using field data collected in 2005, including detailed bathymetric surveys of the channel, LIDAR surveys of the floodplain and

⁴ 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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velocity measurements to estimate flow splits at major channel branches. The model was calibrated and verified initially using recorded data from 2002, 1999 and 1997 flood events.

An initial evaluation of the flood protection capacity of the present dikes was made by computing a series of water surface profiles for a range of discharges. These results were then compared to the 1894 profile published in 1969. Based on the dike information made available, the study found that the dikes would be overtopped at one or more locations and freeboard compromised at several locations. As a result, the authors recommended that high priority be given to re-assessing the adopted design flow currently based on an estimate of the 1894 flood of record at Hope. High priority should also be given to assessing both flood management strategies on the floodplain of the Fraser River and the institutional framework for implementation of those strategies.

Fraser River Port Authority and FREMP were members of the Advisory Committee for this project. A final report from the consultants was received in 2006 and the model is now being used by various parties to help manage flood risks in the Fraser River. For more information, go to www.fraserbasin.bc.ca or http://www.env.gov.bc.ca/wsd/public_safety/flood/structural.html#hydraulic.

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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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