

# **Gravel Extraction Inventory for Lower Fraser River (Mission to Hope) - 1964 to 1998**

prepared for  
**District of Chilliwack**  
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under District of Chilliwack OP01220

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## 1.0 INTRODUCTION

Between Laidlaw and Sumas Mountain, Fraser River occupies a wandering gravel-bed channel that is characterized by an irregular pattern of gravel bar deposition and channel island development. At the present time, there is a concern that the channel bed is rising, which increases flood hazards and threatens the channel banks. The reach also has an exceptionally diverse aquatic ecosystem with high economic value (in alternate years, up to two million pink salmon use the gravel-bed reach for spawning). Any strategy to manage flood hazard must recognize and attempt to maintain this value. As part of the analysis of this problem, the Department of Geography at the University of British Columbia is using detailed survey data and historic airphotos to establish a sediment budget for the river. This substantially improves our understanding of gravel recruitment and deposition in the reach.

In order to accurately reconstruct the historic gravel budget of the Lower Fraser River, however, past gravel removals from the river must be documented. A previous inventory of gravel removal for the period 1973-1986 was completed by Kellerhals Engineering Services Ltd. (KESL) in 1987. Much of the information in this inventory was gathered by discussions with local gravel operators and representatives of the Department of Fisheries and Oceans (DFO), Provincial Ministry of Forests and Lands (the Lands function of which is now administered by British Columbia Assets and Land Corporation), and British Columbia Ministry of Transportation and Highways (MOTH).

Because gravel extraction from Fraser River has been regulated since 1974 by what is now British Columbia Assets and Land Corporation (BCAL), the inventory compiled by KESL appears to be a fairly accurate record. This regulatory agency requires that a provincial royalty be paid for every cubic metre of gravel removed from crown land. This policy was initially requested of the province by DFO as a means of controlling the location and volume of gravel extraction. However, these records alone do not represent a complete record of gravel removal because

Provincial records of gravel removal are based on volumes reported by gravel operators. Pre- and post-excavation survey information is generally not available and therefore the actual amount of gravel removed cannot be verified.

- The British Columbia Ministry of Transportation and Highways has a number of established gravel reserves along the Fraser River and these reserves are not subject to the regulations imposed by BCAL. In addition, MOTH has no internal records of gravel removal.
- Gravel removal operations on private land are also not controlled by BCAL.

Fortunately since 1980 DFO has required permits for gravel extraction (due to concerns that gravel mining may be adversely affecting fish habitat) and additional records of gravel removal, particularly from private land, are available. The effect of this policy has been to restrict permits for instream gravel extraction to a small number of established operations. In some cases since the late 1980s DFO has requested pre- and post-excavation surveys to verify removal volumes.

## 2.0 INVENTORY RESULTS

In preparing this inventory, the intent was not only to update records but also to determine if the previous inventory was complete and whether additional information on gravel removals prior to 1973 could be retrieved. In updating gravel removals to 1998, reliance was largely placed on records compiled by DFO and BCAL. Mr. Kon Johansen of DFO and Mr. John Gerbrandt of BCAL were extremely helpful in this regard.

Table 1 lists known gravel removal volumes to date and the location of each site is shown on Figures 1A-D (to maintain consistency, the site numbers used in the 1987 inventory have been retained). Included in this table are some updates to gravel removal volumes from the period 1973-1986 that were discovered during the current research. For example, Mr. Ken Lukawesky of MOTH indicated that approximately 306,000 m<sup>3</sup> of gravel was removed from Fraser River between 1969 and 1974 during an upgrade of Highway #7 between Agassiz and Hope while similar volumes were removed during dike reconstruction in the early 1970's (see Section 3.0). Table 2 is a list of local gravel operators and government representatives that were contacted to update the gravel removal inventory.

This inventory documents the removal of approximately 4,570,000 m<sup>3</sup> of gravel since 1964 -- an average of 130,000 m<sup>3</sup> per year. Figure 2 illustrates the historical variation in annual gravel removal in the area between Hope and Sumas Mountain. Apart from two large gravel removals in 1995 (Foster Bar) and 1996 (Powerline Island), maximum volumes of gravel removal occurred in the 1970's and early 1980's. Scuffler dredge activity, to increase the depth of the mainstem channel for navigation purposes, is not included in these totals as this material is not removed from the channel (see Section 5.0). Additionally, KESL reported that 92,000 m<sup>3</sup> of gravel was moved in 1974 during construction of a buried pipeline upstream of the Agassiz Bridge (West Coast Transmission Co. Ltd.). Because the waste pile was retained within the active channel (the sediment was stockpiled at the downstream end of the island located immediately upstream of the bridge), the excavated volume is not included in this inventory. Also not included in this inventory are documented removals adjacent to Strawberry Island and Mission Bar where only sand was dredged.

Information on gravel removal prior to 1974 is more difficult to obtain as the industry was not regulated and no provincial or federal records were kept. Discussions with local gravel operators have provided some information on historical gravel removals but the volumes documented in this report do not represent the total amount. For example, approximate volumes of gravel removals in Minto Channel have been documented back to the mid-1960s. However, historical airphotos clearly show that gravel removals in this area extend back to the 1940's (small-scale excavations on Minto Bar are visible on 1949 and 1954 airphotos).

## 3.0 GRAVEL REMOVAL OPERATIONS

At the present time, there are few active gravel removal operations on the Fraser River. Indeed there is currently a moratorium on all gravel removal as DFO is concerned that gravel extraction will adversely affect critical spawning and rearing habitat. However, there is an increasing demand for this resource with rapid urbanization of the Fraser Valley. The following is a partial

list of gravel operations that are discussed in more detail as they have been operating for a number of years or they represent a significant removal volume.

**Vosco Dredging Company Ltd. (formerly Chilliwack Gravel Sales Ltd.), Minto Channel (Site 4-1, Figure 1B)**

This is one of the oldest gravel removal sites on the Lower Fraser River and the majority of gravel has been removed by dragline from the central portion of the channel. Gravel has also been removed by bar scalping from a site located immediately downstream of the dragline excavation. Mr. Bob Vosburgh, who owns Vosco Dredging, has been working at this site for over thirty years and in an interview with KESL he indicated that gravel removal commenced in 1966 with the excavation of approximately 23,000 m<sup>3</sup>. Prior to regulation of the industry in 1974, Mr. Vosburgh indicated that a number of small, unlicensed operations were removing gravel from exposed river bars throughout the study area.

Because this gravel operation is on private land, Vosco is not subject to provincial regulations. Since 1980, however, they have required a permit from DFO and a ban on dragline excavations by DFO ended operations in 1994. A number of pre- and post-excavation surveys were conducted for both the instream and bar scalping operations in the period 1987-1990.

**Steelhead Aggregates Ltd. (formerly Cascade True Mix Ltd., Blackhams Construction Ltd. and Rempel Brothers Concrete Ltd.), Minto Channel (Site 4-2, Figure 1B)**

This gravel removal site is located about 1 km upstream of Vosco Dredging and is also situated on private land. Unlike the downstream operation, the majority of gravel has been removed by bar scalping on the south side of Minto Channel (the bar is situated downstream of a sharp bend in the channel). According to Mr. Wesley Norrish, Lyall Hamilton and Sons Ltd. and Ballan Sand and Gravel initially used this site in the 1950's and early 1960's. He estimates that removal volumes at this time were initially modest with less than 3,000 m<sup>3</sup> of gravel being excavated annually. During those early years, the site was used by a number of contractors and anyone could access the bar. In 1967, the Norrish family bought the land around Minto Landing, effectively preventing other contractors from removing gravel from the site. At this time, they also established a concrete business (Cascade True Mix Ltd.) and gravel removal volumes increased significantly. According to the records of Mr. Norrish, about 7,600 m<sup>3</sup> of gravel was removed in the first year of business with up to 40,000 m<sup>3</sup> being excavated annually by the time they sold the business in 1976. The concrete portion of the business was sold to Rempel Brothers Concrete Ltd., while the rights for gravel removal were sold to Blackham's Construction Ltd. Both of these businesses eventually sold out to Steelhead Aggregates.

According to Mr. Bob Esau, who has been working at this site since 1972, scalped volumes were supplemented by mid-channel dragline excavations up until about 1978. Gravel excavation at this site is ongoing and pre- and post-excavation surveys have been conducted intermittently since 1987.

Steelhead Aggregates has also recently been involved in gravel extraction at Foster Bar, located at the entrance to Upper Minto Channel (Site 6-1, Figure 1B). According to DFO records, at

least 300,000 m<sup>3</sup> of gravel was scalped from this site in 1994-1995 during low flow conditions. Foster Bar is not on private land and gravel removal is subject to provincial royalties.

On a side note, Mr. Norrish was also able to provide some insight into gravel removals in general in the 1950's. Between 1948 and 1956, the Norrish family removed gravel from Gill Bar (Sites 6-2 to 6-4) along with a number of other contractors. Total removals during this time were generally low (< 5,000 m<sup>3</sup>/yr) as the gravel was initially loaded by hand into small trucks (the trucks could haul about 4 m<sup>3</sup>). By the 1960's, changing flow patterns cut off access to the bar and trucks could no longer drive onto the site. Foster Bar (Site 6-1) was also a common site of gravel removal during this time but it was not used as frequently as Gill Bar.

### **Hope Ready Mix Ltd., Croft Island (Site 10-1, Figure 1D)**

Although large volumes of gravel have not been removed from this site annually, it has been in operation since at least the 1950's. During that time period, between 5,000 and 10,000 m<sup>3</sup>/yr of gravel have been removed from a large bar, immediately downstream of Croft Island. The bar is located on the right-hand side of Fraser River about 3 km downstream of Hope Bridge. Gravel at this site is removed by bar scalping – a process that involves the use of heavy machinery to lower the bar surface, generally to the low water mark.

Mr. H.A. Corbett owns Hope Ready Mix Ltd. and has been working at this site since 1964. When Mr. Corbett arrived on the scene, Rutledge Gravel initially supplied gravel from the bar to his business until he took over the gravel removal in 1968. According to Mr. Corbett, Rutledge Gravel began working this site in the 1950s and gravel removal from the bar likely extends back into the 1930s and 1940s (if not earlier) as it was a good gravel source for the town of Hope. It is not expected that removal volumes were significant during this time, as demand would not have been high. However, Mr. Corbett indicated that Rutledge Gravel did supply gravel to CN Rail for lining tunnels through the Coquihalla.

This bar was also a major source of gravel for MOTH during an upgrade of Highway #7 between 1969 and 1974. For this project, Mr. Corbett estimates that approximately 75,000 m<sup>3</sup> of gravel was removed from his site in 1973.

### **Highway #7 – Agassiz to Hope (Sites 9-1, 9-2, 9-3 and 10-1)**

According to Ken Lukawesky of MOTH, approximately 306,000 m<sup>3</sup> of gravel was dredged from the north side of the Fraser during an upgrade of Highway #7 between Agassiz and Hope. The upgrade occurred over a period of several years from 1969 to 1974. This estimated volume does not include the 100,000 m<sup>3</sup> of gravel removed in 1964-65 to construct the Katz Flats section of this highway (Site 9-2, Figure 1D). This earlier construction phase was handled by MOTH personnel while the later phase was contracted out. Unfortunately, Mr. Lukawesky was unable to give exact locations for the larger gravel removal. However, we were able to contact a road engineer (Mr. Rasmus Sjøvold of Emil Anderson Contracting Co. Ltd.) who worked on this project for Catree Construction. By his recollection, gravel was removed from three locations: Ruby Creek (Site 9-1), Katz Flats (Site 9-2) and immediately downstream of Croft Island (Site 10-1).

A portion of this larger removal was accounted for in the 1987 inventory with the recorded removal of 76,000 m<sup>3</sup> from Ruby Creek in 1973. In addition, Mr. Corbett of Hope Ready Mix Ltd. has estimated that MOTH removed about 100,000 m<sup>3</sup> from his site downstream of Croft Island for the highway upgrade. For the purposes of this inventory, the remaining volume (130,000 m<sup>3</sup>) has been allocated to Site 9-2, Katz Flats.

It should also be noted that the 1987 inventory has a recorded removal of 111,000 m<sup>3</sup> from the Fraser River Debris Control Trap (Site 8-1, Figure 1C) in 1977-78. This estimate was provided by Mr. Frank Csizmadia of the Ministry of Forest and Lands who indicated that the gravel was used by MOTH. However, Mr. Csizmadia was unsure of the date of gravel removal. Because this site is adjacent to Highway #7, this recorded volume is most likely a reference to the construction that occurred between 1969 and 1974. As such, this removal volume has not been recorded in this updated inventory nor has this site been included as a removal site.

### **Dike Upgrades in the Early 1970's (Sites 6-1, 6-8 and ?)**

In the early 1970's (1971 to 1974), MELP secured significant funding to upgrade dikes in the Lower Fraser Valley. This work generally involved building the dikes up with gravel (the dikes required widening) and facing them with riprap. MELP administered the construction contracts and a number of local firms were involved in the process. Unfortunately, as MELP contracted the work out, there are no provincial records of gravel removal. We were able to contact a former MELP employee, Mr. Bob Edwards, who oversaw the various contracts. Mr. Edwards has no recollection of removal volumes but he was aware of gravel being removed from Harrison Bar, Foster Bar (Site 6-1), and Powerline Island (Site 6-8) for the dike upgrades and from Greyell Slough for construction of a wing dam (Figure 1B).

In the study area, contracts for the engineering of the dike reconstruction were awarded to two companies. Willis, Cunliffe and Tait secured the contract for dike upgrades on the south side of the river from Chilliwack Mountain to Rosedale. Mr. John Wedler, the principal of J.W. Wedler and Associates, worked for Willis, Cunliffe and Tait at this time and he recalls that about 76,000 m<sup>3</sup> of gravel was removed from Foster Bar between 1971 and 1973 for the dike work. Emil Anderson Construction was sub-contracted to do the construction and a former foreman supervisor, Mr. Alec Nichol, recalls additional gravel removal (bar scalping) from a site immediately upstream of the Agassiz-Rosedale bridge on the left hand side. However, Mr. Nichol was unable to provide an estimate of gravel removal from this site.

The contract for the north side of the river, between Harrison Mills and Seabird Island, was secured by Catree, a company formed by Bob Cattermole and Tretheway. Mr. Rasmus Sjøvold worked for Catree on this project and he estimates that approximately 100,000 to 200,000 m<sup>3</sup> of gravel was taken from Powerline Island (Site 6-8) for some of the upgrades. Gravel was also probably removed from Harrison Bar, located at the confluence of Harrison River and Fraser River, for upgrades around Harrison Mills. Unfortunately, both of the principals of Catree have passed away and removal volumes can not be estimated at this time.

#### 4.0 PRIVATE LAND

As previously noted, there are several sites along Fraser River that are private land and gravel operations at these locations are not subject to provincial regulations. This list includes Steelhead Aggregates Ltd. and Vosco Dredging Company Ltd. in Minto Channel as well as Tranmer Bar – a site owned by Mr. Spaeti who allowed Vandale Holdings to extract gravel in 1993, 1994 and 1995 (Site 6-10, Figure 1C).

The question is how are these sites within the main channel of the river privately owned? This problem extends back to the end of the 19<sup>th</sup> century when land titles were handed out. Because the river is constantly changing its course, portions of some of these properties have been eroded away and are now part of the main channel. However, they are still considered private property under their original property line.

#### 5.0 SCUFFLER DREDGING

Since 1950 there has been a dramatic increase in boat traffic between Mission and Hope. Most of this activity is related to the forestry industry as the river provides cost-effective transportation for wood products. Public Works Canada maintains a navigation channel along Lower Fraser River, which requires annual dredging as the river naturally tends to form riffles. This maintenance dredging is carried out using a scuffler dredge, a device that drags sediment away from shallow spots in the channel and deposits it along the margins of the navigation channel or within deeper pools. Since the sediment remains in the active channel, dredged volumes have not been included in this report. KESL reported that the annual volume of gravel moved by scuffler dredge in the study area varied between 54,000 and 82,000 m<sup>3</sup> in the period 1979 to 1986.

Because few boats used the Sumas to Hope reach of Fraser River prior to 1950, Public Works was initially not very active in this reach. When demand for a navigation channel grew, gravel was moved using the scuffler dredge. However, Public Works was involved in limited dredging before this time and the records are ambiguous as to whether the gravel was simply moved to another area of the channel or onto shore. Records indicate that 58,000 m<sup>3</sup> was dredged by clam-shell adjacent to Chilliwack Mountain in 1944-45<sup>1</sup>. Also between 1914 and 1922, approximately 190,000 m<sup>3</sup> was hydraulically dredged from Nicomen Bar to relieve pressure against Nicomen Island where banks were being heavily eroded. A similar volume was removed by drag-line from this bar but the records clearly indicate that this gravel was retained within the channel.

#### 6.0 MAINTENANCE DREDGING

There are a number of sites where small-scale maintenance dredging is required to remove annual accumulations of generally fine-textured sediments. Cattermole Timber operates a dryland sort and booming ground downstream of Chilliwack Mountain (Site 3-3, Figure 1A). Cattermole has indicated that dredging of the entrance is required every few years due to excessive accumulations of sand and silt. In the past (1974, 1983-1987), they have dredged

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<sup>1</sup> Fraser River System History of Improvements 1871 to 1948, Public Works Canada, July 1949.

gravel from the main channel with the material being used onsite for construction purposes as noted in Table 1.

A similar situation is found on the downstream side of Bristol Island where International Forest Products Ltd. (Interfor) also operates a dryland sort and booming ground (Site 10-2, Figure 1D). This facility was constructed in 1985 and because it is situated in a “slack” water area, dredging of sand and silt-sized sediment is required every three to four years to maintain boat access. In addition to this maintenance dredging, Interfor has mined an adjacent gravel bar for onsite construction purposes. According to DFO, BCAL and Interfor records, approximately 50,000 m<sup>3</sup> of gravel was removed between 1985 and 1995.

The District of Chilliwack undertakes periodic removal of sediment deposited adjacent to a sewer outfall located upstream of Chilliwack Mountain (Site 3-6, Figure 1A). According to Mr. Eric Dyck, Superintendent of Facilities, clean-up of this outfall last occurred in about 1986 although there is no record of volume removed. According to the records of Kon Johansen (DFO), however, approximately 20,000 m<sup>3</sup> of sediment was dredged at this time. There is no record of sediment removal at this site prior to 1986. A new outfall was constructed several hundred metres downstream of the old site in 1995 but sediment removal has not been required as of yet.

The largest annual maintenance operation is located at the Fraser River Debris Control Trap (Site 8-1, Figure 1C), which has been in operation since the 1970's. According to KESL records, approximately 19,000 m<sup>3</sup> of sediment are removed annually from this site. The dredged material is predominantly sand and silt with a minor gravel component (< 10 percent). Because some of this material is returned to the downstream channel and the gravel component is minor, these volumes have not been included in Table 1.

## **7.0 FLOOD OF 1948**

The possibility that gravel from Fraser River was used during the flood of 1948 was investigated during the preparation of this inventory. The 1948 flood is one of the largest floods on record and it affected much of the Lower Fraser Valley. In response to extremely high water levels associated with rapid spring melting, an Emergency Flood Committee was established in Chilliwack for the period May 27 – June 16, 1948. In the District of Chilliwack, this flood committee was assisted by the Canadian Army which took over the direction of flood operations on June 1<sup>st</sup>. During this time period, the existing dike system failed at several locations and a majority of the work consisted of repairing failures and reinforcing the dikes with sand bags. This work was complicated by the general disrepair of the dikes, which had become overgrown with brush and trees. Additionally, in some areas the dikes had been constructed over a wooden trestle frame, that had rotted over time.

During this time period, gravel was used to fill the sand bags and all dike road surfaces were gravelled to permit vehicle access. The sand bags were used not only to reinforce the dikes but also for road fills – many of the approach roads to the dikes passed through slough beds and were

under three to six feet of water. Records from the Chilliwack Archives indicate that the gravel came from four pits<sup>2</sup>:

- The Keith Wilson Pit on Vedder River, which was already operating as a municipal gravel pit.
- A pit was opened at the Royal Canadian School of Military Engineering. This pit was situated on Kieth Wilson Road, with gravel extraction from the fan of Vedder River.
- Jespersen Pit was opened on the Jespersen farm, which is located on the left-hand side of Fraser River immediately upstream of Carey Point. This pit was capable of producing 3,800 m<sup>3</sup> of gravel on two eight hour shifts.
- The McGrath Pit at Rosedale was a private pit and removed gravel from the contemporary floodplain.

Of the four pits, the Jespersen Pit is the only pit from which gravel might have been removed directly from Fraser River. However, the records are ambiguous as to whether a pit was established on the floodplain or whether gravel was removed by dragline from the river. The records indicate that four bulldozers, two draglines and one shovel were used at the site. As such, it is probable that the bulldozers and shovel were used to remove gravel from the floodplain while the draglines may have extracted gravel from the river (this may have been a difficult task, however, given the height of the river). If we assume that this pit was in full operation for about 14 days and that half the gravel was being removed from the river, approximately 26,000 m<sup>3</sup> of gravel may have been removed from Fraser River.

Following the flood, the Government of Canada and the Government of British Columbia established the Fraser Valley Dyking Board. The mandate of this board was to repair, strengthen and reconstruct the dikes in the Fraser River and remove water and debris from the flooded land. Approximately \$10,000,000 was allocated to the board with the majority of the work to be completed within two years.

A final report prepared by the board gives some information of possible gravel removal from Fraser River<sup>3</sup>. A majority of original dikes in the Valley had been built by building a ditch or borrow pit parallel to the dike on the land side and using the material to form the dike. However, these ditches were too close to the dike, inducing seepage through the dikes and weakening the structure at the toe. During the flood of 1948 many of the failures were directly attributed to this situation. As such, one of the mandates of the board was to fill in all of these ditches (approximately 110 km of ditches throughout the Valley had to be filled). A majority of these ditches were filled in by hydraulic dredge, using material from Fraser River.

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<sup>2</sup> Chilliwack Archives. Chilliwack Emergency Flood Committee Report of Operations. June, 1948. Add.MSS. 654.

<sup>3</sup> Final Report on the Activities of Fraser Valley Dyking Board from its inception on July 22<sup>nd</sup> 1948 to March 1<sup>st</sup> 1950. Fraser Valley Dyking Board. March 15<sup>th</sup> 1950.

The report does not give specific volumes dredged at each site but it does include the cost of hydraulic dredging (including average cost per m<sup>3</sup>) as well as a figure showing the location of dredging. In our study area, there are two areas where dredging occurred:

At East and West Nicomen Islands, \$15,209 was spent on hydraulic dredge filling. At an average cost of \$0.33/m<sup>3</sup>, this works out to about 46,000 m<sup>3</sup> of dredged material. Since only half of the dike system around Nicomen Island is on the Fraser River side, approximately 23,000 m<sup>3</sup> of sediment would have been dredged from Fraser River. Because about 20% of the instream sediment is sand-sized, this value must be adjusted by a factor of 0.8 to represent the gravel fraction only (~ 18,000 m<sup>3</sup>). The other half of the diking system faces Nicomen Slough and it is assumed sediment would have been dredged from the slough, which is not of interest for our calculations since it is isolated from Fraser River sediment inputs

The second area is in the vicinity of the confluence of Sumas River with Vedder Canal. The figure shows that hydraulic dredging occurred alongside the dike extending east from the confluence. Because of its closer proximity, sediment for these ditches was probably dredged from Sumas River. As such it is outside our area of interest.

Mr. Wesley Norrish worked in the gravel industry at this time and he recalls that in excess of 100,000 m<sup>3</sup> of gravel was dredged from Fraser River for dike repairs. However, he was unable to provide exact locations or a more reliable estimate as a number of contractors were involved in the dike repairs.

## **8.0 LIMITATIONS OF INVENTORY**

This updated inventory represents an attempt to record the majority of gravel removals that have occurred over the past fifty years. However, there are a number of limitations to this survey:

- Gravel removal from the 1950's and 1960's is very difficult to establish. Prior to regulation of the industry in 1974, Mr. Bob Vosburgh of Vosco Dredging has noted that a number of small, unlicensed operations were removing gravel from exposed river bars throughout the study area. Records do not exist for these removals and many of the people involved in the industry during this time period have either passed away or are no longer in the area. For example, gravel extraction in Minto Channel has been established back to the mid 1960's. However, small-scale extractions are visible on airphotos from 1954. Although there are no records of these excavations, demand during the 1950's and 1960's would have been much less than it is today.
- There is a certain degree of uncertainty regarding removal volumes from Minto Channel. Vosco Dredging and Steelhead Aggregates extract gravel from private land in this side channel which, as noted, is not subject to provincial regulations. As a result, removal volumes are based on estimates from the gravel operators and the estimates of DFO and BCAL representatives. These estimates do not always agree and the removal volumes for some years have upper or lower limits (Table 1). However, the upper and lower limits may well cancel each other out, giving a fairly reliable estimate of gravel removal.

- Records of gravel removal from MOTH have been extremely difficult to gather. This has resulted not only from a lack of proper documentation but also a difficulty in establishing contacts with relevant personnel who would be able to provide approximate volume estimates. For example, the 1987 inventory notes that sediment was removed from Wahleach Channel but MOTH has been unable to provide a date or volume estimate for this extraction. In addition, Frank Csizmadia of the Ministry of Forestry and Lands (1987 inventory) had knowledge of gravel removals by MOTH at the downstream end of Herrling Island (Site 6-9) and opposite Sea Bird Island (Site 7-1). However, MOTH has been unable to account for these removals. Despite these limitations, two of the larger projects in the area have been accounted for. Gravel removals for construction of Highway #7 between Agassiz and Hope have been recorded. In addition, we were able to contact a former employee who was involved in the construction of Highway #1 in the Lower Fraser Valley in the late 1950's and early 1960's. According to Mr. Gordon Vance, material for this construction predominantly came from two sources. For construction of the highway west of Lickman Interchange, gravel was removed from Evans Pit – a gravel pit located on the west side of Vedder Canal. For areas further east, the gravel came from Bailey Pit, which has since been converted into a municipal dump. Mr. Vance had no knowledge of Fraser River gravel removals during this major construction project.

There is little doubt that the total recorded volume of gravel extraction in Table 1 represents a minimum estimate. However, the province has regulated the industry since 1974 and DFO has required an additional permit since 1980. As such, the post 1974 inventory appears to represent a relatively complete record of removal volumes. Discussions with local operators did not uncover additional gravel removals that were unrecorded by the representatives of these two government agencies. The greatest uncertainty remains in the period prior to 1974.