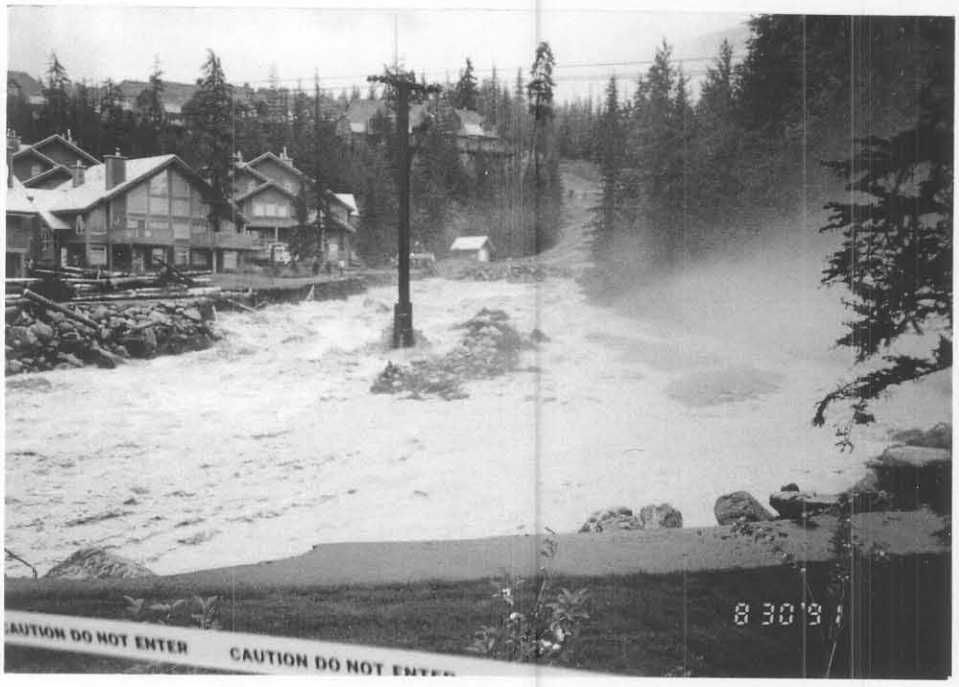
FEDERAL-PROVINCIAL FLOODPLAIN MAPPING AGREEMENT

PROVINCE OF BRITISH COLUMBIA
Ministry of Environment, Lands and Parks
Water Management Division

A DESIGN BRIEF ON THE Floodplain Mapping Study

Whistler Area

An Overview of the Study Undertaken
to Produce Floodplain Mapping in the
Resort Municipality of Whistler



Fitzsimmons Creek Flood of 8/30/91

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File: 35100-30/119-4671

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DESIGN BRIEF ON THE FLOODPLAIN MAPPING STUDY

RESORT MUNICIPALITY OF WHISTLER

PREFACE

The purpose of this Design Brief is to present a description of the methodologies used and the results of the study undertaken to produce the floodplain mapping sheets for the Resort Municipality of Whistler, Drawing No. 89-16, Sheets 1-4 (Appendix 5).

1. LOCATION

The Resort Municipality of Whistler is located in the Squamish-Lillooet Regional District in the southwestern portion of British Columbia as shown on Figure 1. The Resort Municipality is a rapidly growing community located approximately 125 kilometres from Vancouver via Highway 99.

Figure 2 is a Key Plan of the study area which indicates the location of the floodplain mapping drawings produced for the study.

2. BACKGROUND TO STUDY

The Ministry of Environment, Lands and Parks has been involved in subdivision approvals in the Whistler area since 1974 when legislation was initiated to control subdivision of lands subject to flooding in British Columbia (Appendix 1.1).

The Resort Municipality of Whistler first passed flood control requirements in a 1976 zoning bylaw. Bylaw No. 380, which contains the latest flood control requirements for the Resort Municipality, was adopted in September, 1984 (Appendix 1.2).

The Ministry was involved in the 1975 to 1978 period in the determination of flood profiles of the Fitzsimmons Creek fan area in connection with construction of a training wall (see Photos 1 and 2, Appendix 2). The present "Village Centre," which is located on the Fitzsimmons Creek alluvial fan, is protected by the training wall as indicated on Drawing No. 89-16-2 (Appendix 1.11). In connection with this training wall project, the Ministry issued preliminary floodplain mapping of Fitzsimmons Creek in October, 1978.

In order to assist in the administration of flood control requirements when this function was regionalized in the mid-1980s, the Ministry issued Drawing No. 84-40 in July, 1984 entitled "Whistler Area Flood Levels." The information shown on the drawing is based on data available from a variety of sources.

An extension of the training wall is under construction (August/September 1990) which will extend the original structure from Lorimer Road downstream to near Nancy Greene Drive as shown on Drawing Nos. 89-16-2 and 3.

The Resort Municipality has grown rapidly in recent years. Appendix 3 is a "Whistler Valley Directory" which provides information of public services and indicates the names of

streets, roads, etc., in the floodplain mapping area. Discussion with municipal staff indicates that the Resort Municipality has recently become involved in the preparation of the Fitzsimmons Creek Management Plan. Flood photos (November, 1989) shown in Appendix 2 were provided by Mr. Waldron, Assistant Municipal Engineer. The front page photo of Fitzsimmons Creek during the flood of August 30, 1991, was taken by Mr. R. Cameron, Flood Control and Response Section.

3. PRESENT STUDY

The 1990 floodplain mapping study is based on 90 cross sections of watercourses in the Whistler area, obtained in 1988 (Appendix 1.3). The cross sections cover Millar Creek from the Cheakamus River confluence to Nita Lake (Drawing No. 89-16-1) and Alta Creek from Green Lake to Alta Lake (Drawing Nos. 89-16-2 and -3). Previous surveys undertaken in 1984 (Appendix 1.4) involving 6 cross sections on the Green River near the outlet of Green Lake (Drawing No. 89-16-4) were also used in this study.

Topographic mapping, based on air photos obtained in August, 1983, at 1:5000 scale with 2 metre contour intervals, was used in the study (Appendix 1.5) Hydrology studies of the Whistler area were completed in September, 1989 (Appendix 1.6) and reviewed in early 1992 based on floods which occurred in November 1990 and August 1991 (Appendix 1.13).

4. FLOOD MAGNITUDES

4.1 General

In accordance with the policy of the Ministry of Environment, Lands and Parks, the flood levels and floodplain limits shown on floodplain mapping sheets are based on a designated (1:200 year frequency) flow plus an allowance for hydraulic and hydrologic uncertainties. The sensitivity of flood levels to flows for the various watercourses in the study areas is discussed in Section 5.

4.2 Millar and Alta Creek Flows

A regional hydrology study carried out for the Whistler area in September, 1989 (Appendix 1.6) is summarized below. Drainage areas were measured from 1:50,000 scale mapping at 3 locations along Millar Creek, at 2 locations along Alta Creek and at the outlet of Green Lake at Gauge 08MG004. The measured drainage areas at the various locations along these watercourses are summarized in Table 3.

The hydrology study was initiated with a review of the historical flood flow information for gauged basins in close proximity to the study area. There is a general reduction in unit peak flow proceeding in an easterly direction from the coast to the Lillooet River valley. The peak flows for this region may be generated by snowmelt, glacier melt, rainfall or rain-on-snow. The more extreme events normally occur in October to November and are the result of rainfall or rain-on-snow.

Frequency analyses were performed on hydrometric stations with five or more years of record which were in close proximity to the study area (Table 1). Several hydrometric stations with less than five years of record were included in the regional analysis. These

stations are 08GA016 Brandywine Creek, 08GA033 Rubble Creek, 08GA038 Chance Creek and 08GA040 Culliton Creek.

TABLE 1
STUDY AREA HYDROMETRIC STATIONS

No.	Name	Period of Record
08GA056	Sentinel Creek	1966-74
08GA023	Rubble Creek	1925-34
08GA024	Cheakamus River	1925-47
08GA017	Cheakamus River	1917-50, 1955-68
08GA043	Cheakamus River	1958-87
08MG021	Twentyone Mile Creek	1974-80, 1982-83
08MG003	Green River	1914-52
08MG004	Green River	1923-47
08MG007	Soo River	1924-47
08MG006	Rutherford Creek	1924-47

Mean annual maximum daily discharge (MAMDD) figures for hydrometric stations with 5 and less years of record were adjusted to long-term estimates where their period of operation overlapped long-term stations. These estimates were plotted together with the MAMDDs for long-term stations against their respective drainage areas on log-log graph paper. No clear linear relationship was apparent between drainage area and MAMDD, other than a general reduction in MAMDD as drainage area decreased. Aside from this being a hydrologically and climatologically complex area, one reason a relationship was not found may be partly due to the length of time some hydrometric stations were operated. More confidence was placed in hydrometric stations with 20 or more years of record.

A graphical relationship (Figure 3) was developed which related drainage area to MAMDD by passing the slope of the Water Survey of Canada Envelope Curve for B.C. through both Rutherford and Twentyone Mile Creeks to make estimates of MAMDD for the ungauged study basins.

Computer frequency analyses were run on nearby hydrometric stations with 10 or more years of record. From a summary of these analyses (Table 2) the regional ratios of the 1:20 and 1: 200 return periods to the MAMDD were estimated to be 1:1.9 and 1:3.5 respectively.

TABLE 2
RATIOS OF 20-YEAR AND 200-YEAR TO MEAN PEAK FLOWS

No.	Name	20-yr:Mean	200-yr:Mean
08GA017	Cheakamus River	1.91	3.50
08GA023	Rubble Creek	2.40	8.97
08GA024	Cheakamus River	1.59	2.25
08GA054	Mamquam River	1.97	3.62
08GA056	Sentinel Creek	1.84	2.84
08GA057	Mashiter Creek	2.22	4.09
08GA061	Mackay Creek	2.10	3.23
08GA064	Stawamus River	1.69	2.27
08GA071	Elaho River	1.81	2.45
08MG003	Green River	1.51	2.19
08MG004	Green River	1.59	2.53
08MG006	Rutherford Creek	2.05	3.73
08MG007	Soo River	1.79	3.31

Instantaneous to maximum daily discharge ratios (I/D) were determined from a linear relationship developed between the I/D ratios for 08GA071 Elaho River, 08GA054 Mamquam River and 08GA057 Mashiter Creek and their drainage areas.

Extreme flow estimates (Table 3) based upon the latter regional analysis are as follows:

TABLE 3
PEAK FLOW ESTIMATES

Creek	Location	Drainage Area (km^2)	Peak Flow (m^3/sec)			
			Daily		Instantaneous	
			1:20	1:200	1:20	1:200
Millar	Outlet of Nita Lake	12.3	21.3	39.2	45.4	83.5
	Outlet of Alpha Lake	19.8	25.5	56.0	51.5	113
	Upstream of Cheakamus River Confluence	33.7	45.2	83.3	85.4	157
Alta	Upstream of Twentyone Mile Creek	13.3	22.4	41.3	47.3	87.1
	Upstream of Green Lake	48.0	58.9	108	107	195

5. HYDRAULIC ANALYSES

5.1 General

Information sources listed in Appendix 1 were utilized in the HEC-2 water surface profile computer program developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers in Davis, California. The flood profile calculations assumed open water flow conditions.

Flood profiles were calculated for the Green River a distance of 0.5 km downstream from Green Lake; for Alta Creek (River of Golden Dreams) a distance of 5.0 km from Green Lake to Alta Lake; and for Millar Creek a distance of 3.3 km from the Cheakamus River confluence to Alpha Lake and 0.5 km from Alpha to Nita Lakes.

A plot run of each watercourse cross section was obtained to assess the ground survey data and the extensions of the surveyed cross sections obtained from the existing topographic mapping. Output from the plot runs was used to review other data such as flow regime, loss coefficients, bridge or culvert information, reach lengths, overbank data and relative Manning's "n" values.

Highwater data corresponding to measured flows from a specific flood occurrence was not available in order to calibrate Manning's "n" values in the study area. The roughness characteristics at each cross section were estimated using the color photographs provided by the Surveys Section, site visits, experience gained in other studies and a review of the information available in a book published by the U.S. Department of the Interior entitled "Roughness Characteristics of Natural Channels." Following is an overview of the computer runs for the above-noted watercourses.

5.2 Green Lake Flood Levels

River cross-sectional data at the outlet of Green Lake (Appendix 1.4) indicate that the Green River in the 0.5 km reach downstream of the lake outlet is steep and narrow having a floodplain width of between 20 to 80 metres. The Water Survey of Canada gauge 08MG004, Green River at Rainbow, was located downstream of the lake outlet and has a record period (1914 and 1923 to 1948) of 26 years. Photos 5 and 6 (Appendix 2) indicate the Green Lake shoreline and a view of Green River downstream of the lake outlet.

Calculations based on the above-noted river cross section and flow data were undertaken by Ministry staff in 1984 and determined a flood level (1:200 year) of 635.5 metres (GSC datum) for Green Lake. This level, which included an allowance for hydraulic and hydrologic uncertainties, was used for administrative purposes and shown on Drawing No. 84-40 in July 1984 as discussed in Section 2.

The floods of November 9 and 10, 1990 and August 29 and 30, 1991 in the Whistler area resulted in the highest levels unofficially observed on Alta and Green Lakes as follows:

Date	High Water Levels (metres, GSC datum)	
	Alta Lake	Green Lake
November 1990	639.25	634.74
August 1991	639.40	634.90
Flood Level adopted for administration purposes in 1984 (Drawing No. 84-40)	640.0	635.5
Adopted Flood Level 1992 study	640.5*	636.0**

* discussed in Section 5.3
** discussed below

As indicated above, the flood levels adopted by the Ministry for administration purposes in 1984 exceed the maximum (unofficial) observed levels by 0.6 metres for both Alta and Green Lakes.

A survey of the 1990/91 high water levels for Alta Lake was undertaken by Ministry staff (Appendix 1.12). Lakeside residents were interviewed and stated that the 1990/91 levels were the highest observed by residents in 52 years.

A survey of Green Lake levels was undertaken by R.B. Brown and Associates and documented in a report by Peter Ward and Associates Ltd. (Appendix 1.13). The Green Lake flood levels were unofficially reported to be the highest observed since 1956 (Appendix 1.14) based on interview of local residents by Ministry staff.

As a result of the 1990 and 1991 flooding events in the Whistler area, a review of flood frequencies and levels was undertaken by Dr. Peter R.B. Ward, P.Eng., for Burrard International Ltd. and Stanley Properties Ltd. Dr. Ward requested that Ministry staff review a November 1991 draft of his report based on Ministry experience in the Whistler area (Appendix 1.15). Dr. Ward's final report is dated February 10, 1992. A paper outlining the August 29/30, 1991 flood event in the Whistler area was presented by Dr. Ward, et al., at a symposium on Geotechnique and Natural Hazards, May 6 to 9, 1992, in Vancouver, B.C. (Appendix 1.16).

An assessment of the Green Lake 1:200 year flood level and outflow estimates presented in the Ward report of February 10, 1992, has been made by Mr. D.E. Reksten of the Hydrology Section (Appendix 1.17). The procedure used in the Ward report considered to be the most reliable by Mr. Reksten was based on the estimated return period of the August 29/30, 1991 flood event. A ratio was applied to the calculated August 1991 lake outflow to obtain the 1:200 year outflow as discussed below.

An outflow rating curve for Green Lake was calculated based on the river cross-sectional data obtained in 1984 (Appendix 1.4). The calculation determined that a maximum outflow of 163 m^3/s occurred in August 1991 when the Green Lake level reached 634.9 metres.

The Ward report states, that in terms of damage to creekside vegetation and transport of debris and bedload in Fitzsimmons Creek, the August 1991 flood appears to be about a 50 to 80-year return period event. As stated previously, Ministry staff interviews with local residents suggest that lakes in the Green River watershed of the Whistler area reached levels in the order of a 35 to 50-year (or greater) return period.

The 200-year to 50-year return period flow ratio value was estimated by Ward to be 1.35. This ratio was based on a regional analysis of flood flows for various return periods for distributions with small skew. The value is considered conservative relative to a frequency analysis ratio of Gauge 08MG004 (Green River at Rainbow) which yields 1.25. Using the ratio of 1.35 yields an estimated 200-year return period outflow of 220 m^3/s which corresponds to a level on Green Lake of 635.6 metres.

Based on the assessment of the Ward report by Mr. Reksten, a flood level of 636.0 metres is recommended for Green Lake for administrative purposes. This level is 1.1 metres above the maximum observed flood level on Green Lake which occurred in August, 1991, and allows for a lake outflow approximately 1.6 times greater than that experienced in the 1991 flood event.

5.3 Alta Creek

A total of 38 river cross sections were obtained along the 5.0 km thalweg distance of Alta Creek from Green Lake to Alta Lake. An additional 4 cross sections cover a portion of Twentyone Mile Creek upstream of the Alta Creek confluence. There are 2 railway bridges, 1 highway (99) bridge, and 2 small foot path road bridges in the study area as shown on Drawing No. 89-16-3. Alta Creek is known locally as the "River of Golden Dreams" (Appendix 3).

Alta Creek has a relatively flat profile varying from 0.05% to over 0.4% in the area immediately downstream of Twentyone Mile Creek confluence. As indicated on Drawing No. 89-16-2 and -3, the alluvial fan of Twentyone Mile Creek is separated from Alta Creek and Alta Lake by the BCR right-of-way. There is a potential for Twentyone Mile Creek to reestablish itself in old channels and enter Alta Lake directly, instead of at the existing downstream confluence with Alta Creek.

Photos 7 to 12 (Appendix 2) show the Alta Creek floodplain area. The photos of the flood of November 1989 indicate the conditions at the confluence of Alta Creek with Twentyone Mile Creek.

Photo 13 is a view of Alta Lake from Lakeside Park looking north towards the lake outlet. Photo 14 is a view of the paved Valley Trail which crosses the upper end of the Alta Lake floodplain. Fill has been placed in the vicinity which prevents flood flows from being directed into Nita Lake.

Manning's "n" value for the Alta Creek channel was estimated to vary from 0.03 to 0.05 in the study area. Overbank "n" values were estimated to average 0.10. Flows used in the backwater analysis (Section 4) are summarized as follows:

Return Period	Flow (cms)	Location
Q200 I	195	At Green Lake
Q200 D	108	
Q20 I	107	
Q20 D	58.9	
Q200 I	87.1	Upstream of Twentyone Mile confluence
Q200 D	41.3	
Q20 I	47.3	
Q20 D	22.4	

The designated flood levels (based on the Ministry practice) were equal to the 1:200 year daily flood level plus 0.6 metres or the 1:200 year instantaneous flood level plus 0.3 metres, whichever elevation is the greater. The designated flood level for the instantaneous flow dominates in the study area resulting in a level averaging 0.25 metres higher than the daily criteria.

Sensitivity studies indicate that for the 1:200 year daily flow, an increase in Manning's "n" values of 40% results in an average flood level increase of 0.22 metres. An average increase in flood levels of 0.10 metres occurs for a flow increase of 16.4 m^3/s above the 1:200 year (108 m^3/s) daily flow.

As indicated on Drawing No. 89-16-2, the flood level (allowance for hydraulic and hydrologic uncertainties included) for Alta Lake is 640.5 metres. The flood level of 640.0 metres previously used for administrative purposes by the Ministry was based on an assumed freeboard of 1.4 metres above a high winter (1965 to 1968) recorded level (Appendix 1.7).

The results of the 1990 Ministry profile studies were compared to a previous analysis of the area dated February 21, 1989 by Hay and Company. The consultant study was undertaken to determine the impact on flood levels of a proposed subdivision located near Alta Lake adjacent to Alta Creek. Analysis of these results in May, 1989 (Appendix 1.7) concluded that the flood level of Alta Lake should be a minimum of 640.3 metres pending the result of this floodplain mapping study. The maximum unofficially observed level (52-year period) was 639.4 metres as discussed in Section 5.2.

5.4 Millar Creek

A total of 32 cross sections were obtained along Millar Creek between the Cheakamus River confluence area and Alpha Lake, a distance of 3.3 km. In this reach, there are 2 railway bridges, and 3 road bridges. The watercourse is culverted under Highway 99, in the Industrial Park area and at Alta Lake Road near the outlet of Alpha Lake (see Photos 15, 16 and 18, Appendix 2). The culverts restrict flood flows causing an overtopping of these roads during a 1:200 year flood event.

The slope of Millar Creek varies from 0.23% in the 2 km immediately upstream of Highway 99 to 0.66% in the 0.9 km reach immediately downstream of the culverts at the

outlet of Alpha Lake. Drawing No. 89-16-1 indicates the flood levels determined for Millar Creek in this reach.

An additional 11 cross sections were obtained along Millar Creek in the 0.46 km reach between Alpha and Nita Lakes. The maximum slope is 1.9% for a distance of 0.24 km in this area. There are 3 minor road or foot bridges in this reach, one of which has been abandoned. Photos 19 and 20 are views of Nita Lake (Appendix 2).

In the Industrial Park area, located along Millar Creek Road, upstream of Highway 99, landfill has been placed in the floodplain. The fill is generally set back from the creek channel in accordance with local Bylaw requirements. A debris rack upstream of Highway 99 (Photo 15, Appendix 2) is designed to reduce blockage problems at the culvert under the highway.

Photo 17 (Appendix 2) indicates the Millar Creek floodplain which is undeveloped in the area between the Industrial Park and Alpha Lake. There is a relatively large number of residential developments around Alpha Lake and future expansion of this floodplain area is anticipated. Flooding problems associated with bridge and culvert blockages in the Whistler area have been documented (Appendix 4). This experience suggests that the suitability of the existing culvert under Alta Lake Road near the outlet of Alpha Lake should be reviewed taking into account the residential development noted above.

6. FLOODPLAIN MAPPING

6.1 General

The flood levels determined in the study were used to delineate the floodplain limits onto the existing 2 metre contour mapping of the study area. The floodplain mapping for the Resort Municipality of Whistler, Drawing No. 89-16, Sheets 1 to 4, indicates the location of river cross sections and survey monuments, the floodplain limits and the flood levels determined in the study.

6.2 Tributary Alluvial Fans

Several of the tributary alluvial fans in the study area are known to be active based on documented information on flooding problems related to sediment deposition, channel avulsion and bank erosion.

The August 29/30, 1991 flood on Fitzsimmons Creek resulted in damage to five bridges. A major cleanup operation involved the removal of 128,000 m^3 of gravel and about 1,000 trees within the floodplain. The removal of debris and gravel, the installation of rock riprap, bridge reconstruction and restoration of essential services plus parkland damages total approximately $3.7 million (Appendix 1.16).

As indicated in Section 2, the Resort Municipality is involved in the Fitzsimmons Creek Management Plan. Several engineering reports have recently been prepared in connection with Fitzsimmons Creek. A paper by Russell deals with long-term management concerns for the creek (Appendices 1.8 to 1.11).

A report by Thurber Consultants Ltd., dated January, 1987 (Appendix 1.18), outlines the possible geotechnical and hydrologic hazards which would affect the future developments

of the area surrounding the existing gondola base located on the Whistler Creek alluvial fan. Flooding problems related to Whistler Creek and Nineteen Mile Creek during the December 1980 flood are documented in Appendix 4.

Following is a list of alluvial fans noted on the mapping sheets which are known to be active.

Fan Area	Drawing No. 89-16
Whistler Creek	Sheet 1
Fitzsimmons Creek	Sheets 2 and 3
Twentyone Mile Creek	Sheets 2 and 3
Nineteen Mile Creek	Sheet 4

The approximate limits of the Whistler Creek and Fitzsimmons Creek alluvial fans have been delineated based on the background information noted above, a review of topographic data and site visits. The limits of Twentyone Mile and Nineteen Mile Creek fans have not be delineated as sufficient background study information was not available.

As noted on the floodplain mapping sheets, the entire area of the tributary fans is subject to special flood hazards due to avulsion and erosion caused by channel accretion and/or debris jamming.

7. CONCLUSIONS

1. This design brief presents an overview of the studies undertaken to produce the floodplain mapping sheets for the Whistler area, extending from the outlet of Green Lake in the north to the confluence of Millar Creek and the Cheakamus River in the south, a distance of approximately 14 kilometres.

2. The floodplain mapping is deemed to be preliminary as it is based on 2 metre contour intervals within the floodplain areas of all watercourses. In addition, the existing contour mapping is not adequate to define the limits of the tributary alluvial fans in the study area.

3. Drawing No. 89-16 Sheets 1 to 4 replace "Whistler Area Flood Levels," Drawing No. 84-40-1 dated July 1984 and "Fitzsimmons Creek Floodplain Mapping," Drawing No. A5175 Sheets 1 to 3 dated October 1978.

4. The adequacy of existing culverts or bridges should be reviewed taking into account the effect of blockages on upstream flood levels in developed areas such as Alpha Lake.

5. Documentation of flooding problems and geotechnical studies should be undertaken to define the limits of the tributary alluvial fans in the study area and the results shown on future revisions to the existing floodplain mapping of the Whistler area.

6. The Resort Municipality of Whistler and the Hydrology Section of the Ministry of Environment, Lands and Parks should actively seek the cooperation of Water Survey of Canada in the establishment of hydrometric gauging stations in the Whistler area.

8. RECOMMENDATIONS

1. It is recommended that the floodplains delineated on Drawing No. 89-16, Sheets 1 to 4, be Interim Designated under the terms of the Federal Provincial Floodplain Mapping Agreement.

2. The Drawings may be used for administrative purposes related to the preparation of hazard map schedules for official plans; floodproofing requirements in zoning and building bylaws; and the identification of floodable lands by Subdivision Approving Officers.

R.W. Nichols

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Flood Hazard Identification

RWN:khh



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING
WHISTLER AREA
STUDY AREA LOCATION

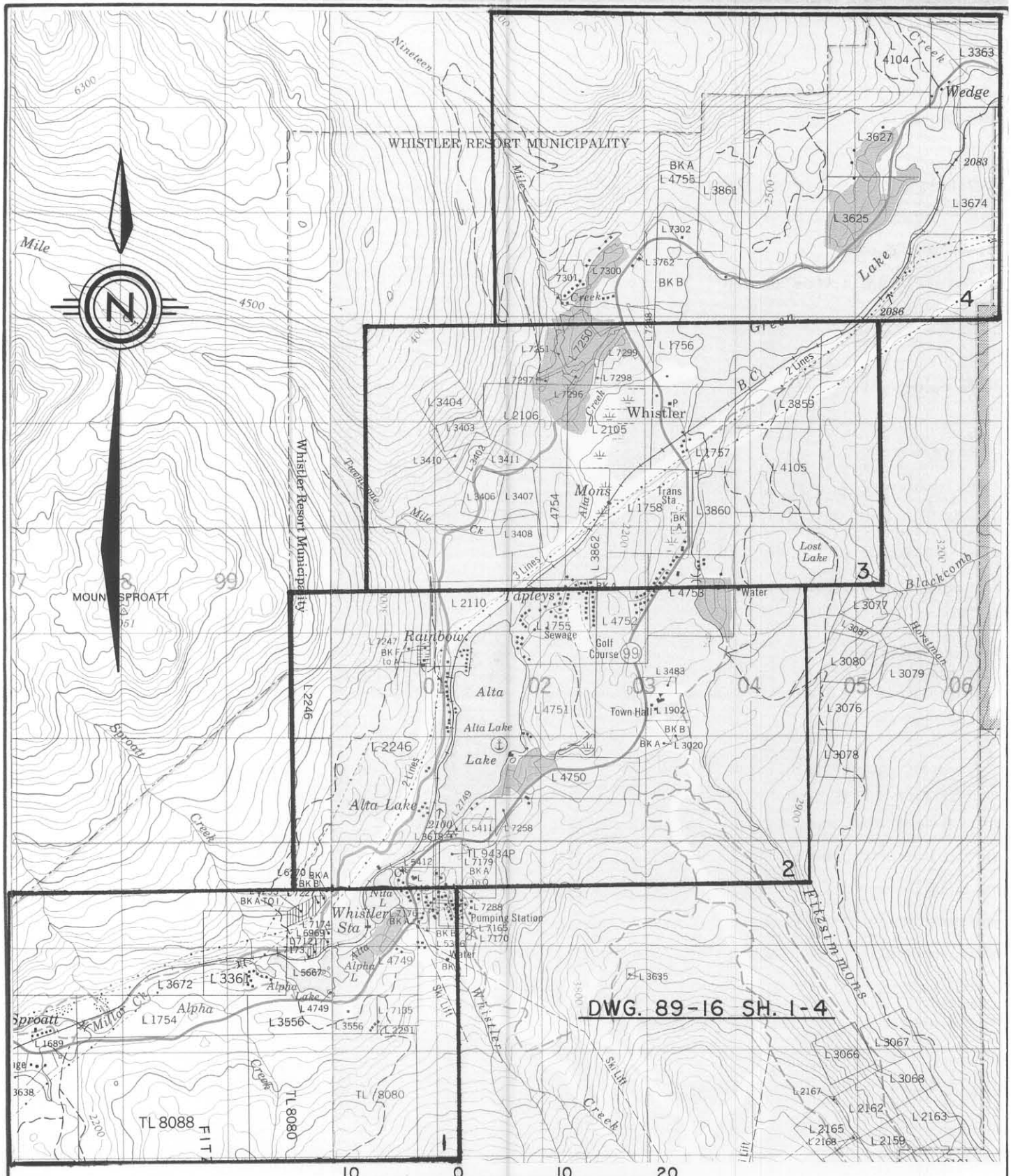
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DATE
NOV. 1990

R.W. NICHOLS ENGINEER

FILE No. 01-4300 S.1 DWG No. FIGURE 1

BCIL 7673-M E



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY A DESIGN BRIEF ON THE

FLOODPLAIN MAPPING
WHISTLER AREA
KEY PLAN

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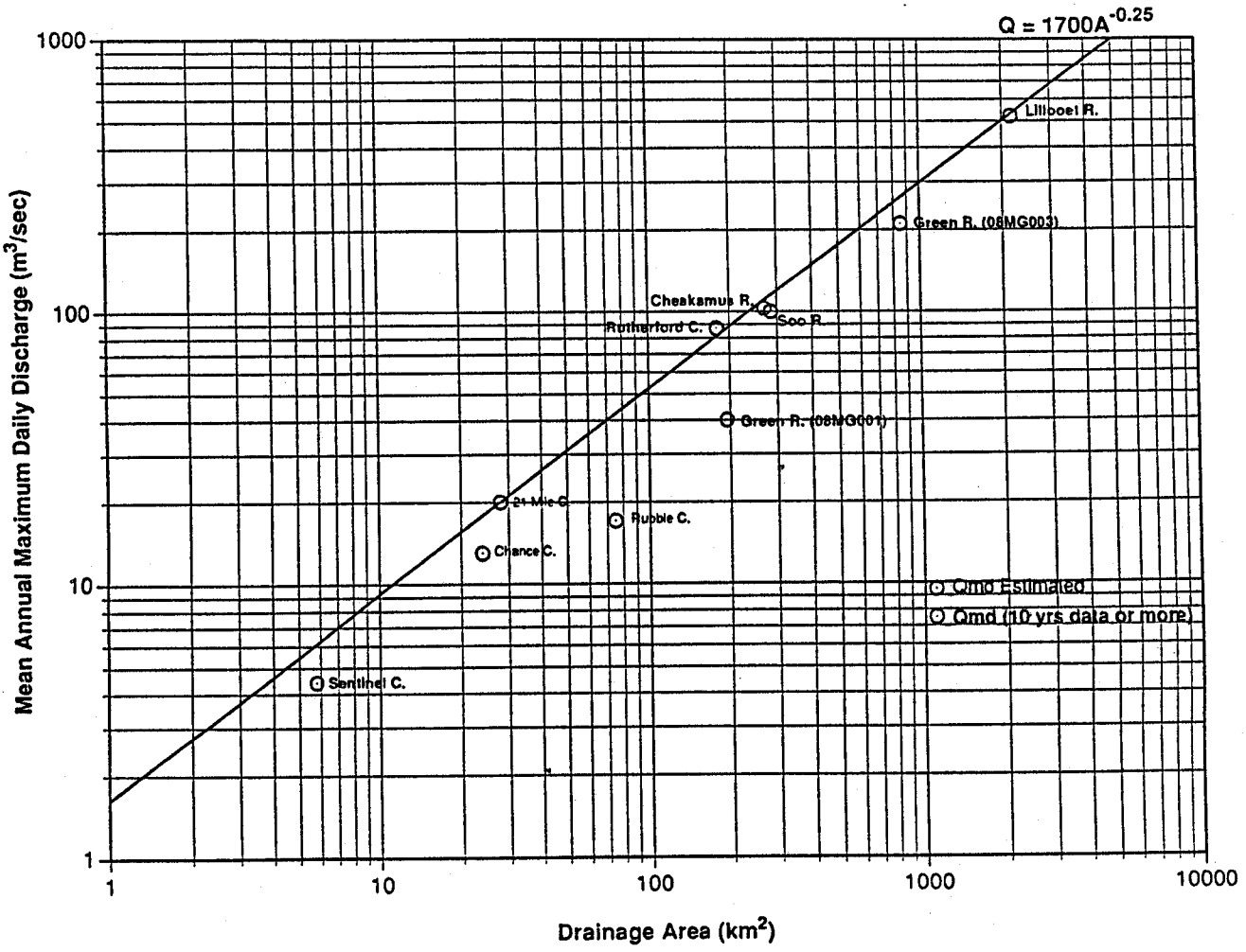
DATE NOV. 1990

R.W. NICHOLS ENGINEER

FILE No. 01-4300 S.1 DWG No. FIGURE 2

VAN CAL 15712

MEAN ANNUAL MAXIMUM DAILY DISCHARGE (MAMDD)
VS.
DRAINAGE AREA (1)



(1) Reference Appendix 1.6

Province of British Columbia Ministry of Environment WATER MANAGEMENT BRANCH		TO ACCOMPANY REPORT ON FLOODPLAIN MAPPING WHISTLER AREA
SCALE: VERT. HOR.	DATE MARCH, 1992	D.E. REKSTEN ENGINEER FILE No. 01-4300-S.1 DWG. No. FIGURE 3

VAN CAL 15712

APPENDIX 1

Detailed Information Sources

No.	Source	Contents
1.	File: 0305030-16 A, Volumes 1-6, Feb. 1975 to March, 1984.	Correspondence files related to the Flood Damage Reduction Program in the Whistler area.
2.	Flood Control Bylaw No. 380, District of Whistler, adopted September 17, 1984.	An amendment of Bylaw 303-1983 outlining building setback and elevation requirements in the District.
3.	Project No. 88-FDC-2, field survey carried out in the Whistler area during May 9-29, 1988.	90 cross sections of watercourses in the Whistler area including 4 water surface profiles, 4 road profiles and 1 railway profile; bridge and culvert details and photos.
4.	Project No. 84-FDC-2, field survey carried out on the Green River on May 2, 1984.	6 cross sections of the Green River near the outlet of Green Lake including photographs at each cross section.
5.	Map Production Division, Surveys and Resource Mapping Branch, Project No. 83-127	Base mapping of the Whistler area (1:5000 scale, 2 metre contours from August 1983 air photos - completed in June, 1984).
6.	"Whistler Area Peak Flows," Study 293, September 28, 1989, File S2105, Hydrology Section, Water Management Branch, Ministry of Environment.	Results of a hydrology study to determine peak flows at a number of locations within the Whistler area.
7.	"Alta Lake Flood Construction Level," File: RZ-26-3-85-7, May 4, 1989, M.V. Currie, P.Eng.	Analysis of available information by M.V. Currie concluded that Alta Lake flood level for the interim would be 640.3 metres.
8	"White Gold Estates," April 1989, SEL 5572, Report by Sigma Engineering Ltd.	A preliminary design report for White Gold Estates flood protection for the Ministry of Environment.
9.	"Fitzsimmons Creek Training Wall Alignment and Floodplain Assessment," January, 1989, SEL 5542, report by Sigma Engineering Ltd.	An assessment of the affects of a proposed extension and realignment of the Fitzsimmons Creek training berm.
10.	"An Example of Creek Management in British Columbia," by S.O. Denis Russell, Dept. of Civil Engineers in B.C.	A paper presented at the 43rd Annual Conference of the CWRA, May, 1990.

APPENDIX 1
(cont'd)
Detailed Information Sources

No.	Source	Contents
11.	"Resort Municipality of Whistler - Preliminary Design - Proposed Stream Training Works - Fitzsimmons Creek," Water Managment Branch, File P77-9, March, 1985.	Background information related to the training works proposed for Fitzsimmons Creek.
12.	"Whistler-Pemberton High Water Marks," Project No. 9129F022, September, 1991, T. Dignan, Technical Support Section, Water Management Division, Ministry of Environment, Lands and Parks.	Survey of maximum lake levels in Whistler area as a result of the August 30, 1991 flood event.
13.	"Flood Discharge Magnitudes in Fitzsimmons Creek and Green River, Whistler, British Columbia," Ward and Associates Ltd., February 10, 1992	Computations are made of the magnitude of likely 100-year peak flows based on the November 1990 and August 1991 Whistler area floods.
14.	Memo to R. Nichols from B. MacFayden, December 20, 1991, File: 01-4300-S.1, documenting discussions with local residents concerning Green Lake flood levels.	Background information on unofficial observations of Green Lake flood levels.
15.	Memo to Mr. D. Reksten, P.Eng., from Dr. P.R.B. Ward, P.Eng., November 15, 1991.	Contents of first draft report on Fitzsimmons Creek and Green River Flood Discharges provided for comments by Ministry Staff.
16.	"The 50-year Flood in Fitzsimmons Creek, Whistler, British Columbia," P.R.B. Ward and N.A. Skermer.	A paper presented at a Geotechnique and Natural Hazards Symposium, sponsored by the Vancouver Geotechnical Society and the Canadian Geotechnical Society, May 6-9, 1992.
17.	"Green Lake Flood Level and Outflow Estimates,", memorandum to C.H. Coulson from D.E. Reksten, May 19, 1992.	A review of the February 1992 report by P. Ward and Associates and recommended Green Lake flood levels.
18.	"Geotechnical Hazards Assessment Whistler Creek," Thurber Consultants Ltd, Vancouver, BC., January, 1987.	A study to outline possible geotechnical and hydrolgic hazards on the alluvial fan of Whistler Creek.

Index to Photos



Photo 1

Fitzsimmons Creek

View looking north along existing retaining wall just upstream of ski lift (See Dwg. 89-16-2) "Village Centre" on left of photo. "Blackcomb Way" on right of photo.

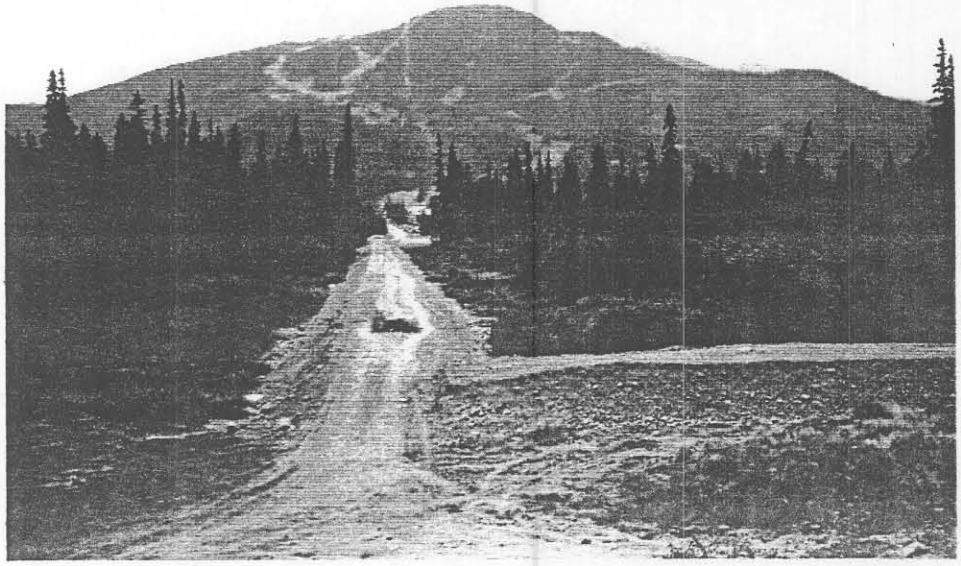


Photo 2

Fitzsimmons Creek

View looking south along training wall extension which is under construction. Photo taken from vicinity of "Nancy Greene Drive" near "White Gold" area (Dwg. 89-16-3).

*Note: All photos taken on August 14-15, 1990 except November 1989 flood photos which were provided by staff of the Municipality of Whistler.

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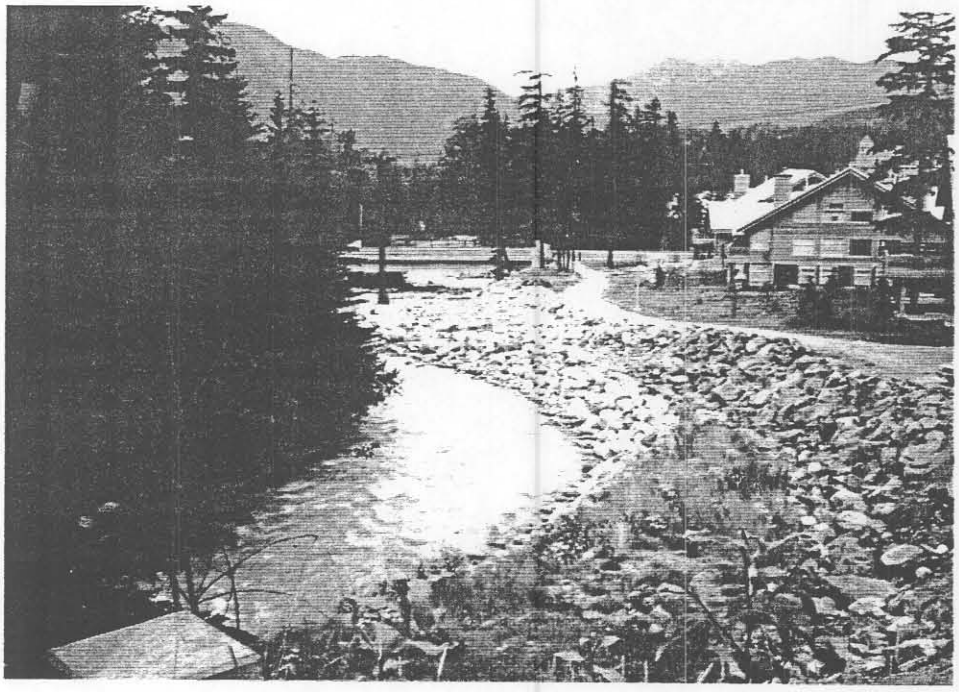


Photo 3

Fitzsimmons Creek

View looking north (downstream) along Fitzsimmons Creek with "Blackcomb Way" bridge in background (Dwg. 89-16-2).

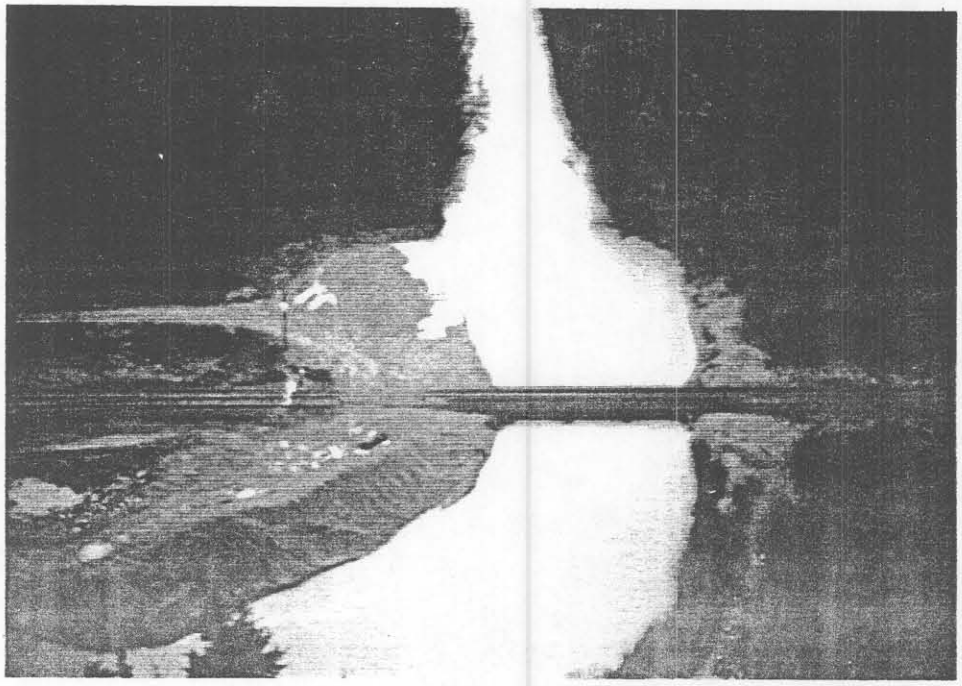


Photo 4

Fitzsimmons Creek (November 1989 flood)

View looking north at B.C.R. crossing just upstream of Green Lake (Dwg. 89-16-3).

Index to Photos



Photo 5

Green River

View looking south (upstream) from near Highway 99 at first bend in river downstream of Green Lake (Dwg. 89-16-4).

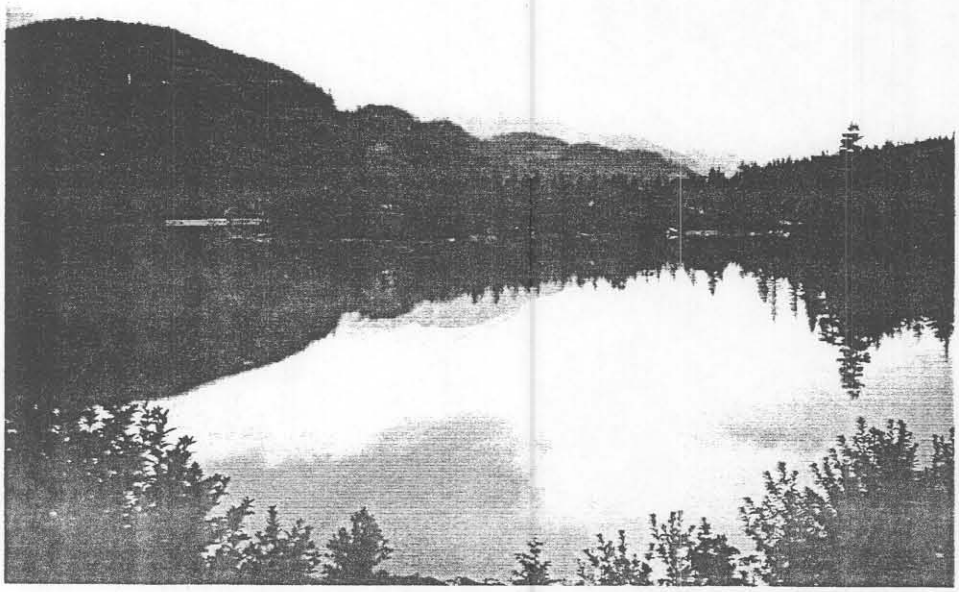


Photo 6

Green Lake

View looking south from Highway 99 towards Lakeshore Drive near Emerald Park (Dwg. 89-16-4).

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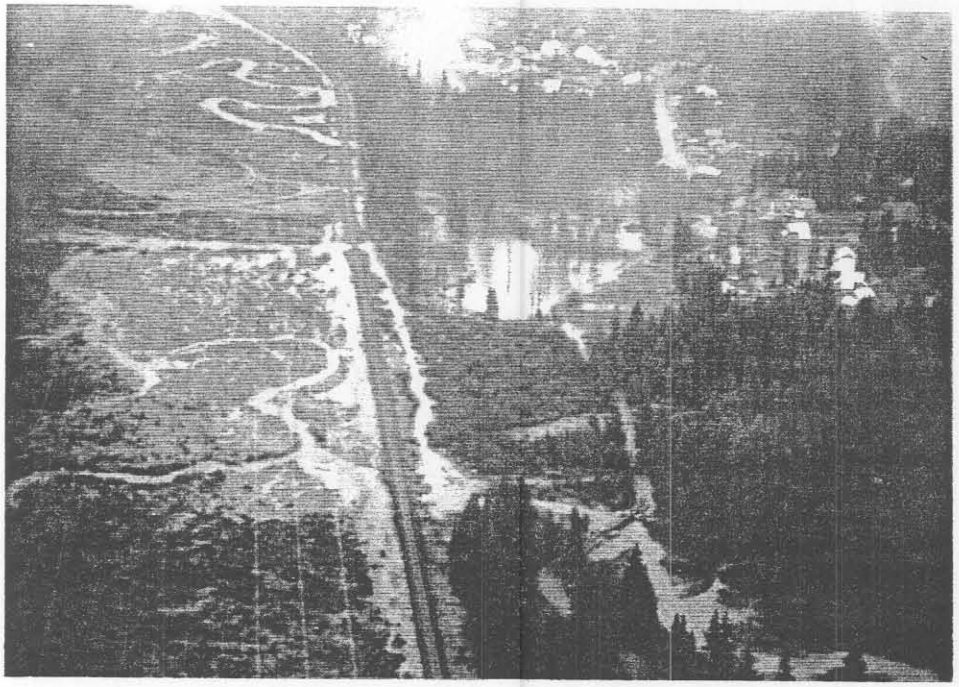


Photo 7

Alta and 21 Mile Creeks (November 1989 flood)

Looking north along B.C.R. with 21 Mile Creek fan in lower left; confluence of creeks at B.C.R. crossing in centre of photo; and Alta Creek upstream of confluence in lower right of photo (Dwg. 89-16-2 and 3).

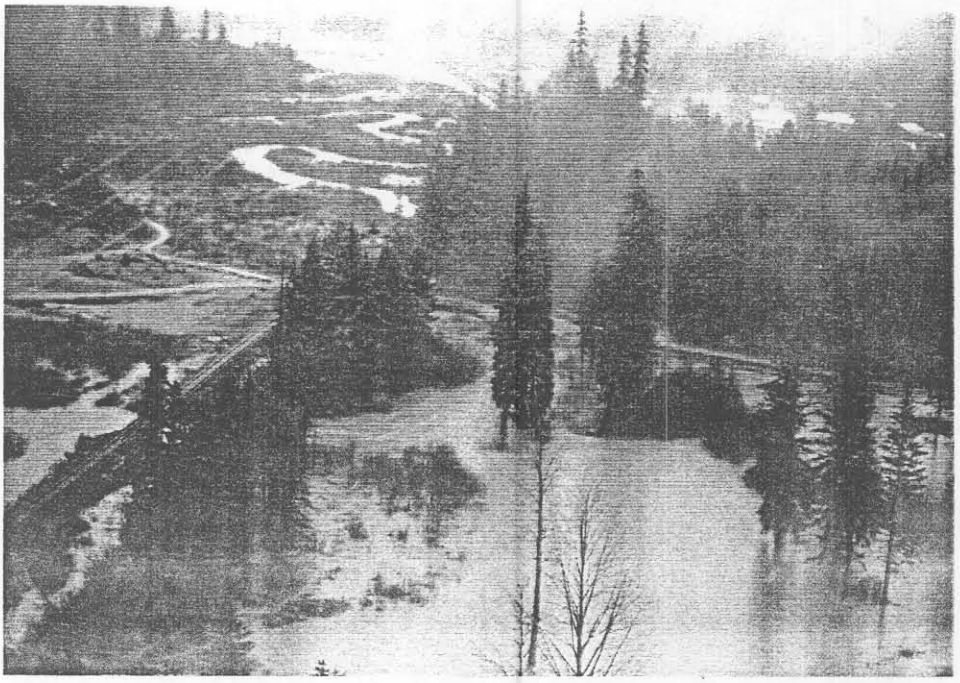


Photo 8

Alta and 21 Mile Creeks (November 1989 flood)

Closeup view of confluence area. B.C.R. on left of photo; "Valley Trail" on centre right of photo (Dwg. 89-16-3).

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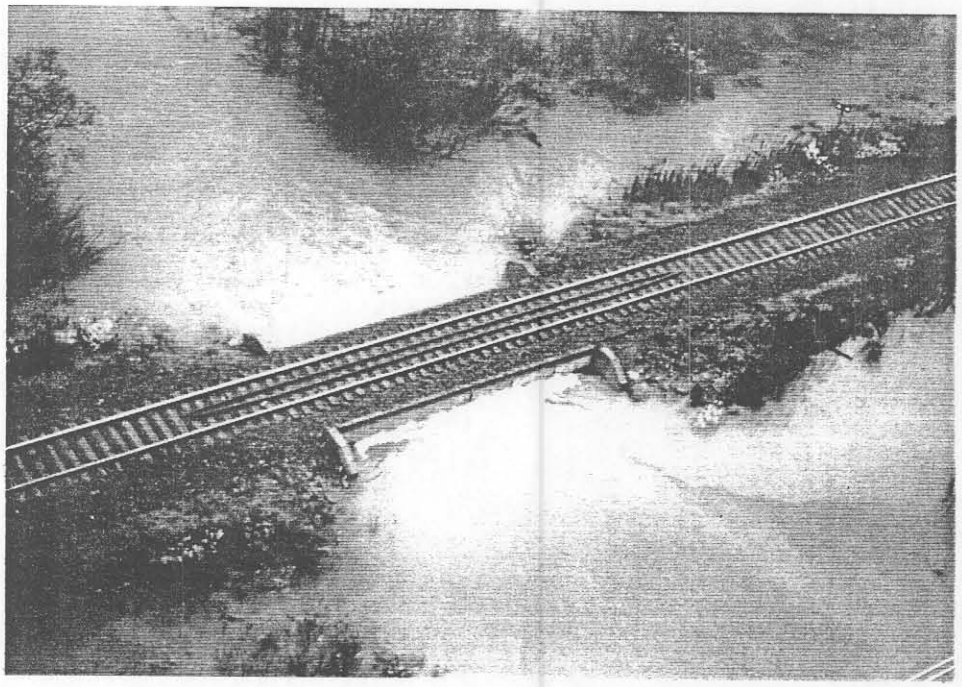


Photo 9

Alta and 21 Mile Creeks (November 1989 flood)

Photo looking east at B.C.R. bridge at confluence area, which is in upper part of photo. 21 Mile Creek is in lower part of photo (Dwg. 89-16-3).



Photo 10

Alta Creek (November 1989 flood)

Area just downstream of Photo 9 showing "Valley Trail" bridge and abandoned older bridge on right of photo (Dwg. 89-16-3).

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Photo 11

Alta Creek Floodplain (November 1989 flood)

Red roofed home can be seen in Photo 7. Small creek causing local flooding drains the adjacent golfcourse. Lower half of photo (approximately) is within the Alta Creek floodplain (Dwg. 89-16-3).



Photo 12

Alta Creek Floodplain

Floodproofed home shown in photo is also in Photo 11. "Whistler Cay" area (Dwg. 89-16-3).

Appendix 2

Index to Photos

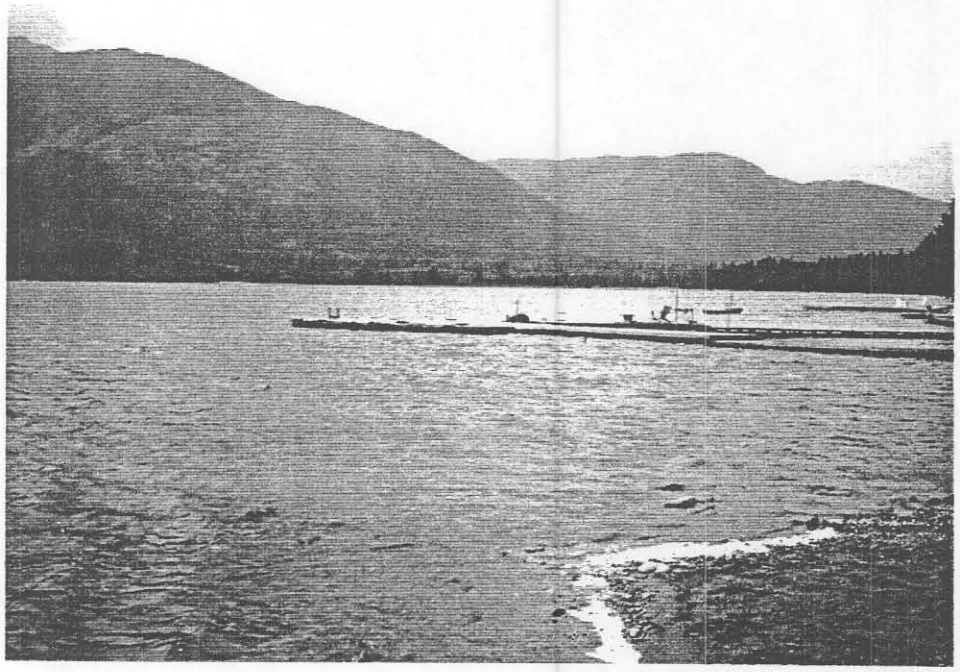


Photo 13

Alta Lake

From Lakeside Park looking north towards the lake outlet (Dwg. 89-16-2).



Photo 14

Alta Lake Area

View of paved "Valley Trail" in upper portion of Alta Lake drainage area (Dwg. 89-16-7).

Index to Photos

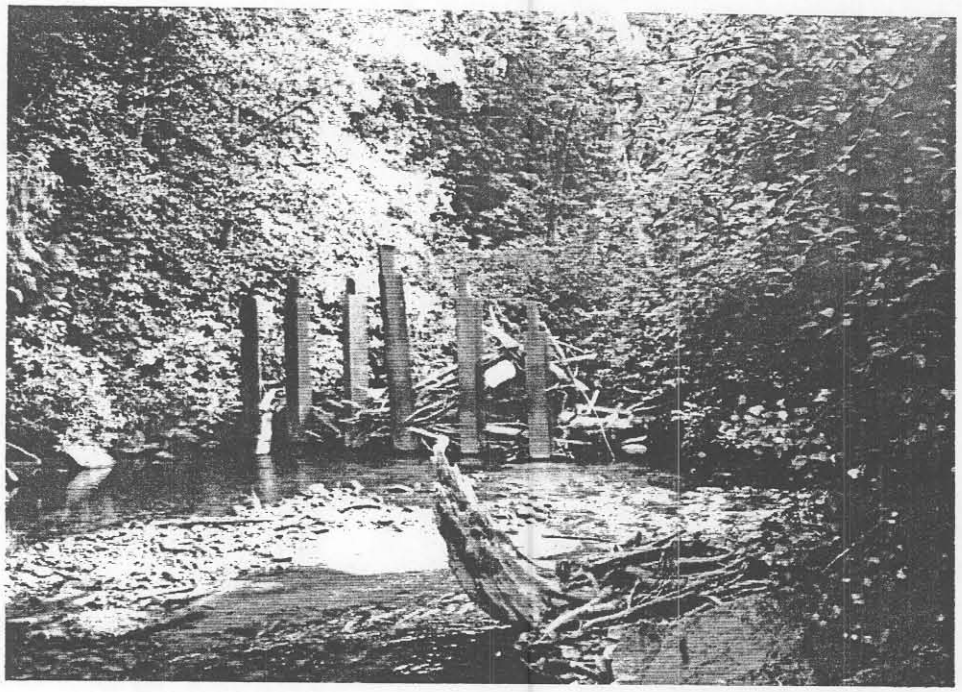


Photo 15

Millar Creek

Debris rack looking upstream of Highway 99 crossing, Industrial Park area (Dwg. 89-16-1).

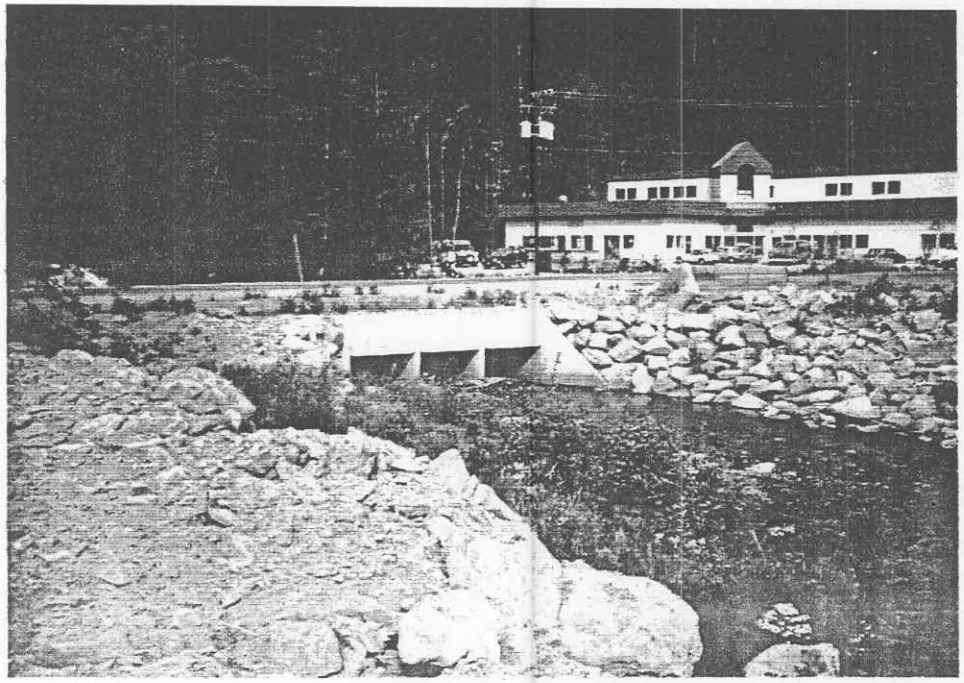


Photo 16

Millar Creek

Concrete bridge over creek in Industrial Park area near Cross Section 10 (Dwg. 89-16-1). Note fill in floodplain area in foreground of picture.

Index to Photos

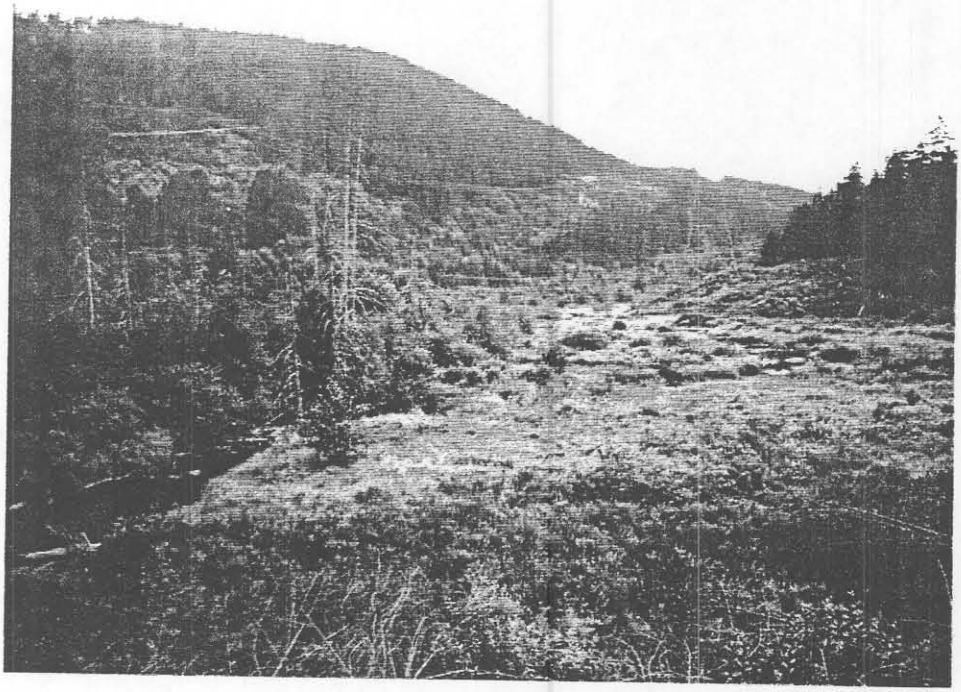


Photo 17

Millar Creek

Floodplain between Industrial Park and Alpha Lake.

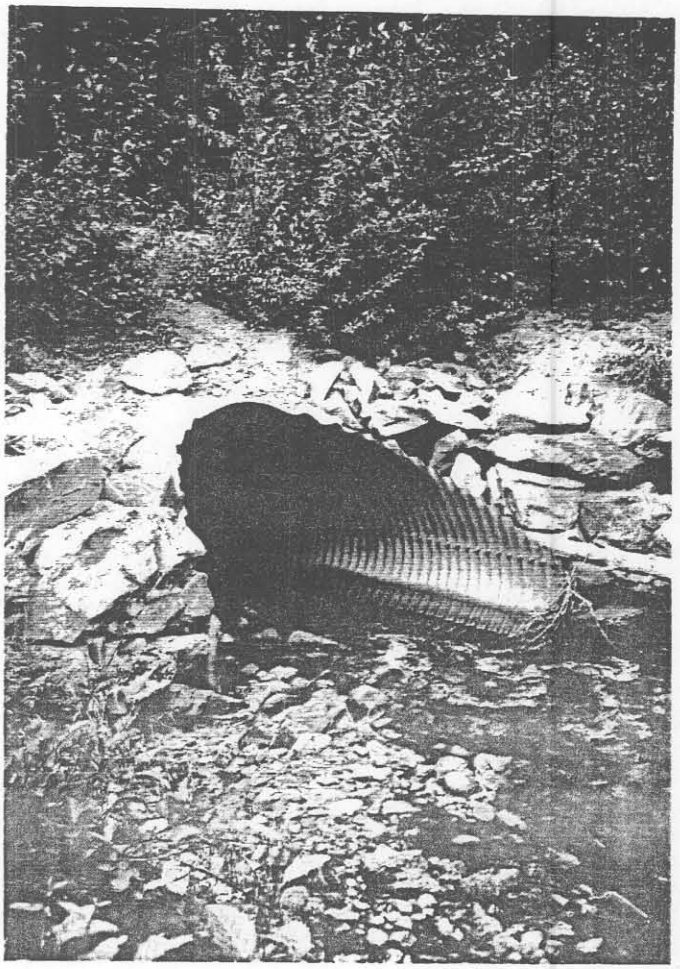


Photo 18

Millar Creek

Culvert across creek on Alta Lake Road at outlet of Alpha Lake.

Appendix 2

Index to Photos

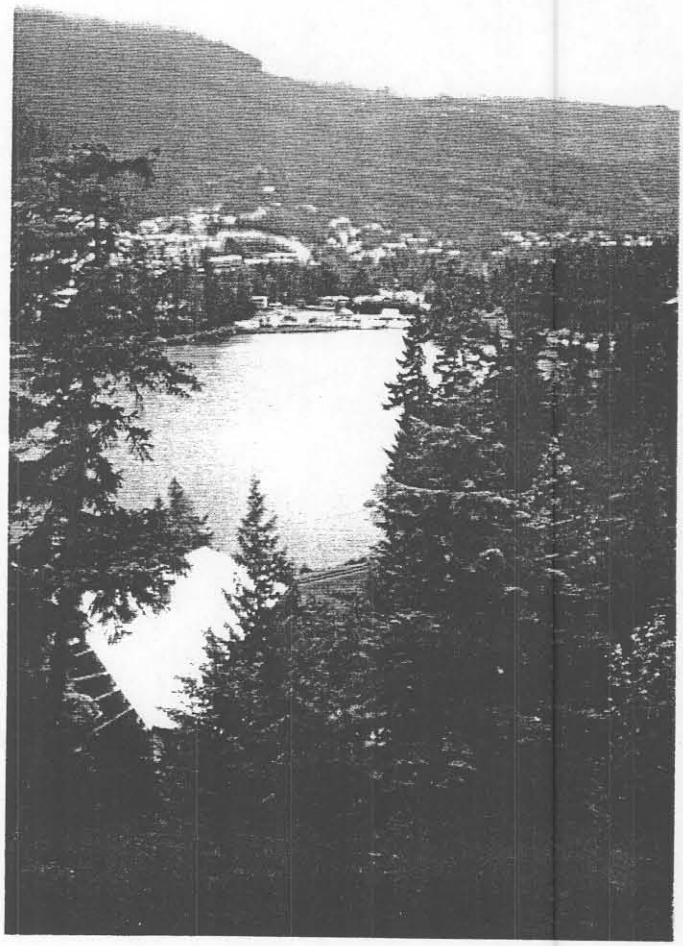


Photo 19

Nita Lake

View looking south from Alta Lake Road towards lake outlet, "Whistler Centre" area (Dwg. 86-16-1).

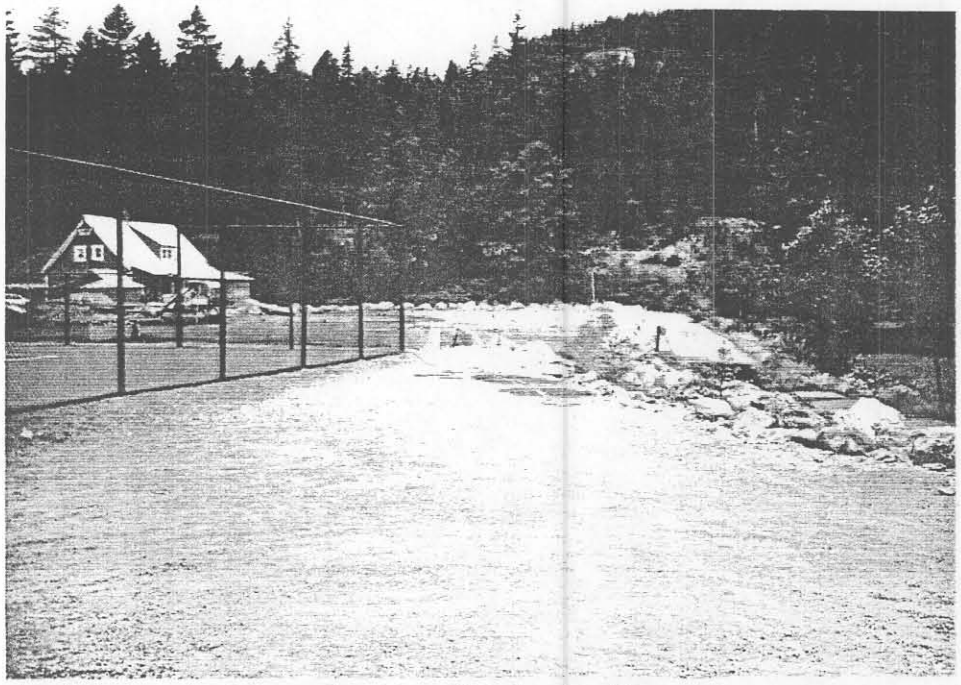
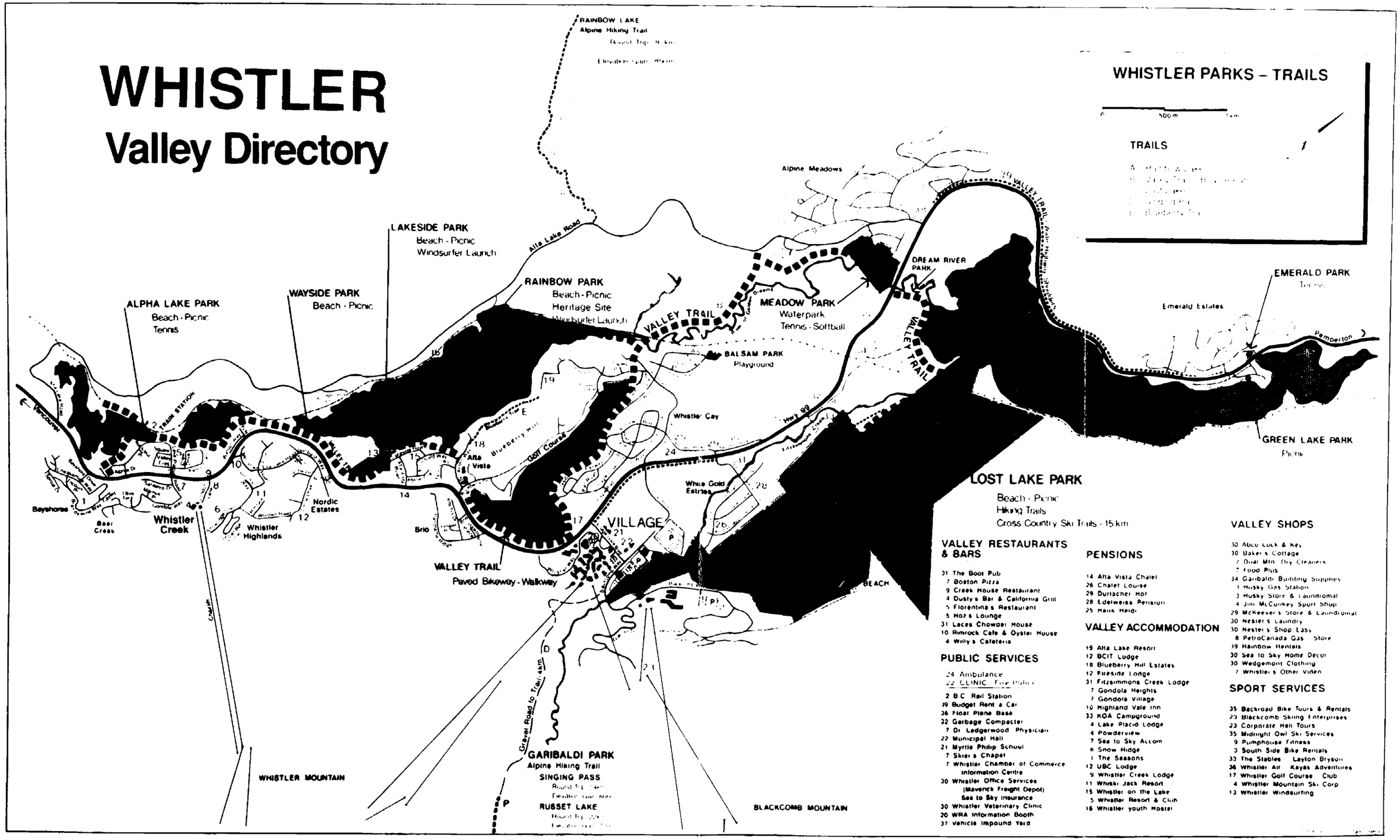


Photo 20

Nita Lake Outlet

View showing fill placed at lake outlet. Paved"Valley Trail" on right of photo.

WHISTLER
Valley Directory



VALLEY RESTAURANTS & BARS

31 The Boot Pub
7 Boston Pizza
9 Creek House Restaurant
4 Dusty's Bar & California Grill
5 Fiorentina's Restaurant
5 Hoz & Lounge
31 Laces Chowder House
10 Rimrock Cafe & Oyster House
4 Willy's Cafeteria

PUBLIC SERVICES

24 Ambulance
22 CLINIC Fire Police
2 B C Rail Station
39 Budget Rent a Car
36 Float Plane Base
32 Garbage Compactor
7 Dr Ledgerwood Physician
22 Municipal Hall
21 Myrtle Philip School
7 Skier's Chapel
7 Whistler Chamber of Commerce Information Centre
30 Whistler Office Services (Maverick Freight Depot)
Sea to Sky Insurance
30 Whistler Veterinary Clinic
20 WRA Information Booth
37 Vehicle Impound Yard

PENSIONS

14 Alta Vista Chalet
26 Chalet Louise
29 Durlacher Hof
28 Edelweiss Pension
25 Haus Heidi

VALLEY ACCOMMODATION

19 Alta Lake Resort
12 BCIT Lodge
18 Blueberry Hill Estates
12 Fireside Lodge
31 Fitzsimmons Creek Lodge
7 Gondola Heights
7 Gondola Village
10 Highland Vale Inn
33 KOA Campground
4 Lake Placid Lodge
4 Powderview
7 Sea to Sky Accom
6 Snow Ridge
1 The Seasons
12 UBC Lodge
9 Whistler Creek Lodge
11 Whistler Jack Resort
15 Whistler on the Lake
5 Whistler Resort & Club
16 Whistler youth Hostel

VALLEY SHOPS

30 Abco Lock & Key
30 Baker's Cottage
7 Dial Mtn Dry Cleaners
7 Food Plus
34 Garibaldi Building Supplies
1 Husky Gas Station
3 Husky Store & Laundromat
4 Jim McConkey Sport Shop
29 McKeever's Store & Laundromat
30 Nester's Laundry
30 Nester's Shop Easy
8 PetroCanada Gas Store
19 Rainbow Rentals
30 Sea to Sky Home Decor
30 Wedgemont Clothing
7 Whistler's Other Video

SPORT SERVICES

35 Backroad Bike Tours & Rentals
23 Blackcomb Skiing Enterprises
23 Corporate Heli Tours
35 Midnight Owl Ski Services
9 Pumphouse Fitness
3 South Side Bike Rentals
33 The Stables Layton Bryson
36 Whistler Air Kayak Adventures
17 Whistler Golf Course Club
4 Whistler Mountain Ski Corp
13 Whistler Windsurfing

APPENDIX 4

Newspaper Article and Photos of

December 1980 Flood

From

"The Whistler Question," January 8, 1981, Volume 6

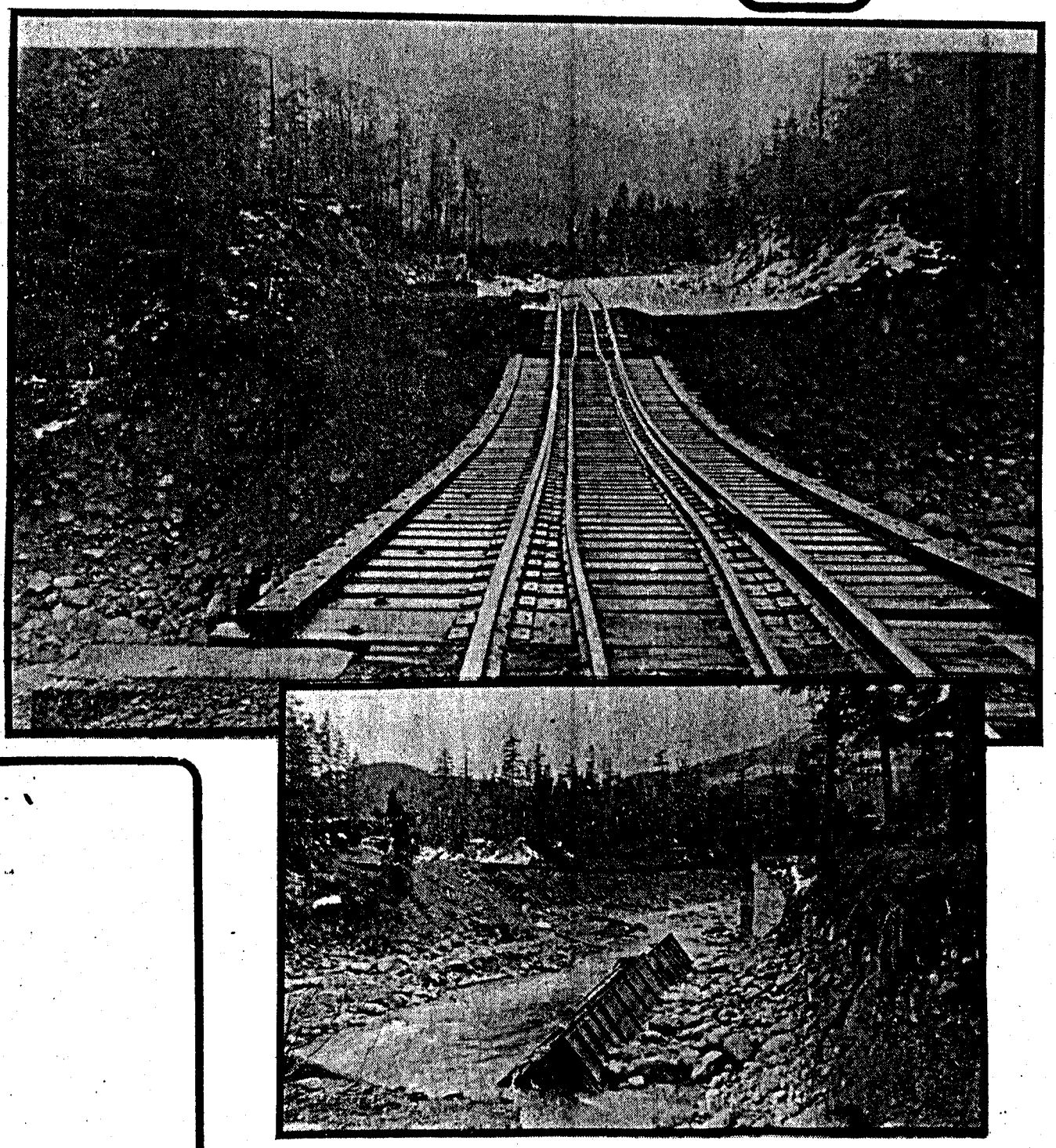
(Courtesy of "Whistler Museum and Archives Society"
1011 Highway 99, Box 1122, Whistler, B.C.)

THE Whistler Question

WHISTLER'S LOCAL WEEKLY NEWSPAPER 932-5131

.25

VOL. 6 ISSUE 1 JANUARY 8, 1981



BCR Rutherford Creek crossing hangs by its rails after December 26 flood washed away all supports and girders (see inset) downstream.

econd class mail Reg. No. 3748
ostage Paid at Whistler, B.C. V0N 1B0

THE Whistler Question
WHISTLER'S LOCAL WEEKLY NEWSPAPER

VOL. 6 ISSUE 1 JANUARY 8, 1981

THINK SNOW -- WHAT ELSE!

Heavy rains flood valley

Water, water everywhere!

The continual rain that started falling on the west coast of British Columbia on Wednesday, December 24, had, by noon Friday, turned into a veritable deluge that has since been referred to as a '50 year flood'.

Portions of the Fraser Valley near the mountains at Hope, and from Squamish to D'Arcy, were the area hardest hit by the rainstorm and subsequent flooding.

Not only did it rain, but the temperatures rose to the point where the freezing level was at the 8000 foot level on the mountains and almost all of the early winter snows melted and came tumbling down the mountainsides, briging gravel, logs and debris with it.

By Friday evening the communities of Whistler and Pemberton were cut off from the outside world with no rail or highway access for days.

Hardest hit in the Whistler area was the Alpine Meadows region, which was itself isolated for a time, as well as being without water.

The culprit in this case was 19 Mile Creek, which, swollen to capacity by the rain, broke through its banks about 200 m. upstream from the highway and flooded the 'gravel pit' at the entrance. This lake then overflowed across the entrance road, cutting off the subdivision and spewing large chunks of ice and debris onto the highway which was in danger of being washed away. Highways crews eventually cut through the highway by the entrance to allow the flood waters to spill into Green Lake.

Meanwhile the bridge across 19 Mile Creek on Valley Drive was washed out, taking with it the main water supply to the northern part of the subdivision. This has since been restored on a temporary basis.

The water also washed away the fill surrounding a new house on the river bank, leaving it standing on the edge of a cliff. Other properties backing onto the creek also suffered erosion damage and one sauna was washed away.

And this wasn't the only trouble spot – a log and ice jam at the mouth of the Green River caused the water level on Green Lake to rise almost 8 feet and some waterfront homes were flooded. Mayor Pat Carleton, who with many others, was stranded in Vancouver, flew up to Whistler by helicopter on Saturday to inspect the damage and, if necessary, to order the removal of this log jamby blasting. Fortunately this was not necessary.

Prompt action by the lift company crews at Whistler prevented serious flooding there. The volume of water in Whistler Creek forced the removal of the skiers bridge at the bottom of Franz's run as well as the culvert between the upper and lower parking lots.

Lower down Whistler creek the stream overflowed its banks and went across Karen Crescent and flooded the crawl space in at least two multiple dwelling units. In this case, the municipality arranged to have the stream deepened and a small dyke built.

But everywhere it was the bridges that suffered the most. In many cases the water volume was not the culprit, but rather the logs, ice and boulders that were being carried down by the floods.

In the Whistler area bridges rendered impassable by the flood included several logging bridges across the Cheakamus to the south, the bridges over Blackcomb Creek and Fitzsimmons Creek just south of White Gold Estates, the bridge on Valley Drive, the bridge to the Wedge Creek gravel pit, etc., etc.

Mayor Pat Carleton, in an interview on January 5, reported that other damage that would have to be repaired included damage to the water systems, the sewer lines (between Tamarisk and the Industrial Park Miller Creek washed the road and sewer line fill away), the sewer treatment plant, the day skier parking lots, the Village gas tank farm, the culverts in Brio Estates, and the x-country ski trails which were extensively damaged.

Carleton admitted that the majority of the damage occurred to the roads and highways and estimated this at about $250,000 cost to the Ministry of Highways in the Whistler area alone.

And things were just as bad, or worse, to the north and south.

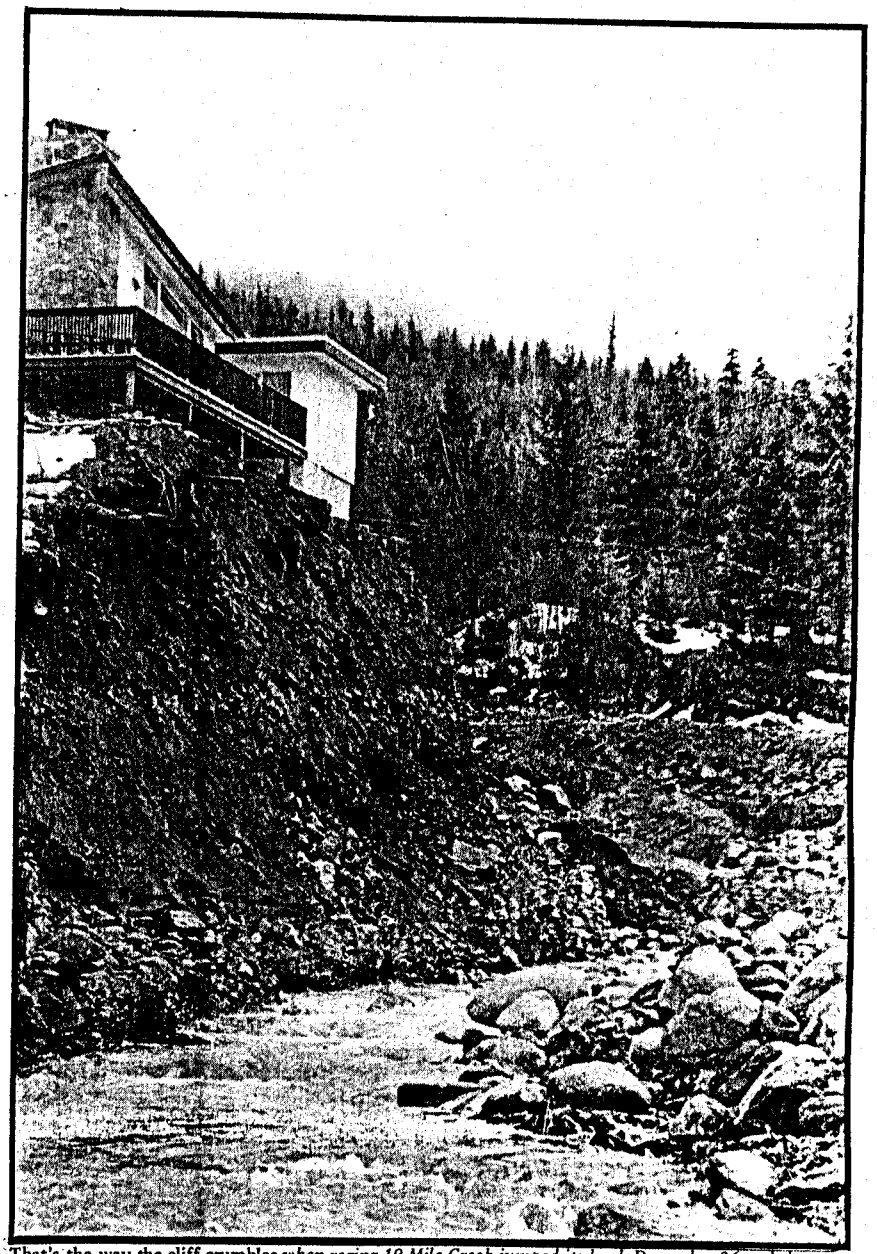
Large areas of the lowlands to the north of Squamish were flooded and had to be evacuated on Saturday, and the main highway was washed out at the base of the Brohm Lake Hill and also at the Culliden Creek crossing about 5km south of the Cheakamus Canyon.

Other sections of the road were flooded but not washed out.

In Garibaldi, the Daisy Lake dam overflow plus the water in Rubble Creek resulted in one house being swept away into the Cheakamus River and another falling into the water. The bridge to Alpine Lodge was undermined and fell into the river, cutting off access to Doug McDonald and family who live on the other side.

To the north, the highway was completely washed away by the Green River just north of the Rutherford Creek junction, as well as being flooded and eroded elsewhere between Whistler and Pemberton. In this same area, just south of the

continued on page 8



That's the way the cliff crumbles *when raging 19 Mile Creek jumped its bank December 26 and threatened to topple a Valley Drive duplex into the Alpine Meadows abyss.*

NOTICE OF SUBSTANTIAL COMPLETION

Parcel 17 — Whistler Village
Seagreen Developments Ltd.
Contract No. 4 — Framing
Lancaster Consturction Co. Ltd.

Notice is hereby given that as of December 15, 1980 the above mentioned project has been substantially completed in accordance with the Mechanics Lien Act.

Nixon & Browning
Management Limited
Construction Managers

NOTICE OF INTENTION TO APPLY FOR A DISPOSITION OF CROWN LAND -

In Land Recording District of New Westminster and situated in the Resort Municipality of Whistler.

Take notice that L.K. Shoup Robinson of Resort Municipality of Whistler, occupation Municipal Clerk intends to apply for a water lot of the following described lands:

(a) Unsurveyed
(b) Commencing at a post planted at the Iron Pin in the North West corner of Lot 12, Block C, Plan 10167, D.L. 4750 (known as 3335 Lakeside Road) thence westerly 45.27 m. (150'); thence northerly 15.24 m. (50'); thence easterly 45.27 m. (150'); thence southerly 15.24 m. (50'); and containing .07 ha more or less.

The purpose for which the disposition is required is public water access to Alta Lake and construction of public wharf.

L. Kristina Shoup Robinson
Municipal Clerk
Resort Municipality of Whistler
Dated December 31st, 1980

At public access

New wharf for Alta Vista slated as municipality applies for water lease

The main public access at Alta Lake in the Alta Vista subdivision has been slated for Municipal improvements sometime this year with Council now moving to obtain a water lot lease of the unsurveyed foreshore from provincial authorities.

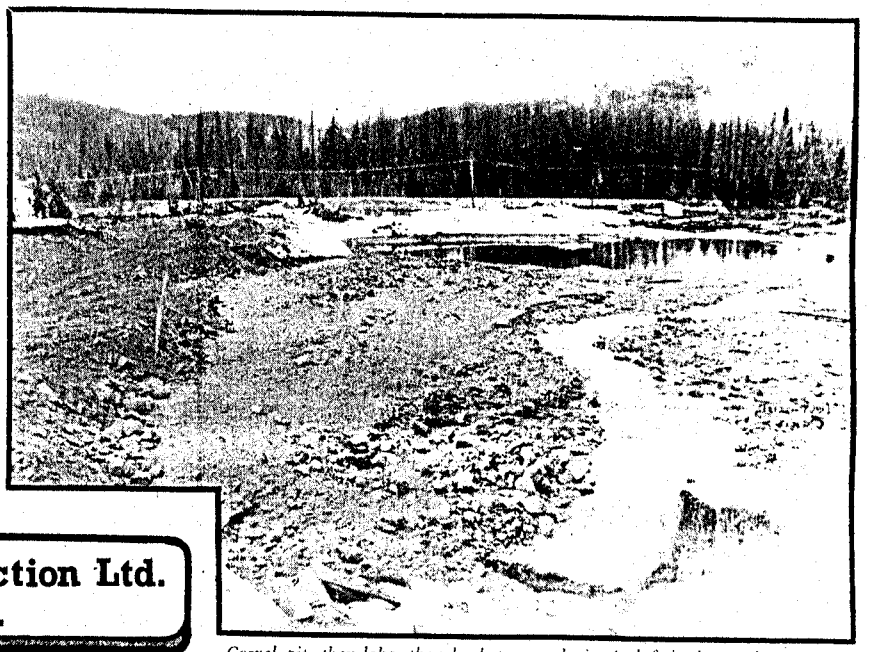
A great number of people use the access in the summer for swimming, boating, windsurfing and aesthetic viewing.

Some concern has been expressed over the possible discharge of sewer into the area during emergency situations and Alderman Sid Young requested a report on the status of sewer flows in the area before any action takes place.

A motion was supported by Council to proceed with the application for the water lease. It was noted that the lease would be covering an area 50' wide and 150' in length to accommodate an adequate wharf.

Nearby, the Alta Lake Inn has applied for a water lot lease to the Ministry of Lands, Parks and Housing and that application came before Council for their referral. It was noted that the Inn also was attempting to acquire an area of land along the foreshore of the lake. The water lot was for boat moorage.

Council gave their approval to the two referrals on the condition that the Municipality be granted a statutory seven metre right-of-way along the foreshore and that the existing buildings not be expanded as they were held to be non-conforming. It was noted that the water lot lease was a formality as the boat moorage already exists.



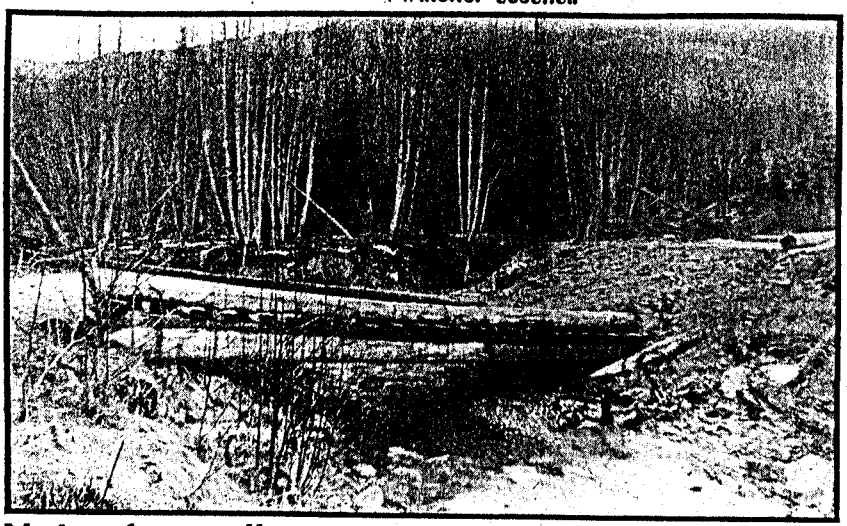
Gravel pit, then lake, then back to gravel pit. At left is the newly rerouted 19 Mile Creek bed as crews repaired flood damage and prepared to return the creek back to its original path.

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Bridge just south of White Gold Estates lies partially repaired following the flooding that occurred in Blackcomb Creek.

Notes from all over

* Congratulations to Ray and Catherine Wiens whose new son, Darrell Jonathan born on January 2 in Squamish was the first child of 1981 in the Squamish Hospital.

* Best wishes for a speedy recovery to Whistler Director of Skiing Services Dave O'Keefe, who broke his leg badly on Sunday, January 4.

* Then there's the story of the hockey goal posts from the school that disappeared last week and were mysteriously returned.

* Congratulations to former Whistler resident and alderman John Hetherington who was elected alderman in the Village of Invermere in the recent election.

* And then there's the story of the enthusiastic young man who spent Tuesday afternoon stapling posters for a local establishment on almost every hydro pole (5 to a pole!) in the valley and also throughout Whistler Village. Tacky show!!

* The T.V. viewing broadens dept. – with the recent affiliation of CHEK Victoria with the CTV network, Whistler will get the benefits of CTV on 7 and CBC on 13. All we have to do now is to get rid of the Frobisher Bay job vacancies and the Eskimo programmes!

Freestyle now in WMSC

Whistler Mountain Ski Club has now expanded their sphere of operation to include Freestyle.

As a result of Freestyle being organized as a division of the CSA, the ski club has appointed Whistler Ski School Director Bob Dufour as their Freestyle Chairman.

To promote our awareness for freestyle local expert Steve Vogler will be giving a free freestyle clinic on Whistler on Saturday, January 10.

NOTICE

Take note that application has been made to the Motor Carrier Commission for an increase in tariff rates. Changes may be examined at the office of the applicant. Subject to the consent of the Motor Carrier Commission, the proposed effective date is February 8, 1981. Any objections may be filed with the superintendent of Motor Carrier, 4240 Manor Street, Burnaby, B.C. on or before January 22, 1981.

Whistler Taxi Ltd.
7421 Ambassador Crescent
Whistler, B.C.

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—STRATA MANAGEMENT
—TIME SHARE AT WHISKI JACK
—LINEN AND MAID SERVICE

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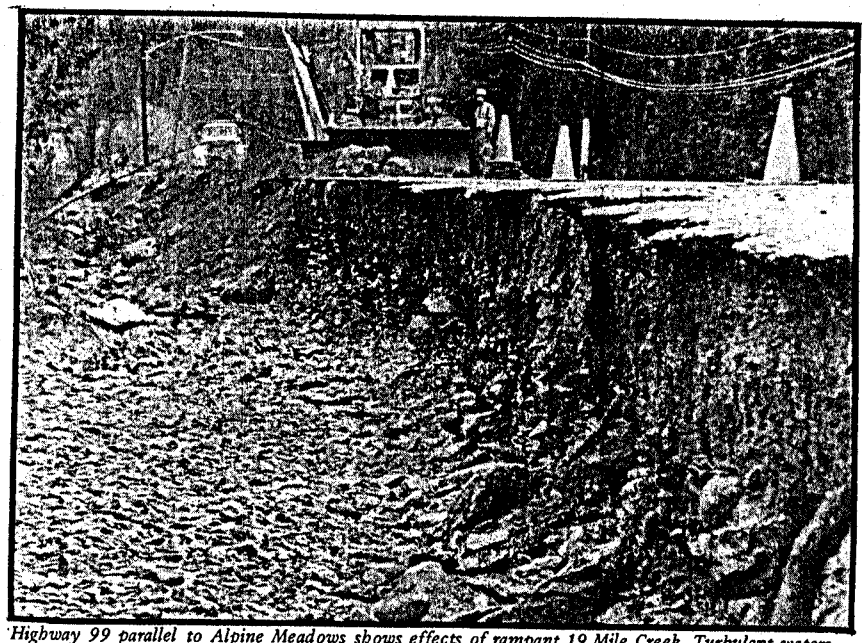
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Some stranded, some soaked

from page one



Highway 99 parallel to Alpine Meadows shows effects of rampant 19 Mile Creek. Turbulent waters carved a new creek bed for hundreds of yards.

Tisdale hydro switching station, two giant hydro transmission towers toppled over and ended up a mass of twisted metal when the flood water washed the footings out.

B.C. Rail reported massive washouts, slides and missing bridges between Squamish and Lillooet.

Once again, the Rutherford Creek area was a bad one with the 80 ft. steel railroad bridge there being washed into the river. To the north about 200m of track was washed into the Green River just south of Nairn Falls.

In the Pemberton area there was more damage to the railroad line between Pemberton and D'Arcy, and in the Pemberton Meadows area several homes were flooded by up to 4 ft. of water. Surprisingly enough it was not the mighty Lillooet that caused the problem, but instead the tributary stream such as Miller and Ryan Creek.

Homes owned by Peter Kuurne, Gordon Ferguson, Ole Jensen and the Gilmore's were among those hardest hit by the brown water, while neighbours in the same area were unaffected.

The bridge over Miller Creek suffered some damage and had to be repaired.

And what about the people?

Those out of the Whistler Valley at the time were unable to return, although there were 10 helicopters reportedly in the area on Saturday ferrying residents in and tourists out. Those arriving by air included Mayor Pat Carleton, Whistler Creek's Penny Wright and the Liquor Store Manager Dennis Lamarche.

Fortunately there were no serious accidents or injuries as a result of the storm, although there were tales of houses accessible only by boat (the Barnfield's on Alta Lake), and stories of people trying to walk home to Alpine Meadows dodging giant ice flows on the way!

Several Whistlerites including Neil Roberts and family and Bob Currie were stranded for 3 days in Pemberton, and the Garibaldi Highlander Hotel was chock full of local residents and visitors on Friday night and Saturday night.

And what about the unsung heroes of the day? Highways foreman Robin Dell found himself short of staff (there were in Vancouver!) and had a desperate few days trying to cope with the flooded roads, putting in culverts and filling in the shoulders. He is since in hospital and we wish him a speedy return to Whistler.

All the volunteer services in the valley spent most of Friday night on watch or helping out — Lindsay Wilson and the firemen, Dave Cathers and the Search & Rescue, and of course Works Foreman Cliff Jennings and staff who had to cope with water lines, flooding and a sewer treatment plant that was inundated with flood water.

As far as repairs are concerned, the road to Vancouver was opened briefly on Saturday evening and then opened on a limited basis on Sunday, December 28. The following day the road to Pemberton was passable with several detours and both highways are still being worked on.

Alpine Meadows was reconnected to the outside world by late Saturday, December 27 and the northern portion of Alpine had water by Monday.

Still under repair are the B.C. Hydro transmission line and the B.C. Rail line. Estimates on the latter vary anywhere from two to six weeks to complete the repairs to the line. In the meantime B.C.R. are running trucks from Squamish to Pemberton and D'Arcy.

Regarding claims for damage as a result of the Christmas flood residents of the Squamish/Pemberton area should contact the Field Office at 38011 3rd Avenue in Squamish, phone 892-5019.

Highland brings in new year with new team

Bruce MacDougall, a principal in the Highland Lodge, announced on Monday, January 5, that Linda Bell, who had previously managed the Whistler Vale Hotel, has taken over the position as manager from Dan LaCasse.

Ms. Bell, a graduate of the BCIT Hotel Management course, has managed hotels in Australia and Vancouver and has her own relief management and hotel accounting company in Vancouver.

Changes planned for the Highland, one of Whistler's established hotels, includes changing the menu in the dining room, changing the wine list, and embarking on a maintenance program in the hotel itself and the new annex.

Others on the new Highland management team include Debbie O'Hanley, Food Manager; Christal Snider, Beverage Manager; Mary Young, Front Desk Manager; and Chefs Denis and Phillipe.



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