PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED ALCAN PIPELINE VOLUME II (FORT NELSON TO SUMAS)

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PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED ALCAN PIPELINE VOLUME II (FORT NELSON TO SUMAS)

June 1976

FOR

GULF INTERSTATE ENGINEERING COMPANY
Houston, Texas

BY

C.D. SCHULTZ & COMPANY LIMITED
Vancouver, Canada

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TABLE OF CONTENTS

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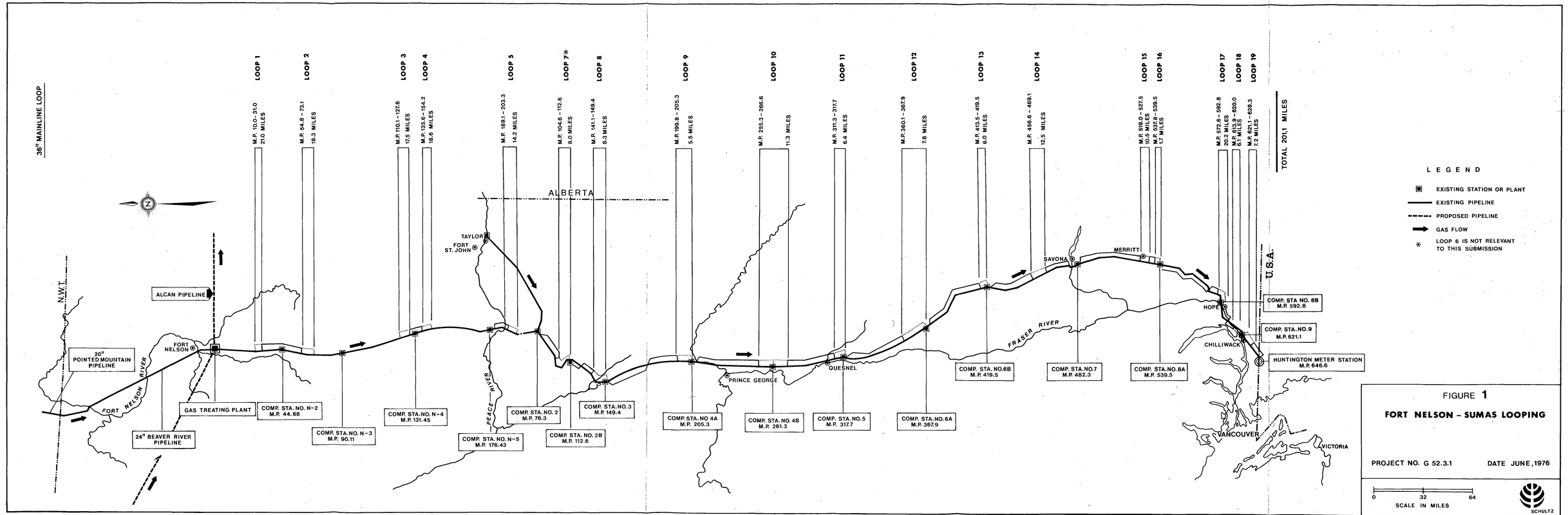
...continued

MISCELLANEOUS MAPS AND TABLES

OTHER VOLUMES

LIST OF TABLES

LIST OF FIGURES


36" MAINLINE LOOP
LOOP 1
M.P. 10.0 - 31.0
21.0 MILES
LOOP 2
M.P. 54.8 - 73.1
18.3 MILES
LOOP 3
M.P. 110.1 - 127.6
17.5 MILES
LOOP 4
M.P. 135.6 - 154.2
18.6 MILES
LOOP 5
M.P. 189.1 - 203.3
14.2 MILES
LOOP 7*
M.P. 104.6 - 112.6
8.0 MILES
LOOP 8
M.P. 141.1 - 149.4
8.3 MILES
LOOP 9
M.P. 199.8 - 205.3
5.5 MILES
LOOP 10
M.P. 255.3 - 266.6
11.3 MILES
LOOP 11
M.P. 311.3 - 317.7
6.4 MILES
LOOP 12
M.P. 360.1 - 367.9
7.8 MILES
LOOP 13
M.P. 413.5 - 419.5
6.0 MILES
LOOP 14
M.P. 456.6 - 469.1
12.5 MILES
LOOP 15
M.P. 519.0 - 527.5
10.5 MILES
LOOP 16
M.P. 537.8 - 539.5
1.7 MILES
LOOP 17
M.P. 572.6 - 592.8
20.2 MILES
LOOP 18
M.P. 613.9 - 620.0
6.1 MILES
LOOP 19
M.P. 621.1 - 628.3
7.2 MILES
TOTAL 201.1 MILES
ALBERTA
N.W.T.
U.S.A.
ALCAN PIPELINE
20" POINTED MOUNTAIN PIPELINE
FORT NELSON
FORT NELSON RIVER
GAS TREATING PLANT
24" BEAVER RIVER PIPELINE
COMP. STA. NO. N-2 M.P. 44.68
COMP. STA. NO. N-3 M.P. 90.11
COMP. STA. NO. N-4 M.P. 131.45
COMP. STA. NO. N-5 M.P. 176.43
PEACE RIVER
TAYLOR
FORT ST. JOHN
COMP. STA. NO. 2 M.P. 76.3
COMP. STA. NO. 2B M.P. 112.6
COMP. STA. NO. 3 M.P. 149.4
COMP. STA. NO. 4A M.P. 205.3
PRINCE GEORGE
COMP. STA. NO. 4B M.P. 261.3
QUESNEL
COMP. STA. NO. 5 M.P. 317.7
COMP. STA. NO. 6A M.P. 367.9
COMP. STA. NO. 6B M.P. 419.5
SAVONA
COMP. STA. NO. 7 M.P. 482.3
MERRITT
COMP. STA. NO. 8A M.P. 539.5
FRASER RIVER
HOPE
CHILLIWACK
COMP. STA. NO. 8B M.P. 592.8
COMP. STA. NO. 9 M.P. 621.1
HUNTINGTON METER STATION M.P. 646.6
VANCOUVER
VICTORIA
LEGEND
EXISTING STATION OR PLANT
EXISTING PIPELINE
PROPOSED PIPELINE
GAS FLOW
* LOOP 6 IS NOT RELEVANT TO THIS SUBMISSION
FIGURE 1
FORT NELSON - SUMAS LOOPING
PROJECT NO. G 52.3.1
DATE JUNE, 1976
0 32 64
SCALE IN MILES
SCHULTZ

PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED ALCAN PIPELINE (FORT NELSON TO SUMAS)

1.0 DESCRIPTION OF PROPOSED ACTION

Northwest Pipeline Corp., Westcoast Transmission Company Limited, Alberta Gas Trunk Line Co. Ltd., and Foothills Pipe Lines Ltd. propose to construct and operate a pipeline system that will transport natural gas from the Prudhoe Bay area of Alaska to the metropolitan United States. This pipeline, known as the Alcan Pipeline, would follow the Alyeska Pipeline from Prudhoe Bay to Fairbanks, then parallel the Alaska Highway to Fort Nelson in northern British Columbia. From Fort Nelson, a portion of the gas would be delivered into the main transmission line of Westcoast for transport to the Northwest Pipeline Corp. system near Sumas on the B.C.-Washington border. The rest of the gas would be delivered to the Alberta Gas Trunk system east of Fort Nelson for eventual delivery to the U.S. mid-west.

Westcoast Transmission Company Limited propose to increase the transmission capacity of their existing pipeline system from Fort Nelson to Sumas by constructing 201 miles of pipeline looping on their main gas pipeline. This report presents the environmental assessment of this part of the Alcan proposal.

A detailed description of this project is presented elsewhere in this submission. A summary of the proposed developments is presented below.

1.1 Purpose

The rationale behind, and justification for the Alcan Pipeline is presented elsewhere in this submission. However, the primary purpose of the Looping Program proposed by Westcoast Transmission Company Limited is to increase the transmission capacity of their existing mainline from Fort Nelson to Sumas. This is required to carry approximately 700 million cubic feet of Alaskan gas per day to the United States. This represents approximately 31 percent of the volume of gas to be transported over the Alcan Pipeline.

1.2 Location

Westcoast Transmission Company Limited presently carries gas from the Fort Nelson and Fort St. John gas fields to Vancouver and American markets on their mainline system. This system extends from northeastern to southwestern British Columbia in a southerly direction and consists of the Fort Nelson Mainline (30-inch outside diameter pipe) and the Fort St. John Mainline (30-inch outside diameter pipe). Much of the mainline has been looped in previous years with 36-inch outside diameter pipe.

A total of approximately 201 miles of 36-inch outside diameter pipeline looping is to be constructed. The Loop locations (18 in total) are shown in Figure 1, and described in Table 1. Detailed maps for each Loop are contained in Part C of the miscellaneous materials presented at the end of this volume.

TABLE 1

PROPOSED LOOPLINE DESCRIPTIONS

LOOP NO.	TITLE	MILE POST	MILES	LEGAL DESCRIPTION
1	Big Beaver Creek	From M.P. 10.0	21.0	Within Unsurveyed Crown Land, Peace River District, (N.T.S. 94-J-10, Block B)
		To M.P. 31.0		Within Unsurveyed Crown Land, Peace River District (N.T.S. 94-J-2, Block J)
2	Trutch Creek	From M.P. 54.8	18.3	Within Unsurveyed Crown Land, Peace River District, (N.T.S. 94-G-15, Block G)
		To M.P. 73.1		Within Unsurveyed Crown Land, Peace River District (N.T.S. 94-G-10, Block G)
3	Pink Mountain	From M.P. 110.1	17.5	Within Unsurveyed Crown Land, Peace River District, (N.T.S. 94-G-2, Block H)
		To M.P. 127.6		Within Unsurveyed Crown Land, Peace River District (N.T.S. 94-B-16, Block E)
4	Cameron River	From M.P. 135.6	18.6	Within Unsurveyed Crown Land, Peace River District, N.T.S. 94-B-16, Block C)
		To M.P. 154.2		Within District Lot 1331, Peace River District
5	Peace River	From M.P. 189.1	14.2	Within Unsurveyed Crown Land, Peace River District, (N.T.S. 94-B-1, Block A)
		To M.P. 203.3		Within Unsurveyed Crown Land, Peace River District (N.T.S. 93-O-16, Block G)
6	Note: This Loop is not applicable to this submission			
7	Pine River	From M.P. 104.6	8.0	Within Unsurveyed Crown Land, Peace River District
		To M.P. 112.6		Within District Lot 2467, Peace River District
8	Parsnip River	From M.P. 141.1	8.3	Within Unsurveyed Crown Land southwest of District Lot 12576, Cariboo District
		To M.P. 149.4		Within District Lot 11808, Cariboo District
9	Summit Lake	From M.P. 199.8	5.5	Within District Lot 2939, Cariboo District
		To M.P. 205.3		Within District Lot 12295, Cariboo District

...continued

Table 1 - continued

LOOP NO.	TITLE	MILE POST	MILES	LEGAL DESCRIPTION
10	Hixon	From M.P. 255.3	11.3	Within District Lot 4585, Cariboo District
		To M.P. 266.6		Within the East half of District Lot 3028, Cariboo District
11	Kersley Creek	From M.P. 311.3	6.4	Within District Lot 4526, Cariboo District
		To M.P. 317.7		Within District Lot 8669, Cariboo District, Plan A1536
12	Williams Lake	From M.P. 360.1	7.8	Within Unsurveyed Crown Land north of District Lot 8884, Cariboo District
		To M.P. 367.9		Within District Lot 12332, Cariboo District
13	100-Mile House	From M.P. 413.5	6.0	Within District Lot 2136, Lilloet District
		To M.P. 419.5		Within Block A of the SW 1/4 of District Lot 4262, Lilloet District
14	Hihium Lake	From M.P. 456.6	12.5	Within Section 24, Township 24, Range 23, west of the 6th Meridian, Kamloops Division, Yale District
		To M.P. 469.1		Within Section 27, Township 22, Range 22, west of the 6th Meridian, Kamloops Division, Yale District
15	Nicola River	From M.P. 519.0	10.5	Within District Lot 1650 Yale Division, Yale District
		To M.P. 527.5		Within Block B of District Lot 1426, Kamloops Division, Yale District
16	Coldwater River	From M.P. 537.8	1.7	Within District Lot 340, Kamloops Division, Yale District
		To M.P. 539.5		Within District Lot 1828, Kamloops Division, Yale District
17	Coquihalla River	From M.P. 572.6	20.2	Within Section 22, Township 7, Range 24, west of the 6th Meridian, Yale Division, Yale District
		To M.P. 592.8		Within Lot A, Section 18, Township 5, Range 25, west of the 6th Meridian, Yale Division, Yale District, Plan 17677

...continued

Table 1 - continued

LOOP NO.	TITLE	MILE POST	MILES	LEGAL DESCRIPTION
18	Seabird Island	From M.P. 613.9	6.1	Within Section 9, Township 4, Range 28, west of the 6th Meridian, New Westminster District
		To M.P. 620.0		Within Lot 2 of the SE 1/4 of Section 13, Township 3, Range 29, west of the 6th Meridian, and of Section 18, Township 3, Range 28, west of the 6th Meridian, New Westminister District, Plan 4863
19	Chilliwack	From M.P. 621.1	7.2	Within Parcel A, Cheam Indian Reserve No. 1, New Westminister District, Plan 31218
		To M.P. 628.3		Within the SW 1/4 of Section 28, Township 26, east of the Coast Meridian, New Westminister District
		TOTAL MILEAGE =	201.1 Miles	

1.3 Land Requirements

The proposed Loops will be located, with minor exceptions, on existing rights-of-ways where Westcoast has multiple pipeline rights. In those isolated instances where a minor pipeline diversion is necessary (because of construction obstacles), no significant increase in land requirements is anticipated, with the exception of Loop 15 (Nicola River) between M.P. 519.0 and 527.5. This Loop will by-pass the Nicola-Mameet Indian Reserve and will require an additional ten miles of right-of-way. Assuming the right-of-way is 100 feet wide, this represents an additional land requirement of approximately 120 acres.

No additional land will be required for compressor stations, roads, or other miscellaneous facilities. Existing facilities (or rights-of-way) will be used.

1.4 Proposed Facilities

The proposed Looping Program consists of approximately 201 miles (spread over 18 loops) of 36-inch outside diamater steel pipe with a wall thickness of 0.390 inches (Grade 60, Westcoast Specification No. 102, Revision 33). In areas where additional strength is required (i.e. road crossings), pipe with a wall thickness of 0.469 inches will be utilized. All pipe will be manufactured in accordance with Catagories II and III of the CSA-Z245 Series.

No additional facilities will be required for this program. Principal pipe storage yards are presently maintained at the Fort Nelson gas processing plant, at the Fort Nelson maintenance and operation base, and at Mile Post 301 on the Alaska Highway, Chetwynd, Willow Flats, Prince George (Shelly), Station 3 (McLeod Lake), Savona and Hope. These

bases, and existing access routes will be utilized. No additional land is required for compressor station sites. Additional compressor units and support facilities will be built as required adjacent to the existing facilities on the existing sites.

1.5 Schedule

The schedule of activities for Westcoast Transmission Company Limited on works related to those sections of the Alcan Pipeline which are located in British Columbia are summarized in Figure 2. This schedule is preliminary, and subject to revision.

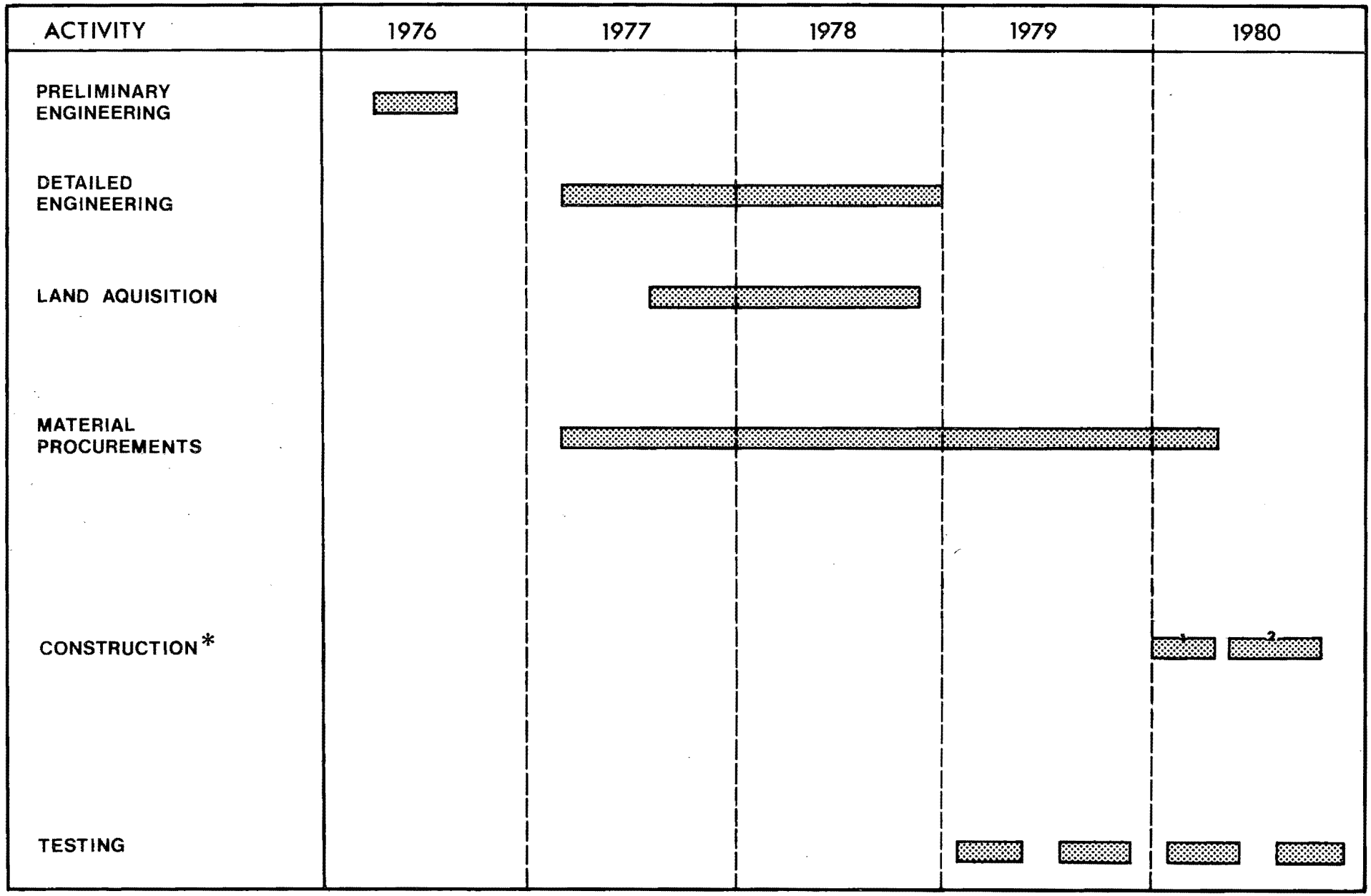
Pre-construction activities on the Mainline Looping Program from Fort Nelson to Sumas will be undertaken concurrently with the Beaver Creek/Zama Lake section that falls within Westcoast's area of responsibility.

Construction of the 18 Loops between Fort Nelson and Sumas is planned to commence in January, 1980. The target completion date is November 1, 1980. Construction of Loops 1 - 3 will be completed during the period January - March, 1980. Winter construction of these Loops is required because of the prevalence of organic terrain in the region. Loops 4 - 19 will be constructed during the summer and autumn of 1980. Loop 6 is not applicable to this submission (hence, only 18 Loops).

One spread (500 workers) will be utilized during the winter construction period, and two spreads during the summer period.

FIGURE 2

SUMMARIZED SCHEDULE OF ACTIVITIES
for
WESTCOAST TRANSMISSION COMPANY LIMITED



*Numbers on bars indicate spreads

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1.6 Construction Procedures

The standard procedure utilized for constructing previous pipelines will be employed for the proposed Loops as follows:

Route Location - based on functional requirements, aerial photographs and map interpretations, aerial reconnaissance, and environmental factors.

Clearing - machine cleared, with hand-clearing in sensitive areas. Unmerchantable timber is burned on a sled, and any merchantable timber salvaged if required.

Grading and Ditching - the right-of-way is graded as required to facilitate access and location of the ditch.

Installing Pipe - involves stringing, welding, x-raying of welds, coating and lowering in of the pipe.

Back-filling - pipe is covered and mounded to allow for settlement of soil.

Testing Pipe - installed pipe is air or hydrostatic tested to check for structural soundness. No testing is done after the initial test since repairs are done with pretested pipe and 100% X-ray examination of welds.

Cleanup - all debris that results during construction is removed from the right-of-way and surrounding area, and all areas utilized during construction are restored to their natural contour, as nearly as is reasonably possible.

Revegetation - left to natural means unless required to control erosion in which case artificial seeding and/or fertilization is undertaken. Revegetation is also done at the request of the landowner and/or controlling government authority.

The above procedures would be utilized for construction of the proposed Loops. A schematic diagram of construction activities is presented in Figure 3.

In addition to the standard procedures presented above, the following procedures are utilized when and if required:

Erosion control - Drainage blocks are installed on all slopes where rill and/or gully erosion will occur. On specific steep slopes with high potential for erosion, berms are constructed.

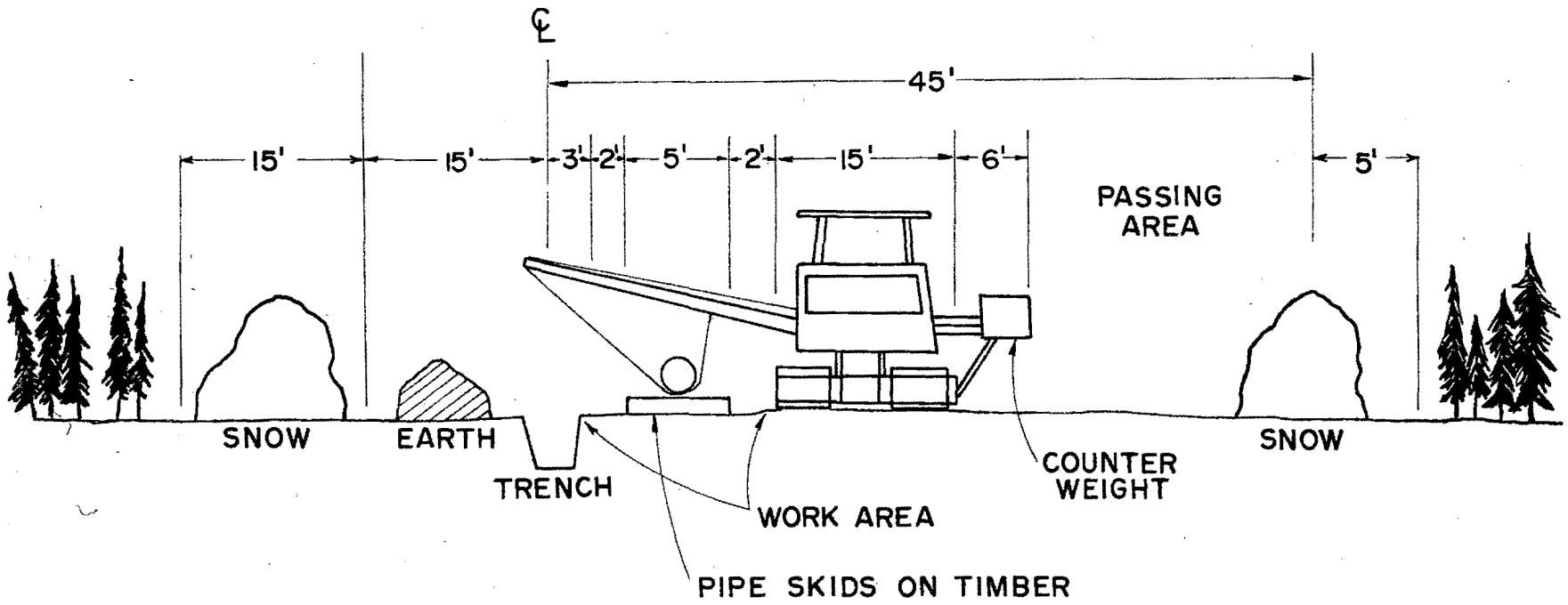
Watercourse Crossing - Concrete river-weights are installed on all major river crossings. Also, across the complete floodplain of a meandering watercourse, it is standard practice to bury the pipeline at full river depth (four to ten feet).

Bog Crossings - Neutral buoyancy of the pipe traversing saturated organic terrain is achieved by installing concrete swamp weights.

Permafrost - Special procedures for permafrost are required, and provided for in Westcoast's standard contract document (see below). Permafrost, if present, would be sporadic and confined to organic terrain along the two northern loops (Loops 1 and 2) on the Fort Nelson Mainline.

FIGURE 3

PIPELINE R.O.W. DURING CONSTRUCTION



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Environmental considerations are an integral part of the pipeline construction specifications employed by Westcoast on all of their pipeline projects. A copy of these requirements is contained in Appendix II of Volume III.

A maximum work force of approximately 1,000 men will be required during construction. It is anticipated that these people will be obtained from the labor pool within British Columbia, and that approximately 20 percent of the personnel requirements will be obtained from local resources. Construction camps will be provided for the workers.

1.7 Operational and Maintenance Procedures

The existing Westcoast system is served by field offices at Fort Nelson, Fort St. John, and Prince George with head offices located in Vancouver. Smaller area offices are maintained at McLeod Lake, Quesnel, Savona and Hope. Principal pipe storage yards are maintained at the Fort Nelson gas processing plant, the Fort Nelson maintenance and operation base, at Mile Post 301 on the Alaska Highway, Cabin Lake, Yoyo Central, various areas in the Fort St. John gathering system, Chetwynd, Willow Flats, Prince George (Shelly), Station 3 (McLeod Lake), Savona and Hope. Warehouses are located at Fort St. John, Fort Nelson and Compressor Station 5 (Australian), with maintenance machine shops at Compressor Station 5 (Australian), and the Fort Nelson gas processing plant.

Westcoast currently operates an extensive telecommunications system composed of company-owned and leased facilities. "Main Haul" circuits comprise four full-time party line or selective private telephone channels interconnecting all company compressor stations, offices, warehouses and

other fixed installations throughout the entire operating area. These channels are in the main leased from the B.C. Railway Company and are carried over that company's microwave system. A small portion of the facilities is leased from CN-CP Telecommunications for service in the southern area of the Westcoast system. In those areas where the Westcoast pipeline system is not within reasonable range of existing telecommunications systems, Westcoast owns and operates multi-channel point-to-point radio coverage.

Westcoast also owns and operates a two-way radio system which provides mobile radio coverage along the pipeline rights-of-way and contiguous highways throughout the pipeline system. Two-way radio base stations are provided at all compressor stations to provide coverage to mobile radio-equipped vehicles in the compressor station areas and to provide backup support to telephone channels. The present two-way radio system is controlled from Fort Nelson, Fort St. John, Prince George, Savona, and Vancouver and can, when required, be remotely connected into a continuous end-to-end communications system. At present, the two-way radio system comprises approximately sixty base stations with 125 mobile and portable radio sets.

All of the Westcoast compressor stations, process plants and major sales metering locations are equipped with remote control/telemetry/data acquisition facilities operated under the control of a computerized master station in the Westcoast Vancouver Gas Control office. This

system provides the gas control operation with minute-by-minute information regarding volumes into and out of the pipeline system, pressure and line pack conditions, station and unit operating parameters, alarms and status, etc. The control system also provides for remote starting and stopping of various prime movers within compressor stations and for the adjustment of discharge pressure set points.

With the addition of the proposed Mainline Looping, it is proposed that modest additions or modifications will be made to the already existing crews and operating, communications, and maintenance facilities maintained by Westcoast. In particular, there will be an increase in emergency maintenance equipment in the Fort Nelson area to serve the proposed and existing pipelines. This equipment will be in the form of mobile muskeg, excavation, lifting, welding and dozer equipment. Portable housing units will also be added for crew accommodation.

1.8 Future Plans

Specific information related to future planning is not available at this time. However, in the event of termination of operations and abandonment of the pipeline, the standard procedure within British Columbia is to leave the pipe in the ground, and to salvage the surface facilities.

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 Physical Features

2.1.1 Topography, Physiography, Geology

In 1964, S.S. Holland divided the province of British Columbia into 10 physiographic divisions complete with smaller physiographic units. These physiographic divisions were based upon the geology and surficial geology of the landforms present throughout the province.

The 18 Loops proposed run transversely across 7 physiographic divisions. Beginning in the northeastern part of the province these divisions are as follows: Alberta Plateau, Rocky Mountain Foothills, Rocky Mountain Area, Rocky Mountain Trench, Southern Plateau and Mountain Area, Coast Mountain Area, and the Coastal Trough. Loops 1, 2, 3, and 4 lie in the Alberta Plateau division; Loop 5 lies in the Rocky Mountain Foothills division, Loop 7 lies in the Rocky Mountain Area division; Loop 8 lies partly in the Rocky Mountain Trench; the rest of Loop 8 lies partly in the Rocky Mountain Trench; the rest of Loop 8 and Loops 9, 10, 11, 12, 13, 14, 15 and 16 lie in the Southern Plateau and Mountain Area division; Loop 17 lies in the Coast Mountain Area division, and Loops 18 and 19 lie in the Coastal Trough division.

a) Alberta Plateau

Loop 1 lies in the Fort Nelson Lowland (below 2,000 feet in elevation) of the Alberta Plateau. It is an area of extremely low relief, in places flat, in places very gently rolling. The lowland lies in the Fort Nelson River drainage but over large areas drainage is not established and lakes and muskegs abound. The topography reflects the gentle nature of the underlying rocks and bedrock exposures are rare.

The area was covered by the Keewatin Ice Sheet in the Pleistocene. Ice movement was west and southwest with transported drift and boulders coming from the east. Elongate drumlins and flutings are readily apparent but of low relief so as not to show up in mapping. The land is covered by extensive moraines and meltwater channels, many of which now contain vastly smaller streams than just after the Ice Age.

Loops 2, 3, and 4 lie in the Alberta Plateau generally between 3,000 - 4,000 feet in elevation. The plateau is drained by the Peace River which has deeply incised it. The upland surface is flat or gently rolling. Drainage is poorly organized; there are large areas of muskeg and streams meander across the surface to join a trunk stream. The plateau for the most part is heavily wooded but areas along the Peace are lightly wooded and much land has been cleared for agricultural purposes.

The Peace River valley was originally covered by glacial lakes which left shoreline deposits at 2,750 feet and 2,260 feet; the latter deposed sediments to about 100 feet.

b) Rocky Mountain Foothills

Loop 5 lies in the Rocky Mountain Foothills zone along the eastern margin of the Rocky Mountains. The western boundary is along a fault of Palaeozoic rocks thrust over Mesozoic formations which forms the grey limestone Front Ranges. The eastern boundary, especially between the Murray and Peace Rivers, is a series of faults separating the folded sedimentary formations of the foothills from the flat-lying plains. There is a lack of uniformity in the surface due to Triassic limestones in one section, Cretaceous sandstones in another, and the waning intensity of structural deformation moving in an eastward fashion.

The inner foothills on the west are higher and more rugged than the outer belt of foothills on the east. The outer foothills are more gently folded and only slightly faulted. Elevations of the foothills increase southward from the Liard River to the area between the headwaters of the Pine and Prophet Rivers, after which the elevations diminish.
The structural grain of the bedrock has resulted in prominently developed, northwesterly trending, longitudinal ridges and a trellis pattern of drainage, especially in the area west of Loops 5 and 6. Most of the landforms have been only slightly modified by glaciers.

c) Rocky Mountain Area

Loop 7 lies in the Rocky Mountain Area. It is bounded by the Rocky Mountain Trench on the west and the Rocky Mountain Foothills on the east. Loop 7 lies in the Hart Range of the Rocky Mountains. These are moderately rugged mountains which rarely exceed 7,500 feet.

The Loop lies in an apparent natural division of the Hart Range at Azouzetta Lake between the Murray and Solitude Ranges on the east and the Misinchinka Range to the west. The Murray Range is 4 miles wide on the Hart Highway and rises to nearly 6,700 feet with well timbered lower slopes. The western face dips about 40° and the northeast scarp is fretted with cirques with steepened headwalls. The Solitude Range is 3 miles wide. It is composed of a block of folded limestone with a southwest facing dip slope and cirques on the northeast. Both of these ranges are similar topographically and structurally to the Front Ranges of the Continental Ranges and occupy the same position on the western side of the Foothills.

The Misinchinka Ranges lie between Azouzetta Lake and the Rocky Mountain Trench. They are 15 miles wide. Their composition of Misinchinka Schists is reflected in their subdued topography. These rocks are unable to support the precipitous slopes and castellated forms characteristic of the southern ranges. The Misinchinka Ranges have rounded wooded summits up to 6,500 feet. They are drained by creeks flowing west into the Parsnip or east into the Peace River. Westward flowing creeks tend to be parallel in a direction oblique to the Trench but consistent with the direction of Misinchinka Schists.

The combination of greatly lessened elevation and relief, different lithology and structure, and reduced alpine and valley glaciation have resulted in a subdued alpine topography.

d) Rocky Mountain Trench

The north part of Loop 8 lies in the Rocky Mountain Trench straddling the Parsnip River. The trench extends northwestward from the United States to the Liard River (900 miles). The trench is broken by the McGregor Plateau near its middle and is displaced 15 miles east. The northern part is only 2 - 9 miles wide, and contains the northward flowing Parsnip River.

The Rocky Mountain Trench is a structurally controlled erosional feature. Its structure is unknown and highly variable. The trench existed in pre-glacial time as a topographic feature and as an erosional form carrying the headwaters of the pre-glacial Peace and Fraser Rivers. The McGregor Plateau break is a result of these features. The form of the trench was modified by ice but the main effect was the derangement of previously established drainage systems, and in post-glacial time the streams have incised themselves to varying depths in the deep drift of the trench.

e) Southern Plateau and Mountain Area

The eastern part of Loop 8 and Loops 9, 10, 11, 12, 13, 14, 15 and 16 lie in the Interior Plateau. It is one of the major physiographic divisions of the province. It is encircled by mountains; on the west by the Coast and Cascade Ranges, north by the Skeena and Omineca Mountains, east and southeast by the Rocky and Columbia Mountains. On the northeast the plateau merges with the Rocky Mountain Trench. Transition between the plateau and the

mountains is fairly rapid; the boundary is where the plateau is completely dissected and country is truly mountainous. The plateau is almost completely drained by the Fraser River.

The southern part of Loop 8 and Loops 9 - 12 lie in the Fraser Basin which occupies the zone between 2,000 and 3,000 feet. The northeast boundary is the Rocky Mountain Trench. The surface of the plateau is flat or gently rolling, covered with drift with few exposures of bedrock. The surface is incised by the Fraser and its tributaries. Surface drainage is poorly organized and numerous lakes and poorly drained depressions are found.

The area was occupied by ice whose movement created drumlins indicating an eastward to northeastward movement of ice north of Prince George and northward, north of Quesnel. Eskers were formed by meltwater during the waning stages of glaciation in the Fraser Basin.

Although the Fraser Basin was originally formed by erosion of a northward flowing tributary of the Peace River in pre-glacial times, a reversal of flow has occurred and the Fraser River has incised a deep valley in the drift in the Basin. At Prince George the river is 700 feet below the upper surface. Part of Loop 9 occupies a part of the Fraser Basin north of Prince George known as the Nechako Plain. It was formed from the sediments of three pre-glacial lakes centered in a basin around Prince George, Fort St. James and Vanderhoof. Varved clays were deposited and some of the higher drumlins became islands.

Loop 13 lies in the Fraser Plateau area, east of the Fraser River. The plateau is a flat and gently rolling country with large areas of undissected upland laying between 4,000 and 5,000 feet. West and south of Canim Lake, the surface rises to 6,000 feet. The southern boundary is the Thompson Plateau which is determined by largely undissected flows of basalt. The eastern boundary is the 6,000 foot contour line.

Loops 14, 15 and 16 cross the Thompson Plateau, underlain by flat or gently dipping basalt flows. Steep escarpments occur along the river, with almost horizontal upper surfaces. Much of the plateau is covered with glacial drift up to 2,000 feet. The drift has been modeled into drumlin-like forms by ice movement. These and the eskers provide much of the low relief on the surface. Ice movement was northeastward. There is a belt of

ice-marginal meltwater channels extending northwestward of Clinton for 15 miles.

f) Coast Mountain Area

Loop 17 lies in the Cascade Mountains. These extend from the northwestern states into Canada as far as Lytton, bordered to the west by the Fraser River and to the north and east by the Thompson Plateau. The Cascades are composed of folded and metamorphosed volcanic and sedimentary rocks with granitic intrusions and batholiths. The summits and peaks are fairly uniform in height ranging up to 8,500 feet.

The peaks and ridges are serrate showing the effects of intense alpine glaciation. Cirque basins occur on the north and northeast slopes. At lower elevations between 6,000 and 7,000 feet, rounded ridges and dome-shaped mountains have been formed by the Cordilleran Ice-Sheet. Truncated spurs, hanging valleys, mountain tarns and glaciated rock surfaces are common. Since the Pleistocene, the Cascades have been free of ice except for a few small glaciers in the Skagit Range.

g) Coastal Trough

Loops 18 and 19 lie in the Georgia Depression and Georgia Lowlands area. This area is underlain by granitic rocks as well as inliers of older formations. The Lowland area extends from the ocean to between 2,000 and 4,000 feet, but below 2,000 feet the Georgia Lowland Remnants are more extensive and are seen as gently sloping surfaces.

Both loops lie in the Fraser Lowland which is an area of depositional rather than erosional origin. It includes the delta of the Fraser River, from Pt. Grey to Laidlaw and extending southward to the coast at Bellingham. The area is bounded by mountains on all sides which rise abruptly from the plain.

The area consists of extensive low uplands, 50 - 1,000 feet in elevation, separated by wide flat-bottomed valleys. The uplands are of 4 main types: (1) a core of unconsolidated deposits with rolling hummocky surfaces of glacial till and glacio-marine deposits; (2) a core of unconsolidated deposits with commonly flat terraced surfaces of glacial outwash; (3) a core of bedrock overlain by a thin mantle of glacial and glacio-marine deposits; and (4) raised marine delta with a possible core of bedrock.

Flat-bottomed valleys up to 3 miles wide separate the uplands. The major valleys range from a few feet to 75 feet above sea level.

All valleys except Burnaby Lake-Still Creek and the Fraser are former embayments of the sea and were not cut by the streams presently there.

The Fraser Lowland includes the Fraser River Delta, which has been the subject of sedimentary deposition since the late Cretaceous (ca. 70,000,000 years). The granitic basement is overlain by as much as 15,000 feet of late Cretaceous, Tertiary and Quaternary sedimentary rocks. Parts of the late Cretaceous to middle Eocene are visible surficially along the northern part of the lowland in a long 15^{o} slope.

During Pleistocene and recent periods the area has received depositions of marine, non-marine, glacial and non-glacial origins. During ice advances, ice accumulated to 7,500 feet and depressed the land as much as 1,000 feet.

Recent deposits from the Fraser River of deltaic, Channel and floodplain deposits are building the delta seaward at a rate of 28 feet per year.

2.1.2 Surficial Geology and Soils

a) Loop 1

The entire Loop 1 segment is underlain by glaciolacustrine silty clays of variable thickness, which in turn are underlain by till. Both the till and lacustrine deposits are bentonitic.

A variable thickness of peatmoss covers the inorganic materials. Topography of this Loop segment is nearly level with a slight slope to the west, and both surface and subsurface drainage are poor. The soil is gleyed indicating that the water table is very near the surface and the infiltration capacity is very low.

b) Loop 2

For nearly the entire length of this Loop segment, the surface material is till, with a sandy loam to loam texture. The soils of the area are orthic to gleyed luvisols with very thin Ah horizons. In the lowlands peatmoss cover ranges from one to two feet. Surface drainage is generally poorly developed except on hillsides and stream valleys.

c) Loop 3

Loop 3 is underlain by till on the uplands and slopes, and glaciolacustrine clays in the lowlands. The till is stony to bouldery with a sandy matrix. It is variable in thickness, being thin on top of the uplands and relatively thicker on the flanks of the hills. Glacio-lacustrine materials are silty to clayey in composition and exceed six feet in thickness.

d) Loop 4

Again, as in the previous Loops, two major types of surficial deposits are present in the area of Loop 4: till and glaciolacustrine clays. Till covers the uplands and slopes; while glaciolacustrine clays underlie the surface near the Cameron River. The till is stony with a sandy matrix and generally resistant to erosion on relatively steep slopes. Glaciolacustrine clays are subject to slumping specifically in the spring. Some alluvial silts and sands form the floodplain of the Cameron River.

North of the Cameron River, soils have been developed on glacial till, coarse outwash and residual materials. All soils fall in the grey or grey brown luvisolic groups. Outwash and residual soils are often sandy or gravelly. Along the Cameron River, alluvial and aeolian deposits of sandy loam exist. South of the Cameron River, grey to grey brown loam soils have been developed on glacial till. There are organic soils in the Cameron River valley.

e) Loop 5

The Loop portion is located partly in the gravel outwash plain. The outwash, comprising of sand and gravel, is from 20 to 40 feet thick and overlies fine-grained glaciolacustrine sediments. Part of the Loop follows the Peace River valley. The lower portion of the river bank to an elevation of about 1,800 feet on the north end, and 2,200 feet in the south, is composed of bedrock. The rest of the bank is apparently composed of fine-grained glacial sediments which may include till. The rest of Loop is positioned on till and glaciolacustrine silts and clays.

f) Loop 7

Most of the Loop segment is positioned on either recent sand and gravel alluvial sediments of the Pine River, or on till and glacial outwash forming benches along the river.

g) Loop 8

The Loop is situated partly in alluvial and glacio-fluvial gravels. The gravel is medium to coarse-grained in a sandy matrix. It is over 20 feet deep and has almost level surface with occasional terraces. The rest of the Loop segment is in till which is sandy and stony in character and over five feet in thickness.

h) Loop 9

The entire Loop segment is positioned in deep till which is very stony with a sandy matrix. Occasional small streams and meltwater channels along the pipeline Loop have relatively steeper surface slopes but show no erosion.

Most of the area is covered by soil whose textures range from sandy loam to clay loam with varying amounts of stone and gravel. The finer textures are found on the lower, gentler slopes whereas the higher steeper hills have larger amounts of stones and gravel.

i) Loop 10

Most of the Loop segment is underlain by till which is loamy with numerous stones. It is resistant to erosion even on relatively steep slopes. The rest of the Loop is underlain by glaciolacustrine sediments of silty loam composition.

The soils of the area are luvisolic and of sandy loam to loam texture, derived from non-calcareous glacial till. They are very compact and of low permeability.

j) Loop 11

The entire Loop segment is positioned on very stony till which has a silty and sandy matrix. Overlying this are water deposited materials including lacustrine clays and alluvium.

The soils are all included in the luvisolic soils group. They range from well drained to poorly drained on the lacustrine clays to an alluvial sandy material.

k) Loop 12

The entire Loop segment is positioned in thick and stony till which is resistant to erosion.

l) Loop 13

The entire Loop segment is positioned in thick and stony till which is resistant to erosion.

m) Loop 14

The entire Loop segment is underlain by till of a very stony composition. Some glacial erratics are many feet in diameter. The till is generally thick but occasional bedrock outcrops may be encountered.

n) Loop 15

Stony till underlies the surface along the Loop segment except in the locality of the Nicola River where the surface is underlain by alluvial silty sands with occasional gravel lenses.

o) Loop 16

Most of the pipeline route is positioned on till which is sandy, stony and relatively thin. A number of small bedrock outcrops occur along the route. The soils are derived from glacial till, lacustrine or alluvial deposits.

p) Loop 17

The Boston Bar Creek portion of the segment is positioned in till and avalanche debris. Avalanches are active along most of the Loop portion but the pipeline is near or at the bottom of the valley, where avalanches only deposit material and consequently there is no danger of pipeline rupture.

The rest of the pipeline, is positioned in alluvial gravels of the Coquihalla River, except for a few pockets of till.

q) Loop 18

The entire Loop segment is positioned on floodplain of the Fraser River. The floodplain is composed of about six to ten feet of silty sand overlying gravel.

Loop 18 is constructed in predominantly cleared land. This land is part of the Fraser River Delta and the soils in this area are very complex and varied. All

soils are derived from Fraser River floodplain deposits. Both gleysols and regosols occur in the Loop area. Gleysol soils are associated with shifting or high water tables, such as is found in delta land. They are poorly drained soils with 12 to 18 inches of consolidated or uncolsolidated muck or peat at the surface. This soil is common in the low lying areas.

Regosols are well and imperfectly drained soils that lack discernible horizons. These soils are found on the lowland areas of the loop. Several regosol subgroups are found in this group.

r) Loop 19

The entire Loop segment is positioned on the floodplain of the Fraser River. The floodplain material is made of five to ten feet of silty sand overlying gravel.

The soils of this area are derived from Fraser River floodplain deposits and are quite varied over the length of the Loop. Brunisol, gleysol and regosol soils are found here.

Brunisol soils are moderately well drained and are composed of medium to coarse particles. They are developed under forest conditions. Their use for agricultural purposes is limited due to their poor qualities of texture and moisture holding capacity.

The gleysols have been developed under swamp forest in the presence of a high or fluctuating water table which presents problems for their use in agriculture.

The mull regosols receive high use for crop planting.

2.1.3 Climate

The Westcoast pipeline stretches from Fort Nelson south to the 49th Parallel. In running the length of the province, almost every major climatic zone is traversed. British Columbia has been broadly classified into climatic zones (Chapman et al., 1956). Specific data has been taken from representative stations within each zone from Canadian Normals and from the Climatology Atlas of Canada. Some climatic details are given in Part A of the miscellaneous materials presented at the end of this volume.

Loops 1 to 7 occur within the Northeast Climatic Zone. The representative stations are Fort Nelson and Beatton River. This area is located in the northeastern part of the province and is characterized by great extremes in climate. It is typically a continental cold, humid (taiga) climate. The annual precipitation is not high, at 12-23 inches with most of this coming in the form of summer rains. Snowfall accounts for about one-third of the total precipitation and averages about 40 inches. The greatest single amount of rainfall in 24 hours was 3.17 inches in August.

The mean temperature for January (the coldest month) is $-9.8^{\circ}F$ for Fort Nelson and $-3.1^{\circ}F$ for Beatton River. Extreme minimums are $-61^{\circ}F$ and $-54^{\circ}F$, respectively. In contrast, the mean daily temperatures for July for Fort Nelson and Beatton River are $62.1^{\circ}F$ and $57.4^{\circ}F$. Extreme maximums for the area are $90^{\circ}F$ and $89^{\circ}F$, respectively. Fort Nelson typifies the extreme ranges of temperature of a temperate continental clime, with mean daily differences from January and July of $72^{\circ}F$ and differences in extremes of $159^{\circ}F$. Approximately 140 days of the year are frost-free.

The winds in the northeastern section are variable, but without the influence of major mountain and valley systems, tend to be from the western quarter (NW, W, SW). At Fort Nelson the annual winds are markedly north-south in orientation while at Beatton River, the westerly winds are predominant. In the summer the winds are more westerly at Fort Nelson. This area does not generally receive severe thunderstorms arising from convectional currents. Maximum gusts in the area average 70 to 80 m.p.h.

Loops 8 to 11 occur within the Central Interior Climatic Zone. The representative weather records for these loops are from Prince George and Quesnel. The regime is sub-boreal continental cold humid to humid. Annual precipitation may range from 14-24 inches. The driest months are March and April and the wettest is August. Prince George recorded an annual average of 24.43 inches of precipitation and Quesnel 21.31 inches. The seasonal pattern is dry spring and wet summer and fall. The greatest precipitation to fall in 24 hours occurred in August with 1.97 and 1.54 inches for Prince George and Quesnel respectively.

The temperatures also reflect the continental influence but are moderated somewhat by milder Pacific disturbances. The mean daily temperature for January was 10.7° and 11.6° respectively, but the extreme minimums were -58° and -51° for Prince George and Quesnel. The mean daily temperatures for July are 58.9° and 62.5°F. The maximum temperatures, occurring in July, read 94° and 98°F. The difference in the range of mean temperatures is slightly less than the more northern continentally influenced sections of the pipeline. The number of frost-free days is increased to approximately 170.

The winds in the Central Interior Zone have a north-south orientation at Prince George. Northwest winds would be expected, but the influence of the Interior Trench may affect the wind. Gusts of 70 to 80 m.p.h. may occur in storms. Summer thunderstorms are infrequent over the area.

Loops 12 to 16 occur in the Southwest Interior Climatic Zone. The representative stations chosen were at Williams Lake, Kamloops and Merritt. This section of the pipeline lies in a continental cold winter regimen but a warm semi-arid to sub-humid summer regimen. The seasonal pattern of precipitation is dry spring and wet winter (wet summer near Williams Lake). Mean annual precipitation for Kamloops, Merritt and Williams Lake was 10.26, 10.02 and 15.81 inches. The greatest 24 hour precipitation for the three stations is 1.66 inches in July in Kamloops, 2.24 inches in June in Merrit and 1.68 inches in January in Williams Lake. Snowfall is less at Kamloops and Merritt, averaging about 33 inches; Williams Lake averages 60.1 inches.

The mean daily temperatures for the coldest month, January was 21.5^{o}F, 18.2^{o}F and 13.6^{o}F, respectively in Kamloops, Merritt and Williams Lake. Extreme minimums in January and December were -37^{o}F, -46^{o}F and -45^{o}F. The mean daily temperature for the hottest month, July; were 70.0^{o}F, 63.5^{o}F and 60.3^{o}F respectively. Extreme maximums were 107^{o}F, 102^{o}F and 93^{o}F for the three stations. The frost free period was approximately 190 days. This section of pipeline reflects the rainshadow effect caused by the western cordillera and the continental effects of the extremes in temperature.

Winds in the Southwest Interior Zone are generally northwesterly. However, southerly winds often accompany severe

thunder and lightning storms in this semi-arid region. Blowing dust is sometimes a problem.

The last three Loops, 17 to 19 occur in the Coastal Climatic Zone. The weather stations used in this area were located at Hope and Sumas Canal. The outstanding feature about this area is the tremendous effect of the Pacific Ocean on the climate. The seasonal pattern of precipitation is wet winter, with the least amount of rainfall occurring in July. This sub-humid to humid climate receives large amounts of precipitation. The mean annual amounts for Hope and Sumas Canal are 63.03 and 71.06 inches. Snowfall only accounts for about 10 percent of this total. The greatest 24 hour precipitation is 4.16 inches in February at Hope and 4.29 inches in January at Sumas Canal.

Temperatures have been greatly modified by the coastal influence and do not exhibit the extreme ranges found in other sections of the pipeline. The mean daily temperature of the coldest month, January, at Hope was 31.0°F and at Sumas Canal, 35.8°F. The extreme minimums were -12°F in December in Hope and -13°F in Sumas Canal. Mean daily temperatures in the hottest month, July, was 65.4°F and 65.6°F, respectively. Extreme maximum temperatures were 104°F and 99°F. The average number of frost-free days is approximately 310.

Winds along the coast are generally southeast in direction. Northwest winds in the winter may accompany rainy weather (snow at higher elevations). Thunderstorms are rare along the coast and rainfall is steady and moderate.

2.2 Terrestial Environment

The terrestial environment has been assessed for each of the proposed Loops of the existing Fort Nelson to Sumas gas pipeline. Divided into overviews of vegetation, forestry, and wildlife, this study draws on government documents, studies by government and university personnel, and field assessments during previous assignments (Schultz International Ltd., 1975b).

Details of the specific bio-geoclimatic zones discussed in the vegetation section, and data from field work, are located in Appendix I of Volume III.

2.2.1 Vegetation and Forests

a) Loop 1

This Loop passes through upland forests of white spruce and aspen, interspersed with low areas of treed muskeg dominated by black spruce. Lodgepole pine are scattered along better drained ridges in both types of areas.

In some forests, the white spruce are 60 feet in height or greater, with a diameter of two feet or more, and are of commercial value.

An area south of Parker Creek has been logged and is now covered by young aspen.

b) Loop 2

This Loop passes through areas typical of the boreal forest zone, including treed muskeg areas with scattered black spruce, and upland forests of white spruce,

aspen, and birch. Some of the white spruce approaches commercial size.

South of M.P. 68.2 is an extensive burned area, which now supports a thick growth of scrub birch and scattered black spruce.

c) Loop 3

This Loop extends from lodgepole pine forests with scattered aspen through moderately well drained ridgetop forests of pine, mixed spruce-aspen and pine, to white spruce dominated mixed forests, to pure stands of white spruce.

Between M.P. 22.5 and 24.0 there is a unique treeless meadow, characterized by scrub birch, shrubby cinquefoil, willow, and blueberry.

d) Loop 4

Loop 4 lies in the boreal forest zone. North of the Cameron River, lodgepole pine forests alternate with low aspen forest containing scattered, taller white spruce.

Around the Cameron River there is some clearing for agricultural purposes, mainly grazing.

South of the river, there are large areas of young lodgepole pine interspersed between taller stands spruce and aspen, suggesting disturbance of the vegetation cover, probably by fire or timber harvest.

e) Loop 5

The Loop lies in the Peace River Parklands of the boreal forest zone. It extends through open forests of lodgepole pine and aspen with some white spruce to the edge of the Peace River valley. About the Peace River, it passes through aspen-dominated mixed forests, then southwards into white spruce dominated uplands forest. Around Moosecall Lake, black spruce treed muskeg occurs. Some of the white spruce areas have been extensively logged.

f) Loop 7

Loop 7 passes through the transition zone between the boreal forest regions and the sub-alpine Engelmann spruce-fir regions.

The Loop begins in open white spruce forest with scattered pine, Engelmann spruce and alpine fir, the latter two at higher elevations particularly. As the line parallels the river, parts of it located farther away from the river, are covered by tall white spruce-aspen-fir-pine forests. Along the river, brush willow, balsam poplar, and alder cover the alluvial flats. In backwater areas along the river, black spruce-lodgepole pine muskeg swamp predominates.

g) Loop 8

Loop 8 is located in the transition area between the boreal spruce zone, the sub-alpine spruce and fir zone, and the sub-boreal spruce zone. The vegetation is varied, ranging from stands of lodgepole pine to spruce-aspen-birch forests and brush willow along creeks. Alpine fir was observed in spruce forests.

The Loop begins in an area of dense lodgepole pine which was formerly logged. There is some clearing for agriculture on the north-east bank of the Parsnip River. South of the Parsnip River an extensive area of spruce-aspen-pine forest continues more or less to the end of the Loop.

h) Loop 9

This Loop lies in the sub-boreal spruce zone. This Loop marks the first appearance of the interior variety of Douglas fir.

The Loop crosses closed forests of alpine fir, white spruce, and scattered Douglas fir, interspersed with open muskeg-string bogs surrounded by white spruce and alpine fir. The area has been selectively logged for the best white spruce and Douglas fir.

i) Loop 10

This Loop is situated entirely within the Cariboo Parklands Biogeoclimatic Zone, with the dominant trees in the course of the Loop being lodgepole pine, aspen, and Douglas fir with scattered birch, black and white spruce, and willows. Most of the area has been selectively logged and the taller trees remaining are scattered widely.

The Loop ends near Hixon with much clearing of land evident.

j) Loop 11

This Loop is situated in the Cariboo Parkland zone. Aspen, lodgepole pine, and Douglas fir are the dominant tree types in the area, with aspen and birch in disturbed areas.

Most of the land around the highway and the railway has been cleared for agricultural purposes. The pipeline is used extensively for grazing by both domestic and wild animals. Most of the area has been logged as well.

k) Loop 12

The Loop is located in the Cariboo Parklands zone. Aspen, lodgepole pine, and Douglas fir comprise the dominant trees in the various vegetation communities.

More than half of the Loop passes through a tall Douglas fir-lodgepole pine forest which is somewhat open in structure. Trees may be as tall as 100 feet, but most trees are 60 feet to 70 feet. Some areas have more pine, some have more fir, and some are aspen dominant. Along the ridge where the pipeline is located, the area has been logged in the past.

Toward the end of the Loop, there is some cleared land around Five Mile Creek.

l) Loop 13

Loop 13 lies in the Cariboo Parkland zone. Douglas fir, aspen, and lodgepole pine are the dominant tree species in this Loop.

The Loop begins on the outskirts of 100-Mile House in semi-cleared land beside a power transmission line. The surrounding forest is composed of Douglas fir and lodgepole pine with aspen and birch; the largest trees have been cut.

m) Loop 14

This Loop lies in three biogeoclimatic zones: the sub-alpine spruce and fir, the interior Douglas fir, and the Ponderosa pine - bunchgrass zones. The distinction between the sub-alpine and interior zones appears blurred along the pipeline, but there is a very sharp line of demarcation between the interior Douglas fir and Ponderosa pine zones.

The Loop begins in predominantly lodgepole pine forest with scattered good stands of Douglas fir. This pine forest continues to about M.P. 464.0 where a distinct eco-tone is noticed; the forest becomes drier, the trees spaced wider apart, and the ratio of lodgepole pine to Douglas fir increases. Towards the North Thompson River the area has become increasingly drier, and the open stands on the higher slopes of the ridge are almost exclusively Douglas fir. Ground cover is not extensive and consists of bear-berry, rabbitbush, and bunchgrass.

By M.P. 467.0 Ponderosa pine, Rocky Mountain juniper, rabbitbush, and sagebrush are common. Cottonwoods line the creeks.

n) Loop 15

This Loop lies in the Ponderosa pine - bunchgrass zone; Ponderosa pine, Douglas fir, rabbitbush, juniper, and grasses are the major species in this region. Ground cover is not extensive; there may be only clumps of grass in areas of bare ground. Most of the grassland areas are quite short which may be a result of severe grazing pressure.

On the west side of Guichon Creek and south, much of the land has been cleared and is now under cultivation and heavy irrigation. To the south of the Nicola River the line passes into stands of Ponderosa pine, areas of which have been logged.

o) Loop 16

This Loop lies in the Ponderosa pine - bunchgrass zone. The Loop is very short and runs through open Ponderosa pine forest with scattered Douglas fir which has been selectively logged. Rocky Mountain juniper, snowbrush, and saskatoon constitute the underbrush. About the Coldwater River are cottonwoods and willows, and semi-cleared agricultural land.

p) Loop 17

This is the longest Loop encountered in the looping program. Most of its twenty mile length lies in the coastal western hemlock zone, although the northern part, in the Boston Bar Creek Valley, may lie in the sub-alpine mountain hemlock zone.

The Loop begins in the narrow floodplain and lower slopes of the steep-sloped Boston Bar Creek Valley. The surrounding forest on the mountain slope is a closed Douglas fir, hemlock and fir forest. Shrub cover is sparse. Avalanches have swept away vegetation on steep slopes. The valley bottom has a cover of willow, cottonwood, and some aspen and alder. Along the Coquihalla River the pipeline largely keeps to the flat valley bottoms where vegetation consists of dense growths of willow brush and cottonwoods. The

Loop ends in a dense forest of maple, alder, willow, and cottonwood where trees may reach 80 feet. Scattered Douglas fir, hemlock, and cedar may reach 100 feet or more.

q) Loop 18

This Loop lies in the coastal western hemlock zone where western hemlock, Douglas fir, and red cedar are the dominant conifers; broadleaf maple, cottonwood, and arbutus the deciduous trees.

Almost all of the land has been cleared for agricultural purposes. The only areas which still harbor deciduous tree growths are in woodlots and on the Indian Reserve; in these areas, a rich floristic display is exhibited.

r) Loop 19

Although this Loop is situated in the coastal Douglas fir zone, all of the land in the Loop area has been cleared for agricultural purposes. Some large deciduous trees remain bordering the creeks and canals.

2.2.2 Wildlife

a) Loop 1

Canada Land Inventory (C.L.I.) maps for ungulate capability rate this particular area as Class 4 (poor to moderate) with excessive soil moisture and snow depth, and adverse climatic factors working against good ungulate production. Moderately suitable (Class 4) habitat is available for woodland caribou in the area, although numbers are unknown.

The only ungulates which would occur here in substantial numbers are moose. Their most favorable habitats are more open areas of new regeneration, and watercourses, such as those in southern parts of the loop around Parker Creek.

Loop 1 crosses two traplines. Beaver, marten, mink, and lynx appear to be the most important species. Lynx are at a low point in their cycle and will stay low in numbers for three to four years.

Capability for waterfowl production as assessed by the Canada Land Inventory is very low. The drier uplands are rated as Class 7 (lowest potential) with severe limitations such as lack of flowing water, reduced marsh edge, reduced soil fertility, and excessively flat topography. The wetter muskeg areas are only slightly better, rated as Class 6.

b) Loop 2

Because of adverse conditions of climate, topography, and snow depth, this area is rated at moderate capability moose habitat, or Class 3 on C.L.I. maps for moose or caribou. Numbers of moose or caribou are unknown, but moose would be more numerous.

The area has a very low to negligible capability for waterfowl; the topography is very flat and not conducive to good wetland development. Loop 2 area rates as Class 7 on C.L.I. maps.

c) Loop 3

Moose are the most widespread and abundant ungulates in this area. In the winter, snow depth is not so critical to moose as for deer, but will restrict most of the prime wintering range to under 3,000 feet. South and west facing "breaks" along the river valleys or exposed burn areas are especially favored areas.

The uplands area along which the Loop extends is rated as moderately high quality range for moose and mule deer. There are slight limitations to ungulate production in this area arising mostly from excessive snow depth in winter months. Approximately 60 percent of the uplands are rated Class 3 (moderately high) and 40 percent as Class 2 winter range. This is high quality wintering area upon which animals from surrounding areas depend.

The valley bottoms are rated as high quality wintering areas for moose; climatic conditions in the valley are less harsh, and because there is a greater variation of browse along creeks. The meadow area around M.P. 23 is probably one of the best wintering grounds for moose in the region.

The Alberta Plateau of which this area is part of has few lakes, ponds, or good wetlands. The area has almost no potential for waterfowl and has been given the lowest rating on Canada Land Inventory capability maps.

d) Loop 4

Moose are fairly abundant and widespread throughout this region. While the ridge area has a moderately high C.L.I. rating for moose and mule deer, only 40 percent is high quality winter range. Valley bottomlands, especially along the Cameron River, have a high rating for winter use, with good browse and wind protection.

The Loop 4 area contains few lakes suitable for wetlands development, and is rated Class 7 for waterfowl by the Canada Land Inventory.

e) Loop 5

Moose are the most abundant ungulates in this area, although in recent years, mule deer have been immigrating to the area. Moose and deer are to be found in all areas, and especially in the mixed forests along the Peace River.

The uplands area has a moderately high capability for moose and deer. The absence of marshland habitat and excessive snow depth are limiting factors (C.L.I. Maps).

About 30 percent of the area is rated as Class 2 winter range for moose; this includes the forested areas of the Peace River Valley. With the construction of the Site 1 Dam below the Bennett Dam, much of this wintering area will be lost.

With few lakes or ponds, and a steep topography that precludes the development of wetland habitat, waterfowl ratings for the area are Class 7.

f) Loop 7

This Loop area is rated as Class 5 range for moose and caribou by the Canada Land Inventory; production of ungulates is generally low. Snow depth is excessive; other factors such as availability of food plants, adverse topography, wind, exposure, soil moisture or depth to bedrock are moderately severe.

Some moose will summer along small watercourses and winter in valleys below 3,000 feet, or in south or west-facing burn slopes with extensive aspen-willow regeneration.

Woodland caribou may also be found in alpine meadows near the Loop. Rocky Mountain goats and mule deer may also occur in limited numbers in the Loop area.

Production of waterfowl is negligible due to adverse topography. Capability is rated as Class 7 by Canada Land Inventory.

g) Loop 8

The Loop area is rated at 60 percent Class 4 range for moose and 40 percent Class 3 winter range according to Canada Land Inventory. Snow depth is excessive, and production is limited by adverse topography and/or climate. A strip along the Parsnip and Pack Rivers is rated as Class 3 winter range for moose. In general, moose production will only be moderate in this area.

This area is rated as Class 7 (C.L.I.) with negligible water-fowl production. Tudyah Lake is rated Class 5 and may support limited populations of diving ducks, teal, and grebes.

h) Loop 9

The area of Loop 9 is rated as 80 percent Class 4 range for moose and 20 percent Class 3 winter range for moose according to the Canada Land Inventory. Summer distribution of moose is general over the whole area, with larger numbers around the Crooked River - Summit Lake area where there are more preferred plants.

Waterfowl production is low: Summit Lake is rated by the C.L.I. as Class 6, the uplands are Class 7.

i) Loop 10

The area of Loop 10 is given a low rating for ungulate capability: 80 percent Class 4 range and 20 percent Class 3 winter range for moose. Excessive snow depth is a limiting factor in each case. The Fraser River nearby offers excellent winter range for moose, but snow depth is still limiting. Even so, moose are the most abundant and widespread of all ungulates present and are generally found anywhere good browse is found.

Waterfowl production is rated as Class 7, due to unsuitable aquatic and topographic features.

j) Loop 11

This Loop is situated in moderately high (Class 3) winter range for moose and mule deer along the Fraser River.

Moose are widely distributed throughout unfarmed lands during summer. Deep snow at higher elevations force moose to migrate annually between higher summer ranges and lower winter ranges along the Fraser. Moose winter in the Douglas fir forests on the gentle slopes and ridges.

Mule deer are found in greater numbers to the south, but are still fairly numerous in the Loop area. Wintering is restricted to exposed river slopes and mature Douglas fir forests.

Around the settled areas and the farms, ungulate activity is likely reduced by hunting pressure.

Near the beginning of the Loop, along Kersley Creek and its tributary, beaver activity has been noted.

Waterfowl production over the Loop is generally very low. Some small lakes in the area are rated as Class 5 and may support small populations of waterfowl.

The open farmlands interspersed with tall mixed woods provide excellent habitat for songbirds.

k) Loop 12

Important ungulate species in this area are moose and mule deer. Moose are widely distributed throughout the unfarmed lands during the summer, and migrate annually to lower winter ranges along the Fraser River. Moose also winter on slopes in the Douglas fir forests.

Mule deer are fairly abundant in the general area, especially near the farmed areas where summer gardens and forage crops offer variety of diet. The area north and west of the Loop is good wintering range. This includes the slopes of the Fraser River Valley and the valleys of South Hawks Creek and Johnny Creek.

The Loop area is rated as moderately good (Class 3) habitat for moose and deer.

There is low potential for waterfowl production along this Loop. The uplands are rated as Class 7 by Canada Land Inventory. Four or five wetland areas in the proximity of the Loop are rated of moderate (Class 4) potential.

l) Loop 13

No Canada Land Inventory Maps are available for this area. Upland habitat along this Loop is of comparable quality to that on the Loop 12, and is probably of Class 3 to Class 4 wintering conditions for moose and deer, with a better capability along Bridge Creek. Farming activities in this area will reduce use by ungulates.

Beaver activity has been noted along this section of the route.

Bridge Creek may provide some limited habitat for waterfowl, but the rest of the Loop area has few suitable waterfowl habitats; lakes in the area having reduced marsh edge.

m) Loop 14

A moose population is maintained at elevations above 3,500 feet; migrating during the colder months into the valleys. The best moose range is north of M.P. 466.0 in the interior Douglas fir and sub-alpine areas.

Deer are found throughout the area, but excellent winter ranges exist on the south and west slopes of the bluffs on either side of Gorge Creek (MacDonald, 1975). These areas support a population over 4-6 months.

Black bears occur in this area, and because of its remoteness, cougar may occur in the Loopline area.

In no part of this Loop area are conditions conductive to suitable wetlands development. The area is rated Class 7 for waterfowl by Canada Land Inventory.

The cliffs west of the Loop at M.P 468.0 would be excellent habitat for falcons, hawks or eagles. The cliffs are remote, command a panoramic view of the valley and are rather inaccessible. Their proximity to the Loop make timing constraints desirable during spring and early summer.

n) Loop 15

Canada Land Inventory Mapsheets for Ungulate Capability have not been made available for this region. Judging from topography and surface cover, the area appears poor for moose, but has moderate capability for deer. The forests south of the Nicola River appear to be the best habitat, although there is moderate deer habitat along Guichon Creek. The presence of farmlands increase the capability of this area to support deer, although hunting pressures may reduce this. Areas used as rangeland are probably not good deer habitat.

The steep and rolling dry zone through which this Loop passes has low waterfowl capability. Even the Nicola River is too fast moving to permit much marsh edge.

o) Loop 16

There is no Canada Land Inventory classification for ungluate production in this area. It appears to be rather steep and dry for moose, but deer may occur throughout, especially at higher, cooler elevations. Rocky Mountain goats and sheep may also occur at higher elevations. The open Ponderosa pine, Douglas fir forests have little

underbrush and of this, most is unpalatable to deer. The best deer habitat is likely found along the Coldwater River, near areas of farmland.

This dry area with adverse topography is rated Class 7 waterfowl habitat by the Canada Land Inventory.

p) Loop 17

Ungulate capability has not been published by the Canada Land Inventory for this region. The northern area (Boston Bar Creek Valley) is likely too steep for moose; but the dense willow alder shrubs along the Coquihalla River are more suitable habitat. These floodplain forests offer many of the plant species preferred by moose for winter browse, and are probably used extensively for this purpose. Deer too, will likely winter along the flat bottom-lands of the river valley.

In the remoter sections of this area, and at higher elevations, mountain goats and bighorn sheep could be expected.

The area of Loop 17 is very rugged and fairly remote. Large predatory mammals such as cougars, wolves and black bears occur in the area. Grizzly bears may be found in the northern sections.

Production of waterfowl is negligible in this area, with the possible exception of harlequin ducks which breed on fast flowing inland streams. Waterfowl capability is rated Class 7 by the Canada Land Inventory. These remote areas, relatively unaffected by man, are attractive to falcons, hawks and eagles for nesting. The deciduous forests along the Coquihalla River provide very good habitat for songbirds.

q) Loop 18

Loop 18 lies in agricultural land. Woodlots may support a local population of deer, especially on the surrounding hillsides to the north.

Except for a small area to the south, the actual land covered by this Loop is not suited to waterfowl production. However, the various sloughs near Agassiz provide moderately high waterfowl habitat for migration and wintering stop-overs. Whistling swans and Canada geese frequent these backwater areas, feeding on the rich beds of sedges.

The sloughs and backwaters along the Fraser River are the prime wintering areas of bald eagles; these birds perch in the cottonwoods and on the gravel flats along the sloughs waiting for dead salmon to float downstream. These salmon, which have died following their spawning migration, provide a mainstay in the diets of the eagles during the winter months.

r) Loop 19

This Loop lies in totally cleared agricultural land. Deer are found only on the forested slopes to the south of the Loopline.

This area is classed as possessing moderately high capability for waterfowl migration stops or wintering ranges. Various backwater sloughs, recharged during high-water in the Fraser River, the drainage canals and the creeks, provide good wintering habitat. The fields and crops in the area provide feed for ducks, geese and swans.

The sloughs and backwater channels of the Fraser also provide excellent wintering habitat for substantial numbers of eagles.

2.3 Aquatic Environment

Assessment of the aquatic environment along each of the proposed loops is presented in three sections: hydrology and hydrography, water quality and use, and fisheries. Data used in making this assessment include information from relevant government departments and personel, reference material, overview field assessment and analysis conducted during previous studies (Schultz International Ltd., 1975b).

2.3.1 Hydrology, Hydrography

a) Loop 1

Of about six watercourses in this section, two are large creeks, named Big Beaver and Parker. The larger creeks near the pipeline are dammed by beaver. Much of the area is marshy and ill-drained.

The nearest Water Survey of Canada station is the Fort Nelson River. The mean peak flows and maximum recorded discharge are correlated with increases in both temperature and precipitation in May, June, July, and August (see figure in Part A of the miscellaneous materials presented at the end of this volume). Hydrographs of small streams such as those crossed by the pipeline are generally more erratic, with peak flow occurring slightly earlier in the year than that of the large river. However, beaver dams tend to dampen the fluctuations and flow pattern would be closer to that of a larger river. Lowest flows occur in December, January, February, and March.

b) Loop 2

Watercourses within this Loop include a small river called Trutch Creek, and five crossings of its tributaries.

The nearest Water Survey station is the Sikanni Chief River. Since the watercourses in Loop 2 are apparently not regulated by beaver dams, fluctuations in discharge will be relatively greater than indicated in the hydrograph, and peak flows may occur slightly earlier in the year. Washouts of culverts at the crossing sites indicate that the peak flows are significantly greater than those that were observed, and that culvert blockage by drifting brush may occur. Very low discharges and complete freezing of the small creeks are likely during December, January, and February.

c) Loop 3

One watercourse crossing was investigated in this section The creek is a major tributary of Cameron River and is crossed about two miles upstream of their confluence. The surrounding vegetation is willow scrub. Stream banks are quite steep, about three meters high, and are generally stable.

The nearest water recording and weather stations are Blueberry River and Beatton River, respectively. The cold, dry winters result in very low stream discharge values in December, January, February, and March, with seasonal high water in May following snowmelt. Rainfall in June or July may also cause high discharge rates. This stream may cease flowing or freeze to the bottom in winter.

d) Loop 4

The major watercourse in Loop 4 is the Cameron River, tributary to the Halfway River. It is crossed twenty miles upstream of its confluence with the Peace.

Representative water and weather stations are the same as for Loop 3. Having approximately ten times the discharge of the tributary described in Loop 3, the Cameron River will likely remain flowing through winter, although discharge will be low and a complete ice cover is expected. Lowest discharge occurs during December, January, February, and March, with high water resulting from snowmelt in May and potential high flows in June and July from precipitation. The small creek near Mile 147 will probably stop flowing and freeze completely during the winter.

e) Loop 5

The Peace River is crossed by Loop 5 about eight miles downstream of the Bennett Dam. The lake from the Site One Dam will raise the Peace River above the present water level. Clearing of this reservoir area has already taken place.

Discharge from the Bennett Dam is regulated and normal seasonal fluctuations are dampened. Discharge appears to be maintained around 40,000 cubic feet per second (1,275 m^3/second). Although the Peace River at the crossing site does not freeze over during the cold, dry winter, the future lake probably will.

f) Loop 7

The major watercourse crossed in this Loop is the Pine River. Several creeks are crossed near their confluence with the Pine, since the pipeline follows the river channel for eight miles. In addition, a small lake is crossed near its outlet and the pipeline lies very close to the Pine River bank at another location.

Discharge of the Pine River is recorded at East Pine, downstream from the pipeline crossing and after the Sukunka and Moberly rivers have joined the Pine. Its hydrograph shows low flow in December, January, February, and March, moderate flow after mid-August, and peak flow in June following snowmelt, perhaps increased by summer rainfalls which occur in June and July. The river and tributaries at M.P. 105.0 and 111.5 may remain flowing through winter. All others are expected to stop flowing and dry up or freeze to the streambed.

g) Loop 8

The Parsnip River and two creeks are crossed by the pipeline right-of-way in this section. The original river crossing has had no apparent effect on the river and negligible effects are anticipated from another crossing.

The Parsnip River has its greatest annual discharge near the beginning of June, while the period from August through March has low discharge, with a small increase in October. Winters in the area are cold and dry, and small streams probably stop flowing or freeze to the streambed. Information received from B.C.Hydro and

Power Authority indicate that should the McGregor Diversion project go ahead, peak flows of the Parsnip River in the vicinity of the pipeline crossing will double.

h) Loop 9

Two medium-sized marshy creeks are crossed in Loop 9. One is called O'Dell Creek and passes under the John Hart Highway before entering Summit Lake. The other enters a small lake after crossing the pipeline, and eventually enters Crooked River, the outlet of Summit Lake.

The creeks have a low gradient and are regulated by beaver dams. Their high water levels in May and June are a result of snowmelt and low discharges occur from August through March.

i) Loop 10

Through this section, four small creeks are crossed. Two of the creeks join and flow into the Fraser River, while the others are tributaries of Hixon and Naver Creeks which also join and enter the Fraser. Two crossings are a short distance upstream of farmhouses and there is a group of buildings downstream on Trapping Creek.

A water gauge is maintained on Naver Creek, into which drain two of the four creeks in this section. As precipitation is more equally distributed through the year and winters are not so cold as at the Loops farther north, these streams may not have as great a seasonal fluctuation in discharge. Relatively low flows occur in August and September and in December, January, and February.

j) Loop 11

Four small creeks are crossed in this Loop within three miles of their confluence with the Fraser River. At least one of these has excellent fish habitat at the pipeline crossing, but is blocked downstream by other stream users. Considering downstream conditions, the effects of pipeline construction on the streams will be negligible if temporary stream crossing structures are removed and the streambed restored.

Discharge of Kersley Creek is recorded from April through September, and indicates a peak discharge in April, decreasing to near zero by August. Cooler weather in September and October may result in increased discharge for October and November, but low flows are expected through February.

k) Loop 12

Five-Mile Creek and a small tributary are crossed in this Loop. Both of these creeks are expected to cease flow completely between September and February.

Water discharge records are available for Five-Mile Creek for the period from April through September. These indicate a peak discharge in May and near zero discharges from August, probably continuing near zero through February.

l) Loop 13

One creek is crossed by the pipeline in this section. This creek, which flows into Bridge Creek about a mile downstream, is not marked on topographic maps and has a fairly steep gradient, making fish use unlikely.

The hydrograph of Bridge Creek shows an extended period of high water from May through July. The tributary crossed by the pipeline is not expected to have such an extended peak, but its time of high flows within this period is not evident. Low flow can be predicted for the period September through March.

m) Loop 14

As the pipeline descends from 4,500 feet elevation to 1,900 feet elevation in ten miles within this Loop, it crosses six small creeks tributary to Gorge Creek, and one medium and one small creek, Barricade and Silver-spring, which run directly into Deadman River. Both Barricade and Gorge creeks are too steep to permit fish migration beyond the region of their confluence with Deadman River, although fish may be resident in the upper tributaries of Gorge. The pipeline crossing of Barricade Creek is within 100 meters of the confluence with Deadman River, which supports sport fishing and perhaps salmon, rainbow trout, and Dolly Varden char spawning.

The discharge of Deadman River is recorded by Water Survey of Canada and shows an extended period of high water from April through July, with maximum usually occurring in May. The low flow period occurs from September through February. Precipitation is quite evenly distributed through the year, and is low in all months. The small creeks near

4,000 feet elevation may freeze completely over winter, while Barricade may remain flowing, as does Deadman River.

n) Loop 15

The Nicola River, Guichon Creek, and Stumble Creek are crossed in this Loop. Construction in Nicola River and its tributaries is regulated under the British Columbia Gravel Removal Order of the Fisheries Act.

This Loop is in a dry interior climate with less than one inch of precipitation in all months but December and January. The small creeks were nearly dry when inspected in June, and are expected to cease flowing by August. Nicola River has maximum flows in May and June as a result of snowmelt. Discharge decreases rapidly through July, and low flows occur from September into March. Jesse Creek may continue at a very low flow through the winter.

Guichon Creek shows a peak flow in May, with low flows from August into March, and has occasionally stopped flowing during summer and fall, but not through winter.

o) Loop 16

No watercourses are crossed in this section of the proposed construction.

p) Loop 17

Twenty-three major watercourse crossings are encountered by the present gas pipeline right-of-way through this twenty-mile Loop. Of these, 17 are crossings of the Coquihalla River and four are crossings of Boston Bar Creek, a major tributary. Dewdney and Karen Creeks, also tributaries, are crossed once each.

The Coquihalla valley has a moderately wet coastal climate, and the river receives runoff from elevations as high as 6,000 and as low as 500 feet. Precipitation is high from October through March, much of it is snow from December through February at low levels, and over a greater period at higher elevations.

Melting of the snowpack at this range of elevations gives the river's hydrograph a broad peak in May and June, while fall and winter rains can also produce high discharges. The only period of consistantly low flow is August, September and early October. Temperatures are moderate compared to the interior loop areas, and none of the watercourses are expected to develop a complete ice cover.

q) Loop 18

Maria Slough is the only watercourse crossed in this section. Its water level is determined by that of the Fraser River.

Maria Slough is located in an area of high winter precipitation (much of it in rainfall, but also receiving snowmelt from higher elevations nearby). It is expected to exhibit maximum discharge in May and June from snowmelt and rainfall, and moderately high discharge from November through February from winter rainfall. The low flow period should occur from late July through September, with moderate flow in March and April. Only a light covering of ice over a short period, if at all, is expected on this watercourse over winter.

r) Loop 19

This loop crosses agricultural land on the south side of the Fraser Valley. Hope Slough, connected at both ends to the Fraser River, is crossed three times, and three small creeks and a medium creek are crossed once each. The larger stream, Elk Creek is regulated as a water supply upstream of the pipeline crossing.

As in Loop 18, high rainfall during winter months and snowmelt from higher elevations produce a hydrograph with peak flows in May and June, moderate to high flows from November through February, and low flows from late July through September.

2.3.2 Water Quality and Use

a) Loop 1

The streams throughout this Loop drain muskeg areas and are reported as having darkly colored waters. Suspended sediments are generally not high, even at peak annual flow, owing to the low gradient, organic soils and settling in beaver ponds.

No water use permits have been recorded within five miles downstream of the pipeline crossings.

b) Loop 2

Trutch Creek is perhaps typical of many in the area, having excessive color and turbidity at times of high discharge, but running swift and clear at others. Populations of many aquatic organisms are adapted to short exposures to such water conditions and would not be adversely affected unless high silt levels were maintained.

No water use permits have been recorded within five miles downstream of the pipeline crossing.

c) Loop 3

The Cameron River and its tributaries are similar to those watercourses in the area at Loop 2.

No water use permits have been recorded for this tributary of the Cameron River.

d) Loop 4

Water quality on the Cameron River reflects bank erosion during high discharge; suspended solids, the dissolved solids, turbidity and color decrease, as discharge decreases.

No water use permits have been recorded within five miles downstream of the pipeline crossing.

e) Loop 5

Because of settling in Williston Lake above the dam, suspended sediments in the river at the pipeline crossing are at a low concentration.

Water use licences CL27722 and 27721 are issued to B.C. Hydro for power development. No conflicts with pipeline construction are anticipated.

f) Loop 7

The Pine is a gravelled river with slightly turbid water, and a reasonable amount of suspended and dissolved solids during high water.

No water use permits have been recorded within five miles downstream of the pipeline crossing.

g) Loop 8

The major watercourse in this area is the Parsnip, a river with heavy flow during late spring and heavy silt loads.

Two water use licences are recorded for the Parsnip River, about five miles downstream from the pipeline crossing: Finlay Forest Industry, licence CL33624 and B.C. Forest Products, licence CL35059. However, they are apparently not operative as the users now obtain their water from Williston Lake.

h) Loop 9

The water in both creeks in the Loop 9 section appears colored but not turbid, typical of bog or lake water with organic soils.

No water use permits have been recorded on either of the creeks in this area.

i) Loop 10

The streams in this area, flowing downhill from the ridge and through wooded areas, are clear and have stable banks. Where logging has occurred there may be some debris in streambeds and some bank erosion.

Three licences are issued for water use on Trapping Creek: CL28248 to C. Hudson and CL39138 to Camile Hudson, both within two miles of the pipeline, and CL29877 to Pinewood Properties, five to six miles downstream of the pipeline.

No other water use permits are recorded, but the creeks crossed at M.P. 264.0 and M.P. 265.3 pass by farmhouses and may be used within one mile downstream of the pipeline crossings.

j) Loop 11

Kersley Creek is reported to have very clear water with some color, perhaps from organic soils. The low level of suspended solids even at relatively high water would suggest good water conditions for gravel-spawning fish species.

Two water use licences are recorded for Kersley Creek within three miles downstream of the pipeline. Licence L5300 to F. Fredlington and L5243 to Mr. Kaufman. One of these may be the irrigation weir at the highway culvert.

k) Loop 12

The water in Five Mile Creek is reported clear and colored, similar to that observed in Kersley Creek in Loop 11.

Three water use licences are issued to the Superintendent General of Indian Affairs for Williams Lake Indian Reserve, within five miles downstream of the pipeline crossing.

l) Loop 13

The pipeline crosses a stream at M.P. 416.0. It is reported to have turbid, slightly colored water with relatively high dissolved solids.

No water use permits have been recorded within five miles downstream of the pipeline crossing.

m) Loop 14

Loop 14 crosses Gorge Creek at M.P. 459.4, and Barricade Creek at M.P. 467. Both drain from upland areas. The former is reported to be clear, with a moderate amount of color, typical of a moderately slow moving, slightly boggy small stream. Barricade Creek has a higher velocity, and slight turbidity, probably due to stream-bed erosion at high water levels. This creek likely runs clear most of the year.

No water use permits are recorded for any of the water-courses within five miles downstream of the pipeline.

n) Loop 15

The Nicola River is reported to have high levels of suspended solids, to be moderately colored and eroding the riverbank at river bends upstream and downstream of the pipeline crossing.

Five water use licences are recorded for the Nicola River within five miles downstream of the pipeline.

About three miles downstream, licences are issued to a Mr. Gellrich (licence 10456, 33801) and H.A. Stadele (licence 34790). Four miles downstream, licence 4112 is issued to Diamond J. Ranch, and five miles downstream, A.W. and M.M. Baker have licence 32565.

o) Loop 16

No watercourses are crossed in this section of the proposed construction.

p) Loop 17

The Coquihalla River has clear, moderately soft water which becomes slightly turbid water during late spring discharge. Runoff and streambed erosion are in June. The generally clean water even during high water may be the result of a watershed with coarse grained soil and low potential for siltation.

Four water use permits are recorded for the Coquihalla River within five miles downstream of the last crossing. These are licence 15885, J.H. Lamprey; 15869, A. Tudor; 15884, Frost Investments, and 16502, Mr. Mikwasik.

q) Loop 18

Water in Maria Slough, being in an area of high rainfall, is expected to be low in dissolved and suspended solids, except where back-up from the Fraser River may introduce suspended solids.

Water use licence 37190 on Maria Slough is issued to W. and A. Whorly.

r) Loop 19

Low levels of suspended and dissolved solids are expected in these watercourses from agricultural activity.

No water use permits are recorded downstream of the pipeline crossings.

2.3.3 Fisheries

a) Loop 1

Beaver dams are characteristic of streams throughout this Loop, and the aquatic community will be heavily influenced by the environment created by them. The partially isolated ponds, still waters and flooding are not productive of commercial or sport fish species, though six species have been recorded from streams in the area. Low precipitation and low temperatures during the winter months will result in complete ice covers on the streams when their discharge is at its annual minimum, and beaver or other ponds may provide the only suitable overwintering habitat for fish.

Spawning migrations and spawning would occur from April through September for the fish species found in similar watercourses in the area.

b) Loop 2

Streams in this Loop do not appear to be affected by beaver activity near the pipeline right-of-way. The small size of the streams during their high flow period suggests that four of the five small creeks will become very small and will not remain flowing through the winter. Five fish species have been recorded from streams in the

area but Trutch Creek and the creek near M.P. 68.0 are the only stream locations where fish are likely to be found during winter. Mountain whitefish and Dolly Varden char eggs may be present in spawning gravels of these streams over winter and could be damaged by siltation. All streams crossed by the pipeline may be used for spawning in the spring and summer.

Minor sport fishing for whitefish, Arctic grayling, or Dolly Varden might be supported in Trutch Creek.

c) Loop 3

Seven fish species are recorded from the area in similar habitat and probably use the creek during spring, summer and fall. Over-wintering habitat exists in nearby Cameron River and possibly in the tributary as well. Sport fishing potential near the pipeline crossing is low.

d) Loop 4

The Cameron River can be expected to provide habitat for spring and fall spawning and for over-wintering. Eight fish species are recorded from small river habitat in this area. Mountain whitefish, Arctic grayling and Dolly Varden char may be present in sufficient numbers to support limited sport fishing. Both mountain whitefish and Dolly Varden char spawn in the fall and their eggs are present in the gravel through the winter.

e) Loop 5

The great changes in fish habitat caused by changing the river at the pipeline crossing from a large turbid river with seasonal fluctuations, to a large clear river with

little fluctuation, and eventually to a lake with a regulated water level, make a prediction of fish species relatively difficult. Thirteen species are recorded from the Peace River, while twenty-one species could live in a lake. Which fish species, if any, will live successfully in the lake will depend on many factors unrelated to the pipeline crossing. Sport fishing may be supported near the crossing site, both in the river and in the future lake.

f) Loop 7

The Pine River provides year-round fish habitat and supports sport fishing and spring and fall spawning. Nine species of fish have been recorded from the area, including Arctic grayling, Dolly Varden char, and rainbow trout. Some of its tributaries support spring spawning in their lower reaches, and those that keep flowing may provide fall spawning habitat.

g) Loop 8

Thirteen species of fish are recorded from the Parsnip River area, including sport fish spawning in the spring (Arctic grayling and rainbow trout), and in the fall (Dolly Varden char and mountain whitefish). Much of the spring spawning may take place in tributaries rather than the river itself. Five of these species and an additional four are found in stream habitat in the area. Fish movement into the creek from Tudyah Lake may be hampered by the waterwheel installed near the mouth, and by the beaverdam downstream of the pipeline crossing.

The Parsnip River and Tudyah Lake will support fish over winter. The smaller creeks are expected to dry up or freeze completely during the winter, and the creek entering Tudyah Lake will have a very small discharge, if any.

h) Loop 9

Nine species of fish may occur in the bog-like habitat provided by the creeks. No spawning areas sensitive to siltation were observed. Upstream fish movement from Summit Lake to the pipeline crossing may be blocked in high discharges by the water velocity through a culvert on the John Hart Highway.

i) Loop 10

Streams crossed in the Loop are of marginal fish habitat because of their small size. Seven species of fish including rainbow trout, Dolly Varden char, and coho salmon may use the streams farther downstream, but their presence as far upstream as the pipeline is doubtful.

j) Loop 11

A few Dolly Varden char and rainbow trout may be resident in the small streams. Low winter flows and downstream obstructions limit the use of these streams by fish.

k) Loop 12

Fish are not expected to be maintained in either of the creeks crossed.

l) Loop 13

The creek at M.P. 416.0 appeared to have a fairly steep gradient at the crossing site, with boulder substrate and possible fish barriers above and below the right-of-way. Since water quality was acceptable for fish use, the creek may be used by fish downstream where it nears Bridge Creek. With the probability of the creek drying up or

freezing, fish remaining over winter at the right-of-way is not considered likely.

m) Loop 14

Considering the high gradients preventing fish migration in both Gorge and Barricade Creeks, the presence of fish near the pipeline crossings is unlikely. Deadman River, a tributary of Thompson and Fraser Rivers, may provide spawning habitat for coho salmon. Nine fish species, including rainbow trout and Dolly Varden char, could be found in Deadman River and its tributaries. Indications of sport fishing at the confluence of Barricade Creek and the river were observed on June 5.

n) Loop 15

Sixteen species of fish may be represented in the Nicola River and its tributaries. Among these are spawning salmon and freshwater sport fish.

o) Loop 16

No watercourses are crossed in this section of the proposed contruction.

p) Loop 17

The Coquihalla is a clear swift river with clean gravel bottom and several tributaries suitable for fish rearing, entering the Fraser River about 90 miles from the ocean. As such, it could be expected to support spawning of several species of Pacific salmon, as well as steelhead trout and several species of resident fresh water fish. However, a partial blockage to upstream migration exists in a canyon about five miles from the confluence with

the Fraser River. At this point, a natural constriction of the river, possibly worsened by railway tunnel construction in 1915, blocks upstream movement except during high water levels. Salmon, which enter the river in fall and are nearing spawning condition, cannot pass this barrier in any significant numbers. Approximately 15,000 pink, and several hundred each of coho, chum, and sockeye salmon, spawn in the three miles of suitable habitat downstream of the obstruction.

Sea-run rainbow trout (steelhead) spawn in March and April after passing the canyon during May-June high water of the previous year (summer-run) or during minor flood peaks from November through March (winter-run).

Since the Coquihalla is one of only four rivers near Vancouver supporting a summer run of steelhead, it received considerable fishing pressure as access was improved. Logging activities in the valley from the early 1940's and continuing to the present, undoubtedly had an adverse effect on some spawning and rearing habitat. The population of summer run steelhead entering the river, once estimated to be 3,000 fish, is now apparently less than 300, and fishing has been restricted for many years in an attempt to allow it to increase.

Although closure to angling above the canyon prevents their exploitation, resident populations of Dolly Varden char, cutthroat trout, rainbow trout, and mountain whitefish could support sport fishing.

q) Loop 18

About twenty species of fish may be found migrating through or living in similar habitats in the area. It is not expected that pipeline construction will damage spawning habitat or adult fish of any of these species.

r) Loop 19

Many species of fish may be found in the slough and medium sized creek. It is not expected that pipeline construction will damage spawning habitat or adult fish of any of these species.

2.4 Socio-economic Environment

The proposed Looping Program passes through five regional areas of B.C.: the Peace River Region (Loops 1, 2, 3, 4, 5, 7, 8), the Prince George Region (Loops 9, 10), the Quesnel Region (Loops 11, 12, 13), the Thompson-Nicola Region (Loops 14, 15, 16) and the Fraser Valley Region (Loops 17, 18, 19). This section presents an overview assessment of socio-economic conditions in these regions, including more detailed descriptions of the towns close by the proposed Loops. Specific details as they apply to the actual Loop areas are also included. Impacts on the socio-economic environment are discussed in Chapter 3.0.

2.4.1 Peace River Region

a) Regional Overview

The Peace River region is located in the northeast of British Columbia, covering 80,500 square miles of varied terrain. The section west of the Rocky Mountains consists of plateaus and mountains similar to those found elsewhere in the province's interior, while east of the Rockies the landscape is typical of the Interior Plains of North America. Despite its large size, the region contains only two percent of the province's population.

While agriculture was the dominant economic activity up until the 1940's, resource industries such as forestry, mining, and oil and gas extraction have expanded since that time, resulting in sporadic but continuing population growth. Like other areas that are basically dependent on primary resource exploitation, the region has experienced surges of population growth, generally related to major development projects.

The seasonality and instability of economic activity combined with the relative remoteness of the area have given rise to a number of social-community problems. A high incidence of mental illness, particularly among women, the prevalence of alcololism, housing shortages, and chronic unemployment among the region's 2,000 status and non-status Indians are examples of these problems. Average per capita incomes are four percent lower than the provincial average.

Before World War II virtually all economic and social communications were with Alberta, since no road or rail links with southern British Columbia had been constructed. The completion of the Alaska Highway in 1942 connected Dawson Creek to Alaska and the Yukon, and by 1952 the John Hart-Peace River Highway provided access to southern B.C. via Prince George. More recently, the Pacific Great Eastern (now British Columbia) Railway was extended to Dawson Creek and Fort St. John in 1958, and Fort Nelson in 1971. Rail freight, express and passenger service to Edmonton is provided by the Northern Alberta Railway, which intersects with the B.C. Railway at Dawson Creek. Scheduled airlines provide access from Fort Nelson, Dawson Creek and Fort St. John to Whitehorse in the north and Vancouver and Edmonton to the south and east.

Improvements in transportation facilities have made commercial agriculture more viable, while also allowing forest industries to expand. Discovery of oil and natural gas in the Great Plains area has led to still more economic and population growth.

Farming directly employed 1,655 persons (9.2 percent of the labor force) in 1971, and generates approximately $20,000,000 a year in farm cash income. The oil and gas industry employed about 200 people in the processing phase in 1974, but the numbers involved in well drilling and servicing were much greater, totaling 700 - 1,000 during the peak winter months of 1972. Many of the exploration and development crews were imported into the region, being part of Alberta and B.C. oil and gas identity. However, these numbers are probably decreasing as a result of the gradual decline of drilling activity since 1972. Forest industries, the third major economic activity, employed approximately 1,800 people in logging and milling in 1974.

b) Fort Nelson

The northermost of the major settlements in the Peace River region is Fort Nelson, a village with an estimated population of 3,200 in 1975. Located too far north for extensive commercial agriculture, it is dependent primarily on lumbering and oil and gas exploration and processing. Mining activity has increased in recent years, and is likely to become increasingly important in the Fort Nelson area. Its strategic location at the terminus of the British Columbia Railway, and on the Alaska Highway and Fort Nelson-Liard-Mackenzie River system, makes the village a significant transportation center and stopping-off point for vacationers.

In recent years Fort Nelson has received a million-dollar school, an extension to the hospital, and improved its water system and streets. Construction of housing and commercial facilities has increased since the early 1960's, reaching a permit value of $12,579,780 in 1974. A steady increase in the volume of retail trade from $1.3 million in 1961 to $3.7 million in 1974 has encouraged the establishment of several chain supermarkets and numerous other retail and service industries.

In general, unemployment is quite low in the northeast of British Columbia, and this is particularly true of Fort Nelson. The Canada Manpower Center in that community estimates that on the average, 20 - 30 people are unemployed, but there is considerable seasonal fluctuation. Currently (June 1976), there are about 146 people unemployed in Fort Nelson. Seasonal fluctuations are related to the seasonal activity of bush operations. Other fluctuations result from problems such as railway shutdowns and periodic layoffs in the mining and lumber industry.

The employment situation in the Fort Nelson area has always favored traditional male occupations, and as a result the population's male/female ratio was 65:35 in 1971. The predominance of males and the unstable nature of resource-extraction industries is reflected in the transience of a significant portion of the work force, particularly during the summer months.

c) Fort St. John

Fort St. John is the oil and gas capital of British Columbia, and its 1976 population of over 13,000 makes it the second-largest settlement in northeast

British Columbia. Rapid growth since the late 1950's is attributable to an upsurge of oil and gas exploration and extraction agricultural development, and increased lumber production by several sawmills in the area. Development of the Peace River hydro power project during the 1960's also contributed to the town's growth.

Although job opportunities in Fort St. John are highly seasonal, unemployment is generally relatively low because the unemployed tend to move to Dawson Creek or completely out of the region. In June of 1976, 688 people were registered as in search of employment.

Transportation is a significant industry in Fort St. John, as indicated by the fact that 32 truck lines provide services in that center. The British Columbia Railway line passes through the town, and Canadian Pacific Airlines is the major scheduled air carrier operating out of Fort St. John.

2.4.2 Prince George Region

a) Regional Overview

South of the Peace River Region settlement, the next major center is Prince George, situated in an extensive basin in the Central Interior Plateau. The vegetation cover is a transition from the boreal forest in the north to the dry-belt forests of the southern interior. The forest industries which are the mainstay of the region's economy have actively exploited this resource since the 1940's. Before World War II, a combination of small-scale farming, logging, placer mining, and trapping supported the small population; but since 1941 rapid economic growth

has brought about a more than thirteen-fold increase in the region's population. Between 1941 and 1975 the population increased from approximately 5,250 to approximately 71,000, with an average annual growth rate of 7.1 percent since 1971.

Since the 1940's, the Prince George centered region has grown to become the hub of B.C.'s northern and central interior. The Canadian National Railway connects Prince George with the seaport of Prince Rupert on the west coast and Edmonton to the east. During the 1950's construction of the John Hart Highway to Dawson Creek and railway links to Quesnel in the south and the Peace River region in the north were an essential part of a high rate of economic growth.

b) Prince George

The city of Prince George is the third largest settlement in British Columbia, after Greater Vancouver and Greater Victoria. Its 1975 population of over 64,000 is economically dependent primarily on the three pulp mills and twelve sawmills within the city boundaries, as well as (in order of importance) services, trade, construction, and agriculture. Two chemical plants, an oil refinery, three modular housing firms, and several light manufacturers are also established in the city.

As a result of the center's rapid economic growth, worker incomes are above the national average, as reflected in the 1974 retail sales of $4,630 per capita. This figure makes Prince George the leader among Canadian cities under 100,000 population. Per capita spending in Vancouver was $2,400, while the provincial average was $2,240. Average weekly earnings per worker were $181.82 in 1973, compared to the national average of $160.20.

The significance of Prince George as an industrial and commercial center has been matched by its increasing importance as a center of government administration. More than 30 federal and provincial government departments maintain regional offices there, and the College of New Caledonia is undergoing a $10 million expansion to meet the needs of a population which is now increasing at the rate of seven and one-half percent a year.

It is expected that government policies to decentralize, should they mature, will bring about an increase in government institutional concentration in the Prince George area.

A large hospital and many specialized consumer and social services are available, and the city's airport is being up-graded to handle main jet aircraft traffic. Canadian Pacific and Pacific Western Airlines connections to Vancouver, Edmonton, the Peace River region, the Yukon, Alaska, and several regional centers help to make Prince George one of western Canada's most important air transportation nodes.

A growing tourist industry is a significant factor in the city's economy. Hotel and motel development has been a leading growth sector in Prince George. A major project currently under development is the $3.5 million Stage Inn, which will add 120 rooms to the existing 1,636 rooms of hotel and motel capacity. Facilities are available to handle conventions of up to 2,000 visitors.

Several large shopping centers are recently being completed, and construction of office and commercial space is continuing. Two television stations, three radio stations, and a daily newspaper serve the region's communication needs. Numerous parks, resorts, beaches and two golf courses comprise the bulk of outdoor recreation facilities for local residents and visitors. One of these parks, Whiskers Point Park, is on the shore of McLeod Lake and directly on the proposed pipeline route. A variety of indoor recreation facilities is also available.

Because Prince George has grown so chaotically over the last two decades, all levels of government have been unable to provide adequate social services at the required rate. In January of 1975 the city's boundaries were extended so that it's land area was increased by six times and it's assessment base doubled to $320 million. A new master community plan for the city is expected to ensure more orderly and balanced development in the future.

Because Prince George has a more diversified economic base than single-resource oriented settlements such as Fort Nelson, the seasonal variation in unemployment rates is much less. The average rate of unemployment, however, has increased gradually over the last decade to the point where it is approximately twice the 1965 rate. This trend is consistent with changes on the provincial level. The pool of unemployed people has increased to 4,246 on June 6, 1976, as indicated by figures supplied by the Prince George Canada Manpower Center. Of these, between 50 and 60 percent are males.

2.4.3 Quesnel Region

a) Regional Overview

Seventy-five miles south of Prince George and adjacent to the pipeline route is the town of Quesnel, with a population of approximately 7,500 in 1975. At this point the Quesnel River joins the Fraser, and settlement is concentrated on a tongue of alluvial sediment at the mouth of the river. The region was initially developed as a fur-trading and placer gold mining area during the nineteenth century, and since World War II has depended primarily on forest industries, ranching, mixed farming, and tourism, in that order of importance.

Rapid economic growth has continued for three decades, with the most recent significant addition to the region's economy being a pulp mill which began operation in 1972. Settlement has gradually spread along both rivers and Highway 97, which connects Quesnel to Prince George in the north and Williams Lake in the south. A number of unincorporated small centers in the immediate vicinity of Quesnel have increased their populations as well.

Although Quesnel is much less significant as a transportation mode than Prince George, it is an important link between the mining town of Wells, eighty miles to the east, and the Nazko-Blackwater River ranching area to the west. From Quesnel, highway, rail and air transportation to Vancouver and the north has been established.

Before the 1940's, mixed farming and sporadic placer gold mining activity were virtually the only basic economic activities in the area. After about 1946, however, large numbers of small sawmills appeared, producing lumber to be shipped mainly to the United States via Vancouver. These

small operations have since been replaced by a few larger corporations, and lumber production has increased steadily. The world's largest sheathing plywood plant is located in Quesnel, and a 750-ton per-day kraft pulp mill opened recently. Farming is still important, with specialized beef production replacing mixed farming as the most important land use.

b) Quesnel

The town of Quesnel is taking advantage of its location, resource base and colorful history to actively promote investment in forest industries, transportation and the tourist industry. Forest activities are by far the most important sector of the town's economy at this time, employing approximately 40 percent of the labor force.

The full range of urban, social and other services are available in Quesnel, including secondary schools, a good hospital, a radio and television station, a weekly newspaper, a variety of supermarkets and other shopping facilities, a library, movie theaters and other recreation facilities.

Despite the variety of available amenities, Quesnel is still subject to many of the social and community problems described in the case of the Peace River region. Family breakdown, alcoholism, high crime rates, and conflict between white youths and immigrants from Pakistan and India are particularly serious difficulties.

Employment conditions have improved and been slightly diversified over the years as the hundreds of highly-seasonal small sawmills were replaced by a few larger ones, and the area developed as a local and regional service center with tourist facilities.

The current (June 1976) unemployment rate is between seven and eight percent, which is comparable to the provincial figure.

c) 100-Mile House

To the south of Quesnel the next major center which is close to the pipeline route is 100-Mile House, a small center which relies on ranching, mining, forestry and recreation. Its growth has been recent, with population increasing from 161 in 1951 to 1,500 in 1975.

Community services now include an airport, a hospital, schools, and highway connections to the north and south.

The area contains ranch lands which are currently being marketed as recreational "ranchettes", aimed primarily at Vancouver region residents.

2.4.4 Thompson-Nicola Region

a) Regional Overview

Thirty miles south of 100-Mile House the proposed pipeline runs due south through the Thompson-Nicola region. Passing the settlement of Savona at the western end of Kamloops Lake, it continues on through the larger town of Merritt.

Most of this region consists of rolling plateaus and highlands incised by deep river valleys. The dry zone below 3,000 feet is covered by grasslands which support ranching and irrigated farming, while merchantable timber stands are found at the higher altitudes where rainfall is heavier.

Most of the region was unsettled until the early nineteenth century, when the fur trade led to the establishment of a few trading posts. The 1850's gold rush brought a wave of settlement and began a still-active metal mining industry. Agriculture, transportation, lumbering and tourism became important much later.

Today both trans-continental railways, the Trans-Canada Highway, Highway 5, and scheduled air services serve the region. Kamloops is the major regional center, and dominates much of the economic activity in the area.

The Thompson-Nicola region contains a wide variety of mineral deposits. Copper is the most important and is produced principally at the mines in the Highland Valley. Craigmont Mines near Merritt and Similkameen Mine near Princeton are also important. Other industrial minerals found in the area include gold, silver, lead, zinc, molybdenum, and nickel. The area of highest mineral potential is the Highland Valley, to the west of the pipeline route between Logan Lake and Merritt.

Major undeveloped coal deposits are also found in the same area, and exploration is continuing. The Hat Creek coal deposits are being considered as the basis of a major potential thermal electric generating plant, which would be operated by the B.C. Hydro and Power Authority to supply power to the load centers in the southern part of the province.

Forestry is an important industry, with most logging activity being located in the upland area. A major pulp mill was opened in 1967 just west of Kamloops, which also has major sawmill complexes within short distances of the city. Other major sawmills are in operation at Merritt,

Savona, and in the Fraser River valley to the west. Total rated daily capacity of the sawmills in the Thompson-Nicola region (excluding Kamloops) was in the order of 1.3 million boardfeet measured in 1973. The industry is currently in decline due to lower lumber prices in the United States, which usually absorbes 75 to 80 percent of British Columbia lumber exports, but it is expected that in the long-run the forest industry will be basically sound.

Agriculture in the Thompson-Nicola region is mainly founded on beef production and irrigated fruit and vegetable products. The tourist industry caters to travellers and vacationers.

b) Savona

This small wayside community, with a relatively stable population of about 350, is dependent on a sawmill, some agriculture, and a few highway services. A compressor station and pipeline service depot of Westcoast are located at the edge of the village. Few services or recreation facilities are available, and residents tend to rely on Kamloops for most services. However, the community has a satellite television transmitter, telephone service, and a few other basic amenities.

c) Merritt

Merritt is situated in the broad, grassy valley of the Nicola River at its confluence with the Coldwater River. Considerably larger than Savona and comparable in size to Quesnel, it functions as the trading center for the Nicola Valley and Highland Valley region. A paved highway connects it with Kamloops, 62 miles away, and Princeton, 56 miles to the south. Another highway leads to Spences Bridge, located on the Thompson River and the Trans-

Canada Highway. The Canadian Pacific Railway has a branch line which passes through Merritt on its way from Princeton to Spences Bridge.

Merritt's population of 6,000 depends for its livelihood on three major industries - mining, forestry, and ranching. Craigmont Mines has the largest single payroll in the town, employing some 450 people in 1975, but production levels are being reduced.

The full range of urban services are available in Merritt. An airport supplements the road and rail lines, parks and beaches are plentiful, and the municipality provides recreation facilities such as a curling rink, arena, and swimming pool. Two weekly newspapers, a radio station, and a cablevision company are established there, and the usual medical and educational facilities are available to residents.

2.4.5 Fraser Valley - Hope to Sumas

a) Regional Overview

At Hope, the pipeline right-of-way crosses the southern Trans-Provincial Highway and enters the Fraser Valley Region, running along the southern bank of the Fraser River to the United States border at Sumas.

The Fraser Valley is one of Canada's richest agricultural areas, and is very densely populated. A large variety of field crops are produced, as well as poultry, milk, eggs and livestock. Food processing plants are scattered throughout the region, some forest products are processed in several locations, and tourism is an important industry in some Fraser Valley settlements.

Another important function of the region is that of a transportation corridor - the Trans-Canada Highway extends through the valley from Hope to Vancouver, as do the two trans-continental railways. The British Columbia Hydro Railway also connects several Fraser Valley centers to Vancouver.

On a regional level, employment and unemployment rates are much more constant than they are in the interior of the province. Most valley communities, with the possible exception of Hope, are close enough to each other and to Vancouver so that the effects of seasonal fluctuations and sudden growth or decline in one center are dispersed throughout the region as a whole. In recent years communities such as Abbotsford have begun to function as bedroom communities for people employed in Vancouver, leading to population growth without a comparable expansion of the region's economic base.

b) Hope

The town of Hope is within a few miles of the pipeline, and Loop 17 is to be constructed to the immediate north of the town. Its population of 3,500 is sustained by logging and tourism - agriculture is virtually non-existent, unlike most of the Fraser Valley. Other than basic services such as schools, medical services and a post office, Hope has few amenities for a town of its size. However, it is important as a highway node connecting the Trans-Canada and southern Trans-Provincial Highways. The town is characterized by highway service functions, including motels and camping grounds.

c) Chilliwack

Chilliwack is more typical of the settlements in the valley. Population growth has been gradual, reaching 9,135 in 1975, while the population of Greater Chilliwack reached 37,500. Because agriculture has for many years been the single most important sector of the economy, the city has a much more stable character than Hope or northern settlements such as Fort Nelson and Quesnel. Agricultural activity is complemented by the lumber industry. Tourist attractions such as Cultus Lake also contribute to the regional economy.

A large regional medical facility is located in Chilliwack, and a regional junior college was opened recently.

Communications in the area are handled by B.C. Telephone Company, CN-CP Telecommunications, a radio station, and a weekly newspaper. Chilliwack has its own municipal airport with a 2,500-foot paved strip, and Kent Aviation Services provides local charter service.

A major Armed Forces Base is located next to the town, providing a substantial and consistent support to the economy, as a result of the large civilian workforce employed there.

As of June 6, 1976, 1,095 people were unemployed in Chilliwack, a figure 200 - 300 above the usual unemployment rate at that time of year. Because of climatic conditions the logging industry declines during the winter, as does agriculture, with the result that there is great seasonal variation in unemployment rates.

d) Abbotsford

The District of Abbotsford is approximately equal in size to Greater Chilliwack, with a population of 42,000 in 1975. Some 9,500 of these live in the village of Abbostford. Situated 45 miles east of Vancouver, Abbotsford is also located on the Trans-Canada Highway four miles north of the Canada-U.S. boundary, and is served by the British Columbia Hydro Railway and a Canadian Pacific Railway branch line. It has a large airport which functions as an emergency alternative to Vancouver International Airport.

The District consists of a large farming area, a residential area, and a commercial-industrial area. The principal sources of income are farming and related food processing, some brick and tile manufacturing, and retail and service trade.

2.4.6 Socio-economic Conditions at Each Loop Segment

a) Loops 1-3

All of these Loop segments are located on Crown land, with access via the Alaska Highway. Stands of merchantable timber are limited in all of the looping areas, and there is minor hunting and trapping activity. Sites of archaeological importance are not known and there is low potential for their existence. The Fort Nelson and Prophet River native Bands have widespread interests in the general area of Loop 1, but there are no Reserves holdings near Loops 2 and 3.

Construction of Loop 1 will bring it to within one mile of the Alaska Highway. Loop 3 passes within 1/4 to 3/8 mile of the end of Sikanni Chief Airfield and crosses the Alaska Highway at Mile 146.

b) Loop 4

This Loop segment lies mainly on Crown land with access from logging and construction roads. Prehistoric or historic sites have not been found, although native campsites may be located along the Cameron River. There are no native Reserve holdings nearby. The area has a moderately highy capacity for outdoor recreation, especially hunting, and present land use includes cattle grazing. Most merchantable timber has been harvested.

The southern end of Loop 4 extends to within approximately one mile of the Halfway River, and to within a short distance of several cattle ranches.

c) Loop 5

The proposed Loop segment is on Crown land with access from the Portage Mountain Highway. Several archaeological sites have been identified near the right-of-way and there is a good potential for further sites to be uncovered. Agriculture and forestry operations exist near the right-of-way and good capability for recreation exists alongside the Peace River.

There are no native Reserve holdings near the proposed Loop area.

Commercial stands of timber are found in patches throughout this "parkland".

d) Loop 7

The proposed Loop segment lies on Crown land and is directly accessible from the John Hart Highway (No. 97) and the British Columbia Railroad. No known archaeological sites exist but the probability of discovery is high along the Pine River. Two 500 Kv powerlines of B.C. Hydro also occupy the route. There is no significant mining or agricultural potential. Some commercial timber stands have been logged on the upland slopes.

Recreational capacity in this area is rated moderate; at present there are no facilities to support recreation.

No native Reserve holdings exist in the area.

e) Loop 8

This proposed Loop segment lies on Crown land except for several private parcels by the Parsnip River crossing. The entire area is directly accessible from the John Hart Highway. The route is also shared with the B.C. Hydro transmission system. The British Columbia Railroad crosses the Loop segment at 142.2.

No known archaeological sites exist but the area around the Parsnip crossing may have historical significance. Moderate recreational development has potential at this crossing.

No merchantable timber is found on the right-of-way. No native Reserve holdings are in this area. Two fur traplines cross the right-of-way.

f) Loop 9

The proposed Loop segment is on Crown land immediately north and east of the settlement of Summit Lake. Direct access to the area is possible from several points on the John Hart Highway. No direct impact on the settlement is foreseen. No known archaeological sites exist. Several major native Reserve holdings are in the vicinity, owned by the McLeod Lake Indian Band of McLeod Lake, B.C. The area also has historical significance in the fur trade. A fur trapline crosses the right-of-way.

Selective logging is a basic local activity, followed by tourism, hunting and some trapping. Recreational potential is high, and future development is probable. Several campgrounds, cottage areas, and picnic sites have been developed in the area.

g) Loop 10

The proposed Loop segment is on both Crown and private land; access is from several local roads.

Archaeological sites exist in the vicinity of the Fraser River, but would be improbable in the immediate area of the Loop. No native Reserve holdings are in the vicinity. The southern end of the Loop segment is one mile from the settlement of Hixon.

Present land use includes trapping, logging, ranching, forage croplands, hunting, and recreation. The recreational potential is low, but a youth detention camp near Trapping Lake may signal further recreational development around the lake. Two traplines cross the right-of-way.

The community of Hixon is largely a highway-based settlement involved in commercial, service and maintenance activities, and some forestry and ranching.

h) Loop 11

The proposed Loop segment is largely on private land; access is provided throughout from Highway 97 or, if required, from the B.C. Railway tracks alongside the right-of-way.

Archaeological sites have been found in the area and more may exist.

Present land uses include pasture, forage crops, and selective logging in the uplands. No public recreation sites exist and rated capacity is moderately low. Complications may arise in connection with the adjoining Railway right-of-way. No native Reserves are in the immediate area.

i) Loop 12

The proposed Loop segment is largely on private land. Access on the south-east end can be attained directly from Highway 97, via the "Horsefly Road" which crosses the right-of-way at Mile 367.9. This road also provides access to the local municipal dump.

Several native Reserve holdings exist in the immediate vicinity, owned by the Williams Lake Indian Band; none are adjacent to the right-of-way. This continuously inhabited area has yielded many archaeological sites but none are expected in the Loop segment, except possibly near Five Mile Creek.

Logging and ranching are the local economic mainstays. The regional center of Williams Lake is 15 miles westward and provides a broad basis for employment and urban-related amenities. Recreation is orientated towards highway-based transient services or cottaging and camping in lake areas to the east.

j) Loop 13

This Loop segment is on both Crown and private land; access is available from secondary roads.

Two archaeological sites exist east of the Loop segment but the potential for any more is low. There are no local native Reserves.

The area supports limited timber cutting, ranching, forage crops, and winter trapping. The community of 100 Mile House provides urban-related economies and amenities, including an airstrip. Recreational capacity is low and tourist services are largely limited to highway traffic. B.C. Railway and B.C. Hydro power lines share the vicinity and cross the Loop segment right-of-way.

The north-end of the right-of-way ends immediately adjacent to a municipal water tower, the 38-bed 100 Mile District General Hospital, and 40+ mobile home park and campground.

k) Loop 14

This Loop segment lies primarily on Crown land; access is limited to range access roads, some possibly with weather restrictions.

Archaeological sites have been identified around Hihium Lake in an area where the Bonaparte, Kamloops, Deadman's Creek, and Nicola Indian Bands have joint Reserve holdings; further pre-historic sites may be found on the adjacent Loop segment.

The lake area (M.P. 457) has been reserved for future provincial park development as recreational potential is rated highly. Present land use focuses on selective logging, ranching, and hunting.

1) Loop 15

A This proposed Loop segment is located on Crown and private lands. It has been routed away from the main-line, around a native Indian Reserve, thus requiring approximately ten miles of additional right-of-way. Access to the proposed Loop segment is limited to local roads including the access road to an open-pit mine.

B The Lower Nicola Indian Band own the large Nicola-Mamet Reserve (11,333.6 acres) through which the present mainline runs. Other Bands - the Upper Nicola , the Douglas Lake, and the Coldwater Indian Bands - occupy or hold Reserves in the general area; many share interests in major holdings. There are no designated archaeological sites but the potential for such sites is quite significant.

C Land use along the existing mainline focuses on grazing and forage crops. The proposed Loop route crosses small private land holdings and some irrigated croplands. The massive tailings pond of the nearby Craigmont Mine and the access road to the mine, share close proximity to the proposed right-of-way.

The Loop segment crosses Highway 8 and the Canadian Pacific Railway alongside the Nicola River. The settlement of Lower Nicola, and the town of Merritt, five miles to the east, provide most of the economic and social base for the area. Recreational capability is largely restricted to the Nicola River area, and small upland fishing lakes.

m) Loop 16

This proposed Loop segment crosses Crown and private land; limited access is by local road.

Paul's Basin Reserve, owned by the Coldwater Indian Band, is close to the Loop segment. Archaeological site potential in the area is, however, low.

Planning for a highway route through this corridor (the Coquihalla Highway) and the local forestry roads program are of concern to right-of-way developments.

Land use is restricted to limited rangeland and forage crops. No large-scale recreational potential exists. Canadian Pacific Railway and Trans-Mountain Pipeline also occupy this route.

n) Loop 17

This Loop segment is primarily on Crown land; access is by secondary road.

No archaeological sites are recorded and a potential for sites exists only at the southern end of the segment. The Kawkawa Lake Reserve, owned by the Union Bar Indian Band, straddles the pipeline route immediately down from the Loop segment.

Land use focuses on the area as a route through the Cascade Mountains. The Canadian Pacific Railroad was withdrawn because of unstable local conditions but a major highway is planned through the route. Small, localized recreational sites exist along the Coquihalla River, with higher development potentials nearer to Hope. Local economies and amenities are based largely on transportation and tourism functions at nearly Hope.

o) Loop 18

This proposed Loop segment is located across private land and two native Reserves. Access is from Highway 7 and local roads.

Archaeological sites occur around the Loop area and there is a significant potential for more. Historical sites may also be encountered, related to early settlement efforts.

Seabird Island Reserve (5,290 acres) is owned by the Seabird Indian Band; the smaller Reserve (M.P. 619), is owned by the Cheam Indian Band.

Agricultural development is the feature land use along the Loop segment; no recreational facilities are planned, although capability is high along the shores of the Fraser River. The Canadian Pacific Railway mainline also serves the area. Local amenities and economies are based at nearby Agassiz and other valley centers.

p) Loop 19

This proposed Loop segment crosses two native Indian Reserves and private land. Access is by local roads and Highway 401.

Archaeological sites have been designated in the area and some are adjacent to the right-of-way. The Reserve at M.P. 621 is owned by the Cheam Band and at M.P. 623.6 by the Skwah Band. Other native Band interests occur in the vicinity.

Agriculture crops and farmland are developed throughout most of the segment. Economies and amenities are centered in nearby Chilliwack, a major regional center. Utilities crossing or adjacent to the segment include the Canadian National Railway mainline and the Trans-Canada Highway. No recreational sites are developed nearby.

2.4.7 Supporting Socio-economic Data

Data selected to illustrate the socio-economic environments as discussed previously, are contained in Part B of the miscellaneous materials presented at the end of this volume, and Appendix IV - Part C in Volume III. The map data are presented in illustration of the corridor conditions and are not intended to be a description of the total province.

2.5 Hazards

The pipeline route south from Fort Nelson is in a region of low seismic risk. Field inspection of the existing line which has been in operation since 1957, showed no major erosional or instability problems. The Looping program should not initiate problems which would endanger the line.

Several stream and river crossings are involved in the Looping program. Problems such as meandering, bottom scouring, and bank erosion must be addressed. These problems are discussed in Chapter 3.0 of this report.

In addition to natural hazards there are self-induced and man-induced factors which can lead to rupture in the pipeline. These hazards include defects in materials, unrelieved construction stresses, and accidental or deliberate contact with the pipe by heavy equipment.

3.0 ENVIRONMENTAL IMPACT OF THE PROPOSED PROGRAM

The proposed Looping Program involves laying new pipe alongside the already existing pipeline in a previously established right-of-way. Except for Loop 15, which will be placed in a new location outside an Indian Reserve, instead of along the existing line in the Reserve, new cleared areas will be minimal. Impacts will therefore be largely restricted to those generated at the time of burial of the pipe. Socio-economic impacts will be largely limited to the communities nearby the looping areas.

A maximum work force of approximately 1,000 men is proposed to carry out the whole project. The proposed work schedule (see Figure 2) begins in January 1980, and ends in the autumn of 1980. Excluding demands for support services, a total of 6,500 man-months of work will be required. About 20 percent of this could be suitably supplied from local sources; this is the maximum amount; labor requirements could alleviate unemployment in any of the regions along the Looping Program.

Furthermore, the proposed program is located (for the most part) within a developed corridor. Transport and support services are present and available within a matrix of settlement and communication of a high order. Given the short length of the program and the small work force employed, construction and operation of the loopline is unlikely to have any noticeable regional impacts.

Specific impacts along the proposed loops are outlined in the following sections (3.1 - 3.18). Socio-economic impacts are outlined in Figure 4.

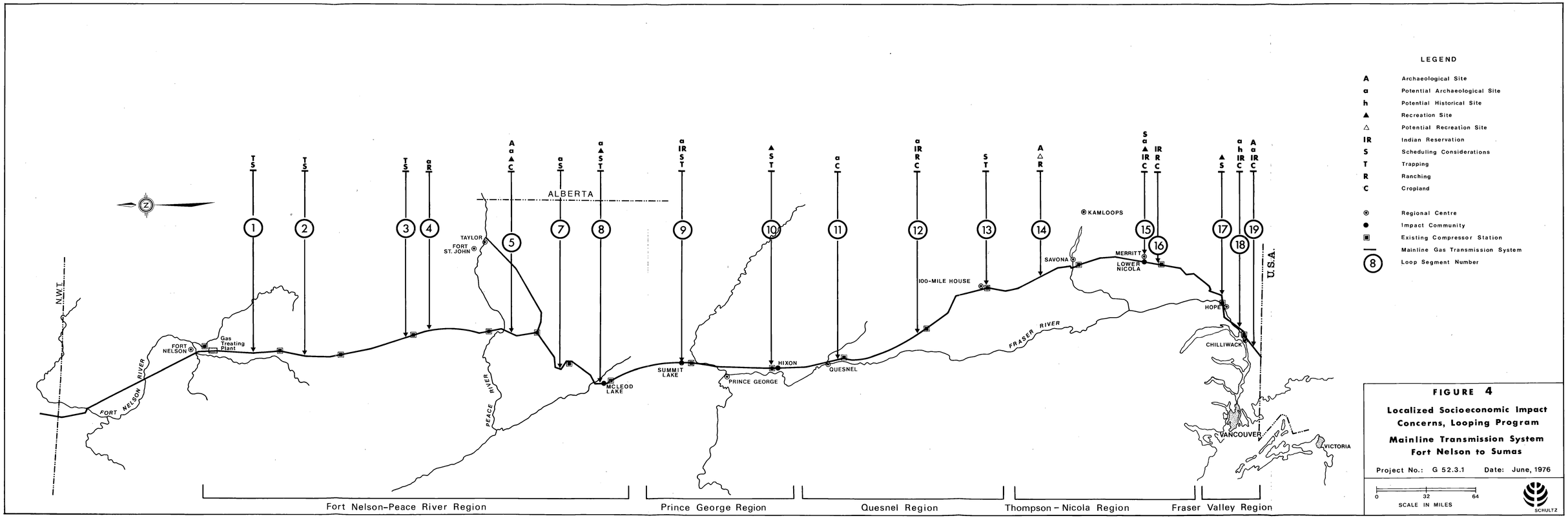


FIGURE 4

Localized Socioeconomic Impact Concerns, Looping Program

Mainline Transmission System Fort Nelson to Sumas

Project No.: G 52.3.1 Date: June, 1976

3.1 Loop 1

No major environmental impacts are expected in this Loop, which largely crosses areas of muskeg. Winter construction and good clean-up at watercourse crossings will be required to avoid minor impacts on fish movement and spawning. Since most of the stream crossings are small and have stable banks, there are unlikely to be slumping or erosion problems.

Two commercial traplines which cross the right-of-way may be disrupted during the construction period.

3.2 Loop 2

This Loop has a hilly topography and often steeper stream-banks that are more susceptible to erosion. Channel erosion is taking place in several streams and Trutch Creek is undercutting its banks. At M.P. 68.0, stream erosion has exposed the existing pipe. Stocks of potential sport fish in Trutch Creek might be affected by construction activity.

Between M.P. 58-60, surface rill and gully erosion is extensive and the right-of-way is largely unvegetated.

The pipeline at Mile 72 crosses bedrock on the steep slope. This seems to be stable but unvegetated.

Two commercial traplines which cross the right-of-way may be disrupted during the construction period.

3.3 Loop 3

Loop 3 follows a hilly area at about 3,800 feet before dropping to cross tributaries of the Cameron River at 3,000 feet. Loop 3 also crosses Atick Creek and the Beatton River. The crossings of both these water courses were stable. The upland area is prime ungulate winter range, while the streams may be important for spawning of Cameron River fish. Both

of these resources could be adversely affected by loopline construction. A commercial trapline in the vicinity may be disrupted.

3.4 Loop 4

After following a ridgetop for five miles, Loop 4 descends to cross the Cameron River and climbs again through moderately hilly terrain. The Cameron River is an important fish stream, and the river valley is important ungulate winter range. The bank on the south side of the Cameron River (M.P. 142.5) is subject to minor slumping and gully erosion involving five to six feet of the surface material/which may expose the pipeline. No major environmental problems are anticipated in this area, given adequate construction techniques.

Archaeological sites, mainly native migratory campsites, may be discovered but the possibility is low.

3.5 Loop 5

This Loop passes over relatively flat land, the deeply incised valley of the Peace River, then uphill and southwards beside Moosecall Lake. Potential impacts on fisheries from siltation are likely to be minimal because of the river size. The river valley is important range for big game species. Both of these potential impacts will be greatly superseded by the flooding of the river valley by B.C. Hydro.

A minor impact on recreational values (i.e. visual impact) will be noticed at the Peace River crossing. Archaeological sites exist in the area and more may be discovered, also in the vicinity of the river crossing.

3.6 Loop 7

Loop 7 follows a level stretch along the Pine River. This river is changing position slowly, and could expose buried pipeline at a later date. Possible impacts on spawning Dolly Varden char may be noted; construction timing should attempt to avoid these. No impacts on wildlife are expected.

A potential exists for uncovering archaeological sites along this movement route.

3.7 Loop 8

Loop 8 begins near the John Hart Highway which it follows for most of its course. After crossing the Parsnip River, it climbs about 500 feet and descends near Tudyoh Lake to the valley of the Pock River. The Parsnip River as well as the minor stream crossings in this area appear stable, meander very little; there is likely to be no problem from erosion. Construction-induced siltation at crossings, however, might have some impact. Possible changes in the river's flow characteristics are not expected to precipitate negative impacts at the pipeline crossing. There appear to be no potential impacts on wildlife in this Loop.

Recreation and settlement activities at the Parsnip River crossing will be disrupted, and archaeological sites may also exist in the crossing area. Two commercial traplines cross the right-of-way and may suffer disruption if construction scheduling is changed from summer to winter.

3.8 Loop 9

This Loop crosses hilly country in a southerly direction and parallel to the John Hart Highway. The area has only moderate wildlife value and no significant fishstreams

are crossed. Erosional problems are not foreseen along this route. No environmental major impacts are anticipated.

A fur trapline crosses the right-of-way but impact may be minimal from summer construction schedules. Archaeological sites may be uncovered during construction, and general concerns may arise with the nearby McLeod Lake Indian Band.

There will be a short-term demand for personal and off-hour services from Summit Lake community during the normally busy summer season.

3.9 Loop 10

Passing southward through moderately hilly country, Loop 10 begins by crossing the valley of Trapping Creek and ends near Hixon. The terrain appears stable to erosion and the small streams of only marginal fish habitat value. The area has only a low ungulate habitat value and impacts are therefore not anticipated.

No archaeological sites are expected in the Loop segment. There will be minor interference with road access to the youth camp at Trapping Lake. There may be a short-term demand for personnel and off-hours services from Hixon community.

Two fur traplines registered to McLeod Lake residents cross the right-of-way.

3.10 Loop 11

Loop 11 traverses moderately level ground, crossing several minor creeks. None of the streams are important fish habitats because of blockages downstream by highway and railway

culverts, and beaverdams. The area is moderately good ungulate winter range. No major impacts are anticipated in this stretch.

No socio-economic impacts are expected in the area. A potential exists for discovery of archaeological sites.

3.11 Loop 12

After passing over fairly level terrain, Loop 12 ends after crossing Five Mile Creek. No problems of erosion or conflicts with wildlife are expected to occur. The streams in this section are too small to be significant fish habitat.

Several native Bands have major Reserves in the immediate vicinity and concerns may arise. Archaeological sites may arise in the Five Mile Creek area.

Personal and off-hour services may be sought in Williams Lake on a short-term basis.

3.12 Loop 13

Beginning just past Bridge Creek, Loop 13 climbs uphill to Ninety-three Mile Creek. No significant environmental conflicts are anticipated; the terrain is stable to erosion; the one stream crossed by the pipeline is not significant fish habitat; nor is the area prime wildlife habitat.

Two commercial fur-trapping lines cross the right-of-way but disruption from summer construction will be minimal. Personal and off-hours services will be sought in 100 Mile House on a short-term basis.

Construction activity will disrupt residents of an adjacent mobile home park and a nearby community hospital.

3.13 Loop 14

Loop 14, after crossing fairly level country, drops over 2,000 feet in elevation to Barricade and Silverspring Creeks. The steep grade from M.P. 464.0 to 467.0 may need some stabilization against erosion. Barricade Creek is close to the Deadman River which supports salmon spawning and sports fishing. Siltation in tributary streams in this area could have adverse impacts. To the west of the line, potential raptor nesting could be affected by construction noise. No potential impacts on ungulates are expected.

Both archaeological and recreation values are high in the Hihium Lake area and construction may conflict with sites or access.

Some disruption of ranching activities may occur.

3.14 Loop 15

This Loop passes southwards through dry, rolling country to beyond the Nicola River. Gully and hillside erosion may be a problem in this Loop, if not controlled. Adverse impacts on salmon spawning in Guichon Creek and the Nicola River could result if erosion is not contained. Serious impacts on wildlife are not expected.

Re-routing of this Loop segment around the Nicola-Mameet Reserve should remove conflicts in land use with the Lower Nicola Band. A marked potential exists for discovering archaeological sites in the vicinity.

Personal and off-hours services will be expected from nearby Merritt.

Construction on the re-routed Loop segment will disrupt agricultural croplands if construction activities are poorly scheduled.

Short-term disruptions of the paved access road to Craigmont Mines will occur; continual slope erosion near the road may present long-range problems in vegetation stability.

3.15 Loop 16

This Loop occurs in the Coldwater River valley. No stream crossings are encountered. Impacts on wildlife are not expected. Some erosion may occur on steep slopes if adequate control measures are not practiced.

Archaeological discovery potential is low in spite of proximity to an Indian Reserve. Some ranching operations may be disrupted.

3.16 Loop 17

Several potential environmental impacts exist in this Loop which follows Boston Bar Creek and the Coquihalla River. In some places, crossings may become exposed by meander migration and/or downcutting of the Coquihalla River. This river is an important salmon and steelhead spawning stream. The major spawning species, pink salmon, spawns only during odd-numbered years. Construction activity should be timed to avoid disruption of salmon runs. The alluvial deposits along the Coquihalla River are composed primarily of gravel, with insignificant amounts of silt and sand. Consequently, heavy siltation during construction is unlikely. No major impacts on wildlife are expected from this Loop.

Disruption of minor recreational sites will occur. Personal and off-hours services will be sought in Hope.

3.17 Loop 18

No major environmental problems are anticipated in this Loop. The terrain is level and stable to erosion.

Concerns may arise about crossings on the two native Reserves and there is a significant potential for uncovering archaeological and historical sites.

Disruption of local agriculture activities will occur.

Local services will be sought in Agassiz.

3.18 Loop 19

No major environmental impacts are expected from the construction of this Loop.

Concerns may arise about crossings on the two native Reserves or latent land use issues with related Indian Bands in the vicinity. Some archaeological sites have been designated next to the right-of-way and more may occur requiring protection.

Disruption of local agricultural activities will occur.

Local services will be sought in Chilliwack.

3.19 Impact of Hazards and Pipeline Integrity

Hazards are of greatest concern when they result in the exposure and rupture of the pipe allowing the gas to escape rapidly. Given ignition, destruction of the nearby vegetative cover, and the possibly consequent soil erosion might occur. The potential hazard to wildlife depends upon the density of wildlife and the size of the subsequent burn, and is considered slight. Smaller leaks in the pipe as a result of material or welding defects may damage surface vegetation directly around the leak, but are not serious unless they are undetected for an extended period of time.

4.0 MEASURES TO ENHANCE THE ENVIRONMENT OR TO AVOID OR MITIGATE ADVERSE ENVIRONMENTAL EFFECTS

As outlined in Chapter 3.0, most of the construction of this Looping Program takes place along the existing pipeline rights-of-way; mitigative measures will be required in specific cases of stream crossings, steep banks, and precautionary measures taken to avoid disruption of potential archaeological sites. These measures are suggested in the following sections dealing specifically with each Loop. Beyond this, general mitigative procedures can be incorporated directly into construction techniques for application at all sites. Westcoast Transmission Company Limited has already adopted a series of such guidelines for pipeline construction (see Appendix II, of Volume III).

Impacts on the socio-economic environment, as outlined in Chapter 3.0, will be minimal considering the size of the project relative to the scale of development in much of the pipeline corridor. The proposed construction program could hire a small part of its work force from local centers on temporary basis, replacing them with new staff from subsequent centers as the program moves on. More rationally, the locally hired work force could be kept on either by the season, or by lay-off and re-hire from season to season. Much would depend on the willingness of workers to move with the project. However, except in the smaller communities, the temporary employment of 100 workers will do little more than marginally effect the unemployment situation. Even if the whole work crew were hired in Prince George, it would only reduce the number of male unemployed by 25 percent from the current level of over 2,000.

Requirements for housing during the construction program are also likely to be minimal, as a moving campsite will follow the activity along the line.

4.1 Loop 1

The presence of muskeg makes winter construction preferable; this will minimize effects on streams along the Loop. Temporary culverts and log crossings should be removed before the spring freshet.

Financial compensation for trapline disruptions during winter construction should be considered.

4.2 Loop 2

Winter construction will minimize effects on streams and spawning activity in this Loop. Particular care will be needed to prevent accelerated erosion, and in some cases berming and/or artificial revegetation may be necessary following pipeline construction. The Loopline should be buried to a sufficient depth on watercourse crossings to ensure that future meanders do not expose it.

Financial compensation for trapline disruptions during winter construction should be considered.

4.3 Loop 3

Construction in the watercourses should be carried out during low-flows to minimize impacts on spawning. As with other streams, care must be taken to avoid stream blockage by debris, and to prevent exposure of the loopline by stream meander by burying the pipe to a sufficient depth. In the upland area, proper timing of construction activity can avoid undue harassment of animals.

Compensation may be required for disruption of fur-trapping activities.

4.4 Loop 4

Careful construction practices will be necessary to avoid stream siltation and to prevent erosion on the Cameron River crossing. This could best be achieved by constructing the crossing during low flow. Late summer construction would also reduce impacts on ungulate winter-grazing. Care should also be taken with construction debris in the area of the river. Across the whole width of the floodplain, the loopline should be deeply placed to avoid future exposure by lateral migration of meanders. On steeper north slopes of the river, erosion control by berming in a manner similar to that already present is recommended. Similar measures are required on the south side of the river to check existing slumping and erosion and to prevent its recurrence.

Assessment should be made for incidence of archaeological sites on the right-of-way.

4.5 Loop 5

A major concern on this Loop is the crossing of the Peace River. Care must be taken to prevent streambank erosion and slumping as has been experienced on the nearby Williston Reservoir: Westcoast Transmission Company Limited, in conjunction with B.C. Government agencies is planning to armor river banks with rock as a preventive measure.

Assessment should be made for the incidence of archaeological sites on the right-of-way. Disruption of agriculture operations may require compensation.

4.6 Loop 7

Construction activities should, if possible, take place during low flow, from November to March to minimize impacts on fish stocks. The September to November period is critical for spawning. Deep burial of the pipeline along the course of the floodplain will mitigate possible future problems from river meander.

Archaeological reconnaissance should be conducted along the Pine River area.

4.7 Loop 8

Loopline construction should take place at low stream flow (August to March) to minimize impact on fish stocks. The final engineering design of the Parsnip crossing, perhaps incorporating armouring of the river banks, will have to take into account possible damages in the river's flow characteristics resulting from the proposed McGregor Diversion project.

Compensation for commercial and recreational disruptions should be considered. In addition, two commercial trap-lines in the area may experience disruption despite summer construction schedules and require compensation.

4.8 Loop 9

No special mitigative measures were identified for Loop 9.

Camp management should consider direct supervision over personnel using services and facilities in the nearby community.

An archaeological reconnaissance may be warranted along the right-of-way. No compensation may be necessary for trapline interests if construction takes place during summer.

4.9 Loop 10

Construction of Loop 10 is not expected to pose problems to wildlife, stream crossings, or slope stability; therefore standard construction practices will be adequate.

No compensation may be required for trapline interests because of construction on summer schedules. Compensation may be required for dry disrupted croplands.

Camp management should consider direct supervision over personnel using services and facilities in the nearby community.

4.10 Loop 11

No major impacts are expected in Loop 11. Construction activity at low water flow will minimize stream disturbance. Temporary stream crossing structures should be removed when construction is completed.

Archaeological reconnaissance over the area is recommended. Interference with agricultural crops may require compensation.

4.11 Loop 12

No special mitigative measures are anticipated for this Loop. Construction during low water flow would minimize

impacts on streams.

An archaeological reconnaissance is recommended in the loop segment near Five Mile Creek.

Compensation may be required for interference with agriculture crops and ranch operations.

4.12 Loop 13

Construction effects will be minimal on this Loop over the fall-winter period; standard practices will be sufficient.

No compensation may be required for trapline interests because of construction on summer schedules.

Construction activities near 100 Mile House should be scheduled and designed to minimize impacts on adequate mobile homes and the nearby hospital. A temporary fence may be required to protect local children from construction activity.

Camp management should consider direct supervision over personnel using services and facilities in the nearby community.

4.13 Loop 14

Construction should be timed to the low flow period (late summer to February) to minimize potential effects on streams and spawning fish. This is the best period to avoid potential effects on nesting raptors in the area. Erosion control measures such as adequate berming must also be employed.

An archaeological reconnaissance is recommended for the Loop segment.

The access road to the right-of-way may find future service as access to a provincial park reserve on the eastern end of Hihium Lake and should be designed and maintained to withstand this extended use.

4.14 Loop 15

Care in constructing stream crossings, and erosion control measures are important mitigative measures anticipated on this loop.

An archaeological reconnaissance is recommended on the proposed route.

Landscape and access designing is required around the Lower Nicola settlement and the Nicola River crossing to restrict use of access roads and minimize adverse impacts on local tree cover (cottonwoods) alongside the river.

The access road to the Craigmont Mine may be seriously disrupted and may require a scheduling consideration. Potentially unstable slopes above the road will require designed stabilization measures. Right-of-way design and location could be critical in this vicinity, immediately adjacent to the Indian Reserve boundary. Consultation must be held with mine management on these problems.

Camp management should consider direct supervision over personnel using services and facilities in nearby communities.

4.15 Loop 16

Except for erosion control measures such as berming on steep slopes, no other special mitigative procedures are anticipated for this Loop.

Disruption of minor croplands and ranching operations may require compensation.

4.16 Loop 17

Construction of the numerous river crossings will have to be approved by regulatory agencies (B.C. Fish and Wildlife Branch, Canadian Fisheries Service, and the International Pacific Salmon Fisheries Commission) and should be timed to produce minimal impact on fish spawning activity. Therefore, construction is recommended during the low flow period of August through early October during an even-numbered year. Westcoast Transmission Company maintains a liaison with the Fisheries service to ensure the correct handling of these matters.

If construction occurs during an odd-numbered year, additional care will be required to prevent an impact on the pink salmon. Consideration should also be given by government authorities to removing the obstruction preventing fish passage above the canyon. This obstruction is in part an impact of earlier railway buildings. This would substantially add to the existing spawning area and perhaps increase fish production in the river.

Present land use will not be affected by construction of this segment. However, a major highway is being planned for the valley. Considering the restricted nature of the valley where construction of a variety of facilities might conflict with each other, liaison with all concerned parties is highly recommended to ascertain the timing of any construction.

Minor disruption of recreational sites near the lower end of the Loop segment and at several other isolated locations may require compensation.

4.17 Loop 18

Construction of the Maria Slough crossing should be completed during March and April or early fall to least affect fish stocks.

Compensation will be required for disrupted croplands.

Archaeological and historical site reconnaissance should be made.

4.18 Loop 19

The same considerations regarding fish stocks apply as in Loop 18.

Compensation will be required for disrupted croplands.

Conflicts over land use and construction may arise with local Indian Bands and should be resolved or else alternative routes sought.

Archaeological reconnaissance may be recommended.

4.19 Measures to Avoid or Mitigate Adverse Impacts of Hazards

Where Loops are to be constructed across steep slopes, appropriate slope stabilization techniques (e.g. grading of slopes, terracing) should be applied to mitigate any potential hazard of slope instability. Similar techniques (including revegetation, berms, drainage blocks) should be used to minimize erosion and loss of overburden on steep slopes. Careful investigation of the Loop routes will have to be carried out to identify and design mitigating measures in these circumstances.

River crossing hazards such as scouring, pipe buoyancy, meandering and bank erosion should be mitigated by good engineering practice such as burying the pipe below the maximum scour depth for the full floodplain width, providing weighting collars where required, and using heavier guage pipe for the crossing.

Man-induced hazards should similarly be mitigated by careful installation of the pipeline and by clearly marking the pipe route and fencing-off above-ground facilities to prevent damage by third parties.

5.0 UNAVOIDABLE IMPACTS WHICH WOULD RESULT FROM THE PROPOSED PROJECT

The pipeline Looping Program will result in few significant unavoidable impacts. The most important area of concern will be stream and river crossings which are important fish spawning areas (notably on Loops 14, 15 and 17). The construction activity must be properly timed and managed to prevent increased sediments in the watercourse which can smother incubating eggs, young fish, or fish food organisms. Accidental discharge of toxic materials into watercourses can also seriously affect aquatic populations.

Construction activity may also disrupt prime ungulate winter range (Loop 3) and a possible raptor nesting area (Loop 14) unless timed to avoid sensitive periods of the year.

Summer construction activity will disrupt agricultural land use in several areas (Loop 15, 16, 18 and 19), taking the land out of production for a year. The disturbed areas should be quickly brought back into production with the careful replacement of the top soil and with good farming practice.

Winter construction could disrupt traplines in some areas (Loop 2, 3, 10 and 13). In many places (Loop 9, 12, 15, 16, 18 and 19) the route passes nearby Indian lands where concerns may arise, particularly if archaeological sites are uncovered. Archaeological values exist in other areas as well (Loop 5, 11 and 14) where artifacts will be destroyed unless care is taken.

6.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITIES

For the purpose of this statement, "short-term" is generally taken to mean the period during the construction and operation of the proposed pipeline system. "Long-term" is generally taken to mean that period of time beyond the lifetime of the pipeline system.

In general, the proposed Looping Program from Fort Nelson to Sumas will not significantly affect the short-term use, nor the long-term productivity of the local environment. Since the proposed construction program follows an existing pipeline in an established right-of-way, changes in use patterns will be minimal. Also, the possibility that the Looping Program will initiate a course of action which will be detrimental to future generations is considered to be remote.

The implementation of the Alcan project and the accompanying Looping Program could reduce the demand in the U.S.A. for Canadian natural gas and thus prolong the life of Canadian gas reserves (the Fort Nelson gas field for example) for Canadian use. There could also be a consequent reduction in the pressure to develop Canada's Arctic gas potential which would allow more time for the settlement of native land claims and for the evaluation of northern development proposals. The project will also give additional economic stability to the existing Westcoast Transmission system.

The 18 loops that are being proposed traverse a variety of environments, and the existing rights-of-way are presently serving a variety of short-term uses. These uses, which have been described previously, will not be modified by the Looping Program. However, in the long-term, changes in use will occur. A summary of the present utilization of each Loop, and considerations on long-term productivity is presented below.

6.1 Loop 1

The principal land use practices in the area are limited to hunting and trapping. The existing right-of-way is used extensively for snowmobile access. This will not change with the proposed construction program.

In the long-term, the right-of-way will revert to the vegetation type which typifies the area. This will obstruct future access into the area, thus reducing human use of the area.

6.2 Loop 2

The comments that were presented for Loop 1 also apply to this Loop.

6.3 Loop 3

The principal land use practices in the area are hunting, trapping, and summer range for cattle. The existing right-of-way is extensively utilized for snowmobile access. Also, the cattle in the area utilize secondary growth of grasses and herbs found along the right-of-way. In the short-term, these use patterns will not change because of the Looping Program.

In the long-term, the present use of the right-of-way will be eliminated. Vegetation growth on the right-of-way will hinder access, and restrict grazing by cattle. Consequently, cattle will utilize natural meadows in the region to a greater extent, coming into greater competition with moose.

6.4 Loop 4

The principal land use practices in the area are hunting and ranching. Recreational fishing has a high capability, but is limited because of poor access. Logging activities have occurred in the past, but existing stands have not matured sufficiently for resumption of logging activities.

In the short-term, no significant change in land use practices is expected. During construction, a minor impact on the sport fishing potential may occur, but mitigative measures can reduce this.

In the long-term, the productivity of the area will be increased as the timber matures. Minor negative impacts on the aesthetics of the region may persist because of construction activities.

6.5 Loop 5

The land use practices in the area are primarily logging, ranching, agriculture and hunting. The recreational potential at the Peace River crossing is considered high. Recreational facilities could be developed in an area traversed by the right-of-way.

In the short-term, the Looping Program will not result in a change in land use. The existance of an established right-of-way precludes further modification to use patterns.

In the long-term, the productivity of the area will be increased. The northern section of the loop will probably be exposed to farming activities, the timber stands will mature for further logging acitvity, and the visual impact of the right-of-way will be eliminated by revegetation.

6.6 Loop 7

Present land uses and facilities in the area include the John Hart Highway, B.C. Railway, two 500 Kv transmission lines of B.C. Hydro, and logging.

In the short-term, the Looping Program will not significantly affect other land uses in the area. A possibility exists that recreational facilities may be developed, and that the highway may be up-graded, but conflicts here can be avoided through planning.

In the long-term, the elimination of the pipeline system will ease the congestion through the area. Revegetation of the right-of-way will subsequently improve the visual quality of the region.

6.7 Loop 8

Present land uses within the area are primarily logging and tourism. Sport fishing in the Parsnip River is considered good. Development along or near the right-of-way is intense and includes the B.C. Railway, power lines, roads, and a permanent construction camp. The John Hart Highway is also in close proximity.

In the short-term, detrimental effects of the Looping Program on man's use of the local environment will be minimal. There is the possibility of future recreation facilities

in the vicinity of the pipeline, but conflicts are avoidable. The impact of the fisheries resources in the Parsnip River during construction will be minimal.

In the long-term, the productivity of the area will increase. Congestion will be reduced, and the visual impact of the cleared right-of-way will be eliminated.

6.8 Loop 9

Logging is the primary land use in this region, with hunting being of secondary importance. Existing facilities crossed by this Loop are few in number. The right-of-way is used for access, and for wildlife grazing and browsing.

In the short-term, no change in the present land use is anticipated.

In the long-term, the right-of-way will revegetate into stands of merchantable timber, thereby increasing productivity.

6.9 Loop 10

Present land use patterns along this Loop are logging, hunting, and to a limited extent, cultivation. The area is also used as rangeland for cattle, and trapping. Three water use licenses have been issued for Trapping Creek.

In the short-term, no major change in land use will result from the Looping Program. Siltation of Trapping Creek during construction should not unduly affect the downstream water license holders.

6.10 Loop 11

Principal land use practices in this area are farming, ranching and logging, with rangeland activity the major use. Two water licenses have been issued for Kersley Creek.

Short-term utilization of the area will not be significantly affected by the construction of this Loop. The increase in turbidity of Kersley Creek during construction will be of short duration, and should not greatly inconvenience the downstream water users.

Productivity over the long-term will increase for logging, and decrease for the ranging of cattle.

6.11 Loop 12

Present land use practices are hunting, logging, and ranching. The south end of the loop crosses the Cariboo Highway. Three downstream water use licenses have been issued to the Williams Lake Indian Reserve.

In the short-term, use patterns will not be affected. Caution should be exercised to ensure that the downstream water users are not unduly inconvenienced.

In general, the value of the area will, in the long-term, change because of the reduction of range-land along the right-of-way, and because of impaired access to the region.

6.12 Loop 13

Present land use practices include logging, agriculture clearing under pasture, hunting, and ranching. Extensive use of the right-of-way is made by snowmobiles, probably for access to traplines. Several logging roads, the B.C. Railway, and a highway are crossed by or adjacent to this Loop.

The short-term use of the region will not be affected by the proposed Loop.

In the long-term, access to the area will be slightly reduced, as will rangeland along the right-of-way. The productivity for logging will increase.

6.13 Loop 14

Principal land use practices in the area are logging, hunting, and ranching. The recreational potential in the vicinity of Hihium Lake is high.

No major effect on existing use patterns is anticipated because of this Program. The potential conflict with recreational concerns near Hihium Lake are avoidable.

In the long-term, the forest productivity of the area will increase with revegetation of the right-of-way.

6.14 Loop 15

Land use presently practiced in this area involves logging in the northern section, and farming in the southern end. Sport fishing in the Nicola River is good. This loop will by-pass the Nicola-Mameet Indian Reserve that is traversed by the existing pipeline. Five downstream water licenses have been issued, and the area is well developed.

A major land-user in the northern section is the Craigmont Mine operation which is building a massive tailings pond in the upper Stumbles Creek area.

In the short-term, changes in land use will be minimal. The diversion from the existing right-of-way will result in an additional ten miles of right-of-way, but land use impacts will not be significant. Water use in the Stumbles Creek area involves activities at the mine tailings pond.

In the long-term no significant change in land use or productivity is anticipated. Long-term erosion of the poorly-vegetated repose slopes in the area of the Craigmont Mine is a possibility following disruption.

6.15 Loop 16

The principal land use practice in this area is cattle ranching and a transportation corridor for several major utilities.

In the short-term, no significant change in land use is anticipated. This also applies to the long-term productivity of the region.

6.16 Loop 17

Land use practices in the area include logging, sport fishing, and camping. Recreational use by snowmobilers and cross-country skiers also occurs. A major, four-lane highway is proposed for the route followed by the pipeline.

In the short-term, present land use will not be significantly affected, and potential conflicts with the proposed highway can be resolved by careful planning.

In the long-term, the productivity of the region will increase. The optimum use of this region is probably that of recreation/tourism, and revegetation of the pipeline right-of-way will eliminate the visual impact of the clearing. Construction and reclamation procedures which minimize visual impacts should be encouraged.

6.17 Loop 18

This Loop crosses two Indian Reserves and is intensively developed agriculturally. One downstream water license is recorded.

In both the short-term and long-term, no significant change in land use will result from this Loop.

6.18 Loop 19

The comments that were presented for Loop 18 also apply to this Loop, with the exception that no water use licenses are recorded.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Considerations on the irreversible and irretrievable commitments of resources must take into account the fact that the proposed Looping Program from Fort Nelson to Sumas follows an existing pipeline within an established right-of-way. Commitments have, in general, already been made, with the obvious exceptions of additional construction materials required, and additional natural gas committed for transport and consumption. This fact is significant when considering irreversible and irretrievable commitments of resources.

7.1 Land Features and Uses

Except for the creation of a new 10 mile right-of-way on Loop 15 there do not appear to be any permanent changes in the current land use pattern along the route of the proposed Looping Program. This has been discussed in Chapters 3.0, 4.0 and 5.0.

Construction of the proposed Loops will require few additional modifications to the terrain; the existing right-of-way will not be altered to any great extent. It is recommended that, following the abandonment of the pipeline system, land modifications that create a highly negative visual impact be suitably re-sculptured, if they occur in high-use areas.

7.2 Endangered Species and Ecosystems

From all available evidence, the proposed Looping Program will not cause the elimination of any endangered species or ecosystem.

Minor alterations to existing ecosystems may occur as a result of the Looping Program; however, these changes in a total perspective, will be minor.

7.3 Socio-Economic Considerations

The proposed programs will utilize a maximum workforce of approximately 1,000 men, spread across a well developed portion of British Columbia. Furthermore, it will create only a few permanent jobs. It is improbable that indirect actions such as housing developments or improved support facilities will be a result of the proposed loopline. Existing facilities will be utilized, but additional requirements or "spin-offs" are not anticipated.

No conflicts with known archaeological or historical sites appear to be generated by the proposed program. In certain areas, archaeological surveillance during construction has been recommended, and under British Columbia statutes will be administered by the provincial archaeologist.

No loss of scenic value is expected from this program. Following abandonment of the system, the existing right-of-way should be returned to that use, determined by regional land use plans, which is most appropriate.

7.4 Resources Lost or Uses Preempted

The Looping Program will not significantly curtail the range of beneficial uses of the environment along the proposed route. As discussed in the previous chapters, the right-of-way currently enhances certain land uses, such as trapping, and may be required to continue such activities beyond the lifetime of the pipeline. It appears unlikely that the resources used to construct the proposed Loops will contaminate other associated resources or foreclose their usage.

7.5 Finite Resources

The non-renewable resources that would be committed as a result of the proposed action include the natural gas to be transported, and all of the materials required for construction.

Construction materials required include all components of the pipeline system, plus the resources required to build it (i.e. fuel and lubricants, replacement parts, welding supplies, cement, lumber, etc.). Estimates on the amounts required were not available at the time of this writing. Of these materials, everything but the above-ground components of the pipeline system would be irreversibly and irretrievably committed.

MISCELLANEOUS MAPS AND TABLES

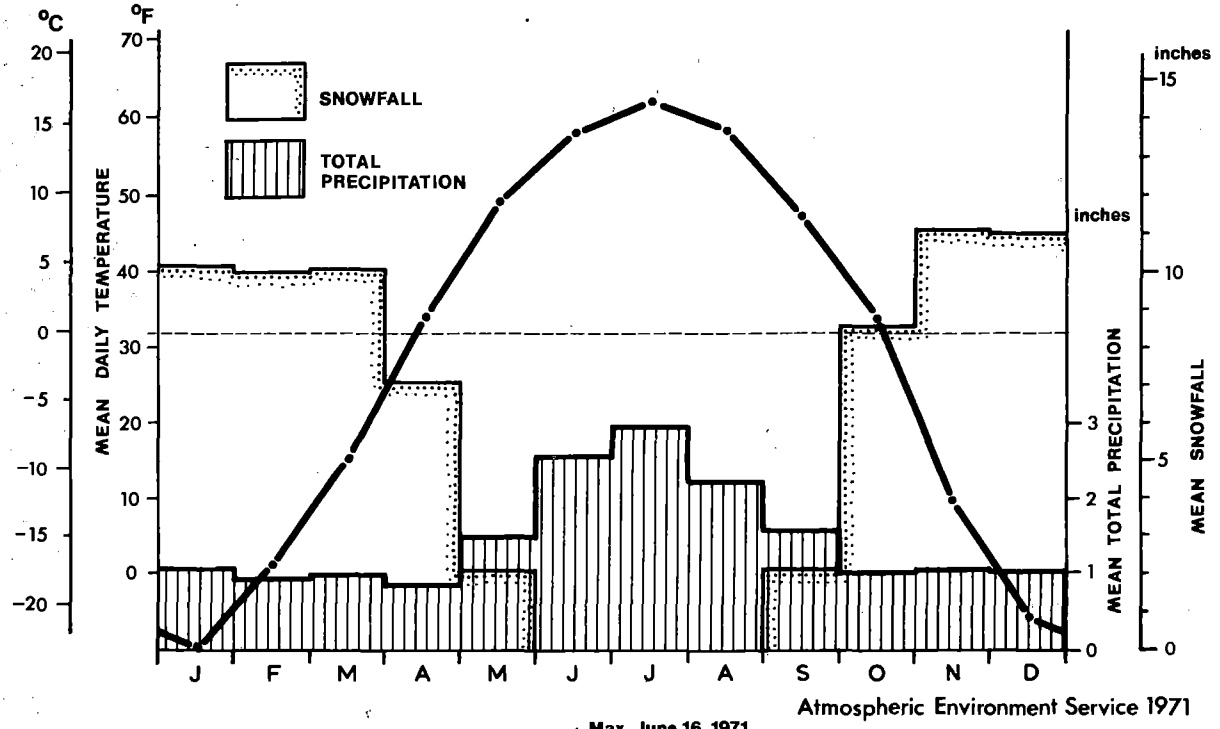
PART A	REPRESENTATIVE CLIMATIC AND HYDROGRAPHIC DATA
PART B	SOCIO-ECONOMIC INFORMATION
PART C	LOOP MAPS

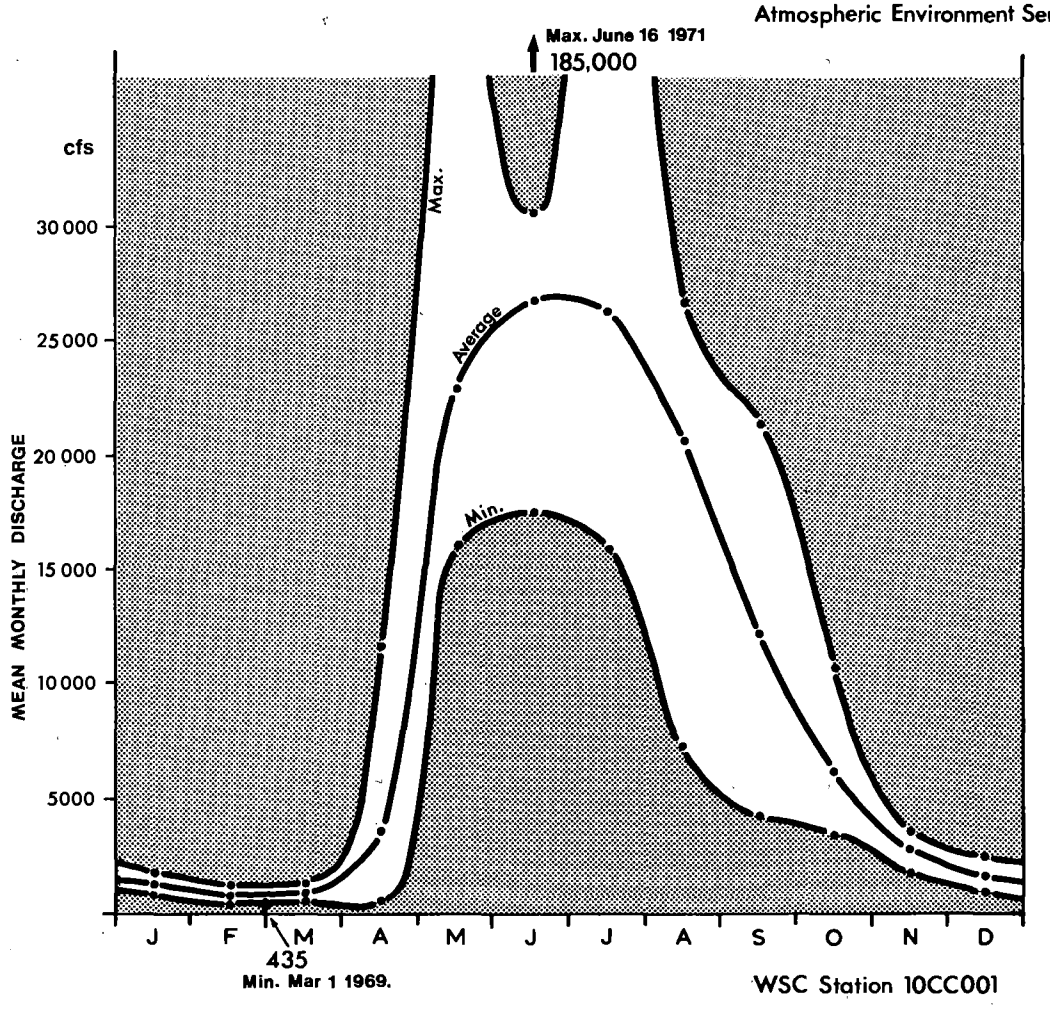
PART A

REPRESENTATIVE CLIMATIC AND HYDROGRAPHIC DATA

REPRESENTATIVE CLIMATIC (**FORT NELSON**)
AND HYDROGRAPHIC (**FORT NELSON R.**) DATA

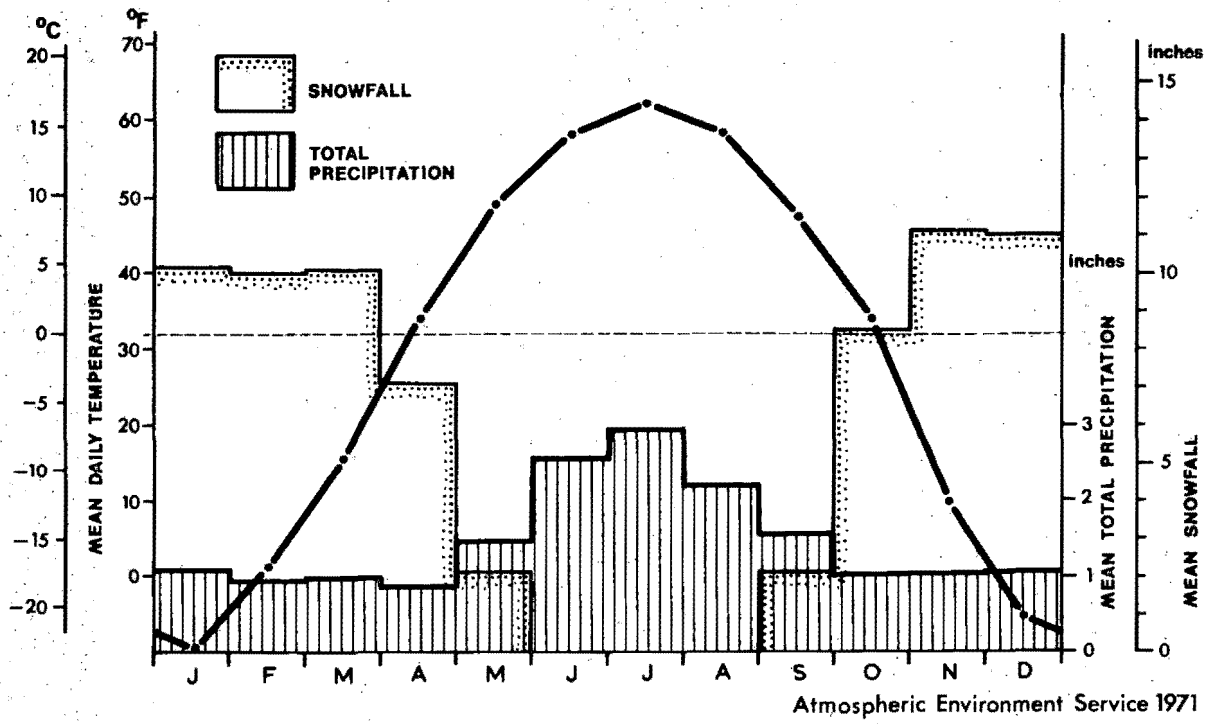
LOOP 1



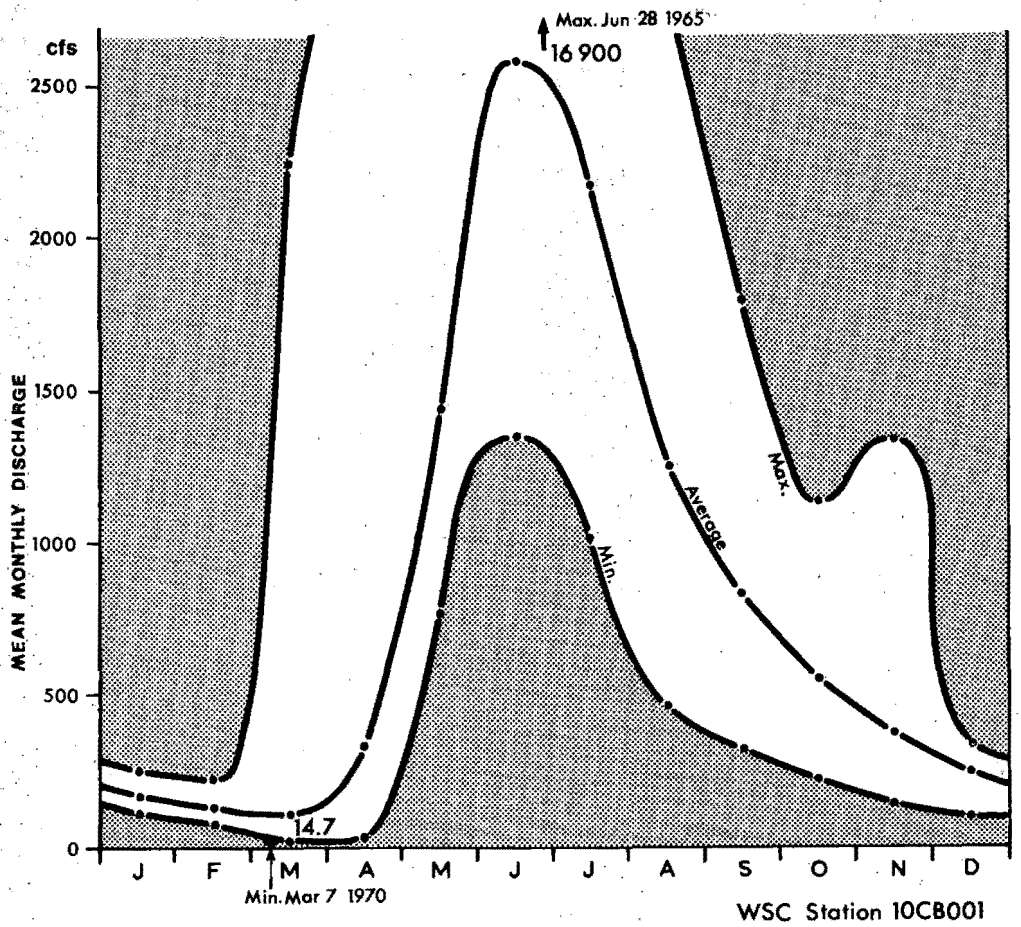


REPRESENTATIVE CLIMATIC (**FORT NELSON**)
AND HYDROGRAPHIC (**SIKANNI CHIEF R.**) DATA

LOOP 2



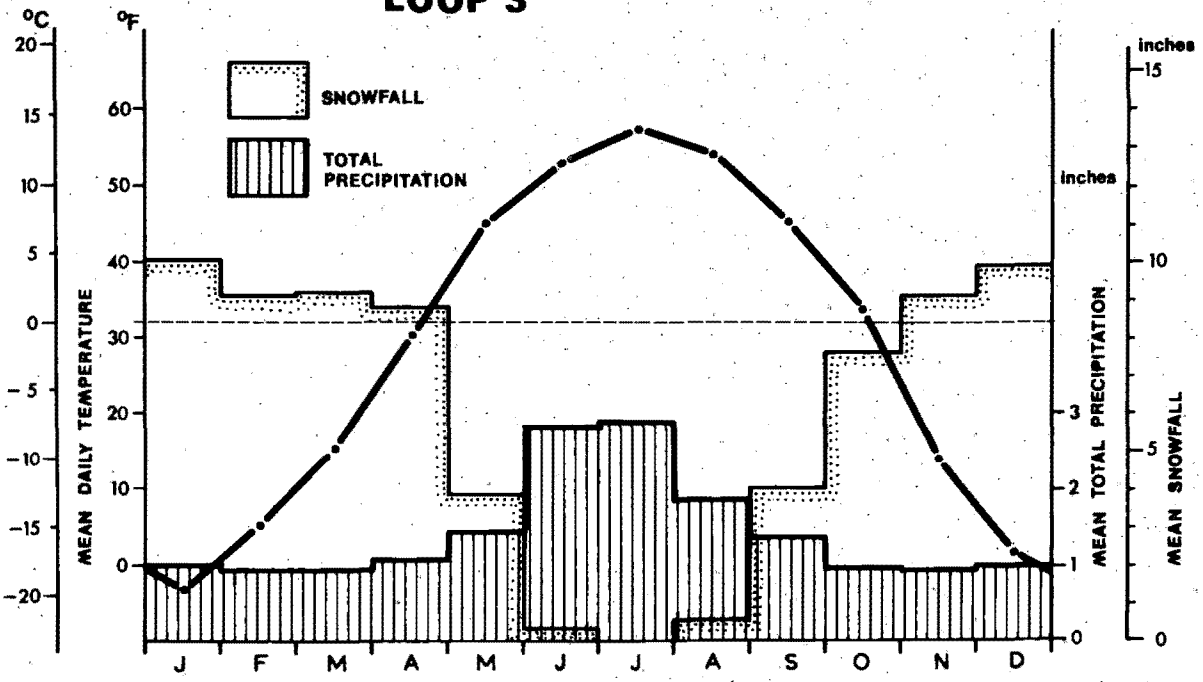
Atmospheric Environment Service 1971



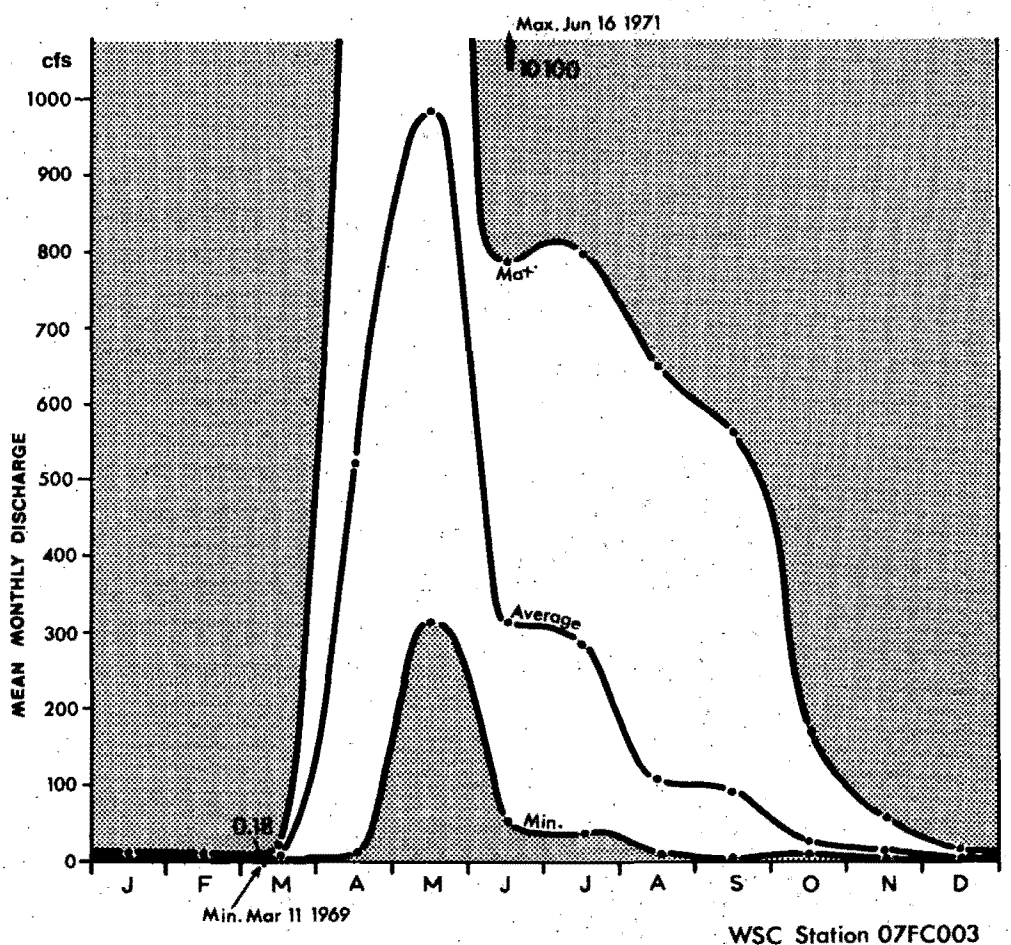
WSC Station 10CB001

REPRESENTATIVE CLIMATIC (**BEATTON RIVER**)
AND HYDROGRAPHIC (**BLUEBERRY R.**) DATA

LOOP 3



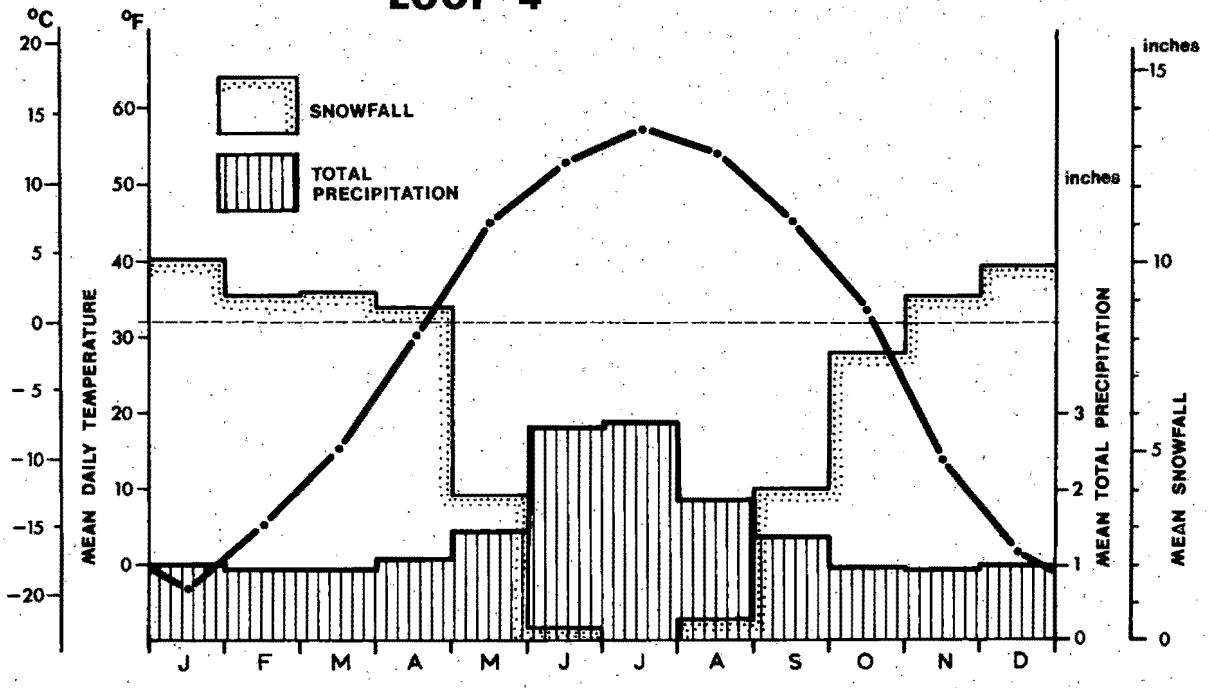
Atmospheric Environment Service. 1971



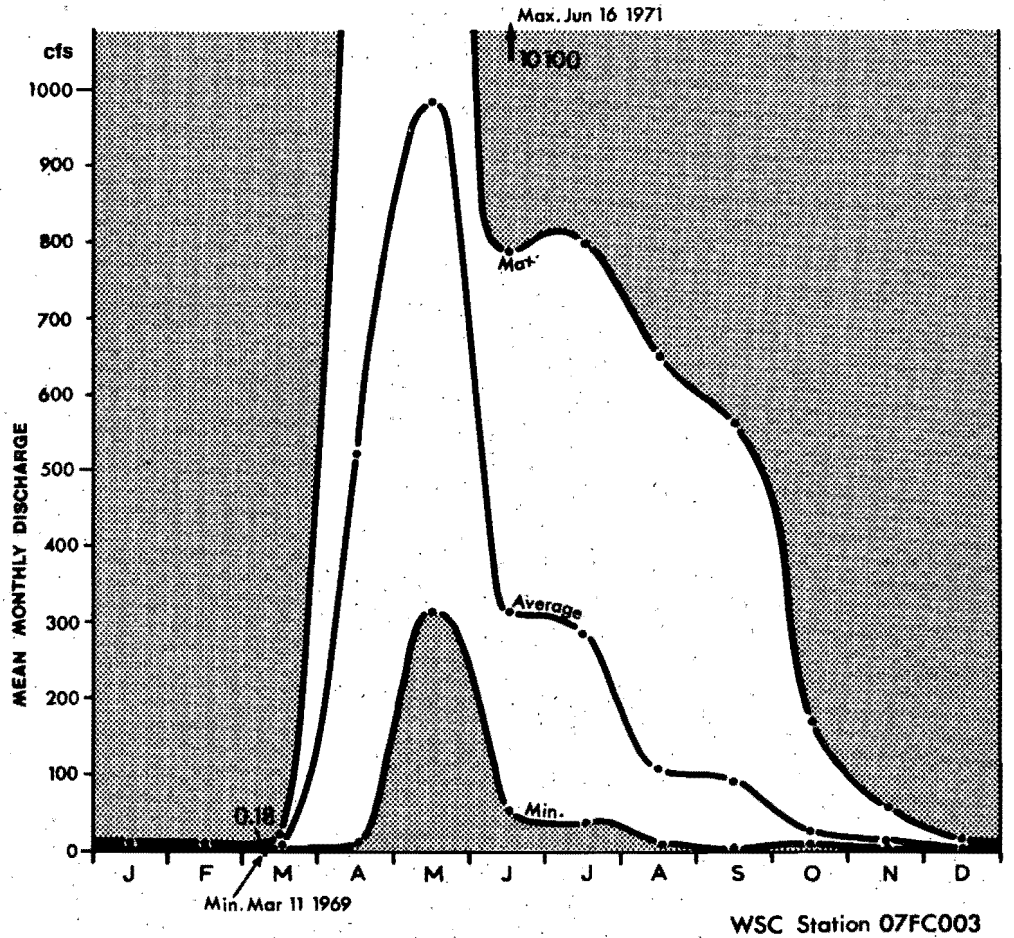
WSC Station 07FC003

REPRESENTATIVE CLIMATIC (**BEATTON RIVER**)
AND HYDROGRAPHIC (**BLUEBERRY R.**) DATA

LOOP 4



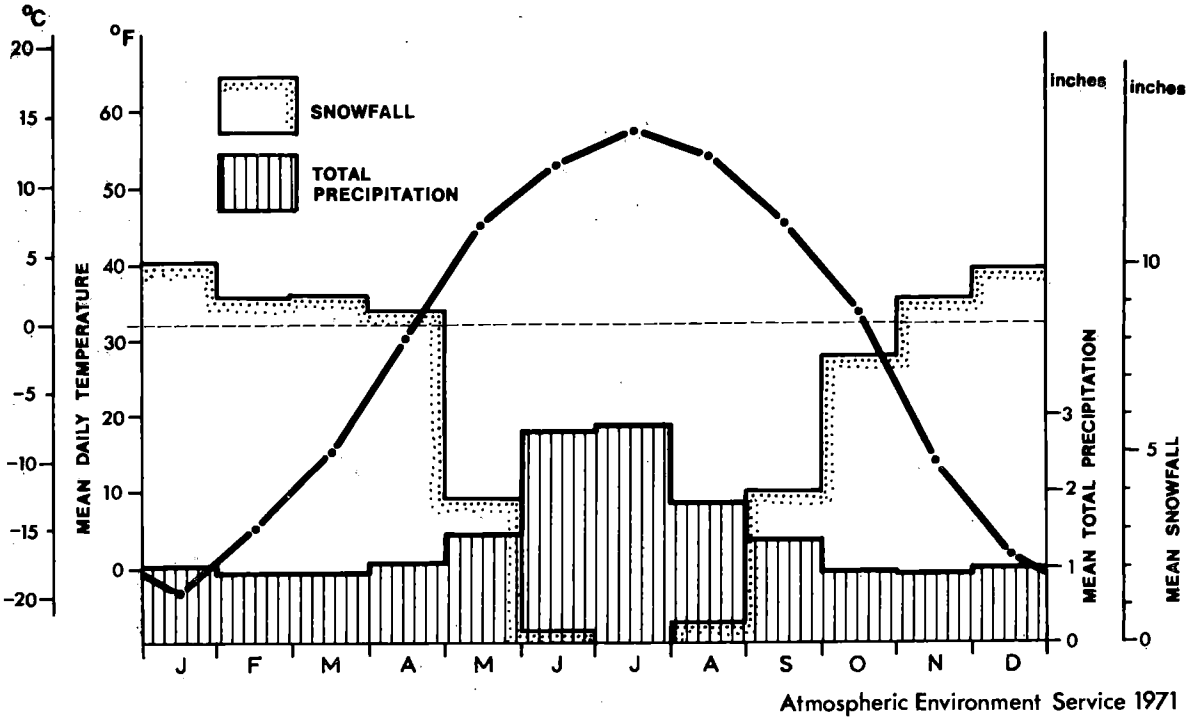
Atmospheric Environment Service 1971



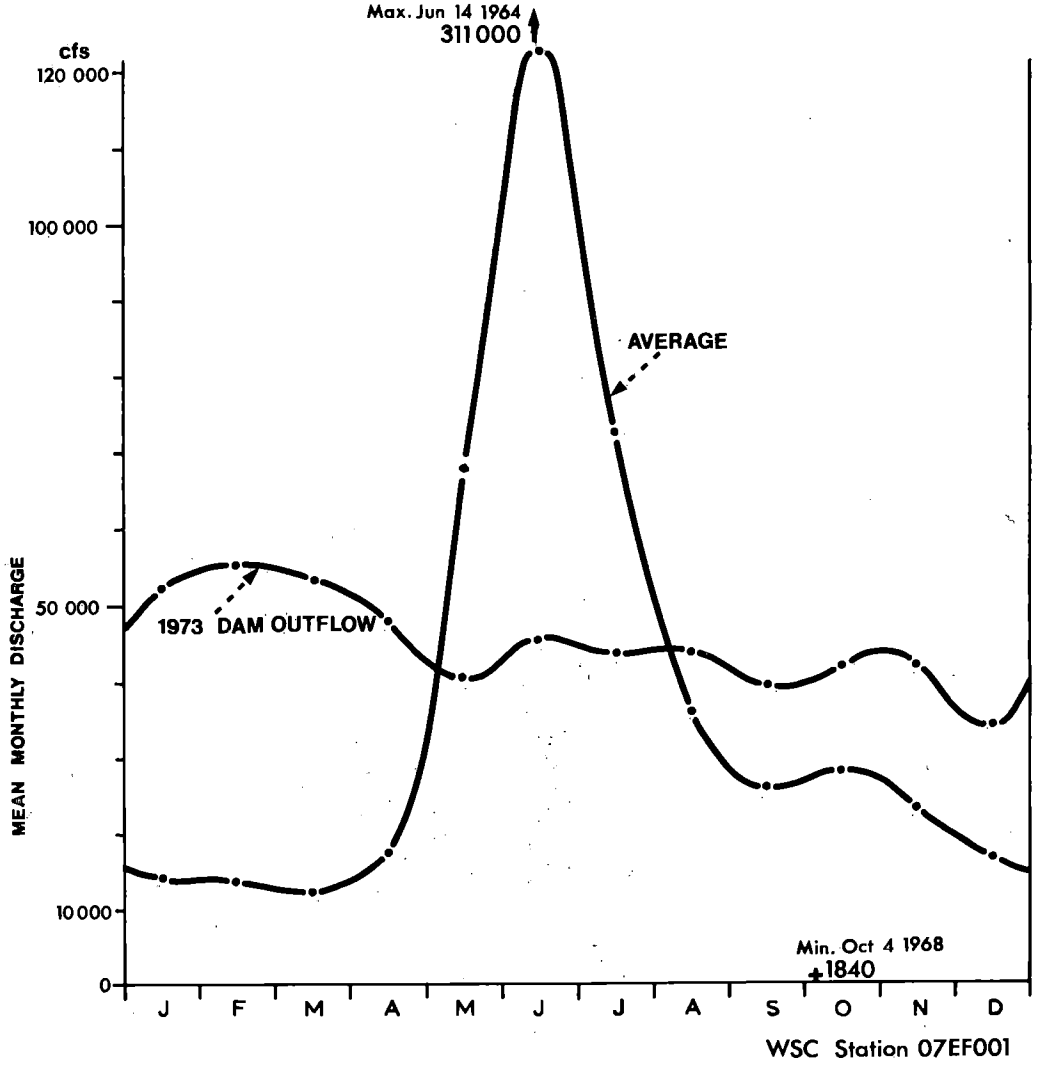
WSC Station 07FC003

REPRESENTATIVE CLIMATIC (**BEATTON RIVER**)
AND HYDROGRAPHIC (**PEACE R.**) DATA

LOOP 5



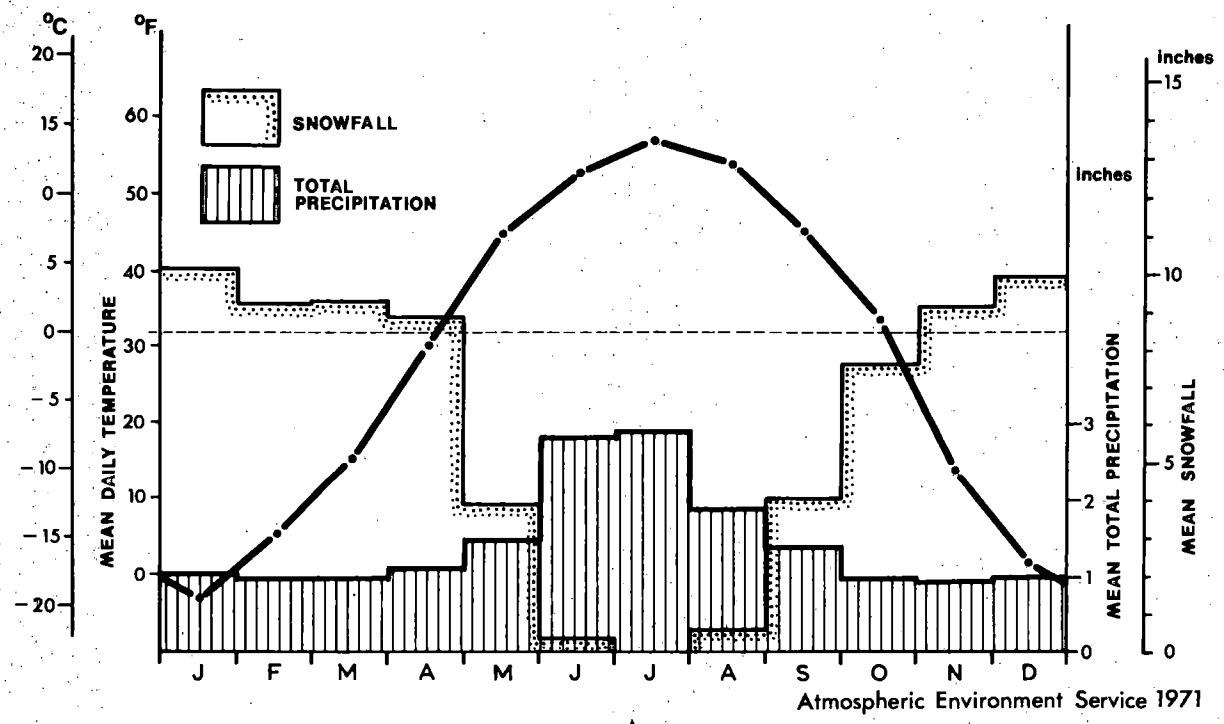
Atmospheric Environment Service 1971



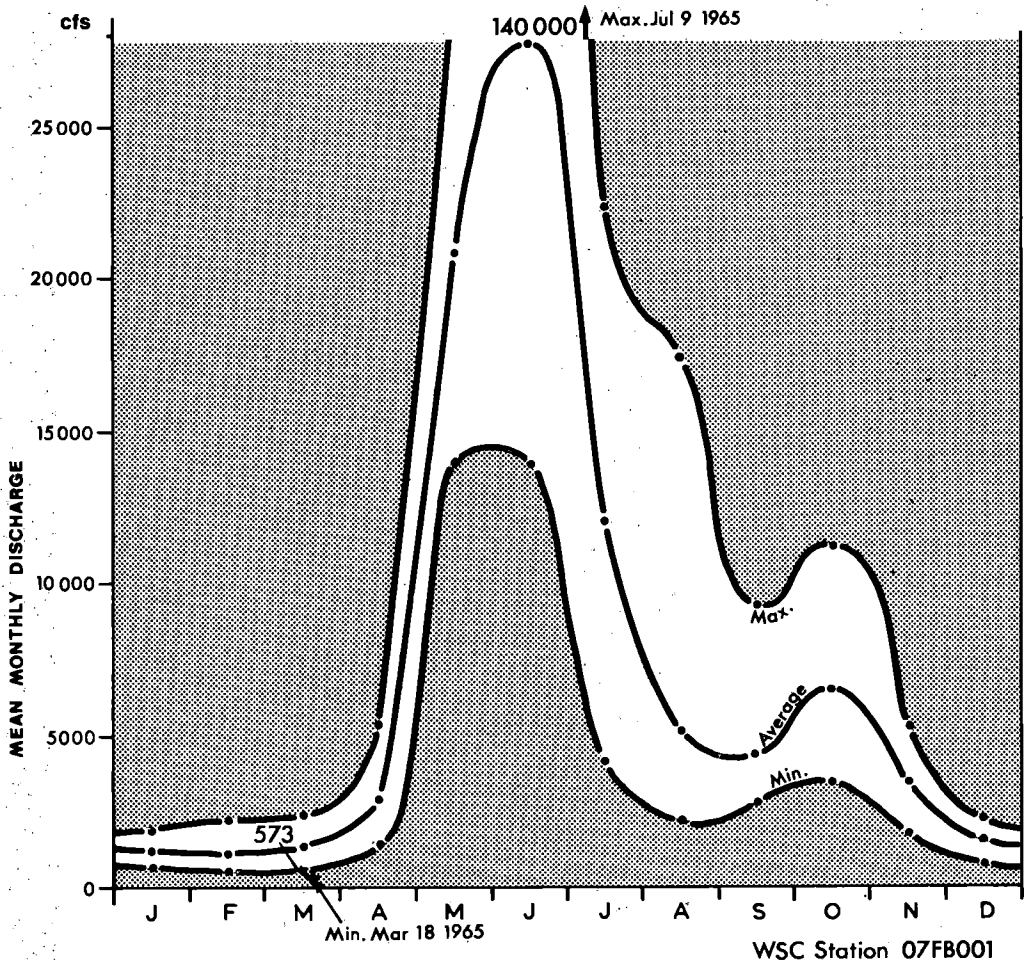
WSC Station 07EF001

REPRESENTATIVE CLIMATIC (**BEATTON RIVER**)
AND HYDROGRAPHIC (**PINE R.**) DATA

LOOP 7



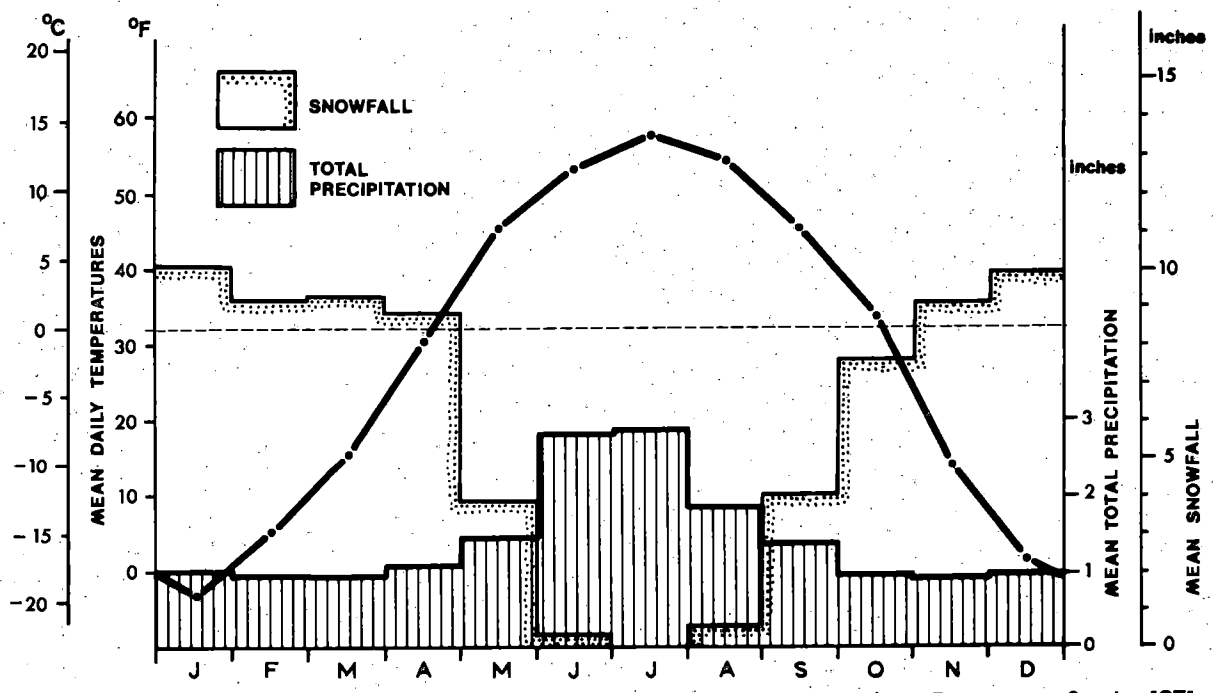
Atmospheric Environment Service 1971



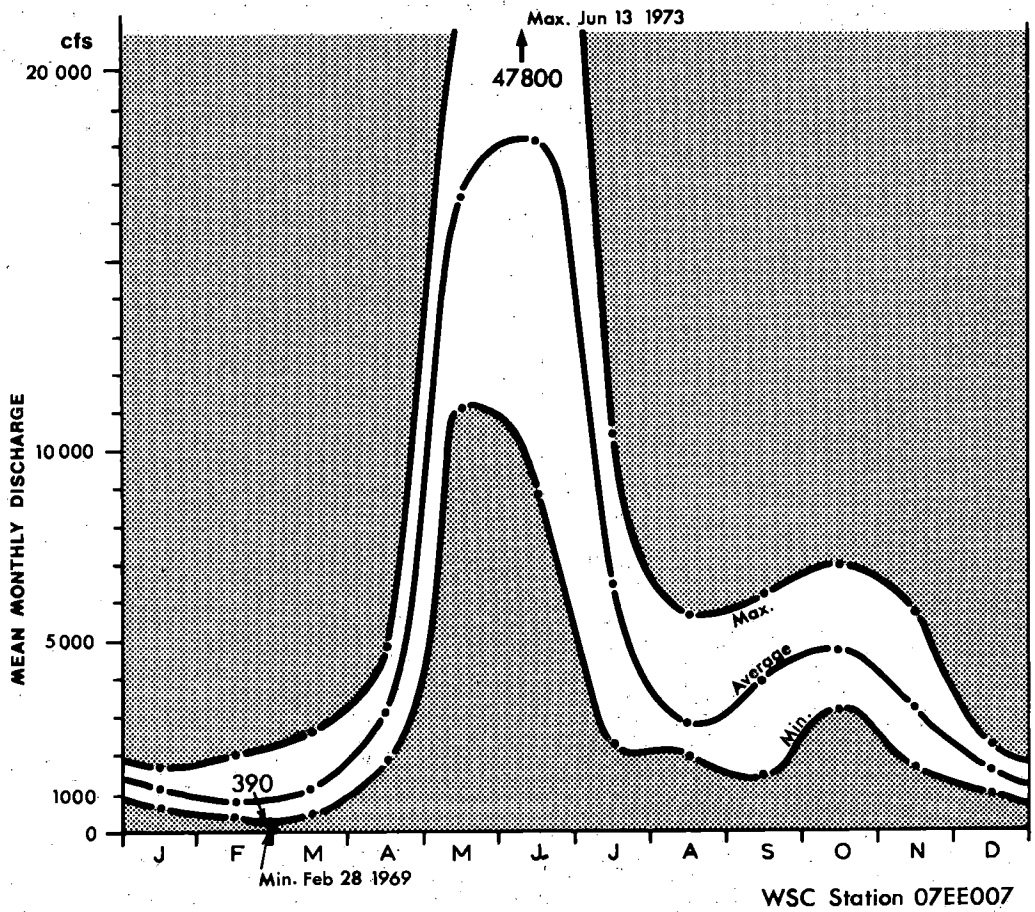
WSC Station 07FB001

REPRESENTATIVE CLIMATIC (**BEATTON RIVER**)
AND HYDROGRAPHIC (**PARSNIP R.**) DATA

LOOP 8



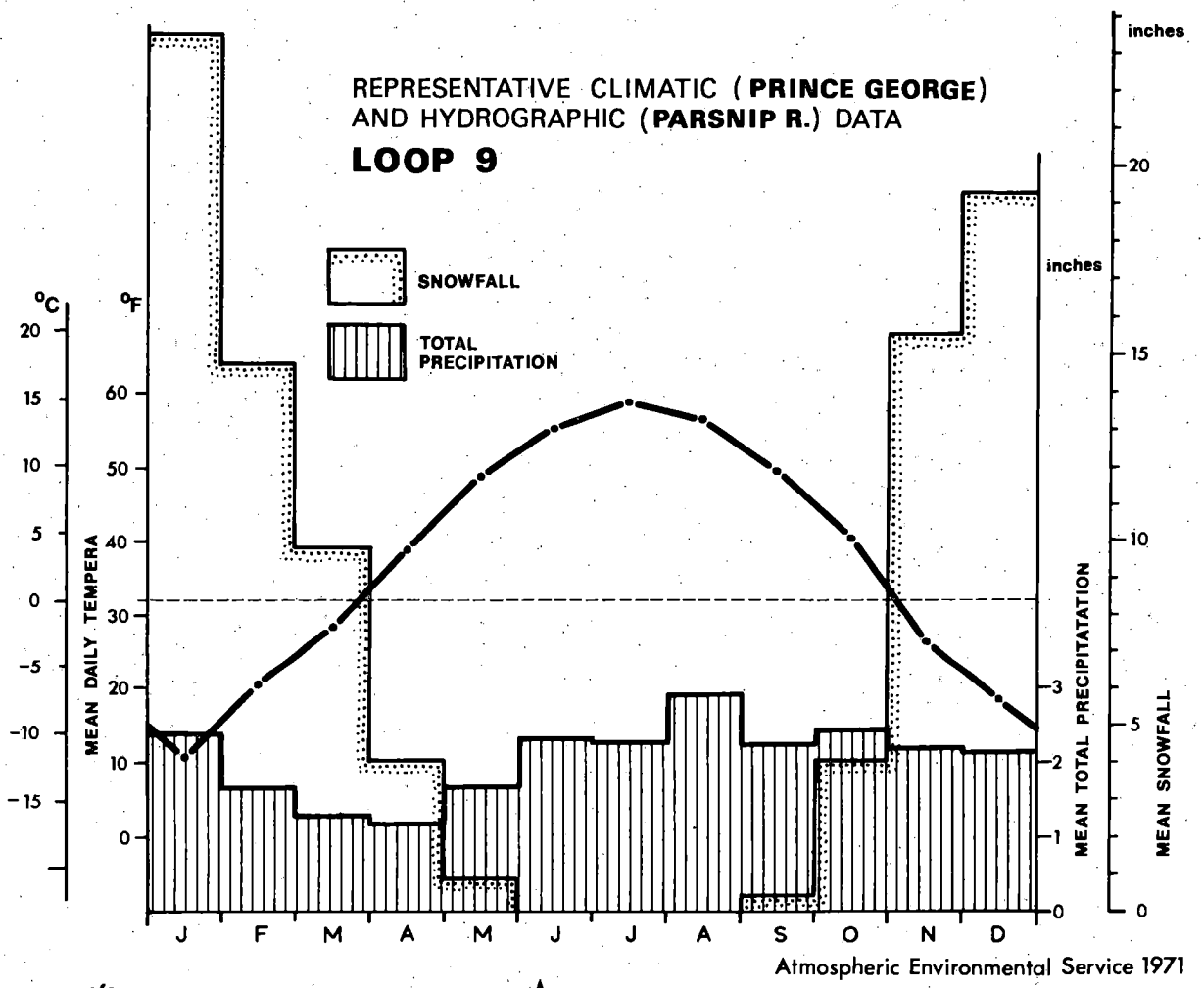
Atmospheric Environment Service 1971



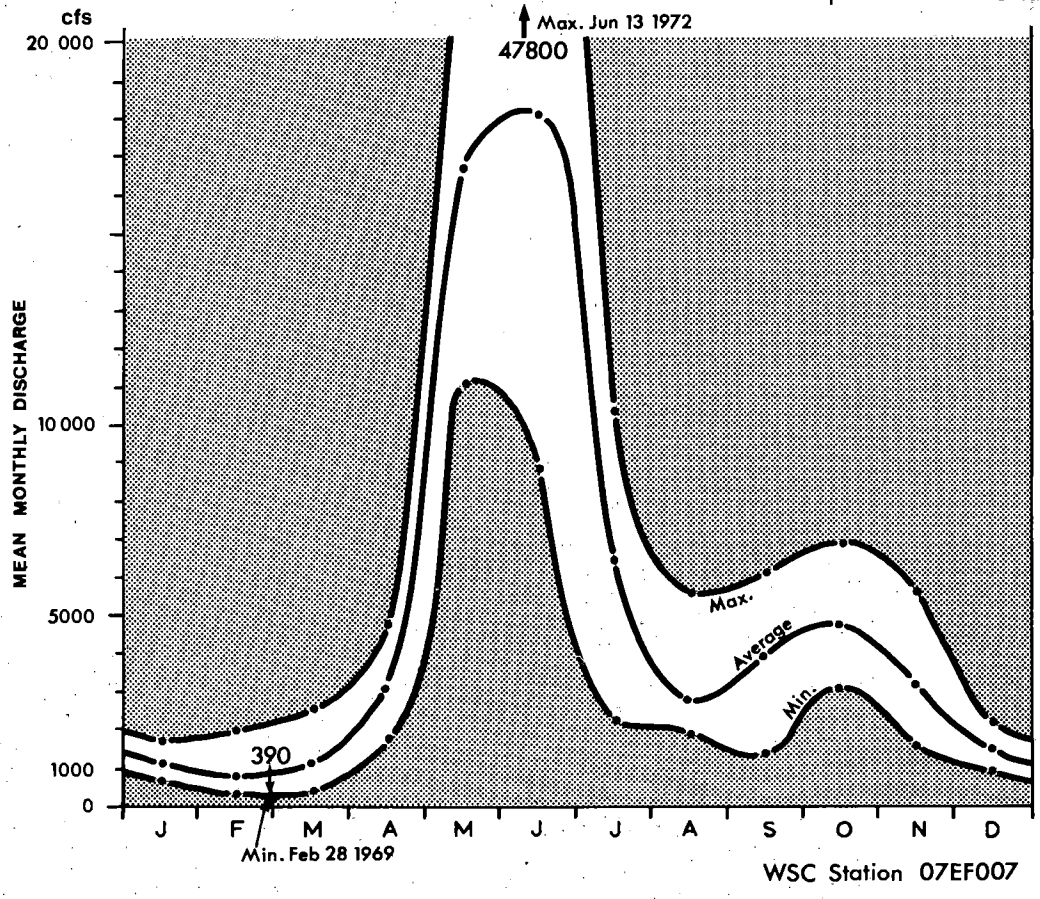
WSC Station 07EE007

REPRESENTATIVE CLIMATIC (**PRINCE GEORGE**)
AND HYDROGRAPHIC (**PARSNIP R.**) DATA

LOOP 9



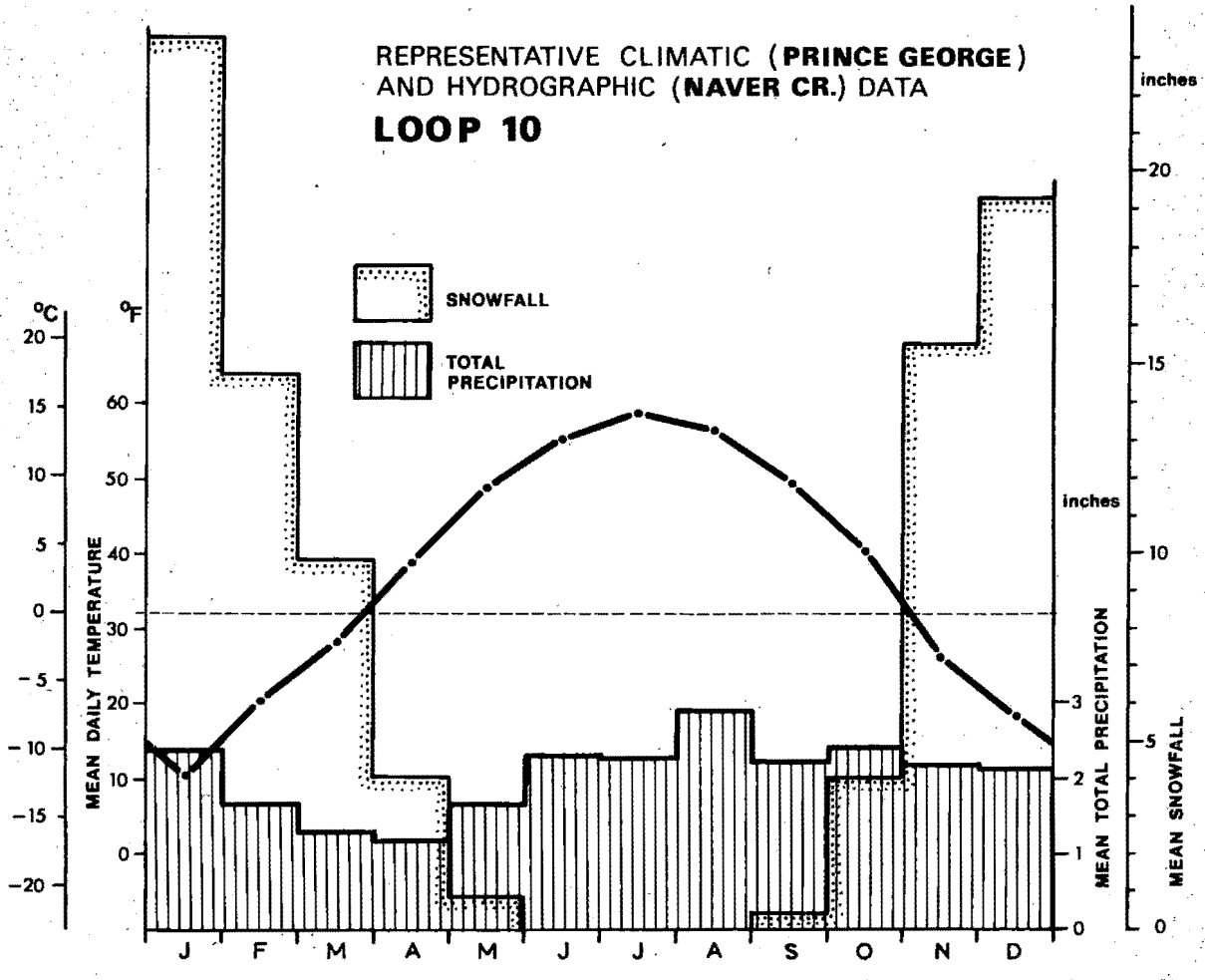
Atmospheric Environmental Service 1971



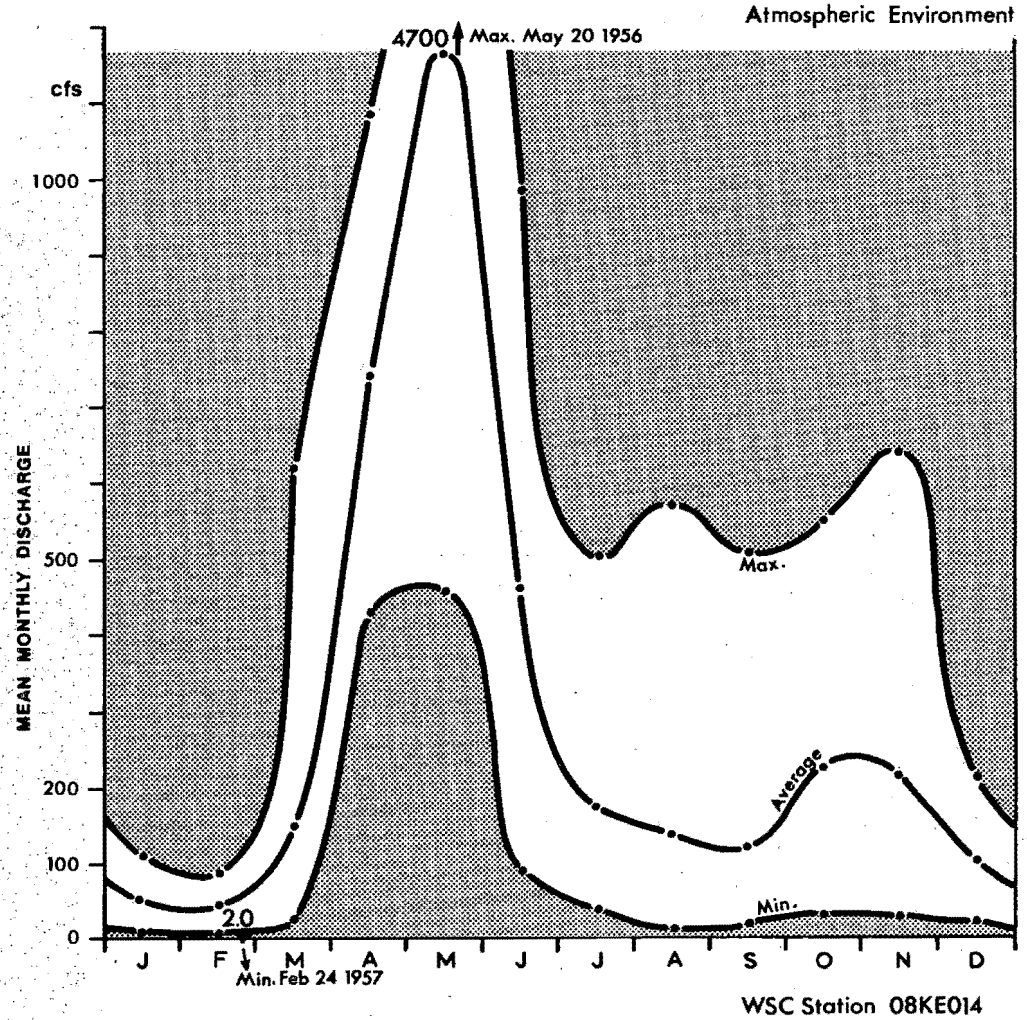
WSC Station 07EF007

REPRESENTATIVE CLIMATIC (**PRINCE GEORGE**)
AND HYDROGRAPHIC (**NAVER CR.**) DATA

LOOP 10



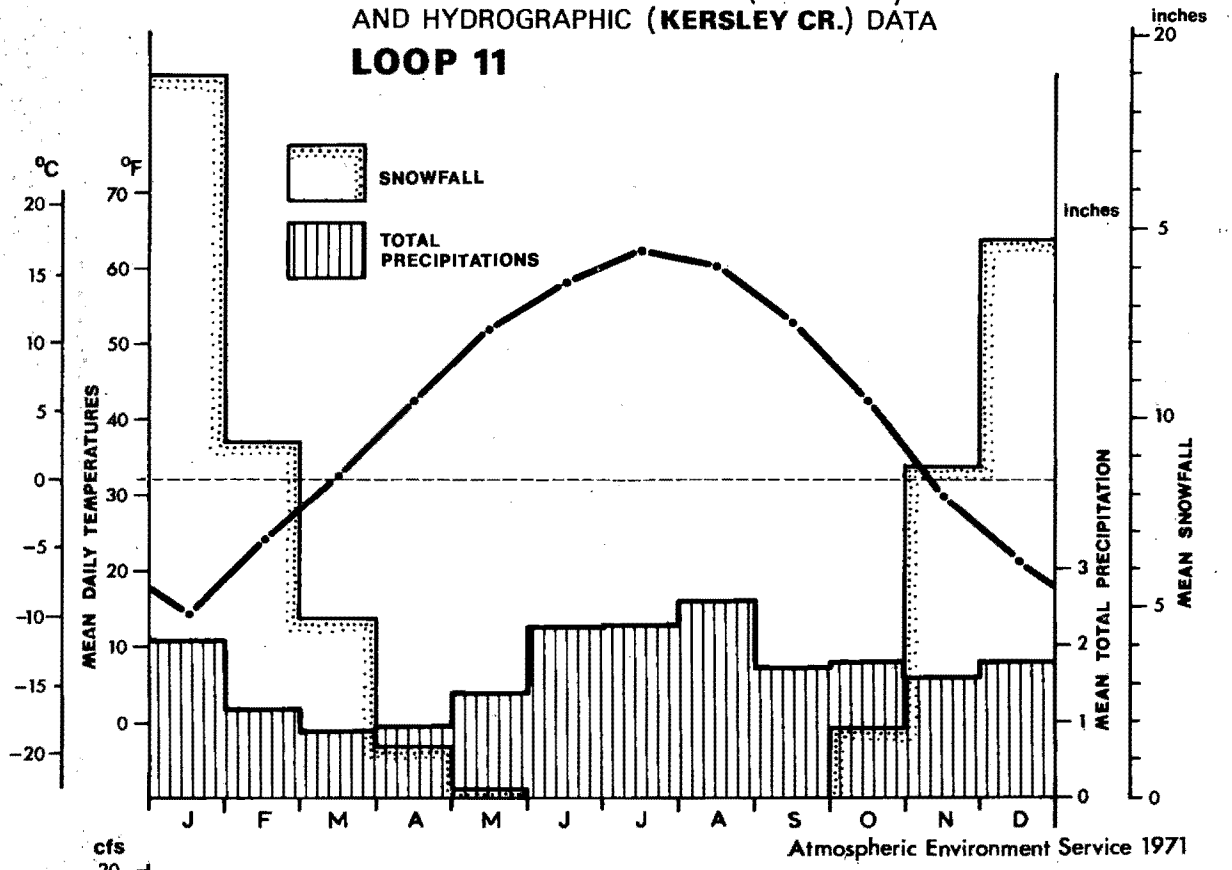
Atmospheric Environment Service 1971



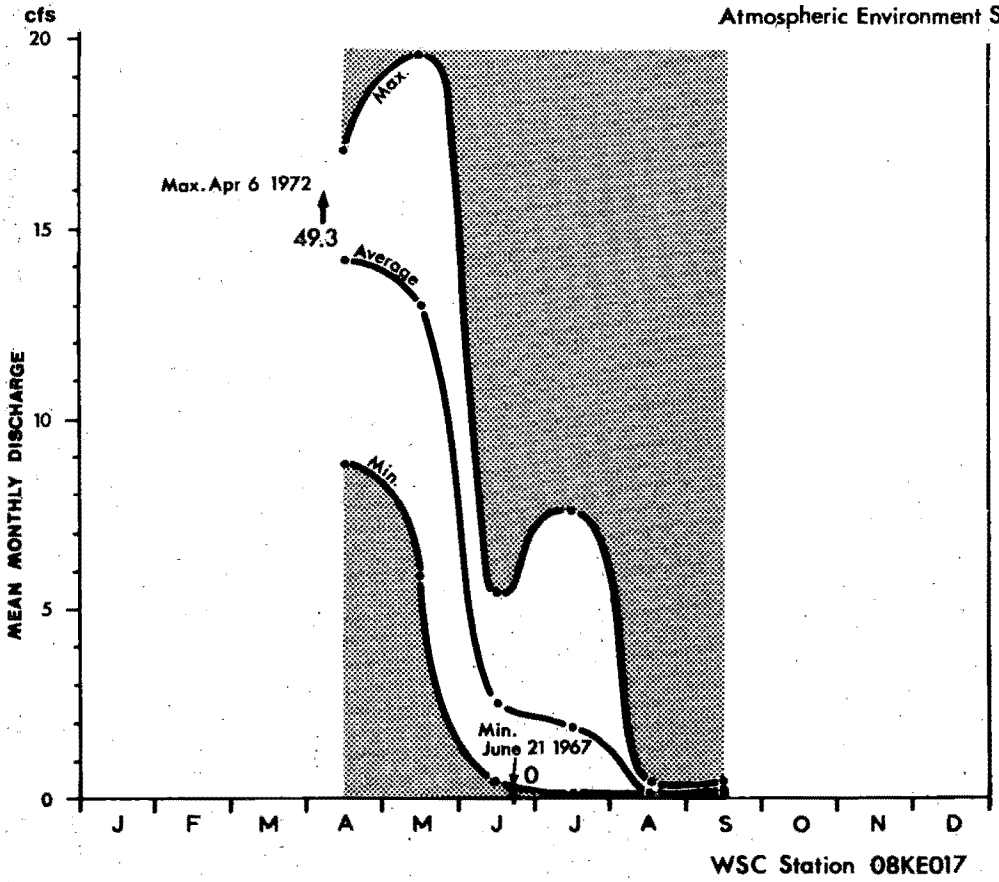
WSC Station 08KE014

REPRESENTATIVE CLIMATIC (**QUESNEL**)
AND HYDROGRAPHIC (**KERSLEY CR.**) DATA

LOOP 11



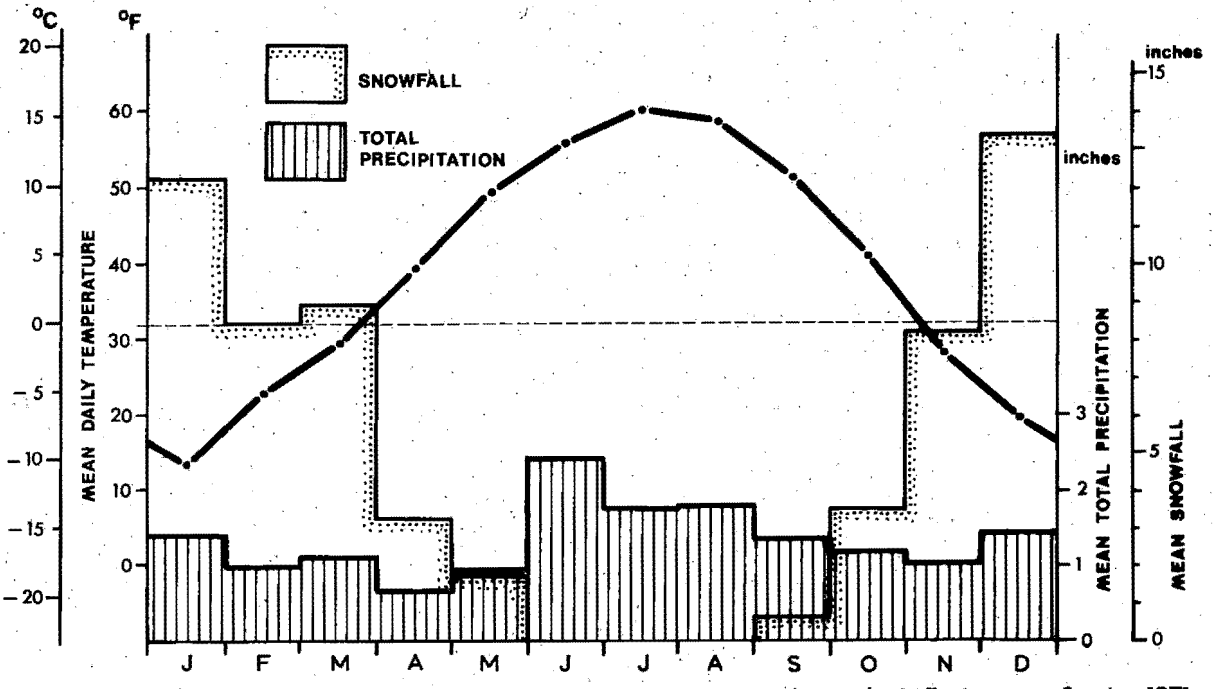
Atmospheric Environment Service 1971



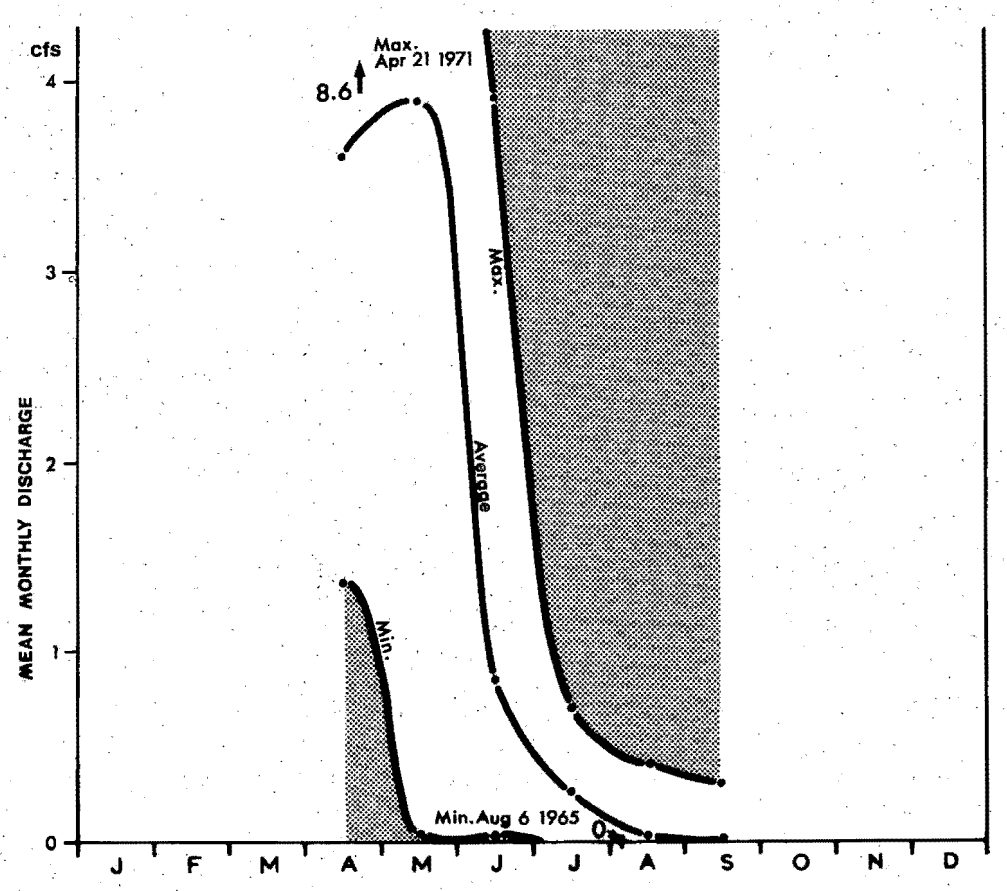
WSC Station 08KE017

REPRESENTATIVE CLIMATIC (**WILLIAMS LAKE**)
AND HYDROGRAPHIC (**FIVE MILE CR.**) DATA

LOOP 12



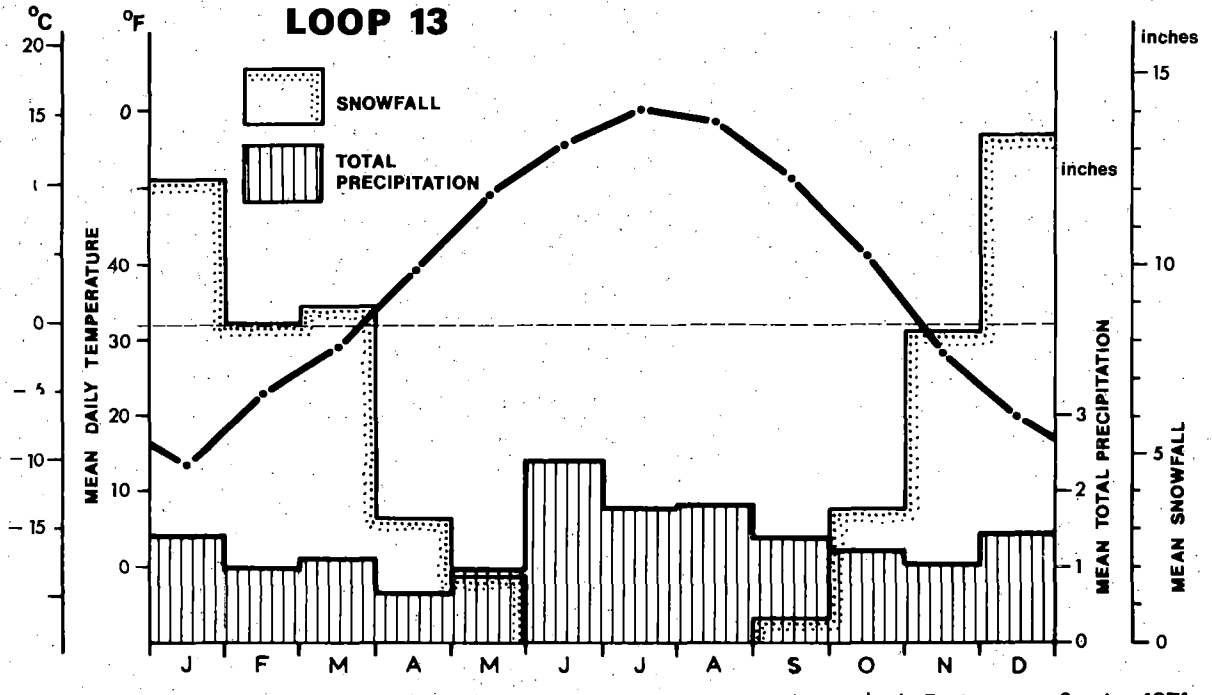
Atmospheric Environment Service 1971



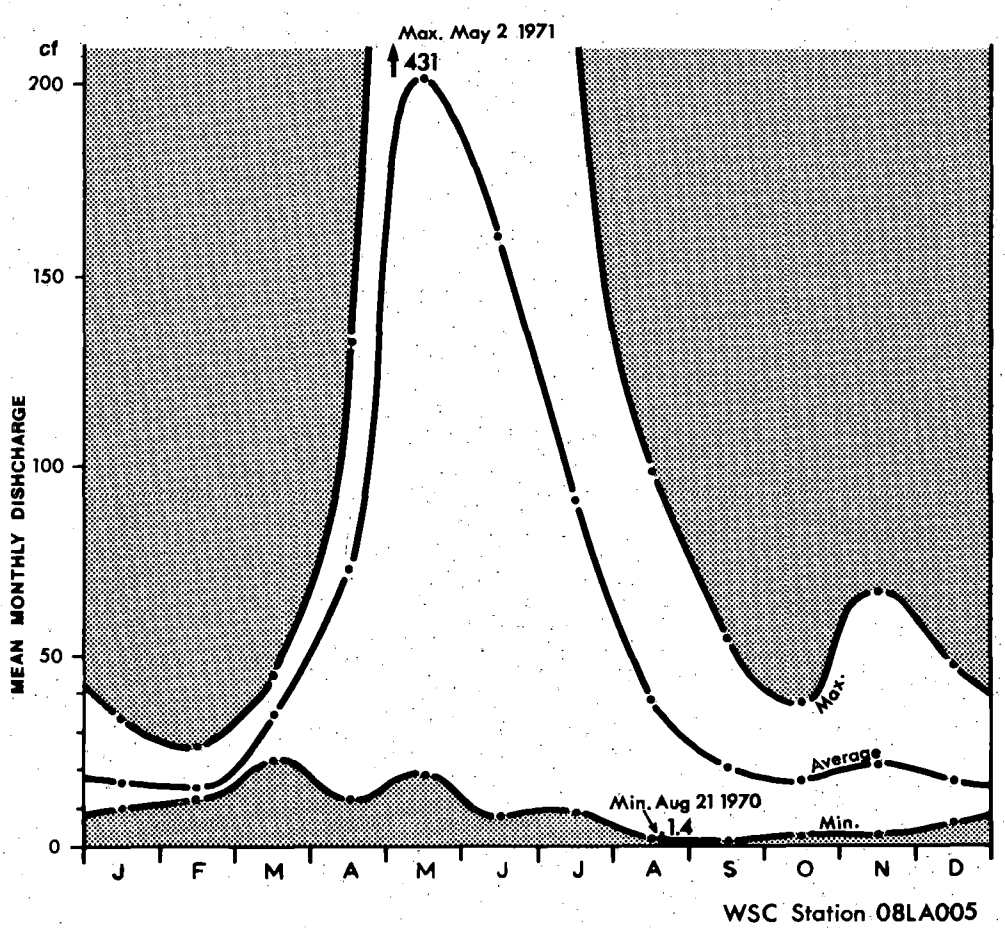
WSC Station 08MC027

REPRESENTATIVE CLIMATIC (**WILLIAMS LAKE**)
AND HYDROGRAPHIC (**BRIDGE CR.**) DATE

LOOP 13



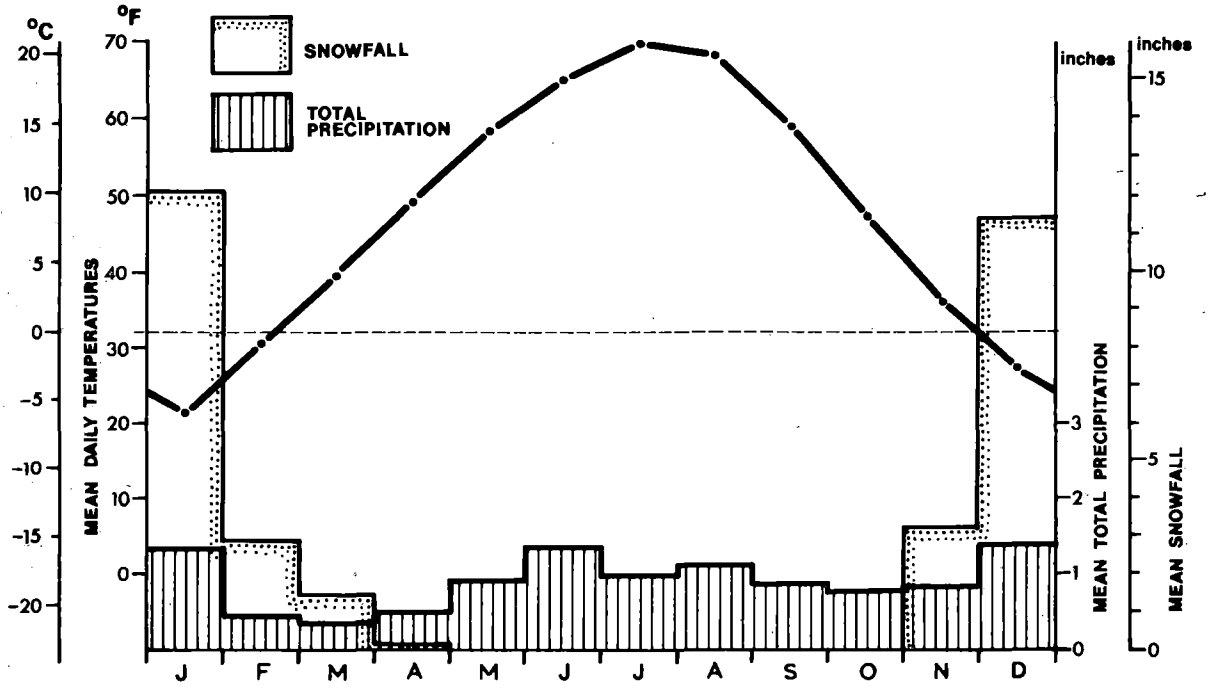
Atmospheric Environment Service 1971



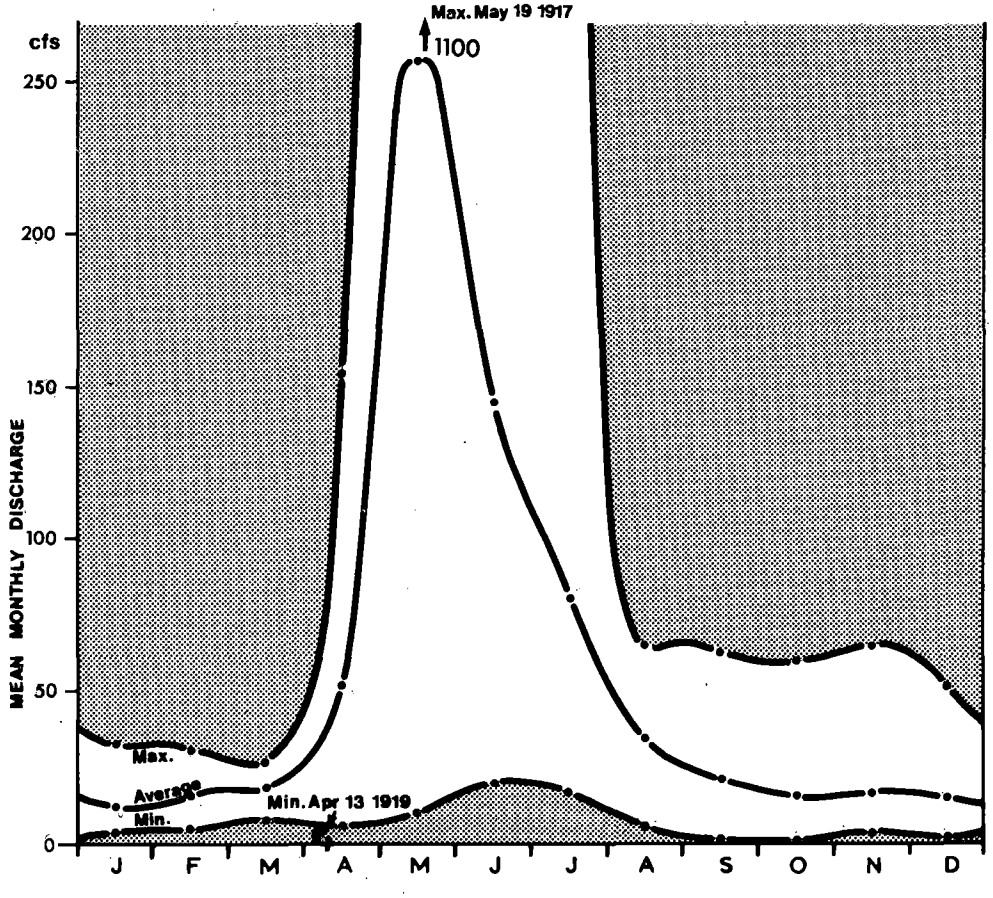
WSC Station 08LA005

REPRESENTATIVE CLIMATIC (**KAMLOOPS**)
AND HYDROGRAPHIC (**DEADMAN R.**) DATA

LOOP 14



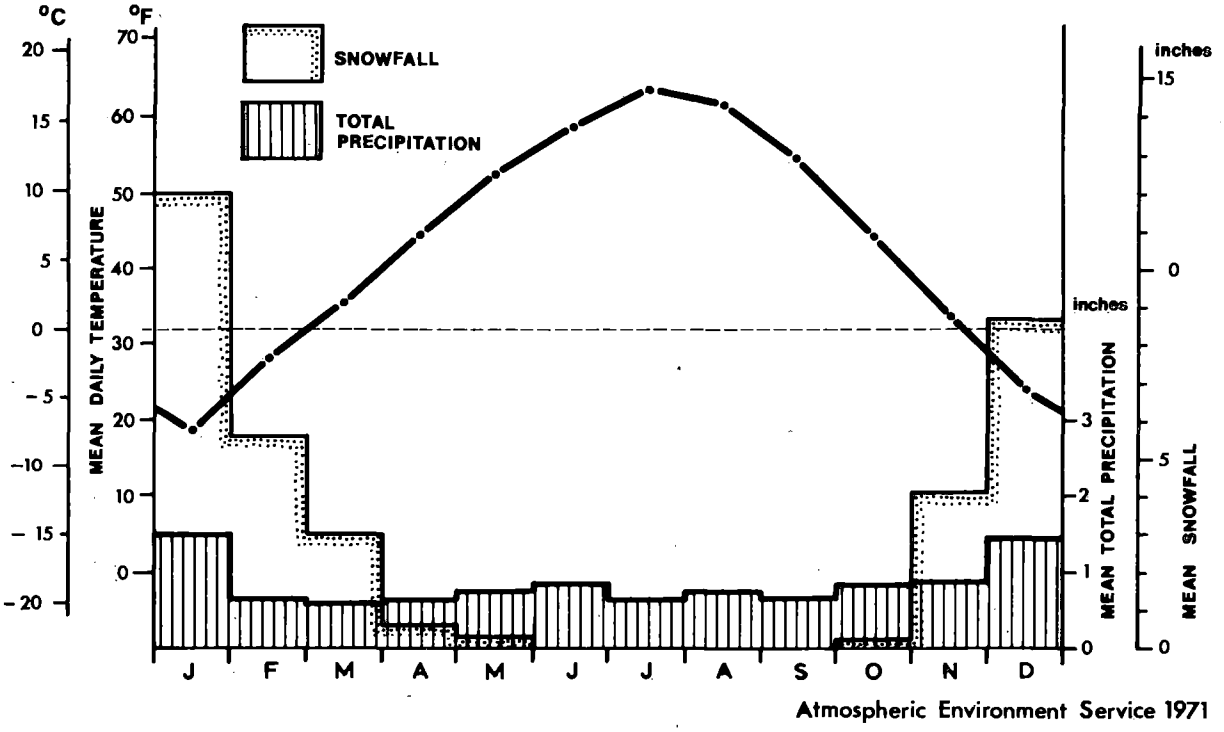
Atmospheric Environment Service 1971



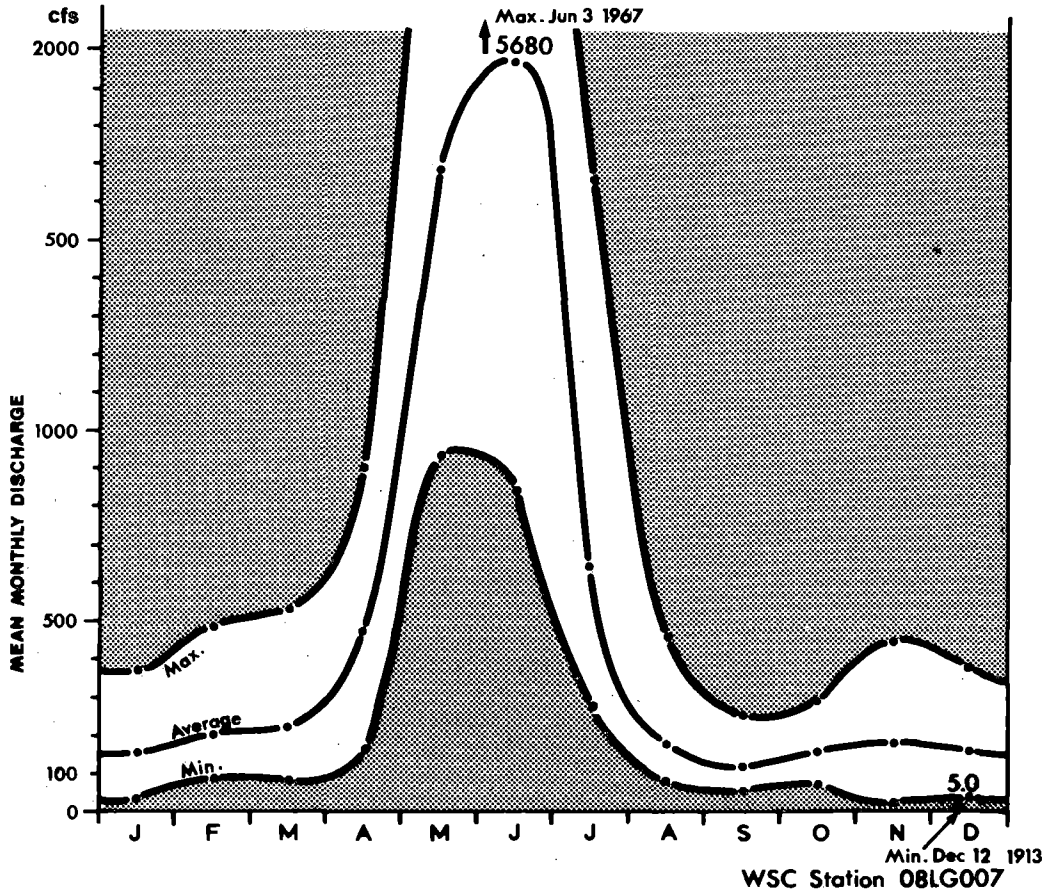
WSC Station 8LF027

REPRESENTATIVE CLIMATIC (**MERRITT**)
AND HYDROGRAPHIC (**NICOLA R.**) DATA

LOOP 15



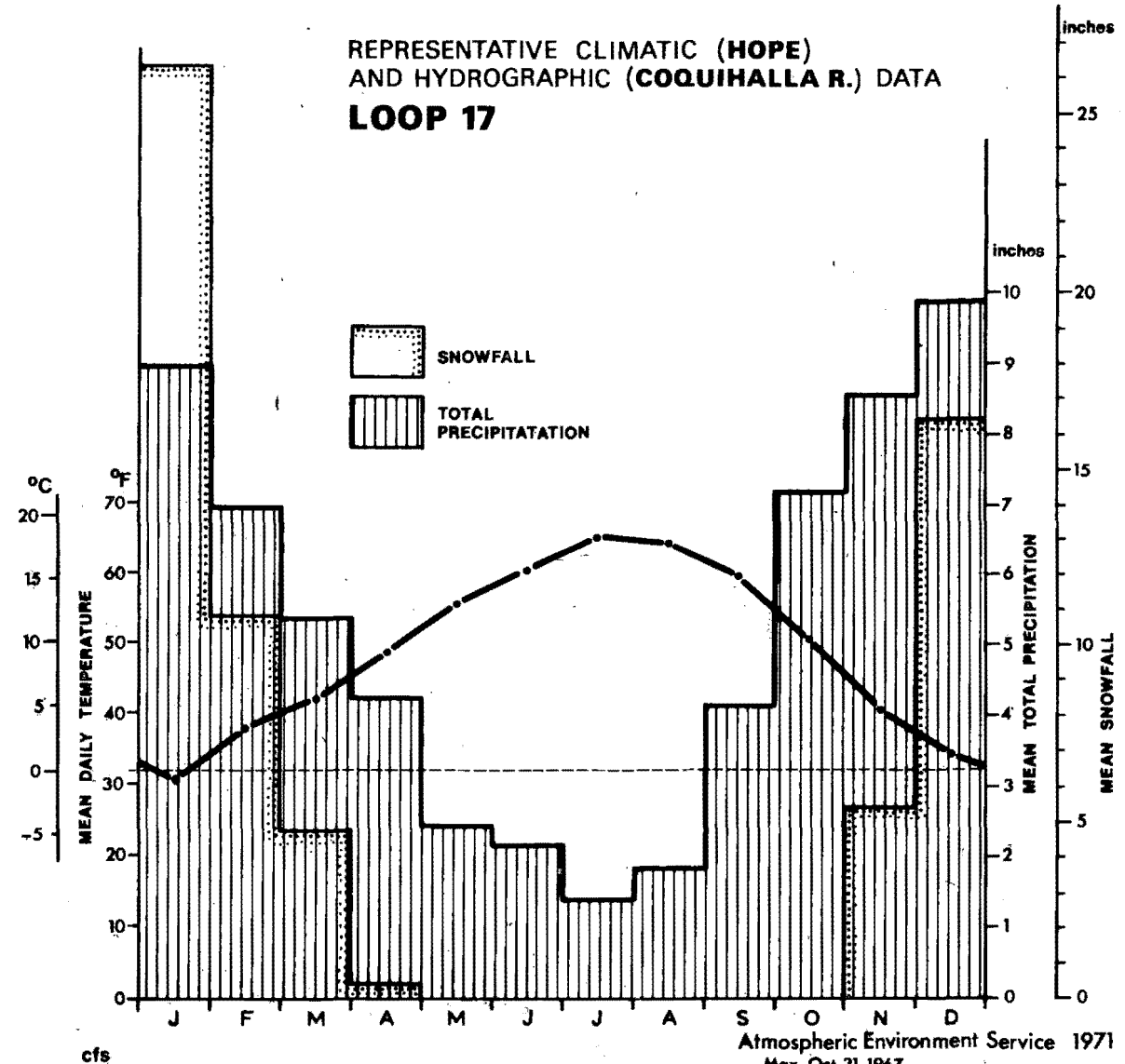
Atmospheric Environment Service 1971



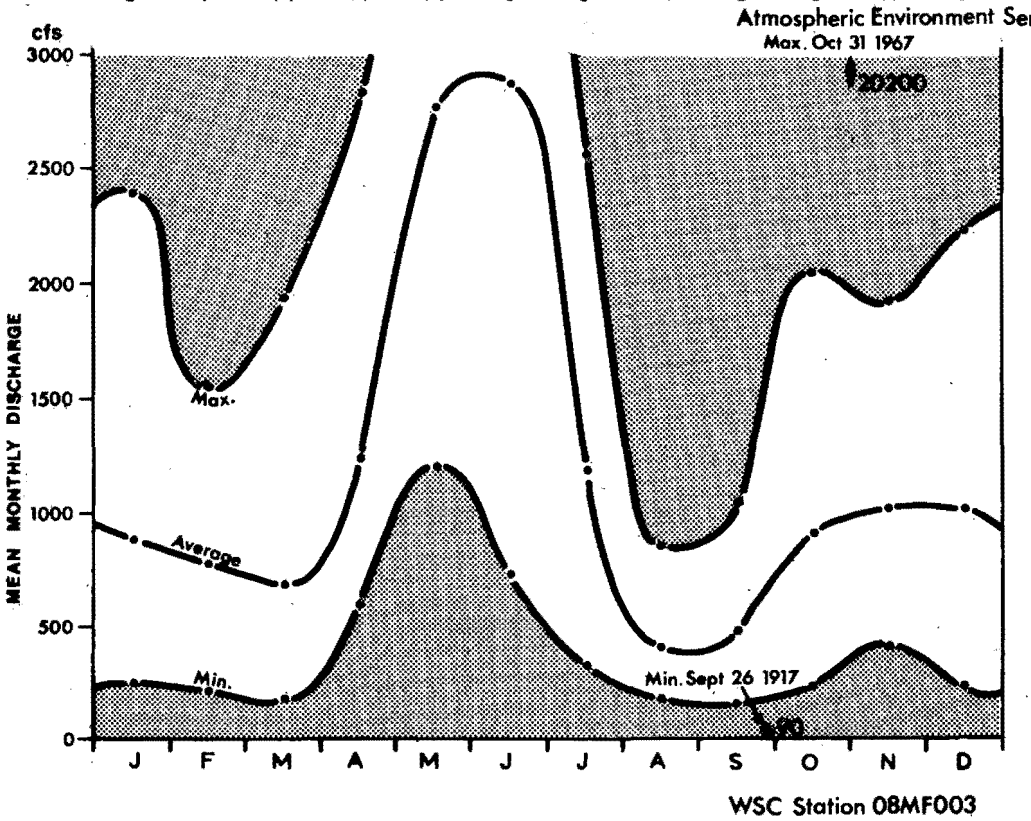
WSC Station 08LG007

REPRESENTATIVE CLIMATIC (**HOPE**)
AND HYDROGRAPHIC (**COQUIHALLA R.**) DATA

LOOP 17



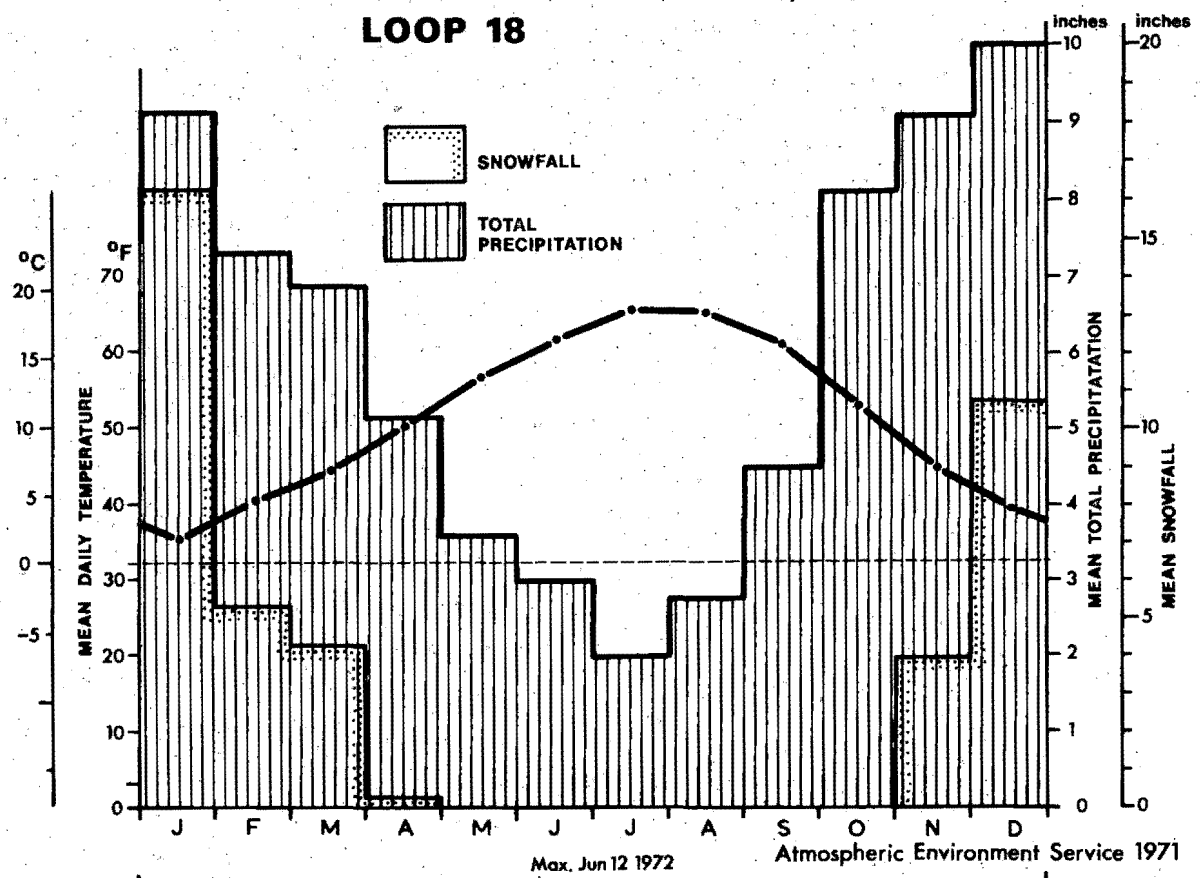
Atmospheric Environment Service 1971



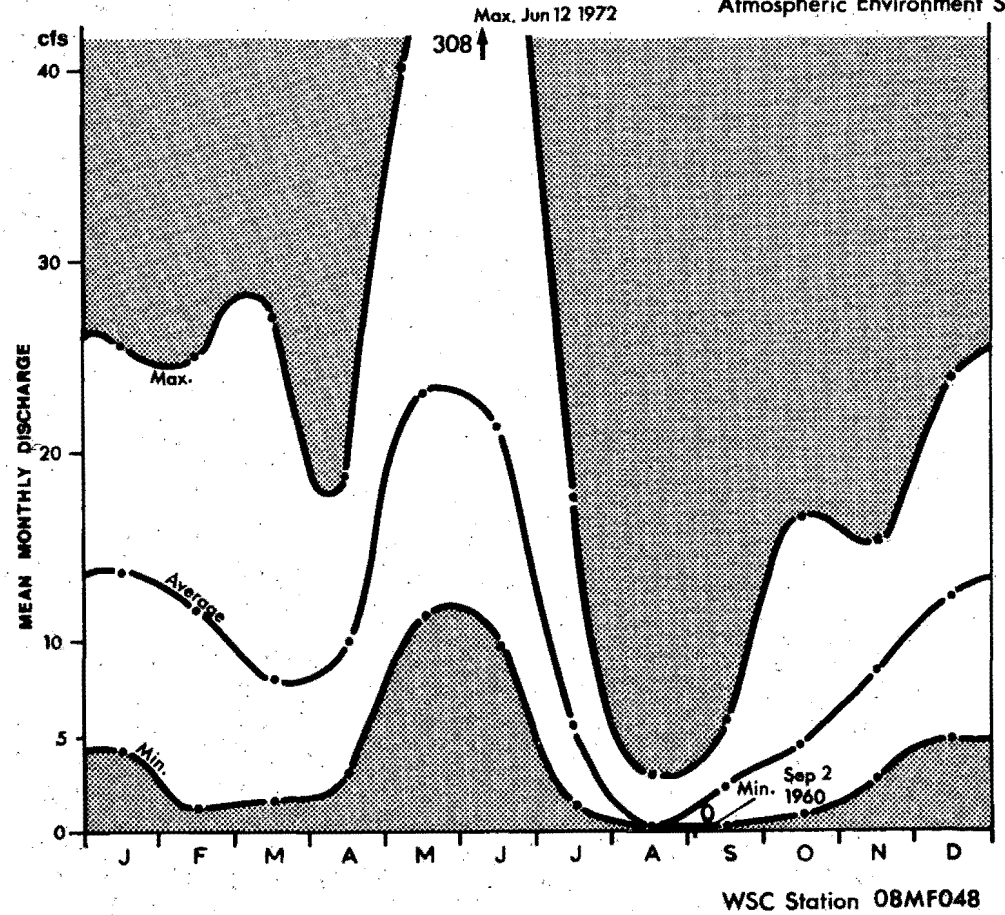
WSC Station 08MF003

REPRESENTATIVE CLIMATIC (**SUMAS CANAL**)
AND HYDROGRAPHIC (**ELK CR.**) DATA

LOOP 18



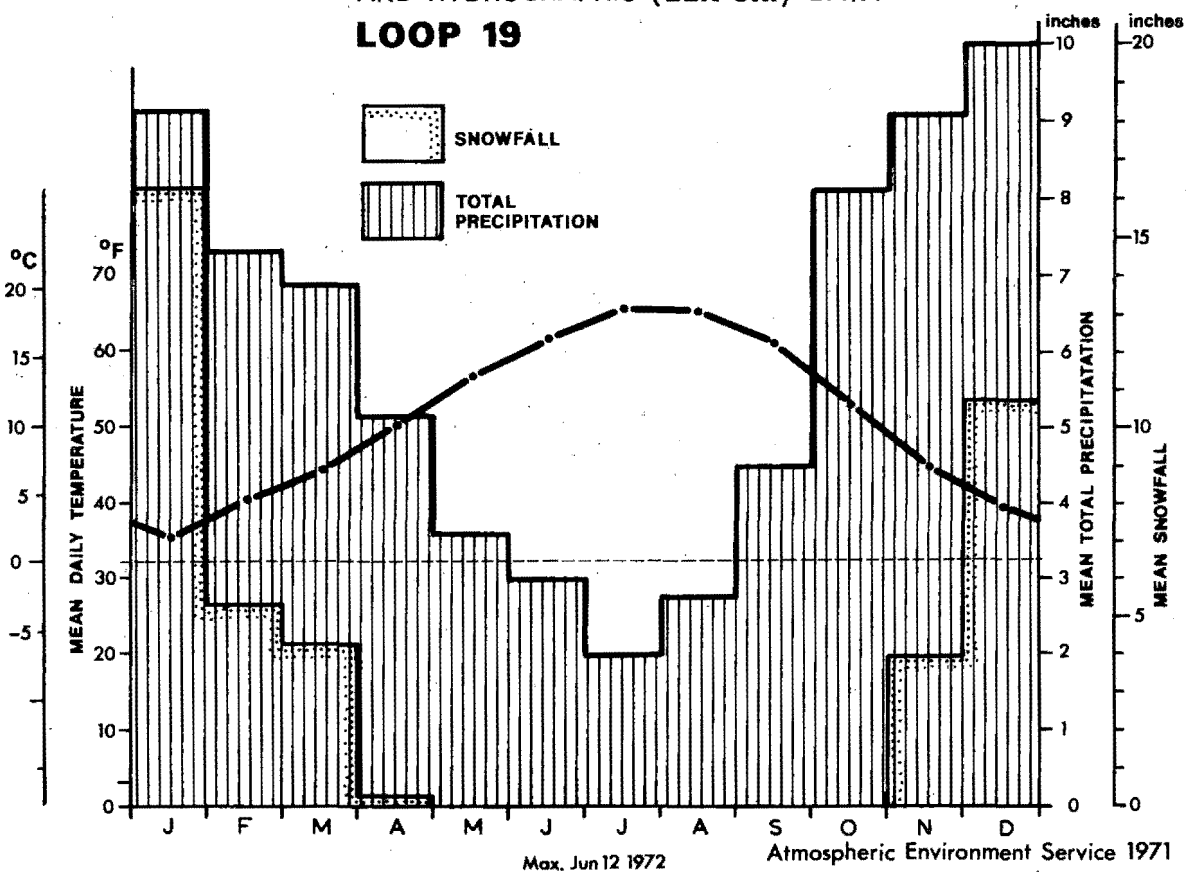
Atmospheric Environment Service 1971



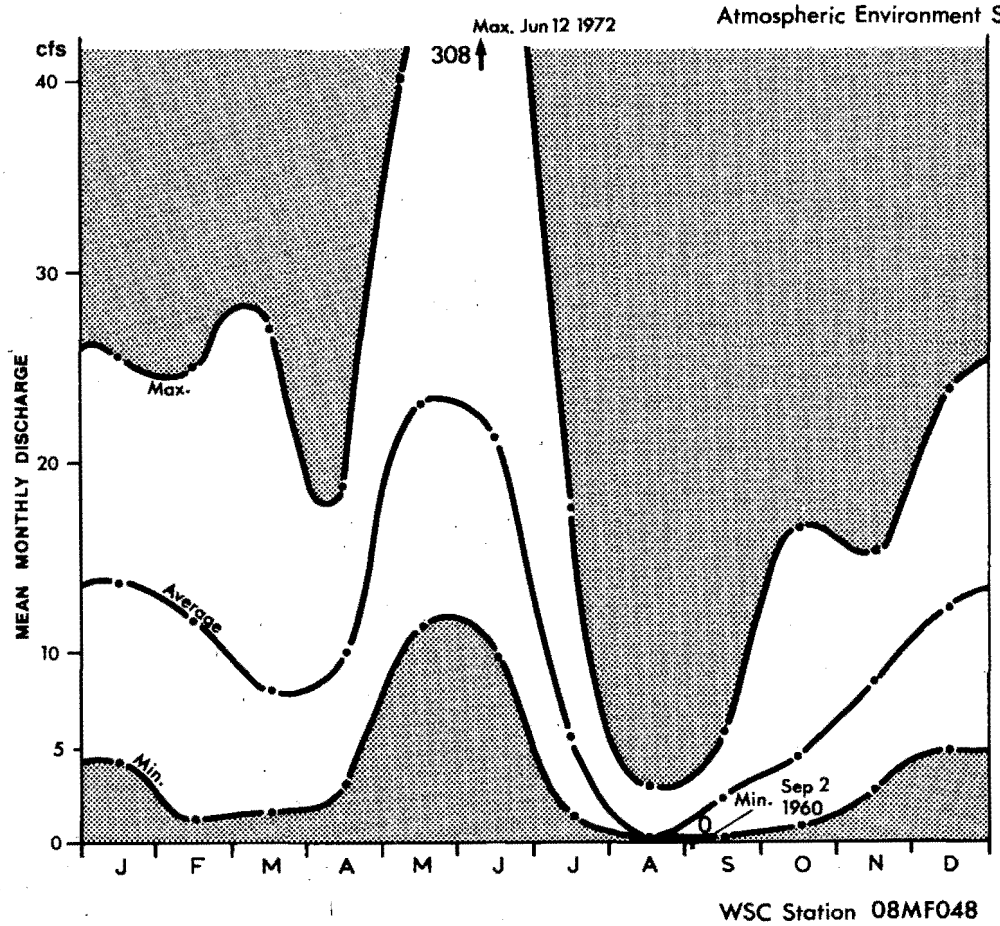
WSC Station 08MF048

REPRESENTATIVE CLIMATIC (**SUMAS CANAL**)
AND HYDROGRAPHIC (**ELK CR.**) DATA

LOOP 19



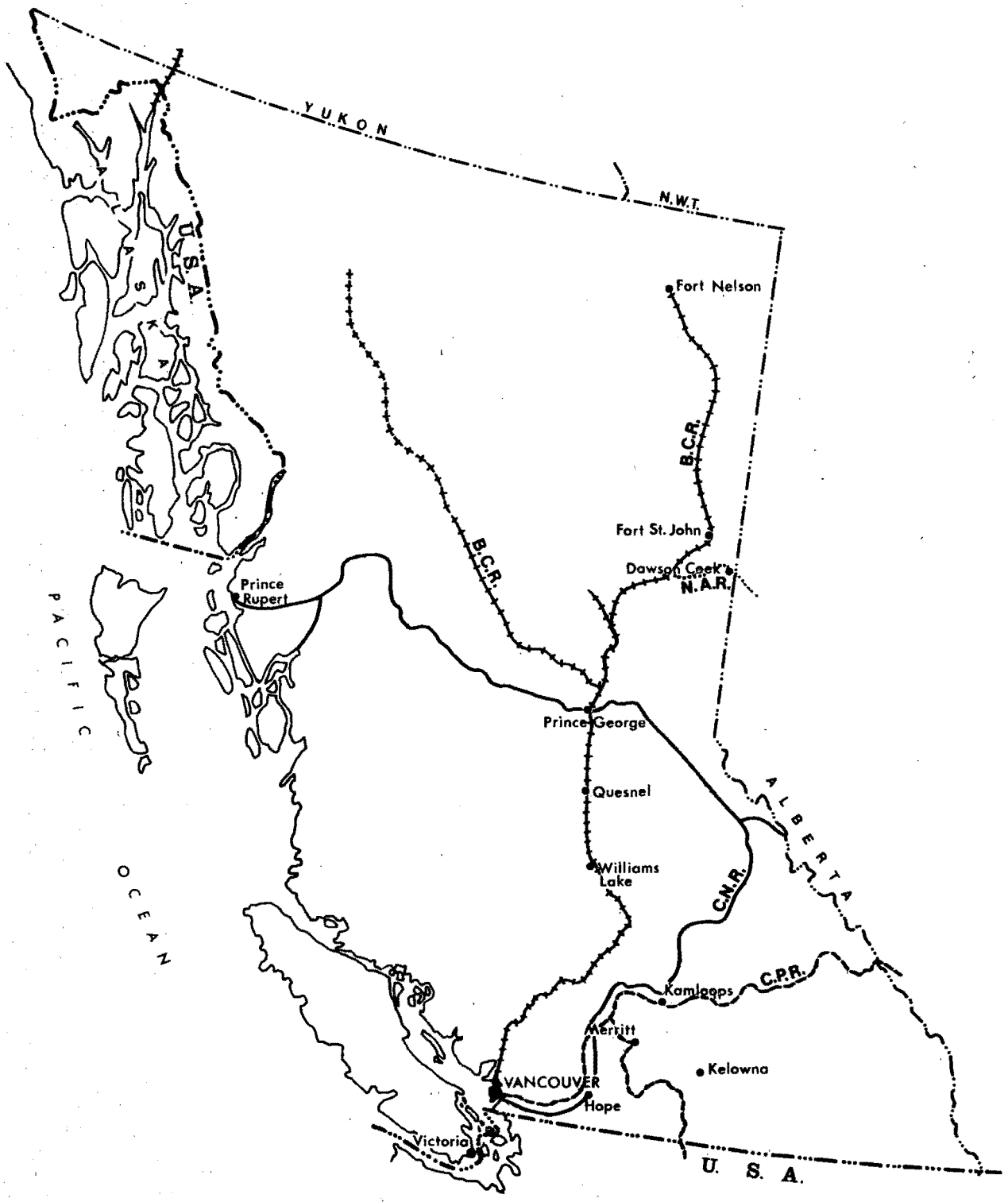
Atmospheric Environment Service 1971



WSC Station 08MF048

PART B

SOCIO-ECONOMIC INFORMATION



CORRIDOR RAILROAD LINES

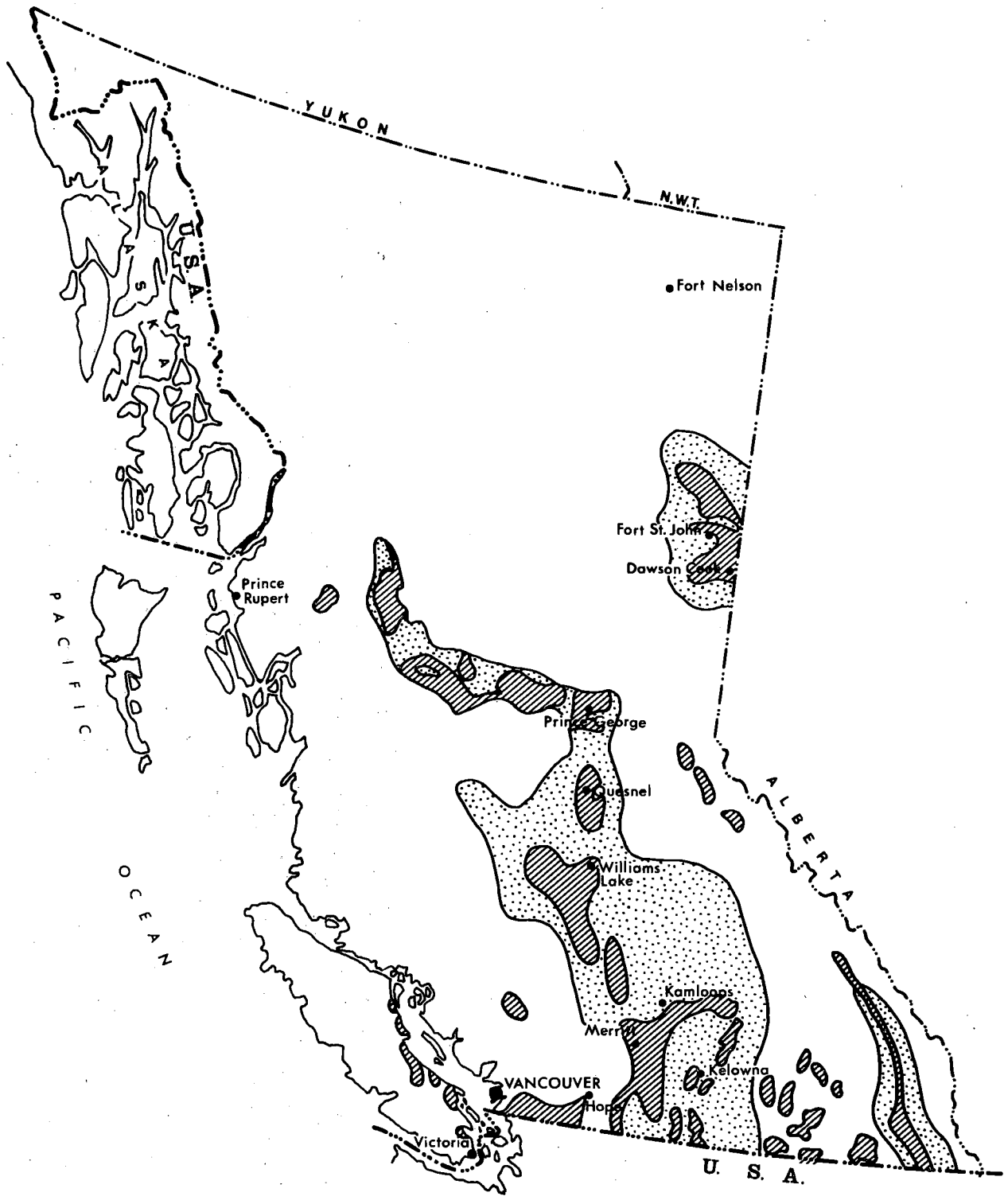
LEGEND

+++++++	B.C.R.	British Columbia Railway
- - - - - - -	C.P.R.	Canadian Pacific Railway
———	C.N.R.	Canadian National Railway
.....	N.A.R.	Northern Alberta Railway
-+-+-+-+-		White Pass and Yukon Route

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA - MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



CORRIDOR FARMING AREAS

LEGEND

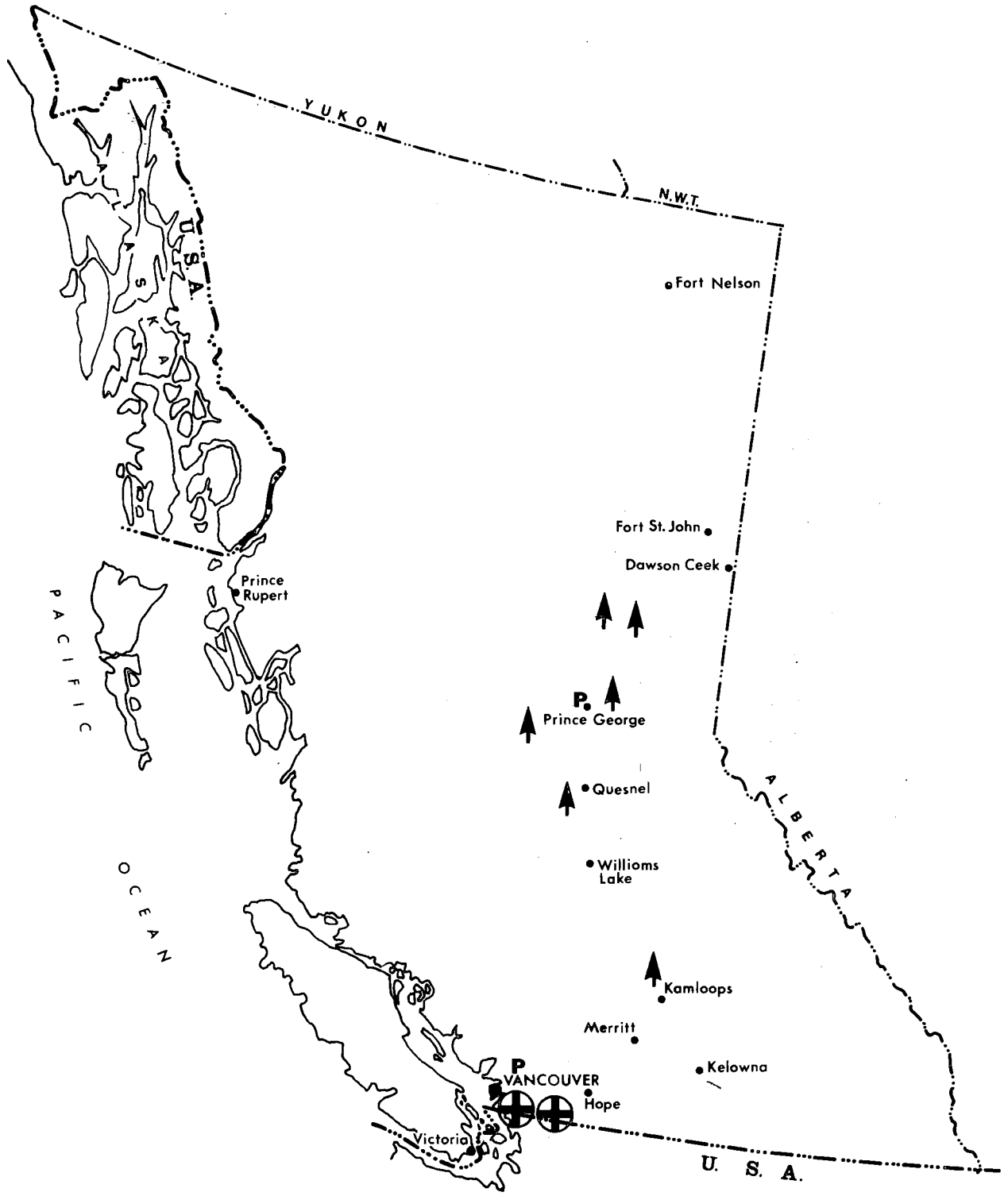
Main farming areas

Range lands

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA – MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



CORRIDOR PULP AND PAPER MILLS

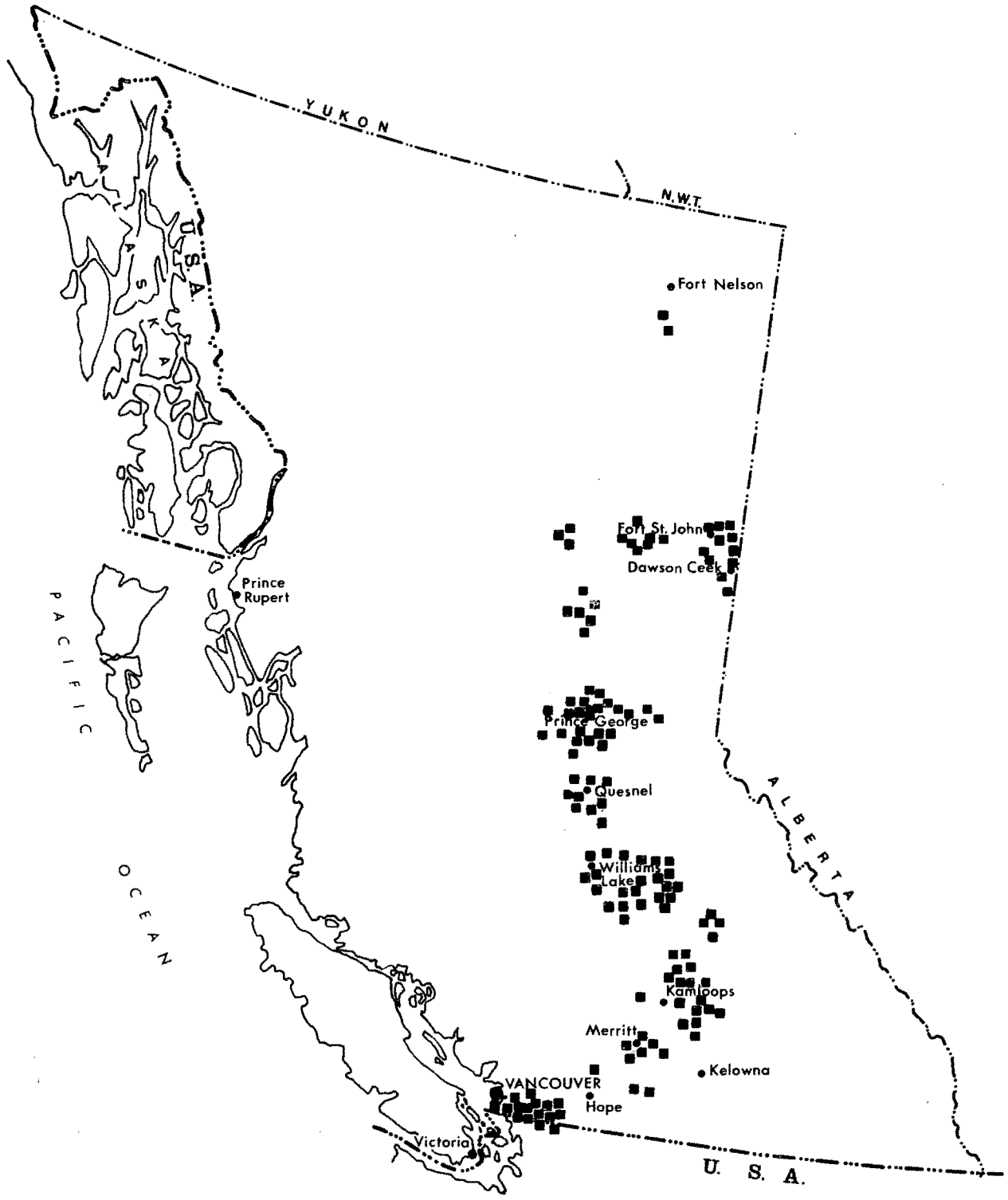
LEGEND

- Pulp
- P — Pulp and paper
- Paper only

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA - MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



LEGEND

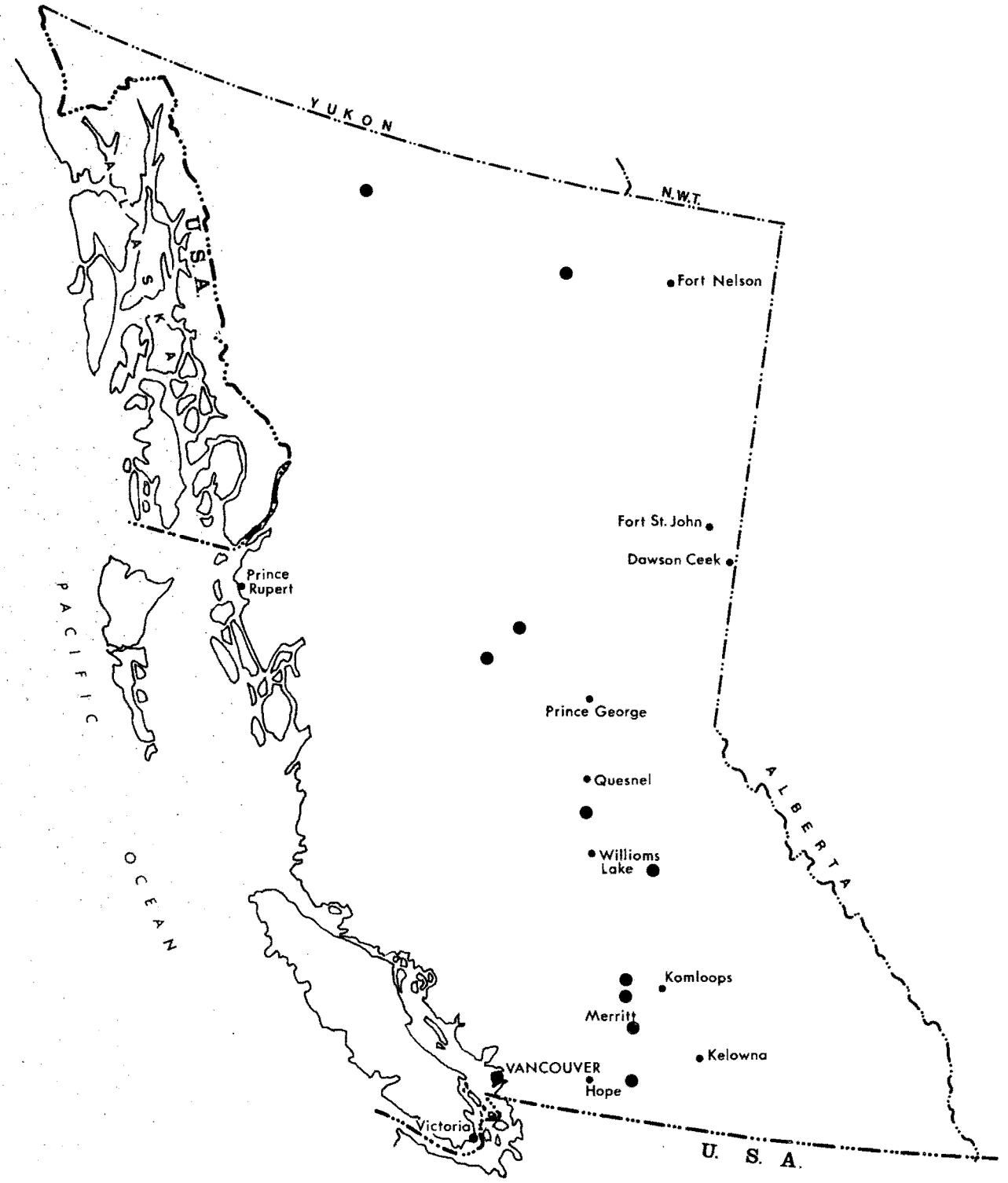
■ Sawmill

CORRIDOR SAWMILLS

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA - MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



LEGEND

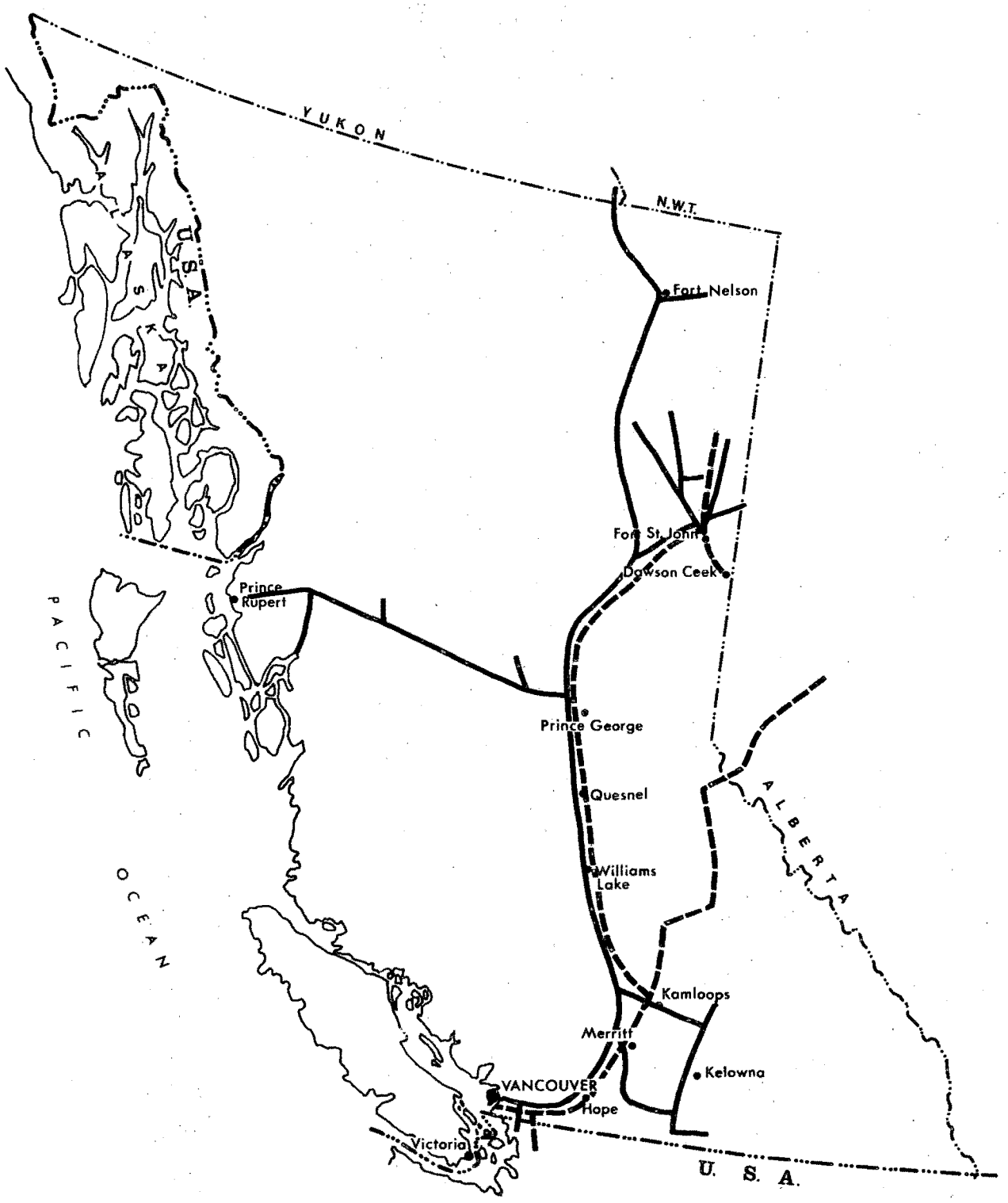
● Principal mines

CORRIDOR MINERAL INDUSTRY

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA – MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



LEGEND

Natural gas (operating)

Oil

EXISTING PIPELINES IN CORRIDOR

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA - MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ

LEGEND

Ferry Routes

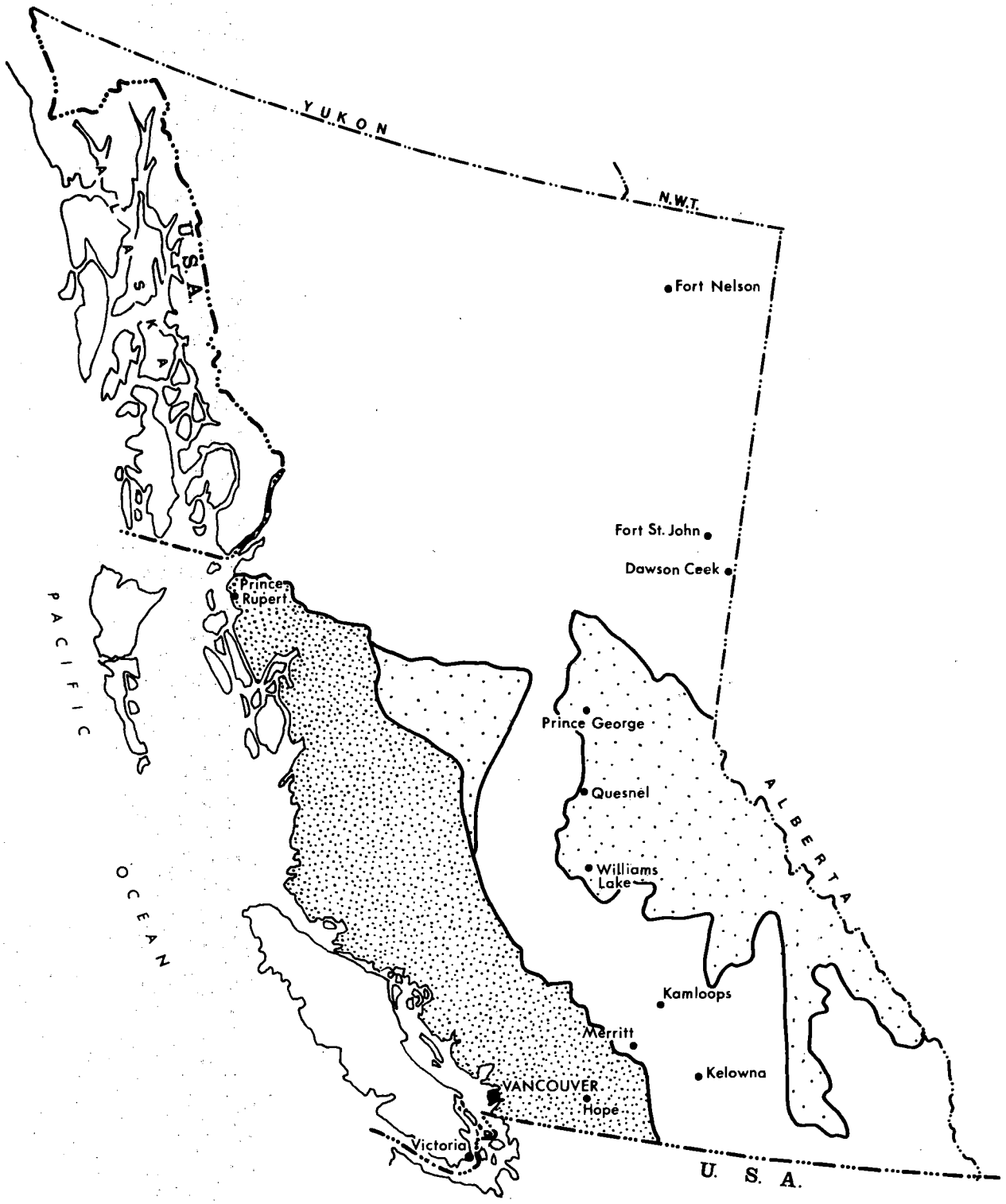
Highways

MAIN HIGHWAYS ALONG PIPELINE CORRIDOR

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA – MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ



LEGEND

- 0 - 2000 cu ft per acre
- 2001 - 4000 cu ft per acre
- over 4000 cu ft per acre

CORRIDOR FOREST RESOURCES – DENSITY

PROJECT No. G 52.3.1
DATE: JUNE, 1976

Data Source:
British Columbia Department of Economic Development,
BRITISH COLUMBIA – MANUAL OF RESOURCES AND DEVELOPMENT,
November, 1974

SCHULTZ

POPULATIONS AND PRINCIPAL SOURCES OF INCOME OF

SETTLEMENTS ALONG PIPELINE CORRIDOR - FORT NELSON TO SUMAS

Settlement	Population (1975)	Principal Sources of Income
Fort Nelson	3,200	Gas and oil exploration, lumbering, gas processing
Fort St. John	9,200	Farming, lumbering, tourism, oil and gas exploration
Prince George, Greater	72,000	Lumber, pulp, manufacturing, transp.
Quesnel, Greater	19,500	Lumber, pulp, ranching, farming
Williams Lake	5,250	Ranching, lumbering, tourism
100-Mile House	1,500	Lumbering, mining, ranching, tourism
Savona	500	Lumbering, tourism
Merritt	6,000	Mining, lumbering, tourism
Hope	3,700	Logging, tourism
Chilliwack, Greater	37,500	Agriculture, wood products
Abbotsford, District of	42,000	Agriculture, light manufacturing

SOURCE: B.C. Municipal Year Book, 1975, Sanderson Publications Ltd., Vancouver, B.C.

TIMBER SCALED IN BRITISH COLUMBIA

SELECTED YEARS 1965-1975

Year	Coast	Interior	Province
	(In millions of cubic feet)		
1965	858	675	1,533
1968	985	717	1,702
1971	1,003	994	1,997
1973	1,156	1,321	2,477
1975	624	1,159	1,783

Source: British Columbia Department of Economic Development, 1976

VALUE OF MINERAL PRODUCTION IN BRITISH COLUMBIA

SELECTED YEARS 1965-1975

Year	Total Production (in millions of dollars)
1965	280.7
1968	405.0
1971	528.0
1973	1,113.6
1975	1,223.3

Source: British Columbia Dept. of Economic Development, 1976

LABOR FORCE, EMPLOYMENT AND UNEMPLOYMENT

IN BRITISH COLUMBIA

1965 - 1975

(thousands of persons)

Year	Labor Force	Male	Female	Employed	Unemployed	% of Labor Force Unemployed
1965	666	469	197	639	28	4.2
1970	878	592	286	810	67	7.6
1975	1,122	721	401	1,028	94	8.4

Source: Britich Columbia Dept. of Economic Development, 1976

VALUE OF NATURAL GAS AND CRUDE OIL PRODUCTION

IN BRITISH COLUMBIA

1971 - 1975

Year	Crude Oil Production (millions of dollars)	Natural Gas Production (millions of dollars)
1971	65	34
1972	63	40
1973	70	46
1974	106	74
1975	97	78

Source: British Columbia Dept. of Economic Development, 1976

PART C

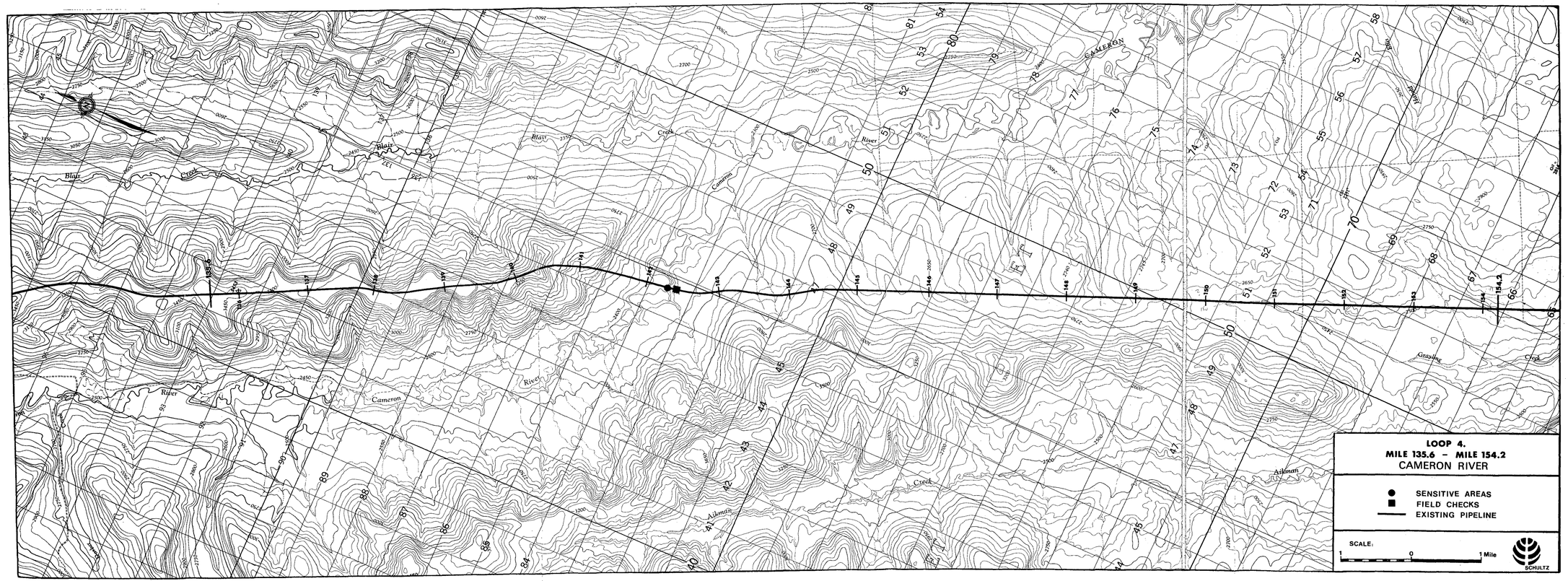
LOOP MAPS

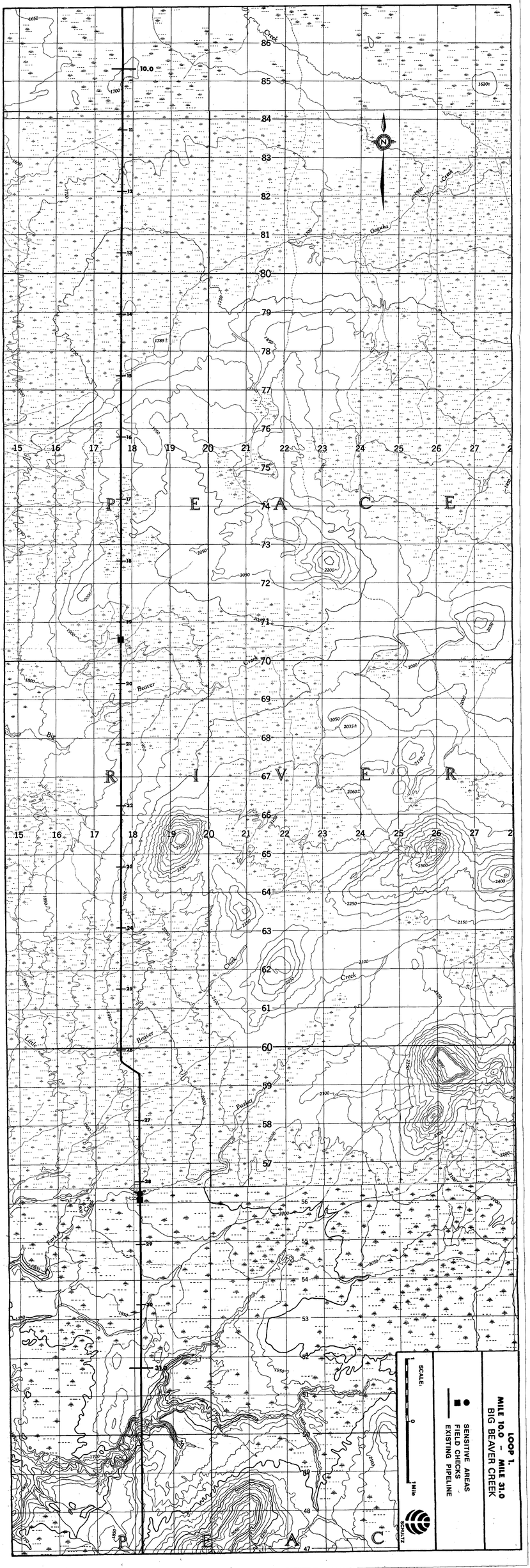
LOOP 1.
MILE 10.0 - MILE 31.0
BIG BEAVER CREEK

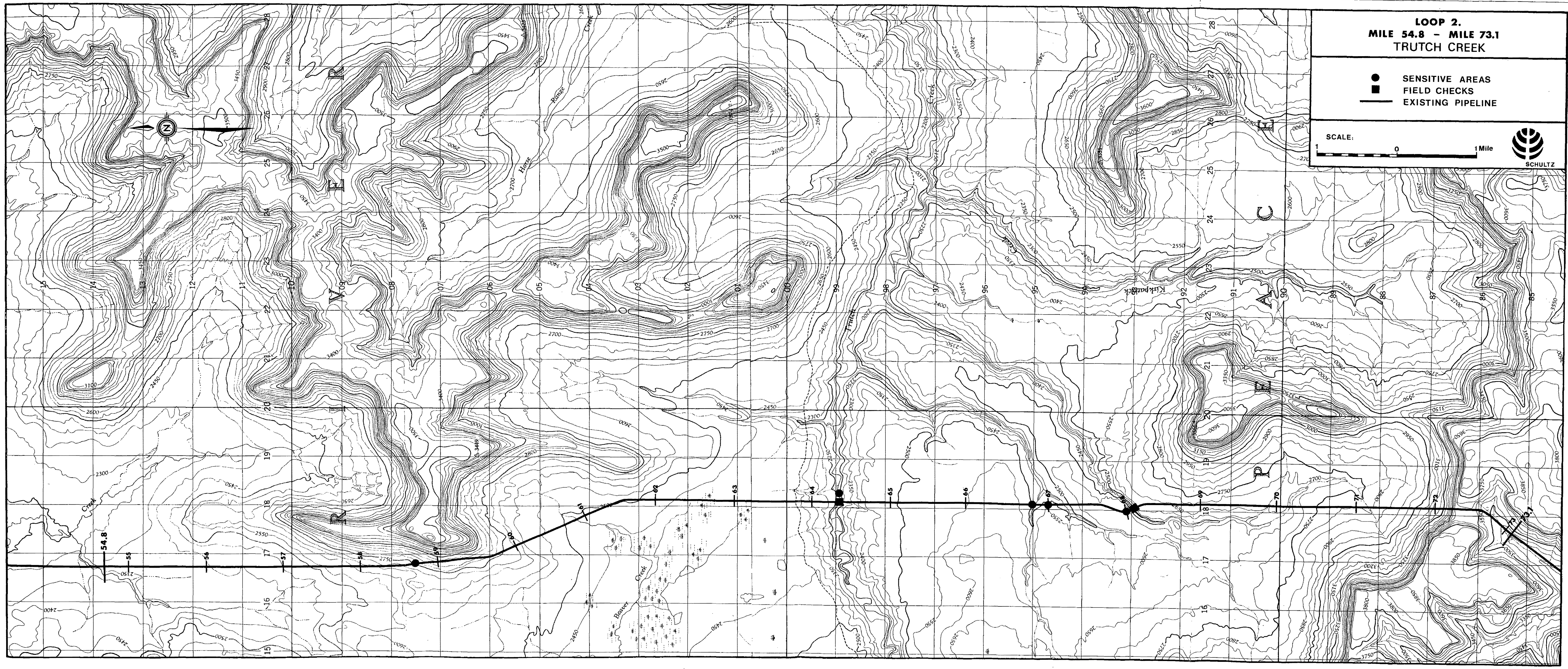
- ● SENSITIVE AREAS
- ■ FIELD CHECKS
- ━ EXISTING PIPELINE

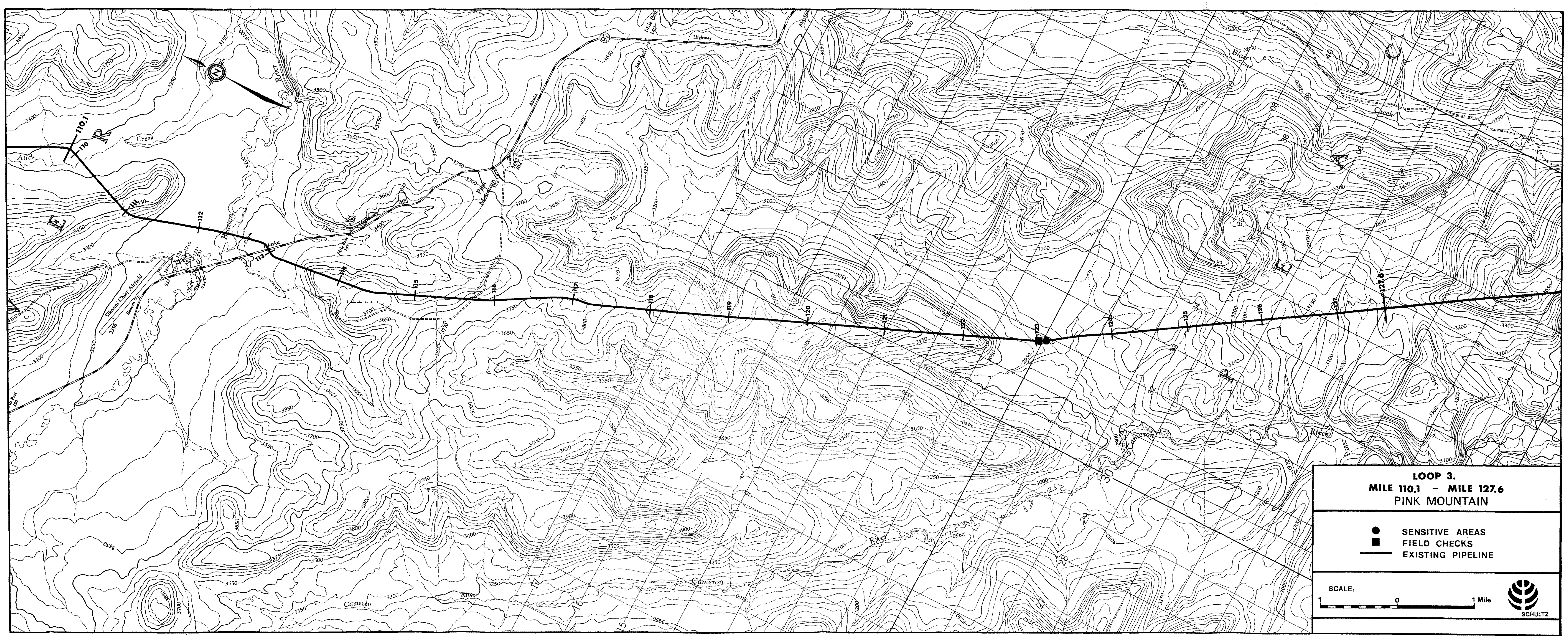
SCALE: 1 0 1 Mile

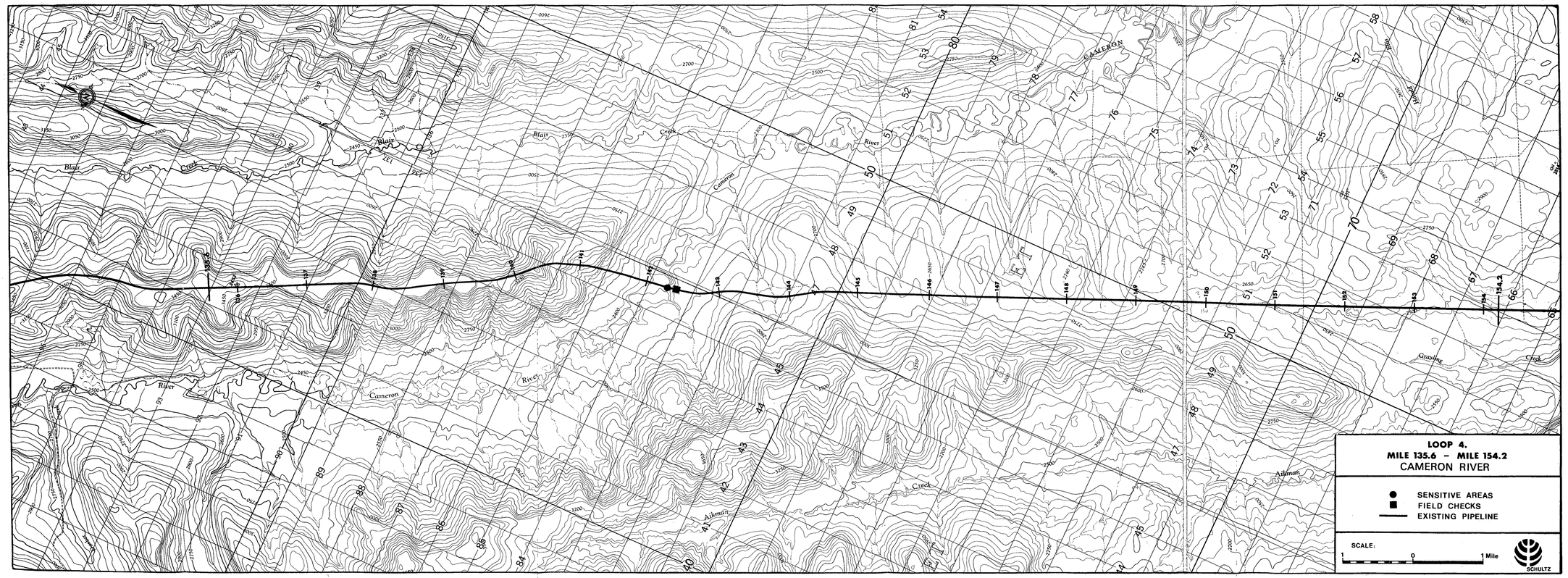
SCHULTZ

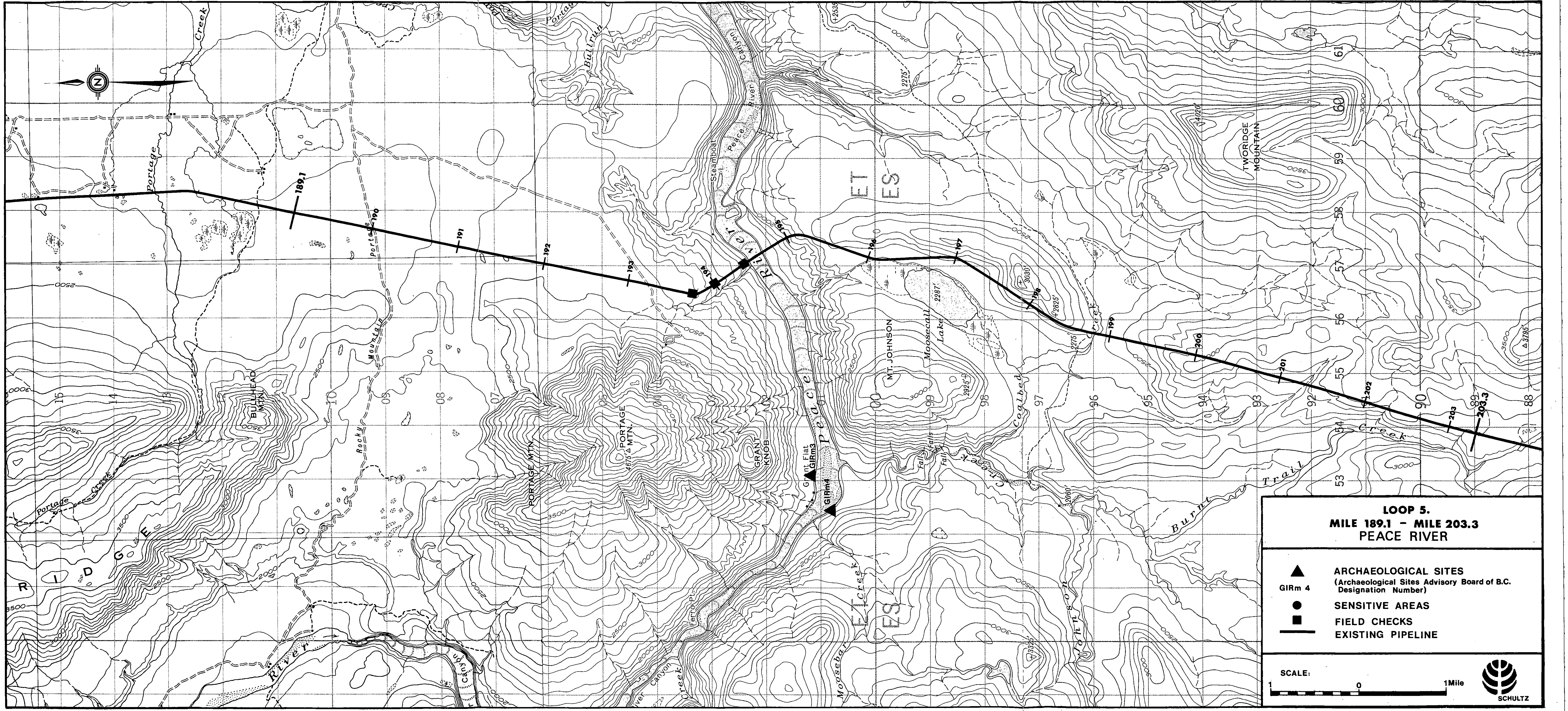

LOOP 4.
MILE 135.6 - MILE 154.2
CAMERON RIVER
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE:
1 0 1 Mile
SCHULTZ
Blair Creek
Cameron River
Aikman Creek
Grayling Creek
CAMERON
135.6
154.2


LOOP 1
MILE 10.0 – MILE 31.0
BIG BEAVER CREEK
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE:
1 Mile
0
SPECTRA ENERGY
PEACE RIVER
Big Beaver Creek
Little Beaver Creek
Parker Creek
Gataka Creek
10.0
31.0

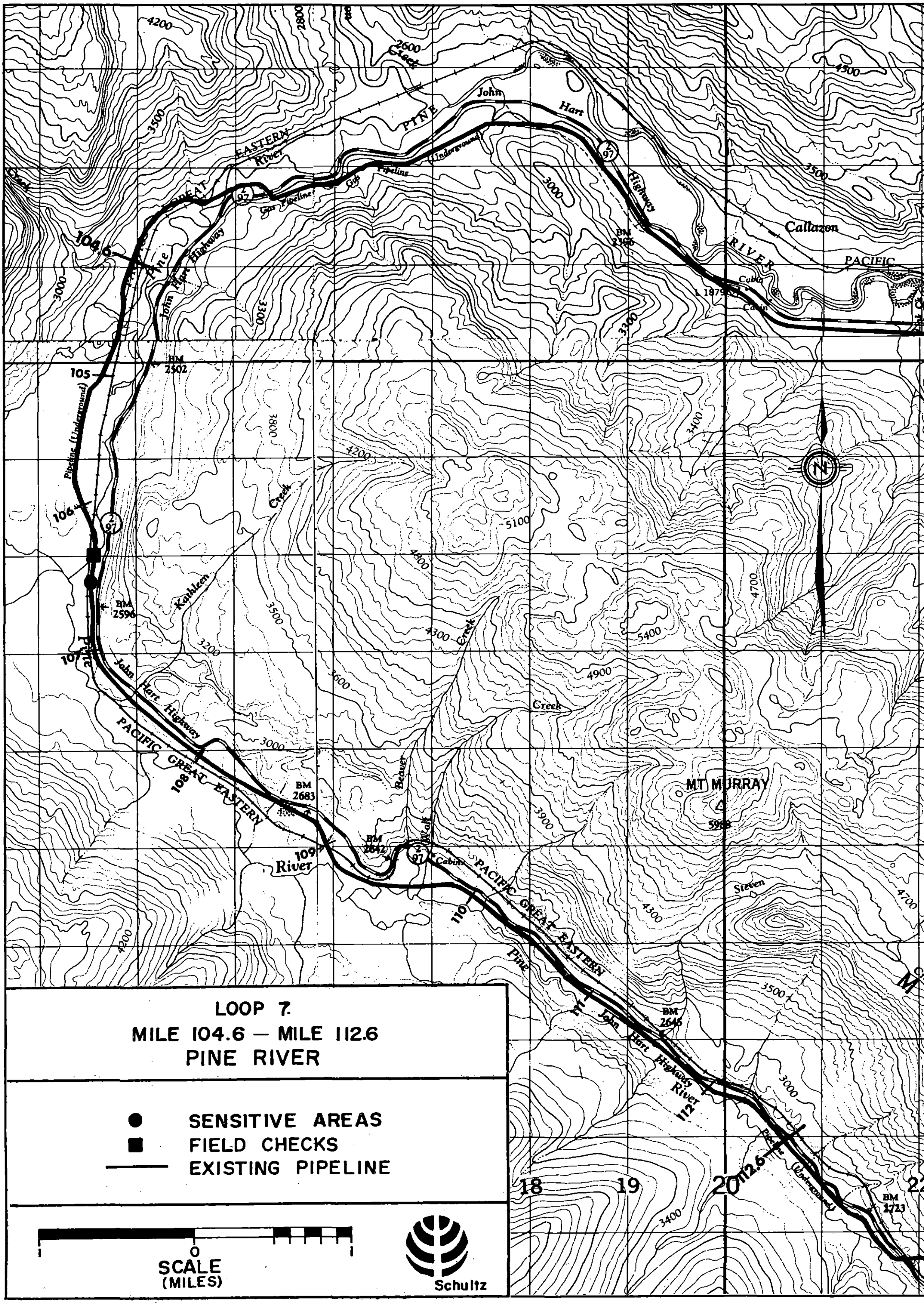

LOOP 2.
MILE 54.8 - MILE 73.1
TRUTCH CREEK
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE
1
0
1 Mile
SCHULTZ


LOOP 3.
MILE 110.1 - MILE 127.6
PINK MOUNTAIN
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE:
1
0
1 Mile
SCHULTZ
Cameron
River
Creek

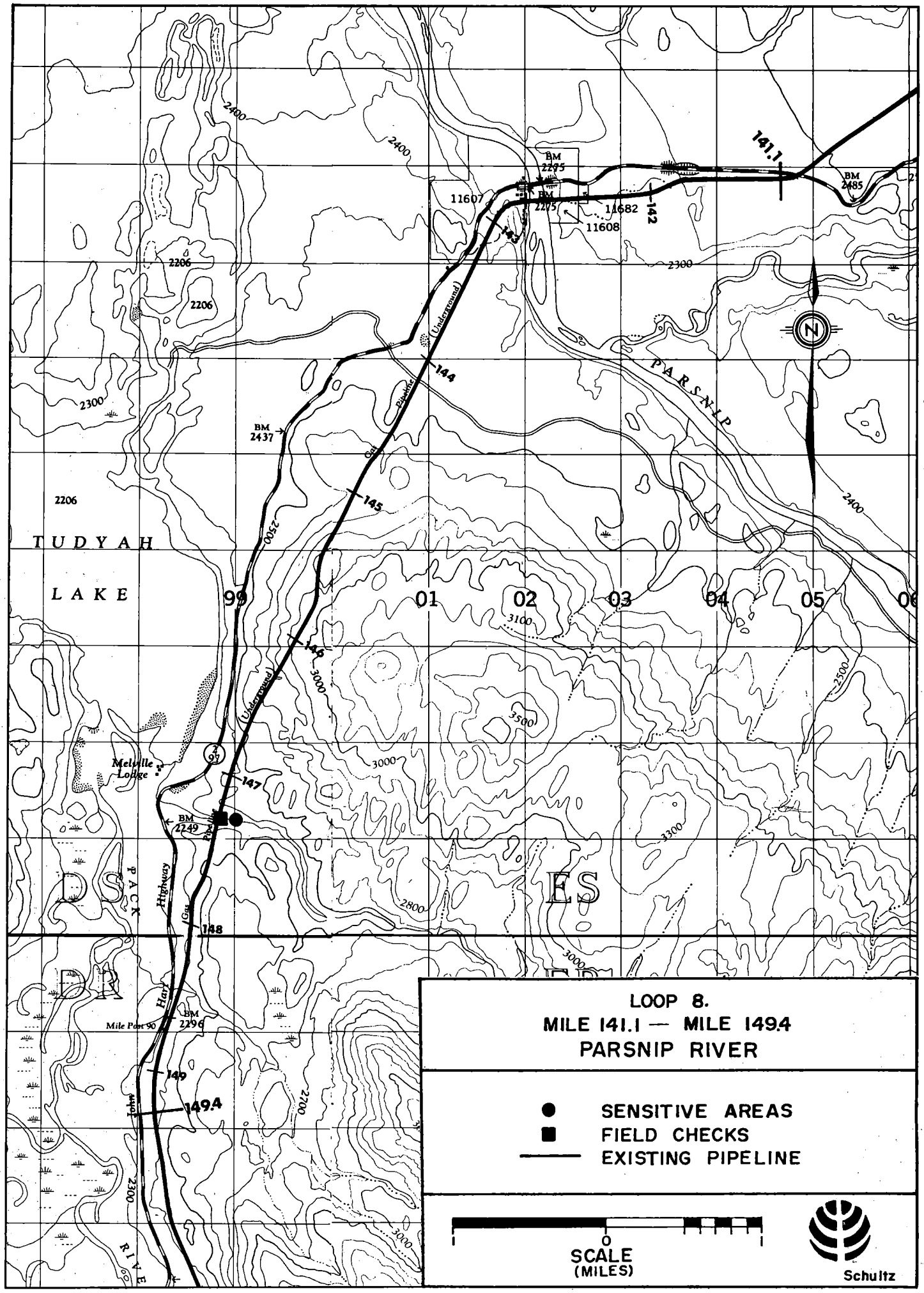

Blair Creek
Cameron River
Aikman Creek
Grayling Creek
CAMERON
HAT
LOOP 4.
MILE 135.6 – MILE 154.2
CAMERON RIVER
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE:
1 0 1 Mile
SCHULTZ

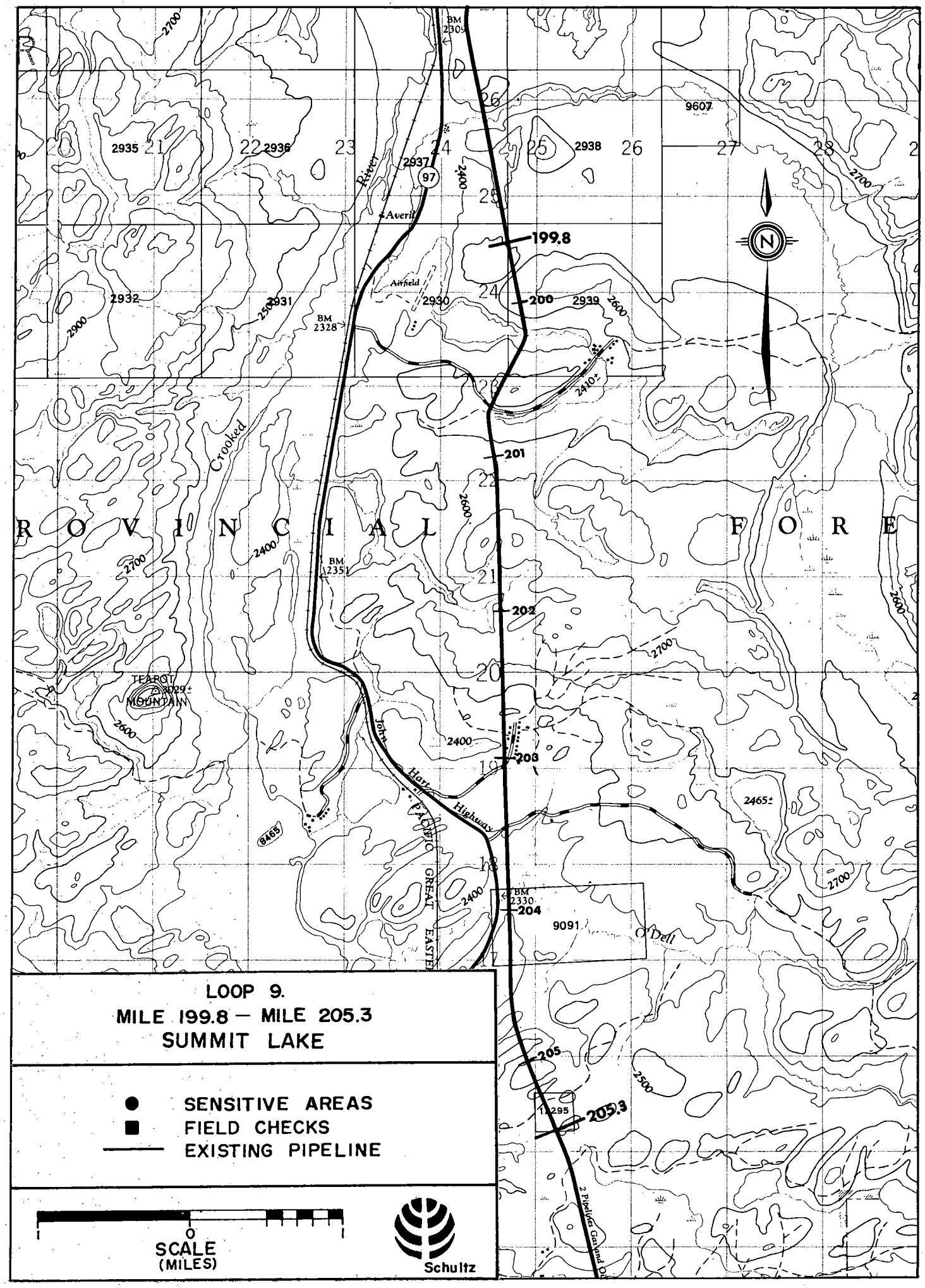


LOOP 5.
MILE 189.1 - MILE 203.3
PEACE RIVER
ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)
GIRm 4
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE:
1
0
1Mile
SCHULTZ
189.1
190
191
192
193
194
195
196
197
198
199
200
201
202
203
203.3
Peace River
Peace River Canyon
Steamboat
Bullrun
Portage Creek
Portage Mountain
Rocky Mountain
Portage
BULLHEAD MTN.
PORTAGE MTN.
PORTAGE MTN.
GRANT KNOB
Grant Flat
GIRm3
GIRm4
MT. JOHNSON
Moosecall Lake
Coalbed Creek
Moosebar Creek
Johnson
Burnt Trail Creek
TWORIDGE MOUNTAIN
RIDGE
Falls
River
Canyon
Creek



LOOP 7.
MILE 104.6 — MILE 112.6
PINE RIVER


LOOP 8.
MILE 141.1 — MILE 149.4
PARSNIP RIVER
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
141.1
142
143
144
145
146
147
148
149
149.4
11607
11608
11682
BM 2295
BM 2275
BM 2485
BM 2437
BM 2249
BM 2296
PARSNIP
TUDYAH
LAKE
Melville Lodge
Mile Post 90
Highway
Pipeline
(Underground)
99
01
02
03
04
05


LOOP 9.
MILE 199.8 — MILE 205.3
SUMMIT LAKE
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
199.8
200
201
202
203
204
205
205.3
Averill
Airfield
Crooked River
TEAPOT MOUNTAIN
3029±
BM 2309
BM 2328
BM 2351
BM 2330
2935
2936
2937
2938
2932
2931
2930
2939
9607
9091
2410±
2465±
1295
2 Pipelines Gas and Oil
PACIFIC GREAT EASTERN
Hart Highway
John's
O'Dell

LOOP 10.
MILE 255.3 — MILE 266.6
HIXON

ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)
GIRm 4

SENSITIVE AREAS

FIELD CHECKS

EXISTING PIPELINE

SCALE (MILES)
0

Schultz

LOOP 11.
MILE 311.3 — MILE 317.7
KERSLEY CREEK

▲ GIRm 4 ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)

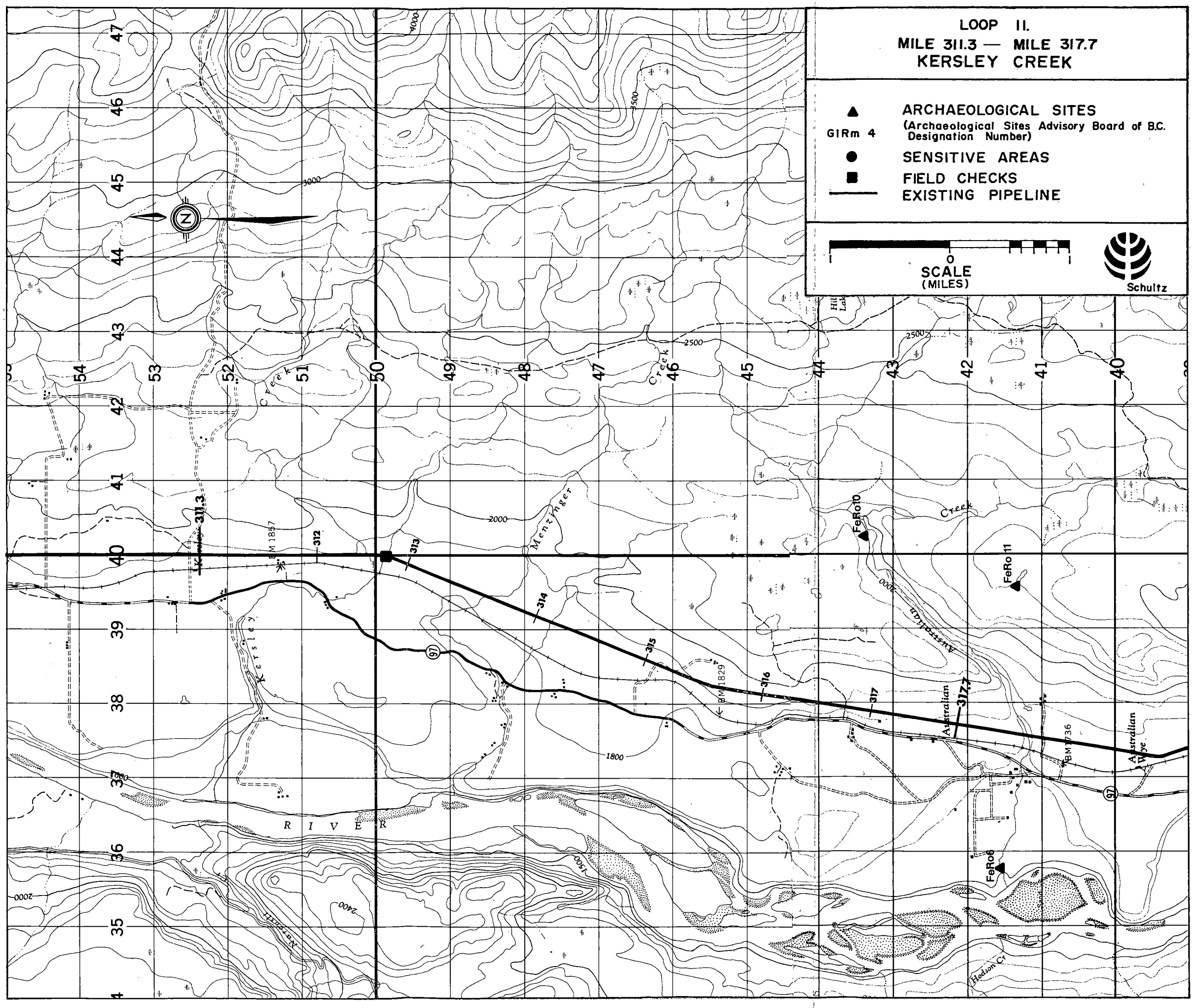
● SENSITIVE AREAS

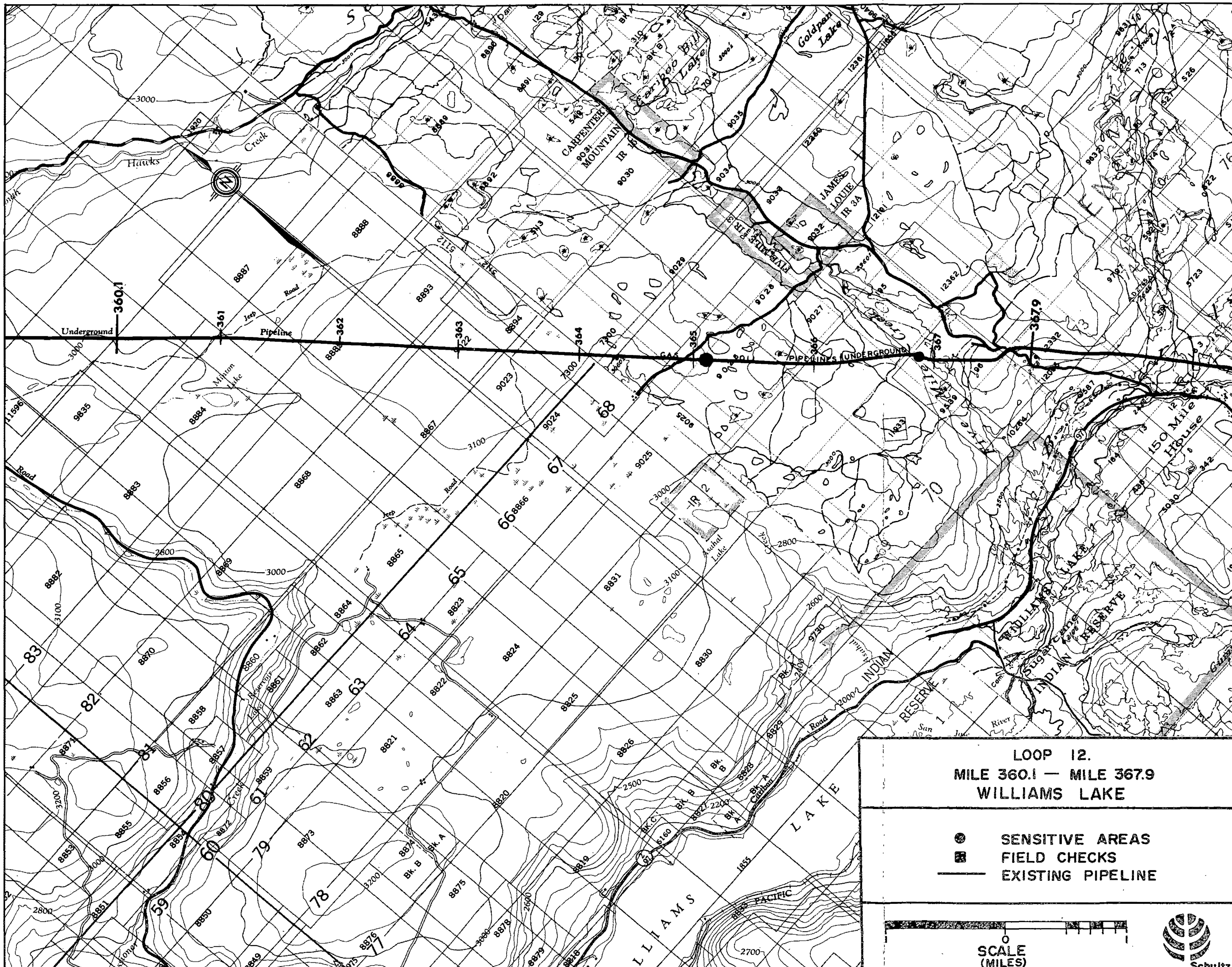
■ FIELD CHECKS

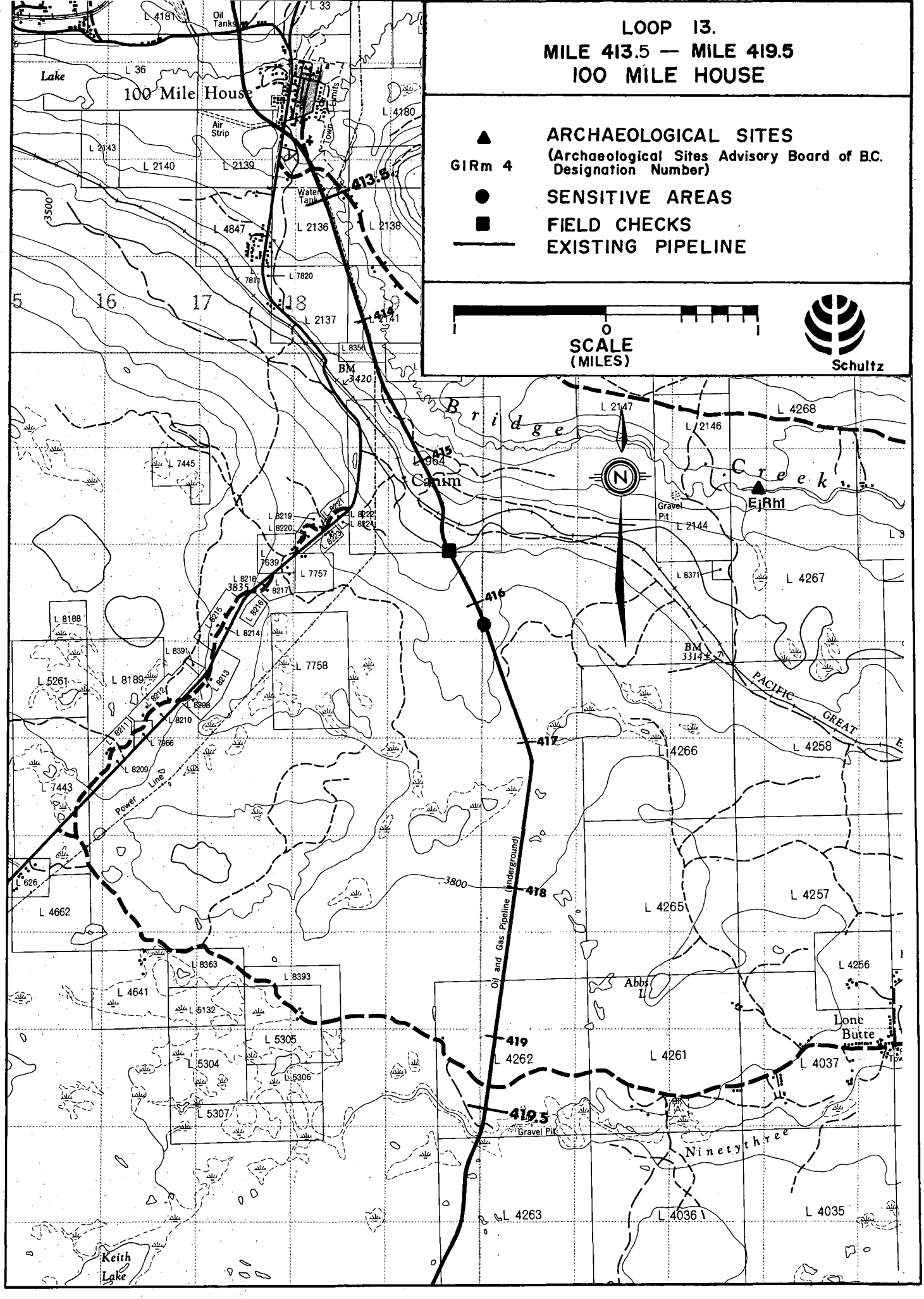
EXISTING PIPELINE

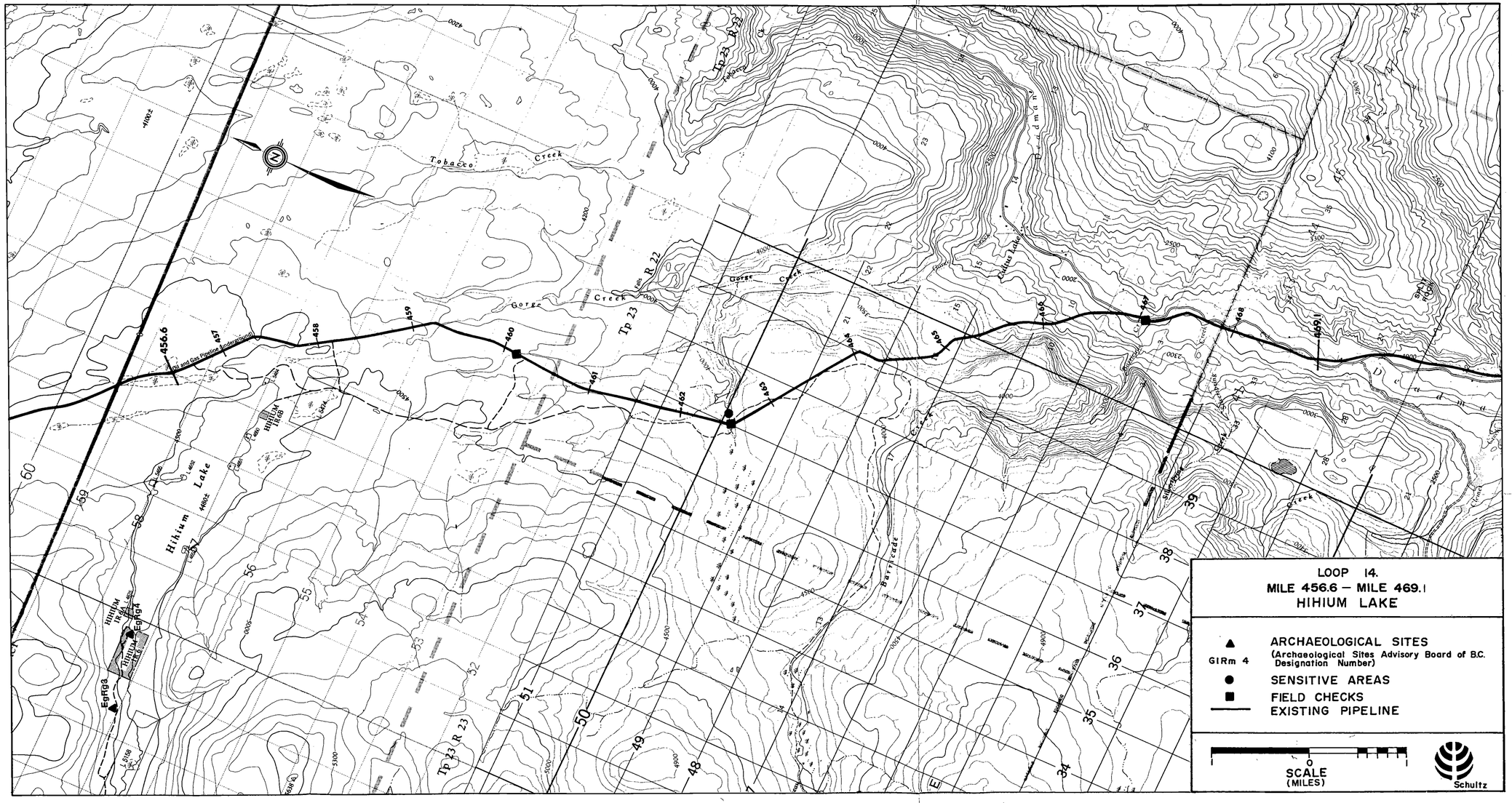
0
SCALE
(MILES)

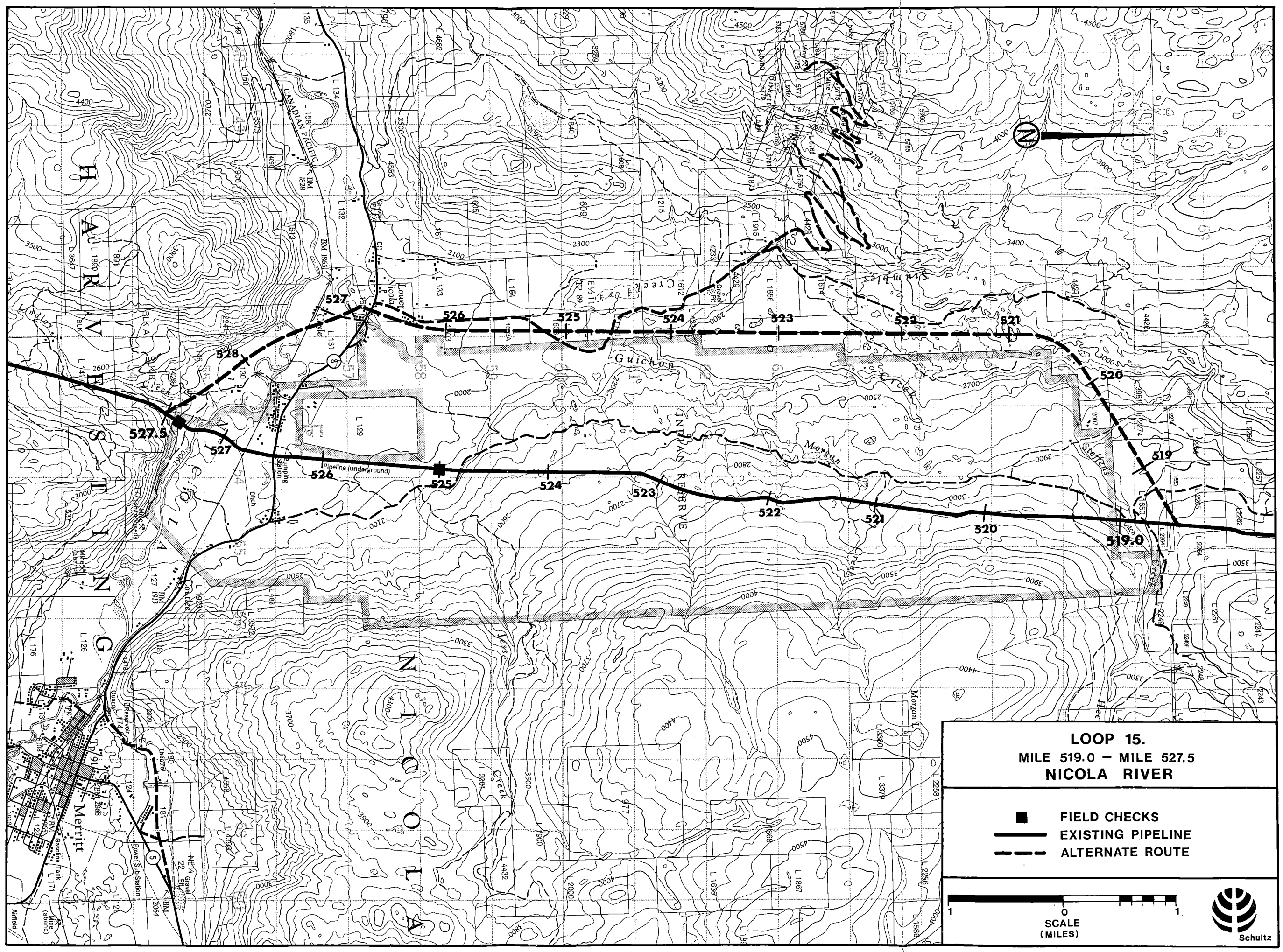
Schultz

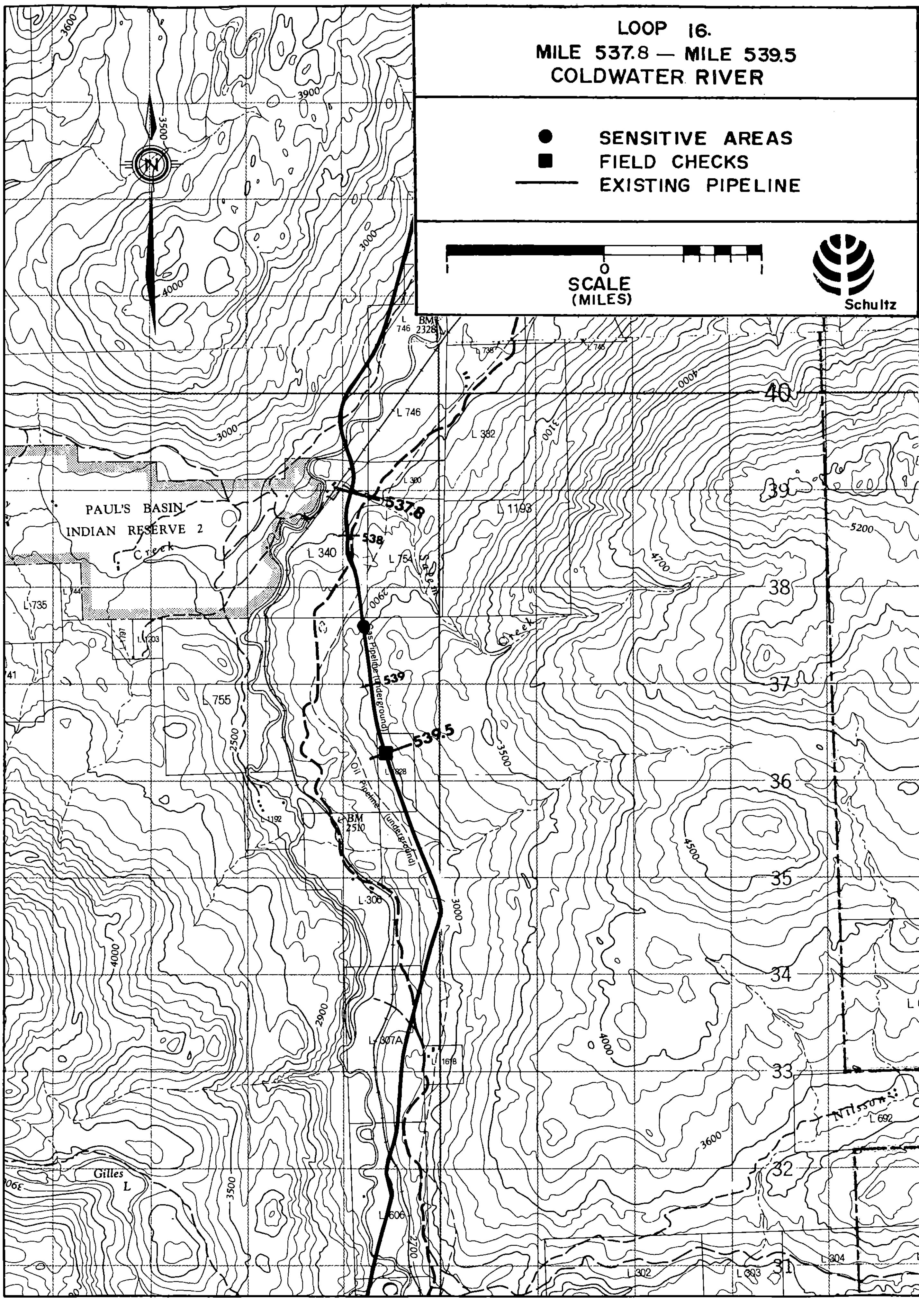


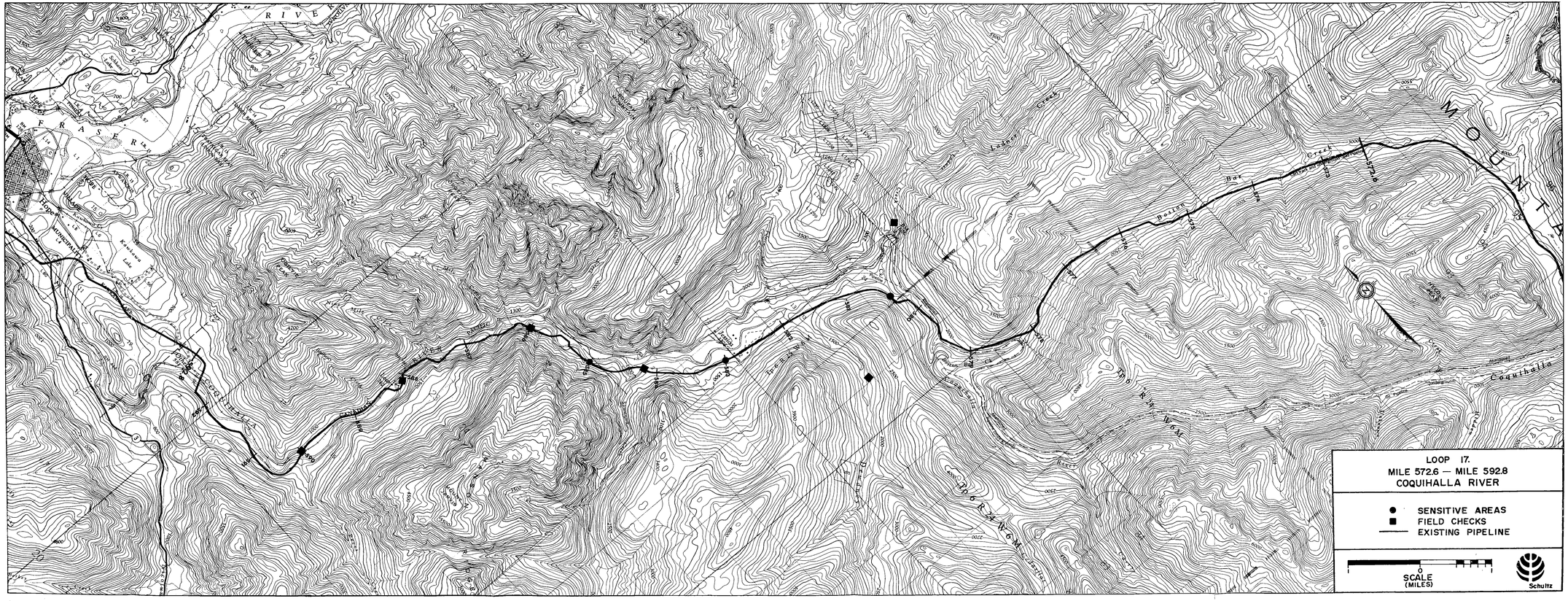

LOOP 12.
MILE 360.1 — MILE 367.9
WILLIAMS LAKE
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
SCALE
(MILES)
0
Schultz
Underground
Pipeline
GAS
PIPELINES (UNDERGROUND)
360.1
361
362
363
364
365
366
367
367.9
Hawks
Creek
Carpenter Mountain IR 15
James Louie IR 3A
Goldpan Lake
150 Mile House
Williams Lake Indian Reserve
Sugarcane
Road
Jeep Road
IR 2
San Jose River
Williams Lake

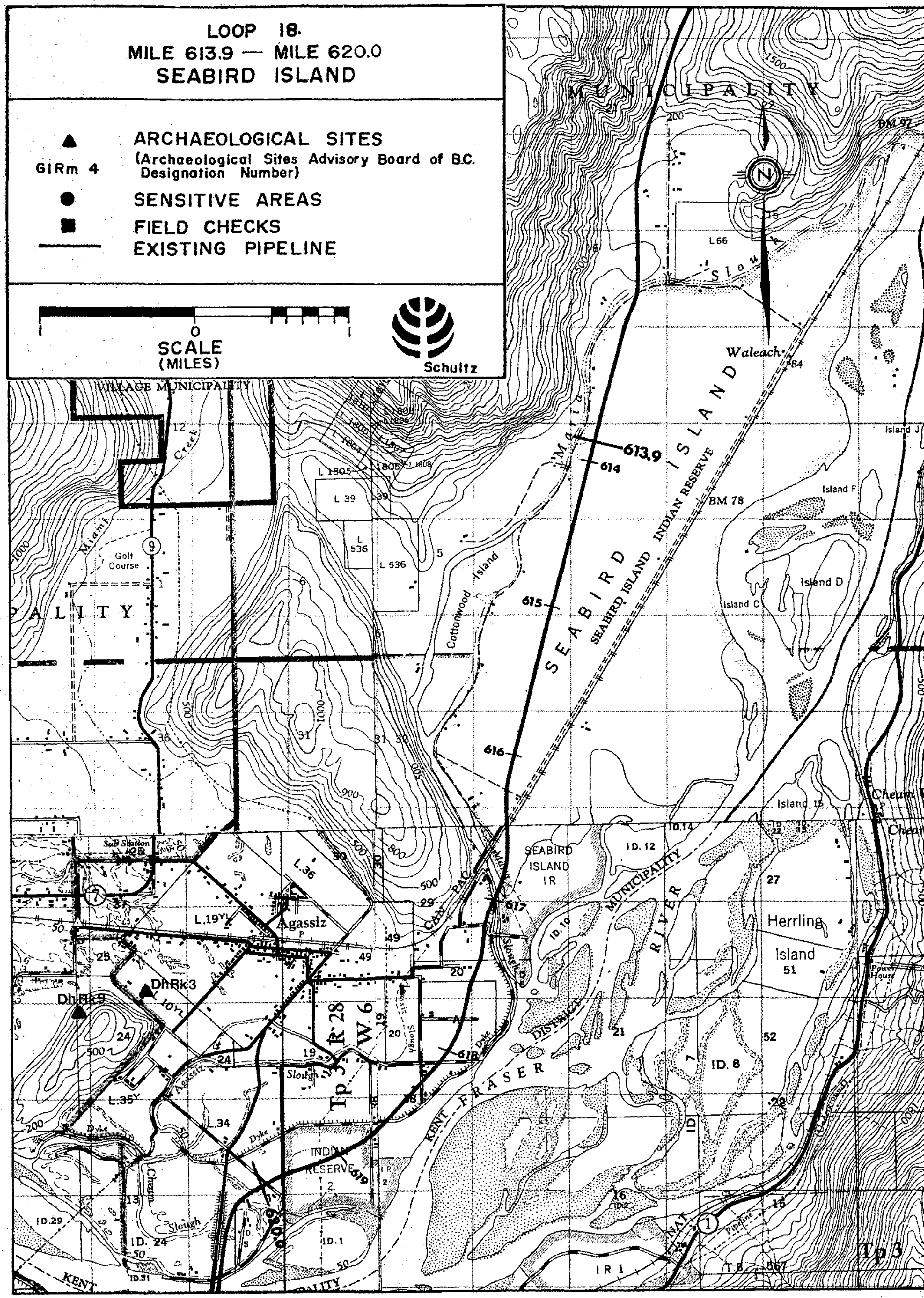

LOOP 13.
MILE 413.5 — MILE 419.5
100 MILE HOUSE
ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)
GIRm 4
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
100 Mile House
Lake
Air Strip
Town Limits
Oil Tanks
Water Tank
Bridge
Canim
Creek
EjRm
Gravel Pit
Power Line
Oil and Gas Pipeline (underground)
PACIFIC GREAT
Abbs
Lone Butte
Ninetythree
Gravel Pit
Keith Lake
413.5
414
415
416
417
418
419
419.5

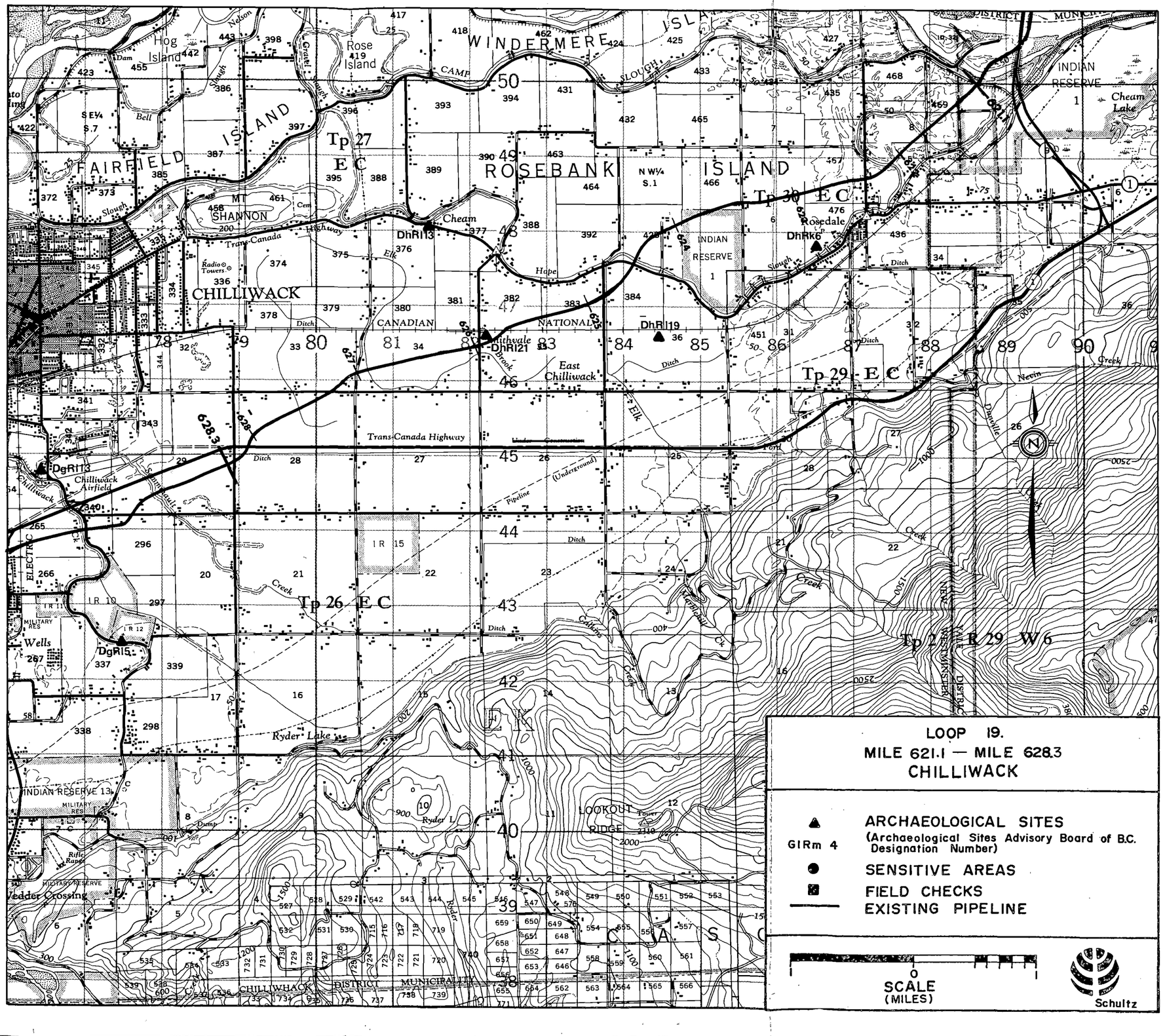

LOOP 14.
MILE 456.6 – MILE 469.1
HIHIUM LAKE
ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)
GIRm 4
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
Tobacco Creek
Gorge Creek
Hihium Lake
Barricade
Twp 23 R 23
Twp 23
R 22
456.6
469.1
EgRg3
EgRg4
HIHIUM 14-58
HIHIUM 14-59
HIHIUM 14-60
HIHIUM 14-61


LOOP 15.
MILE 519.0 – MILE 527.5
NICOLA RIVER
FIELD CHECKS
EXISTING PIPELINE
ALTERNATE ROUTE
SCALE (MILES)
1
0
1
Schultz
Merritt
Guichon
Morgan
Steffens
Pipeline (underground)
Pumping Station
Power Sub Station
Airfield
Theatre
Gasoline Tank
Quarry
Reservoir
Ditch
Creek
519.0
520
521
522
523
524
525
526
527
527.5


LOOP 16.
MILE 537.8 — MILE 539.5
COLDWATER RIVER
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
PAUL'S BASIN
INDIAN RESERVE 2
Creek
537.8
538
539
539.5
Gas Pipeline (underground)
Oil Pipeline (underground)
L 746
L 382
L 1193
L 340
L 754
L 735
L 755
L 1192
L 306
L 307A
L 1618
L 606
L 692
L 302
L 303
L 304
BM 2328
BM 2510
Gilles
L
Nilsson
40
39
38
37
36
35
34
33
32
31
3600
3900
3500
4000
3000
2900
2500
2700
3100
4700
5200
4500


LOOP 17.
MILE 572.6 — MILE 592.8
COQUIHALLA RIVER
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz


LOOP 18.
MILE 613.9 — MILE 620.0
SEABIRD ISLAND
ARCHAEOLOGICAL SITES
GlRm 4
(Archaeological Sites Advisory Board of B.C. Designation Number)
SENSITIVE AREAS
FIELD CHECKS
EXISTING PIPELINE
0
SCALE
(MILES)
Schultz
MUNICIPALITY
SEABIRD ISLAND
SEABIRD ISLAND INDIAN RESERVE
Waleach
613.9
614
615
616
617
618
619
620
Island J
Island F
Island D
Island C
Island 15
BM 78
BM 97
Cottonwood Island
Herrling Island
Cheam
Power House
SEABIRD ISLAND IR
MUNICIPALITY
RIVER
KENT FRASER DISTRICT
Agassiz
Sub Station
Golf Course
Miami Creek
VILLAGE MUNICIPALITY
DhRk3
DhRk9
Tp 3 R 28 W 6
Agassiz Slough
Cheam Slough
INDIAN RESERVE
L 39
L 536
L 1805
L.36
L.19
L.35
L.34
ID. 12
ID. 8
ID. 24
ID.29
IR 1
KENT



LOOP 19.
MILE 621.1 — MILE 628.3
CHILLIWACK

▲ GIRm 4 ARCHAEOLOGICAL SITES
(Archaeological Sites Advisory Board of B.C. Designation Number)

● SENSITIVE AREAS

▩ FIELD CHECKS

EXISTING PIPELINE

0
SCALE
(MILES)