

MINISTRY OF THE ENVIRONMENT

WATER RESOURCES OF THE
SPRINGBROOK PROJECT AREA

East Kootenay Region

(Submitted to ELUC Secretariat, Springbrook
Biophysical Land Classification Project)

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WATER RESOURCES OF THE SPRINGBROOK PROJECT AREA
(EAST KOOTENAY)

1. INTRODUCTION

This report, requested by the ELUC Secretariat, represents the B.C. Water Resources Service input to Phase I of the Springbrook Biophysical Land Classification Project. Except for one set of snowpack measurements in February 1975, this report is based mainly on published hydrometeorological data and information from branches of the Water Resources Service. The report contains assessments of snowpack conditions, runoff regime, water use and water quality. Some general comments regarding the possible effects of logging and other land uses on the hydrology of the study area are made.

Recommendations are made for further studies and data collection which will improve our knowledge of the water resource. These recommendations must be considered in relation to the scope of the Springbrook study and the requirements of other resource agencies.

2. WATERSHED CHARACTERISTICS

The study area is located east of the Kootenay River (Figure 1), and is characterized by steep, deeply incised upland valleys with a large floodplain area along the Kootenay River. Elevations range from 2550 feet on the floodplain to 9200 feet on the east boundary of the study area. The main valleys are oriented in a north-south direction. The drainage system consists of five tributaries to the Kootenay River (Figure 2), the Lussier River (320-square mile drainage area), Wolf Creek (16 square miles), Lewis Creek (12 square miles), and two small streams, Saugum and Lakit Creeks which have poorly defined drainage boundaries. There are two main sub-basins of the Lussier River watershed formed by Coyote Creek and Diorite Creek. Also included in the study area are Whiteswan Lake and Alces Lake which are part of the White River system.

The Lussier River basin, which drains most of the study area, ranges from 2550 feet to 9200 feet with a median elevation of 5500 feet (i.e., half the drainage area is above 5500 feet). In the upper Lussier basin (Fig. 2) aspect is generally north while in the lower Lussier aspect is southwest. Diorite Creek, a high elevation tributary near the mouth of the Lussier River, with a drainage area of 24 sq.mi., ranges from 2800 feet to 9175 feet with a median elevation of approximately 7000 feet. Coyote Creek, drainage area 60 sq.mi., enters the Lussier River at 4050 feet and drains elevations up to 9200 feet. This sub-basin has a median elevation of approximately 6500 feet.

Stream profiles for the Lussier River system show a wide range in channel slopes (Figure 3). Most of the mainstem Lussier River has slopes averaging 1.3 percent (69 feet per mile) with a small portion in the headwaters having slopes of 36%. The channel of Coyote Creek follows a similar pattern, but Diorite Creek is much steeper with an average slope of 6.8 percent.

Wolf Creek drains an area of 16 square miles. Basin elevation ranges from 2550 feet to 9180 feet with a median of 3500 feet. The mainstem channel up to elevation 3100 feet has an average slope of 1.2 percent but above this, slopes average 21 percent (Figure 4). Surface drainage patterns in the lowland areas are not well defined.

The Lewis Creek watershed drains an area of 12 square miles ranging from 2550 feet to 8690 feet in the southeast corner (median elevation 4500 feet). Basin aspect is southwest, being more westerly above 3500 feet. Channel slopes are moderate below 3200 feet, but above this, channel slope averages 13 percent (Figure 5). Below 3500 feet drainage patterns tend to be poorly defined with Lazy Lake, for example, having no surface water flow into or out of it. Springs are common with some used for domestic water supply.

Saugum Creek drains an area of roughly 7 square miles, but the watershed boundary is poorly defined below 3500 feet. Elevation ranges up to 7500 feet, although most of the basin is below 4000 feet. Watershed aspect is southerly. Lakit Creek drains a similar area with drainage patterns poorly defined. Flows disappear into a subsurface drainage system in the Kootenay River floodplain.

3. PRECIPITATION (SNOWPACK CONDITIONS)

As the ELUC Secretariat, Climate and Data Services Section, is providing a general assessment of the climate, only snowpack conditions based on snow course data obtained by the Hydrology Division of the B.C. Water Resources Service will be assessed. Details of the following snowpack analysis can be obtained from the Hydrology Division.

Although no snow courses are operated within the study area, there are 13 snow courses in the vicinity ranging from 10 to 40 miles from the study area boundary (Fig. 6). The closest one is #201, Thunder Creek, located five miles east at elevation 6600 feet. All these snow courses have complete depth and water equivalent data for February 1, March 1, April 1 and May 1 sampling dates for the 1970-74 period; this is used as the base period for this analysis. Also included are data from selected Atmospheric Environment Service meteorological stations in the region.

3.1 Regional Snowpack

Based on the available data, the regional pattern of mean April 1 snow depth and water equivalent is shown in Figures 7 and 8. The B.C. Climatic Maps, Canada Land Inventory, were used as a guide for the general orientation of the isolines of snow depth and water equivalent. Figures 9 and 10 show the regional pattern for mean May 1 snowpack conditions. These maps are presented only to indicate the general pattern in this area and should not be used to estimate amounts for a specific site or small area.

3.2 Study Area

In an attempt to obtain some form of model for areal variation in snowpack conditions in the study area, water equivalents and depths were plotted against snow course elevation. The relationships with elevation are fairly good. On February 26, 1975 (March 1 sampling date), seven snow depth and water equivalent measurements were made near Lazy Lake between 3000-foot and 6000-foot elevation and the data compared to concurrent samples at the nearby snow courses. The results of this comparison indicated that for the

same elevation, snowpack accumulation is less in the Springbrook study area than in the Purcell Mountains to the west and the Rocky Mountains to the east. This is explained by the "shadow effect" of the Purcell Mountains which extends well to the east of the study area boundary,

Based on the analysis of the available data, the areal variation of snow depth and water equivalent in the study area during the February 1 to May 1 period can be summarized as follows:

ELEVATION	MEAN DEPTH (in.)				MEAN WATER EQUIVALENT (in.)			
	Feb. 1	Mar. 1	Apr. 1	May 1	Feb. 1	Mar. 1	Apr. 1	May 1
2500	3	0	0	0	0.5	0	0	0
3000	5	4	0	0	1.5	1	0	0
4000	14	15	11	0	3	4	3	0
5000	22	24	25	12	5	7	7	4
6000	31	34	39	37	7	9	11	12
7000	40	44	53	62	9	12	15	20

(Estimates above 7000 feet are not made due to the lack of data above the tree-line.)

Using elevation as the main factor in determining areal variation, but with some adjustment for aspect and slope, isohyetal maps of February 1 and May 1 snowpack conditions are shown in Figures 11 to 13. These estimates must be treated with caution when considering specific sites where snowpack conditions may depart from the average as defined simply by elevation. For example, small forest openings and north-facing slopes will likely have greater snowpack accumulation than forested areas and south-facing slopes. More data would be required to determine how great the departure would be.

Based on four long-term snow courses (greater than 20 years of data) where snow has always been recorded in the February 1 to May 1 period, snowpack conditions in a maximum year can be 50 to 100% greater than average and 50 to 80% below average in a minimum snowpack year with the greater variation at the lower elevations.

3.3 Summary

Considering only the February 1 through May 1 period, areal variation in snowpack conditions is least on February 1 when maximum conditions for the season occur below 3500 feet and minimum conditions occur above 5500 feet. By May 1, areal variation is greatest with the snowpack having disappeared below 4500 feet, but at its maximum above 6500 feet. On February 1 the study area will usually be completely snow-covered with the snowline rising to 4500 feet by May 1.

On the average, snow depths 30 inches and greater are found above 6000 feet on February 1 and above 5400 feet on April 1. Water equivalent amounts can range up to 20 inches at 7000 feet on May 1.

Local topographic conditions may affect these estimates substantially, but by how much is not known.

4. RUNOFF

No active hydrometric stations are located within the study area (aside from stations on the Kootenay River). Three inactive stations with short periods of record have been operated on the Lussier River, Wolf Creek and Lewis Creek and provide a limited amount of information.

Based on six complete years of data (Table 1), annual runoff in the upper Lussier basin (above Lussier Hot Springs, drainage area 95 square miles) averaged 18.5 inches and ranged from 13.0 to 22.9 inches in the period measured. April-September runoff accounts for 75% of the annual total. Using this percentage and the available April-September runoff data for Wolf Creek and Lewis Creek, the estimated mean annual runoff from these two watersheds is 7 and 10 inches respectively. These runoff amounts are lower than those for the Lussier River due in part to the lower median elevation of their drainage areas. Regional climatic mapping (B.C. Climatic Maps, C.L.I.) indicates a net water deficit in the lowland area and thus, on an annual basis, no surface runoff is contributed.

The monthly runoff patterns shown in Figures 14 to 16 are typical of watersheds whose main source of runoff is from snowmelt. Low flows occur

from August through April and runoff volumes reach a peak in June. April 1 snow water equivalent averages 15-20 inches with subsequent April-September runoff amounting to 10 or 15 inches. Figure 17 indicates the influence of major rainfall contributions during May and June, adding to the snowmelt flows.

Daily runoff amounts follow the same pattern through the year as described for monthly runoff. Recorded daily flows on the Lussier River for a low runoff year and a high runoff year are compared in the flow duration curves in Figure 18. Daily flows on the Lussier River exceeded 500 cfs for over two months in the high runoff year, but never reached this magnitude in the low runoff year. Lowest daily flows usually occur in February or March. Low flow amounts at an ungauged location are very difficult to estimate as they depend so greatly on local geology, topography and man-made interference (domestic and irrigation water use).

The recorded maximum daily flow on the Lussier River is 1,460 cfs (15.4 cfs/square mile) measured on June 14, 1947. Other hydrometric data in the area indicate daily peak flows of similar magnitude (in cfs/sq.mi.). Regional peak flow data compiled by Water Survey of Canada² indicate that for interior mountain drainages 200 square miles in area, daily peak flows of 29 to 30 cfs/square mile can occur.

The effect of extreme spring freshet flows will be most widespread and noticeable along the mainstem Kootenay River which forms the western boundary of the study area. The estimated 200-year return period annual maximum daily flow converted to a water level or elevation is used to define the floodplain zone for development on areas adjacent to larger rivers and streams in British Columbia. Based on a statistical analysis of hydrometric data collected at Canal Flats, Skookumchuck and Fort Steele, the mean annual and 200-year maximum daily flows with corresponding geodetic elevations are:

STATION	MEAN ANNUAL MAXIMUM		200-YEAR MAXIMUM*		AREA (Sq. mi.)
	Daily Flow cfs	Elevation ft.	Daily Flow cfs	Elevation ft.	
Canal Flats	18,800	2679.7	34,000	2681.9	
214053 Skookumchuck	24,900	2557.4	44,900	2562.0	2780
214065 Fort Steele	40,300	2508.3	71,500	2512.6	4350

*Preliminary data subject to revision.

On June 19, 1974, low-level air photos were obtained in the Canal Flats area and the reach between Fort Steele and Wasa for floodplain definition purposes by the Water Resources Service. This information has not been prepared in final map form as yet, but preliminary maps are available on request through the Hydrology Division. The flow and elevation at Canal Flats, Skookumchuck and Fort Steele on the date of photography are:

June 19, 1974*

STATION	Elevation ft.	Daily Flow cfs
Canal Flats	2681.3	29,400
Skookumchuck	2560.2	36,700
Fort Steele	2510.0	62,300

*Preliminary data subject to revision.

These elevations are one to three feet below the elevation of the 200-year return period flow and one to three feet above the elevation of the mean annual maximum flow. Although a more detailed analysis is required the above information gives some idea of the Kootenay River floodplain zone.

It should be mentioned that Wasa Lake, being connected with the Kootenay River through a small channel, experiences flooding problems from Kootenay River peak flows. Comparative water level data have been obtained on Wasa Lake and the Kootenay River since 1965 to study this problem. When sufficient data is available a decision will be made on the feasibility of blocking road culverts which interconnect Wasa Lake and the Kootenay River during the freshet period.

5. WATER USE

Purposes for which water is licenced in the study area include irrigation (agriculture), stock watering, mining, power and domestic. A map showing water use diversion points from streams and springs is available from the Hydrology Division.

The following description of water use will be divided into diversions from the Lussier River, Wolf Creek, Lewis Creek (including the Wasa Lake area), Saugum Creek and Lakit Creek. Details compiled from Water Rights Branch records on individual licenced amounts, date of priority and purpose are available from the Hydrology Division, Water Investigations Branch. A summary of diversion amounts is given in Table 2.

5.1 Lussier River

Licensed water use in the Lussier River basin dates from July 1906. On the mainstem Lussier River there are presently ten points of diversion with amounts totalling 750 acre-feet for irrigation (April 1 to September 30) of 268 acres and 2,500 gpd (3.4 acre-feet per year) for year-round domestic use. On Diorite Creek, a tributary to the Lussier River, water is diverted from five points with amounts totalling 282 acre-feet for irrigation, 5,000 gpd (6.7 acre-feet per year) for domestic use and two cfs (1,448 acre-feet) for power developed at a power house near the north end of Premier Lake. The major user in the basin is Skookumchuck Ranch Limited which irrigates 107 acres of agricultural land and holds the licence for power purposes.

The Fish and Wildlife Branch diverts 15 cfs (10,860 acre-feet per year) from Mutton Creek, a Lussier River tributary, into a spawning channel draining into Alces Lake.

Two relatively small tributaries, Brad Creek and Pape Creek, are used for irrigation and, according to Water Rights Branch Regional Engineer's reports, are fully recorded (minimum flow equal to licenced diversion amount).

The Lussier River goes dry in certain reaches during some years, usually in the August-September period.

5.2 Wolf Creek

Water use on Wolf Creek dates from 1883 with most development occurring in the 1927-36 period. At present there are six points of diversion with amounts totalling 1,240 acre-feet for irrigation of 532 acres, 60 acre-feet of storage for irrigation, 4,000 gpd (5.4 acre-feet) for domestic use and 46.5 acre-feet for conservation.

The major water user is 3 Sons Investment Limited which holds licences at three diversion points. A dam has been constructed to impound 60 acre-feet during the October 1 to July 1 period. 803 acre-feet are diverted downstream from the dam for irrigating 432 acres of land. Licences are also held to divert 3,500 gpd (4.8 acre-feet) for domestic use. Some of the 3 Sons Investment land has been purchased by the Crown and the water licence amendments required by that change of land ownership have not been completed.

The Fish and Wildlife Branch, Department of Recreation and Conservation, acquired a water licence for 46.5 acre-feet with the purchase of land in L. 10309. Although the original licence was for irrigation, the water will be used for storage to form a duck marsh for conservation purposes. The Branch also holds an irrigation licence for 23.5 acre-feet to be used in connection with the Premier Ridge Habitat Improvement project.

The highest (furthest from mouth) diversion in the Wolf Creek basin is on Wasa Creek where 100 acre-feet is diverted for irrigation.

A Water Rights Branch Regional Engineer's report in July 1972 states that the low flow (September) is fully recorded. Therefore, any additional water licences would have to be covered by equivalent storage.

5.3 Lewis Creek and Wasa Lake Area

Water has been licenced for use in the Lewis Creek basin since 1898. At present, including diversions from springs, there are 15 points of diversion with amounts totalling 858 acre-feet for irrigation (April to September 30) of 566 acres, 6,000 gpd (8.1 acre-feet per year) for domestic use and stock watering and 101,000 gpd (136 acre-feet per year) for mining purposes.

Giant Mascot Mines Limited holds a licence on Lewis Creek at its source for 1,000 gpd (1.4 acre-feet) for cooling mine mill equipment and 2,000 gpd (2.7 acre-feet) for domestic use. Below the diversion point, the creek sinks into a tailings pond located in Lot 6855. Another licence is held for using water from Estella Springs which is actually seepage water flowing out of the Estella Mine Tunnel. The intake is a small concrete dam located 100 feet inside the mine portal. The 100,000 gpd (136 acre-feet) from this source is used in the ore concentrating process and then flows into the tailings pond. The low flow measured from this spring during the 1965-66 winter was 180,000 gpd (0.33 cfs).

Under a licence now held by the East Kootenay Regional District, 5 cfs (754 acre-feet) is diverted through a pipeline from Lewis Creek to Lazy Lake to "maintain an adequate water level" for the benefit of landowners on Lazy Lake. To accommodate downstream water users with prior rights, water can be diverted only from May 15 to July 31 when streamflows are relatively high.

There is one licence for power purposes which amounts to 0.66 cfs (478 acre-feet). However, the power house has been abandoned and the water is actually used for irrigation.

Tracy Creek is the source of 75 acre-feet of water for irrigation of 30 acres in Lot 2898. Tracy Creek is not a direct tributary of Lewis Creek, but sinks in the vicinity of Lot 2898. In times of high flow it flows overland to the south and sinks in Lot 3045.

Wasa Lake Improvement District has applied for a licence to divert 1,500 acre-feet per year for land improvement purposes from Lewis Creek to Wasa Lake in order to improve water levels in Wasa Lake. However, the licence has not been granted. Not enough is known about the relationship between Wasa Lake inflow and outflow and the connection with Kootenay River water levels to ascertain the usefulness of diverting water from Lewis Creek. Lewis Creek is heavily licenced and has been known to go dry in the lower reaches in the August-September period. If water was diverted from Lewis Creek,

the level of Lewis Slough, which has a more direct outflow to Kootenay River, could be lowered to a point where wildlife habitat could be affected,

The source of domestic water for residents on Wasa Lake is eight springs east of Wasa Lake which supply a total of 2,000 gpd (2.7 acre-feet) for domestic use and 5 acre-feet for irrigating 3.2 acres.

5.4 Saugum Creek

Saugum Creek is fully committed for irrigation and conservation use. Total demand on the creek during the April 1 to September 30 period is 1,121 acre-feet, mainly for conservation projects by the Provincial Fish and Wildlife Branch.

It is proposed to build a dam at the outlet of Saugum Lake to maintain water levels for wildfowl nesting. The rest of the water licences held by the Fish and Wildlife Branch are in connection with the Bummers Flat Wildfowl Habitat Improvement Project.

Two licences are held by other for irrigation use totalling 71.5 acre-feet and there is one licence for 500 gpd for stock watering purposes.

5.5 Lakit Creek

There are a number of diversions on Lakit Creek, but it is not known for certain if all of them are in use. Irrigation licences total about 200 acre-feet and for domestic use 1,000 gpd (1.4 acre-feet).

6. WATER QUALITY

There is limited measured water quality data, but there are a few locations in the study area where water quality problems exist.

Wasa Lake is heavily used for recreation and permanent residences have been built around the lake. It appears that Wasa Lake levels are related to the level of Kootenay River during high spring freshet flows and in June 1974 septic tanks were flooded which contaminated water in Wasa Lake. Periodic coliform samples have been taken over the last few years by the Health Branch and since an Improvement District was formed in 1969, coliform content has been well within the standards recommended for public bathing.

Although there have been no indications to date of any problems, there could be a potential for water quality problems in Lewis Creek in connection with the mining tailings ponds in its headwaters,

Premier Lake water quality is apparently satisfactory,

It has been reported that water in Kootenay River periodically has high fecal coliform counts, apparently from improperly treated domestic sewage discharged at the Skookumchuck pulp mill site.

7. HYDROLOGICAL IMPACTS OF LAND MANAGEMENT

There are several purposes for which water is used in the study area. These include irrigation for agriculture, domestic water supply, conservation projects, land improvement, mining processing and fish spawning. Major land uses are agriculture, forestry and grazing. This section deals mainly with the possible effects of logging on the water resource, and to a lesser extent the effects of grazing. As no research on the hydrologic impacts of these land uses has been done in this region, the following inferences are based on the results of research done elsewhere,

The main source of runoff in the study area is the snowpack accumulation at higher elevations with additional input in the form of rain. Highest monthly rainfall amounts occur in May and June at the same time that snowmelt rates are reaching their peak. A major consideration in how various land uses will affect the water resource is their effect on snowpack accumulation patterns.

Removing forest cover from a watershed can affect runoff production by reducing transpiration and interception losses, thus increasing water yield in proportion to cutting intensity. Snow accumulation in the opening created by cutting will be increased and, depending on opening size, snowmelt rates can be increased due to increased radiation input received by the snowpack as compared to conditions under a forest cover.

Results from 39 studies of the effects of altering forest cover on water yield have been summarized by Hibbert (1967). Forest cover reduction generally increased water yield, but these increases are reduced by reforestation. The amount of change is variable, depending on the proportion of the

watershed clearcut, climate, soils, topography and other factors. There is evidence that water yield increase is proportional to reduction in forest cover and that the rate of decline is related to the rate of vegetation recovery.

Goodell (1959) reports that the coniferous forests of the western United States influence peak flows of snow-fed streams by affecting the accumulation and melting rate of snow. According to Anderson and Hobba (1959) in a study of floods in the forests of the northwestern United States, clearcutting increases the magnitude of both rain-snowmelt and snowmelt flood flows,

Increased peak flows could result in increases in streambank erosion and consequent increased sediments in the stream. Skidding of logs down mountain slopes is likely to concentrate the flow and scour out a path to the natural watercourse. Roads with inadequate drainage and located too close to streams are also sources of sediments in the stream.

Any change in the low flow characteristics of a stream due to tree removal could affect the quantity of water available for licenced use. Very little study has been done, but it could be expected that the reduced transpiration as a result of clearing would tend to increase low flows.

Strips of forest cover along stream banks, especially on smaller streams, can ensure that natural water temperature fluctuations are maintained. In addition, a "leave strip" can effectively prevent cross-stream falling or skidding, and provides a barrier against sediment and debris resulting from logging on valley sides. This protection is desirable for those stream systems where maintenance of a good environment is considered critical for fisheries and domestic water supply. Spatially continuous vegetational shading may not be necessary if water temperature is the main consideration. For example, topographic shading (high steep banks) may be sufficient. Green strips on the north bank of east-west oriented streams can be of little use in providing the essential mid-day shade and a south-bank strip may be adequate (Goodell, 1971).

Grazing on open and forested grasslands may have hydrologic impacts in relation to soil erosion and stream sedimentation. Grazing animals may affect infiltration, soil erosion and runoff in several ways:

1. By reducing vegetation which would normally intercept precipitation;
2. By causing soil compaction through trampling and thus reducing soil infiltration rates;
3. By reducing and scattering litter which acts as a kind of cushion on top of mineral soil;
4. By removing root material of the grass, especially when soils are moist, thus reducing soil-binding facilities provided by the roots.

In forested summer ranges it is not likely that overgrazing occurs and thus, no significant problem exists. However, it is known from other areas that overgrazing by livestock can result in soil compaction (Hoover, 1962; Wilm, 1962), leading in turn to infiltration rate reduction, reduced groundwater recharge, increased overland flow, greater runoff contribution to flooding and greater soil erosion problems. Moderate grazing, for example, leaving approximately 50% of vegetation for carry-over, will not likely result in drastic impacts. Dense concentrations of cattle on wet soils can lead to excessive trampling and compaction and should be avoided.

8. SUMMARY

The Springbrook Study Area covers a wide range of hydrological conditions, from the flat, lowland area in the valley bottom to the steeply sloping areas at the higher elevations. The lowland area contributes little to runoff as annual evapotranspiration losses exceed precipitation amounts. Surface drainage patterns below 3500 feet are poorly defined with many streams which drain higher elevations disappearing to become sub-surface water. There are many springs in the area mainly occurring close to the Kootenay River channel.

At higher elevations (above 5000 feet) substantial annual snowpack accumulations result in mean annual runoff amounts of 18 inches or more, 75% of which runs off in the May-September period.

Snowpack amounts in the study area are less than those in the surrounding region due to the shadow effect of the Purcell Range to the west. Within the study area, snowpack accumulation varies mainly with elevation. The rate of increase with elevation is least in early winter, reaching a maximum

in May when elevations below 4500 feet are snow-free and elevations above 6000 feet have accumulated maximum amounts for the year. Although elevation is the main factor in areal snowpack variation, other topographic characteristics such as aspect, slope and vegetation will affect areal patterns.

Licensed diversion of water for irrigation, domestic, and conservation purposes is intense in the lowland areas. Lewis Creek, Wolf Creek and Saugum Creek are considered to be fully licensed. Although runoff amounts are substantial during May-July, water demand reaches a peak during July-September when streamflows have receded to near minimum values for the year. Any future water diversion would have to be covered by suitable storage works which would impound water during the freshet.

Potential water quality problems appear to be centered around Wasa Lake which is used intensely for summer recreation. Wasa Lake is poorly drained and flooding around Wasa Lake as the result of Kootenay River freshet peak levels compounds the water quality problem.

9. RECOMMENDATIONS

If "biophysical mapping" is to be used as the basis for making interpretations and decisions regarding land use management, maps depicting various hydrologic and climatic parameters are necessary. The only way maps of this type can be produced is by having an adequate network of stations monitored over a suitable period of time. The existing hydrologic data base in the Springbrook Project area is inadequate for providing anything but a very superficial water resource inventory. The following recommendations are made with this in mind.

9.1 Water Quality

The largest gap in the data base is in chemical and physical water quality. The only water quality data available in the study area are coliform count samples obtained periodically by the Health Branch for Wasa Lake. These samplings should be continued.

Mining tailings ponds are located in the headwaters of Lewis Creek, but no water quality information is available on this creek. There is an application by the Wasa Lake Improvement District to divert water from Lewis Creek to Wasa Lake. As it has been stated that the quality of Lewis Creek water could be suspect due to various land uses upstream, water quality samples should be obtained on Lewis Creek near its mouth (in Lot 1266).

Some indication of sediment production in logged and unlogged areas could be obtained by sampling chemical and physical properties of water in the Lussier River above the mouth of Coyote Creek. Timber harvesting has been carried out in the Lussier River basin near its confluence with Coyote Creek. If periodic sampling was carried out on the Lussier River above the logged-off area and just above the mouth of Coyote Creek, a comparison of sediment load and nutrient leaching could be made.

It is recommended that the above sites suggested for water quality samplings be investigated by the Environmental Studies Division of the B.C. Water Resources Service to determine the frequency, type of sampling and analysis required. Then a regular monitoring program should be set up.

9.2 Water Quantity

In order to improve our understanding of the runoff regime in the study area, hydrometric stations should be established on the Lussier River at the confluence with Coyote Creek and on Lewis Creek above Lazy Lake diversion. Automatic water-level recorders should be installed or manual staff gauges installed with daily observations.

Discharge measurements should be obtained at water quality sampling sites at the time of sampling.

9.3 Snow Courses

There are no snow courses within the study area. In relation to the impact of logging on the water resource, it is recommended that four snow courses in the upper Lussier River watershed be operated for at least two years, sampled on April 1, May 1 and June 1. They should be located at about

5500 feet elevation with two in a clearcut area and two in a forested area. Of the two in each area, one should be located on a north-facing slope and one on a south-facing slope. These data could give an indication of the effect of aspect and vegetation cover on snowpack accumulation and depletion.

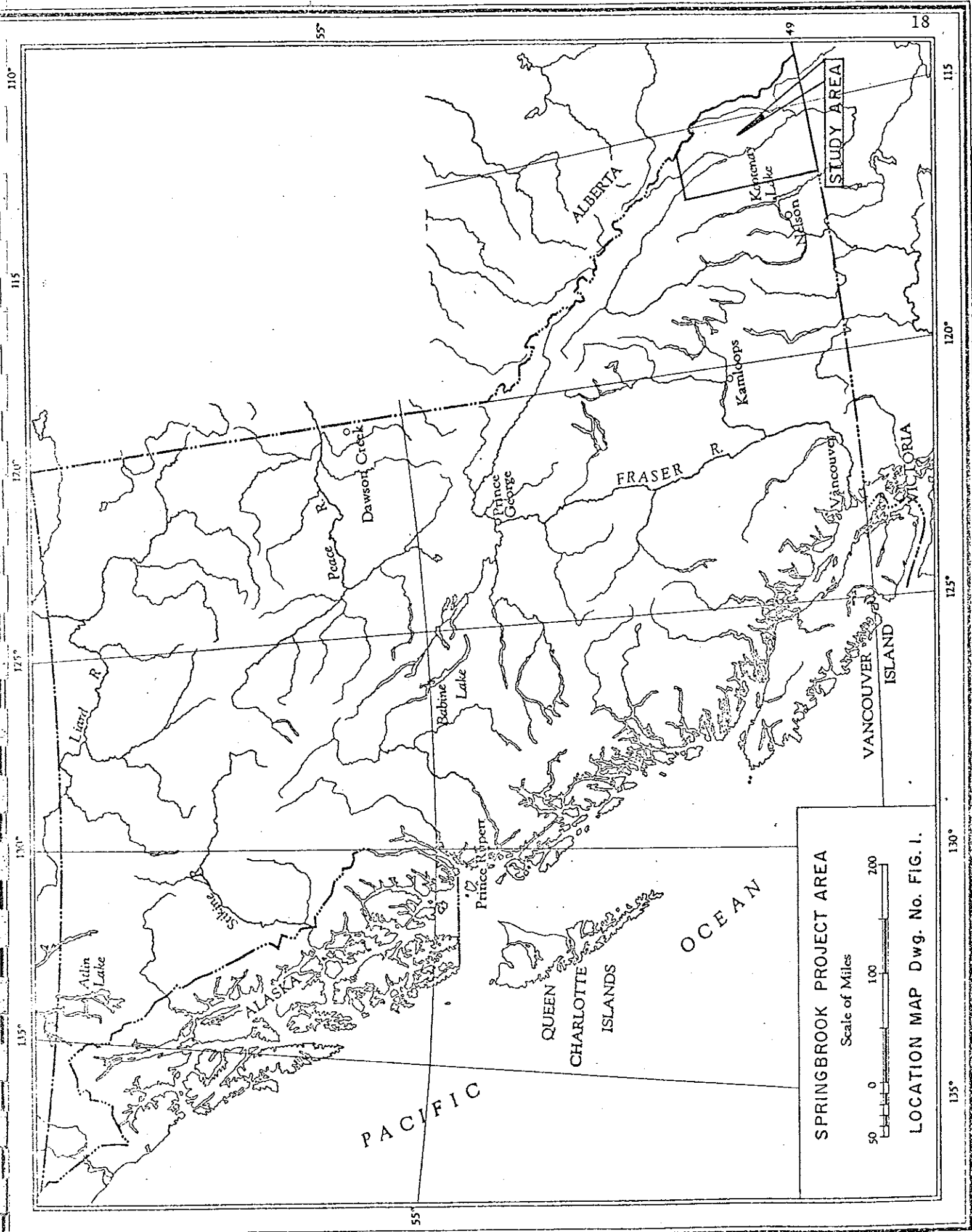
9.4 Summary

These recommendations will require field reconnaissance and consultation with all resource agencies in order to satisfy as many data needs as possible.

In future stages of the Springbrook Project, it is suggested that all resource agencies use watersheds as the basic planning and management unit. In doing so, conflicts and interactions between various resource uses would be more easily identified and solved.

10. REFERENCES

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110°

115

120°

125°

130°

135°

55°

49

18

115

120°

125°

130°

135°

ALBERTA

FRASER R.

STUDY AREA

Kamloops

Kamloops Lake

Nelson

Peace R.

Dawson Creek

Prince George

Liard R.

Babine Lake

Vancouver

VANCOUVER ISLAND

VICTORIA

Prince Rupert

QUEEN CHARLOTTE ISLANDS

PACIFIC OCEAN

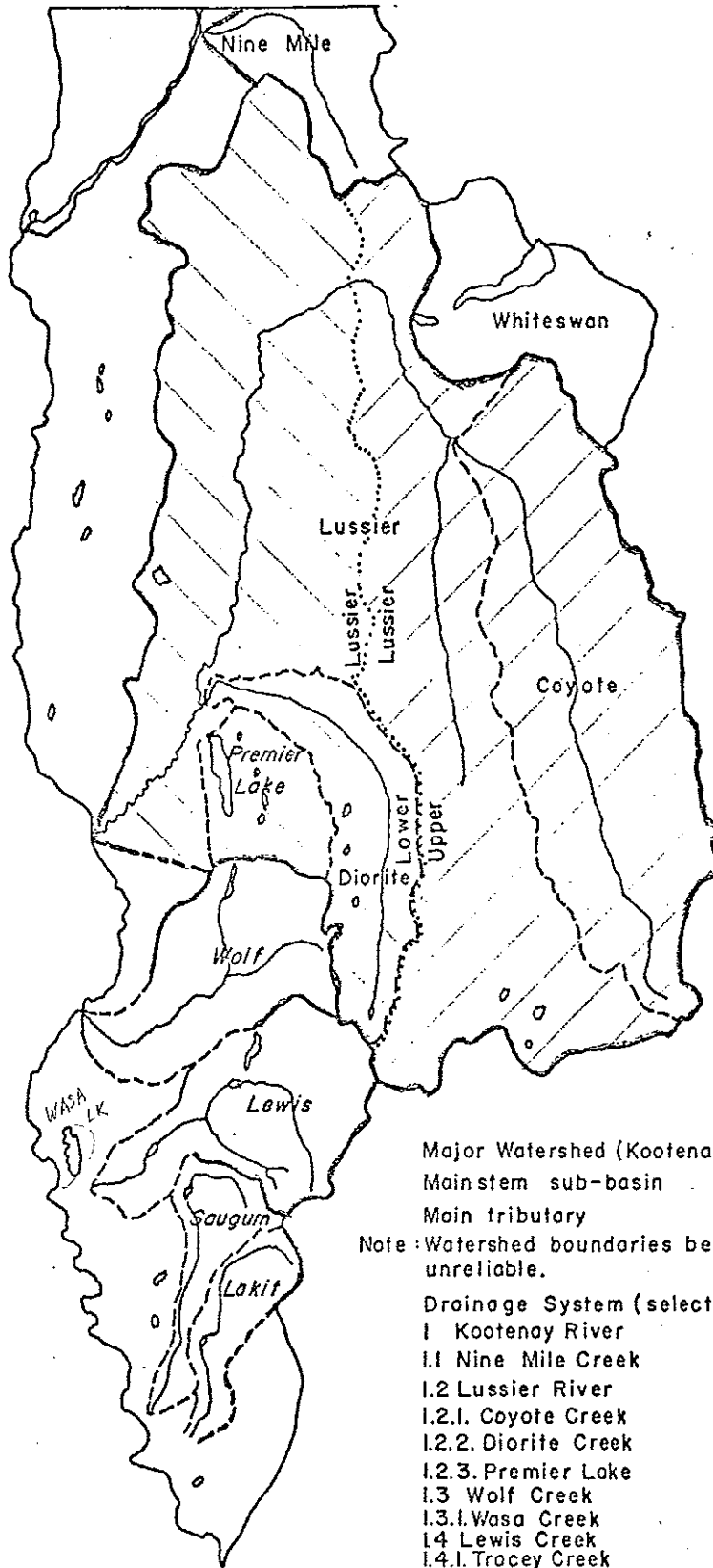
ALASKA

SPRINGBROOK PROJECT AREA

Scale of Miles



LOCATION MAP Dwg. No. FIG. I.



BRITISH COLUMBIA
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 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 WATERSHED BOUNDARIES

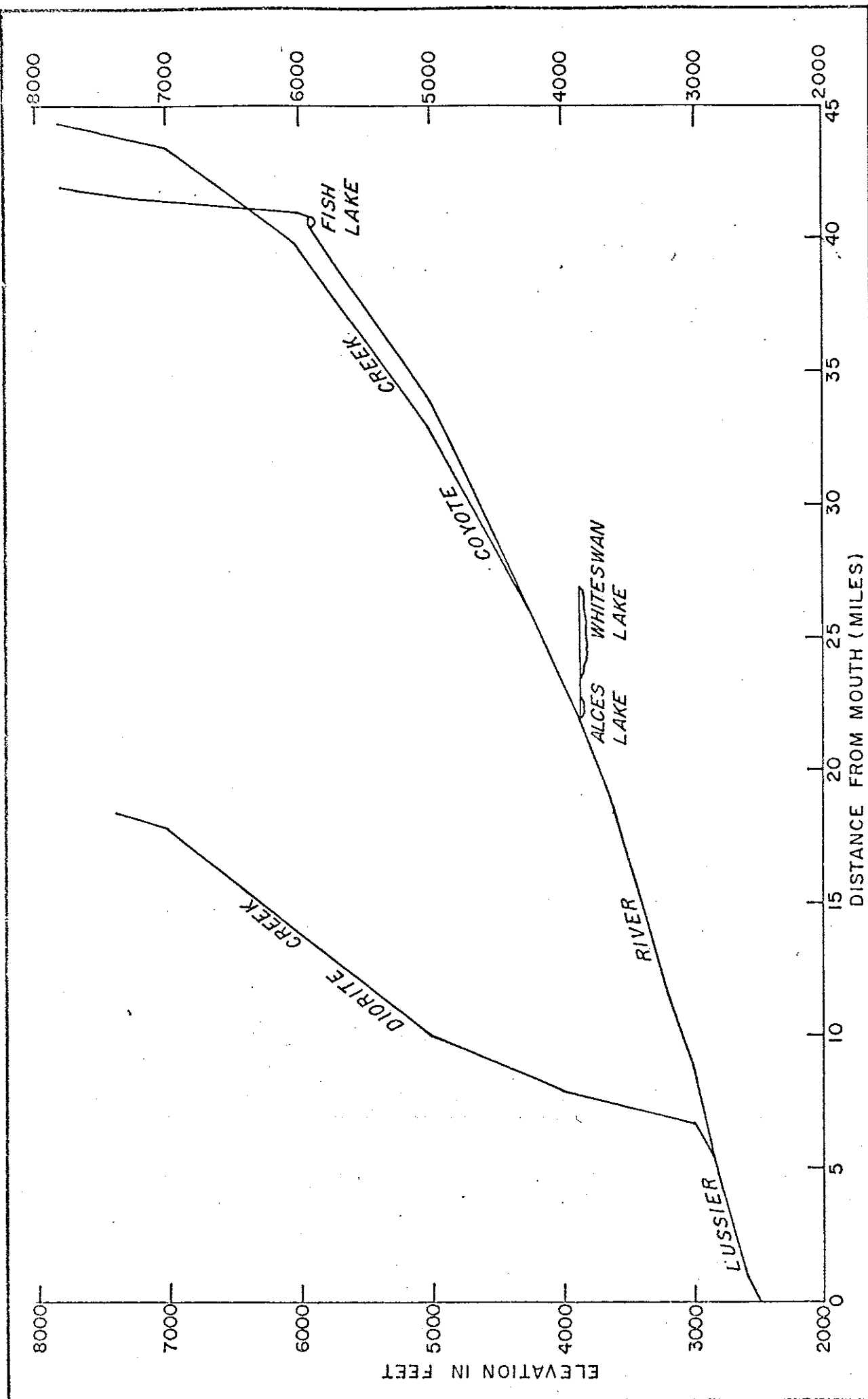
SCALE: VERT.
 HOR.

DATE

FILE No.

DWG. No. FIG. 2

ENGINEER



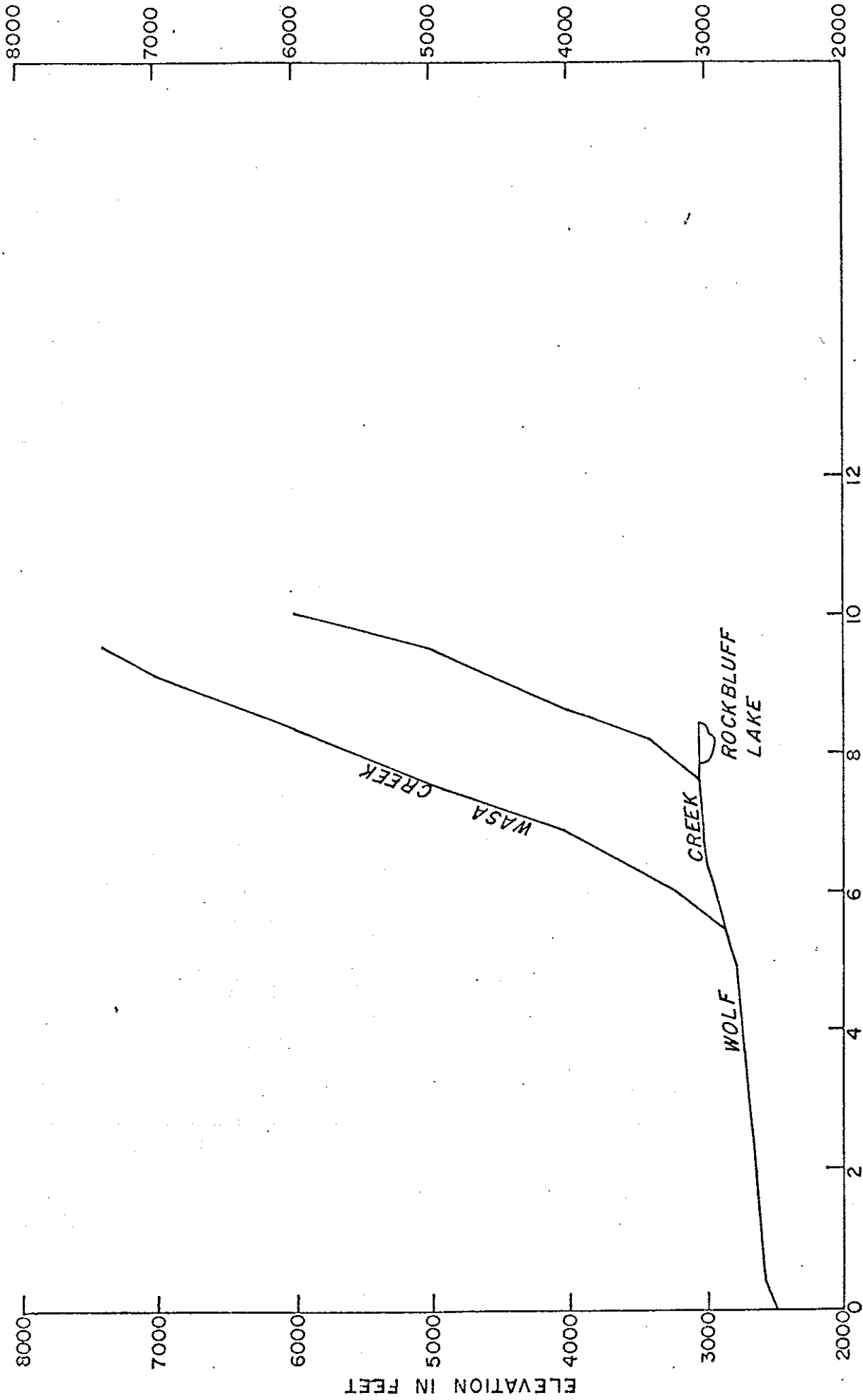
TO ACCOMPANY REPORT ON
WATER RES. OF THE SPRINGBROOK PROJECT AREA
LUSSIER RIVER STREAM PROFILE

BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

SCALE: VERT. 1 inch = 1000 Feet
 HOR. 1 inch = 5 Miles

DATE _____
 ENGINEER _____

FILE No. _____ DWG. No. **FIG. 3**



DATE: 1

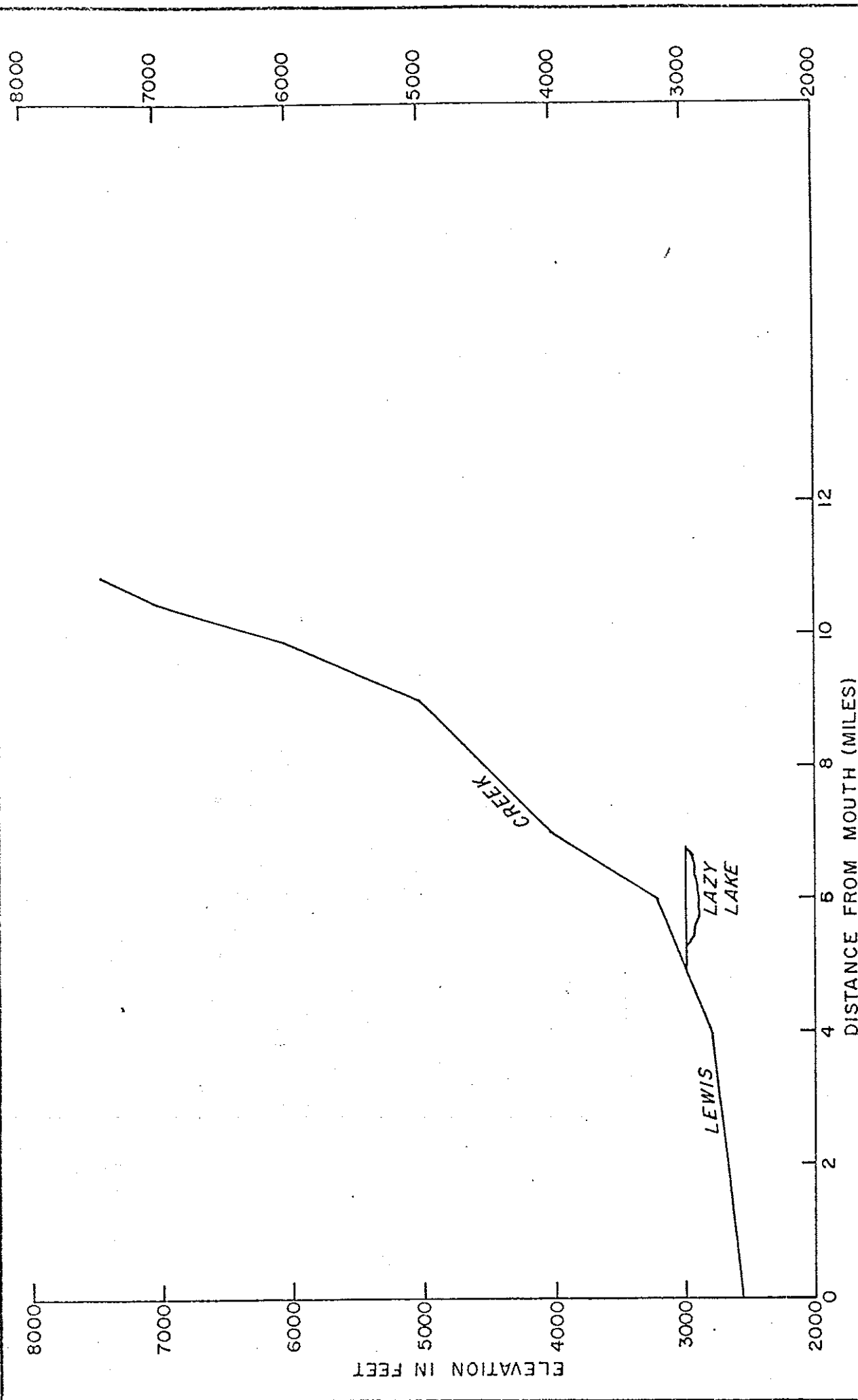
SCALE: VERT. 1 inch = 1000 Feet
 HOR. 1 inch = 2 Miles

ENGINEER

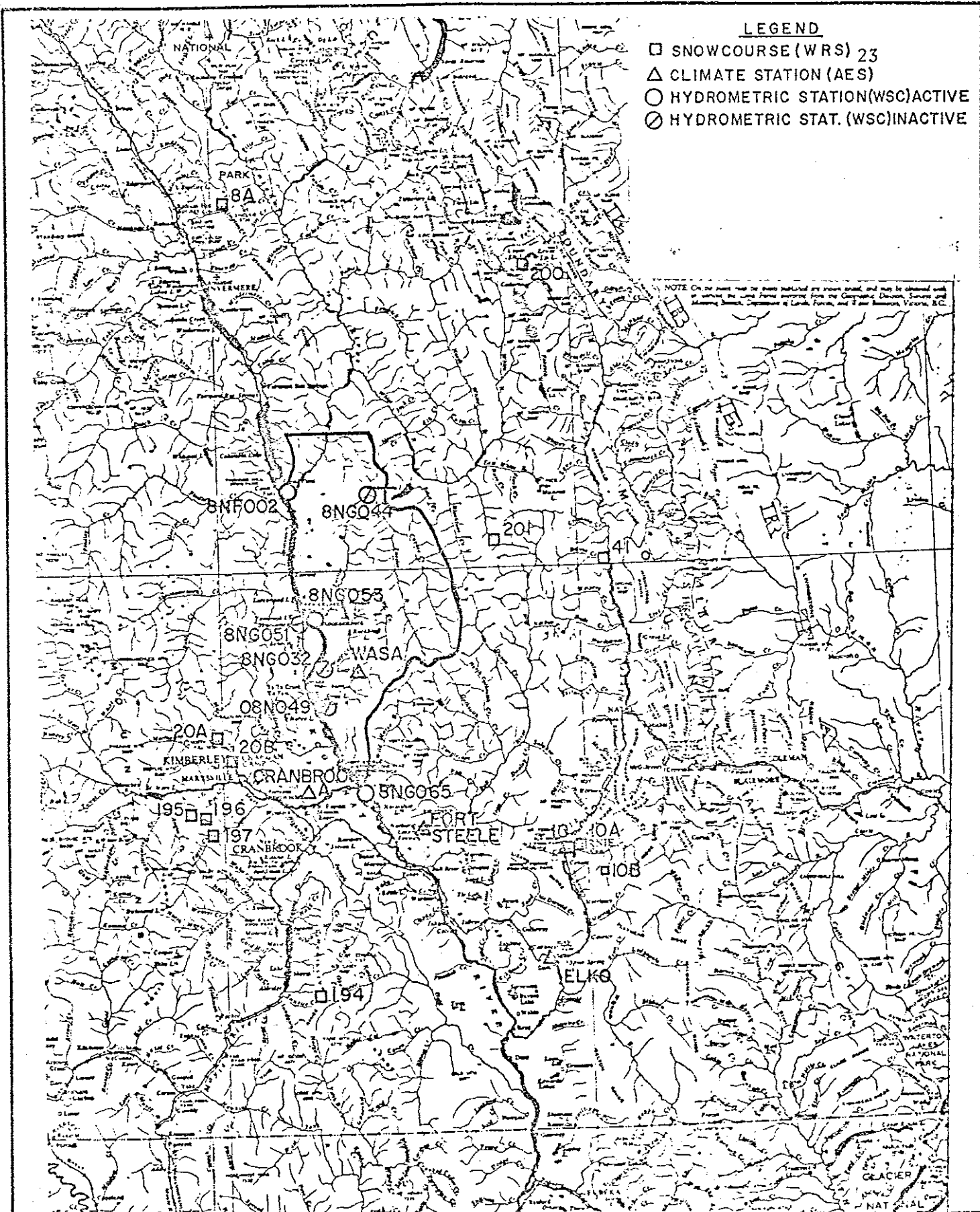
FILE No. DWG. No. FIG. 4

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 WOLF CREEK STREAM PROFILE

BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH



BRITISH COLUMBIA DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES WATER RESOURCES SERVICE WATER INVESTIGATIONS BRANCH	TO ACCOMPANY REPORT ON WATER RES OF THE SPRINGBROOK PROJECT AREA LEWIS CREEK STREAM PROFILE	SCALE: VERT. 1 inch = 1000 Feet HOR. 1 inch = 2 Miles DATE 22 ENGINEER
FILE No. DWG. No. FIG. 5		



- LEGEND**
- SNOWCOURSE (WRS) 23
 - △ CLIMATE STATION (AES)
 - HYDROMETRIC STATION (WSC) ACTIVE
 - ⊙ HYDROMETRIC STAT. (WSC) INACTIVE

NOTE On the same map the area indicated as shown above, and may be obtained only by writing the Land Force Director from the Geographic Division, Survey and Mapping Branch, Department of Lands, Forests, and Rangelands, Victoria, B.C.

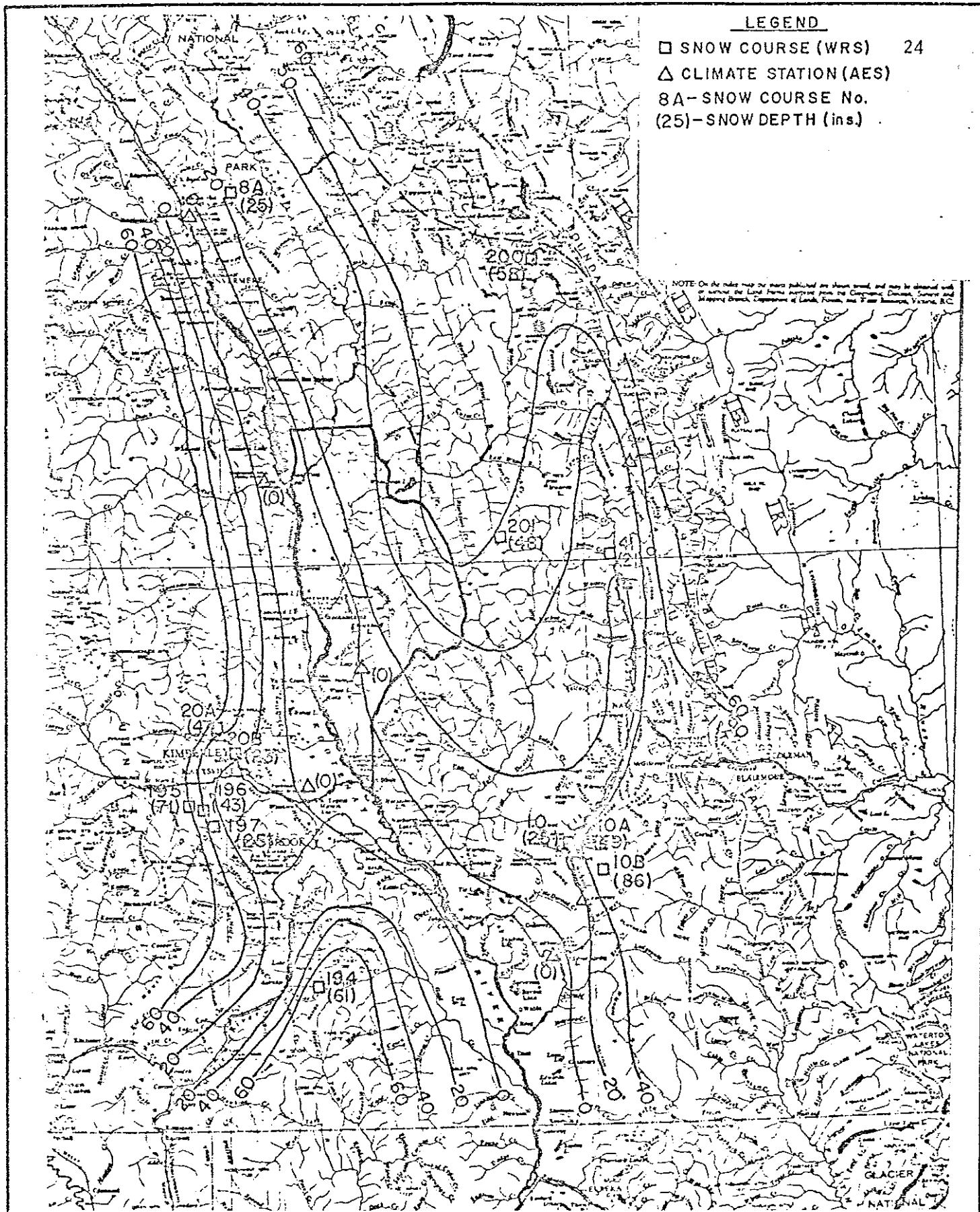
BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 LOCATION OF HYDROMETEOROLOGICAL
 STATIONS

SCALE: VERT. _____
 HOR. 1 inch = 16 miles

DATE _____

ENGINEER _____
 FILE No. _____ DWG. No. FIG. 6



LEGEND

- SNOW COURSE (WRS) 24
- △ CLIMATE STATION (AES)
- 8A-SNOW COURSE No.
- (25)-SNOW DEPTH (ins.)

NOTE: On the right side the points published are shown, and may be obtained with or without the Local Forest Survey from the Cartographic Division, Survey and Mapping Branch, Department of Lands, Forests, and Water Resources, Victoria, B.C.

BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

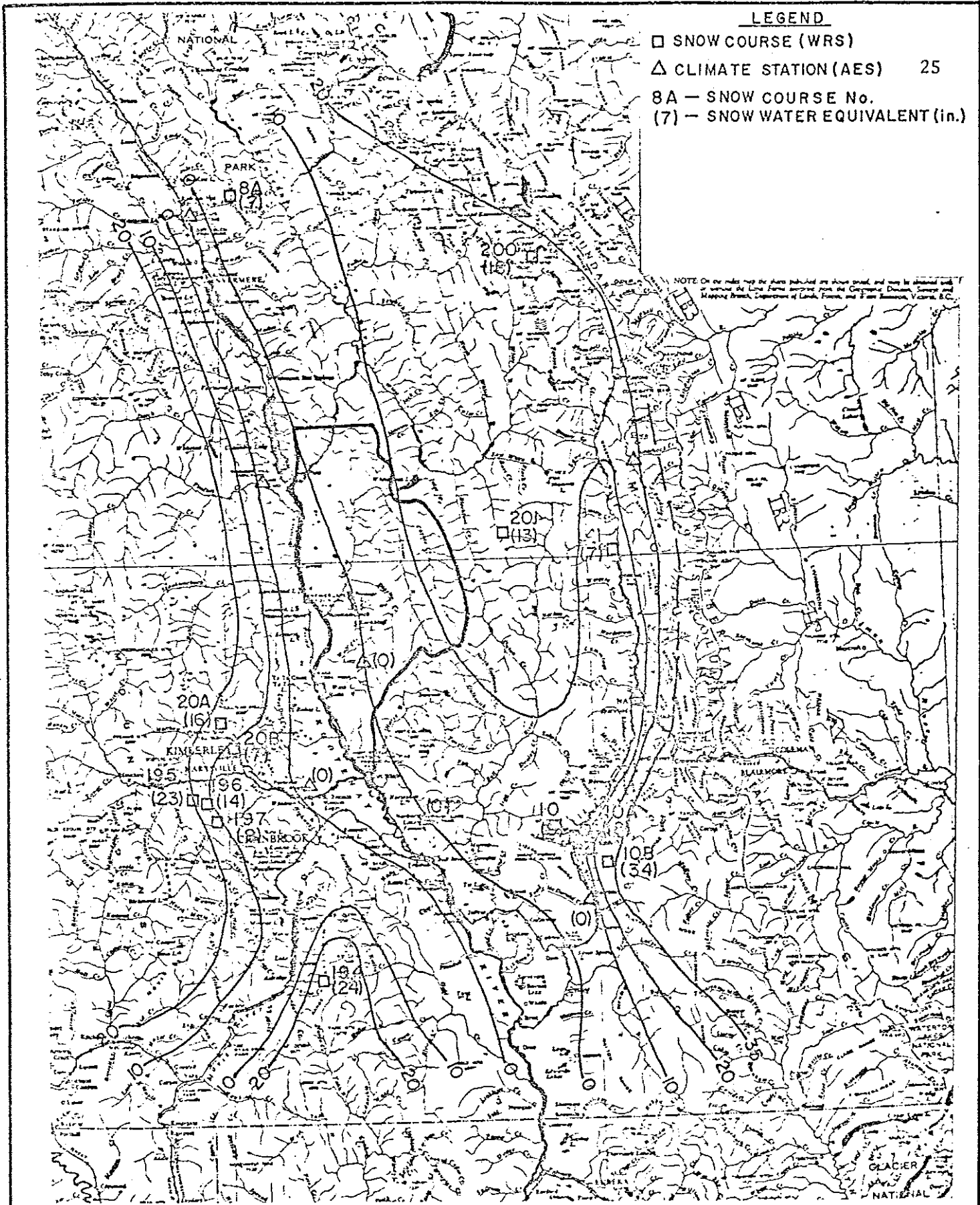
TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MEAN APRIL 1st SNOW DEPTH (inches)

SCALE: VERT. _____
 HOR. 1 inch = 16 miles

DATE _____

ENGINEER _____

FILE No. _____ DWG. No. **FIG. 7**



BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MEAN APRIL 1 SNOW WATER EQUIVALENT (in.)

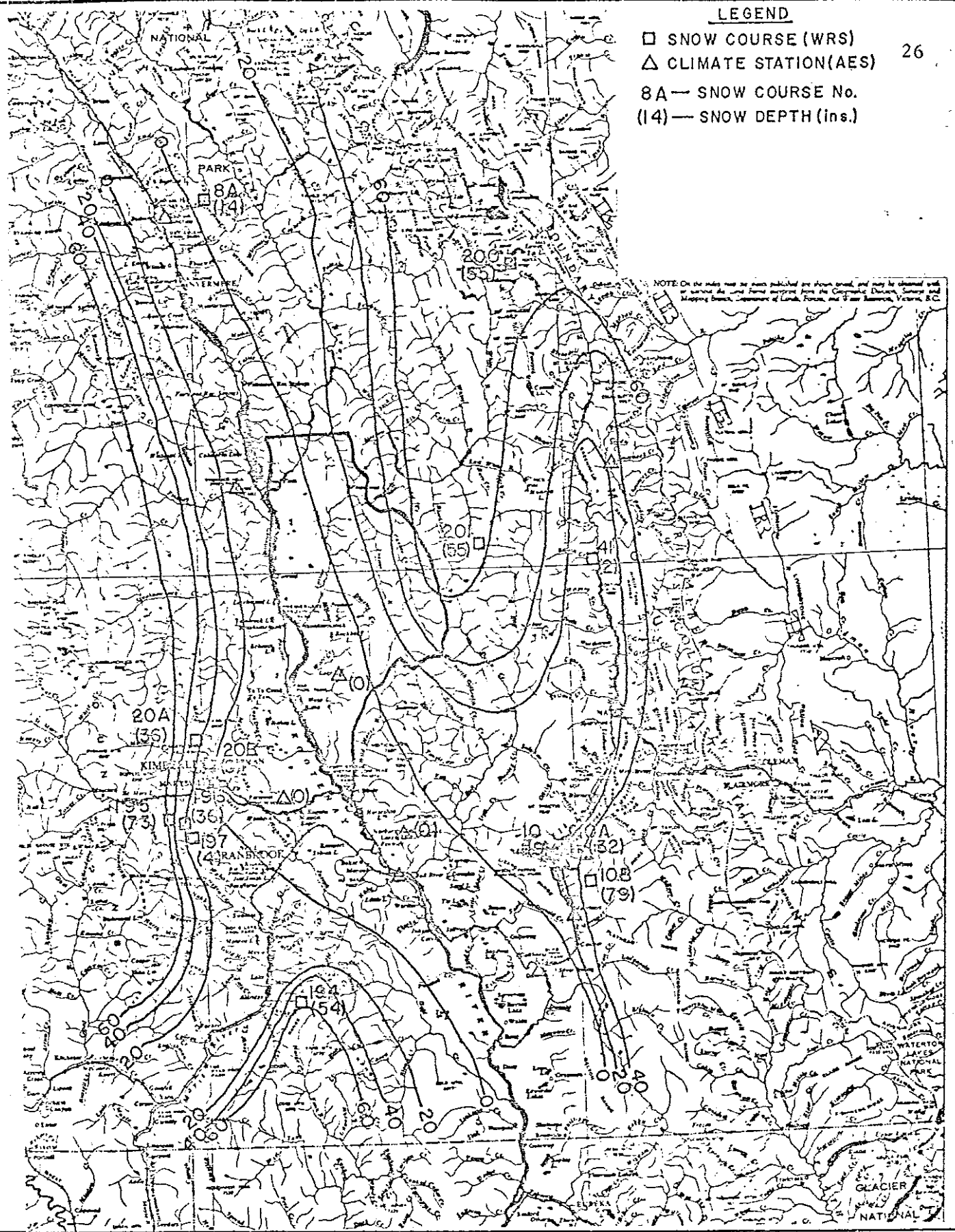
SCALE: VERT. _____
 HOR. 1 inch = 16 miles

DATE _____

ENGINEER _____
 FILE No. _____ DWG. No. FIG. 8

LEGEND

- SNOW COURSE (WRS) 26
- △ CLIMATE STATION (AES)
- 8A — SNOW COURSE No.
- (14) — SNOW DEPTH (ins.)



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 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MEAN MAY 1st SNOW DEPTH (inches)

SCALE: VERT. _____
 HOR. 1 inch = 16 miles

DATE _____

ENGINEER _____

FILE No. _____ DWG. No. FIG. 9

LEGEND

27

- SNOWCOURSE (WRS)
- △ CLIMATE STATION (AES)
- 8A — SNOW COURSE No.
- (5) — SNOW WATER EQUIVALENT (in.)



BRITISH COLUMBIA
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 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

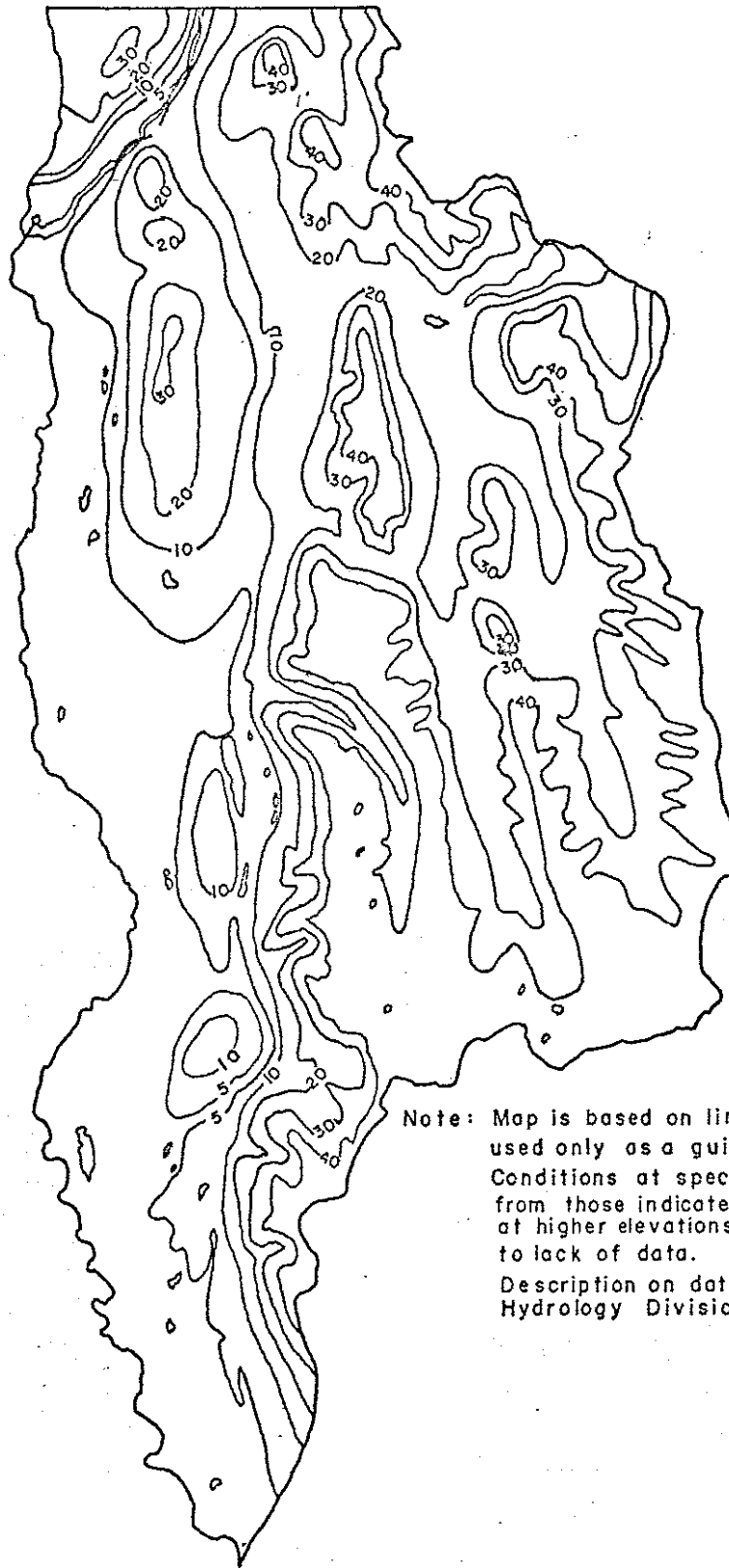
TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MEAN MAY 1st SNOW WATER EQUIVALENT (in.)

SCALE: VERT.
 HOR. 1 inch = 16 miles

DATE

..... ENGINEER

FILE No. DWG. No. **FIG. 10**



Note: Map is based on limited data and should be used only as a guide for regional variation. Conditions at specific sites may vary widely from those indicated. Snowpack conditions at higher elevations are not estimated due to lack of data. Description on data analysis is given in Hydrology Division report.

BRITISH COLUMBIA
DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
WATER INVESTIGATIONS BRANCH

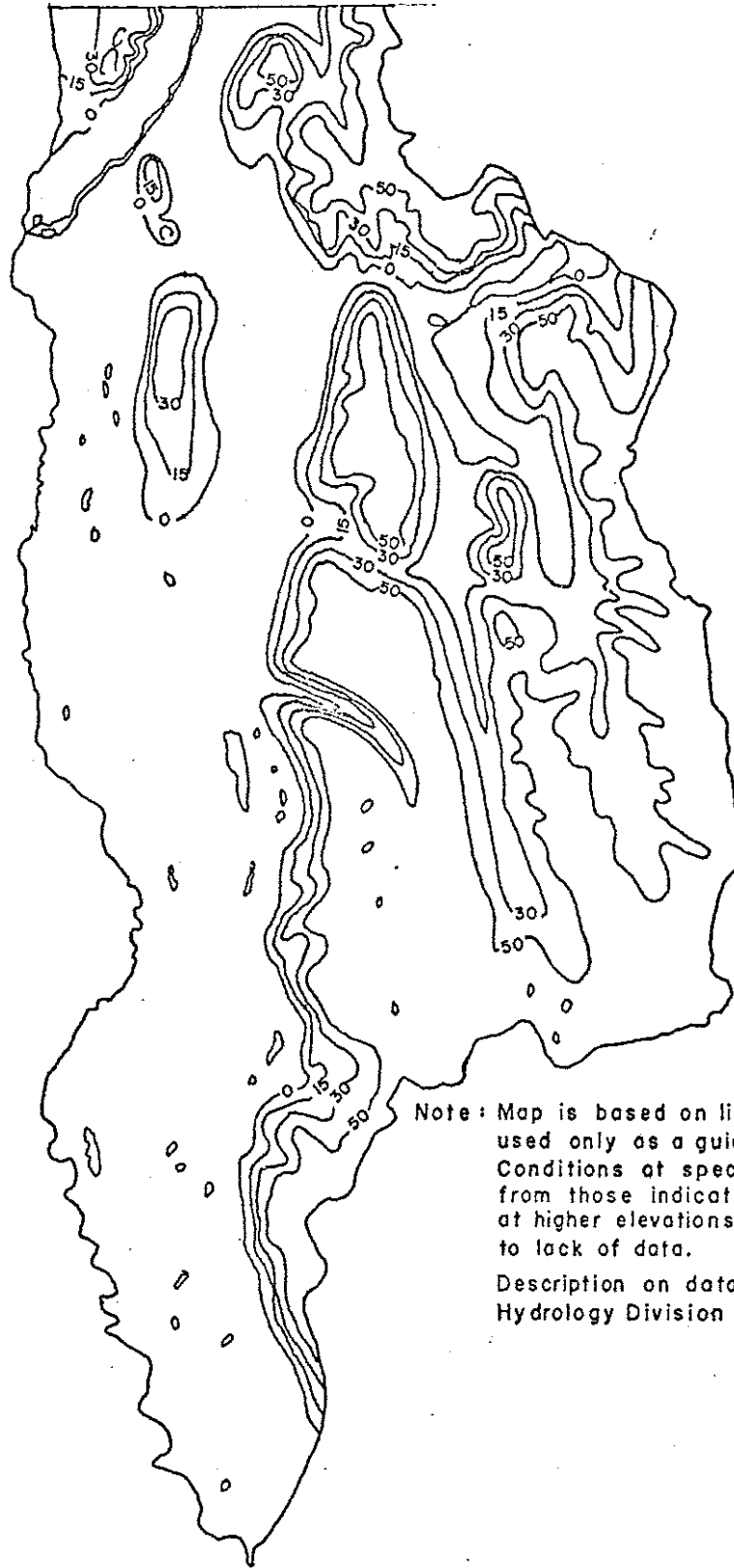
TO ACCOMPANY REPORT ON
WATER RES. OF THE SPRINGBROOK PROJECT AREA
MEAN FEBRUARY 1st SNOW DEPTH (in.)

SCALE: VERT.
HOR. 1 inch = 4 miles

DATE

ENGINEER

FILE No. DWG. No. FIG. II



Note: Map is based on limited data and should be used only as a guide for regional variation. Conditions at specific sites may vary widely from those indicated. Snowpack conditions at higher elevations are not estimated due to lack of data.
Description on data analysis is given in Hydrology Division report.

BRITISH COLUMBIA
DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
WATER INVESTIGATIONS BRANCH

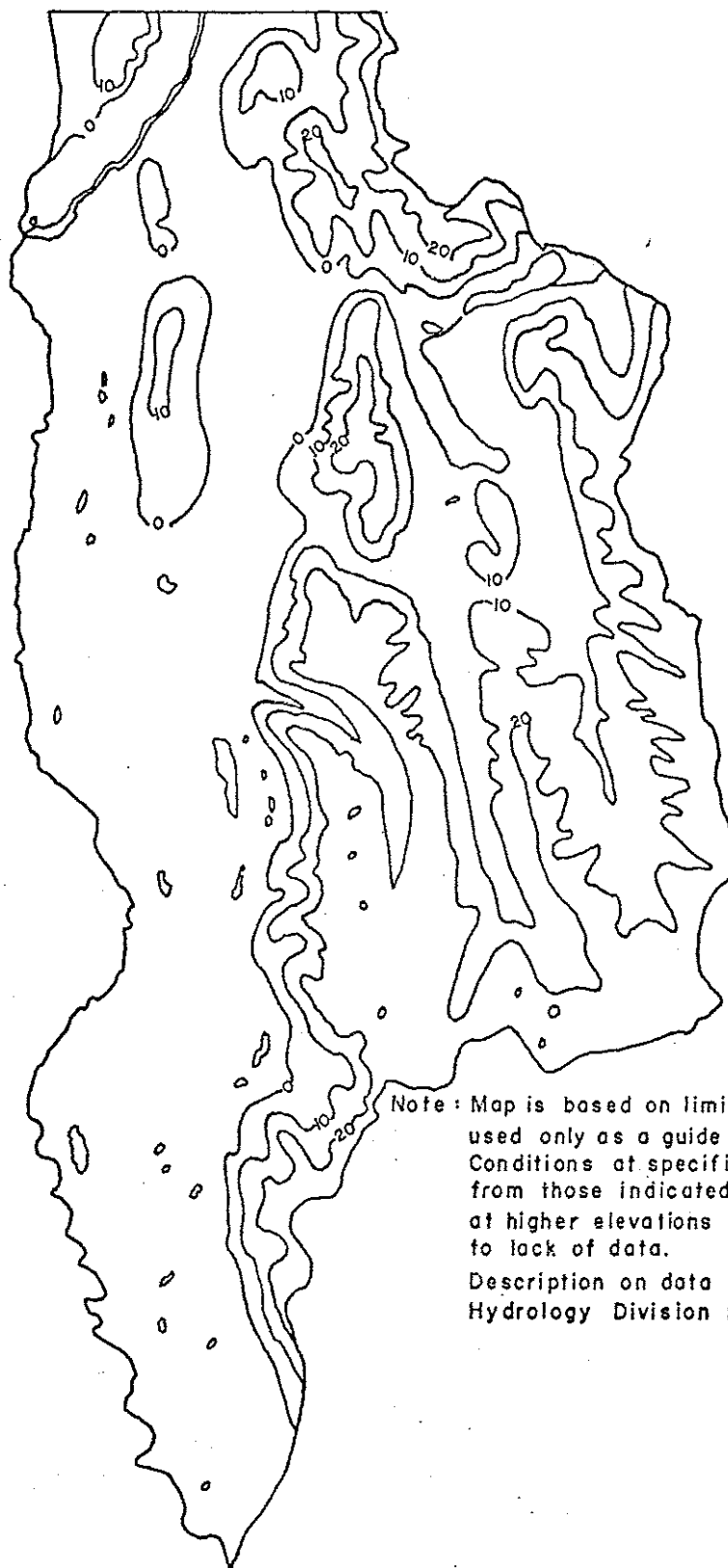
TO ACCOMPANY REPORT ON
WATER RES. OF THE SPRINGBROOK PROJECT AREA
MEAN MAY 1st SNOW DEPTH (inches)

SCALE: VERT. _____
1 inch = 4 miles

DATE _____

ENGINEER _____

FIG. 12



Note : Map is based on limited data and should be used only as a guide for regional variation. Conditions at specific sites may vary widely from those indicated. Snowpack conditions at higher elevations are not estimated due to lack of data. Description on data analysis is given in Hydrology Division report.

BRITISH COLUMBIA
DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
WATER INVESTIGATIONS BRANCH

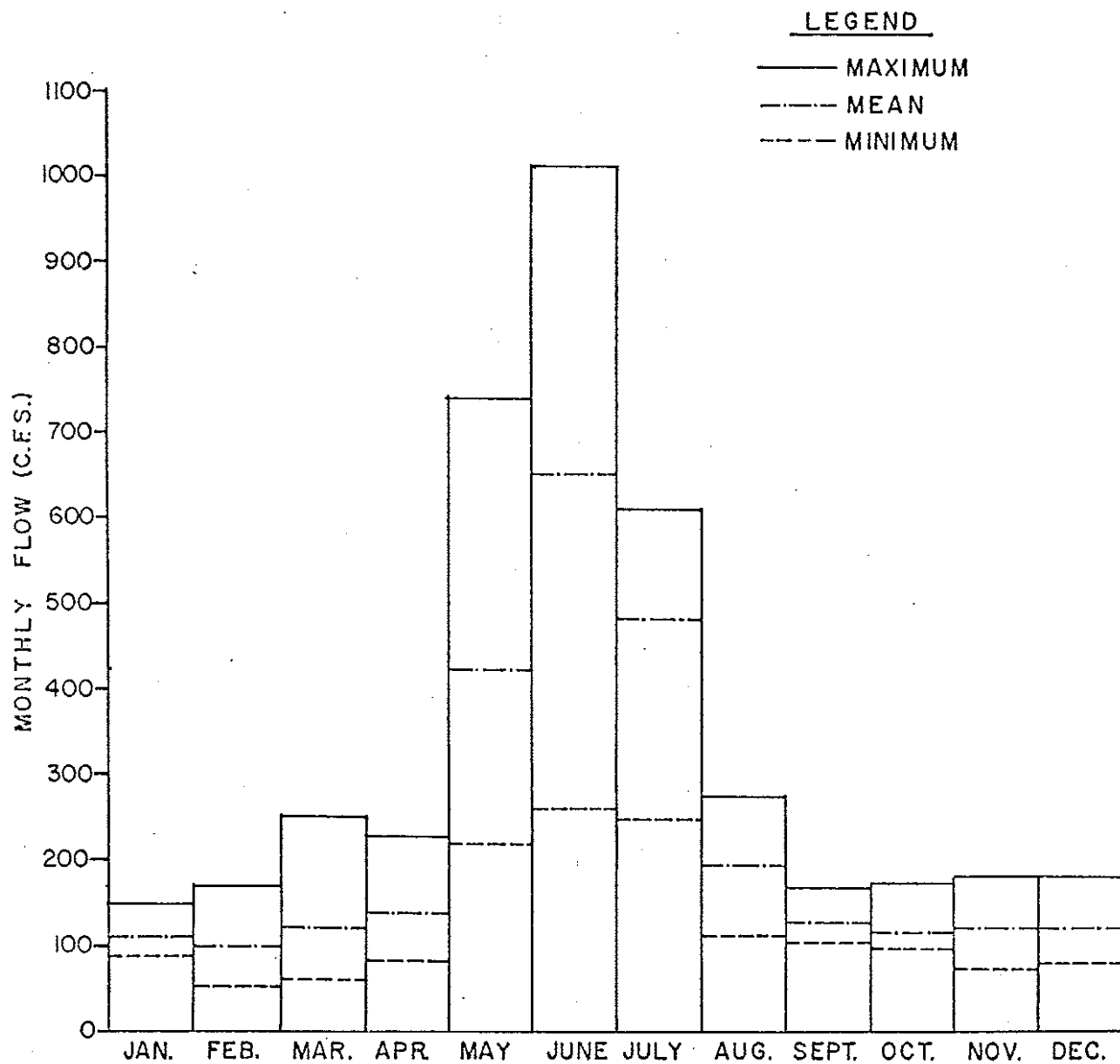
TO ACCOMPANY REPORT ON
WATER RES. OF THE SPRINGBROOK PROJECT AREA
MEAN MAY 1st SNOW WATER EQUIVALENT (in.)

SCALE: VERT. _____
HOR. 1 inch = 4 miles

DATE _____

ENGINEER _____

FILE No. _____ DWG. No. FIG. 13



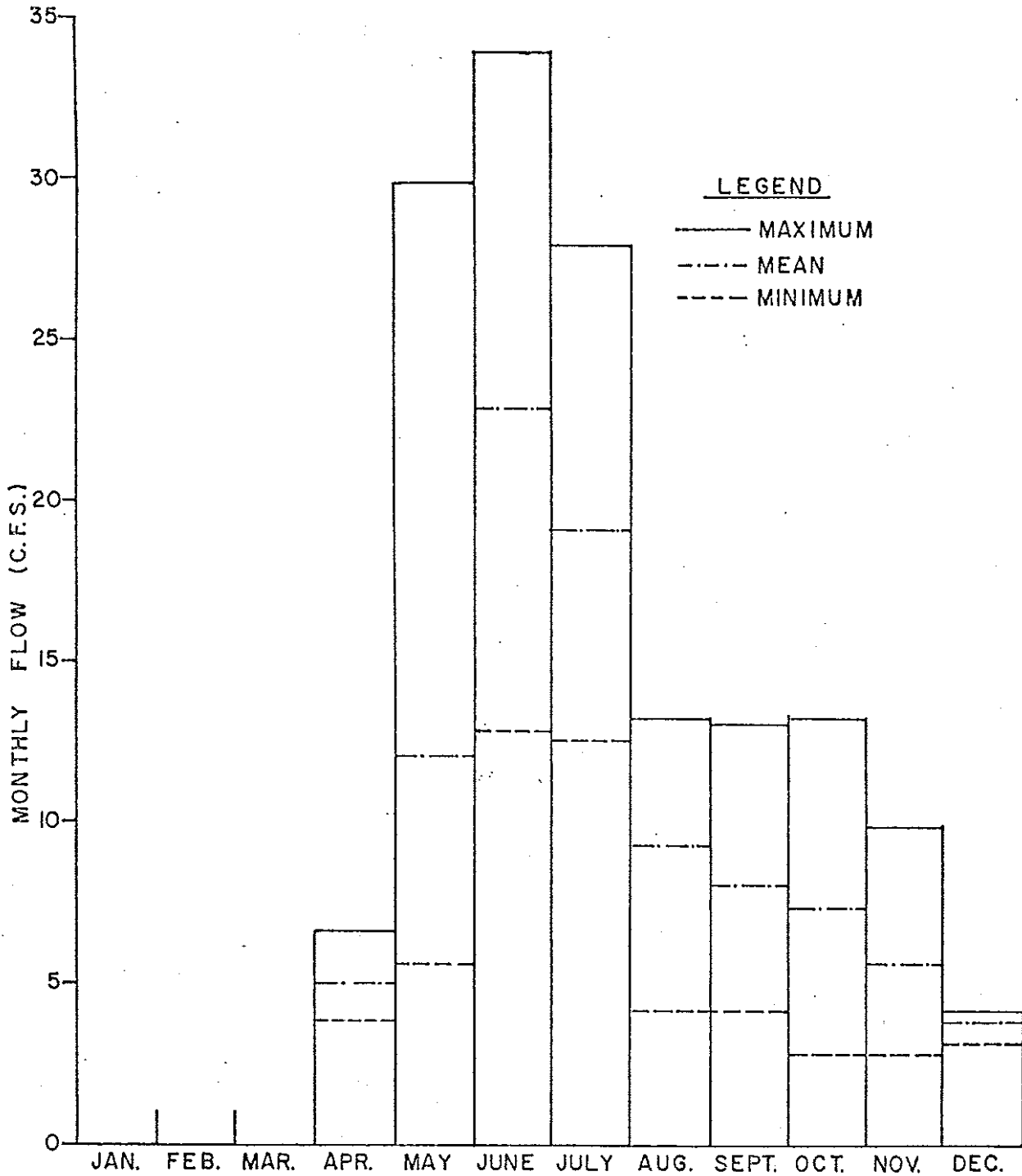
BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MONTHLY RUNOFF DISTRIBUTION
 08N6044 LUSSIER RIVER

SCALE: VERT. 1 inch = 200 C. F. S.

DATE

ENGINEER



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 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MONTHLY RUNOFF DISTRIBUTION
 08NG032 WOLF RIVER

SCALE: VERT. 1 inch = 5 C. F. S.

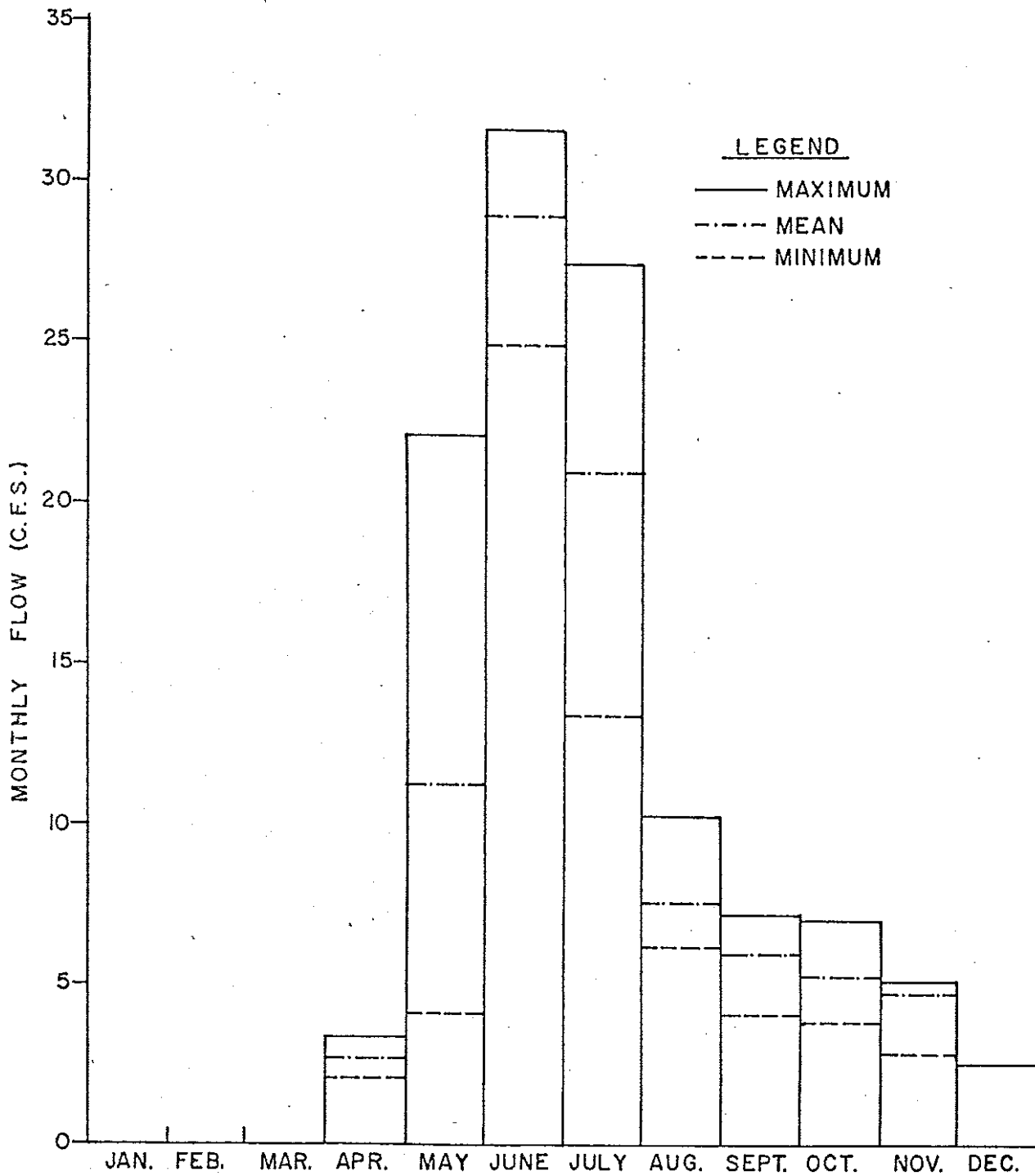
HOR. 1 inch = 2 Months

DATE

ENGINEER

FILE NO.

DWG. NO. FIG. 15



BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES. OF THE SPRINGBROOK PROJECT AREA
 MONTHLY RUNOFF DISTRIBUTION
 08NGO49 LEWIS CREEK

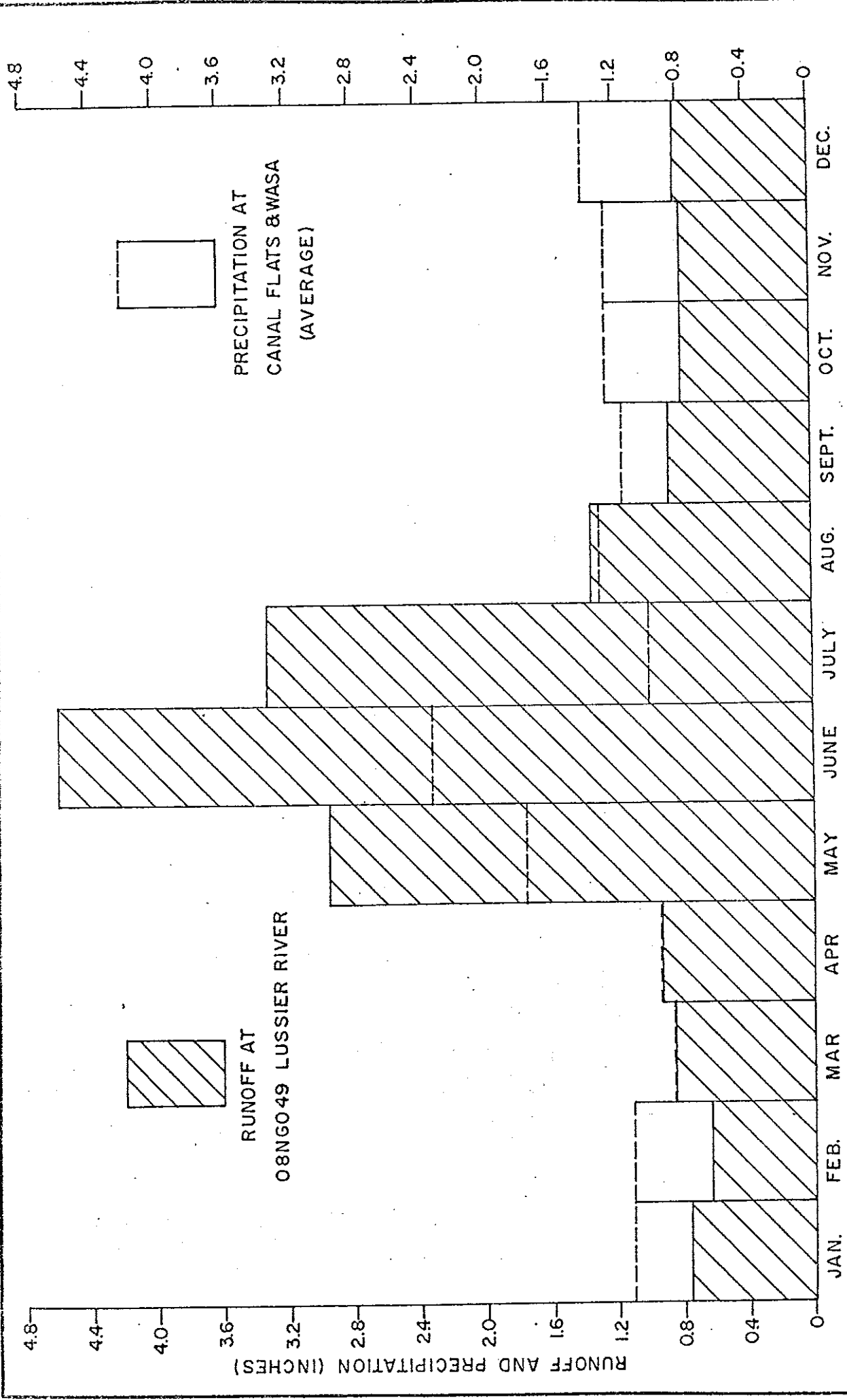
SCALE: VERT. 1 inch = 5 C.F.S.
 HOR. 1 inch = 2 months

DATE

ENGINEER

FILE No.

DWG. No. **FIG. 16**

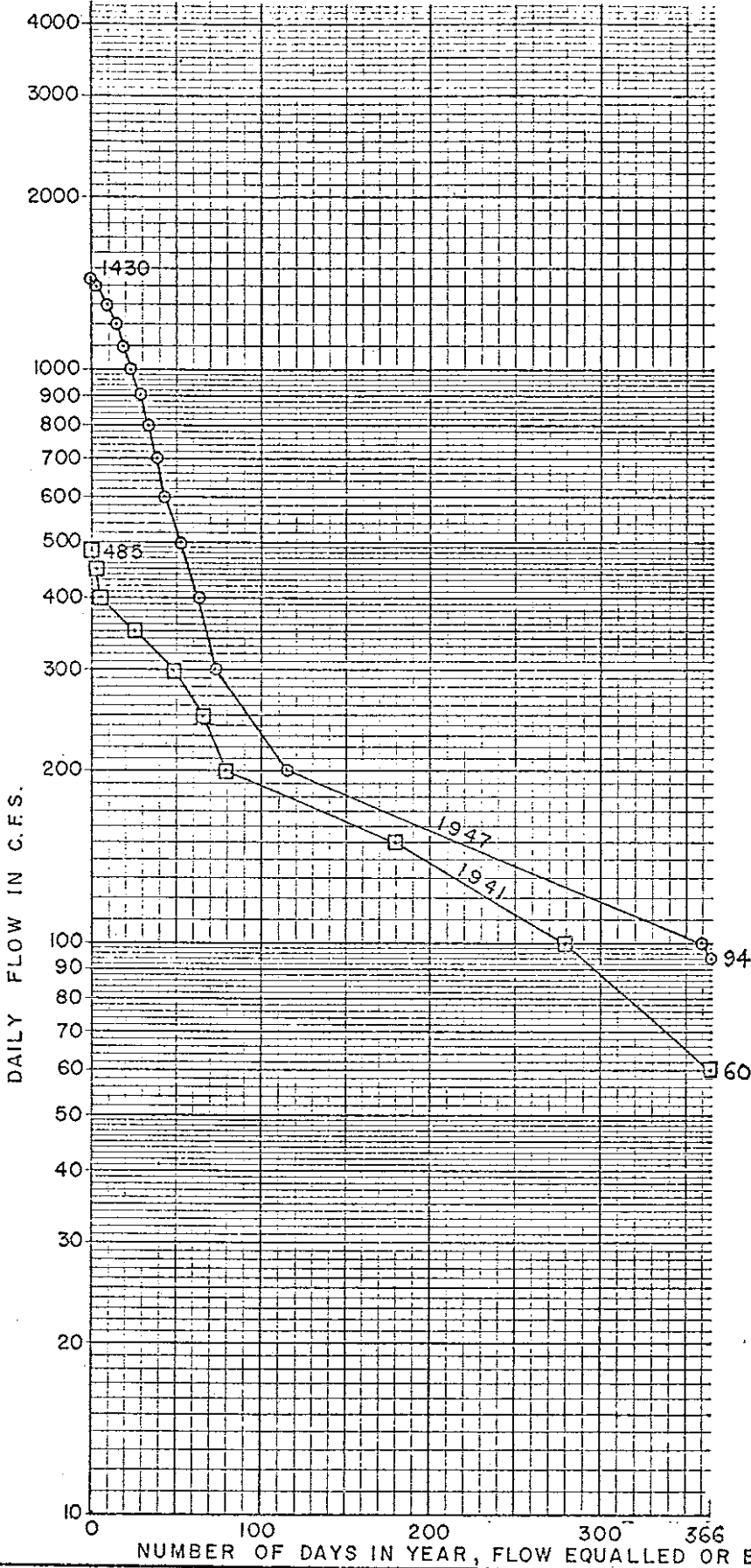


TO ACCOMPANY REPORT ON
WATER RES. OF THE SPRINGBROOK PROJECT AREA
MEAN MONTHLY PRECIPITATION AND
RUNOFF DISTRIBUTION

BRITISH COLUMBIA
 DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

SCALE: VERT. 1 inch = 0.8 inch
 HOR. 3/4" = 1 Month

DATE _____
 ENGINEER _____
 FILE No. _____ DWG. No. **FIG. 17**



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 WATER RESOURCES SERVICE
 WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
 WATER RES OF THE SPRINGBROOK PROJECT AREA
 FLOW DURATION CURVES
 08N6044 LUSSIER RIVER

SCALE: VERT. As Shown
 HOR. " "

DATE

ENGINEER

FILE No.

DWG. No. **FIG. 18**

TABLE 1 HYDROMETRIC DATA SUMMARY

LUSSIER CREEK NEAR WASA - STATION NO. 08NG016

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1920	---	---	---	---	94.0	452	291	57.6	15.6	---	---	---	---	1920
MEAN	---	---	---	---	94.0	452	291	57.6	15.6	---	---	---	---	MEAN

LOCATION - LAT 49 57 37 N DRAINAGE AREA 300 SQ MILES
LONG 115 40 10 W NATURAL FLOW

LUSSIER CREEK NEAR WASA - STATION NO. 08NG016

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1920	---	855 CFS ON JUN 30 *	14.0 CFS ON SEP 4 *	---	1920
				---	MEAN

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

364

LUSSIER RIVER NEAR CANAL FLATS - STATION NO. 08NG044

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1940	---	---	---	---	---	---	---	---	114	106	101	81.8	---	1940
1941	90.4	169	249	85.1	223	261	248	113	117	123	106	109	158	1941
1942	106	95.5	105	153	511	804	612	242	159	107	122	---	---	1942
1943	---	---	---	---	219	620	547	273	113	107	104	179	---	1943
1944	132	75.3	125	234	338	418	---	---	---	73.5	77.2	92.5	---	1944
1945	122	110	97.5	96.4	309	509	608	153	120	---	129	129	---	1945
1946	96.6	71.5	81.5	127	499	712	516	211	169	102	115	123	236	1946
1947	150	132	140	146	742	1010	298	132	108	176	180	121	278	1947
1948	77.0	53.7	57.3	119	547	894	521	238	134	---	138	---	---	1948
MEAN	111	101	122	137	424	654	479	195	129	114	119	119	224	MEAN

LOCATION - LAT 50 07 36 N DRAINAGE AREA 95 SQ MILES
LONG 115 33 54 W NATURAL FLOW

LUSSIER RIVER NEAR CANAL FLATS - STATION NO. 08NG044

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1940	---	---	---	---	1940
1941	---	485 CFS ON JUL 8	60.0 CFS ON MAR 23	114000 AC-FT	1941
1942	---	1030 CFS ON JUN 8	88.0 CFS ON MAR 7	---	1942
1943	---	720 CFS ON JUN 16	---	---	1943
1944	---	582 CFS ON JUN 8	64.0 CFS ON FEB 8	---	1944
1945	---	710 CFS ON JUN 30	75.0 CFS ON APR 15	---	1945
1946	---	850 CFS ON JUN 22	64.0 CFS ON FEB 15	171000 AC-FT	1946
1947	---	1430 CFS ON JUN 14 *	94.0 CFS ON DEC 31	201000 AC-FT	1947
1948	---	1110 CFS ON MAY 23	51.0 CFS ON FEB 13 *	---	1948
				162000 AC-FT	MEAN

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

WOLF CREEK NEAR TA TA CREEK - STATION NO. 08NG032

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1928	---	---	---	---	17.3	24.6	27.9	13.3	9.7	---	---	---	---	1928
1929	---	---	---	4.7	8.3	21.5	12.5	8.3	7.5	6.7	4.9	4.3	---	1929
1930	---	---	---	3.7	7.2	12.8	13.5	9.0	6.5	---	---	---	---	1930
1949	---	---	---	---	---	---	---	4.3	4.3	2.8	2.7	3.2	---	1949
1950	---	---	---	4.3	4.9	21.7	20.0	8.2	5.8	6.9	5.9	---	---	1950
1951	---	---	---	5.2	29.7	33.8	27.1	12.9	13.0	13.3	---	---	---	1951
1952	---	---	---	6.6	14.0	22.2	15.9	8.9	8.0	7.8	6.9	---	---	1952
1953	---	---	---	5.6	6.1	22.2	14.5	9.2	6.1	5.3	5.6	---	---	1953
1954	---	---	---	---	8.3	23.1	21.7	10.7	12.4	8.9	7.4	---	---	1954
MEAN	---	---	---	5.0	12.0	22.7	19.1	9.4	8.1	7.4	5.6	3.8	---	MEAN

LOCATION - LAT 49 50 17 N NATURAL FLOW
LONG 115 40 20 W

WOLF CREEK NEAR TA TA CREEK - STATION NO. 08NG032

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1928	---	35.2 CFS ON JUL 6	6.5 CFS ON APR 24	---	1928
1929	---	25.4 CFS ON JUN 14	4.0 CFS ON DEC 8	---	1929
1930	---	15.9 CFS ON JUL 4	3.4 CFS ON APR 1	---	1930
1949	---	---	2.5 CFS ON DEC 28 *	---	1949
1950	---	33.8 CFS ON JUN 23	3.8 CFS ON APR 22	---	1950
1951	---	44.9 CFS ON MAY 24 *	4.7 CFS ON APR 7	---	1951
1952	---	25.7 CFS ON JUN 12	5.6 CFS ON APR 1	---	1952
1953	---	31.8 CFS ON JUN 20	5.0 CFS ON SEP 23	---	1953
1954	---	27.4 CFS ON JUL 2	4.2 CFS ON MAY 3	---	1954

LEWIS CREEK NEAR TA TA CREEK - STATION NO. 08NG049

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1949	---	---	---	---	---	---	---	8.2	8.0	7.9	8.0	---	---	1949
1950	---	---	---	2.1	4.1	30.4	23.1	7.1	4.5	3.7	3.7	---	---	1950
1951	---	---	---	2.0	22.0	30.2	27.4	10.2	7.2	7.0	6.1	---	---	1951
1952	---	---	---	3.3	16.1	31.5	15.2	6.1	4.9	4.7	3.9	---	---	1952
1953	---	---	---	2.9	5.0	24.8	13.3	6.3	4.0	3.9	2.7	2.6	---	1953
1954	---	---	---	2.6	9.5	27.3	25.6	7.3	6.6	4.0	3.5	---	---	1954
MEAN	---	---	---	2.6	11.3	28.8	20.9	7.5	5.9	5.2	4.7	2.6	---	MEAN

LOCATION - LAT 49 48 44 N
 LONG 115 37 36 W NATURAL FLOW

LEWIS CREEK NEAR TA TA CREEK - STATION NO. 08NG049

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1949	---	---	---	---	1949
1950	---	52.0 CFS ON JUN 21	2.1 CFS ON APR 1	---	1950
1951	---	48.5 CFS ON JUN 16	1.9 CFS ON APR 1 *	---	1951
1952	---	38.5 CFS ON JUN 4	1.9 CFS ON APR 1	---	1952
1953	---	48.5 CFS ON JUN 13	2.6 CFS ON APR 8	---	1953
1954	---	62.0 CFS ON JUN 30 *	2.6 CFS ON APR 1	---	1954

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

--- AC-FT MEAN

TABLE 2 SUMMARY OF LICENCED WATER USE

BASIN	ANNUAL LICENCED AMOUNTS (ac.-ft.)				
	IRRIGATION	DOMESTIC	MINING	POWER	OTHER
Lussier R.	1109	10	-	1448	-
Wolf Cr.	1351	5	-	-	-
Lewis Cr.	1170	17	138	-	1230
Saugum	72	-	-	-	1980
Lakit	184	1	-	-	-