PART IV

WATER QUANTITY MONITORING, TECHNOLOGICAL ADVANCES AND CONCLUSIONS

CHAPTER 17

Water Quantity Monitoring

17.1 INTRODUCTION

The Okanagan Study has revealed the need for an improved monitoring system with respect to water quantity (including climatic data), water quality and waste treatment. Only through an adequate sampling of existing conditions and the changes of trends that are taking place is it possible to check the adequacy of the proposed water management plans as outlined in the final report.

Even prior to the signing of the Okanagan Basin Agreement in October 1969, it was recognized that there was a serious lack of hydrometric, meteorological and water quality stations in the basin and in the spring of 1969 the two governments undertook to initiate a number of new stations.

While such additional stations gave only two or three years of record prior to the evaluation stage of the study they at least supplied some information particularly in the tributaries where little or no data was available. Moreover, these new stations provided an improved base for future water management decisions.

Fortunately during 1969 to 1973, some extreme hydrological events occurred including two single droughts in 1970 and 1973 as well as a record flood in 1972 which in total volume exceeded the 1948 flood.

17.2 OBJECTIVES OF MONITORING

Water quantity monitoring in its broader aspects should, in addition to providing adequate hydrological coverage include any additional water elevations or discharges needed to assess water quality and waste treatment. Only through an updated monitoring system is it possible to meet the ongoing and future objectives which are stated below:

a) To provide current data on water shortages, diversions, discharges, precipitation, temperature, water quality and waste water treatment for day to day decisions on water management.

b) To provide a check on the water quantity models developed during the

Okanagan Study as well as nutrient loadings and limnological changes that have been forecast for the next 10 to 15 years for whatever waste treatment is undertaken.

c) To provide a basic data bank on hydrology, meteorology, limnology and water quality of sufficient length and detail for a comprehensive statistical analysis.

It will be recognized that the monitoring stations for the above three objectives are to a large degree complementary and in total expand the basis for future planning and design.

17.3 MONITORING ACCURACY

Based on the three objectives, a framework monitoring program is summarized in Table 17.1. The table indicates the limits, accuracy and approach for each of the three stated objectives with an understanding that a review of the study will be undertaken in 1980 as recommended in the final report.

Some limits must be placed on the monitoring to make it practical and economical. Thus, minor storages and diversions are not included because they do not have a significant effect on water quantity modelling. Further, stations are limited for the most part to the main valley lake and river systems and the principal tributaries.

The goal of the statistical analysis mentioned under objective 3 is to define the flow characteristics of the main valley lake and river system, the principal tributaries, as well as by some process of regionalization, the flow characteristics of ungauged minor streams.

The accuracy in the time-sampling is best defined by the number of years of observation. An increase in accuracy is accomplished at progressively higher costs, because the time-sampling error varies inversely as the square root of the number of years of record. Thus, the improvement becomes progressively less as the length of record increases. A 25 year record of observation at least is required for determining the statistical characteristics of a stream. For minor streams the regionalization process results in greater errors that those records for the principal streams from which they were derived.

Typical flow characteristics included in statistical analysis are:

- Mean annual flow
- Standard deviation of mean annual flow
- Mean monthly flow
- Standard deviation of mean monthly flow
- Mean seasonal (freshet) flow
- Standard deviation of mean seasonal flow
- Flood flows with various frequencies
- Low flow - durations for various frequencies

TABLE 17.1

FRAMEWORK PLAN FOR WATER QUANTITY, QUALITY AND WASTE TREATMENT MONITORING

		(1)	(2)	(3)
OBJECTIVES		To provide current data on water storages, diversions, discharges, precipitation, temperature, water quality and waste water treatment for day to day decisions on water management.	To provide a check on the water quantity models developed during the Okanagan Study as well as the nutrient loadings and limnological changes that have been forecast for the next 10 to 15 years assuming tertiary or equivalent treatment is undertaken as outlined in the findings and recommendations.	To provide a basic data bank on hydrology, meteorology, Limnology and water quality of sufficient length and detail for a comprehensive statistical analysis.
LIMITS	Quantity	Exclusive storage reservoirs < 100 ac.ft. Exclusive diversions < 50 ac.ft./year Exclusive minor tributaries	Same as for (1)	Modifications indicated from experience gained under (1) and (2)
	Quality	Main beach areas, water supply sources, main valley lake and river system and selected tributaries.		
	Waste Water Treatment	All municipal industrial waste water discharges and areas served by septic tanks having positive effluent discharges. *In* areas where heavy concentration of industrial discharges to ground water and/or septic tanks water quality of local wells to be monitored.		
ACCURACY	Quantity	Equivalent of at least 25 years observation record in the main valley lake system and in the principal tributaries for statistical analysis. Through regionalization procedures the equivalent of 10 years of records can be obtained for minor ungauged tributaries. In addition continuing records are required for those stations needed for operation purposes.	Same as for (1)	Same as for (1)
	Quality	Commensurate with water quantity.		
	Waste Treatment	Commensurate with water quantity.		
APPROACH		Operate monitoring stations as required to provide interpretations needed.	Same as for (1)	Establishment of 25 years of continuous records of water discharges in principal tributaries. Through regression and other forms of analysis establish relationships between basin and climatic factors and runoff for use in ungauged minor streams.

Flow characteristics will be increasingly utilized in the future in accordance with modern practice which is in contrast to past procedures where flows for specific periods are studies. Thus, the object is to consider the flows expected in the future in terms of probability of occurrence and from these basic statistics to generate a set of flow data for use in the water quantity simulation model. Ideally, the incorporation of water quality parameters in such a model is needed to obtain the optimum from such an operation.

Since most waste water discharges are or should be monitored continuously, the controlling factor here with respect to the accuracy of loadings will be dependent upon the frequency of water quality sampling. Such sampling should be more frequent as the discharge increases and from experience, a sampling program should be set up. However, it is important from time to time to check by an independent means, the waste discharge from industrial and municipal plants for gross errors in flow recording instruments.

Similarly in the case of gravity or pumped irrigation diversions, independent measurements should be made occasionally, not only at the point where the water is taken into the system but also at the point of use. Normally, the latter can be checked at least roughly by counting the number of sprinklers in use.

The required accuracy of climate data commensurate with water quantity and quality monitoring is difficult to define although it would appear that a minimum of 25 years of continuous record are needed which adequately cover all portions of the basin.

17.4 WATER QUANTITY MONITORING

Water quantity monitoring involves the measurement of the various portions of the hydrologic cycle starting with precipitation, evapotranspiration and evaporation, surface and subsurface runoff and ground water. It also requires the measurement of significant water diversions, farm irrigation use and the amount of return flow from such diversions. Monitoring is carried out cooperatively between the Provincial and Federal Governments.

Climatic monitoring including precipitation, temperature, wind, humidity, cloud and sunshine as well as evaporation and evapotranspiration is carried out by the Atmospheric Environment Service, Environment Canada in cooperation with Provincial authorities. In addition to the above, the British Columbia Mater Resources Service, Department of Lands, Forests and Water Resources has established within the major river basins of the Province, a number of snow courses where snow depths and snow water equivalents are measured during the winter months.

In the hydrometric field, a cooperative program by Water Survey of Canada, Inland Water Directorate, Environment Canada and the British Columbia Water Resources Service has been in existence for a number of years with the Provincial agency sharing a portion of the cost. In areas such as the Okanagan Basin some additional stations have been set up by local water authorities with respect to their water supply operations.

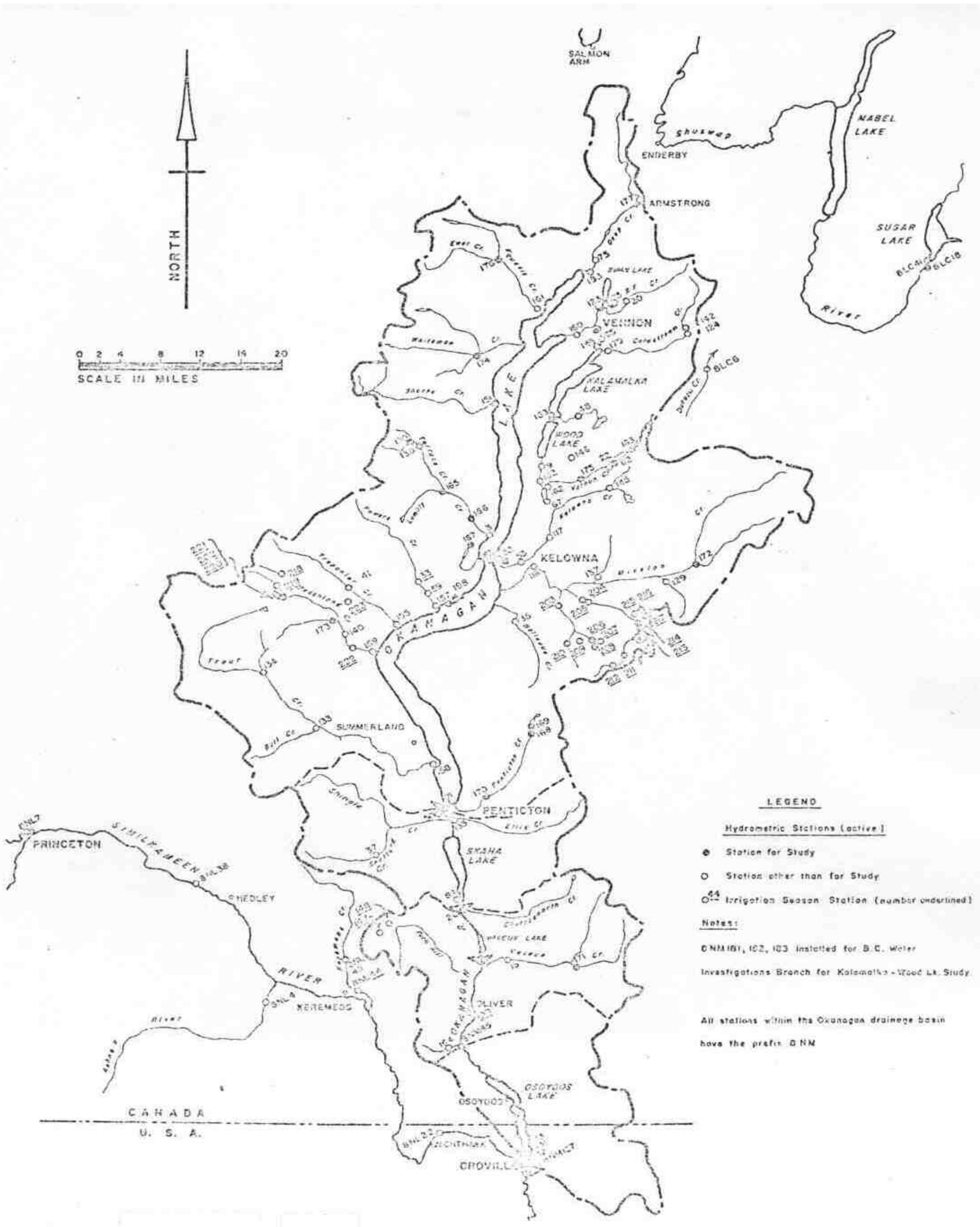
While ground water is not presently licences in British Columbia, the British Columbia Water Resources Service has developed an inventory of ground-water data through the cooperation of well drillers and consulting engineers as well as from the results of contract drilling by the Department. Similar investigations in areas of the Province not covered by the British Columbia Mater Resources Service have been undertaken by the Inland Waters Directorate, Environment Canada.

All the above mentioned agencies have been involved in water quantity monitoring under the Okanagan Basin Study and in the preparation of Task Reports which provide the basic data for this portion of the report. Active hydrometric stations in the Okanagan Basin are shown in Figure 17.1.

The Atmospheric Environment Service assisted by the British Columbia Water Resources Service, installed 11 high and 14 low level climatic stations under study funds. This just about doubles the number of active stations within the basin as indicated in Figure 17.2. Figure 17.3 shows the active snow courses within the Basin and surrounding area. For actual detailed information on historic and derived data, the reader is referred to Technical Supplement III - Water Quantity Alternatives and Supporting Water Quantity Data.

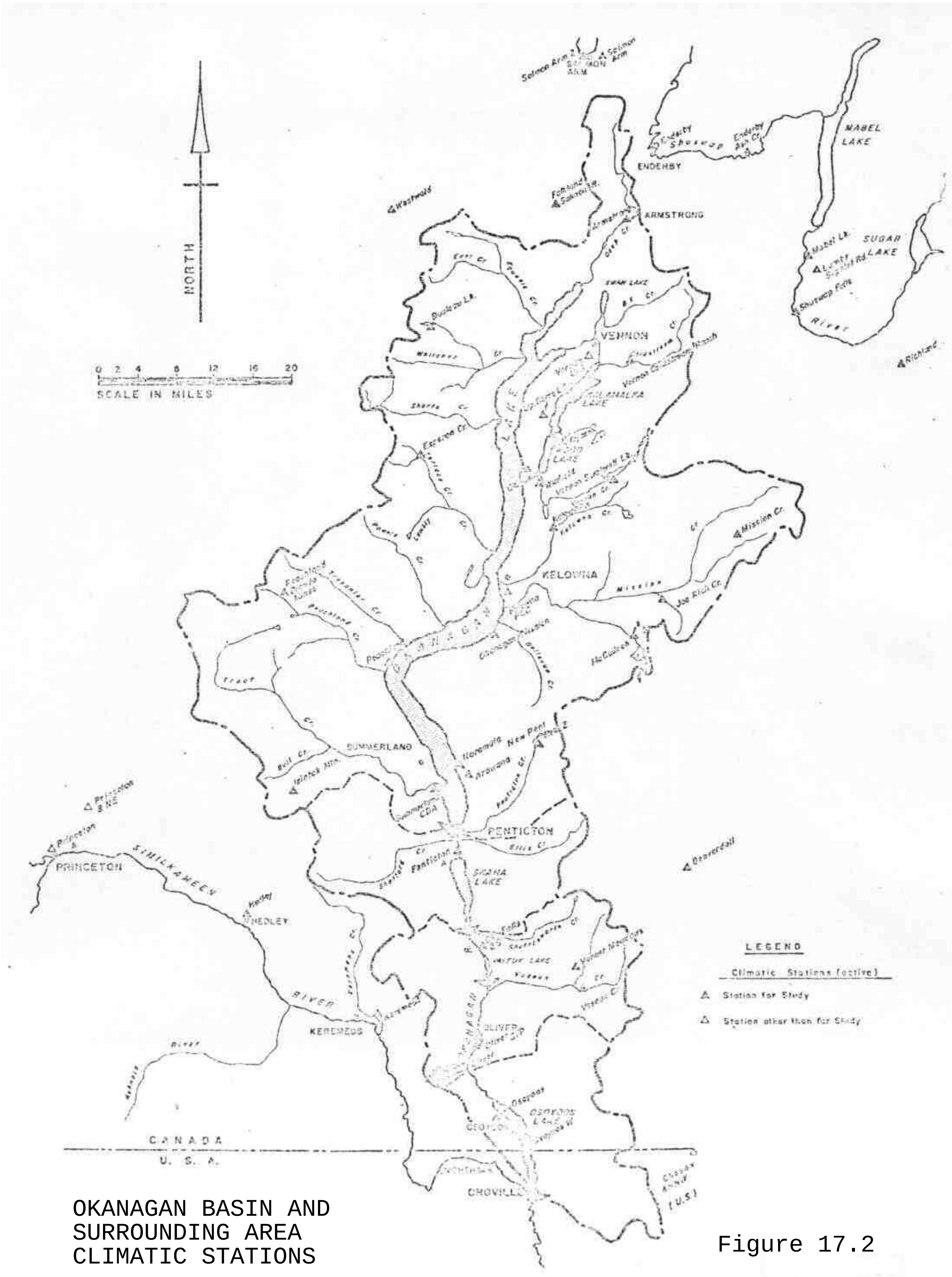
In order to support the short-term objectives, namely the "meeting of day to day decisions on water management", it would be desirable to have the immediate transmission of data from widely dispersed stations in the Basin, particularly at higher elevations to a central control point in the valley. Such information would be most useful during the spring freshet period (April to July inclusive) in the operation of the computer forecasting model. At present, such input to the model is limited to the valley air temperatures from which snow field air temperatures are estimated. It would also be desirable to have other important parameters, namely tributary water discharges, snow water equivalent and soil moisture and also the actual air temperatures within the snow fields as a check against present estimates.

At this time, the cost of such installations would appear to preclude their introduction.



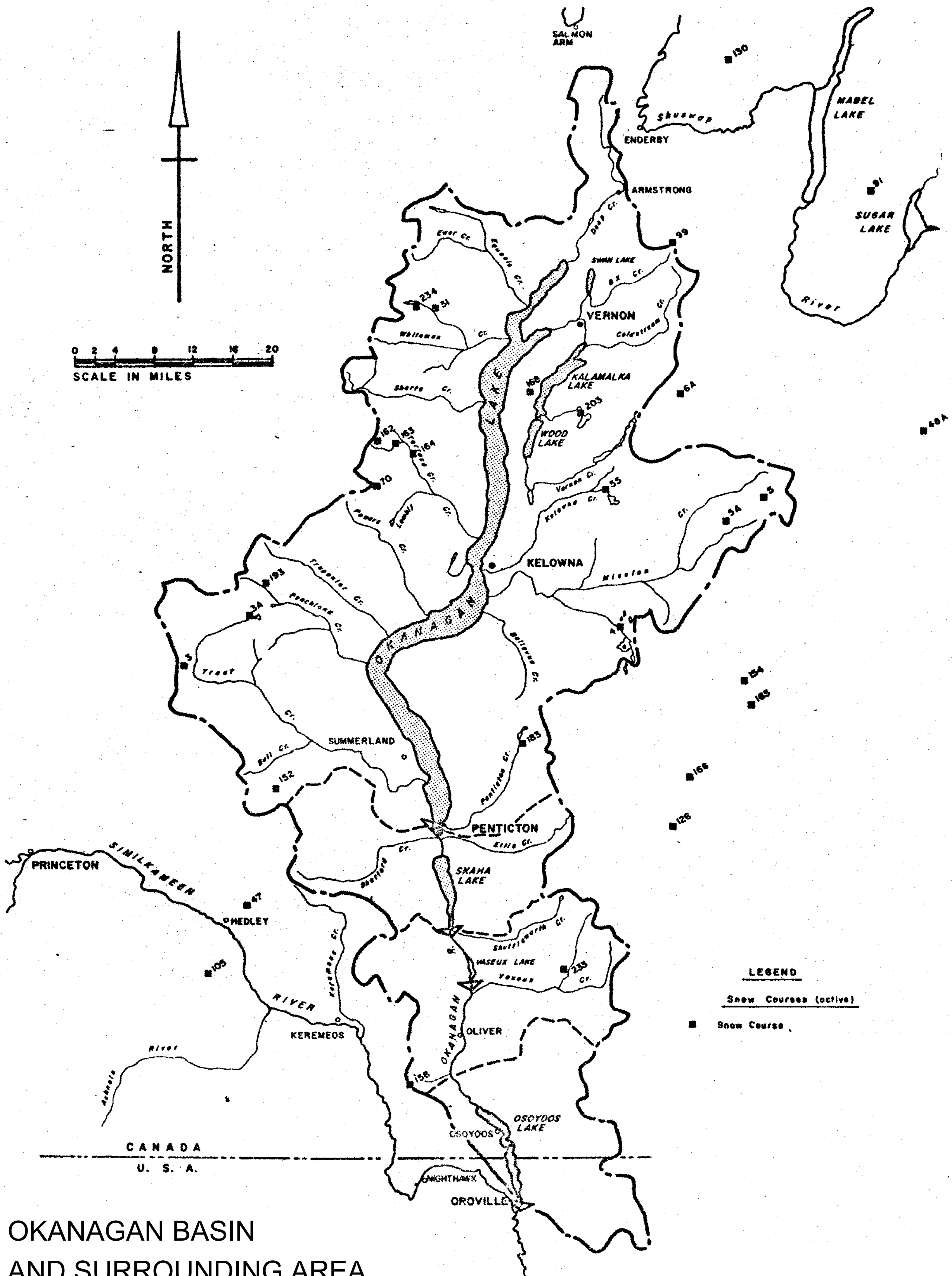
OKANAGAN BASIN HYDROMETRIC STATIONS

Figure 17.1



OKANAGAN BASIN AND
SURROUNDING AREA
CLIMATIC STATIONS

Figure 17.2



OKANAGAN BASIN
AND SURROUNDING AREA
SNOW COURSES

Figure 17.3

Further, in the case of snow survey data observations are made in the field usually at or near the first of each month and such information is conveyed by telegram to Victoria for computer analysis a few days later.

At present, then, hydrometeorlogical data other than snow survey information, temperature observations at valley stations and related precedent factors are most useful in meeting the intermediate or long-term objectives where a delay of several months between the time of observation and availability of record are not important.

The type of information that should become available from the ongoing water quantity and climatic monitoring by 1980 is indicated in the following subsections.

17.4.1 Water Quantity Analysis to be Carried Out in 1980

a) Re-assessment of the eight principal tributaries to Okanagan Lake to check the tentative flows derived in this study. For those tributary stations with 25 years of record in 1980 a statistical analysis is proposed.

b) Re-assessment of the operation of the mainstem Okanagan River system and the extension of the model downstream through Osoyoos Lake to Oroville.

17.4.2 Climatic Analysis to be Carried Out in 1980

a) A check on the relationship between precipitation and latitude and elevation which has been used in the water quantity modelling.

b) A check on Okanagan Lake evaporation derived for the period 1921 to 1970, based on historic temperatures and limited pan evaporation records at Summerland.

c) The tentative relationship between lake evaporation and elevation derived in Technical Supplements I and II should be checked.

d) The monthly precipitation patterns developed for the near average inflow year of 1971 should be expanded to show equivalent conditions for dry and wet years.

e) Rainfall intensities should be derived, particularly for tributary streams where little or no information is available.

No doubt, in attempting to answer the above questions in 1980 will indicate the need for additional stations which hopefully can be introduced at that time.

The long-term objectives are essentially those that measure climatic trends which may be apparent by the year 2000. These will consist of key stations which for the most part are in operation at the main population centres as well as some or all of the higher elevation stations recently introduced.

17.5 WATER QUALITY RECORDS AVAILABLE FROM STUDY

The stream and lake water quality station locations are shown in Figure 17.4 as well as outfall and flow estimate locations. The actual data are available in Technical Supplement IV in summarized form. Individual results are stored in B.C. Water Resources Service files.

The Water Quality monitoring initiated under the study was discontinued in the latter part of 1973 and with the exception of some detailed work undertaken by the British Columbia Water Resources Service as a separate study of the Wood - Kalamalka Lake areas and the day to day requirements of water management there is no ongoing water quality program in the Okanagan Basin today. It is recommended that such a program be re-activated at the earliest possible date in order to parallel the water quantity and climatic data monitoring which have been on a continuous basis since their inception.

17.5.1 Selection of Water Quality Monitoring Stations

Water quality monitoring stations can be classified as follows:

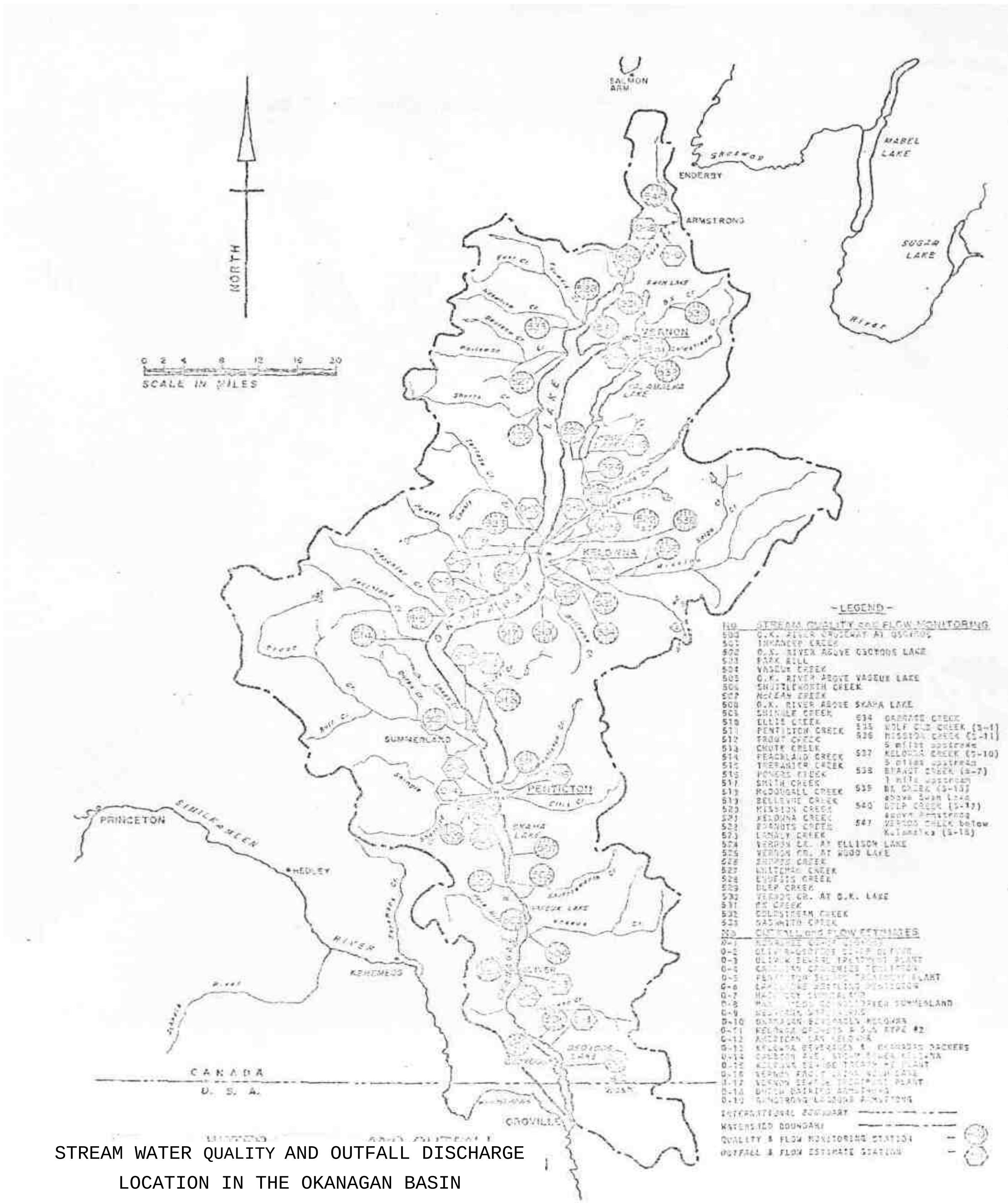
a) Waste treatment monitoring stations (Figure 17.4)
b) Tributary monitoring stations (Figure 17.4)
c) Main lake monitoring stations (Figure 17.4)
d) Dustfall and Precipitation Nutrient monitoring stations (Figure 17.5)
e) Septic tank groundwater monitoring (Figure 17.6)
f) Recreational beach monitoring

The waste treatment monitoring stations listed and shown in Figure 17.4 (Nos. 0-1 to 0-19) are part of the ongoing program of the Pollution Control Branch and no further implementation is required for this phase of the program.

The procedure with respect to the selection of tributary and main lake monitoring would be as follows:

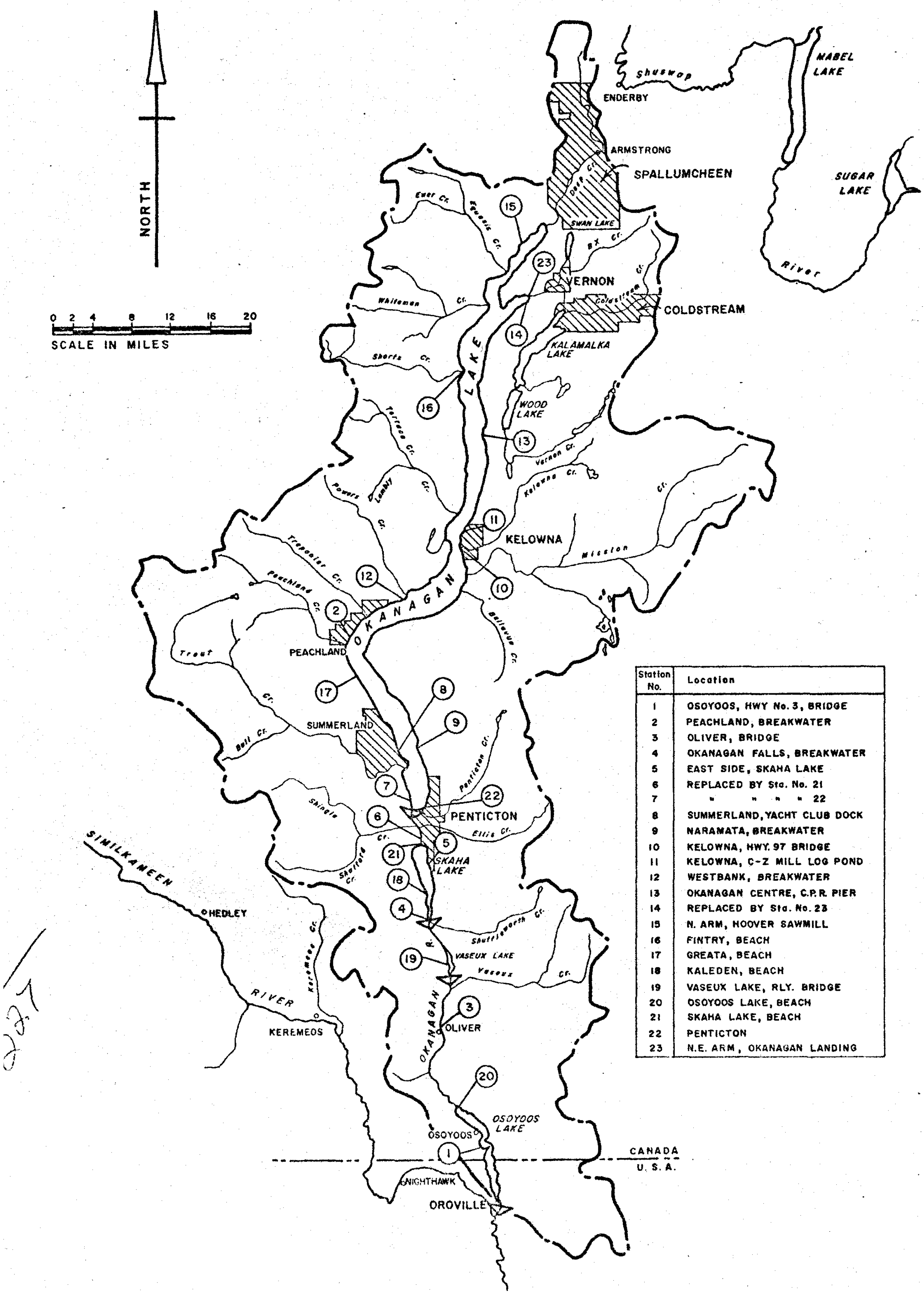
a) Careful examination of active hydrometric stations and the selection of these whenever suitable as water quality stations.

b) Additional water quality stations needed using wherever possible the same locations as the Federal Water Quality Stations enclosed at the end of



STREAM WATER QUALITY AND OUTFALL DISCHARGE
LOCATION IN THE OKANAGAN BASIN

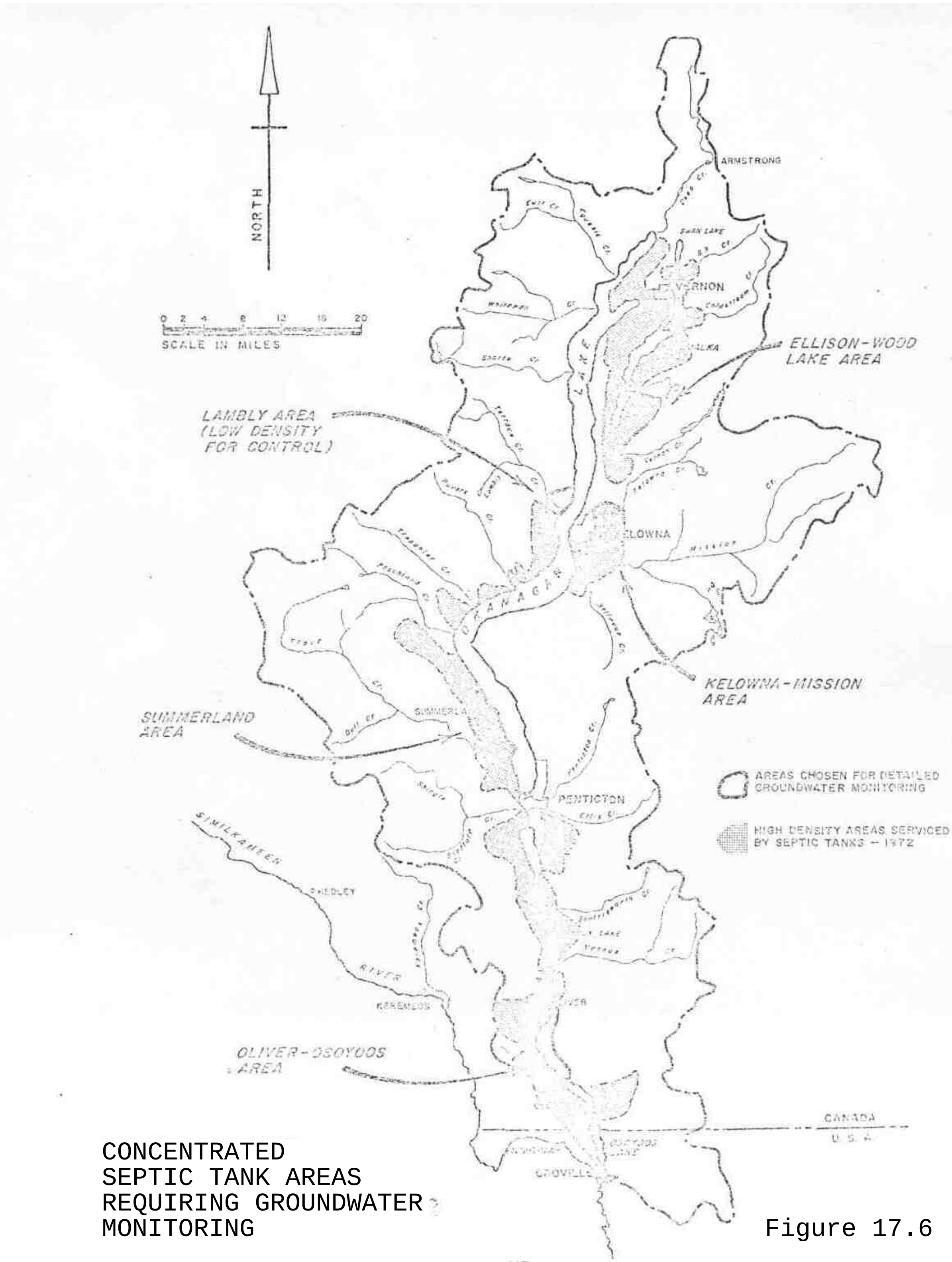
Figure 17.4



Station No.	Location
1	OSOYOOS, HWY No. 3, BRIDGE
2	PEACHLAND, BREAKWATER
3	OLIVER, BRIDGE
4	OKANAGAN FALLS, BREAKWATER
5	EAST SIDE, SKAHA LAKE
6	REPLACED BY Sta. No. 21
7	" " " 22
8	SUMMERLAND, YACHT CLUB DOCK
9	NARAMATA, BREAKWATER
10	KELOWNA, HWY. 97 BRIDGE
11	KELOWNA, C-Z MILL LOG POND
12	WESTBANK, BREAKWATER
13	OKANAGAN CENTRE, C.P.R. PIER
14	REPLACED BY Sta. No. 23
15	N. ARM, HOOVER SAWMILL
16	FINTRY, BEACH
17	GREATA, BEACH
18	KALEDEN, BEACH
19	VASEUX LAKE, RLY. BRIDGE
20	OSOYOOS LAKE, BEACH
21	SKAHA LAKE, BEACH
22	PENTICTON
23	N.E. ARM, OKANAGAN LANDING

DUSTFALL AND PRECIPITATION STATIONS LOCATIONS

Figure 17.5



CONCENTRATED
SEPTIC TANK AREAS
REQUIRING GROUNDWATER
MONITORING

Figure 17.6

this Chapter.

Thus, a number of the streamflow and water quality stations shown in Figure 17.4 may be retained, some deleted and others added.

The dustfall and precipitation nutrient monitoring stations are shown in Figure 17.5.

While indications are that this source is a relatively minor contributor of phosphates it would be desirable to re-establish a few of these stations and operate them at least to 1980.

Concentrated septic tank areas which are proposed for groundwater monitoring are shown in Figure 17.6. This will require a detailed examination of the ground water wells within the selected areas and some revision of such sampling after the early results have been analyzed. While such a program will not provide a quantitative measurement of phosphate and nitrogen input to ground water, it will provide an indication of any changes that are occurring.

Main beach areas should also be monitored with respect to health in accordance with the grid sampling method developed by this study.

17.6 CONCLUSIONS

The lack of adequate basic data in water quantity, climatology and particularly water quality at the start of this study has required that heavy reliance be placed on new station information collected during the past three or four years in the case of hydrology or only about two years in the case of water quality. Fortunately, the last three years have provided a wide range of hydrological events varying from drought conditions in 1970 to a record flood year in 1972.

With about 50 years of hydrometric records along the mainstem stream, flows are estimated to have an accuracy of ± 15% on an annual basis compared to ± 20% or greater in the tributaries where there is a serious lack of information. With the additional errors introduced in water quality sampling computed nutrient loadings can only be considered as first estimates and in some areas may be out by one order of magnitude.

While the new hydrometric and meteorological stations have been operated continuously since their inception the majority of the water quality stations were discontinued in 1973 after two or three years of record. Hence, one of the most urgent requirements at the present time is the re-establishment of a number of these stations at the earliest possible date. The same conditions also apply to the limnological and dustfall and precipitation nutrient monitoring stations.

Groundwater monitoring in heavily concentrated septic tank areas will proceed as outlined in Section 17.5.1 although the actual selection of wells for water quality sampling will require field inspection.

Apart from the monitoring described in this Chapter is the need for more detailed water quantity modelling operating over a weekly or even daily basis during the freshet period to more accuractly reflect the hydrology of the major tributaries. A similar addition is needed to the mainstem model in routing flows through Osoyoos Lake.

Better water quantity modelling will improve the estimate of nutrient inputs providing water quality sampling measurements are commensurate with water quantity measurements. In freshet periods this will probably require quality sampling of the major tributaries on a weekly basis. Initially, these detailed studies should be concentrated in those tributaries which have been recommended for multiple water use, namely:

Mission Creek
Equesis Creek
Trepanier Creek

Applied research should also be continued, particularly in the climatological field with respect to the following:

a) Relationship between precipitation, latitude and longitude in the Okanagan Basin.
b) Check on the estimated lake evaporation at Okanagan, Skaha and Osoyoos Lakes.
c) Extension of studies on lake evaporation versus elevation.
d) Probable monthly precipitation patterns over the basin for dry and wet years.
e) Rainfall intensity frequency curves for the major tributaries.

17.7 RECOMMENDATIONS

The body of the text of this Chapter contains a generalized description of a proposed monitoring program which will keep water quantity and quality in the Okanagan Basin under constant observation and evaluation. The following recommendations made at this time serve as guidelines in the establishment of a water quantity and quality monitoring program for the Okanagan Basin.

1) Hydrometric stations were established under the Study in eight selected tributaries which were most representative of the Basin as a whole. It is

recommended that these stations be operated continuously to the year 1980. At this time, as assessment of the program can be made with probable continuation of records to the year 2000. In combination with this program, it will be necessary to determine what additional headwater storage and diversion measurements will be required as well as any additional stream stations. It may be desirable to select those streams which are proposed for multiple water use for additional monitoring in the first instance.

2) It is recommended that the work of the monitoring program be applied to continuing research on the relationships between precipitation, latitude, longitude, elevation and lake evaporation.

3) Most Water Quality monitoring initiated under the study was discontinued in the latter part of 1973. It is recommended that a modified version of this program be re-activated at the earliest possible date in order to parallel the water quantity and climatic data monitoring which have been on a continuous basis since their inception.

4) It is recommended that a detailed groundwater quality monitoring program be carried out in areas where ground disposal of wastes are most concentrated.

5) It is recommended that key dustfall and precipitation stations be re-activated.

6) It is recommended that details of the above monitoring program be a joint effort by the Federal and Provincial agencies involved in order that wherever possible multi-purpose monitoring stations can be initiated with the intermediate objective of reviewing the program in 1980. In setting up such a program careful consideration should be given to the present day, intermediate and long-term objectives that are presented in the monitoring framework plan outlined in Table 17.1.

7) In the assessment of the monitoring program, careful study should first be made of existing records and on going stations as outlined in the following Figures and Tables.

   a) <u>HYDROMETRIC STATIONS – MAINSTEM</u>

      Figure 17.7 – Okanagan Basin Hydrometric Station Records Upstream Oroville, Washington.

      Figure 17.8 – Okanagan Basin Hydrometric Station Records Upstream Oroville, Washington.

TABLE 17.2

MEAN ANNUAL RUNOFF OF TRIBUTARY STREAMS

(Reference Figure 17.19)

	Sub-basin	Mean Annual Runoff (k.a.f.)	Percentage Distribution
1.	Testalinden Cr.	0.7	0.1
2.	Marron R.	1.1	0.2
3.	Wolfcub Cr.	1.7	0.2
4.	Irish	2.0	0.3
5.	Eneas	3.1	0.5
6.	McLean	3.5	0.5
7.	McDougall	4.4	0.6
8.	Naramata	5.9	0.9
9.	Park Rill	6.3	0.9
10.	Shuttleworth	6.7	1.0
11.	Deep	8.4 *=adjusted (UBC, (WRS, (Grid sq.	1.2
12.	Naswhito	12.6	1.8
13.	Peachland	12.9*	1.9
14.	Powers	13.1*	1.9
15.	Bellevue	15.1	2.2
16.	Ellis	15.3	2.2
17.	Kelowna	18.0*	2.6
18.	Shingle	20.2	2.9
19.	Equesis	21.1*	3.1
20.	Trepanier	28.0	4.1
21.	Vaseux	28.7	4.2
22.	Penticton	30.6*	4.5
23.	Shorts	32.6	4.7
24.	Whiteman	33.0	4.8
25.	Lambly	35.4	5.2
26.	Vernon	57.1*	8.3
27.	Trout	80.8*	11.8
28.	Mission	154.7*	22.5
	Sub-total	653.0	95.1
1.	Low Area 3	0.2	0.03
2.	Low Area 7	0.9	0.1
3.	Low Area 9	1.6	0.2
4.	Low Area 2	1.9	0.3
5.	Low Area 4	2.1	0.3
6.	Low Area 5	2.4	0.4
7.	Low Area 8	2.9	0.4
8.	Low Area 6	21.6	3.2
	Sub-total	33.6	4.9
	Total	686.6	100.0

Note: Taken from UBC Computer Output dated May 18, 1971.
"Natural (Virgin) Inflows in k.a.f." - average of 49 years (1921-69).

HYDROMETRIC STATION RECORDS OKANAGAN LAKE AND TRIBUTARIES - Part I

NO.	NAME	NOTES
BNM 83	Okanagan L. at Kelowna	
71	Okanagan L. at Penticton	7, 11
54	Trout Cr. near Faulder	
42	Trout Cr. near Summerland	
158	Trout Cr. at mouth	7
154	Camp Cr. at mouth near Thirsk	
133	Bull Cr. near Crump	
85	Darke Cr. at Meadow Valley	
23	Darke Cr. [illegible]	
55	Trout Cr. Summerland Diversion	
140	Peachland Cr. above diversions	
29	Peachland Cr. near Peachland	
33	Peachland Cr. [illegible]	
109	Peachland Cr. at mouth	7
41	Trepanier Cr. near Peachland	
155	Trepanier Cr. at mouth	7
13	[illegible] Cr. at mouth	
35	Powers Cr. above Westbank Diversion	
59	Powers Cr. below Westbank Diversion	
34	Powers Cr. Westbank Diversion	
127	Powers Cr. at mouth	7
44	[illegible] Cr. near [illegible]	
141	Lambly Cr. below Terrace Cr.	
58	Lambly Cr. near Kelowna	
3	Lambly Cr. near mouth	7
132	Lambly L. Diversion to Powers Cr.	
134	Terrace Cr. near Kelowna	
128	Esperon Cr. near Kelowna	
181	Shorts Cr. at mouth	7
46	Whiteman Cr. near [illegible]	7
47	[illegible] Cr. near [illegible]	
24	Equesis Cr. near Vernon	
182	Equesis Cr. near mouth	7
52	Irish Cr. near Vernon	
113	Deep Cr. at Armstrong	
25	Deep Cr. near Vernon (Sta. 3)	
155	Deep Cr. at mouth	7
177	Deep Cr. at Tower Rd.	7
213	McDougall Cr. [illegible]	
[illegible]	Peachland Cr. [illegible]	
227	Peachland L. near Peachland	10
221	Peachland L. [illegible]	10
219	Peachland Cr. [illegible]	10
222	[illegible] L. near Peachland	
199	Westbank Cr. at mouth	
[illegible]	Lambly Cr. above Terrace Cr.	
166	Lambly Cr. below [illegible] Cr.	
167	Lambly Cr. [illegible] Rose Valley L.	
174	Whiteman Cr. above [illegible] Cr.	
183	Whiteman Cr. at mouth	7
[illegible]	[illegible] Cr. near mouth	
172	[illegible] Cr. near mouth	
277	Peachland Cr. at Outlet of [illegible] L.	10

LEGEND

DISCHARGES Continuous Recording Gauge

Manual Gauge

STAGE Continuous Recording Gauge

Manual Gauge

Seasonal e.g.

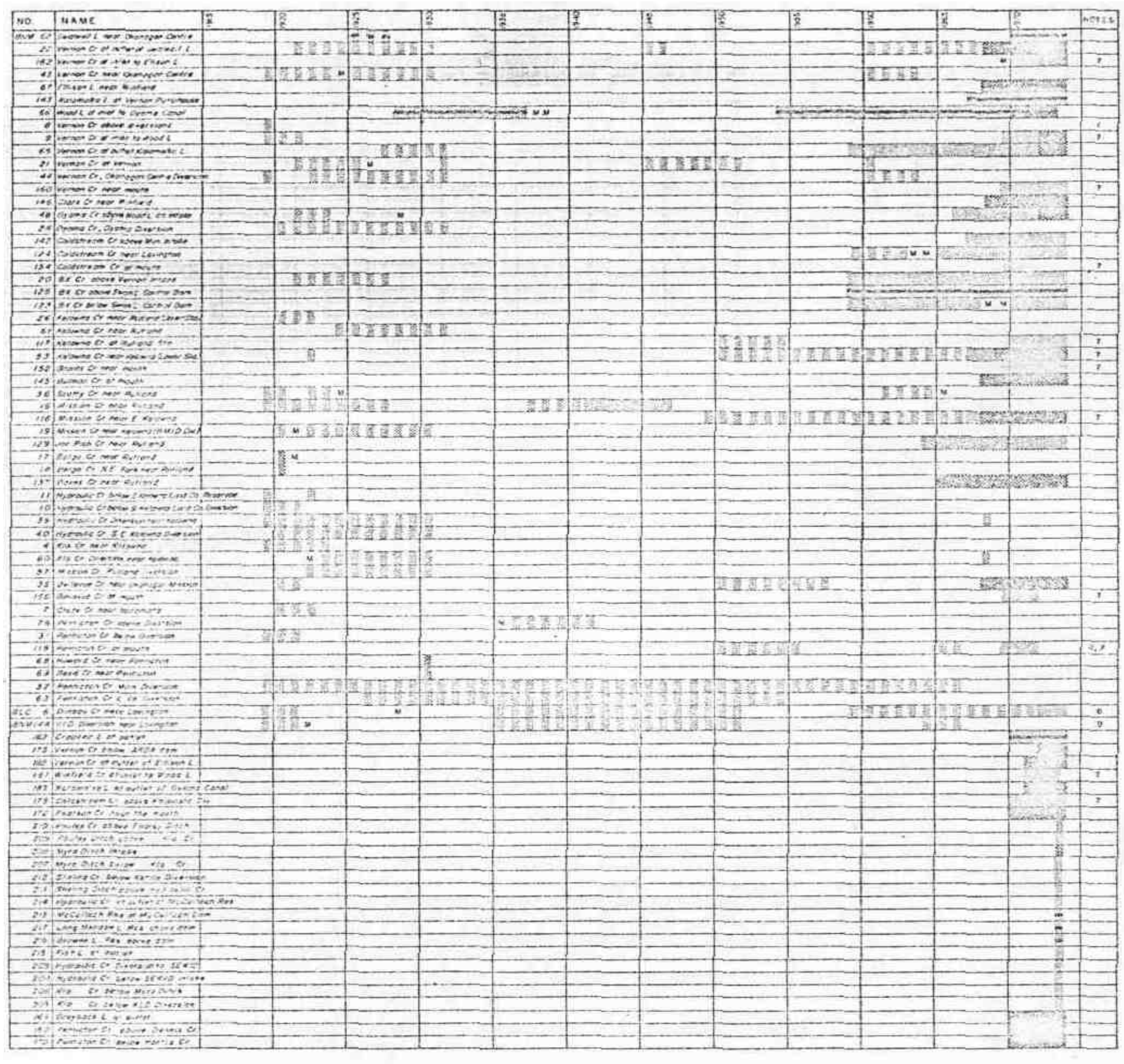
Miscellaneous Measurements M M M M M

NOTES

7 water quality data available
10 meter reading
11 telemetering device installed

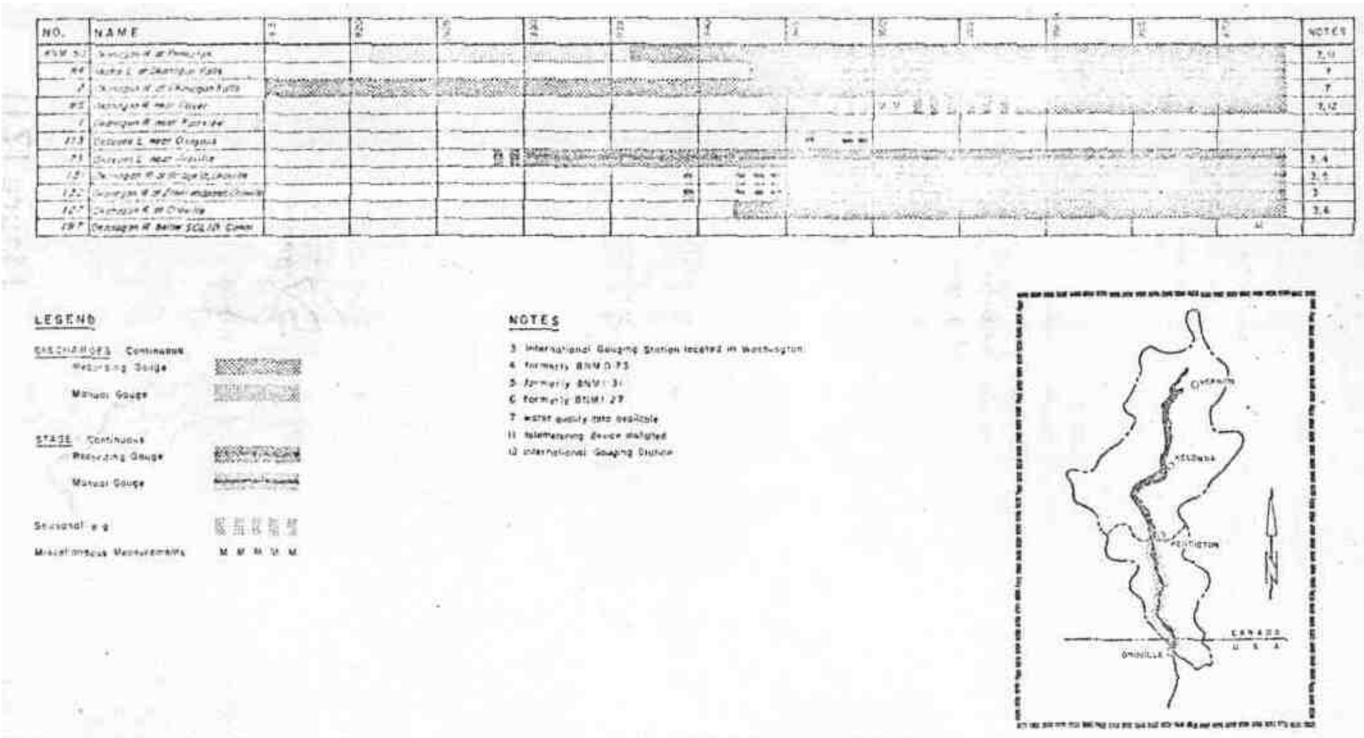
OKANAGAN BASIN HYDROMETRIC STATION RECORDS

UPSTREAM OROVILLE, WASHINGTON - Part 1		Figure 17.7

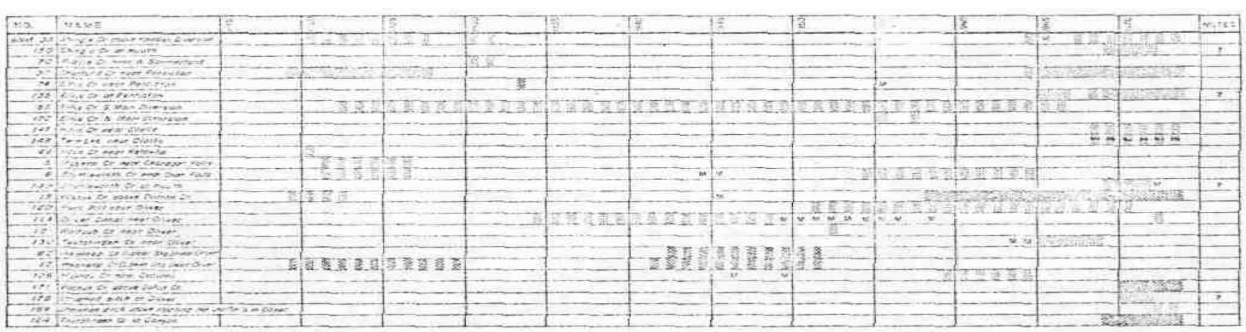


OKANAGAN BASIN HYDROMETRIC STATION RECORDS
UPSTREAM OROVILLE, WASHINGTON - PART 2

Figure 17.8

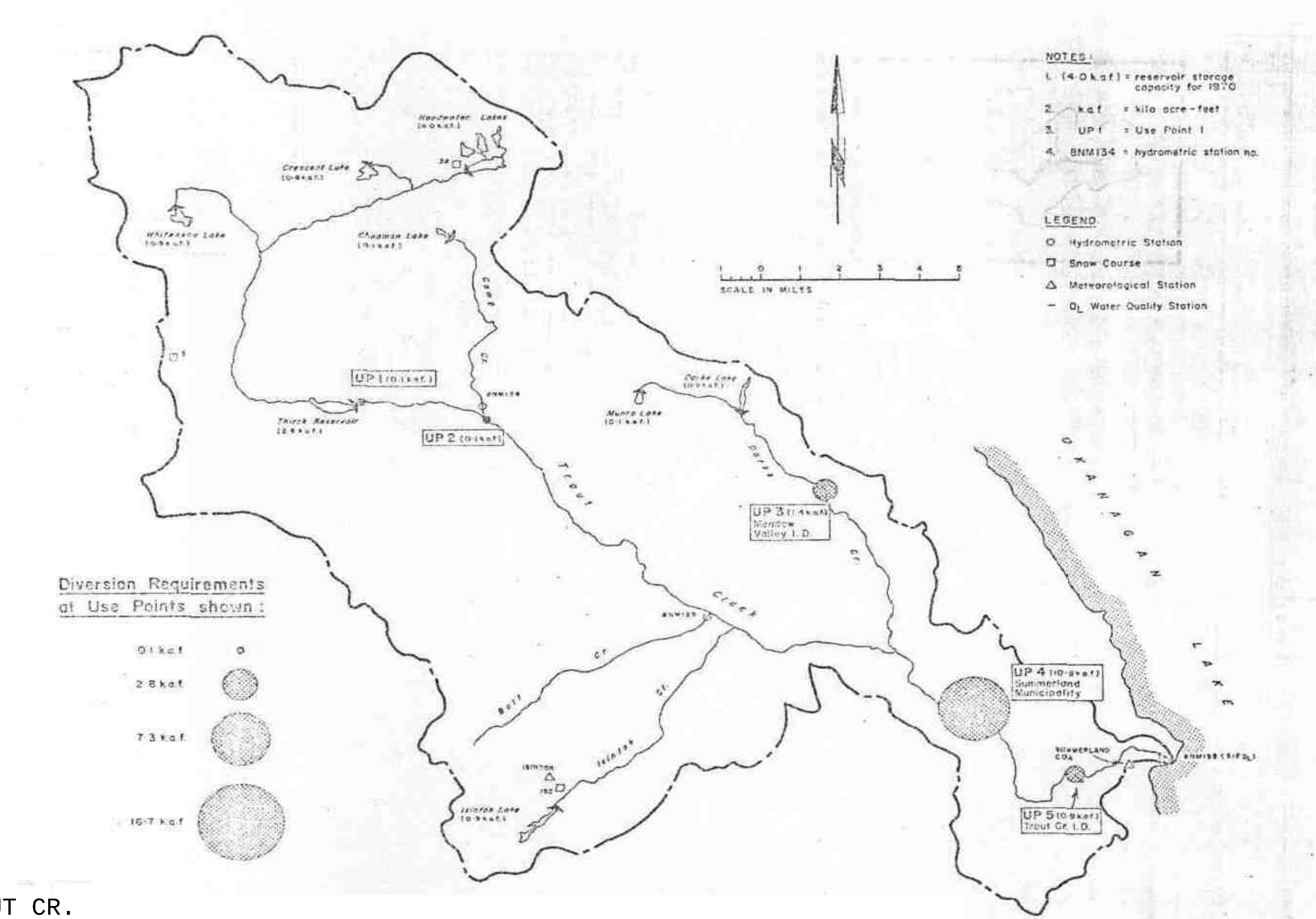


OKANAGAN BASIN HYDROMETRIC STATION RECORDS UPSTREAM OROVILLE, WASHINGTON-Part 3 Figure 17.9



OKANAGAN BASIN HYDROMETRIC STATION RECORDS UPSTREAM OROVILLE, WASHINGTON – Part 4

Figure 17.10

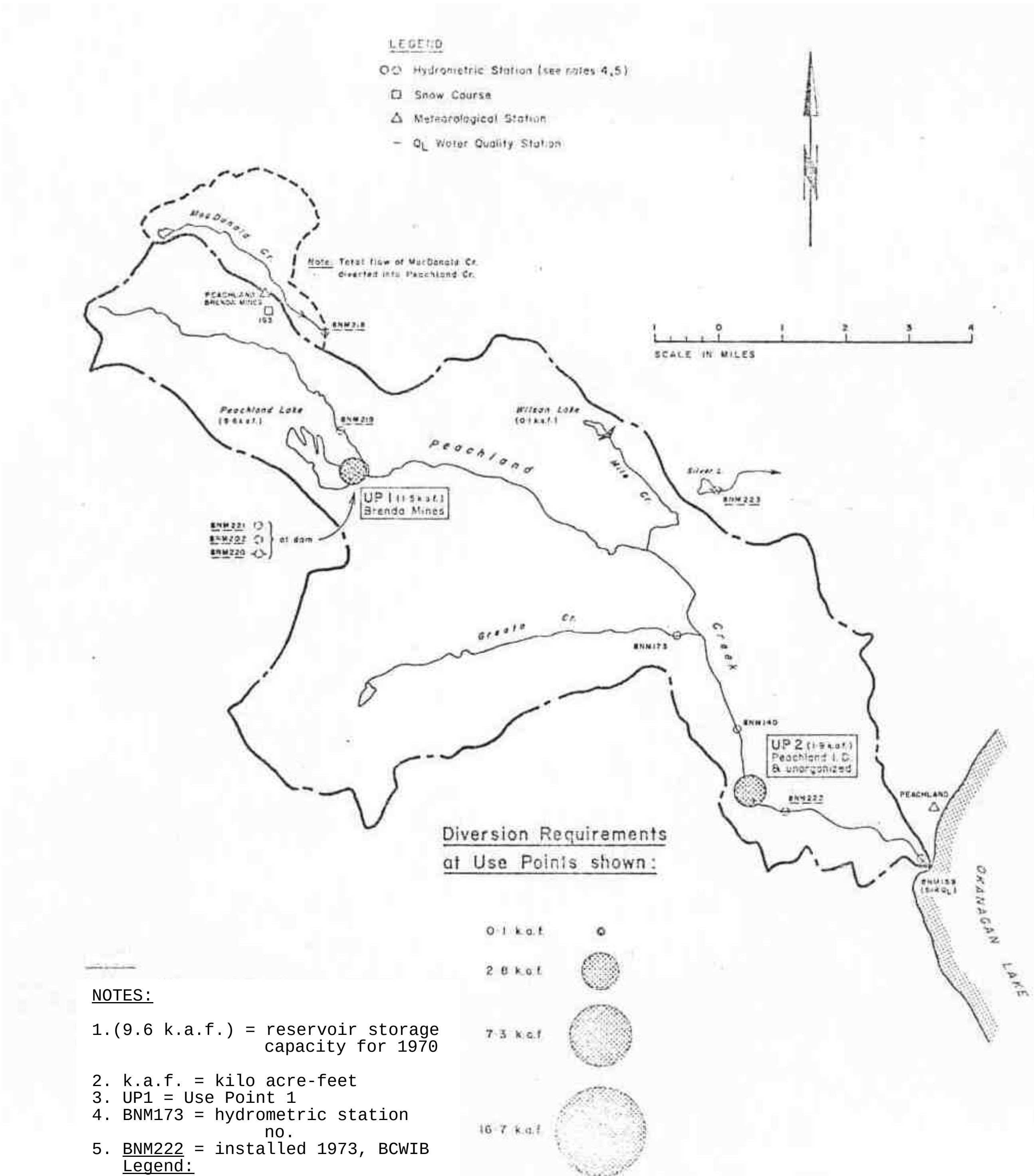


TROUT CR.

ANNUAL 1970 DIVERSION REQUIREMENTS AT USE POINTS

HEADWATER STORAGE CAPACITIES (as of 1970) HYDROMETEOROLOGICAL STATIONS (as of 1973)

Figure 17.11



NOTES:

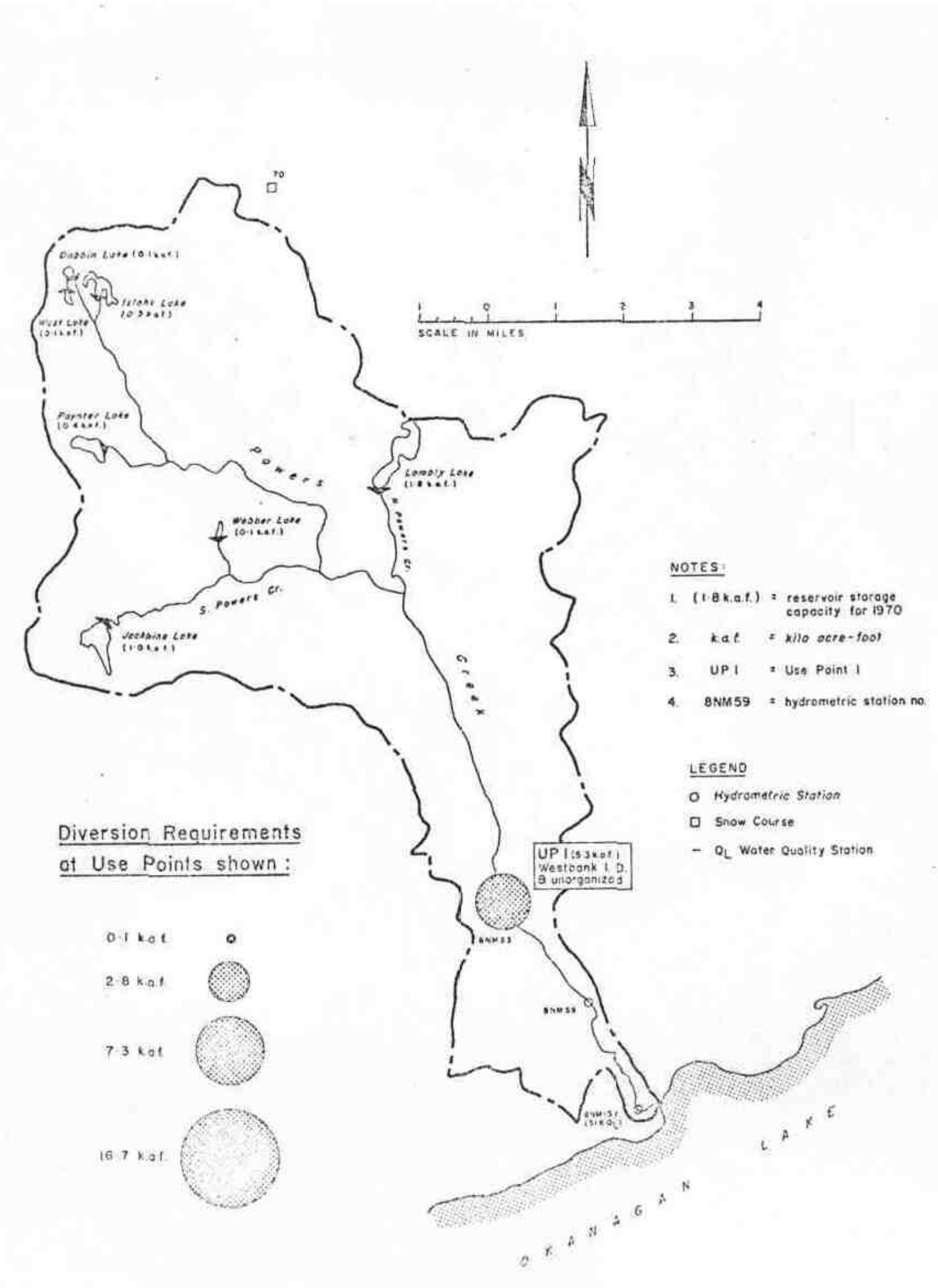
1.(9.6 k.a.f.) = reservoir storage capacity for 1970

2. k.a.f. = kilo acre-feet
3. UP1 = Use Point 1
4. BNM173 = hydrometric station no.
5. BNM222 = installed 1973, BCWIB
Legend:
0 discharge
-0- stage only
0 recorder

PEACHLAND CREEK - ANNUAL 1970
DIVERSION REQUIREMENTS AT USE POINTS

HEADWATER STORAGE CAPACITIES (as of 1970)
HYDROMETEOROLOGICAL STATIONS (as of 1973)

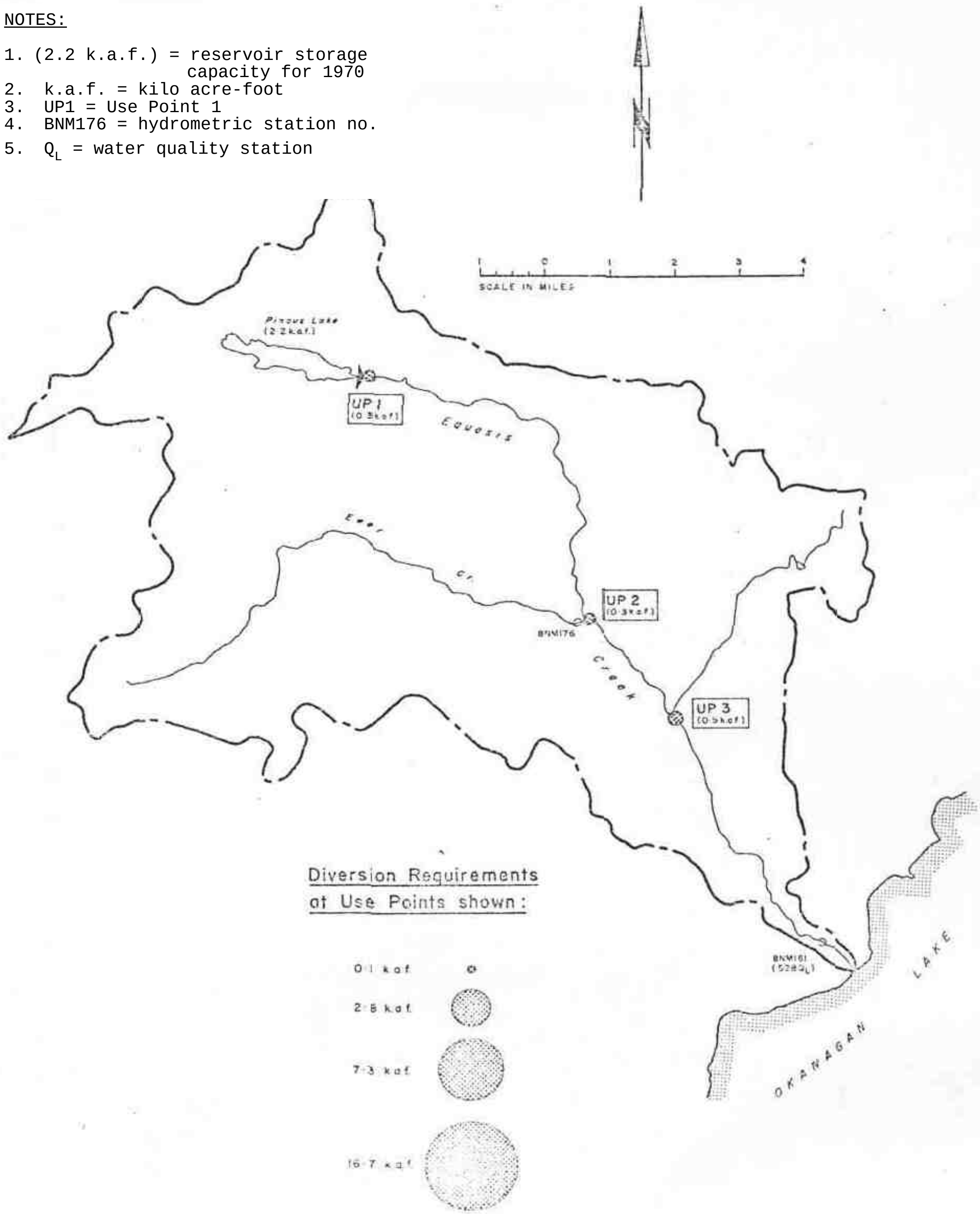
Figure 17.12



POWERS CREEK—ANNUAL 1970
DIVERSION REQUIREMENTS AT USE POINTS

HEADWATERS STORAGE CAPACITIES (as of 1970)
HYDROMETEREOLOGICAL STATIONS (as of 1973)

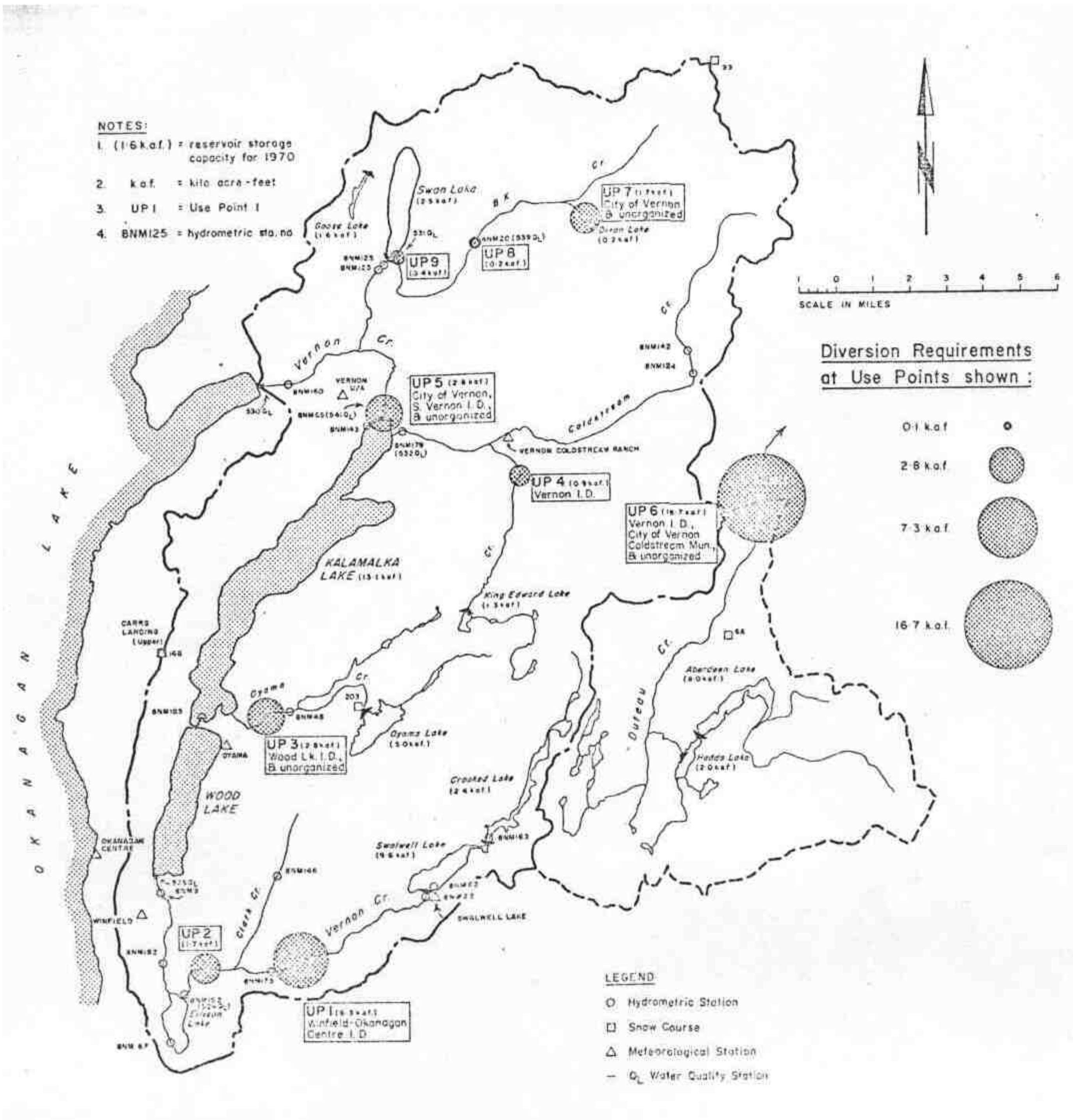
Figure 17.13



EQUESIS CREEK - ANNUAL 1970
DIVERSION REQUIREMENTS AT USE POINTS

HEADWATER STORAGE CAPACITIES (as of 1970)
HYDROMETEOROLOGICAL STATIONS (as of 1973)

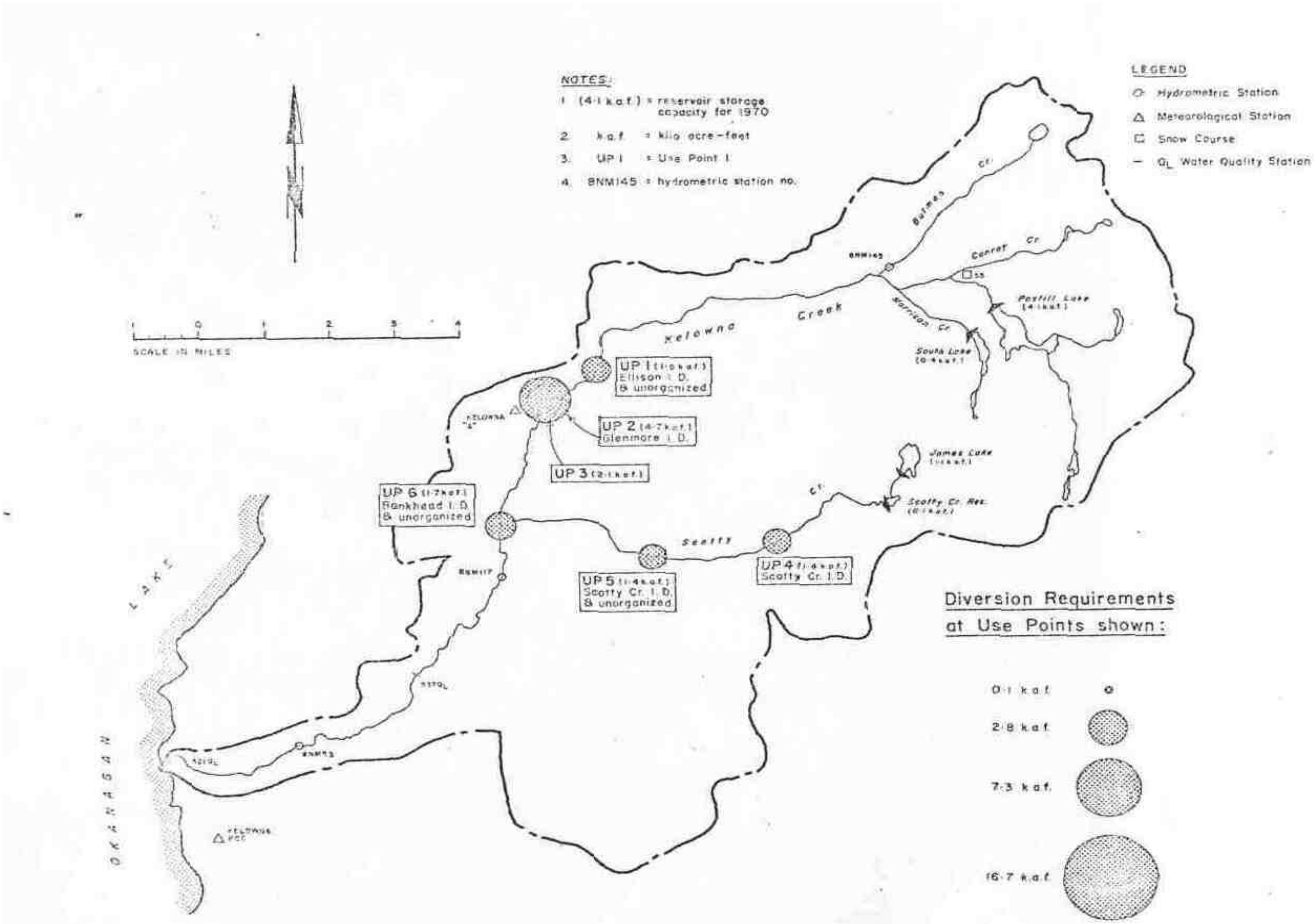
Figure 17.14



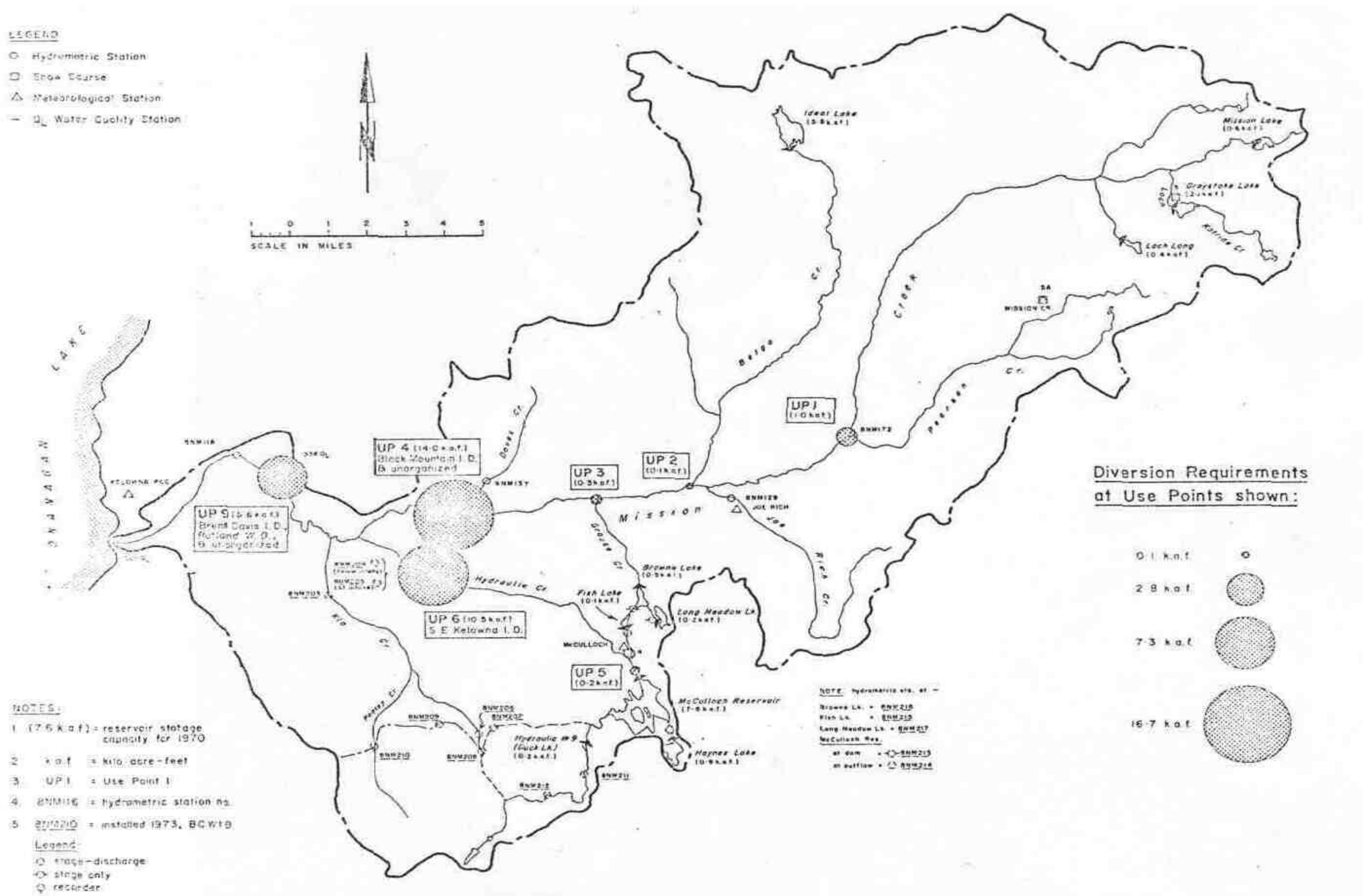
VERNON CREEK - ANNUAL 1970
DIVERSION REQUIREMENTS AT USE POINTS

HEADWATER STORAGE CAPACITIES (as of 1970)
HYDROMETEOROLOGICAL STATIONS (as of 1973)

Figure 17.15

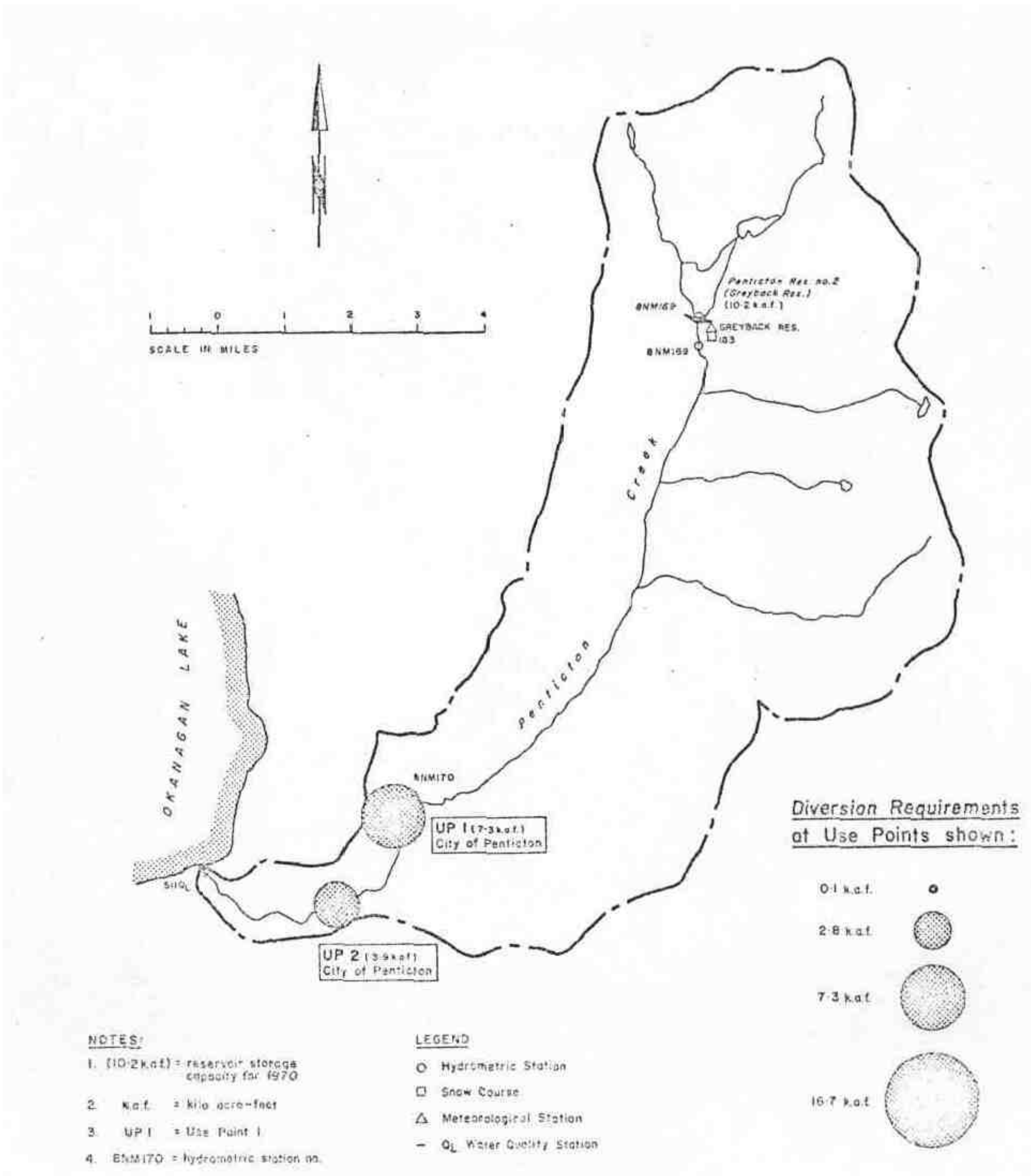


KELOWNA CREEK
ANNUAL 1970 DIVERSION REQUIREMENTS AT USE POINTS
HEADWATER STORAGE CAPACITIES (as of 1970) HYDROMETEOROLOGICAL STATIONS (as of 1973) Figure 17.16



MISSION CR.-ANNUAL 1970 DIVERSION REQUIREMENTS AT USE POINTS
HEADWATER STORAGE CAPACITIES (as of 1970) HYDROMETEOROLOGICAL STATIONS (as of 1973)

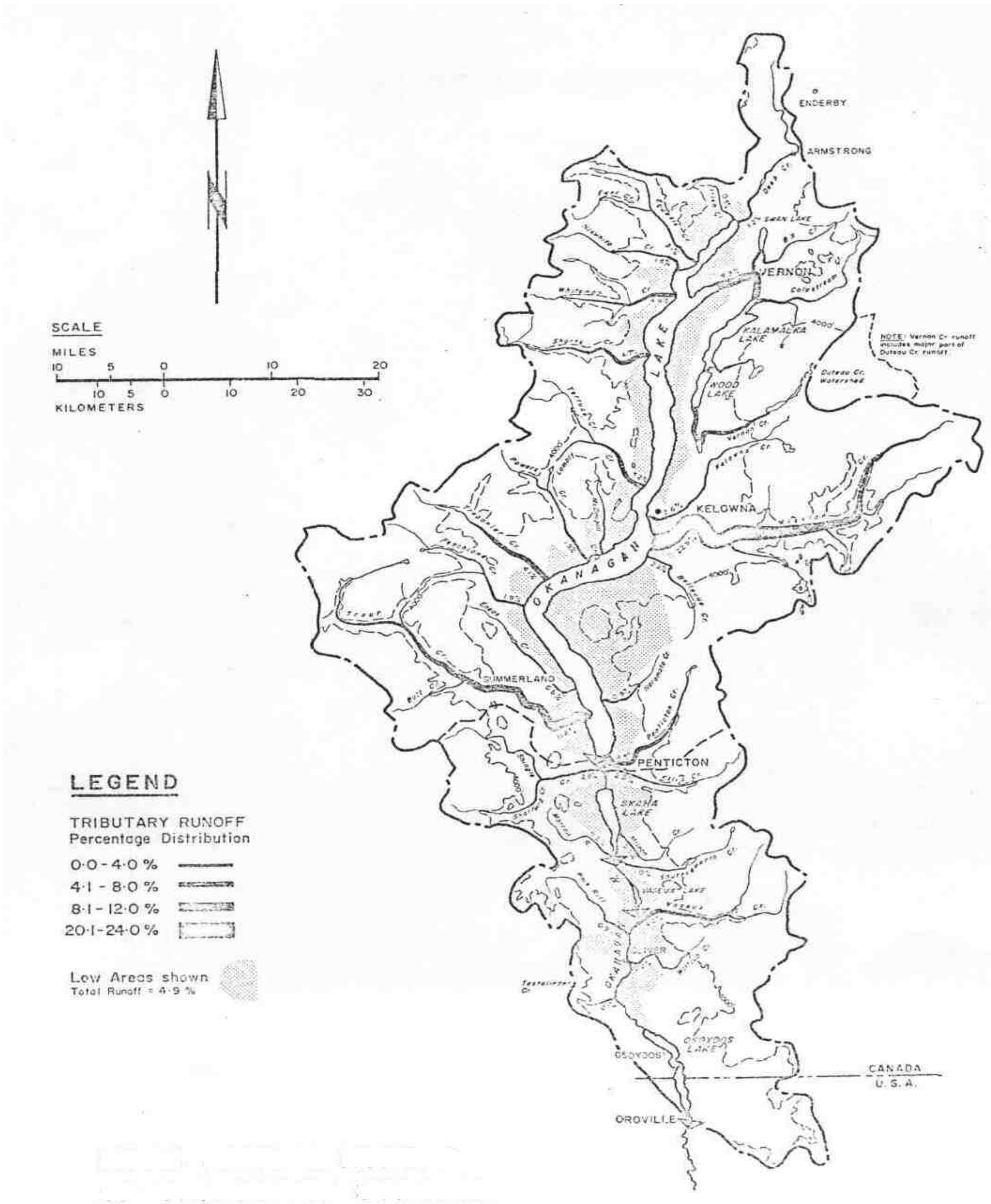
Figure 17.17



PENTICTON CREEK - ANNUAL 1970
DIVERSION REQUIREMENTS AT USE POINTS

HEADWATER STORAGE CAPACITIES (as of 1970)
HYDROMETEOROLOGICAL STATIONS (as of 1973)

Figure 17.18



MEAN ANNUAL RUNOFF
OF TRIBUTARY STREAMS
UPSTREAM OF OSOYOOS LAKE

Figure 17.19