

PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

Hon. R. G. WILLISTON, *Minister*

V. RAUDSEPP, *Deputy Minister of Water Resources*

REPORT
of the
WATER
RESOURCES
SERVICE

DECEMBER 31

1969

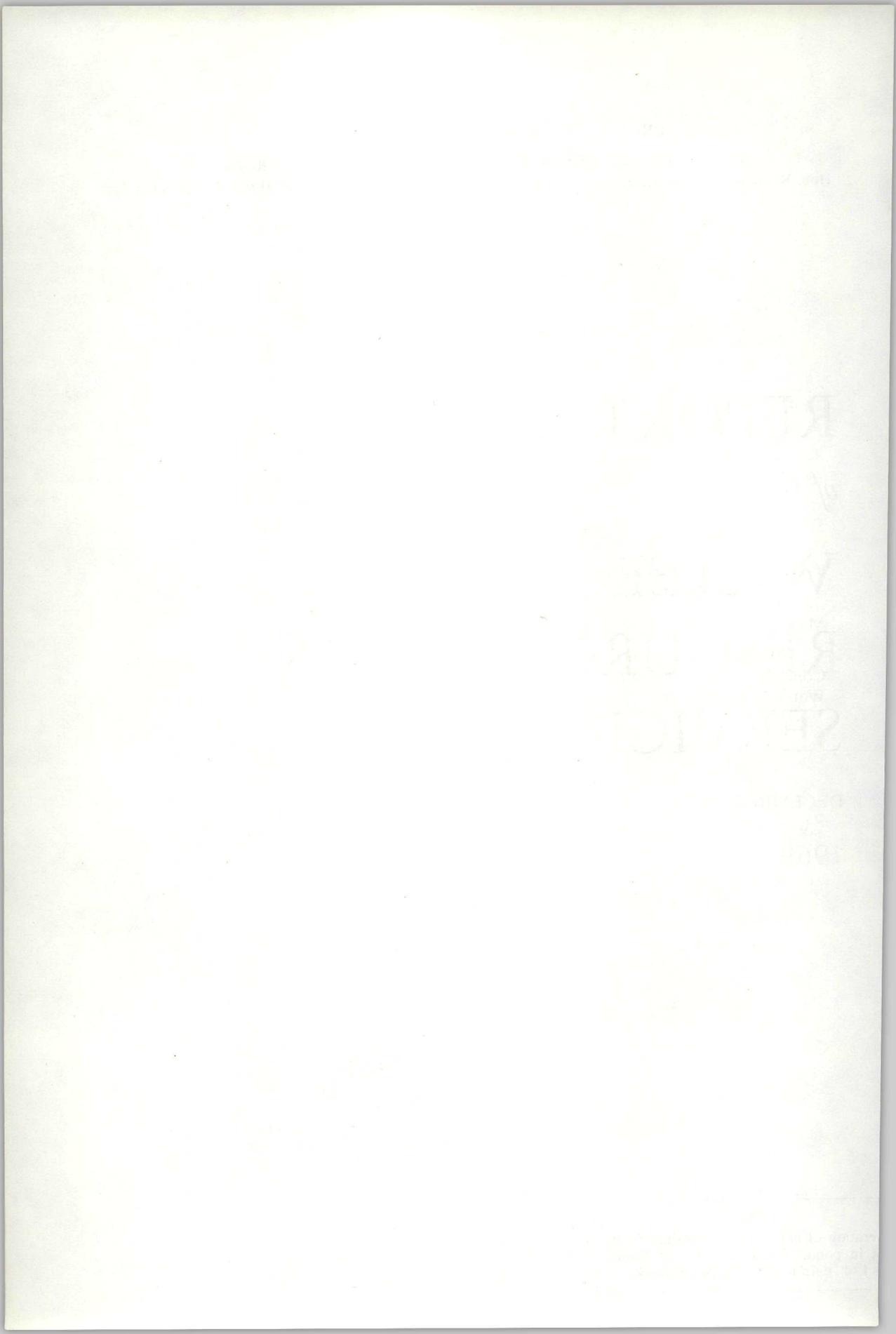


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1970

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VICTORIA, BRITISH COLUMBIA, February 11, 1970.

*To Colonel the Honourable JOHN R. NICHOLSON, P.C., O.B.E., Q.C., LL.D.,
Lieutenant-Governor of the Province of British Columbia.*

MAY IT PLEASE YOUR HONOUR:

Herewith I beg respectfully to submit the Annual Report of the British Columbia Water Resources Service of the Department of Lands, Forests, and Water Resources for the year ended December 31, 1969.

RAY WILLISTON,
Minister of Lands, Forests, and Water Resources.

VICTORIA, BRITISH COLUMBIA, February 11, 1970.

*The Honourable Ray Williston,
Minister of Lands, Forests, and Water Resources,
Victoria, British Columbia.*

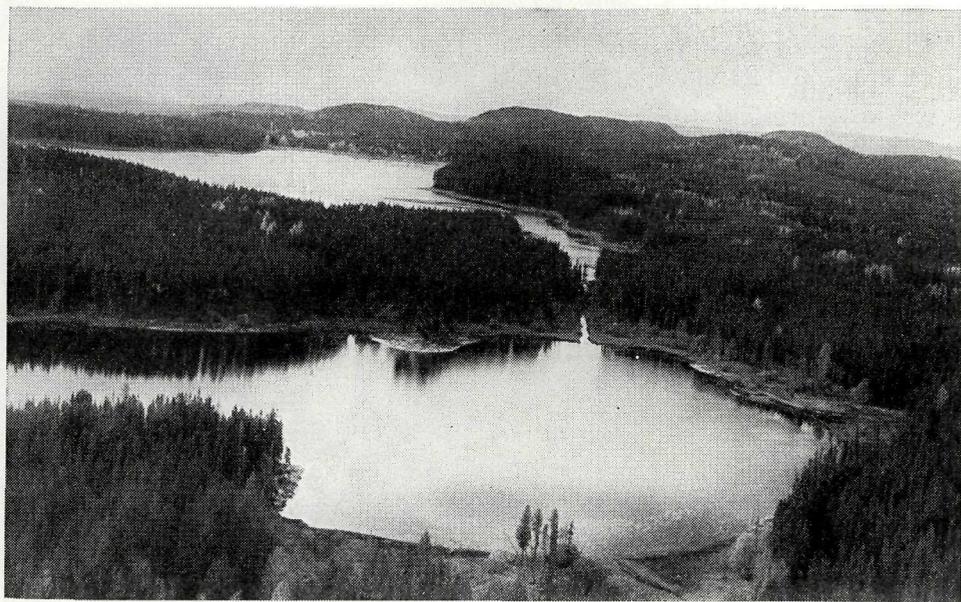
DEAR SIR,—I have the honour to submit the Annual Report of the British Columbia Water Resources Service of the Department of Lands, Forests, and Water Resources for the 12 months ended December 31, 1969.

V. RAUDSEPP,
Deputy Minister of Water Resources.

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McCulloch Reservoir: Main reservoir in background (Hydraulic Lake),
Minnow Lake in foreground; Southeast Kelowna Irrigation District.

BRITISH COLUMBIA WATER RESOURCES SERVICE

December 31, 1969

V. RAUDSEPP, *Deputy Minister.*

G. E. SIMMONS, *Assistant Deputy Minister.*

A. F. PAGET, *Consultant.*

F. S. MCKINNON, *Chairman, Pollution Control Board.*

WATER RIGHTS BRANCH

H. D. DEBECK, *Comptroller of Water Rights.*

A. K. SUTHERLAND, *Deputy Comptroller of Water Rights.*

WATER INVESTIGATIONS BRANCH

B. E. MARR, *Chief Engineer.*

T. A. J. LEACH, *Assistant Chief Engineer.*

POLLUTION CONTROL BRANCH

W. N. VENABLES, *Director.*

INSPECTOR OF DYKES OFFICE

W. R. MEIGHEN, *Inspector of Dykes.*

W. S. JACKSON, *Assistant Inspector of Dykes.*

SOUTHERN OKANAGAN LANDS PROJECT

L. A. PINSKE, *Supervisor.*

ACCOUNTING DIVISION*

M. B. MACLEAN, *Departmental Comptroller.*

PERSONNEL OFFICE*

K. M. HANSON, *Personnel Officer.*

MAIL AND FILE ROOM†

D. S. PRESTON, *In Charge.*

PUBLIC RELATIONS OFFICE

R. A. V. JENKINS.

* Services shared with Lands Service.

† Services shared with Lands Service and Forest Service.

WATER RESOURCES SERVICE

V. RAUDSEPP, P.ENG.
DEPUTY MINISTER OF
WATER RESOURCES

The Water Resources Service, being one of the three Services of the Department of Lands, Forests, and Water Resources, was created in 1962, and Mr. A. F. Paget, Comptroller of Water Rights, became the first Deputy Minister of the British Columbia Water Resources Service. Mr. Paget, after a distinguished career in British Columbia water administration, resigned due to ill health, effective April 1, 1969, and was appointed to the position of Consultant.

The Water Resources Service is in charge of the management of the British Columbia water resources. Under the *Department of Lands, Forests, and Water Resources Act*, the Deputy Minister of Water Resources has jurisdiction over all matters pertaining to the water resources of the Province.

The Water Resources Service is still undergoing development and expansion. It consists of three main Branches—(1) Water Rights Branch, which administers the control and use of surface water under the authority of the *Water Act* and supervises generally the administration of improvement districts which have been incorporated under the *Water Act*. The first *Water Act* was passed in 1909 after a gradual evolution from water-use regulations that originated from the *Gold Fields Act* of 1859. (2) Water Investigations Branch, which was formed in 1962, deals with technical water resources matters which are not directly connected with the administration of the *Water Act* or with the *Pollution Control Act, 1967*. (3) Pollution Control Branch, which administers the *Pollution Control Act, 1967*, was added to the Water Resources Service in 1965.

In addition to these three Branches, (4) the Pollution Control Board, under its Chairman, deals with pollution control standards and appeals from the decisions of the Director of the Pollution Control Branch; (5) the Inspector of Dykes is in charge of the *Dykes Maintenance Act*; (6) the Supervisor of Southern Okanagan Lands Project; (7) the Personnel Officer; (8) the Departmental Comptroller; and (9) the Mail and File Room, are carrying out their respective functions.

The spring of 1969 had good snow packs in the lower coastal and southern watersheds and well below-average snow accumulation in the central and northern regions. Flooding occurred in many of the smaller valleys in the southern Interior, resulting from the combination of heavy snow pack, local storms, and an early

period of hot weather. The worst such flood was at Trail, where damage exceeded a million dollars. The Province provided technical and financial assistance to the flood victims and the City of Trail.

All the Branches and officers of the Water Resources Service experienced increased activities in 1969 as a result of continuous expansion of the economy of the Province. The increased demand for water licences, pollution control permits, engineering and administrative advice and supervision, exceeded from time to time the capabilities of individual offices, and backlogs of incomplete assignments or outstanding applications showed an increase in all the three Branches. High staff-turnover rate in professional and draughting positions was also a factor contributing to the increase in unfinished assignments.

The Water Rights Branch received a total of 2,244 applications under the *Water Act*, of which some 1,500 were new water-licence applications. A total of 1,100 new licences were issued in 1969.

Technical advice on water matters to the general public and communities continued at a high rate through the Victoria and district offices. Supervision of dam construction and inspection of the existing structures from a public safety point of view was intensified.

The demand for electric energy in the Province showed in 1969 an over-all increase of approximately 8.8 per cent, based on preliminary hydro and thermal general statistics. The British Columbia Hydro and Power Authority experienced an annual load growth of 11 to 12 per cent in 1969.

The Peace River power development has now five of its ultimate ten units totaling 2.3 million kilowatts installed, bringing the total Provincial hydro-electric installed capacity slightly over 4 million kilowatts. The total thermal capacity is 1.3 million kilowatts, giving an aggregate British Columbia electric generating capacity of 5.3 million kilowatts.

The developments under the Columbia River Treaty included the continuing co-ordination of Libby Reservoir preparation, which activities must be completed by 1972. Arrow Lakes dam was officially dedicated as Hugh Keenleyside Dam in June.

Implementation of the Federal-Provincial Fraser River Flood Control Agreement, which was signed in May, 1968, continued and tenders for the first project will be called in early 1970. A Federal-Provincial agreement for Okanagan Basin study was signed in October.

The Water Investigations Branch continued to be in charge of ARDA water projects programme. The total cost of the approved projects is \$26 million, of which \$20.5 million has actually been expended.

Co-operation with the University of British Columbia and the B.C. Research Council was continued with an aim to intensify teaching and interdisciplinary research programmes involving water resources. Hydrological research is also being continued by the staff members of the Water Investigations Branch and other outside consultants.

A number of stream-improvement proposals or projects received attention. Potential hydro-electric power studies in the northern portion of the Province are continuing, with an emphasis on the Liard River.

The Pollution Control Board completed its air-pollution study and forwarded recommendations to the Cabinet. Effluent treatment standards received consideration.

The Pollution Control Branch staff was substantially strengthened and its internal reorganization and interdepartmental lines of communication received further refinement. The Director received 162 applications for pollution control permits and

issued 59 permits. Studies are continuing on the existing effluent and waste discharges with an aim to bring these under permit as soon as possible.

Mr. C. J. Keenan, Director of Pollution Control, in charge of the Pollution Control Branch, resigned, and was replaced by Mr. W. N. Venables, who had occupied the position of Assistant Director, effective September 1st.

A more detailed description of activities is given in the reports of separate Branches and offices, which follow.

CONSULTANT

A. F. PAGET, P.ENG., CONSULTANT

This office was created on April 1, 1969.

Work went forward on the Kootenay Lake Board and agreement was reached to use a modified formula to compute discharges in future years.

Meetings were held and agreement was reached to prepare a report to the United States and Canadian Governments by the Board of Engineers, Columbia River Treaty, on the operation of the Columbia River Treaty.

The Consultant served on a special committee relative to the flood damages in Trail caused by creek flooding. Approximately 1 million dollars was raised and paid out for individual damages. A report was prepared for the committee by Mr. T. H. Oxland, Water Rights District Engineer, setting out the corrective measures to prevent further flooding. This report was given to the Government.

The Consultant acted with the Lands Service to see if remedial action could be taken to protect the cliffs around the University of British Columbia.

Many meetings were held and discussion took place on subjects relating to power.

The first part of the paper discusses the general principles of water treatment, including the importance of maintaining a high level of disinfection to prevent the spread of waterborne diseases.

The second part of the paper describes the various methods used for water treatment, such as coagulation, flocculation, sedimentation, and filtration, and discusses the advantages and disadvantages of each.

The third part of the paper discusses the importance of maintaining a high level of disinfection to prevent the spread of waterborne diseases, and describes the various methods used for disinfection, such as chlorination, ozonation, and ultraviolet radiation.

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WATER RIGHTS BRANCH

The Water Rights Branch is the agency of the Provincial Government which administers the control and use of surface water under the authority of the *Water Act*.

The main principles of the *Water Act* regarding the use of water are:—

- (1) The property in and the right to the use and flow of all the water at any time in any stream in the Province are for all purposes vested in the Crown in right of the Province. The common-law principle of riparian water right has been abolished.
- (2) Licence-holders have a right to the use of water under the terms and conditions of the water licence issued by the Comptroller of Water Rights. Earlier licences have priority over licences issued later.
- (3) Retention of a water licence is dependent upon the beneficial use of the water, payment of the water-licence rentals, and observance of the regulations of the *Water Act*.
- (4) A water licence is generally made appurtenant to a parcel of land, mine, or undertaking, and it will pass with any conveyance or other disposition thereof.
- (5) If it is necessary that a water licensee construct works on another person's land, he can expropriate the land reasonably required if a voluntary agreement cannot be reached. If the works will be on Crown land, the water licensee may acquire a permit to occupy Crown land for such purpose.

The second major function of the Water Rights Branch is to generally supervise and assist the administration of the improvement districts which have been incorporated under the *Water Act* for irrigation, waterworks, drainage, dyking, street-lighting, fire protection, and several other purposes. An improvement district is a self-governing public corporate body administered by elected trustees. The undertaking of an improvement district can be financed by Provincially guaranteed debenture issues.

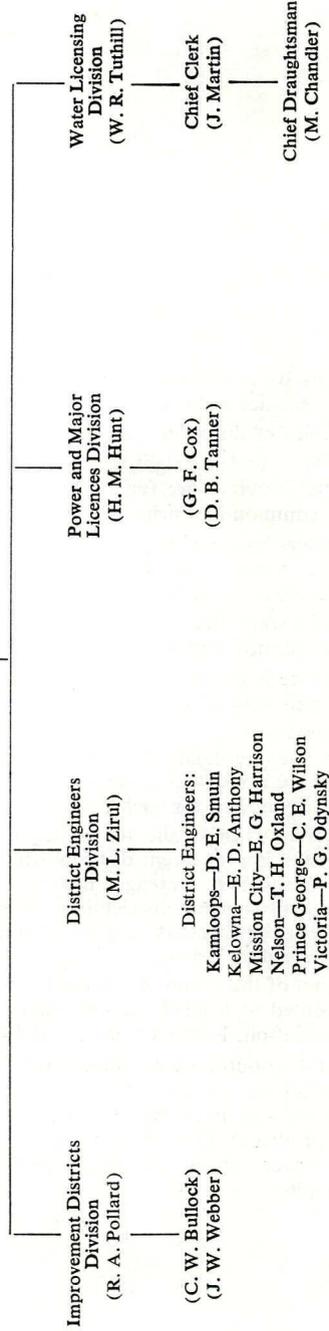
The administration of the *Water Act* is carried out by the Comptroller of Water Rights and his staff, who are located at a headquarters office in Victoria and district offices at Victoria, Kamloops, Kelowna, Nelson, Prince George, and Mission City.

Water is a natural resource which often has a controlling influence on economic development of other resources and, therefore, is in competitive demand by the utilizers of other resources. Much of the vast industrial expansion presently occurring in this Province is associated with the use of British Columbia water. A large number of communities have been incorporated into improvement districts under the *Water Act* to operate community projects and provide essential amenities.

ORGANIZATION CHART OF THE WATER RIGHTS BRANCH, YEAR ENDED DECEMBER, 1969

Comptroller of Water Rights
(H. D. DeBeck)

Deputy Comptroller of Water Rights and Departmental Solicitor
(A. K. Sutherland)



WATER RIGHTS BRANCH

H. D. DEBECK, P.ENG.
COMPTROLLER OF WATER RIGHTS

The Water Rights Branch is responsible for the administration of all use of water in British Columbia under the provisions of the *Water Act*. For this purpose a licensing system has been developed over the course of the last century, from its origin in the *Gold Fields Act* of 1859 through a gradual evolution to the first *Water Act* of 1909 and on to the present *Water Act*. In addition to providing for the administration of water use, the *Water Act* also provides for the incorporation of improvement districts which provide local services in water-related and other fields. The Water Rights Branch also carries out a great number of engineering studies on water matters, including water supply, erosion, and flood protection. The capital undertakings of improvement districts are given careful scrutiny, both with regard to economic feasibility and engineering adequacy, and some engineering services are provided to improvement districts and to groups proposing to organize districts for water-supply purposes. During 1969 a large number of water-supply feasibility studies were carried out, and final design and supervision of construction were provided to improvement districts by both headquarters and district engineering staff.

In terms of water supply, the year 1969 was noteworthy for serious flooding conditions on many of the smaller streams in the southern Interior of the Province. These floods resulted from the combination of a heavy snow pack, local storms, and an early period of unusually hot weather. The worst such flood was that on Trail Creek, which passes through the City of Trail, where damage to property exceeded a million dollars. The staff of Water Rights Branch district offices was called upon in many instances to investigate causes of floods and recommend measures to guard against recurrence of flood damage.

In the field of water licensing, activity continued at a high level during 1969. Although the total of new applications received was less than the record of 1,624 new applications in 1968, it was still nearly 10 per cent above the total for the highest previous year. Because of a shortage of engineering staff in the district offices, which exceeded 25 per cent for most of the year, it was not possible to carry out the necessary field investigations for the flood of applications received in 1968 and 1969. As a result, the number of applications outstanding reached a new high of 2,400 at the end of November. This represents a serious reduction in the standard of service to the public and it is to be hoped that the availability of staff in 1970 will be sufficiently improved to permit a substantial reduction in the number of outstanding applications. Because water licences, once issued, are permanent, all applications are carefully investigated, both on the ground and through the office record system. Since no corners can be cut in carrying out this work, there is little flexibility in dealing with an increased work load in this most important phase of water resource administration.

The Improvement Districts Division continued to be active during the year. Ten new improvement districts were incorporated and 14 were dissolved, mostly for the purpose of amalgamation with other districts or incorporation as municipalities under the *Municipal Act*. Boundary extensions were authorized by Order in Council for many districts. The number of improvement districts in existence at the end of 1969 was 300.

The Improvement Districts Division also carried out feasibility studies for a number of proposed water-supply systems and provided final design and supervision of construction for several projects under which improvement district water systems are being rehabilitated with the assistance of the Federal and Provincial Governments under the *Agricultural Rehabilitation and Development (British Columbia) Act*. The engineering and economic feasibility of water-supply projects being undertaken by improvement districts was also studied by this Division.

The Power and Major Licences Division continued to be occupied during the year with work associated with approval of plans and other aspects of the Columbia River Treaty projects and other major power projects in the Province. Work was completed during the year on the Arrow Lakes project, which had been declared operational late in 1968 and was formally opened on June 9, 1969. Construction work on Mica Dam reached full scale in 1969 and will continue at a high level for several years. At the Peace River project, units 4 and 5 were placed in service, bringing the installation up to half its ultimate capacity, and contracts were let in 1969 for units 6, 7, and 8. Lake Williston, the reservoir, continued to fill and reached elevation 2,143 feet, which is 67 feet below full pool. Filling was slow during 1969 because of a very low inflow and high demand for power. Construction commenced during the year on the Jordan River project, at which the plant is being rebuilt for peaking service.

The preparation of the Canadian portion of the Libby Reservoir is being carried out by several departments of the Government of British Columbia. The Water Resources Service has been assigned a co-ordinating role in this work, both with respect to the departments directly involved and those with interests in the results of the project. Liaison is also carried out with the United States authorities. Staff work on this project is being provided by the Power and Major Licences Division.

Because of the wide seasonal variation in stream flows in British Columbia, the storage of water is one of the most significant features of water management in the Province. About 600 storage dams are now under licence in British Columbia. In some circumstances, such dams are capable of imposing a severe hazard to life and property, particularly in the mountain valleys of British Columbia. For this reason a programme of inspection of storage dams is carried on based on the powers of the engineer and the Comptroller under the *Water Act*. This programme is divided between the staff of the district offices and the headquarters staff of the Power and Major Licences Division.

Technical services were supplied to support the Provincial representative on the Columbia River Treaty Permanent Engineering Board and the Canada-British Columbia Columbia River Liaison Committee and its advisory subcommittee.

The year 1969 was marked by a large number of staff changes, most of which involved engineering staff. In the district offices, Mr. R. J. Talbot left his position as District Engineer at Kelowna to become Programme Director for the Fraser Valley Joint Programme Committee, and was replaced by Mr. E. D. Anthony, who had been Assistant District Engineer at Kamloops. Mr. F. Mueller left his position on the engineering staff of the Mission office and Mr. S. B. Carroll and

Mr. W. M. Cheney left the engineering staff of the Kelowna office at the end of 1969. Engineering staff vacancies in the district offices were filled by Mr. H. Van Camp at Kamloops, Mr. J. M. Anderson at Prince George, and Mr. L. R. Lewis at Nelson. At the end of the year there were four engineering vacancies in the district offices, one more than at the end of 1968.

In the Victoria engineering staff, Mr. P. J. Leslie resigned as Chief of the Improvement Districts Division and was replaced by Mr. R. A. Pollard, who transferred from Water Investigations Branch; Mr. J. W. Ngai transferred from the Power and Major Licences Division to Water Investigations Branch, and Mr. N. I. Cross resigned from that Division to return to England.

Mr. E. J. Folwell retired as Administrative Officer in the Improvement Districts Division and has not yet been replaced.

The activities of the Water Rights Branch for 1969 are recorded in greater detail in the reports of the separate divisions of the Branch in the following pages.

WATER LICENSING DIVISION

W. R. Tuthill, Chief of Division

The Comptroller of Water Rights administers the *Water Act*, under which rights to the diversion of water within the Province are granted for almost every conceivable use. Licences are issued for domestic, waterworks, irrigation, mining, industrial, power, storage, and other purposes. Licences are required, with few exceptions, before any person, company, corporation, community, or government agency uses water from any surface-water source.

The Licensing Division is responsible for the processing of new applications for licences and amendments to existing licences. In order to maintain complete records, the Division is divided into two offices—the General Office, which handles the clerical aspects of licensing, and the Draughting Office, which handles the mapping requirements. These offices are responsible for maintaining the many files, indexes, maps, and other records required for the orderly processing of new and pending applications and keeping track of the rights granted under existing licences and amendments thereto. Close liaison is required with the District Engineers Division and its six district offices, situated at strategic locations in the Province, for field investigations and reports on applications and amendments.

Applications for water licences were down slightly from the 1968 record. However, the number of applications pending increased by some 300. The number of licences issued remained almost constant.

Several changes in routine were initiated in the General Office to speed up the application procedure. Changes were also made in the Draughting Office in order to give additional emphasis to updating of water-rights maps.

The main functions and details of activities for 1969 of the General and Draughting Offices are contained in their reports, which follow.

GENERAL OFFICE

Although the number of new applications for water licences has fallen off somewhat from the record total for 1968, staff shortage in our district offices have reduced the number of reports on applications received by us, and, as a result, the number of applications pending has increased over the 1968 figure of 2,019.

The implication, contained in our 1968 report, that the number of new applications had a bearing on the number of objections received does not appear to be correct, as with a reduced number of applications we have had an increased number

of objections. Many of these objections are to a few very controversial applications and it is of interest to note that many objectors are basing their objections on possible pollution grounds rather than on matters which come under the jurisdiction of the Comptroller of Water Rights.

No particular new trends are discoverable from this year's final figures. Applications for licences to authorize the use of water on subdivisions and for various mining purposes continue to arrive at a rate comparable with previous years, and liaison is maintained with the Public Utilities Commission and with the Mines Reclamation Committee where applicable.

A number of licences for the Creston Valley Wildlife Management Area Authority are being processed, and the issue of these in the near future should enable the Authority to make an early start on its conservation projects in the Kootenay River Valley, near Creston.

Staff changes in the General Office have been fewer than in recent years, there having been two staff members promoted and transferred to other sections of the Branch, two promotions within the General Office, one transfer from another department, and one resignation. Two new members have joined the staff. The present establishment of the General Office comprises one Clerk 7, two Clerks 5, three Clerks 4, three Clerks 3, two Clerks 2, two Clerks 1, one Clerk-Stenographer 3, one Clerk-Stenographer 2, and one Clerk-Typist 2.

The principal activities of the General Office in the 12-month period ended December 31, 1969, are shown in the following table, together with the same data for the five preceding years:—

	1964	1965	1966	1967	1968	1969
Applications for—						
Licences.....	1,119	1,277	1,333	1,386	1,624	1,503
Rights-of-way.....	207	273	259	271	339	227
Apportionments.....	47	68	65	82	73	75
Transfers of appurtenancy.....	72	90	112	92	97	119
Change of works.....	306	329	367	317	324	270
Approvals.....	40	44	32	37	40	50
Totals.....	1,791	2,081	2,168	2,185	2,497	2,244
Average monthly applications.....	149	173	181	182	208	187
Changes of address, ownership, etc.....	2,274	2,348	2,144	2,884	2,921	2,701
Cancellations and abandonments.....	258	350	254	267	296	399
Totals.....	2,532	2,698	2,398	3,151	3,217	3,100
Conditional licences issued.....	1,026	1,034	1,163	1,122	1,127	1,103
Final licences issued.....	422	415	543	612	405	444
Totals.....	1,448	1,449	1,706	1,734	1,532	1,547
Rights-of-way issued.....	297	333	338	333	347	356
Approvals disposed of.....	28	38	25	27	30	45
Totals.....	325	371	363	360	377	401
Objections to applications.....	(1)	(1)	(1)	(1)	450	493
Annual over-all total.....	6,092	6,599	6,635	7,430	8,073	7,785

¹ No records kept.

NOTE.—“Extension of time orders” have been consolidated with “applications for change of works,” for 1964 to 1966, inclusive.

ADMINISTRATIVE DRAUGHTING OFFICE

The Administrative Draughting Office is staffed by a Chief Draughtsman, a Supervising Draughtsman, four Draughtsmen 3, three Draughtsmen 1, and three clerks. The main functions of this office are checking the legal status and clearing of water applications; compiling, revising, and maintaining water-rights maps; preparing plans for water licences; clearing land applications for the Lands Branch;

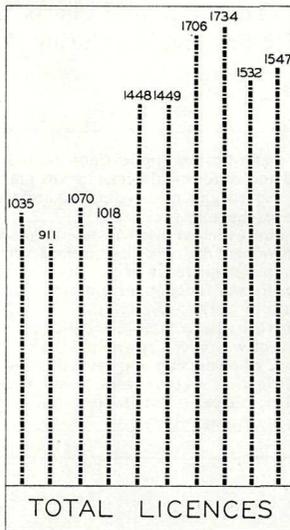
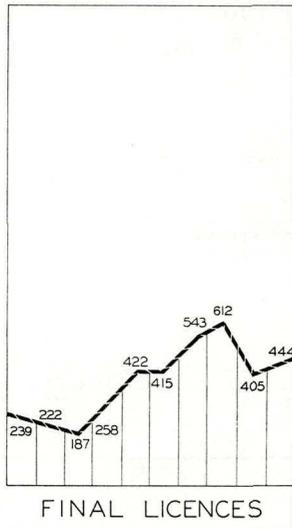
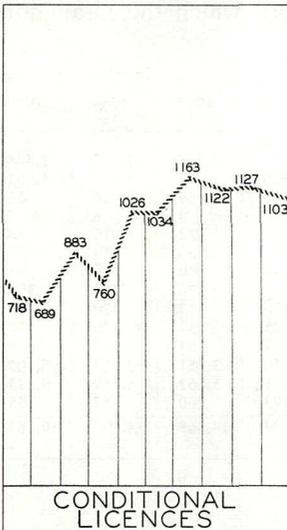
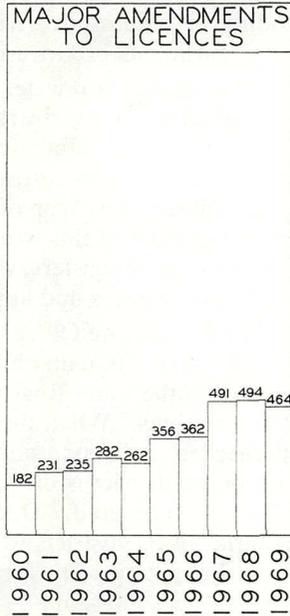
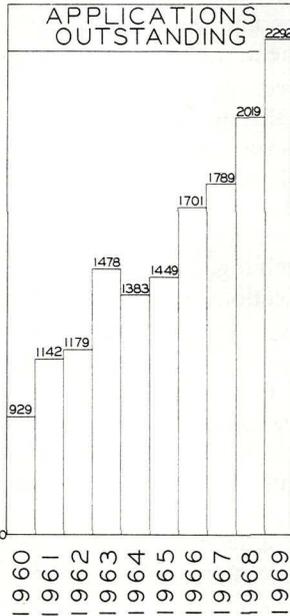
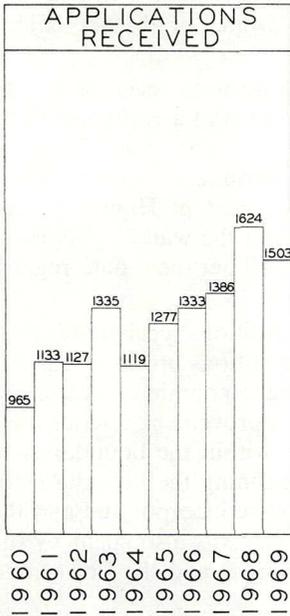
checking petitions and preparing legal descriptions for improvement districts; and attending to requests for maps and various information from our district offices, other departments of Government, and the public.

Applications for water licences and amendments to licences received by the Licensing Division are cleared through the Draughting Office, and a complete check is made of the legal status of every application received. In most cases this work entails a search of records of other departments of Government, such as Land Registry Office, Surveyor of Taxes, Lands Branch, Department of Highways, etc. Upon completion of this work, all applications are entered on the water-rights maps and in the stream registers, which together form a record of all pertinent data regarding all water licences and applications within the Province.

The Draughting Office is responsible for checking all petitions received requesting incorporation into an improvement district. Checking petitions involves searches of records of the Land Registry Office and Surveyor of Taxes to obtain correct property descriptions. When the petitions to incorporate an improvement district have been checked and found correct, a plan showing all lands within the boundaries of the proposed district is drawn up and a legal description defining the boundaries of the district is prepared. During 1969, eight new districts were incorporated and the boundaries of 31 districts were amended. Considerable time was also spent by the staff on draughting work for the Improvement District Division and the Power and Major Licences Division.

The table and charts which follow illustrate the work which the Draughting Office has handled during the last five years:—

	1965	1966	1967	1968	1969
New water-licence applications cleared and plotted on maps	1,184	1,268	1,299	1,533	1,448
Final and conditional licence plans prepared	1,587	1,920	1,957	1,640	1,961
New water-rights maps compiled and traced	71	40	59	26	51
Water-rights maps revised	15	8	9	6	7
New improvement districts described and plans prepared	19	9	12	16	8
Improvement districts' descriptions and plans amended	46	52	38	59	31
Reference maps renewed	21	46	40	29	48
Extensions of time, apportionments, transfers of appurtenancy ..	289	368	174	158	194
Change of works	198	176	317	320	270
Approvals	38	25	37	26	50
Rights-of-way over Crown land	333	337	333	347	356
Change of ownership and cancellations	2,698	2,410	3,151	3,217	3,100
Land clearances (purchases, leases, Crown grants, etc.)	6,475	6,641	5,662	6,759	8,623
Land clearances (cancellations)	2,251	1,493	280	57	35
Totals	15,217	14,793	14,368	14,193	16,182



ISSUED

ISSUED

DISTRICT ENGINEERS DIVISION

M. L. Zirul, P.Eng., Chief of Division

For administrative purposes, the Province of British Columbia is divided into 27 water districts. Water Rights Branch district offices, each in the charge of a District Engineer, are located at Kamloops, Kelowna, Mission City, Nelson, Prince George, and Victoria, each district office being responsible for administration of the *Water Act* within a number of water districts. The accompanying map sheet shows water district boundaries and areas administered by district offices.

The effort to cope with the increasing number of applications for water licences requiring investigation and reporting on has continued, although all district offices except Prince George have lost ground in this respect. The effort has been hampered in most cases by our inability to hold staff at the Assistant District Engineers' level (Engineer 3) in the face of the more favourable salaries being offered in the private sector. A considerable amount of District Engineers' time was required also in the investigation and reporting on local floods which occurred in the south-central and southeasterly parts of the Province as a result of rapid runoff of the above-average winter's snow pack and storm conditions experienced in some areas. In particular, the District Engineer at Nelson was involved in the investigation of conditions leading to the disastrous flood which occurred in Trail on April 24th, and prepared a report containing a preliminary design of works recommended to provide adequate capacity for Trail Creek flood flows and to eliminate the probability of occurrence of future flooding from this source. He also prepared a report recommending construction of works designed to reduce future flooding in the Kimberley area.

The District Engineers' reports indicate that good water-supply conditions prevailed generally throughout the Province, with adequate flows being maintained in most streams, with very few exceptions, well into the normally dry season. This did have the effect of greatly reducing conflicts over water use normally demanding attention by the district offices and allowed them to direct the effort of available staff to more constructive endeavour.

The District Engineers serve on the Technical Advisory Committees of the regional districts contained within their administrative areas. They are also called upon to advise and assist the staffs of other departments of Government in problems involving stream flows or water supply. They are involved in supplying field assistance in the way of recording water levels in observation wells and sampling snow courses for the Groundwater and Hydrology Divisions of the Water Investigations Branch, and have undertaken various phases of projects being carried out by our Improvement Districts Engineering Division.

As in the past, the district offices have produced a limited number of water supply feasibility studies, including design of waterworks for various groups or existing improvement districts within their areas and they have organized and supervised the construction of river-bank protection or flood-prevention work in several instances where governmental assistance has been given owners in the carrying out of projects.

The following table summarizes the state of the water-licence application situation at the respective district offices at the end of the report period and records the activity connected with amendment of existing licences and new water licences added to their files:—

Summary of Water-licence Application Situation and Licence Amendments Reported on by District Offices for Period November 1, 1968, to October 31, 1969

	District Offices						Total
	Kamloops	Kelowna	Mission City	Nelson	Prince George	Victoria	
Applications for water licences—							
On hand, November 1, 1968.....	284	172	121	291	121	65	1,054
Received during year.....	337	230	252	239	144	222	1,424
Cancelled or abandoned.....	31	55	30	28	26	14	184
Inspected and reported on.....	187	149	172	152	154	199	1,013
On hand, October 31, 1969.....	403	198	171	350	85	74	1,281
Applications for approvals under <i>Water Act</i> , section 7, reported on.....	4	7	6	15	3	2	37
Reports for final water licences.....	34	134	71	73	34	16	360
Water-licence amendment reports—							
Apportionment.....	14	27	13	15	4	7	80
Transfer of appurtenancy.....	28	25	20	27	5	16	121
Change of works.....	28	32	0	36	2	6	104
Extension of time.....	6	9	0	0	5	44	64
Other.....	0	3	19	0	2	0	24
New conditional water licences entered.....	369	225	178	151	120	139	1,182
New final water licences entered.....	53	105	141	102	35	30	466

The separate reports of the respective District Engineers follow.

KAMLOOPS DISTRICT OFFICE

D. E. Smuin, P.Eng., District Engineer.

The Kamloops District Office administers the *Water Act* in the Kamloops, Ashcroft, Cariboo, and Nicola Water Districts within the Fraser River drainage basin in the south-central part of the Province, an area comprising some 50,000 square miles.

Water supply and the demand therefor varies considerably within the four districts administered. In some areas the available flow in many streams has been fully appropriated for established use, and additional development is hindered by lack of further readily available water. On the other hand, in some sparsely settled areas, particularly in the Chilcotin area, there is still a surplus of this vital resource.

During the report year, despite a severe staff shortage, many water-use problems received attention. The weather was favourable in that rainfall was sufficient in most areas for good crop production, although some sections of the Cariboo experienced excessive moisture, particularly during hay-cutting periods.

Shortage of staff was a continuing condition which worsened in 1969 as both Assistant District Engineers' positions were vacant from May to September, the period of the year when most problems requiring investigation occur. District technical staff was utilized whenever it was possible to do so but, needless to say, many controversies received only minimal attention.

After the very successful accomplishments by this office in 1968, it is disheartening to note the ground lost during 1969 as a result of the severe shortage of staff.

During the year the Kamloops office lost the services of Assistant District Engineer E. D. Anthony, who was promoted to the position of District Engineer at Kelowna. Engineering Aide R. W. McPetrie resigned to accept other employment. Mr. H. Van Camp joined the staff to fill one of the two Assistant District Engineer vacancies and Mr. J. E. Fetters joined as engineering assistant.

Engineering Investigations and Projects

Prepared a report on probable effects of a proposed channel improvement in the lower Salmon River.

Carried out supervision of construction of Smith and Yook Lake dams.

Supervised the construction of channel improvements in Peterson Creek at Kamloops.

Supervised the excavation, by the water-users community, of the outlet channel from Monte Lake.

Inspected the site of a recurring drainage problem at the outlet of Moutell Creek, Salmon Arm area.

Prepared a report on the possible diversion from Walloper Creek to augment irrigation water supplies in the Knutsford area.

Assisted personnel of the Pollution Control Branch in connection with their Canim Lake pollution study.

Prepared a feasibility report for Hillcrest Waterworks District to determine the economic feasibility of developing groundwater to augment their present surface supply.

Inspected obstruction of Williams Lake River caused by the collapse of a railway culvert, and made suggestions to alleviate basement flooding caused by high water levels in Williams Lake.

Inspected and ordered removal of causeway remnants in flood channel of North Thompson River.

Conducted an investigation of water use by Brenda Mines and silting of water resulting from construction of tailings-dam, in co-operation with staff of Kelowna District Office.

KELOWNA DISTRICT OFFICE

E. D. Anthony, P.Eng., District Engineer

The Kelowna District Office administers the *Water Act* in the Fairview, Grand Forks, Princeton, Revelstoke, and Vernon Water Districts, which comprise the Kettle, Similkameen, and Okanagan drainage basins, the Shuswap River drainage basin above Sicamous, and the portion of the Columbia River basin from its confluence with the Canoe River down to the north end of the Upper Arrow Lake.

While an average snow pack and normal soil-moisture contents indicated an anticipated average spring run-off, heavy rainfalls and mild temperatures during the melt period resulted in near record peak flow in many of the streams in the northern portion of the Okanagan basin. Flooding occurred around Kalamalka and Swan Lakes and along Vernon and BX Creeks. High flows in Duteau Creek flooded portions of Lumby. Studies are now under way to determine a more accurate method of forecasting run-off in the Kalamalka Lake and BX Creek watersheds.

Although the spring run-off approached record proportions, there were no reports of damage caused by failure of any licensed storage structures. An unlicensed storage dam failed near Rutland in May, causing considerable damage. In September, a tailing-pond failed, causing damage in the City of Greenwood. It is proposed, next summer, to update our data on licensed storage structures in order to assess more accurately the safety of these works.

The majority of the storage reservoirs were filled to capacity by the above-average spring run-off. Okanagan Lake peaked at 1,123.56 feet G.S.C. datum on June 12, 1969, bringing the lake level to within 0.23 feet of full allowable storage. Ample storage water and normal summer precipitation resulted in very few complaints of water shortages being received.

In April, 1969, Mr. R. J. Talbot, P.Eng., District Engineer, accepted a position with the Fraser River Flood Control Programme and was replaced by Mr. E. D. Anthony, P.Eng.

Despite numerous changes in staff, a record number of final-licence reports was submitted and 204 water-licence applications were processed.

With the continued development in the district, the problems involved in water resources development become more complex. The number of requests to attend meetings of regional district planning boards, improvement districts, and the general public increased markedly during the past year.

A summary of the water-licence applications processed by this office during the past 10 years is shown in the following table:—

Year	Applica- tions Received	Reports Sub- mitted	Cancelled or Aban- doned	Total
1960.....	193	141	22	163
1961.....	168	146	13	159
1962.....	115	153	31	174
1963.....	211	177	18	195
1964.....	192	193	46	239
1965.....	187	145	13	158
1966.....	196	165	35	200
1967.....	209	156	27	183
1968.....	229	209	24	233
1969.....	230	149	55	204

Engineering Investigations and Projects

Supervised the reconstruction of the irrigation system of the Wood Lake Irrigation District.

Prepared a feasibility study of the installation of a domestic-water system for the Brash Creek Local Improvement Area of the Regional District of North Okanagan.

Prepared a report on the use of Lambly Creek water by Lakeview Irrigation District.

Prepared a report on the availability of unrecorded water in the Kalamalka Lake watershed and the effect of the proposed industrial development at Winfield on the water availability.

Prepared a cost estimate of proposed channel improvements to Boundary Creek for erosion and flood control.

Prepared a cost estimate of proposed drainage works in the Ambrosi Subdivision for the Regional District of Central Okanagan.

MISSION CITY DISTRICT OFFICE

E. G. Harrison, P.Eng., District Engineer

The Mission District Office assists the Comptroller of Water Rights in the administration of the *Water Act* in the Vancouver and New Westminster Water Districts, an area of approximately 40,000 square miles in southwestern British Columbia. Most attention is required in a 1,000-square-mile portion of the Lower Fraser Valley and Sechelt-Powell River areas.

Fortunately, water during the year was in good supply and only a few complaints of shortage required attention. This made it possible to devote more time to the inspection of applications for water licences. The increase in population, as well as the general expansion and development within the two water districts, have been reflected in an increased demand for water, and again this year a record number of

applications for water licences was received, along with a proportional number of objections thereto, all of which required investigation. The increase in number of applications for amendments to water licences also continued this year. An above-average number of applications for apportionments and transfers of appurtenancy were received as changes were made in land use or as land was subdivided.

There has also been an increase in the number of complaints, both from individuals and groups or organizations, regarding the use of chemicals for spraying road and transmission-line rights-of-way, and in the use of pesticides which may affect streams. Complaints have also been received in connection with gravel-washing operations and similar works near streams, which interfere with or destroy fish and waterfowl. Many investigations and discussions with interested individuals and groups have taken place in attempting to resolve some of those problems at a local level.

Personnel changes and a continued shortage of staff has had an effect on production during the year. Normally there are six full-time employees on the Mission District Office staff, comprising a District Engineer, Assistant District Engineer, technician, two engineering aides, and a clerk-stenographer. No replacements have so far been obtained for the Assistant District Engineer and two engineering aides who resigned during the summer, consequently the office has been operating at reduced strength. Until recently it has been possible to cope with the routine office business which has been continually increasing since the office was established in 1961, but recently investigations of applications for water licences, final-licence surveys, and other matters have unavoidably fallen behind. Participation in the technical planning committee meetings of regional districts and attention to the increased numbers of requests from ratepayers' groups, small municipalities, improvement districts, and others for assistance in improving waterworks systems and other works has made additional demands on the office.

Engineering Investigations and Projects

Assisted Lindell Beach Residents' Association with design and construction of new water intake in Spring Creek.

Investigated and advised residents at Irvines Landing regarding water supply.

Assisted Town of Hope in completing construction of dykes on Coquihalla River.

Advised Blue Water Park Improvement District regarding extension of water system.

NELSON DISTRICT OFFICE

T. H. Oxland, P.Eng., District Engineer

The Nelson, Kaslo, Cranbrook, Fernie, and Golden Water Districts, which contain some 26,000 square miles in the southeast corner of British Columbia, are administered by the Water Rights District Office at Nelson. This office is presently staffed by a District Engineer, two Assistant Engineers, a technician, and a clerk-stenographer, all permanent employees. During the summer, two survey assistants were employed to help with final-licence surveys and with field work for miscellaneous engineering studies.

The work this year has been dominated by the investigation of flooding and erosion problems which resulted from the high-volume run-off from the record snow pack which occurred in the southwest section of the district. The major flood in Trail Creek in April this year, which caused heavy damage within the City of Trail, resulted primarily from heavy rain on a melting snow pack. In Kimberley, the same

rain-storm caused flooding in residential areas adjacent to the city. In the Creston area, normally intermittent watercourses caused local flooding of orchard areas. In the Castlegar area, slides in several small mountain creeks damaged property and blocked the main highway. Reports on these floods have been prepared and implementation of flood-control works is presently under study by the parties concerned.

A cool, wet spring and summer followed the extremely cold winter, with the result that good stream-flow was maintained during most of the year. The number of water-use complaints, therefore, were minimal as compared to flood, erosion, and pollution complaints.

The request for assistance from improvement districts and water-users communities decreased this year, and the backlog of outstanding reports requiring attention has been reduced to one. The feasibility report for the Mirror Lake area was abandoned after water users evidenced a lack of interest in formation of an improvement district.

The Technical Planning Committee meetings for the three regional districts within the Nelson District were attended throughout the year.

The applications for water licences received continues to outnumber the reports submitted for applications inspected. The staff time involved in inspecting flooding problems and preparation of reports, particularly in the preparation of the report covering the Trail Creek flood at Trail, was the chief cause for lower output in other directions this year. The applications for water licences, particularly in the settled areas, also requires more staff time, since extensive investigation is necessary when many of the suitable water sources are already fully committed under existing licences.

Engineering Investigations and Projects

Only one feasibility report initiated last year remains to be completed, that is the report for the Oasis Improvement District. Feasibility reports for water supply were completed for the Ootischenia Improvement District, the Slocan Park Improvement District, and Ainsworth Townsite.

A report was prepared for the Trail Flood Disaster Committee which contained recommendations for flood control on Trail Creek within the municipal boundaries of both Trail and Warfield.

A report was also prepared on the flooding that occurred at Kimberley.

Two domestic-water storage dams for the City of Trail were inspected and recommendations for the operation of these storages were worked out with the city. Construction of a temporary spillway for the Violin Lake dam was also approved.

In addition to the above, 30 flood and erosion problems, most of which were within the Creston, Trail, and Castlegar areas, received attention in varying degree, depending upon their severity.

Seventeen pollution problems were investigated in the West Kootenay area. The major cause of these problems was faulty construction of logging-roads, which interfered with normal drainage patterns.

Nine complaints of unauthorized diversion of streams and seven water-sharing complaints were also investigated.

Rehabilitation of the borrow area for the High Arrow Dam and the control of drainage through this area was undertaken by British Columbia Hydro during the early fall. This work was based on proposals agreed upon during meetings of the District Engineer with officials of British Columbia Hydro this year.

One river-bank protection project to arrest erosion on the Elk River near Hosmer was completed this year, in co-operation with the Water Investigations Branch.

PRINCE GEORGE DISTRICT OFFICE

C. E. Wilson, P.Eng., District Engineer

The Prince George, Quesnel, Peace River, Liard, Atlin, Fort Fraser, Hazelton, and Prince Rupert Water Districts, which contain approximately two-thirds of the area of British Columbia, are administered by the Prince George District Office. The staff is made up of a District Engineer, an Assistant District Engineer, an engineering technician, and a clerk-stenographer. Normally one student is employed during the summer to assist in the draughting and survey duties of the office. However, this past year the position of Assistant District Engineer was vacant. An additional student was hired to allow use of the engineering technician for more pressing matters.

Unusual sub-zero weather prevailed through the latter few days of December and all of January, except for the second week. Temperatures reached a low of 45° F. below zero.

Frazil ice formed in the Nechako River and piled up at the confluence with the Fraser. Within hours the entire Nechako River through Prince George was choked with ice, causing the river level to rise, resulting in extensive flooding in the Island Cache and lumber storage-yards in the industrial area.

The run-off in the area generally was much less than normal, except for the Upper Nechako watershed, thus causing little flooding. Some frozen culverts were reported in the Quesnel and Giscome areas, but this problem was generally taken care of by the Department of Highways.

During the months of May and June, this area had extremely hot and dry weather and a water-shortage problem developed on Vienna Creek, south of Prince George. The remainder of the summer was cool and wet and no further water-shortage problems were experienced.

The Lafreniere and Willow River Improvement Districts were incorporated. Lafreniere for waterworks and Willow River for road-building purposes.

The District Engineer attended meetings of the Technical Planning Committees of the Regional Districts of Bulkley-Nechako and Fraser-Fort George. The Cariboo Regional District Technical Planning Committee had its first meeting in October. A number of meetings sponsored by the Regional District of Fraser-Fort George were attended when water-supply and sewage-disposal proposals for the Greater Prince George area were discussed.

The District Engineer visited the Queen Charlotte Islands and discussed various problems with local residents.

Meetings were attended at Fort St. John, Chetwynd, Quesnel, Lafreniere Sub-division, College Heights Improvement District, Charella Gardens, and Port Clements Improvement Districts to discuss water problems.

Water-level observations for test-wells in the Prince George area were continued for the Groundwater Division.

Engineering Investigations and Projects

Inspected erosion damage at McBride, Valemount, Chilako River, and on the Nechako River in Prince George. Channel improvements were carried out on Dore Creek at McBride and Swift Creek at Valemount.

Inspected alleged flooding damage in Giscome area on Eaglet Lake, winter ice-flooding in the Cottonwood Improvement District area adjacent to Prince George, and flooding due to high levels on Cluculz Lake.

Inspected dams on Vandenberg Creek at Telkwa, Wolf Creek at Port Edward, Pickard Creek at McLeese Lake, and Vienna Creek at Red Rock.

Prepared report, including design and cost estimate, covering possible protection of Island Cache area at Prince George by dykes, and investigated feasibility of construction of an earth-fill dam and water supply for Halltray Farms north of Vanderhoof. Engineering information was collected for future feasibility studies at Hazelton and Moberly Lake near Chetwynd. The completed water supply feasibility study was reviewed with the residents of Endako, but they decided not to proceed with construction at this time.

Inspected the widening of the old channel built by Canadian National Railways in 1914 between the two parts of Burns Lake.

Assisted the Improvement Districts Division in engineering work for the Pineview and Blackburn Improvement Districts.

A summary of the water-licence applications processed by this office during the past seven years is shown in the following table:—

Year	Applica- tions Received	Reports Submitted	Cancelled or Aban- doned	Total
1963	77	38	8	46
1964	161	116	30	146
1965	135	101	31	132
1966	164	121	20	141
1967	133	81	19	100
1968	142	123	21	144
1969	144	154	26	180

VICTORIA DISTRICT OFFICE

P. G. Odynsky, P.Eng., District Engineer

The Victoria District Office administers the *Water Act* throughout Vancouver Island, the Gulf Islands, and adjacent islands. This area comprises the Victoria, Nanaimo, and Alberni Water Districts.

The office staff in 1969 consisted of a District Engineer and one engineering technician, in addition to which two university students were hired during the summer to carry out final-licence surveys and assist with draughting and clerical duties.

Weather conditions varied widely during 1969. Heavy snowfalls with freezing temperatures established new records throughout the island region during January, the temperature falling to 4° F. for Victoria and -4° in Nanaimo on December 30, 1968. Snow lay at sea-level until the end of January. In March and April most island snow courses reported new record high-water equivalents. Warm day temperatures and cool nights in April and May caused run-off to be extended well into June, without significant flooding. Some shortage of water began to develop in July. Rainfall in August ended the long period of warm, dry weather which began in April.

The steadily increasing demands made on the water resource as a result of the increase in population in the islands region has increased the work load of the Victoria District Office to the point where difficulty is experienced in completing the necessary inspections and administering normal water-resource use. The Victoria District Office will soon require additional engineering or technical staff in order to fulfil effectively its technical, administrative, and public-relations responsibilities throughout the islands region.

Engineering Investigations and Projects

Investigations were made and action taken or reports forwarded on complaints of water damage due to flooding or erosion on the following streams: Robertson River at Mesachie Lake, Black Brook at Qualicum Bay, Nanoose Creek near Nanoose Bay; unnamed surface run-off in the Happy Valley and Saanich areas, Sproat Lake and McCoy Lake near Port Alberni; surface storm run-off in Harewood District, Nanaimo, Langford Lake, Chase River at South Wellington, York Lake at Cedar, Mason Spring at Cordova Bay, Miller Brook at Esquimalt, Annie Creek at Qualicum Bay, and Michael Lake at Cedar.

Supervision was provided for the Cowichan River bank-protection project undertaken by the Village of Lake Cowichan.

Investigations were made of the following complaints of pollution of streams: Bilston Creek by a slaughter-house; Bird Creek at Mill Bay by silt; Menzies Creek by silt resulting from highway construction; Heyd Brook near Tofino, resulting from construction of a youth hostel.

Other miscellaneous investigations were carried out as follows: Use of water under licences on Utility Brook at Youbou inspected and reported on; storage dams on Oliphant Lake and China Lake, Malahat District, inspected together with licensed use of water from Bamber and Oliphant Creeks; inspected and reported on water system proposals of Garnett Creek Water-users Community at Cherry Point; investigations made, meetings held and reports forwarded for licensing use by the Greater Victoria Water Board and by municipalities in Victoria area; investigations made, meetings held, and report forwarded for licensing storage of water on Young Lake at Sooke; water shortage investigated in South Taggard Creek near Mill Bay, Cypress Springs at Deep Cove, Averill Creek at Somenos, Chris Spring at Esquimalt Lagoon, and French Spring at Maple Bay; inspected the existing water system from Mercantile Creek for the Village of Ucluelet; investigated licensed use of water from Enos Lake at Nanoose Bay; investigated complaints of unauthorized dams on Metchosin Creek and Hewitt Creek in the Metchosin area; investigated proposed use of water for mining and milling copper ores from Marble River, Alice and Victoria Lakes in the Port Hardy area; investigated complaints of obstructions and unauthorized works in the Robertson River at Mesachie Lake; inspected complaint of removal of topsoil from lands adjacent to the Nanaimo River, possibly resulting in the river flooding a drilled well in the area; inspected complaints of obstructions in Millstream Creek at Langford; inspected complaint of obstruction by landfill of drainage from a spring-fed swamp at Qualicum Bay.

IMPROVEMENT DISTRICTS DIVISION

R. A. Pollard, P.Eng., Chief of Division

There are now 300 improvement districts incorporated under the *Water Act*, four less than a year ago. During 1969 the following new districts were incorporated: Blue Water Park Improvement District, Campbell-Bennett Bay Improvement District, Lafreniere Improvement District, Lake Kathlyn Improvement District, Mountain View Waterworks District, North Gabriola Fire Protection District, Stardel Waterworks District, Triangle Mountain Improvement District, Wasa Land Improvement District, and Willow River Forest Improvement District. The following districts were dissolved: Arnold Waterworks District, Asp Creek Irrigation District, Chase Waterworks District, Hillside Waterworks District, Mission Dyking District, Port Hardy Improvement District, Selma Park Improvement District, Sicamous Improvement District, Silverdale Dyking District, Sumas No. 3 Road

Irrigation District, Valleyview Irrigation District, Westbank Waterworks District, West Lantzville Waterworks District, and Western Latoria Road Waterworks District.

The territorial boundaries of an improvement district and the object, or objects, for which the district is incorporated is set out in its Letters Patent. Upon petition of the trustees, the Letters Patent may be amended to include new lands within the district or exclude land, or to include extra objects. Many districts which were originally incorporated for one purpose now have several. The activities for which the districts are responsible include irrigation, waterworks, dyking, drainage, and land improvement. The Letters Patent of 34 improvement districts were amended in 1969, most changes being boundary amendments.

All improvement districts are empowered by the *Water Act* to raise revenue by the levying of a tax or taxes upon one or more of a number of bases and by the imposition of tolls and other charges. They are also empowered to issue debentures to obtain funds for capital purposes. In many cases, improvement district debentures and interest thereon are guaranteed by the Province pursuant to the *Improvement Districts Assistance Loan Act*. There is now \$9,394,500 of such guaranteed debentures outstanding, of which \$1,766,000 was guaranteed during 1969.

ENGINEERING SERVICES

The Engineering Section of the Improvement Districts Division provides a comprehensive technical service to improvement districts, or communities considering incorporating as improvement districts, throughout the Province. This service is variously concerned with domestic water-supply schemes, irrigation projects, or drainage and sewerage works. The nature of assistance provided falls generally into three categories.

Where new schemes or rehabilitation of existing works are contemplated, the Section carries out an engineering investigation, and then prepares a report giving technical recommendations, cost estimates, and an assessment of the economic feasibility of the scheme.

Once the decision to initiate a project has been made, the district then submits plans, specifications, and details of proposed financing methods for checking and approval by the Section. Certain requirements must be met before a recommendation for Government guarantee of a loan will be made. In many instances, details of a project are discussed at length with the district's consultants, and revisions or modifications recommended.

In some circumstances the Section assumes full responsibility for the engineering of a project. After the preliminary surveys and investigation have been completed, the Section then prepares final design drawings, specifications, and contract documents, and finally provides supervision of construction.

Advice is also given to districts regarding operational problems, or modifications and repairs to existing systems.

Throughout the year, personnel from the Division travelled extensively in the Province, holding meetings with district trustees, organization committees, municipalities, and other groups actively concerned with problems of development. About 50 improvement districts were visited regarding their administration alone.

Reports Prepared and under Preparation

Brash Creek Area.—Following a request from a small community located near Brash Creek, 4 miles east of Enderby, an investigation into water-supply possibilities

was carried out. The ensuing report indicated that the provision of a water system to serve this area was not economically feasible.

Campbell-Bennett Bay Improvement District.—This district was formed in order to acquire and operate works formerly owned by Mayne Island Water Co. Ltd. An interim report was prepared in which the existing works were appraised and the administrative implications of the proposed take-over by the district were outlined. Following completion of current ownership negotiations, it is intended to prepare a second report in which recommendations regarding system modifications and future policies will be made.

Covert Irrigation District.—Situating about 3 miles west of the City of Grand Forks, this is an old established district which has experienced considerable subdivision into small parcels. There is a conflict of interest between the large landholders and the small parcelholders, who are mainly part-time farmers. To satisfy its requirements for water, the district has recently drilled a well to supplement the gravity supply from July Creek. Two reports were prepared during the year proposing extensions of the pipe-lines to ensure adequate distribution of the well water and covering different supply areas, but these proposals cannot be implemented until the conflict is resolved.

Cranberry Fire Protection District.—Having recently amended their Letters Patent to include water supply, the Cranberry Fire Protection District, located 4 miles south of Nanaimo, desired to have the cost aspects of water supply investigated. The subsequent report showed that the density of existing development was inadequate to support the cost of a community water-supply system.

Elko.—Following receipt by the Comptroller of a petition by two groups of landowners in Elko, one to form an improvement district and the other a water-users community, an investigation was made of possible sources of water supply for Elko. A memorandum/report was prepared which concluded that a new water system for an improvement district was not at present economically feasible. Applications to form a water-users community would therefore be considered.

Fort Nelson Improvement District.—Demands on the Fort Nelson Improvement District for new water and sewer services in the area have continued during 1969. At the request of the district, two reports were prepared on proposed water and sewer system extensions—(1) water and sewer service for First Avenue NE. and part of Second and Third Avenues NW.; and (2) water service for Third Avenue NE. It was shown that these extensions could not be financially self-supporting under the district's present tax and toll structure without a capital contribution from each benefiting landowner.

Grand Forks Irrigation District.—This district covers a large area to the south and east of the City of Grand Forks. The present low-pressure pumping system was designed and constructed by the Lands Department in the early 1920's and still operates effectively. Most farmers have abandoned furrow irrigation, however, and find that the old system is too expensive when the extra cost of pumping to produce pressure for sprinkler irrigation is added. A pilot area of about 1,000 acres within the district is being studied to see if it is feasible to replace the existing works with a high-pressure system fed from wells.

Haslam Lake.—Powell River Education Pipe-line: In response to requests by local property owners, the pipe-line from Haslam Lake which supplies the District of Powell River was inspected and a memorandum/report prepared on the possible hazard of flooding in the event of a rupture of this pipe-line between the lake and surge shaft. It was concluded that the chance of pipe-line failure is remote and, even if it should occur, there would be no danger to life or property.

Hutchinson Cove Area.—At the request of local property owners, a report was prepared on the technical and financial aspects of providing a water system to serve the Hutchinson Cove area near Sooke on the west coast of Vancouver Island. The ruggedness of the local terrain and the long lengths of pipe-line required would make the cost of the scheme exceptionally high. The report, therefore, concluded that the proposal was not economically feasible at this time.

Larkin Waterworks District.—Composed mainly of dry-land farms, Larkin is a rich agricultural area to the south of Armstrong in the Okanagan Valley. Farm activities have been hampered for a great many years by an irregular water supply from a small creek. A report was prepared recommending a well source feeding an enlarged distribution system to a somewhat extended area. Subsequently, the well was drilled and has proved to be adequate. The district has resolved to proceed with the construction of the scheme in 1970.

Otter Lake Waterworks District.—Otter Lake is a rich agricultural area to the west of Armstrong which takes a bulk supply of water from the city. Because Armstrong is at a generally lower level than Otter Lake, the district has suffered pressure difficulties and water shortages in dry summers. A report has been prepared recommending the replacement of the old system with a modern water supply fed from a high-capacity well which exists to the southeast of the district.

Quadra Island.—At the request of land owners on the southern part of Quadra Island, a study was made of the possibilities for a community water supply for the area. Earlier investigation had indicated that the only economically feasible source could be groundwater, if available in quantity, to serve the settlements of Quathiaski Cove and Heriot Bay. The Groundwater Division, Water Resources Service, studied the surficial geology of the area and recommended rotary test-drilling to locate suitable aquifer material. A report was prepared proposing a separate water system for Quathiaski Cove and Heriot Bay on the tentative assumption of a suitable well in each settlement.

Vananda Waterworks District.—At the request of the trustees, the district's gravity domestic water system was inspected and a report prepared with recommendations for improving the system. Two schemes were proposed—Scheme A, to cost \$86,000 for a new gravity pipe-line along the old route, with booster pumping to high parts of the district; and Scheme B, to cost \$72,000 for pumping from Priest Lake to a reservoir, and thence via a new, shorter, gravity pipe-line to Vananda.

Design and Engineering Services

Fort Nelson Improvement District.—At present this district obtains its water supply from the Muskwa River by pumping during the winter months through a 6,000-foot-long pipe-line into a 40,000,000-gallon reservoir near the community for use during the entire year. During the summer freshet the Muskwa carries too heavy a sediment load for domestic use of the raw water. A study is being made on obtaining a new, year-round source of water for the district, either by constructing a new open water intake on the Muskwa, together with a sedimentation pond, or from groundwater with provision for any treatment which may be required to improve the chemical quality of the water. The Water Supply and Investigations Division and the Groundwater Division of the Water Investigations Branch have assisted in this work. A topographic survey was made by the Investigations Division of a proposed new intake area on the Muskwa River. With technical advice from the Groundwater Division, cable-tool, test-well drilling was conducted on an alluvial bar of the Muskwa River near Fort Nelson under an \$8,600 contract supervised by the Improvement Districts Division. This exploration proved up an aquifer of sufficient

capacity to supply this growing district. However, the chemical quality of the raw groundwater may not be good. Samples pumped from a successful test well are presently being analysed.

Grandview Waterworks District.—ARDA Project 29044, namely, the second-stage rehabilitation of the farm water-supply system serving the Grandview Waterworks District, was commenced in April, 1969, and completed by November. The work, involving modifications to the intake and approximately 20,000 feet of pipelines and service pipes, was carried out by the district, using direct labour. Engineering services for both design and supervision were provided by this Division. The final cost will be substantially below the original estimate of \$57,000.

Quinsam Heights Waterworks District.—This district is part of the Greater Campbell River Water District and contains some of the highest developed ground in the Greater Water District. Low-pressure problems have developed in high areas, partly as a result of head loss in the Greater Water District's mains. The problem was examined and recommendations made for immediate and future action to be taken to correct the situation.

Slocan Park Improvement District.—An application for ARDA assistance in reconstructing the Slocan Park water system has been accepted by the Federal and Provincial Governments and the design of the new system has commenced.

Steele Springs Waterworks District.—The existing system which provides water to this agricultural community had developed pressure problems. The trustees were given advice on how to determine the source of their troubles and, after effecting some repairs, have removed the immediate problem. A long-term shortage exists, however, and further work will be needed to make the system adequate in all respects.

Wood Lake Improvement District.—ARDA Project 29008, namely, rehabilitation of the Wood Lake irrigation works, commenced in 1967 and was essentially completed in 1969. The new system operated throughout the 1969 irrigation season. The new works have resulted in a much reduced consumption of water by the district, which suggests that the irrigated area could be extended, thereby broadening the revenue base. Water supply and use during the 1970 irrigation season, at least, must be observed before this can be confirmed.

Walhachin Waterworks District.—The water system serving the Walhachin Waterworks District was originally installed in 1907 and is now generally in very poor condition. This Division is investigating alternative sources of supply, in addition to other aspects of system operation, with a view to assisting the district with the urgent problem of system rehabilitation.

Water Supply and Sewerage Proposals Reviewed

District	Description of Proposal	Status of Project at End of Year	Approximate Estimated Cost
B.C. Fruitlands Irrigation District	Installation of sanitary sewer system ..	Preliminary planning stage....	\$2,442,000
Blackburn Improvement District	Installation of domestic-water system	Well completed, other works postponed until next year	222,000
Canal Flats Improvement District	Installation of sanitary sewers and domestic-water system	Under construction.....	283,000
Clearbrook Waterworks District	Major extensions to existing water system	Construction completed	66,000
Clearwater Improvement District	Installation of domestic-water system...	Preliminary planning stage....	284,000
East Creston Irrigation District	Renewal of syphon.....	Construction imminent.....	31,000
Fort Fraser Waterworks District	Installation of sanitary sewer system and sewage lagoon	Construction completed.....	163,000

Water Supply and Sewerage Proposals Reviewed—Continued

District	Description of Proposal	Status of Project at End of Year	Approximate Estimated Cost
Hagensborg Waterworks District	Major water system extensions to serve Hagensborg (West)	Under construction	\$61,000
Lafreniere Improvement District	Installation of sanitary sewers and domestic-water system	Preliminary planning stage....	128,000
Mill Bay Waterworks District	Extension of water system to a new subdivision	Preliminary planning stage ...	9,000
Nechako Improvement District	Installation of sanitary sewer collection system	Preliminary planning stage....	1,212,000
North Cedar Waterworks District	Construction of additional well and miscellaneous pipe-line extensions	Under construction	50,000
Ootischenia Improvement District	Installation of domestic-water system; groundwater sources	Preliminary planning stage ...	165,000
Pineview Improvement District	Installation of domestic-water system...	Construction completed	253,000
Saltair Waterworks District ...	Major modifications to distribution works	Construction completed	70,000
Traders Cove Waterworks District	Installation of domestic-water systems	Preliminary planning stage....	70,000
Triangle Mountain Improvement District	Installation of domestic-water system...	Construction imminent	30,000
Westbank Irrigation District...	Extension to sewer system	Preliminary planning stage....	23,000
Willow Point Waterworks District	Extension of supply pipe-line.....	Construction imminent	166,000

POWER AND MAJOR LICENCES DIVISION

H. M. Hunt, P.Eng., Chief of Division

MAJOR LICENSING ADMINISTRATION

Activities on such major developments as the Duncan and Arrow Lakes projects during 1969 consisted mainly of reservoir cleanup as aftermaths to the previous years of vigorous construction activity on the dams and ancillary works. On the other hand, work at Mica dam-site maintained its fast pace toward the scheduled initial filling date in April, 1973. Progress on the massive Peace River project continued to be entirely satisfactory, and units 4 and 5 were put into commercial service, thereby completing the installation of half of the ultimate capacity of 2,300 MW of the Gordon M. Shrum Generating Station.

Much of the Division's time was spent co-ordinating the work of preparing Libby Reservoir for the flooding deadline of May, 1972.

Inspections of dams throughout the Province were undertaken, including existing structures and such new works and reconstruction of old dams as those included in the Jordan River Hydro Electric project, with a view to determining their adequacy from a safety standpoint and to ensure that construction was proceeding in accordance with the design assumptions.

FLOOD-CONTROL OPERATIONS

Generally, inflows to the various reservoirs in the Province during 1969 were below average. For example, Nechako reservoir fell short of filling by three-tenths of a foot. However, both Duncan and Arrow reservoirs were full by mid-July and draughting from storage for power operations was commenced in August. Williston reservoir continued to fill, but not as rapidly as anticipated.

In view of these circumstances, special operations for flood control were not required.

POWER-POLICY PLANNING

Specific fields of study in connection with power-policy planning include the compilation of historical electric-power generating records and the preparation of forecasts of future load growth, studies of international power-system developments such as the Columbia River, review of other benefits available to the public at hydro-electric developments, and preparation of an inventory of available undeveloped power resources.

UNDEVELOPED WATER POWER IN BRITISH COLUMBIA

The Water Rights Branch of the Department of Lands, Forests, and Water Resources, Government of British Columbia, in conjunction with the Inland Waters Branch of the Department of Energy, Mines and Resources, Government of Canada, has prepared an Index of Undeveloped Hydro-electric Power Sites in British Columbia which is part of a study covering the whole of Canada. Many of the sites have received only a cursory examination, and further sources of energy, although not yet fully explored, are known to exist. The index lists the figures derived by many investigators over the course of 30 years or so, and reference should be made to their original work in order to assess the current validity and relevance of their conclusions.

Planning, Kootenay and Pend-d'Oreille Rivers

Of more immediate concern, studies are under way at present to determine the most suitable methods of developing the additional potential made possible on these two rivers by implementation of the Columbia Treaty. Consideration is being given to developing the extra capability that will be provided by improved control of stream-flow by operation of Libby reservoir, and the most promising scheme is that known as the Kootenay Canal plant. This project could contribute in excess of 200 megawatts (average) of additional power at a most attractive cost.

The possibility of developing the Pend-d'Oreille River between the headwaters of Waneta plant and the International Boundary is also being studied, and a power plant of around 500 megawatts capacity appears to be feasible.

HYDRO-ELECTRIC POWER PROJECTS UNDER CONSTRUCTION

Additional Installations at Existing Plants

The City of Revelstoke is increasing its reservoir storage, thereby firming up the available energy at the Walter Hardman Plant, by raising Coursier Lake dam some 22 feet.

Peace River Development

The year 1969 saw the completion of virtually all the major works in progress. The completion of all work on the switchyard, control building, and the installation of units numbers 4 and 5 allowed these two units to go into commercial operation during the year, thus marking the end of work on the first half of the powerhouse. Excavation and initial concrete placements were also completed for the second half of the powerhouse. With the exception of the award of a contract for the installation of units 6, 7, and 8, no new work was contracted out during 1969.

Columbia River Development

Arrow Lakes Dam.—While the dam was declared operational on October 10, 1968, it was not until June 9, 1969, that Premier W. A. C. Bennett officially dedicated the dam and named it the "Hugh Keenleyside Dam" in honour of the retiring

Chairman of the British Columbia Hydro and Power Authority. Since that time all contract work has been completed, with the exception of some minor site-cleanup, and no new contracts have been issued.

Mica Creek Dam.—This dam, towering 800 feet above bedrock, will be the highest in Canada and the second highest of its type in the world. The diversion tunnels, which were completed in 1967, continued to be successfully used to divert the Columbia River around the dam-site to permit the Guy F. Atkinson, Arundel International, L. E. Dixon International, Commonwealth Construction, and Dillingham Corporation consortium to continue their work under the \$136,262,000 main dam contract. Construction progress to date has been good, and the contractors' earnings have been approximately \$40,000,000.

Work under this contract includes not only the main dam which, with the placement of over 10,000,000 cubic yards of fill material is now complete to elevation 1,980 feet, but permanent outlet works which are proceeding well and spillway excavation which has advanced to the point where control structure concrete pours are now being made. Good progress has also been made on such related work as foundation treatment, drainage tunnels, transformer-bench excavation, power-intake excavation, diversion-tunnel modification, and reservoir-clearing.

Libby Reservoir.—The construction of a dam on the Kootenai River in Montana, U.S.A., near the town of Libby, is the last major works to be authorized under the Columbia River Treaty. The reservoir formed by the dam will extend some 42 miles into Canada and will be over 150 feet deep at the border. It is anticipated that impoundment of water will commence during the spring of 1972.

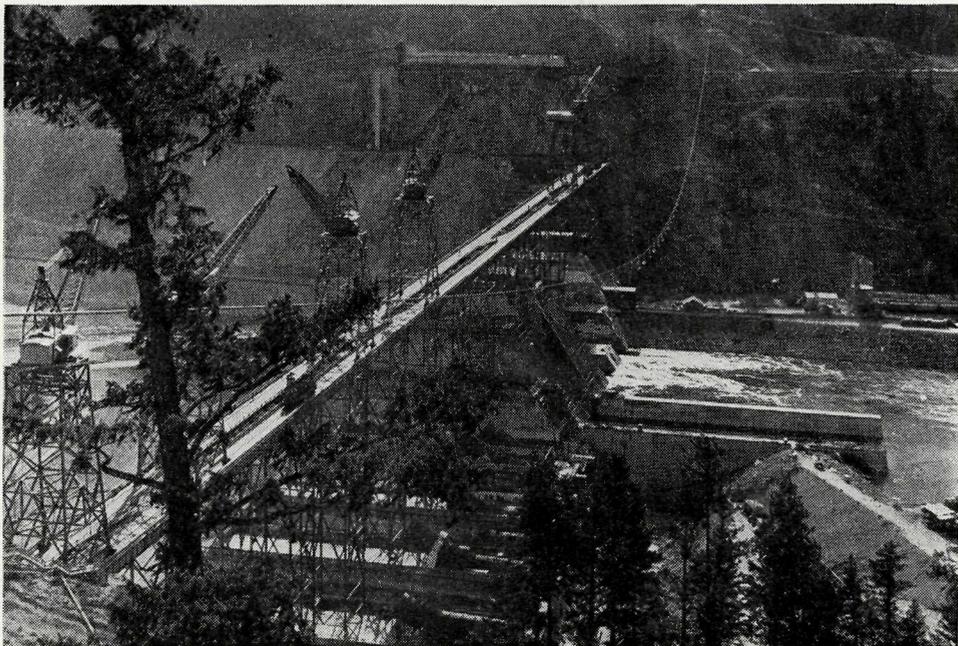
By an Order in Council, the responsibility for preparing the reservoir for flooding was assigned to various branches of the Government: Property acquisition, road relocations, and replacement of highway bridges were assigned to the Department of Highways, while flood-line marking, topographic and cadastral surveys, timber cruising and removal, and the various hydraulic and flowage studies associated with such large-scale inundation of private properties and Crown-owned land were delegated to the Department of Lands, Forests, and Water Resources. The function of co-ordinating the several activities was assigned to the Water Resources Service, and more specifically to the Power and Major Licences Division.

During 1969, merchantable timber mostly from Crown land was removed from the area to be flooded. Logs were decked and periodically sold by public auction. By the end of 1969, 2,300 acres were cleared to specification while 3,800 acres were under treatment; the total area to be cleared is 9,000 acres.

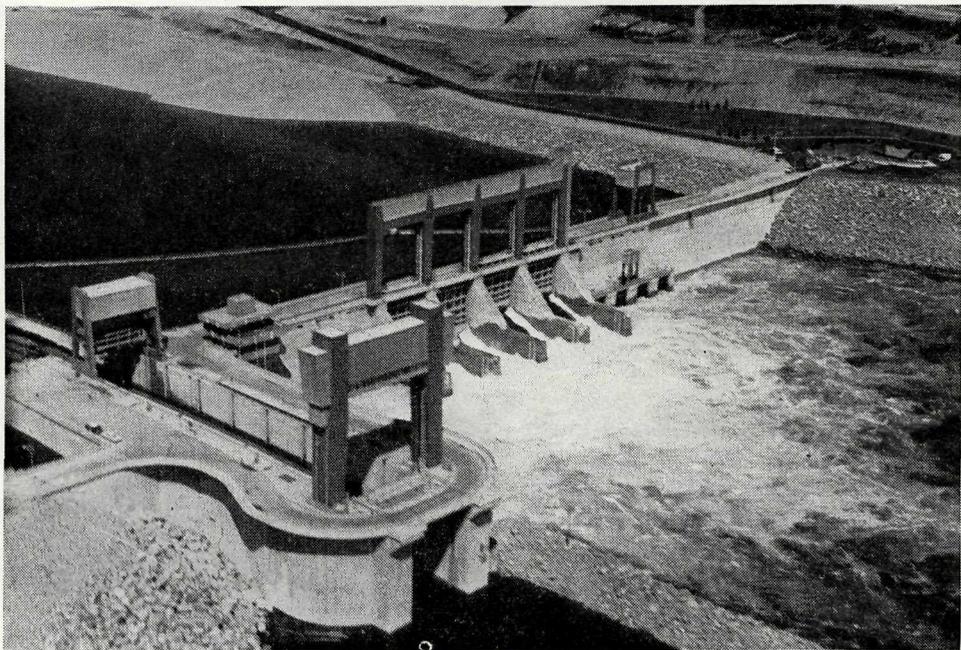
Acquisition of property to be flooded has proceeded rather slowly owing to the protracted nature of negotiations. However, work has commenced on the approaches to the new highway bridge at Wardner; a contract valued at \$1,073,170 was let in September for this purpose. The replacement for the existing Waldo bridge, to be relocated at Kikomun Creek, is at the design stage and is scheduled for construction during 1970; it will form part of the future Southern Trans-Provincial Highway. Survey work for the 22 miles of roads to be relocated in the area is complete and construction will take place during 1970.

Negotiations were concluded between the Province of British Columbia and the Canadian Pacific Railway Company by the signing of an agreement in March, 1969, that the Province would compensate the company in the amount of \$3,200,000 for flooding the railway bridge and track at Wardner. The first of four instalments of \$800,000 was made on April 15th.

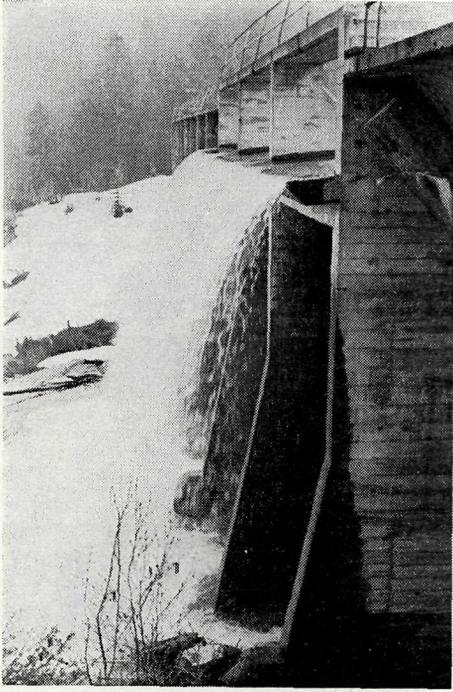
A report from a recreational consultant was received toward the end of 1969. The report indicated the high recreational potential of the reservoir, and suggested



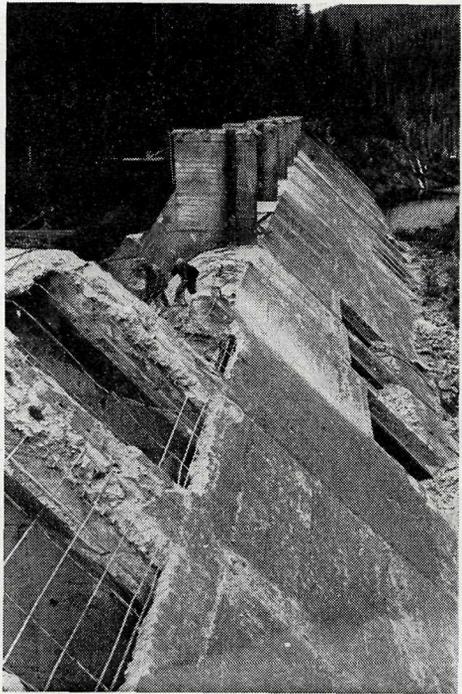
Libby dam.



Hugh Keenleyside dam—official dedication, June 9, 1969.



Henriette Dam on Howe Sound.



Jordan River Dam reconstruction.

specific areas which could be developed for marinas, beaches, picnic-grounds, and parkland. Project cost appraisals will be submitted by the Parks Branch early in 1970 for the prime recreational sites recommended for development.

A joint meeting was held in October, 1969, with the U.S. Corps of Engineers, the authority responsible for Libby development in Montana, to discuss progress and items of common interest and concern.

A soils and geological survey undertaken during the year has revealed that although there may be one or two areas of potential slide, they should not occur suddenly or be large enough to create damaging waves.

Jordan River Redevelopment

The main purpose of the Jordan River redevelopment, which is located some 40 miles west of Victoria and which will add 150 megawatts of plant capacity to the Vancouver Island supply, is to supply Greater Victoria and other Island centres during periods of peak demand.

The redevelopment will extend over three years and includes rehabilitation of two dams, Bear Creek dam and diversion dam, and the construction of a new 117-foot-high 430-foot-long concrete gravity dam at the Elliott site. Water will be diverted from Elliott dam through an 18,100-foot-long power tunnel and a 5,350-foot-long penstock to a new 150-megawatt turbine and generator unit on the right bank of the river, 1,000 yards from the ocean.

In addition to the \$7,498,000 tunnel contract let in 1968 to Emil Anderson Construction Ltd., several contracts were let in 1969 and are tabled below:—

Contract Number	Description	Contractor	Cost
JR-3.....	Turbine and governor.....	Nissho-Iwai Co. Ltd.	\$864,000
JR-4.....	Power plant and Elliott dam.....	Emil Anderson Construction Ltd.	9,547,957
JR-5.....	Generator.....	Mitsubishi Canada Ltd.....	911,251
Total.....	\$11,323,208

Contracts have now been let for over two-thirds of the \$27,500,000 redevelopment project. As well as the contract work being done by outside contractors, considerable rehabilitation work on the two existing dams is being carried out by British Columbia Hydro and Power Authority's own forces. Work is proceeding on all phases of the project and it is expected that the project will be on line in October, 1971.

DAM INSPECTION

During 1969 the dam inspection programme, instituted in 1967, was continued, and a total of 13 field trips was made. Twenty-six major dams and a number of smaller structures were inspected for adequacy and safety, and reported upon. A number of these dams, for instance, Mica Dam, Coursier Lake Dam, and Peachland Dam, were inspected while under construction to insure compliance with the previously approved plans. Other dams such as Fulton Lake Dam and Pentiction Dam were inspected to ensure that initial operations produced no harmful or unexpected effects. The majority of the remaining visits were made as part of the continuing schedule of visits to ensure that adequate maintenance is being carried out and that no untoward conditions develop. As a result of these visits,

recommendations were made to the owners of several of the dams concerning improvements in maintenance practices. Several visits were also made to review the progress of rehabilitation operations being carried out at two dams where such action was considered necessary following the 1967 and 1968 inspections.

Whatshan Plant Rebuilding

On February 2, 1969, the British Columbia Hydro and Power Authority closed down the Whatshan Plant as it was soon due to be flooded out by the rising waters of Arrow Lakes reservoir. Design work is now under way for the construction of a new and enlarged powerhouse at a higher elevation, and it is expected that the plant will resume operation in 1972.

GENERATION AND LOAD GROWTH

Interim Estimate of Electrical Generation in 1969

It is estimated that the total amount of electrical energy produced in British Columbia during 1969 was 26,539 gigawatt-hours.* As is shown by the tabulation below, this total is 12.8 per cent greater than that of 1968; however, due to the fact that a net import of energy during 1968 has given way to a net export of energy during 1969, the percentage increase in load amounts to 8.75 per cent (1½ per cent above the 10-year average).

It will also be noted that the tabulation shows a very considerable shift in emphasis from thermal generation to hydro generation. This is due entirely to the commencement of operations at the Gordon Shrum plant on the Peace River. This plant has now taken over much of the load previously supplied by the Burrard thermal plant.

The tabulation shows that generation by utilities increased by 17.4 per cent during the year; but, when allowance is made for transfers of energy to and from other systems, the rate of load growth is believed to be around 11–12 per cent. The exact figure will not be known until the British Columbia Energy Board's next biennial survey has been completed some time in 1970.

	Generation in Gwh.*		Per Cent Change
	1968	1969	
Utilities—			
Hydro	9,525	13,028	36.8
Thermal	2,848	1,497 (S)	—47.4
Totals	12,373	14,525	17.4
Industries—			
Hydro	9,743	10,530	8.0
Thermal	1,415 (P)	1,484 (P)	4.9
Totals	11,158	12,014	7.6
Total hydro generation	19,268	23,558	22.2
Total thermal generation	4,263	2,981	—30.1
Total British Columbia generation	23,531	26,539	12.8
Net import	800
Net export	170
Total British Columbia load	24,331	26,359	8.75

(P)=Preliminary (based on D.B.S.).

(S)=Station service requirements for British Columbia Hydro's Burrard, Georgia, and Port Mann thermal plants have been deducted from this figure.

* 1 gigawatt-hour (gwh.)=1,000,000 kilowatt-hours.

Growth during Previous 10-year Period

The tabulation below shows statistics for generation and load in the Province over the 10-year period ending in 1968. This shows the over-all percentage increase for the full period and the average growth rates. It should be noted that the latter are compounded rates.

ELECTRIC GENERATION AND LOAD IN BRITISH COLUMBIA, 10-YEAR PERIOD, 1958-68

Year	Electrical Generation in Gwh.			Net Import or Export	Total Electrical Load		
	Hydro	Thermal	Total		Gwh.	Mw.	Per Cent Change
1958.....	11,219	686	11,905	20 (E)	11,885	1,356.7	----
1959.....	11,750	712	12,462	20 (I)	12,482	1,424.9	5.0
1960.....	12,669	965	13,634	4 (I)	13,638	1,556.8	9.2
1961.....	12,371	1,001	13,372	25 (I)	13,397	1,529.3	-1.8
1962.....	13,572	1,176	14,748	9 (I)	14,757	1,684.6	10.1
1963.....	14,262	1,347	15,609	27 (E)	15,582	1,778.8	5.5
1964.....	15,558	1,713	17,271	6 (I)	17,277	1,966.8	10.5
1965.....	15,258	3,238	18,496	456 (I)	18,952	2,163.4	10.0
1966.....	17,043	4,093	21,136	27 (E)	21,109	2,409.7	11.3
1967.....	17,506	4,130	21,636	999 (I)	22,635	2,583.9	7.2
1968.....	19,268	4,263 (P)	23,531	800 (I)	24,331 (P)	2,769.9	7.5
Over-all 10-year increase.....	71.7%	52.1%	97.6%	-----	104.7%	-----	-----
Mean annual increase.....	5.6%	20%	7.1%	-----	7.3%	-----	-----

(E)=Net export to other provinces and (or) United States.
(I)=Net import from other provinces and (or) United States.
(P)=Preliminary figure subject to revision.
Gwh.=gigawatt-hour=1 million kilowatt-hours.
Mw.=1 thousand kilowatts (average output).

USE OF ELECTRONIC COMPUTING EQUIPMENT

Programming for the maintenance of licence and file records on the I.B.M. 360 computer is now complete; however, occasional improvements are being made as found necessary.

A programme for determining the daily spillway discharge under design flood conditions was developed during the past year. Contemplated studies include the compilation of electrical generation statistics, and analysis of backwater effects of dams and reservoirs.

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

The Power and Major Licences Division is responsible for providing technical support to the British Columbia member of the Permanent Engineering Board. Among the several functions required under the terms of the Columbia River Treaty, the Board has to report to the Governments of Canada and the United States of America on progress being achieved under the treaty, to assist in reconciling differences between the development agencies of the two nations (termed the "Entities"), and to assemble flow records of the Columbia and Kootenay Rivers at the International Boundary.

The Chief of the Power and Major Licences Division is the nominated alternate member to Mr. A. F. Paget, the member representing the Province, with responsibility to assist the member in the performance of his duties and to take his place at Board meetings in his absence. In addition, the Chief of the Division is a member of the Permanent Engineering Board Committee, whose function it is to assist the Board in considering proposals and operating plans received from the Entities.

A meeting of the Board was held in Victoria in May, 1969, to discuss progress of project construction and of Entity studies; a joint meeting was held with the Entities on the same day to review study progress. The Board visited the Mica and Libby projects in August to assess construction progress.

STATISTICAL ANALYSIS OF WATER LICENSING

As these statistics are generally not subject to changes of any appreciable consequence from year to year it is proposed that tabulations indicating licensed water volumes and rates of flow for various uses by the various districts in the Province be prepared every alternate year, or as often as appears desirable. Accordingly, the tabulations shown in the 1968 Annual Report of the Water Resources Service may be referred to for current usages. Agencies having need of more detailed information may apply to the Comptroller of Water Rights.

WATER INVESTIGATIONS BRANCH

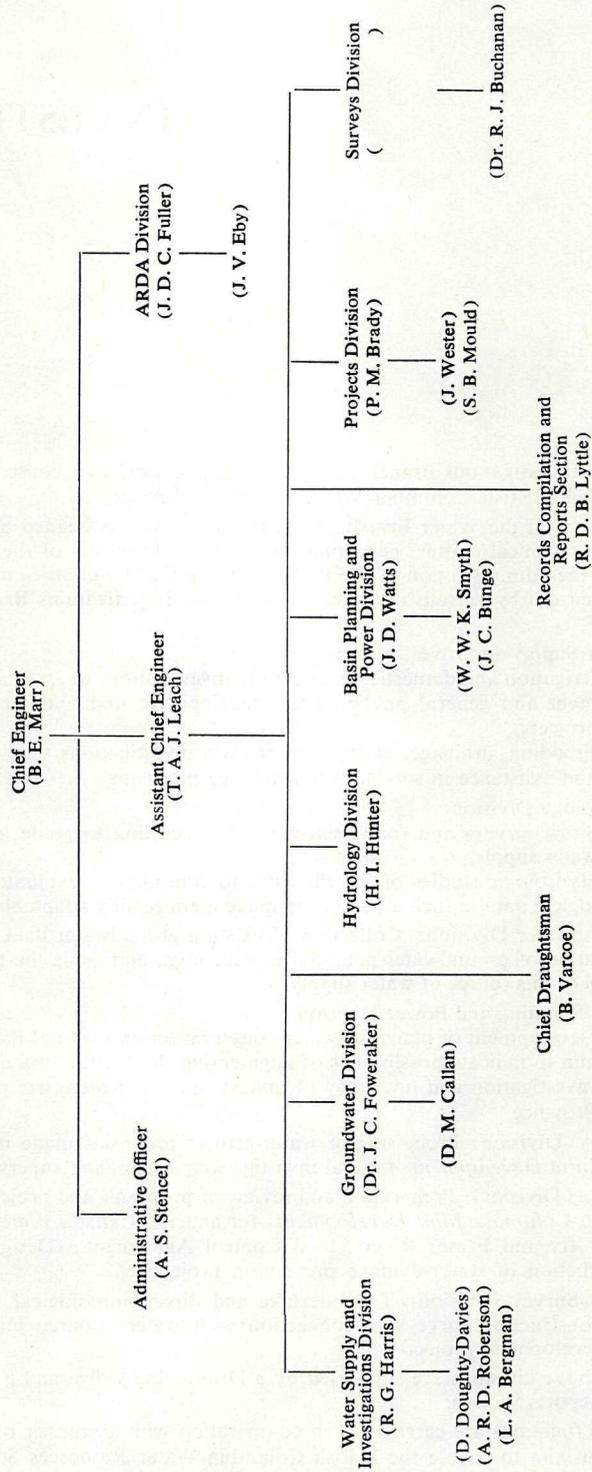
The Water Investigations Branch was formed in late 1962 as a consequence of the creation of an independent British Columbia Water Resources Service.

The functions of the Water Investigations Branch, which is headed by the Chief Engineer, are to deal with technical matters pertaining to the water resources of the Province not directly connected with the administration of the *Water Act* and the *Pollution Control Act, 1967*. These functions, carried out by various divisions of the Water Investigations Branch, are briefly summarized below.

- (1) Water Supply and Investigations Division:
 - (a) Irrigation and domestic water-supply investigations to assist and advise the Department and general public in the development and maintenance of water-supply projects.
 - (b) Flooding, drainage, and stream-erosion investigations to give engineering advice and assistance in solving water-damage problems.
- (2) Hydrology Division:
 - (a) Snow surveys and snow-melt run-off forecasting to guide judicious utilization of water supply.
 - (b) Hydrologic studies of the Province to compile and evaluate basic hydrometeorological data in such a form as to make them readily adaptable.
- (3) Groundwater Division: Collection of existing groundwater data and investigation and evaluation of groundwater potential to encourage and guide the future use and conservation of this source of water supply.
- (4) Basin Planning and Power Division:
 - (a) Development of plans for water conservation on regional basis with an immediate aim to indicate possibilities of augmenting the existing water supply.
 - (b) Investigation and inventory of undeveloped hydro-electric power potential of the Province.
- (5) ARDA Division: Processing of water-project proposals made under the *Agricultural and Rural Development Act* and investigation, design, and supervision of projects.
- (6) Projects Division: Preparation and review of proposals and projects under the *Canada-British Columbia Joint Development Act* and the *Canada Water Conservation Assistance Act* and Fraser River Flood Control Agreement. Design and supervision of construction of water-damage prevention projects.
- (7) Water Survey Division: To undertake and direct limnological, ecological, hydraulic, and construction surveys in connection with water-resource planning, investigations, and development projects.
- (8) The above divisions are supported by a Draughting Office and a Records Compilation and Reports Section.

The above functions are carried out in co-operation with a number of other Governmental agencies with an aim to enable the British Columbia Water Resources Service to foster better use of water resource, which is one of the principal physical foundations of the economic development of the Province.

ORGANIZATION CHART OF THE WATER INVESTIGATIONS BRANCH, YEAR ENDED DECEMBER, 1969



**WATER
INVESTIGATIONS
BRANCH**

B. E. MARR, P.ENG.
CHIEF ENGINEER

The Water Investigations Branch was created in December, 1962, and deals with technical matters related to the water resources of the Province, which matters are not directly connected with the administration of the *Water Act* and the *Pollution Control Act, 1967*.

To carry out Branch functions, a number of divisions have been formed and a detailed account of their activities in 1969 is given in the following pages. Also included are reports on the operation of the Draughting Office, Records Compilation and Reports Section, and the Reports Library. The latter two offices also perform certain services for the other Branches of the Water Resources Service.

A major change in personnel occurred in 1969 with the appointment on April 1st of Mr. V. Raudsepp to the position of Deputy Minister of Water Resources. Mr. Raudsepp had been Chief Engineer of the Water Investigations Branch since its formation in 1962, and under his direction the Branch has grown and matured in meeting the challenges associated with water-resource management in British Columbia.

The Water Investigations Branch continued to be involved in water projects under the Federal-Provincial ARDA programme (*Agricultural and Rural Development Act*). The total number of approved projects in this category now stands at 56, with an aggregate construction cost of \$26,000,000. Of these, 31 have been completed at a cost of \$20,500,000 and 25 are under construction. A further 31 are under various stages of study.

The Water Investigations Branch is responsible for processing and implementing approved projects under the Canada *Water Conservation Assistance Act* by providing engineering services and by inspection of project execution. The three projects approved to date involve some \$4,400,000 of construction work, with contracts in the amount of approximately \$1,400,000 being let in 1969.

The signing of the Federal-Provincial Fraser River Flood Control Agreement in May, 1968, has resulted in a considerable increase in Branch activity in this field. Under the Agreement, senior staff members are involved in the Joint Federal-Provincial Board and Committee set up to administer the Agreement, and also in special study groups established to set design criteria. The Province is responsible for implementing the construction aspects of the programme, and this will involve expenditures in the order of \$40,000,000 over the 10-year life of the Agreement. It is anticipated that the first construction contract will go to tender early in 1970.

Over the past several years, Mr. T. A. J. Leach, Assistant Chief Engineer, has directed studies on a proposal to augment Okanagan Valley water supply by diverting water from the adjacent Shuswap River basin. This has resulted in several preliminary reports on alternative possible diversion arrangements and their downstream results. This work has continued in 1969 and the importance of the Okanagan Basin water resource problems was given added and broader recognition by

the signing of the Canada-British Columbia Okanagan Basin Agreement on October 29, 1969. This Agreement provides for testing of water-resource planning techniques for comprehensive studies in the Okanagan River basin on water quality and quantity under a Federal-Provincial Consultative Board and Study Committee. In anticipation of the signing of the Agreement, the Water Investigations Branch has been active in some preliminary work related to these studies.

The Water Supply and Investigations Division, under Mr. R. G. Harris, continues to carry a heavy work load. In addition to its field survey work and flooding and erosion studies, the Division has been involved in the rehabilitation of a number of irrigation systems under the ARDA programme. Among major construction projects now under way is the final design and construction of the Black Mountain irrigation system with Mr. L. A. Bergman, engineer in charge, assisted by Mr. K. N. Pleasance, and the rehabilitation of the Winfield and Okanagan Centre irrigation system with Mr. P. W. Newson being assisted by Mr. J. C. Kwong. A major project under preliminary study by Mr. J. H. Doughty-Davies is the South East Kelowna Irrigation District system. The year 1969 also saw a start being made on the Peachland Irrigation District system and the construction of the second phase of the rehabilitation of the Westbank Irrigation District system. Staff changes in 1969 included the resignation of Mr. J. H. Morley, Hydraulic Engineer, who returned to university, with Mr. J. C. Ngai and Mr. E. V. Payne joining the Division as Hydraulic Engineer and Assistant Hydraulic Engineer respectively. Mr. S. B. Mould continued to work out of the field office at Oliver.

The Hydrology Division, under Mr. H. I. Hunter, continues to expand the snow-survey network providing basic data for the good management of the water resources of the Province. The performance of the field technicians in the installation and servicing of remote stations in mountainous regions is particularly noteworthy. The run-off forecasting procedures that have been developed are of great value in the operation of water facilities throughout the Province. Hydrology studies both on a basin and regional basis are becoming an increasingly important aspect of the Division's work and this trend is expected to continue. Mr. A. Pipes left the Division to take up an appointment on the research staff at the University of British Columbia and was replaced by Mr. D. E. Reksten, Hydraulic Engineer. Mr. C. H. Coulson, Hydraulic Engineer, is responsible for the preparation of the Snow Survey Bulletin which is issued six times each year. The Hydrology Division was responsible for local arrangements in connection with the Seventh Canadian Hydrology Symposium held in Victoria in October.

The Groundwater Division, under Dr. J. C. Foweraker, continued the expansion of the groundwater-observation network and water-well inventory, and data now available from this Division is much used by outside agencies. Another important aspect of the Division's activity is advising and assisting other Departments of Government on their groundwater problems. The added work load of preliminary drilling and water-quality sampling in the Okanagan Valley preparatory to the signing of the Okanagan Basin Agreement has kept the Division fully occupied this year. The available manpower was stretched to the limit with the resignation of Mr. J. P. Parry, Geological Engineer, to take up an overseas appointment, and a continuing engineering vacancy from the previous year. Mr. P. L. Hall joined the Division late in the year and Mr. D. M. Callan was promoted to Senior Hydraulic Engineer.

The Basin Planning and Power Division, under Mr. J. D. Watts, has continued field investigations and office studies of the hydro-power potential of the Liard River as its major project this year. Work has also progressed on a number of planning

and other studies in connection with water use throughout the Province. The Division lost Mr. R. A. Pollard through promotion to another Branch and late in the year Mr. R. W. Nichols joined the Division as a Hydraulic Engineer. Mr. J. C. Bunge was promoted, joining Mr. W. W. K. Smyth as Senior Hydraulic Engineers.

The ARDA Projects Division continues to handle ARDA water projects, under Mr. J. D. C. Fuller as Division Chief and Mr. J. V. Eby, Construction Engineer. The Division lost Mr. N. I. Guild through resignation but was strengthened by the addition of Messrs. E. W. D. Bonham and G. S. Sutherland, who join Mr. N. M. Morison and Mr. H. H. Nesbitt-Porter as Hydraulic Engineers and Mr. J. P. L'Aventure, Assistant Hydraulic Engineer. Six ARDA projects were essentially completed during the year and major projects in the process of construction include the Southern Okanagan Lands Irrigation District rehabilitation and the Vernon Irrigation District system. The work of the Division now includes the construction of projects under the Federal-Provincial Fraser River Flood Control Agreement, and this has placed an additional load on senior staff.

The Projects Division was very active this year in the design and construction of a number of river-training and flood-control projects. This Division is also deeply involved in the Fraser River flood-control programme and has prepared a number of studies in establishing design criteria. Senior staff members have the additional responsibility of serving on committees and study groups in connection with this flood-control programme. Mr. P. M. Brady was appointed Division Chief in May, 1969. There was a staff loss with the resignation of Mr. A. A. MacTaggart, while Mr. B. J. W. Taylor and Mr. R. H. Cameron joined Mr. W. Tempest as Hydraulic Engineers, and Mr. J. Wester continued as Senior Hydraulic Engineer.

The Water Investigations Branch has been involved in a number of water-quality studies and this has led to the appointment to the staff of Dr. R. J. Buchanan, Biologist, in the newly formed Water Surveys Division.

The draughting services of the Water Investigations Branch, under Mr. B. Varcoe, Chief Draughtsman, have continued on a high level although this section has been plagued by a high staff-turnover. The Records Compilation and Reports Section handled an increased volume of work. Mr. A. S. Stencel, who has general supervision over this Section as well as his duties as Administrative Officer for the Branch, is assisted by Mr. D. R. B. Lyttle and staff. The Water Investigations Branch is now in the process of establishing a library for the Water Resources Service, and Miss D. Cogswell is fully occupied in this task.

The Branch acknowledges the assistance received during the year from other Government specialists and outside services in the carrying-out of its functions in the investigation, planning, and development of water resources.

In addition to the activities of the Water Investigations Branch staff, co-operation was continued with the Civil Engineering Department and the Agricultural Engineering and Botany Departments of the University of British Columbia. The Civil Engineering Department receives financial support from the Water Resources Service and is intensifying its teaching and research programme in the field of water resources. The Water Investigations Branch has assisted in this programme whenever possible by providing field facilities and holding discussions with University of British Columbia staff members. A water-quality and algæ survey is being carried out jointly by the Agricultural Engineering and Botany Departments. The facilities of the British Columbia Research Council, Biology Division, have also been called upon from time to time throughout the year in connection with water-resource problems.

The increase in joint Federal-Provincial activities recorded in 1968 continued in 1969. The implementation of the Fraser River Flood Control Agreement has involved a number of meetings and discussions. Discussions have also been held on a number of occasions with the Federal Department of Energy, Mines and Resources in connection with the Okanagan Basin Study Agreement which was finally signed on October 29th. A market study in connection with the hydro-electric potential of the Yukon River by diversion to tidewater in Alaska or British Columbia has involved meetings with representatives of Canada and the State of Alaska.

The issuing of the Letters Patent in connection with the formation of the Okanagan Basin Water Board is noted. This Board, being a local policy body, is expected to act in an advisory capacity in connection with water problems in the Okanagan Basin.

Senior members of the Water Investigations Branch continued to participate in a number of committees dealing with water-resource matters, including ARDA committees, the National, Provincial, and Screening Committee for the International Hydrological Decade, the IHD Hydrology Subcommittee of the National Research Council, Co-ordinating Committee for Hydrometeorological Networks, the Board and Committee in connection with the Fraser River Flood Control Agreement, the Board and Committee in connection with the Okanagan Basin Agreement, Land Use Working Committee, and Mines Reclamation Act Technical Committee.

At year-end, the Water Investigations Branch staff consisted of 62 permanent and 44 continuous temporary positions. Among these there were 33 civil engineers, four geological engineers, one hydrometeorologist, and one biologist. There were 11 vacant positions.

WATER REQUIREMENTS IN THE OKANAGAN AND SOUTH THOMPSON RIVER BASINS

T. A. J. Leach, P.Eng., Assistant Chief Engineer

The 1966 preliminary report on the Shuswap River-Okanagan Lake water-supply canal and the subsequent report of 1967 dealt with the effects on the discharges of the Shuswap River and South Thompson River under present water-use conditions.

A third report, completed in July, 1968, entitled "Present, Future, and Ultimate Water Requirements in the South Thompson Watershed and Their Effects in Combination with the Shuswap River-Okanagan Lake Water Supply Canal Diversion (Scheme 3)" extended this examination to a time when consumptive use within the northern watersheds would be many times that presently occurring. The conclusions were, however, that even with a maximum total consumption in a drought-year under the ultimate development of about 900,000 acre-feet (including the canal diversion of 300,000 acre-feet), there remains a residual drought flow of 12½ million acre-feet in the Thompson River through Kamloops, which exceeds the future water-supply needs of this region of the Province. The effect on fishery of such development was not assessed.

Subsequent to the release of the above-mentioned report, the Lumby Chamber of Commerce and Agriculture and the Lumby District Agriculture Society submitted a petition to the British Columbia Minister of Agriculture for an economic and feasibility study of the development of storage in Sugar Lake rather than Mabel Lake which, in turn, was referred to the British Columbia Water Resources Service, Department of Lands, Forests, and Water Resources.

The petition also proposed the construction of an irrigation system using Sugar Lake storage for irrigation under pressure to Cherryville, Mabel Lake, Lumby, Lavington, Vernon, and Armstrong areas. In effect, the petition proposed an

entirely new system with storage at Sugar Lake and a gravity canal from Sugar Lake to the Okanagan via Lumby and Lavington, with a feeder-line to Armstrong and Enderby.

The inclusion of an investigation of the feasibility of a canal directly from Sugar Lake expanded the original objectives of the Water Resources Service study. This investigation had been initially limited to a replacement of all or part of Mabel Lake storage by a reservoir at Sugar Lake, while still retaining the same canal location between Enderby and Okanagan Lake.

It will be noted that with storage at Sugar Lake, a further third location for the canal should also be considered, namely, a pumped water supply from the fore-bay of the British Columbia Hydro and Power Authority Shuswap Falls Plant. The pumped water flowing westward through Lavington Pass would follow the same location in this reach as the gravity canal from Sugar Lake.

The following schemes, therefore, have been investigated with respect to the Shuswap River diversion:—

Scheme Designation	Canal Location	Storage Reservoirs	Remarks
E.....	Enderby to Okanagan Lake by gravity or low-lift pumping (35 feet)	Mabel Lake and (or) Sugar Lake	Variations of previous Scheme 3.
SF.....	Shuswap Falls to Okanagan Lake Watershed by high-lift pumping (380-foot static head)	Sugar Lake storage	New scheme.
SL.....	Sugar Lake to Okanagan Lake Watershed by gravity	Sugar Lake storage	New scheme as proposed by Lumby brief.

Under the three diversion locations at Enderby, Shuswap Falls, and Sugar Lake, varying storages have been assumed for Sugar Lake by itself (including the present storage of 100,000 acre-feet) as well as in combination with storages on Mabel Lake in an attempt to meet the same objectives as obtained under Scheme 3, namely:—

- (1) Provide water each year for the North Okanagan in the amount of approximately 100,000 acre-feet.
- (2) In addition to the basic requirements in (1), to supply additional supplementary water to Okanagan Lake in years with below-average inflow up to 200,000 acre-feet in an extreme drought-year.
- (3) Provide adequate minimum residual flows in the Shuswap River at Enderby, particularly during the irrigation season (April to September, inclusive), after meeting the above objectives as well as providing for the future and ultimate water requirements within the Shuswap River Watershed.
- (4) Where possible, to create additional benefits, including flood control and in the case of the double reservoir schemes with storage limited to 100,000 acre-feet at Mabel Lake, to regulate the water fluctuations there much as they have occurred in the past for the benefit of recreation.

In the case of the Sugar Lake or Shuswap Falls diversions, the cost of serving water from the proposed canal to the Lumby area has been compared with the cost of servicing these areas from local sources. The latter information originally determined in 1961 in the British Columbia Water Resources Service Report 593, entitled "North Okanagan Irrigation and Domestic Water Supplies, Volumes 1 and 2," has been revised to conform with 1968 prices and interest rates. Similarly, the Hilton gravity supply-project costs as well as the North Armstrong project have been re-estimated to illustrate typical irrigation costs in these regions.

All scheme operations have been examined over a 40-year period (1921–1940 and 1947 to 1966) and under the projected future and ultimate consumptive use within the Shuswap River watershed. In addition, the degree of flood control afforded by the various reservoir combinations as well as their effect upon the hydro-power generation at Shuswap Falls have been determined.

Low-elevation air photography at approximately 500 feet to 1 inch was obtained during the first week of June, 1969, of the Shuswap River, which will form a basis for the evaluation of flood-control benefits that might be realized from the various schemes.

From preliminary figures, it is evident that any diversion from Sugar Lake or Shuswap Falls would be several times the cost of the equivalent diversion from Enderby under Scheme 3. Further to this, the servicing of irrigable land within the Shuswap River Basin can best be done from local water sources at costs no greater, and in many cases less, than a diversion from the proposed Sugar Lake canal.

Federal-Provincial Okanagan Joint Planning Study

During the latter part of 1968 the Province accepted a proposal by the Federal Department of Energy, Mines and Resources to undertake a joint planning study of the Okanagan Basin water resources which the Federal agency wished to carry out to gain experience in water-resource planning.

In order to expedite this work prior to the signing of an agreement, three committees were formed early in the year. Through this early planning it was possible to start an inventory of water-quality input to the Okanagan Basin and to expand the previous work along this line initiated several years ago by the British Columbia Water Resources Service.

On October 29, 1969, the Canada-British Columbia Okanagan Basin Agreement was signed by the Federal Minister of Energy, Mines and Resources and the Provincial Minister of Lands, Forests, and Water Resources.

The agreement calls for the expenditure of two million dollars over the next four years, equally shared between the two governments. It is stated that "the purpose of this Agreement is to develop a comprehensive framework plan for the development and management of water resources for the social betterment and economic growth in the Okanagan Basin."

It goes on to state that "the study will also embrace any areas likely to be affected by the adoption of the various alternative solutions, including, but not limited to, the possibility of diverting water from the Shuswap-Thompson Basin."

Discussions are now under way to implement this Agreement.

WATER SUPPLY AND INVESTIGATIONS DIVISION

R. G. Harris, P.Eng., B.C.L.S., Chief of Division

The functions of the Water Supply and Investigations Division can be divided into two main divisions—(a) irrigation and domestic water-supply projects; and (b) flood- and erosion-control and drainage projects. In addition, this Division is responsible for the major field surveys required by Water Investigations Branch Divisions.

During the past year, investigations were continued or initiated on five water-supply projects and seven flood- and erosion-control projects. Of the water-supply projects, construction was continued or initiated on five under the ARDA programme, involving the preparation by this Division of final design, including con-

tract documents. The total estimated capital cost of the projects under construction, with which this Division is involved, is approximately \$6,500,000.

Technical staff attached to the Division were responsible for field surveys for the projects under construction for both the obtaining of engineering data and the layout of design, and the supervision of construction.

The main projects dealt with in 1969 are summarized below.

WATER-SUPPLY PROJECTS

Black Mountain Irrigation District

The Black Mountain Irrigation District, which includes the community of Rutland, is one of the major fruit-growing districts in the Okanagan Valley, consisting of approximately 5,000 acres of irrigable lands.

At the request of the district, an engineering study was carried out on a combined irrigation and domestic-water supply system to replace the existing open flume and ditch system. A report prepared by the Water Investigations Branch in 1965 outlined a new water-supply system to supply water under pressure to some 4,550 acres of irrigable lands, and 530 farm domestic connections from the proposed Gopher Flats reservoir, supplied from the existing intake on Mission Creek through 3.5 miles of open canal. The proposed project, with an estimated capital cost of \$3,030,000, was approved for ARDA assistance in 1966.

In view of the continuing development of the area, the district subsequently expressed concern over possible contamination of its water supply in the 3.5 miles of open canal, and of possible algæ problems associated with the proposed Gopher Flats reservoir. An alternative scheme was therefore investigated, proposing the construction of a large settling-basin at the Mission Creek intake and providing a closed system from the intake to the distribution system. The revised scheme, which effected considerable changes in the distribution-system layout and provided for higher operating pressures and a larger peak carrying capacity, was accepted by the district and approved by ARDA authorities.

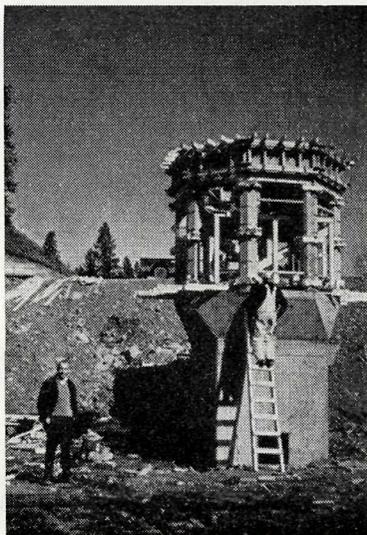
The new system, at the original estimated cost of \$3,030,000, will provide irrigation water to approximately 4,900 acres of farm lands and year-round supply to over 600 domestic connections in the district. Four years have been estimated to complete the project, which involves considerable improvements and repairs to the district's storage and diversion works, in addition to the construction of the settling-basin and distribution system. The latter consists of over 40 miles of pipeline in sizes from 4- to 48-inch diameter, several pressure-reducing stations, three booster-pump stations, and a chlorination and flow-recording station. Domestic and irrigation water will be provided from Mission Creek, with emergency and (or) stand-by winter domestic supply from two wells in the Rutland area.

The distribution system in the Rutland Flats area, which consists of approximately 14 miles of 4- to 24-inch-diameter pipe and 350 service connections, was installed in 1968. The Nickel Road Pump Station, completed during the fall of 1968, supplied this area with domestic water through the winter of 1968/69. A 20,000-gallon storage reservoir, the Cornish Road Pumping Station, and two booster pumps, all constructed in 1969, completed the standby domestic-water supply works. During the winter of 1969/70, approximately one-half of the district will be provided with domestic water through the newly completed part of the water system. This alternate source of domestic supply will permit construction to proceed during the winter of 1969/70 on some of the components of the gravity supply system.

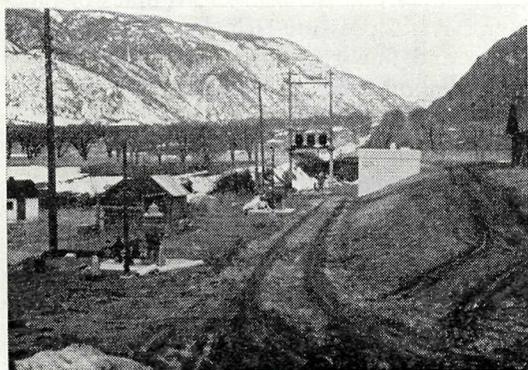
BLACK MOUNTAIN IRRIGATION DISTRICT
INTAKE WORKS ON MISSION CREEK



Settling-basin.



Intake tower.



KEREMEOS IRRIGATION DISTRICT
IRRIGATION PUMPING-UNITS AT EAST SYSTEM
OF WELLS.

The settling-basin earthwork, most of the control works, the main supply line and the two largest pressure-reducing stations were constructed in 1968 and 1969.

The construction of the distribution system in the northeastern part of the district, which consists of approximately 16 miles of 4- to 20-inch-diameter pipe and 300 service connections, commenced in 1969. The chlorinator-booster pump station, another four pressure-reducing stations, and two booster pump stations, along with the 16 miles of distribution pipe, are scheduled for completion for the 1970 irrigation season.

The construction of the new system is being carried out by district forces and will require approximately another two years to complete.

Peachland Irrigation District

The Peachland Irrigation District is situated within the Okanagan Valley, approximately 13 miles south of the City of Kelowna, on the west side of Okanagan Lake. Primarily a fruit-growing area, the district presently supplies irrigation water to about 500 acres of farm lands. The boundaries of the district enclose a total area of about 1,480 acres, of which 640 acres are classified as suitable for agriculture.

The original system was installed in 1906 by the Peachland Townsite Company. However, as the service and water supply proved to be inadequate, the land-owners purchased the system in 1920 and subsequently incorporated the area into an improvement district under the British Columbia *Water Act*.

The Peachland Irrigation District is supplied with irrigation water from Peachland Creek by a gravity system, supplemented by upstream storage released from Peachland Lake and Wilson Lake reservoirs. Domestic water is supplied from individual springs and wells, or from cisterns filled from the irrigation system. In general, the system has reached the end of its useful life, and, in addition, it does not meet the present requirements of the district for the supply of irrigation and domestic water.

In July, 1965, the district requested that a study be carried out to consider the feasibility of replacing the present irrigation system with a combined irrigation and domestic system. Field surveys were carried out in 1966, and subsequent mapping of the district and storage reservoirs was completed in 1967. The preliminary report in 1968 indicated that the capital cost for a new water system would be approximately \$648,000. Financial assistance under the ARDA programme was secured in June, 1969.

A short description of the proposed water system is as follows: The intake on Peachland Creek consists of an earth-fill dam 17 feet high, creating a headpond with a capacity of 16 acre-feet. The distribution system consists of approximately 62,000 feet of pipe-line of sizes 4- to 24-inch diameter, two booster stations, five pressure-reducing stations, and a chlorinator.

The first phase of construction, comprising the clearing of the intake site and the grading of the main supply-line, commenced in July of 1969. By the end of 1969 excavation of the pond area was completed and the material used to construct the earth-fill dam. In addition, a portion of the main supply line was also completed.

The construction of the new system is being undertaken by the district's own work force and will require approximately two years to complete.

Sion Improvement District

In 1969 the Branch prepared a report for the Sion Improvement District at Grand Forks on the feasibility of extending service to properties within Lot 700, a

section of land lying between the two areas that form the present district. Service would be provided to 88 acres of irrigable land and 77 residential connections.

The North Grand Forks and South Grand Forks areas of the Sion Improvement District are served by independent water systems, installed in 1968. The properties within Lot 700 could be served by an extension from the North Grand Forks system which, in addition, could provide an interconnection to the South Grand Forks system of the improvement district. The interconnection would be a desirable feature for balancing demands between the two existing systems and for allowing over-all demand to build up over a longer period before additional well capacity is required.

Because of the present small demand on the existing systems, a two-stage development is indicated. Stage One would cover the construction of the distribution system for Lot 700 and the interconnection to South Grand Forks, and would cost an estimated \$58,900. Stage Two, which may not be required for a number of years, envisions the construction of a new well and pumphouse when the demand of the combined system grows beyond the present supply capability. It is estimated that Stage Two could be implemented in 1980 for about \$66,000.

South East Kelowna Irrigation District

The South East Kelowna Irrigation District, incorporated as an improvement district under the *Water Act* in 1920, contains an area of about 8,627 acres with over 3,000 acres under irrigation, mainly in tree fruits. The original works were installed by private companies during the period 1905 to 1911.

Gravity water is supplied to the district by two irrigation systems of about equal size in area and one domestic system. The irrigation system to the east is commonly referred to as the K.L.O. system with an intake on Canyon (K.L.O.) Creek, while the irrigation system to the south is known as the S.K.L. system with an intake on Hydraulic Creek. The domestic system, with an intake on Canyon Creek and serving about 200 farm connections, supplies the central area within the K.L.O. irrigation system. The remaining areas are served by springs or cisterns.

Commencing in 1964, and continuing through 1968, partial renewals financed under the ARDA programme have been carried out under three projects, work being mainly done on the S.K.L. system, with lesser expenditures on the K.L.O. and farm domestic systems.

In 1967 engineering assistance was requested for the design of a settling-basin, which has been included in the estimates for the third ARDA project. The purpose of the basin was to desilt the water being diverted from Canyon Creek for use in the K.L.O. system. During freshet periods, Canyon Creek carries a heavy bed load of sand and silts, causing excessive wear on irrigation equipment. The basin, which was constructed during the latter part of 1968, accommodates a maximum design flow of 50 cubic feet per second.

The fourth project under the ARDA programme was initiated in June, 1967, when the South East Kelowna Irrigation District requested the Water Investigations Branch to prepare a preliminary report for the proposed rehabilitation of the main concrete ditch and steel siphon across Canyon Creek and to survey a proposed storage reservoir for farm domestic supply. This project was expanded in January, 1968, when the district requested engineering studies be carried out on the rehabilitation of the existing Canyon Creek dams, the development of additional storage at the Turtle Lake reservoir-site, and reconstruction of No. 9 Dam on Hydraulic Creek, and further replacements in the diversion and distribution system.

Subsequently, it was proposed to establish a new intake on Hydraulic Creek and to construct a fully pressurized combined irrigation and domestic system.

In connection with this latter proposal, field surveys have been carried out covering the main diversion systems and storage reservoirs, including all existing reservoirs supplying storage water to the district.

Processing of this information was completed by November, 1969, and it is expected that a preliminary report with estimates of cost will be completed in early 1970.

Westbank Irrigation District

The Westbank Irrigation District, which includes the Townsite of Westbank, is situated approximately 7 miles south of the City of Kelowna, on the west side of Okanagan Lake.

During the period 1958 to 1963, the district carried out partial rehabilitation of the existing distribution system by financing renewals from the Renewal Reserve Fund. However, in 1964, faced with immediate and costly replacement of the remaining portions of the distribution system, including major improvements to the storage works, the district applied for ARDA assistance.

The construction of a concrete intake dam and screening works, and the installation of 7,000 feet of 34-inch-diameter steel pipe-line, represented the first phase of rehabilitation of the district's works under the ARDA programme. This project was completed in April, 1966, at a capital cost of \$160,000.

The second phase of rehabilitation includes the replacement of the district's distribution system with about 70,000 feet of pipe-line, to provide approximately 1,500 acres of irrigable land with a combined irrigation and farm domestic supply. To provide the annual water requirement of 4,200 acre-feet, Lambly (Bear) Lake and Islaht (Horseshoe) Lake dams will be reconstructed to provide additional storage. In addition, Dobbin Lake, West Lake, Paynter Lake, and Jack Pine Lake dams will be improved to provide adequate freeboard and capacity.

The 1,500 acres of irrigable land is composed of approximately 1,000 acres within the Westbank Irrigation District and 500 acres within the Powers Creek Water-users Community, which is to be incorporated into the Westbank Irrigation District.

At the present time, the settlement of Westbank and a number of farms within the irrigation district are being provided with domestic service from a system installed by the Westbank Waterworks District. This district has now been amalgamated with the Westbank Irrigation District, and the domestic service will be provided from the new system.

During 1969, approximately 38,000 feet of pipe-line was installed, including the main supply-line and distribution system for the area formerly served by the Powers Creek Water Users' Community and the major portion of the main supply line for the area within the Westbank Irrigation District.

In addition, the reconstruction of storage works on Lambly (Bear) Lake reservoir, including the diversion from Paddle Creek, was nearly completed.

It is expected that reconstruction of the storage works and replacement of the distribution system will be completed in 1970.

Winfield and Okanagan Centre Irrigation District

The irrigation and domestic system now operated by the Winfield and Okanagan Centre Irrigation District was constructed in 1909 by a private company. Incorporated in 1930, the district took over the system in 1949. To provide additional irrigation supply over the original entitlement of 1 acre-foot per acre from Vernon

Creek, in 1931, the district developed 2,445 acre-feet of storage in Crooked Lake, and in 1944 reconstructed Swalwell Lake dam to provide an additional 9,585 acre-feet of storage to supply approximately 1,900 acres of orchard land and about 300 domestic connections.

Following approval of a preliminary report by the Water Rights Branch in 1965, which recommended extensive replacements, the district was granted financial assistance under the ARDA programme. The renewal plan was amended in February, 1968, to accommodate changes which were found necessary in the course of final design by the Water Investigations Branch. The revised scheme, which will include a new intake and screening works, at a site about 1 mile upstream from the existing intake, will provide irrigation water for 2,113 acres, and domestic water for 350 connections.

The first phase of construction, comprising the rehabilitation of Swalwell Lake and Crooked Lake storage dams, was completed in 1967. Additional work included the improvement of 4,000 feet of diversion channel in Vernon Creek and the building of a new office. By the end of 1968, the distribution system, consisting of 95,000 feet of 4- to 16-inch pipe-line laterals, and about 8,000 feet of 24- to 32-inch main supply-line, was completed.

In 1969, the remaining 28,000 feet of 30-inch main supply-line was installed. At the site of the new intake on Vernon Creek, the clearing and most of the pond excavation have been completed. In addition, a 100-foot-long diversion tunnel, which carries the main supply-line and provides a sluiceway for draining and flushing out the intake pond, was also completed. The tunnel was lined with corrugated metal pipe, pressure-grouted on the outside to seal the pipe, and guniting on the inside for protection of the pipe. A contract has been let for the construction of the concrete intake and screening works.

It is anticipated that this project will be completed by mid-1970.

Fort Nelson Water Supply

In connection with a proposed new water-supply system for Fort Nelson, topographic surveys were carried out along a 1-mile reach on the left bank of the Muskwa River immediately downstream of the Alaska Highway, to ascertain a location for a settling-basin. The survey was carried out for the Improvement Districts Division, Water Rights Branch, which is undertaking the engineering study.

The feasibility of using groundwater as a source of supply, as an alternative to pumping from the Muskwa River, was under investigation by the Groundwater Division of the Water Investigations Branch, which selected locations and supervised the drilling of six test wells in the same general area as the possible settling-basin. Horizontal position and geodetic elevations for these wells were established by the survey party for the Groundwater Division.

WATER-STORAGE RESERVOIR INVENTORY

A programme of mapping major water-storage reservoirs in the Southern Interior of the Province was initiated in 1964. Areas presently included under this programme are the Okanagan and Similkameen Basins and a portion of the Kamloops and Nicola areas. The surveys have included both existing storage reservoirs and potential reservoir-sites. This information has assisted in the administration of water rights and the carrying out of water-supply augmentation studies in the water-deficient areas. It has also been the basis of design in the reconstruction of a number of existing storage dams under the ARDA programme.

Reservoir maps are being prepared by photogrammetry and from field surveys. Subaqueous information is being obtained by the use of echo-sounding equipment.

Of the approximately 118 storage reservoirs presently under licence in the Okanagan Basin, about 100 reservoirs are in operation. Of the total, adequate information is available on 73, mapping is nearing completion on an additional 8, surveys and mapping are pending on 15, and the remaining 23 reservoirs are considered to be too small to be included in the programme. Approximately 16 reservoir-sites have either been abandoned or have not been developed.

The mapping programme for the Similkameen Basin includes about 11 existing and potential reservoir-sites, of which surveys have been completed on the 11 and mapping on 5.

FLOODING, DRAINAGE, AND EROSION PROJECTS

Okanagan Flood Control

In 1964, an extensive survey was made of the Okanagan flood-control works and a report on suggested rehabilitation of the works was prepared. In 1967 this report was revised with the costs updated and this year's run-off conditions presented a further opportunity to study the hydraulics of the Okanagan River.

The high 1969 spring run-off, particularly on some of the major side creeks, raised the flow in the Okanagan River higher than in the previous study-years. Accordingly, the flow in various sections of the Okanagan River channel was metered and the water-surface profile was observed with particular emphasis on the portions of the channel which had been improved. From this field data calculations were made to test the assumptions of the roughness factor for various bottom and side-slope conditions as used in the 1967 report.

It was found that except where there were stop-logs in some of the drop-structures (which gave an artificial back-water curve), the water slopes as observed were very close to the high-water profiles predicted in the 1967 report. Thus, it was possible to conclude that the original roughness factors were correct and a recalculation of the high-water profile was not required.

Lake Windermere

Following representations made by a number of residents living along the shoreline of Lake Windermere in the vicinity of Athalmer, an investigation was made to consider the feasibility and cost of constructing a dam at the outlet of Lake Windermere to control the low water level of the lake to facilitate the launching of boats during the latter part of the summer.

As Lake Windermere has a maximum depth of just over 20 feet and contains numerous shallow bays, the extensive growth of aquatic weeds also presents a problem to boating.

A bathometric survey was carried out along the developed sections of the shoreline of the lake, and the position of the main boathouses was noted on air photographs. In order to study the backwater effect from Toby Creek on the out-flow from Lake Windermere during the spring run-off, four gauging-stations were established on the Columbia River between the lake outlet and the confluence of the Columbia River and Toby Creek. Two gauging-stations were established on Toby Creek as well. The area extending from Lake Windermere to Toby Creek was controlled for photogrammetric mapping in order to study the effect of flooding of low-lying lands from the construction of the proposed control dam.

It is expected that a report will be completed early in 1970.

MISCELLANEOUS SURVEYS

During the summer season, the field survey staff attached to this Division carried out a number of surveys required by the Projects Division of the Water Investigations Branch in connection with erosion, flood-control, and drainage studies.

The main surveys carried out in 1968 for this purpose are summarized below.

Cottonwood Island Flooding

In connection with the flooding problem on the Cottonwood Island area at Prince George, surveys were carried out to gain more information on the nature of this problem. Eleven cross-sections and a thalweg profile were obtained along a 3-mile reach of the Nechako River from the new John Hart Highway bridge to the confluence of the Fraser River. Intensive topography was also obtained in critical areas of the Cottonwood Island Improvement District.

Fraser River Dyking

In connection with the proposed improvements to be carried out to the Fraser River dyking system under the Canada-British Columbia Fraser River Flood Control Agreement, typical channel cross-sections were required covering certain sections of the Fraser River and tributaries, as follows: 58 cross-sections extending over a 58-mile section of the Fraser River, from Barnston Island to Agassiz, and 10 cross-sections covering sections of the Vedder Canal, Alouette River, and Nicomen Slough.

Kettle and Granby Rivers

River cross-sections and profiles were taken on the Kettle and Granby Rivers in connection with flooding problems in the Grand Forks area.

The river sections covered included the Kettle River from the United States' Boundary to a point 20 miles downstream, and the Granby River from the confluence with the Kettle River to a point 2½ miles upstream. Nine gauges previously established by the Projects Division were tied to Geodetic Survey of Canada Datum. In addition, discharge measurements were taken on both rivers, and evidence of flooding and erosion was noted on air photographs.

Pemberton Valley Dyking District

In connection with flooding problems from the Lillooet River and its tributaries in the vicinity of the community of Pemberton, a mapping programme, including detailed surveys, was carried out in 1965 and 1966 by this Division, followed by the preparation of a report in 1967 entitled "Preliminary Report on Pemberton Valley Dyking District Drainage Proposals."

In 1968, the area of investigation was expanded to include the sections of Pemberton Valley extending from the outlet of Lillooet Lake to a point about 16 miles upstream from Pemberton, a distance of approximately 36 miles.

In 1969, to carry out a more detailed analysis of the flooding on the Lillooet River system, including Lillooet Lake, additional hydrometric data were obtained by field surveys, as follows: Location and monumentation and survey of cross-sections of a 22-mile section of Lillooet River extending upstream from Lillooet Lake, and of a 5½-mile section of the Birkenhead River extending upstream from Lillooet Lake; surface and thalweg profiles on Lillooet River for a 22-mile section extending upstream from Lillooet Lake; a bathometric survey of the upper and lower narrows downstream of Lillooet Lake; obtaining water-surface profile for a section of the

Lillooet River below Lower Tenasse Lake; establishing a control network between Lillooet Lake and Lower Tenasse Lake for photogrammetric mapping; and obtaining other miscellaneous information.

Squamish River

Early in 1965 a report entitled "Erosion and Flood Control in the Lower Squamish Valley" was completed, presenting a preliminary proposal for channel stabilization, erosion, and flood-control works in the Lower Squamish Valley, from the Cheakamus River junction south to Howe Sound and including the lower Mamquam River.

In connection with this project, profiles and cross-sections were obtained along the left bank of the Squamish River, extending from the confluence of the Mamquam River to a point 5 miles downstream for proposed dyking of the bank.

HYDROLOGY DIVISION

H. I. Hunter, Hydrometeorologist, Chief of Division

SNOW-COURSE NETWORK

The British Columbia snow-course network continued its expansion in 1969 with the establishment of 24 new and two reactivated courses. With deletion of three courses, the network will have 205 in active operation this coming sampling season. New additions included five in the heavy water-producing Fraser and Thompson headwater regions, one each at the low-level Meteorological Branch weather-reporting stations at Burns Lake and Puntzi Mountain, and one in the Chilcotin region at Big Creek. The six new Columbia sampling-sites include five in Kootenay National Park, where the Federal Parks Branch have initiated a special ecological study in a large burn area, and one on Jordan River drainage close to Revelstoke. Further north, one course was established on Parsnip and one on the Toad River watersheds. On Mainland coastal drainage, courses were located on the Squamish, Toba, Homathko, Wannock, and Bella Coola watersheds, and on Vancouver Island three were located on the Campbell River watershed. Those reactivated were Precipice on the Bella Coola and Elk River on the Campbell River catchments. Courses deleted from the network were Shalalth on the Bridge River and June Lake and Memory Lake on the Puntledge River basins. See following table for details of the 1969 revisions to the snow-course network.

Local snow surveyors representing Provincial, Federal, and private agencies made 733 snow-course measurements at fixed sampling dates during the 1969 build-up and depletion periods with these measurements published in the February 1st, March 1st, April 1st, May 1st, May 15th, and June 1st issues of the British Columbia Snow Survey Bulletin. In addition to this total, 78 special measurements were made prior to and between the six regular sampling dates. Helicopter, light ski-equipped aircraft, over-snow machine, skis, and snowshoes were used to reach the more isolated sampling-sites.

1969 Revisions to the British Columbia Snow-course Network

Number	Name	Elevation	Latitude	Longitude	Basin	Watershed
		Feet				
73	Precipice (reactivation).....	4,000	52° 26'	125° 38'	Coastal	Bella Coola.
79	Elk River (reactivation).....	1,200	49° 51'	125° 49'	Vancouver Island	Campbell.
93	June Lake (deletion).....	3,200	49° 29'	125° 15'	Vancouver Island	Puntledge.
96	Memory Lake (deletion).....	4,200	49° 35'	125° 23'	Vancouver Island	Puntledge.
143	Shalalth (deletion).....	4,800	50° 45'	122° 14'	Fraser	Bridge.
	<i>Additions</i>					
205	Whistler Mountain.....	4,750	50° 03'	123° 00'	Coastal	Squamish.
206	Big Creek.....	3,730	51° 43'	123° 02'	Fraser	Chilcotin.
207	Puntzi Mountain.....	3,100	52° 08'	124° 06'	Fraser	Chilcotin.
208	Mount Copeland.....	5,570	51° 06'	118° 28'	Columbia	Columbia.
209	Mount Roosevelt.....	4,700	58° 28'	125° 22'	Liard	Toad.
210	Adams River.....	5,650	51° 35'	119° 23'	Fraser	Thompson.
211	Burns Lake.....	2,620	54° 14'	125° 44'	Fraser	Nechako.
212	Revolution Creek.....	5,550	53° 47'	120° 22'	Fraser	Fraser.
213	Holmes River.....	6,230	53° 16'	119° 28'	Fraser	Fraser.
214	Azure River.....	5,300	52° 37'	119° 43'	Fraser	Thompson.
215	Penfold Creek.....	5,500	52° 45'	120° 34'	Fraser	Quesnel.
216	Mount Sheba.....	4,900	54° 32'	121° 48'	Peace	Parsnip.
217	Bella Coola.....	4,525	52° 31'	126° 38'	Coastal	Bella Coola.
218	Machmell River.....	4,540	51° 46'	126° 04'	Coastal	Wannock.
219	Tiedemann Glacier.....	4,580	51° 21'	124° 58'	Coastal	Homathko.
220	Toba River.....	5,100	50° 41'	123° 54'	Coastal	Toba.
221	Wolf River (upper).....	4,900	49° 42'	125° 40'	Vancouver Island	Campbell.
222	Wolf River (middle).....	3,500	49° 42'	125° 41'	Vancouver Island	Campbell.
223	Wolf River (lower).....	2,100	49° 44'	125° 42'	Vancouver Island	Campbell.
224	Vermilion River No. 1.....	5,500	51° 12'	116° 04'	Columbia	Kootenay.
225	Vermilion River No. 2.....	5,290	51° 13'	116° 04'	Columbia	Kootenay.
226	Vermilion River No. 3.....	5,150	51° 13'	116° 04'	Columbia	Kootenay.
227	Vermilion River No. 4.....	5,500	51° 13'	116° 04'	Columbia	Kootenay.
228	Vermilion River No. 5.....	5,155	51° 12'	116° 06'	Columbia	Kootenay.

Last winter the Division's three technicians visited 37 courses to provide at-site snow-sampling instruction to local snow surveyors and during the summer completed maintenance work at 56 courses. This field work involved 234 man-days of technician time.

SNOW PRESSURE-PILLOW INSTALLATIONS

This past summer three new pressure-pillow installations were made, with one located at the Mission Creek snow course in the Okanagan, one at the Mission Ridge snow course in the Bridge River region, and one at Seymour Mountain on Vancouver's North Shore watershed. The latter was established for the University of British Columbia's Department of Civil Engineering as part of a snow-melt field research project.

Pillows used by the Division are made of neoprene, 12 feet in diameter, and are 8 inches thick when filled with a 350-gallon mixture of methyl alcohol and water. A rubber hose connects the pillow to a manometer on which a float-actuated recorder is installed. Accumulation of snow on the pillow increases its internal pressure which, in turn, is transferred to manometer and recorder to provide a continuous record of snowpack water equivalent. In addition to the pillow, a thermograph is located at each site which provides a continuous record of temperature. These measurements are expected to prove very useful in the development of forecast procedures for both long- and short-term river flow.

STREAM-FLOW FORECASTING

Several volume forecast procedures were revised and updated, including those for East Kootenay and Upper Columbia stream-gauging stations and for inflows to Powell and Upper Campbell Lakes. Because of future inundation of the Wardner

and Newgate stations by Libby Reservoir, a forecast procedure was developed for Kootenay River at the new Fort Steele gauging-station.

The investigation of hydrometeorological factors affecting Fraser River stream-flow, begun in 1967, was continued. Its objective is to improve both seasonal and daily run-off forecasting methods for use in water-resource management and flood-control operations. Studies completed in 1969 include derivation of spring-summer forecast procedures for several Fraser and Thompson River gauging-stations and derivation of a method for predicting daily flows during the critical snow-melt period. The daily-flow technique is still in a preliminary stage, but has been applied to historical flows for the Fraser River near Marguerite and Thompson River, near Spences Bridge gauging-stations. As a result of these studies, a number of snow courses were installed in areas of the Fraser basin where basic data had previously been lacking.

Just prior to snow-melt run-off last spring, the general snow pack distribution was such that heavier-than-usual snow lay on the lower coastal and Vancouver Island mountain ranges and on watersheds close to the International Boundary, with these snow packs decreasing with increasing latitude and becoming below to well-below average in the central and northern regions of the Province. Accordingly, the quantitative volume forecasts published in the April 1st and May 1st bulletins followed this pattern with above-average snow-melt run-off from the central and northern regions. Stream-flow measurements for the forecast period show that actual volumes were in general agreement with those predicted.

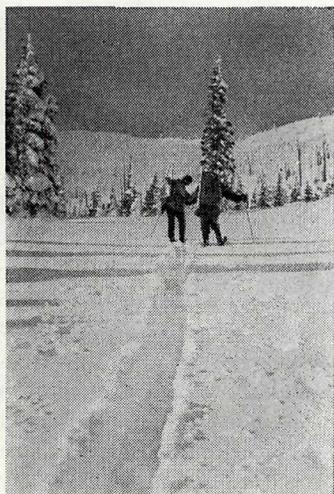
During the freshet period, daily stream-flow data were received for key stream-gauging stations from the Water Survey of Canada, Department of Energy, Mines and Resources. Hydrographs and associated meteorological data were plotted and assessment made of the expected short-term stream-flow. For the important Fraser gauging-stations, the annual peak was lower than usual with this attributed to the below-average basin snow pack and the controlled sequence of melt during the freshet period.

The six issues of the Snow Bulletin were distributed to a mailing-list of some 800 subscribers. In addition to snow-course measurements, these publications contain a written and graphical description of current watershed snow packs, quantitative run-off volume forecasts, and assessment of potential high water on those rivers subject to flooding.

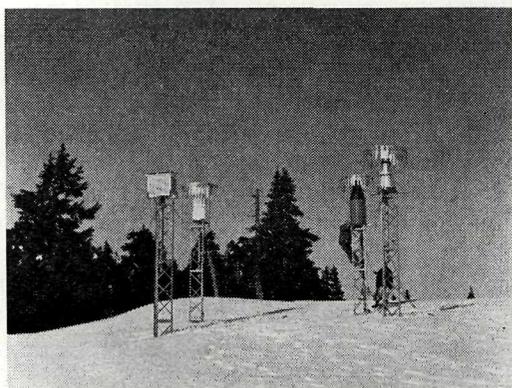
INTERNATIONAL HYDROLOGICAL DECADE PROJECTS

The primary objective of the International Hydrological Decade Study, near Carrs Landing in the Okanagan Valley, is to investigate the interaction between the various components of the hydrological cycle to obtain a more quantitative description of them. In excess of three years of daily hydrological and meteorological data have now been collected, and a complete and up-to-date data listing is being prepared. These records have allowed the development of a fairly comprehensive computer simulation of the fluctuations in the components that describe the daily pattern of water movement on the watershed. The promising results from the synthesis have led to the critical evaluation of the watershed data and permitted revision to the data-collection schedule that should allow further improvement to be made to the analyses.

The ultimate objective of the project is to use the water-balance information, especially during the hydrologically active snow-melt run-off season, to fulfil broader regional water management objectives. Considerable efforts have been made to assess the significance and representativeness of the study in the evaluation of the regional hydrological regime. Application of selected parameters for regional fore-



Snow surveyors en route to Old Glory snow course, elevation 7,000 feet.



Meteorological instrumentation at a summit station on the Beaufort Mountain Range (International Hydrological Decade Project).



Pressure-pillow installation showing pillow and recorder and a Stevenson screen which houses a hygrothermograph and maximum and minimum thermometers. Mission Creek snow course, 6,000 feet, on Okanagan Lake watershed.

cast of water resources has been greatly assisted by the knowledge of the relationship of the parameter to its hydrological environment.

The "Mountain Transect" International Hydrological Decade project with the Federal Meteorological Branch as co-operator, continued in 1969. It was initiated to gain knowledge relative to the distribution of precipitation and temperature over mountainous terrain and hopefully to develop horizontal and vertical relationships which would have regional application.

Meteorological stations have been and are being located along two transects at varying elevations on both windward and leeward slopes of the Beaufort Range on Vancouver Island. This past summer three new stations were established, one each at the low-elevation windward and summit-sites of the second transect and one at an upwind-site in the Kennedy Lake area. Instrumentation at the two transect stations include a digital precipitation-recording gauge, Sacramento precipitation-storage gauge with bubbler system, and a totalizing wind anemometer. At the Kennedy Lake site only a precipitation-storage gauge was installed. A total of nine stations are now operational with eight serviced by helicopter at 20-day intervals throughout the year. The ninth is serviced by ground access and on a monthly basis.

In 1969, office studies included abstraction by Toronto headquarters Meteorological Branch personnel of twice-daily measurements of precipitation and temperature from three transect and from four permanent low-level meteorological stations for period November 1, 1967, to October 31, 1968. Abstracted from nearby rawinsonde stations were 850 and 700 millibar temperatures, relative humidities, components of wind direction and speed, large-scale vertical motion, stability, and precipitable water factors. These data were forwarded to Victoria where they were transferred to IBM data-sheets, key-punched, and used as input in the Division's multiple regression programme. Because of malfunctioning of precipitation recorders due to both mechanical and adverse weather conditions, there were large gaps in the transect station precipitation record. Analyses of results indicate significant relationships for ground temperatures, especially when using radiosonde temperatures as a predictor, but not too significant for precipitation. However, more data are required before these relationships can be properly assessed.

HYDROLOGICAL DATA COMPILATION AND PROCESSING

Our existing hydrometric library, which was compiled manually, is now in the process of revision to a machine listing of each stream-gauging station's historical data. This is required to make the data compatible with the new and corrected tape file of the Water Survey of Canada, the Federal agency responsible for stream-gauging in British Columbia. When completed, an immediate and updated reference print out hydrometric data library will be available for use by Water Resources Service engineers and technicians. Each year the Division co-ordinates all of the Service's new stream-gauging station installation requests and assigns priorities. Maps (1 inch to 10 miles) showing the location of active and inactive all-year stations have been completed for the Province. The Division is the repository for historical hydrometeorological information, which is updated monthly and used by Water Resources Service Personnel. In addition, the Division handles all requests for non-published data. The Deputy Minister and Chief Engineer are responsible for the operation of Okanagan Lake, and to assist them in making outflow decisions a continuous graphical plot is made of Okanagan Lake levels and outflows.

In 1969, the programmer analyst has written or partially written the following programmes:—

- (1) In order to increase operating speed, all of the Division's programmes which make use of tape or disk storage were rewritten to utilize these devices in the unformatted mode.
- (2) A graphical weighting procedure, using the calcomp plotter, has been added to the correlation-analyses programme for developing the best weighting of independent variables. Based on multiple-correlation coefficient values, this procedure plots the relationships between any dependent variable and any three independent variables. This technique was developed by C. H. Coulson, engineer attached to the Division, and will be the subject of an original paper to be presented at the 1970 annual meeting of the Western Snow Conference.
- (3) A programme has been written to generate appropriate snow-course data from the tape file for use in the Snow Bulletin.
- (4) A programme has been written to convert Water Survey of Canada's hydrometric tapes to a form compatible for use in the local computer. In conjunction with this, the programmer is currently working on a revision of the tape data format to a form more suitable for our use, a retrieval programme to extract and print any station's historical data, and development of a mini-tape for use in other programmes.
- (5) In the process of preparation is the programme to list and print the complete back record of each station's data for permanent storage in the Division's hydrometric file. A programme is also being written to list annual revisions and updates to this file.
- (6) In the test stage are programmes to update and correct the snow-course measurement tape file and to list and update the Carrs Landing International Hydrological Decade Study basin basic-data tape file.

MISCELLANEOUS

Special hydrology studies were completed for Upper Campbell Lake on Vancouver Island and for 21-Mile Creek in the Alta Lake region north of Squamish. The objective of the Upper Campbell study was to improve the reliability and accuracy of volume run-off forecasts for this important hydro-electric basin and for 21-Mile Creek to estimate water yield for domestic water supply to the Whistler Mountain resort area.

The Chief of the Division is a member of several active working committees which include the National Research Council Sub-committee on Hydrology, Western Snow Conference Executive Committee, British Columbia Hydrometeorological Networks Co-ordinating Committee, Columbia Basin Forecast Committee, and ARDA Agro-Climatology Committee. He is also a member of the Programme Committee for the forthcoming "International Symposium on the Role of Snow and Ice in Hydrology."

As Chairman of the Arrangements Committee for the Seventh Canadian Hydrology Symposium, the Chief of the Division was responsible for planning and implementing a technical meeting on "Instrumentation and Observation Techniques," which was held October 8 and 9, 1969, in the Empress Hotel. In attendance were some 150 Canadian instrument specialists, representing Federal and Provincial agencies, university science faculties, and private enterprise. Also, preliminary work has been spent in the planning and preparation for the annual meeting of the "Western Snow Conference," which is to be held this coming April in Victoria.

Two technicians attended a "Snow Surveyor's Conference" at Jackson, Wyoming, which was sponsored by the United States Department of Agriculture's Soil Conservation Service and the State of Wyoming.

GROUNDWATER DIVISION

J. C. Foweraker, Ph.D., P.Eng., Chief of Division

WATER-WELL INVENTORY

Data on existing water wells and groundwater use continue to be collected by field reconnaissance and through co-operation with government agencies and well-drilling contractors.

Additional inventory work was also carried out in the following areas: Chetwynd to Dawson Creek, Quesnel, Edgewater, Metchosin-Sooke area of Vancouver Island, Saanich Peninsula, and Gulf Islands.

WATER-WELL MAPS

A total of 104 new water-well maps was compiled during the year. These new maps cover areas in the following districts:—

District	Number of New Maps
Coast, Range 5	5
Kamloops	56
Kootenay	15
Lillooet	12
Osoyoos	13
Similkameen	3
	—
Total	104

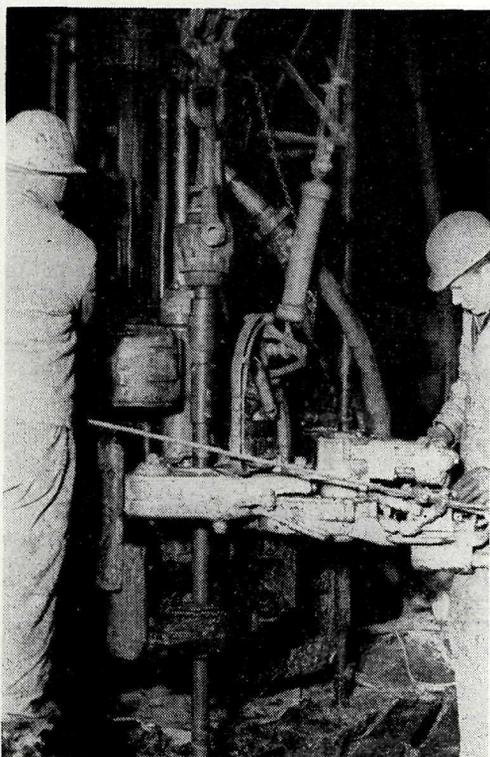
During the year, all water-well maps were reindexed.

OBSERVATION WELLS

Observation-well Network

Data continued to be collected and recorded on existing observation wells. During the year, a number of new observation wells were added to the network. Three observation wells were completed at Walhachin, three were completed at Chetwynd, and four at Groundbirch in the Peace River Area. All the above-mentioned observation wells are of small 2-inch diameter, except one 4-inch well constructed at Chetwynd. New observation wells equipped with well screens and 6-inch casing have been completed in several areas of the Province. Two wells were installed at Keremeos and one at Williams Lake in order to monitor the effect on local groundwater levels by pumping from nearby recently completed large-capacity production wells. The observation well at Williams Lake replaces an earlier small-diameter well installed in 1967.

Two additional observation wells were added to the International Hydrological Decade Study Basin near Carrs Landing on the Okanagan watershed. Both of these wells were drilled into bedrock. One well was completed using small-diameter plastic casing and the second well completed with 6-inch-diameter casing. The larger diameter well is equipped with water-level recording equipment.



GROUNDWATER INVESTIGATIONS

Power tongs being used on night-shift to remove 800 feet of locked drill rod (exploratory hole near Armstrong).



Null balance equipment for recording groundwater temperatures in wells.

The Observation Well Network at the year-end consisted of the following:—

Coastal watersheds	3
Fraser watershed and Lower Mainland	45
Okanagan and Similkameen watersheds	31
Columbia watershed	2
Northern watershed	8
	—
Total	89

Three observation wells to be completed at Athalmer in December are not included in this year's network total.

Two observation wells were destroyed by vandals. One was located southwest of Westwold and the other, a high-altitude observation, was located on Morfee Mountain, north of Prince George.

Equipment for Recording Data in Observation Wells

Groundwater-level recording equipment using compressed air has been further modified by the staff of the Groundwater Division. This equipment continues to be used on four observation wells, and satisfactory results have been obtained at temperatures down to 40 degrees below zero.

Water-level recording equipment is at present installed on seven wells. This year, recording equipment was removed from three observation wells where adequate records have been obtained over a number of years. Monthly readings will, however, continue to be taken on these wells. This recording equipment has been installed on three other observation wells where more detailed records are required.

PUBLICATION

Work has been completed on a new publication entitled "Groundwater and Geology of the South Prince George Area, Central British Columbia." This work was carried out under ARDA Research Project 10014. The main objectives of the investigation were:—

- (1) To discover and outline high-yield aquifers in the arable but water-short Pineview and Beaverley Districts in the southern part of the Prince George area that would be suitable for agricultural development.
- (2) To determine the costs of installations of water-wells in these same two areas.
- (3) Clarification of the Tertiary stratigraphy of the Upper Fraser River Drainage Basin.

A consulting geologist was engaged to finalize the report.

WATER-WELL DRILLING AND TESTING OPERATIONS

Okanagan Falls Irrigation District

Limited assistance, mainly in pumping tests and analyses of results, has been given to the Okanagan Falls Irrigation District during their large-capacity well-drilling and well-construction programme being carried out under the current ARDA rehabilitation programme. The contractor experienced considerable difficulties in the construction of his first large-scale well, which was designed with a long sand-packed louvered screen. The contractor drilled a second well near the first site. This second well was tested for 24 hours at over 1,200 gallons per minute; data from this test are currently being analysed.

Fraser Valley Trout Hatchery near Abbotsford

Considerable technical assistance and guidance have been given to the Department of Public Works on a groundwater-development programme to supply the Fraser Valley Trout Hatchery project near Abbotsford. Two large-capacity test-production wells and a series of small-diameter test-holes have been completed this year at the site. The first large-capacity 16-inch-diameter well encountered varied but predominantly fine materials and the section from 88 to 150 feet was sand-packed, using 10-inch pipe size, 30-slot stainless-steel screen. Blank sections were placed opposite the finest materials at 118 to 125 feet and 135 to 140 feet. A 72-hour pumping test was then run at a constant rate of 1,290 U.S. gallons per minute.

The second large-capacity 16-inch-diameter test-production well encountered very variable but coarser materials. A 12-inch-diameter, 100-foot-long pipe size, specially designed multiple-slot stainless-steel well screen with blank section, was set between 116 and 216 feet. A 72-hour pumping test was then run at a constant rate of 2,000 U.S. gallons per minute. The results of this test are currently under study.

Both of these large-capacity wells performed very well under test, and together with a well constructed earlier at the site, give a combined capacity of 8½ cubic feet per second.

Fort Nelson Improvement District

The Groundwater Division gave technical assistance and guidance to the Improvement Districts' Division of the Water Rights Branch in the search for, and development of, a groundwater supply for the Fort Nelson Improvement District.

Six 6-inch shallow-cased test-holes were drilled in silts and gravels by cable-tool method near the Muskwa River. Two of these holes were completed with short screens as observation wells, and a third hole was completed as a test well. A 6-inch-diameter, 8-foot-long well screen was installed between 36 and 44 feet. A successful pumping test was run on this well for 24 hours at a constant rate of 225 U.S. gallons per minute. The iron content of the water was high, however there was a sharp drop in the iron content of a sample of this water left standing in air for 48 hours.

TEST-HOLES AND OBSERVATION WELLS COMPLETED BY
THE ROTARY DRILLING METHOD

This year, the Groundwater Division has carried out a number of rotary drilling programmes to obtain information on subsurface geology and groundwater potential and movement. These programmes are outlined below.

Village of Chetwynd

Six exploratory shallow test-holes were drilled at Chetwynd in shallow alluvial deposits of Windrem Creek. Observation wells were constructed in three of the holes, including a 4-inch-diameter low-capacity test well.

Although the test-hole results showed the groundwater potential to be limited, the village is proceeding with plans for the construction of a 6-inch-diameter test well early in 1970. Guidance and technical assistance will be provided by the Groundwater Division.

Groundbirch ARDA

Four test-holes, one reaching a depth of 680 feet, were drilled near Groundbirch in the Peace River area. The test drilling provided some new information on water-bearing sand and gravel deposits and on subsurface geology.

Observation wells were completed in all four test-holes in order to record groundwater fluctuations and movement in various zones within a buried channel located in this area.

Fort Nelson Improvement District

Two test-holes were drilled near the Muskwa River by rotary method to obtain information on groundwater potential and geology. One test-hole penetrated 450 feet of unconsolidated deposits in the Muskwa Valley bottom before encountering bedrock. This rotary test-hole programme was part of a programme of groundwater exploration and development being carried out with the Improvement Districts Division, Water Rights Branch, for the Fort Nelson Improvement District. The results of this work are currently being studied.

Walhachin Water Works District

In response to a request from the Improvement Districts Division, Water Rights Branch, a programme of groundwater exploration was undertaken by the Groundwater Division for the Walhachin Water Works District. Five test-holes were drilled, and three of the holes were subsequently used for the construction of observation wells. The results of this test drilling programme are currently under study.

Kootenay River Flats near Creston

Between 50 and 100 observation wells are being constructed during the 1969/70 winter on the Kootenay River Flats near Creston. Data on groundwater levels and on seepage in this area are being collected so that quantitative relationships between changes in level of Kootenay River in this area and the groundwater table and seepage can be established. Recorders are to be installed in some of the observation wells.

Athalmer

A number of observation wells are currently being installed in Athalmer, near Invermere. Data on groundwater-level fluctuations obtained from these wells will be studied in relation to changes in the level of Lake Windermere. Recorders are to be installed on two wells.

North Okanagan Valley Deep Rotary Test-hole Drilling

Three deep rotary test-holes were drilled through unconsolidated valley-floor deposits on the west side of the north end of the Okanagan Valley, south of Armstrong. The holes were drilled to obtain information on subsurface geology and on location of aquifers. Over 1,000 feet of unconsolidated deposits, including 800 feet of sand, were encountered in one hole. Complex drilling-fluid mixtures, special drilling techniques, and equipment were used to overcome the many difficulties associated with drilling deep, uncased holes in great thickness of sand. In one hole the contractor had 800 feet of drill rod stuck down the hole; however, this was finally pulled out using special equipment.

An experimental hole was also drilled, using a special foaming agent in place of conventional drilling fluids. Further work will be required to complete the subsurface assessment of this area.

Observation-well Construction Completed under the Okanagan Valley Water Quality Data Collection Programme

Thirty-four observation wells not included in the regular network were completed by the Groundwater Division in four selected "study areas" in the Okanagan

Valley. These areas are located near Osoyoos, Summerland, and in the Glenmore Valley. This project was included as part of the 1969 programme of field work recommended by an interim Federal-Provincial sub-committee, responsible for studying land and agricultural aspects of the above-mentioned programme. The observation wells will be used for the dual purpose of collecting samples of groundwater for water-quality analyses, and for recording data on groundwater-level fluctuations and movement.

PRELIMINARY FIELD INVESTIGATIONS OF GROUNDWATER POTENTIAL AND GEOLOGY

This year, Groundwater Division personnel carried out preliminary field investigation in many areas of the Province on one or more of the following problems:—

- (a) Groundwater potential.
- (b) Geology.
- (c) Feasibility of test drilling.

The investigations were carried out in response to requests for technical assistance from a number of agencies and from the Department. A list of the preliminary investigations is as follows:—

- Fraser Valley Trout Hatchery Site near Abbotsford.
- Village of Chetwynd.
- Groundbirch Area in the Peace River Block.
- Walhachin Water Works District.
- Kootenay River Flats, near Creston.
- Athalmer, near Invermere.
- Fort Nelson Improvement District.
- Larkin Improvement District.
- 83-Mile Creek, near Green Lake.
- Edgewater-Vermilion Irrigation District.
- Quadra Island—Quathiaski Cove and Heriot Bay.
- Cormorant Island—Alert Bay.
- Keremeos Irrigation District.
- Winfield.
- Osoyoos "Study Areas."
- Summerland "Study Area."
- Glenmore Valley "Study Area."
- Shuttleworth Creek Improvement District.

OKANAGAN VALLEY WATER QUALITY DATA COLLECTION PROGRAMME

An interim Federal-Provincial sub-committee was formed to study land and agricultural aspects as they may affect water quality in the Okanagan Lakes system, and to make recommendations for a feasible programme for the 1969 field season. The Chief of the Groundwater Division was appointed chairman of this sub-committee. Two meetings were held prior to the commencement of the field season, and a programme of work which could be carried out with the limited funds and staff available was agreed upon.

Groundwater Division personnel are engaged in the following projects associated with the field programme recommended by this sub-committee:—

- (1) Water-well inventory survey in the Okanagan Valley.
- (2) Collection of groundwater samples, four times a year, from approximately 75 domestic-water wells for nutrient analyses and bacteriological analyses.

- (3) Collection of groundwater samples from approximately 20 water wells for full chemical analyses.
- (4) Compilation of existing geological information on the Okanagan Valley.
- (5) Assistance in the selection of four "study areas" for detailed investigations.
- (6) Drilling and construction of 35 observation wells within the above-mentioned four "study areas" for groundwater analyses of nutrients, etc., and recording of groundwater-level fluctuations.
- (7) Collection of groundwater samples, four times a year, from 15 tile drains located in two of the "study areas" for nutrient analyses.
- (8) Collection of surface-water samples and observation of flow in ditches and creeks within the selected "study areas."

MISCELLANEOUS

In addition to the activities of the Division outlined above, it should be noted that there has been an increase in 1969 in the number of inquiries concerning all matters dealing with groundwater.

During the field season, two trainees from Afghanistan and one from the U.S.S.R. spent a part of their Canadian tour with Groundwater Division personnel in British Columbia. The Canadian tours were arranged through the Canadian Development Agency and the Department of Energy, Mines and Resources.

The trainees were shown various aspects of the Division's work, including current field operations in British Columbia.

BASIN PLANNING AND POWER DIVISION

J. D. Watts, P.Eng., Chief of Division

This Division of the Water Investigations Branch has two main functions—

(1) the development of plans for water management on a regional or watershed basis, with the immediate aim of improving surface-water supplies in areas where readily available supplies have been exhausted; and (2) the inventory of the undeveloped water-power potential of the Province.

The following work has been done during the past year:—

WATER-MANAGEMENT STUDIES

Nicola-Kamloops Area

Under the agreement between the Civil Engineering Department of the University of British Columbia and the British Columbia Water Resources Service, work has continued by faculty members, with student and graduate assistance, on the water-resources planning study of the Nicola-Kamloops area, encompassing some 3,800 square miles.

A report entitled "Water Resources of the Nicola-Kamloops Area, Report No. 1—Preliminary Appraisal," published by the university during the year, outlines the proposed planning process and gives a preliminary appraisal of the water resources and related industries of the area.

A study was made of flood irrigation in the Nicola area to assess the water requirements of crops grown under this irrigation system.

A related study, using a test area elsewhere, is attempting to develop a hydrologic technique to determine the areal distribution of run-off.

Work is in progress on a soil survey for the Canada Land Inventory which can be expected to lead to a fuller understanding of the land-use capability of the area and an assessment of the potential water demand for agriculture.

Shuswap River Diversion

As a supplement to the main proposal to divert Shuswap River waters to the Okanagan via Enderby, study was made of the economic feasibility of two main alternatives:—

- (a) Gravity-flow diversion by canal from Sugar Lake to Okanagan Lake and North Okanagan irrigable areas via Lumby:
- (b) A pumping scheme diverting water at Shuswap Falls and feeding into a canal system flowing via Lumby to Okanagan Lake and North Okanagan irrigable areas.

Each of the alternatives and their variations have been demonstrated to be much more expensive to construct and maintain than the initial diversion proposal via Enderby.

In addition to the above, an estimate and report was made on the cost of developing three local irrigation projects, namely:—

- (a) North Armstrong:
- (b) Lumby:
- (c) Hilton.

Each of these areas has different characteristic problems and each was investigated in relation to the various major diversion schemes.

It was concluded that the cost of providing a basic irrigation water supply would be in the general order of \$100 per acre served per year. Development of an irrigation system in either the Hilton or Lumby area was considered to be uneconomic at this time. Development of the North Armstrong project was considered to be marginal and perhaps economic if high-yield crops can be produced in the warmer climate.

Creston Flats Area

When Libby Dam, now under construction on the Kootenai River in the United States, goes into operation, considerable changes will take place in the flow pattern of the river downstream in British Columbia. The flow will be more evenly distributed throughout the year, removing the threat of spring floods to the dyked areas at Creston. However, the change in flow pattern and possible changes in permitted Kootenay Lake storage-levels to allow greater power production at Lower Kootenay River hydro-electric plants have made necessary a programme of observation of the dyked areas to determine the damage, if any, to lands under cultivation. A programme of probable five-year duration has been commenced. Large-scale air photography, including infra-red colour photography, has been obtained as a base for field observation of crop productivity and delineation of areas damaged by an excessively high local or general water table. A number of groups of observation wells have been installed to provide data of water-table elevations. Collection and interpretation of pumping records of the eight pumping stations within dyked areas will commence next year. It is anticipated that this continuing programme will indicate the behaviour of the water table under varying conditions.

Miscellaneous

1. In response to a request from the Atlin District Board of Trade, a preliminary study was made of the feasibility and probable cost of a water supply and sewerage system for the settlement of Atlin, a small community without municipal

organization, which serves as the administrative centre of a vast undeveloped region in northwestern British Columbia. The study concludes that the cost of such services in this northern region, with severe climatic conditions, is extremely high.

2. Preliminary benefit-cost studies were prepared jointly with personnel from the Projects Division for three dyking districts in the Lower Fraser Valley, in order to assess the feasibility of amalgamation of West Langley and Derby Dyking Districts, and East Langley and Glen Valley Dyking Districts. Derby and East Langley Dyking Districts have no flood-protection works constructed at the present time. It was determined that preliminary design should proceed for West Langley and Derby Dyking Districts on an amalgamated basis, and for East Langley Dyking District as a separate project.

HYDRO-POWER INVESTIGATIONS

Liard River

Preliminary design studies of possible developments at three sites on the Liard River were continued. These sites are Site A, 30 miles upstream from the mouth of the Fort Nelson River; Site E, 16 miles downstream from Lower Crossing; and Site G, near Mile 552 on the Alaska Highway. It is anticipated that a report on these developments will be available early in 1970.

Geological advice and assistance were again provided by Dolmage, Campbell and Associates. A summer field crew obtained additional geologic mapping at Site E, as well as preliminary mapping at a potential spillway for the Site G development in the Hillgren Lakes area. A ground search for sufficient, suitable construction materials in the area of Site G was also carried out by this crew.

Further subsurface information was obtained this year from two seismic-refraction surveys undertaken by Canjay Exploration Ltd., under the general supervision of Dolmage, Campbell and Associates. The first survey programme in April explored the river channel, upstream and downstream from the axis of the proposed dam at Site G, for possible sources of construction material. The size of the deposits defined by this survey proved insufficient to provide the total requirements for the proposed dam. Seismic refraction was also undertaken near previous overburden drill-hole sites to ascertain whether this method could distinguish effectively between bedrock, compacted till, and the unconsolidated gravel, sand, and silt deposits. Good correlation between the overburden drill-hole logs and the seismic profile permitted the authorization of a second programme.

In August, a second seismic programme was undertaken by Canjay Exploration Ltd. involving work at Sites G, E, and X. At Site G, the survey was designed to determine the bedrock profile across the Leguil Creek seepage path, and to explore and define possible construction-material sources adjacent to Mile 548 on the Alaska Highway. At Site E, some 12 miles downstream from Lower Crossing, determination of the bedrock profile on the left abutment, and a construction-materials search were carried out. At Site X, approximately 10 miles downstream from the junction of the Liard and Fort Nelson Rivers, the seismic survey sought to establish the bedrock profile along the axis of a possible fourth dam and power development.

Sufficient quantities of locally available materials have now been located to ensure that an earth-fill dam can be constructed at Site A. However, further exploration will be necessary in the vicinity of Sites E and G to identify additional quantities of gravel. Preliminary results from the seismic survey at Site X indicate that considerable depths of overburden cover the bedrock in the river channel and on the left bank.

A final report from the consultants on the results of the August programme is expected shortly.

New topographic mapping of the Liard River and its tributaries, the Fort Nelson and Kechika Rivers, was completed by the Surveys and Mapping Branch of the Lands Service for use in the power studies. Further new mapping of the upper Liard River and the Dease River is in progress.

Yukon River

Office studies to evaluate alternative proposals for utilization of the water resources of the Upper Yukon River system for hydro-electric power development were continued. The catchment area involved lies partly in British Columbia and partly in Yukon Territory. Possible diversion schemes include one in which the power-generation facilities would be located in the Taiya Valley, close to Skagway, Alaska, and another in which those facilities would be located in the Taku Valley in British Columbia. The diversion structures for both major schemes would be located in Yukon Territory.

Topographic mapping of the Taku Valley and of possible tunnel routes from Atlin Lake to the Taku Valley is in progress by the Surveys and Mapping Branch of the Lands Service.

OTHER ACTIVITIES

The Chief of the Division is a member of the Fraser River Joint Programme Committee, established by the agreement between Canada and the Province of British Columbia to undertake a programme of studies and works for flood control in the Fraser Valley. The Committee has been very active throughout the year, having held 12 meetings of the full committee in addition to sub-committee and other related meetings. Ten applications to participate in the programme have been received from municipalities. These are being processed through the phases of soils investigation, detailed design and estimates, and preparation of contract documents. The design of the flood-control works for the District of Kent has been completed and construction is expected to commence early in 1970.

The Chief of the Division is a member of the Upper Yukon Power Market Study Committee, comprised of representatives from the Governments of Canada, the United States, and British Columbia. This committee has also been active during the year and is expected to report in mid-1970 to the governments represented on the potential markets for hydro-electric power which may be produced from the waters of the Upper Yukon River catchment.

The Chief of the Division is a member of the Rural Development Planning Committee and has participated in its meetings during the year.

ARDA PROJECTS DIVISION

J. D. C. Fuller, P.Eng., Chief of Division

J. V. Eby, P.Eng., Construction Engineer

The ARDA Projects Division was formed in 1963 for the purpose of investigating water-project proposals and preparing submissions under the Federal-Provincial *Agricultural and Rural Development Act* (ARDA) assistance programme. The Division is also responsible for the design and construction supervision of certain approved projects. The British Columbia Department of Agriculture is charged with the over-all administration of the ARDA programme. Under an interdepartmental co-operative arrangement, the British Columbia Water Resources Service is respon-

sible for implementation of ARDA water projects, which responsibility has been delegated to the Water Investigations Branch.

Since the inception of the ARDA programme, many of the requests for assistance have been approved and successfully completed, while others are in various stages of construction. In some instances, especially where construction has been carried out by contract, supplementary assistance has been requested to cover rising costs and complete the projects.

Since the start of the ARDA water-projects programme in British Columbia in 1963, a total expenditure of \$26 million has been authorized and \$20.5 million actually expended on ARDA water projects.

Actual and potential water projects under the ARDA programme total 92 in number, and, of these, 56 have requested or received assistance, 31 are under study prior to a possible proposal submission, and 5 are in abeyance for various reasons.

Provincial and Federal authorities have approved 56 proposals to date, and 31 of these have been completed, leaving 25 presently under construction.

Of the projects under construction, six were brought into operation during the year and may be considered completed in the construction sense. The 25 incomplete projects are mostly multi-year projects, some of which may not be completed until 1971 or later.

Some of the 31 completed projects have still to submit final claims for reimbursement in respect of such items as contractors' holdbacks and legal or survey costs pending.

Project descriptions will be given here only for those of the 92 projects where significant changes have taken place during 1969. A description of the remaining projects may be found in the reports covering the period 1964 to 1968.

Engineering services for projects are being provided by the Water Investigations Branch and by the Water Rights Branch, as well as by consulting engineers.

PROJECTS ESSENTIALLY COMPLETED DURING THE YEAR

1. *Sion Improvement District Rehabilitation—ARDA Project 29010.*—This project has been carried out under contract, with design by consulting engineers. The works comprise three separate well systems, each with a large irrigation pump and small domestic water pump. Operation during 1969 revealed only a very small irrigation demand for that year.

2. *Lakeview Irrigation District Diversion Works—ARDA Project 29040.*—This project involves the supply of irrigation water and domestic water for farm use and includes the replacement of a diversion dam on Lambly Creek, main flume, and canal with more permanent works. Design was carried out by consulting engineers with construction by contract.

3. *West Bench Irrigation District—ARDA Project 29038.*—The Prairie Farm Rehabilitation Administration, Canada Department of Agriculture, has been responsible for the design of the project, which includes a new intake into deep water in Okanagan Lake, and construction of a concrete storage reservoir.

4. *Boundary Line Irrigation District—ARDA Projects 10035, 29024, and 29024(S).*—The original irrigation project was extended to include the provision of domestic water. Later, under Project 29024(S), an increase was made in pumping capacity. Construction was carried out by district forces.

5. *Wood Lake Irrigation District Rehabilitation—ARDA Projects 29008 and 29008(S).*—This project comprises a gravity-fed distribution system for irrigation and domestic water, with intake and chlorination facilities. Construction was by district forces and included some work on storage dams.

6. *Surrey Drainage Project at Halls Prairie Road—ARDA Project 29019.*—Provides drainage and flood protection in the Surrey Dyking District within the Municipality of Surrey. Design was carried out by consulting engineers.

PROJECTS UNDER CONSTRUCTION OR STUDY

7. *Southern Okanagan Lands Irrigation District Rehabilitation—ARDA Projects 10010 and 29041.*—The basic purpose of these projects is to rehabilitate the existing irrigation supply system of the Southern Okanagan Lands project, a Provincially operated system, and in addition provide a supply of domestic water for rural users. New works are being constructed over a period of about six years.

Since the start of construction in 1964, Systems 4, 5, 6, 7, 8, and 9, with a combined installed horsepower of 2,575, have been completed. Pipe-distribution works have also been installed for all of these systems. During 1969, construction included completion of pump systems 4 and 6 with a combined horsepower of 650, and a start of work on number 1 system, which will have an installed capacity of 175 horsepower. Work on the number 4 system included installation at the pumphouse of a rotating screen, which operated successfully during the irrigation season.

Other construction included further flume rebuilding and a start on rehabilitation of the 3,500-foot-long 78-inch-diameter main Oliver siphon, involving part relining and part pipe replacement.

Design work included the number 1 distribution system and pumphouse, scheduled for operation in 1970. Proposals were finalized, in conjunction with consultants, for the replacement of flumes 1 to 5. Design of the Oliver siphon was also completed during the year.

Construction is being carried out mostly by district labour, with some work by contract. Certain electrical and mechanical components of the project have been designed by consulting engineers.

8. *Vernon Irrigation District—ARDA Project 29004.*—Construction of the new pressurized irrigation and rural domestic-water system for the Vernon Irrigation District continued throughout 1969, with expected completion date in the spring of 1971. Replacement of the old system of canals and pipe-lines, serving approximately 10,000 acres of irrigated land, began in July, 1966, and is now about 70 per cent complete. The completed project will involve over 100 miles of new pipe-lines, up to 48 inches in diameter, nine pumping stations totalling 1,720 horsepower, three chlorinating stations, several pressure-reducing stations, and the reconstruction of new intakes and storage facilities.

Work completed during 1969 included the following:—

- (a) Installation by district crews of 25,000 feet of 30-inch pipe to complete the 16-mile section of main supply-line from the temporary intake structure on the Grey Canal to the Goose Lake balancing-reservoir.
- (b) Installation by district crews of approximately 80,000 feet of distribution pipe-line in sizes 4-inch to 20-inch.
- (c) Construction by contract of chlorinating stations at Goose Lake, King Edward intake, and the main line temporary intake.
- (d) Construction by contract of the main line pressure-reducing station 2 and the Reimer Road valve chamber.

9. *Winfield and Okanagan Centre Irrigation District—ARDA Project 29017.*—This project is more fully described under the Water Supply and Investigations Division section of the Report. An open gravity system is being replaced by a pressurized system utilizing available head at the existing source. The project is designed for the needs of modern sprinkler irrigation methods and will also supply farm

domestic water. Construction, started in 1967, is by district forces and continued during 1969.

10. *Black Mountain Irrigation District Rehabilitation—ARDA Project 29018.*—This project is also more fully described under the activities of the Water Supply and Investigations Division. The existing open gravity system, taking water from Mission Creek, is being replaced with a closed-pipe system, supplying sprinkler pressure for irrigation and a water supply for rural domestic purposes. Work continued during 1969, and is being carried out by district forces.

11. *Glenmore Irrigation District—ARDA Projects 29020 and 29020(S).*—This project replaces an existing mainly open gravity distribution system with a pressurized closed-pipe system fed from a balancing reservoir, constructed in 1964 under ARDA Projects 10003, 29005, and 29005(S). Available pressure is augmented by booster pumping at several locations to provide adequate sprinkling pressure for irrigation as well as a domestic supply for predominantly farm use. Construction is being carried out mostly by district forces, and during 1969 comprised mostly pumphouse construction and installation of remaining small pipe-lines. Consulting engineers have provided assistance with electrical work.

12. *Keremeos Irrigation District Rehabilitation—ARDA Project 29027.*—This project replaces the original open gravity system, drawing water from the Ashnola River and Keremeos Creek by pumping from two batteries of wells into the east and west systems to provide irrigation and farm domestic water. Construction of both systems is mostly complete except for some pipelaying at the west system. During 1969 major work comprised completion of the west pumphouse and district office construction under contracts, and pipe installation at the west system by district forces. Consulting engineers have assisted with electrical design.

13. *South East Kelowna Irrigation District Second and Third Projects—ARDA Projects 29003 and 29031.*—This scheme is more fully described under the Water Supply and Investigations Division section of this report. The project, being completed in stages, provides for the replacement of a predominantly open irrigation works with a pressurized gravity-fed system. Work is being carried out by district forces. Studies are under way regarding rehabilitation of the remaining works comprising storage facilities and main canals.

14. *Okanagan Falls Irrigation District—ARDA Project 29035.*—This project involves replacement of the existing unsatisfactory water supply from the south end of Skaha Lake by a new groundwater pumping system, together with replacement of several pipe-lines and construction of a 40,000-gallon reservoir. The district is presently supplying domestic water to about 200 connections in the townsite of Okanagan Falls.

An 8-inch test well was drilled in 1968, under the guidance of the Groundwater Division, which will be used as a production well in the completed system. A second large-production well was drilled in 1969. The pumping system design will be completed after final testing of this well.

Other work carried out by the district in 1969 included replacement of approximately 2,300 feet of steel pipe-line with 8-inch diameter asbestos-cement pipe.

15. *Ellison Irrigation District Rehabilitation—ARDA Project 29036.*—The old gravity system is being replaced by more permanent works suitable for pressure irrigation. Design is being carried out by consulting engineers, and construction by district forces.

16. *Westbank Irrigation District Second Project—ARDA Project 29042.*—This project is more fully described under the Water Supply and Investigations Division section of this report. The first project comprised replacement of intake works

and main conduit. The second project comprises replacement of the distribution system and reconstruction of storage dams. The system supplies both irrigation and domestic water for farm use. Construction by district forces commenced on the second phase in the fall of 1968.

17. *Groundwater Research Project at Prince George—ARDA Project 10014.*—A report on this project is under preparation, as discussed under the Groundwater Division section of this report.

18. *Peachland Irrigation District—ARDA Project 29047.*—This project provides for replacing the old open system with a pressurized pipe-line supplying both irrigation and domestic water. A more detailed description of this project is given in the Water Supply and Investigations Division section of this report.

19. *Kamloops Indian Reserve 1 Irrigation—ARDA Project 29005.*—This project comprises an intake on the North Thompson River, with pumphouse and distribution system to provide irrigation to some 780 acres of land within the reserve. The Indian Affairs Branch of the Federal Government is responsible for the design and construction of the project by direct labour.

20. *Naramata Irrigation District Supplementary Water Supply—ARDA Project 29045.*—This project comprises a pumphouse with 600 installed horsepower on Okanagan Lake, forcemain, and concrete balancing-reservoir. These works are connected to the existing gravity main and distribution system to provide a supplementary water supply during dry years, such as 1967, when insufficient run-off is available. Construction, part by district forces and part by contract, started in the fall of 1969. Consulting engineers are responsible for design of the pumphouse.

21. *Grandview Waterworks District Second Project—ARDA Project 29044.*—The second stage of this system, providing domestic water for farm use, was started during the year. Engineering services are being provided by the Water Rights Branch.

22. *Black Mountain Irrigation District Additional Storage—ARDA Project 29050.*—This project will increase district storage from 7,800 to 9,500 acre-feet for irrigation use by construction of a dam at Fish Hawk Lake. Construction during 1969 was confined to some clearing of timber. A consulting engineer is providing engineering services.

23. *Slocan Park Improvement District Water Supply System—ARDA Project 29043.*—A pressurized irrigation and domestic water system will supply the small community by a combined gravity and pumped supply from Wolverton Creek and the Slocan River. The Water Rights Branch is responsible for the design of this project, construction of which will commence in 1970.

24. *Glenmore Irrigation District—Bulman Creek Storage Dam—ARDA Project 29049.*—The Glenmore and Ellison Irrigation Districts are jointly constructing a dam on Bulman Creek which will increase their combined storage for irrigation purposes from 5,300 to 6,300 acre-feet. The homogeneous fill dam, to be constructed during 1970, will have a maximum height of 45 feet, crest length 1,300 feet, and volume 100,000 cubic yards. Construction during 1969 was confined to land clearing. Design is by consulting engineers.

OTHER ACTIVITIES

The Division has been involved in the construction aspects of the Federal-Provincial Fraser River Flood Control Programme. Under the Joint Agreement, the Province is responsible for constructing approved projects.

During 1969, meetings were held with consulting engineers appointed for the engineering design of flood-protection works within the Districts of Kent, Pitt

Meadows, and Richmond. Efforts were largely concerned with the establishment of construction contract procedures and standard contract documents.

PROJECTS DIVISION

P. M. Brady, P.Eng., Chief of Division

The Projects Division has as its main function the investigation, review, and implementation of major flood-control, land-reclamation, erosion-control, and drainage projects. This includes studies and designs for projects to be constructed under the 1968 Fraser River Flood Control Agreement as well as the preparation and review of proposals for submission under the *Canada-British Columbia Joint Development Act* and the *Canada Water Conservation Assistance Act*.

In addition, the Division designs and supervises construction of water-damage prevention projects either directly or under agreements with local authorities or individuals.

LOWER FRASER VALLEY

The signing in May, 1968, of the Federal-Provincial Agreement for the implementation over a 10-year period of a major flood-control programme for the Lower Fraser Valley has resulted in an appreciable involvement of Projects Division staff both in studies and design.

A regional flood study covering the Lower Fraser Valley from Agassiz to the sea was completed this year and is being used in establishing design criteria for internal drainage behind the dyking systems. This involved an analysis of all available run-off data for the Lower Mainland and also the relation between run-off and physical characteristics of the watersheds. The study was programmed through the IBM 360 computer.

The computer was also utilized in a backwater study for the same stretch of river, providing one method of establishing a water profile for dyke-design purposes.

In co-operation with Federal Government engineers, a reassessment and re-distribution of economic benefits from flood-control works in the Lower Fraser Valley were completed and used in the establishment of a project-classification system.

The Fraser River Joint Programme Committee, of which the Chief of the Division is the current Vice-chairman, was formed under the terms of the Agreement to plan and co-ordinate studies necessary for the assessment and implementation of the programme projects. Staff of the Projects Division is involved in work groups that provide technical assistance to the committee's Programme Director, and in studies and designs assigned to the Province by the committee.

Work-group functions include the assessment of dyke standards and design, and the river-erosion studies necessary to establish the scope and estimated costs of bank-protection works. Detailed bank-protection studies have been completed for the Municipalities of Kent and Pitt Meadows and have been initiated in several other areas. A general study to reassess and update the bank-protection requirements and costs for the Fraser River between Agassiz and the Pitt River is also currently under way.

Work being carried out on assignment to the Province includes the internal drainage and hydrology studies necessary to establish the pumping and floodbox capacities, and the detailed design of all bank-protection works. Internal drainage and hydrology studies have been completed for the Municipal Districts of Kent, Pitt Meadows, and Mission, and are under way for the Township of Richmond and the Municipal District of Matsqui. The bank-protection works for the District of

Kent, estimated to cost \$880,000, have been designed, and basic information required for design in other areas is being collected.

Preliminary designs and cost estimates were prepared for the Derby and East Langley Dyking Districts. These districts have no works at present, and the feasibility of amalgamation of the Derby Dyking District with West Langley Dyking District and East Langley Dyking District with Glen Valley Dyking District was explored. A cost-benefit study indicated that the former amalgamation would be economically sound, but in the case of East Langley Dyking District there appeared to be no economic advantage to combining the districts.

LOWER SQUAMISH VALLEY

In 1965 a report was prepared on flood and erosion control in the Lower Squamish Valley. During 1969, the design and construction of the second-stage bank protection was completed and that of the third stage, dyke and bank protection, to be completed this fiscal year, was initiated. The total construction cost of these two stages will be approximately \$380,000. The estimated total cost of the comprehensive flood- and erosion-control measures outlined in the 1965 report, which was originally intended to be a joint Federal-Provincial project under the *Canada Water Conservation Assistance Act*, is \$2,000,000.

ALBERNI FLOOD CONTROL

The design of the \$1,400,000 flood-control project to raise River Road along the Somass River and to control Kitsucksus Creek and improve the internal drainage works, thus reducing the possibility of flooding in the west section of the former City of Alberni, was completed in 1967. A second revised agreement between Canada and the Province of British Columbia to allow for increased costs was signed during the year under the *Canada-British Columbia Joint Development Act* and the *Canada Water Conservation Assistance Act*. A contract totalling \$1,085,-546.51 for construction under the agreement was awarded in July. Approximately \$375,000 worth of work was constructed, with the balance to be completed next year. This work is being carried out on behalf of the Water Resources Service by the Department of Highways.

BELLA COOLA VALLEY

A comprehensive study pertaining to river damage and prevention on the Bella Coola River and side streams between Bella Coola and Hagensborg was initiated, and mapping of the area was completed under private contract. During the year the Division assisted the British Columbia Department of Highways in the assessment of local river-erosion problems and bank-protection requirements.

PEMBERTON VALLEY FLOODING

During the year, hydrometric data and survey information for the Lillooet Lake-Lillooet River system was obtained for the Division. Some 10 river and lake gauges were installed by the Branch and these are read by local people under a co-operative arrangement with the Pemberton Valley Dyking District. This, together with river and lake surveys information, will be used in the preparation of proposals to alleviate a flooding problem in the Pemberton Valley.

COWICHAN RIVER FLOODING

A preliminary report on flooding and erosion by the Cowichan River at Lake Cowichan and in the Lower Cowichan Valley was completed in 1967. Any further

action on the proposals contained in this report awaits the results of studies by the Federal Department of Fisheries on the economic value of the Cowichan River as a fishery resource.

KITIMAT RIVER

Field survey information necessary for a study of the flooding problem at Kitimat was completed by the District of Kitimat during the year and submitted to the Division. It is hoped that this information, together with the large-scale mapping of the area and hydrology study previously undertaken by the Water Investigations Branch, can be used in preparing proposals for flood and erosion control of the Kitimat River at Kitimat.

VILLAGE OF HOUSTON

Studies and design for dykes and bank-protection works along Buck Creek and the Bulkley River, necessary to reduce flooding within the Village of Houston, were completed. Construction of the required works, costing approximately \$100,000, is nearing completion, and it is anticipated that the project will be completed early in 1970.

LUMBY

Field surveys and studies pertaining to flooding within the Village of Lumby were carried out and a subsequent report outlining solutions and costs was completed.

MISSION CREEK

Field surveys and studies pertaining to river-bank erosion near the mouth of Mission Creek at Kelowna were carried out. The preparation of a report on this matter was initiated and will be completed early in 1970.

GRAND FORKS

River-data collection and surveys, necessary for a study of flooding and bank-erosion problems along both the Granby and Kettle Rivers in the Grand Forks area, were carried out during the year. This information will be utilized in studies and the compilation of a report for this area.

NORTH AND WEST VANCOUVER FLOOD-CONTROL PROJECT

In 1967 an agreement was signed under the Canada *Water Conservation Assistance Act* providing for a major flood-control project, totalling \$2,301,480, in both the District of North Vancouver and the District of West Vancouver. While the North Vancouver components involving control of Mosquito Creek and bank-protection work in Capilano River were completed in 1967, there has been no request from the District of West Vancouver concerning implementation of the balance of the works.

HASTINGS CREEK FLOOD-CONTROL PROJECT

This year saw completion of a contract for the construction of some 7,500 feet of reinforced-concrete pipe and culvert to intercept and collect the several branches of Hastings Creek, and a diversion to Lynn Creek, eliminating the flooding of land and residences below Kilmer Road in North Vancouver. The Greater Vancouver Sewerage and Drainage Board acted as the agent for the District of North Vancouver for this project, which cost approximately \$650,000.

MINOR PROJECTS

During 1969, 16 minor flooding and erosion problems were investigated throughout the Province and reports prepared. In seven instances, assistance in the design, supervision of construction, and financing was given by the Water Investigations Branch within the available limited budget of the British Columbia Water Resources Service. The projects constructed included bank protection and dykes for five properties along the Similkameen River, and channel restoration in the lower reach of Harvey Creek below the Squamish Highway. At the end of the year, investigation of requests for assistance in several areas were pending.

STELLAKO RIVER

The Federal-Provincial technical sub-committee appointed to report on the 1967 log drive on the Stellako River, particularly with respect to the effect of log driving on the fishery resource, completed its work this year with the preparation of a report entitled "The Stellako River Log Drive, 1967."

RECORDS COMPILATION AND REPORTS SECTION

A. S. Stencel, R.I.A.

The most important functions performed by the Records Compilation and Reports Section include the assembly of engineering reports, operation of the Reports Library, collection and compilation of technical and cost records, operation of the Branch car-pool, and general office duties for the Branch.

A brief review of the statistics of the Section will indicate that the past year has again been one of growth. This continues a trend that has been evident for a number of years.

During the year, the Reports Library received 80 new engineering reports for assembly and registration. The total of available reports amounts now to 1,610.

Listed below is a numerical and percentage summary of reports received and registered during 10-year periods:—

Periods (Years)	Number of Reports Available	Percentage of Total Available
1915-24.....	175	10.9
1925-34.....	41	2.5
1935-44.....	37	2.3
1945-54.....	115	7.2
1955-64.....	865	53.7
1965-69.....	377	23.4
Totals.....	1,610	100.0

In addition to the new reports, over 530 other copies of reports have been prepared and distributed. The past 12 months also saw requests for over 100 copies of other publications, including inter-library loans, researched and completed by the staff. Another increase was recorded during the year under review in the circulation of periodicals and technical literature.

Of the present total of 1,610 reports in the library, 980 reports have been prepared by the Water Resources Service staff. The following table shows the number of such reports and the various fields which they cover:—

*Technical Reports in Library, Prepared by Water Resources Service Staff
as of December 31, 1969*

Period (Years)	Water Power	Water Supply	Floods, Drainage, Dyking	Ground-water	Hydrology	Miscellaneous	Totals
1911-20.....	13	3	-----	1	-----	2	19
1921-25.....	107	26	3	1	-----	4	141
1926-30.....	25	5	-----	1	-----	4	35
1931-35.....	7	1	-----	-----	-----	1	9
1936-40.....	8	-----	-----	-----	-----	-----	8
1941-45.....	21	10	-----	1	-----	3	35
1946-50.....	14	27	8	1	2	7	59
1951-55.....	26	57	40	8	10	10	151
1956-60.....	6	69	38	1	9	14	137
1961-65.....	5	111	51	5	12	20	204
1966-69.....	-----	140	28	2	1	11	182
Totals.....	232	449	168	21	34	76	980

In order to meet the 1969 needs of all six divisions of the Water Investigations Branch, 320 requisitions covering purchases and (or) repairs of equipment, furniture, machinery, materials, and supplies were prepared, and over 1,200 invoices processed. The Section provided mail and messenger service to all divisions, operated the 33-vehicle Branch car-pool, and assisted in the processing of claims for various water projects under construction.

DRAUGHTING OFFICE

B. Varcoe, Chief Draughtsman

During 1969, the draughting responsibilities of the Water Investigations Draughting Offices were increased by the addition of the draughting requirements of the Groundwater Division, which previously has had its own draughtsman. In addition, more activity in the draughting requirements of the Projects Division has necessitated the placing of another man in the ARDA draughting section.

While there has been over a 50 per cent change in draughting personnel over the past year, a good total of drawings have been completed, despite the obvious handicap created by the breaking-in of new draughtsmen.

Number of report drawings completed and used	93
Number of report drawings unused and (or) incomplete... ..	88
Number of construction drawings completed and used.....	347
Number of drawings completed for the Hydrology Division	24
Number of water-well location maps created from existing mapping for Groundwater Division.....	102
Miscellaneous maps, signs, coloured prints, etc.....	12

Total number of drawings produced..... 666

The air-photo requirements for the Water Investigations Branch were particularly high for 1969. From requests for special flying, 2,642 air photos were received, and from 41 requisitions for normal reprints, mosaic reprints, and enlargements, 1,658 photos were received.

Reproduction costs have increased with the added drawing production, and this year were valued at \$11,700.

12

**POLLUTION
CONTROL
BOARD**

WORLD
CONTROL
BOARD

**POLLUTION
CONTROL
BOARD**

F. S. MCKINNON
CHAIRMAN

The *Pollution Control Act, 1967*, relieved the Pollution Control Board of the administrative functions associated with issuing permits. The Director of Pollution Control, in charge of the Pollution Control Branch of the Water Resources Service, carries out the administration under the *Pollution Control Act, 1967*.

Under the 1967 legislation, the Pollution Control Board acts in an advisory capacity to the Government, sets standards for controlling pollution, and acts as an appeal tribunal in matters of appeals against orders of the Director of Pollution Control.

There was considerable activity in 1969 on the part of the Pollution Control Board, involving matters of appeals, meetings, policy making, and compilation of reports.

The Board took a major step in that its final recommendations to the Executive Council regarding air pollution were submitted in June, 1969, in advance of the date set originally for submission of the report. It was a lengthy document and widely publicized in full so there is no necessity to describe the details at this time.

The membership of the Board was increased from seven members to ten, including the Chairman, who has been employed on a full-time basis since the end of June.

As provided in section 12 of the *Pollution Control Act, 1967*, the Board is empowered to sit as an appeal tribunal. During 1969 only two appeals were made to the Board, one of which was upheld and one refused. The appeal upheld was that of various interested parties relative to the Maliview Subdivision on Saltspring Island and the decision of the Board ordered the installation upgraded to require primary treatment. Subsequently an appeal was filed with the Lieutenant-Governor in Council. In addition, the appropriate officials of the City of Prince George appealed the November, 1968, decision of the Board that they "proceed immediately with construction of works necessary to make fully operative a primary treatment plant by November 9, 1970." The latter appeal was refused.

The Board had four briefs presented in the course of the year that did not require decision. Two were of a general nature in which pollution problems of a broad nature were discussed. One brief dealt with the problems facing the pulp and paper industry of the Province and the steps which are proposed to cope with them. The final brief concerned the proposals to fertilize Great Central Lake to increase the production of fish, and after consideration it was decided that the Board did not have jurisdiction and referred the matter to the Department of Lands, Forests, and Water Resources.

During the course of the year, 11 regular meetings of the Board were held when routine business was transacted.

1947

CONFIDENTIAL

SECRET

U.S. GOVERNMENT

OFFICE

The following information was obtained from a confidential source who has provided reliable information in the past. It is being furnished to you for your information only and is not to be disseminated outside your office.

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POLLUTION CONTROL BRANCH

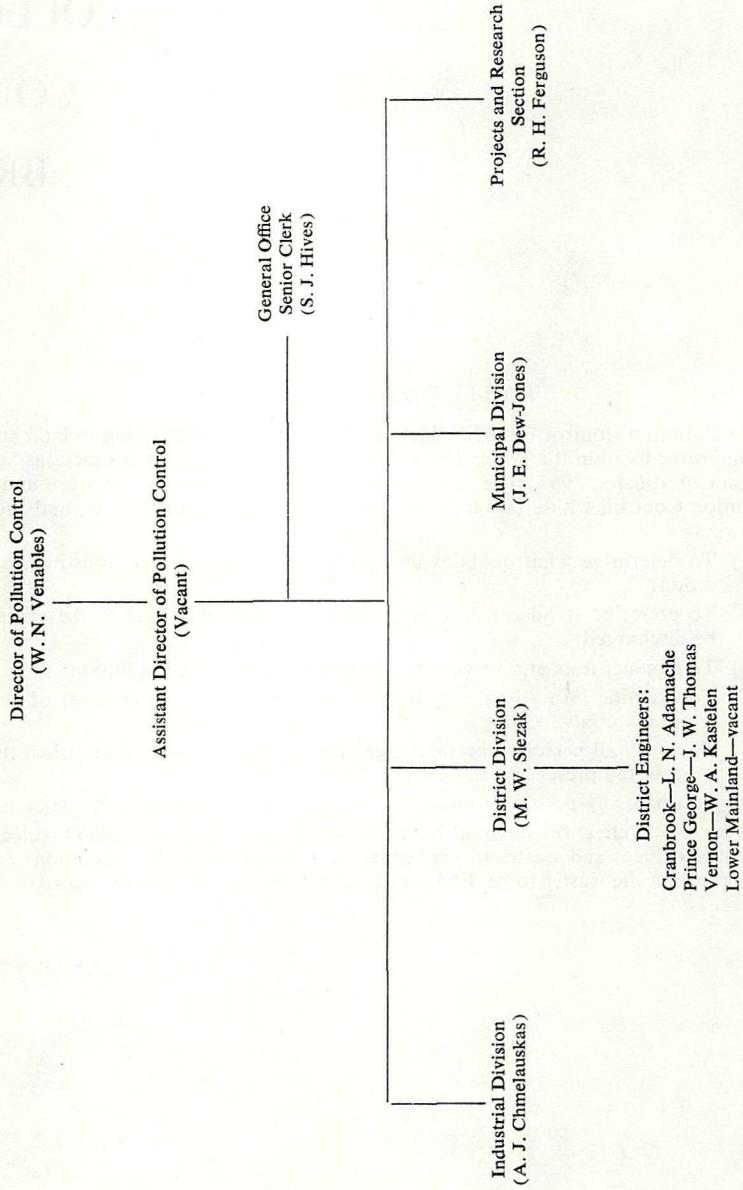
POLLUTION CONTROL BRANCH

The Pollution Control Branch, which deals with matters pertaining to land and water pollution, was formed within the Water Resources Service to carry out the functions laid down in the *Pollution Control Act, 1967*. The administration of the Act is carried forward under the Director of Pollution Control, whose powers and duties are prescribed in the Act, and are, in summary, as follows:—

- (a) To determine what qualities and properties of water shall constitute a polluted condition:
- (b) To prescribe standards regarding the quality and character of the effluent which may be discharged:
- (c) To conduct tests and surveys to determine the extent of pollution:
- (d) To examine into all existing or proposed means for the disposal of sewage or other waste materials:
- (e) To notify all persons who discharge effluent into the said waters when the effluent fails to meet the prescribed standards:
- (f) To order any person to increase the degree of treatment of the effluent.

To carry into effect the intent of the *Pollution Control Act, 1967*, the Director issues permits to discharge effluent and wastes to applicants who comply with the regulations and who satisfy the Director that the wastes to be discharged will not cause pollution in accordance with the Act.

ORGANIZATIONAL CHART OF THE POLLUTION CONTROL BRANCH, YEAR ENDED DECEMBER, 1969



POLLUTION CONTROL BRANCH

C. J. KEENAN, P.ENG. (January to August 31)

W. N. VENABLES, P.ENG. (September 1 to December 31)

DIRECTOR

The Pollution Control Branch is responsible for the administration of the *Pollution Control Act, 1967*, as it pertains to the discharge of wastes to land and water in British Columbia. Certain wastes are excluded from the provisions of the Act and these are set out in the regulations pursuant thereto and the discharge of these wastes are controlled under other legislation by other departments of Government.

The vehicle for controlling pollution under the Act is the permit system and the Act specifically states that: "No person shall discharge sewage or other waste materials on, in, or under any land or into any waters without a permit from the Director."

It is to be noted that discharges to the atmosphere are not covered by permit under the *Pollution Control Act, 1967*, at this time. The Act also provides for the establishment of the Pollution Control Board, whose functions are set out in the Act, and decisions of the Board that may be pertinent to the operation of the Branch are transmitted to the Director of Pollution Control through the Deputy Minister of the Water Resources Service, under whose ægis the Pollution Control Branch operates.

During 1969 it became apparent that to ensure that pollution was adequately controlled, where there was overlapping jurisdiction under other legislation it was necessary to improve the communication and understanding with other administrations within Government and in conformance with announced policy, it is generally accepted that a person or persons wishing to discharge should first obtain the necessary permit or permits under the *Pollution Control Act, 1967*.

During 1969 the Pollution Control Branch was reorganized to assume full status as a Branch within the Water Resources Service, and as of September 1st, three divisions and a section were brought into being and now formulate the Branch organization. The functions and duties of the divisions are clearly defined in order to provide an improved service to the public. The Municipal Division is responsible for the processing of all applications for discharges for all municipal sewerage systems and other domestic wastes. The Industrial Division deals with all applications for permits from industry not connected to a municipal sewerage system (including industrial refuse disposal), and in the performance of their duties the engineers in this Division are generally guided by the dictum that "if wastes are properly managed, pollution will not be caused," and in so doing concern themselves with in-plant controls, as in many cases the quality and quantity of final discharge can be considerably reduced. The Districts Division, with offices established at Cranbrook, Vernon, Prince George, and Victoria, is responsible for the administration of permits once they are issued and the appeal time has lapsed. In so doing it is required to ascertain that the works authorized by the permit are completed in accordance with the plans and specifications, that a monitoring programme is set up to ensure that the dis-

charge is within the limits authorized by the permit, and carry out such other duties as may be assigned to it from time to time. The Projects and Research Section is being developed to provide the necessary contact with the Provincial Laboratories, who carry out all the water-chemistry analyses for the Branch, to correlate the various field studies that are being undertaken from time to time, to carry out specific studies and research to determine the degree and impact of pollution at various levels, to provide the expertise to the other divisions in those matters of a specialty nature.

The philosophy that pollution control is everybody's business has led to the adoption of certain policies within the Branch that are being effected as quickly as the availability of staff permits; for example, copies of all pollution control permits are now available for inspection by the public at each district office; a programme to clarify the objectives of the Act and functions of the Branch has been implemented at various levels of government; participation by discussion with groups showing bona fide interest in and a responsible attitude toward pollution control is being encouraged, and the fact that the Director and the staff are the anti-pollutionists and that the Act is to *control* pollution in British Columbia is being propounded.

ADMINISTRATION

The administration of the Branch was reorganized on September 1st when three divisions were created. Such action was made possible by staff increase authorized for the 1969/70 budget, and the present establishment authorizes 16 positions for professional engineers, which include the positions of the Director, Assistant Director, three Division Chiefs, and 11 others. There are 14 other positions authorized which are filled by clerks, technicians, draughtsmen, and stenographers, and a chemical analyst from the Branch has been seconded to the Provincial Laboratories. The necessary administrative functions associated with the investigation and processing of applications for permits are carried forward by the appropriate division within the Pollution Control Branch and the facts of each investigation are laid before the Director. The Director may then grant, amend and grant, or refuse to grant a permit. Applicants must satisfy the Director that the waste to be discharged will not cause pollution in accordance with the Act. All valid objections to the issuance of a permit are investigated and, where necessary, public hearings or inquiries may be held before a final decision is reached on an application. During the current year a procedure whereby an applicant was advised of all objections was instituted in anticipation that he would take up the matter of the objection with the objector. Indications are that this procedure will ensure that public funds are not wasted in holding unnecessary inquiries, and it is anticipated that the procedure will provide the communication necessary to keep both parties informed.

During 1969, 162 applications were received; 59 permits being granted, 13 amendments to permits granted, 7 applications were refused, 10 applications were voluntarily withdrawn, and the remaining 73 applications are presently being processed or are being held in abeyance awaiting resolution of extenuating circumstances. In many instances where a permit was granted, the applicant was requested to provide facilities in excess of those proposed on his original application. In ruling on an application, the Director first gives consideration (assuming all other matters relative to the application being in compliance with the Act) to any policies or requirements that have been established by the Pollution Control Board. The policy declaration of the Pollution Control Board, as set out in their news release of March 14th, included statements relative to discharge to salt water and a decision by the Director to refuse a permit based on this Board policy is presently being appealed in accordance with the appeal procedures set out in the Act.

INDUSTRIAL DIVISION

A. J. Chmelauskas, P.Eng., Chief of Division

The Industrial Division, established April 1, 1969, replaced the Pulp Mill Division referred to in the 1968 Annual Report. This Division is now principally concerned with the assessment and evaluation of pollution control applications, relevant reports, and plans concerning waste-disposal facilities for all industrial discharges of effluent and (or) refuse. Applications for permits are assessed technically to ascertain that the means or mode of disposal are satisfactory to assure adequate containment (refuse) or receiving-water quality (effluent) consistent with the uses made of receiving waters and the Pollution Control Board policy where applicable.

The Division has been divided into three sections to develop specific expertise with problems of discharges associated with complex industrial processes, and to delegate work and responsibility commensurate with the interest, training, and competence of those working in the Division.

The Forest Products Section is involved for the most part with pulp- and paper-mills, but also includes other attendant industries such as plywood, veneer, particle board, and sawmills. In 1969 three existing and one new pulp-mill were brought under permit. Ten pulp-mills in the Province are not as yet under permit; however, all these mills were contacted early during the year and are currently undertaking inventories and studies in preparation to making application. It is expected that all pulp-mills will be under permit by end of 1970.

The Mining and Mineral Products Section is primarily concerned with the metal- and coal-mining operations; however, included are the metal fabrication and finishing operations, smelting, and industrial mineral development for limestone, cement, and pozzolan.

The General Section is involved with discharges from the petroleum refineries and the petro-chemical industries, industrial chemicals, fermentation industries, food-processing industries, feed-lot operations, laundromats, car-washes, etc., where these industries are not on municipal sewers.

In addition to the evaluation of applications and technical negotiations with the applicants, the Division is involved with field investigations, preparation of reports, recommending on the effluent, and receiving water-monitoring programmes, reviewing statistical tabulation and plots of monitoring results in order to evaluate the effectiveness of disposal systems.

The Division is also used in an advisory capacity to the Taxation Department regarding property-tax exemption of pollution-abatement facilities as provided for under section 24 of the *Taxation Act*.

In dealing with industrial applicants, considerable emphasis is stressed with the applicant to consider and employ, where practical, in-plant measures which will reduce waste load from the plant. This may be achieved by any one or a combination of the following means: Separation of sewer systems, monitoring and alarm devices, recirculation and reuse of process waters, in-plant treatment devices, and the implementation of good housekeeping practice.

Such systematic approach to waste management has its just rewards in economies which are realized in reduced product losses, reduced costs of water supply as the result of reduced consumption, and reduction in the size, complexity, and cost of any out-plant treatment.

Similarly as in effluent control, the disposal of solid waste materials is directed toward the utilization of the waste, either immediately through some useful purpose or stored in such manner that it would be available for some potential future use which may be developed with improved knowledge and technology.

MUNICIPAL DIVISION

J. E. Dew-Jones, P.Eng., Chief of Division

The work of the Municipal Division comprises the processing of applications for permits for all non-industrial discharges. Not only do all municipal discharges come under this category, but also any private non-industrial development not exempted by regulation at this time. Such exemptions are now limited to single houses and duplexes and discharges to a tile disposal-field of up to 5,000 gallons per day of domestic waste. Municipal discharges vary from small housing schemes under the jurisdiction of improvement districts up to the volume discharged from the Iona Treatment Plant of the Greater Vancouver Sewerage and Drainage District. Private development includes discharges under such categories as subdivisions, construction camps, and trailer parks.

The first consideration when an application is submitted is whether or not it comes within the scope of any policy laid down by the Pollution Control Board. Apart from Pollution Control Board policy considerations, applicants must substantiate their submissions on technical grounds. This may involve considerable research and investigation by the applicant and (or) the Branch, particularly in regard to discharges to the sea.

Another technical consideration is that it is often preferable for industrial wastes to discharge to a municipal sewer (sometimes with some degree of treatment) rather than maintain their own treatment facility and local discharge. Much work has been done which is not directly connected with the issuance of permits regarding this matter. Municipalities are beginning to recognize the need to assess present and future industrial discharges which might affect their sewerage systems. Accordingly, the number of applications covering municipal works designed to treat wastes from industry are growing.

The work of assessing applications is both technically and administratively complex. In general, applications are posted and advertised and commonly give rise to objections. In addition, copies of applications are distributed to certain other government agencies for their comment, and these must be taken into account. It is the work of the divisions to assess all the facts and views put forward. In doing so, the engineers involved must strive to keep up to date on the various subjects concerned with their work. The problem this poses will be appreciated when it is realized that a recent textbook on water-quality criteria lists some 3,000 references.

This Division gives consultation upon request, relative to those technical matters where financial assistance is being sought by the municipality under existing legislation.

Approximately 40 permits have been issued during 1969 and 20 applications for municipal discharges are presently being processed.

DISTRICT DIVISION

M. W. Slezak, P.Eng., Chief of Division

Prior to September 1, 1969, the district offices were supervised from Victoria by the Assistant Director. To facilitate expansion within the Branch it became necessary to relieve the Assistant Director of these responsibilities by forming a District Division and appointing a Chief of the District Division.

Within this Division of the Branch lies the responsibility to administer permits granted under the Act. At present the offices are located at Cranbrook, Vernon, and

Prince George, in the Kootenay, Okanagan, and Prince George districts respectively, and a fourth district was created in 1969 for the Lower Mainland and an engineer experienced in the waste-treatment field has been recruited to fill the position of District Engineer for this office. One of the first programmes in establishing a district office is to inventory all major outfalls and sources of pollution within the district.

During 1969, additional staff were also recruited for the established districts in order to carry out site investigations, surveillance work, and investigations of complaints.

A heavy work load continues to be placed on district personnel due to the rapid growth in district office activities. Temporary staff is recruited whenever possible to assist the permanent staff to meet these growth demands. There is considerable diversification of responsibility allocated to district personnel as they monitor effluents to ensure that the quality and quantity are within the limits of the permits, and they assist operators in understanding the operation of treatment plants. District personnel also collect data on the assimilative capacity of the environment, which information is utilized to process and evaluate applications.

During the latter part of the year the duties of the District Engineers have been expanded to the public-relations field and it is anticipated that they will give talks to schools and interested groups in order to permit a better understanding of the mechanics of the *Pollution Control Act, 1967*.

Reports for the established districts are as follows:—

KOOTENAY DISTRICT

L. N. Adamache, P.Eng., District Engineer

The Kootenay District was responsible for the administration of the Act in the Regional Districts of East Kootenay, Central Kootenay, Kootenay Boundary, and all of the Columbia-Shuswap east of Revelstoke. The District Office which was located in Nelson until November 1, 1969, was relocated in Cranbrook, and a sub-office established in Nelson. The move was made to enable more efficient administration of existing pollution control permits and to provide better service to the public.

The staff in 1969 consisted of the District Engineer, an engineering technician, and a part-time clerk-typist. Ten new permits were issued in the Kootenay District in 1969, where there are now a total of 32. Of this number, 20 of the permittees have constructed works in accordance with permit requirements. The remainder are either in the process of preparing to or constructing works. Site investigations were conducted and reports prepared for 19 permit applications in 1969. Inspection of works under permit was conducted on a routine basis.

The basic water-quality monitoring programme initiated for the Columbia River Basin in August of 1968 was conducted with some modifications to the programme in 1969. It is expected that this programme will continue indefinitely to establish the natural, physical, and mechanical characteristics of the water resources and to enable detection of any changes in water quality as a result of changes within the river basin.

The Elk River study was initiated with the co-operation and assistance from the Inland Waters Branch of the Department of Energy, Mines and Resources and the British Columbia Fish and Wildlife Branch, and the study will determine the effects of coal-mining operations on the streams in the Elk River Basin. Initially, five monitoring stations will be established.

The Libby Reservoir study was commenced in 1969 for the purpose of

- (a) examining the potential effects of upstream pollution on the Libby Reservoir;
- (b) establishing data so that the potential effects of the Libby Reservoir on downstream water quality may be ascertained.

OKANAGAN DISTRICT

W. A. Kastelen, P.Eng.(Alta.), District Engineer

The Okanagan District Office was responsible for the administration of the Act in the Regional Districts of Okanagan-Similkameen; Central Okanagan; North Okanagan; Columbia-Shuswap, west of Revelstoke; and the Thompson-Nicola. The District Office was relocated from Oliver to Vernon as of July 1, 1969. The office space in Oliver was converted to a sub-office.

The permanent staff in the Okanagan consisted of a District Engineer, engineering technician, and a clerk-stenographer. Two university students were hired as temporary help in July to assist the permanent staff with sampling and stream surveys.

A continuous sampling programme of the major outfalls and streams in the Okanagan District commenced on September 1st, and lake-sampling was added to this programme in November. In addition to the permit sampling, samples were collected monthly at 19 outfalls, 17 stream and 11 (2 samples per station) lake stations for chemical and bacteriological analyses.

The Canada-British Columbia-Okanagan Basin Agreement was signed in October, 1969, and it is expected that the joint Federal-Provincial water-quality studies will be fully under way in the near future. In May of this year sampling stations were established for the purpose of this study. The three-year Okanagan study initiated by the Pollution Control Branch in 1968 has provided the base-line programme for the joint study and the inventory of all major domestic and industrial-waste discharges in the Okanagan Drainage Basin was completed this year.

Thirteen new permits were issued during the calendar year, giving a total number of 46 being administered by this office. Site investigations were conducted and reports prepared for 19 permit applications. Inspection of treatment works under permit were attended to on a regular basis.

Several requests for information were received and numerous pollution complaints were investigated throughout the year. One public hearing was held in Vernon in connection with the issuance of a permit to a distillery.

PRINCE GEORGE DISTRICT

J. W. Thomas, P.Eng., District Engineer

The Prince George office was responsible for the administration of the Act in the Regional Districts of Cariboo, Fraser-Fort George, Bulkley-Nechako, Skeena A, Skeena B, Peace River, and Stikine.

During 1969 the District Office was initially allocated space in the office of the Water Rights Branch in the Government Building. In February, office space in the Professional Centre was acquired and the office was subsequently relocated.

On September 17th a part-time clerk-typist commenced work and in November a chemical engineering graduate was added to the staff as an engineering technician.

During the year some 16 new permits were issued in the district and a total of 46 permits are now being administered by the Prince George office. Twenty-four site investigations were made and reports prepared.

A start was made on a study of the Upper Fraser from Hope to Valemount, and an inventory of the major domestic and industrial-waste discharges is in progress. A sampling programme in conjunction with the study has been prepared and will be initiated in the spring of 1970.

Several requests for information were received and numerous pollution complaints were investigated throughout the year.

PROJECTS AND RESEARCH SECTION

R. H. Ferguson, P.Eng.

This Section was established in mid-1969 and consists of an engineer, a draughtsman, and a chemical-analyst who works within the Health Branch Division of Laboratories in Vancouver.

It is the responsibility of this Section to establish a programme of water-quality monitoring to co-ordinate monitoring work requiring analytical determination within the capacity of the Provincial Laboratories, to assess and report on receiving water quality and waste-water assimilation capacity, to carry out special studies related to pollution control, and to investigate and advise Branch members on technical matters related to pollution.

The work performed under this Section in 1969 has been primarily concerned with the initial establishment of a water-quality monitoring network and investigation into miscellaneous matters related to pollution control.

The Bridge Creek-Hendrix Creek-Canim Lake study initiated in 1968 continued until late summer of 1969. This study involved sampling of the major contributory streams to the system and the outgoing waters from the system to determine the effect on the receiving waters of agricultural drainage and domestic-waste discharge and to establish base-line data for future investigations of these waters.

GENERAL OFFICE

S. J. Hives

A Senior Clerk is responsible for the operation of this Section. To assist him in these duties are three stenographers, a typist, and a junior clerk. This Section records all incoming mail and carries out the functions necessary to facilitate the administration of the Main Branch Office, and in this regard it should be noted that 300 pieces of mail were registered in November, 1968, and that 750 pieces of mail were registered in the same month in 1969.

IN SUMMARY

The problem of pollution control is essentially that of the management of the unmarketable or socially undesirable by-products of man's activities and in this regard it is reassuring to note that the immediate and potential effectiveness of the *Pollution Control Act, 1967*, is being recognized.

It is acknowledged that education of, communication with, and co-operation by the public is necessary to effect the requirements of the Act so that pollution may be controlled.

Pollution is not only everyone's business it is everyone's responsibility. By positive action major industries are indicating their willingness to accept their responsibilities and it behooves those at all levels of Government to ensure that they in turn recognize, accept, and demonstrate a similar attitude toward effecting pollution control measures.

There is no question that if the Act as amended is accepted, respected, and supported by all, it can provide the vehicle to effectively control pollution in the Province of British Columbia.

PROPERTIES OF THE POLYMERIZATION OF ETHYLENE

The polymer was obtained in the form of a white, crystalline solid, melting at 100°C. It was soluble in benzene, toluene, and carbon tetrachloride. The polymerization was carried out in a stainless steel autoclave at 100°C and 100 atm. The reaction mixture consisted of ethylene, a catalyst, and a solvent. The catalyst was a complex of a transition metal and a ligand. The solvent was a mixture of benzene and carbon tetrachloride. The reaction was carried out for a period of 24 hours. The polymer was then isolated by precipitation into methanol. The yield of the polymer was 85%. The molecular weight of the polymer was determined by gel permeation chromatography (GPC) to be in the range of 10,000 to 100,000. The polymer exhibited a high degree of crystallinity, as determined by x-ray diffraction. The melting point of the polymer was 100°C. The polymer was found to be stable in air and in the dark. It was not soluble in water. The polymer was found to be a good conductor of electricity. The polymer was found to be a good insulator of heat. The polymer was found to be a good insulator of sound. The polymer was found to be a good insulator of light. The polymer was found to be a good insulator of radio waves. The polymer was found to be a good insulator of infrared radiation. The polymer was found to be a good insulator of ultraviolet radiation. The polymer was found to be a good insulator of gamma rays. The polymer was found to be a good insulator of cosmic rays. The polymer was found to be a good insulator of all forms of electromagnetic radiation.

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INSPECTOR
OF
DYKES

REPORT

OF

DAKE

**INSPECTOR
OF
DYKES**

**W. R. MEIGHEN, P.ENG.
INSPECTOR OF DYKES**

The spring run-off in the Fraser and other major river systems was of normal or below-normal proportions and did not produce any major threat to any of the dyking systems in the Province.

As a result, work on the dykes and on the allied pumping and drainage works was of a routine nature, consisting largely of necessary maintenance.

Pumps in Maple Ridge, Pitt Meadows No. 2, Coquitlam, West Nicomen, Sumas, and Matsqui Districts were lifted and necessary overhaul or repair carried out. Repairs were made to three pumphouses in the Coquitlam Dyking District.

A considerable number of meetings with municipal officials were attended to discuss the transfer of responsibility for the dyking and drainage works to the various municipalities.

Numerous meetings of the Joint Programme Committee, established by the Federal-Provincial Governments to carry out the Flood Control programme in the Fraser Valley, were attended throughout the year. As well, many meetings and field inspections of work groups established by this Joint Programme Committee were also attended.

Surveys for the Flood Control programme, authorized by the Joint Programme Committee, are now under way in many parts of the Fraser Valley. It is anticipated that construction will commence in some areas early in the next year.

CHAPTER

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THREE

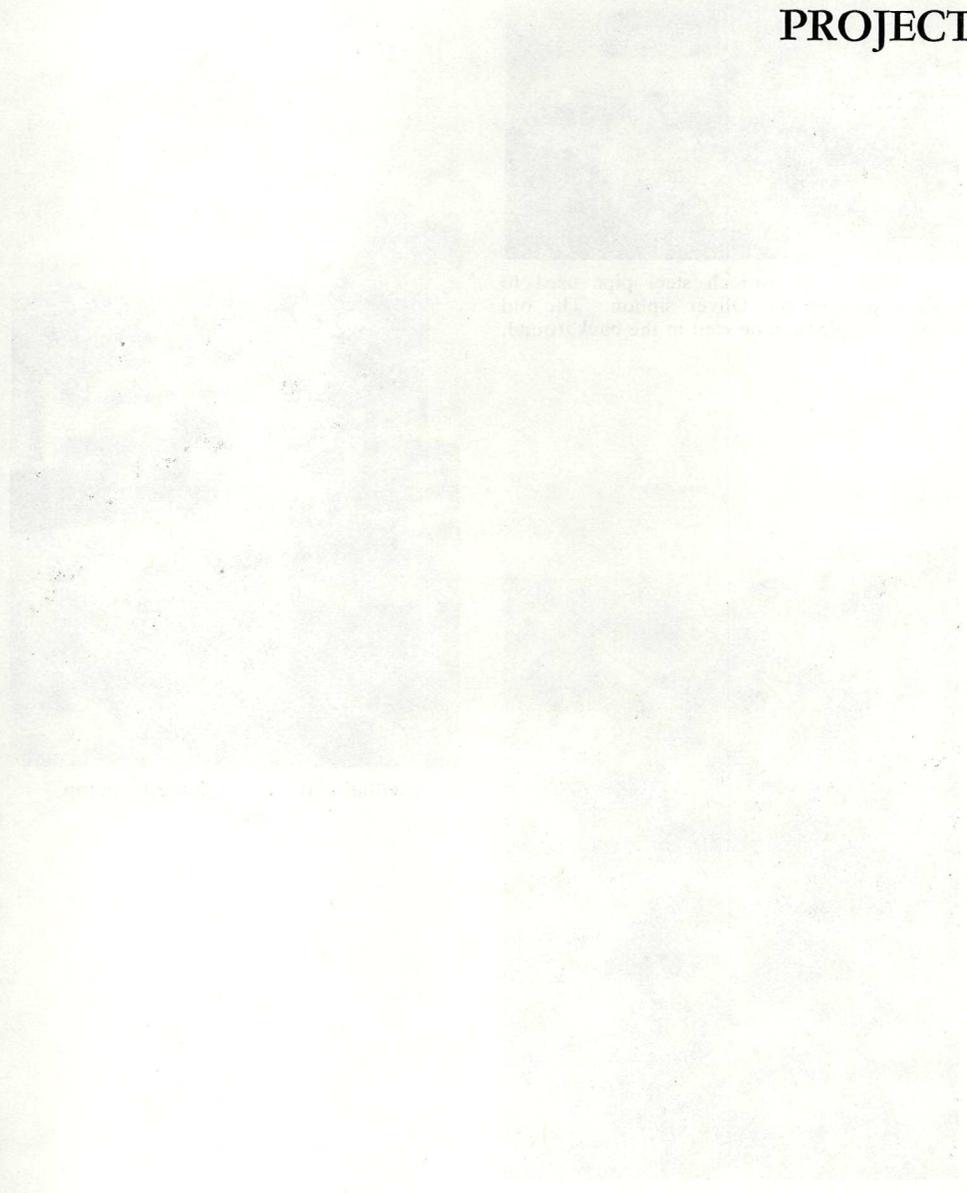
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The first part of the report...

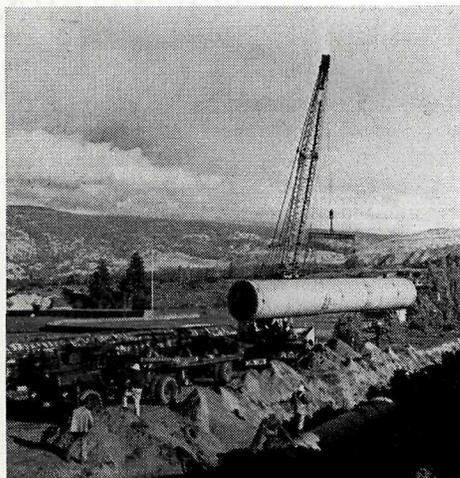
The second part of the report...

The third part of the report...

**SOUTHERN
OKANAGAN
LANDS
PROJECT**



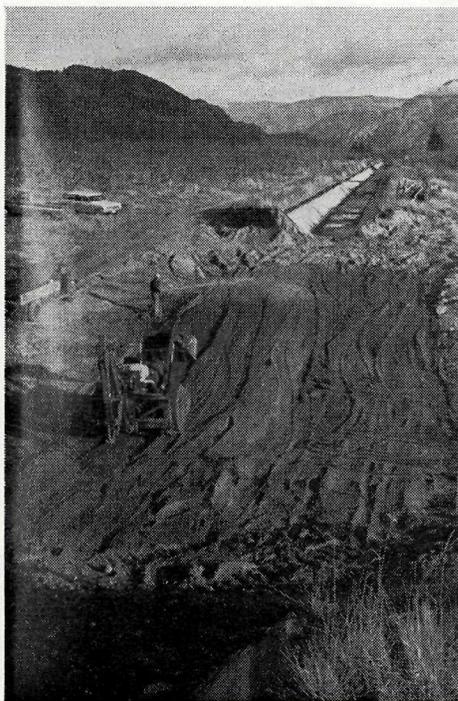
IRRIGATION SYSTEM, SOUTHERN OKANAGAN LANDS PROJECT



Installation of 60-inch steel pipe used to replace part of the Oliver siphon. The old wood-stave pipe can be seen in the background.



Installation of No. 4A domestic pump at well-site.



Fill area for elimination of flume.

**SOUTHERN
OKANAGAN
LANDS
PROJECT**

L. A. PINSKE
PROJECT MANAGER

ADMINISTRATION

Operation and maintenance of the irrigation system and the continuation of the rehabilitation programme being carried out under the *Agricultural Rehabilitation and Development (British Columbia) Act* were the main functions of the Southern Okanagan Lands Project during the year. The reconstruction programme is continuing and on completion of the rehabilitation the administration of the system will be handled by the Southern Okanagan Lands Irrigation District formed as an improvement district under Letters Patent dated July 7, 1964.

In May, 80.3 acres of land in the Tinhorn Creek area were sold after being tendered for sale unsuccessfully on two previous occasions.

The disposition of numerous small portions of land and old river oxbows, which were created by the Okanagan Flood Control channel, was continued as surveys and administrative procedures were completed.

OPERATION

Rehabilitation of the system for the Southern Okanagan Lands Irrigation District was continued by Southern Okanagan Lands Project crew. Construction included No. 4 domestic pump system; commencement of survey and constructing of No. 1 pump system; building of chlorinator facilities at No. 7 pumphouse; completion of No. 6 pump system; replacement or reconstruction of flumes Nos. 4, 5, 6, 7, 11, 12, 13, and 14; installation of rotary screen at No. 4 pump system intake; commencement of rehabilitating the main siphon; fencing and covering of the main canal through residential area of Oliver.

Pump and motor inspection, servicing, and overhaul as well as replacement of deteriorated timbers on trestles, cleaning and pitching of the main canal were carried out under the normal annual maintenance programme.

Water was diverted from the Okanagan River into the main canal on April 22, 1969, and all pumping stations energized shortly after that date.

On July 25, 1969, at approximately 9 p.m., the No. 2, 150-horsepower electric motor burned out at No. 4 pump station. Water service was maintained on a restricted basis with the remaining pumps until July 28, 1969, at 11 p.m., when full service was restored to No. 4 pump system.

Water service to the West Lateral area was curtailed on August 24, 1969, due to a portion of a flume being knocked out by fire-fighting equipment while battling a

forest fire north of Oliver. Service was fully restored in the early evening of August 25, 1969.

The usual ditch-riding service was provided for the Black Sage Irrigation District until September 20, 1969, when they requested to be turned off for the season.

Water which was being diverted to the main irrigation canal for irrigation and domestic purposes was turned off September 30, 1969. No. 4A pump, pumping from a well, and No. 8 pump, pumping from Osoyoos Lake, were immediately placed in operation to provide domestic water on that same date.

Project crews were engaged in the installation of aeration equipment in Osoyoos Lake for the Water Resources Service to be used in a study of aeration as a possible means of improving water quality in the No. 9 pump system.

Annual Revenue to December 9, 1969

Irrigation collections	\$82,100.18
Land sales (principal)	23,386.80
Sundries (topsoil, maps, payments from irrigation district, interest, and lease rentals)	104,622.03
	<hr/>
Total	\$210,109.01
	<hr/> <hr/>

PERSONNEL
OFFICE
AND
ACCOUNTING
DIVISION

PERSONNEL

OFFICE

AND

ACCOUNTING

DIVISION

PERSONNEL

OFFICE

K. M. HANSON

PERSONNEL OFFICER

In 1969, the permanent establishment of the Water Resources Service was increased by 19 new positions. Eleven of these positions were in the Pollution Control Branch, seven in the Water Investigations Branch, and the remaining position in the office of the Deputy Minister.

Work under the Fraser River Flood Control Agreement commenced this year and four temporary continuous positions were established.

The table below indicates a slight increase in activity over both 1967 and 1968. This, combined with the above-mentioned new positions, has brought about considerable more work for this office.

	1966	1967	1968	1969
Recruitments for continuous staff.....	24	31	37	36
Reclassifications.....	18	15	8	10
Promotions.....	10	18	9	17
Internal transfers.....	4	5	---	4
Transfers to other departments.....	4	3	3	1
Terminations for continuous staff.....	17	18	28	28
Retirements.....	3	---	1	1
Short-term, casual appointments.....	25	35	36	40
Transfers from other departments.....	6	4	5	8
Extensions of service granted.....	4	3	2	2

In 1969 only one retirement took place, that of Mr. E. J. Folwell, Administrative Officer, Improvement Districts Division, Water Rights Branch, who retired after 11 years in this position.

Due to ill health, Mr. A. F. Paget, Deputy Minister, resigned and was appointed as Consultant. Mr. Paget was replaced by Mr. V. Raudsepp. Other promotions included Mr. B. E. Marr, Chief Engineer, Water Investigations Branch, replacing Mr. Raudsepp; and Mr. P. M. Brady, Chief of the Projects Division, replacing Mr. Marr. In the Pollution Control Branch, Mr. C. Keenan, Director, resigned to take up a position in industry. Mr. W. N. Venables was appointed in his place. Mr. A. J. Chmelauskas and Mr. J. E. Dew-Jones, along with Mr. M. W. Slezak, were all appointed as Division Heads in the Pollution Control Branch as a result of competitions.

Field trips included a trip to the Nelson, Kelowna, Vernon, and Prince George offices. Other trips to Vancouver, Edmonton, Calgary, Saskatoon, and Regina were undertaken in order to recruit new staff.

The year 1969 was indeed busy, with developments such as the Fraser River Flood Control project, and activity in the future would appear to be somewhat similar, with the Federal-Provincial study of the Okanagan Basin in the offing.

MEMORANDUM
DATE

K. M. [Name]
[Title]

The following information was received from [Name] on [Date] regarding [Subject].

[Name] advised that [Subject] is currently [Status] and [Details].

[Name] also mentioned that [Subject] has been [Action] and [Details].

[Name] stated that [Subject] is expected to [Action] by [Date].

[Name] further noted that [Subject] has been [Action] and [Details].

[Name] also mentioned that [Subject] is currently [Status] and [Details].

[Name] stated that [Subject] is expected to [Action] by [Date].

[Name] further noted that [Subject] has been [Action] and [Details].

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[Name] also mentioned that [Subject] is currently [Status] and [Details].

[Name] stated that [Subject] is expected to [Action] by [Date].

[Name] further noted that [Subject] has been [Action] and [Details].

ACCOUNTING

DIVISION

M. B. MACLEAN

DEPARTMENTAL COMPTROLLER

The steady growth of Water Resources Service over the past several years continued through 1969 with increasing demands on the services of the Accounting Division, particularly in respect of payroll, expenditure control, and the collection of revenues.

The Federal-Provincial Fraser River Flood Control Agreement is now well under way and the recently signed Federal-Provincial Agreement on Okanagan Basin Studies will shortly be activated, all of which require additional expenditure control and the preparation of claims on both the Federal and local governments.

Water-licence accounts increased from 23,116, January 1, 1969, to 23,659, December 31, 1969.

Following is a statement of Water Resources Service revenue from annual rentals for water licences and from application fees under the *Water Act*, arranged by major purposes of the water licences for 1969, and a statement of comparative revenues over a 10-year period:—

Domestic, incidental use, and fees	\$104,712.94
Waterworks	16,160.15
Irrigation	4,121.04
Power	3,205,934.49
Funds received on application	33,648.50
	<hr/>
Total	\$3,364,577.12
	<hr/> <hr/>

Comparison of Revenue for 10-year Period, 1960 to 1969, Inclusive

1960.....	\$1,510,278	1965.....	\$2,251,025
1961.....	1,853,653	1966.....	2,285,932
1962.....	2,115,738	1967.....	2,431,010
1963.....	1,935,778	1968.....	2,749,848
1964.....	2,175,223	1969.....	3,364,577

Printed by A. SUTTON, Printer to the Queen's Most Excellent Majesty
in right of the Province of British Columbia.

1970

ACCOUNTS
RECEIVABLE

At 31 December 1983

At 31 December 1982

The steady growth of W. H. & A. in the last few years has been reflected in the increase in the Accounts Receivable, particularly in respect of the sale of goods on credit. The following table shows the details of the Accounts Receivable at 31 December 1983 and 1982.

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Particulars	1983	1982
At 1 January	100,000	100,000
During the year	200,000	150,000
At 31 December	300,000	250,000

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