

PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

HON. R. G. WILLISTON, *Minister*

A. F. PAGET, *Deputy Minister of Water Resources*

REPORT  
*of the*  
WATER RESOURCES  
SERVICE

YEAR ENDED DECEMBER 31

1966



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in right of the Province of British Columbia.

1967

COVER

Surrey water well being pump tested under  
supervision of Groundwater Division.

PROVINCE OF ONTARIO

DEPARTMENT OF WATER RESOURCES

Water Resources Division

# REPORT

ON

## WATER RESOURCES

## SERVICE

YEAR ENDED 1967

1968



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VICTORIA, B.C., January 23, 1967.

*To Major-General the Honourable GEORGE RANDOLPH PEARKES,  
V.C., P.C., C.B., D.S.O., M.C., C.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, 1966.

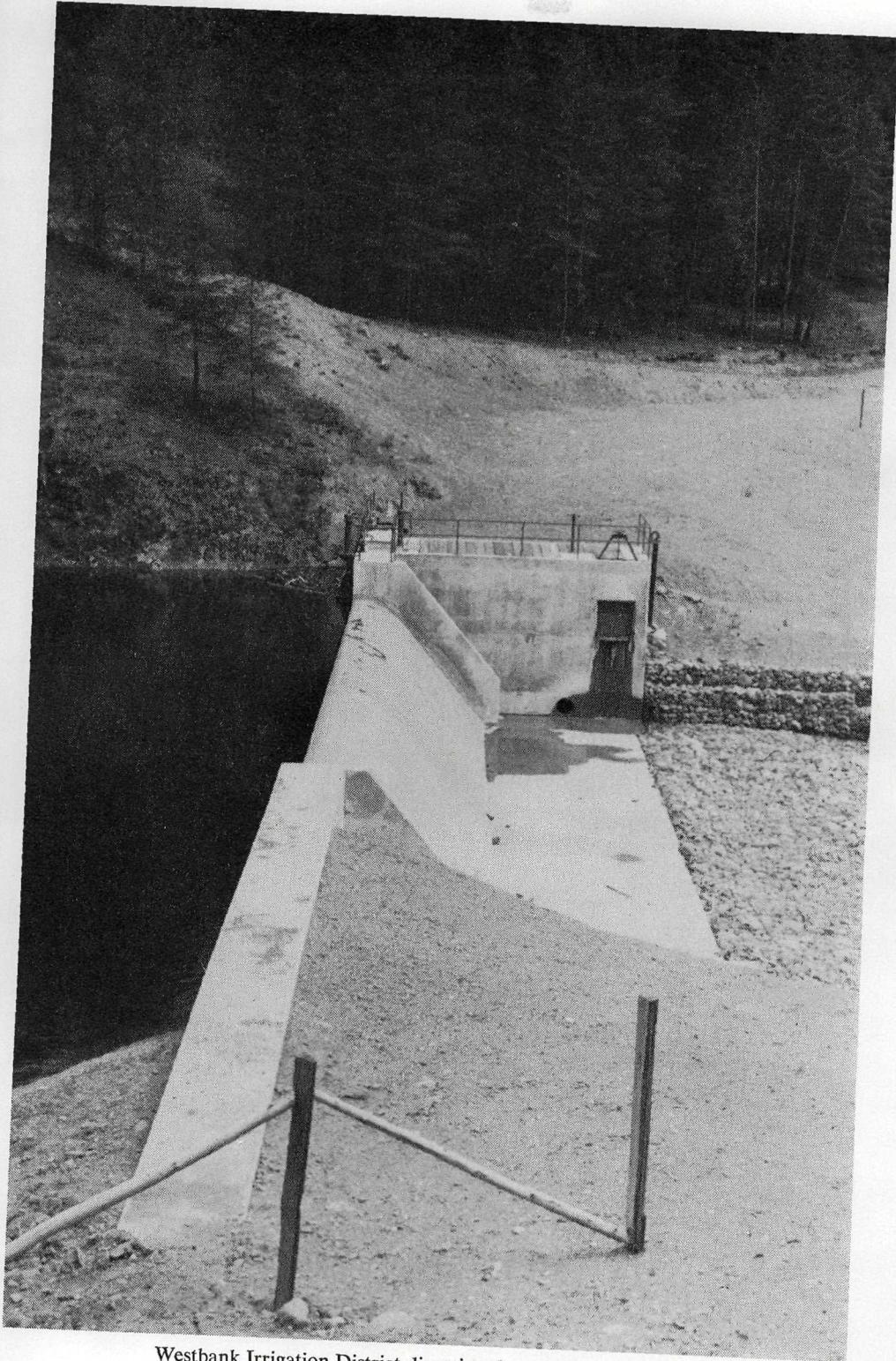
RAY WILLISTON,  
*Minister of Lands, Forests, and Water Resources.*

VICTORIA, B.C., January 23, 1967.

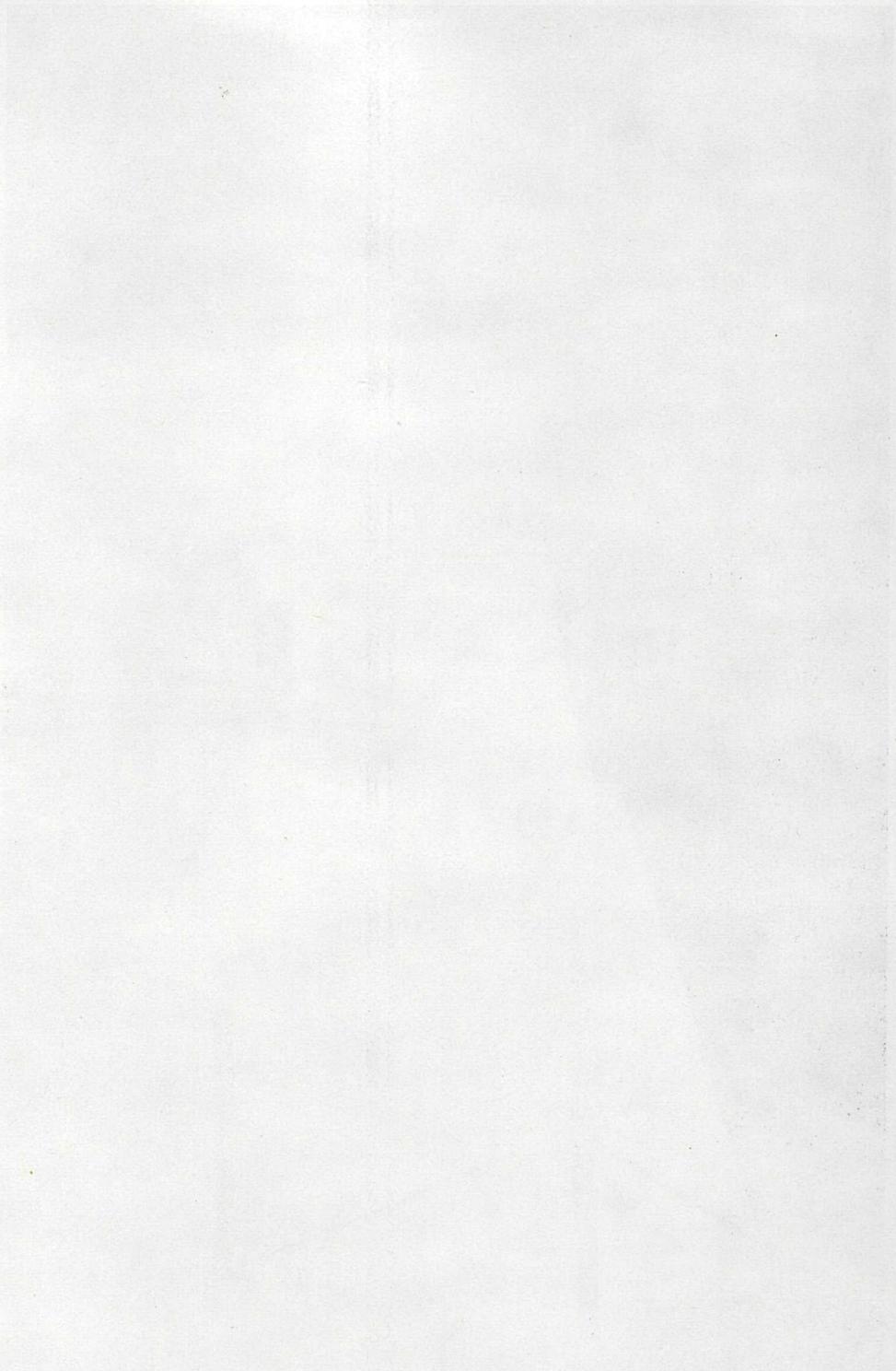
*The Honourable Ray Williston,  
Minister of Lands, Forests, and Water Resources,  
Victoria, B.C.*

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, 1966.

A. F. PAGET,  
*Deputy Minister of Water Resources.*



Westbank Irrigation District diversion dam on Powers Creek.



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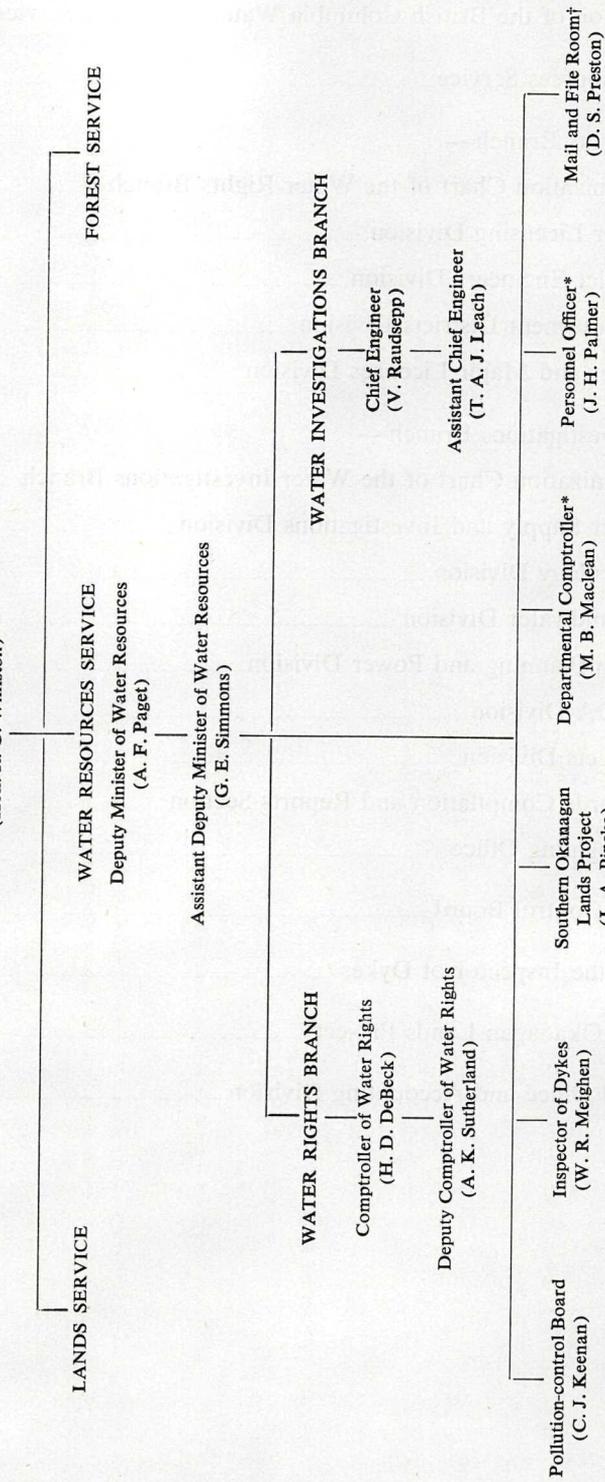
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# ORGANIZATION CHART OF THE BRITISH COLUMBIA WATER RESOURCES SERVICE

## DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

Year Ended December, 1966

MINISTER OF LANDS, FORESTS, AND WATER RESOURCES  
(Hon. R. G. Williston)



\* Services shared with Lands Service.  
† Services shared with Lands Service and Forest Service.

# Report of the Water Resources Service

A. F. PAGET, P.ENG., DEPUTY MINISTER OF WATER RESOURCES

The steady development throughout British Columbia is reflected in the annually increasing number of applications handled by the Water Rights Branch for water licences and the many other administrative processes associated with water administration. In 1966, applications for licences increased by 4½ per cent and the total number of processes handled increased by 2 per cent to 6,635. During the year, 1,706 licences were issued, up 17½ per cent from 1965.

In the six districts, applications for water licences were as follows: Kamloops, 316; Kelowna, 196; Mission, 211; Nelson, 205; Prince George, 164; Victoria, 183.

Revenue from all sources increased for the third successive year, reaching a new high of \$2,286,000 in 1966.

Improvement districts can be formed under the *Water Act* for a variety of needs, and in 1966 eight new districts were created, bringing the net total in the Province to 321 at the end of the year. Of this number 35 are hospital improvement districts, with only two having responsibility for provision and operation of hospital facilities, the remainder being responsible for financial aid toward constructing, equipping, and operating a hospital. In most cases, districts are financed through debenture issues fully guaranteed as to principal and interest by the Province of British Columbia. In 1966, debenture issues totalling \$621,600 were guaranteed, bringing the total outstanding under the *Improvement Districts Assistance Loan Act* to \$13,560,600. During the year, capital works to the value of \$23,635,096 were completed by improvement districts with financing arranged under ARDA, through the Municipal Development and Loan Board, or by means of district resources and borrowings.

During 1965, the last year for which complete data are available, the total amount of energy generated by hydro-electric plants in British Columbia amounted to 15,257,960,000 kilowatt-hours, slightly down from the preceding year, whereas thermal generation nearly doubled the 1964 figure, to 3,238,000,000 kilowatt-hours, Over-all increase in power generation was 7.1 per cent above 1964 output, but imports, netting 456,000,000 kilowatt-hours, were necessary to meet the 10-per cent increase in demand. Over the 10-year period 1955 to 1964, the average annual rate of load growth was 8.0 per cent.

Estimated generation for 1966 is 21,000,000,000 kilowatt-hours, which would represent an increase of about 13.6 per cent over that of 1965. Although energy was both imported and exported during the year, the net result was zero, indicating that British Columbia's installations through interconnection were able to meet demand. This was the result partly of a better water year, and partly of the starting of the fourth and final 90-m.w. unit at the Waneta plant of Cominco Ltd.

Construction on the major flood-control and hydro-electric power projects is progressing satisfactorily. The Portage Mountain Dam received some 23,400,000 cubic yards of material, or about 40 per cent of the total for the completed structure. It is anticipated that power will be available to meet the demand in 1968 as planned. On the Columbia River, the Arrow Lakes dam is on schedule, with good progress both on the earth fill and on the concrete section. Duncan Lake storage dam is well ahead of its time schedule, and storage is expected to be available a year ahead of the planned date of April, 1968. At Mica Creek, preliminary site work is well in hand and good progress was made during 1966 on the diversion tunnels.

Many engineering studies were completed during the year by the Water Investigations Branch. In addition to some 15 irrigation-water supply and nine flood- and erosion-control projects, a comprehensive study was completed on the possibilities of a Shuswap River-Okanagan Lake canal. Most of the water-supply investigations were of existing irrigation systems in need of rehabilitation. The studies provided technical data in support of applications for financial assistance toward system repair under the ARDA programme.

The snow survey programme is constantly being expanded, and new and up-to-date equipment is being installed. A snow-pillow for the continuous recording of snowfall was placed in operation in Manning Park. The results will be assessed at the end of the 1966/67 winter season.

The early snow reports of 1965 indicated an above average snow-pack, but, as the spring months passed, the pack was depleted until, in general, there was an average amount of snow on the catchment areas when the spring run-off commenced. The Interior rivers during midwinter 1964/65 were flowing above average for that time of the year, whereas Coastal streams were at or below their 10-year average. With the melting of the snow-pack, run-off remained above average for the major streams until May, whereas Coastal river volumes dropped below the 10-year May median.

The ground-water programme, designed to assess the potential of that water source, now has 63 observation wells, from which data are being obtained on annual ground-water levels and cyclic fluctuations. This is a net increase of eight wells over the number in use in 1965. Of the total, 18 wells are in the Lower Fraser Valley, 38 are in the Okanagan-Kamloops area, and the remainder at Prince George, in the Kootenays, and on Vancouver Island.

A long-standing and important aspect of Departmental work is the assessment of hydro-electric potential in British Columbia. The Liard River remains as one of the last great streams in British Columbia for which knowledge of power-development potential is lacking. Field investigations during the summer of 1966 have provided sufficient information for a site exploration programme due to start in January, 1967.

The Water Resources Service is now actively engaged in construction programmes, with expenditure in 1966 well in excess of \$2,000,000 for water-supply projects under the ARDA assistance programme. This is approaching the maximum figure set by Federal and Provincial Governments for expenditure in any one year on projects under this programme.

The first agreement between British Columbia and Canada under the *Canada Water Conservation Assistance Act* was made in February, 1966. The project, involving the improvement of stream channels in North and West Vancouver to reduce flooding and erosion, is expected to cost \$23,000,000 and will take at least three years to complete.

A second agreement between the Province and the Federal Government under the *Canada Water Conservation Assistance Act* was reached in late 1966. This pertains to tributary diversion in Hastings Creek in North Vancouver and is estimated to cost some \$600,000.

Other major projects under active consideration which will probably be financed under the *Canada Water Conservation Assistance Act* include flood control at Alberni and flood and erosion control in the Squamish Valley.

Flooding and erosion are pressing and costly problems. A Federal-Provincial committee reassessed the problems in the Lower Fraser Valley, examining not only the current needs of the dyking systems, but also requirements for improved drainage, river-bank stabilization, as well as flood protection on some of the

valley streams. Approximate cost estimates indicate expenditure could exceed \$30,000,000 over a period of time. In this same area, bank protection was carried out during 1966 at a cost to the Province of some \$100,000. This is an annual programme in which the two senior Governments assist the local authority by financing two-thirds of the cost each year.

Limited dyke reconstruction was commenced in two municipalities in the Lower Fraser Valley during the year. The work will form part of the larger dyke improvement programme currently available to local authorities as a joint project wherein Federal and Provincial financial assistance is available in amounts up to two-thirds of the reconstruction cost.

In June, 1966, the area of jurisdiction of the Pollution Control Board was increased with the inclusion of Strathcona Park, thereby ensuring close surveillance of mining developments in the vicinity of Buttle Lake. A major achievement for the year was the development of effluent standards for kraft mills.

Increasing demands on the Department necessitated expansion of office space. Late in the year the Pollution Control staff and the ARDA division were moved to new accommodation in the Professional Centre.

The Great Lakes basin covers 1,200,000 square miles and drains into the St. Lawrence River. The basin is home to 100 million people and 100,000 square miles of agricultural and industrial land. The Great Lakes are the largest freshwater system in the world and provide drinking water for 100 million people. The Great Lakes are also a major source of food and fiber. The Great Lakes are a major source of recreation and tourism. The Great Lakes are a major source of energy. The Great Lakes are a major source of transportation. The Great Lakes are a major source of commerce. The Great Lakes are a major source of culture. The Great Lakes are a major source of history. The Great Lakes are a major source of science. The Great Lakes are a major source of art. The Great Lakes are a major source of music. The Great Lakes are a major source of literature. The Great Lakes are a major source of philosophy. The Great Lakes are a major source of religion. The Great Lakes are a major source of politics. The Great Lakes are a major source of economics. The Great Lakes are a major source of sociology. The Great Lakes are a major source of psychology. The Great Lakes are a major source of anthropology. The Great Lakes are a major source of linguistics. The Great Lakes are a major source of archaeology. The Great Lakes are a major source of paleontology. The Great Lakes are a major source of geology. The Great Lakes are a major source of biology. The Great Lakes are a major source of chemistry. The Great Lakes are a major source of physics. The Great Lakes are a major source of astronomy. The Great Lakes are a major source of earth science. The Great Lakes are a major source of environmental science. The Great Lakes are a major source of public health. The Great Lakes are a major source of education. The Great Lakes are a major source of law. The Great Lakes are a major source of medicine. The Great Lakes are a major source of engineering. The Great Lakes are a major source of technology. The Great Lakes are a major source of innovation. The Great Lakes are a major source of progress. The Great Lakes are a major source of hope. The Great Lakes are a major source of faith. The Great Lakes are a major source of love. The Great Lakes are a major source of peace. The Great Lakes are a major source of justice. The Great Lakes are a major source of freedom. The Great Lakes are a major source of equality. The Great Lakes are a major source of opportunity. The Great Lakes are a major source of prosperity. The Great Lakes are a major source of happiness. The Great Lakes are a major source of well-being. The Great Lakes are a major source of quality of life. The Great Lakes are a major source of human development. The Great Lakes are a major source of global peace and stability. The Great Lakes are a major source of world leadership. The Great Lakes are a major source of international cooperation. The Great Lakes are a major source of global unity. The Great Lakes are a major source of global harmony. The Great Lakes are a major source of global peace. The Great Lakes are a major source of global justice. The Great Lakes are a major source of global freedom. The Great Lakes are a major source of global equality. The Great Lakes are a major source of global opportunity. The Great Lakes are a major source of global prosperity. The Great Lakes are a major source of global happiness. The Great Lakes are a major source of global well-being. The Great Lakes are a major source of global quality of life. The Great Lakes are a major source of global human development. The Great Lakes are a major source of global peace and stability. The Great Lakes are a major source of global leadership. The Great Lakes are a major source of global cooperation. The Great Lakes are a major source of global unity. The Great Lakes are a major source of global harmony. The Great Lakes are a major source of global peace. The Great Lakes are a major source of global justice. The Great Lakes are a major source of global freedom. The Great Lakes are a major source of global equality. The Great Lakes are a major source of global opportunity. The Great Lakes are a major source of global prosperity. The Great Lakes are a major source of global happiness. The Great Lakes are a major source of global well-being. The Great Lakes are a major source of global quality of life. The Great Lakes are a major source of global human development.

## WATER RIGHTS BRANCH

## WATER RESOURCES SERVICE

### 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 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 an amicable 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, providing financial aid to hospitals, fire protection, and several other purposes. An improvement district is a self-governing public corporate body administered by elected Trustees. The undertakings 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.

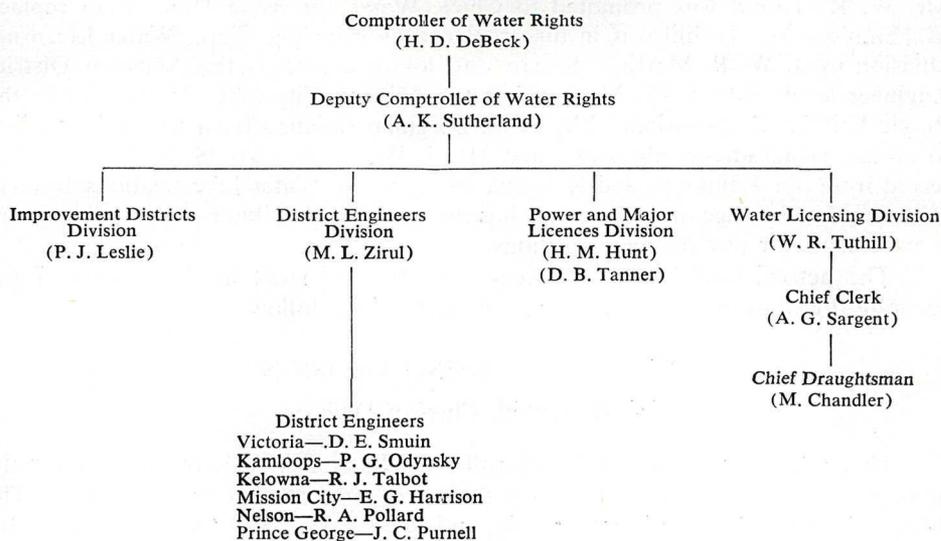
## WATER RIGHTS BRANCH

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*, which has been substantially unchanged since 1939. In addition to administration of water use, the *Water Act* also provides for the incorporation of improvement districts which provide local services in water-related fields and other fields such as street-lighting and the financing of hospitals. In addition to its purely administrative functions, the Water Rights Branch carries out a great number of engineering studies on water matters, including erosion and flood damage and some aspects of pollution control. 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 1966 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 regional engineering staff.

The division of responsibilities between the Water Rights Branch and the Water Investigations Branch, which carries out water investigations of a greater scope, is somewhat flexible, and a close liaison has been maintained between these two branches of the Water Resources Service. There is a sharing of some head office facilities, such as filing, and the district offices of the Water Rights Branch, because of their location, provide office facilities and staff assistance to the Investigations Branch, which in return provides specialist engineering advice to the Water Rights Branch.

### ORGANIZATION CHART OF THE WATER RIGHTS BRANCH, YEAR ENDED DECEMBER, 1966



The trend of steadily increasing activity in the water-licensing field, which has been evident in recent years, continued through 1966. The combined total of applications for new licences and amendments to existing ones increased to a new high, and in spite of an increase of 18 per cent in the number of licences issued from the previous production record established in 1965, the backlog of applications outstanding also reached a new high.

The District Engineers Division has been heavily involved in the increased volume of licensing work and has also undertaken a substantial volume of engineering work not directly connected with licensing.

Work associated with improvement districts continued at a high level throughout the year, both in the administrative and the engineering fields. The number of improvement districts under the *Water Act* reached a new high of 321. As a result of the Federal Government ARDA programme, construction activity by districts reached a very high level, although new project starts were somewhat reduced, toward the end of the year, by the effect of the shortage of capital funds and high interest rates.

During the year the Power and Major Licences Division has been extremely busy with work associated with approval of plans and other aspects of the three Columbia River Treaty projects and the Peace River project, all of which were under active construction phases. A number of other projects of substantial scope were also under review. In addition, this Division has also provided the technical services required in connection with the position of the Deputy Minister on the Columbia River Treaty Permanent Engineering Board and the Canada-British Columbia Liaison Committee, and other special assignments. Extensive use of the computer is made for power-licence rentals, statistical studies of water use, and various engineering studies.

A number of staff changes took place during the year. Mr. H. M. Hunt was appointed Chief of the Power and Major Licences Division, succeeding Mr. J. T. Rothwell, who passed away early in the year. Mr. D. E. Smuin completed his requirements for registration as a professional engineer, and was appointed District Engineer at Kamloops, succeeding Mr. P. G. Odynsky, who will become District Engineer at Victoria early in 1967. Meanwhile Mr. Smuin has been serving as District Engineer at Victoria, replacing Mr. C. Errington, who retired in October. Mr. W. R. Tuthill was promoted to Chief, Water Licensing Division to replace Mr. Smuin. Mr. Tuthill was in turn replaced as Principal Clerk, Water Licensing Division by J. W. P. Martin. Severe staff loss occurred at the Assistant District Engineer level. Mr. F. N. Manson left our Mission City office to transfer to the Public Utilities Commission. Mr. L. A. Bergman resigned from our Nelson office to pursue postgraduate education, and Mr. J. Wester and Mr. S. B. Mould transferred from our Kamloops and Kelowna offices to the Water Investigations Branch. Because of a shortage of engineers, it has not yet been possible to obtain permanent replacements for any of these positions.

The activities of 1966 are recorded in greater detail in the reports of the separate divisions of the Water Rights Branch, which follow.

#### WATER LICENSING DIVISION

W. R. Tuthill, Chief of Division

Under the *Water Act* the Comptroller of Water Rights is responsible for the administration of licensing the use of the water resources of the Province. The Water Licensing Division is responsible, under the direction of the Comptroller, for

the processing of new applications for water licences and amendments to existing licences and for maintaining the records necessary for the administration of the rights when they have been granted. In this regard, close liaison is maintained with the District Engineers Division, which is responsible for field investigations of applications.

The Licensing Division's volume of work during 1966 remained high in comparison to previous years. New applications received were the second highest on record, while the number of licences issued and amended reached new records. The number of applications pending also reached a new high of 1,701, up 252 from 1965. The additional work load was also taken on by the Draughting Office, which assumed the responsibility for the preparation of engineering drawings formerly prepared for the Improvement Districts Division by Water Investigations Branch Draughting Office.

The Licensing Division is composed of the General Office, which handles the clerical aspects of licensing, and the Draughting Office, which looks after the mapping requirements. The main functions of these two offices and details of their activities for 1966 are contained in their reports, which follow.

#### GENERAL OFFICE

The General Office of the Water Rights Branch is divided into the Applications, Amendments, Rights-of-way, and Ground-water Sections.

The Applications Section processes all new applications for water licences, approvals, and permits over Crown land. It compiles and maintains indexes by name, by file number, by licence number, and by water district, and makes use of these and the records of the Accounting Section, and of the Draughting Office, when processing applications.

If objections to the granting of a licence are received, these are fully investigated before adjudication of the application. In some cases the Comptroller may hold a formal hearing before making his decision.

The Applications Section also processes applications for approvals, both for the non-recurring use of water and for making changes in and about streams.

The Amendments Section processes applications for the amendment of existing licences by apportionment, by change of works, by transfer of appurtenancy, etc.

When the land to which a licence is appurtenant is subdivided, the rights and obligations granted and imposed under the licence may be apportioned between the owners of the several parcels in proportion to the interest held by each.

If a licensee wishes to construct additional works, or works other than those authorized under his licence, he may apply for an amendment of the licence by change of works.

If a licensee wishes to transfer the rights he holds under a licence to an additional or other parcel of land, he may apply for a transfer of appurtenancy of the licence. The Comptroller may grant this either in whole or in part.

Other licence amendments include the authorization of additional time in which to construct the works, a change of the purpose for which the water may be used, or the correction of any error in the licence.

The Rights-of-way Section is responsible for the processing of applications for permits for a right-of-way over Crown land from the time they are received until they are issued.

A noticeable feature of the past year has been the number of cases where applicants have requested a permit to occupy an area considerably wider than the 15 feet normal for a pipe-line right-of-way. Most of these applications have been

from mining or pulp-mill companies, and they entail considerable additional work and a very close liaison with both the Lands Service and the Department of Mines and Petroleum Resources.

The Ground-water Section is engaged in preparing the forms and administrative procedures necessary for the licensing of this water source. However, no part of the Province has yet been designated as one to which the *Water Act* will apply with respect to ground-water.

The General Office is also responsible for the processing of abandoned and refused applications and of abandoned and cancelled water licences. Records of water-users' communities, incorporated under the *Water Act*, are also maintained. There were 74 of these at the end of 1966.

During the year under review there have been numerous personnel changes in the General Office. These include two resignations, two transfers, and five promotions. Three new members have joined the staff in the same period. These changes and the necessary staff training, coupled with the general increase in the work load, have made 1966 a particularly difficult year. There are no indications that the volume of work handled during 1967 may be less than during 1966.

The principal activities of the General Office in the 12-month period ended December 31, 1966, are shown in the following table, together with the same data for the five preceding years:—

	1961	1962	1963	1964	1965	1966
Applications for—						
Licences .....	1,133	1,127	1,335	1,119	1,277	1,333
Rights-of-way .....	180	149	164	207	273	259
Apportionments .....	29	56	53	43	68	65
Transfers of appurtenancy .....	32	59	65	72	90	112
Changes of works .....	174	120	164	147	198	185
Approvals .....	24	14	17	40	44	32
Totals .....	1,572	1,525	1,798	1,628	1,950	1,986
Average monthly applications .....	131	127	150	136	162	165
Changes of ownership, address, etc. ....	2,750	2,471	2,264	2,274	2,348	2,144
Cancellations and abandonments .....	426	323	270	258	350	254
Totals .....	3,176	2,794	2,534	2,532	2,698	2,398
Conditional licences issued .....	689	883	760	1,026	1,034	1,163
Final licences issued .....	222	187	258	422	415	543
Totals .....	911	1,070	1,018	1,448	1,449	1,706
Rights-of-way issued .....	158	196	210	297	333	338
Extension of time orders issued .....	75	67	100	159	131	182
Approvals disposed of .....	17	13	19	28	38	25
Totals .....	250	276	329	484	502	545
Annual over-all total .....	5,909	5,665	5,679	6,092	6,505	6,635

#### ADMINISTRATIVE DRAUGHTING OFFICE

The Administrative Draughting Office staff is composed of a Chief Draughtsman, a Supervising Draughtsman, nine draughtsmen, and one clerk. The main functions of this office are checking the legal status of water applications; maintaining stream registers and plan indexes; compiling, maintaining, and revising water rights maps; preparing plats for water licences; clearing land applications for the Lands Branch; checking petitions and preparing legal descriptions and plans for improvement districts; 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 the records of other departments of Government, such as Lands Branch, Land Registry Office, Surveyor of Taxes, Department of Highways, and Department of Mines and Petroleum Resources. 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 water licences and applications.

A major function of this office is the checking of petitions pertaining to improvement districts. This involves searches of the records of the Land Registry Office and Surveyor of Taxes to obtain correct property descriptions. When a petition to incorporate an improvement district has 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. This work accounts for about 25 per cent of the time of the Draughting Office. During 1966 nine new improvement districts were incorporated and the boundaries of 52 districts were amended. Considerable time was also spent by the staff on engineering drawings for the Improvement Districts Division during 1966.

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

	1962	1963	1964	1965	1966
New water licence applications cleared and plotted on maps .....	1,097	1,269	1,099	1,184	1,268
Final and conditional licence plans prepared .....	1,195	1,281	1,633	1,587	1,920
New water rights maps compiled and traced .....	30	9	50	71	40
Water rights maps revised .....	42	10	15	15	8
New improvement districts described and plans prepared .....	10	14	25	19	9
Improvement districts descriptions and plans amended .....	42	38	47	46	52
Reference maps renewed .....	16	30	13	21	46
Extensions of time, apportionments, transfer of appurtenancy .....	182	218	274	289	368
Change of works .....	120	164	147	198	176
Approvals .....	13	19	28	38	25
Rights-of-way over Crown land .....	196	210	297	333	337
Change of ownership and cancellations .....	2,794	2,534	2,532	2,698	2,410
Land clearances (purchases, leases, Crown grants, etc.) .....	.....	6,508	7,155	6,475	6,641
Land clearances (cancellations) .....	.....	1,493	2,263	2,251	1,493
Totals .....	5,737	13,797	15,578	15,217	14,793

# APPLICATIONS

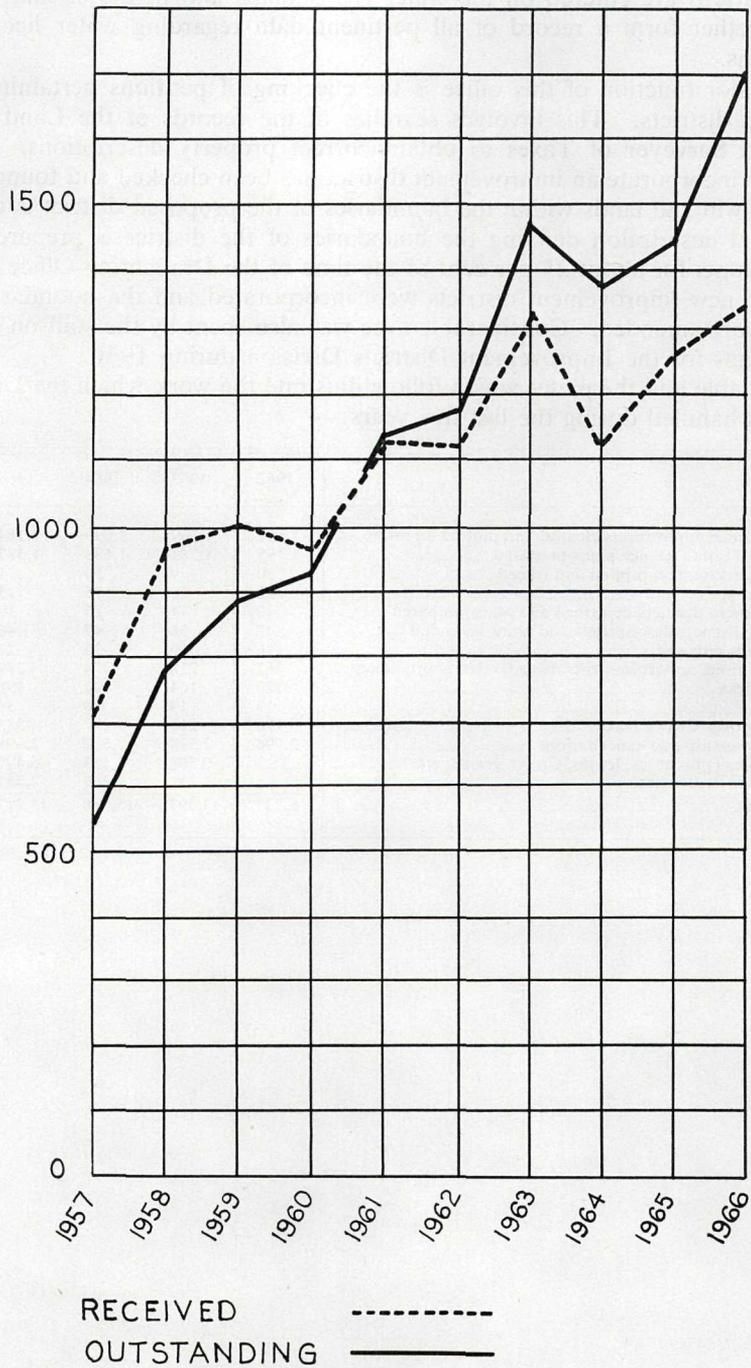


Plate 1

LICENCES ISSUED

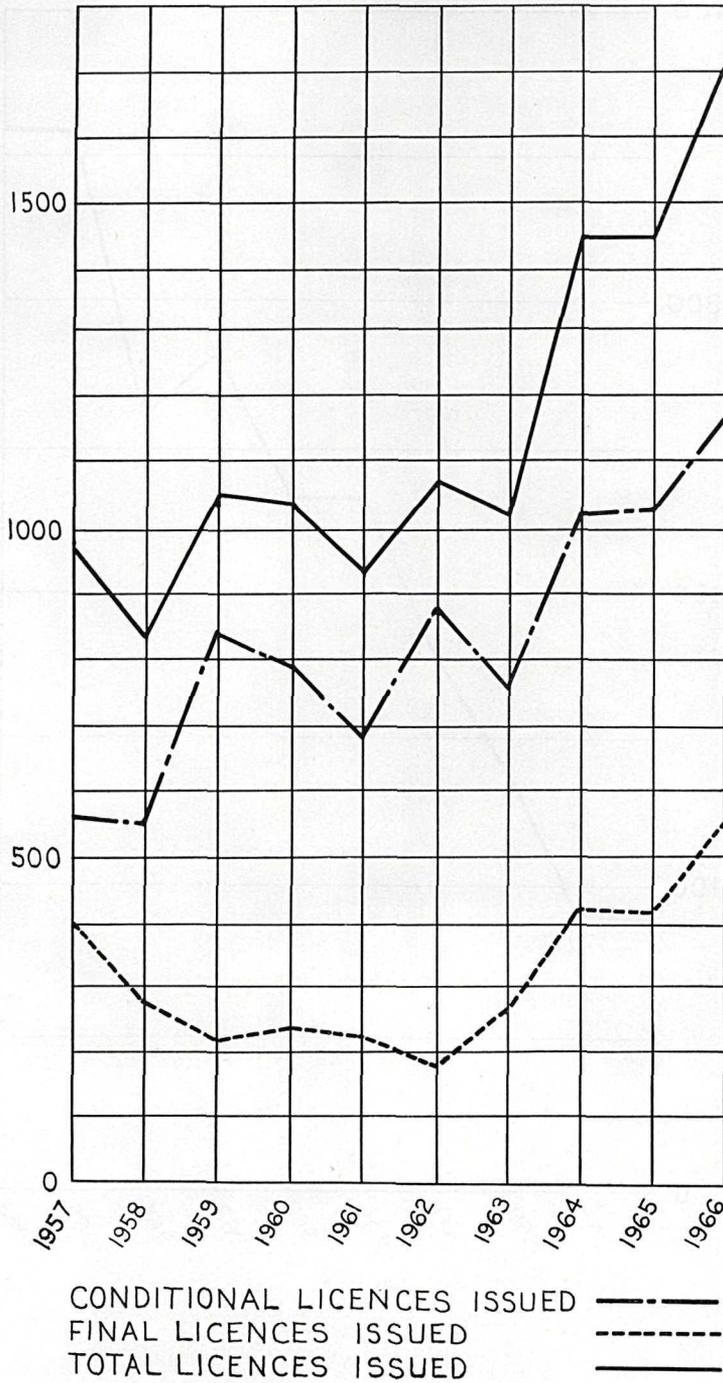


Plate 2

### MAJOR AMENDMENTS TO LICENCES

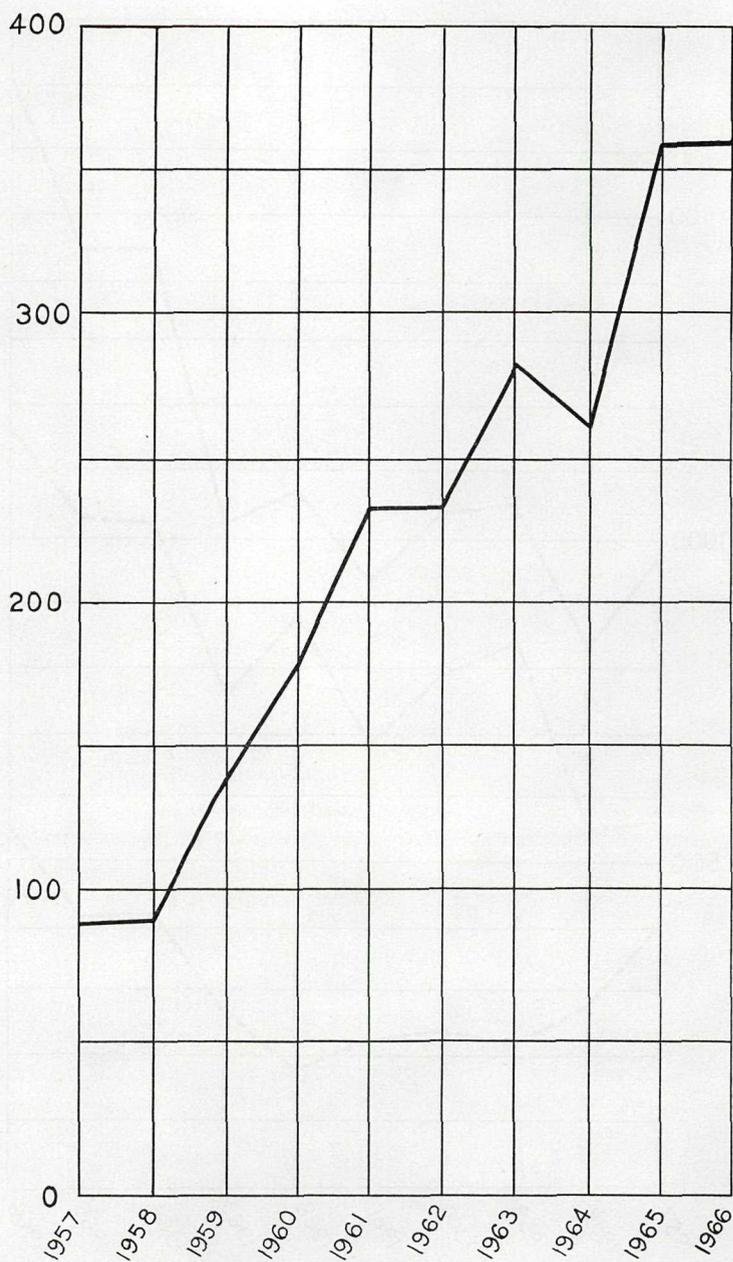


Plate 3

## DISTRICT ENGINEERS DIVISION

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

The Water Rights Branch has regional offices located at Kamloops, Kelowna, Nelson, Mission City, Prince George, and Victoria, each in charge of a District Engineer. The function of the District Engineer is to assist the Comptroller of Water Rights in the administration of the *Water Act* within the region for which he is responsible. District Engineers are empowered under section 37 of the *Water Act* to exercise administrative authority related to the use of water under water licences and approvals issued under the *Water Act* and, in addition, have responsibility for public safety with respect to impounded water and for the prevention and correction of pollution of water sources by sawdust, timber, tailings, gravel, refuse, and similar substances.

The District Engineers investigate and report to the Comptroller on all new applications for water licences, applications for approvals under the *Water Act*, and on applications for amendment of existing licences. Their reports are expected to contain firm recommendations for the disposal of each application received. They have, therefore, a major responsibility as advisers to the Comptroller on matters related to the use of the water resources of the Province.

The staff of the district offices have prepared a number of water-supply reports which include the design of works for waterworks or irrigation supply to new areas or extensions to existing systems and have investigated the financial feasibility of the proposals. They have also carried out a number of investigations and prepared engineering reports on flooding and stream-bank erosion problems. In cases where direct Government assistance has been given in correcting such problems, the District Engineers have drawn up the necessary plans and specifications, engaged equipment, and supervised the work. This arrangement is normally only carried out where the public interest is involved and there is participation in the cost of the project by the owners of property benefiting.

With one retirement, three resignations, two transfers to the Water Resources Investigations Division, and one other engineering position remaining unfilled, the District Engineers Division has suffered from a shortage of staff all year. It is hoped we will be successful in attracting suitable engineering personnel to this Division in the coming year.

The Chief of the Division visited district offices during the year and accompanied the District Engineers on field inspections to assist in resolving problems. Several complaints in the area administered by the Victoria District Engineer required his attention due to the retirement from the service of the Victoria District Engineer. The Victoria District Engineer's position is now covered by a new appointment. The Chief of the Division investigated a flooding and erosion problem at the Village of Zeballos and prepared a report containing a design and cost estimate of corrective works. Engineering reports prepared by District Engineers were reviewed before release to the public.

The separate reports of the District Engineers of the six regional offices follow.

## KAMLOOPS DISTRICT OFFICE

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

The District Engineer at Kamloops is responsible for regulating the use of water under licences in the Ashcroft, Cariboo, Kamloops, and Nicola Water Districts, and assists the Comptroller in administering the *Water Act* within these districts. Although the City of Kamloops is not at the geographical centre of this area, it is

centrally located in the Dry Belt of the Province, where water for irrigation is in greatest demand and the supply is most critical.

In the Kamloops District the 1966 water year began with a mild winter yielding higher than average winter snowfall. At the Kamloops Airport the recorded minimum temperature during the winter was  $-13^{\circ}$  F., which occurred on December 29, 1965, and the accumulated snowfall at the end of March totalled 41 inches, compared with the average of 29.1 inches. Mild weather in February and March brought premature melting of most of the snow at levels below 3,000 feet, which resulted in shortages of water in some areas at the beginning of the irrigation season. Brief but intensive rain showers in July relieved water shortages throughout the four water districts. A maximum rainfall of 0.85 inch for one day was recorded at the Kamloops Airport on July 3rd, and total precipitation for the month was a record 2.72 inches, which fell in nine days. The long-term average for July is 0.97 inch.

Maximum temperatures occurred in August, Kamloops experiencing seven consecutive  $90^{\circ}$  days beginning August 19th. Dry sunny weather in September and October resulted in the harvesting of the best fall hay crop in years for the Kamloops area.

Staff movements, which resulted in a reduction by approximately 50 per cent of the permanent force available for field work, had a marked effect on ability to cope with the work load. In addition to having to curtail the engineering work undertaken, it also became necessary to shorten the survey season and to deploy the field technician to assist the District Engineer in inspecting applications for water licences, to prevent the backlog from increasing out of manageable proportions.

A summary of applications for water licences received and dealt with for the years 1959 to 1966, inclusive, is shown in the following table:—

Year	Water Applications Received	Water Applications Reported On
1959 .....	221	151
1960 .....	186	133
1961 .....	237	95
1962 .....	300	164
1963 .....	330	282
1964 .....	294	290
1965 .....	281	253
1966 .....	316	250

There are now 2,347 active conditional water licences and 2,906 active final water licences under the jurisdiction of the Kamloops District office.

#### *Summary of Year's Work*

Applications for water licences—	
On hand, November 1, 1965 .....	270
Received during year .....	316
Cancelled or abandoned .....	12
Inspected and reported on .....	250
On hand, November 1, 1966 .....	324
Applications for approvals reported on .....	4
New conditional water licences received .....	337
New final water licences received .....	77

*Summary of Year's Work—Continued*

Licence amendments reported on—	
Changes of works .....	69
Transfers of appurtenancy .....	49
Apportionment of licences .....	19
Extension of time .....	84
Change of purpose .....	1
L.R.O. searches made for Victoria office .....	223
L.R.O. plans ordered for and sent to Victoria office .....	466
Final-licence surveys run .....	41
Final-licence survey reports forwarded .....	39
Miscellaneous surveys run .....	17
Dam inspections made .....	46
Meetings attended .....	56
Complaints investigated .....	62
Orders issued .....	10

*Engineering Investigations and Studies*

Investigations concerned with flooding included drainage from Williams Lake Airport into Missioner Creek affecting private property, North Thompson River affecting proposed development of marginal lands, and tail-water from irrigation at Walhachin and at Cherry Creek affecting Canadian Pacific Railway trackage.

Engineering projects included the preparation of construction drawings, specifications, and contract documents for an earth dam at Smith Lake for the Darfield Irrigation District, ARDA Project 29006, a proposal for the renewal of Goldbridge Waterworks Districts distribution system, design and supervision of construction of a new drop structure for a storage dam for the Village of Clinton, and a report covering proposals to extend the Savona Waterworks District's distribution system to serve new subdivisions in the Durand Creek area.

Reported on an investigation of a complaint of pollution of Boss Creek and Canim Lake by Noranda Mines Limited tailings disposal from mining and milling of molybdenum ores.

Inspections made of construction and performance of pile-driven drop structure in spillway of dam on Charcoal Creek near Chase. Failure of this structure necessitated ordering the licensee to lower the spillway of the dam.

Plans were reviewed and field inspections made in connection with dams to store water for irrigation use on Yook Lake near Ashcroft and on Jones Lake near 150 Mile House.

Inspected drilling and testing of water wells for Rayleigh Mount and Heffley Creek Waterworks Districts.

Reported on investigation of effect on Sword Creek of the relocation of Chilcotin Highway west of the Fraser River highway bridge.

Inspected control structure and new outlet channel at the outlet of Salmon Lake, constructed for land-improvement purpose by Douglas Lake Cattle Company.

Supervision provided to bailiffs employed to regulate use of water from Ingram Creek at Westwold and Peterson Creek at Knutsford.

Hydrologic studies undertaken of watersheds of Brenda, Pennask, and Spahomin Creeks in connection with applications for water licences filed by Brenda Mines Limited.

## KELOWNA DISTRICT OFFICE

R. J. Talbot, P.Eng., District Engineer

The Princeton, Fairview, Grand Forks, Vernon, and Revelstoke Districts fall under the jurisdiction of the Kelowna District office. These districts comprise the Kettle, Similkameen, and Okanagan drainage basins; Shuswap River drainage basin, above Sicamous; and part of the Columbia River drainage from its confluence with the Canoe River downstream to Arrow Lake.

Precipitation recorded at Kelowna for the 12-month period from November 1 to October 31, 1966, was 10.5 inches, or 81 per cent of the average annual precipitation of 12.41 inches. During this same period, precipitation recorded at the Penticton Airport was 8.57 inches, or 74 per cent of the average precipitation at that station. While winter snow-pack appeared to be about average at February 1st, readings on most snow courses were down 15 to 20 per cent on the April, May, and June readings, indicating an early run-off. Because of this early run-off, low May and June precipitation, and high spring south-westerly winds, the run-off into Okanagan Lake was only about 54 per cent of its average for the period 1914-65.

The discharge from the Okanagan Lake at Penticton was controlled at a steady 350 c.f.s. throughout the spring because of the below average run-off. Water supply was ample for irrigation and other requirements where the licensees had storage to support demand, but creeks without upstream storage dried early in the summer, causing problems in allocation of water under licences. September and October precipitation was low and watersheds became quite dry. However, rains and snow in November partially recharged the ground.

Forty dams were inspected during the year. Inspections included Nicklen Lake Dam under construction, replacement of the gate on Naramata Irrigation District Big Meadow Dam, and a fish ladder constructed for the Smithson-Alphonse Dam on Mission Creek. It can be seen from the table included in this report that the number of dams being reconstructed or repaired is increasing, presumably a result of more serious and systematic inspection of the storage dams of this district by the staff of the Kelowna office.

In latter years the number of engineering studies completed by this office has increased. The addition in 1963 of a second Assistant District Engineer to the engineering staff of this office has made it possible to carry out more engineering and feasibility studies while still maintaining the flow of routine administrative work. The number of applications for water licences investigated and reported on this year was equal to the average for the past five years, but there was an increase of 35 per cent over 1965 in the number of reports on amendments to existing water licences.

A summary of the activity of this office in connection with water licence applications, dam construction, and preparation of engineering reports for the years 1959 to 1966, inclusive, is shown in the following table:—

Year	Applications Received	Reports	Cancelled or Abandoned	Total Disposed Of	Dams under Construction or Repair	Major Engineering Reports and Studies
1959	156	112	10	122	---	---
1960	193	141	22	163	---	4
1961	168	146	13	159	---	5
1962	115	153	31	174	---	4
1963	211	177	18	195	---	8
1964	192	193	46	239	5	7
1965	187	145	13	158	10	9
1966	196	165	35	200	14	9

*Summary of Year's Work*

Applications for water licences—	
Applications outstanding, November 1, 1965 .....	119
New applications received .....	196
Applications inspected and reported on .....	165
Applications cancelled or abandoned .....	35
Applications on hand, October 31, 1966 .....	115
New water licences received 1966—	
Conditional licences .....	185
Final licences .....	84
Reports for licence amendments .....	141
Final licence and miscellaneous surveys .....	66
Meetings attended .....	51
Complaints investigated .....	99

*Engineering Investigations and Studies*

Prepared a design and supervised the construction of new intake works and concrete settling-tank for the Christina Waterworks District and repairs to the gate works for Big Meadow Dam for Naramata Irrigation District.

Prepared feasibility studies for the storage of water at the headwaters of Fortune Creek for the City of Armstrong, for proposed storage on Bellevue Creek near Okanagan Mission, and for a proposed domestic water system for Hillside Improvement District near Sicamous.

Reviewed and completed a feasibility study for Lakeview Irrigation District in respect of repairs to or replacement of its diversion works from Lambly Creek to Rose Valley Lake.

Prepared a study of the hydrology of Peachland, MacDonald, and Pennask Creeks in conjunction with the District Engineer at Kamloops, for water applications by Brenda Mines Limited.

Supervised construction of the Mission Slough drainage works, south of Kelowna.

Prepared "as constructed" drawing and maintenance instructions for Canyon Waterworks District's new waterworks system.

Inspected a fish ladder for the Smithson-Alphonse Dam on Mission Creek, being constructed by the Provincial Fish and Wildlife Branch.

Participated in the recording of data for the Esperon watershed (at the headwaters of Lambly Creek) in connection with the international hydrologic decade studies.

## MISSION CITY DISTRICT OFFICE

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

The Mission City District Office administers the *Water Act* in the Vancouver and New Westminster Water Districts in the south-west portion of British Columbia.

The increase in the relatively large population and continued prosperity and development of the area have brought about further demands on the water resources to meet the needs of irrigation, industrial, and waterworks projects. These demands are reflected in the increase in the number of investigations of applications for water licences and other activities required of this office during the year. The number of applications investigated and licence reports submitted was up more than 100 per cent over the previous year, and well above the average of any of the five years this office has been established.

Municipalities which had previously attempted to settle water problems themselves now refer those problems to this office. It has been found that many of the investigations are complicated and require discussions and meetings with various representatives and authorities. A long-standing dispute in Sumas between the municipality and one of the ratepayers was settled, after lengthy investigation, when municipal equipment removed an unauthorized dam and other works from a stream under authority of the *Water Act*.

Considerable time has also been required in the investigation of disputes in the unorganized areas. One such complaint, regarding control of water levels in Alta Lake, remains unsettled.

There were no shortages of water attributable to weather conditions or low stream flows. Any disputes regarding water supply were the result of unauthorized diversions and were resolved by attention from this office.

Two orders were issued under authority of section 37 of the *Water Act*, and several warning letters were sent in connection with offences against the *Water Act*.

There are now 3,300 active licence files in the Mission City office, including the 384 new final and conditional licences and approvals received this year. The office was handicapped by lack of an Assistant District Engineer since we have been unable to get a permanent replacement for Mr. L. A. Bergman, who was transferred to the Nelson District office in 1965.

A summary of the work accomplished by the Mission City District office for the 12-month period November 1, 1965, to October 31, 1966, follows:—

#### *Summary of Year's Work*

Applications for water licences—	
Applications outstanding, November 1, 1965 .....	109
New applications received .....	211
Applications inspected and reported on .....	214
Applications cancelled .....	9
Applications on hand, October 31, 1966 .....	97
New water licences received—	
Conditional licences .....	185
Final licences .....	195
New approvals received .....	4
Final-licence reports submitted .....	215
Amendment of water licences reported on—	
Apportionments .....	2
Changes of works .....	36
Transfer of appurtenancy .....	9
Reports for cancellation of licences .....	11
Meetings attended .....	26
Complaints investigated .....	50
Ground-water measurements of Lower Fraser Valley wells .....	12

#### NELSON DISTRICT OFFICE

R. A. Pollard, P.Eng., District Engineer

The Nelson District office administers the *Water Act* in the Nelson, Kaslo, Cranbrook, Fernie, and Golden Water Districts within South-eastern British Columbia, an area of 26,000 square miles with a population of 110,000.

Staff working in the Nelson office during 1966 consisted of a District Engineer, two Assistant District Engineers, a field-survey party chief, and a stenographer, all

full-time employees. Two student assistants were employed during the summer, one of these being retained to assist in plotting surveys and other technical work. Assistant District Engineer L. A. Bergman resigned in August to study for a master's degree in the United States.

In the Kootenays the 1965/66 winter snow-pack and the 1966 spring melt rate were average, with the result that there were no unusual freshet-period floods of natural origin. The early summer was exceptionally cold and wet. The weather changed in early July and remained dry until late fall. In the West Kootenay there was no appreciable rain, except local convective precipitation, between July 5th and October 10th. This drought condition was manifest in unusually low flows or complete drying up of small streams and springs in the autumn, but, fortunately, the irrigation demand was small by this late season. In late December, 1965, a cold snap followed by a heavy snowfall and then a return to mild weather produced an unusual floe-ice jam on the Kootenay River at Canal Flats, which flooded a farm and made two families homeless for several weeks. The ice-pack did not move out until the early spring of 1966.

There was an unprecedented number of complaints in 1966, particularly during the spring, of erosion, sedimentation, slides, washouts, and of slash disposal in streams due to logging. Most complaints were confined to the populated watersheds of the West Kootenay near Nelson. Our staff spent about 40 man-days investigating and reporting on these complaints and inspecting timber sales prior to logging where an effect on the water supply was anticipated. Repeated inspections by our staff have been required to follow up the investigation of the original complaints. Three engineer's orders have been issued to logging operators to clean up streams. In March the District Engineer met with Nelson Forest Rangers and Fish and Wildlife Branch management personnel to discuss the effects of logging on water supply, and some agreement was reached regarding administrative action to be taken.

During 1966, 249 new conditional licences and 109 new final licences were added to the office files, making a total of 7,710. Approximately 5,128 licences are now active (23 per cent of the total for the whole Province), and approximately 2,865 licences have been cancelled.

There was an increase in applications for water licences received in 1966 over those received in 1965. The number inspected and reported on, however, was lower than in 1965 because the staff was one engineer short for two months, and because so much time was devoted to complaints resulting from logging operations. The number of final-licence survey reports and licence-amendment reports remains at the same higher level as for 1964 and 1965, which exceeded earlier years.

This year our office designed and prepared contract documents for a new well, pump-house, and force main at Fort Steele to replace the temporary pumping system which now supplies the new distribution system serving the Fort Steele restoration project. Tenders were called, but the only bid received was considered too high. The work, therefore, has been undertaken with rented equipment and day labour under our supervision.

#### *Summary of Year's Work*

##### Applications for water licences—

Applications on hand, November 1, 1965 .....	184
New applications received .....	205
Applications inspected and reported on .....	124
Applications cancelled or abandoned .....	19
Applications on hand, October 31, 1966 .....	244

*Summary of Year's Work—Continued*

Reports on applications for approvals .....	2
Final-licence surveys and licence amendments reported on .....	148
Pollution investigations .....	21
Flooding and erosion investigations .....	25
Water-use investigations .....	6
Meetings with improvement districts and water-users' communities .....	5
Miscellaneous non-routine meetings and investigations .....	65
Routine calls and problems .....	1,789
Outgoing letters and memoranda .....	1,441
Sampling snow courses .....	16
Orders issued .....	6
Dam inspections .....	6

*Engineering Investigations and Studies*

Domestic water-supply reports were prepared for a proposed improvement district at Slocan Park, Radium Waterworks District at Radium Hot Springs, the Village of Marysville, and for a group of licensees on Barrie Creek near Robson.

Flooding and erosion problems were investigated on Hospital and Thos Creeks near Cranbrook, McKay Slough near Kimberley, Moyie River at Yahk, Dutch Creek at Fairmont, Little Bull Creek near Bull River, Salmo River at Ymir, Acme Creek near Rossland, unnamed creek at Boswell, Rosebud Lake near Nelway, Monroe Lake near Cranbrook, Kootenay River at Canal Flats, Goose Creek at Krestova, Goat River at Creston, Kootenay Lake at Lardeau, Slocan River and unnamed creek at Slocan Park, unnamed stream at Wynndel, Waldie Creek at Robson, and Lime Lake near Gray Creek.

Pumping tests were conducted for the Beaver Falls Waterworks District's drilled well and an exploratory dug well for the Fort Steele restoration project.

A pumping-station and force main were designed for the Fort Steele restoration project at Fort Steele.

An interconnection between springs near Andrew Spring at Nelson and beneficial use of irrigation water under Final Licence 7108 on Birbeck Creek near Gray Creek were investigated.

A division tank was designed for Trust Brook near Winlaw.

An inventory was prepared of irrigated and irrigable areas in Robson and Rasperry Irrigation Districts near Castlegar.

The effect of logging on water supply in the Kootenay region of British Columbia and the possible effect of proposed logging in watersheds of Sitkum, Redfish, and Smoky Creeks near Nelson, Elgood Creek near Rossland, and Duncan Lake watershed were investigated.

A study was conducted to determine the cause of a shortage of water in Norbury Creek near Bull River.

Dams at Paddy Ryan Lakes near Invermere, Moyie Lake near Cranbrook, and Marion Creek near Fairmont were inspected.

Pollution problems investigated included the possible pollution of Wasa Lake by proposed pulp-mill at Skookumchuck, Grigsby Spring near Ymir, La France Creek near Boswell, Coffee Creek near Ainsworth, Bernard Creek near Mirror Lake, Giveout Creek near Nelson by logging-roads, Pedro Creek at Winlaw, Bradley and Bourke Creeks near Nelson by logging, Floyd Creek near Lister by poultry, Cow Creek, Mark Creek and St. Mary River near Kimberley by Cominco's mining operation and fertilizer plants, Burrard Brook near Nelson and Goldsmith Creek near Kaslo by highway construction, Lussier River near Wasa by gypsum-mining, Scho-

field Creek near Kinnaird and Redfish Creek near Nelson by bulldozers grading residential land, Sheep Creek near Salmo by sawdust and stream-channel cleaning, Goat River at Creston and Balfour Creek at Robson by garbage, and Wilds Creek near Wynndel by mineral-prospecting.

PRINCE GEORGE DISTRICT OFFICE

J. C. Purnell, P.Eng., District Engineer

The Prince George, Quesnel, Peace River, Liard, Fort Fraser, Hazelton, and Prince Rupert Water Districts, which comprise the northerly two-thirds of British Columbia, are administered by the Prince George District office. The office is staffed by a District Engineer, an Engineering Assistant, and a stenographer. One student assistant is employed during the summer survey season to assist with final-licence surveys and other survey work.

Cool moist weather occurred in nearly all areas throughout the growing season, which resulted in very little irrigation being required. There were no water shortages during the year. The Prince Rupert and Hazelton Water Districts along the Skeena and Bulkley Rivers near Terrace and Smithers experienced flash floods during the month of October due to heavy snowfall followed by warm weather and rain. The floods resulted in loss of several highway bridges. Precipitation recorded at Prince George for the year was 27.38 inches, which was slightly above the normal of 24.67 inches for this area.

An increase in the demand for water for mining purpose has been observed in the Prince Rupert, Hazelton, Fort Fraser, and Prince George Water Districts. Water requirements for pulp-mills are also on the increase, with applications for water licences being received for mills at Quesnel, Houston, Prince George, and Kitimat, and a future mill is proposed on the Parsnip River north of McLeod Lake. The water requirement of each of these mills is in excess of 100 c.f.s.

Water licence applications received were 164, an increase of 29 over 1965, setting a new record. The number of applications reported on has risen 300 per cent over the 1963 level; however, there is still a considerable backlog of applications to be reported on, with 85 applications still on hand.

There has been an increase over 1965 in water licence amendments requiring attention. With the increasing public awareness of the need for these amendments, we can expect a continuous rise in future years.

The district office assisted the Water Investigations Branch in its study of the effects of log-driving on the Stellako River. The time spent on this study resulted in the noticeable cut-back in surveys completed in 1966. This office also continued assistance to the ARDA engineers, with piezometer readings being taken once each week on five ground-water test wells.

There was continued interest in formation of new improvement districts. Three new districts were incorporated this year—College Heights, Ste. Marie, and Parkridge Heights Improvement Districts.

The rapid expansion within improvement districts immediately adjacent to Prince George has been particularly noticeable in the past year, due to the heavy demand for reasonably priced land outside the city boundaries. It is interesting to note that those improvement districts having substandard systems and limited water supplies are finding it extremely difficult, and in some cases impossible, to supply all existing parcels of land within their boundaries, resulting in little growth within the district or up-grading of their present facilities. On the other hand, those districts having adequate supplies and standard systems are experiencing a tremendous increase in water-users on their systems.

The establishment of a Land Registry Office in Prince George has greatly assisted this office in establishing property-ownership and legal descriptions of lands on which water applications have been made. We have been able to assist the Kamloops District office and the Water Licensing Division in Victoria in obtaining plans and carrying out title searches.

Interest in the ground-water potential in the Pineview area, south of Prince George, has continued. Four new test wells were drilled by the Groundwater Division, and drilling and development of a flowing artesian well south of the airport were carried out by private enterprise.

#### *Summary of Year's Work*

Applications for water licences—	
Applications on hand at beginning of year .....	62
New applications received .....	164
Applications inspected and reported on .....	121
Applications cancelled or abandoned .....	20
Applications on hand at end of year .....	85
Conditional licences added to files .....	80
Final licences added to files .....	37
Active-licence files .....	1,054
Cancelled or abandoned licences .....	522
Final-licence surveys completed .....	45
Routine items and problems .....	703
Dam inspections .....	4
Meetings with improvement districts .....	9
Miscellaneous investigations .....	10
Flooding and erosion investigations .....	6
Outgoing letters and memoranda .....	473

#### *Engineering Investigations and Studies*

Investigated and reported on complaints of flooding and erosion on Bateman Creek and Willow River near Giscome and Sinkut River south of Vanderhoof, flooding caused by alleged dynamiting of beaver dams on Upper Dragon Creek near Quesnel, and flooding allegedly caused by control of levels on Eaglet Lake at Giscome.

Continued the field study of flooding and erosion on Kispiox River north of Hazelton, assisted by Department of Agriculture personnel.

Prepared design and cost estimates for protective revetments on the Bulkley River at Houston and on the Pouce Coupe River near Pouce Coupe.

Assisted Water Investigations Branch on study of the effects of log-driving on the Stellako River and investigation of erosion on the Nechako River at Vanderhoof.

Prepared design and cost estimate of sewer and water extensions for Fort Nelson Improvement District.

Completed a survey and assessment of the existing distribution system in Charella Gardens Waterworks District.

#### VICTORIA DISTRICT OFFICE

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

Water districts under the jurisdiction of the Victoria District office are Alberni, Nanaimo, and Victoria, comprising Vancouver Island and the Gulf Islands. The

staff at present consists of one District Engineer and one engineering technician. Clerical duties are performed by the staff of the Water Licensing Division.

The current industrial expansion which has caused a rapid increase in use of water has not been so evident on Vancouver Island, where lumbering is still the main industry. Mining, however, has played a part in the continuing interest in water, and several operations on the Island required investigations by this office in connection with applications for water licences or complaints of water pollution.

Flooding occurred from some major streams in January and again in December, particularly in the south-east part of Vancouver Island. In contrast, precipitation during the summer months was normal and some water shortages were experienced in the Duncan-Nanaimo area.

A number of meetings were held and investigations made during the year concerning licensing and water use and erosion, pollution, and flooding problems. Greater awareness by the public of the value of water rights has resulted in many inquiries being received, with consequent applications for water licences being made.

Mr. Charles Errington, P.Eng., Victoria District Engineer since 1949, retired from office in October. His duties were taken up by the writer.

#### *Summary of Year's Work*

##### Applications for water licences—

Applications on hand at beginning of period .....	27
New applications received .....	183
Applications inspected and reported on .....	139
Applications refused, abandoned, and cancelled .....	22
Applications on hand at end of period .....	49

#### *Engineering Investigations and Studies*

Investigated flooding from Nanaimo, Chemainus, and Cowichan Rivers, within the south-easterly part of Vancouver Island.

Investigated flooding affecting private property and the public highway at Kelsey Bay in company with Highways Department District Engineer.

Reviewed water-supply potential for Parksville with village water commissioner.

Inspected proposed bridge alterations by MacMillan, Bloedel and Powell River Company over Koksilah River near Duncan.

Attended meeting and reviewed plans for water supply to proposed gaol at Saltair.

Inspected dam at fourth Nanaimo Lake.

Continued discussions with District of Saanich *re* control of Prospect Lake flooding.

Investigated a complaint of pollution of Tsolum River by mill tailings from the Mount Washington Milling Company.

Investigated flooding at Duncan and Cowichan Lake resulting from excessive rainfall during December.

#### IMPROVEMENT DISTRICTS DIVISION

P. J. Leslie, P.Eng., Chief of Division

The number of improvement districts in operation has been increasing steadily for many years, as illustrated in Plate 4, and there is now a total of 321 districts in existence. During the year the following new districts were incorporated: College Heights Improvement District, East Latoria Road Waterworks District, Heffley

### NUMBER OF IMPROVEMENT DISTRICTS

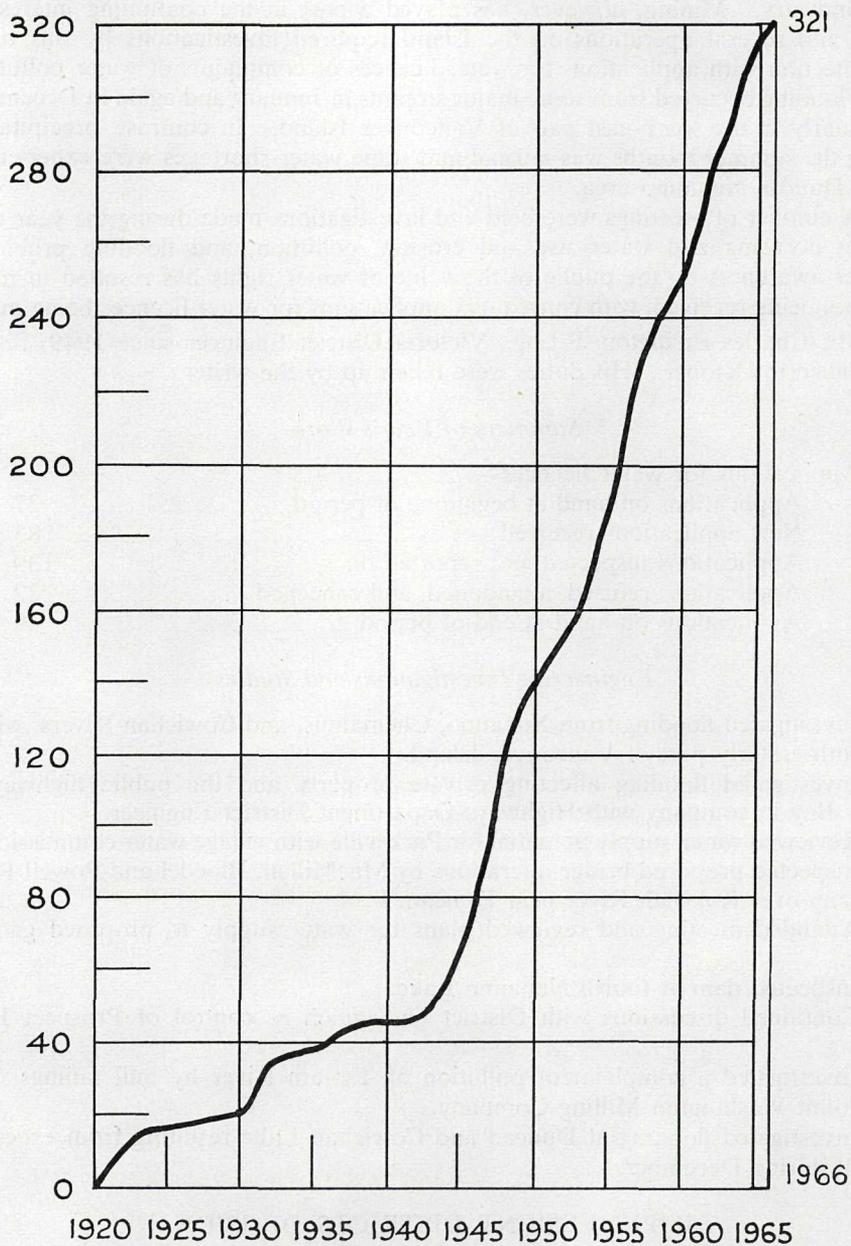


Plate 4

Creek Waterworks District, Hillside Waterworks District, La la Hache Improvement District, Lakeside Orchards Improvement District, Parkridge Heights Improvement District, and Ste. Marie Improvement District. The following districts were dissolved: Hudson Hope Improvement District, Michel-Natal Hospital Improvement District No. 35, and 100 Mile House Sewerage District. Osoyoos Irrigation District and East Osoyoos Irrigation District were amalgamated under the name of Osoyoos Irrigation District.

The object (or objects) for which a district is incorporated is set out in its Letters Patent. Upon petition of the Trustees, action may be taken to have such Letters Patent amended to include extra objects, and many districts which were originally incorporated for one purpose now have several. The activities for which the existing districts are responsible include irrigation (system ownership and operation); domestic waterworks (ownership and operation); dyking-works; drainage-works; land-improvement works; fire protection (provision and (or) operation); street-lighting (provision and (or) operation); garbage collection and (or) disposal; sewerage-works (ownership and operation); parks and playgrounds (provision and (or) operation); cemetery operation; community hall provision and (or) operation; electric-power generation and (or) distribution; mosquito control (financial aid toward); hospital provision and operation (or provision of financial aid toward building and (or) operation of a hospital); and ambulance service (ownership and (or) operation).

Improvement districts incorporated for hospital purposes are distinctively named, with the words "Hospital Improvement District No. " contained within the corporate name. There are 35 such districts now in existence. Two of these have the responsibility for the provision and the operation of hospital facilities, but the remainder are responsible only for providing financial aid toward the constructing, equipping, or operating of a hospital in the vicinity.

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 to raise money by the imposition of tolls and charges. They are also empowered to issue debentures to obtain funds for capital purposes, this being the usual method in use. In many cases, improvement district debentures and the interest thereon are guaranteed by the Province pursuant to the *Improvement Districts Assistance Loan Act*. At the present time there is \$13,560,600 of such guaranteed debentures outstanding, of which \$621,600 was guaranteed during 1966.

During the year, capital works projects to a total value of \$3,635,096 were completed by improvement districts and financed as follows:—

ARDA .....	\$544,000
Municipal Development and Loan Board debentures .....	179,750
District resources and borrowing .....	2,911,346

Section 62 of the *Water Act* enables districts to obtain current operating funds as advances from the Province (for certain purposes only) and to utilize the services of the local Provincial Assessor and Collector to collect these advances from the land-owners in the areas and to repay the Province. The purposes for which this procedure may be used are fire protection, street-lighting, hospital purposes, and ambulance services, providing they are supplied by a fire protection or hospital district. If a larger amount is required for capital purposes, and collection and repayment by the Provincial Collector in the same year would result in too heavy a tax burden for that year, an advance of the required amount may be obtained from the Province, with collection and repayment carried out over a number of years. During 1966 the following advances and collections were made under this section of the Act:—

Assessed and collected for repayment of amounts advanced for the current year .....	\$1,362,869
Amounts advanced in 1966 by the Province repayable in future years .....	1,301,500
Assessed and collected for amounts advanced with repayment over a number of years .....	254,892
Total long-term advances outstanding as at December 31, 1966 .....	1,489,755

#### ENGINEERING SERVICES

The Engineering Section of the Improvement Districts Division handles the technical and engineering work associated with improvement districts throughout the Province. This is principally concerned with domestic water supply, irrigation, drainage, and sewerage projects.

An important facet of the work consists of investigating and reporting on the engineering and economic feasibility of new schemes and checking the technical and financial aspects of proposals submitted by districts.

Other duties include assistance to districts in operating existing engineering works and the dispensation of technical advice. In some instances a complete engineering service has been provided for a particular project from the initial investigation stage to preparation of the design drawings, contract documents and specifications, and, finally, supervision of the installation of the works.

The following is a list of assignments completed during the past year:—

##### *Review of Water Supply and Sewerage Proposals*

*Barrier Irrigation District.*—A review of plans and specifications for a domestic water system to serve Barriere Irrigation District resulted in approval for the project. It is anticipated that construction will be completed early in 1967.

*Big Eddy Waterworks District.*—Approval was given to plans for replacements and improvements to the district's existing domestic water-supply system.

*Blue River Waterworks District.*—Approval was given to a domestic water-supply scheme for the Blue River Waterworks District. The system was installed during the summer.

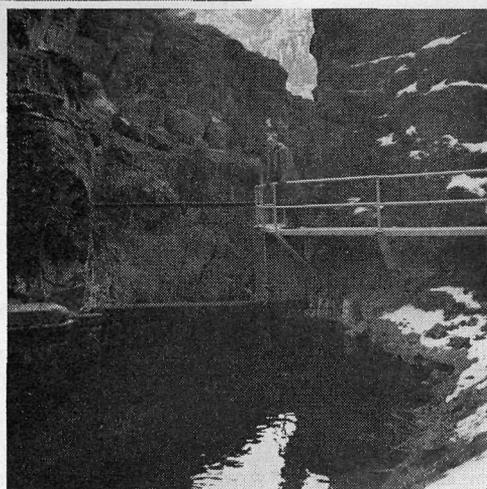
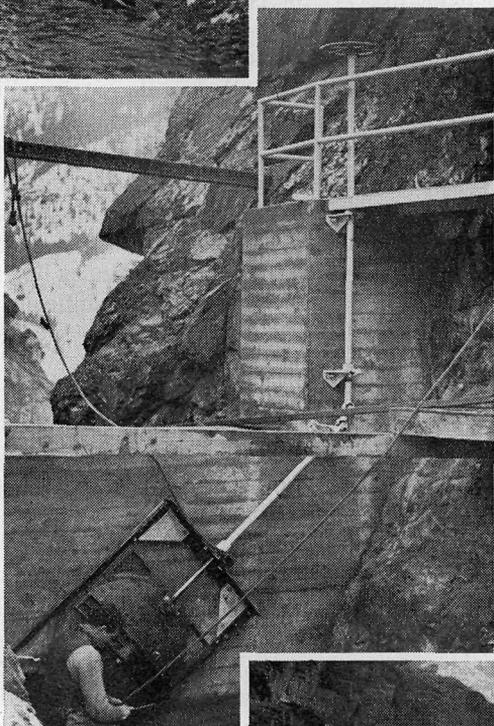
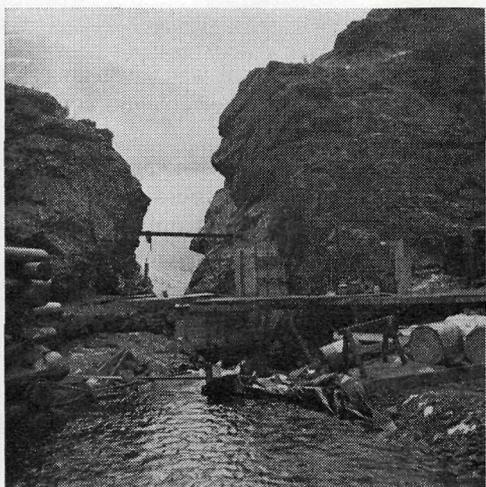
*Chase Waterworks District.* — Plans and specifications were approved for works required by the district to supply water to the Sahhalkum Indian Reserve.

*East Latoria Road Waterworks District.*—The East Latoria Road Waterworks District near Colwood was incorporated in June of this year. The district has submitted plans for installing a domestic water-supply system, using a bulk supply from the Greater Victoria Water District.

*Ellison Irrigation District.*—A preliminary design prepared by the Kelowna District office for rehabilitation of the Ellison Irrigation District's system was reviewed.

*Fort Nelson Improvement District.*—Following protracted negotiations to evolve a satisfactory cost-sharing arrangement between the district and the West-coast Transmission Company, approval was given to sewer and water-supply extensions to serve the 55th Avenue area. Sewer and water extensions to the G. W. Carlson School were also approved.

*Hagensborg West Water Supply.*—A feasibility report for the construction of a domestic water supply to serve Hagensborg West was reviewed. The scheme is not considered economically feasible at this time.



Reconstruction of Murray Creek Dam, Spences Bridge Waterworks District.

*Lac la Hache Improvement District.*—Preliminary approval was given to proposals to service the community of La la Hache with sanitary sewers and sewage-treatment facilities.

*Lower Nicola Waterworks District.*—After several unsuccessful attempts had been made to locate a satisfactory ground-water source to supply the district, it was decided to adopt a scheme for pumping from the Nicola River. Contractors' bids for the works, however, exceeded the estimated costs, and the district's consulting engineer is at present preparing a revised system design in an attempt to reduce costs.

*North Saltspring Waterworks District.*—Plans of water-system extensions to serve the Hundred Hills Subdivision were approved.

*North Wellington Waterworks District.*—Approval was given to preliminary plans for a sewerage scheme to serve the North Wellington Waterworks District. At a plebiscite held in November, a majority of land-owners voted in favour of amending the Letters Patent of the district to include sewage disposal.

*Okanagan Falls Irrigation District.*—Proposals for installing a sanitary-sewer system for the community of Okanagan Falls were reviewed. The scheme is, however, being temporarily held in abeyance.

*Parkridge Heights Improvement District.*—A domestic water-supply and sewerage scheme for the recently incorporated Parkridge Heights Improvement District near Prince George was approved and installed.

*Rayleigh Waterworks District.*—After some difficulty had been experienced in locating a suitable aquifer, a well was drilled having sufficient yield to supply the domestic water requirements of the district. The district's consulting engineers are currently engaged on the system design.

*Ships Point Subdivision, Vancouver Island.*—Following a Water Rights report on a proposed amalgamation of the Ships Point Subdivision with the Fanny Bay Waterworks District, the subdividers decided to install a separate water system. The consulting engineer's plans of the proposed works were approved.

*Sorrento Waterworks District.*—Following submission of a revised design, tenders for the installation of a domestic water-supply system were recalled early in the year, and the contract awarded in May. The system is now installed and operating.

*Todd Hill Irrigation District and Thompson Park Waterworks Company Limited.*—A public utility—namely, Thompson Park Waterworks Company Limited—supplying water to a residential subdivision bordering the Todd Hill Irrigation District near Kamloops has requested amalgamation of the two authorities. The technical and economic feasibility report regarding the proposed amalgamation was reviewed, and meetings were held with the Trustees to consider the policy to be followed.

*West Lantzville Waterworks District.*—Plans were approved for the installation of a domestic water-supply system to serve the West Lantzville Waterworks District. The system is now in operation.

#### *Investigations for Reports*

*Alta Lake Area.*—An investigation was made to determine the probable cost of providing a domestic water supply for the community on the west shore of Alta Lake near Pemberton. The scheme envisaged would use Scotia Creek as a source of supply. A report will be released early in 1967.

*Clearwater District.*—A report describing alternative schemes for supplying water to the Clearwater district in the North Thompson Valley and the estimated costs will be completed shortly.

*French Creek-Hilliers-Coombs Area.*—A number of small communities lying between Cameron Lake and Parksville have requested that the possibility of supplying the area with water from Cameron Lake be investigated. Preliminary studies are at present being made.

*Grantham Area Water Supply.*—Grantham is a small farming community distributed along the Courtenay–Merville Road. As many of the residents have spent considerable sums in drilling unsuccessfully for water, an investigation was made to determine whether installation of a community supply would be feasible. It was, however, concluded that unless a local source could be found, such a scheme would not be economic.

*Sechelt Area Water Supply.*—The Village of Sechelt and three adjacent communities are at present supplied with water by a private water company. The system was originally installed in 1929, and many of the components are now nearing the end of their useful service life. At the request of local organizations, a study of the water-supply position in that area is being carried out to provide the communities concerned with a guide for future planning.

*West Howe Sound Area.*—There are at present six independent domestic water systems in the Gibsons area. These systems are proving inadequate to meet the needs of the expanding population, and it has been proposed that an area organization should assume the responsibility for an over-all water-supply scheme. The various sources of water in the area are being studied in detail, and a report is being prepared to set out the technical and financial implications of such a scheme.

#### *Reports Prepared*

*Black Creek Area.*—A report examining the problem of supplying water in the Black Creek area was prepared. A pumped supply from the Oyster River was found to be the most favourable possibility, but economic feasibility could not be established, due mainly to the low population density.

*Canyon Waterworks District.*—Following completion of the contract for the rehabilitation of the farm water-supply system for Canyon Waterworks District, an "as constructed" report was prepared. This report contained a full description of the works, together with construction drawings, recommended procedures for system maintenance and operation, and suggestions regarding future administrative policy.

*Comox Valley Water Supply.*—The larger communities in the Comox Valley are using their water-supply systems to their full capacity and must seek additional sources of water in the immediate future. A report setting out the technical and economic implications of a regional water-supply system for the valley was prepared. It was recommended that if the communities concerned decided to proceed with such a scheme, a gravity supply from the Puntledge River should be adopted.

*Little River Area.*—A long history of complaints regarding low flow, flooding, and tidal conditions at the mouth of Little River near Comox resulted in an investigation by Water Rights personnel. The subsequent report found that the causes of complaint were natural in origin. Tentative remedial measures were outlined, and the formation of an improvement district to implement them was recommended.

*Long Beach Area Water Supply.*—A report was prepared on the technical and economic feasibility of providing a domestic water supply to the Long Beach area between the Villages of Ucluelet and Tofino. The report found that such a project was not economically feasible, and recommended that consideration be given to an over-all water scheme for the peninsula, using Kennedy Lake as the source.

*Sointula Waterworks District.*—The majority of residents of Sointula, on Malcolm Island, obtain their water supplies from individual wells. Many of these yield an inadequate supply after periods of dry weather and are subject to pollution from septic-tank effluent. Early in the year a test well was drilled, and a subsequent report set out the technical considerations which would govern the exploitation of this source, together with the financial implications of installing a water system to serve approximately 170 connections.

*West Lantzville Waterworks District.*—A report was prepared on a domestic water-supply system for the small community of West Lantzville. A well previously drilled by residents of the district was recommended as a source of supply.

*Wilson Creek Area Water Supply.*—The Wilson Creek area on the Sechart Peninsula at present has no community water-supply system, although there are more than 100 homes in the area. A report was prepared outlining three possible schemes using surface and ground-water sources, and indicating the probable costs involved in each case. The financing of a water system for this area is complicated by the inclusion of the Tsawcome Indian Reserve, which has been subdivided and leased.

#### *Design and Engineering Services*

*Canyon Waterworks District.*—Minor problems arising from the operation of a new farm water-supply system were investigated and rectified. A final inspection of the works was made after the 12-month contract maintenance period, and the contractor discharged.

*Charella Gardens Waterworks District.*—The wells which supply the Charella Gardens Waterworks District are of inadequate yield to meet the district's requirements. Advice was given on what steps would be necessary to obtain an alternative source of supply.

*Gold Bridge Waterworks District.*—Rehabilitation of the Gold Bridge Waterworks District's system was completed in November, and it is now in operation and serving 30 homes in Gold Bridge. The design and supervision of construction was carried out by Water Rights personnel. Local labour and machinery were employed to install the works.

*Grandview Waterworks District.*—The design and specifications for the water system to serve Grandview Waterworks District were completed, and the contract was awarded in June, 1966. Design and supervision were carried out by Water Rights personnel, and the work was completed by October, 1966. This project was financed under the *Agricultural Rehabilitation and Development Act*.

*Lions Bay Improvement District.*—An inspection was made of the water system serving the Lions Bay Improvement District, and advice given regarding operation of the system.

*Royston Improvement District.*—Royston Improvement District, which is supplied with water from the Cumberland system, has for some time suffered from surging problems in its main line. The system was analysed and remedial measures discussed with the district. At last report the system was functioning satisfactorily.

*Spences Bridge Waterworks District.*—Reconstruction of the Murray Creek Dam was carried out to designs prepared by the Division and under its supervision. The new dam is a mass concrete structure 22 feet high.

*Willow Point Waterworks District.*—A field investigation and study of supply conditions in the Willow Point Waterworks District were made to determine future major pipe-line requirements.

*Wood Lake Improvement District.*—Approval under the *Agricultural Rehabilitation and Development Act* has been given to the construction of an irrigation system to serve the Wood Lake Improvement District, near Oyama in the Okanagan. Water Rights personnel are preparing final designs and specifications for a gravity system supplying water for sprinkler irrigation to 832 acres of orchard land in the district. Construction is expected to start early in 1967.

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.

The increasing impetus of the *Agricultural Rehabilitation and Development Act* programme was apparent, and despite some difficulties caused by widely fluctuating construction costs, the Division concluded a successful year.

#### POWER AND MAJOR LICENCES DIVISION

The Power and Major Licences Division is responsible for engineering and administrative duties in connection with the use of water for power generation and for other substantial uses.

The various duties performed by the Division include:—

- (a) Reporting upon the suitability of all power licence applications, and undertaking any further investigations that may be required.
- (b) Administration of the *Water Act* in so far as it applies to the use of water for power purposes, including the calculation and billing of annual rentals and fees.
- (c) Investigation and research necessary to guide the development of Government policy with respect to the utilization of the hydro-electric power potential of the Province.
- (d) Carrying out an engineering review of plans for major licence applications for industrial and mining purposes.
- (e) Compilation of statistics concerning the use of water for all purposes as a guide to future water-resource planning.
- (f) Inspection of all major dams in the Province.

#### MAJOR LICENSING ADMINISTRATION

All water licence applications for power purposes are scrutinized by an engineer of the Division for feasibility and to determine the rentals payable. Where the amount of power to be developed is fairly substantial, further investigation may be made by the Division, including, where necessary, the use of specialist consultants.

In the case of major licence applications, special attention is paid to public safety. This may require carrying out specific studies or obtaining expert advice on such matters as the stability of dams and the necessary measures for dealing with floods. In the case of power licences, the optimization of site potential is reviewed in terms of the economic integration of the proposed hydro development into Provincial loads and resources.

Other aspects, commonly taken into consideration as being in the public interest, are the extent to which reservoirs should be cleared of timber, the effects on fish and wildlife, and the possibility of the use of reservoir areas for recreation.

#### *Existing Licences*

The duties of the Division staff with respect to existing power licences consist of the calculation and billing of annual rentals and fees; the compilation of annual generation figures for use in calculating rentals and preparing statistical records;



Pipe-laying at Grandview Waterworks District near Armstrong.

administration in connection with special clauses in licences, including carrying out the necessary studies and investigations; and interpretation of the *Water Act* with respect to use of water for power purposes, including any general matters pertaining thereto.

In certain major storage licences, notably those applying to the Columbia River and Peace River power projects, the powers of the Comptroller have been set forth explicitly in special clauses in the licences. These special clauses cover such matters as approval of plans for dams and other structures, the clearing of reservoirs, public access to reservoirs, the release of water from reservoirs, and the protection of fish and wildlife. Thus an important function of the Power and Major Licences Division is the implementation of studies and administrative work necessary to enable the Comptroller to exercise his responsibilities with respect to such major water-resource projects.

During 1966, work proceeded on the approval of plans for the Peace River and Columbia River. With major developments of this nature, approval of plans is a process which is expected to continue throughout the period of construction for each project.

Because of the highly specialized nature of major dam construction, it is often necessary for the Comptroller to obtain advice from specialist consultants of internationally recognized stature during the review of plans for major dams. For the Portage Mountain Dam, the Department's general consultant is Mr. D. J. Bleifuss, of Atherton, Calif., who is actively involved in major dam projects on four continents. Dr. H. Q. Golder, of Toronto, Ont., has been retained as specialist consultant on soil and foundation problems for this project. Mr. Bleifuss is also acting as consultant for the Duncan Lake Dam, while the consultant for the Arrow Lakes and Mica Creek Dams is Mr. F. B. Slichter, of Burke, Va. Mr. Slichter was formerly chief civil engineer of the U.S. Corps of Engineers, and brings from his career with the corps a wide experience with dams and other hydraulic structures.

The Power and Major Licences Division is responsible for the background work necessary in making the services of the specialist consultants effective in providing the advice necessary to the Comptroller in the approval of plans. During the course of this work in 1966, meetings were held with these consultants and with engineers of the British Columbia Hydro and Power Authority and its consultants. During 1966, visits were made to the Portage Mountain, Arrow, Duncan, and Mica sites with Mr. Bleifuss, Mr. Slichter, and Dr. Golder in attendance.

#### *Other Major Licences*

The Division is also responsible for the review of plans and other details in connection with major licence applications. A number of major licence applications are being processed by the Branch at present, principally for use in pulp and paper plants and in mining operations. Worthy of particular mention is the development by Celgar Limited at Prince Rupert of additional storage by the construction of a new dam on Rainbow Lake and the raising of the existing dam at the outlet of Diana Lake to form one large interconnected reservoir. These dams were the subject of detailed review during the design and construction stages, and in October a final inspection was made upon completion of the work.

#### POWER-POLICY PLANNING

An important duty of the Division is to assist in the over-all planning of power development in the Province. Studies are made of all potential major developments to determine how they might best fit into a Province-wide hydro-electric system.

This is a continuing task, as fresh scientific and engineering developments constantly improve the feasibility of different projects and thus entail periodic reassessment of the situation.

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

#### UNDEVELOPED WATER POWER IN BRITISH COLUMBIA

In 1954 the Water Rights Branch published a booklet entitled "Water Powers of British Columbia." Studies subsequent to that date have shown the available potential to be several times greater than was then anticipated. Because of this, a review has been made to up-date the information previously published and to make a more realistic estimate of the Province's undeveloped hydro-electric power resources. In the past, calculations of power potential have been unduly conservative, and it is therefore intended to correct this situation, taking into account modern techniques in the development of major sites and the transmission of power over long distances.

For some years the Department of Energy, Mines, and Resources (formerly part of the Department of Northern Affairs and National Resources) of the Government of Canada and the Water Rights Branch of the Government of British Columbia have been engaged in the compilation of an index of known undeveloped hydro-electric power sites in British Columbia, which is itself part of a study covering the whole of Canada. The assembly of data is now more or less complete, and a summary, showing the up-dated totals for different areas of the Province, was included in the 1966 Annual Review of Water Powers of British Columbia, published by the Water Resources Service in July, 1966. The next stage of the study consists of determining the contributions which individual sites can be expected to make when operated in an integrated system. It is believed that this method of calculating potential output will increase the total from known sites by perhaps as much as 50 per cent on the present figure of 23,930,000 kilowatts. It must be remembered, however, that many sites have not yet been investigated at all, and it is possible that the ultimate total may be several times that amount.

#### DEVELOPED HYDRO POWER

The following paragraphs summarize the development of hydro-electric power in British Columbia during the past two years. For further details, reference should be made to previous Annual Reports or to the Annual Reviews of Water Powers of British Columbia.

During the past few years the most massive hydro-electric construction programme in the history of British Columbia has been proceeding on schedule. Four major dams, one on the Peace River and three in the Columbia River basin, are being constructed to provide power, flood control, and downstream flow regulation. Private industry also is increasing its potential; Cominco Limited, for instance, has installed a new unit at its Waneta plant. Other companies are planning additions in the near future, and the City of Revelstoke recently doubled the capacity of its Walter Hardman plant by the addition of a second 4-megawatt unit.

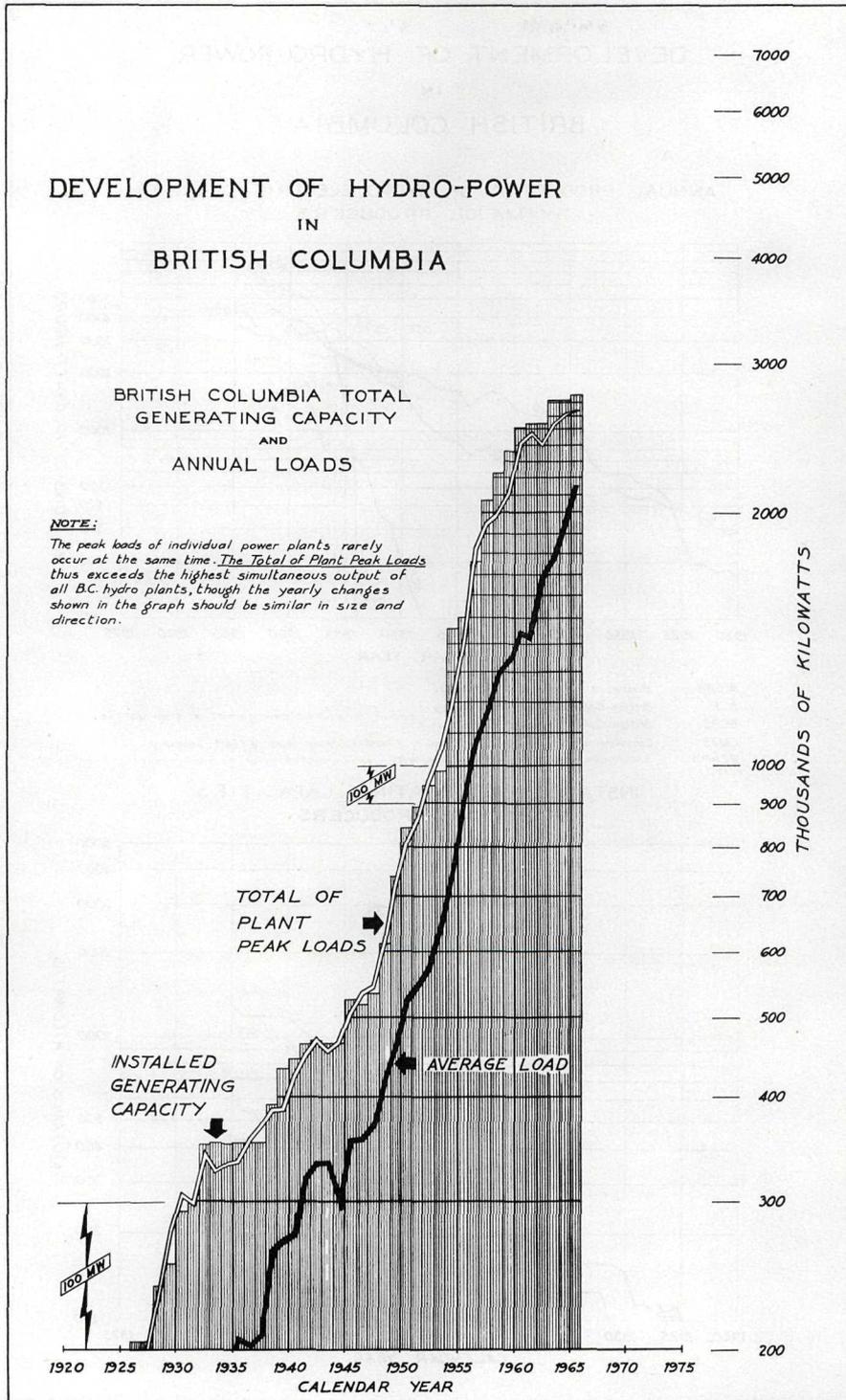
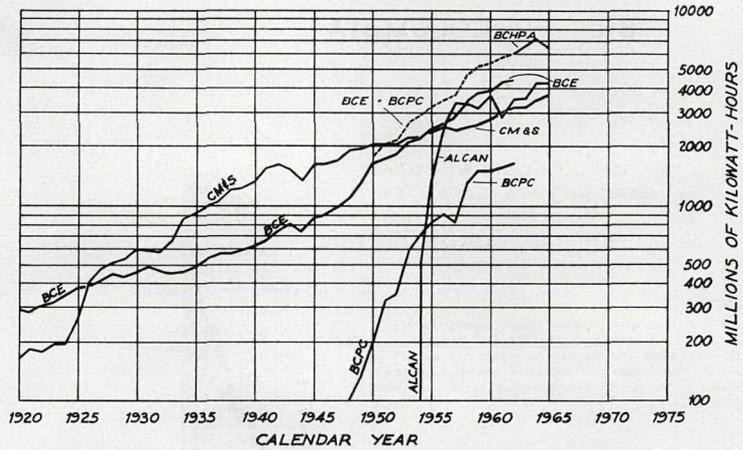


Plate 5

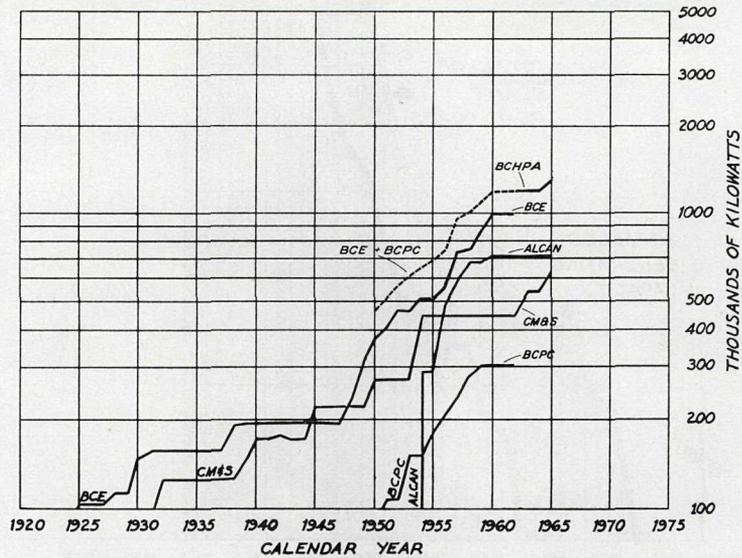
## DEVELOPMENT OF HYDRO-POWER IN BRITISH COLUMBIA

ANNUAL PRODUCTION OF HYDRO-ELECTRIC ENERGY  
BY MAJOR PRODUCERS



ALCAN Aluminum Company of Canada.  
 BCE British Columbia Electric Company } Shown solid until amalgamation then dotted.  
 BCP&C British Columbia Power Commission }  
 CM&S Consolidated Mining & Smelting Company of West Kootenay Power & Light Company.  
 BCHPA British Columbia Hydro & Power Authority - Shown dotted prior to amalgamation then solid.

INSTALLED GENERATING CAPACITIES  
OF MAJOR PRODUCERS



*Generation and Load Growth*

During 1965 the total amount of energy generated by hydro-electric plants in British Columbia was 15,257,960 megawatt-hours, representing a decrease of 1.9 per cent on the corresponding figure for 1964. Thermal-electric generation amounted to approximately 3,238,000 megawatt-hours, nearly double the previous year's figure. Imports of electrical power, which in the past have been negligible, jumped to a substantial level and amounted to 456,000 megawatt-hours (net). Thus, although the over-all increase in power generated within the Province was 7.1 per cent, the load grew by 10.0 per cent.

The total energy generated 10 years earlier, in 1955, was 8,465,000 megawatt-hours, so that over the last 10 years the load has grown at an average rate of 8.0 per cent compounded annually. Generation by private industry accounts for about half of the total, most of which is produced by the two major industrial users, Aluminum Company of Canada at Kitimat and Cominco Limited at Trail and Kimberley, who account for 26 and 20 per cent respectively of the Provincial total. It is inevitable, therefore, that the characteristics of these two industrial loads are reflected very heavily in the Provincial total.

Plate 5 shows the hydro-electric development in British Columbia to date, and the following table shows the hydro and thermal generating totals for the past 11 years. Plate 6 shows the breakdown of generating statistics amongst the major producers.

ELECTRICAL GENERATING STATISTICS FOR BRITISH COLUMBIA, 1955-65

Year	Electrical Generation in Gwh.		
	Hydro <sup>1</sup>	Thermal <sup>2</sup>	Total
1955	7,860	605	8,465
1956	9,315	688	10,003
1957	10,161	542	10,703
1958	11,219	686	11,905
1959	11,750	712	12,462
1960	12,669	965	13,634
1961	12,371	1,001	13,372
1962	13,572	1,176	14,748
1963	14,262	1,347	15,609
1964	15,558	1,713	17,271
1965	15,258	3,238	18,496

<sup>1</sup> From Water Rights Branch records.

<sup>2</sup> From Bureau of Economics and Statistics.

## INTERIM ESTIMATE OF GENERATION DURING 1966

An advance estimate of the total electric generation in British Columbia during 1966 is 21,000,000,000 kilowatt-hours, which represents an increase of 13.6 per cent on the corresponding figure for 1965. However, as there was a substantial import of power in 1965, the increase in load works out at 10.9 per cent. This is even higher than the increase from 1964 to 1965, which was 10.0 per cent. Further details are shown in the tabulation below.

	Generation in Gwh.		Per Cent Increase or Decrease
	1965	1966	
Utilities—			
Hydro.....	7,017	8,070	+15.00
Thermal.....	1,990	2,883	+44.87
Sub-totals.....	9,007	10,953	+21.60
Industries—			
Hydro.....	8,241	8,966	+8.79
Thermal.....	1,248	1,093	-12.42
Sub-totals.....	9,489	10,059	+6.00
Hydro sub-totals.....	15,258	17,036	+11.65
Thermal sub-totals.....	3,238	3,976	+22.79
Total generation.....	18,496	21,012	+13.60
Net import of power.....	456	.....	.....
Total load in British Columbia.....	18,952	21,012	+10.86

NOTE.—All 1966 figures subject to revision.

### HYDRO-ELECTRIC POWER PROJECTS UNDER CONSTRUCTION

#### *Additional Installations at Existing Plants*

The fourth and final 90-mw. unit at Cominco Limited's Waneta plant commenced operation on September 30, 1966.

#### *Peace River Development*

Apart from planned additions to existing plants, the next major hydro-power installation to be completed in British Columbia will be the Portage Mountain Dam on the Peace River, which is scheduled for first power production late in 1968.

The diversion-works for Portage Mountain Dam were completed in time to withstand the 1964 summer freshet, which was the highest ever recorded. Fill-placing operations were started in August, 1964, employing a 15,000-foot-long conveyer system, which is the world's largest, and was built at a cost of \$10,000,000.

A total of 45,622,906 cubic yards of embankment material has been placed so far, and of this total 23,373,307 cubic yards were placed during the 1966 season. This brings the embankment above the 425-foot mark, and represents 79 per cent of the 56,800,000 cubic yards to be placed. This year a world record was achieved on July 19th when a total of 163,200 cubic yards was hauled, placed, and compacted in a 24-hour period. It can be seen that a continued rapid placement rate was maintained throughout the season by comparing the 23,373,307 cubic yards placed this year with the scheduled quantity of 19,500,000 cubic yards or with the 18,469,600 cubic yards placed in the 1965 season. Embankment placement is under the main dam contract, which was let to the Kiewit, Dawson, and Johnson consortium in 1963 at a price of \$73,600,000. Extra work orders and increased prices have caused the value of the contract to rise to approximately \$82,000,000; the contractor's earnings to date total approximately \$67,000,000.

The power-house contract, which was let in 1965 to the Northern, Stewart, Morrison-Knudson, Perini, and Jones consortium at a price of \$77,000,000, started somewhat slowly, but the rate of progress has improved considerably during the last year. The contractor's earnings to date total approximately \$36,000,000.

Other contracts let in 1966 totalled \$71,226,000, the bulk of this, \$43,868,000, being for the construction of the spillway and low-level outlet works, which was let to the Kiewit, Dawson, and Johnson consortium. The remaining \$27,358,000 was

for a number of contracts including central control building, power intake gates, transmission-line clearing, transmission-line equipment, low-level outlet materials, spillway gates, low-level outlet gates, and gate-hoisting equipment. These contracts are all progressing satisfactorily.

#### *Columbia River Development*

*Arrow Lakes Dam.*—Preliminary activities on the project were in progress in late 1964. These consisted of construction of a pipe-line to the Celgar pulp-mill, land acquisition, and railroad relocation. Early in 1965 the contract for the main dam was awarded to Foundation Dravo Limited at a price of \$55,000,000.

Construction of the concrete section of the Arrow Lakes Dam began in April following completion of the cofferdam. The 1,200-foot-long concrete section will include a navigation lock and reservoir discharge-works. The earth section of the dam is being constructed simultaneously by bottom-dump barges placing fill material under water. The contractor's earnings to date total approximately \$27,000,000, and progress on the contract to date is ahead of schedule.

A total of \$10,734,000 worth of contracts was let in 1966 covering such features as clearing, bulkhead gates, navigation lock gates, sluice gates, cranes, and elevators. The project is required to be in operation by April 1, 1969.

*Duncan Lake Dam.*—The main contract, for slightly under \$16,000,000, was let in 1964 to the Mannix, Standard-General, and Emil Anderson consortium, and is proceeding ahead of schedule. The contractor's earnings to date total approximately \$13,800,000. During 1966 a total of \$1,074,000 worth of contracts was let, covering such features as access-road construction. The project is required to be in operation April 1, 1968.

*Mica Creek Dam.*—This dam, towering 800 feet above bedrock, will be the highest in Canada and third highest of its type in the world. A contract for the diversion tunnels, which was let in 1965 to the Perini, Northern, Stewart, Morrison-Knudson, and Mannix consortium for \$21,155,000, is proceeding as scheduled, with the contractor's earnings to date being approximately \$12,900,000.

The main contract, covering the dam, spillway, outlet-works, and power intake channel, is expected to be called in April and awarded in July, 1967. This contract is estimated to amount to \$150,000,000, which would be the largest single contract awarded in Canada.

In 1966 a total of \$22,680,000 worth of contracts was let, covering such features as diversion tunnels, commercial area of Mica Creek townsite, and diversion-tunnel gates. The project is required to be in operation by April 1, 1973.

#### *Use of Electronic Computing Equipment*

Power studies were conducted during 1966 using the special computer programme developed for use on the I.B.M. 1620. Various problems relating to the development of the Peace and Columbia River systems are now under intensive investigation.

During 1967 the Data Processing Division of the Department of Industrial Development, Trade, and Commerce will be switching over to an I.B.M. 360 system. This will greatly facilitate the use of the data which have been diligently compiled over the last few years. Significant improvements are expected in data retrieval and statistical analyses.

During the past year the Water Licensing Division has prepared a complete list of files for the Water Resources Service. This listing includes special codings

to indicate subject-matter and disposition, and the information has been key-punched on to I.B.M. cards ready for use with the I.B.M. 360. This is one of the last major tasks of data-recording required to take full advantage of the latest methods of electronic processing.

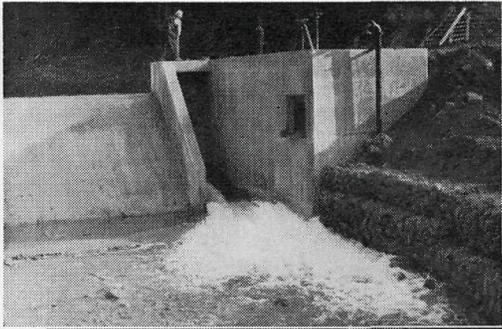
#### WATER LICENCE STATISTICS

The compilation of water licence statistics is now virtually complete. Details of new licences and changes of status are being kept up to date, and listings of all licences issued are prepared from time to time. A revised statistical analysis was carried out during 1965, and the results are recorded below.

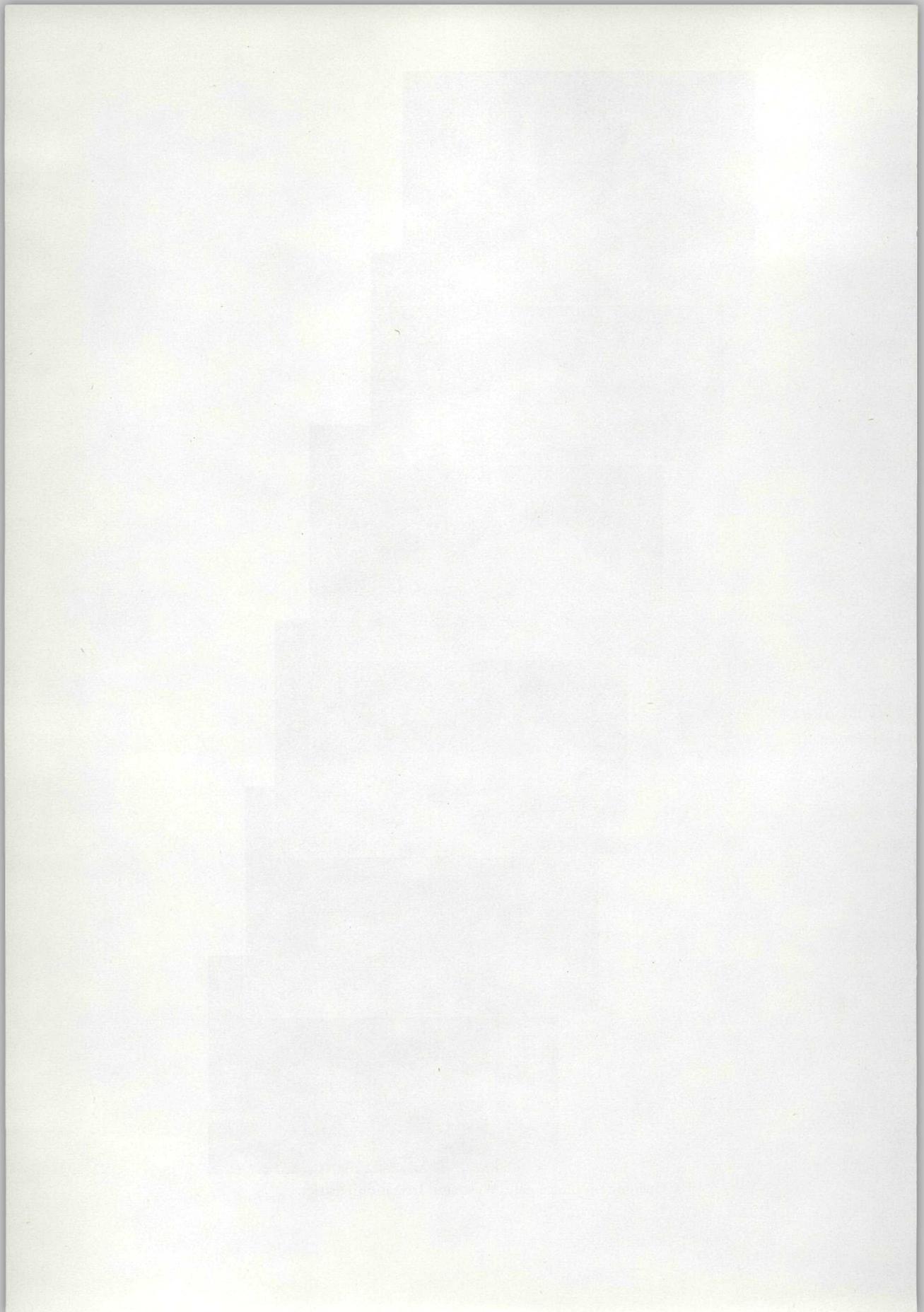
#### *Statistical Analysis of Licensed Water Use as of April, 1965*

Domestic purpose .....	g.p.d.	10,197,000
Incidental use .....	g.p.d.	3,157,000
Irrigation purpose .....	ac.-ft.	769,100
Area irrigated .....	a.c.	310,000
Industrial purpose <sup>1</sup> .....	g.p.d.	179,274,000
Industrial purpose <sup>1</sup> .....	c.f.s.	1,577
Pulp and saw mill .....	c.f.s.	215
Fish or log ponds .....	g.p.d.	4,500
Land-improvement purpose .....	g.p.d.	103,000
Mining purpose <sup>1</sup> .....	c.f.s.	891
Mining purpose <sup>1</sup> .....	g.p.d.	29,000
Hydraulic .....	c.f.s.	21
Processing ore .....	g.p.d.	500,000
Crown land occupied—		
Dam or power plant .....	ac.	155
Right-of-way .....	ac.	3,343
Flooding .....	ac.	178,028
Other purpose .....	ac.	29
Power purpose .....	c.f.s.	216,513
Storage purpose .....	ac.-ft.	89,945,000
Miscellaneous purpose .....	g.p.d.	116,000
Mineral trading purpose .....	g.p.d.	1,160,000
Waterworks purpose .....	g.p.d.	214,262,000
Waterworks purpose .....	c.f.s.	342

<sup>1</sup> Breakdown into sub-purposes incomplete.



Opening the sluice gate, Westbank Irrigation District.



**WATER INVESTIGATIONS  
BRANCH**

## WATER RESOURCES SERVICE

### 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 which took effect on April 1, 1962. The Hydraulic Investigations Division of the Water Rights Branch was transferred to the Water Investigations Branch, and it formed the nucleus of the new Branch.

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, which matters are not directly connected with the administration of the *Water Act*. 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 hydro-meteorological data in such a form as to make them readily adaptable.
- (3) Groundwater Division: Collection of existing ground-water data and investigation and evaluation of ground-water 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 of project proposals.
- (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*. Design and supervision of construction of water-damage prevention projects.
- (7) 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.

## WATER INVESTIGATIONS BRANCH

V. RAUDSEPP, P.ENG., CHIEF ENGINEER

The Water Investigations Branch, which was created in December, 1962, deals with technical matters related to the water resources of the Province, where such matters are not directly connected with the administration of the *Water Act*. At the year-end, the staff consisted of 55 permanent and 28 temporary positions, among which were 31 civil engineers, 3 geological engineers, and 1 hydrometeorologist. Sixteen permanent and 1 temporary position were vacant.

The principal functions of the Water Investigations Branch are carried out by six divisions, as follows:—

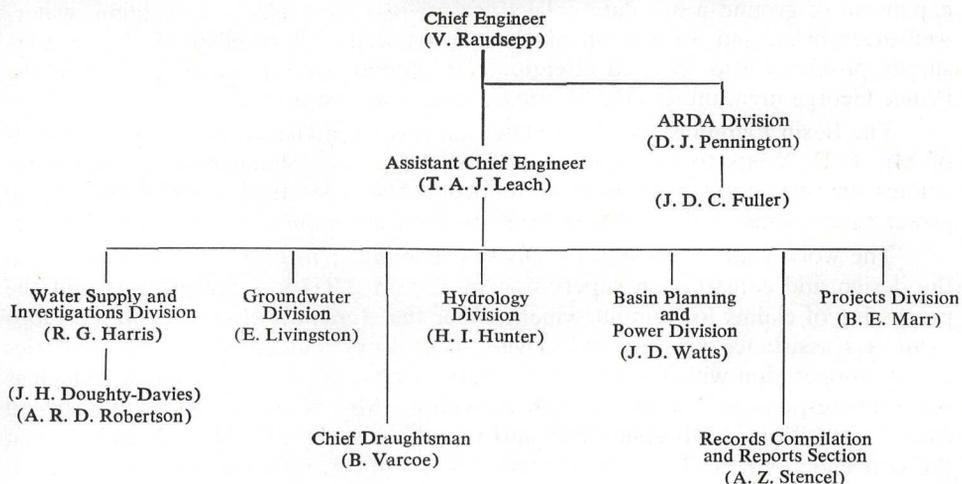
- (1) Water Supply and Investigations Division.
- (2) Hydrology Division.
- (3) Groundwater Division.
- (4) Basin Planning and Power Division.
- (5) ARDA Division.
- (6) Projects Division.

These divisions are supported by a Draughting Office and a Records Compilation and Reports Section. Both these offices also perform certain services for the other branches of the British Columbia Water Resources Service.

An account of the work carried out by the Water Investigations Branch is given in some detail on the following pages. A few general observations are made below.

Continuing availability of Federal-Provincial financial assistance for the construction of rural water projects under the *Agricultural and Rural Development Act* (ARDA) and for other major water-development and water-damage-prevention projects under the *Canada-British Columbia Joint Development Act* and the *Canada Water Conservation Assistance Act* has resulted, as in previous years, in a large number of water-project proposals, of which many have been approved and are

### ORGANIZATION CHART OF THE WATER INVESTIGATIONS BRANCH YEAR ENDED DECEMBER, 1966



under various stages of execution. The Water Investigations Branch has been responsible for the processing of these proposals and for implementing the approved projects by providing engineering services or by inspection of project execution. Under the ARDA assistance programme, a total of 38 water projects with an aggregate cost of over \$20,000,000 has been authorized for execution to date. Some 23 project proposals with an estimated total cost of \$10,000,000 are under investigation. The Canada *Water Conservation Assistance Act* programme involves three approved projects with a total cost of \$3,400,000. One proposal with an estimated cost of over \$2,000,000 is under active study, and several project proposals are in preliminary stages of formulation.

Also falling under the Federal-Provincial assistance programme preparatory work was a Federal-Provincial joint assessment of the Lower Fraser Valley dyke reconstruction, drainage improvement, and river-bank stabilization problems. This study involved review of the existing data compiled by the Fraser River Board and other agencies and supplemented by brief field examinations and office studies. It was estimated that the total cost of the improvements to the existing reclamation works and certain additional flood-control measures would be \$34,000,000.

Among noteworthy projects was a study of the proposed Shuswap River-Okanagan Lake water-supply canal, directed by Mr. T. A. J. Leach, Assistant Chief Engineer. This preliminary comprehensive water-management plan for the Okanagan region was completed and the report released.

In the Water Supply and Investigations Division, under Mr. R. G. Harris, a number of ARDA water projects and project proposals received attention. Final designs and construction supervision of individual projects were carried out by Messrs. D. J. Pennington, T. H. Oxland, J. V. Eby, and W. B. German. Mr. P. W. Newson and Mr. J. Wester, Hydraulic Engineers, joined the Division. Mr. W. B. German was transferred from Oliver to Victoria office and was replaced at Oliver by Mr. S. Mould.

The Hydrology Division, under Mr. H. I. Hunter, continued its main activities in connection with snow-survey network and spring run-off volume forecasting. Substantial snow-course network expansion resulted from the requirements of the Columbia Treaty projects. One "snow pillow," a recording snow-pack measuring device, was installed. Rearrangement of stream-flow data into more useful form was continued. Mr. C. H. Coulson joined the staff as Assistant Hydraulic Engineer.

The work of the Groundwater Division, under Mr. E. Livingston, consisted of expansion of ground-water data collection activities by exploratory drilling, water-well inventories, and installation of observation wells. A number of local water-supply problems also received attention. A ground-water research project in the Prince George area, under ARDA programme, was continued.

The Basin Planning and Power Division was strengthened by the appointment of Mr. J. D. Watts to the position of Division Chief. Water-resource inventory studies on river-basin basis were continued. Also continued were hydro-electric power assessments of the northern streams, with an emphasis on the Liard River.

The work load in the ARDA Division continued to grow in connection with the design and construction supervision of certain ARDA water projects and the processing of claims for reimbursement under the *Agricultural and Rural Development Act* assistance programme. These supervisory and administrative activities are in co-operation with the British Columbia Department of Agriculture, which is generally responsible for the ARDA activities. Mr. W. K. A. Dobson resigned from the position of Division Chief and was replaced by Mr. D. J. Pennington at the year-end. Mr. A. T. McPhail, Hydraulic Engineer, resigned, and Messrs. N. I.

Guild and J. Boardman arrived from England to join the engineering staff of the Division.

Mr. J. D. C. Fuller, Construction Engineer, continued to be in charge of the largest ARDA project—Vernon Irrigation District rehabilitation, with a total cost of \$6,600,000. Mr. P. M. Brady continued the design of the new system for the Southern Okanagan Lands Project. The ARDA Division moved to new offices at Cook Street in November.

A new Projects Division, under Mr. B. E. Marr, was created to deal with the proposed and approved projects under the Federal-Provincial financial assistance programme in connection with the Canada *Water Conservation Assistance Act*.

Senior members of the Water Investigations Branch have participated in a number of committees dealing with water-resource matters, such as Hydrology Sub-committee of the National Research Council, the National and Provincial Committees for the International Hydrologic Decade, several committees in connection with the ARDA activities, the Interdepartmental Advisory Committee for the Pollution Conference, Co-ordinating Committee for Hydrometeorological Networks, and two Federal-Provincial joint committees on proposed water projects.

### SHUSWAP RIVER-OKANAGAN LAKE WATER-SUPPLY CANAL STUDY

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

The results of this ARDA research project are contained in a recently completed preliminary report.

An examination of the total water requirements, including irrigation, domestic, waterworks, and industrial purposes within the Okanagan and North Okanagan areas (Enderby to the International Border), shows that tributary sources are reaching their ultimate development and that additional requirements will have to be obtained from Okanagan Lake.

Okanagan Lake will provide sufficient storage in most years to meet present needs, but with the anticipated population growth and the expected increase in irrigated land, there will be an increasing need for supplementary water for periods of drought such as occurred in 1929 to 1932.

The most feasible source to supplement Okanagan Lake inflow in years of low yield would be a water-supply canal from the Shuswap River, at or near Enderby, which would carry water southward for some 20 miles along the eastern side slopes of Fortune Creek valley, thence across the river in a siphon which would discharge into a canal leading to the Deep Creek channel north of Armstrong. In its movement southward through the improved channel of Deep Creek the water would pass through five drop structures, through a low dam at the outlet of Otter Lake, and a chute near the canal entrance to Okanagan Lake.

Water for the Enderby-Armstrong (North Okanagan) area would be diverted every year, but flows south of Otter Lake would be restricted to the natural run-off of Deep Creek in years of above average inflow to Okanagan Lake. During drought years, in addition to the North Okanagan requirements, supplementary water would be diverted from the Shuswap River for discharge into Okanagan Lake.

Diversion facilities on the Shuswap River would include a 2,600-foot by 55-foot-high dam some 2.5 miles upstream from Enderby, discharging directly into the canal, or, alternatively, a low diversion concrete dam just upstream from the mouth of Fortune Creek in combination with a pumping plant which would lift the water some 30 feet to the canal. Upstream storage would be required on Mabel Lake under either scheme.

Total capital costs range from \$8,700,000 to \$14,600,000 for various pumping schemes, while equivalent gravity schemes would cost between \$11,200,000 and \$16,300,000. Equivalent annual costs per acre-foot of water range between \$9 and \$21, with pumping schemes in all instances running somewhat lower than the equivalent gravity scheme.

### WATER SUPPLY AND INVESTIGATIONS DIVISION

R. G. Harris, P. Eng., Chief of Division

The functions of the Water Supply and Investigations Division can be divided into two main engineering sections—(a) irrigation and domestic water-supply projects and (b) flood- and erosion-control and drainage projects.

During the past year, investigations were continued or initiated on 15 water-supply projects and nine flood- and erosion-control projects. Of these, construction by this Division was carried out on six under the ARDA programme, involving the preparation of final design, including contract documents.

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

The main projects dealt with in 1966 are summarized below.

#### IRRIGATION AND DOMESTIC WATER-SUPPLY PROJECTS

##### *Black Mountain Irrigation District*

Following a request from the Trustees, a detailed inventory and replacement schedule for existing system works was prepared in 1964, together with plans showing layouts of existing and proposed works. The proposed replacements allowed maximum use from existing system components, but limited pressurization to areas where topography provided adequate operating pressures. Domestic supply was not included. In 1965 the district requested that further studies be carried out to consider the feasibility of a fully pressurized system to provide both irrigation and domestic supply to farm areas within the district and to be financed under the ARDA programme.

These studies were completed in August, 1965, and under the proposed new system 4,548 acres of irrigable land and 530 farm domestic connections would be served. The existing low-level ditch from Mission Creek would supply a combined settling-pond and balancing-reservoir constructed at Gopher Flats, which in turn would supply some 52 miles of distribution pipe-lines.

Following approval for ARDA assistance in October, 1966, preparations for final design have commenced.

##### *Doukhobor Lands Water Supply*

*General.*—In recent years the subdivided holdings of the former Christian Community of Universal Brotherhood Limited, in the Grand Forks and Kootenay areas, have been offered for sale, and many of the lots have now been purchased. Individual houses are being constructed on these lots, and water for domestic and irrigation use has become an immediate consideration. Accordingly, in 1962, the British Columbia Water Resources Service was requested to carry out water-supply investigations in these areas.

During 1964 and 1965, water-supply investigations were carried out for the Doukhobor communities in Grand Forks, Raspberry, Brilliant, Ootischenia, and Champion Creek. In 1966 these investigations were continued.

*Shoreacres Area, near South Slocan.*—Feasibility studies were completed for the Shoreacres community, situated at the junction of the Slocan and Kootenay Rivers, near South Slocan. Shoreacres, which has a potential of 261 acres of irrigable land and some 62 households, could be supplied (a) by gravity from Rover Creek, which necessitates an underwater crossing of the Kootenay River; (b) by pumping from the Slocan River; or (c) by pumping from drilled wells on the Shoreacres Terrace. On the basis of water quality and annual operating costs, the Slocan River was recommended as the source of supply.

*Krestova.*—The Doukhobor community of Krestova, situated west of the Slocan River, has recently been subdivided. A preliminary examination of water supply for this area was initiated in the spring of 1966, and the results of this study were turned over to the Nelson District office of the Water Rights Branch for further study.

#### *Kaleden Irrigation District*

Incorporated as an improvement district in 1922, the Kaleden Irrigation District comprised some 540 acres of orchard land and about 130 homes. Water supply for both domestic and irrigation use was being taken from Shatford and Shingle Creeks through an 11½-mile-long system of ditches, flumes, and natural watercourses, augmented from storage reservoirs on Brent, Farleigh, Aeneas, and Marron Lakes.

In 1964, following ARDA approval, a final design of a new system based on pumping from Skaha Lake was commenced in preparation for a construction programme in 1965.

Work on the distribution-system pipe-lines was substantially completed in 1965, and the year 1966 saw final conclusion of the project with construction of a 725-horsepower lake-shore pumping plant and associated intake conduit.

The pumping plant is comprised of two 250-horsepower, one 200-horsepower, and one 25-horsepower vertical turbine units driven by electric motors, and is capable of delivering 4,000 U.S. gallons per minute against a total head of 565 feet. Automatic operation is achieved by a telemetering control system between the pump-house and a 40,000-U.S.-gallon tank reservoir above the irrigated area.

The rehabilitated system is capable of delivering 6½ U.S. gallons per minute for each acre of irrigated land and is comprised of a closed pipe network buried at a sufficient depth to maintain frost-free domestic water service during the winter months.

Final project costs totalled \$325,000, of which \$210,000 has been contributed in equal grants by the two senior Governments under the provisions of the *Agricultural and Rural Development Act*.

#### *Keremeos Irrigation District*

A preliminary study was carried out in 1963 to consider several alternative schemes for rehabilitating the district's irrigation system.

At the present time the district takes water by gravity from the Ashnola River, 8 miles to the west, and from Keremeos Creek, close by. Neither system provides adequate pressure for sprinkler irrigation, and both systems are in need of extensive replacements. The investigation concluded that, subject to results of a ground-water testing program, a supply from wells would appear to be the most economical scheme.

A request for assistance under the ARDA programme was received from the Keremeos Irrigation District in the latter part of 1965, and a preliminary design was completed in 1966. The availability of an adequate ground-water supply has

been confirmed by tests on existing wells in the area. The design provides for a pressurized closed pipe system with water supply from separate well groups in the west and east portions of the district. The total flow required from these wells will be over 8,000 U.S. gallons per minute, demanding a total of 670 horsepower.

The new system is designed to deliver an average of  $6\frac{3}{4}$  U.S. gallons per minute per acre to about 1,220 acres of fruit lands, and to provide water for domestic use to 216 dwellings. The anticipated irrigation charges after allowing for one-third reimbursement from each of the two senior Governments amounts to between \$20 and \$24 per acre.

#### *Naramata Irrigation District*

The district receives water by gravity from Lequime (Chute), Robinson, and Naramata Creeks. Storage has been developed in three reservoirs—Big Meadow Dam on Lequime Creek, Naramata Lake Dam on Robinson Creek, and Elinor Lake Dam. The latter two reservoirs are supplemented by diversion from Lequime Creek. No storage has been developed on Naramata Creek owing to the lack of a suitable storage site.

In 1958 the major portion of the distribution-works was reconstructed at a cost of over \$250,000. Subsequently, a portion of the High Line (diversion from Robinson Creek) and north intake were replaced, and chlorination equipment installed. These works were financed by the issue of Government-guaranteed debentures.

During a dry year the district may not have sufficient water supply to serve the 900 acres of orchard land now under irrigation and about 260 domestic connections. To alleviate this shortage, an ARDA project for raising Naramata Lake Dam approximately 10 feet, for an increase in storage of 300 acre-feet, has been approved. A final design has been prepared by a firm of consulting engineers, and construction is expected to start in mid-1967, with completion before the 1968 irrigation season.

The ARDA approval also included replacement of the steel Mason Line serving 108 acres. This project involved laying 7,500 feet of asbestos-cement pipe, varying in diameter from 10 to 4 inches, and was completed during the fall of 1966. This line provides an important cross-connection within the distribution system to allow maximum use of freshet flow from Naramata Creek.

#### *Okanagan Falls Irrigation District*

The Okanagan Falls Irrigation District obtains its water supply from an intake on the Okanagan River near the outlet of Skaha Lake. The system, now irrigating some 135 acres and supplying domestic water to about 150 consumers, was constructed in 1953. Since then there has been an increase in domestic water use as well as an increase in the use of sprinkler irrigation. A growing problem in the past has been the occurrence of disagreeable tastes and odour in the water during the summer months.

A preliminary report was prepared in 1964, which recommended replacement of portions of the distribution system, construction of a storage tank and booster station, and improvements to the river intake. In October, 1966, the district requested assistance under the ARDA programme to carry out these improvements, and a final design is now being prepared. As an alternative to improving the existing water supply, the use of ground-water is being considered. The Groundwater Division of the British Columbia Water Resources Service completed the drilling of two test holes in August, 1966, the results of which indicated favourable condi-

tions for the construction of two wells to meet the district's needs for irrigation and domestic water.

#### *Okanagan-Mission Irrigation District*

At the request of the district, an engineering study is currently in progress on a combined irrigation and domestic water-supply system to replace an existing irrigation system serving approximately 300 acres of irrigable land. The present gravity system, with a pumping plant on Okanagan Lake, is no longer adequate to supply the area.

#### *Osoyoos Irrigation District*

In October, 1965, the Osoyoos Irrigation District received approval to construct a new irrigation system under the ARDA programme. The proposed system was later revised to include the provision of rural domestic water, and received final approval in August, 1966. The new system will irrigate 435 acres of orchards.

The district was originally comprised of the adjoining areas of East Osoyoos and Osoyoos Irrigation Districts. The two districts amalgamated to reduce the over-all costs of rehabilitation.

#### *Oyama Irrigation District*

Construction of a new irrigation and domestic water system for the Oyama Irrigation District was completed in August, 1966. The project was initiated in 1964 with the preparation of a preliminary report outlining several alternate schemes and the drilling of ground-water test wells. Approval for ARDA assistance to construct a ground-water pumping system was received in March, 1965, and construction was under way by June, 1965.

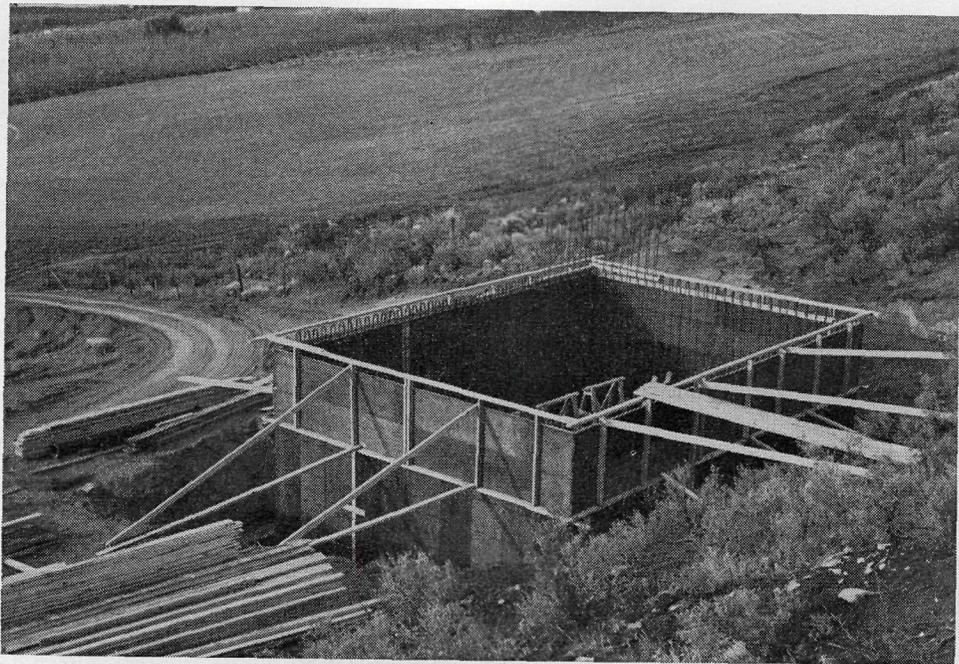
The completed system now serves approximately 320 acres and 50 homes on the west side of Wood and Kalamalka Lakes and about 80 acres on the east side of the causeway between the two lakes. The latter area, now being incorporated into the district, was not included in the original project and did not receive ARDA assistance. Also separately financed were pipe-lines and auxiliary pumping equipment to provide the Vernon Fruit Union packing-house with fire protection.

Total costs of the completed project were about \$215,000. The main pumping-station, totalling 200 horsepower, draws water from a 16-inch-diameter well, 150 feet deep, located near the north shore of Wood Lake. The capacity of this well is in excess of 2,500 U.S. gallons per minute, reportedly one of the highest producing wells of its type in British Columbia. The water is pumped to a 40,000-gallon reservoir above the pump-house, and the operation of the pumps is automatically controlled by water levels. The largest pump, of 1,500 U.S. gallons per minute capacity, is driven by either electric motor or natural-gas engine. The auxiliary power was needed to meet the fire underwriters' requirements for the protection of the packing-house. The gas engine operates automatically in the event of a power failure.

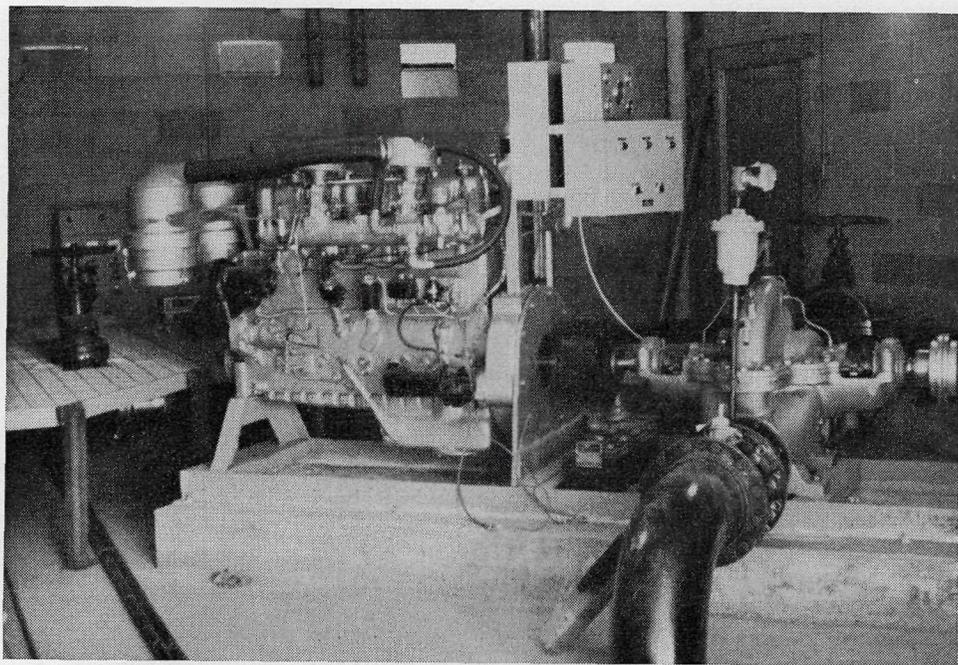
The distribution system involves approximately 5 miles of asbestos-cement pipe in sizes 4 to 12 inches in diameter. A booster pump near the reservoir increases pressures supplied to the upper laterals. A small submersible pump in a second well supplies domestic water during winter months.

#### *Peachland Irrigation District*

Incorporated as an improvement district in 1920, the Peachland Irrigation District took over an irrigation system laid out in 1906 by the Peachland Townsite Company. To augment existing water supply from Peachland (Deep) Creek, stor-



Construction of 40,000-gallon reservoir, Osoyoos Irrigation District.



A 150-horsepower 1,500 g.p.m. pump and auxiliary natural-gas engine, Oyama Irrigation District.

age has been developed in Peachland Reservoirs Nos. 1 and 2 and Wilson Lake. This storage, coupled with a diversion from MacDonald Creek into Peachland Creek, has provided an adequate supply of water up to the present time. Approximately 500 acres of fruit lands are presently under irrigation, the balance of about 780 acres being classed as non-agricultural.

In 1965 the district requested an engineering study to consider the feasibility of a combined irrigation and domestic water-supply system. Field surveys were carried out in 1966 for the purpose of mapping the district, and storage reservoirs and preliminary studies have now commenced.

#### *Water-storage Reservoir Inventory*

A programme of mapping major water-storage reservoirs in the Southern Interior of the Province was initiated in 1964. This information, which also includes potential storage, will assist in the administration of water rights and will enable water-supply augmentation studies to be carried out in water-deficient areas.

Reservoir maps are being prepared by photogrammetry and field surveys. Echo-sounding equipment is being used to obtain sub-surface information. Of approximately 115 existing reservoirs in the Okanagan Basin, about 45 reservoirs remain to be mapped under this programme. Of these, survey data are available on about 14. Surveys have also been carried out on 14 existing and potential reservoirs in the Kamloops, Princeton, and Nicola areas. In 1966 a total of 13 reservoirs was surveyed and mapping completed on 11. This programme is to be continued in 1967.

#### *Westbank Irrigation District*

The district receives water by gravity from Powers Creek and Lambly Creek watersheds, with an intake on Powers Creek, about 6,000 feet upstream from the district boundary. Present storage capacity has been developed on Islat (Horse-shoe), Dobbin, West, Paynter, Jackpine, and Lambly (Bear) Lakes. Total acreage presently being irrigated is about 844 acres, out of a potential of approximately 1,000 acres within the district. Prior to 1964, renewals of the distribution system were being financed from the district's Renewal Reserve Fund. However, faced with immediate and costly replacement of the remaining portions of the distribution and storage works, the district applied for ARDA assistance.

The construction of a concrete intake dam and settling-pond, and screening-works, and the placing of 7,000 feet of 34-inch-diameter steel pipe-line, representing the first phase of rehabilitation of the district's works under the ARDA programme, was completed in April, 1966, ready for operation for the 1966 irrigation season.

The next phase of rehabilitation includes the replacement of the remaining portions of the distribution system and the storage-works. Office studies on this phase were carried out during the year as field data became available. It is expected that a construction programme for this work will be undertaken in the fall of 1967.

#### *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. Although the district was incorporated in 1930, it was not until 1949 that it took over the distribution system under a purchase agreement. During this interval the original entitlement of 1 acre-foot of irrigation water per acre from Vernon Creek proved insufficient for seasonal requirements. As a result, in 1931 the district

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

In 1965 the Water Rights Branch prepared a preliminary report on the rehabilitation of the distribution and storage works, which required extensive replacements. Following approval of the report, the district applied for and was granted assistance for the project under the ARDA programme with a construction period of three years.

The first phase of construction, comprising the rehabilitation of Swalwell and Crooked Lake Dams, and the construction of an access road into the latter dam, was carried out in the fall of 1966. The work consisted of raising and widening the embankments, improving the spillway and outlet channels, and extending the culverts. This work was carried out by the district, using rented equipment.

Studies are now being carried out in preparation for a final design of a new distribution system, including intake, sedimentation tank, and main supply-line. Both final design and construction supervision are being carried out by this Division.

#### FLOODING, DRAINAGE, AND EROSION PROJECTS

##### *Cowichan River Flooding and Erosion*

During 1965 a field survey of the Lower Cowichan and Koksilah River valleys was carried out to provide data for use in the design of flood- and erosion-control works for this area. A limited amount of data was also obtained at the Cowichan Lake outlet to explore the possibility of alleviating flood conditions in the lower valley by upstream storage.

These studies were continued during 1966, and a report outlining possible remedial measures, including cost estimates, is being prepared and is expected to be completed in early 1967.

##### *Kent Municipal Drainage*

In the summer of 1966, as a result of a request from The Corporation of the District of Kent for a study of drainage problems in certain areas of the municipality, the Water Investigations Branch undertook an examination of the major drainage facilities, with particular attention to the bottom-lands at Agassiz, Harrison Hot Springs, and Harrison Mills that are protected by dykes against flooding from the Fraser River and the Harrison River.

In all cases the floodgates that provide for gravity drainage through the dykes during most of the year appear large enough to remove the run-off from the 25-year design winter storms, though repair work is needed on the works at Hammersley Prairie. In the main slough areas, little improvement can be carried out except to maintain weed-free channels. However, many of the secondary channels could benefit from improved vertical alignment and, in some sections, enlarged carrying capacity. To prevent storm water from flooding the fields for long periods during the freshet season when high river-levels prevent gravity drainage through the floodgates, additional pumping capacity would be needed at all stations. At Harrison Mills the required increase in pump capacity would be economically reduced by constructing intercepting ditches at the foot of Mount Woodside to carry hillside storm run-off to the Harrison and Fraser Rivers outside the dyked low lands.

##### *Lower Fraser Valley Sea Dykes and Drainage Pumps*

In July, 1966, an inspection of the sea dykes in the Lower Mainland was carried out and estimates of the repairs and recommended improvements were pre-

pared. Design standards for the dykes were set and based on these; the costs were computed. The sea dykes were taken to be those dykes either downstream of the Fraser Street Bridge and Deas Island Tunnel or dykes within the Municipalities of Delta and Richmond fronting on tidal waters.

In August an inventory was made of the pumping-stations of the dyking and drainage districts of the Lower Fraser Valley. The study was carried out to determine the costs of any improvements, replacements, or additions to the existing drainage-works. The inspections were carried out with the co-operation and assistance of the Provincial Dyking Inspector and the Federal Water Resources Branch.

Pump and motor data were collected for each pumping plant, together with information regarding age, condition, and adequacy of pump-house structures, flood-boxes, discharges, and main drainage courses. Local representatives of municipalities and drainage districts were contacted to gain additional information.

#### *Nicola-Coldwater Rivers Flooding and Erosion*

Following a complaint from the Village of Merritt and previous complaints from riparian land-owners, an investigation of flooding and erosion in the Nicola Valley, from Nicola Lake to Spences Bridge, and along the Coldwater River through Merritt is being undertaken.

Low-level air photography of the valleys and underwater topography of the outlet of Nicola Lake were obtained in 1965, and preliminary studies were initiated.

Investigations were continued in 1966, and sufficient field information has now been obtained to complete the studies on the Coldwater River and to prepare a large-scale topographic map of the area. To allow completion of engineering studies on the Nicola River, further field information will be obtained in 1967.

#### *Nicomekl and Serpentine Basins Drainage Study*

The project area is situated in the District Municipality of Surrey and presently within the Surrey, Mud Bay, and Colebrook Dyking Districts, some 15 miles from the City of Vancouver. The low lands drained by the Nicomekl and Serpentine Rivers represent an area of some 12,000 acres. At the present time, dykes protect these lands from flooding by rivers and by the sea tides. Internal drainage is by gravity through floodgates during periods of low tide and when the flood level of the river has subsided. As heavy fall and winter storms cause flooding in certain areas, it has been suggested that improved drainage with supplementary irrigation would allow more extensive agriculture on these lands.

As an ARDA research project, field surveys consisting of river and dyke profiles and sections were carried out in the summer of 1965. Further hydraulic and hydrometric data were obtained in the winter months. A ground-water drilling programme has also been carried out and is reported under the Groundwater Division activities.

This study culminated in the report "Nicomekl-Serpentine Basins Drainage Improvements." Two methods were suggested to improve the drainage and prevent flooding from the winter storms, and one scheme was proposed to supply irrigation water to agricultural lands.

The first of the drainage and flood-protection proposals which appeared more favourable consisted of (a) bringing the existing dykes up to an improved design standard and (b) installing 21 pumping-stations to lift the flood waters from the local drainage over the dykes during a flood, when the water levels in the river channels are too high to permit drainage by gravity. The second proposal consisted of a combined dam and pumping-station on each of the rivers near their outlets, with

a dozen auxiliary pumping-stations up-river. The existing dykes were considered adequate, requiring only minor improvements. The irrigation scheme would supply water to the farms in conjunction with either of the two drainage proposals.

While estimated costs were shown, it was recommended that these costs be reviewed in the event that the irrigation-water requirements were affected by improved drainage.

#### *Okanagan Flood-control Works*

In 1963 an investigation was commenced to determine the existing condition of the Okanagan flood-control channel and structures which were constructed in 1952-58 jointly by Federal and Provincial Governments. These studies were completed in April, 1965.

Several modifications and improvements in the flood-control works were considered necessary. Extensive bank and channel-bottom protection was required to stabilize the channel at high or design maximum flows. Modification or lowering of the water-supply intake culverts was necessary in order to supply irrigation water to the lands adjacent to the river channel when water flows are below 500 cubic feet per second. Some dredging of the channel and entrance to Osoyoos Lake was also recommended. Replacing portions of the boundary fencing and gates and minor repairs to some of the vertical drop structures were also considered desirable.

As the first cost estimates were prepared in 1964, it was thought desirable to up-date the costs due to the increase in construction costs. In addition, some of the recommended improvements have already been carried out under the annual maintenance programme. It is expected that the revised costing will be completed early in 1967.

#### *Pemberton Valley Dyking District*

A request was received from the district for assistance under the ARDA programme for improvement of drainage and flood protection in Area 2, which lies between Green River and Miller Creek. Further improvements to this area would allow improved drainage and agricultural production and reclamation of farm lands, involving about 2,000 acres. Field surveys were carried out in 1965 and 1966, and a large-scale topographic map is being prepared. An engineering report with recommendations and cost estimates will be completed in early 1967.

#### *Salmon River Valley Flood Control*

Preparations are being made to carry out preliminary flood-and erosion-control and water-supply studies covering the Salmon River valley between Salmon Arm and Westwold. As there were no large-scale maps available, a mapping programme was undertaken in the summer of 1966, consisting of low-level air photography and photogrammetry control. Of the 50 miles controlled, approximately 23 miles are to be mapped at this time for the ground-water studies.

#### *Tsolum River Study*

In November, 1966, a request for a study of the feasibility of flood and erosion control and irrigation water supply was received from land-owners living along the Tsolum River north of Courtenay.

Progress to date consists of gathering hydrometric data, soils classification, and up-to-date air photography. Office computation using this data is progressing.

Briefly, the study involves some 3,000 acres of agricultural land on both banks of the river for 10 miles upstream from the river mouth at Courtenay.

## HYDROLOGY DIVISION

H. I. Hunter, Meteorologist, Chief of Division

## SNOW-COURSE NETWORK

The British Columbia snow-course network, established in 1935, continued to expand in 1966, with 17 new courses established on the Province's watersheds. This makes a total of 169 that will be in active operation in the 1967 snow-sampling season. Of this total, approximately two-thirds will be measured by personnel of co-operating agencies, with the remaining third by part-time employees of the Water Investigations Branch.

The major addition was the installation of seven high-level courses in the heavy water-producing regions of the Columbia basin, with future measurements from these courses destined for use in the operation of the Columbia River Treaty projects. These courses will be sampled by helicopter. Other additions include two on the McGregor and one on the Parsnip basins for the Peace River project; one each on the Bridge River, Stave, and Wahleach Lake watersheds; two on the Okanagan Lake watershed for an International Hydrologic Decade project; one on the Penticton Creek basin and one near Smithers. All were installed at the request of co-operating agencies for the purpose of forecasting volumetric snow-melt water supply. The only deletions were two Penticton Creek watershed snow courses which will be flooded by the reservoir of the Penticton Creek new dam.

Last winter, 20 snow courses were visited to provide snow surveyors with at-site snow-sampling instruction and, as part of the routine summer maintenance work, 29 existing courses were cleared and brushed.

At British Columbia Hydro and Power Authority's request, ground and air reconnaissances were made on Kootenay River drainage to investigate potential snow-course sites for proposed installation in the summer of 1967.

In order to evaluate the promising and newly developed pressure-pillow snow gauge for measurement of snow-water equivalent, a test site was established at the 6,300-foot level on Blackwall Mountain in Manning Park. In addition to the monthly recording pillow, a monthly recording precipitation storage gauge and hygrothermograph were also installed. The latter two instruments, together with the existing snow course, will be used to evaluate the pillow's performance.

## WATER-SUPPLY FORECASTING

Seasonal snow-melt run-off volume forecasts are made for 31 gauging-stations on 19 rivers. This is a continuing programme, with the electronic computer used to up-date and improve existing forecast procedures and, as the required basic data becomes available, develop new forecast procedures for additional watersheds. The installation of new data-processing equipment by the Department of Industrial Development, Trade, and Commerce has resulted in the revamping of programmes to suit this equipment.

During the freshet period, daily stream-flow data are received for key gauging-stations from the Water Resources Branch of the Federal Department of Energy, Mines, and Resources. Hydrographs and associated meteorological data are plotted and short-term assessment made of the expected stream-flow.

In British Columbia, snow surveys are undertaken annually near February 1st, March 1st, April 1st, May 1st, May 15th, and June 1st. They show build-up, maximum accumulation, and depletion of the Province's mountain snow. All results are funnelled by telegraph, teletype, and telephone to Victoria, where the



Instrument test site, Manning Park (elevation, 6,350 feet). Self-recording precipitation storage gauge and over-snow Skidoo.

data are assembled and quantitative forecasts of run-off prepared. As a public service, the observations and forecasts are incorporated in the publication "British Columbia Snow Bulletin" and distributed to interested people and agencies immediately following each of the above six sampling dates.

#### HYDROMETEOROLOGICAL DATA COMPILATION

The rearrangement of past data on stream stages and discharges by gauging-stations is now complete and being used by engineers to facilitate their work. As new measurements become available, the stream-flow record library is up-dated.

Under a cost-sharing agreement with the Federal Water Resources Branch, an assessment is made each year with respect to existing and proposed hydrometric stations. For the calendar year 1966, 10 all-year stations were established, 9 re-established, and 10 discontinued. Partial year or irrigation station measurements were completed on 109 streams by the Federal Water Resources Branch.

At the conclusion of each snow-sampling season, a quality check is made of snow-survey measurements, and these are incorporated with past data then processed and listed by I.B.M. equipment. Statistics derived from this data are updated annually. Preliminary snow-survey measurements were published in the 1966 snow bulletins. Early in the year, copies of the publication "A Summary of Snow Survey Measurements, 1935-65," were mailed to interested agencies and individuals.

#### HYDROLOGIC STUDY BASINS

In co-operation with the Groundwater Division, instrumentation was installed this past summer on the International Hydrologic Decade representative basin near Carrs Landing on the Okanagan Lake watershed. Dependent on the season, daily, weekly, or monthly observations of temperature, precipitation, wind, humidity, evaporation, soil moisture, ground-water, phenological, and snow-course measurements are now being collected.

Data from this 4-square-mile basin will be used to study the hydrologic cycle and to provide indices for forecasting inflow to Okanagan Lake.

#### MINOR HYDROLOGIC STUDIES

In co-operation with the Water Resources Service engineers and outside agencies, minor studies were completed relative to water-supply problems and hydrometeorological network expansion.

#### 1966 SNOW-MELT RUN-OFF

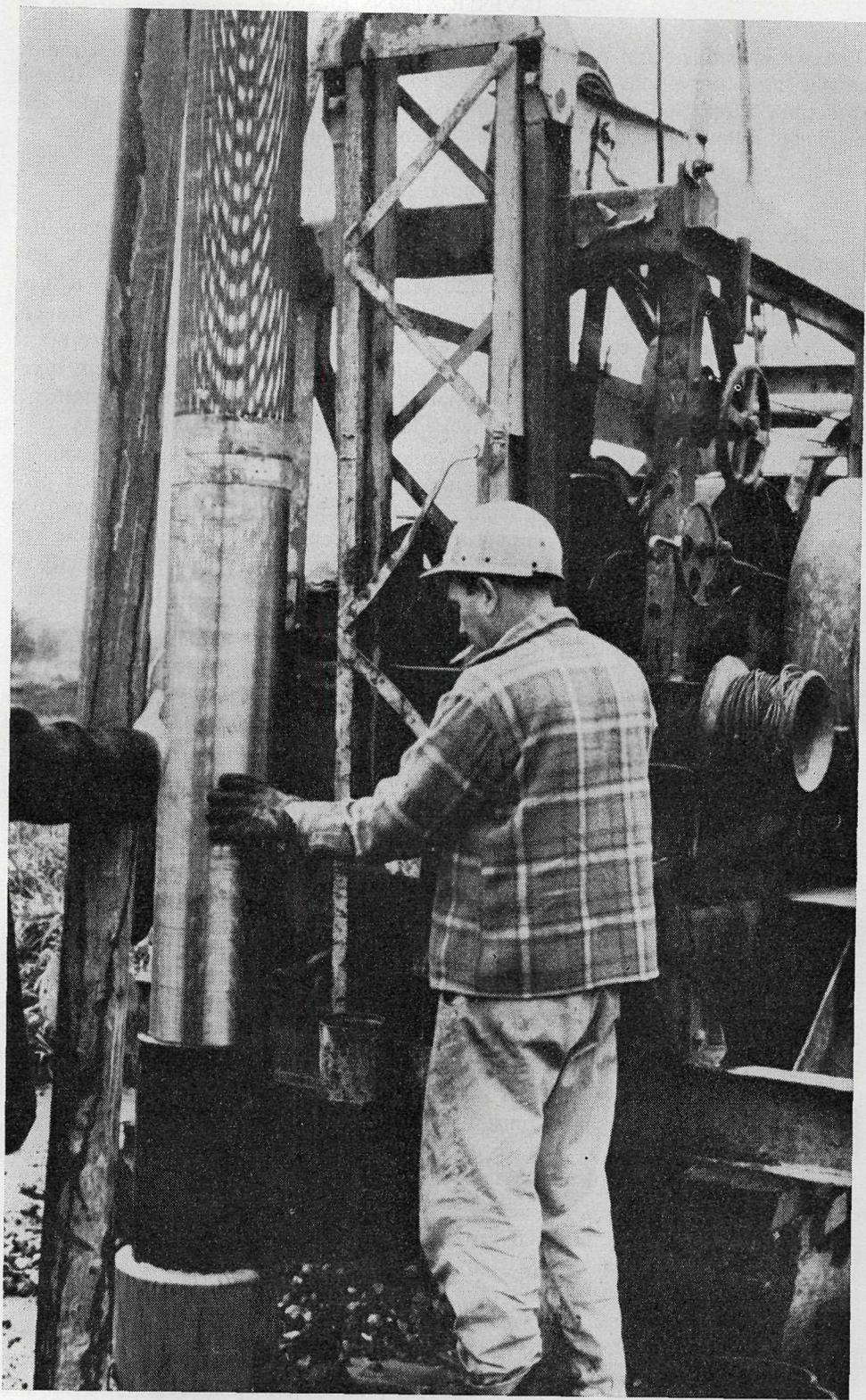
Spring and summer basin run-off was below average on the Kettle, Okanagan, and Similkameen, close to average on the Kootenay, Columbia, and Fraser, and above average on the Lower Mainland, Coast, and Vancouver Island watersheds.

#### GROUNDWATER DIVISION

E. Livingston, P.Eng., Chief of Division

#### WATER-WELL INVENTORY

The collection of data on existing water wells and ground-water use continues. Water-well maps in the Okanagan Valley were brought up to date by locating a number of wells for which records were already on hand. In addition, a water-well



Lowering 10-inch screen into a test well in Lower Fraser Valley.

inventory was carried out in the Rocky Mountain Trench from the United States Boundary to Golden. Maple Ridge and Mission Municipalities on the north side of the Fraser River were also covered by a well inventory to bring well maps of that area up to date.

#### OBSERVATION WELLS

Three observation wells equipped with screens and 6-inch casing were constructed in North Saanich near the Village of Sidney. Two of these are equipped with float-type monthly water-level recorders. The third is being measured manually but can be equipped with a recorder at a later date.

An observation well was constructed in a small aquifer across the Columbia River from Castlegar east of the Castlegar Airport. Two new observation wells were installed as part of the basin study project near Okanagan Lake, discussed below.

A number of observation wells in the Lower Fraser Valley network have been in operation for four years or more. In several cases the wells show only small fluctuations in level over a year, with manual observations taken approximately at monthly intervals. In some cases these small fluctuations do not show the yearly cycle, which is usually expected. In these cases, present plans call for installation of water-level recorders for periods of at least three months to determine the short-term pattern of the fluctuation. Float-type recorders were put on two of these wells and later removed.

Most of the observation wells have small-diameter plastic casings in which standard float-type water-level recorders cannot be used. For this type of well, a special type of recorder was purchased; it is installed on a well south of Aldergrove. Another recorder for small-diameter wells using compressed air has been designed by the staff of the Groundwater Division. It is installed on a well near Langley and is working very well, but will probably be modified in the future. Work on this project will be continued.

In addition, bubble tube equipment has also been developed for use during pumping-tests on deep wells where the usual electric measuring-lines have often been unsatisfactory.

Electrical equipment suitable for measuring temperatures of water in wells up to 800 feet deep has been obtained. The temperatures in observation wells in the Lower Fraser Valley are being measured periodically. A much simpler device using a mercury thermometer for measuring well temperatures has also been designed and built. It works fairly well but needs further modification.

The observation-well network at the year-end consisted of the following:—

Lower Fraser Valley .....	18
North Okanagan .....	19
Kelowna area .....	15
Kamloops area .....	4
Prince George area .....	3
Kootenay area .....	1
Southern Vancouver Island .....	3
	—
Total .....	63

Two wells were abandoned in the Lower Fraser Valley, and one well was abandoned in the Prince George area.

## HYDROLOGIC BASIN STUDY NEAR OKANAGAN LAKE

Work on this project continues in co-operation with the Hydrology Division. Two new observation wells were installed, for a total of five in the basin. Meteorologic and soil-moisture instrumentation was also added; this is described more completely in the report of the Hydrology Division.

## GROUND-WATER TEST DRILLING

Several test water wells and a number of rotary test-holes were drilled under contracts during the year, as indicated below.

*Lower Fraser Valley Deep Drilling*

The programme of test-hole drilling to investigate the possibility of using ground-water for irrigation in a proposed drainage and irrigation project in the Lower Fraser Valley was continued from the previous year. The serious drilling problems were overcome by changing the drilling technique. Five holes were drilled, for a total of 4,210 feet. The results generally were not very encouraging, except for a sandy aquifer between 230 and 260 feet found in the Serpentine Valley north of Cloverdale. A test-well was constructed north of Fry's Corner in this aquifer. Because of severe well-construction problems, testing of the well had not been completed at the year-end.

*North Okanagan Deep Drilling*

A programme of four deep rotary test-holes was planned in the Armstrong area. One hole was drilled to 1,220 feet about 2 miles south of Armstrong. The contract was then terminated because of difficulties in drilling, at the request of the contractor. The results were encouraging.

*Rotary Test-hole Drilling in Okanagan Valley*

Two rotary test-holes were drilled at Okanagan Falls to locate, if possible, an aquifer suitable for supplying domestic and irrigation water in that area. Both holes were terminated when they encountered very loose permeable gravels. Conditions probably are favourable for wells.

Three shallow rotary test-holes were drilled on terraces between 1,600 and 1,750 feet on the east side of Wood Lake to check the feasibility of using ground-water for winter domestic supply in that area. One deeper hole, 167 feet deep, was drilled in glacial materials at a higher elevation east of the south end of Wood Lake. The shallow holes indicate that only a limited amount of ground-water is available on the terraces. Results from the deeper hole are encouraging.

Three rotary test-holes were drilled on the bench south-east of Kelowna at about 1,700 feet. One hole was not completed because of drilling difficulties. One of the other holes was very encouraging; the third had limited success.

Five rotary test-holes were drilled for geologic and ground-water information in the Camp Lister area south of Creston. Drilling was slow because of many very hard boulders. Two of the holes discovered aquifers, probably of limited capacity.

*Village of Sointula, Malcolm Island*

A test-well was drilled at Sointula to follow up a geologic investigation which indicated the presence of an aquifer below sea-level in this area. The well was drilled 246 feet deep with a screen set from 161 to 174. It was test-pumped, indicating a capacity of about 90 imperial gallons per minute.

*Ground-water Research Project at Prince George under  
ARDA Project No. 10014*

Under supervision of the Groundwater Division, work continued on this project. A small amount of additional geologic mapping was done. At the Department of Biology and Botany, University of British Columbia, a graduate student has been studying fossil pollen and spores from samples collected on surface and in drill-holes in an effort to clear up difficult stratigraphic problems which stand in the way of understanding the geology of Tertiary and Pleistocene deposits, which are the aquifers of this area. At the year-end, four test-wells, for a total of 1,438 feet, had been drilled using cable-tool equipment. Pump tests were carried out at the year-end; results of pumping tests were being compiled. Work started on a new contract for test-wells, and one well had partially been completed by the year-end. This project should be completed by mid-year of 1967.

MISCELLANEOUS INVESTIGATIONS

In addition to the above, the following projects were also carried out:—

A brief investigation was conducted at Snowden Forest Camp, Corrections Branch of the Attorney-General's Department, in connection with a well for water supply. A well was drilled on our advice, but it was not entirely satisfactory because of well-construction problems.

Information on ground-water at the Masset Indian Reserve was furnished to the Department of Indian Affairs at its request.

Early in the year a group of residents at Rayleigh, north of Kamloops, who were interested in forming an improvement district, asked for advice in locating a well for supplying a domestic system. A well was drilled at this location by a contractor, who reported a dry hole. Under guidance from the Groundwater Division, four rotary test-holes were drilled in the area. These indicated that the original location was better than any of the others tested, so another contractor reconstructed the original test well, which then produced 60 U.S. gallons per minute during a 24-hour pump test.

At the request of the Parks Branch, Department of Recreation and Conservation, a brief investigation was carried out at the site of a proposed well at the administrative headquarters of Wells Gray Park. Advice on testing and well construction was also supplied to the Parks Branch in connection with a well to supply water for three picnic-sites on Okanagan Lake south of Summerland.

A brief investigation was carried out at the request of the Department of Public Works in connection with a problem of water supply for an existing fish hatchery in Matsqui Municipality near Abbotsford.

A well at Grandview Flats near Armstrong, which was completed in 1965 and turned over to Grandview Flats Improvement District for supplementary water supply, was test-pumped, using the improvement district's pumping equipment. The results agreed generally with results from an inadequate pump test carried out at the time of drilling.

Dam-sites on Lambly Lake were investigated briefly in connection with a proposal to raise the lake-level.

Great progress has been made in adapting the rotary drilling technique to the needs of the Groundwater Division. By use of an improved drilling fluid for shallow or deep holes, the quality of samples has been much improved and the need for drive samples has virtually been eliminated.

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

The following work has been done during the current year.

## WATER-SUPPLY STUDIES\*

*Similkameen Basin*

The results of detailed study and interpretation of all available hydrometeorological data for the 3,000 square miles of river basin were compiled in March of this year. Maps included show isohyets for mean annual precipitation and mean annual run-off for secondary watersheds. Hydrographs for all available stream-gauging stations were prepared, and estimates of the frequency of occurrence of annual flows of any possible magnitude were made.

*Nicola Basin*

A study of the hydrology of the 2,500-square-mile area around Merritt was commenced during the year, but later put into abeyance due to the shortage of staff and work of greater urgency.

*Creston Area*

Begun in response to a brief submitted by the Creston Valley Rural Development Committee, this study considered the present and future water needs of a 90-square-mile urban and agricultural area around the Town of Creston. All available information on climate, soils, and irrigation requirements was collected, analysed, and up-dated where possible. An appraisal was made of all water sources which could be of value, special note being made of the areas which could best be served by each source. The value of Duck Creek as a not yet fully exploited source is stressed.

*Miscellaneous*

As part of a study of wider scope, a preliminary investigation was made of the pattern of mixing of the Columbia and Kootenay Rivers below their point of confluence at Castlegar. A brief float study was carried out, which provided basic data necessary to the success of any detailed future work.

In February, pumping-tests were carried out to determine the capacity of the water-supply medium serving the Village of Oliver. Information on drawdown behaviour was analyzed and recommendations made for improvement of supply.

In March, a preliminary appraisal was made of the value of Bulman Creek as a site for the development of irrigation storage to serve the Glenmore Irrigation District, near Kelowna. Conclusions indicate that storage could be economically feasible and that more detailed study is justified.

## HYDRO-POWER INVESTIGATIONS

*Stikine River*

Ground-control survey and air photography of the Upper Stikine Valley above McBride River, the Lower Stikine Valley below Scud River, and the lower reaches

of the Chutine and Scud Rivers were carried out by personnel of the Surveys and Mapping Branch, Lands Service, to further extend existing large-scale mapping to cover potential dam-sites and reservoir areas. Production of the maps is proceeding.

#### *Iskut River*

Further ground-control survey of the Lower Iskut Valley was carried out by personnel of Surveys and Mapping Branch, Lands Service. Production of the maps is proceeding.

A permanent hydrometric station was installed by the Federal Water Resources Branch as close as practicable downstream of the major potential power-site, near Forrest Kerr Creek, to improve the reliability of hydrologic studies for this project.

#### *Liard River*

Using a float-equipped aircraft and a helicopter, a field inspection of possible dam-sites was made during the summer by engineers of the Service, accompanied by a geologist representing International Power and Engineering Consultants Limited. Fourteen possible dam-sites on the main stem of the Liard River had been previously selected from earlier reconnaissance reports, augmented by studies of more recent air photography and large-scale mapping. The purpose of the inspection was to select the most promising sites for the integrated hydro-electric development of the Liard River within British Columbia and to recommend future priorities in investigation.

The possible dam-sites fall generally into two groups: those located downstream from the head of the Grand Canyon on the Liard, and those located upstream from the canyon. The construction of a major dam at any of the downstream group of sites would flood out all other dam-sites in this group located farther upstream. Investigation of the downstream group was concentrated principally on the three lower sites, being Sites A, H, and I. Site A, the farthest downstream site in the group, is located some 30 miles upstream from the mouth of the Fort Nelson River, in a section where the river breaches a prominent escarpment formed of sandstone and conglomerate beds of the Fort Nelson formation. A major dam at this location would provide the maximum possible concentration of hydraulic head, combined with the greatest volume of active storage for effective regulation of the river-flow. While surface examination of this site did not reveal any feature which would render its development impracticable, it was apparent that a substantial depth of fill could be present in the river-bed and that the strength of the weaker shales underlying the site could be of major importance. These factors can only be determined by a sub-surface drilling programme. Tender forms have been issued for this work, and it is anticipated that drilling at the site is expected to commence in January, 1967.

The examination of Sites H and I did not reveal any compelling reason to prefer either site over Site A. Consequently, further investigation of these sites should not proceed until the feasibility of constructing a major dam at Site A has been ascertained.

Site G, located about 12 miles upstream from the mouth of the Kechika River, appeared to be the best of the sites examined upstream from the Grand Canyon. It would seem suitable for a structure of about 400 feet in height, provided that a possible seepage path along the Leguil Creek valley does not prove to be a major problem. A dam at this location would appear likely to form a part of any integrated hydro-electric development and would eliminate all other possible dam-sites farther upstream in British Columbia. Initial exploration at this site would be

concentrated on ascertaining the depth of unconsolidated material in the river channel and the elevation of bedrock in the Leguil Creek valley.

On the return flight from the Liard River to Fort Nelson, an aerial reconnaissance of the Kechika and Gataga River valleys was made to obtain a preliminary assessment of potential storage possibilities.

Ground-control survey and air photography of the lower Liard River valley, the Fort Nelson River valley, and the upper Kechika River valley were carried out by personnel of the Surveys and Mapping Branch, Lands Service, to extend the existing large-scale mapping to cover potential dam-sites and reservoir areas.

Office studies of Liard River basin hydrology and power potential are continuing.

#### *Cottonwood River near Cassiar*

Subsequent evaluation of the hydro-power potential of the Cottonwood River near Cassiar, in the light of three years of record, substantiates the tentative estimate of last year.

About two-thirds of this potential exists at Dam-site 1, having a firm power of 3,200 to 3,600 kilowatts, on the Cottonwood River, some 18 miles south-west of Cassiar, where a 300- to 310-foot head could be developed. The remaining one-third would be through regulation at Site 3 or 3A, some 8 miles downstream from Site 1, where there is the potential for 150-foot head with a firm power of 1,800 to 2,000 kilowatts.

#### ARDA DIVISION

W. K. A. Dobson, P.Eng., Chief of Division

J. D. C. Fuller, P.Eng., Construction Engineer

This Division was formed in 1963 for the purpose of investigating and preparing water-project submissions under the Federal-Provincial *Agricultural and Rural Development Act* (ARDA) assistance programme, and for the supervision of the construction of certain approved water projects. The over-all administration of the ARDA programme is under the jurisdiction of the British Columbia Department of Agriculture. An interdepartmental co-operative arrangement has charged the British Columbia Water Resources Service with responsibility for ARDA water-projects implementation.

Under the ARDA assistance programme, the Federal Government and the Provincial Government finance two-thirds of the approved or actual cost of water projects, whichever is less.

The number of requests for assistance under the ARDA programme has increased steadily since the programme was initiated, and many of these projects have been approved both Federally and Provincially, and many of these approved projects have been successfully completed and others are under various stages of construction. Because of unforeseen rises in construction costs, particularly where done by contract, it has been necessary to request supplementary assistance to complete some of these projects.

Since the start of the ARDA programme in British Columbia in 1963, about \$3,600,000 in round figures has been expended on the various projects and a total of over \$20,000,000 has been authorized for expenditure to date. In 1963 no requests for reimbursement were received; in 1964 the total expenditures on ARDA projects was \$260,000; in 1965 this rose to \$1,000,000; and in 1966 will be over \$2,000,000. This final figure is approaching the maximum figure set by the Federal-Provincial ARDA agreement for soil- and water-conservation projects of \$2,595,168 in any one year.

Of the 62 water projects which are considered as actual or potential projects under the ARDA programme, 49 have requested assistance. Of those which have not submitted a request, seven are at present under study in order to arrive at a proposal for submission. Six are in abeyance for various reasons.

Of the 49 requests for assistance, 37 have been approved by the Provincial and Federal ARDA authorities. The 12 which have not been approved are either under study as to feasibility or to arrive at a preliminary cost that can be used as a basis for a submission to ARDA authorities.

Of the 37 projects which have received Provincial and Federal approval, 31 are either under construction or are completed. The other six are under final design studies prior to construction.

Of the 31 projects under construction, 18 are completed as far as construction is concerned. The 13 incompleting projects are multi-year projects which may not be completed until 1970.

Of the 18 completed projects, some have not yet submitted their final claims for reimbursement as they have such items as contractors' holdbacks or surveying still to be completed.

To outline each of these 62 projects even in the broadest terms would be a very voluminous undertaking. Six of these projects were outlined in the 1964 Annual Report and 24 were outlined in the 1965 Annual Report of the British Columbia Water Resources Service. Only those which have had significant changes will be referred to again this year. Engineering services for these projects have been provided by the Water Investigations Branch and also by the Water Rights Branch and the consulting engineers.

- (1) *Keremeos Irrigation District Rehabilitation*.—It is proposed to replace the present open gravity system drawing from the Ashnola River and Keremeos Creek by pumping from a series of wells into an enclosed system providing irrigation and farm domestic water supply.
- (2) *Black Mountain Irrigation District Rehabilitation—ARDA Project No. 29018*.—This project will replace the present open gravity system by an enclosed one that will provide sprinkler pressure to the lands which it serves and also rural domestic water supply.
- (3) *Winfield and Okanagan Centre Irrigation District Rehabilitation—ARDA Project No. 29017*.—This project will replace the present expended enclosed system with a new system designed for modern sprinkler irrigation methods and for farm domestic supply and will also include repairs to the district's main storage dams.
- (4) *Glenmore Irrigation District Rehabilitation—ARDA Project No. 29020*.—This project will replace the present open gravity system by an enclosed system which will take advantage of available head, augmented by pumps, to supply the district with adequate pressure for modern sprinkler methods.
- (5) *B.C. Fruitlands Irrigation District Rehabilitation*.—This project, with an estimated cost of \$216,000, will provide a portion of the district's irrigated lands with water under pressure suitable for sprinkler irrigation.
- (6) *Raspberry Irrigation District Rehabilitation—ARDA Project No. 29021*.—This project will supply the district with a rural domestic supply and irrigation to the district's farm lands.
- (7) *South-east Kelowna Irrigation District, Project No. 2—ARDA Project No. 29003*.—This project involves the rehabilitation of part of the distribution-works of the district, replacing expended works with more permanent materials suitable for pressure irrigation.

- (8) *Surrey Drainage Project at Halls Prairie Road—ARDA Project No. 29019.*—This project will provide drainage and flood protection to some 500 acres in the Surrey Dyking District, within the District Municipality of Surrey.

Below is included some detail on ARDA water projects that were either completed during the current year or are continuing projects:—

- (9) *Canyon Waterworks District Rehabilitation—ARDA Projects Nos. 10022 and 29014.*—This project was completed during the year and has proved very satisfactory to the farmers who formerly were very restricted in their water supply each year. Unforeseen rock excavation caused this project to exceed its estimated cost by about \$1,200.
- (10) *Vernon Irrigation District Research Study—ARDA Project No. 10015.*—This study was completed early in the year.
- (11) *Boundary Line Irrigation District Rehabilitation—ARDA Projects Nos. 10035 and 29024.*—The original project to supply irrigation water was started and completed during the year. The work was done by the district's own forces and completed within the estimated cost. This district's request for rural domestic water to be included in its system has been approved.
- (12) *South-east Kelowna Irrigation District, Project No. 1—ARDA Project No. 10021.*—This project, started in 1965, was completed in 1966 by the district, using its own forces, and was completed within the estimated cost. This is part of the district's over-all plan of pressurizing its system.
- (13) *Meadow Valley Irrigation District Storage Rehabilitation—ARDA Projects Nos. 10025 and 29023.*—This project, involving a dam reconstruction and diversion-works, was completed too late to be used this year. It exceeded its estimated cost by about \$5,220, which has been subsequently approved.
- (14) *Kaleden Irrigation District Rehabilitation—ARDA Projects Nos. 10013 and 29015.*—This project was completed in time for the 1966 water season, but exceeded its original estimated cost by some \$30,000 owing to increased contract prices.
- (15) *Nicomekl-Serpentine Rivers Research Project—ARDA Project No. 10032.*—This research project was completed in 1966.
- (16) *Westbank Irrigation District, Project No. 1—ARDA Project No. 10033.*—This project, involving the construction of a concrete diversion weir and the laying of some 7,000 feet of main steel pipe, was carried out by the district, using its own men, and was completed within the estimated cost.
- (17) *Oyama Irrigation District Rehabilitation—ARDA Projects Nos. 10028 and 29001.*—This project was completed during the year and supplies rural domestic as well as irrigation water. It was amended to include an extended area and thus required an additional amount of money to complete. The final cost of this system exceeded the amended amount by about \$6,500.
- (18) *Okanagan-Shuswap Canal Research Project—ARDA Project No. 10031.* This study was completed in 1966.
- (19) *Grandview Waterworks District Rehabilitation—ARDA Projects Nos. 29013 and 29013s.*—This project was carried out in 1966 and, to paraphrase the words of the district's secretary, "the improvement in their water supply is far beyond anything that they had expected." This project was also amended to include additional farm dwellings.

- (20) *Naramata Irrigation District Partial Rehabilitation—ARDA Projects Nos. 10034 and 29016.*—Under this project the final portion of the district's distribution-works has been renewed, and studies are being carried out on the renewal of its Naramata Lake Dam.
- (21) *Prince George Ground-water Research Programme—ARDA Project No. 10014.*—Studies on this programme were continued during the year.
- (22) *Southern Okanagan Lands Irrigation District—ARDA Project No. 10010.*—This was the first of the multiple-year projects to get under way. The first stage, Pumping System No. 5, was completed in time for the 1965 irrigation season and has proved most satisfactory.

The second stage, Pumping System No. 9, got away to a belated start for the 1966 water season due to unexpected factors, such as poor pump-house foundation conditions necessitating major last-minute changes, and then a broken motor shaft on the 200-horsepower pump that delayed full delivery. This unit is still requiring final adjustments.

The third stage, Pumping Systems Nos. 7 and 8 and farm domestic supply to Areas 8 and 9, is well on its way to completion.
- (23) *Summerland Municipal Irrigation Rehabilitation—ARDA Project No. 10029.*—This is a continuing programme which has already replaced three storage dams and several miles of distribution-works. It is being carried out by municipal forces.
- (24) *Penticton City Irrigation Rehabilitation—ARDA Project No. 10024.*—This continuing programme has renewed two distribution systems and the Ellis Creek intake and is continuing work on the Penticton Creek storage, intake, and diversion tunnel. This project has been done entirely under contract and has greatly exceeded the estimated costs. Engineering services have been provided by the Prairie Farm Rehabilitation Administration, Canada Department of Agriculture.
- (25) *Delta Municipality Drainage Project—ARDA Project No. 29002.*—This project is being carried out by municipal forces as the contract bids were considered to be too high. The project is about 50 per cent complete.
- (26) *Winfield and Okanagan Centre Irrigation District Rehabilitation—ARDA Project No. 29017.*—This project got off to a late start in 1966 but managed to get the major part of the work on its storage dams completed before winter conditions arrived.
- (27) *Black Sage Irrigation District Rehabilitation—ARDA Projects Nos. 29009 and 29009s.*—The distribution system of this district was replaced prior to the 1966 irrigation season by the district's own forces. The pumps and pump-house still remain to be completed.
- (28) *Scotty Creek Irrigation District Rehabilitation—ARDA Project No. 29011.*—This district, using its own forces, completed the renewal of its distribution system prior to the 1966 irrigation season and has still to complete work on its intake structure.
- (29) *Naramata Irrigation District Storage-dams Rehabilitation—ARDA Project No. 29022.*—This project was an emergency job, and the initial part, the renewal of the outlet structure on Big Meadow Dam, has been completed. The repairs to Elinor Dam are still to be completed. This work was carried out by the district's personnel.
- (30) *Vernon Irrigation District System Rehabilitation—ARDA Project No. 29004.*—This is the largest ARDA project being carried out in British Columbia. The district has commenced its reconstruction programme by

renewing the distribution-works, which will be supplied from Goose Lake; about 75 per cent of this work is completed. Work is also being carried out on the reconstruction of Goose Lake Dam and the new outlet-works from this lake.

- (31) *Osoyoos Irrigation District Rehabilitation—ARDA Project No. 29012.*—This project has suffered some delay as it was decided to combine the Osoyoos and East Osoyoos Districts into one system. Work is nearly completed on the distribution system, and preparations for the pump-house have been carried out; the pump-house contract has been awarded.

### PROJECTS DIVISION

B. E. Marr, P.Eng., Project Engineer

The Projects Division has as its main function the investigation, preparation, and review of reports for submission under the *Canada-British Columbia Joint Development Act* and the *Canada Water Conservation Assistance Act*, and arranging for the construction of approved projects. These refer to water-development and water-damage-prevention projects of a major character.

In addition, design and construction supervision of other minor water-damage-prevention projects has been carried out.

#### NORTH AND WEST VANCOUVER FLOOD-CONTROL PROJECT

The first agreement involving British Columbia under the *Canada Water Conservation Assistance Act* was made on February 1, 1966, and provides for the construction of channel improvements on streams in North and West Vancouver for flood- and erosion-control purposes. The total cost of the works is estimated at \$2,301,480, with costs up to this amount being shared by Canada (37½ per cent), the Province of British Columbia (37½ per cent), and the local authorities (25 per cent). The Province entered into an agreement on March 2, 1966, with the Greater Vancouver Sewerage and Drainage District, agent for the District of West Vancouver and The Corporation of the District of North Vancouver, to carry out the projects.

During 1966 two construction contracts were let:—

- (1) Capilano River bank protection, involving the construction of some 1,547 feet of protective work on the east bank of the Capilano River, including the raising of the existing bank and the placing of approximately 16,000 tons of stone riprap, at a contract price of \$126,680. This work, completed in October, 1966, provides flood protection to developments in the area and increased utilization of land.
- (2) Mosquito Creek improvements involve construction of a reinforced-concrete box culvert, an earth dam and debris basin, and a reinforced-concrete outlet structure to contain Mosquito Creek and prevent serious flooding and erosion along both banks of the creek over a length of some 2,650 feet. The contract price is \$469,000, and the work is scheduled for completion in 1966.

Provision has been made in the agreements for the control of a further four creeks on the North Shore, but as yet no final plans have been submitted for approval.

#### HASTINGS CREEK FLOOD-CONTROL PROJECT

An agreement under the *Canada Water Conservation Assistance Act* providing for the construction of tributary diversion on Hastings Creek in North Vancouver was entered into in late 1966. The estimated cost of this project is \$600,000.

## ALBERNI FLOOD-CONTROL PROJECT

The final design of the Alberni flood-control project under the Canada *Water Conservation Assistance Act* is now in hand. The project involves the raising of some 7,000 feet of River Road and the rechannelization and dyking of Kitsuksis Creek to prevent the frequent flooding in the western section of Alberni City.

Final drawings and cost estimates are being prepared on behalf of the Water Resources Service by the Department of Highways and should be ready by the end of the year.

## LOWER SQUAMISH VALLEY FLOOD- AND EROSION-CONTROL PROJECT

A report prepared by the Water Investigations Branch was forwarded to the Federal Government early in 1965, followed by a formal submission in late 1965 for a flood- and erosion-control project in the Lower Squamish Valley under the Canada *Water Conservation Assistance Act*. The cost of the project was estimated at \$2,000,000.

During 1966 further field work was carried out and a number of meetings held with Federal Government and local authority representatives. In October a joint committee of Federal and Provincial engineers was formed to study the various aspects of this project.

## OTHER PROJECTS UNDER THE CANADA WATER CONSERVATION ASSISTANCE ACT

During 1966 a number of inquiries and preliminary submissions were made under the Act. Of particular mention in this connection is the Coquitlam River, which has been the subject of a report by the Branch in the past and regarding which further discussion took place with local government officials during the year.

## MINOR PROJECTS

1. *Quesnel River*.—At the request of the Town of Quesnel, a study of river-bank erosion along the Quesnel River within the municipality was undertaken early in the year. A minimum project involving the placing of rock riprap along some 1,000 feet of river bank was accepted by the town, to be carried out during the current financial year, the cost, estimated at \$25,000, to be shared by the Province (75 per cent) and the local authority (25 per cent).

2. *Granby River*.—The Provincial-local landowner cost-sharing scheme initiated in 1965 for the Granby River to assist in combating land erosion was continued in 1966 with the construction of approximately 1,000 feet of dykes.

3. *Similkameen River Improvements*.—A number of requests for assistance in combating river-bank erosion along the Similkameen River were investigated, and in one case assistance was given.

4. *Nechako River*.—Complaints of land erosion by the Nechako River at Vanderhoof were investigated, but the undeveloped nature of the flood-plain land did not warrant remedial action.

*Lower Fraser Valley*

Technical assistance was given to the Federal-Provincial committee in the preparation of a report entitled "An Assessment of Dyke Reconstruction, Drainage Improvements and River Bank Stabilization in the Lower Fraser Valley."

It was estimated that expenditures in the order of \$33,000,000 would be required to give a satisfactory level of flood control in the Lower Mainland and to provide for main drainage and pumping necessary to allow development and utiliza-

tion of the protected land. The scheme encompasses not only the Fraser River dyking system and sea dykes, but also tributary projects on the Coquitlam and Vedder Rivers and the Nicomekl-Serpentine Basin drainage improvements.

#### *Studies for Department of Highways*

1. *Bella Coola Area*.—The highway between Bella Coola and Hagensborg is threatened by flooding and erosion from the Bella Coola River and from side streams joining the Bella Coola on the south bank. This problem was investigated in the company of Department of Highways officials, and the brief report prepared as a result included a number of suggestions to alleviate the problem.

2. *Vancouver Island*.—Peak discharge figures were established for a number of streams on Vancouver Island at the request of the Department of Highways. In arriving at these figures, a regional flood study covering the east and central watersheds of the Island was used. Essentially, a regional flood study relates the mean annual floods in a homogeneous area to basin characteristics, in this case drainage area, annual run-off, and lake area. The mean annual flood is converted to floods of lesser frequency by means of a regional frequency curve established from an analysis of flood data for the region.

3. *Trans-Canada Highway, Kamloops East (Valleyview)*.—A proposal to encroach on the South Thompson River to accommodate the relocation of the Canadian Pacific Railway line, necessary to provide a four-lane highway, was reviewed for the Department of Highways.

#### *Stellako River*

In connection with an investigation by the British Columbia Research Council into the effects of log-driving on the Stellako River, several field trips were made to the area to observe and collect data on the hydraulic aspects of the operation, particularly as they pertain to changes in the river regime.

#### *Winnipeg Flooding*

In April of 1966 a field trip was made to Winnipeg to observe the flood-fighting plan during the emergency situation existing at that time, with the Red River rising to flood stage. Contact was established through the Manitoba Emergency Measures Organization and an opportunity afforded to discuss the many aspects of the problems arising from a major flood with the various organizations and officials involved.

### RECORDS COMPILATION AND REPORTS SECTION

#### A. Z. Stencel

The principal functions performed by this Section during the past year included the assembly of engineering reports, operation of the Reports Library, collection and compilation of technical and cost records, and general office duties for the Branch.

The year 1966 saw over 70 new engineering reports assembled and registered in the Reports Library, bringing the total of available reports to almost 1,400. The Reports Library serves as an extension to the Water Resources Service filing system. A number of reports retained in the library have not been prepared for publication.

The increase in the number of reports received and registered during 10-year periods is illustrated in the following table:—

Period (Years)	Number of Reports Available	Percentage of Total Available
1915-24	175	12.8
1925-34	40	2.9
1935-44	37	2.7
1945-54	114	8.3
1955-64	855	62.2
1965-66	153	11.1
Totals	1,374	100.0

In addition to the new reports, 260 reproductions of older reports have been prepared and distributed during the year, also requests for almost 100 copies of various other publications filled.

Of the total of 1,374 reports in the library, 819 reports have been prepared by Water Resources Service staff. The following table shows the number of such reports and the general fields which they cover:—

*Technical Reports in Library Prepared by Water Resources Service Staff as of December 31, 1966*

Period (Years)	Water Power	Water Supply	Floods, Drainage, Dyking	Ground-water	Hydrology	Miscellaneous	Total
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	108	51	5	12	20	201
1966	---	16	5	---	1	2	24
Totals	232	322	145	19	34	67	819

### DRAUGHTING OFFICE

B. Varcoe, Chief Draughtsman

As in 1965, draughting for the Water Investigations Branch was carried out by a total of 11 draughtsmen, although personnel have changed. One new man was taken on strength and one man left during the year. The work continued to be carried on in the Main Draughting Office, with the ARDA Draughting Section working separately in another room. While separated physically, there was good co-operation between offices, and work from all divisions was carried on in either office as required.

During the year, work was done on 54 projects. These may be broken down into 39 water-investigations projects and 16 construction projects. The investigations projects may be further broken down into 16 projects completed, 10 incomplete, 9 technical, of which no finished drawings were made, and 2 routine and continuing projects for the Hydrology Division. Ninety-four drawings were made for the completed projects, and many drawings, some complete, some incomplete, have been made for the incomplete projects.

The construction projects, of which 14 were done in the ARDA Section, required 213 sheets and 75 working drawings. The largest of these projects were the

Vernon Irrigation District rehabilitation and the Southern Okanagan Lands Irrigation District, who which 57 and 43 drawings respectively were produced.

This past year, more than in previous years, technical knowledge has been used by the draughtsmen in many of the projects on which work was done. In the ARDA Section, it was estimated that approximately 20 per cent of the time was used in design work. In the main office, nine exclusively technical projects were worked on and at least on 11 other projects some technical calculations were required.

WATER RESOURCES BOARD  
POLLUTION CONTROL BOARD

1. The Pollution Control Board shall have the honor of presenting to the Board of Water Resources the following report on the activities of the Board during the year 1967.

2. The Board has held its regular meetings on a monthly basis and has held special meetings as needed. The Board has held a total of 12 regular meetings and 3 special meetings during the year.

3. The Board has received and reviewed 100 applications for permits to discharge pollutants into the waters of the State. The Board has approved 60 of these applications and has denied 40.

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## WATER RESOURCES SERVICE

### POLLUTION CONTROL BOARD

The Pollution Control Board, which deals with matters pertaining to water pollution, was initially formed in 1956 and placed, at that time, under the administration of the Minister of Municipal Affairs. Technical assistance to conduct the Board's business was provided by the Department of Health through the staff of the Division of Public Health Engineering. The functions of the Pollution Control Board were transferred on April 1, 1965, to the Water Resources Service, where administration of the Board is carried on under the Minister of Lands, Forests, and Water Resources, with the Deputy Minister of Water Resources acting as Chairman of the Board.

The functions of the Pollution Control Board are to deal with all matters as prescribed by the Act, technical and lay, pertaining to the discharge of domestic or industrial wastes into any of the water resources of the Province, in areas designated by Order in Council as coming under the Board's jurisdiction. The powers and duties of the Board, carried out under the Executive Engineer, are:—

- (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.
- (g) To appoint technical committees.

To carry into effect the intent of the *Pollution Control Act*, the Board issues permits to applicants who comply with the regulations and who satisfy the Board that the wastes to be discharged will not be detrimental to health, sanitation, or the public interest.

## POLLUTION CONTROL BOARD

C. J. KEENAN, P.ENG., EXECUTIVE ENGINEER

Since placing the Pollution Control Board under the chairmanship of the Deputy Minister of Water Resources and transferring the administration of the operative functions of the Board from the Health Branch to the Water Resources Service in 1965, the Water Resources Service has been able in 1966 to establish a nucleus for a Pollution Control Branch. Under the Executive Engineer there are now established eight positions, four of them engineering posts, the remainder comprising technician, draughting, and stenographic positions. To meet the increasing demands for service, present personnel were moved to new accommodation, where office space will permit staff expansion in the foreseeable future.

The Pollution Control Branch is primarily preoccupied with performing the administrative functions associated with investigating and processing applications for permits. The facts, general, administrative, and technological, of each investigation are laid before the Board when it meets each month to adjudicate on the applications made. The Board may grant, may amend and grant, or may refuse to grant a permit. Applicants must satisfy the Board that the wastes to be discharged will not be detrimental to health, sanitation, or the public interest. Any objections to the issuance of a permit are investigated and, in some cases, public hearings are held before a final decision is taken on the application. During 1966, 39 applications were made, with 27 permits being granted. The remaining 12 applications were either rejected as not being in the public interest and likely to cause some pollution or are being held in abeyance awaiting resolution of extenuating circumstances.

During 1966 the Health Branch, in accordance with the *Pollution Control Act*, continued to provide the Pollution Control Branch with assistance through the use of the public health inspectors, who were responsible for carrying out many routine field inspections and for the taking of samples for both chemical and bacteriological analysis. All samples taken for pollution-control purposes are analysed in the Public Health Laboratories by Health Branch staff.

From the Board's formation in 1956 until 1961, the extent of its jurisdiction was the Lower Fraser Valley downstream from Hope, including all of the Greater Vancouver and Boundary Bay areas. In 1961 the territorial area under the authority of the Board was extended to include all of the Columbia River drainage basin which lies within the Province of British Columbia. Again, effective January 1, 1963, the jurisdiction of the Board as authorized by Order in Council was enlarged to include the entire Fraser River basin and most of the populated area of the east coast of Vancouver Island. On June 20, 1966, the area comprising Strathcona Park on Vancouver Island was placed under the area of jurisdiction of the *Pollution Control Act*.

Strathcona Park was placed under the jurisdiction of the Board to ensure that a close surveillance would be maintained on the mining operations in the vicinity of Buttle Lake. The permit issued for the mining operation calls for a high-quality effluent and rigorous maintenance. A comprehensive continuous sampling programme has been prepared to ensure compliance. With the continued favourable economic conditions in the Province, it is expected that the current high demand for permits to discharge wastes will be maintained. During 1966 many applications of a highly complex nature were processed. These included two new kraft pulp-mills at Prince George, the existing pulp-mill at Powell River, and the widely publicized new mining operation in Strathcona Park.

The major achievement in 1966 was establishment of effluent standards for new kraft pulp-mills to be located on inland fresh waters. The setting of standards required careful investigation of existing national and international practices and present-day technological knowledge pertaining to waste treatment of pulp-mill effluents. The setting of standards called for close collaboration with the Federal Department of Fisheries and the International Salmon Commission, as well as with various Provincial Government agencies. As a result of investigations carried out, the Board has been able to establish permissible levels for suspended solids, total solids, biochemical oxygen demand, dissolved oxygen, mercaptans, sulphides, chlorine, temperature, and colour, as well as numerous other parameters to ensure that the water resources of the Province are preserved for the beneficial use of all. In conjunction with the standards laid down, each new pulp-mill under the Board's jurisdiction is required to undertake an approved reliable monitoring programme under the surveillance of the Pollution Control Branch engineers. The results of each monitoring programme are plotted to evaluate on a continuous basis the effectiveness of the waste-treatment facilities. Each permit carries many special conditions prohibiting practices likely to affect water quality. The standards set are amongst the highest requirements to be found anywhere and have been instrumental to date in prohibiting the location of two pulp-mills on secondary rivers in the Province where adequate treatment could not be provided to meet the prescribed conditions. This early recognition of the need to set effluent standards speaks well for the future preservation of the water resources of the Province.

**OFFICE  
OF THE INSPECTOR OF  
DYKES**

OFFICE  
OF THE INSPECTOR OF  
DYES

**OFFICE OF THE INSPECTOR OF DYKES**

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

**ADMINISTRATION**

The Inspector of Dykes has responsibilities with respect to all dykes in British Columbia. Under the provision of the *Dykes Maintenance Act*, he exercises some authority over various municipalities and dyking districts to ensure that the dykes within their jurisdiction are maintained adequately.

Over 200,000 acres of land in British Columbia are protected by dykes. Within the Lower Fraser Valley, there are at present 35 separately dyked areas; the Kootenay Valley contains four such areas; and there is one near Pemberton in the valley of the Lillooet River.

Ten of the Fraser Valley districts have in years past had their powers of local self-government withdrawn and the areas placed under the direct administration of the Office of the Inspector of Dykes. In these 10 districts, the Inspector holds all of the powers previously vested in the Commissioners or the Trustees, including the establishment of the tax rates and the collection of the levies required to provide funds for the operation of the districts. Proposals are being considered whereby the municipalities would assume the administration of the dyked areas within their municipal boundaries, or alternatively the protected area would be returned to a local self-governing administration having no connection with any municipality.

**OPERATION**

Weather in 1966 was near normal throughout the Province and no major flood threat developed in any area. The spring run-off from the Fraser River basin and from other drainage areas was orderly and of below average proportions.

Annual maintenance of dykes, pumps, waterways, and other drainage structures was carried out by all districts. In addition, two relatively short sections of dyking in the Municipality of Kent, one being part of the Harrison Mills dyke and the other in the vicinity of Hamersley pump, were improved and strengthened. This work was carried out as part of the over-all reconstruction of the municipality's dyking system under a joint proposal whereby the Government of Canada and the Province of British Columbia will participate financially with the local authority toward the cost of reconstruction of all dykes in the Lower Fraser Valley. Also under this same proposal, the Village of Harrison Hot Springs commenced an improvement programme for the Harrison Lake dyke.

River-bank protection work was completed by some 15 districts where erosion of the banks constituted a threat to the dykes. The total expenditure on this work by these 15 dyked areas was approximately \$250,000. By arrangement, the Federal and Provincial Governments each contribute 37½ per cent of the cost of the work, leaving 25 per cent to be financed by the local districts.

OFFICE OF THE DIRECTOR OF THE BUREAU OF THE CENSUS

W. J. MANNING, Director

ADMINISTRATIVE

The Bureau of the Census is pleased to announce that it has received from the Department of the Interior, Bureau of Land Management, a grant for the purpose of conducting a study of the land use patterns in the State of California. The study is being conducted in cooperation with the State Department of Conservation and the State Department of Public Works.

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SOUTHERN OKANAGAN  
LANDS PROJECT

THE THREE OKANAGAN  
FAMILY PROJECT

## SOUTHERN OKANAGAN LANDS PROJECT

L. A. PINSKE, PROJECT SUPERVISOR

### ADMINISTRATION

The Southern Okanagan Lands Project, comprising some 15,500 acres, occupies most of the southern portion of the Okanagan Valley to the International Boundary. The project, with its extensive irrigation system, was constructed under the *Soldiers' Land Act*, and land has been sold largely by public sale since the mid-1920's both for farming and for orchard development. Small areas remain unalienated, and these are being disposed of, largely by public sale, as the demand arises. In 1965 approximately 67 acres were sold in 11 parcels, of which eight were suitable for agriculture and the remainder were town-sized lots within or near the Village of Oliver. Plans were initiated for the disposal of yet more of the unsubdivided areas since public interest continues in the possibilities of the area for grape production.

The project and its irrigation system have been administered by the Province since its inception. The irrigation-works will be transferred to local administration under the *Water Act* as soon as the system has been rehabilitated. Replacement of much of the old gravity system is being carried out with financial assistance from the Federal and Provincial Governments, with funds being made available through the *Agricultural and Rural Development Act*.

### OPERATION

Irrigation service commenced when water was turned into the main canal at the headworks on the Okanagan River on April 12th and continued through to September 20th, except for a brief period between September 15th and 17th when the system was closed down to remove algæ and other aquatic growth.

General repairs and regular maintenance were carried out over the system, including timber replacement on flumes, stave replacement in the small siphon, and lining of the main siphon with creosoted plywood.

Three flumes at the southern extremity of the system were removed. They are no longer required because that area will now be served by the newly installed pressure system which draws water from Osoyoos Lake.

Under the rehabilitation scheme, Pump System No. 9, serving the area from the Richter Pass Highway south to the International Boundary, was completed, and construction commenced on Pump Systems Nos. 8 and 7, which will serve the area from the Richter Pass Highway north to the head of Osoyoos Lake and thence north to Testalinden Creek respectively.

Under Order in Council, the Osoyoos and Black Sage Irrigation Districts were provided with ditch-riding services, for which charges were made at the usual rate.

#### *Annual Revenue*

Irrigation collections .....	\$79,979.00
Land sales .....	47,445.00
Sundries (topsoil, gravel, sand, maps, payments from irrigation districts) .....	59,339.00
	<hr/>
Total .....	\$186,763.00

## FOR THE WEEK ENDING

APRIL 10, 1937

### ADMINISTRATIVE

The following information is being furnished to you for your information. It is the policy of the Association to keep you advised of the latest news in the medical profession. The information is being furnished to you for your information and is not intended to be used in any way other than for your personal use. The information is being furnished to you for your information and is not intended to be used in any way other than for your personal use. The information is being furnished to you for your information and is not intended to be used in any way other than for your personal use.

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PERSONNEL OFFICE  
and  
ACCOUNTING DIVISION

PERSONNEL OFFICE

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## PERSONNEL OFFICE

J. H. PALMER, PERSONNEL OFFICER

The permanent establishment of the Department was increased by 22 positions this year. Two of these were to provide official positions for the Executive Engineer, Pollution Control Board and his secretary, who were temporarily covering off other vacancies in the establishment. One new position of Draughtsman 2 on the staff of the Board was filled, but two other positions of Technician and one as Engineer 4 for this Board remain vacant at the time of writing. The remaining 16 positions were all for the Water Investigations Branch. These included eight engineers, five technicians, and three draughtsmen. It has been possible to fill only two of this group to date.

The table below summarizes personnel activities for 1966 and the three previous years. It will be seen that the Department experienced the same turnover as in 1965, but that this volume was three times what it had been in 1963 and 1964. Comparable figures for earlier years are as follows:—

	1966	1965	1964	1963
Recruitments for continuous staff .....	24	22	18	16
Reclassifications.....	18	20	16	9
Promotions.....	10	4	7	11
Internal transfers.....	4	2	3	16
Transfers to other departments.....	4	5	3	2
Terminations for continuous staff.....	17	17	5	6
Retirements.....	3	3	1	---
Short-term casual appointments and terminations <sup>1</sup> .....	25	25	18	23
Transfers from other departments.....	6	6	---	---
Extensions of service granted.....	4	1	1	---

<sup>1</sup> Excluding Southern Okanagan Lands Project casualls.

While the current economic boom hampered recruitment, particularly of engineers and technicians, the Department was fortunate in obtaining the services of seven engineers, three of whom came from the United Kingdom following advertising there and throughout Canada. Two other engineers were engaged to report early in 1967. This particular competition alone required this office to write over 100 letters for its completion.

Principal promotions during the year included the following in the Water Investigations Branch: Mr. J. D. Watts was promoted to Engineer 5 as Chief, Basin Planning and Power Division; Mr. D. J. Pennington was promoted to Engineer 5 as Chief, ARDA Division; and Mr. B. E. Marr to Engineer 5, Projects Division. In the Water Rights Branch, Mr. H. M. Hunt, a former employee of the Fraser River Board, returned to the Department as Engineer 6 in charge of the Power and Major Licences Division; Mr. D. E. Smuin was promoted to Engineer 4 as District Engineer, Kamloops; and Mr. W. R. Tuthill was promoted Administrative Officer 2 as Chief, Water Licensing Division.

Mr. J. H. Hallett, General Foreman, Southern Okanagan Lands Project was retained beyond the normal retirement age to assist with the rehabilitation of the irrigation-works there, and Mr. E. A. Walls, Administrative Officer 1, Lands Branch, was engaged following his retirement from the Lands Service. Mr. Walls is assisting the Deputy Minister in the administration of Provincially owned lands in the Okanagan flood-control project. Mr. C. Errington, District Engineer, Victoria, had his appointment extended to November 30th when he retired. Mr. W. H.

Christmas, of the Water Investigations Branch, and Mr. A. A. Sutherland, of the Southern Okanagan Lands Project staff, retired after 9 and 20 years' service respectively.

Mr. J. T. Gulliver was awarded a Diploma in Public Administration by the University of Victoria following his completing the course requirements under the Executive Development Training Plan. Mr. R. W. Aldred completed the one-year correspondence course in Basic Public Administration, and Mr. E. J. Nye enrolled for this course.

**ACCOUNTING DIVISION**

M. B. MACLEAN, DEPARTMENTAL COMPTROLLER

Water Rights Branch revenue for 1966 was 1.5 per cent higher than in 1965.

*Revenue by Purpose*

Domestic, incidental use, and fees .....	\$83,030
Waterworks .....	20,427
Irrigation .....	21,936
Power .....	2,084,818
Funds held on application .....	75,721
<b>Total .....</b>	<b>\$2,285,932</b>

*Comparison of Water Rentals and Recording Fees for 10-year  
Period 1957-66, Inclusive*

1957 .....	\$1,152,370	1962 .....	\$2,115,738
1958 .....	1,256,004	1963 .....	1,935,778
1959 .....	1,363,939	1964 .....	2,175,223
1960 .....	1,510,278	1965 .....	2,251,025
1961 .....	1,853,653	1966 .....	2,285,932

Ten-year average, \$1,789,994.

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