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A PRELIMINARY REPORT ON THE EXPLOITS RIVER

BY

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NFLD.

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A PRELIMINARY REPORT

On

THE EXPLOITS RIVER

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St. John's, Newfoundland.
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INTRODUCTION

To maintain and develop Atlantic salmon resources of Eastern Canada in the face of an ever-expanding civilization, salmon must be allowed more efficient use of territories presently available to them, and areas previously unusable must be made open to them.

The Exploits River, the largest river on the Island of Newfoundland, ~~has~~ drains an area of 4300 square miles, and 800-900 linear miles of tributary stream. Only a small portion of this system, approximately one sixth, is available to salmon.

The system has supported anadromous salmon in streams between tidewater and Grand Falls (a distance of 16 miles) for many years. However, the population is small and has been unable to expand due to several strategic barriers on the main river and principal tributaries. An expanding paper-making industry in the area has also exerted an effect on this salmon run.

To evaluate the salmon producing potential of this watershed, a survey of approximately 1300 square miles of ~~inaccessible~~ drainage (inaccessible to salmon) was carried out in 1958. This report presents data and observations collected in that survey. Major consideration is given to fish populations frequenting the drainage, artificial and natural obstructions, as well as industrial activities which may affect Atlantic salmon, and finally, calculation of the potential salmon population which the area is expected to produce.

THE WATERSHED

The source of the river is in the south-west region of the Island. From its head-waters in the Annieopsquotch Mountains it flows through central Newfoundland, terminating on the North-East Coast of the Province. The estuary, approximately five and one-half miles long, is in the Bay of Exploits, Notre Dame Bay.

- Drainage Area -

should have location map

The total drainage area is 4300 square miles. The length of the main river is 166 miles (including standing water) from the extreme southern feeder lakes of King George IV tributary system to the estuary.* The river falls 1120 feet from King George IV Lake to sea level. The greater portion of this drop, 620 feet, occurs between King George IV Lake and Red Indian Lake. (63 miles). A drop of 500 feet (with a more or less even gradient) occurs between Red Indian Lake and tidal water, a distance of 70 miles.

Red Indian Lake (covering an area of 73 square miles) is situated on the main stem of the river. At its outlet is a large storage dam. This dam divides the system into two sections of almost equal size, viz. the Upper Drainage above the dam at Red Indian Lake, and the Lower Drainage, below this dam. The Lower Drainage between Red Indian Lake and tidewater (with which this report is particularly concerned) has an area of 2150 square miles.

* Data obtained from Province of Newfoundland, Department of Mines and Resources Map, 1955, Scale 1 inch = 10 miles, and Federal Government, Department of Mines and Technical Survey Maps, 1949-1954 (preliminary) Scale 1.5 inches = 1 mile.

The existence of a natural falls on the main river at Grand Falls, 16 miles from its mouth, divides this Lower Drainage into accessible (to Atlantic salmon) and non-accessible areas. The watershed below this obstruction has an area of 774 square miles. The watershed above it (presently inaccessible to salmon) has an area of 1375 square miles. The entire river drainage has 780 lakes. The largest bodies of water are Red Indian Lake, Victoria Lake, Lloyds Lake, and King George IV Lake, all occuring in the Upper Drainage.

There are 870 miles of tributary streams. The area below Red Indian Dam contributes 576 miles of stream to this total, with 347 miles occuring in the inaccessible area, and 229 in the accessible portion.

- Forestry and Agriculture -

The river flows for most of its length through densely forested country, although in upper reaches of the drainage, immediately north and west of Red Indian Lake, there is only scattered tree growth. This area consists principally of exposed rock, shrub, and bog. All other regions produce useful tree growth. (Newfoundland Royal Commission on Forestry, 1955).

The forest areas consist largely of Balsam Fir (virgin and regenerated) and Black Spruce (regenerated). Balsam Fir is most dense throughout the higher, mountainous, more remote areas where little logging and no burning has occurred. In the downstream areas, where extensive burns and logging have occurred within the last fifty years, Black Spruce is dominant, with White Birch approaching somewhat similar proportions.

Stands of Trembling Aspen, Larch, White Spruce, and ~~Red~~ White Pine are scattered throughout the area.

Some land close to the river's mouth has been cleared for agriculture, but these areas are quite limited and restricted to the north bank of the river between Grand Falls and Bishop's Falls. (Figure 2).

- Geology and Soils -

The area is underlain by Paleozoic strata (mostly volcanic). Some Paleozoic sedimentary rock is evident in downstream regions.* Outcroppings of these strata are common throughout the main river-bed. These rock formations and the resulting soils tend to be of moderately acidic nature (pH 4.5 - 5.0). It is expected that this tendency influences the chemical characteristics of the river and its tributaries.

- Precipitation -

Annual rainfall in the area ranges from 35 to 40 inches (Surface Water Supply of Canada, 1952) throughout a 30-year period.# Flash floods resulting from continuous heavy rains are irregular occurrences. Yearly discharge, calculated at Grand Falls, ranges between 22,000 and 4200 c.f.s, while discharge in late Spring and Summer months range between 22,000 c.f.s. in May and 4600 c.f.s. in August.

- Characteristics of the Main River -

Between tidewater and the Exploits Dam the river basin is confined, moderately steep, and uniformly deep. Its width varies

* Data obtained from Provincial Department of Mines and Resources, Geological Map, 1954, Scale 1 inch = 12 miles.

\# For comparative purposes the mean annual rainfall over the more southern Avalon Peninsula is 55 inches (40 years).

between 500 and 1500 feet. Few shallow regions are present except for an $11\frac{1}{2}$ mile section between Log Boom Landing and Badger Chute, where depths vary from 6 inches to no more than 3 feet. Measurements and observations of the river bottom adjacent the banks indicate a depth of approximately 2 to 5 feet at points ranging from 10 to 20 feet offshore.

The river bottom consists, principally, of medium to large gravel mixed with a predominance of fine rubble. Boulder and bedrock vary, on the whole, from sparce in the upper sections to moderate in the lower regions. Velocities of the river range from approximately 4 feet per second in the upper more restricted sections to 2 to 3 feet per second in the wider, less precipitous lower sections.

Depths, velocities, and discharge of the river may vary not only according to daily drainage run-off, but are controlled to some extent by manipulation of the Control Dam at the outlet of Red Indian Lake. This manipulation is in turn governmed by the head of water in Red Indian Lake and the recurrence of logging operations on the river.

The main river below Red Indian Lake and several streams flowing into the river were examined for temperature fluctuation and pH. Oxygen determinations were made (Rideal-Stewart Modification of the Winkler Method) at several points on the main river.

Main river pH values during the late Summer ranged from 6.1 to 6.5. Tributary streams have comparable pH values, ranging between 6.0 and 6.6. Dissolved oxygen levels of the main river vary between 4.4 ppm. (at 54°F) to 6.5 ppm. (at 58°F).

Late Summer surface water temperatures of the main river and tributary streams ranged from 54° in the deeper, more confined, swift flowing areas to 64° in the more slow flowing shallow areas.

These criteria are indicative of water conditions suitable for the rearing of Atlantic salmon. pH values, though indicating slightly acidic waters, are above lethal limits (pH 4.0 - 5.0) set for salmonid fish. Oxygen levels at the observed temperatures indicate 40 to 60% saturation. In areas of excessive organic decomposition these levels may be seriously reduced.

FISH POPULATIONS

- Species in Inland Waters -

Several published lists and descriptions of the fishes of Newfoundland are available. Jordan, D.S. and B.W. Everman, 1902 indicate the range of certain species known to be present in Newfoundland, but apparently make no definite reference to the Island. Breder, C.M., 1929 briefly makes reference to anadromous species of the Atlantic coast which migrate into Newfoundland streams. The Newfoundland Fisheries Research Commission, 1932 published the first list of fishes in the Newfoundland Fishing Area. They indicate the presence of anadromous Atlantic salmon and note that a "land-locked variety (is) also common in "ponds", lakes, etc." Also there is mention made of "Brook trout"* and "Sea trout". The occurrence of Three-spined stickleback* is also noted. Frost, N., 1940 points out the indigenous presence of Atlantic salmon and "chars" (referring to native Speckled trout), and indicates the introduction of Rainbow trout, Brown trout, and a species of White fish, into the waters of the Island. Dymond, J.R. 1947 indicates the species known by him to be present in Newfoundland and Labrador. Bigelow, et al, 1948 gives ranges and life histories of several species which are prominant anadromous species indigenous to Newfoundland. Backus, H.R., 1957 in discussing the fishes of Labrador includes several species which are anadromous or possibly resident in the waters of the Island of Newfoundland. Scott, W.B., 1958 lists the presence of Atlantic salmon, Ouananiche, (land-locked salmon), Brown trout,# Rainbow trout,# Brook trout (Mud trout), Arctic char, Smelt, Eel, White fish,# Shad, Alewife, Three-spine stickle-

* It remains to be determined that the mention of these species is meant to refer to their also occurring in freshwater.

\# Introduced

back, Nine-spine stickleback, and Top-Minnow, in these waters.

Species distribution studies on the Island have not been carried out in any detail. In this regard the Royal Ontario Museum (correspondence, 1949) has supplied some information concerning specimens taken from a number of lakes in Newfoundland.

Fish Populations Indigenous to the Exploits River Drainage

The following is a preliminary, and possibly incomplete, list of species present in the system:

Common Name	Scientific Name
Atlantic salmon Ouananiche (land-locked salmon)	*Salmo salar*
Speckled trout (Mud trout Sea trout	*Salvelinus fontinalis*
Arctic char	*Salvelinus sp.* *
Three-spine stickleback	*Gasterosteus aculeatus*
Eel	*Anguilla rostrata* #

Resident Species

These include Ouananiche and Speckled trout in many stream systems and lakes. A true picture of populations of these species, and the extent to which they would support a useful sport fishery, can only be determined by further investigation. It appears that Ouananiche populations could be successfully exploited, though at present they support only a limited sport fishery.

Onananiche

Populations of land-locked salmon were found in several larger lakes, such as South Twin and Sandy Lakes, and in the main river between Grand Falls and Red Indian Lake. Fish obtained by

* Taxonomy deferred.

Not positively identified.

angling were not large, although specimens up to half a pound were caught on several occasions.

Speckled trout

In many sections of the main river, tributary streams, and several lakes, the speckled trout is living in association with Ouananiche. No specimens over one-quarter pound were obtained by angling, and the species seemed less numerous than Ouananiche in the main river.

Three-spine stickleback

This species has been found in Corduroy Lake (a small body of water close to Grand Falls), South Twin Lake, and in the stomachs of Speckled trout and Ouananiche from the main river.

Anadromous Species

Atlantic salmon

Past Runs - The existence of Atlantic salmon runs in the Exploits River and tributaries below Grand Falls has been known since the days of the Beothic Indians.*

Howley, J.P. 1874, in discussing the activities of the Beothics (deriving his information from notes by Peyton, J. (undated) and Cartwright, J. 1768) indicates the Beothics to have been dependent on salmon. No definite figures are available as to the quantities in which salmon were removed from the river. Nor is there apparently any reference by this or other authors (Harp, E, undated; Spec. F.G, 1922; Cormac,-undated) to the size or times of the runs. It is explained by Howley (op.sit) that

* The now extinct Beothic Indians were the original inhabitants of the Island. This semi-nomadic tribe resided in the interior, but journeyed to the East Coast, via the Exploits River each year, at which time they obtained provisions of salmon from this and other rivers in the area. The extinction of this race was brought about through their wholesale slaughter by the white man in the middle and late 19th century.

small bands of Beothics migrating annually from the interior to Notre Dame Bay caught salmon in the freshwaters of the Exploits by spearing,and possibly by the use of rudimentary weirs set close to the banks of the river.

There is reason to believe that the Micmac Indians, prominent in the area in the late 19th and 20th century, were not as dependent on fishing as were the Beothics, but did take some advantage of the annual salmon migrations in the area. (Spec, F.G., 1922).

White men were engaged in salmon fishing on the Exploits in the late 19th and early 20th century. Peyton describes a commonly used woodstake weir trap set close to the bank and in which salmon were effectively trapped. Howley (op.cit) points out that bands of "Salmon Fishers" gained a good deal of their livlihood from annually fishing the Exploits River with these traps. Again no definite indication is given as to the numbers of salmon removed, nor the size of runs during the first years of the white mans prosecution of the fishery.

In later years the Newfoundland Guide Book, 1911 indicates " .... a tributary of the Exploits (Great Rattling Brook) (is) a splendid river", and further that this river is "rarely visited by an angler". Palmer, C.H., 1928 points out that "Good salmon fishing can be obtained as far as Grand Falls, and above, splendid trout and Ouananiche (land-locked salmon) fishing. Besides the main river, as far as Grand Falls, good fishing can be had on Stony, Little, and Great Rattling Brooks".

Calderwood, W.L. 1930, discussed the "factors which usually have to be considered for the preservation of the salmon fisheries", and mentions, in regard to the Exploits River, "The angling water may be said to extend to about 12 miles (upstream) and such of this water as I have seen is first class". Blair, A.A. 1943, maintains that "Considering the size of the Exploits River, it is not much value to the salmon industry".

Statistics on commercial catches of Newfoundland salmon are available from the year 1888. These records give little insight into availability of salmon in and around Notre Dame Bay, much less any indication of the trends followed by Exploits River salmon exposed to commercial netting or their possible escapement throughout the years. The picture is obscured even further by the fact that portions of the Atlantic salmon catch in the Bay of Exploits need not be destined to enter and spawn in tributaries of the Main River. This fact has been demonstrated through studies in the Maritime Provinces, as reported by Elson, P.F. 1955, and Kerswill,C.J. 1955.

Catch statistics for the entire Island over the last thirty years indicate a downward trend similar to the decrease in mainland commercial catches as described by Elson and Kerswill (loc.cit).

Lacking more explicit commercial data, it is probable that populations of Atlantic salmon entering the Exploits River have decreased in the past thirty years.

Angling data for the Province is available for the period 1911 to 1915 in terms of numbers of persons fishing and "numbers of fish taken". Angling returns for the period 1916 to 1941 are completely lacking. For the interval 1942 to 1952 data is available in terms of rod days, numbers of fish taken, and total weight of fish. "Catch per unit of effort" data can be derived from statistics maintained on many Newfoundland salmon rivers including the Exploits since 1953 (Appendix C).

The lack of detail concerning spawning migrations (up river) in early times, and the obvious sketchy nature of and commercial/sport fishery data presents little opportunity to trace the Exploits River run before 1949.

Passage of salmon up the main river to Grand Falls was relatively unobstructed until 1906 or 1907. Their access to the tributary waters of Great Rattling Brook has been completely blocked at a point on the main stream approximately three miles from its mouth. However, approximately twenty-five miles of tributary stream have been available below this obstruction. Little Rattling Brook and Stony Brook have remained accessible to salmon up to the present time.

The construction of a Pulp Mill (and dam) in 1907 at Bishop's Falls (Newfoundland Royal Commission on Forestry, 1958) on the main river, some three miles from the estuary has possibly impeded salmon moving upstream to their spawning grounds in Great Rattling, Little Rattling, and Stony Brooks.

There is evidence to show that attempts were made previous to 1911 to prepare a route for salmon around the Grand Falls barrier (Newfoundland Guide Book, 1911). It is doubtful if numbers of salmon could, previous to, or after the construction of this ladder, negotiate the obstacle. Certainly, after construction of the Grand Falls dam in 1909, salmon passage was completely blocked.

Calderwood (loc.cit) indicates that salmon might gain access to regions above Grand Falls by entering a pond in the Stony Brook system, and find their way into adjacent (and upstream) Sandy Brook system. This possibility has not been tested.

Obstructions to salmon already mentioned and others in the main river will be considered in more detail in a separate section.

Recent Runs - Salmon enter the Exploits River most probably in the latter part of June. The peak of the run, as far as can be surmised, is in mid-July, with numbers decreasing until perhaps early October.*

At the present time an accurate estimate of the size of the salmon run up the Exploits River cannot be stated with certainty. However, a rough estimate can be given.

If it is assumed that approximately 10% of the salmon run to a large river, such as the Exploits, is taken by anglers,# then from data supplied in Appendix C the annual run would possibly be in the vicinity of 3000 to 6000 fish in recent years (1953 - 1958). This assumption is based on angling reports which may be incomplete. However, judging from the amount of rearing area available, a spawning escapement of 3000 to 6000 salmon does seem reasonable for this river.

* These trends are deduced from data obtained in conducting a salmon transfer project on Rattling Brook (Norris Arm) during 1956-1958. This stream flows into Bay of Exploits approximately 5½ miles from the mouth of Exploits River.

\# The percentage of total runs taken by anglers may be as high as 26% on small streams such as West River, or as low as 18% on Middle Brook. A rough estimate of 20% was taken for Salmon Brook. These data are obtained from counting trap and counting fence reports, 1955-1957. (2). Blair, A.A. 1951 estimates anglers account for 3-12% of the run to Gander River.

Sea trout

The presence of anadromous Speckled trout in the Exploits drainage below Grand Falls is verified by angling statistics. The extent to which this species enters the lower drainage, their range, and the degree to which they support a sport fishery, cannot be estimated from data now available.

Catadromous Species

The presence of the common eel in the lower regions of the system is known. However, no specimens were collected during the course of this survey. The ability of the species to circumvent stream obstructions suggests that their range may extend to lakes and streams above the Grand Falls barrier.

ARTIFICIAL AND NATURAL OBSTRUCTIONS

Natural obstructions have had considerable effect on salmon of the Exploits system, principally because of their permanent and strategic location on the main river and its tributaries.

Three storage dams on the main stem, and a multitude of lesser logging dams on tributaries, have altered the system's natural environment considerably. In changing the habitat and partially or completely blocking the river and streams for nearly fifty years,these dams have greatly influenced the salmon run to this river.

The first to recount the existence of a large waterfall on the Exploits River was John Buchan, 1811. Murray A. and J.P. Howley, 1811 in reporting on the geology of the area listed and described the falls, rapids, and changes in elevation of the main river from tidewater to the head of Red Indian Lake. Calderwood (loc. cit) describes features of obstacles in the lower drainage pertinent to salmon migration. Blair, A.A., 1943 catalogues three of the more important obstructions in the Lower Drainage. Desbarats, 1948 reports a spirit level survey on the main river to evaluate hydro-potential, and therein maps the river.

- Obstructions on the Main River Below Red Indian Lake -

Table I summarizes eight major obstacles on the main river. A sketch of each barrier is given with the following descriptions, and composite photographs may be found in Appendix C.

TABLE I

OBSTRUCTIONS ON THE MAIN RIVER

Name	Obst. No.	Distance from river mouth	Type of Obst.	Degree of Obstruction
Bishop's Falls	1	3.4 miles	Rapids and storage dam	Difficult but passable
Grand Falls (including dam)	2	15.8 "	Falls and storage dam	Complete
Upper Grand Falls	3	16.5 "	Falls and rapid	Passable
Goodyear Falls	4	17.9 "	Falls and rapid	Passable
Log Boom Landing	5	19.9 "	Holding Boom	Periodically passable
Badger Chute	6	31.6 "	Rapid	Passable
Red Indian Falls	7	48.4 "	Rapid	Difficult but passable
Exploits Dam	8	69.9 "	Control and storage dam	Complete

See also Figure 2, Appendix B for main river obstructions in accessible region.

1. Bishop's Falls

Murray, A. and J.P. Howley (loc.cit) describe Bishop's Falls as "a fall of 19 feet". This falls is considered as having been passable to salmon prior to construction of a pulpmill and dam at Bishop's Falls.

The A.E. Reed Company, in 1907, completed the construction of the pulpmill (capacity:130 tons ground wood per day) and a 2-unit powerhouse. In that year the present storage dam was extended across the river immediately over or downstream from the existing fall. In 1928 these premises became, and remain, the property of the Anglo-Newfoundland Development Company (Harmsworth Interests).

Calderwood,(loc.cit) observing this obstruction some years after the completion of the dam and pulpmill, indicates that ".....owing to a rough slope with a gradient of about one in thirteen which is situated on the right bank immediately below the dam, fish are able to ascend". He further describes what remedial steps could be taken to assist salmon over this difficult area. Evidently his suggestions, as such, were never carried out.

Blair, A.A. 1943 describes fundamental features of Bishop's Falls dam and rapid sections. He expresses uncertainty that the minor salmon passage facilities at the dam are of any use.

The power plant was enlarged in 1953 to accommodate nine turbines (usually 8 are in use),providing a maximum output of 21,900 H.P., and having an ultimate potential of 25,000 H.P. The plant supplies the towns of Bishop's Falls and Grand Falls. Emergency power for pulp mill operations at Grand Falls is also supplied from this source. The dam, it is believed, was not modified to any extent by these alterations.

The obstruction at present consists of a low concrete dam, surmounting on its right side (looking downstream)* an extensive and tortuous rapid area. A powerhouse and single remote sluice gate are located at the left, extreme end, of the dam. Water retained by the dam floods at least one mile

*All obstructions are referred to in this manner.

of river, and provides a 35-foot head for operation of the powerhouse.

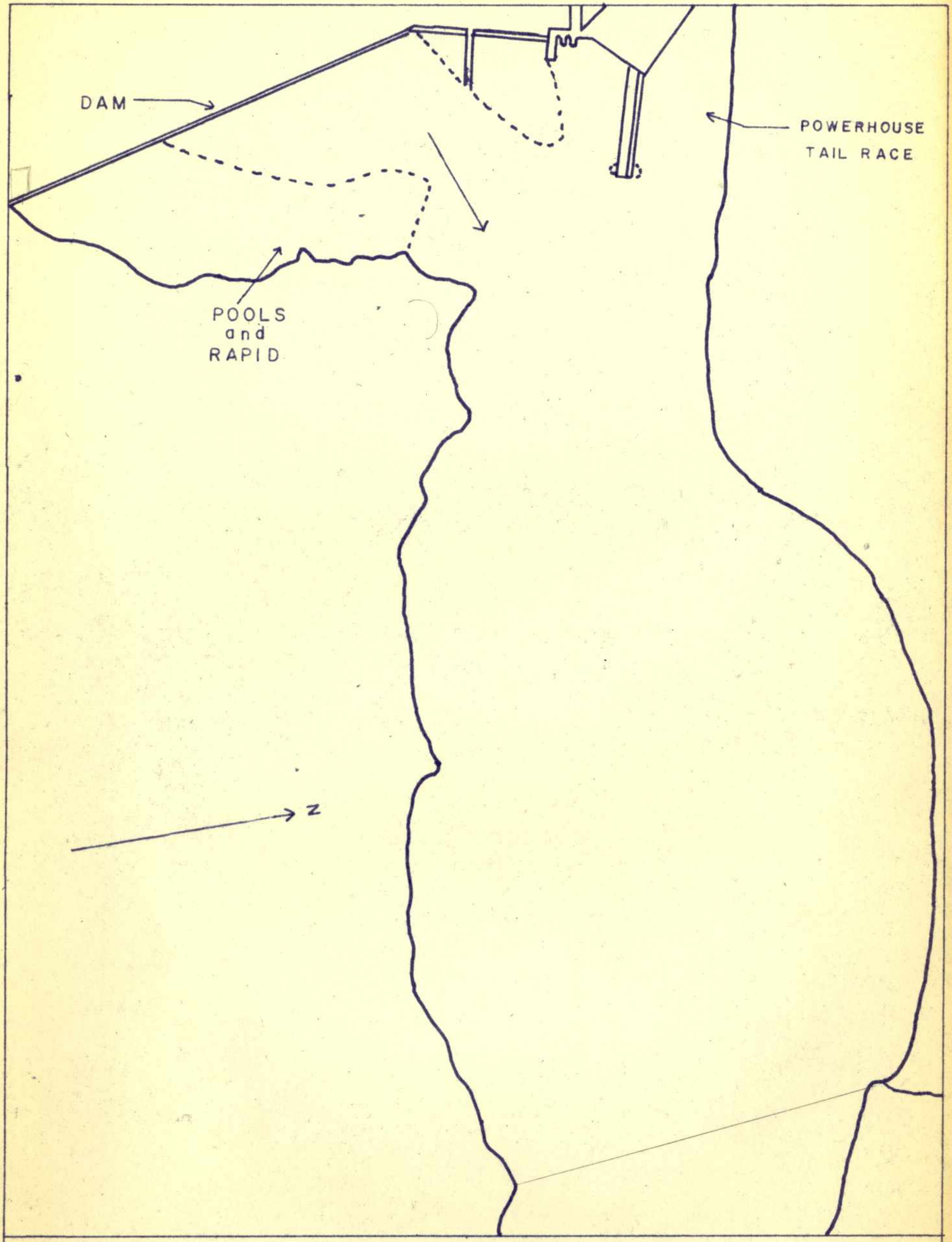
The Dam - From the powerhouse on the left side, to its southern extremity, the dam is 810 feet long, and at its greatest height is 35 feet (at a point mid-way between the banks of the river). Its least height is 4 feet (at the extreme right end).* Two sluice gates are located in the dam. One provides an escape for excess forebay water, and is immediately adjacent to the powerhouse. Another is removed about 160 feet from the powerhouse and drains excess storage water. Storage volume is increased 3 feet by addition of flash-boards across the entire length of the dam.

The Rapids - Downstream from the dam, and confined to the right side of its course, the river bed is an exposed confusion of large boulder and slabs of bed rock scattered on a bed rock base. Water spilling over the right half of the dam flows torrentially over this outcropping to join the main flow of water (spilling over the central, higher sections) some 600 feet downstream from the dam. In passing through this portion of the river, water drops a height of about 34 feet at velocities of 2 to 5 feet per second.

Passage of salmon - Adjacent to the right bank along this rapid area (See sketch) are five to eight large pool-like basins. Migrating salmon find access to streams above the obstruction via this lateral series of pools. By this means they eventually pass over the dam either through a 1' x 6' orifice in the lowest flash-board, or by directly jumping over this low region of the dam.

Beyond the pool region, that is toward mid-stream,

*All heights include a 3 foot flash-baord extension.



Bishops falls and Exploits river

Scale : 1 inch = 180 feet

the height of the dam, the precipitous step-like benches of bed-rock, and the high velocities at all observed water levels, make this area difficult, if not impossible, for salmon passage.

At the present time it is known only that salmon are caught along each bank below the obstruction in one or two of the ascending pools, and at the mouths of Great Rattling and Stony Brooks upstream from Bishop's Falls.

2. Grand Falls

Murray and Howley (loc.cit) say that, "The Grand Falls consist of a succession of chutes (one of about 30 feet), and violent rapids, somewhat over a mile in length, and giving altogether, from bottom to top, a rise of 145* feet. At a short distance above the Grand Falls there is an abrupt chute of 15 feet......". (This latter height is not included in their summarization of the total height of Grand Falls).

Since Murray and Howley's description, the severity of this obstruction has been compounded by construction of a low concrete storage dam. As far as can be ascertained, this structure, in conjunction with a powerhouse and papermill, was completed in 1909 by its present owners, the Anglo-Newfoundland Development Company.

It was pointed out previously that attempts were made as early as 1911 to construct a salmon ladder around the falls, and perhaps the dam as well. (Newfoundland Guide Book, 1911). Calderwood (loc.cit) says "The Grand Falls form a much more serious obstruction than Bishop's Falls .... the upper river is completely closed by Grand Falls. Owing to the great force of the precipitous

* 105 feet is, perhaps, more correct since the above figure is the elevation from sea level.

fall, fish will not lie near the foot, but will congregate about 150 yards below ....." As in the case of Bishop's Falls, suggestions of Calderwood to make the obstacle passable to salmon were not apparently carried out. Blair, A.A. 1943 briefly states "At Grand Falls ..... there is a natural obstruction and a dam which salmon cannot get over".

The falls and dam are discussed separately below.

Grand Falls - The fall presents a concave, perpendicular face, 25 to 30 feet high. The concavity results from the union of two widely separated water courses meeting at the lip of the falls to form an open U-shaped crest. The right crest or arm of the fall (looking downstream) is 65 to 70 feet wide, while the width of the left arm is 30 to 40 feet.

Immediately above the fall,extensive, irregular rock outcrops divert the rivers course into two main channels. This diversion originates at the foot of a dam some 1100 feet upstream. Water passing over this structure is directed into either channel, and thence to the lip of the fall, at which point the courses again become one in the manner described above.

The descent of the water over the fall creates a turbulent, narrow gorge extending 500 to 600 feet downstream. At its most narrow point the gorge is 60 to 70 feet wide, and ranges from 30 to 40 feet in depth.

A principal rock fault in the left wall of the gorge, some 200 feet below the fall, creates a minor run-around by which a small amount of water moving down the left channel may pass the main fall during periods of moderate to high water conditions.

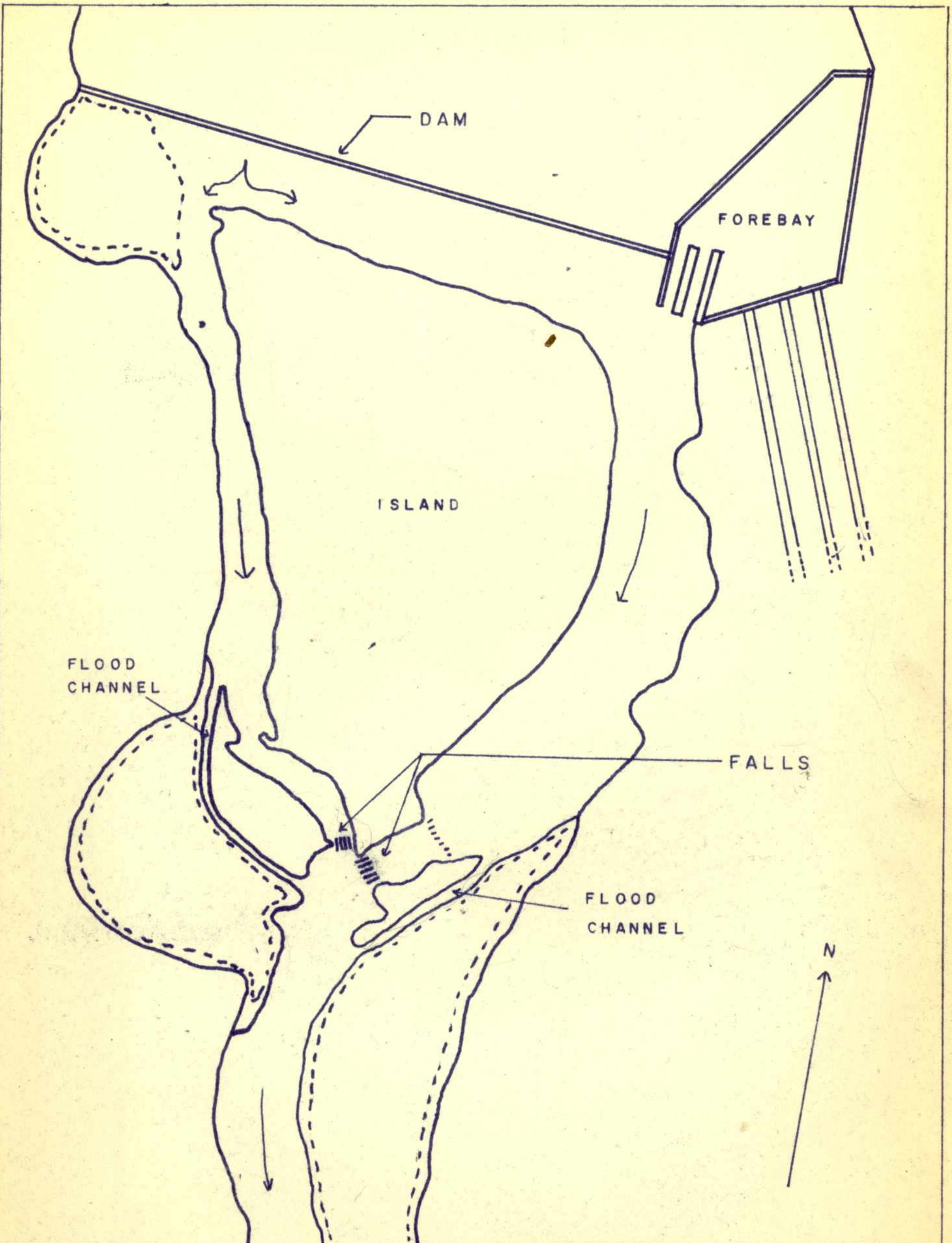
The slope of this run-around is approximately 30% (34/127) at its outlet below the falls; a 5 - 10% slope occurs between the region of greater slope, and a point well above the falls where this secondary channel meets the main channel.

A rock fault, similar to that just described, exists in the right wall of the gorge. There is, however, no direct connection between this channel and the main flow of water proceeding to the right arm of the fall. Hence, water (at the time of observation) could not bypass the fall by this potential run-around.

The Grand Falls Dam - This is a low concrete structure located 1000 to 1200 feet above the falls. Stored water is used in log storage and as a means of convenience in the paper mill, located on the left bank, but primarily provides head for an eight unit powerhouse (Max. H.P. 64,000) located on the same side.

The length of the dam is about 850 feet, with a height of 14 to 20 feet (including a 3 foot flash-board extension). Its right end terminates in a concrete abutment set into a steep bank. The left end is adjacent to the spillways of the powerhouse forebay. The river bed behind the dam is flooded for perhaps half a mile upstream. Depths of water in the storage basin range from 14 to 20 feet immediately behind the dam, and decrease to approximately 5 feet at the upstream extremity of the flood area.

Approximately 1500 feet downstream from Grand Falls, and about 500 feet upstream from Stony Brook, a rock bench in the river bed causes the river to drop a height of 6 to 10 feet.



Grand falls and Dam

Scale : 1 inch = 180 feet

This obstacle has been noted on several occasions, all of which have been at times of high water.

The river at this point is 600 to 700 feet wide. At high water levels three separate sections were noted. The most precipitous section is that 100 to 125 feet adjacent to the right bank. Here the drop is a perpendicular 6 to 8 feet, the current very swift, and a great amount of turbulence. The central 300 to 350 feet has a slope of no more than 20% (8-10/45-50). The current is in the vicinity of 8-9 feet per second. Though there is extreme turbulence at the bottom of this chute-like area, the water passing through is smooth. The 200' - 225' adjacent to the left bank is the least severe. Here water passes moderately slowly over rock outcrop. The rocky region extends some 200 to 250 feet downstream from a point in line with the bench-like formation on the opposite bank. Within this distance there is a gradual drop of 10-15 feet, and at observed water levels the current was swift, but not impassable to salmon.

Presumably this obstacle may cause salmon some difficulty at low water. It may be considered difficult but passable to those salmon venturing beyond Stony Brook to the waters below Grand Falls.

3. <u>Upper Grand Falls</u>

The river in this area is 500 to 600 feet wide. The obstruction extends completely across the river, and consists of three sections.

(a) Left Bank Rapids.

(b) Mid-stream Fall.

(c) Right Bank Run-around.

The Left Bank Rapids - This rapid section is 90 to 100 feet wide at its lower end, 60 to 70 feet wide at its upper end, and 550 to 600 feet long. The vertical drop is 4 to 5 feet. Velocities of the water passing through this chute range from 3 feet per second at its upper end to 8 feet per second mid-way between inlet and outlet.*

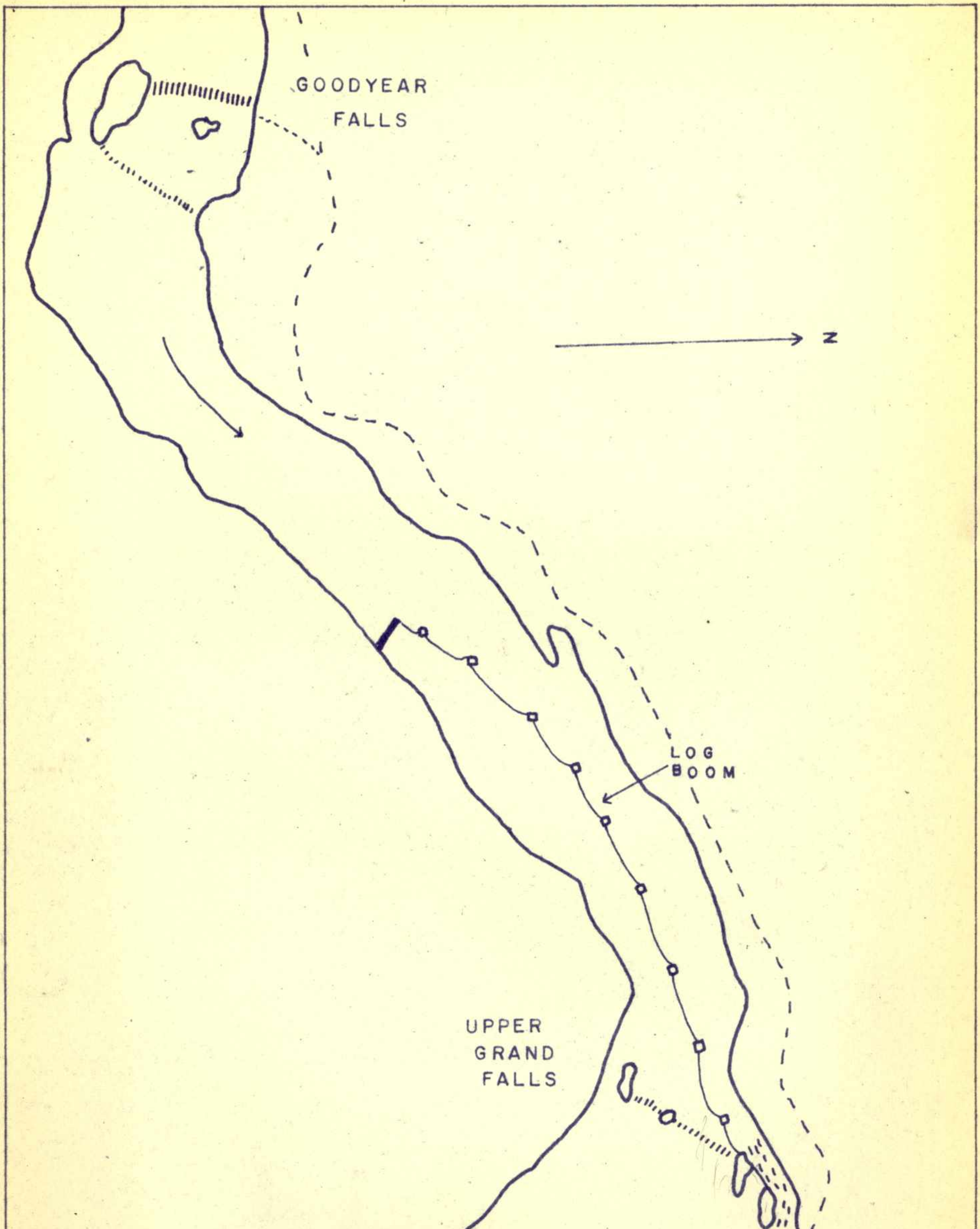
Mid-stream Fall - This section includes 400 to 500 feet of the river's width. For the greater part of its width the fall has a perpendicular drop of 6 to 8 feet. An uneven rock protrusion exists in the central region of this section (its perpendicular height being 8 to 10 feet). Except for this irregular outcrop, the fall has a noticably smooth, but shallow, flow of water, over its lip. (6 to 10 inches at time of observation).

A small island on the extreme left of the fall acts as a diversion between the Mid-stream Fall and the Left Bank Rapid. Adjacent to this island, toward mid-stream, there is a concrete sluice gate, 6 to 8 feet wide. The purpose of this structure is unknown.

At the extreme right end of the fall (i.e. between the central outcrop and another small island close to the right bank) the lip of the fall is reinforced by 2 inch planking which extends about 10 feet from the lip, and appears to cover the entire distance between the island and central outcrop.

Right Bank Run-around - There is a shallow run-around separating the right end of the mid-stream fall from the right bank of the river. The passage is 95 to 100 feet in

* Velocities mentioned are the average of two measurements taken by the "floating chip" method over a length of 100 feet and 10 to 15 feet from the left bank.



Upper Grand falls and Goodyear falls on Exploits river

Scale : 1 inch = 550 feet

length, and arcs to the right of the island. It is 25 to 30 feet wide at its narrowest.

The most precipitous drop in this section is at the lower end of the run-around. At observed water levels it appears to be, at the most, 3 feet over a length of 25 feet.

Water passing through this channel enters approximately 50 feet upstream from the lip of the fall, and emerges over a wide area immediately below at right-angles to the fall.

A log-boom extends from the island near the Left Bank Rapid to a point on the right ban approximately 4000 feet upstream. This boom and its associated piers direct pulpwood into the Left Bank Rapid, and thence to the Paper Mill.

4. Goodyear Falls

The width of the river in this vicinity is 1100 to 1200 feet. The obstacle consists of a low fall, covering three-quarters of the river's width, and a long rapid. It is convenient to consider the fall and rapid separately - i.e.

(a) The Left Bank Fall, and

(b) The Right Bank Rapid

The Left Bank Fall - Extending from the left river bank toward a large island, located close to the right bank, is a low fall. The fall is approximately 4 feet high, though there are two regions in mid-water which rise to a height of 6 to 8 feet. The distance between left bank and island is 350 to 400 feet.

From the bank to a point 250 feet offshore the lip of the fall is exceptionally smooth, and appears to be compact gravel. Beyond this point, and continuing to the island, the rock formation becomes more jagged, and its height increases to

6 to 8 feet. Covering the lip of the fall in this latter region is a layer of 2 inch planking. This extends approximately 10 feet back from the lip.

The Right Bank Rapid - A rapid flow of water passes between the previously mentioned island and the right bank. This area measures 700 feet in length, being 80 to 100 feet wide at its upper end, and 250 to 300 feet at its lower end. The vertical drop is quite uniform and gradual, with slope approximately 2 to 3% (15-20/700). Velocity of the water varies from 3 feet per second at the upper end to 7 feet per second at the lower end.*

Observations from a remote point on the right bank indicate that waters adjacent to the island are calm. While there is one large pool at the right bank, the waters above and below this quiet area are swift and may be difficult for salmon to navigate.

A log boom extends partially across the river in this region. It is secured to a small pier on the tip of the previously mentioned island, and extends upstream across the river to the left bank. This apparatus directs logs driven downstream into the Right Bank Rapid.

5. Log Boom Landing

The river at this point is 1200 to 1300 feet wide. Its average depth is 1.5 to 2.5 meters.# A small island, approximately 300 to 350 feet wide is situated in mid-water, being some 400 feet removed from the right bank.

* Each figure the result of two readings taken over 100 feet at points 20-25 feet off right bank.

Twenty-nine soundings.

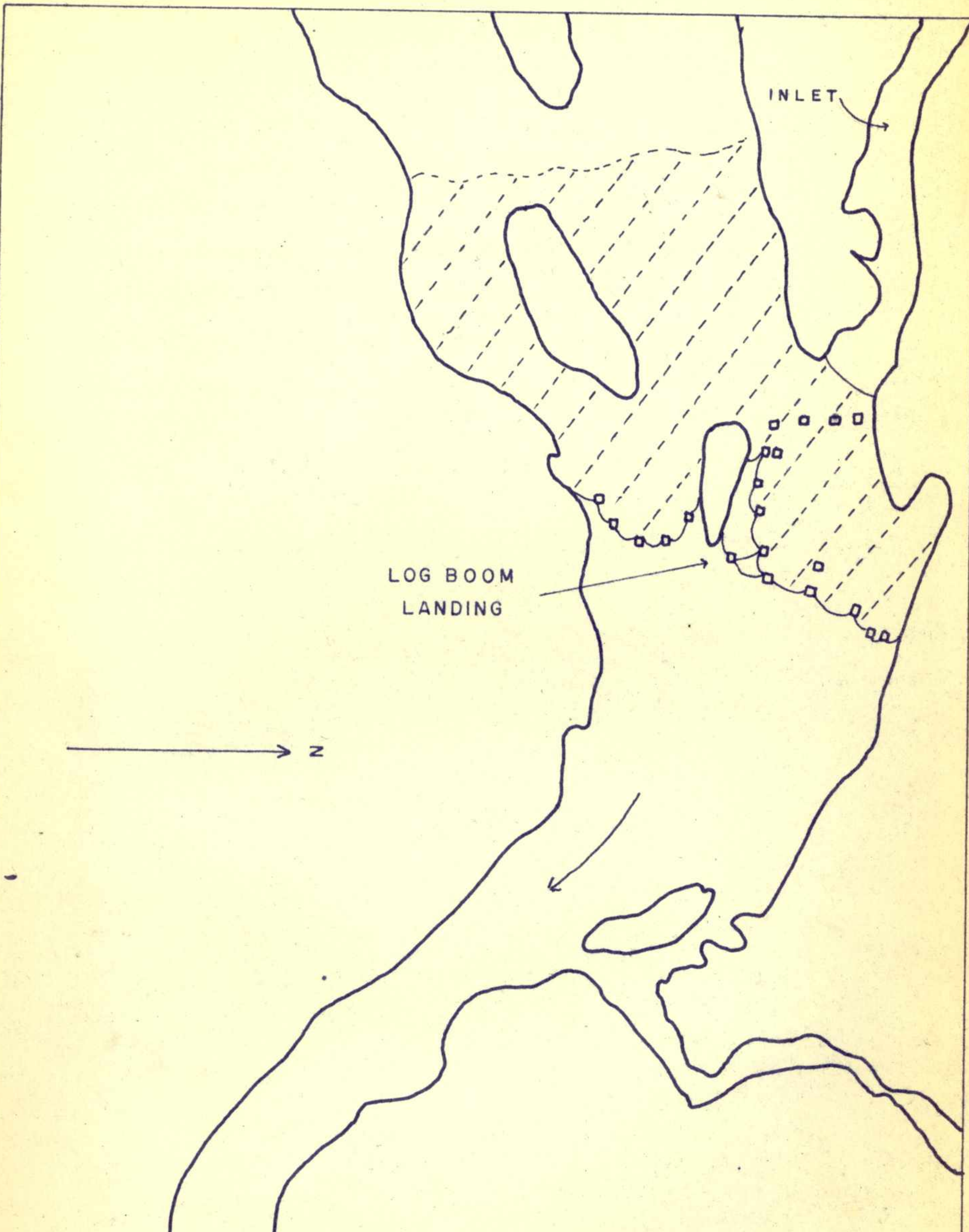
Between this island, and extending to either bank, there is a series of floating log booms connected to 10 stationary log piers. Each boom consists of 3 separate logs and is in the vicinity of 30 feet long. This equipment functions as a "temporary" retainer of pulpwood. Logs driven down from the upper reaches of the river throughout the Spring and Summer are retained at this barrier. As required, a suitable number of logs are allowed to escape the boom and continue downstream to the mill.

The area covered by logs behind the boom apparently varies from week to week. During the months of July, August, and early September, its surface area varied more or less in the vicinity of 30 to 50 acres.

The pressure of large numbers of logs straining against the boom is sufficient to push many logs below the surface. A continuing increment of logs from upstream regions will force logs, immediately behind the boom, into a solid wall extending from water surface to river bottom. Since the greatest depth in the vicinity of the boom is no more than 2.5 meters* (immediately adjacent the left side of the island), the number of logs and pressure required to form a solid wall of logs is greatly reduced as compared to that required if the retainer were located over deeper waters.

Salmon approaching the obstruction may have difficulty finding a passage through the maze of logs, particularly if approach is made along the shallow bank regions. Salmon passage may be possible in areas of greatest depth where logs may not be so closely packed. In any case, salmon

* Velocity in this area was 2 to 3 feet per second.



Log Boom Landing and Exploits river

Scale: 1 inch = 550 feet

could be held up at this point until a channel is opened. Also, unnecessary injury may result from their attempts to pass between closely packed logs.

6. Badger Chute

"Badger Chute" refers to a "bottle-neck" rock outcrop constricting the river to a narrow passage. The passage is slightly less than one-half the width of the river in adjacent areas (550 to 600 feet above the chute and 400 to 450 feet below).*

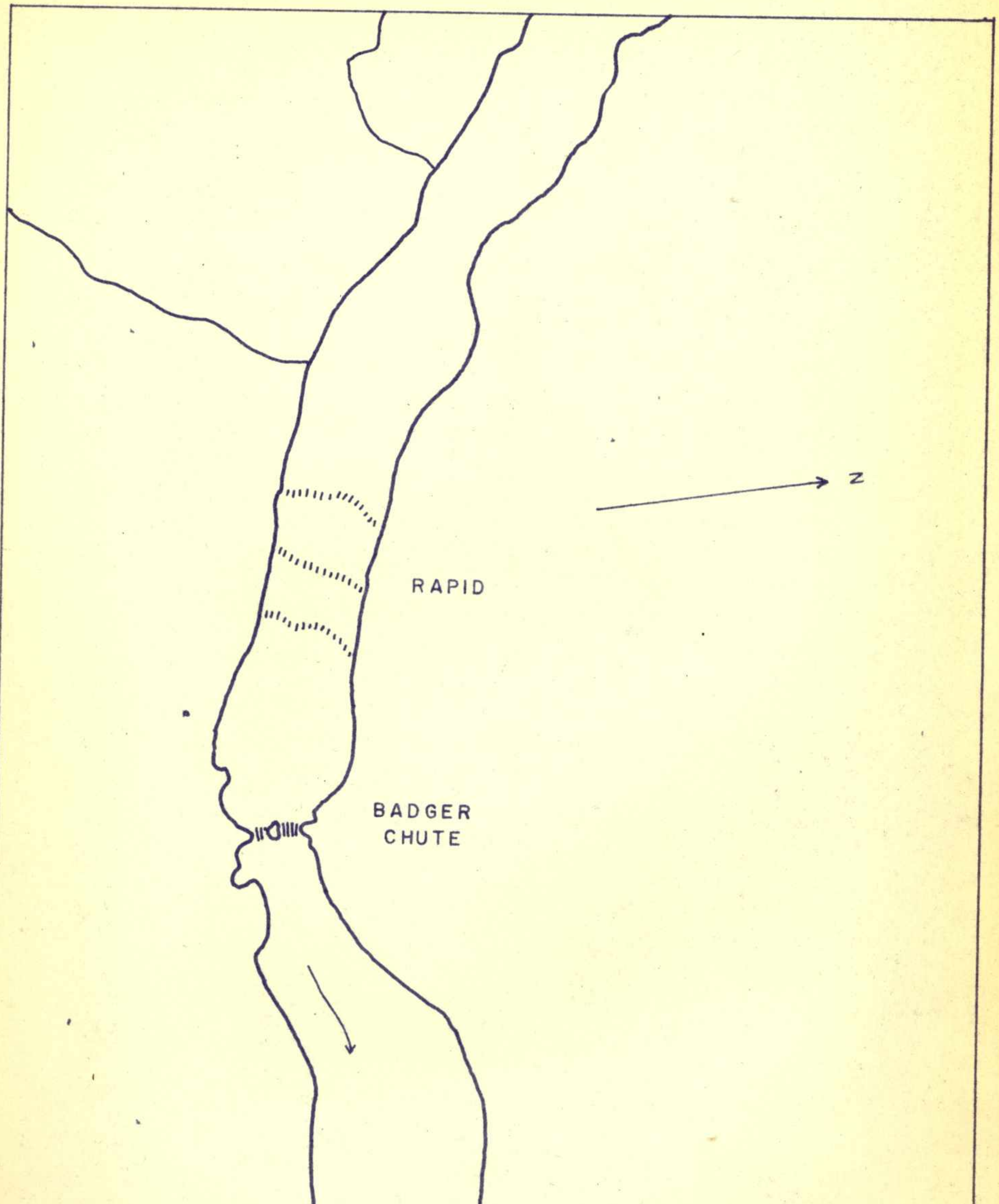
The "chute" is 150 to 160 feet wide. However, this is reduced to approximately 110 feet by the presence of a large rock outcrop in mid-stream. The greatest length of the chute is 55 feet (measured along the left bank). The vertical drop within this distance is 10 to 12 feet.

The vertical drop and constriction cause water to pass through the orifice at an increased velocity which, along the left bank, was approximately 6 feet per second).# The force of water through the constriction causes high velocities for a distance of 90 to 100 feet downstream from its lower end. Higher velocity, coupled with the irregularities of the rocky banks, cause strong eddies on either bank immediately below.

Associated with Badger Chute proper is a series of rapids, the lower end of which is perhaps 800' upstream from the chute. The rapid area is 500 to 600 feet long and extends

* Estimated measurements.

\# Excessive turbulence in mid-waters prevents determination of velocity by the method used. However, it would appear that mid-stream velocities would be greater than that along either bank.



Badger Chute and Exploits river

Scale: I inch = 550 feet

completely across the river, which at this point is 500 to 600 feet wide. The vertical drop is close to 15 feet (2 to 3% slope), and occurs very gradually over extensive bedrock layers, each drop being 1 to 2 feet high.

Between the lower end of these rapids and the entrance of the chute, the river expands to form a large pool-like area 60-70 feet wider than the river. The waters of the left bank pool are quite calm, with only a slight current. Observations from a remote point indicate the pool on the right bank to be quite calm.

7. Red Indian Falls

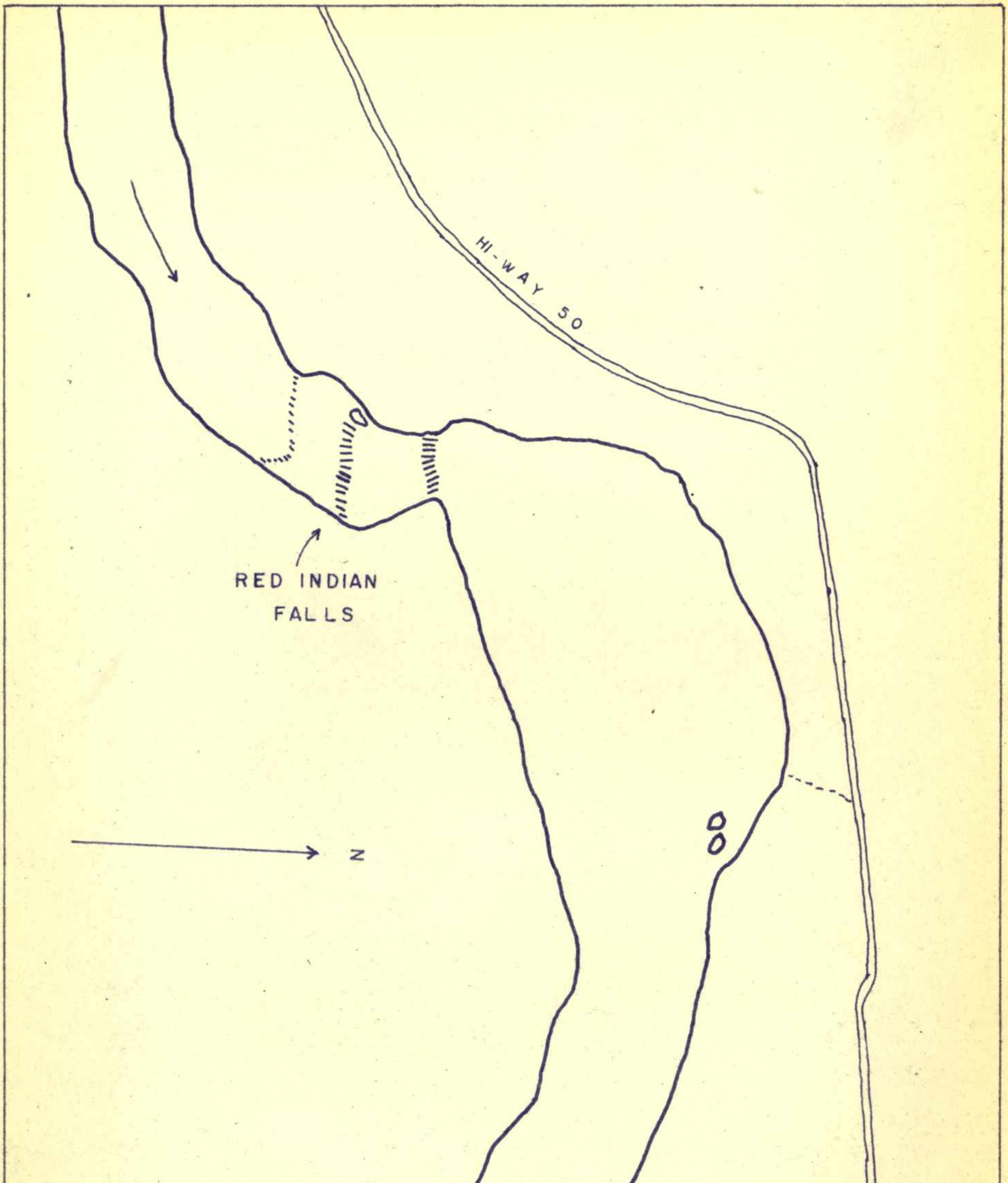
This obstacle may present the greatest difficulty encountered by salmon migrating beyond Grand Falls. It takes the form of an extremely fast rapid 425 to 450 feet long, with vertical drop of 25 to 28 feet. Bedrock outcropping confines the river on either side.

The downstream or lower 200 feet of its length is the least severe. Turbulence is excessive for most of its width. However, the vertical drop in this area is no more than 10 feet. (5% slope). Relatively quiet waters are observed on either bank. Mid-stream velocities may well be over 8 feet per second.*

The upper 225 feet is more extreme. Turbulent irruptions, and high velocities, over most of the river's width make passage through this section very difficult indeed.

The river bed adjacent the right bank is more precipitous and direct than that adjacent the left bank.

* Velocities over 100 feet at a distance of 50 feet from the north bank were approximately 6 feet per second.



Red Indian falls and Exploits river

Scale: 1 inch = 550 feet

Considering the left bank of this upper section its absolute length is approximately 225 feet. The distance along the bank, however, is close to 300 feet. This added distance is due to widening of the rapids on the left bank. As a result of this widening the full force of the main river current is not experienced in this area of the upper section. Rather, the river bed drops in gradual stages of 2 feet or less, and 6 inches to 2 feet of relatively quiet water passes over the area. There is one vertical drop of 4 to 5 feet at the extreme upper end.

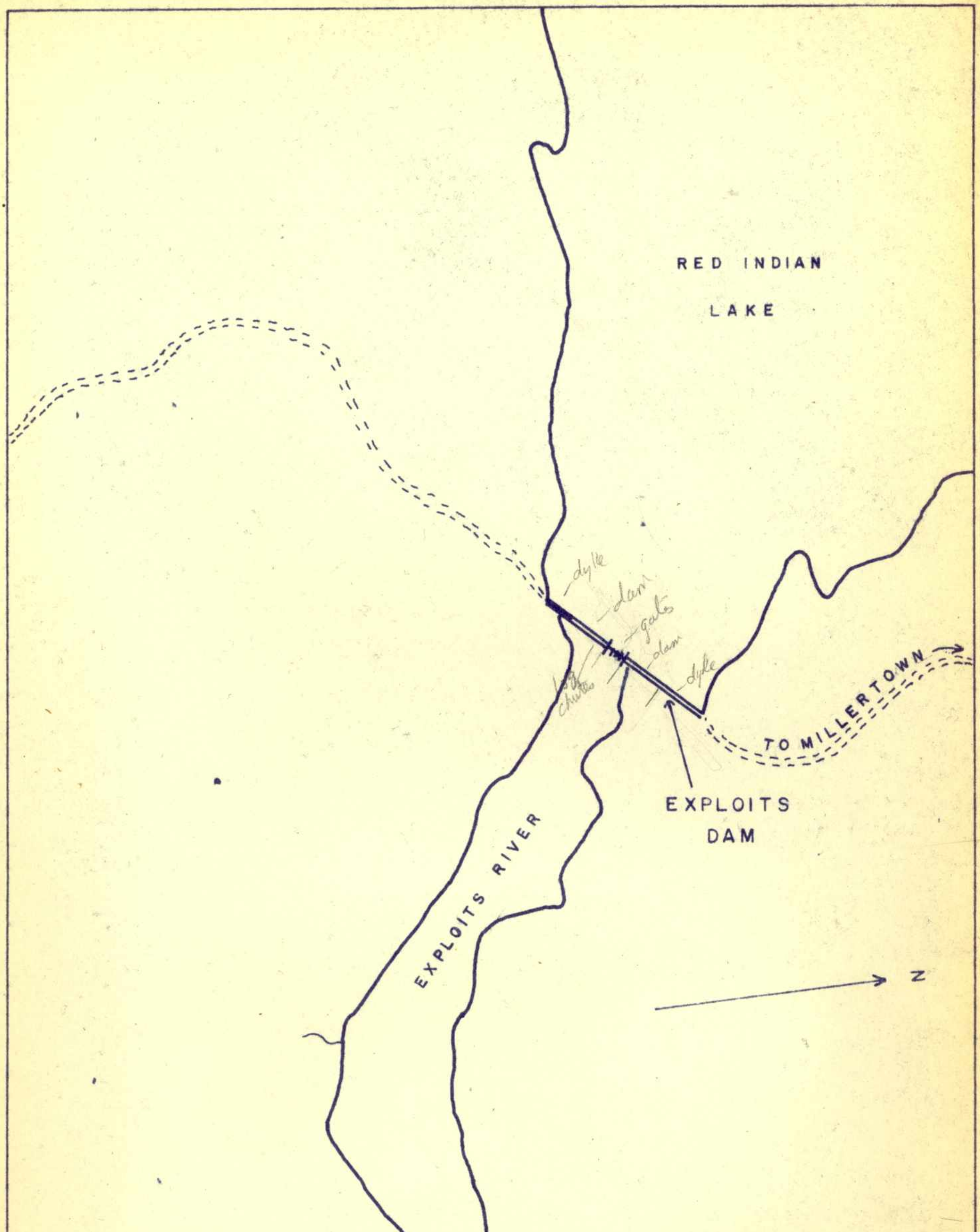
Where this expansion merges with the lower, more confined section, a turbulent channel arises immediately adjacent the left bank. The channel is rather narrow, approximately 10 feet, and 50 to 55 feet long, with a vertical drop of 6 feet (10% slope) between its upper and lower ends.

The river above the falls flows in a northerly direction. However, immediately below the falls it makes an abrupt turn to a west-northwest direction (i.e., there is close to a 90° bend in the river at this point). As a result, a lake-like expansion has been formed at the foot of the falls. This widening covers an area of close to ½ square mile.

8. The Exploits Dam

The structure acts as a storage dam governing both the height of Red Indian Lake, and the flow of the Upper Drainage water into the lower section of the Exploits River.

It is a steel reinforced, concrete structure, with four electrically operated gates. Total height is 28 feet measured from the top of the dam to its foundation (at a point



Exploits Dam and Exploits river

Scale: 1 inch = 700 feet

immediately to the left of the sluice gates). The length is approximately 630 feet, and may be conveniently divided into five sections.

Section	Length
(a) North bank abutment	214 feet
(b) Sluice Gates	85 "
(c) Smaller emergency gates	98 "
(d) Log chutes	206 "
(e) Southern abutment	30 "
	632 feet

A short, wide channel, leading from Red Indian Lake to the dam, is 1100 feet wide. The difference in the width of this channel and the width of the dam is close to 470 feet. This is accounted for by approximately 230 feet on either side of the dam being earth and gravel dyke extending between the dam abutments and the banks of the channel.

The four main sluice gates are each 15 feet wide. The seven emergency gates are each 10 feet wide, and each of the 26 log chutes are 6 feet wide.

Obviously, such a structure is a total obstruction to salmon seeking access to tributaries draining into Red Indian Lake.

- Tributary Obstructions -

To determine their effect on salmon, each tributary obstruction must be dealt with as the need arises, that is, as salmon attempt to occupy the stream areas concerned. Occupation of these areas will depend primarily on the success with which salmon are able to negotiate and disperse beyond main river obstructions. It is essential then, to remedy main river obstructions initially, and tributary obstructions secondarily, as salmon gain access to the localities.

Appendix A of this report lists and describes 43 artificial and 20 natural obstructions on the more important tributaries of the Exploits River below Red Indian Lake. (See also Figures 3-5 Appendix B). Approximately 48 less important obstructions on secondary streams tributary to Great Rattling Brook, Noel Paul Brook, and Harpoon, are not included.

The table summarizes:

(a)	Artifical and natural obstructions which may require fishways.	- 9
(b)	Dams requiring gate control or removal in order to ensure a seasonal minimum flow of water to downstream areas.	- 11
(c)	Dams which may require sluice or gate-floor alterations to facilitate salmon passage.	- 3
(d)	Old unused and deteriorated dams which should be removed or at least cleared of debris in order that an unobstructed passage be maintained.	- 9
(e)	Beaver dams.	- 7
(f)	Other obstructions which might require removal or further observation.	- 12
(g)	Natural obstructions requiring remedial work.	- 12

The more important obstructions on significant tributaries are discussed below (general recommendations are included).

Great Rattling Brook

Camp 1 Dam and Falls (1)* - A combined natural and artificial obstruction which, for many years, has prevented salmon from utilizing excellent spawning ground in the river and tributaries located above this point. Not on any maps?

The dam is 12 feet high, and the natural fall is 19 feet high. A fishway is under construction here in conjunction with experimental transfer of adult salmon from Rattling Brook (Norris Arm) to Great Rattling Brook (Exploits River).

Reports on this obstruction and others in the system have been made at the time the above-mentioned projects were being contemplated.

Tote Brook Dam (2) - A crib-work dam 22 feet high, which is presently a partial obstruction to salmon transferred to Great Rattling Brook. Following a Summer of logging in 1958, the dam is being reconstructed and a fishway built into the dam by the Anglo-Newfoundland Development Company.

Stony Brook

Stony Rapids (7) - A fall of 10 to 12 feet at the beginning of this rapid makes salmon passage difficult, but not impossible. The remaining length covered by the rapid is less precipitous. Engineering surveys have been carried out on this obstruction in 1958, with the intention of remedying the difficult

* Numbers in parentheses refer to obstructions numbers as listed in Appendix A and indicated on maps (Figures 3-5; Appendix B).

section in 1959.

Sandy Brook

Sandy Brook Rapids (9) - This natural obstruction consists of two impassable rapids. A fall of 20 feet at the bottom of the lower section would make salmon passage beyond this point impossible. A second precipitous fall of 10 to 15 feet at the top of the upper section would also prove impossible for salmon.

The constricted banks and severe angle of the stream bed between the upper and lower limits of the rapid magnify the problem of allowing salmon to pass beyond the initial and terminal falls.

Mile 18 Dam (10) - This structure is a log-crib dam, 10 feet high and 25 feet wide. During log driving periods some means of allowing salmon past the obstruction shoud be provided. At other times gates should remain open.

Sandy Lake Dam (11) - This 8 foot dam is of the log-crib type. Provision should be made for unhindered passage of salmon past this point by maintaining open gates.

Tom Joe Brook

Mile 2 Falls (23) - This complete barrier requires further investigation. Remedial work may prove useful.

Mile 3 Dam (26) - This dam is 6 feet high, and has been allowed to deteriorate to the point where gates have collapsed into the passageway, and driftwood has piled up behind the dam and across the passageways. This should be remedied by clearance of the passageway and/or by removal of the structure.

Mile 7 Dam (27) - This dam is in a more severe state of disrepair than that mentioned previously. The passage is almost totally blocked by the collapsed gates, gate-runners, and driftwood. At the present time water escapes downstream by seepage through the crib-work. Again a clear passage should be maintained.

Pemahac Brook

Mile 2 Dam (32) - This partial obstruction consists of remnants of a dam foundation. A 3-foot drop is encountered here. Immediately below the barrier is a 3-foot natural fall which, combined with the wooden structure, may result in hold-up of salmon.

Mile 1 Falls (34) - The fall (height 30-35 feet) will no doubt be a complete barrier to salmon. The amount of spawning area located above may prove to be of value. The obstacle merits further investigation.

Badger Brook

Mile 3 Rapids (37) - This series of rapids may at times be difficult but passable to salmon. Each section of the series is separated by 200 to 400 yards of relatively quiet waters. The most severe is the second section encountered in travelling upstream. Here there is an initial fall of 5 feet, followed by 3 benches, 1 to 3 feet in height. This difficult area might be altered by remedial blasting.

The lower rapid of the series should cause little difficulty.

The upper rapid is a fall of approximately 6 to 8 feet. There is, however, a quiet run-around (50 feet to 60 feet wide) in association with the fall. The existence of this passage would make it unnecessary to carry out work on the fall itself.

Joe's Lake Dam (38) - This key dam controls the level of a series of three large lakes. The height of the dam is 15 feet. The three gates have been removed and water passes freely through the apertures. The height between stream and gate floors is probably not more than 3 feet.* As a result, little difficulty would be encountered by salmon if the structure remains in such a state.

Should this structure again be put into use, fish passage facilities would be required.

South Twin Lake Dam (41) - This dam at its greatest height is 15 feet. There appears to be a 3-4 foot dead head at the bottom of the highest gate. A full head of water is presently retained.

If the small amount of stream area above this point is considered valuable to salmon, fish pass facilities will be needed. Otherwise, a guaranteed minimum flow is all that seems necessary.

North Twin Lake Dam (42) - Few details are available on this structure. In regard to remedial work on this structure, it seems hardly necessary, since very little spawning area is located above this point. However, a minimum flow should be maimtained.

Mary-Ann Lake Dam (43) - This log-crib dam may raise the level of Mary-Ann Lake at least 12 feet.

The base of the structure has been erroded so that water presently passes under the gates, rather than over gate flooring, which is 3 to 4 feet above the stream bed.

* Estimated.

Shoring of the foundation, provision of minimum flow, and adjustment of the gate floor, might prove adequate for salmon passage.

Mile 10 Dam (45) - This small dam is beginning to deteriorate. Its height is not presently known. At the time of observation the gates were raised and water flowed over the gate floors which were 1 to 2 feet from the surface of the stream.

Noel Paul Brook

Noel Paul Dam (47) - This barrier is located at the exit of Noel Paul Steady approximately 15 miles above the mouth of the stream.

The structure is 23 feet high from gate floor to top of dam. The lower lips of the sloping gate floors are 5 to 6 feet from the stream bed. The upstream end of the gate floors are met by a 4 to 5 foot partition which causes water to drop swiftly from the lip of this partition to the gate floor. These partitions or deadheads also act in retaining water when the steady is at low level. Such a structure will require fish passage facilities since there appears to be little chance of salmon ascending through the gate apertures.

Mile 24 Rapid (48) - This rapid area is close to the inlet of Noel Paul Steady. The most severe section is the lowest or initial 65 feet. In this distance the water drops a height of 18 to 20 feet.

The upstream section of the rapid immediately adjacent this most severe section may be difficult but passable to salmon. The remaining upstream portion of the rapid consists of three bed rock benches 1 to 5 feet high, and separated from each other by short stretches of relatively quiet water.

Some remedial work would be necessary in the lower section, and possibly in the region termed difficult but passable.

Mile 30 Dam (49) - This log dam is a complete obstruction to salmon. The dam is 12 feet high. The distance from each gate floor to surface of stream is 6 feet. The structure is beginning to deteriorate. Should repairs be made to this dam allowance might be made for fishway facilities.

Douglas Lake Dam (51) - At the observed water levels this log dam would be a complete obstruction. Its height is 15 feet. A 4-6 foot* deadhead is inserted below the gates. The lower lip of the log chute is 2 feet from the surface of the stream. Should water be allowed to pass over the floor of the chute, the obstruction might be passable.

NOTE: There are at least 13 logging dams distributed on 9 streams draining into Noel Paul Brook below Noel Paul Steady, and 5 dams on tributaries above Noel Paul Steady (up to Douglas Lake).

These dams are for the most part deteriorated and located at the head waters of each stream. Little spawning area is to be found in regions above these obstructions. They do not influence, to any great extent, the total amount of available spawning ground in the Noel Paul system, and are not considered of great importance at this time. The major point of interest concerning these lesser dams is that all gates be kept open, and a minimum flow of water be maintained in the stream below each dam.

* Estimated.

Generally, each dam possesses one or two gates, and is seldom over 8 to 10 feet in height.

Two streams below Noel Paul Steady are blocked by impassable beaver dams, and there is only one stream which is blocked by an impassable waterfall, this being approximately 8 to 10 feet high, having a slope of perhaps 40 to 60%. This obstruction is located on the fifth stream above the mouth of Noel Paul Brook.

Harpoon Brook

Mile 6 Dam (59) - This old, deteriorated, dam is 12 feet high. One gate, at least, is presently suitable for salmon passage. The floor of the midstream gate has only a slight angle, and its downstream lip is 2 feet from the stream surface.

A great amount of rotting timber and old stumps have been collected behind the dam, blocking the midstream gate. This debris should be cleared away to allow free passage, and a minimum flow of water should be maintained.

Ambrose Lake Dam (61) - This old dam is presently used only as a vehicular bridge. Gate slots are situated to one side of the main stream flow, and one set of narrow piers in mid-stream support the crossing. The stream bed appears to be unobstructed.

NOTE: There are 5 logging dams and 2 beaver dams distributed on 11 larger tributaries of Harpoon Brook.

As with those obstructions on tributaries of Noel Paul Brook, these dams are located at the headwaters of each stream, and for the most part, are deteriorated, have one or two gates, and are not over 8 to 10 feet high. The principal point of interest will be in maintaining open gates free of debris, and providing a minimum flow of water in each stream.

ATLANTIC SALMON POTENTIAL

- The Main River -

Spawning facilities provided by the main river (See Table II, page 50) do not add a great deal to the overall potential of the system. Gravels in most sections are of fair to excellent caliber, but depths of water adjacent the river banks, as well as in mid-stream, are generally in excess of those satisfactory for spawning grounds. However, these conditions may represent excellent nursery areas which, as will be seen, are not abundant in tributary streams.

- Tributary Streams -

In general, tributaries of the Exploits River each present an average or two to seven miles of salmon-rearing water. (See Appendix D). There are, however, five exceptional streams with 25 to 100 miles of useful "salmon" water, and one prominent stream, Great Rattling Brook, with as much as 180 miles.

Many of these streams appear to offer an abundance of ideal spawning areas, though quiet, protected areas for the rearing of juvenile fish are not as numerous as might be desired.

The topography of the drainage basin lends itself to the formation of streams which, in most cases, slope quite gradually but directly to the main river. Headwaters consist generally of one or several natural or artificial lakes, often increased in surface area by construction of logging dams. Source waters of these lakes flow through small, ecologically juvenile streams, which present a good deal of slow flowing, sandy bottom, stream area.

Gravel riffles suitable for spawning are situated, for the greater part, below these head-water lakes. Consequently, "main-stream" areas may prove to be of greatest value in producing salmon. The lack of rearing areas in these moderate to swift "main-stream" sections limit the numbers of salmon produced. However, areas in the river and in numerous small lakes and ponds may compensate for this deficiency.

The more outstanding stream systems are reviewed in the following:

Major Tributaries

Great Rattling Brook - This stream, largest in the Lower Drainage, supports an annual run of salmon. A total obstruction $3\frac{1}{2}$ miles above its mouth has, until recently, prevented salmon from utilizing more than 25 of its 180 miles of main and tributary waters.

The size of the population migrating to this tributary is not accurately known, but it is estimated at 1200 to 1700 fish.

The completion of a fishway and other remedial work carried out in the area will allow the present run to make more full use of the extensive spawning and nursery areas located above the obstruction.

It is the view of certain workers that large, secondary streams of the system will act as the principal source of spawning areas, while the main river may function in providing a good deal of excellent nursery area.

An estimate of the maximum potential this area may be expected to have is in the vicinity of 10,000 to 12,000 spawning fish, or approximately half the number calculated as the potential for the entire Lower Drainage. (See following section for method of calculating potential).

Stony Brook - As in the case of Great Rattling Brook, this stream also supports an annual run of salmon. The size of the run is not known, but estimates based on available salmon-rearing waters would indicate a population of 1500 to 1700 fish.

Spawning facilities appear to be located in the upper three miles of the main stream, and throughout a single large secondary stream known as West Stony Brook. Several large pools and moderate lengths of quiet water in the lower portions of the secondary stream seem to be more than adequate for the population presently being maintained.

Little Rattling Brook - A small stream flowing into the river below Grand Falls. It is believed to support a small number of salmon, possibly between 500 and 1000. Observations as to location and extent of spawning and rearing areas have not been carried out on this stream.

Sandy Brook - This stream enters the river six miles above Grand Falls. Its capacity to produce salmon will be governed, to a large extent, by the installation of fish passage facilities around the natural obstruction 4½ miles above its mouth. Extensive gravel riffles are evident in the region below the fall, but the major portion of rearing areas, at least in the main stream, seem to be located in the 11 miles from the fall to Sandy Lake Dam.

Three secondary streams, viz., West Branch, Coronation and Caledonia Brooks, enter the main stream above the obstruction. West Branch is by far the more important in regard to gravels available for spawning grounds. This tributary contributes 9 - 11 miles of good gravels and nursery area. The number of dams on the stream may reduce its usefulness. The latter two streams, being more juvenile, have an abundance of sandy stream bottom more suitable for rearing of young salmon.

A maximum potential of 4000 adult fish seems consistant with the apparent value of this drainage.

Badger Brook - The main stream of this watershed is quite short, but provides moderate to excellent spawning facilities in its upper four miles. A major tributary, Mary Ann Brook, will provide 4 to 6 miles of both spawning and nursery areas.

Maintaining an accessible passage through the dam at Joe's Lake may allow salmon the use of some 10 to 12 miles of good gravels distributed throughout Powderhorn, Rocky, Catamaran, and North Twin Brooks. These streams enter directly into large lakes and may not be fully utilized by Atlantic salmon.

The drainage area is occupied mainly by bodies of standing water and bog areas, with the result that for the large area drained,its usefulness is quite limited. A potential of 2000 fish is estimated for this system.

Noel Paul Brook - This stream enters the river 38 miles above Grand Falls. The 15 miles of stream between its mouth and the complete obstruction at Noel Paul Steady is excellent spawning and nursery area with fine to coarse gravel evident throughout.

The mouth of the main stream at its greatest width is 250 to 300 feet wide, being no less than 150 feet throughout the first 10 miles of stream length.

Water depths, at the time of observation, ranged from a usual 6 inches to 2 feet, and upwards to 3 and 4 feet in several pool-like expansions of the main stream.

Approximately 43 miles of tributary stream are available in ten secondary streams of the watershed below Noel Paul Steady. Each offers 2 to 6 miles of salmon-rearing water. Those streams more proximate to the main streams union with the Exploits River appear to have greater amounts of suitable areas for spawning and rearing, than do those closer to and beyond Noel Paul Steady. On each of these lower tributaries fine to coarse gravels are predominant in the more downstream sections. Sandy, slow-flowing areas are predominant in the upper source-water areas, and numerous boggy, lake-like areas replace direct, swift-flowing streams. This condition is aggravated by the presence of numerous deteriorating dams which retard stream flow and reduce the amounts of more suitable rearing areas. Due to the existence of these areas, a total of 25 to 30 miles of stream is considered as good to excellent spawning and rearing area.

Noel Paul Steady is believed to be an artificial expansion of the main stream (Figure 29), and is normally 8 to 9 miles in length. At the time of observation only a narrow stream of water meandered through its sandy, mud-like bottom. The main stream from Noel Paul Steady to its source waters in Snowshoe and Blizzard Ponds is for most of its length excellent spawning and rearing area. Its width is 75 to 100 feet, and it possesses 19 miles of more or less continuous gravel riffle areas submerged below 6 inches to 2 feet of water. The utility of this region may be diminished somewhat by the great distance salmon must travel to the area, and particularly through Noel Paul Steady. Approximately 17 miles of tributary stream flows into Noel Paul Brook above the Steady. Boggy, lake-like expansions are again prominent in the upper reaches of these streams, and detract from their overall suitability. Dams and lake-like expansions resulting from these are not as common as on streams below the Steady.

There is a possibility that some 6000 salmon may be required to make maximum use of the entire watershed. However, considering only that region below the major obstruction at Noel Paul Steady, there are adequate facilities for 2500 to 3000 salmon.

Harpoon Brook - This stream contributes 34 miles of salmon-rearing water to the overall potential of the drainage. Of this total approximately 14 miles of good to excellent spawning area are offered by the main stream. An added 12 to 15 miles are contributed by nine tributary streams.

As in the case of Noel Paul Brook, rearing areas and spawning grounds are limited to the more downstream sections. The value of the upper 1 or 2 miles is reduced due to the prominence of bog areas and damming of the head-stream areas.

The system may contribute in the vicinity of 2000 spawning fish to the total potential of the Exploits drainage.

These latter four tributaries, with the exception of Badger Brook, on becoming accessible will sustain the greater part of the system's salmon population.

Sandy Brook, being the first major tributary above Grand Falls, may be suitable for initial development of the area's salmon populations. However, access to this stream will be governed by two passable, and one periodically passable, Main River obstructions.

Several lesser tributaries a short distance upstream from the outlet of Sandy Brook (See following section) also bear consideration in this respect.

Minor Tributaries

A number of smaller tributaries entering the river between Grand Falls and the Exploits Dam, principally Pamahac and Tom Joe Brooks, may contribute significantly to the value of this inaccessible drainage.

It has been mentioned previously that the average stream in this region presents 2 to 7 miles of salmon-rearing waters. Each is generally 25 to 50 feet wide for most of its length. In all, there are 12 streams of this caliber, which collectively contribute a total of 80 miles of suitable rearing water to the overall potential.*

These streams appear to have an abundance of excellent gravels for most of the length. Water flow is thought to be continuous throughout each season, with depths varying from 6 inches to 2 feet in swift flowing streams, and up to 4 to 6 feet in the infrequent quiet pools.

Each stream may contribute between 200 and 1000 spawning fish to the total potential of the drainage.

*This figure does not include mileages of nine streams which appear to be of very little consequence, or are blocked by exceedingly large natural obstructions.

Pamahac Brook and Tom Joe Brook appear to offer greater amounts of suitable spawning area than do other "average" streams in the area. Obstructions on those are few and of relatively minor significance. Their smaller stream length may prove advantageous in conducting initial "controlled" management techniques. As with Sandy Brook, however, access to those streams is governed by three, and in the case of Pamahac, four main river obstructions.

- Manner of Determining Salmon Potential -

The amount and suitability of spawning grounds, if determined within reasonable limits, provides a fundamental guide in judging the salmon-rearing capacity of a stream. All other factors, such as food, cover, predation, and angling, are at the outset, secondary to this criterium.

The Exploits River, as well as its tributaries between tidewater and the Exploits Dam, have been examined on foot and by the use of helicopter (principally on the tributaries). Areas with a predominance of fine to coarse gravels, over which water is flowing at an estimated depth of 6 inches to 3 feet, and with moderate to swift current, have been considered as suitable salmon-rearing waters. Each stream and river section has subsequently been classified with reference to (1) the extent of drainage area (in the case of tributary systems), (2) size of the existing population, and (3) size of its potential population. (See Appendix D for reference tables).

Estimates of the potential population for each stream are perhaps the more significant. The manner in which these are determined is summarized below.

According to Elson, P.F., and J.C. Kerswill, 1955, approximately 150 lbs. of female salmon per mile of salmon-rearing water are required to maintain stocks at highest levels.* Numbers of salmon (both male and female) which are equivalent to this figure may be derived using spawning escapement data.

It has been determined from data obtained at Rattling Brook, Norris Arm (Canada Dept. of Fish. 1955-1958) that an average annual spawning escapement of 760 salmon, both grilse and large salmon, is maintained by 1672 pounds of female salmon.

These figures were determined by numerical counts of the run over a period of three years. This enumeration has also shown the run to be predominantly grilse, the proportion being 70% grilse, and 30% large salmon, or 532 grilse, and 228 large salmon.

If the average weight of salmon less than 6 lbs. is 4 lbs, and the average weight of salmon 6 lbs and over is 10 lbs, the total number of pounds of salmon would be 2,128 lbs. of grilse and 2,280 lbs. of large salmon.

Sex-ratios within each size group indicate the predominance of male grilse, while among larger salmon the proportion of male to female is approximately equal. Hence, the grilse sex-ratio has been taken as 75:25 (male:female), while for larger salmon a 50:50 proportion has been assumed. These proportions, particularly the former, may vary among various populations, but seem, at least in this case, indicative

* This has been determined using as a basis a stream with 30-70 miles of salmon-rearing water, with an average width of 75 ft.

of male to female ratios.

Referring then to the poundages of grilse and large salmon, females would account for 25% of the total weight (2128 lbs) contributed by grilse, i.e. 532 lbs., while larger female salmon would account for perhaps 50% or 1140 lbs. of the total (2280 lbs) attributed to larger salmon. As a result, 1672 lbs. (532 + 1140) of female salmon is equivalent to the total 760 salmon in the average run to this stream. Therefore, 0.45 salmon (760/1672) is proportional to 1 pound of female salmon.

Referring again to the work of Elson and Kerswill, 150 pounds of female salmon per linear mile of salmon-rearing water is the equivalent to 67.5 salmon per mile (0.45 X 150).

Thus, in determining the potential of a stream, this latter figure (67.5 salmon) multiplied by the number of miles of salmon-rearing water gives the number of salmon that a stream is capable of supporting.

One point should be borne in mind when applying this conversion factor. The stream (and perhaps the population entering the stream) from which the above data is obtained, does not appear to be outstanding with respect to available spawning facilities and rearing areas. Hence the factor being used (0.45) may be somewhat low in respect to other spawning and rearing areas and the Exploits Drainage in general. Nonetheless it can be used to estimate the number of salmon potentially required to make optimum use of salmon rearing waters in this watershed.

- Salmon Potential of the System -

TABLE II

Estimated Potential Number of Salmon to be supported in the Exploits River Drainage

Section of Drainage	Miles of Salmon Rearing Water	Potential Spawning Fish
Main River		
Between Grand Falls and Exploits Dam	11 1/ (width 1500 ft)	7,000 2/
Major Tributaries - (Less Great Rattling Brook) -	221	14,000
Minor Tributaries - (Less Little Rattling and Stony Brooks) -	91	6,000
Others	35	-
Tributaries Below Grand Falls	229	15,000
TOTALS: Above Grand Falls	358	27,000
TOTALS: Entire Lower Drainage	587	42,000

1/ Includes only Log Boom Landing to Badger Chute (See Appendix D).

2/ This figure is questionable since it is difficult to determine what success, if any, salmon might have in utilizing this area, particularly since scouring may be excessive.

Table II indicates the estimated potential number of spawning fish which are required to make maximum use of all suitable waters in the Lower Exploits River. Since the basis on which these figures are determined have been adapted to a wide range of conditions, many of which may not be conducive to maximum production of salmon, the rather ideal figures presented, in many cases, have to be reduced. To what extent a reduction should be made can only be determined when prevailing conditions under which salmon are existing are more accurately studied.

Further, the presence of a major obstruction in the main stream of both Sandy and Noel Paul Brooks will reduce the number of miles of rearing water initially available in major tributaries from 221 miles to 84 miles. Hence the number of potential spawning fish which initially may be supported in major tributaries will be reduced from 14,000 to 6,000 fish, and the total potential of the area above Grand Falls diminished to 19,000 fish.

- Atlantic Salmon Stocking -

Where there is possibility that a sizeable run of salmon may be developed in a river, there invariably arises the question of initiating a stocking program. On the assumption that the Exploits River may be further developed as a salmon-producing river, it is advisable to consider briefly how this may best be accomplished.

To start or strengthen a population of fish, the basic requirement is a source of adult fish or their progeny. Where it can be shown that natural reproduction of the parental stock is insufficient to provide adequate numbers of young to maintain or increase stocks, the introduction of mature adults, eggs, fry or fingerlings may be quite beneficial.

Economically there is much to be said for the introduction of adult mature fish. By this means the costs involved in providing complex hatchery facilities are avoided, assuming, of course, that a source of mature prolific fish is readily available and the numbers introduced are sufficient to develop the stock in a moderate period of time.

At the present time a stocking program is being carried out on Great Rattling Brook. Transfer of fish from Rattling Brook (Norris Arm) into upstream regions of Great Rattling Brook will, it is hoped, implement the run of salmon now using the lower reaches of the watershed. Questions regarding the success and sufficiency of this program are not yet fully answered. There is evidence though that adults introduced have adapted well to their "new" environment.

Should the now inaccessible drainages of the Exploits River above Grand Falls be made available to salmon, it seems quite probable that the natural run of salmon attracted to these regions would be inadequate to make use of the expansive spawning facilities in the area. As a result, it would seem advisable that some manner of developing an adequate run be determined.

The proximity of large runs of salmon in upper reaches of the N.W. Gander River, as well as smaller runs to adjacent rivers such as Stony, Great Rattling, and Peters Arm Brooks, may be of some advantage in planning a stocking program. Temporary facilities for stripping and fertilizing eggs at convenient locations, as well as transfer of mature adults, may be convenient alternatives to the establishment of elaborate, permanent hatchery facilities.

POLLUTION

Contamination of Newfoundland's freshwaters by industrial wastes and sewage is not widespread, though the pulp and paper, and mining industries, do dispose of wastes into rivers of the Island. The effect on fish populations of such effluent wastes is an important consideration in any biological evaluation of a stream system.

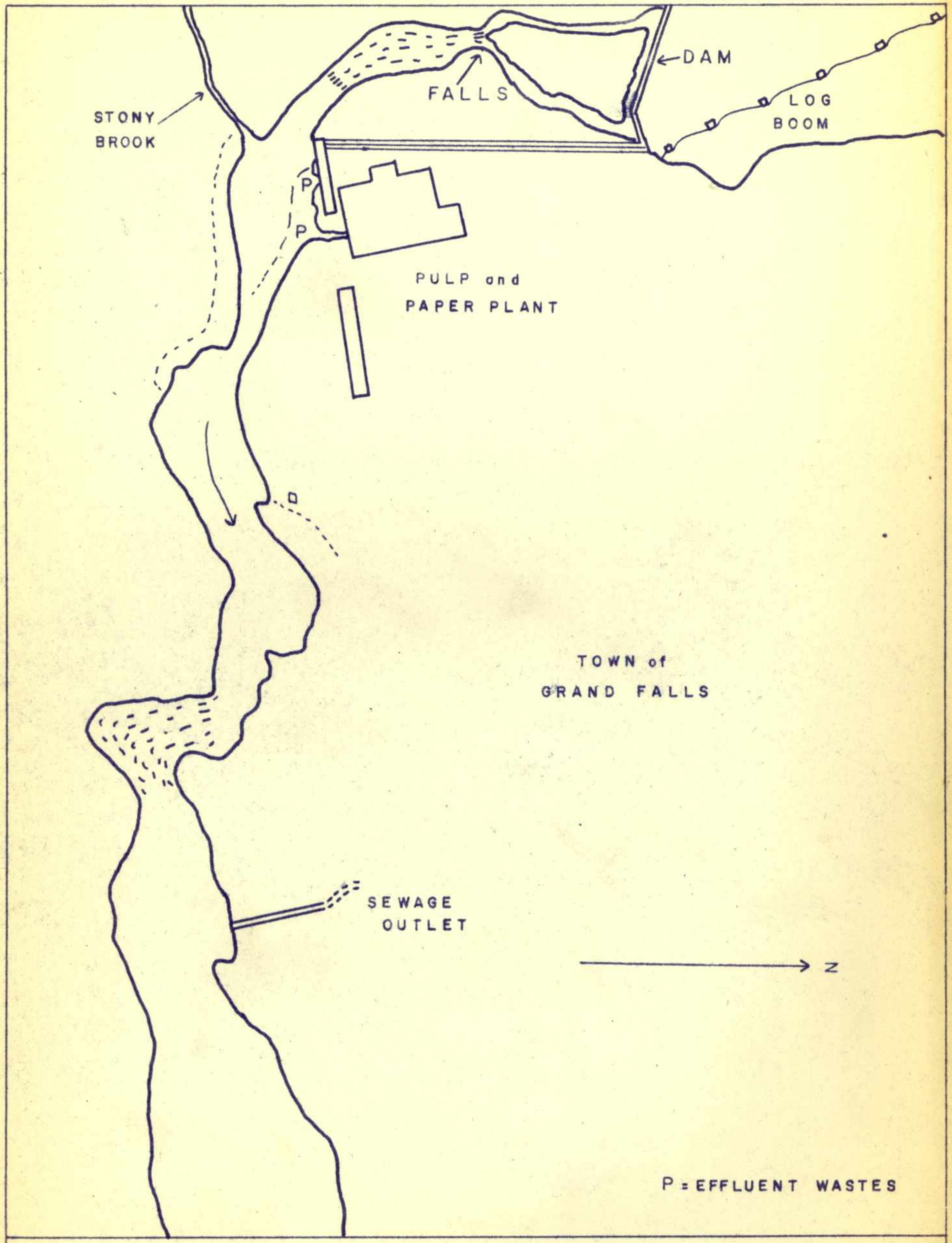
Industrial wastes may detrimentally affect aquatic life by (a) excessive utilization of dissolved oxygen by the foreign matter; (b) changing the hydrogen-ion concentrations; (c) smothering of organisms (vertebrate and invertebrate) and natural river bottom soils, and finally, (d) through the accumulation of definitely toxic substances (Henderson, C. 1949). Migratory fish such as Atlantic salmon may be transiently subjected to one or several of these effects in passing through polluted regions of a river, also, their offspring may be forced to seek existence in such waters for varied periods of time until their seaward migration.

The Exploits River has, for many years, borne a burden of wastes from pulp and paper manufacturing and sewage wastes which enter the river at Grand Falls. Also, effluents resulting from hydraulic mining at Buchans, are disposed of into Red Indian Lake.

- Pulp and Paper Wastes -

Grand Falls

The Anglo-Newfoundland Development Company has operated a pulp and paper mill at Grand Falls for the past 50 years. At present the plant produces 800 tons of newsprint and 45 tons of wrapper per day (Paper Making at Grand Falls - undated). Spruce



Grand falls and Exploits river

Scale : 1 inch = 550 feet

and fir are utilized in a combined Groundwood-Sulphite process. Paper manufacturing here results in the deposition of bark, wood fiber, and chemical effluents in the river.

The problems of determining what effects are brought about by these depositions, and the extent to which they have a detrimental effect on salmon have not been resolved. Calderwood (loc. cit.) has stated ".....dilution here is very considerable, and in a comparatively short distance the white waste disappears from the water .... The fact remains that salmon are freely caught in the clear water opposite the mill, below Stony Brook. On that side of the river they are able to avoid the sulphite waste liquor". At the time of writing, he believed "....the sulphite waste does not injure the angling, although it may, for some distance, entirely prevent fish rising". Waldichuk, M. 1956, in discussing Industrial Pollution, indicates "In general, effluents from a given tonnage of sulphite pulp produces about 10 times as great a pollution hazard as that from an equal tonnage of Kraft pulp".

The Grand Falls digester system is capable of producing 200 tons of sulphite pulp per day. It would appear then that effluents from this level of production do constitute a danger to salmon. Certain circumstances may modify this danger.

Flow patterns and the velocity of the river at the entrance of the main effluent is such that white waste does not extend completely across the river. Rather, it covers 50 to 60 feet of the river's width (total width in this section is. perhaps, 300 to 350 feet), and is visible 800 to 1000 feet downstream from its point of origin.

There are two principal sources of effluent at the Grand Falls Mill. Firstly, a profuse but intermitant flow of "calcine" residual, waste liquor, and wood fiber, which result from the production of SO_2 gas and pulp, by the Sulphite process.(The periodicity of this flow is not known). A second but lesser, and apparently continuous, flow enters some 100 yards downstream, and possibly is residual water removed in the production of paper. There are also three minor sources of relatively clear water emerging at various points between and above these major sources of effluent.

A preliminary survey of the effects of these effluents will be carried out in the near future.

A bark disposal problem accompanies the dangers of chemical effluents from the mill. A series of 6 drum barkers process 525 cords of wood per drum per day, and remove in the order of 10 to 15 tons* of dry bark per day. The bark, after removal, is periodically dried, pressed, shredded, and burned in boilers for generating steam. When sufficient stores of pressed bark has been gathered, the removed bark, rather than being pressed, is diverted into the river to be carried downstream and settle to the bottom in regions of low water velocity.

Oxygen demanded by decomposition of this organic deposit may, in areas of relatively quiet water or in periods of low water, reduce dissolved oxygen level to below minimum requirements of salmon.

An attempt will be made, in the near future, to delimit these settling areas, and evaluate in more detail, the chemical and physical effects resulting from intermitant bark disposal.

* Estimated.

Bishop's Falls

Previous to 1953 a pulp mill was operated at the present site of Bishop's Falls Power Plant. As far as can be determined, this plant had a production of 130 tons of groundwood per day. All stock produced was hydraulically pumped to the Grand Falls Paper Mill.

Groundwood pulp production requires little or no chemical action, but is essentially a mechanical process. It is assumed, then, that effluents from the plant had little effect on salmon. Bark removal may have been quite prodigious. Calderwood (loc. cit) has pointed out that bark was screened against entrance to the river. Large piles of partially decomposed bark are still in evidence below the powerhouse, but the contamination of water resulting from this decaying material does not seem to be of great importance.

- Mining Wastes -

Hydraulic mining of lead and zinc at Buchans produces residual silts which flow into Red Indian Lake via Buchans Brook. From the air the light gray colour of these silts may be seen covering an area of 100 acres or more, and extending well into central regions of the lake. This outstanding irregularity may have a direct effect on fish resident in the lake, and indirectly influence the chemical composition of lake water flowing into the Exploits River - thereby affecting fish present in the river.

- Sewage -

Domestic sewage disposal at Grand Falls and the adjacent town of Windsor result in two sewage disposal areas along the river.

Sewage from Grand Falls has been directed into the river for an unknown number of years, and enters presumably in an unaltered state approximately $\frac{3}{4}$ of a mile below the Paper Mill.

A sewage line from Windsor was completed in 1958, and is thought to be equipped with a comminutor to facilitate dispersal of raw sewage. The exit of this line is adjacent to the exit of Grand Falls sewage outlet.

It is believed that the amount of raw sewage presently entering the river is sufficiently diluted so that dangerous levels of contamination are not experienced.

- Petroleum Oils -

Drainage and sludge removed from diesel engine service pits at the Bishop's Falls C.N.R. Roundhouse have been reported to have deleterious effects on salmon.

These cleanings are dumped into a moderate size settling basin, through which a small creek is flowing. Oils are transported via this stream to the Exploits River.

Appearance of oils on the surface of river water in this area is not continuous (its periodicity is not known). At the time of observation a film of oil extended 70 to 80 feet toward mid-water, and was visible approximately 100 yards downstream from its origin at the mouth of the small creek.

This problem has been brought to the attention of authorities on several occasions, and those responsible for this contamination have taken steps to reduce it. Further observations may be of some value in establishing the effect this might have on salmon.

EFFECT OF INDUSTRIAL DEVELOPMENT

Two major industries, paper-making and heavy metal mining, form the basis of economy in Central Newfoundland. Each of these are dependent to varying degrees on water supplies provided by the Exploits River system.

Development of these industries, particularly paper-making, has brought about extensive alterations to the main stem of the river and many lakes and tributary streams.

Mining operations, as they are conducted at Buchans, have made use of stored water from Buchans Lake and Red Indian Lake as a waste disposal basin for the past 30-50 years. Continued logging operations require building of dams and manipulation of water levels, while paper-making, as previously noted, necessitates disposal of waste materials.

Taken together or separately these factors alter natural environmental conditions required by fish, and ultimately lead to suppression of existing fish populations.

In view of the widespread effect paper-making and logging has on salmon in this area, an outline of the industry's development and operation is given below.

- History of the Logging Industry -

A lumber industry, dependent on White Pine (now obsolete in the area), existed for some 20 years previous to initiation of paper-making. These operations made use of the main Exploits River in transporting logs from Red Indian Lake to Botwood (Bay of Exploits). The effects of this early industry on the river and its fish populations are lost in history, being masked by the advance of pulp and paper-making.

The Anglo-Newfoundland Development Company, initiating their operations at Millertown, have maintained a widespread pulpwood logging program throughout the watershed since 1905. Construction of the mill and power dam at Grand Falls began about the same year, and went into operation in 1909. Their storage dam at the mouth of Red Indian Lake was, quite probably, constructed about the same time.

The A.E. Reed Company, now annexed by the Anglo-Newfoundland Development Co. Ltd., began pulp manufacture at Bishop's Falls in 1909. Their initial source of pulpwood was Great Rattling Brook and Jumper's Brook areas.

- Logging Activities -

Pulpwood cutting has been active in recent years in more remote areas of Great Rattling, Sandy Brook, and Victoria Lake tributary systems. Formerly Badger Brook, Noel Paul Brook, Harpoon Brook, and regions proximate to the Exploits River, were areas of greatest activity. These latter regions, having been logged over, are now dormant and await maturation of a regenerated tree growth. This rotation of logging centers (requiring approximately 80 years to complete one cycle) involves a drainage-wide distribution of logging dams. Dams, in various states of repair, are most common on larger tributaries where log driving was, or is, recurrent throughout warm seasons. Small tributaries entering directly into the river are generally not blocked by dams, since driving on these streams is dependent on high water conditions of late Spring.

Logging operations are relatively unmechanized as yet. This lack of mechanization has allowed stream beds to remain relatively unaltered, since they are not used as tractor roads and wood storage areas.

Cutting of wood has been conducted with reasonable consideration given to keeping streams clear of slash etc., though scattered examples of debris collection at old dams are in evidence.

Dense, low, deciduous tree growth along stream banks appears to be left undisturbed. Hence stream bank erosion is not excessive. A canopy of White Birch is left untouched in most areas, and is sufficiently dense to retain top soils, thus large scale erosion problems are avoided.

Bark deposition in streams used in log driving constitutes a possible hazard to eggs and young salmon. These deposits bring about depletion of vital dissolved oxygen.

On streams where driving occurs periodically throughout the Summer, log jams may prove hazardous to migratory adult salmon. Should streams be completely or partially blocked, hold-up problems may occur. Spawning bed disturbances may also result from excessive abrasion by jammed logs.

Log booms (specifically designed to direct or retain logs) are also hazardous. Hazards arise, as in the case of Log-Boom Landing (c.f. Obstructions on Main River), where pulpwood is jammed from stream surface to bottom during periods of adult salmon migration and descent of smolts. Oxygen depletion and destruction of spawning beds may occur when bark deposits are allowed to collect downstream from these devices.

SUMMARY

(1) During the Summer of 1958 a survey was carried out on approximately 1300 square miles of the Exploits River drainage between Grand Falls and Red Indian Lake. Information was also gathered on the area between Grand Falls and tidewater.

(2) Data was obtained on 47 artificial, and 24 natural, obstructions in the system. Three major obstructions on the main river at Bishop's Falls, Grand Falls, and Red Indian Lake, and three total obstructions on significant tributaries in the Lower Drainage, prevent salmon from making full use of the system. Main river obstructions should be given first consideration.

(3) Salmon can ascend the river only to Grand Falls, 16 miles from the river's outlet. Prior to 1911 they may have had access to regions above this point.

(4) The estimated annual run of salmon is 3000 - 6000 fish. The system may be capable of supporting a potential spawning escapement of 35,000 to 40,000 fish. Removal of the blockade at Grand Falls alone would allow the development of an estimated annual escapement of 19,500 fish.

(5) Four tributaries, namely Sandy Brook, Badger Brook, Noel Paul Brook, and Harpoon Brook, appear to have the greatest potentials and would sustain a large portion of the system's future salmon population.

(6) Some manner of artificial stocking would aid in reaching maximum utilization of the inaccessible area within a

reasonable period of time.

(7) Fish populations, including Atlantic salmon, Ouananiche, and Brook trout, are subject to very little angling pressure. The reported catch of Atlantic salmon has varied between 80 to 600 fish over the past six years.

(8) Physical and chemical conditions (in natural waters) appear to be suitable for the development and maintenance of greater numbers of salmon. An exception is found in the Grand Falls area where industrial effluents and bark from paper-making operations are deposited in the main river.

(9) Major centers of logging are presently Victoria Lake, Sandy Brook, and Great Rattling Brook areas. Log driving is conducted primarily during the Spring months, and to a lesser extent throughout the Summer. Superficial observations indicate that these operations may hinder salmon migration, spawning, and survival of the young.

(10) The majority of dams are closed while not in use, and several have deteriorated, or otherwise block fish passage facilities.

RECOMMENDATIONS

Recommendations are offered on the basis of preliminary information presented in this report.

(1) Advantage should be taken of the high productive potential presented by the Exploits River Lower Drainage. This would require removal of the total obstruction at Grand Falls, and gradual development of at least four useful tributary systems.

(2) Two partial obstructions on the main river and two total obstructions on major tributaries above Grand Falls in the same locality should be made passable to salmon as conditions require.

(3) The effect of Bishop's Falls Obstruction in delaying or blocking passage of salmon should be evaluated.

(4) More accurate data should be obtained concerning numbers of salmon utilizing accessible areas of the drainage.

(5) The reproductive efficiency of this salmon population should be evaluated so that future development of the run may be anticipated,and assisted if necessary.

(6) More accurate data should be collected concerning the ability of Ouananiche and Brook trout populations to support a useful sport fishery.

(7) Data should be obtained concerning toxic effects on fish resulting from bark and effluent disposal at the Grand Falls Paper Mill.

(8) The varied ramifications of logging operations, particularly stream bed modifications and water fluctuations, should be studied to determine the effects such operations have on anadromous fish in the area.

(9) Attempts should be made to maintain all streams clear of debris and unobstructed after logging operations on the stream have temporarily or permanently ceased.

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APPENDIX A

Artificial and Natural Obstructions on Tributaries of the Exploits River.

APPENDIX A.

DISTRICT ....

Stream Obstructions

( )
Artificial

C Complete Obstr.		BD	Beaver Dam
F Falls		LD	Logging Dam
L Logging Jam		PD	Power Dam
P Pollution		PO	Partial Obstr.
R Rapids		#	Estimated
U Underground Stream			

Name of Main River	Index No.	Location of Obstruction: Tributary	Obst NO.	Details	Type	PO or C	Dimensions: No of Gates	Height of Gate	Width of Gate	Suggested Remedial Action
Great Rattling Brook	C 89-3	N/A	1	At exit of Camp 1 Lake	LD	C	1 gate 1 sluice	8 ft.	8 ft.	Fishway being installed
		Tote Brook	2	At exit of Tote Lake		P	3 gates 1 sluice	2@20'# 1@15'#	22 ft.	Fishway being installed
Little Rattling Brook	C 89-4	N/A	3	4 miles above mouth	LD					
" " "		N/A	4	8½ miles above mouth	LD					
" " "		N/A	5	At exit of Rattling Lake	LD					
Lemottes Brook	C 89-8	N/A	8	1/5 mile above mouth	LD	P	1	5 ft	6 ft	Nil
Sandy Brook	C 89-11	N/A	10	18 miles above mouth	LD	P	3	?	?	Maintain open gates and minimum flow.
			11	20½ miles above mouth at exit of Sandy Lake	LD	C ?	5	1@4 ft 4@8ft	3@ 6 ft 2@ 9 ft	Maintain open gates and minimum flow.
		West Brook	12	2 miles above junction with Sandy Brook	LD	P	2	10 ft	8 ft	Maintain open gates and minimum flow.

DISTRICT ....

Stream Obstructions

(Artificial)

C Complete Obstr.	BD Beaver Dam		
F Falls	LD Logging Dam		
L Logging Jam	PD Power Dam		
P Pollution	PO Partial Obstr.		
R Rapids	# Estimated		
U Underground Stream			

Name of Main River	Index No.	Location of Obstruction: Tributary	Obst. No.	Details	Type	PO or C	Dimensions: No. of Gates	Height of Gate	Width of Gate	Suggested Remedial Action
Sandy Brook	C 89-11	West Brook	13	1 mile above West Lake. Dry stream below.	LD	C ?	2	10	8	Fishway desirable, otherwise maintain open gates and minimum flow.
		West Brook	14	3½ miles above West Lake. Not yet constructed	LD	?				Examine when built.
		West Brook	15	5 miles above West Lake. completed 1958	LD	P	2	12	9	Fishway desirable, otherwise maintain open gates and minimum flow.
		Coronation Brook	16	3 miles above junction with Sandy Brk.	LD					
		Caledonia Brook	17	2 miles above junction with Coronation Brk.	LD					
			18	7 miles above junction at exit of large lake	LD					
Aspen Brook	C 89-14	N/A	21	2 miles above mouth	LD	C ?	2			
Tom Joe Brook	C 89-15	N/A	26	2 4/5 miles above mouth	LD	C ?				Remove debris from gate slots.

DISTRICT ....

Stream Obstructions

(~~Natural~~)
Artificial

C Complete Obstr.	LD Beaver Dam		
F Falls	LD Logging Dam		
L Logging Jam	PD Power Dam		
P Pollution	PO Partial Obstr.		
R Rapids	# Estimated		
U Underground Stream			

Name of Main River	Index No.	Location of Obstruction: Tributary	Obst. No.	Details	Type	PO or C	Dimensions ~~Survey Date~~: ~~Rock.~~ No. of Gates	Height of Gate	~~Avg.~~ Width of Gate	Suggested Remedial Action ~~Final Disposition~~
			27	6½ miles above mouth	LD	C				Remove debris and old gate slot.
Middle Brook	C 89-16	N/A	30	5 miles above mouth	LD	C ?	2	6 ft.	6 ft.	Abandoned; remove gate and provide minimum flow.
		N/A	31	½ mile above 1st large lake	LD	P	1			Abandoned. Gates not present. Remove and clear stream
Pomahac Brook	C89-18	N/A	32	2 miles above mouth at exit of lake	LD	P	1	-	6 ft.	Abandoned. Gates not present. Remove and clear stream
Junction Brook	C 89-19	N/A	35	4½ miles above mouth at exit of small lake	LD	C ?	2	8	8	Adjustment of gate floor, and maintain minimum flow.
		N/A	36	At exit of Middleton Lake	LD	C	3	2@ 10' 1@ 5'	2 @ 8' 1 @ 10'	Adjustment of gate floor. Maintain minimum flow.
Badger Brook		N/A	38	At exit Joe's Lake	LD	C ?	3	12 ft	2 @ 9' 1 @ 12'	Adjustment of gate floor. Fishway may be necessary.
		N/A	39	At exit of Rocky Lake	LD	P	2	6 ft.	1 @ 9' 1 @ 12'	Maintain open gates and minimum flow.

DISTRICT ....

Stream Obstructions

(Artificial)

C	Complete Obstr.	BD	Beaver Dam
F	Falls	LD	Logging Dam
L	Logging Jam	PD	Power Dam
P	Pollution	PO	Partial Obstr.
R	Rapids	#	Estimated
U	Underground Stream		

Name of Main River	Index No.	Location of Obstruction			Type	PO or C	Dimensions			Suggested Remedial Action
		Tributary	Obst. No	Details			No. of Gates	Height of Gate	Width of Gate	
		N/A	40	At exit of Trouble Pond	LD					
		N/A	41	At exit of South Twin Lake	LD	C	4	1@10 ft 3@ 6 ft	1 @ 9 ft 2 @ 7 ft 1 @ 10 ft	Maintain open gates and minimum flow.
Badger Brook	C 89-20	North Twin Brook	42	At exit of North Twin Lake.	LD	P ?	3			Maintain open gates and minimum flow
		Mary Ann Brook	43	At exit of Mary Ann Lake	LD		2	12 ft.	9 ft.	Maintain open gates and minimum flow.
Red Indian Brook	C 89-21	N/A	44	5 miles above mouth Retainer wall across stream		P ?	1	5 ft #	6 ft. #	Remove or maintain open.
		N/A	45	10 miles from mouth at exit of 1st lake	LD	P ?	2	6 ft	6 ft.	Maintain open gates and minimum flow.
Noel Paul Brook	C 89-23	N/A	47	14 4/5 miles above mouth - at exit of Noel Paul Steady	LD	C	4 11 chutes	16 ft 4 ft	6 ft. 9 ft.	Fishway required.

DISTRICT ....

Stream Obstructions

(~~Natural~~)
Artificial

C Complete Obstr.	BD Beaver Dam
F Falls	LD Logging Dam
L Logging Jam	PD Power Dam
P Pollution	PO Partial Obstr.
R Rapids	# Estimated
U Underground Stream	

Name of Main River	Index No.	Location of Obstruction: Tributary	Obst. No	Details	Type	PO or C	Dimensions: No. of Gates	Height of Gate	Width of Gate	Suggested Remedial Action
Noel Paul Steady	C 89-23	N/A	49	6 miles above Noel Paul Steady	LD	C	2 7 chutes	2 @ 8' # 5 @ 5' # 2 @ 3'	2 @ 6' # 6 @ 15' # 1 @ 7' #	Fishway required.
		N/A	50	13 miles above Noel Paul Steady	LD	P	2	4 ft #		In disrepair. Maintain minimum flow.
		N/A	51	At exit of Douglas Lake	LD	P ?	2 1 chute	2@15' 1@ 6'	2 @ 9 ft. 1 @ 15 ft.	Adjust sluice floor. Fishway may be required.
Michaels Brook	C 89-25	N/A	54	1 mile above mouth	LD	P	2			In disrepair.
		N/A	56	5½ miles above mouth	LD	P				In disrepair.
		N/A	57	7½ miles above mouth at exit of lake	LD	P				
Harpoon Brook	C 89-29	N/A	59	6 miles above mouth	LD	C	2	1@ 9' 1@6'	9 ft. 9 ft.	In disrepair. Remove debris and maintain minimum flow.
		N/A	60	At exit of ~~first~~ Second small lake	LD	?	2			
		N/A	61	At exit of Ambrose Lake	LD	P	2	10 ft.	9 ft.	Maintain open gates and minimum flow.

DISTRICT ....

Stream Obstructions

(~~Natural~~ Artifical)

C Complete Obstr.
F Falls
L Logging Jam
P Pollution
R Rapids
U Underground Stream
BD Bear : Dam
LD Logging Dam
PD Power Dam
PO Partial Obstr.
Estimated

Name of Main River	Index No.	Location of Obstruction: Tributary	Obst. No.	Details	Type	PO or C	Dimensions: No. of Gates	Height of Gate	Width of Gate	Suggested Remedial Action ~~Final Disposition~~
Name unknown (Immediately below Exploits Dam) on south side	89-31	N/A	62	½ mile above mouth	LD	?	2			
		N/A	63	6 miles above mouth at exit of lake	LD	P ?	1	10 ft	8 ft.	Maintain open gates and minimum flow.

APPENDIX A

DISTRICT ....

Stream Obstructions

(Natural)

C	Complete Obstr.	BD	Beaver Dam
F	Falls	LD	Logging Dam
L	Logging Jam	PD	Power Dam
P	Pollution	PO	Partial Obstr.
R	Rapids	#	Estimated
U	Underground Stream		

Name of Main River	Index No.	Location of Obstruction			Type	PO or C	Dimensions ~~Survey Date~~		Final Disposition
		Tributary	Obst. No	Details			Length	Height	
Green Woods Brook	C 89-5	N/A	6	At mouth	R	C	70 - 100	30 - 40	Remedial work required.
Stony Brook	C 89-6	N/A	7	At mouth	F & R	P			Remedial work required.
Sandy Brook	C 89-11	N/A	9	4½ miles above mouth	R	C	lower 100 ft# upper 150 ft#	45 ft # 30 ft #	Fishway required.
Leech Brook	C 89-12	N/A	19	½ mile above mouth	F	C	lower 35 ft. upper 10 ft.	40 ft. 30 ft.	
Aspen Brook	C 89-14	N/A	20	1½ miles above mouth	F	C	20 - 30 ft #	25-30 ft #	
Tom Joe Brook	C 89-15	N/A	22	½ mile above mouth	BD	C ?			Remedial work required.
		N/A	23	1½ miles above mouth	F	C	15 ft. #	10-12 ft #	Remedial work required.
		N/A	24	500 yds. above falls	BD	C			Remedial work required.
		N/A	25	2½ miles above mouth Series of 3.	BD				Remedial work required.
Tom Joe Brook	C 89-15	S.E. Branch (at 2nd Lake)	28	500 yds. above lake	F	C	10 ft.	8-10 ft.	Remedial blasting.
Middle Brook	C 89-16	N/A	29	½ mile from mouth series of 3.	BD	C			Remove if possible.
Junction Brook	C 89-19	N/A	33	½ mile from mouth	BD	C ?			Remove if possible.
		N/A	34	1½ mile from mouth	F	C	45 ft.	30-35 ft #	Remedial work required.

DISTRICT ....

Stream Obstructions

(Natural)

C	Complete Obstr.	BD	Beaver Dam
F	Falls	LD	Logging Dam
L	Logging Jam	PD	Power Dam
P	Pollution	PO	Partial Obstr.
R	Rapids	#	Estimated
U	Underground Stream		

Name of Main River	Index No.	Location of Obstruction			Type	PO or C	[illegible]		Final Disposition
		Tributary	Obst. No.	Details			[illegible] Length	[illegible] Height	
Badger Brook	C 89-20	N/A	37	2½ miles above mouth series of 3 rapids - 2nd most severe	R	P ?	75 ft.	10-12 ft#	Remedial work may be required.
Black Duck	C 89-22	N/A	46	2 miles from mouth	BD	C			Remove if possible.
Noel Paul Brook	C 89-23	N/A	48	At inlet of Noel Paul Steady	R	P	250-300 ft	35-40 ft#	Remedial work required.
		N/A	52	½ mile above Douglas Lake	R	C	300-350 ft#	40-50 ft#	Remedial work required.
Michaels Brook	C 89-25	N/A	53	½ mile above mouth	BD	C ?			Remove if possible.
		N/A	55	3 miles above mouth	F	C	30-50 ft. #	15-20 ft#	Remedial work required.
Harpoon Brook	C 89-29	N/A	58	1½ miles above mouth	F	P	10 ft.	5 ft.	Remedial work required.

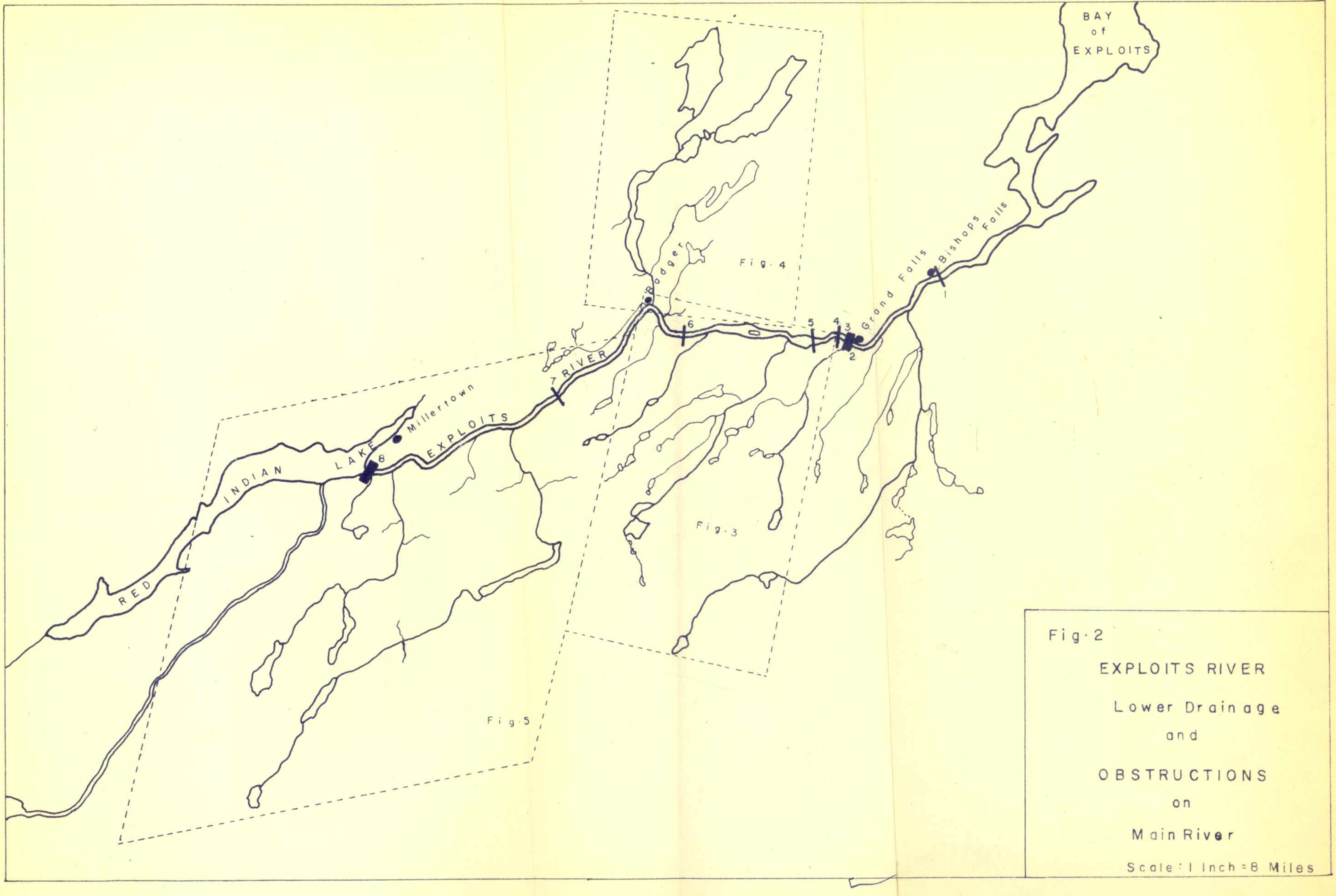
APPENDIX B

Figures

LIST OF FIGURES.

Fig. 1

OUTLINE of NEWFOUNDLAND
and
EXPLOITS RIVER DRAINAGE



Fig·2

EXPLOITS RIVER

Lower Drainage and OBSTRUCTIONS on Main River

Scale: 1 Inch = 8 Miles

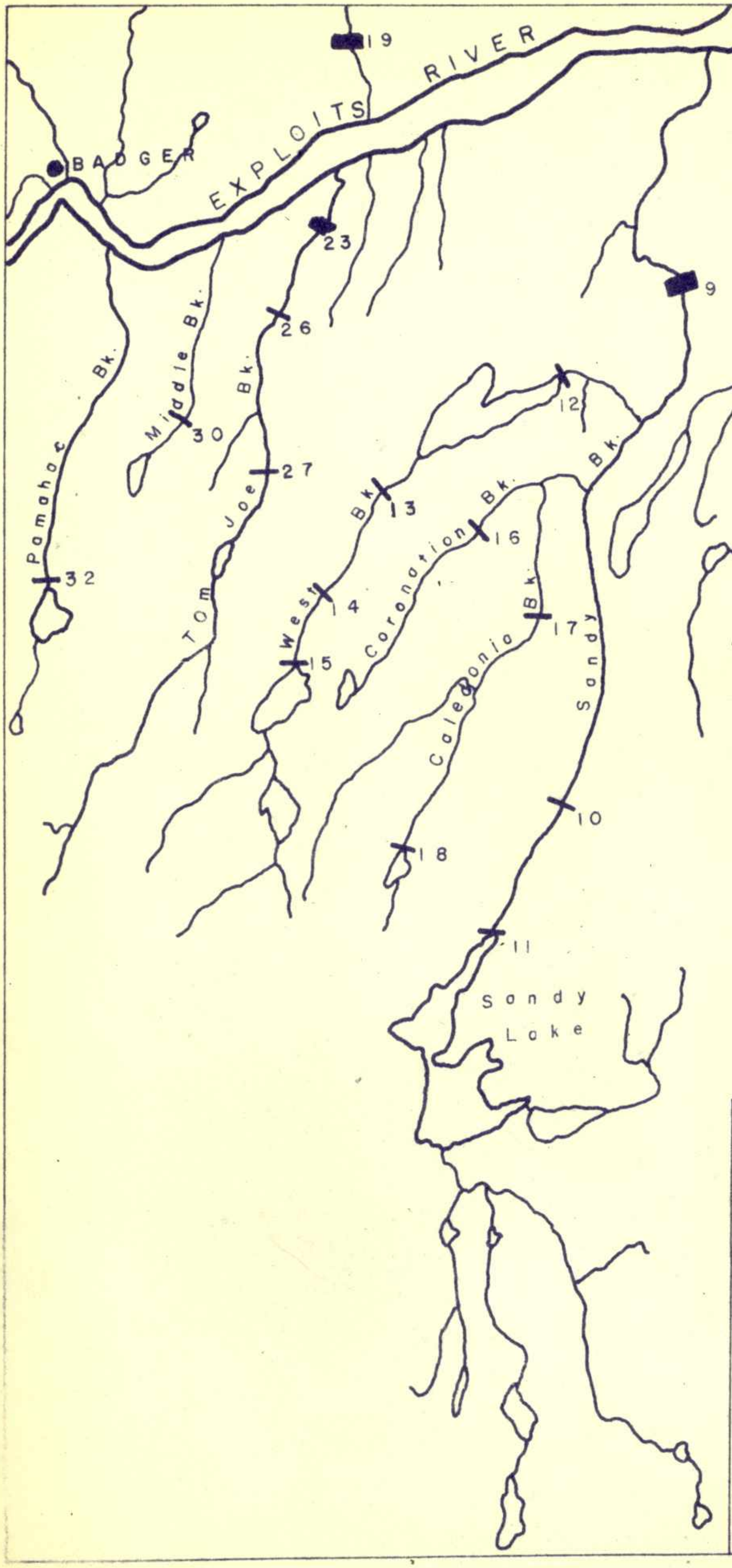


Fig. 3

OBSTRUCTIONS on TRIBUTARIES of the EXPLOITS RIVER

SCALE: 1 Inch = 2.5 Miles

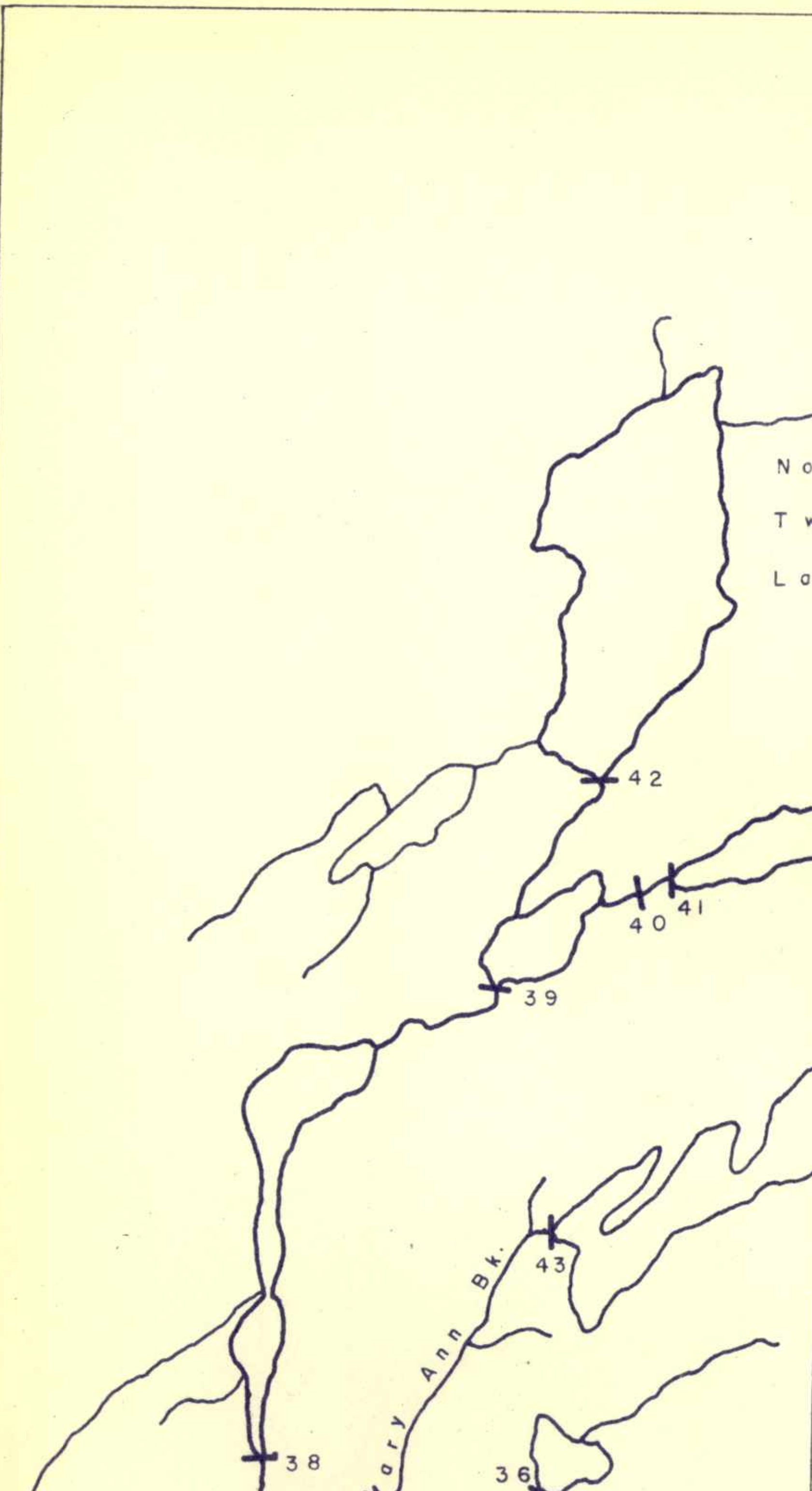


Fig. 4

OBSTRUCTIONS
on
TRIBUTARIES
of the
EXPLOITS RIVER

SCALE : 1 Inch = 2.5 Miles

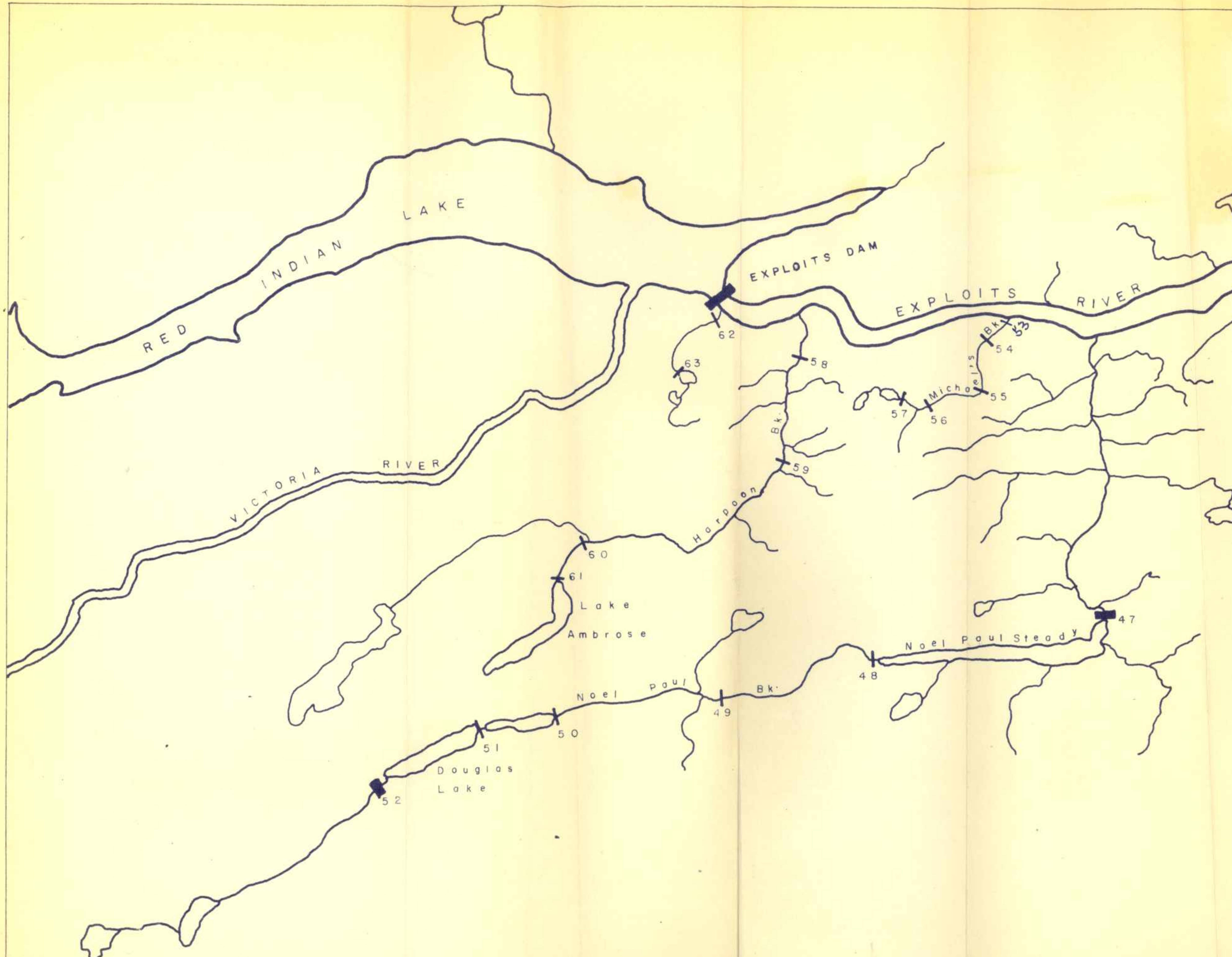
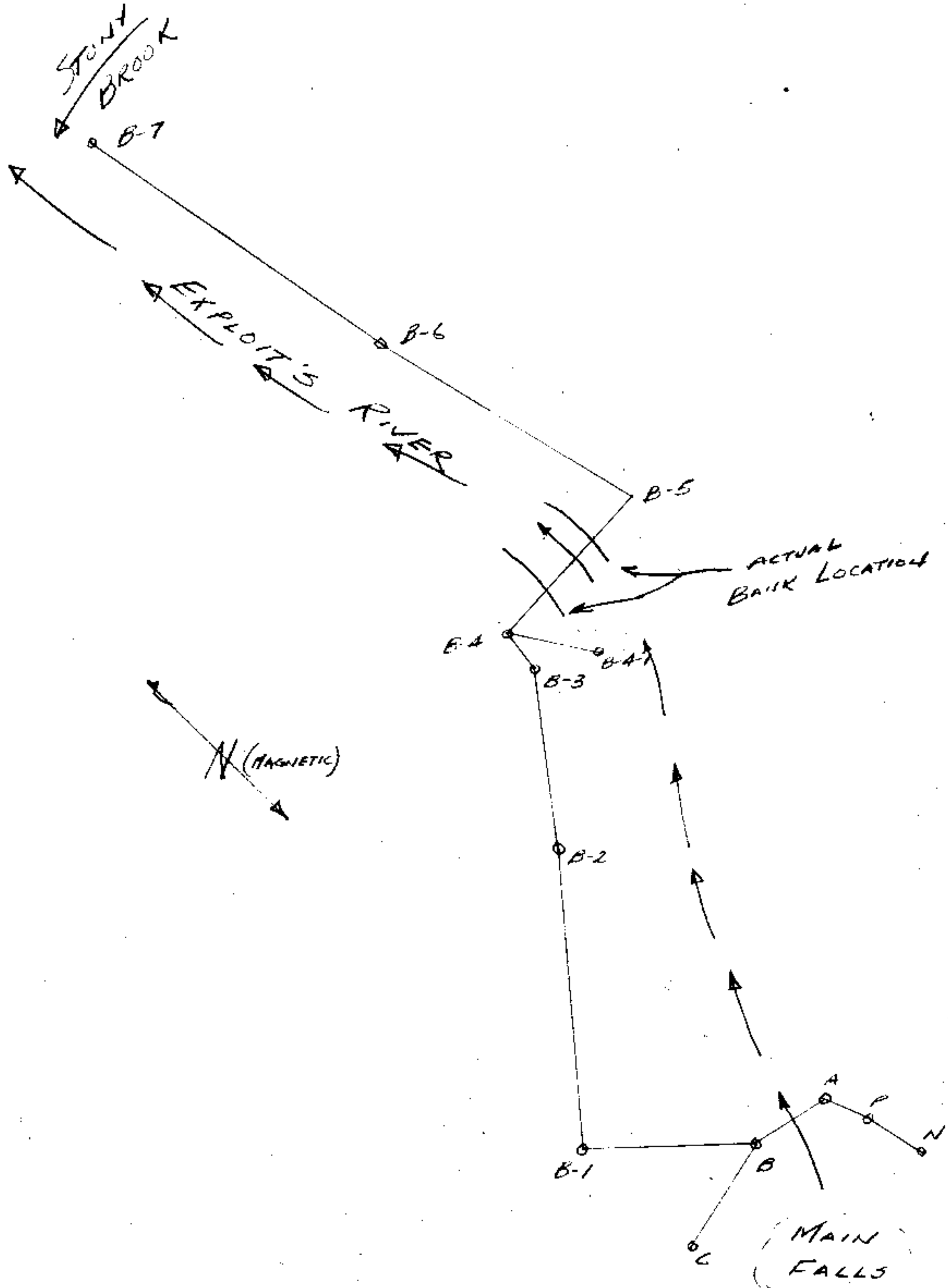


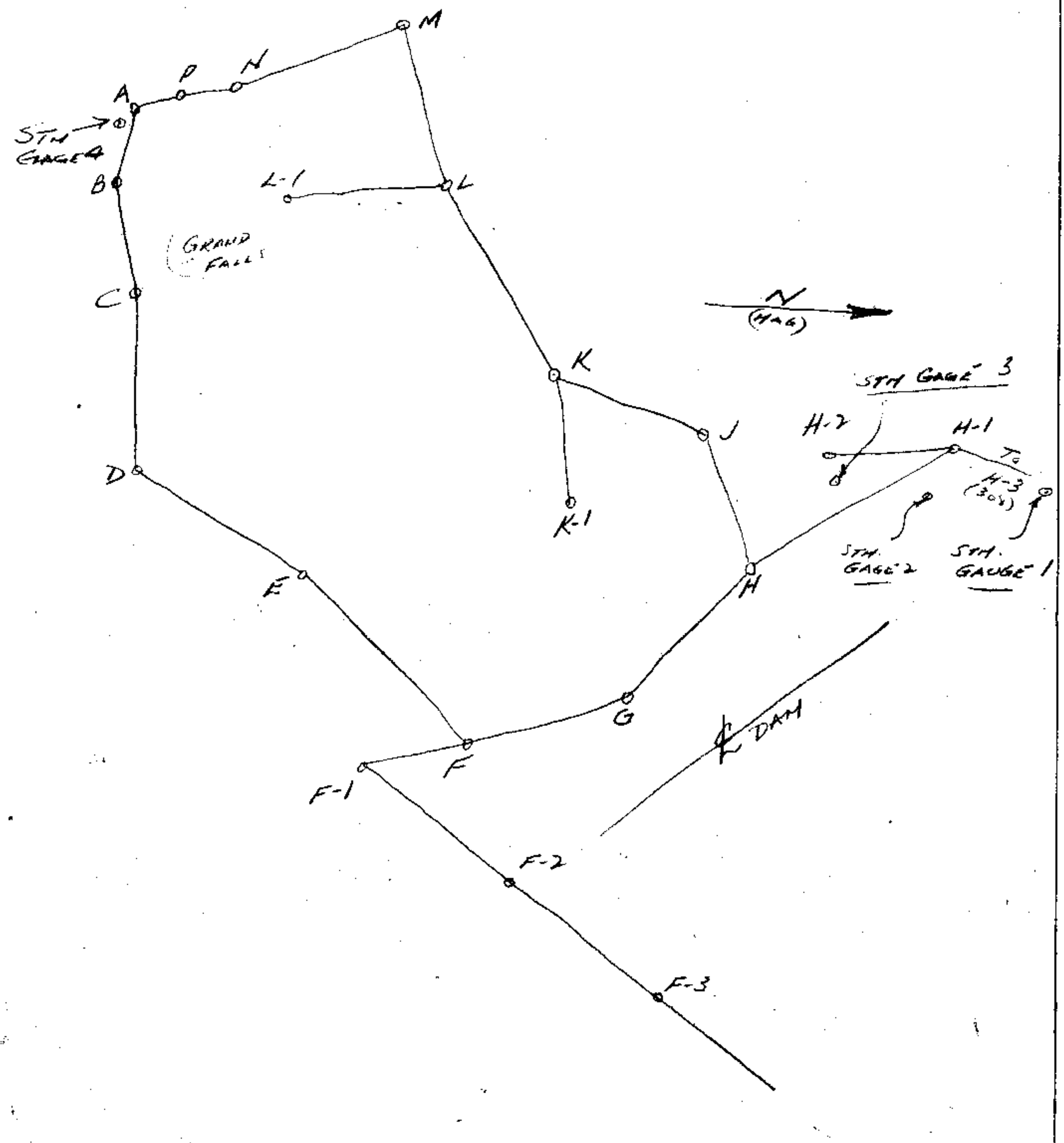
Fig. 5

OBSTRUCTIONS on TRIBUTARIES of the EXPLOITS RIVER

SCALE: 1 Inch = 2.5 Miles



DRAWN: R. GOULD	DEPARTMENT OF FISHERIES, CANADA	DATE: 13-6-60
CHECK:	EXTENSION TRAVERSE - GRAND FALLS	SCALE: 1" = 100'
APPROVED:		DWG. No.



DRAWN:	DEPARTMENT OF FISHERIES, CANADA	DATE:
CHECK:	— TRAVERSE —	SCALE: 1" = 200'
APPROVED:	— GRAND FALLS —	DWG. No.

Figure 6: Bishop's Falls Obstruction.

Figure 7: Grand Falls Obstruction.

Figure 8a: Upper Grand Falls Obstruction - Right Bank Run-around.

Figure 8b: Upper Grand Falls Obstruction - Central Fall.

Figure 8c: Upper Grand Falls Obstruction - Left Bank Rapid.

Figure 9a: Goodyear Falls Obstruction -
Left Bank Falls.

Figure 9b: Goodyear Falls Obstruction -
Right Bank Rapid.

Figure 10: Log Boom Landing.

Figure 11: Badger Chute Obstruction.

Figure 12a: Red Indian Falls - Upper Section.

AUG 1958

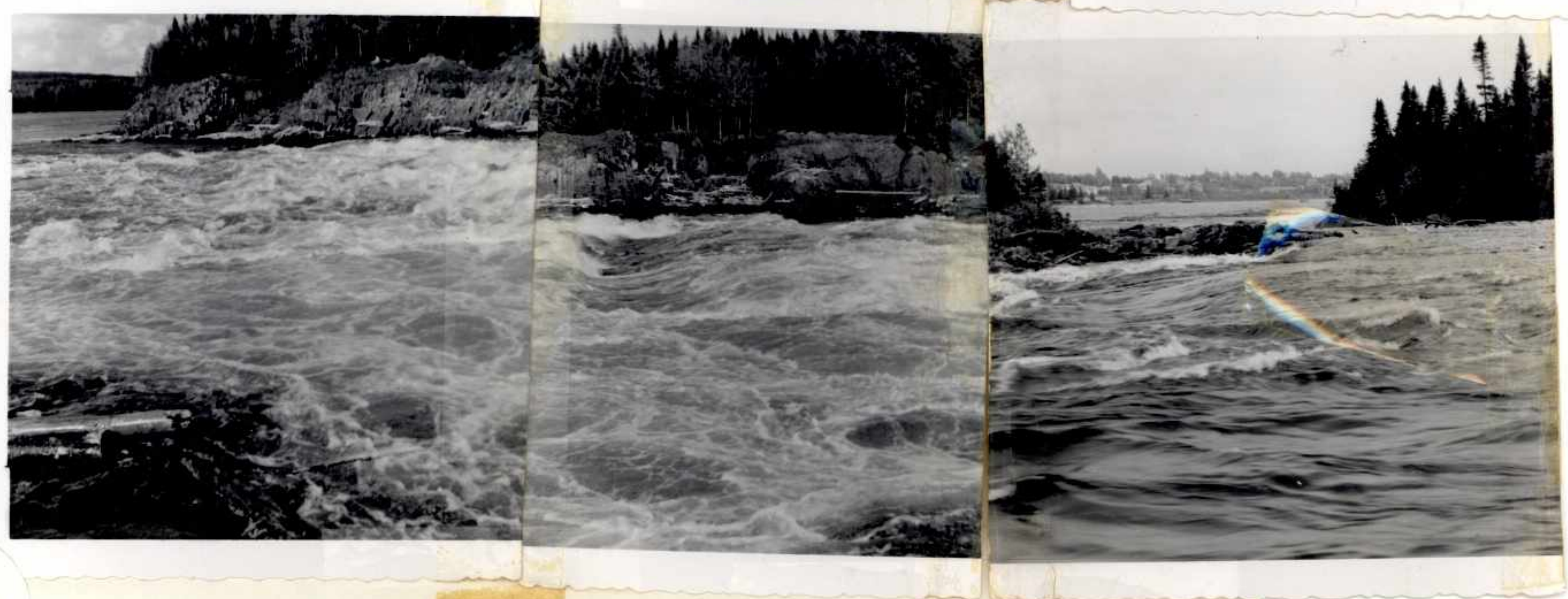


Figure 12b: Red Indian Falls - Lower Section.

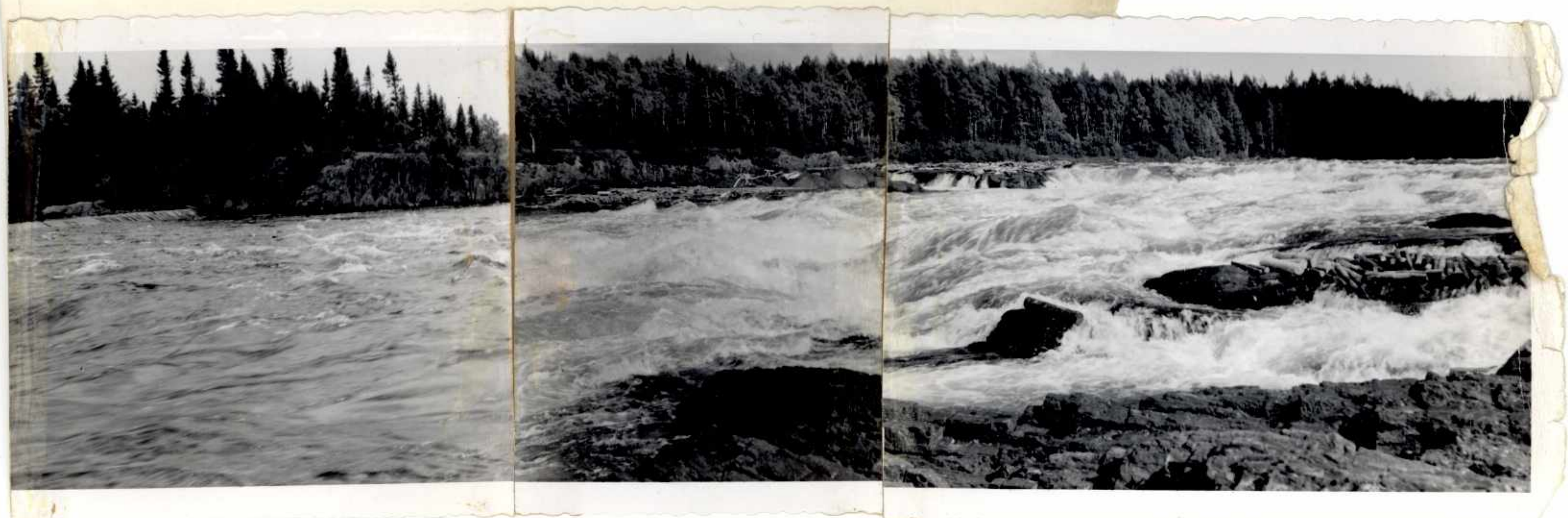


Figure 14a: Sandy Brook Falls - Lower Section

Figure 14b: Sandy Brook Falls - Upper Section

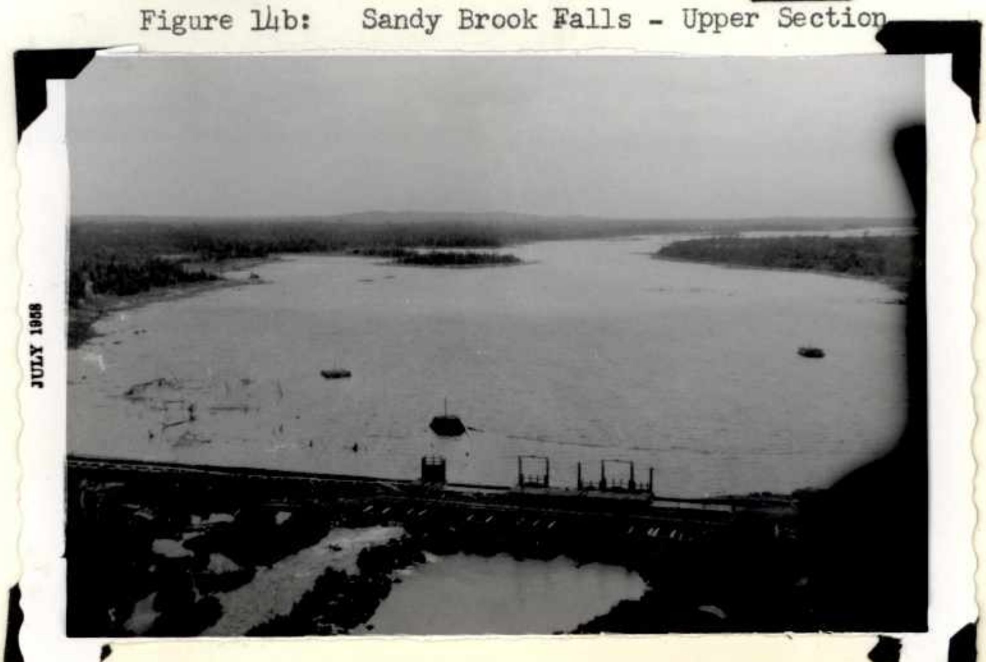


Figure 15: Main Dam on Sandy Brook (Obst. 11

Figure 16: Dam on West Brook (Obst. 15)

Figure 17: Obstruction on Tom Joe Brook (Obst. 23)

Figure 18: Badger Brook Mile 3 Rapid (Obst. 37)

Figure 19: Main Dam Badger Brook (Obst. 38).

Figure 20: Mary-Ann Lake Dam (Obst. 43)

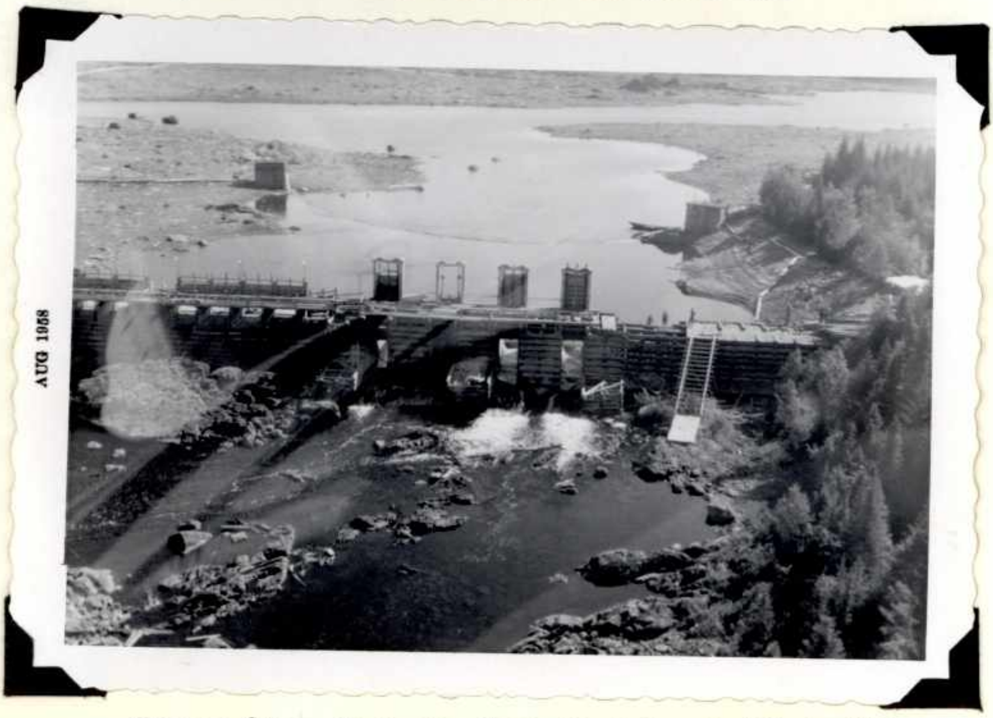


Figure 21: Main Dam Noel Paul Brook (Obst. 47)

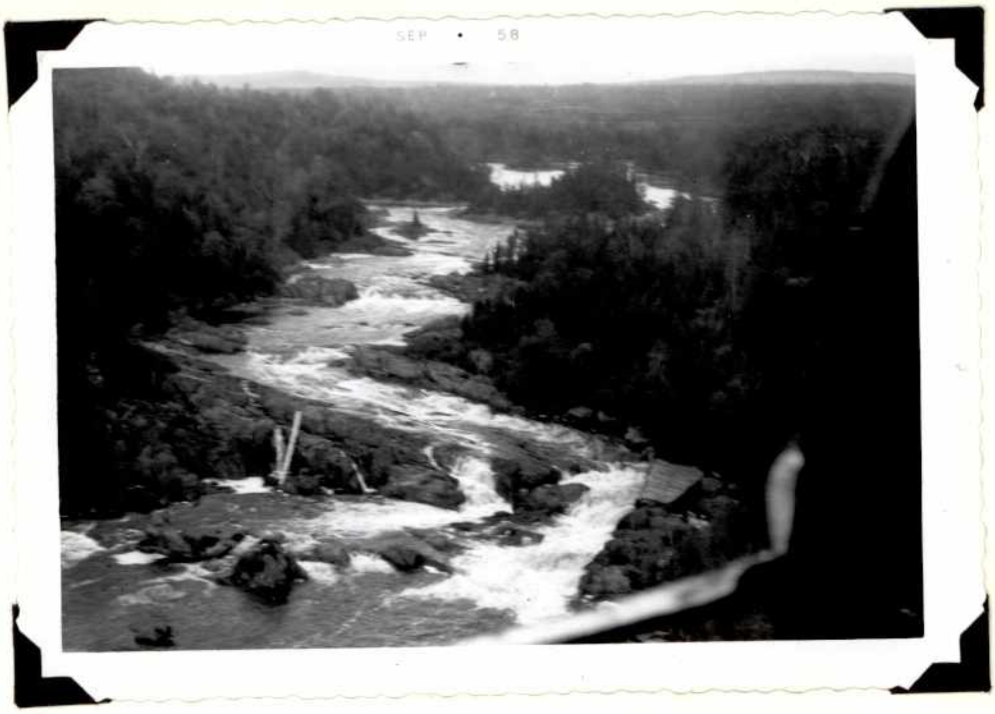


Figure 22: Rapids above Noel Paul Steady (Obst. 48)

Figure 23: Mile 30 Dam, Noel Paul Brook (Obst. 49)

Figure 24: Douglas Lake Dam, Noel Paul Brook (Obst. 51)

Figure 25: Falls on Harpoon Brook.

Figure 26: Mile 6 Dam, Harpoon Brook (Obst. 59)

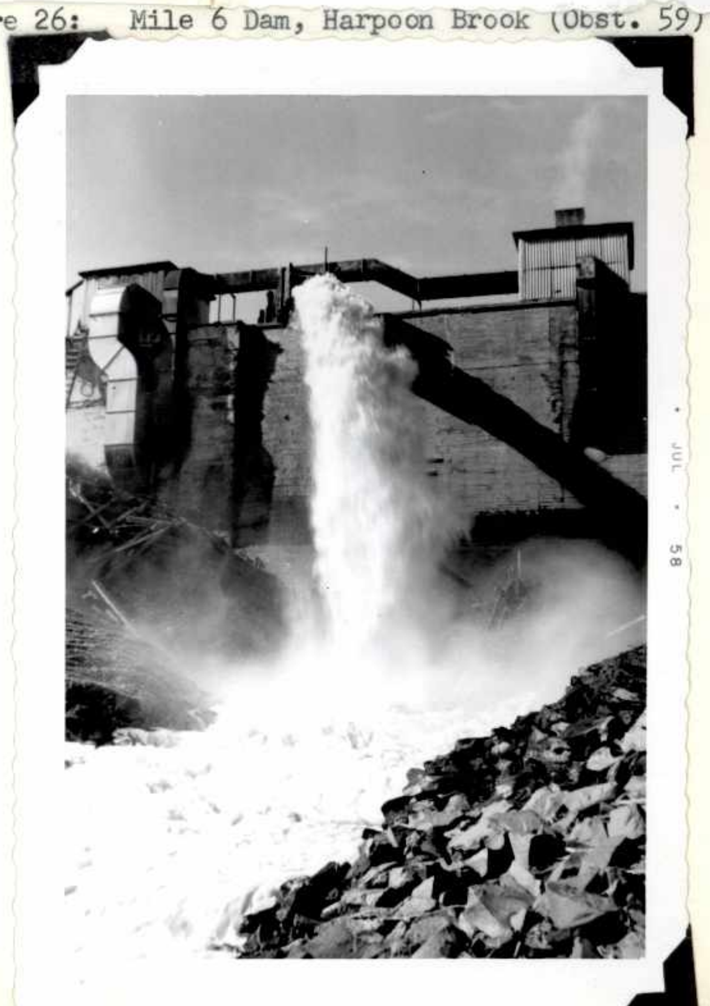


Figure 27: Effluent Discharge from Grand Falls Paper Mill.

Figure 28: Flow Pattern of Effluent Discharge from Grand Falls Paper Mill.

Figure 29: Noel Paul Steady at Low Water Level

Figure 30: Deteriorated Dam - Tom Joe Brook

Figure 31: Deteriorated Dam - Tom Joe Brook.

APPENDIX C

Salmon Angling Record of Exploits River

1911-1958.

Salmon Angling Record of Exploits River

1911 - 1958.

Year	Number of Fish Taken	
1911	134	
1912	83	
1913	-	
1914	57	
1915	51	
--	-	
1942	18	
1943	13	
1944	219	
1945	282	
1946	80	
1947	60	
1948	222	
1949	111	
1950	121	
1951	80	
1952	109	
	Grilse	Salmon
1953	616	45
1954	77	2
1955	382	3
1956	474	8
1957	657	11
1958	397	74

APPENDIX D

Atlantic Salmon Potential

Reference Tables.

SUMMARY OF SALMON REARING WATERS IN THE EXPLOITS RIVER.

SECTION	LENGTH (Miles)	AVERAGE WIDTH (Feet)	REMARKS	CLASSIFICATION*	
				Population (No. of fish)	Potential (No. of fish)
Mouth to Bishop's Fall Dam	3.5	800	Exceedingly deep waters. Little gravel.	--	Nil
Bishop's Fall Dam to Grand Falls	12.5	950	Bark deposits, effluents, deep waters.	--	Nil
Grand Falls to Goodyear Falls	2.0	950	Deep waters. Gravels inundated.	Nil	C - A
Goodyear Falls to Log Boom Land	2.0	950	Spawning conditions good along banks. Mid-waters deep.	Nil	C - D
Log Boom Land to Badger Chute	11.5	1500	Good to excellent spawning conditions throughout.	Nil	G
Badger Chute to Red Indian Falls	17.0	950	Spawning conditions good along banks. Mid-waters deep.	Nil	C - D
Red Indian Falls to Exploits Dam	21.5	550	Spawning conditions good along banks. Mid-waters deep.	Nil	C - D

* See note re basis of classification.

SUMMARY SALMON REARING WATERS IN TRIBUTARIES OF EXPLOITS RIVER.

TRIBUTARY	Index No.	Length of Stream # Main (miles)	Trib. (miles)	Total (miles)	REMARKS	CLASSIFICATION* Area (Cl.)	(Sq.mi.)	Population (No. of fish)	Potential (No. of fish)
--	C89-1	--	--	--		--	--	--	--
--	C89-2	--	--	--		--	--	--	--
Great Rattling Brook	C89-3	60	120	180	Excellent spawning and rearing potential.	5	572	E	H
Little Rattling Brook	C89-4	17	6	23	Not observed.	1	47	E	E
Green Woods Brook	C89-5	7	1	8	Of little value. Total obstruction at mouth.	1	14	Nil	C
Stony Brook	C89-6	20	6	26	Good spawning and rearing facilities.	2	100	E	E
Corduroy Brook	C89-7	3	--	3	Slow flowing, much submerged veg.	--	--	Nil	B
Lemottes Brook	C89-8	0.5	--	0.5	Narrow - of little use.	1	7	"	A
Rushy Pond Brook	C89-9	1	3	4	Slow flowing, much submerged veg.	1	17	"	B
Wigwam Brook	C89-10	3	--	3	Some spawning area, mostly bog.	--	--	"	B
Sandy Brook	C89-11	21	38	59	Excellent spawning and rearing potential.	3	197	"	F
Leech Brook	C89-12	7	--	7	Extensive bedrock. Major obstructions near mouth.	2	62	"	C
Pynn's Brook	C89-13	1	--	1	Slow flowing, Much submerged veg.	--	--	"	A
Aspen Brook	C89-14	2.5	--	2.5	Small amounts of spawning area. Total obstruction near mouth.	1	14	"	B
Tom Joe Brook	C89-15	7	2	9	Good spawning and rearing facilities.	1	29	"	D
Middle Brook	C89-16	6	--	6	" " " " "	1	) 16	"	C
Rocky Brook	C89-17	3	--	3	" " " " "	1	)	"	B
Pemahac Brook	C89-18	7	3	10	" " " " "	1	21	"	D
Junction Brook	C89-19	5	4	9	" " " " "	1	25	"	D
Badger Brook	C89-20	7	22	29	Excellent spawning and rearing potential.	4	276	"	E
Red Indian Brook	C89-21	10	5	15	Good spawning and rearing facilities.	2	54	"	D
Black Duck Brook	C89-22	7	--	7	" " " " "	1	13	"	C
Noel Paul Brook	C89-23	36	61	97	Excellent spawning and rearing potential.	4	388	"	G
Valley Brook	C89-24	2	--	2	Extensive bog.	--	--	"	A
Michaels Brook	C89-25	7	--	7	Good spawning and rearing facilities.	1	15	"	C
Name unknown	C89-26	2	--	2	Extensive bog.	--	--	"	A
Name unknown	C89-27	3	--	3	Good spawning and rearing facilities.	1	) 9	"	B
" "	C89-28	3	--	3	" " " " "	1	)	"	B
Harpoon Brook	C89-29	16	18	34	Excellent spawning and rearing facilities.	3	157	"	E
Name unknown	C89-30	2	--	2	Extensive bog.	1	--	"	A
" "	C89-31	6	--	6	Good spawning and rearing facilities.	1	23	"	C

#Not including standing waters

*See note re basis of classification.

BASIS OF CLASSIFICATION

This classification provides a means of comparing the suitability of individual tributary streams.* It is based on (a) the extent of drainage area, and (b) the size of the potential population.

Each mode of classification has been made more broad than required in considering the Exploits River drainage. This has been necessary in order that various stream systems throughout the Province may be compared in a similar manner.

Classification by Extent of Drainage Area.

Each stream has been placed in one of ten classes (numbered 1 to 10) on the basis of the size of area it drains. The classification is as follows:

Extent of Drainage Area	Class
Less than 50 square miles	1
51 - 125 square miles	2
126 - 250 " "	3
251 - 500 " "	4
501 - 1,000 " "	5
1,001 - 2,000 " "	6
2,001 - 3,000 " "	7
3,001 - 4,000 " "	8
4,001 - 5,000 " "	9
More than 5,000 " "	10

Classification by Size of Potential Salmon Population

The method of calculating numbers of salmon which a tributary may support has been outlined previously (c.f. Atlantic Salmon

* Adapted from previous staff reports.

Potential). Each stream has been placed into one of nine classes (indicated as A to 1) according to the number of salmon it may potentially support. The classification is as follows:

Potential Number of Salmon	Class
Less than 150	A
151 - 300	B
301 - 600	C
601 - 1,200	D
1,201 - 2,500	E
2,501 - 5,000	F
5,001 - 10,000	G
10,001 - 20,000	H
More than 20,000	I

Thus, Great Rattling Brook, classified as 5H, has the largest area and greatest potential in the system, while Badger Brook, classified as 4E, having a similar drainage area, does not have a correspondingly high salmon potential.