REPORT ON PROPOSED ABOIDEAU

GASPEREAU RIVER (KINGS COUNTY) N. S.

DEPARTMENT OF FISHERIES

December 1957

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INTRODUCTION

In March 1952 the Federal Department of Agriculture's Maritime Marshland Rehabilitation Administration requested the comments of the Federal Department of Fisheries regarding a proposal to build an aboideau across the Gaspereau River near Hortonville. The Department immediately pointed out the existence of important anadromous fish runs which could be adversely affected.

In February 1957, the Right Honourable James G. Gardiner, Minister of Agriculture, requested our Minister to have his officials consider and report on the effects of an aboideau to be built at Horton Flats on the Gaspereau River. A complete review was promised but attention was drawn to the fact that on the basis of existing knowledge of the fisheries and aboideau operation, little hope could be held for the maintenance of the fish populations.

In these circumstances, the Nova Scotia Minister of Agriculture and Marketing, suggested that it would be advantageous to have a committee of senior officials from the interested Departments meet to review the problem and present a joint report. Such a committee was established consisting of B. W. Hamer, Headquarters Engineer, Department of Fisheries, C. D. Carter, Assistant to the Chief Engineer, Maritimes

Marshland Rehabilitation Administration, and C. E. Henry, Assistant Director, Agricultural Engineering Services, N. S. Department of Agriculture and Marketing.

It is not unreasonable to expect a great diversity of opinion would exist in such a committee of engineers. From the outset it was obvious that even with the most stringent terms of reference, the final report could at best only include a statement from each Department. When, however, one or other representative began to question the facts presented by the other, even a composite report was felt to be impossible. It was decided, therefore, that each individual would report to his principals. On the basis of these separate presentations, the decision as to action could be made by those responsible for such decisions. This is the summation of the problem from the viewpoint of the Federal Department of Fisheries.

DESCRIPTION OF THE PROJECT

The location of the project is shown in Figure 1. A rock-fill dam would be constructed across the Gaspereau River about 1,000 feet upstream from the present provincial bridge on highway No. 1.

The dam would be fitted with gates operated to allow the river discharge to drain into the estuary at low tide stages, and prevent the inflow of estuarial waters at higher tide stages, except perhaps in nominal amounts if required for fisheries purposes. Cost of the structure is estimated by the designers to amount to $300,000.

PURPOSE OF THE PROJECT

In direct correspondence from the Department of Agriculture only the most general information is given of the purpose of the project. From committee discussion more detail has been added. These data are recorded without comment. This action, however, must not be taken as acceptance other than as information. Since the information is mainly economic, sound comments would be possible only after a survey by economists which is now being carried out insofar as fisheries are concerned.

The Gaspereau River lies in Kings County, Nova Scotia, in an area where the level of agricultural production is considered by the Provincial Government to be relatively high and the availability of land for expansion limited. Of the estimated 475 acres of marshland adjacent to the river, approximately 275 are protected by dykes, but these structures need rebuilding at an estimated cost of $110,000. It is maintained that the one large aboideau proposed would protect nearly all the 475 acres and besides thus adding about 200 acres of arable land, give greater security and improved drainage. Estimates by the Maritime Marshland Rehabilitation Administration indicate that this new aboideau could provide protection to the land at a lower annual cost than a series of dykes and smaller aboideaux (See Appendix 1).

The Nova Scotia Department of Agriculture is convinced that most of the 22 farmers now owning and operating

Gaspereau River marshlands are relatively efficient. They would be able to make good use of additional arable lands to increase their income and improve their standard of living.

The developed marshland will, it is hoped, correspond to the Nova Scotia rating 3 with a potential gross annual benefit of $77 per acre. It is difficult to assess the net return. To do this allowance must be made for a development period of some five years of extensive draining, liming, cultivation and planting before full production is realized. It is maintained, however, that the natural fertility of the soil is high and thus, once established, it can maintain high hay yields at little expense.

A second purpose for the large aboideau is to carry Provincial Highway No. 1 over the river. At the present time the existing temporary narrow Bailey bridge must be replaced. A suitable permanent bridge is estimated to cost approximately $300,000, i.e. about the same as the proposed aboideau which, it is maintained, could be widened to carry the roadway at little appreciable extra cost.

The problem of financing may also enter into the choice, If it can be assumed that the cost of the aboideau would be borne equally by the Nova Scotia Department of Highways and the Federal Department of Agriculture through the Maritime Marshland Rehabilitation Administration the cost to the Province of Nova Scotia for both bridge and the extra land would be $150,000 rather than $300,000.

It is also maintained that when the tidal currents are reduced by the proposed aboideau, under-cutting of the Grand Pre dykes, near the mouth of the Gaspereau River estuary will be reduced.

FISHERIES OF THE GASPEREAU RIVER

The commercial fisheries of the Gaspereau system are alewives, smelts and striped bass. The important sport fish are salmon, trout and striped bass.

The annual value of the fisheries of the Gaspereau River System is estimated at about $21,000 (Appendix 2). In addition a nominal dollar value should be added to indicate the value of the sports fishery, and the secondary benefits created by it, to the community at large. Such values are not readily measured in monetary terms.

Alewives

Alewives, known locally as gaspereau, give the river its name by reason of their historic abundance. Anadromous in habit, they return to freshwater to spawn after spending three or four years in the sea. Spawning takes place in ponds or sluggish river stretches where the eggs sink and adhere to stones and aquatic vegetation. Hatching occurs in about six days. The young commence to migrate seaward from soon after hatching until well on in the autumn. Spent adults return to sea soon after spawning.

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The productivity of the Gaspereau system in alewives is beyond doubt since it has supported a relatively intensive fishery for many years. The most important spawning area is in the shallow eastern end of Gaspereau Lake (Figure 1) near Lanes Mills. Most young remain in the favourable rearing areas of this lake for several months, feeding on the abundant plankton and themselves providing food for trout and other fish.

The commercial catch over the past ten years has ranged from 850 to 7,338 cwt. (Appendix 3), averaging 3,880 cwt. The landed value has risen from $1.50 per cwt. in 1948 to $3.00 in 1956. At the 1956 value of $3.00 per cwt., the landed value of the average catch is $11,650.

Part of the catch is salted for export and the remainder marketed fresh. At the 1956 average <u>marketed</u> prices, the latest available, the average value to the local fishermen would be approximately $16,600. Annual expenses in supplies, equipment and overhead appear to be small so that the net return is probably well in excess of $10,000.

In 1955, 1956 and 1957 there have been approximately 30 persons fishing alewives commercially on the river. Most of these are local residents and operate square nets during the run. The usual occupation of most of the commercial fishermen is mixed farming. Of the total number, it is estimated that about one quarter would benefit directly from the proposed marshland reclamation.

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Most of the commercial fishermen spend little time away from their usual farm work except when the fish are known to be running, and then only for a few hours a day when the fish are available at the square net sites. The net monetary return from the commercial fishery therefore would appear to be equivalent to a wage averaging more than $110 per week each to 30 fishermen for intermittent work during the season which lasts approximately 3 weeks.

In addition to the commercial catch, fishery officers estimate that approximately 500 persons catch alewives every year for their own domestic use, and that their annual catch is approximately 25,000 lb.

Smelts

Smelts, also anadromous, enter the lower reaches of the river in the spring of the year to spawn. The density of concentration in these spawning runs makes the smelts, like alewives, easy to net. Catches for domestic use are easily made by amateur fishermen with simple equipment.

Commercial catches in the Gaspereau River system over ten years ranged from 20 to 75 cwt. (Appendix 3), averaging 43½ cwt. At the 1956 landed value of $15 per cwt., the average catch would be worth $652. Important quantities are also caught by local residents for their own consumption.

Salmon

Adult salmon enter the Gaspereau River during the spring and summer months, spawn in the autumn and return to the sea. The young hatch the following spring and usually remain two years in the river system before descending to the ocean. The principal spawning and nursery areas for this species are in the natural river channel between White Rock and Gaspereau Lake.

The Gaspereau system has undoubtedly carried much larger runs of salmon in the past than at present. This is a fish which has been seriously affected by industrial developments and any change in its natural freshwater environment. On the Gaspereau it has been confronted with power developments which diverted flows from normal channels. In addition it has also likely felt the general decline common to all Maritime rivers recently. There is no doubt, however, on the basis of recent advances in fish culture the populations can be again built up.

Angling catches over the last ten years have varied from 15 to 57 fish (Appendix 4), an annual average of 29.6 salmon and 242 pounds. There is also little doubt that the system contributes to the commercial fishery along the coast. On the basis of recent assessments made by Fish and Game Associations, one could claim that each salmon caught by sports fishermen was worth as much as $180 to the local economy. More important is the fact that this is typical of the spawning runs to small rivers which are exceedingly important as a basis for maintaining the present catches and rebuilding the population.

Trout

Speckled trout, most of which remain in freshwater throughout their life provide the most important angling in the system. Catches have varied between 600 and 1400 fish annually in the past eight years, averaging 1027 (Appendix 4).

There is no doubt that the large number of young alewives in the river, play an important part in maintaining the trout fishery. There is thus an abundant supply of food and reduced predation on the young trout.

Striped Bass

Angling catches of striped bass over the last ten years have ranged from 16 to 1000 fish per year or an average of 483 (Appendix 4). The value as food of the annual average 1,694 lb. catch, if taken at a nominal figure of say 20¢ per lb. in the round, would be about $340, and would have amounted to over $1,000 in 1954. Its recreational value is undoubtedly several times as great.

Striped bass usually spawn in the lower part of a river, just above the head of tide. Insofar as is known their normal spawning grounds in the Gaspereau are upstream of the proposed aboideau site. They are strong swimmers but little is known of their reaction to fishways. Their present spawning, feeding and angling sites would be seriously affected by the proposed aboideau. The result would probably be a considerable change in the local fishery and could result in its almost complete loss.

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PREVIOUS INDUSTRIAL DEVELOPMENTS
AND REMEDIES APPLIED

The Nova Scotia Light and Power Company has developed the hydro power potential of the Gaspereau River system beginning with its first plant in 1920 to the practical ultimate with the most recent installation in 1953. To provide for the continuance of the river's fish populations, the company has spent a total of $58,000 for construction of fishways at Gaspereau Lake and White Rock and also various screens and diversion channels. In addition it is recognized that there has been considerable expense to the Nova Scotia Light and Power Company and the Department of Fisheries in operation, maintenance, and supervision of the fish passes and fishery. It is recognized as well that water for the maintenance of fish migration results in loss of power. There is some disagreement as to the amount of money involved therein. In the overall the Department has considered the expenditures justified since the runs have been maintained.

Figure 1 shows the principle features of the hydro power development of the system and related provisions for maintenance of the fisheries. The natural system previously drained from Aylesford Lake and Gaspereau Lake down the Gaspereau River channel, with Trout River and Black River as tributaries.

In 1920 the first hydro power station was built at White Rock, including facilities for fish passage. This was followed by the Hell's Gate plant in 1929. During the 1930's the Gaspereau Canal was built, with Trout River diversion dam, a control structure on Gaspereau Lake, and various other small dams. The hollow Bridge canal and power station followed in 1940, and Lumsden plant in 1941. Methals station was built in 1947, and a new White Rock canal power station and fishway completed in 1953.

The full development of the hydro power potential involved a major change in river flows of the system, diverting the regulated discharge from storage in Aylesford and Gaspereau Lakes through Trout River Pond and into Black River Lake, before returning it to the natural channel. Between Gaspereau Lake and Black River junction the river channel contains only water draining from the remaining 17 square miles of catchment below the dam and water released for lake level control or fisheries purposes.

During spring and early summer months, the Nova Scotia Light and Power Company releases water through Lanes Mills fishway into the natural river channel. Ascending alewives are then able to move past Black River to Lanes Mills fishway and into Gaspereau Lake to spawn. The spent adults return along the same course, as do most of their progeny until low water levels due to power production in the summer dry out the shallow end of the lake next to Lanes Mills outlet. Downstream migrants from the lake for the remainder of the season, pass with the draft of water for power production through

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the Forest Home control gates into Trout River Pond, where screens at Cashman Dam prevent them going through the turbines. A diversion gate and canal at one end of the screen leads them with a small flow of water into the natural Trout River channel and thence down Gaspereau River.

As hydro development progressed new fisheries problems continued to arise and be overcome. The last serious problems appear to have been solved by 1954 and it is expected that their solution will result in a substantial future growth of average alewife production.

EFFECTS OF EXISTING ABOIDEAUX AND DYKES ON FISHERIES

Dykes were built in the Maritimes to protect tidal lands from early in the 15th Century until the mid 19th Century at which time most of to-day's dyked lands had been reclaimed. Declining prosperity and trade were followed by development of the motor vehicle, each reducing the value of the marshlands which are used largely for hay production.

Most dykes paralleled the shore and did not attempt to close off waterways. There is therefore little experience of the effects on fish life of large aboideaux which modern machinery and construction methods tend to make more economical than maintenance of existing dykes. The extreme local tidal range at the Gaspereau River also limits comparison between most existing structures and the proposal with which this report is concerned.

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It is true that small aboideaux have been installed without serious objection from the Department of Fisheries in Aulac River (N.B.), Johnson River (P.E.I.), Missaguash River (N.B.), New Horton Creek (N.B.) and Chiganois River (N.S.), for example. In all cases there were almost negligible runs of anadromous fish involved. These normally fluctuate from almost nothing to a noticeable run. To use the operation of such structures as an indication of the extent of probable damage is basically unsound since in most instances the runs are unexploited. The presence of fish merely indicates that the run is not completely exterminated although it is usually below the level where it can be used economically.

The only existing structure comparable to that proposed is the aboideau on the Shepody River in New Brunswick, shown in the photograph, Figure 2. This is about 2 miles upstream from the mouth of the estuary, with a watershed of about 137 sq. miles above it. It has two gates each 16 ft. deep by 20 ft. wide which are mechanically hoisted using electric power and manual control. The lintol of the gate opening is at mean sea level with the sill 16 ft. below and a concrete diaphragm wall extending from the lintol to well above high water level. The gate structure was built in the right bank of the river. Across the natural river channel is a rock-fill dam approximately 600 ft. long. The control gate channel joins the natural channel below a wharf, about 300 to 400 feet downstream from the dam. From that point to the dam the natural channel has silted up considerably since closure of the dam in March 1956. Scour has produced a pool outside the gates approximately 150 ft. wide by 300 ft. long and several feet deep at low water.

At Shepody the approximate rise of the tide varies from 21 feet neaps to 45 foot spring tide. The inner pool level as shown in the diagram (Figure 3) is near the mean level where rate of tide rise and fall is greatest. This maximum rate varies from one foot in 10 minutes for neap tides to as much as a foot every 5 minutes with spring tides.

The inner water level has been normally held about 13 feet above the gate sill. The gates are usually opened for approximately a quarter of an hour or more before the tide rises to that level, to release accumulated river water, and closed soon after the balance point has been reached. Upstream migrant fish may enter against the outward current during this 10 or 15 minute period. However their passage is limited by the velocity produced by the head difference through the gate. Over the length of the gate structure the limiting head for alewives probably can not exceed 12 inches. A second short period of fish passage may exist when the tide has risen above the reservoir level if migrant fish do not resist or oppose the suddenly reversed current.

On the falling tide the gates may again be opened after or shortly before the tide reaches the inner pool level, and closed when sufficient water has been discharged. Until the tide falls below the pool level there is no outward attraction flow such as normal fish-pass collection systems require, and there is no reason to expect that alewives or other fish will collect in large numbers near the gate during a short period of inflow on the falling tide. It takes only 5 to 10 minutes after the tide has fallen below the balance point until outward velocities become too high to let fish enter.

During 1956 observations showed fish being attracted away from the control gate channel by leaks in the rock fill dam, apparent in Figure 2, which also had the effect of preventing the original channel from silting up as completely as had been expected. Remedial work early in 1957 was not entirely successful. The leaks continue to keep the center of the natural channel from silting up and apparently produce a much greater attraction there than exists at the gate, where a small leakage also occurs. A typical observation over one 2½ hr. period following high tide on September 27, 1957, showed 46 salmon jumps in the old river channel near the leaks and only 2 jumps near the gates.

It must be remembered that the Shepody River has never been known to carry important runs of alewives and salmon. For this reason detailed records have not been maintained. While it is admitted that small numbers of alewives, tomcod, and salmon have entered through the aboideau gates in both years of operation, it is obvious that there has been serious delay and that the spawning escapement is a small portion only of those fish observed outside the aboideau.

POSSIBLE EFFECTS OF HORTONVILLE ABOIDEAU ON THE FISHERIES

Predictions of the effects of a large aboideau on the fisheries in the Gaspereau River must be made from existing knowledge of fish behaviour, and from experience with similar structures elsewhere. On this basis some possible changes seem likely and are supported by the evidence of fish behaviour at Shepody.

Pertinent Design Factors

Maritime Marshland Rehabilitation Administration officials indicate that gates in the Gaspereau River structure need only be 300 to 400 square feet in area. In this connection attention is drawn to the fact that the catchment area of the Gaspereau system is approximately 180 square miles, roughly half again as large as that of the Shepody where a gate area of 600 square feet has been provided.

As at Shepody, the natural river channel is to be closed by a rock-fill dam, with extensions at either end to high ground. The control gate structure is to be built in one bank (Figure 1). Details of this gate structure are not yet fixed, but it is tentatively proposed to combine one or more relatively small flap gates able to carry normal summer river discharges with manually operated vertical sliding gates similar to those at Shepody for flood discharges. The sliding gates could also be manipulated in an attempt to provide optimum conditions for fish passage. It is maintained that careful design and operation would ensure that scour maintains a suitable pool below the gate structure to act as a holding pool for fish waiting to migrate upstream.

Possible General Effect on Fisheries

The principal effect of the structure will lie in the limitation of or changes in the pattern of entrance and upstream movement of spawning migrants. Undoubtedly the restricted and intermittent opening of the gates with generally high velocities will set up an obstruction. The transportation affect of the incoming tide, acting as it normally does twice a day from two miles or more below the aboideau site to four or five miles above, would largely be lost. Conversely, although the net amount of fresh water discharged into the estuary would be approximately the same, its range of attraction when carried out by the tide may be reduced because of the decreased volume of that tide.

There is no doubt therefore that even under the best conditions, runs of alewives and other anadromous fish will be held up. There may conceivably be a lack of attraction in the sea to draw them into the river itself. The result must be a drop in productivity.

If the gates are arranged and operated to hold a freshwater inner pool as at Shepody, well above sill level at all times with no appreciable drainage during the low tide stages and if the gates are opened only a short while on the rising and falling cycles, it does not appear reasonable that upstream fish passage could be satisfactory. On the incoming tide no obstacle would be presented until tide levels reach the gate sills, assuming them to be at the present channel floor level about six feet below Mean Sea Level (Figure 3). Tidal rise at Gaspereau varies from approximately 32 foot neaps to 53 foot spring tides so the sill would be reached with the tide about one third full. From then until the tide level is within approximately two feet of inner pool level - a period of a few minutes to perhaps an hour depending on gate proportions, operation and river discharges - fish waiting in the pool or coming in near the head of the tide would be unable to ascend further because of the velocity of river flow through the restricted gate opening. During the next five to eight or ten minutes the tide will reach the balance point of levels with the inner basin, rising at the rate of 3" to 6" approximately each minute. The operator would close a manually operated gate in the next five to ten minutes as the tide begins to flow into the inner basin, after which no fish will have a chance to enter again until the balance point is approached on the falling tide, some three or four hours later. The tide will then be dropping at the rate of a foot each 3 minutes, more or less, allowing perhaps five minutes for alewives to be attracted and enter and ten minutes at most for stronger swimming fish. The failure of the human element which has been shown to occur in the operation of other aboideaux, can only increase the difficulties.

If continuous discharge over the low tide cycle is permitted, fish passage conditions might conceivably not be as poor. However, a flap tidal gate of the required size unless specially designed to reduce the effort required by fish to pass, will likely present a complete barrier at all tidal stages to all but a few of the strongest swimmers. Vertical lift gates would undoubtedly increase the versatility of operation. Continued discharge during low tide stages would tend to give improved attraction over that at Shepody. It might be possible at the Gaspereau River to eliminate the bad features of leakage from the rock fill dam and the long pocket of old river channel separated from the gates. Such problems, however, are intrinsic in aboideau design to some degree. Not only would careful design be involved but also a additional perhaps undesirable expense to ensure a watertight diaphragm on the downstream face and gates near the edge of the present channel.

A possible provision which would probably increase the fish-passing efficiency of the structure would be to allow a continuing substantial inflow of water at a suitably designed gate during the higher tide stages. This would allow fish to continue to enter the river throughout most of the high tide stage, instead of as at Shepody where they have only a brief entry period shortly after head of tide reaches the gate, and an apparently poorer entry period on the falling tide. Officials of M.M.R.A. point out that silt from the inflow of muddy estuarial water would be deposited in the inner pond, which would be the n tural river channel now widened by the action of present tidal currents as well as river flows. Silt could appreciably reduce the storage available to hold river discharges during high tide stages. If the available storage became sufficiently curtailed, high river flows could result in extensive flooding of the enclosed marshlands. The damage produced by such flooding would be increased if the water were not fresh. However, it is pointed out that as shown at Shepody even a small flow in the river channel can limit the extent of silt deposition. Silting would in any event occur over a period of time from erosion of the catchment and river banks. During winter months and for a few days at a time when the Nova Scotia Light and Power Company finds it necessary to spill excess water it would likely be feasible to close such an entrance at high tide stages.

Fish ladders or lifts have been suggested for the structure. These would, it is maintained, give passage over longer periods. Other means would have to be employed to provide attraction water. Automatic gates and pumps with a fish pass of large proportions to handle the large quantity of fish at the peak of the alewife migration would appear essential. To provide for the wide range of tidal and discharge conditions, such a fish pass would be without known precedent, undoubtedly complicated and completely experimental. Present knowledge would not appear to offer any promise of justifying its expense.

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Particular Effects on Gaspereau River Species

In assessing particular effects of the Hortonville Aboideau on the fish in the Gaspereau River, it is felt that judgment should be based on the efficiency with which the most important species, the alewives, are handled. If this species can enter without undue delay, others could also migrate freely. A possible exception is the smelt but its estuarial habitat would be severely altered by the aboideau in any event.

It is a general rule that any obstruction, natural or artificial, in a fishes' migration route causes delay even though provided with the most efficient of fish passes. Such delays if only slightly protracted, can have a serious effect on spawning. As a matter of fact, serious delay can wipe out a run.

Alewives are noted for their ability to work their way through shallows and up riffles in small streams to reach their spawning grounds, but it has been found difficult in fishway practice to ensure that they will enter a ladder, or having entered, will progress steadily to the head pool and thence upstream. They migrate naturally in schools, and appear reluctant to enter any channel which conflicts with their schooling behaviour. It is usual for them to "pile up" at the entrance to a fishway or to climb part way in a fish ladder and then refuse to ascend further. They will even back down a ladder to the entrance pool after having entered and at night or on occasion drop a mile or more downstream from an obstacle. The stimuli which lead to such erratic behaviour are not easily observed or understood. However, it appears that, until the alewives are almost completely ripe and urgent in their search for a spawning place, migration to the spawning grounds is still influenced greatly by their schooling behaviour patterns.

It appears therefore unlikely that more than a few erratic strays from the edge of a school would quickly enter any fish passing device in the aboideau structure, unless of sufficient width so that a large part of the school could immediately follow through. Unless the school could keep a considerable width it appears more likely that stray fish from the edge would drop back to the school than that the school would enter after them. Provided the entrance width and other conditions are suitable so that the school will enter continuously once started, an appreciable time may be taken before sufficient fish from the edge of the school have examined the restriction and enter, or allow themselves to be drawn in by a positive current, to lead the main body.

In a river with reasonably constant levels and discharges it has been possible to obtain conditions under which alewives will ascend a fish pass. In a tidal estuary, it appears likely that due to the rapidly changing conditions of flow and level no sufficiently stable conditions could be obtained over a sufficiently long period of time with any fish pass to permit entry of more than a few strays from a school of alewives or fish of similar behaviour, until the fish were so ripe that schooling instincts were submerged by urgency of spawning.

Assuming the alewives, after some delay, have entered the inner fresh water pool, they must still ascend through White Rock fishway, the natural river channal above, and Lanes Mills fishway into Gaspereau Lake, some seventeen miles upstream and 620 feet above Mean Sea Level. This requires an important output of energy, which may not be possible for a fish too near spawning. However, the spawning grounds in the lake must be reached by the run if it is to be maintained.

At present there is delay at White Rock Fishway which may be due to the apparent reluctance of individual fish to separate from their companions. The runs arrive at Gaspereau Lake only a few days before spawning. A further delay of two or three weeks would undoubtedly be fatal.

After being delayed at the dam the alewives would probably adjust quickly to the fishway at White Rock and spend very little time in the river between. If they delayed appreciably the second time the run would probably not reach Gaspereau Lake. If they passed quickly the present fishing sites and methods would no longer be effective. It would become necessary to fish in the estuary below the dam, requiring large new investments in trap or gill nets, boats and other equipment, with the added dangers of exposed sites

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and powerful tides. The new methods would not be likely to fit very well into the fishermen's usual farming pattern, and would probably result in fewer fishermen, a smaller catch even if the productivity of the river were maintained, and a greatly reduced net monetary return.

Interference with any detail of natural environment can result in harm to a fish population in many ways. For example, Dr. Huntsman has reported (p.103, "Fishes of the Gulf of Maine" by Bigelow and Schroeder) that great numbers of alewives are sometimes killed in estuaries under certain unusual conditions of tide, apparently by repeated changes between salt water and fresh for which an anadromous fish requires thorough acclimatization. It is possible they might be exposed to similar or other harmful conditions at an aboideau structure if they can not pass readily. This same trouble will undoubtedly arise if the downstream migrants are exposed to too rapid a transition to salt water as a result of limited fresh water discharge and lowered tidal interchange.

In summary, it is obvious that important and roughly predictable losses will result from the delay in migration caused by the aboideau and from changes in habitat within the river. Some of these may be overcome by change in design and operation but on the basis of present knowledge, complete remedies are impossible.

SUMMARY

(1) It is contended that the proposed aboideau will:

(a) protect and improve approximately 275 acres of marshland belonging to some 22 owners who are now farming at moderate efficiency.

(b) **provide** approximately 200 additional acres for these or other owners to enable more efficient farming and more profitable returns.

(c) carry Provincial Highway No. 1 at little extra costs.

(d) indirectly protect the Grand Pre dykes.

(2) The present fisheries in the Gaspereau river system provide food supplies worth approximately $21,000 on the producers' level at a conservative estimate. The alewife fishery, the most important, gives part time work providing an important cash return for limited investment to about 30 commercial fishermen and important food supplies to an estimated 500 persons. Food and recreation is provided to many sport fishermen.

(3) The construction of the large aboideau at Hortonville will obstruct the spawning runs of alewives, salmon and smelt. It will bring about changes in the river environment already upset by power developments. This will undoubtedly lead to a major reduction in or elimination of the smelt and alewife runs. Salmon and striped bass fishing will be reduced. Trout will be

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affected by the important loss of food, and because a few are anadromous in habit.

(4) Numerous remedial measures have been suggested in the planning and operation of the aboideau. In certain instances, these do not take into account the behaviour of the fish. In others there would be interference with the operation of the aboideau for the purposes for which it is being designed, or the remedial measures involve costs of such magnitude as to render the project uneconomical. It is unfortunate as well that almost all have no known precedent.

RECOMMENDATIONS

In making recommendations, it is recognized that the commercial and sport fisheries of the Gaspereau river system are of substantial importance especially to the local area. They have been maintained over the years by careful planning at considerable effort and expenditure while permittin full development of an available limited hydro power potential. In addition on the basis of present knowledge there is little hope of devising remedial facilities which would ensure their continuance on anything but a much reduced and uneconomical scale.

Insofar as can be discovered, the loss of even part of the fishery would result,in a drain to the economy greater than the agricultural benefits expected. There is no doubt that to obtain a sound perspective a thorough economic study should be made of the aboideau project and any other alternative such as repairs to existing dykes coupled with the construction of a bridge to carry the highway.

In these circumstances, the officials of the Department of Fisheries cannot recommend acceptance of the proposal insofar as fisheries are concerned.

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COST-BENEFIT COMPARISON OF ABOIDEAU AND DYKES

N.S. 72 Horton (Gaspereau Aboideau)

This analysis was prepared by the representative for M.M.R.A. on the Aboideau Study Committee, except for the addition of column (C), comparing the costs benefits similarly on the basis of dyking to protect 275 acres, and the calculation of net costs of protection per acre as shown. In compiling column (C), maintenance was assumed at the same rate per acre as in (A).

	(A) Dyke & Small Aboideau	(B) Dam	(C) Redyking
1. Acreage	344	466	275
2. Provincial Agr. Rating & Gross Benefit/Acre	3($77.00)	3($77.00)	3($77.00)
3. Cost of Protective Structures	$179,000	$300,000	$110,000
4. Less Cost Chargeable to N.S. 8 for Bank Protection (Grand Pre Dyke)	nil	$35,000	nil
5. Less Value of Highway Bridge	nil	$150,000	nil
6. Net Cost of Protective Structures	$179,000 (=$520 per acre)	$115,000 (=$246 per acre)	$110,000 (=$400 per acre)
7. Annual Costs per Acre			
(a) Capital 3% per year	$15.60	$ 7.40	$12.00
(b) Sinking Fund @ 3½% for 70 years	$ 1.80	$ .85	$ 1.38
(c) Maintenance-(For Dam based on $150,000)	$ 1,83	$ 1.29	$ 1.41

(Cont'd)

	(A) Dyke & Small Aboideau	(B) Dam	(C) Redyking
8. Total Annual Cost	$19.23	$9.54	$14.79
9. Gross Benefit Cost Ratio	$ 4.01	$8.08	$ 5.21
10. Net Benefit Cost Ratio	$ 3.01	$7.08	$ 4.21
Net Benefit per acre	$57.50	$67.50	$62.20
Total Gross Annual Benefit @ $77.00 per Acre	$26,500	$35,900	$21,200

Note: It is pointed out that the Net Benefit Cost Ratio (10) does not reflect the additional costs involved in developing the reclaimed land to the expected productivity. It would appear normal, under the provisions by which marshland reclamation is considered, for the cost of the basic protective structures to be only one third of the total cost of development, and the farmer's future annual production costs must also be allowed for in calculating a true net return.

Evaluation of these and other factors such as the apparently subsidized interest rates applicable would require a thorough economic appraisal.

VALUE OF GASPEREAU RIVER FISHERIES

Monetary:

Gaspereau: commercial catch 3,880 cwt @ $4.28	$16,000
domestic catch 25,000 lb. @ 10¢	2,500
Smelts: commercial catch 43½ cwt @ $15	650
domestic catch, 3000 lb.(assumed) @ 20¢	600
Striped Bass: 1694 lb.(483 fish) @ 20¢	340
Salmon: 242 lb.(29 fish) @ 50¢	120
Trout: 791 lb.(1027 fish) @ 50¢	395
	$21,205

Note: this value is based on catch statistics for the past ten years. It is not considered an estimate of future productivity in quantity, and does not reflect the rising prices received. Nominal values as food are given to sport fish catches.

Recreational:

The Gaspereau River system includes most of Kings County, Nova Scotia, and provides most of the recreational fishing locally available for the County's population of 37,816 (1956). It is pointed out that despite the County's extensive shoreline, local tidal conditions prevent appreciable sport fishing at sea.

COMMERCIAL CATCH STATISTICS

Gaspereau River, Kings Co., Nova Scotia

Alewives:

	Catch	Value to Producer	
		As Landed	As Marketed
1948	850 cwt.	$ 1,275.	$ 2,590.
1949	2,474 "	3,711.	7,885.
1950	6,320 "	11,055.	19,794.
1951	7,338 "	18,245.	27,812.
1952	5,660 "	14,195.	24,370.
1953	4,763 "	11,927.	19,725.
1954	3,528 "	8,920.	14,598.
1955	2,681 "	6,802.	10,014.
1956	2,034 "	6,102.	8,705.
1957	3,150 "	-	-

Smelts:

1947	30 cwt.	$ 330.	
1948	25 "	250.	
1949	35 "	350.	
1950	75 "	750.	
1951	20 "	200.	Same Marketed Value
1952	60 "	600.	
1953	50 "	500.	
1954	50 "	500.	
1955	60 "	900.	
1956	30 "	450.	

SPORT FISHING CATCH STATISTICS

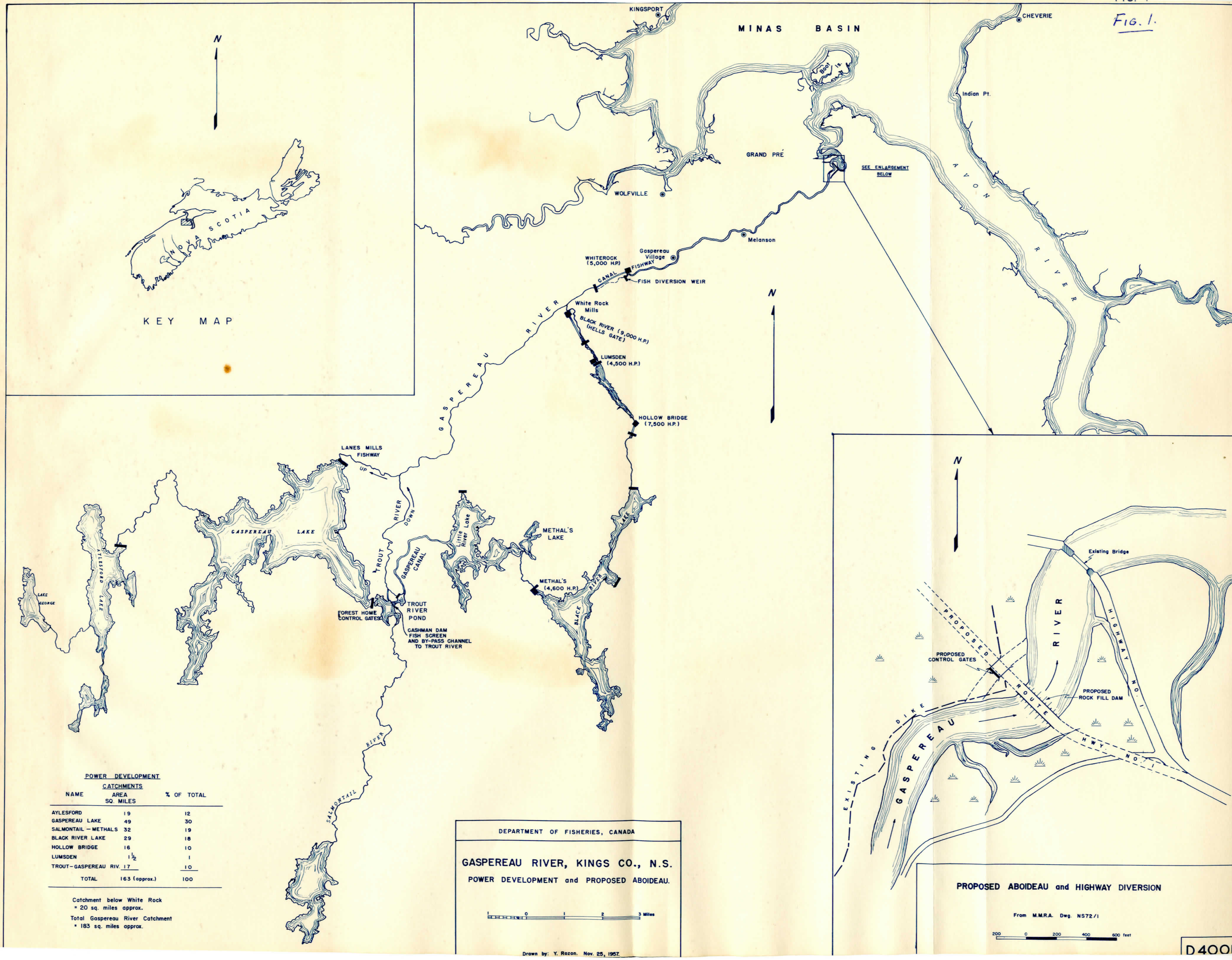
Gaspereau River, Kings County,
Nova Scotia.

	SALMON No. of Fish	SALMON Weight	STRIPED BASS No. of Fish	STRIPED BASS Weight
1947	30	239 lbs.	230	875 lbs.
1948	57	482 "	180	790 "
1949	35	293 "	650	1,830 "
1950	27	218 "	550	1,650 "
1951	20	175 "	1,000	2,700 "
1952	15	193 "	360	1,070 "
1953	35	223 "	550	1,900 "
1954	26	197 "	925	5,025 "
1955	22	128 "	375	1,025 "
1956	29	272 "	16	71 "

SPECKLED TROUT, Gaspereau System

1949	1,400 fish	1,210 lbs.
1950	600 "	495 "
1951	1,030 "	800 "
1952	1,155 "	855 "
1953	1,340 "	985 "
1954	1,175 "	865 "
1955	900 "	635 "
1956	615 "	483 "

Fig. 1.



POWER DEVELOPMENT

CATCHMENTS

NAME	AREA SQ. MILES	% OF TOTAL
AYLESFORD	19	12
GASPEREAU LAKE	49	30
SALMONTAIL — METHALS	32	19
BLACK RIVER LAKE	29	18
HOLLOW BRIDGE	16	10
LUMSDEN	1½	1
TROUT-GASPEREAU RIV.	17	10
TOTAL	163 (approx.)	100

Catchment below White Rock = 20 sq. miles approx.

Total Gaspereau River Catchment = 183 sq. miles approx.

DEPARTMENT OF FISHERIES, CANADA

GASPEREAU RIVER, KINGS CO., N.S.

POWER DEVELOPMENT and PROPOSED ABOIDEAU.

1 0 1 2 3 Miles

Drawn by: Y. Rozon. Nov. 25, 1957.

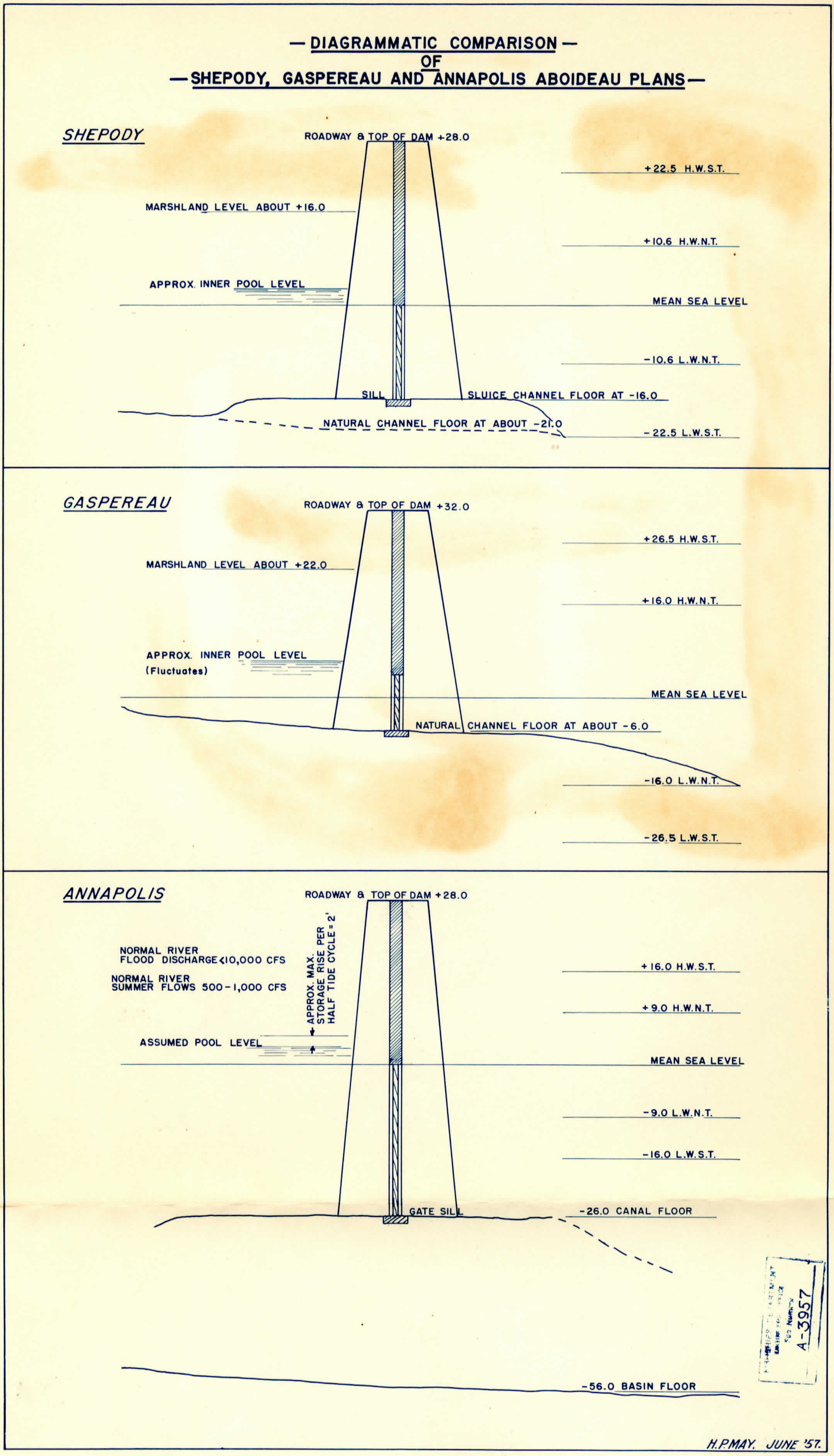
PROPOSED ABOIDEAU and HIGHWAY DIVERSION

From M.M.R.A. Dwg. NS72/1

200 0 200 400 600 feet

D4001

Photograph taken December 14, 1957 provided by M.M.R.A. Estuary channel in foreground, dam and gate structures in mid distance, with protected marshland and inner pool beyond. The left bank is only a short distance beyond the right edge of the picture. Tide is moderately low. The leaks, now reduced, are visible along the base of the dam, as is their effect in keeping the channel open to their level.


— DIAGRAMMATIC COMPARISON —
OF
— SHEPODY, GASPEREAU AND ANNAPOLIS ABOIDEAU PLANS —
SHEPODY
ROADWAY & TOP OF DAM +28.0
+22.5 H.W.S.T.
MARSHLAND LEVEL ABOUT +16.0
+10.6 H.W.N.T.
APPROX. INNER POOL LEVEL
MEAN SEA LEVEL
-10.6 L.W.N.T.
SILL
SLUICE CHANNEL FLOOR AT -16.0
NATURAL CHANNEL FLOOR AT ABOUT -21.0
-22.5 L.W.S.T.
GASPEREAU
ROADWAY & TOP OF DAM +32.0
+26.5 H.W.S.T.
MARSHLAND LEVEL ABOUT +22.0
+16.0 H.W.N.T.
APPROX. INNER POOL LEVEL
(Fluctuates)
MEAN SEA LEVEL
NATURAL CHANNEL FLOOR AT ABOUT -6.0
-16.0 L.W.N.T.
-26.5 L.W.S.T.
ANNAPOLIS
ROADWAY & TOP OF DAM +28.0
NORMAL RIVER
FLOOD DISCHARGE<10,000 CFS
NORMAL RIVER
SUMMER FLOWS 500-1,000 CFS
APPROX. MAX. STORAGE RISE PER HALF TIDE CYCLE = 2'
+16.0 H.W.S.T.
+9.0 H.W.N.T.
ASSUMED POOL LEVEL
MEAN SEA LEVEL
-9.0 L.W.N.T.
-16.0 L.W.S.T.
GATE SILL
-26.0 CANAL FLOOR
-56.0 BASIN FLOOR
A-3957
H.P.MAY. JUNE '57.