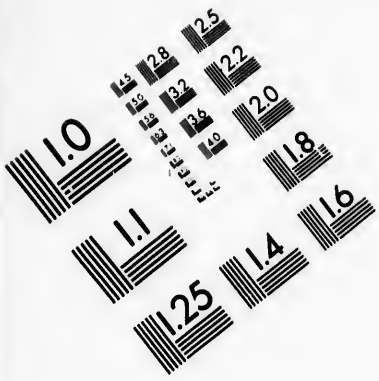

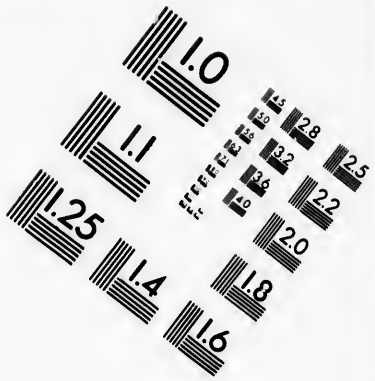

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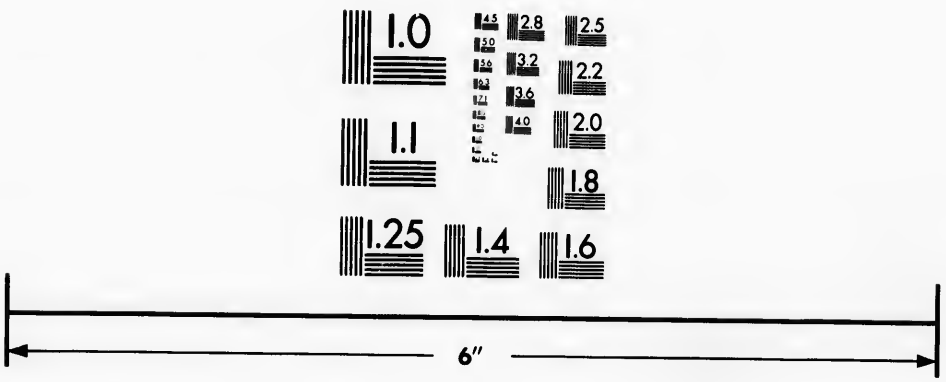

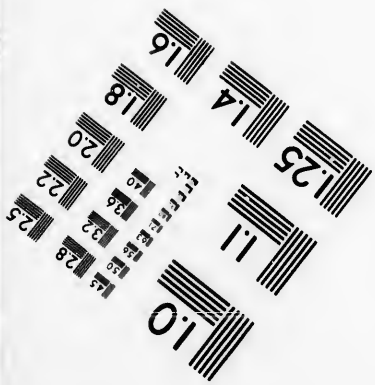

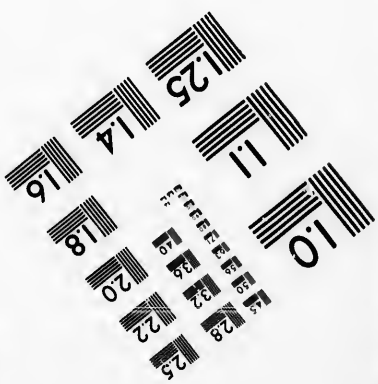

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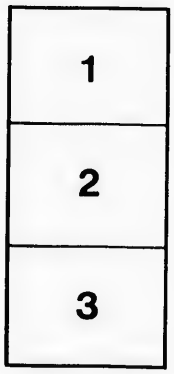

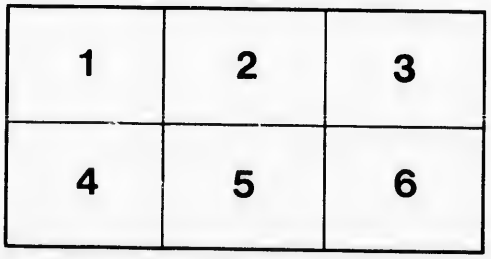

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BAIE VERTE CANAL.

12

REPORT

386-

OF THE

CHIEF ENGINEER OF PUBLIC WORKS

ON THE

CONSTRUCTION OF A CANAL

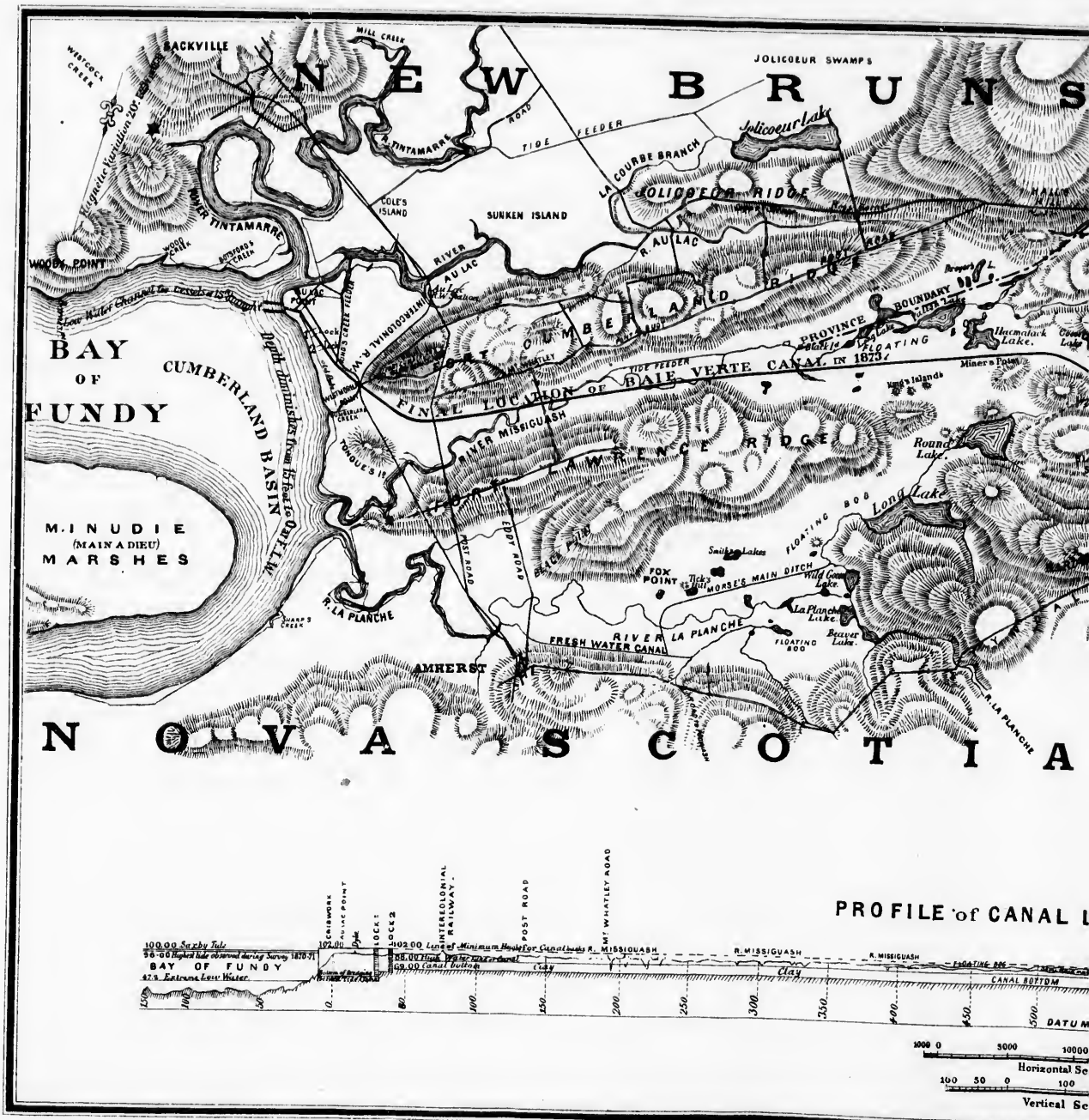
BETWEEN THE

GULF OF ST. LAWRENCE

AND THE

BAY OF FUNDY.

OTTAWA:
PRINTED BY I. B. TAYLOR, 29, 31 & 33 RIDEAU STREET.
1874.


NEW BRUNS
NOVA SCOTIA
BAY OF FUNDY
CUMBERLAND BASIN
MINUDIE (MAIN A DIEU) MARSHES
BACKVILLE
MILL CREEK
WESTCOCK CREEK
TINTAMARRE
TIDE FEEDER
JOLICOEUR SWAMPS
Jolicoeur Lake
LA COURBE BRANCH
JOLICOEUR RIDGE
COLE'S ISLAND
SUNKEN ISLAND
LOWER TINTAMARRE
WOOD'S POINT
R. AU LAC
BOUNDARY
PROVINCE
FLOATING BOG
Tamarack Lake
Miner's Point
Round Lake
Long Lake
Wild Goose Lake
La Planche Lake
Beaver Lake
FOX POINT
MORSE'S MAIN DITCH
FRESH WATER CANAL
R. LA PLANCHE
AMHERST
EDDY ROAD
POST ROAD
R. MISSIGUASH
PROFILE of CANAL L
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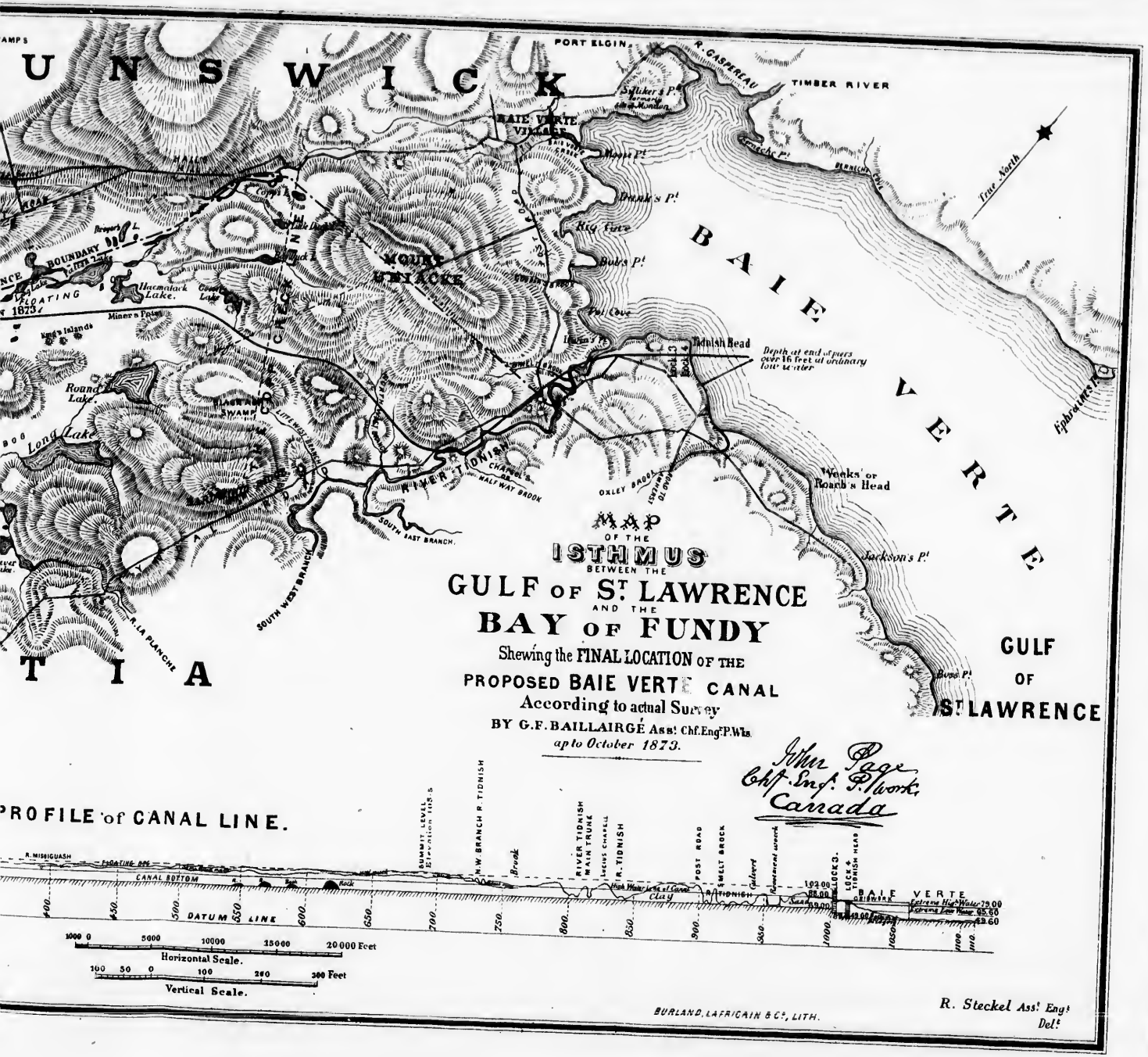
U N S W I C K
PORT ELGIN
R. GASPEREAU
TIMBER RIVER
BAIE VERTE VILLAGE
Moore's Pt.
Drake's Pt.
Big Cove
Bubs Pt.
Pat. Cove
Tidnish Head
Depth at end of piers over 16 feet at ordinary low water
Fishermans P.
Weeks' or Roach's Head
Jackson's P.
Bugs Pt.
BAIE VERTE
GULF OF St LAWRENCE
True North
MOUNT WHATLOCK
BOUNDARY
FLOATING
Haematite Lake.
Miner's Point
King's Islands
Round Lake
Long Lake
SWAMP
RIVER TIDNISH
CHANNEL
HALF WAY BROOK
OXLEY BROOK
LOWER DIGDOG
SOUTH EAST BRANCH.
SOUTH WEST BRANCH.
LITTLE WEST BRANCH
R. LA PLANCHE
T I A
MAP
OF THE
ISTHMUS
BETWEEN THE
GULF OF St LAWRENCE
AND THE
BAY OF FUNDY
Shewing the FINAL LOCATION OF THE
PROPOSED BAIE VERTE CANAL
According to actual Survey
BY G.F. BAILLAIRGÉ Ass.t Chf. Eng.r P.Wks.
up to October 1873.
PROFILE of CANAL LINE.
R. MISEGUASH
FLOATING BOG
CANAL BOTTOM
DATUM LINE
SUMMIT LEVEL Elevation 115.5
N.W. BRANCH R. TIDNISH
Brook
RIVER TIDNISH MAIN TRUNK
LOCUS CHANNEL
R. TIDNISH
POST ROAD
SMELT BROOK
Culvert
Embankment work
LOCK 3.
LOCK 4
TIDNISH HEAD
BAIE VERTE
Extreme High Water 29.00
Extreme Low Water 05.60
Rock
Clay
1000 0 5000 10000 15000 20000 Feet
Horizontal Scale.
100 50 0 100 200 300 Feet
Vertical Scale.
BURLAND, LAFRICAIN & Co., LITH.
John Page
Chf. Engr. P. Wks.
Canada
R. Steckel Ass.t Engr
Del.t

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BAIE VERTE CANAL.

REPORT

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1874

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COPY OF A REPORT

OF THE HONORABLE THE PRIVY COUNCIL, APPROVED BY HIS EXCELLENCY THE GOVERNOR GENERAL IN COUNCIL, ON THE 9TH MAY, 1873.

(In No. 38,591.)

On a memorandum, dated 8th May, 1873, from the Hon. the Minister of Public Works, reporting that in the Session of Parliament held in 1868, the Senate passed an Address praying that copies of all documents and surveys relative to the construction of a Canal to connect the waters of the Gulf of St. Lawrence with those of the Bay of Fundy, might be procured from the Governments of Nova Scotia and New Brunswick, and submitted to the Minister of Public Works for report thereon.

That this information having been as far as possible collected, the whole was referred to the Chief Engineer of the Department, Mr. Page, who reviewed, in a comprehensive report, the various schemes that had been projected, and stated that further explorations and surveys were required before any opinion could be given on so important an undertaking.

That in July, 1870, the Chief Engineer, having been instructed to have such surveys and examinations made, he selected Mr. G. F. Baillairgé, an officer long connected with this Department, as a proper person for the discharge of this important duty, who, as soon as suitable arrangements could be made, proceeded to the place and completed the survey, &c., by the following June, when being ordered on other important services, it was only in April 1872, that his plans, reports, and other documents could be submitted.

That at this time, the Chief Engineer being very busy with other matters, it was considered advisable to invite Messrs. C. S. Gzowski and Samuel Keefer, who had already made a special report on the subject, under the authority of the late Canal Commission, to examine the said plans and documents, with a view to an early decision.

That these gentlemen have submitted several reports on the question, one of which is their General Report, dated February, 1873, in which they enter at considerable length into the subject, and recommend a canal, accessible only at half-tide from Cumberland Basin.

That the surveys of Mr. Baillairgé having been made for a canal accessible at all times of the tide, he was subsequently instructed to furnish an estimate of the cost of a half-tide canal, on one of the lines which he had surveyed.

That owing to the diversity of opinions that exists in regard to the different projects submitted, it is considered advisable that the whole subject, more particularly the half-tide projects, should be referred to, and reported upon by the Chief Engineer of his Department.

The Minister therefore recommends that all the documents be referred to the Chief Engineer, Mr. Page, in order that he may investigate the whole matter, and advise the Government as to the course best to adopt in regard thereto.

The Committee submits the above recommendation for Your Excellency's approval.

Certified.

(Signed,) W. A. HIMSWORTH,
Clerk Executive Council.

To the Honorable,
The Minister of Public Works,
&c., &c., &c.

OTTAWA, May 10th, 1873,

(No. 19,415—Subject 22—Ref. 30,685.)

SIR,—In compliance with the terms of the accompanying copy of an Order in Council, dated 9th Instant, I have the honor to refer to you all the documents and surveys relative to the construction of a canal to connect the waters of the Gulf of St. Lawrence with those of the Bay of Fundy, in order that you may investigate the whole subject, (more particularly, the half-tide canal projects) and report advising the Government as to the course best to adopt in regard thereto.

I have the honor to be, Sir,
Your obedient servant,

(Signed,) F. BRAUN,
Secretary.

JOHN PAGE, Esq.,
Chief Engineer, Department of Public Works,
Ottawa.

REPORT

OF THE

CHIEF ENGINEER OF PUBLIC WORKS

ON THE

BAIE VERTE CANAL.

(In No. 38,591.)

THE SECRETARY OF PUBLIC WORKS.

OTTAWA, 10th December, 1873.

SIR,

I duly received your letter, No. 19,415, together with an order of the Honorable the Privy Council, dated 9th May, 1873 (copy prefixed), directing an investigation to be made relative to the different projects recently submitted for a canal between the Bay of Fundy and the Gulf of St. Lawrence.

In carrying out these instructions, it may be premised, that for the past 50 years a project of this kind has been at intervals before the public, and has resulted in several instrumental surveys being made, and numerous reports descriptive of the respective localities prepared.

These explorations appear to have been chiefly carried on at the instance of, or directly through, the Government of New Brunswick, who naturally retained the documents connected with them, and subsequently (1868) handed over as many of them as could be collected, to the Dominion Government.

All the plans and reports thus received were sent to me, with instructions to examine them, so as to advise the best course to adopt, in order to comply with the import of an address passed by the Senate and House of Commons on the subject.

In May following, I submitted a brief summary of these reports, together with such remarks in relation to them as circumstances seemed to warrant; it is not therefore

deemed necessary to refer again to them, further than to say that they had in view the construction of a canal of much less capacity than that now contemplated, and such as would be quite inadequate to the requirements of the present time.

On the whole, it was found that the documents did not contain sufficient information to enable a reliable opinion to be formed of a work of this extent, nature and importance; still it was clearly stated that a line between Cumberland Basin and Baie Verte was the most favorable route of any that could be selected for the purpose.

I therefore recommended that authority be obtained to make such surveys and examinations of the isthmus, &c., as would enable the whole subject to be laid fully and clearly before the Government.

This was subsequently authorized, and in July, 1870, Mr. G. F. Baillairgé was detailed to the duty of conducting the surveys and examinations required, which fully occupied him until the early part of June, 1871.

In February of that year, Mr. Samuel Keefer, secretary to the Canal Commission, made a special report to that body "on the practicability of the Baie Verte Canal," making various suggestions on the subject, which, together with the estimated cost ($3,250,000) of carrying them out on the scale recommended, are endorsed by Mr. C. S. Gzowski, one of the Canal Commissioners.

In April, 1872, Mr. Baillairgé submitted a carefully prepared map of all that section of the country between Cumberland Basin and Baie Verte, and for a width of fully 10 miles, shewing minute soundings of the harbors at both ends, accompanying which were profiles of six different survey or trial lines, and a report containing much valuable information relative to the tides, harbors, rivers and general nature of the country.

The principal features of the scheme recommended for adoption are to make the low water level of the canal about the height of the lowest neap tides in Cumberland Basin, or about 85 feet over datum*—bottom to be 69 feet over datum—and to make the high water level about two feet under ordinary spring tides, or 88 feet over datum, so as to leave a range of 3 feet for lockage purposes, &c., during neap tides.

This reserve, it is stated, should be as large as possible, but its height should be such as not to interfere permanently with the drainage of the marshes; if, however, the quantity thus retained be found insufficient, some of the rivers which empty into Cumberland Basin might be converted into reservoirs.

For a canal, accessible at all times of the tide, four locks are to be placed at the

* The assumed datum line of all levels marked on the map, shewn on the profiles, or referred to in the report, is 50 feet below ordinary low water of spring tides of the Bay of Fundy.

western terminus, three of them to have a lift of 40½ feet, and one to be arranged so as to exclude the tide after the level reached the elevation of ordinary high water, or 88 feet over datum.

This summit level he proposes to extend either to a little above the post road bridge over the River Tidnish, a distance of 16¾ miles, or to about the full extent of the canal at Tidnish Head, where two locks, embracing a lift of about 22½ feet, are to be built.

Thence outwards into Baie Verte, piers of cribwork are to be carried for such a distance as may be necessary for the protection of the channel after it has been dredged to a depth of 16 feet at low water. Piers at the western entrance are also to be built, and the channel made to a depth of 16 feet.

An estimate of quantities of excavation, pierwork, &c., required on each of the six lines described in the report is furnished, based upon forming a canal accessible to vessels of 15 feet draught at all times of the tide; but no estimate is given of the cost of carrying out the work on either line.

The Au-Lac, viâ Tidnish route, is recommended as the most favorable with respect to access at low water, elevation of the ground, water supply, and drainage of adjoining lands.

It is also stated that the terminus for a canal accessible to vessels of a like draught at about half-tide, can be located between Au-Lac Point and Sharp's Creek; but "the best entrance in such case would be between the outlet of the La Planche and Sharp's Creek."

The report of Mr. Baillairgé on his survey, together with the plans and other documents connected with it, were handed to me in the latter end of April 1872; but being at the time unable to give that attention to the matter which its importance demanded, the Minister invited Messrs Gzowski and Keefer to examine the plans, report, &c., and to favor the Government with their opinion on the subject.

These gentlemen at once complied, and after making some suggestions relative to the location, &c., prudently intimated that no decisive opinion could be given without a formal examination of the locality, and more time to consider the question.

In reply to a letter subsequently addressed to them on the subject, they informed the Minister that one of them was ready, if desired, to go over the ground to ascertain whether the best line had been selected.

In the latter end of August of that year, after an examination of the locality had been made by Mr. S. Keefer, they pointed out a number of objections to the line recommended, and directed attention to what was considered a more favorable and better route, a location survey of which they desired to have made under their own personal direction.

This having been authorized, the survey was made, plans prepared, and a general report on the subject, "with Mr. Gzowski's approval prefixed," was handed to the Minister in February last.

The latter document, together with others submitted since that time, contain elaborate descriptions of the design contemplated, the main features of which may be readily understood from the following synopsis:—

It is stated that there are great difficulties to be encountered in the construction of a canal through the isthmus; but that they can all be surmounted with care, skill, &c.

The entrance on Cumberland Basin is recommended to be at the mouth of the River La Planche, and from there the line continues straight to Fox's Point, thence trends to the Northward, and after passing in a winding course through Long Lake and certain swamps, it crosses, then follows in nearly the same direction the Little West branch of the Tidnish River.

Near the junction of this branch with the main river, the third lock is to be placed, and the water level below it raised five feet over high water in Baie Verte, by a dam at the mouth of the river.

From this lock downwards, the canal winds along either in the main channel of the river, or low ground adjoining it, to Tidnish Head, and by means of "a sea embankment," two-and-a-quarter miles long, is continued at the same level to the fourth or entrance lock, situated in the bay, at about 1,600 feet out from Weeks' Point.

This lock will have a lift varying from five to fifteen feet, and is to be connected with the shore by a water-tight embankment; and at the lower end, two parallel piers, 1,800 feet long, are to be built out to a depth of fifteen feet at low water.

At the Western entrance it is proposed to have two locks, both carried to the same height; the first, situated near the mouth of the La Planche, will have a varying lift from 0 to 12 feet, and the second, about 600 feet further inland, will be a guard lock, with gates facing both ways, and adapted to a lift of from 0 to 10 feet in either direction, and so as to keep out such spring tides as rise over ninety-two feet above the datum line.

It is recommended that arrangements should be made for the upper reach to have a variation of six feet—high water being assumed at ninety-two feet, and low water eighty-six feet over the datum line of Baillairgé's survey. The space between these heights in the prism of the canal, and certain adjoining lakes, is intended for the storage of water for the supply of navigation during periods of low tides.

This summit level is twelve-and-a-half miles long, and the reach between the third and fourth locks, $7\frac{7}{10}$ miles in length; the total distance between the respective outlet locks is $20\frac{1}{2}$ miles.

At the summit, 118 feet over datum, for a quarter of a mile in width, and a mile and a half in length, there is a spongy vegetable moss, from ten to fifteen feet in depth, under which was found from ten to fifteen feet of red clay, resting on red sandstone.

The bottom of the canal being seventy feet over datum, the solid excavation through the summit will be twenty-eight feet, besides twenty feet of moss; and the general depth of cutting through the marshes will be 22 feet.

Relative to the water supply, it is stated "the quantity that can be stored between the fluctuating surfaces of the upper reach, 6 feet deep, and 12½ miles long, is 69,696,000 cubic feet; area of the adjoining lakes, 24,718,400 feet, which if all drawn down six feet to feed the canal, will afford a supply of 148,190,400 cubic feet; total, 218,186,400 cubic feet.

The water required for lockage, &c., daily, when the canal is worked to its full capacity, is estimated at 12,000,000 cubic feet, so that the storage capacity will be equal to the requirements of eighteen days.

When proceeding with the works, it is proposed first to excavate through the marsh lands on the summit level, a channel fifty-four feet wide at surface, eighteen feet wide at bottom, and eighteen feet deep, and to use the material to form an embankment along the sides. Gullets of similar dimensions are to be cut through the moss at the water-shed to drain and dry it, so that it can be burned; when this has been done, and a channel cut through the earth and rock underneath, temporary road bridges put up, and a suitable outfit provided, the water is to be admitted into the cut, and allowed to take its course freely to Baie Verte.

This, it is stated, will have the effect of scouring out the channel in the most expeditious and economical manner. The floating bog to be cut into convenient patches, and floated out to sea.

The greater part of the material, it is said, will be thrown into the shallows in Baie Verte; but it is not likely to injure the fishing ground, "as the more valuable Shad fisheries of Cumberland Basin have a bottom precisely similar to that which this material will supply."

Carrying out the works as proposed, including land damages, superintendence, &c., is estimated to cost $5,317,000.

The Contractor for the works to take the risk, and have the benefit of the scouring operations.

It has been deemed proper to submit the foregoing outline of matters relating to the projected canal from the time a survey was ordered by the Department, up to the

time when the documents were placed in my hands for examination and report. This course has been adopted in order to place in a comparatively short connected form the information embodied in papers, that from the nature of the subject are in some cases unavoidably long.

On carefully reading them over, and endeavoring to consider the different plans, charts, &c., it became evident that many of the questions involved, would be more readily and better understood by an examination of the locality, and especially of the routes that had been recommended for the canal.

To enable this to be done, it was thought best to have the salient points of the respective lines marked out on the ground.

On the La Planche and Tidnish line, recommended by Messrs. Keefer and Gzowski, this was done by Mr. David Stark, the gentleman who made the location survey under their direction. And Mr. G. F. Baillairgé marked out the Au-Lac and Tidnish route, recommended by him as the best of all the trial lines run at the time the general survey of the isthmus was made.

I met these gentlemen at the place, and went over the respective routes with them, getting such verbal explanations in each case as was of great assistance to me in acquiring a more general knowledge of the locality in a much shorter time than could otherwise have been done.

In the course of this visit, whenever it was found or considered necessary that other or closer examinations were required, they were at once ordered, and for the most part have since been made.

The information thus obtained, and collected from all other known available sources, together with that conveyed in previous reports, will, it is believed, enable the engineering part of the subject to be placed fairly and fully before the Department.

It would, however, have been desirable to be able to state in a general report on a matter of this kind the extent and nature of the trade likely to be benefitted by the projected works; but although efforts have been made in various ways to get the information necessary to enable this to be done, very little success, so far, has been attained.

This may have arisen, either from not knowing the proper authorities to apply to, or

from that part of the matter not having as yet assumed such a definite shape as would warrant other than a general opinion to be given in relation to it, even by those who, in other respects, have duly considered the subject.

It may at once be stated that the construction of a navigable channel between the Bay of Fundy and the Gulf of St. Lawrence, on any line that can be selected, will be an undertaking attended with unusual difficulty, not only from the nature of the work to be done, but from the great difference in the elevation of the respective tides.

In Cumberland Basin, the tides rise from 35 to 16 feet over ordinary low water line; those at the head of Baie Verte range from 5 to 9 feet. At times the water in Cumberland Basin is fully 18½ feet over that in Baie Verte; whilst at ebb-tide the water in Baie Verte is fully 19½ feet higher than that in Cumberland Basin.

The tide waters of the respective bays approach to within 6¾ miles of each other, and the dividing ridge at the lowest place is only 9 feet higher than a tide observed on the 25th October, 1870, and only 5 feet over the *Saxby* tide of October, 1869.

The surface of this ridge is of a soft marshy nature, under which there is for the most part clay resting on red sandstone.

The waters of Baie Verte are at all times clear and transparent, except during heavy gales from the eastward, when sand at times is washed inwards, so that the water is now at some places represented to be of less depth than it was 30 years ago.

The waters of the Bay of Fundy are at all times heavily loaded with dark brown mud and sand, especially during the first half of the tide, but as the water continues to rise the quantity of mud held in suspension diminishes; nevertheless, even the surface water of ordinary tides carries with it sufficient sediment to form the extensive and productive marshes found at numerous places along the shores and head of the Bay.

The channel through that part of the Bay of Fundy known as Cumberland Basin, is described as being about one mile and a half wide, with a depth varying from 30 to 14 feet at low water, up to Barnes' Reef, or to half a mile below the upper end of Woody Point; and through this reef, Mr. Baillairgé in August last, found a channel 900 feet wide, and of sufficient depth at extreme low water to admit of a vessel drawing 15 feet to pass. (See his report appended.)

From Barnes' Reef to the mouth of the River Au-Lac, a distance of about 3 miles, the channel has a depth of from 30 to 15 feet, and the course is north-easterly. Thence,

upward to the mouth of the River La Planche, a course S. by E. half E.; the distance is nearly 3½ miles, and the depth diminishes to almost nothing at extreme low water, which is about 2½ feet lower than ordinary low tides.

The course of prevailing winds on the Bay of Fundy is from the S. W. to W. S. W.—thus, a vessel with a fair wind up the Bay to near the mouth of the River Au-Lac, would there have to take a course within a few points of the wind, in order to reach the mouth of the River La Planche, and that too in a comparatively narrow channel, with dangerous patches of rocks and stumps at several places on the lee shore, and, it is said, quicksands at many places on the other side.

The objects proposed to be gained by the construction of the contemplated canal being to avoid the dangers of sailing round the Atlantic coast of Nova Scotia, and the shortening of the sea voyage to places situated in the Bay of Fundy, &c., &c., it is natural to suppose that an entrance easy of access and approach would have been selected, unless some formidable barrier in the way of its construction or cost was likely to be encountered.

Instead, however, of this being the case, Messrs. Keefer and Gzowski, the gentlemen entrusted with the first location survey, advise the Bay of Fundy terminus to be at the mouth of the River La Planche—a place, it is to be feared, that has little to recommend it as an entrance to a line of general navigation at any stage of the tide.

This will be evident by a glance at the Chart of the Bay and observing the position of the river, and channel to it, when no one willing to be convinced, can fail to foresee the difficulty that must be experienced by a sailing vessel in reaching the outlet of the River La Planche during south-westerly winds, which are said to prevail in that section nearly as steadily as trade winds, except during the summer months, when they become more southerly.

Adverse winds blowing across the channel, dangers near the shore, and fogs, are some of the perplexing difficulties certain to be experienced in making or leaving the proposed entrance. These facts, there is good reason to believe, are practically known to many who have had occasion to navigate that part of the coast.

Between Cumberland Creek and the mouth of the Missiguash, the stumps and roots of an underground forest extend for half a mile along the beach, for a width of fully 100 feet, adjoining which, for at least a like distance, and a width of 400 feet, the beach is

thickly studded with stones; some are of large dimensions, and stand considerably over the surface. The elevation of the ground, in which the stumps are firmly rooted, is from 8 to 18 feet over the bottom of a half-tide canal, and many of the rocks also stand considerably over that line, so that in its present condition this would be a most dangerous place for vessels either leaving or making for a navigable channel on the north shore of the bay.

Between the outlets of the rivers Missiguash and La Planche there is also an underground forest for a distance of 1,900 feet along the beach, and a width of 200 feet; and for a still greater distance the adjoining lower part of the beach is covered with large masses of stone for a width of from 600 to 1,000 feet.

Borings were made at several places in this vicinity, which indicated rock in position at the depth of 3 feet above the bottom assumed by Mr. Keefer for a half-tide canal terminus.

Cumberland Basin from Black Point to the mouths of the rivers La Planche and Au-Lac is of a triangular shape, the sides of which are about 7, 6 and 3½ miles respectively, containing an area of about ten square miles; the channel previously described is on the north and easterly sides of it, and Minudie Flats occupy all other parts of it, or 6½ square miles.

The northern part of the Flats for an area of 1¼ square miles, stands for a height of from 1½ to 7½ feet over low water line, and the other parts containing an area of 5¼ square miles, is from 7½ to 25½ feet over low water.

It will thus be evident that Minudie Point could afford little or no shelter whatever to works, or to the entrance of a canal situated at the mouth of the La Planche at any time between half tide and high water.

None of these impediments to navigation, or to the works connected with the construction of a canal, are mentioned by Mr. Keefer in any of the numerous reports sent in by him between May, 1872 and May, 1873.

It is, therefore, only fair to conclude that he did not know of their existence, rather than that he knew and failed to communicate the information, especially as it is mentioned in the specification submitted by him, that berths for the crib-work of the pier (stated in his general report to be 2,500 feet long) are to be dredged out uniformly to the level of 54 feet, and close ranges of piles are represented on his plan to be driven 18 feet into the bottom, which, on the shoal that extends out on the north side of the river, is rock at the level of 57 feet feet over datum.

Baie Verte.

The terminal works recommended by Mr. Keefer for this outlet of the canal, as already stated, are chiefly "a sea embankment" $2\frac{1}{4}$ miles long, inside of which the water level is to be maintained at 5 feet above the surface of the spring tides—the construction of a lift lock 1,600 feet out in the bay, and connecting it with the shore by a bank, and building two parallel entrance piers 1,800 feet long.

This "sea embankment" it is stated in the specification submitted, is to be formed of material excavated from the prism of that part of the canal across Tidnish point; but the rock and boulder stone "found in this excavation, are to be reserved for filling the "cribs along this embankment, and for the rip-rap protection of the outer slopes."

These banks are to be carried up to 4 feet over canal surface, and a puddle bank (not shewn on plans) is described to be carried up in the middle part of them.

Their outer slopes are to be protected by crib-work from 10 to 15 feet in width, filled with stone, and raised to high water in the Bay, over which a heavy rip-rap wall is to be formed.

"The site of the lock is to be enclosed by a suitable coffer-dam sufficiently large to "embrace the whole of the lock, including its wings, with proper allowance for slopes, and "high enough to be safe from inundation by the highest tides, and strongest prevailing "winds on this coast."

For the carrying out of this plan, the aggregate length of crib-work required will be about 18,000 feet, and the immediate entrance will be in a depth of 15 feet at low water, or within 400 feet of the length stated in Mr. Baillairgé's rough estimate of pier-work as required, if carried to a depth of 16 feet at extreme low water; and which it may be observed was designated as "excessively lengthy and expensive."

On considering this part of the *scheme* there is reason to believe:—

1st. That the cost of the proposed works has been much under-estimated.

2nd. That to carry them out effectually in the manner intimated would be nearly, if not altogether, impracticable.

3rd. That even if they were executed, there is reason to fear they would not long continue to answer the purpose contemplated.

Relative to the estimated cost of carrying out the works at the Baie Verte terminus, it may be said that the crib-work for the protection of the banks alone would at the lowest rates of any work of a like kind that has been done under this Department for the past ten years, and that under the most favorable circumstances, amount to nearly, if not altogether as much as Mr. Keefer has estimated for the entire work connected with the so called "sea embankment."

In this connection, it may be observed, that the entrance piers proposed at the Baie Verte and Bay of Fundy would cost fully 33 per cent. more than his estimate. Moreover the outlet locks at the Baie Verte and Bay of Fundy alone, would, together with cofferdams, &c., &c., cost at least two-thirds of the entire sum estimated by Mr. Keefer for the whole of the locks.

2nd. It is well known that a properly made earth bank of sufficient dimensions, either with or without a puddle wall longitudinally through it, when resting on a good foundation is quite likely to be tight under a moderate head of water. To form such a bank in a tide-way would, however, in all probability be attended with a much greater degree of uncertainty than might be supposed from a cursory view of the matter, or any theoretical deductions from ordinary bank formation.

A moderate wind acting on water otherwise smooth would raise a surf less or more destructive to a bank of loose clay or earth; a little more force would act on hard material, and in time, even rock yields to the cutting effects of waves.

In making a bank at even a moderate distance out in a river, or any sheet of water, little progress can be made during a high wind from any direction within 45 degrees on either side of the point towards which the bank bears.

If such wastage takes place in ordinary cases, there is every probability that it would be experienced to a much greater degree in a tide-way.

The materials for this bank being intended to be taken from Tidnish Point, its formation must be commenced near that shore, and extend outwards in a direction that unavoidably would leave its outer end open to the attacks of the sea during construction.

It would at the same time be in a constant current acting either inwards or outwards at heights corresponding to the rise and fall of the tides, and its outer end would be exposed to the full action of the sea raised by easterly storms, that sweep all but directly into the Bay.

These various causes operating against its formation and stability, it is to be feared could not be guarded against, at anything like a moderate expense, as any protection put in immediately at its outer end that could not be wholly and readily removed would be certain to prevent its answering the purposes contemplated.

The bottom of the Bay along the line of the proposed extension being sand and gravel, at some places of considerable depth, it would have of course to be removed down to a surface that would admit of the bank forming with it a water-tight connection.

But as this clearing of the seat would be almost certain to be again filled up by the action of every incoming tide, it could only be kept a very short distance in advance of the other work; and any attempt to form the bank, or any part of it, without the bottom being cleared, would doubtless prove a complete failure.

In short, the great uncertainty and difficulties connected with making a suitable bank capable of withstanding a pressure of 15 feet head of water, as it would be subjected to, at spring tides, leads, in my opinion, to the conclusion, that to be successful in effecting the object in the manner, position, and to the extent proposed, would be all but, if not altogether, impracticable.

3rd. Admitting that the works at Baie Verte were carried out as recommended by Mr. Keefer, it is questionable whether they would remain in good condition sufficiently long for navigation to derive much benefit from them.

It appears that the highest water observed during the time of Mr. Baillairgé's survey was 77.37 feet over the assumed datum, but in August of the present year it rose to 79 feet over the same line; these heights, it may be stated, were taken at a place beyond the influence of the waves. It may also be mentioned, that at the breaking up of winter in 1872, it is said that large masses of ice were driven on to the banks, in the cove immediately above Weeks' Point, which are from 7 to 10 feet above the highest spring tides. At the time above alluded to (August last), high water was within 7 feet of the top line of the proposed "sea embankment," and heavy rolling waves were driven up the Bay, of a height and with such force as to leave no doubt whatever that an earth embankment must have yielded to their cutting effect.

It is not improbable that the waves would have passed over the banks to such an extent, as to raise the level inside, and that this, together with the wearing away of their top, must soon have resulted in their destruction.

Were even a small breach to take place at any time in one of the banks, whether caused by the sea, or defect in the bank itself, there would, doubtless, be great difficulty in stopping it, if it could be done at all, under a head of water varying from 5 to 15 feet in height.

An occurrence of this kind might result from various causes, such as the following:—the bottom, at places, might by mistake or otherwise, not have been properly cleared, or during the progress of the works the sea might have carried gravel or sand on to the end of the bank, that inadvertently might not have been removed—unsuitable material might, at places, be put in the bank itself—stone might have been put on the top for its protection, and afterwards a settlement occur at that place, until the stone were under the water surface, although the top by raising may have been kept at the regular height.

The great risk and outlay inevitably connected with the construction of a dock so far out in the Bay, irrespective of the question of future maintenance, give the impression that dangers have been invited, and unestimated expense recommended, that might, with advantage to the undertaking, have been avoided.

In short, the almost certainty of failure to make water-tight banks in the manner proposed, in a sea-way, and the docks connected with them, even if they were made, leads to the conclusion, that it would not be judicious to entertain a project so unlikely to be attended with success, and to which there are so many practical objections.

The foregoing matters relative to the entrances recommended by Messrs. Keefer and Gzowski, having been brought under notice, it is now proposed to draw attention to their location line between these points.

On the 27th August, 1872, Mr. Keefer reports that he had made an examination, alone, of the isthmus between the Gulf of St. Lawrence and the Bay of Fundy, as his "colleague, Mr. Gzowski, was unable to attend."

On this occasion he had a map of the survey previously authorized by the Department of Public Works, and other documents connected with the projected canal.

He remarks that from Fort Cumberland and Fort Lawrence ridges, an "Engineer "has a good opportunity, even without the advantage of a survey, of forming his "judgment as to the proper location for the canal," and then arrives at the conclusion that the line recommended by Mr. Baillairgé is not the one nature has pointed out.

He therefore advised a location survey to be made of the La Planche and Tidnish line *vid* Long Lake and the Black Ash Swamp, &c.

This having been agreed to, in carrying it out, a spongy mass of vegetable growth "entirely free from any mixture of sand or soil," was discovered at the summit, to take advantage of which the line was carried more to the eastward than was at first intended.

It may be here stated that the fact of finding a mossy plain near the water-shed does not appear in the light of a discovery to any of the gentlemen engaged on the first survey, as they state that several were crossed by the trial lines then run.

The surface of the moss referred to, however, is, as already stated, 48 feet over the intended bottom of the canal, from 15 to 18 feet of which is said to be rock, and from 10 to 15 feet clay, the upper part being moss.

Through the marshes the general depth of cutting will be about 22 feet.

	Cubic yards.
Total quantity of earth excavation on the located line will be	9,160,000
Rock excavation	440,000
Moss (most of which can be removed by draining and burning)	1,090,000

A location line is generally understood to be one that has been decided upon, marked out on the ground, represented on the plan, and relative to which such details have been obtained as enable correct information to be supplied for both present and future reference.

How many of these characteristics are applicable to the line in question may be inferred from the following quotation :—

In a report dated 12th April, 1873 (see Appendix), Mr. Baillairgé states that on the location plan submitted by Mr. Keefer, the River La Planche, as shewn, "is from 3,000 "to 5,000 feet out of its true position at several points; La Planche Lake is represented "on the north instead of the south side of the river; the River Tidnish and its "tributaries are also incorrectly indicated; Tidnish Head, although a short distance from

"the location line, is placed 1,000 feet too far north into the waters of Baie Verte. "Similar inaccuracies occur with respect to the roads, and the relative situation of the "high and low land."

"The discrepancies are so great and so numerous that it is a question how far the "profile on which the La Planche and Tidnish location line calculations are based can be "relied on."

This gentleman, after having made a further examination of the respective places, repeats these statements in a recent report, in which other remarks of a like nature are also given. (See Appendix.)

The estimate of excavation above quoted having been examined in detail by Mr. Baillairgé, he points out conclusively that considerable omissions have been made in the calculations, a few of which may be stated in order to convey some idea of their extent.

1st. The estimate does not include any dredging at either of the entrances.

2nd. No provision has been made in the estimate for back ditches, or other means of draining the lands adjoining the canal.

3rd. The estimate does not embrace any quantities or sum for the mucking and clearing the seats of the banks, nor has any provision been made for getting rid of the floating bogs, other than that they may be cut up "into convenient patches and floated out to sea."

4th. No provision is made for slope walls along the sides of the canal, which on the summit-reach would require to be not less than 10 feet high in order to adapt them to a variable level of six feet as proposed; and on the reach between the third and fourth locks they would require to be at least four feet high; this will be evident, as it is stated that "when the canal is in full operation it will always be necessary to have the modern "appliances of steam tugs at each end, and others in the reaches for towing."

Other omissions might be enumerated, but as these alone would cost at least *four hundred and fifty thousand dollars*, it will be evident that no fair comparison can be made between any such so-called estimate and one that would give a nearly correct statement of the work to be done.

In short, to get a fair idea of the approximate cost of carrying out the work described in Mr. Keefer's report and specification, some of the items should be more than doubled, others have 15 per cent. added, or the whole should be increased an average of 25 per cent., viz.:—

The estimate of Messrs. Keefer and Gzowski of the 18th February, 1873, is.....	$5,317,000
Add 25 per cent. for under value placed on works, &c...	1,329,250
For omissions	450,000
	$7,096,250
Probable actual cost of work, say.....	$7,100,000

In reference to "the method of proceeding with the work," it is proposed "to "remove the principal part of the earthwork—it is impossible to say how much—by "means of the tidal power of the Bay of Fundy."

First, a gullet is to be cut in the "axis of the canal," and the material used to form banks to serve as dykes to isolate the canal from the adjacent lands. One or more gullets "are to be cut through the moss at the summit to drain it and dry it up, so that it can "be burned." Afterwards a channel is to be cut through the earth and rock at this place—certain bridges and other work constructed—an outfit, &c, provided; then, "the "water of Cumberland Basin may be admitted into it (the channel) and allowed to take "its course freely to Baie Verte."

The current is to be trained, guided and other arrangements made so as to scour out the canal to the proper depth and dimensions.

This scheme looks very much like one that originated with Captain H. O. Crawley in 1843, whose report, Mr. Keefer states, was in his hands when he made that reconnaissance from Fort Cumberland and Fort Lawrence ridges before mentioned.

In the report above alluded to, Captain Crawley, after discussing numerous questions connected with the subject of a channel of communication between the Bay of Fundy and the Gulf of St. Lawrence, remarks: "it may be worth while to consider what would be "the effect of cutting a channel from water to water, leaving it to the waters themselves "to complete the communication to render it navigable."

But in a subsequent letter, after describing the probable effects which the currents would have on the marshes and banks adjoining, and even on the channel itself, Captain Crawley states, "these circumstances, deduced from theory, appear to me to render it "doubtful after all if a channel as proposed would be easily navigable; at all events so "much uncertainty appears to exist, that the project would be very hazardous, &c., &c.; "that it is not desirable to prosecute the enquiry further."

The abandonment of the scheme, however, scarcely leaves it open for another person thirty years afterwards to claim its paternity, even although all benefits arising from it are freely offered to the contractor, on his assuming all the risk and expenses connected with carrying it out.

It is, however, much to be regretted that the unusual degree of penetration which can foresee the ultimate success of a scheme carried out in this manner, and even indicate the places where, the material washed out, will be deposited by the sea, its suitableness for certain fisheries, &c., should not also be able to fix with some degree of accuracy the quantity that would be removed, and the length of time that the operations would occupy.

The means of furnishing the supply of water for the proposed La Planche and Weeks' Point line of canal is to be obtained from two sources—first, from the high water of the Bay of Fundy; secondly, from the fresh water lakes at the sources of the La Planche.

Between low and high-water level of the canal, there will be a range of six feet, intended to form the storage for the water to be used for navigation, which for the twelve and a half miles of the summit level, is estimated at ..... 69,696,000 cubic feet.
The area of Round Lake, Long Lake, and other smaller lakes, is 24,748,400 square feet, which if drawn down six feet, = ... 148,490,400 ,, ,,

Total..... 218,186,400 cubic feet.

The above estimate assumes that the lakes can be drawn down six feet, or to the level of eighty-six feet over datum; but, from Mr. Baillairgé's report, it appears that the average elevation of the bottom of these lakes is at least 88 feet. This being the case, there would only be 168,000,000 instead of 218,186,400 cubic feet of water in reserve, when the level is at ninety-two feet over datum.

It will readily be admitted that a canal on which the levels are maintained at an uniform height, will be likely to meet the requirements of navigation to better advantage than one on which the reaches are subject to frequent variation.

In the first, there would be little or no perceptible current, and the surf raised by vessels in passing through, would act generally about the same line, thus admitting of the banks being protected by the least height of walling.

But when the supply is furnished at distant intervals, there must be a considerable range in the water levels, consequently strong currents will be met with at times, and to meet the case a greater height of protection walling must be built.

When the supply is intermittent, the more frequent it can be furnished, the less will be the current, and the range between high and low-water surfaces will also be of the least extent. It therefore seems natural, as the waters of the Bay of Fundy have to be used to feed the canal, that levels should be adopted that would allow the supply to be introduced as often as the tidal fluctuations would admit.

Instead, however, of this being the case, Messrs. Keefer and Gzowski select for the low-water level a height to which the tides for part of the time barely rise, and such as, for long continuous portions of the time, would admit little or no supply, while for the high-water level, an elevation has been adopted that could only, when at its height, be at rare intervals supplied by the tide.

It may at once be stated that a daily record of the rise and fall of the tides in Cumberland Basin was kept from the 13th August to the last day of December, 1870,

and during that, time there were between the 13th and 31st August, four days; in September, two days; in October, three days; in November one day; and none in December, that the tides did not rise to eighty-six feet.

Between the 13th and 31st August there were ten days; in September, fourteen days; in October, sixteen days; in November, twenty days; and in December, twenty-two days, that the tides did not rise to over 88½ feet.

Between the 13th and 31st August there were fifteen days; in September, twenty-three days; in October, twenty-five days; in November, twenty-three days; in December, twenty-five days, that the tides did not rise to over 90½ feet (height of springs, full moon)

The new moon spring tides in August, 1870, rose for three days to from 92 to 92½ feet, and in each of the following four months they were for five days from 92 to 94½ feet above datum.*

It will be evident that tides that rise to 86 feet only, could have no influence on a canal, the low-water level of which is at the same elevation. In fact, unless the tide rises from eighteen inches to two feet over the surface line of the canal, it cannot within the comparatively short period of its rising, slack water, &c., produce much effect on the reach.

The same remarks apply to any level to which the water may have fallen, or be at, below the assumed high-water line.

For the months of June, July, and August, there is reason to believe that the spring tides seldom rise as high as at other times; in August, 1870, there was only one day that the tide rose to 92·5 feet. This being the case, it is barely possible that for once in each of these months the water of the summit level might reach a height of ninety feet over datum, by admitting as much as could flow through the prism of the canal, and allowing none to escape; but there is no reason whatever to believe that it could be raised higher than ninety feet, although questionable whether it could reach that height.

If this be correct, it will be evident that a further reduction must be made in the storage capacity of the lakes, and also of the canal.

In reality, the 168,000,000 cubic feet previously mentioned would, during the summer months, be reduced to 95,000,000 cubic feet, or barely eight days' supply at the estimated quantity of water required daily for the efficient working of the canal.

It may be said that the water can be introduced at a lower level at such times: this could of course be done, provided the tides rise higher than the surface of the canal; but it should be borne in mind that this can only be the case on the rising tides after neaps, as the water in the canal would in all probability be as high as the range of the falling tides after springs.

* On the 25th October, 1870, an exceptionably high tide of 96 feet was observed; and on the 5th October, 1869, the "Saxby tide" rose to 100 feet over datum.

In the face of these facts, it is strange to find the deliberate statement that "the "volume of water in the canal and lakes between + 86 and + 92 on the summit level, will "be sufficient to keep the canal in full operation with 110 lockages a day, for no less than "eighteen days, without any addition from other sources. But the spring tides which "occur about every fourteen days will be sure to render the supply continuous."—And a few paragraphs further on, it is stated, in relation to the high-water level of ninety-two feet, that "it must be observed that there would be no means left of draining and im- "proving the lands at the head of these marshes. By keeping the bottom down to + 70, "and reducing the level of the lakes to + 90, sufficient drainage will be afforded for this "object; or they may be reduced to a still lower level with better effect," &c.

In fact, first claiming for the scheme a supply sufficient for 18 days, and immediately afterwards admitting the necessity of reducing it one-third. In short, the supply is represented to be one-third more than it is admitted the drainage of the lands in the vicinity would allow, and $2\frac{1}{4}$ times greater than it could possibly be at any time (except it might be when navigation first opened in the spring), and that, too, without having made any provision whatever for the protection of the banks to meet such a variation of level as it would involve.

In reference to the waters of Cumberland Basin, it is stated that while low water is exceedingly muddy "the high water is generally pretty clear, and quite as admissable for canal purposes, as that taken from the Grand River to feed the Welland Canal. No exception can therefore be taken to the admission of any tide water above the low-water level of the summit."

This comparison is rather unfortunate, inasmuch as the Grand River water at Dunnville, is as clear as any river water in the Dominion, except the St. Lawrence; in fact it could scarcely be otherwise, as the large area above the dam forms a settling pond, where the water remains in a great measure stationary for a considerable length of time. At many places along the feeder it is used for culinary purposes, but in passing through the canal, which has a descent of fully 330 feet, the currents, action of winds, cutting effects of the waves raised by steam vessels, &c., together with the dredging operations that have for many years been in progress, render it quite turbid and muddy before reaching the foot of the mountain range of locks. In short, it enters the canal moderately clear but becomes extremely muddy before leaving it.

There is no doubt whatever that the waters of Cumberland Basin are generally clearer when at or near their full height than at other stages of the rising tide; still the direction and force of the wind, at the time, affect the purity of the water to a smaller or greater extent.

In calm weather, the water carries with it less earthy matter than in rough weather, when the sea, stirred up by high winds, washes the shore and banks with such cutting effects as rapidly wear them away.

But the high water, although less muddy than the first half of the tide, is nevertheless that which supplies the deposit that eventually forms marsh lands such as can be rendered highly productive by dyking and draining.

Dr. Dawson, in his "Acadian Geology" states :—"The rising tide sweeps away the "fine material from every exposed bank and cliff, and becomes loaded with mud and fine "sand, which, as it stagnates at high water, it deposits in a thin layer on the surface of "the flats, &c., &c.

"The falling tide has little effect on these deposits, and hence the gradual growth of "the flats, until they reach such a height that they can be overflowed only by the high "spring tides. They then become natural or salt marsh covered with coarse grasses, "&c., &c."

This having been the case in the past, there seems no reason to believe that, so long as the same condition of things continues to exist, it will be otherwise in the future.

If the water of the Bay of Fundy is let directly into the canal, and thence passes into the series of shoal lakes represented as suitable to form storage for the canal supply, there is good reason to believe that the lakes would in time be, as other low places have been, converted into marsh lands.

This, together with the certainty of not being able to maintain anything like the high-water level proposed, and the fact of the bottom of the lakes being at least two feet higher than the line on which the water calculations are based, clearly points out the undesirableness of adopting a scheme based on a theory that bears so little investigation.

The La Planche, Tidnish and Weeks' Point line, together with the arrangements connected with it, as recommended by Messrs. Keefer and Gzowski, being liable to so many positive objections that could, in no perceptible way, be neutralized by any future practical advantages, while none of the trial lines previously run seemed to indicate a route that could be looked upon as coming within the range of a reasonable outlay, it was therefore considered desirable, as already stated, that a further examination should be made, and that Mr. Baillairgé, from his knowledge of the locality, and who was then in the vicinity, should be entrusted with that duty.

He was requested to search for the lowest point of the water-shed that could be approached, and left by a line on which there would be the least depth and extent of rock cutting; and also to run such lines of levels as would enable it to be fully determined whether it would be better to continue the summit level on to near Baie Verte, or descend by a lock, on reaching the valley of the Tidnish River.

In order to obtain further information relative to a line leading towards the eastern entrance, he was directed to explore that part of the country more fully, especially a ravine that seemed to extend from a point about half a mile below Doyle's Mill on the Tidnish, to within half a mile of Weeks' Point, as a line in this direction appeared quite favorable at both ends; but towards the middle it was so closely wooded that no opinion could be given in relation to it, other than that, if the elevation was suitable, the line would not be open to the objections of the one that had been proposed along the shore of the bay.

It was, however, subsequently found that, where this line passes through, or in the vicinity of Squire Thompson's property to the valley of Oxley's Mill brook, the ground was even higher than the low part of the dividing ridge between the Bay of Fundy and Baie Verte. This fact proved conclusively that it was unnecessary to proceed further with the examination of this part of the country.

The general map of the survey previously made shewing clearly the contour and elevation of the high and low lands, it was only necessary to direct attention to those places where more minute information was required, or a change of the line desirable to avoid rock or other heavy cutting.

This enabled a thorough examination to be made in a short time at those places, the result of which has been the obtaining of a more favorable route, the highest ground on which does not exceed 105½ feet over the datum line already mentioned, and with comparatively little rock excavation on it at any place.

The arrangements best suited to the circumstances, it is believed, will be to make the high-water line of the canal 88 feet, and the low-water line 85 feet over datum—to place detached locks in connection with Cumberland Basin, and two locks, also detached, at Baie Verte, and to continue the summit level the whole distance between these points.

In a preceding part of this report, an attempt has been made to describe the position of the channel and flats in Cumberland Basin, and the difficulties as well as dangers that a vessel would be certain to encounter in passing much to the eastward of the Au-Lac River during south-westerly winds, which, on this coast, prevail for a great portion of the season of navigation.

It may further be stated that a sailing vessel in the upper part of this bay can scarcely, at any time, make headway against the tide, whether ebbing or flowing, except with a strong favorable breeze—the current in the channel on the north side of the basin being from four to five knots an hour, and through which all vessels, bound upwards must pass.

There are no natural harbors in this vicinity, and few, if any, at other places on the upper part of the Bay of Fundy, consequently, at the turn of the tide, vessels come to anchor, if possible; but in certain winds, from the nature of the coast, no safe or sheltered anchorage can be found, they are therefore obliged to lie aground on the beach or mud-banks until a favorable opportunity occurs for proceeding towards their destination.

There being in reality no place that possesses any very striking advantages to recommend it for an entrance to a canal, either in the way of access, accommodation, or facilities of construction, the choice should of course be made of the place that is the least objectionable.

For this purpose there are three places, near the north angle of the basin, deserving of consideration, viz. :—

1st. Inside of the mouth of the River Tintamarre.
2nd. At or near what is known in the locality as Cumberland Creek.
3rd. On the southerly side of Au-Lac Point.

It may be at once stated, that no matter where an entrance is made on Cumberland Basin, sailing vessels downward bound could not reasonably be expected to leave the canal earlier than within an hour of full tide, nor upward bound vessels reach the entrance over an hour after the tide has begun to ebb. Vessels provided with steam power, or those using tugs, could of course enter or leave the canal at any time when the height of the tide admitted.

In reference to the place *first* mentioned, it may be said that the lower part of the Tintamarre has a direction nearly north-east, and the current in it, is at times fully six miles an hour; the channel is abont 450 feet wide at bottom; the banks have considerable slope, and are not less than 38 feet high over low-water line.

By removing part of the slopes, the bottom might be made 750 feet, and the surface level 850 feet wide at half-tide; but although widening would give more space, all that could be done in that way, could have no perceptible influence on the current. When the tide is ebbing, a strong south-west wind raises a heavy sea in this channel, such that a vessel from either direction would experience considerable difficulty in passing through. The current of the outgoing tide is stronger than when it is rising; the difference is, however, so little, that it is quite probable the only line of entrance to a canal that could be adopted in such a case would be nearly at right angles to the channel. In leaving, as well as entering it, vessels would have to veer round until they were all but broadside on to the current, an operation it is to be feared that, under the circumstances, would be both difficult, uncertain, and extremely hazardous.

Taking all these matters into full consideration, must, it is believed, lead to the conclusion that it would be injudicious to select a place so situated for the entrance to a canal.

2nd. Immediately at and above Cumberland Creek the shoal already referred to as covered with rocks, &c., extends for a considerable distance along and out from the shore, so that even a cursory examination of the locality clearly shows that there is no place in this vicinity at all suitable for the entrance to a canal.

From this creek towards Au-Lac Point the shore line is nearly straight, and the beach generally has less inclination than elsewhere. At a place about the middle of this stretch the low-water line is nearer to the shore than it can be found anywhere else on the easterly side of the basin. At this place, about 700 feet out from ordinary high-water mark, an elevation suited to the assumed bottom line for a half-tide canal, or 54 feet over datum, can be obtained.

The shore has a direction nearly parallel to the current when the tide is making or ebbing, and winds from the south-west are all but at right angles to it; still it may be said that the entrance to a canal might be placed at such an angle to the shore that the currents would interfere as little as possible with the ingress or egress of vessels. This, it is true, could be attempted, but there is reason to fear with no greater prospect of success than there would be on any other straight coast on which the prevailing winds blow directly, and where the channel is comparatively narrow and the current from opposite directions alternately strong.

3rd. At Au-Lac Point, from the line of ordinary high-water, outwards, the bottom has a descent from the surface of the marsh to 71 feet over datum in the first 500 feet; for the next 300 feet the inclination is only five feet, and 400 feet further, or 1,200 feet from the shore, the bottom elevation is 54 feet, or at the height assumed for a half-tide navigation. At this place an entrance to a canal could be made in a direction W. by S. $\frac{1}{2}$ W., or nearly in line of the deep-water channel through the bay below, and fully three-and-half points to the westward of the course of south-west winds. Here the volume of water at the rising tide is divided into two parts; one takes a north-east direction up the River Tintamarre, and the other a southerly course towards Sharp's Creek, Rivers Hebert, Macan, &c.

On the ebbing tide they again unite at or near the place where they separated, but the points of convergence as well as those of divergence are constantly changing with the fall and rise of the tides; nevertheless, there is invariably an eddy or large area of comparatively smooth water between the respective places and the shore, such as would enable vessels to enter at any time that the bay below could be navigated, and when the height of the water permitted.

It has been, nevertheless, stated that an entrance in such a position "would expose "the lock gates to the direct assault of the sea and the full force of south-west "winds," &c., &c., but as the line would be nearly east, and the range of the lock gates north-east, it will be evident that the circumstances are not as represented in the above quotation, apart from the result certain to be produced by the alternate meeting and separation of the waters of the two channels

In short, any wind that would interfere with a vessel entering or leaving a canal so situated, would render it extremely hazardous, if not impossible, to proceed higher up, or towards the mouth of the River La Planche at any stage of the tide.

In the low water anchorage above Woody Point, known as the "Sackville anchorage," there is good holding ground, which vessels were frequently observed to take advantage of, when the survey was in progress.

Au-Lac Point has the advantage of being near this anchorage—is accessible in any wind that will carry a vessel up the bay, and could be left in any wind that a vessel might safely venture downwards. There are no foul or dangerous rock-covered banks in the vicinity; and in other respects there is probably no place on Cumberland Basin that has more advantages and fewer objectionable features than the southerly side of Au-Lac Point, for the western terminus of the contemplated canal.

To form an entrance at this place it is proposed to construct two parallel piers 250 feet apart, the northern one of which will be about 1,100 feet long, and that on the south side 1,500 feet long—the channel to be excavated to the level of 54 feet over the datum line, and the seat for the piers made one foot lower.

From the end of the piers inwards, the channel, for a distance of 1,850 feet, will sweep round until it has a south-easterly direction at about 950 feet below the end of the first lock, whence it is to be continued on a line nearly parallel to the shore. The sides of this part of the channel to be protected by a docking of timber, well tied back into the banks, or by a wall of rubble masonry.

It is believed that for even a half-tide navigation there should be three locks at this end of the canal; nevertheless, for the purpose of comparison it will for the present be assumed that two will answer the purpose, and that they should be placed 600 feet apart, and arranged as described for those proposed to be built at the mouth of the River La Planche.

The head of the second lock would be about 4,200 feet from the shore; thence the line follows a course which at six-sevenths of a mile further on, crosses the Intercolonial Railway at an angle of 60 degrees.

It then continues along the valley of the Missiguash, crosses the post road between Amherst and Sackville at about 2½ miles from the inner end of the piers, and at one mile and seven-eighths further on, it crosses the Mount Whatley Road.

For seven miles from the western terminus, the depth of cutting through the marsh land, to make the bottom of the canal 69 feet over datum will be from 22 to 23 feet; in this distance, the line at several places, crosses the upper and narrow part of the River Missiguash.

At the end of the seventh mile, it enters a floating bog that has a depth of from 6 to 10 feet or more, and extends fully 5¼ miles.

The surface of this bog is a species of live moss, from 10 to 15 inches deep, under which is a stratum one foot or more in depth of closely matted roots. When a pole is pushed into it, some resistance is felt at from two to three feet below the surface, after which it passes down quite freely, and when withdrawn is coated with black muck.

Levels taken at the same places, at different seasons of the year, seem to indicate that the elevation of the top crust of the bogs is variable, being higher in the spring and after a succession of heavy rains, than when dry weather has continued for any considerable time; their height throughout will average about 96 feet over datum; it is unsafe to venture across them without a guide, except when the surface, is fully frozen over. It was ascertained by borings that at the depth above mentioned (6 to 10 feet) the material is chiefly clay, but towards the eastern end, rock was found at several places, varying from 2 to 11 feet over the contemplated bottom line of the canal.

From the end of the bogs eastward for three quarters of a mile to the summit, or to about 13 miles from the entrance piers, the elevation is from 100 to 105½ feet over datum. For this stretch the upper part consists of moss and black muck, from two to five feet deep, underneath which, clay and sand were found for the full depth to canal bottom.

From the summit the line sweeps round to the south-east, and at a distance of about three-quarters of a mile crosses the North-west branch of the Tidnish River at an elevation of 92 feet.

The muck on this part of the route varies from three to six feet in depth.

Thence a straight course is followed until near the Tyndal Road, where the line curves more to the eastward, and intersects the main trunk of the river at about one mile and a quarter from where it first crosses the North-west branch. Between these places the general surface of the ground has a height of from 95 to 83 feet.

The line then follows the river for a short distance, and after crossing the first bend near Lucius Chappell's, it takes a northerly course until after crossing the post road leading to Baie Verte Village, at a distance of about one mile and nine-tenths from the first intersection of the main river.

The elevation of the ground on this part of the route varies from 74 to 93 feet.

Continuing on from the point above mentioned, the line crosses Smelt Brook and three bends of the Tidnish in a course leading towards the south side of the river outlet, thence takes an easterly direction across Tidnish Head to the water line of the bay, a distance of 2¼ miles.

On this part of the route, the ground varies in height from 70 to 94 feet; there are, however, two small hillocks near the junction of the Tyndal and Baie Verte roads which rise to a height of 101 feet.

The course of the river at a few places is to be changed, and a current constructed near its mouth of sufficient capacity to carry the water through under the canal. On Tidnish Head, two lift locks are to be built in line with the eastern portion of the canal and the deep water channel through the bay.

From the inner end of the piers at Au-Lac Point, to the water line of Baie Verte, the total distance is 19¼ miles.

In considering the various questions connected with the Baie Verte entrance to the canal, it should be borne in mind that the soundings shewn on the map have been reduced to an assumed low-water line of 65·57 feet over the same datum line to which the soundings at the western terminus, and levels along the route have been referred. It appears that this line was arrived at from certain marks on the abutments of Tidnish Bridge, which were pointed out to Mr. Baillairgé by an observant person who resides in the locality. During the 9½ months, however, that the survey was in progress, the water was only once (30th September, 1870) down to 66·86 feet, or to within 16 inches of the assumed low-water line; but taking the lowest tide each month for the whole time of the survey, the average is 67·85 feet or 27 inches over the assumed low-water mark.

These facts, together with the recorded observations of Admiral Bayfield, who gave much attention to the subject, leads to the conclusion that the available depth of water at low tide may fairly be taken at about 18 inches more than shewn on the map.

This, it is believed, might be done judiciously, even if it were fully established that at distant intervals the tide did fall to the line above stated, as it must be quite evident that such an occurrence could only be of so short duration as could not to any practicable or even appreciable extent interfere with navigation.

The course thus intimated, it is considered, will bear the fullest investigation, and it is therefore recommended for adoption. At the entrance to the canal it is proposed to form a triangular-shaped basin by means of two piers extending out from the shore, and embracing an area of fully eleven acres. The north pier to be 4,000 feet long, placed so as to have an easterly direction in line with the locks on the shore and the deep water channel through the bay. The pier on the south side to be nearly at right angles to the shore, or have a north easterly course, and be about 4,000 feet long, and so situated as to partly overlap the channel leading to the canal; but at a point on its inner line at right angles to the outer end of the north pier the distance will be 400 feet, and at its inner end, also at right angles to that on the north side, the distance between the respective piers will be 2,200 feet.

The seat of the north pier, and channel alongside of it for a width of 200 feet, are to be dredged to the level of 51 feet over datum.

The seat for the outer one-third of the south pier is also to be sunk to 51 feet over datum, and for the next 1,400 feet it may be dredged to 57 feet, thence to the shore the seat for the pier may be made 61 feet over datum.

When the trade, or for the purpose of sheltering vessels engaged in it, or those frequenting the port, renders it necessary, the area of deep water may be increased by dredging to such an extent as may be required.

By placing the south pier or breakwater in the oblique position described, and allowing it to overlap part of the channel, the heavy seas raised and driven in by easterly winds will be carried past, and vessels will be able to enter the harbor in any weather that they can safely approach.

The pier should be carried up to at least seven feet over high-water line, but a large part of the outer side of the south pier may possibly with advantage be made from four to five feet lower than the front.

This would to some extent prevent the shock of the waves from injuring the superstructure, and admit of the sea rolling over it during heavy storms which probably might have a tendency to make smoother water inside.

The outlet lock at this end of the canal may be placed near the shore line, and have a lift of from five to fourteen feet according to the height of the tide, and the next lock will be situated 600 feet further inland, and have a lift varying from seven to fourteen feet, as the summit level may be at high or low-water.

The distance between the second and third locks, following the line of the canal, will be about 18½ miles.

To secure a depth of 16 feet in the summit reach throughout, when the canal is down to the assumed low-water line of 85 feet, the bottom must of course be made uniformly 69 feet over datum. This taken from the general elevation of the ground at the points above mentioned will give an idea of the depth of the excavation at the respective places.

For a canal 100 feet wide at bottom, with slopes of two horizontal to one vertical in clay cutting, and in rock of 3 inches to the foot rise, Mr. Baillairgé estimates the quantity of materials to be removed as follows :—

	Cubic Yards.
Clay and earth excavation in prism of canal, lock pits, &c....	12,078,000
Rock excavation.....	44,800
Removal of muck from line of channel.....	726,600

The banks on both sides of the canal to be carried up to two feet over the highest known tide, or to the height of 102 feet over datum ; seats of all embankments to be mucked for a space of from 12 to 15 feet in width, commencing at a line immediately under the top front edge of the slope, and extending outwards, or the mucking may be done under the slope itself as circumstances may require.

Where the line passes through boggy or mossy ground, whether soft or otherwise a space 15 feet or more in width should be dug out along the front edge of the bank, and the place be afterwards made up with the best class of material that can be obtained in the excavation.

	Cubic Yards.
Mucking under seat of banks	83,000
Removing muck from front edge of banks through bogs	150,000
Cutting back ditches	60,000
Excavation and dredging at Baie Verte terminus of canal	446,000
do do Western terminus	330,000
	1,069,000

It has been considered proper to draw attention to these matters separately from the prism excavation, not only for the reason that they in the aggregate form a large item of work, but from the fact that there may possibly be as much if not more work of a similar kind on the La Planche route, and for which no provision whatever appears to have been made in the estimate for that line.

The material of the marshes and at other parts along the route, is of a nature that there will be apparently no great difficulty experienced in excavating; even the bogs can all be drained by commencing operations at or near the north branch of the Tidnish, and continuing westward through the summit.

But from numerous borings made on the line it is found that at many places the material gets to be much harder as the depth below the surface increases.

In short, the examinations, borings and trials made, lead forcibly to the conclusion that the channel, if intended for use in the present age, will have to be formed in what may be considered the ordinary uninteresting manner of doing so by means of manual labor or steam excavators, or both combined.

Captain Crawley's discarded idea of scouring out a channel, or any modified way of effecting the same object by using "the tidal power of the Bay of Fundy for that "purpose, it is to be feared, would scarcely warrant the supposed startling enquiry,—what "is to become of the five or six millions of cubic yards of stuff washed out of the canal if "removed in this way? even although the prompt answer be ready that the shallows of Baie Verte are there to receive it, and the Bay of Fundy be open for—"an infinitesimal "amount of the same material, which, in the ages that are past, its own waters have "thrown upon the land."

WATER SUPPLY.

The question of obtaining a sufficient supply of water suitable for a navigable canal through the isthmus between Cumberland Basin and Baie Verte, has led to many suggestions being made relative to the best way of effecting the object.

On the first inception of the project a canal of limited capacity was contemplated, which it was considered might be fed from fresh water lakes in the vicinity.

The scheme was however subsequently referred to Thomas Telford, Esq., who recommended a canal of larger dimensions, and advised that the highest spring tides in Cumberland Basin be adopted as the top water level of the canal.

Captain Crawley afterwards surveyed the locality, and in his report objected to the introduction of the muddy waters of the Bay of Fundy into a canal, and as a sufficient supply of fresh water could not be found, he considered it unadvisable to prosecute the inquiry further.

The various reports having been referred to me, as already stated, I advised in May, 1869, that the main level should be made from 10 to 12 feet below the highest tides in Cumberland Basin.

In February, 1871, Mr. S. Keefer, Secretary to the Canal Commission, appointed by the Government, reported on the scheme for the information of that body, and suggested, as an alternative course, that an elevation might be adopted by which "the clear water of "the Gulf would be the source of supply, and render the canal independent of the fresh water streams."

Mr. G. F. Baillairgé, to whom was entrusted the surveys and examinations authorized in 1870, recommended the adoption of a low-water level 11 feet under the highest tide he had observed during the time of his survey.

To admit the Bay of Fundy water freely into the canal, and to keep such a reserve in the canal itself as would not permanently interfere with the drainage of the marshes; this range he assumed at three feet. If these were found insufficient to meet the requirements, it was proposed that one or more of the rivers which have their outlet on Cumberland Basin should be converted into reservoirs.

Mr. Keefer, in his general report of February, 1873, recommended the adoption of a low-water level about 10 feet under the highest tide, with a variable level of six feet to afford "storage for the water to be used for working the canal," and that this, together with certain lakes, the waters of which could be drawn down when required, would be replenished by the tides "through the second lock, and through the supply gates at the bend of the La Planche."

All the surveys and examinations that have been made of the locality lead to the conclusion that the so-called lakes met with, are maintained chiefly by the rain-fall, melted

snow, &c., &c. At all events, judging from the dimensions of such streams as flow out of them, and could be rendered available for any particular line, they would form only a very small item towards supplying a canal.

In fact, it is almost a certainty that if they, together with the bogs, were once drained or drawn down to the assumed low-water level of the proposed canal, they could not be replenished or again raised to the level of 92 feet over datum, by all the water that could pass through the full surface width of the canal at the time of the *high tides* during any one month in the year, *even if no water whatever was used for the purpose of navigation during that period.*

This statement, however sweeping it may appear, is fully sustained by the elevations of the tides to which attention has been previously directed, and especially when it is borne in mind that for the last hour of the flow the tide rises from two and a half to three feet, and when at its height the slackwater, or "stand" does not continue more than from ten to twenty minutes before the water begins to fall, and then it goes down still more rapidly than it rose.

It is considered proper to remark here that the surface width of the proposed canal would be more than double that of both the "second lock" and "the supply gates at the "bend of the La Planche," which have been erroneously represented as adequate not only to admit sufficient water for consumption but also to replenish the lakes, whereas they could do neither the one, nor the other.

These are facts that will be evident to any one who practically understands matters of the nature of those under consideration, or who can properly apply towards a theoretical solution of the question some of the information which was collected for that purpose during the first survey authorized by the Department, and which is duly on record in this Office.

There is good reason to believe that any channel for navigation that could possibly be made through this section of country, must draw its supply mainly from the Bay of Fundy, the waters of which are so highly charged with mud as to have been always looked upon by most people who have seen them, as an insuperable objection to their use for such a purpose.

It is quite true that towards high tide the water holds less earthy matter in suspension than at other periods of its flow, but it is to be feared that even when at the highest stages there are serious objections to letting the water pass directly into a canal, as the adoption of this plan would be all but certain to result in the channel being eventually to some extent silted up; besides, the means of admitting the supply would be wholly inadequate to the requirements.

Both these questions having been at some length discussed in a preceding part of this report, it is now intended to describe the plan proposed to meet the objections.

It has been stated that slack water at full-tide does not continue longer than from ten to twenty minutes, and that during the hour previous to that time the tide rises from $2\frac{1}{2}$ to 3 feet, and falls even more rapidly. This shows that the time is comparatively short in which the tide is higher than the surface level of the canal, consequently it is desirable that the opening for admitting the water from the bay should be as wide as circumstances will permit, as the wider it is, the greater will be the quantity of water received. But if the supply be sent directly into the canal, no benefit could be derived from the opening being greater than the surface width of the channel: still, if it be less the inward flow will be restricted.

All the water, however, that could pass in this way, even through the largest serviceable openings, during the time that the tides were higher than the canal, would be barely adequate to meet the requirements of navigation, without providing for the low tides in any one month, but especially the summer months.

In considering this matter fully, one is led to conclude that the position of the reservoirs is at least equally as important as their extent, especially in view of the questionable benefits that could be derived from lakes situated near the middle of the route, such as could be readily emptied, and having to depend mainly on being replenished by the tide passing through the canal itself. The closer this part of the subject is examined in connection with the tidal elevations, the greater appears the fallacy of predicating a theory of supply on such a basis.

There is first the error of supposing that the canal could pass such a volume of water over navigation height in the short time of high tides (a few of which only occur at distant intervals) as would fulfil, in even a remote degree, the conditions represented.

And, secondly, the objectionable currents that would be produced in the canal, besides the still more injurious results of silting up the channel.

To meet these various questions in a way and to an extent that it is believed cannot fail to effect the objects contemplated,—it is proposed to carry out "the original idea" in this respect, but under existing circumstances, in a somewhat different manner.

The River Au-Lac, from its mouth up to the Aboideau, over which the Intercolonial Railway crosses, is to be converted into a reservoir, which at a mean between the assumed high and low-water lines of 85 and 88 feet over datum, will have an area of about 6,000,000 of feet.

The River Missiguash, from near its mouth up to the line where the canal first crosses it, is also to be converted into a reservoir, and will, at the height above mentioned, have an area of 4,700,000 feet.

	Feet.
These two reservoirs would have an area of.....	10,700,000
Area of canal, say	16,300,000
	27,000,000

In the three feet between the low and high-water levels of 85 and 88 feet over datum, there would be 81,000,000 cubic feet of water when the whole is filled, or about $6\frac{1}{2}$ days' consumption.

This, it is believed, from the position of the reservoirs and other special conditions about to be described, will be fully as much, as is likely to be required at any one time; besides, there is nothing except the drainage of the marshes that prevents the height of water being increased, if unusual circumstances should render it necessary.

In carrying out this plan, an earthen dam is proposed to be formed at the mouth of the River Au-Lac, and another near the outlet of the River Missiguash; and at each place a channel, about 260 feet wide, is to be cut to a depth of about one foot or more below the low-water line of the canal in the most sheltered and advantageous position for connecting the basin with the respective reservoirs inside the dams. In each of these channels a bulk-head is to be constructed, with such a number of openings as will, in the aggregate in each case, make about 250 feet in width for the admission of the waters of the bay, when they rise to the level of 85 feet over datum, or to such other height as it may at the time be thought proper to admit them.

These reservoirs are to be connected with the canal by means of channels about 100 feet wide, and two feet lower than the assumed low-water line. Where they connect with the canal, a supply weir is to be constructed of such a capacity that the two, *i. e.*, the Au-Lac and the Missiguash Weirs, will be about equal to the surface width of the canal; otherwise, that each of them shall have a breast-wall with sluices in it of such dimensions that the aggregate area of those in both weirs shall allow, when open, as much water to enter the canal, as if it passed over a breast the same length as the canal is wide.

The objects proposed to be gained by adopting a low-water line of 85 feet over datum, and by introducing the water into reservoirs instead of directly into the canal, may be briefly stated as follows:—

1st. For all the time that a record was kept of the rise and fall of the tides in Cumberland Basin, there were only four days in August, two days in September, three days in October, one in November and none in December, that full-tide did not rise to over 85 feet above datum, although there were two days in each of the three first-mentioned months that it was only from five to seven-tenths of a foot above 85 feet, and one day in November two-tenths, or 85·2 feet.

In August there were two days; in September, five days; in October, four days; in November, four days; in December, two days, that the tides rose to 86 and 86·9 feet.

In August there were two days; in September, four days; in October, four days; in November, six days; in December, 10 days, that the tides rose to elevations varying from 87 to 87·9 feet. The foregoing statements show that there are only two days in each of the months mentioned in which no supply could enter the reservoirs at a level of 85 feet, although there would be other two days each month that but little would be received.

But the wide openings made to admit the water into the reservoirs would allow, between the levels of 86 and 86·9 feet, as much water to enter in two tides as would nearly supply the requirements of navigation for a day.

For other parts of the month there is no doubt whatever but the supply would be so abundant, that both the reservoirs and canal might be kept at any desired height.

The fresh water lakes along the route that could be rendered available, without any great outlay, might be of service in the summer months when the tides are lowest.

In short, the principal reason that has led to the low-water level of 85 feet over datum being recommended, is the fact that there is only a very short period in any one month that water for supply cannot be introduced from the sea; and it may be added, that it has also led to a variation of three feet in the summit level being considered sufficient when viewed in connection with the contemplated facilities for admitting the water.

2nd. Reservoirs are recommended for several reasons, some of which may be enumerated as follows:—

(1.) The beds of the Au-Lac and Missiguash Rivers are convenient to Cumberland Basin, and can be converted into reservoirs of considerable extent at comparatively little expense.

(2.) From their position, a connection between them and the sea can be made independently of the canal, thus securing the means of admitting a much larger quantity of water during the rising and "stand" of the tide than could be done in any other way. The proposed arrangements will admit of fully *six times* as much water being stored at a tide as could be drawn directly "through the second lock" and through the supply gates at the bend of the "La Planche," and *three times* as much as could enter directly through an opening the full width of the canal.

(3.) They will form settling ponds, in which the water, by being allowed to remain quiescent for a few hours, will be likely to deposit much of its impurity before being admitted into the canal, a matter that, under the peculiar circumstances, is of considerable importance, as it meets to some extent, the objection to the waters of the upper end of the Bay of Fundy being used to feed a canal.

(4.) Ordinary tides of about 86½ feet, will furnish water for nearly three quarters of an hour, and high tides, an hour and three quarters; in both cases the time of rising and "stand" is included.

The water in the reservoirs may therefore be allowed to remain quiescent for at least three hours, and still have fully six hours each tide for it to pass slowly into the canal, and that too at places 2½ miles apart.

Otherwise, it would give an average of nearly *five* times as long as there could possibly be, if the water entered the canal directly from the Bay of Fundy.

These statements obviously lead to the conclusion that reservoirs situated at or near the western terminus, would be in every respect better than on any other point on the route, and as nature has already all but formed them, it would certainly be the reverse of judicious to overlook advantages that can be so easily rendered available.

In this connection it is deemed proper to draw attention to a statement prepared, at my request, by Mr. R. Steckel, a pains-taking and competent young man, who for several years has been employed by the Department. In it, are given the results of a careful theoretical computation of the quantity of water that would enter the reservoirs at each tide from near the full moon, until the tides are on the rise after the last quarter of the moon. This range of tides has been selected as one of the most unfavourable of any part of any month in the year, for supply at the elevation required; nevertheless, the results shew that sufficient water can be furnished at even these times by carrying out the plan recommended. (See Appendix.)

The dam across the mouth of the Au-Lac River, and also that at the outlet of the Missiguash, may both, as already stated, be formed of clay; but the outer faces of them should be protected by means of brush-wood arranged in layers, or with stone, or both combined, as may be subsequently determined.

The construction of these dams, cutting channels to admit water into the reservoirs, and from thence into the canal, will, in the aggregate, amount to about 380,000 cubic yards.

For the Au-Lac reservoir and race-way there will be nearly 5,000 lineal feet of dyke to be built, about one-half of which should be of sufficient width on top to form a roadway for access to the dam.

At the Missiguash reservoir there will be fully 1,100 feet of dyke to be formed to connect with those already built.

At the eastern end of the line, near the outlet of the River Tidnish, a regulating weir should be constructed and so arranged that it can be used for emptying the canal when found necessary.

For the crossing of the Intercolonial Railway, a swing bridge of wrought iron, with abutments and centre pier of masonry, must be constructed; and the openings made of sufficient capacity to admit of the water passing nearly as freely as at other parts of the canal.

A swing bridge will also have to be built for the post road between Sackville and Amherst, and another for the post road between Tidnish and Baie Verte; and means provided for carrying the traffic of other roads over the canal at such places as may be required.

To construct a canal suited to the levels, and on the line above described, with a bottom width of 100 feet, locks 40 feet wide, and 270 feet long between the gates, reservoirs for supply at the western entrance, &c., &c., would, there is reason to believe, cost as follows :—

Excavation in prism:—

	Cubic Yards.	
Earth, clay, &c.	12,148,000	
Rock	41,800	$4,413,172
Muck (liquid)	726 600	
Entrance piers, Baie Verte and Bay Fundy		783,160
Railway and post road bridges, and other means for crossing canal		172,500
Four lift locks		951,600
Guard gates east of Missiguash reservoir, and weir and flume at mouth of Tidnish River		105,000
Land damages and superintendence		450,000
		$6,875,432*
Dredging at both entrances, mucking seats of banks, removing muck from face of banks, through bogs; cutting back ditches and new channel for River Tidnish; slope walls, &c., &c.		500,000
Constructing dams at mouth of the Au-Lac and Missiguash Rivers, cutting channels to and from reservoirs, constructing bulk-heads and regulating weirs, forming dykes, &c.		260,000
Culvert for carrying Tidnish River under canal		55,000
		$7,690,432
Say		$7,700,000

This estimate, it will be seen, is about $600,000 higher than that for the La Planche and Weeks' Point Line, which is in some measure due to the quantities of work to be done being fully represented and estimated at rates sufficient for their execution, as well as in some measure to the contemplated arrangements for the water supply.

It has been prepared, as above stated, for a canal 100 feet wide at bottom; but it may be observed that a channel 80 feet wide would allow vessels the full width of the locks to pass each other freely, under ordinary circumstances, in the reaches.

* This estimate is based on rates and prices varying from *fifteen* to *one hundred-and-fifty per cent.*, or an average throughout of 25 per cent. higher than those of Mr. Keefer's estimate, *i.e.* if from $6,875,432 twenty per cent. is deducted, the sum will be $5,500,346, or what the work would amount to at that gentleman's valuation.

By making the bottom, of the latter width, the quantity of excavation in the prism would be reduced one-seventh, without causing any serious apprehension that the diminished sectional area would, to any great extent, interfere with the navigation.

At all events, there is good reason to believe that it would be of fully as much benefit to the trade to increase the depth one foot or more throughout, as it could possibly be to have a canal of the greater width.

As directed by the Order of the Honorable the Privy Council, my attention has been chiefly given to matters connected with the construction of a canal accessible at the western or Bay of Fundy entrance at about half-tide, and at the Baie Verte end at all stages of the tide.

It may, however, be stated that the western entrance recommended, is so situated that it can be made serviceable at low-water, or at any other elevation of the sea.

To render this entrance available, say for 18 hours out of every 24, or three-fourths of the time daily, would probably cost in addition to the above estimate about $400,000.

To adapt the western entrance to low-water navigation would cost about $800,000 more than the estimate for a half-tide canal.

Having thus endeavored to discuss the various leading questions bearing on the subject without entering into the details of construction, it is now proposed to give a brief *résumé* of the objections, already stated, to the formation of a canal from the mouth of the River La Planche, *viâ* Long Lake and Tidnish, to Weeks' Point; and to repeat some of the chief reasons why, in my opinion, the Au-Lac and Tidnish line *viâ* the valley of the Missiguash, should be adopted.

1st. The mouth of the La Planche, from its position, is unfavorable for the entrance to a line of general navigation, adverse winds rendering it difficult of approach for a great part of the season. Dangers exist at its outlet and along the shores of the comparatively narrow channel that leads to it, and there is no safe anchorage in that vicinity.

2nd. The eastern end of the canal would depend upon the stability of a bank upwards of 2¼ miles long, such as it is to be feared could neither be satisfactorily formed to resist a pressure of from five to 15 feet head of water, nor be protected in the manner proposed to permanently answer the purpose contemplated; and although the risk and expense were incurred of constructing a lock 1,600 feet out in the bay, the entrance would still be near a dangerous rocky shore.

3rd. The line of canal through the valley of the Tidnish is extremely crooked, and the damming of the river would flood the low lands for several miles.

By keeping the water in the summit level at the elevation proposed, the drainage of the marsh lands between Long Lake and Cumberland Basin would be obstructed.

4th. To introduce the waters of the Bay of Fundy directly into the canal for the purpose of supplying a series of lakes situated at least seven miles in the interior, intended to feed the canal itself, would have a tendency not only to silt up the channel, but there would be a certainty of failure to either fill the lakes or furnish the supply required for navigation by the means proposed.

5th. The omission of numerous essential items of work, and the insufficiency of the estimate to meet the expenditure on the works enumerated, has a tendency to mislead as to the probable cost.

The Au-Lac and Tidnish line, as proposed, is free from all these objections and in its favor it may be said :—

1st. That its western terminus would be in a position that could be safely approached or left by vessels in any wind or weather that the Bay of Fundy could be navigated; there are no dangers in the vicinity; while it presents facilities for being made available at any stage of the tide, and it would be near what is known to be and is described in the "Sailing directions" as good anchorage.

2nd. A capacious harbor will be formed at the eastern terminus, the immediate entrance to which is in deep water—remote from shoals, reefs, or other dangers; no questionable expedients are resorted to, or unnecessary risks invited in its construction; all the works connected with it being intended to be made secure when the operations are in progress.

3rd. The elevation of the water level is such as will admit of the marshes being properly drained, and the arrangements proposed will guard against private property being inundated in the valley of the Tidnish.

4th. The adoption of a low-water level of 85 feet over datum admits of drawing a supply from the Bay of Fundy, when little or no water could be received at the level of 86. By means of reservoirs at the western entrance, three times as much water can be stored at a tide, as could enter the canal directly during the rise and stand of the tide, and six times as much as could enter in the manner proposed for the La Planche and Weeks' Point line.

They would also form settling ponds, and would allow at least five times as long for the water to pass into the canal, as there would be, if it entered the canal directly.

5th. The estimate of quantities is full for all classes of work that are likely to be required, and is extended at rates believed to be the full value of the respective items.

I am, therefore, of opinion that the Au-Lac and Tidnish line, *viâ* the valley of the Missiguash, is the best that can be selected for the formation of a navigable channel between the Bay of Fundy and Baie Verte, or the Gulf of St. Lawrence.

I have the honor to be,

Sir,

Your obedient servant,

(Signed) JOHN PAGE,

Chief Engineer, Public Works.

APPENDIX

TO

CHIEF ENGINEER'S REPORT

ON THE

BAIE VERTE CANAL.

APPENDIX No. 1.

REPORT OF G. F. BAILLAIRGÉ, ON S. KEEFER'S HALF-TIDE PROJECT FOR THE BAIE VERTE CANAL, AND ESTIMATE OF PROBABLE COST.

(In No. 29,889.)

F. BRAUN, Esq.,
Secretary of Public Works,
Canada.

DEPARTMENT OF PUBLIC WORKS,
OTTAWA, 12th April, 1873.

SIR,

I have the honor to return you herewith the map and profiles of my survey for the Baie Verte Canal, together with Mr. Keefer's report on the projected work, and his plan and profile of the La Planche Tidnish and Weeks' Point line, as located for the construction of the half-tide canal recommended by him.

These documents were submitted to me, for the purpose of enabling me to prepare an estimate of a similar canal on one of the routes I have examined, as set forth in your instructions of the 9th instant, and respecting which the following report is now furnished.

In comparing the official plan of Mr. Keefer's location survey with the map of my survey, the accuracy of which is admitted at page 18th of the printed report of Messrs. Keefer and Gzowski, of 18th February, 1873, I was struck by the singular disparity between the two plans, although both are drawn on the same scale.—The river La Planche, on the location plan, is from 3,000 to 5,000 feet out of its true position at several points; La Planche lake is represented on the north instead of the south side of that river; the river Tidnish and its tributaries are also incorrectly indicated; Tidnish Head, although a short distance only from the location line, is placed 1,000 feet too far north into the waters of Baie Verte. Similar inaccuracies occur with respect to the roads and to the relative situation of the high and low land.

The discrepancies are so great and so numerous, that it is a question how far the profile on which the La Planche and Weeks' Point location line calculations are based, can be relied on.

It has been already shown in my report of the 8th April, 1872, (pages 159-166 of Public Works Report for 1872), that the supply which can, under any circumstances, be derived from the fresh water of the rivers and lakes on the isthmus between Baie Verte and Cumberland Basin, is altogether inadequate for the requirements of a ship canal; that it must necessarily be taken from the tide-water of the Bay of Fundy; that the rivers emptying into this bay can be converted into reservoirs together with the canal, in order to ensure a full supply of water during all stages of the tide, and that the "Au-Lac and Tidnish route" should be adopted in preference to any other, for a full-tide canal.

Messrs. Keefer and Gzowski, to whom my report and plans were submitted prior to their location survey, have adopted the same source and partly the same mode of supply, but they have recommended the construction of a half-tide canal on the La Planche and Week's Point route through Long Lake, based on the following scheme, proposed by Mr. Keefer.:—

1st. To admit the Bay of Fundy water into the canal and lakes at the head of the La Planche marsh, through the entrance lock and the stop-gate at the bend of the La Planche river, near the Intercolonial Railway, from the time the tide has attained an elevation of 86 feet over datum until it reaches 92 feet, and to utilize the fresh water from those lakes.

2nd. To keep a surplus depth of six feet of water between the elevations of 86 and 92 in the upper reach of the canal and in the lakes, in order to provide against any deficiency that might occur during a long succession of low neap tides.

3rd. To use the main channel of the Tidnish, and to raise the water five feet above high or fifteen feet above low water of Baie Verte, from its mouth upward to Lock No. 3, above Doyle's mill, and downward to Lock No. 4 at Weeks' Point, a distance of eight miles.

The first proposition is applicable alike to the La Planche and the Au-Lac line, if the lakes of the Missiguash are connected with the latter, their bottom elevation being no greater than that of the La Planche lakes, and if a stop-gate is placed on the river Au-Lac near the railway or elsewhere.

The second proposition is incompatible with the first, and is inapplicable to either of these lines; and the third proposition, although it applies to both lines, is highly objectionable—for the following reasons :—

1st. Supposing that the available volume of tide-water will be sufficient to raise the level of the canal and lakes to an elevation of 92, the storage capacity of the latter would be only 99 millions of cubic feet instead of 148½ millions as estimated by Mr. Keefer, who bases his calculation on a depth of six feet, whereas his own profile, together with the observations and soundings made during my survey, show conclusively that the average elevation of the bed of these lakes is no less than 88 feet above datum, which reduces the depth to be used for calculation to four feet.

2nd. The average quantity of water which can be admitted through the prism of the canal, between the elevations of 86 and 92 or even more, together with the small supply of fresh water that can be obtained, will barely suffice to meet a daily expenditure of about one half of the quantity required for the total expenditure of 12 millions of cubic feet as estimated by Mr. Keefer, during an average monthly range of tides such as will occur during the months of May, June, July and August

3rd. If the high-water level of the canal and reservoirs is maintained at an elevation of 92 in the upper reach, it will be nearly on the same level as the top surface of the marshes and bogs eastward of Cumberland Basin, up to and beyond La Planche Lake, and will thus obstruct the drainage and prevent the improvement of the same.

4th. A portion of the low lands along the River Tidnish will be permanently flooded, if the surface of the lower reach is placed at the elevation of 82, proposed by Mr. Keefer, because the river would thus be raised from five to 15 feet above its ordinary tidal level.

5th. The navigation through the River Tidnish will be unavoidably impeded by shar curves of from five to eight degrees.

6th. Although Mr. Keefer contemplates the construction of a waggon road on each side of the canal from material excavated, (which, of course, can be easily accomplished

between Cumberland Basin and the Tidnish,) he appears to have made no provision for continuing the same along the River Tidnish, the intention being no doubt that tug steamers are to be used exclusively for towing on the canal. [See pages 15-21 of his Report.]

Taking the foregoing into consideration, it is evident that Mr. Keefer's scheme is not practicable so far as regards the water supply, and not applicable in other respects to either of the lines under consideration. I have nevertheless prepared an estimate for a half-tide canal on the Au-Lac line, based on the adoption of his scheme, as regards the use of the River Tidnish line down to Weeks' Point, the mode of supply recommended by him, and his prices—for the purpose of showing that the difference of cost between the two routes is too trifling to be used as an argument in favor of the La Planche line, when compared with the paramount advantages of the Au-Lac line, which can be converted into a full-tide canal, at any time hereafter, at a comparatively small additional cost.

This estimate "No. 1" is as follows :—

BAIE VERTE CANAL.

Estimate of a Half-tide Canal by the Au-Lac and Tidnish route, based on Mr. Keefer's project for the La Planche route, using the River Tidnish, and placing the Baie Verte entrance lock in the sea opposite Weeks' Point or Roach's Head, as proposed by him :—

	$ cts.
9,320,000 cubic yards, excavation in earth, @ 30cts.	2,796,000 00
640,000 " " in fluid muck, @ 10cts.	64,000 00
660,000 " " in rock, @ $1 50cts.	990,000 00
For embankments, Baie Verte	268,000 00
" four locks	793,000 00
" one railway and four common road bridges	69,000 00
" entrance piers at Bay of Fundy and Baie Verte	365,000 00
" Tidnish Dam, and waste weirs and stop-gates	105,000 00
" land, land damages, damages to property, engineering and superintendence	200,000 00
	$5,650,000 00

It has been shown, however, that Mr. Keefer's scheme cannot be adopted for the reasons given ; I have found it necessary, therefore, to submit another estimate (No. 2), subjoined hereto, showing the probable cost of a practicable canal, with a tow-path, accessible during all stages of the tide in Baie Verte, and for 16 hours out of 24 in the Bay of Fundy, where its terminus can be extended for access at low water hereafter, by the addition of one lock, and by dredging the channel to a depth of 16 feet, which can be accomplished by a further expenditure of $375,000.

At the eastern end, the full-tide terminus is retained, because a vessel entering the canal from the Bay of Fundy at half-tide, and proceeding through it at the rate of four miles an hour, would reach Baie Verte at the time of low water, and would have to wait there three hours longer before going to sea, the time of high and low water being from $2\frac{1}{2}$ to three hours earlier at Baie Verte than at Cumberland Basin, under ordinary circumstances.

The same delay would occur for vessels proceeding from the Gulf of St. Lawrence to the Bay of Fundy.

Estimate "No. 2" is as follows :—

BAIE VERTE CANAL.

Estimate of a Half-tide Canal by the Au-Lac and Tidnish route, recommended by Mr Baillairgé—accessible 16 hours out of 24 :—

	$ cts.
12,100,000 cubic yards, excavation in loam and clay, and dredging in sand, &c., &c., @ 30cts	3,630,000 00
1,500,000 cubic yards, excavation in sand, @ 20cts	300,000 00
1,000,000 " " in fluid muck, @ 10cts	100,000 00
970,500 " " in rock and shale, @ $1 50cts	1,455,250 00
4 locks, 2 at each end of canal	760,000 00
1 permanent railway bridge across river Au-Lac 1 " road " " " " 1 railway swing bridge, across canal 4 road " " " 2 " " across locks	215,100 00
Small bridges across feeders and drains, and ferry scows	12,240 00
Dam and stop-gates, river Au-Lac and main feeder	47,160 00
Waste weir at Chappell's Brook, below Tidnish Bridge	29,430 00
Culvert, river Tidnish	47,880 00
Tide-gates and culverts for drainage	14,860 00
New dykes	41,000 00
Land and water damages	68,000 00
Piers at Baie Verte terminus	600,000 00
Piers at Bay of Fundy terminus	247,000 00
Slope wall lining inner face of canal banks	120,000 00
Superintendent's, lockmasters', laborers' and bridge keepers' houses	14,000 00
	$7,701,920 00
Add for superintendence and contingencies, 5 per cent. on cost of excavation, and 10 per cent. on cost of other works	515,929 00
	$8,217,849 00

The quantities stated in my first report have been reduced in the above estimates.

1st. By making the calculations for a half-tide instead of a full-tide canal.

2nd. By increasing the number of curves, thereby shifting the line to lower ground, and avoiding a portion of the rock excavation.

3rd. By reducing the dimensions of the channels to be dredged at each terminus.

4th. By altering the slopes of the rock cuttings from two in one to a quarter in one.

5th. By changing the location of locks Nos. 3 and 4, from Tidnish Bridge to Tidnish Head, as originally shown by the dotted lines on the map of my survey.

6th. By diminishing the number of basins from six to two.

7th. By increasing the grade of the tow-path across the high ground.

8th. By shortening the length of the piers at Baie Verte from 9,000 to 4,000 feet each, and by altering the position of the south pier, so as to form an extensive basin.

9th. By shortening the entrance piers on the Bay of Fundy from 2,000 to 1,250 feet each.

A sketch showing the relative position of the Au-Lac and La Planche lines is attached hereto.

I have the honor to be,
Sir,
Your most obedient servant,

G. F. BAILLAIRGÉ,
Assistant Chief Engineer, Public Works.

APPENDIX No. 2.

REPORT OF G. F. BAILLAIRGÉ, ON THE BAIE VERTE CANAL "FINAL LOCATION SURVEY OF 1873."

(In No. 38,591)

DEPARTMENT OF PUBLIC WORKS,
OTTAWA, 17th November, 1873.

JOHN PAGE, ESQ.,
Chief Engineer of Public Works,
Dominion of Canada.

SIR,—The following supplementary Report on the final location of the Baie Verte Canal, is herewith submitted as requested by you.

Shortly after receiving your instructions, I left Montreal for Shediac on the 27th of last June, and reached Baie Verte on the 4th of July.

Pending your arrival, I marked out the Au-Lac and Tidnish line as instructed; I afterwards established the exact relative elevations of Round Lake and Long Lake, at the head of La Planche, which I found to be 94·16 and 92·16, on the 17th of July, above the datum originally adopted.

The waters of Round Lake rise to about 95·29 in the spring of the year, and probably fall to 93·25 towards autumn; those of Long Lake, according to actual observation, rise to 95·14, and are said to fall to 90·66.

These levels and the soundings taken in the spring of 1871, show that the average elevation of the bottom of these lakes is about eighty-eight feet, as stated in my second report of the 12th of last April, respecting the half-tide canal scheme proposed by Mr. Keefer.

I endeavored also to ascertain the difference of level between the Missiguash Lakes, near the upper end of Cumberland Ridge and Round Lake, but could only do so approximately, owing to the impossibility of taking correct levels during summer across the bogs. These bogs, as before described in my original report of the 8th of April, 1872, consist of decayed vegetable matter saturated with water and covered with moss and coarse grasses; they rise or fall with the water upon which they float; some of the lakes which are found in the midst of these bogs, appear at first sight to have neither an inlet nor an outlet, when looking at the surface of the ground around them, but they communicate with other lakes by underground streams beneath the top crust of the bogs. According to levels taken on the 13th of last August, I found the elevation of Dwyer's Lake, Patten and Hackmatack Lakes, to be about 95½ feet, or one foot and a half above the surface of Round Lake, as established on the 17th of the preceding month.

From the 18th to the 25th of July, the field work was discontinued, in order that I might point out to you the various lines previously surveyed, and their termini in the Bay of Fundy and Baie Verte; and draw your attention to the obstructions impeding the navigation of the channels leading thereto, as stated in my first report, at page 166 of Appendix to Public Works' Report of 1872.

The instructions you gave me before your departure for Ottawa were carried out as speedily as practicable.

1st. By running a line of levels from Tidnish Head Marsh, along the south shore of Baie Verte to Weeks' Point or Roach's Head, a distance of 2·35 miles.

2nd. By cross-sectioning and boring the stony and rocky portions of the beach at the mouth of the La Planche and below the outlets of the Missiguash and Cumberland Creek

3rd. By levelling and sounding another line on the crest of the lower reef of Woody Point, opposite Barnes' ship yard.

4th. By running a new line of levels through the forest from Weeks' Point, *viâ* Squire Oxley's mill brook, Squire Thompson's meadow, J. R. Chappell's mill brook, and across the River Tidnish, to the junction with the Au-Lac and Tidnish line, a distance of over five and a half miles.

In addition to the foregoing, I made the rough location survey and additional test-borings authorized by your telegram of the 29th of July; and after the time first fixed for the completion of the field work on the 27th of August had been extended to the 7th of September, I determined the position of the lowest ground between Hackmatack and Round Lakes, and also between the latter and the valley of the Little West branch of the River Tidnish.

The result of the examinations made may be briefly described as follows, viz :—

I.—As Regards the Shore Line.

This line, which extends from Tidnish Head Marsh to 16 feet depth of water at extreme low tide, opposite Weeks' Point, is about 7,000 feet longer than the line terminating in the same depth of water opposite Tidnish Head.

The quantity of excavation roughly calculated, on the former, is about 1,500,000 cubic yards greater than on the latter; some 230,000 cubic yards of this quantity appear to be solid sandstone rock, according to the borings made, and the indications of the rock surface near the high-water line on the shore.

The length of cribwork required at Weeks' Point from the shore, on the shortest line to deep water, is about 8,000 feet for the east and west piers, equal say to 320,000 cubic yards, for structures of the minimum dimensions consistent with safety.

The length of cribwork which will probably be found sufficient for the protection of the Tidnish Head terminus, is 8,600 feet for the North West and South East piers, equal say to 308,000 cubic yards; the length of these piers was originally supposed to be the same as that of the dredged channel; this, however, does not appear to be indispensable. In order to reduce the cost of the work, it is now proposed to construct the piers in the position shown on the map of the original survey by the full blue lines, so as to form an extensive basin for the accommodation of coasting and fishing vessels, and susceptible of being deepened at any time for vessels of 15 feet draught.

The width of the dredged channel along the North West pier is limited to 100 feet at bottom, but may be hereafter increased to several hundred feet when required. From the end of the piers, which terminate in a depth of about 14 feet at extreme low water, it is proposed to increase the width of the channel to 300 feet, as far as a depth of 16 feet at extreme low water.

The extreme low water here referred to, is the same as that which is represented by the soundings on the original map, viz., 65·57 above datum, and it is based, as formerly stated, on local information. The lowest water observed during the time of the former survey, which lasted about 9½ months, or from 11th August, 1870, to 1st June, 1871, was 66·87, or 1·30 above the assumed extreme low-water line; this occurred only once during the time stated, viz., on the 30th of September, 1870. The average minimum range of low water, taking the lowest tide of each month between the 11th August, 1870, and the 1st June, 1871, was 67·85 above datum, or 2·28 feet above the supposed line of extreme low water. The average mean range of low water, taking the average low water of each month between the same dates, was 69·28, or 3·71 above the assumed low water line. [See Note A.]

Note A.—At bottom of page 160 of Appendix to Public Works' Report, the following corrections should be made in accordance with the manuscript of my original report:—

Instead of "Average mean range of low water, taking the lowest tide of each month 67.85"
Read "Average mean range of low water, taking the average low water of each month..... 69.28"
Read "Average minimum range of low water, taking the lowest tide of each month 67.85."

The depth of water, therefore, that will be generally available for navigation in Baie Verte at low tide, will be from 17·30 to 18·28 and 19·71, instead of 16 feet; the depth of water that would be found at the end of the piers would be from 15·30 to 16·28 and 17·71, instead of 14 feet.

The highest water observed up to the present year was 77·37 on the 29th December, 1870, but on the night of the 27th of last August, it rose to 79 feet above datum, during a storm caused by a strong north-easterly gale of wind which lasted from the 23rd to the 29th, destroying several of the dykes, post-road bridges, fences and buildings around the bay.

Any embankment that might be constructed, such as that proposed by Mr. Keefer, from Tidnish Head to Weeks' Point, would probably be destroyed by such a storm, and would be exposed to considerable danger from the shoving and piling of ice, such as occurred, I was informed, during the spring of 1872, in the cove immediately above Weeks' Point, where the ice piled in large masses upon the highest portion of the shore, some eight or 10 feet above high water.

The deep-water approach to Weeks' Point is more dangerous than towards Tidnish Head, on account of the proximity of the rocky shore from Jackson's Point upwards to the former, as may be seen on the map.

Under all the circumstances, the terminus I first recommended, on Baie Verte appears to be the most suitable both as regards the safety of vessels, the preservation of the works, and the cost of their construction.

II.—Cross Sections and Borings of Beach between the Outlets of the Rivers La Planche and Missiguash.

The borings of this beach shew that it consists of a bed of clay, hard pan, and gravel, mostly covered with loose stones and stumps of the underground forest referred to in my first report; this stratum varies from about 10 feet in depth at half-tide, to four feet at low water, the understratum being solid rock.

The elevation of the base line running north and south through the mound at station five of the original survey, near the ordinary high-water margin of the shore between the La Planche and the Missiguash, varies from 84 feet above datum near the outlet of the latter, to 92 at the mound, and thence to 52 in the channel of the former.

The first visible range of stumps of the underground forest cropping out beyond the shore is 500 to 1,000 feet westward from the base line, the elevation of the soil in which they are deeply rooted varying from 64 to 80 feet.

The surface elevation of the half-tide line is about 70¾ above datum, and extends from 750 to 850 feet westward from the base line.

The elevation of the line 1,900 feet southward from the base varies from 47 to 51.

The margin of extreme low water is 47·20 above datum, its distance from the base line being from 1,800 to 2,200.

The extent of beach covered with fragments of rock, boulders and stumps is nearly one half a mile in length by one third of a mile in breadth from the low water channel towards the shore, the remainder being composed of a coating of soft red mud on adhesive stiff blue clay.

The stumps and loose rock or boulders, the size of which varies from one cubic foot to 2½ cubic yards, more or less, may no doubt be partly removed, at great expense; but it must not be forgotten that the understratum is solid sandstone rock according to all the indications from the borings. The surface of this rock at various points is about two to five feet above the elevation of the bed of the channel required for a half-tide canal terminus, the bottom of which for a draft of 15 feet and one foot extra for keel-way should not exceed 54·71 feet over datum, for the mean rise and fall of the tides.

The level proposed by Mr. Keefer for the bottom of his La Planche half-tide canal terminus is 54 feet above datum, or 2¾ to 5¾ feet below the surface of the rock just described.

The obstructions immediately above the outlet of the La Planche, in Cumberland Basin, are worse than those above noted, because the loose rocks and boulders are larger and more numerous.

Cross Sections and Borings of Beach between the Missiguash and Cumberland Creek.

The upper stratum of this beach is similar to that of the beach precedingly described, excepting that the number of stumps and fallen trunks of branchless trees from five to 24 inches in diameter, of the underground forest, are more numerous, and the stones, although of a smaller size, are so closely packed and imbedded in the soil that the beach may be said to be paved with them.

The depth of the borings made, varies from five feet at a distance of 1,600 feet from the shore, westward, to 10 feet at a distance of 800 feet; these borings which are chiefly through red clay, stones and gravel, could not be sunk any deeper than indicated owing to the compact stony nature of the subsoil.

The elevation of the base line which runs south 19° 52′ east, near the margin of ordinary high water, and through a point $4\frac{9}{10}$ feet westward from Station 12 on the mound built during the former survey, varies from 88 to 93 feet above datum.

The first visible range of stumps of the underground forest cropping out beyond the shore is 400 to 700 feet westward from the base line, the elevation of the ground in which they are still firmly rooted, varying from 63·17 to 73·80 above datum.

The half-tide line of which the surface elevation is about $70\frac{3}{4}$ over datum, extends 450 to 500 feet outward from the base line.

At 1,500 feet from the latter, the elevation is about 54 feet, the level of the bottom of Mr. Keefer's proposed half-tide entrance channel.

The margin of extreme low water is 47·20 above datum, its distance from the base line being from 2,000 to 3,000 feet.

The extent of beach covered with stumps, stones and half-buried trunks of trees, is more than half a mile from north to south, and as much, at least, from the low water channel to eastward, the remainder from the stump range to the shore being stiff adhesive blue clay with a coating of red mud.

The low water channel from opposite Cumberland Creek to where it terminates above the outlet of the La Planche is also obstructed by loose rock and boulders at various points, as well as by quicksands near the upper end and along the Minudie Flats upon the western shore.

The beach opposite Cumberland Creek and that near the mouth of the La Planche are shown on the general map and on the detailed accompanying diagrams A and B; their situation, as will be seen, is such that vessels attempting to ascend Cumberland Basin from the Au-Lac to the La Planche, or to descend along the same route during half-tide, must necessarily pass near them or over them, and run the risk of striking some one of the numerous obstructions in their path, especially as they would sometimes have a stiff current of from five to six miles an hour to contend against, and the prevailing south-westerly winds to drive them ashore.

The stumps and trunks of trees observed on the beach near the outlets of the above named streams consist of fir, spruce, beech, pine, tamarac and hardwood, which are yet in a perfect state of preservation, being nearly as sound as if the trees of which they once formed part, were still growing, as may be seen from some specimens I collected on the spot. The bark on some of them still adheres to the timber, and their roots are imbedded in hard white sand beneath a black peaty substance at the surface, some of which is still apparent, although washed over by the water of the sea at every tide with a swift current of from five to six miles an hour, and although they are submerged twice a day during each succeeding high tide by a depth of water varying from 12 and 16 feet at lowest neap tides, to 23 and 33 feet at spring tides.

In the original survey the elevation and position of the beaches along Cumberland Basin, from the lower end of Woody Point up to Sharp's Creek and beyond it, on both sides of the channel, were ascertained by means of soundings on a series of lines which formed the radii of a circular arc embracing the entire bay, the centre of the arc being at a mast planted for the purpose on the summit of Fort Cumberland; this year they have been partly verified, as you requested, by means of levels taken when the tide was out, as shown by the diagrams and profiles before referred to.

III.—Barnes' Reef, at Lower End of Woody Point, Bay of Fundy.

The levels and soundings taken on the crest of this reef, on the 11th of August, 1873, show contrary to the general belief that it does not extend far enough to obstruct the channel leading to the canal entrance at Au-Lac Point; the breadth available for vessels drawing fifteen feet, at extreme low water, is 900 feet, the greatest depth of which is 28½ feet; and as the difference between extreme low and ordinary low water spring tides is 2·80 feet, this additional depth of water will be generally found in the channel from Woody Point upwards, besides what is represented by the extreme low water soundings shown on the map.

But the depth of the low water channel, for nearly three-quarters of a mile below Barnes' Reef, is only from 13½ to 16½ feet, according to the Admiralty Chart of 1861; the deepening of this portion of the channel to an uniform depth of 16 feet during low water, does not appear to be advisable, as it is probable that it would fill up again; the best course therefore to adopt, in the event of a whole-tide canal being required, will be for vessels of 15 feet draft to wait from ¾ of an hour to 1 hour before passing through, as the tide rises from nearly 4 to 8 feet during the first hour.

Barnes' Reef, as will be seen by reference to the survey map, is 2,650 feet below the upper projection of Woody Point; the beach for that extent, and some 2,000 feet further up stream towards Snowden's Creek, consists of solid sand stone rock, from which blocks are quarried for railway structures and mill stones.

The remainder of the beach above and below Woody Point consists of soft and stiff mud and quick sand.

The usual anchorage for large vessels frequenting the high water ports near Cumberland Basin is below Barnes' Point. Schooners generally anchor further up, in what is called the Five Fathom Hole, about mid-way towards Au-Lac and Tintamarre.

IV.—Squire Thompson Line.

This line was examined between the 4th and 6th, 14th and 16th of August. The distance from its intersection with the shore line near Oxley's Mill Brook, to where it intersects the located line, is 292·93 chains of 100 feet, or 5·55 miles, most of which had to be cut through the forest.

The comparison of this route with the located line prolonged downwards to Weeks' Point, is as follows, viz.:—

Located Line viâ North-West Valley of the Tidnish and Shore Line, or from Au-Lac to Weeks' Point.

	Miles.
Shore to Shore	21·38
" to 16ft. at extreme low-water, Bay of Fundy	0·85
" to 16ft. " " Baie Verte	0·90
Total	23·13

Trial line viâ Located Line, through North-West Valley and the Squire Thompson Line to Weeks' Point.

	Miles.
Shore to Shore	20·68
" to 16ft. at extreme low-water, Bay of Fundy	0·85
" to 16ft. at " " Baie Verte	0·90
Total	22·43

The above comparison shows that if the canal route was traced from the Au-Lac Terminus through the Valley of the Missiguash and along the Squire Thompson Line to Weeks' Point, it would be seven-tenths of a mile shorter by the Valley of the North-West, than the located line through the same valley and along the shore line, to the deep water terminus at Weeks' Point, or to a depth of sixteen feet at extreme low water in Baie Verte.

If the shortest route by the Squire Thompson Line to Weeks' Point is compared with the shortest route of the located line terminating near Tidnish Head, the difference in favor of the latter is nearly six-tenths of a mile.

The elevations of the land on the Squire Thompson route from Weeks' Point to its intersection with the located line, are approximately as follows, viz.:

Locality.	Feet above Datum.		Depth of Cutting in feet.
	Elevation.	Average Elevation.	
First Mile, from Weeks' Point	75 to 90	84	15
Second Mile, in valley of Squire Oxley's mill brook	85 to 126	106	37
Third Mile, across Squire Thompson's meadow, &c.	111 to 162½	130	61
Fourth Mile do do do	94 to 163¾	125	56
Fifth Mile, in valley of R. Chappell's mill brook	75 to 94	83	14
Sixth Mile, across the Tidnish to Junction	70 to 97	85	16

The depth of cutting on the first six miles of this line is so much greater than on the corresponding six miles of the located line terminating near Tidnish Head, as may be seen by the elevations marked on the map, that it was not considered advisable to test the nature of the material to be excavated on it; but there is no doubt, judging from the formation of the ground, that the quantity of rock excavation would be considerable.

V.—Rough Location Line established during the Summer of 1873.

When the preliminary survey was made in 1870-71, no correct map of any portion of the isthmus could be procured; the extent of country, the number of bays, streams and lakes that had to be surveyed, levelled or sounded, and bored, were so great, covering more than 200 square miles,—and the difficulties attending the sounding and field work on the Bay of Fundy, and on the bogs, were of such an unusual character, that it was impossible during the 9½ months of the survey in question to do all that would have been required for a location survey, especially as the field operations were ordered to be discontinued before they were fully completed.

Sufficient information, however, was obtained and furnished to enable any engineer of practical skill, ability, and judgment, to determine whether or not the projected work is practicable, whether it can be supplied in the manner proposed, or otherwise, and in what direction a location line might be sought for.

Mr. Keefer, in discussing the merits of the original survey, appears to have lost sight of the foregoing considerations, and to have ignored that it was the Chief Engineer, and not his Assistant, who had been instructed to furnish the Government with a report on the work, and the cost of its construction.

His criticism of the survey has not prevented him, however, from adopting the source of supply recommended, and nearly the same elevation for the bottom of the upper reach of the canal, although no acknowledgment of the same has been made in his report.

With the aid of the map, profiles, and report I originally furnished, the location survey and other examinations made this year, were comparatively an easy task, and were accomplished in the course of two-and-a-half months.

The rough location line established during the past summer, passes over the lowest ground, and avoids nearly the whole of the rock excavation of the preliminary line, and the objectionable termini and curves of the La Planche location route. It is the best that can possibly be obtained, unless greater curvature is resorted to for motives of economy. Its position is shown on the map by the *full blue line*.

The western portion of the line originally recommended from the mouth of the Au-Lac to Goose Lake, has been shifted from the north to the south side of Cumberland Ridge, or from the valley of the Au-Lac to that of the Missiguash, chiefly for the purpose of diminishing the quantity of rock excavation, and of otherwise reducing the cost of the projected work to a minimum.

The terminus, however, of the Au-Lac line on the Bay of Fundy, has been retained; any other terminus for a whole or a half-tide canal, whether at the mouth of the Missiguash or at the outlet of the La Planche, being dangerous on account of the loose rocks, boulders, stumps, and quicksands, laying in the path of vessels to those streams, and not susceptible of being rendered available for navigation during low water when the requirements of trade demand it.

The objection made to it on account of the south-west wind blowing directly into the mouth of the canal is groundless, inasmuch that such is not the case, because the south-west wind traverses the entrance piers at an angle of 45 degrees; but admitting that any danger to the entrance lock is to be apprehended on that account, it can easily be protected by slightly altering its position, or that of the piers, as shown by the full blue lines.

The central portion of the located line, from Goose Lake to Lucius Chappell's marsh on the Tidnish, passes slightly to the south-west of the original line, through the valley of the North-West; it traverses the crest of the watershed between the valleys of the Missiguash and Tidnish, the lowest elevation of which is 105½ feet, being respectively 10½ and 6¼ feet lower than the summits of the north and south sections of the original line, and 12½ feet lower than the summit of the La Planche and Weeks' Point line, recommended by Mr. Keefer.

The line through the North-West valley is about 3,300 feet shorter than the corresponding part of the *blue line* through the Little-West valley. In order to remove all doubts respecting the relative advantages of the North-West and Little-West valleys, a line through each of them was traced on the lowest ground that could be found; their respective lengths, elevations and borings, show that the North-West located line is superior to the Little-West line, as regards distance, the probable quantity of rock excavation, and the construction of an expensive culvert which will be avoided by its selection. [See Note B.]

The eastern portion of the located line from Lucius Chappell's to Tidnish Head marsh, passes generally to the northward of the original line, portions of it being in the valley of the main trunk of the Tidnish, which it is proposed, should be diverted at a few projecting points, from its present circuitous channel into a straighter one, so as to not interfere with the drainage of the country along that stream, as would be the case by adopting Mr. Keefer's scheme of raising the surface of the river to a level of about five feet above the high water of Baie Verte, or to an elevation of 82 feet.

For the reasons given in my first report, it was formerly proposed to terminate the upper reach of the canal near the Tidnish post-road bridge; it is now proposed to extend it as far as the shore near Tidnish Head, and to cross the Tidnish near its outlet, where it will be necessary to construct a culvert under the canal for the escape of the river water.

The eastern terminus, which is the same as that originally proposed, with the exception of the basin afterwards recommended in my subsequent report of the 12th April, 1873, on the half-tide canal scheme, has been already described.

NOTE B.—The borings on the section of the line through the North-West valley were made under the supervision of Alex. Munro, P.L.S. of Port Elgin, N.B.

Comparison of the Au-Lac and Tidnish Location Line through the Valley of the Missiguash, with the La Planche Location Line.

During the location of the central and eastern portions of the former line, measurements were taken at various points in order to ascertain the exact relative position of the corresponding portions of Mr. Keefer's location line, so as to indicate it correctly on the map of the original survey. The necessity of doing this arose from the fact that the located line shown on his own plan, does not correspond with his location line on the ground; the discrepancies between them are too numerous to be explained in detail; it may be sufficient to state that the intersections of his line with the various bends of the Tidnish and with the post-roads are not shewn in their true positions in scarcely any instance, the points shewn to be on dry ground, being frequently in the river, the lower portion of his line towards Tidnish Head is some 300 feet shorter than represented on his plan.

These discrepancies, however, which have been verified on the field, are not so striking as those before referred to in my second report of the 12th of last April, wherein I stated, amongst other things,—that the river La Planche on his location plan is from 3,000 to 5,000 feet out of its true position at several points,—that La Planche lake is represented on the north instead of the south side of the river,—that Tidnish Head is placed 1,000 feet too far north into the waters of Baie Verte,—and that similar inaccuracies occur with respect to the roads and the relative situation of the high and low land.

The length of the La Planche location line as given by Mr. Keefer, is 20½ miles between his entrance locks, but he has not drawn attention to the fact that the total sailing distance from a point opposite the mouth of Au-Lac to the deep water entrance of his Baie Verte terminus near Weeks' Point would be 24·93 miles.

The length of the Au-Lac and Tidnish rough location line established during the past summer is 18·67 miles between the entrance locks; the total sailing distance over this route from the same starting point taken for the La Planche, or from 16 feet depth of water at extreme low water, in the Bay of Fundy, to the same depth of water opposite the Weeks' Point entrance, is 22·32 miles, instead of the 24·93 miles, on the La Planche located line.

This shows a difference of 1·83 miles between the entrance locks, and of 2·61 miles of sailing distance in favor of the located route of the Au-Lac and Tidnish through the North-West valley.

The tables of distances appended to this report show the comparative lengths of the location line determined during the past summer, and of the La Planche location line recommended by Mr. Keefer.

Water Supply.

The line now recommended for adoption through the valley of the Missiguash, is not so favorable with respect to the water supply as that through the valley of the Au-Lac, because the surface area of the latter, which, it was proposed, should be converted into a reservoir for feeding the canal, is thrice greater than that of the Missiguash, (see page 195 of Appendix to Public Works Report, 1872) nor is it so favorable as regards the river system of the two valleys; the river Au-Lac being no longer used for the formation of new marsh land, whilst the Missiguash is still used for that purpose.

The difficulty, however, with respect to the water supply, may be obviated by using only the outlet of the Au-Lac from its mouth to the railway Aboideau as a reservoir, in which case the construction of one expensive railway bridge and one post-road bridge, will be avoided,—and by constructing a dam with proper stop-gates across the outlet of the Missiguash, in order to obtain an equivalent storage capacity for the water required, including what will be furnished by the increased volume in the upper reach of the canal, owing to its additional length from the Tidnish post-road crossing, to Tidnish Head.

With respect to the stoppage of the marsh land formation on the Missiguash, which will be affected by the canal according to the water level that may be adopted, and the distribution of the supply, the compensation that may be demanded on that account, will probably be no greater, and may possibly be less, than what it would cost to purchase the land in the valley of the Au-Lac, where its value is greater than in the valley of the Missiguash.

With the above exceptions, the mode of providing water for feeding the canal, and the elevations at which the water should be kept in the reservoirs and canal, as well as the elevation of the bottom of the upper reach of the latter, are the same as those previously recommended, but the supply will be more difficult to distribute and to regulate than in the valley of the Au-Lac, on account of the additional dam at the mouth of the Missiguash, and the greater disconnection of the canal from the feeding reservoir; in the former case, the permanent working expenses will be materially increased, and in the latter case, the simultaneous distribution of the water held in reserve cannot be effected by means of several weirs on a long extent of the upper reach, as could be accomplished in the valley of the Au-Lac, where the tide can be conducted to a greater distance eastward, or for about eight miles from the shore, than through the Missiguash, the supply from which can only be introduced conveniently at the first intersection of the canal with the river, some 3¼ miles from the Bay of Fundy terminus, and 4·20 miles from the site of the proposed dam across the outlet of the river. The supply from the lower portion of the Au-Lac, before referred to, will enter the canal through the King's Creek feeder, which connects with it about a quarter of a mile above the upper lock, and $2\frac{4}{10}$ miles below the head of the Missiguash Feeder.

As the practicability of the canal depends chiefly on the adequacy of the water supply; and if the mode suggested for obtaining it, is not considered sufficient to meet any emergency that might arise from leakage, evaporation and absorption, or otherwise, the deficiency can be provided for, in various ways, viz:—

1st. By connecting the lakes at the head of the Missiguash with the canal, which can be easily accomplished, as they are in its vicinity; and by uniting the canal with Round Lake and Long Lake, at the head of the La Planche—to effect which, it will be necessary to construct a dam at the foot of Long Lake, so as to raise it to the same elevation as Round Lake, or from ninety two to ninety four feet over datum, as may be required,—and to cut a race-way from Round Lake across the bog, a distance of 5,000 feet, to its intersection with the canal, opposite the western or lower end of Hackmatack Lake, as shown on the map by the *red dotted line*.

In such case, supply weirs would have to be constructed at or near the junction of each race-way with the canal, in order to supplement the tidal supply if needed, by means of the fresh water held in reserve in one or more of the above named lakes.

The supply can be still further augmented, if necessary, by creating reservoirs in the valley of the Little-West or of the North-West; this can be done by flooding the lowest portions of the land between the canal and the water-shed, where it is unfit for agricultural purposes, owing to its swampy nature and the great difficulty of draining it, so long as the Tidnish is dammed at Doyle's mill.

In the latter case, the minimum elevation of the water surface in the upper reach of the canal and in the reservoirs, should be eighty-five, and the maximum elevation not more than eighty-eight feet above datum, as previously proposed.

The same elevations are also proposed for the canal, in the event of converting one or more of the above named lakes into fresh water reservoirs.

The lakes at the head of the Missiguash are fed by many small springs, and by the drainage water from the surrounding uplands; they furnish a minimum supply of 11·30 cubic feet per second. Those at the head of the La Planche are fed chiefly by the

drainage water from the uplands around them; Round Lake and Long Lake, together with all the lakes at the head of the La Planche, north and south of the Tyndal Road, furnish a minimum supply of 11·54 cubic feet per second, of which, probably not more than one-third is supplied by the two former lakes.

Whenever any deficiency would occur in the fresh water supply of the lakes, it could be remedied to a certain extent, by introducing such surplus tidal water as would not be required for the maintenance of the upper reach of the canal throughout, at an elevation of eighty-eight feet above datum, providing the water can be raised in the latter to a sufficient height for the purpose, without detriment to the drainage or otherwise.

As the drainage and improvement of the bogs around the lakes depend on the elevation of the water in the latter, their surface should be maintained as much as practicable at an uniform elevation of less than ninety four.

If the question is asked,—why not connect the lakes directly with the canal, reduce them to the same elevation proposed for the latter, or to eighty-eight, and thereby dispense with dams and weirs?—the answer is, that in such case the lakes would be almost emptied, their bottom elevation being about eighty-eight feet over datum, as already stated.

Either one or the other of the precedingly proposed modes of supply, viz: by using only the fresh water of the lakes, or by establishing reservoirs in the North West or in the Little West valley, to be filled with salt water,—can be adopted, without affecting the present facilities for the drainage of the marshes, which would be increased instead of being diminished, providing the proposed elevations are adhered to.

2nd. The La Planche, or a portion of the Tintamarre, as stated in my original report, might be converted into reservoirs at any time, if required.

3rd. The supply might be increased during high spring tides by raising the surface elevation of the canal to ninety, or even to ninety two, the high water level recommended by Mr. Keefer, providing suitable feeders and stop-gates are constructed; but in such case the drainage of the marshes and bogs through the canal would be prevented; the construction of expensive tidal race-ways outside of the canal banks, with tide-gates or aboideaux and dyking at their outlets, would be rendered unavoidable, and the maintenance and working expenses of the canal would be greatly and unnecessarily increased.

In order to maintain the surface elevation of the upper reach of the canal as much as possible at an uniform elevation between eighty-five and eighty-eight, the water might be retained, if found requisite at the elevation of ordinary spring tides, for one or two days every fortnight, by means of stop-logs or otherwise, at the mouths of the feeders and over the crests of the dams, because their elevation will seldom exceed eighty-nine and a half, or one and a half feet above the variable top-water surface of the canal. When the spring tides rise to a greater height than ninety two or ninety three above datum, they can be shut out from the canal by the same means; in this case, vessels entering from the Bay of Fundy, would have to lock down into the canal.

In my first report, I stated that the Bay of Fundy water is only admissible for the supply of the canal towards the time of high water, or after it has attained an elevation of 85, because it is then comparatively clear or free from sediment.

The correctness of this statement may be disputed, because the formation of new marshes takes place during the time of high water; although this cannot be denied, it

may probably be accounted for by the fact that when the tidal water ascends the winding streams leading to the bogs, it washes off a considerable portion of the sediment, with which it becomes more densely charged, from the soft muddy banks of those streams in its upward course.

Whether this hypothesis be true or not, there is no doubt, however, that more or less sediment will be deposited in the canal; but as the latter is to be fed from reservoirs, sufficient time may be generally allowed for the deposit of the sediment on the bottom of the reservoirs, before the water is introduced into the canal, so that any obstruction to the navigation that might be apprehended from that source, is not likely to be serious, especially as it can easily be removed by dredging.

Further details respecting the water supply will be found in the appended table under that heading.

LOCKS AND BASINS.

Their number will of course depend on the decision that will be made, whether the canal is to be a whole-tide one or not, and on the extent of the accommodation to be given to vessels. The number and lifts of the locks required for a whole-tide canal are shown in my original report.

Their relative position and arrangement on the located line are nearly the same as originally represented by the full *red lines* at the western terminus and the *red dotted lines* at the eastern terminus. By this disposition of the locks, the upper reach of the canal, as before stated, will extend almost from shore to shore; this arrangement of the locks was originally intended and would have been adhered to, if an error had not been committed in the calculation of the quantity of excavation for placing the locks otherwise, near the river Tidnish post-road bridge, for obtaining a rock foundation. This error, to which Mr. Keefer makes special reference in his memorandum, dated 27th August, 1872, was only discovered after my report had been printed for the use of the House of Commons, and your attention has been called to it by me since then; I can, however, be scarcely held responsible for it, as the calculation was made at a time when my life was despaired of; my original report was prepared and written before I had completely recovered, and it was not possible for me under the circumstances to verify the accuracy of all the calculations.

The error in question, coupled with the fact that the original calculations were for a whole-tide canal of the same sectional area through earth and rock, and for locks of 18 feet draught of water, with extensive basins between them, together with dredged channels at each terminus, 300 feet in width and 16 feet in depth at extreme low water, swelled the quantities considerably above what was actually required, and greatly to the advantage of the half-tide canal scheme on the La Planche and Weeks' Point location line, especially as the calculations for the latter make no provision for ditching, dredging, and mucking under the seats of the canal banks, nor any for the rock excavation at the Weeks' Head and La Planche termini.

Judging from the appearance of the beach at Tidnish Head, where solid rock appears near high water surface, it is highly probable that a suitable foundation will be found for the entrance locks at Baie Verte, on the line as now located.

EXCAVATION.

The probable quantity of excavation required to be done for the construction of a canal, including the cuts or new river channels across the bends of the Tidnish, also the

feeders and ditches, on the line through the North-West valley, will be nearly as follows, viz. :—

For a Half-Tide Canal, not intended for extension to full-tide in the Bay of Fundy, but accessible during extreme low water in Baie Verte, for vessels of 15 feet draught, and an allowance of one foot extra for keel-way throughout :

	Cubic yards.
Earth excavation	14,319,753
Rock „	44,736
Total	14,364,489

For a Half-Tide Canal, designed for extension to full-tide at the Bay of Fundy terminus, and accessible during extreme low water in Baie Verte, for vessels of 15 feet draught, and an allowance of one foot extra for keel-way throughout :

	Cubic yards.
Earth excavation	14,595,898
Rock „	44,736
Total	14,640,634

In the preceding estimates of quantities, the canal prism is calculated for a depth of 16 feet of water, with a bottom width of 100 feet, the slopes being two horizontal to one vertical through earth, and ¼ horizontal to one vertical in rock cuttings.

Allowance has been made for the mucking required under the embankments, not merely for the purpose of rendering them water-tight, but, also for the prevention of slides in the trunk of the canal, especially through the bogs.

The latter, as before stated, consist generally of a crust of moss at the surface, and of semi-fluid vegetable matter beneath, forming a stratum which rises and falls with the water whereon, it may be said, they float, as can be tested by any one who will venture over them in summer, during the driest season.

When the canal is constructed, the drainage of the bogs to be traversed can be accomplished by commencing the excavation through the water-shed of the Missiguash and Tidnish, or from the valley of the former into the North-West or Little-West, which are considerably lower, as may be seen by referring to the elevations indicated on the map.

Once this drainage is effected, as suggested or otherwise, there is no doubt that the semi-fluid matter will be greatly reduced, probably to ¼ or less of its present thickness, which varies from six to ten feet or more.

This applies not only to the boggy material under the seats of the banks, but also to the surface of the canal prism, for a considerable distance ; a corresponding reduction should therefore be made, either in the quantity or in the cost of the excavation.

Again, as regards mucking under the banks across the bogs, it should be borne in mind that the permanent surface elevation of high water in the canal, is limited to 88 feet, whereas the surface of the bogs rises to 96 and 103 more or less, or from eight to fifteen feet above the proposed water level. It will be needless, therefore, to do any more mucking than what is necessary to provide against the loss of water through the boggy stratum, and to prevent the soft material from sliding into the trunk of the canal, whether through bogs, swamps or otherwise, unless their surface elevation is less than 88, in which case the seats of the embankments must, of course, be mucked more thoroughly—a contingency which has also been provided for.

Round Lake Line.

After the rough location line from Au-Lac to Tidnish Head was sufficiently established, I explored a line through the valley of the Missiguash and Round Lake towards that of the Little West, and took such levels as were necessary to determine the lowest ground across the water-shed, between the valley of Round Lake and that of the Little-West,—the elevations of which are indicated on the map, along the *blue dotted line*.

No borings were made, as the exploration was only finished on the 7th September, the day fixed for the close of the survey; judging, however, from the formation of the ridges along the line, it is very probable that the quantity of rock is much greater than on the located line.

The Round Lake line is 2,300 feet = 0·44 miles shorter than the trial line through the valley of the Little West, but it is about 1,000 feet = 0.20 miles longer than the located line through the valley of the North West.

In the estimate furnished with my last report, the locks, weirs and bridges are supposed to be carried up to the same height as the towing path, or to an elevation of 102 feet over datum; the culvert and waste-weir near the mouth of the Tidnish,—the piers and abutments of the railway bridge,—the locks at Baie Verte and those at the Bay of Fundy terminus, excepting the upper portion of the lower locks, are calculated as being of masonry;—the railway bridges are estimated as being of iron;—the other structures were intended to be constructed of timber or crib work and earthwork.

In addition to the diagrams and profiles before referred to, various statements are appended hereto, showing—the lengths of the several lines examined—the relative quantities of excavation and pier work on the located lines—the surface area, and water-storage capacity of the reservoirs,—and the daily elevation of high water in the Bay of Fundy and Baie Verte,—the whole of which, together with the foregoing and previous reports, will, it is believed, enable you to determine the relative merits of the different routes and schemes in connection with the projected work.

I have the honor to be,

Sir,

Your most obedient servant,

G. F. BAILLAIRGÉ,

Assistant Chief Engineer, P. W.

COMPARISON of the Au-Lac and Tidnish rough location line, through the valleys of the Missiguash and of the North-West Branch and Main Trunk of the Tidnish, with the La Planche location line.

	Chains of 100 feet.	Miles.
AU-LAC AND TIDNISH LOCATION LINE,		
Through the valleys of the Missiguash and of the North-West Branch and Main Trunk of the Tidnish.		
(Route recommended by Mr. Baillairgé).		
Shore to shore		
do 16 feet, at half tide.....Bay of Fundy	1,016·50	19·25
do 16 feet, at extreme low water, Baie Verte ...	12·00	0·23
	92·00	1·74
Total for half-tide—Susceptible of being extended to full-tide.....	1,120·50	21·22
LA PLANCHE LOCATION LINE,		
Through Long Lake, Little West and Tidnish Valleys, to Weeks' Point or Roach's Head.		
(Route recommended by Mr. Keefer.)		
Shore to shore		
do 16 feet, at half-tide .....Bay of Fundy	966·00	18·29
do 16 feet, at extreme low water, Baie Verte	37·00	0·70
	140·00	2·65
Total for half-tide—Not susceptible of being extended to full-tide.....	1,143·00	21·64
Difference in favor of Au-Lac and Tidnish Route.....	22·50	0·42

SAILING DISTANCES COMPARED.

AU-LAC AND TIDNISH LOCATION LINE,		
Viâ Missiguash and North-West Valleys.		
(Recommended by Mr. Baillairgé).		
Shore to shore		
do 16 feet at extreme low water, Bay of Fundy.....	1,016·50	19·25
do 16 feet do do Baie Verte, (opposite Weeks' Point entrance).....	45·00	0·85
	117·00	2·22
Total.....	1,178·50	22·32
LA PLANCHE AND WEEKS' POINT LOCATION LINE.		
Viâ Long Lake, Little-West and Tidnish Valleys.		
(Recommended by Mr. Keefer).		
Distance between Entrance Locks, Bay of Fundy and Baie Verte.....	1,078·00	20·42
Entrance Lock, La Planche to 16 feet, at extreme low water, Bay of Fundy....	210·00	3·98
do do Weeks' Point to 16 feet at extreme low water, Baie Verte	28·00	0·53
Total.....	1,316·00	24·93
Difference in favor of Au-Lac and Tidnish Route, viâ Missiguash and North-West Valleys.....	137·50	2·61

STATEMENT showing Quantities of Excavation, &c., for a Half-Tide Canal, on the respective located lines.

Canal 100 feet wide at bottom. Slopes 2 to 1 in Earth—1 to 1 in

STATEMENT showing Quantities of Excavation, &c., for a Half-Tide Canal, on the respective located lines.

Canal 100 feet wide at bottom. Slopes 2 to 1 in Earth—1½ to 1 in Rock. Low-water level of Upper Reach 11 feet below highest tide observed in 1870, in the Bay of Fundy, or 85 feet above Datum.

AU-LAC AND TIDNISH.

Length of Canal between entrance Locks.	Excavation, in Cubic Yards. (See notes A, B below).										Length of Piers at Termini, in Feet.	
	Canal Prism.					Fluid Muck and Moss under Canal banks.	Solid Muck under Canal banks.	Ditching.	Dredging.		Bay of Fundy.	Baie Verte.
	Earth.	Rock.	Fluid Muck, &c.	Solid Muck.	Moss.				Bay of Fundy.	Baie Verte.		
Miles.												
18·67	12,078,095	44,735	726,626	Included with Earth.	Included with Fluid Muck.	150,000	83,055	60,000	330,451	446,250	North Pier.. 1,100 South Pier.. 1,500	North Pier... 4,000 South Pier... 4,000

LA PLANCHE AND WEEKS' POINT.

20·50	9,160,000	440,000	Included with earth.	1,090,000	Omitted.	Omitted.	Omitted.	Omitted.	Omitted.	Only one Pier estimated.. 2,500	Crib-work outside of banks .. 14,480 West Pier... 1,800 East Pier.... 1,800

NOTE A.—Excavation connected with Au-Lac and Tidnish Line, viz. :— { Channels for River Tidnish..... .... 69,535 cubic yards.
{ Dams and Feeders—Mouths of Au-Lac and Missiguash 376,000 do

NOTE B.—The above quantities on the Au-Lac and Tidnish Line would have to be increased by 692,000 cubic yards for a three-quarter tide canal, and by 600,000 cubic yards more, or 1,292,000 cubic yards in all, for a full-tide canal.—G. F. B.

Water Supply from Bay of Fundy, proposed to be kept in reserve in the Rivers Au-Lac and Missiguash and in Upper Reach of Canal.

	Feet.	Feet.	Feet.
Surface area of the Au-Lac, from the proposed dam near its outlet to the Railway Aboideau	4,979,000		
do King's Creek Feeder, from River Au Lac to the canal	690,000		
do Railway Creek, from River Au-Lac to Post Road, south of Au-Lac Railway Station	250,000		
Total surface area of Au-Lac, between outlet-dam, and railway, &c., at elevation of 88 above datum		5,919,400	
Surface area of the Missiguash, from proposed dam near its outlet to junction of canal		4,775,060	
Total surface area of proposed Reservoirs in Rivers Au-Lac and Missiguash, at elevation of 88 above datum			10,694,400
Surface area of upper reach of canal, from St. 42 to St. 999, at elevation of $\frac{85+88}{2}$, or at 86½ 95,700 × 170 feet			16,269,000
Total area Au-Lac and Missiguash Reservoirs and upper reach of canal			26,963,400
Depth of water in reservoirs and upper reach of canal above lowest navigable surface			3
Total volume of water which can be kept in reserve in the reservoirs of the Rivers Au-Lac and Missiguash, and in the upper reach of the canal, on the location line, between the elevations of 85 and 88 over datum			80,890,200
N.B.—If the upper portion of the Au-Lac eastward of the railway, is converted into a reservoir, the additional volume available will be		20,000,000	
The River La Planche, from its outlet to the Post Road Aboideau, if converted into a reservoir, will furnish		23,406,000	
A portion of the River Tintamarre may be converted into a reservoir as shown on the map, thus adding to the volume of water in reserve		25,500,000	
Total additional volume of water available as above			68,900,000
Total			149,790,200

G. F. B.

BAY OF FUNDY.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, which is 50 feet below Ordinary Low Water of Spring Tides.

N.B.—Extreme low water of spring tides is 2.75 feet below ordinary low water of spring tides.

Date.	August, 1870.—Elevation above Datum in Feet.													
	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	First Quarter of Moon		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	Full Moon		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	.....		.....	.....	.....	.....	.....	90·4	.....	.....	.....	.....	.....	.....
15	.....		.....	.....	.....	.....	.....	90·2	.....	.....	.....	.....	.....	.....
16	.....		.....	.....	.....	.....	88·9c	.....	.....	.....	.....	.....	.....	.....
17	.....		.....	.....	87·5	88·4e	.....	.....	.....	.....	.....	.....	.....	.....
18	.....		.....	.....	87·7	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	Last Quarter		85·6a	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....		85·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21	.....		85·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	.....		85·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	.....		.....	86·0b	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	.....		.....	86·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	New Moon		.....	.....	.....	88·2d	.....	.....	.....	.....	.....	.....	.....	.....
27	.....		.....	.....	.....	.....	89·7f	.....	.....	.....	.....	.....	.....	.....
28	.....		.....	.....	.....	.....	.....	90·9g	.....	.....	.....	.....	.....	.....
29	.....		.....	.....	.....	.....	.....	.....	91·5h	.....	.....	.....	.....	.....
30	.....		.....	.....	.....	.....	.....	.....	.....	92·5i	.....	.....	.....	.....
31	.....		.....	.....	.....	.....	.....	.....	.....	92·3	.....	.....	.....	.....
Number of Tides	4		2	2	2	2	2	3	1	3	.....	.....	.....	.....

Low water:—*a*, 55.6; *b*, 51.6; *c*, 52.5; *d*, 52.8; *e*, 51.4; *f*, 51.0; *g*, 49.7; *h*, 49.5; *i*, 48.3.

* Rate of Rise of Tide in Feet.

	16th.	20th.	31st.
Last half of last hour	0·7	1·0	0·8
Last hour	2·6	2·8	2·0
Fifth do	6·3	5·9	6·8
Fourth do	7·6	6·5	8·7
Third do	8·0	6·3	9·5
Second do	8·8	6·0	11·4
First do	6·5	4·6	6·1

Duration of Slack Water or Stand after Tide reached its greatest elevation, on the preceding dates—also Duration of Rise—in Hours and Minutes.

Duration of Stand	0-10	0-15	0-10
do Rise	5-39	5-35	5-50

* Rate of Fall of Tide in Feet.

	16th.	23rd.
First half-hour	1·2	1·4
First hour	3·6	3·4
Second do	7·0	5·0
Third do	6·8	5·6
Fourth do	6·6	5·7
Fifth do	5·7	5·3
Last do	3·8	4·0

Duration of Slack Water or Stand, after Tide reached its lowest elevation, on the preceding dates—also Duration of Fall—in Hours and Minutes.

Duration of Stand	0-10	0-10
do Fall	6-25	6-40

* Rise and Fall of Tides were registered every five minutes, except on Sundays and stormy days, &c.; the rate per hour, in each case, is given at the respective dates stated in the following tables for each month. In cases where the daily tidal register of any month is not complete, the range and rate of the tides are based on those of the corresponding tides in one of the other months. Night Tides not observed.—G. F. B.

BAY OF FUNDY.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	September, 1870.—Elevation above Datum in Feet.													
	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	First Quarter of Moon								91·3					
3	.....	.....	.....	.....	.....	.....	.....	90·0	.....	.....	.....	.....	.....	.....
4	.....	.....	.....	.....	87·2	88·6	.....	.....	.....	.....	.....	.....	.....	.....
5	.....	.....	86·5*b*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	.....	.....	86·8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	.....	.....	.....	.....	.....	88·7	.....	.....	.....	.....	.....	.....	.....	.....
9	Full Moon ...	.....	.....	.....	.....	.....	89·3*c*	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	90·5	.....	.....	.....	.....	.....	.....
11	.....	.....	.....	.....	.....	.....	.....	90·8	.....	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....	.....	.....	90·0	.....	.....	.....	.....	.....	.....
13	.....	.....	.....	.....	.....	.....	89·8	.....	.....	.....	.....	.....	.....	.....
14	.....	.....	.....	.....	.....	.....	89·0	.....	.....	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	87·0	88·0*d*	.....	.....	.....	.....	.....	.....	.....	.....
16	.....	.....	.....	86·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Last Quarter	85·0*a*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	85·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	86·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....	.....	86·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21	.....	.....	.....	87·0*e*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	87·4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	Autumnal Equinox.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....	89·6	.....	.....	.....	.....	.....	.....	.....
25	New Moon..	.....	.....	.....	.....	.....	.....	.....	91·9*g*	.....	.....	.....	.....	.....
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	93·2*i*	.....	.....	.....
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·0*j*	.....	.....
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·6	.....	.....
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·0	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	90·9*f*	.....	92·6*h*	.....	.....	.....	.....
Number of Tides.. ..		2	5	4	3	4	5	2	1	1	3	.....	.....	

Low water :—*a*, 55.7; *b*, 55.0; *c*, 54.9; *d*, 52.8; *e*, 51.4; *f*, 49.8; *g*, 48.0; *h*, 48.2; *i*, 47.4; *j*, 47.3.

Rate of Rise of Tide in Feet.

	2nd.	14th.	27th.	30th.
Last half of last hour..	0·9	1·1	1·3	1·0
Last hour	3·0	3·3	4·1	3·4
Fifth do	7·4	6·9	8·5	7·4
Fourth do	8·2	7·5	9·7	8·5
Third do	8·6	8·3	10·1	8·9
Second do	9·4	8·5	12·7	11·2
First do	7·0	6·0	9·7	5·8

Rate of Fall of Tide in Feet.

	5th.	25th.
First half-hour	1·0	1·4
First hour	2·6	4·3
Second do	6·7	8·7
Third do	6·4	9·1
Fourth do	6·0	7·8
Fifth do	4·6	5·7
Last do	2·0	4·2

Duration of Slack Water or Stand after Tide reached its greatest elevation on the preceding dates—also Duration of Rise—in Hours and Minutes.

Duration of Stand	0–10	0–20	0–05	[illegible]
do Rise.....	5–35	5–20	5–13	5–30

Duration of Slack Water or Stand after Tide reached its lowest elevation on the preceding dates—also Duration of Fall—in Hours and Minutes.

Duration of Stand	[illegible]	0–05
do Fall	6–30	6–35

BAY OF FUNDY.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	October, 1870.—Elevation above Datum in Feet.													
	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	First Quarter	.....	.....	.....	.....	.....	89·5	.....	.....	.....	.....	.....	.....	.....
2	.....	.....	.....	.....	.....	88·7	.....	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	87·5*c*	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	.....	.....	86·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	.....	.....	.....	.....	87·8	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	.....	.....	.....	.....	87·9*d*	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	88·7	.....	.....	.....	.....	.....	.....	.....	.....
8	.....	.....	.....	.....	.....	.....	89·5*f*	.....	.....	.....	.....	.....	.....	.....
9	Full Moon	.....	.....	.....	.....	.....	.....	90·0*h*	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	90·7	.....	.....	.....	.....	.....	.....
11	.....	.....	.....	.....	.....	.....	.....	90·1	.....	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....	.....	89·9	.....	.....	.....	.....	.....	.....	.....
13	.....	.....	.....	.....	.....	88·6	.....	.....	.....	.....	.....	.....	.....	.....
14	.....	.....	.....	.....	.....	88·1	.....	.....	.....	.....	.....	.....	.....	.....
15	.....	.....	86·7*b*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	.....	85·6*a*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Last Quarter	85·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	85·7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	Earthquake	.....	86·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21	.....	.....	86·4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	87·8*e*	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	.....	.....	.....	.....	.....	.....	89·9*g*	.....	.....	.....	.....	.....	.....	.....
24	New Moon	.....	.....	.....	.....	.....	.....	.....	91·5	.....	.....	.....	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	93·3*k*	.....	.....	.....
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*96.0*n*
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·6*m*	.....	.....
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	92·6*j*	93·6*l*	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	90·7*i*	.....	.....	.....	.....	.....	.....
31	First Quarter	.....	.....	.....	.....	88·5	89·0	.....	.....	.....	.....	.....	.....	.....
Number of Tides.....		3	4	4	5	5	5	4	1	1	2	1	.....	1

Low water:—*a*, 58·5; *b*, 55·3; *c*, 54·3; *d*, 51·9; *e*, 52·7; *f*, 50·9; *g*, 50·2; *h*, 50·3; *i*, 51·6; *j*, 50·1; *k*, 49·0; *l*, 48·3; *m*, 74·0; * *n*, say 46·0.—S.-W. Gale and highest observed Tide on the 25th.

Saxby Tide, 5th Oct., 1869. (New Moon).—Rose to 100 feet above Datum at 1 a.m; fell to about 42·50 above Datum.

Rate of Rise of Tide in Feet.

	3rd.	11th.	15th.	17th.	25th.	28th.
Last half of last hour	0·6	0·6	1·2	0·6	0·7	1·2
Last hour.....	3·1	2·5	2·8	2 0	1·3	2·8
Fifth do	7 1	6·9	6·1	5·1	5·5	7·1
Fourth do	7·8	8·2	6·9	6·0	9·6	8·9
Third do	7·6	8·6	7·2	6·3	10·6	9·6
Second do	7·7	9·5	7.5	6·7	12·4	11·0
First do	5·0	5·5	5·2	3·8	8·1	6·8

Rate of Fall of Tide in Feet.

	3rd.	6th.	8th.	21st.	28th.
First half hour	1·0	0·9	0·7	1·6	1·4
First hour	3·6	3·1	3·1	3·9	4·3
Second do	6·1	6·5	7·1	6·0	8·7
Third do	6 7	7·0	7·7	6·6	9·1
Fourth do	5·6	6·5	6·8	6·3	7·6
Fifth do	4·7	5·3	5·5	5·4	5 7
Last do	2·4	3·5	3·8	3·1	4·2

Duration of Slack Water or Stand, after Tide reached its greatest elevation on the preceding dates—also Duration of Rise—in Hours and Minutes.

Durat'n of Stand	0-15	0-10	0-15	0-10	0-15	0-15
do Rise .	5-20	5-50	5-20	5-25	5-45	5-35

Duration of Slack Water or Stand, after Tide reached its lowest elevation on the preceding dates—also Duration of Fall—in Hours and Minutes.

Duration of Stand..	0·5	0-10	0-10	0-10	0·5
do Fall ...	6-35	6-35	6-40	6-30	6-35

BAY OF FUNDY.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	November, 1870.—Elevation above Datum in Feet.													
	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	.....	.....	.....	.....	.....	88·0	.....	.....	.....	.....	.....	.....	.....	.....
2	.....	.....	.....	.....	87·9	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	87·4*j*	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	.....	.....	.....	.....	.....	88·1*i*	.....	.....	.....	.....	.....	.....	.....	.....
5	.....	.....	.....	.....	.....	88·1	.....	.....	.....	.....	.....	.....	.....	.....
6	.....	.....	.....	.....	.....	88·6	.....	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	88·8*j*	.....	.....	.....	.....	.....	.....	.....	.....
8	Full Moon ..	.....	.....	.....	.....	88·8	.....	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	.....	.....	.....	.....	89·3	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	88·9	.....	.....	.....	.....	.....	.....	.....	.....
11	.....	.....	.....	.....	.....	88·5	.....	.....	.....	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	87·6	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	.....	.....	.....	.....	87·0	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	.....	.....	.....	86·7*b*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	.....	.....	.....	86·2*c*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	Last Quarter	85·2*a*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	.....	86·5*d*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	87·7*g*	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....	89·1*l*	.....	.....	.....	.....	.....	.....	.....
20	.....	.....	.....	.....	.....	.....	.....	90.5	.....	.....	.....	.....	.....	.....
21	.....	.....	.....	.....	.....	.....	.....	.....	91·9*m*	.....	.....	.....	.....	.....
22	New Moon .	.....	.....	.....	.....	.....	.....	.....	.....	.....	93·0	.....	.....	.....
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·5	.....	.....
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·4*o*	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94·2	.....	.....
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	93·4*n*	.....	.....	.....
27	.....	.....	.....	.....	.....	.....	.....	.....	91·0	.....	.....	.....	.....	.....
28	.....	.....	.....	.....	.....	88·8*k*	.....	.....	.....	.....	.....	.....	.....	.....
29	First Quarter	.....	.....	.....	87·1*k*	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	86·0*e*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Number of Tides		1	4	6	9	2	1	2	.....	2	3	.....	.....	

Low water :—*a*, 57·0; *b*, 56·6; *c*, 57·3; *d*, 56·1; *e*, 54·7; *f*, 54·4; *g*, 55·0; *h*, 53·6; *i*, 53·8; *j*, 53·3; *k*, 52·3; *l*, 52·7; *m*, 49·0; *n*, 49·0; *o*, 47·0.

Rate of Rise of Tide in Feet.	15th.	28th.	29th.
Last half of last hour ...	0·9	0·9	0·5
Last hour	2·5	2·8	2·3
Fifth do	5·2	6·4	6·5
Fourth do	6·4	8·1	6·8
Third do	6·9	7·8	7·5
Second do	7·2	8·7	9·1
First do	3·5	5·6	4·4

Rate of Fall of Tide in Feet.	3rd.	4th.	21st.
First half-hour	0·9	1·0	1·4
First hour	2·9	3·1	4·3
Second do	6·1	6·2	7·9
Third do	6·4	6·6	8·3
Fourth do	6·2	6·1	7·4
Fifth do	5·4	5·8	5·7
Last do	3·1	3·3	1·9

Duration of Slack Water or Stand, after Tide reached its greatest elevation on the preceding dates—also Duration of Rise—in Hours and Minutes.			
Duration of Stand	0–20	0–5	0–10
do Rise	5–35	5–35	5–35

Duration of Slack Water or Stand, after Tide reached its lowest elevation on the preceding dates—also Duration of Fall—in Hours and Minutes.			
Duration of Stand	0–10	0–10	0–10
do Fall.....	6–30	6–30	6–40

BAY OF FUNDY.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	DECEMBER, 1870.—Elevation above Datum in Feet.													
	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1				86·7										
2					87·5									
3					87·8*b*									
4						88·0								
5						88·2*f*								
6						88·5								
7	Full Moon					88·8								
8						88·6								
9						88·0								
10						88·4								
11					87·8									
12					87·3*c*									
13					87·8*d*									
14						88·0*g*								
15	Last Quarter			86·9*a*										
16					87·2									
17						88·0*h*								
18							89·2							
19								90·4*i*						
20										92·1*j*				
21	Winter Solstice										93·8*k*			
22	New Moon											94·2*l*		
23												94·2		
24											93·5			
25									91·8					
26								90·2						
27						88·7								
28					87·1*e*									
29	First Quarter				87·3									
30					87·5									
31					87·8									
	Number of Tides			2	10	10	1	2	1	1	2	2		

Low Water :—*a*, 55·9 ; *b*, 54·5 ; *c*, 54·5 ; *d*, 54·7 ; *e*, 54·0 ; *f*, 53·7 ; *g*, 55·0 ; *h*, 54·4 ; *i*, 51·1 ; *j*, 49·4 ; *k*, 50·0 ; *l*, 47·2.

Rate of Rise of Tide in Feet.	12th.	14th.
Last half of last hour	0·9	0·6
Last hour	2·6	1·8
Fifth do	6·8	5·4
Fourth do	7·2	7·0
Third do	7·3	7·7
Second do	8·7	8·3
First do	4·9	3·9

Rate of Fall of Tide in Feet.	5th.	20th.
First half-hour	1·0	1·5
First hour	3·2	4·3
Second do	6·4	7·1
Third do	6·8	8·9
Fourth do	6·6	7·4
Fifth do	6·0	6·1
Last do	3·8	4·3

Duration of Slack Water or Stand, after Tide reached its greatest elevation on the preceding dates—also duration of Rise—in Hours and Minutes.		
Duration of Stand	0-10	0-10
do Rise	5-20	5-40

Duration of Slack Water or Stand, after Tide reached its lowest elevation on the preceding dates—also Duration of Fall—in Hours and Minutes.		
Duration of Stand	0-10	0-50
do Fall	6-15	6-41

BAY OF FUNDY.

Half-Tide Elevation, or Mean Level between High and Low Water, referred to Datum, which is 50 feet below Ordinary Low Water of Spring Tides.

Extreme Low Water, Springs, is [illegible] feet below ordinary Low Water Springs.

Year.	Month.	Date.	Elevation above Datum in Feet.		
			High Water.	Low Water.	Half-Tide Line, or Mean Level.
1870	August	15	88·90	51·40	70·15
		16	88·40	52·50	70·45
		20	85·00	55·60	70·30
		23	86·00	54·60	70·30
		24	86·50	54·50	70·40
		25	88·20	52·80	70·50
		26	89·70	51·00	70·35
		27	90·90	49·70	70·30
		28	91·50	49·50	70·50
		29	92·50	48·30	70·40
		31	92·00	48·90	70·45
					11)774·10
				Average.....	70·37
1870	September	8	89·30	51·40	70·35
		14	88·00	52·80	70·40
		17	85·00	55·70	70·35
		21	87·00	54·90	70·95
		24	91·90	48·00	69·95
		25	93·20	47·40	70·30
		26	94·00	47·30	70·65
		29	92·60	48·20	70·40
		30	90·90	49·80	70·35
					9)633·70
				Average.....	70·41
1870	October	3	87·90	54·30	70·65
		9	90·00	50·30	70·15
		15	86·70	55·30	71·00
		17	85·00	58·50	71·75
		21	87·80	52·70	70·25
		22	89·90	50·20	70·05
		24	93·20	49·00	71·15
		25	96·00	46·00	71·00
		26	94·60	47·00	70·80
		27	93·60	48·30	70·95
		28	92·60	50·10	71·35
		29	90·70	51·60	71·15
					12)850·25
				Average.....	70·85
1870	November	3	87·40	54·40	70·90
		4	88·10	53·80	70·95
		7	88·80	53·30	71·05
		14	86·70	56·60	71·65
		15	86·20	57·30	71·75
		16	85·20	57·00	71·10
		19	89·10	52·70	70·90
		21	91·90	49·00	70·45

BAY OF FUNDY.

Half-Tide Elevation or Mean Level between High and Low Water, &c.—*Concluded*

Year.	Month.	Date.	Elevation above Datum in Feet. High Water.	Low Water.	Half-Tide Line, or Mean Level.
1870	November *(Continued)* ...	24	94·40	47·00	70·50
		26	93·40	49·00	71·20
		28	88·80	52·30	70·55
		29	87·10	53·60	70·35
		30	86·00	54·70	70·35
					13)921·70
				Average	70·90
1870	December	3	87·80	54·50	71·15
		5	88·20	53·70	70·95
		12	87·30	54·50	70·90
		15	86·90	55·90	71·40
		19	90·40	51·10	70·75
		20	92·10	49·40	70·75
		21	93·80	50·00	71·90
		22	94·20	47·20	70·70
		28	87·10	54·00	70·55
					9)639·05
				Average	71·01
1871	January	5	89·10	Low-water section of Gauge broken by ice.	
		9	88·60		
		11	88·80		
		12	87·60		
		13	86·95		
		14	86·00		
		17	89·80		
		18	89·80		
		19	90·75		
		20	91·80		
		21	92·67		

SUMMARY.

Mean Tidal Level.—Bay of Fundy.

Year.	Month.	Half-Tide Line, or Mean Level for each Month.
1870	August	70·37
	September	70·41
	October	70·85
	November	70·90
	December	71·01
		5)353·54
	Half-Tide Line, or Mean Level of the Sea	70·71

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum which is 50 feet below Ordinary Low Water of Spring Tides in the Bay of Fundy.

Date.	August, 1870.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2														
3														
4	First Quarter													
5														
6														
7														
8														
9														
10														
11	Full Moon								74·38*d*					
12									74·38*e*					
13									74·82					
14									74·52					
15									74·52*f*					
16									74·13					
17								73·80*a*						
18														
19	Last Quarter							73·78*b*						
20							72·67							
21							72·54							
22							72·50							
23														
24								73·84*c*						
25									74·05*g*					
26	New Moon							73·78						
27								73·65						
28									74·67					
29										75·01*i*				
30									74·74					
31									74·09*h*					
Number of Tides							3	5	10	1				

Low water —*a*, 68·71 ; *b*, 68·57 ; *c*, 68·78 ; *d*, 67·26 ; *e*, 69·13 ; *f*, 68·94 ; *g*, 67·34 ; *h*, 67·71 ; *i*, 67·69.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	September, 1870.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1									74·24*f*					
2	First Quarter							73·48						
3								73·24						
4														
5								73·24						
6									74·40*g*					
7									64·36*h*					
8									74·28					
9	Full Moon							73·07						
10									74·74					
11									74·94					
12														
13										75·24				
14									74·48					
15								73·07*d*						
16								73·07						
17	Last Quarter						72·90*c*							
18							72·99*b*							
19							72·40							
20								73·24						
21														
22							72·46*c*							
23	Autumnal Equinox							73·92						
24									74·54*i*					
25	New Moon													
26									74·80					
27									74·52					
28									74·61					
29										75·19*j*				
30								73·82*e*						
Number of Tides							4	9	11	2				

Low water:—*a*, 68·48; *b*, 67·99; *c*, 68·24; *d*, 68·32; *e*, 66·86; *f*, 67·82; *g*, 67·44; *h*, 67·74; *i*, 67·96; *j*, 67·24.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	October, 1870.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1	First Quarter							73·07						
2							72·94*b*							
3								73·48						
4								73·74						
5									74·03					
6									74·11					
7							72·94*c*							
8									74·21					
9	Full Moon							73·61*e*						
10									74·07					
11									74·15*h*					
12								73·86						
13									74·32*i*					
14								73·80						
15								73·21						
16							72·69*d*							
17	Last Quarter						72·63							
18								73·24						
19						71·99*a*								
20							72·65*	73·65†						
21						71·61*	72·78†							
22								73·57*f*						
23								73·01						
24	New Moon							73·57*g*						
25								73·61						
26										75·13*l*				
27									74·28					
28									74·36*j*					
29								73·90						
30											76·57			
31	First Quarter								74·38*k*					
Number of Tides						2	6	14	9	1	1			

Low water —*a*, 70·61; *b*, 68·32; *c*, 67·82; *d*, 67·57; *e*, 68·34; *f*, 68·61; *g*, 67·30; *h*, 67·38 *i*, 67·59; *j*, 66·99; *k*, 67·59; *l*, 67·21.

* A. M. † P. M.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date	November, 1870.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1								73·15*d*						
2								73·03						
3							72·99*a*							
4								73·69						
5							72·07*b*							
6														
7								73·96						
8	Full Moon							73·94						
9								73·90						
10								73·71						
11									74·71					
12									74·61					
13									74·24					
14								73·38*e*						
15								73·57						
16	Last Quarter							73·32*f*						
17														
18														
19														
20														
21							72·80*c*							
22	New Moon								74·07*g*					
23										75·57				
24									74·19					
25									74·11					
26											76·05			
27														
28									74·80*h*					
29	First Quarter													
30														
Number of Tides							3	10	7	1	1			

Low water:—*a*, 68·13; *b*, 69·19; *c*, 68·63; *d*, 68·03; *e*, 69·57; *f*, 68·90; *g*, 68·38; *h*, 68·26.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	DECEMBER, 1870.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2														
3														
4														
5														
6									74·96*a*					
7	Full Moon								74·80					
8										75·63				
9									74·07					
10										75·28				
11									74·99					
12														
13									74·03*b*					
14									74·03					
15	Last Quarter								74·74*c*					
16									74·01					
17										75·36*f*				
18														
19														
20														
21	Winter Solstice													
22	New Moon													
23								73·19		75·13*g*				
24									74·92*		76·17†			
25										75·09				
26														
27									74·90*d*					
28									74·19*a*					
29	First Quarter									75·36				
30												77·94*h*		
31														
Number of Tides								1	11	6	1	1		

Low water:—*a*, 70·71; *b*, 69·28; *c*, 69·71; *d*, 68·11; *e*, 68·24; *f*, 70·30; *g*, 69·86; *h*, 70·32.

* A.M. † P.M.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	JANUARY, 1871.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2														
3								73·99*e*						
4							72·28*a*							
5							72·15							
6	Full Moon									75·36				
7									74·84					
8														
9									74·78*		76·61†			
10										75·36				
11									74·17*i*					
12									74·82					
13								73·74*f*						
14	Last Quarter							73·65*g*						
15														
16														
17														
18							72·59*b*							
19								73·65*h*						
20	New Moon							73·09						
21									74·36					
22														
23									74·01					
24										75·34				
25							72·99*c*							
26						71·90								
27									74·24*j*					
28	First Quarter						72·82*d*							
29														
30														
31														
Number of Tides						1	5	5	7	3	1			

Low water; —*a*, 71·74; *b*, 69·19; *c*, 68·94; *d*, 70·34; *e*, 70·65; *f*, 68·99; *g*, 68·74; *h*, 69·09; *i*, 68·74; *j*, 70·34.

* A.M. † P.M.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	February, 1871.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2														
3							72·67							
4							72·36							
5	Full Moon													
6														
7								73·80						
8								73·82						
9								73·99						
10									74·86*f*					
11									74·74*g*					
12	Last Quarter						72·74*a*							
13														
14									74·80*h*					
15									74.07					
16														
17							72·84*b*							
18									74·01					
19	New Moon							73·69*d*						
20														
21										75·03				
22								73·32						
23								73·99						
24								73·11*e*						
25								73·90						
26									74·05*i*					
27	First Quarter													
28								73·36						
Number of Tides							5	9	6	1				

Low water :—*a*, 68·94 ; *b*, 70·94 ; *c*, 70·65 ; *d*, 70·11 ; *e*, 69·24 ; *f*, 69·11 ; *g*, 69·34 ; *h*, 70·88 ; *i*, 70·11.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	March, 1871.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2														
3								73·59*b*						
4								73·19						
5														
6	Full Moon						72·71*a*							
7									74·21					
8								73·78						
9								73·30						
10									74·78*c*					
11								73·94						
12														
13	Last Quarter								74·19*f*					
14									74·99					
15								73·80*e*						
16														
17								73·74						
18								73·36						
19														
20	New Moon—Vernal Equinox							73·82						
21									74·19*g*					
22										75·15				
23								73·76						
24									74·74					
25							72·96							
26														
27														
28									74·19*h*					
29	First Quarter									75·63				
30							72·90	73·32						
31								73·86*d*						
Number of Tides							3	12	7	2				

Low water :—*a*, 69·99; *b*, 71·19; *c*, 70·63; *d*, 71·57; *e*, 69·82; *f*, 70·16; *g*, 69·57; *h*, 70·80.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	April, 1871.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1														
2							72·59							
3														
4									74·07*f*					
5	Full Moon								74·01					
6									74·94					
7										75·64*i*				
8									74·69					
9										75·05				
10														
11										75·24*j*				
12	Last Quarter								74·82					
13										75·32				
14								73·90*a*						
15								73·94						
16								73·90						
17														
18									74·13*g*					
19	New Moon								74·90					
20								73·57*b*						
21								73·36						
22									74·57*h*					
23									74·32					
24														
25								73·78						
26								73·74*c*						
27	First Quarter							73·94						
28								73·09*d*						
29							72·96							
30								73·19*e*						
Number of Tides							2	10	9	4				

Low water :—*a*, 68·28 ; *b*, 68·82 ; *c*, 70·13 ; *d*, 70·61 ; *e*, 70·86 ; *f*, 70·32 ; *g*, 69·30 ; *h*, 68·28 ; *i*, 68·74 ; *j*, 69·69.

BAIE VERTE.

Oscillations of Tidal Vertex, or Daily Elevation of High-Tide above Datum, &c.—*Continued.*

Date.	May, 1871.—Elevation above Datum in Feet.													
	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1								73·28						
2														
3														
4	Full Moon								74·15*f*					
5									74·17					
6									74·57					
7										75·19*j*				
8											76·24			
9									74·92					
10									74·88*g*					
11	Last Quarter								74·65					
12									74·12					
13								73·90*e*						
14								73·94						
15														
16									74·03*h*					
17									74·07					
18								73·82						
19	New Moon							73·38						
20								73·71						
21								73·15						
22														
23									74·07*i*					
24									74·07					
25									74·03					
26							72·74*a*							
27	First Quarter							73·99*d*						
28								73·99						
29														
30							72·65*b*							
31								73·57						
								73·94*c*						
Number of Tides							2	11	12	1	1			

Low water:—*a*, 70·82; *b*, 69·32; *c*, 70·28; *d*, 71·01; *e*, 69·03; *f*, 68·32; *g*, 70·24; *h*, 69·38; *i*, 68·65; *j*, 67·74.

BAIE VERTE.

Half-Tide Elevation, or Mean Level, between High and Low Water, referred to Datum, which is 50 feet below Ordinary Low Water of Spring Tides, in the Bay of Fundy, where Extreme Low Water, Springs, is 2·75 feet below ordinary Low Water Springs.

Year.	Month.	Date.	Elevation above Datum in Feet.		
			High Water.	Low Water.	Half-Tide Line, or Mean Level.
1870	August	11	74·38	67·26	70·82
		12	74·38	69·19	71·78
		15	74·52	68·94	71·73
		17	73·80	68·71	71·25
		19	73·78	68·57	71·18
		24	73·84	68 78	71·31
		25	74·05	67·94	70·99
		29	75·01	67 69	71·35
		31	74·09	67·71	70·90
					9)641·31
				Average.....	71·26
1870	September	1	74·24	67·82	71·03
		6	74·40	67·44	70·92
		7	74·36	67·74	71·05
		13	75·24	68·32	71·78
		15	73·07	68·32	70·69
		17	72·90	68·48	70·69
		18	72·99	67·99	70·49
		22	72·46	68·24	70·35
		24	74·54	67·96	71·25
		29	75·19	67·24	71·22
		30	73·82	66·86	70·34
					11)779·81
				Average.....	70·80
1870.	October	2	72·94	68·32	70·73
		7	72·94	67·82	70·38
		9	73·61	68·34	70·97
		11	74·15	67·38	70·77
		13	74·32	67·59	70·95
		16	72·69	67·57	70·13
		19	71·99	70·61	71·30
		22	73·57	68·61	71·09
		24	73·57	67·30	70·43
		28	74·36	66·99	70·68
		31	74·38	67·59	70·98
					11)778·31
				Average.....	70·76
1870	November	1	73·15	68·03	70·59
		3	72·99	68·13	70·56
		5	72·07	69·19	70·63
		11	74·71	68·13	71·42
		13	73·38	69·57	71·47
		16	73·32	68·90	71·11

BAIE VERTE.

Half-Tide Elevation or Mean Level between High and Low Water, &c.—*Continued.*

Year.	Month.	Date.	Elevation above Datum in Feet.		
			High Water.	Low Water.	Half-Tide Line, or Mean Level.
1870.	November (*continued*)	21	72·80	68·63	70·71
		22	74·07	68·38	71·22
		28	74·80	68 26	71·53
					9)639·24
				Average	71·03
1870.	December	5	74·96	70 71	72·83
		12	74·03	69·28	71·66
		14	74·74	68·71	71·72
		21	75·13	69·86	72·49
		26	74·90	68·11	71·51
		27	74·19	68·24	71·21
		29	77·94	70·32	74·13
					7)505·55
				Average	72·22
1871.	January	3	73·99	70·65	72·32
		4	72·28	71·74	72·01
		11	74·17	68·74	71·45
		13	73·74	68·90	71·32
		14	73·65	68·74	71·19
		18	72·59	69·19	70·89
		19	73·65	69·99	71·82
		25	72·99	68·94	70·96
		27	74·24	70·34	72·29
		28	72·82	70·34	71·58
					10)715·83
				Average	71·58
1871.	February	9	74·86	69·11	71·98
		10	74·74	69·34	72·04
		11	72·74	68·94	70·84
		13	74·80	70·88	72·84
		16	72·84	70·94	71·89
		18	73·69	70·11	71·90
		23	73·11	69·24	71·17
		25	74·03	70·11	72·07
		28	72·69	70·65	71·67
					9)646·40
				Average	71·82
1871.	March	3	73·59	71·19	72·39
		6	72·71	69·99	71·35

BAIE VERTE.

Half-Tide Elevation or Mean Level between High and Low Water, &c.—*Continued.*

Year.	Month.	Date	Elevation above Datum in Feet.		
			High Water	Low Water.	Half-Tide Line, or Mean Level.
1871.	March (*continued*)	10	74·78	69·82	72·30
		13	74·19	70·86	72·52
		15	73·80	70·63	72·21
		21	74·19	69·57	71·88
		27	74·19	70·80	72·49
		31	73·86	71·57	72·72
					8)577·86
				Average.....	72·23
1871.	April	3	74·07	70·32	72·19
		6	75·04	68·74	72·19
		10	75·24	69·69	72·47
		13	73·90	68·28	71·09
		17	74·13	69·30	71·71
		19	73·57	68·82	71·19
		21	74·57	68·28	71·43
		25	73·74	70·13	71·93
		27	73·09	71·61	72·35
		29	73·19	70·86	72·03
					10)718·58
				Average.....	71·86
1871.	May	3	74·15	68·32	71·23
		6	75·19	67·74	71·47
		9	74·88	70·24	72·56
		12	73·90	70·28	72·09
		15	74·03	69·38	71·70
		22	74·07	68·65	71·36
		25	72·74	70·82	71·78
		26	73·99	71·01	72·50
		29	72·65	69·32	70·99
		31	73·94	69·03	71·48
					10)717·16
				Average.....	71·72

BAIE VERTE.

Half-Tide Elevation or Mean Level between High and Low Water, &c.—*Concluded.*

SUMMARY.

Year.	Month.	Half-Tide Line, or Mean Level for each Month,—above Datum, in feet.
1870.	August	71·26
	September	70·89
	October	70·76
	November	71·03
	December	72·22
1871.	January	71·58
	February	71·82
	March	72·53
	April	71·86
	May	71·72
		10)715·67
	Half-Tide Line, or Mean Level of the Sea	71·57

General remark respecting Tidal Observations, upon which the preceding Tables, showing the Daily Elevation of High Tide, &c., are based.

The fluctuations of the Rising and Falling Tides in the Bay of Fundy and Baie Verte were indicated by Gauges placed in each Bay, and were registered every five minutes in the Gauge-books by persons constantly employed for that special purpose. The Gauges were marked in Feet and Tenths, except one of the Gauges at Baie Verte, which was marked in Feet and Inches, as noted in the Gauge-book, from 10th August to 10th October, 1870.

G. F. BAILLAIRGÉ.
Assistant Chief Engineer, Public Works.

BAIE VERTE.

Gauges used during Survey of 1870–71, at Tidnish Bridge.

* Old Gauge No. 1. — From 10th August, 1870, to 25th November, 1870.	Elevation above Datum, Bay of Fundy.	† Gauge No. 2. — From 25th November, 1870, to 4th February, 1871.	Elevation above Datum, Bay of Fundy.	‡ Gauge No. 3. — From 4th February, 1871, to 31st May, 1871.	Elevation above Datum, Bay of Fundy.
Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
14	79·57	29·57	79·57	33·00	79·57
13	78·57	29·00	78·57	32·00	78·57
12	77·57	28·00	77·57	31·00	77·57
11	76·57	27·00	76·57	30·00	76·57
10	75·57	26·00	75·57	29·00	75·57
9	74·57	25·00	74·57	28·00	74·57
8	73·57	24·00	73·57	27·00	73·57
7	72·57	23·00	72·57	26·00	72·57
6	71·57	22·00	71·57	25·00	71·57
5	70·57	21·00	70·57	24·00	70·57
4	69·57	20·00	69·57	23·00	69·57
3	68·57	19·00	68·57	22·00	68·57
2	67·57	18·00	67·57	21·00	67·57
1	66·57	17·00	66·57	20·00	66·57
0	65·57	16·00	65·57	19·00	65·57
		15·00			
Figures represent Elevation of Water above Extreme Low Water, Baie Verte.	—	Figures represent Elevation of Water above Extreme Low Water, Bay of Fundy.	—	Figures represent Elevation of Water above bottom of Canal, with 19 feet of water at Extreme Low Water in Baie Verte, the elevation of the bottom being 46·57.	—

BAIE VERTE GAUGES.

	Feet.			
* Add	65·57	to Readings of	Gauge-book No. 1.	Tested by Level.
† do	50·57	do	do No. 2.	This Gauge placed 0·57 ft. too high.
‡ do	46·57	do	do No. 3.	

BAY OF FUNDY GAUGE.

The Bay of Fundy Gauge consisted of several sections, each ten feet in length. Each section was planted in the slope of the bank of Au-Lac Point, at an elevation of ten feet above that of the other. The zero of the lowest section was placed at the level of Ordinary Low Water Springs; the numbering thence of the feet and tenths was continued downward to Extreme Low, and upward to Extreme High Water.—G. F. B.

APPENDIX No. 3.

BAIE VERTE CANAL.

THEORETICAL COMPUTATION OF THE BAY OF FUNDY TIDE-WATER SUPPLY, OVER THE BREASTS OF WEIRS, BASED ON THE TIDAL VARIATIONS OBSERVED.

Assuming that the canal surface is not to be raised above elevation 88, and that the volume of water necessary to maintain this fluctuating level constantly at an intermediate height, between elevations 85 and 88, is to be introduced over the breasts of supply weirs into the canal prism from the Au-Lac and Missiguash reservoirs, where the muddy tide-water is to remain at rest for a short time, in order that the greater part of the sediment with which it is charged may be deposited therein—the most unfavorable time in each month for obtaining the supply required to meet the simultaneous expenditure of water for locking and other purposes, is, according to the tidal observations, the interval elapsing from about two or three days after full moon to within a day or two of the succeeding new moon.

If it is demonstrated that during the lapse of time just described, the available supply is abundant to meet all demands, it is clear that any doubts which may be entertained as to the adequacy of the tidal supply of the reservoirs, and at the levels proposed by Mr. Baillairgé, will be effectually removed.

Let g represent the acceleration of gravity in feet per second,

h the height of the water in Cumberland Basin above the reservoir-surface at any stage of the tidal influx,

t the time required by the tide to rise h feet above reservoir-surface,

H the total height in feet which the tide rises above the reservoir-surface at the time of high water in Cumberland Basin,

T the length of time in seconds required by the tide to rise H feet above the reservoir-surface,

r the rate of rise of the tide in feet per hour, at the commencement of its influx into the reservoir,

t_s the duration of slack water in seconds at high water,

b the breadth in feet, of the opening through which the water is admitted into the reservoir—equal to 250 feet for the Au-Lac, and 200 feet for the Missiguash reservoir,

a the mean area of the reservoir equal to 5,915,000 square feet for the Au-Lac, and 4,775,000 square feet for the Missiguash reservoir,

L the length of the reservoir = 9,200 feet for Au-Lac, and 21,800 for Missiguash,

c a coefficient, denoting the ratio between the average breadth of the elongated reservoir and the breadth of the opening through which the water finds ingress, with approximate correction for friction, enlargements, etc., applied as found necessary; value for Au-Lac = 2·20, for Missiguash = 0·93,

0.54 a factor, denoting the product of the mean rate of vertical rise of the Bay of Fundy tides in feet per hour, by the mean horizontal surface velocity of the current in feet per second.

Then we have the following relations:

1st. When the rise of the tide above the reservoir-surface and the current are such that the water cannot reach the upper end of the elongated reservoir before the gates are

closed at its mouth, the total volume of water supplied up to the time the influx is stopped, is: (neglecting the comparatively insignificant correction for friction, etc.)

$$Q = v = \left\{ \tfrac{1}{2}\sqrt[4]{.474573}\sqrt[2]{2g}\, b \right\} \left\{ h^{\frac{5}{2}} \frac{2T}{5H} + H^{\frac{3}{2}} t_s \right\} + \left\{ \frac{0.54\, r\, b\, T}{H} \right\} \left\{ \frac{h^2}{2} - \frac{h^3}{6H} \right\} \quad (1)$$

This formula is applicable only so long as h does not exceed the numerical value of the positive root of the equation:

$$h^{\frac{5}{2}} \left\{ \frac{T}{H^{\frac{1}{2}}} \sqrt[4]{.474573}\sqrt[2]{2g} \right\} + h \left\{ \frac{.54\, r\, T}{H} \right\} = Lc \quad (2)$$

2nd. When the duration and velocity of the tidal influx are barely sufficient for it to reach the head of the reservoir during the time of slack water, and to raise the equilibrium water level of the reservoir a height w above its surface elevation prior to the ingress of the tide; the numerical value of w is determined by equation:

$$\left\{ \tfrac{3}{2} t_s \left(H - w \right)^{\frac{1}{2}} + \frac{T}{H} \left(H - w \right)^{\frac{3}{2}} \right\} \left\{ \tfrac{1}{2}\sqrt[4]{.474573}\sqrt[2]{2g} \right\} + \\ + \left(H - w \right) \left\{ \frac{0.54\, r\, t_s}{H} \right\} + \left(H - w \right)^2 \left\{ \frac{0.54\, r\, T}{H^2} \right\} = Lc \quad (3)$$

and the volume of stationary water in the reservoir above the elevation just mentioned, is:

$$v_2 = a\, w \quad (4)$$

The additional volume v_3 of flowing water stored up in the reservoir when the gates are closed at the turn of the tide is:

$$v_3 = b\, c \left\{ \tfrac{2}{5} \left(H - w \right)^{\frac{5}{2}} \left(\frac{T}{H^{\frac{1}{2}}} \sqrt[4]{.474573}\sqrt[2]{2g} \right) + \left(H - w \right)^3 \left(\frac{0.54\, r\, T}{3H^2} \right) \right\}; \quad (5)$$

and the total volume of water supplied up to the time that the influx is stopped is:

$$Q = v_2 + v_3 \quad (6)$$

3rd. When the inward tidal current reaches the head of the reservoir before the time of slack water—

The height z of the water in equilibrium, which has accumulated in the reservoir prior to the occurrence of slack water in Cumberland Basin, is determined by equation:

$$\left(H - z \right)^{\frac{3}{2}} \left\{ \frac{T}{H^{\frac{1}{2}}} \sqrt[4]{.474573}\sqrt[2]{2g} \right\} + \left(H - z \right)^2 \left\{ \frac{0.54\, r\, T}{H^2} \right\} = Lc\ ; \quad (7)$$

and the volume of stationary water in the reservoir above its surface elevation, prior to the influx of the tide, is:

$$v_1 = a\, z \quad (8)$$

The height u of a similar sheet of water accumulated in the reservoir during the time of slack water is determined by equation:

$$\left\{ \tfrac{3}{2} t \left(H - z - u \right)^{\frac{1}{2}} + \frac{T}{H} \left(H - z - u \right)^{\frac{3}{2}} \right\} \left\{ \tfrac{1}{2}\sqrt[4]{.474573}\sqrt[2]{2g} \right\} + \\ + \left\{ H - z - u \right\} \left\{ \frac{0{,}54\, r\, t_s}{H} \right\} + \left\{ H - z - u \right\}^2 \left\{ \frac{0.54\, r\, T}{H^2} \right\} = Lc\ ; \quad (9)$$

and the corresponding volume of stationary water in the reservoir is:

$$v_2 = a\, u \quad (10)$$

The additional volume of flowing water stored up in the reservoir when the gates are closed at the turn of the tide, is:

$$v_3 = b\,c\left\{\frac{2}{3}\left(H-z-u\right)^{\frac{5}{2}}\left\{\frac{T}{H^{\frac{1}{2}}\sqrt[4]{.474573\ldots}\sqrt[2]{2g}}\right\}+\left(H-z-u\right)^{3}\left\{\frac{0.54\,r\,T}{3H^{2}}\right\}\right. \qquad (11)$$

and the total volume supplied up to the time the influx is stopped, is:

$$Q = v_1 + v_2 + v_3 = a\left(z+u\right) + v_3 \qquad (12)$$

If adequate means are devised, enabling us to equalize, at all times, the depth of the storage water in the reservoirs and the canal during the interval elapsing between one tidal influx and the next, three tides of ninety will suffice, according to the above formulas, to raise the low-water level three feet, from eighty-five to eighty-eight, over their entire surface of 27,000,000 square feet.

This fact proves conclusively that the canal, together with the reservoirs, can be filled from elevation 85 to 88, during any one of the low ranges of spring tides, which occur every month towards the time of full moon.

Proceeding therefore on the basis that the canal and reservoirs are full up to their maximum permanent elevation of 88, on the 12th of October, 1870, at 1.35 p.m., when the volume of water consumed in one half day is yet less than the quantity furnished by the corresponding tidal influx, and that the surface of both the reservoirs and the canal is invariably brought to an uniform level during the time elapsing between one tidal influx and the next, when the canal is worked steadily up to its full capacity, viz., at the rate of a daily consumption of 12,000,000 cubic feet, we obtain the following:

Table

TABLE OF FLUCTUATIONS of the Bay of Fundy Tide Water Supply at the Low Water Level of 85 above Datum, based on the above formulas.

Date. 1870.	Elevation of High Water Surface in Cumberland Basin.	Elevation of Reservoir Surface at beginning of each Tidal Influx.	H, Total Rise of the Tide above Reservoir Surface.	r, Rate of Rise per Hour at the beginning of the Tidal Influx.	T, Time occupied by the Tide in rising H feet above Reservoir Surface.	t_s, Duration of Slack Water or stand at High Water.	v	v_1	v_2	v_3	Q, Total Volume of Water supplied at each Tidal Influx.	Mean Volume of Surplus Water remaining in Canal and Reservoirs above 85 at beginning of each Influx, assuming the mean semi-diurnal consumption to be 6,000,000 Cubic Feet.	Total Volume of Surplus Water stored up in Canal and Reservoirs at end of each Influx.
Oct.	Feet.	Feet.	Feet.	Feet.	Seconds.	Seconds.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.	Cubic Feet.
12	89·95	88·00	1·95	4·10	2784	600	.....	.....	2,673,000	7,196,000	9,869,000	80,880,000	80,880,000
13	88·95	87·78	1·17	3·25	1980	600	3,241,000	.....	.....	.....	3,241,000	74,880,000	78,121,000
13	88·65	87·67	0·98	3·10	2100	600	2,610,000	.....	.....	.....	2,610,000	72,121,000	74,731,000
14	88·40	87·55	0·85	3·00	1560	600	1,761,000	.....	.....	.....	1,761,000	68,731,000	70,492,000
14	88·10	87·39	0·71	2·75	1385	600	1,253,000	.....	.....	.....	1,253,000	64,492,000	65,745,000
15	87·40	87·22	0·18	1·30	580	600	105,000	.....	.....	.....	105,000	59,745,000	59,850,000
15	86·70	87·00	.....	.....	.....	900	.....	.....	.....	.....	.....	53,850,000	53,850,000
16	86·00	86·77	.....	.....	.....	600	.....	.....	.....	.....	.....	47,850,000	47,850,000
16	85·50	86·55	.....	.....	.....	600	.....	.....	.....	.....	.....	41,850,000	41,850,000
17	85·00	86·33	.....	.....	.....	600	.....	.....	.....	.....	.....	35,850,000	35,850,000
17	85·00	86·11	.....	.....	.....	600	.....	.....	.....	.....	.....	29,850,000	29,850,000
18	85·30	85·89	.....	.....	.....	600	.....	.....	.....	.....	.....	23,850,000	23,850,000
18	85·70	85·66	0·04	0·60	110	600	8,000	.....	.....	.....	8,000	17,850,000	17,858,000
19	86·00	85·44	0·56	2·30	1380	600	870,000	.....	.....	.....	870,000	11,858,000	12,728,000
19	86·20	85·25	0·95	3·00	1500	600	2,013,000	.....	.....	.....	2,013,000	6,728,000	8,741,000
20	86·40	85·10	1·30	3·60	1880	600	3,714,000	.....	.....	.....	3,714,000	2,741,000	6,455,000
20	87·10	85·02	2·08	4·20	3440	600	.....	2,352,000	2,993,000	6,854,000	12,199,000	455,000	12,654,000
21	87·80	85·25	2·55	4·40	3620	900	.....	4,843,000	5,099,000	6,004,000	15,946,000	6,654,000	22,600,000
21	88·80	85·62	3·18	5·40	3780	900	.....	8,873,000	6,125,000	6,393,000	21,391,000	16,600,000	37,991,000
22	89·90	86·19	3·71	5·70	3920	900	.....	12,187,000	7,190,000	6,731,000	26,108,000	31,991,000	58,099,000
22	90·50	86·93	3·57	5·70	3900	900	.....	11,438,000	6,735,000	6,625,000	24,798,000	52,099,000	76,897,000
23	91·50	87·63	3·87	6·10	4020	600	.....	13,790,000	6,574,000	7,149,000	27,513,000	70,897,000	98,410,000

DEPARTMENT OF PUBLIC WORKS,
OTTAWA, December, 1873.

R. STECKEL,
Civil Engineer.

APPENDIX No. 4.

BAIE VERTE CANAL.

BROCKVILLE, 6th December, 1872.

DEAR SIR,—I am in possession of Room No. 8, in the House of Commons, the same as I had for the Canal Commission, and have one draughtsman there at work on my plans He, however, is a mere copyist, and is of little use to me in the preparation of the drawings for the mechanical structures.

It would facilitate my work most materially if you could spare me the services of Mr. Wise for a month. He has done the same kind of work for me before, and can more readily, than any one else I know of, put my ideas on paper in such a manner as to render the work perfectly plain to those intending to bid for it. I may say that my plans are all settled upon; I have constantly been working at them at home, and have them, as you may say, matured, but they only exist in my brain; the thing is now to elaborate them fully on paper. This I could do if I had time, but men like Wise have a special aptness for the manual part of the profession, and can draw more rapidly than I could myself. As the canal is now closed for the winter, it strikes me you might spare him to me for a short time.

Mr. Stark will be back to-morrow, and he will have the charge, under me, of preparing the plans and calculations. I shall get on with them as fast as I can, but I do not see my way clear for being ready by the time you mention—the 1st January. I think I will be able to present you my plans and specifications by the 1st February.

Permit me at this stage to refer to my position in reference to this canal for the future. I have official instructions from yourself for making the location survey—nothing further. This is now done, and to comply strictly with them I should now go on and make my report; but from your unofficial letters I gather that you are more anxious I should go on and prepare the canal for letting, than to stop here and make a good report of my proceedings. But for this, should I not have official instructions? Do not misunderstand me. If I ask the question, you must not infer that I hesitate to take action upon your verbal or unofficial instructions. It is only that I should be duly charged with the duty I have undertaken for the Government. Again, when my plans are given in, I wish to know in what relation I may stand to them. I cannot agree to their being turned over to others to be carried into effect, in whom I have no confidence. In this case I could not vouch for their success. The only way in which I can be held responsible for the canal will be to appoint me the Chief Engineer, with the option of selecting my resident Engineer. Then I can visit the works as often as may be necessary, and thus direct the operations.

Up to this time you are aware that I have done all the work, while Mr. Gzowski, whose time has been taken up with the very important works at his bridge, has been unable to make the personal examination referred to in the instructions. He therefore stands in the relation of a consulting engineer, and as such has favored me with his approval of all that I have done.

Should it meet the wishes of the Government that he should retain that position for the execution of the works, it will be a pleasure and satisfaction to me.

I go to Ottawa again on Monday. Please address me there.

Yours faithfully,

(Signed,) SAMUEL KEEFER.

Hon. H. L. Langevin, C. B.,
&c., &c., &c.