GEOLOGICAL SURVEY OF NEW JERSEY

Henry B. Kümmel, State Geologist

BULLETIN 2

A Report on the Approximate Cost

OF A

Canal between Bay Head and the Shrewsbury River

BY

HENRY B. KÜMMEL
State Geologist

To the One Hundred and Thirty-fifth Legislature of the State of New Jersey

In accordance with a Concurrent Resolution passed by the Legislature, April 6, 1910

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Report on the Approximate Cost of a Canal Between Bay Head and the Shrewsbury River.

BY HENRY B. KÜMMEL, STATE GEOLOGIST.

To the Senate and House of Assembly of the One Hundred and Thirty-fifth Legislature of the State of New Jersey:

I have the honor to submit a report made in accordance with the following concurrent resolution passed by the Legislature, April 6th, 1910:

"WHEREAS, The construction of the Inland Waterway along the New Jersey Coast has already shown in a marked degree the advisability of such an improvement, and

"WHEREAS, There is a general demand that the same be continued by means of a canal from Bay Head, in Ocean County, to the Shrewsbury River in Monmouth County; therefore, be it

"*Resolved,* By the House of Assembly (the Senate concurring), That the State Geologist be directed, from such data as may be in his possession, to ascertain the approximate cost of the construction of a sea-level canal, with minimum depth of six feet and minimum width at the water level of sixty feet, between Bay Head and the Shrewsbury River; and to report at the next session of the Legislature.

"*Resolved,* That the Governor be authorized to appoint two competent residents of the State, who shall estimate the value of the real estate necessary to be taken for the line of such canal, their estimate thereon to be incorporated in the report of the State Geologist."

The above resolution did not carry with it any appropriation of money, nor did it direct or authorize any survey of a canal route. So far as the State Geologist is concerned it directed only the preparation of an estimate of the *approximate* cost, prepared from data already in possession of the Survey. These data consisted of published topographic maps on a scale of 2,000 feet per inch, with contour intervals of 10 feet, manuscript geological

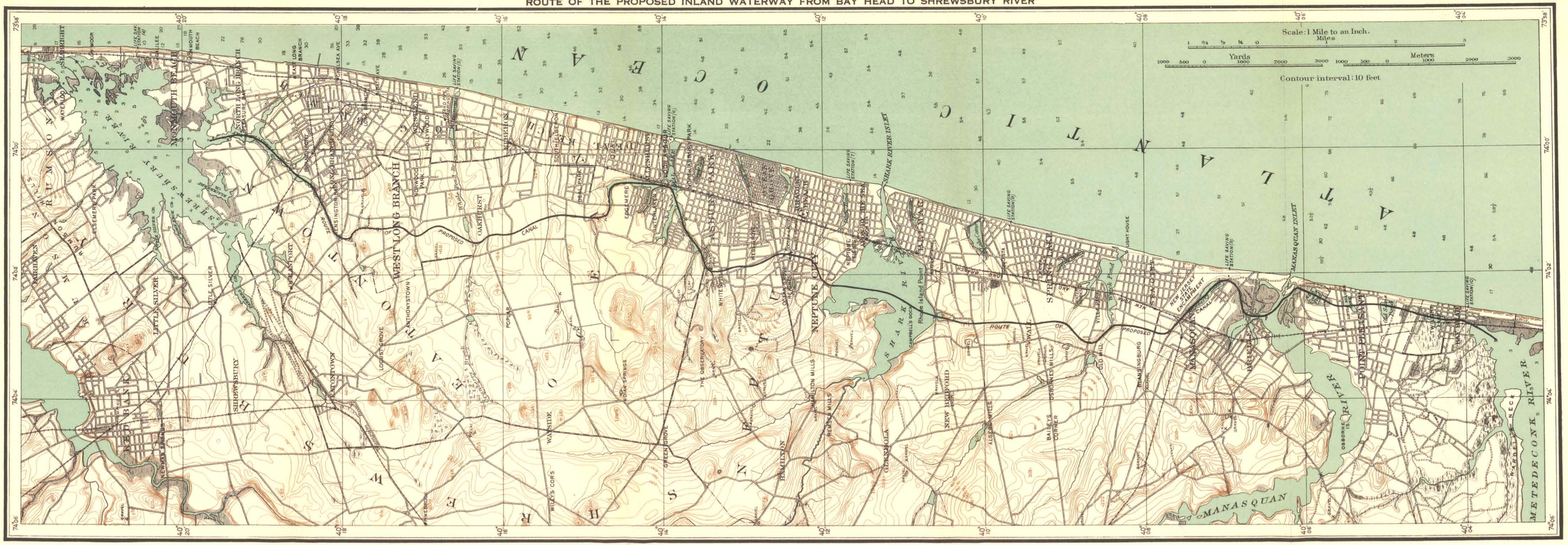
maps of the rock formations, and well-borings showing strata. There was also a detailed report of the cost of a canal for a part of the route, *i.e.*, from Bay Head to Manasquan Inlet, made in 1903 by C. C. Vermeule, under the direction of the State Geologist, in accordance with an act of the Legislature of that year.

The report which I herewith submit has been prepared from the above data and under the conditions imposed by the resolutions cited. The profile of the proposed route (Fig. 1) has been drawn from the topographical map as accurately as possible, and the amount of excavation carefully computed on the basis of that profile. Mr. C. C. Vermeule has kindly made for me the estimates of the cost of bridges, and other engineers and contractors have made suggestions as to the probable unit cost of excavation. Messrs. R. W. Herbert, of Monmouth County, and A. O. S. Havens, of Ocean County, appointed by the Governor under authority of the resolution, made the appraisal of the right of way. The estimate of cost, while only approximate, is probably as accurate as can be had without a detailed survey of the route and bids for construction.

THE R0UTE.

Location.—Several factors were kept in mind in selecting the route. It was necessary to avoid, so far as possible, all built-up sections of country, and yet if the canal is to serve the shore communities the route must not be far removed from them. A straight route would be the shortest, and from this point of view alone the cheapest, but on the other hand since the canal must be a sea-level canal, the *lowest* route, other things equal, would be the best. The route finally determined upon is the result of compromise between these conflicting factors. It is not the shortest, nor the lowest. It does not altogether avoid built-up sections; it of necessity crosses several lines of railroad and in some places it is some distance from the shore communities. All thing considered, however, it is probably the best route that can be found, since it utilizes, so far as possible, all existing waterways. Its exact location is shown upon the accompanying map. (Plate I.)

ROUTE OF THE PROPOSED INLAND WATERWAY FROM BAY HEAD TO SHREWSBURY RIVER



To accompany the report of Henry B. Kümmel, State Geologist.
Made by direction of a resolution of the Legislature, April 6, 1910.

Route of Proposed Canal

NEW JERSEY GEOLOGICAL SURVEY

Bay Head to Manasquan River.—The route from Bay Head to Manasquan Inlet follows the survey for a tide waterway made in 1903[1]. It "begins a little north of the present railroad bridge over the outlet of Twilight Lake at Bay Head and follows up said outlet and through Twilight Lake. Thence crossing Osborn Avenue and Sea Avenue, it skirts the easterly edge of Maxon's Pond, after which it follows the line of Baltimore Avenue through Point Pleasant. * * * After reaching Central Avenue, the canal curves eastward through Cooks Pond and follows the outlet of Cooks Pond to Manasquan Inlet." The route is quite direct, following the existing water courses and cutting through Bay Head and Point Pleasant in such manner as to do the least possible injury to property.

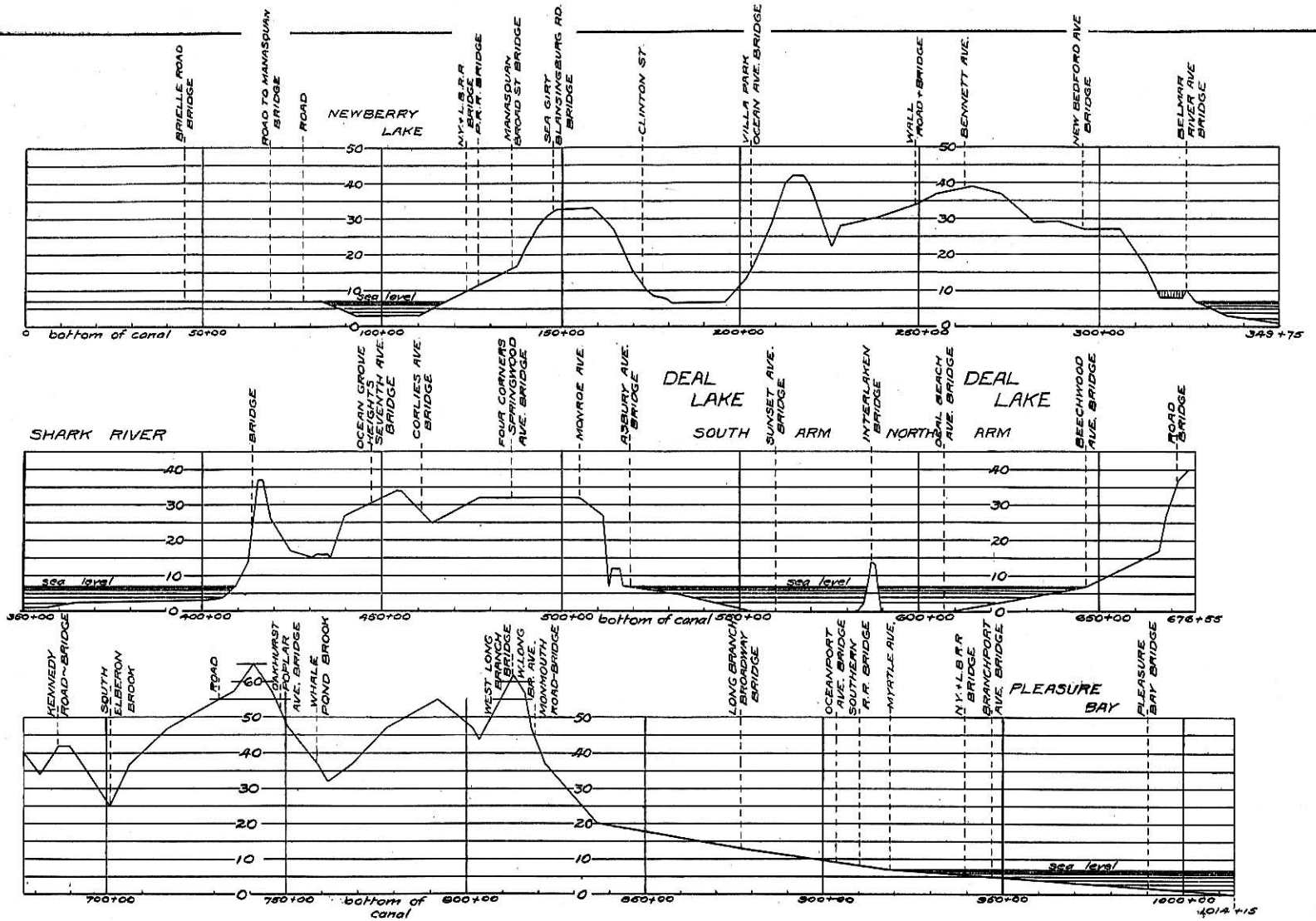
Manasquan Inlet to Deal Lake.—From the inlet it lies up and across Manasquan River towards Brielle and thence through the salt meadows and along Newberry Lake south of the State Encampment. Passing westward from Newberry Lake along a swampy depression the route turns north just after crossing Broad Street, Manasquan, which it nearly parallels to the stream feeding Wreck Pond. Following up this stream almost to Old Mill, it turns north up a side ravine, keeping on the low ground east of Wall road, to which it lies parallel, as far as Heroys Pond on the south shore of Shark River.

The proposed canal would enter Shark River at Heroys Pond on the south side and leave on the north shore along a short ravine at Neptune avenue, Ocean Grove Heights. Hence it curves slightly to the northeast for a few hundred yards, following the line of a small brook, thence north between Bennett and Stokes avenues, Ocean Grove Heights, to the south arm of Deal Lake near the Asbury Park standpipe. Here the route by following first the south arm and then the north arm of Deal Lake makes a detour to the east and takes advantage of a waterway which will need but comparatively little dredging to give the required depth. Two railroad bridges will be avoided by cutting through the narrow neck of land at Interlaken station. From the north end of Deal Lake at Beechwood Avenue the route follows up a

[1] Annual Report of the State Geologist for 1903, pp. 1-15.

ravine through the golf links at Deal and continues in a slightly sinuous course northward about midway between Whale Pond road on the west and Locust Avenue on the east. It passes slightly west of the triangle of roads at West Long Branch and then curves eastward across the Monmouth road to a swampy depression which it follows past the north end of the Long Branch Cemetery to the head of Pleasure Bay at Myrtle Avenue. In order to secure the necessary depth of water, some dredging will have to be done along Pleasure Bay to a point about half a mile north of the Pleasure Bay drawbridge. The entire length of the route as thus laid out is 21.76 miles. Of this distance 9.47 miles are along present water routes which vary in depth from 1 to 7 feet, the maximum needed, and which will have to be deepened accordingly. The balance is through upland with a maximum elevation of 58 feet above sea level or 65 feet above the bottom of the canal as proposed. From Bay Head to the head of Newberry Lake at Sea Girt the maximum elevation is only a few feet above sea level and much of the route is along existing waterways. From Newberry Lake to Shark River the maximum elevation is 35 feet A. T. and for more than two miles the elevation is 20 feet or more above sea level. Between Shark River and Deal Lake the maximum height is 30 feet A. T. and for 1 1/3 miles over 20 feet A. T. North of Deal Lake heights of 55 to 60 feet are twice reached and for 3 miles the elevation is over 20 feet, making in all about 6 1/3 miles in which the excavations will have to be to a depth exceeding 27 feet (Fig. 1).

Dimensions of Canal.—The resolution prescribes a sea-level canal 60 feet wide at the surface, with a minimum depth of 6 feet. A sea-level canal is a necessity, since a sufficient supply of water for a lock canal cannot be obtained from any drainage system in that vicinity. To obtain a depth of 6 feet it is necessary to estimate on a 7-foot cutting. In making the estimates I have figured on a side slope of 1 1/2 horizontal to 1 vertical, which will give a bottom width of 39 feet. This slope continues 3 feet above the water level, where it is interrupted by a bench or shoulder 6 feet wide on each side. Above this bench the slopes continue at the same gradient (1 1/2 to 1) to the top of



PROFILES
INLAND WATERWAY
MANASQUAN INLET TO PLEASURE BAY

To accompany the Report of H. B. Kümmel, State Geologist.

Fig. 1.

the cut. The cross-section of the canal at West Long Branch, where will be the maximum cutting, is shown in Fig. 2. Owing

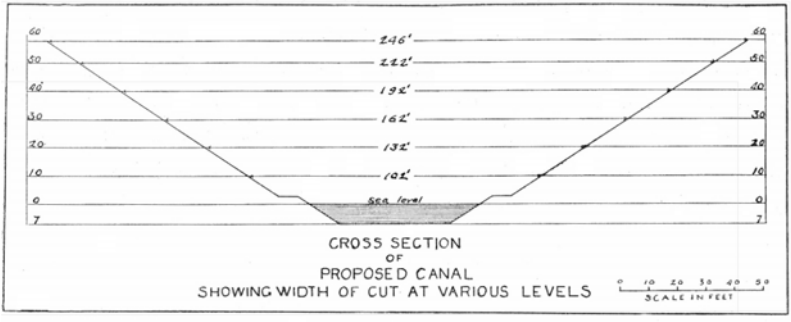


Fig. 2.

to the flaring sides of the cut, it will be noted that each additional foot of elevation increases the width 3 feet and adds greatly to the amount of excavation. At the point of maximum elevation of 58 feet near Oakhurst, the top of the cut will be 246 feet wide. At West Long Branch it will be 237 feet wide, and for 6 1/3 miles of the route it will range between 130 and 246 feet in width.

If, in excavation, quicksand in large quantities should be found, it would probably be necessary to make slopes with much less gradient than 1 1/2 to 1 or resort to protective works of some sort. In either case the cost would be greatly increased by the additional excavation necessary or by the retaining walls.

NATURE OF THE MATERIAL.

No hard rock is known to occur anywhere along the route. Well-borings and other excavations reveal only beds of sand, with locally layers of clay and some greensand marl. So far as may be inferred from all known data, no material may be expected along the route which can not be readily excavated with a steam shovel without blasting.

AMOUNT AND COST OF EXCAVATION.

Method of Computation.— The following method was followed in estimating the amount of excavation necessary. The cross-section of the canal was drawn to scale and the following table compiled, which shows the area of the cross-section of the canal prism and the number of cubic yards of excavation per linear foot for all elevations from 6 feet below sea level to 55 feet above.

TABLE 0F AREAS AND VOLUMES.

Elevation in feet above Sea-level.	*Area of Cross-section Sq. ft.*	*Cu. Yds. of Excavation per 1 ft. linear.*
— 6,	40 1/2	1.50
— 5,	84	3.11 1/9
— 4,	130 1/2	4.83 3/9
— 3,	180	6.66 6/9
— 2,	232 1/2	8.61 1/9
— 3,	288	10.66 6/9
Sea-level,	346 1/2	12.83 3/9
1,	408	15.11 1/9
2,	472 1/2	17.50
3,	540	20.00
4,	622 1/2	23.05 5/9
5,	708	26.22 2/9
6,	796 1/2	29.50
7,	888	32.88 8/9
8,	982 1/2	36.38 8/9
9,	1,080	40.00
10,	1,180 1/2	43.72 2/9
11,	1,284	47.55 5/9
12,	1,390 1/2	51.50
13,	1,500	55.55 8/9
14,	1,612 1/2	59.72 2/9
15,	1,728	64.00
16,	1,846 1/2	68.38 8/9
17,	1,968	72.88 8/9
18,	2,092 1/2	75.50
19,	2,220	82.22 2/9
20,	2,350 1/2	87.05 5/9
21,	2,484	92.00
22,	2,620 1/2	97.05 5/9
23,	2,760	102.22 2/9
24,	2,902 1/2	107.50

Elevation in feet above Sea-level.	*Area of Cross-section Sq. ft.*	*Cu. Yds. of Excavation per 1 ft. linear.*
25,	3,048	112.88 8/9
26,	3,196 1/2	118.38 8/9
27,	3,348	124.00
28,	3,502 1/2	129.72 2/9
29,	3.660	135.55 5/9
30,	3,820 1/2	141.50
31,	3,984	147.55 5/9
32,	4,150 1/2	153.72 2/9
33,	4,320	160.00
34,	4.492 1/2	166.38 8/9
35,	4,668	172.88 8/9
36,	4,846 1/2	179.50
37,	5,028	186.22 2/9
38,	5,212 1/2	193.05 5/9
39,	5,400	200.00
40,	5,590 1/2	207.05 5/9
41,	5,784	214.22 2/9
42,	5,980 1/2	221.50
43,	6,180	228.88 8/9
44,	6,382 1/2	236.38 8/9
45,	6,588	244.00
46,	6,796 1/2	251.72 2/9
47,	7,008	259.55 5/9
48,	7,222 1/2	267.50
49,	7,440	275.81 5/9
50,	7,660 1/2	283.72 2/9
51,	7,884	292.00
52,	8,110 1/2	300.38 8/9
53,	8,340	308.88 8/9
54,	8,572 1/2	317.50
55,	8,808	326.22 2/9

A profile of the route taken from the topographical maps was then drawn on a scale of 400 feet per inch horizontal and 20 feet per inch vertical. This profile was divided into short sections, the average height of which could be accurately determined from the drawings. The cubic contents of each prismoid was then calculated by the formula $V = L \times \frac{A + a + 4M}{6}$, in which "V" equals volume, "L" length of the prismoid, "A" the area of the larger cross-section, "a" that of the smaller and "M" the area of a cross-section midway between A and a, *i. e.*, the cross-section corresponding to the average height.

The following table shows by sections the amount of excavation thus computed, except that for the section from Bay Head to Manasquan Inlet the estimate made in 1903 by Mr. Vermeule[1] was taken. It must be borne in mind that these figures, except for the short section between Bay Head and Manasquan Inlet, are not based upon detailed instrumental surveys, but from data taken from the topographic map. The latter is as accurate as its scale warrants, and these figures are approximately correct. While an instrumental survey would unquestionably result in somewhat different figures, it is doubtful whether such differences would amount to 8 or 10 per cent. These figures will be considerably increased if by reason of quicksand it is necessary to adopt side slopes with less gradient than $1\frac{1}{2}$ to 1.

TABLE OF DISTANCES AND AMOUNTS OF EXCAVATION.

	Distance Feet.	*Cubic Yards of Excavation.*
Bay Head to Manasquan River,	13,600	727,411
South shore of Manasquan River to upper end of Newberry Lake,	11,800	92,473
North end of Newberry Lake to Shark River,	20,900	1,618,590
Shark River,	8,260	35,767
Shark River to Deal Lake,	10,740	912,037
Deal Lake,	13,000	55,718
Deal Lake to Pleasure Bay,	27,200	3,529,756
Pleasure Bay,	9,500	57,043
	115,00	7,028,795

METHODS OF WORK.

Excavation.—Suction dredges could probably be employed for those portions of the route between Bay Head and Newberry Lake, across Shark River, Deal Lake and Pleasure Bay. The amount of excavation which could probably be handled in this manner is estimated at 968,412 cubic yards. For the balance of the material it would probably be necessary to use steam: shovels.

Disposal of Material.—The cheapest method of disposing of

[1] Annual Report of the State Geologist of N.J. for 1903, p. 11.

the material is to place it upon the land adjoining the canal, but this method has very serious disadvantages. For the most part the route lies through high, well-drained country. Low tidal marshes on which it might be spread to their great improvement are absent except along a very limited portion of the route. For at least eleven miles the route is through good farms or across suburban property which is rapidly increasing in value and much of which will in a few years be built up or included in the large country homes of the wealthy. Some of it is now valued by the appraisers at $1,000 per acre. It is in those sections of the route where the land has the greatest elevation, where the cutting is deepest, where the excavation is greatest, and where the amount of material is largest, that the land has the most value and the plan of placing it along the canal will be most objectionable because of the enormous size of the embankments and their inherent ugliness.

In order to comprehend better what is involved in placing the material along side the cut, it will be well to take a few specific instances. At West Long Branch, where the canal trench would have a top width of 222 feet and a depth of 62 feet, it would be bordered by two embankments each 200 feet wide at the base and 27 2/3 feet high, if all the excavated material be dumped on the banks. South of Oakhurst, where the maximum cutting occurs, and where the canal trench would be 246 feet wide at the top and 65 feet deep, there would need to be two embankments each 200 feet wide and 31 feet high. For most of the distance between Deal Lake and Shark River the embankments would be 8 1/3 feet high if 200 feet wide each and nearly 24 feet high if only 100 feet wide at the base. South of Shark River for considerable stretches they would be 10 1/3 feet high and 206 feet wide, with a maximum height of 12 feet where the cutting was deepest. For more than 6 miles of the entire route the embankments, if 200 feet wide, would range in height from 6 to 31 feet.

To dispose of the material in this manner it would be necessary to purchase land in addition to that needed for the right of way or to acquire the right to fill. For those portions of the route bordered by swampy areas it is possible that the owners would be willing to have their land filled without cost, or,

what is much less likely, might even pay a small sum for the privilege. The maximum distance so covered will probably not exceed 43,160 feet, or about 8 miles. For upwards of 11 miles (58,840 feet) land would certainly have to be purchased along the right of way. If we assume that adjoining those portions of the route with a less elevation than 20 feet the material could be piled in two 100-foot embankments with maximum height of between 18 and 19 feet; adjoining those with elevation 20 to 35 feet, in embankments 150 feet wide with maximum height of 20 feet; and for the remaining portions in embankments 200 feet wide with maximum height of 31 feet, there would be needed in addition to the right of way for the canal itself—

For 25,640 linear feet, a strip 200 feet wide;
For 24,500 linear feet, a strip 300 feet wide;
For 8,700 linear feet, a strip 400 feet wide;

or 366 acres in all.

There are serious objections from the esthetic standpoint to disposing of the material in huge piles along the route. Much of the region traversed is one rapidly being developed for summer homes. To cross it with a trench from 100 to 250 feet wide and from 10 to 65 feet deep and bordered on both banks by piles of clay, sand and gravel from 100 to 200 feet wide and 10 to 31 feet high is certainly a proposition against which much can be said from the standpoint of scenic beauty. And in a region of this character this factor in its future development cannot be ignored.

Various other methods of disposing of the material have been considered, but they all involve enormous expense for hauling, and if the material is dumped on land, for the cost of the land. If, on the contrary, the material is towed to sea and dumped, there will be very high costs for towing. It has been suggested that it will be possible to sell large quantities of the dirt for filling purposes. This may be true, particularly if the work be done piecemeal and its accomplishment be distributed over a considerable period so as not to glut the market. In making up an estimate of this character, however, the possibility of selling or even giving away the material seems so uncertain that it is not safe to include it and make any allowance in dollars and cents for it. To mention it as a possibility is all that can be done in this connection.

Cost of Excavating and Disposing of Material.—For the portion of the route from Bay Head to Manasquan Inlet, for which an estimate for a canal has already been made,[1] no new figures were compiled. The total cost of that portion of the route as previously determined, is added to the final estimate as given on page 19.

For the balance of the route, that is from Manasquan Inlet to Shrewsbury River, the cost of excavation will depend chiefly upon the plan adopted for disposing of the material. In making this estimate of cost it is assumed that for the following portions of the route and volumes of material a suction dredge can be used and the material pumped on the adjacent lowland, at the cost indicated below.

	Distance in Feet.	*Volume in Cu. Yds.*	*Cost Per Unit.*	*Total Cost.*
Manasquan Inlet to upper end of Newberry Lake, ...	11,800	92,473	16c.	$14,795 68
Shark River, ...	8,260	35,767	22c.	7,868 74
Deal Lake, ...	13,000	55,718	20c.	11,143 60
Pleasure Bay, ...	9,500	57,043	19c.	12,238 17
	42,560	241,001		$46,046 19

If on the balance of the route a steam shovel and elevators be used, the material being placed along the canal in two embankments as outlined on pages 11 and 12, the cost of excavation is estimated as follows :

6,060,383 cubic yards @ 16c., ...	=	$969,661 28
79.5 acres of land @ $1,000, ...	=	79,500 00
286.5 acres of land @ $750, ...	=	214,875 00
		$1,264,036 28

The above unit price of 16 cents per cubic yard includes contractor's profit and cost of plant. It is based on results attained in digging, elevating, and piling a somewhat heavy clay along the Chicago drainage canal. It is probably low and could be attained only if the work were done under large contracts and

[1] C. C. Vermeule, Annual Report of the State Geologist for 1903.

with efficient superintendence. Much railroad work, including excavation of loose sand and gravel, haulage a few hundred feet and dumping in making an embankment, costs much more than this figure. It is very doubtful whether with the limited appropriations which are usually made for State work and the small piecemeal contracts resulting therefrom, this unit price can be obtained in practice. Any increase in the unit price for excavation will, of course, largely increase the final cost. The value of the land is based on the appraisal made by Messrs. Herbert and Havens.

If instead of piling the material along the banks, it be hauled to waste places we may estimate the cost as follows:

Excavation and loading on cars,	4 ½ cents
Hauling and dumping—Average haul of 2 miles,	13 ½ cents
Spreading,	1 ½ cents
Contractor's profit,	3 cents
	22 ½ cents

6,060,383 cu. yds. @ 22½ cents = $1,363,586.17.

Assuming that it will be possible to dump an average of 9 feet or 14,520 cubic yards per acre, 417 acres of waste land will be needed.

It is doubtful whether suitable dumping grounds so located that the average railroad haul will not exceed 2 miles can be obtained for less than $100 per acre. If so, the cost of land for this purpose will be $41,700. If suitable lands cannot be obtained within the specified distance a longer haul may be necessary. With the average haul increased to 3 miles, the unit price would be increased from 22½ to 29 cents with a corresponding increase for excavation from $1,363,586 to $1,758,381. In view of the great increase in cost due to long hauls it would be manifestly cheaper to pay high rates for dumping grounds near the canal than to attempt to utilize cheap or possibly free dumping grounds with attendant long hauls.

The cost of towing and dumping the material at sea is so excessive, amounting to 25 cents or more per cubic yard, for a 5 mile tow (which is the average needed under the most favorable

conditions), in addition to the cost of digging and hauling to a dock, that it does not seem worth while to consider this manner of disposal.

BRIDGES.

According to the latest maps the route is crossed by 52 streets and roads and by 6 lines of railroad. A few of the former have very little existence except on paper, but by far the greater number are frequently traveled and many of them are improved stone or gravel roads over which there is constant traffic. Only one wagon road is now provided with a drawbridge, and none of the railroad crossings now have draws. It is assumed that in the event of the canal construction, it will be possible to close a number of the least important roads so as to reduce as far as possible the number of bridges necessary to construct and maintain. In making this assumption the question of damages in closing established roads must not be overlooked, but at the most they would probably be less than the cost of a corresponding number of bridges. No estimate can be made as to the amount of such damages, but their possibility must not be overlooked. It is assumed that for the portion of the canal between Pleasure Bay and Manasquan Inlet there will be at least 31 bridges, including 4 railroad bridges. These cross at all elevations up to 55 feet and with their approaches vary in length from 80 to nearly 300 feet. Two estimates of their cost have been made. One provides for overhead clearance of 40 feet and 30-foot draws where this cannot be obtained; the other for 20-foot clearance with draws for lower bridges. The latter plan will be the more economical in the long run, although the first cost is higher, but its adoption will restrict the use of the canal to boats needing less than 20 feet head room.

Bridges with Forty-Foot Clearance.—For bridges having a height of 45 to 55 feet above sea level, the type selected is a steel viaduct consisting of five 40-foot spans on concrete foundations. The roadway is carried by two steel plate girders with transverse I2" I-beams, spaced 8 feet apart, the floor being made up with buckle plates on which is laid a macadam roadway, making a substantial and permanent structure. Bridges of the above

height have no draw. All bridges of a less height are provided with drawbridges of the rolling lift or bascule type. Also the spans are reduced to 30 feet. At each side of the draw span there is a concrete pier the full height of the bridge, beyond which is a steel viaduct on concrete footings extending out to within ten or twelve feet of the top of the cut. In all cases the ends of the viaduct rest upon concrete abutments with wing walls.

It will be noted that by this plan there will be 40 feet clearance above sea level and 29 out of 31 bridges will require a draw. The estimated cost on the foregoing plan is as follows:

Branchport Ave.,	Draw,	$9,000
Long Branch Railroad,	"	12,000
Myrtle Ave.,	"	7,100
New Jersey Southern Railroad,	"	7,600
Oceanport Ave.,	"	7,100
Broadway,	"	7,100
West Long Branch,	No Draw,	10,600
Poplar Ave.,	" "	10,600
Kennedy Road,	Draw,	16,000
Crosby Ave.,	"	16,000
Beechwood Ave.,	"	11,900
Deal Beach Ave.,	"	7,100
Interlaken,	"	7,100
Sunset Ave.,	"	7,100
Ridge Ave.,	"	7,100
Asbury Ave.,	"	7,100
Monroe Ave.,	"	11,900
Springwood Ave.,	"	11,900
Corliss Ave.,	"	11,900
Seventh Ave.,	"	11,900
Sylvania Ave.,	"	16,000
Shark River Road,	"	7,100
New Bedford Ave.,	"	11,900
Bailey's Corner Road,	"	14,000
Ocean Ave.,	"	7,100
Blansingburgh Road,	"	11,900
Broad Street, Manasquan,	"	7,100
Freehold and Jamesburg Railroad,	"	12,000
Long Branch Railroad,	"	12,000
Main Street, Manasquan,	"	7,100
Brielle Road,	"	7,100
		$311,400
Contingencies 10%		31,140
Total,		$342,540

Bridges with Twenty-Foot Clearance.—The second estimate is made up upon the assumption that the overhead clearance is to be limited to twenty feet above sea level and that in all cases where this can be secured, draws will be eliminated. This plan will not be cheaper in first cost for the reason that if such a limitation be adopted it immediately becomes expedient to raise as many of the bridges as possible so as to give a clearance of 20 feet, thereby saving the expense of operation and maintenance of drawbridges. This is especially important at the four railroad crossings, not only on account of saving in operating expenses, but more particularly on account of the avoidance of possible accident at open draws upon these railroads, all of which carry a large passenger traffic. To carry out this plan will require raising the grade of the railroads and the appoaches at several of the highway bridges. As will be seen from the following estimate, the drawbridges are reduced to 10 instead of 29 shown in the previous estimate. The estimate of cost is as follows:

Branchport Ave.,	Draw,	$9,000
Long Branch Railroad, new bridge and raising of grade,	No Draw,	42,000
Myrtle Ave.,	Draw,	7,100
New Jersey Southern Railroad, new bridge and raising of grade,	No Draw,	15,600
Oceanport Ave.,	Draw,	7,100
Broadway,	"	7,100
West Long Branch,	No Draw,	10,600
Poplar Ave.,	" "	10.600
Kennedy Road,	" "	13,500
Crosby Ave.,	" "	13,500
Beechwood Ave.,	" "	14,500
Deal Beach Ave.,	Draw,	7,100
Interlaken,	"	7,100
Sunset Ave.,	"	7,100
Ridge Ave.,	No Draw,	12,500
Asbury Ave.,	" "	12,500
Monroe Ave.,	" "	9,500
Springwood Ave.,	" "	9,500
Corliss Ave.,	" "	9.500
Seventh Ave.,	" "	9,500
Sylvania Ave.,	" "	9,500
Shark River Road,	Draw,	7,100
New Bedford Ave.,	No Draw,	6,700
Bailey's Corner Road,	" "	6,700
Ocean Ave.,	" "	9,000

Blansingburgh Road,	No Draw,	$6,700
Broad Street, Manasquan,	" "	9,000
Freehold and Jamesburg Railroad and raising grade,	" "	19,000
New York and Long Branch Railroad and raising grade,	" "	24,000
Main Street, Manasquan,	Draw,	7,100
Brielle Road,	"	7,100
		$346,800
Contingeneies 10%		34,680
Total,		$381,480

It will be observed that the second plan costs $38,940 more than the first, but it eliminates 19 drawbridges of which 4 are railroad bridges. If we estimate that each railroad draw requires the attendance of two men at $50 per month and that each highway draw requires the attendance of one man at $50 per month, we have a total saving in charges of $1,150 per month or $13,800 yearly. We may also estimate the supplies, repairs and replacement account at $1,000 annually for each railroad drawbridge and $600 annually for each highway drawbridge, making $13,000 annually for all of the bridges eliminated, which, added to the wages account saved, makes a total saving in operation of $26,800 yearly. It is, therefore, apparent that the second plan is decidedly the more economical. The choice of plan must be determined by weighing the saving in annual operating expenses and any danger of accident against the decreased availability of a waterway with only 20 feet head room as compared with one with 40 feet head room under the bridges.

RIGHT OF WAY.

In estimating the width of the right of way necessary, it has been assumed that a strip at least 50 feet wider than the cut must be obtained, thus giving 25 feet leeway on either bank. This is exclusive of any ground necessary for dumping the material, if it should be determined to place it along the canal. As noted above, the appraised value of the right of way was made by Messrs. R. W. Herbert and A. O. S. Havens. Their report to Governor Fort is herewith presented :

"*To Hon. John Franklin Fort,*
Governor of New Jersey:

We, the undersigned, having been appointed by you commissioners to appraise the value of the property needed for the proposed Inland Waterway from Bay Head, in Ocean County, to Pleasure Bay, in Monmouth County, according to maps prepared by Henry B. Kümmel, State Geologist, beg to report that the amount thought necessary to secure the right-of-way for said Waterway is

ONE HUNDRED FIFTY SIX THOUSAND DOLLARS.

We found all people consulted very enthusiastic over the proposition, with an inclination to make concessions in prices and in some instances donations of right-of-way.

Most respectfully submitted,

RICHARD W. HERBERT,
A. O. S. HAVENS,
Appraisers.

December the sixteenth,
A. D. Nineteen Hundred and Ten.

SUMMARY OF COSTS.

For convenience of reference a summary of costs is here presented.

Bay Head to Manasquan Inlet—			
Cost of section from Bay Head to Manasquan Inlet, according to estimates heretofore made, but not including right-of-way, and including one additional railroad bridge, ...	$148,109		$148,109
Manasquan Inlet to Shrewsbury River—			
Dredging 42,560 linear ft., 241,001 cubic yards, at 16c. to 22c., ...	46,046		46,046
Excavating and dumping 6,063,383 cu. yds. Including cost of land for dumping and hauling @ 16c. to 29c. per yd., according to plan of disposal adopted, ...	$1,264,036	to	1,800,081
Thirty-one highway and railroad bridges, according to plan adopted, ...	342,540	to	381,480
Right-of-way for canal, ...	156,000		156,000
Net total, ...	$1,956,731	to	$2,531,716
Administration, engineering, legal and contin-agencies 10 per cent., ...	195,673	to	253,171
	$2,152,404	to	$2,784,887

To the above figures must be added the cost of any retaining walls, rip-rap along the canal, approaches to the canal where it

passes through high ground, additional excavation which may be necessary through the adoption of gentler side slopes and also damages for closing a number of roads now crossing the proposed route. Neither the necessity nor the amount of these additional items can be now determined from any data in my possession and, therefore, no estimate of their probable cost can be made.

In considering the above figures one other condition must be kept in mind. The estimate has been made on the assumption that the entire excavation be covered by one or two large contracts; the same with the bridges. If, however, the policy heretofore followed in the inland waterway dredging of doing the work in small sections by contracts of $75,000 to $100,000, be pursued in this work, not only will the administrative and other overhead charges be greatly increased, but the unit prices obtainable will be considerably in excess of those given above, and the ultimate cost will be much larger.

Allusion has been made to the cost of maintaining drawbridges over the canal. One other probable maintenance charge should be mentioned. For more than 6 miles the canal, if dug, will be bordered by banks more than 20 feet high. So far as known the bulk of the material is sand. The wash from these slopes in wet weather and the wind-blown sand in dry weather will be considerable, and will probably result in no small shoaling of the canal. Periodical dredging will, therefore, be necessary to maintain its depth, but, in default of accurate data on this subject, no estimate of the cost can be made.

Respectfully submitted,

HENRY B. KÜMMEL,

State Geologist.

Trenton, N. J.,

January 30, 1911.