HOUSE OF REPRESENTATIVES, 43RD CONGRESS, 1ST SESSION, EX. DOC. NO. 220: CANAL CONNECTING THE MISSISSIPPI RIVER WITH THE GULF OF MEXICO; LETTER FROM THE SECRETARY OF WAR, APRIL 17, 1874

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WM. W. BELKNAP

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43D CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { EX. DOC. No. 220.

CANAL CONNECTING THE MISSISSIPPI RIVER WITH THE GULF OF MEXICO.

LETTER

FROM

THE SECRETARY OF WAR,

IN RELATION TO

The ship-canal to connect the Mississippi River with the Gulf of Mexico.

APRIL 17, 1874.—Referred to the Committee on Railways and Canals and ordered to be printed.

WAR DEPARTMENT, *April* 15, 1874.

The Secretary of War has the honor to transmit to the House of Representatives, in connection with his letter of the 4th of February last, relative to the ship-canal to connect the Mississippi River with the Gulf of Mexico, (published in House Executive Document 113, copy herewith,) Report of the Chief of Engineers, dated the 15th instant, and accompanying papers upon the same subject.

WM. W. BELKNAP,
Secretary of War.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., April 15, 1874.

SIR: In transmitting the reports of the board of engineers upon the ship-canal from the Mississippi River, near Fort St. Philip, to Isle au Breton Pass, and upon deepening the entrance to that river by constructing jettees at the mouth of one of its passes, I abstained from any discussion of the question of applying the jettee system to improving the entrance, as certain information, important in the final treatment of the subject, had not then been collected by Captain Howell. This comprised certain soundings from the bars of the Southwest and South Passes out seaward several miles, as well as other data, including a carefully-prepared plan and estimate of the cost of applying the jettee system to those two passes.

All the results of the soundings connected with the bar of the Southwest Pass have been received, and the most important of those, relating to the South Pass bar, and I beg leave to present some views upon the

subject, which necessarily assume the form of a review of what has been advanced by others.

The important fact developed by the soundings recently made by Captain Howell relates to the depth now existing in the Gulf, just seaward of the mouths of the river. Taking the maps and profiles exhibiting the depth as it existed in 1838, and recognizing the fact that the bar of the Southwest Pass has advanced since 1838 at the rate of about 300 feet in a year, the jettee advocates have taken it for granted that the bars of the Southwest and other passes are now being extended in a part of the Gulf where the water is very deep, into which very deep water the jettees will push the obstructing part of the bar, which they create, and also the material which forms the bar's annual growth, and will thus easily maintain the depth of 25 feet, or greater, on the bar. But during all this time, since 1838, the river water, in addition to pushing the bars annually into the Gulf about 300 feet, has been depositing the greater part of the earthy matter it held in suspension, upon the bottom of the Gulf, beginning at the outer edges of the bars, and extending seaward between five and ten miles. This is not the earthy matter forming the bar, which the river water pushed along its bed until it reached the sea, but the earthy matter which forms the bottom of the Gulf for several miles seaward of the bars.

Upon examining the map of the recent soundings of Captain Howell we find that, at the crest of the present bar of the Southwest Pass, there was, in 1838, a depth of 125 feet. We also find that where, in 1838, at the distance of 13,000 feet seaward of the bar, there was a depth of 145 feet, there is now only a depth of 45 feet, (this point, where the depth is only 45 feet, being 3,000 feet seaward of the crest of the bar.) We find, further, that this bar is now being extended annually into the Gulf in water not so deep as the bar was advancing in in 1838. We find, also, that from the crest of the present bar to a depth of 100 feet the distance is now 8,000 feet; whereas, in 1838, from the crest of the bar to 100 feet depth the distance was 4,700 feet; and we find, further, that from this point, where there is now 100 feet depth outward, for the distance of some eight or ten miles, the deposit made on the bottom of the Gulf, between 1838 and 1873, is between 60 and 70 feet thick, or at about the rate of 2 feet per year.

The mean annual amount of earthy matter in suspension carried to the Gulf by the Mississippi River would cover an area of one square mile 241 feet thick. The Southwest Pass carries to the sea 0.34 part of this, and the larger portion of this mass is deposited on an area about two and a half miles wide and ten miles long. If all were deposited on this area it would form a deposit 3.26 feet thick. We have found, by the comparison of soundings, that over much the greater portion of the area the deposit is, on an average, 2 feet thick. The other portions of the suspended matter are carried ten or twenty miles, or even greater distances, further seaward, and also over greater widths than the mean I have used of two and a half miles.

The opinion has been expressed by some engineers, in discussing the question of the application of the jettee system to the entrance of the Mississippi River, that the earthy matter of the bar and the earthy matter held in suspension will be pushed out by the jettees so far that a littoral current, which is supposed by them to exist outside the bar, will carry this earthy matter away from the approach to the entrance.

They seem either to forget or not to know that the greater part of the earthy matter held in suspension which is brought to the crest of the bars is deposited between the crest and points from five to ten miles

directly seaward of them, and in the direction of the mid-line of the pass prolonged, which direction the current of the river maintains after it passes over the crest of the bar.

If there was a littoral current of force sufficient to carry off any large quantity of this earthy matter, it would not have been deposited where it is now, and always has been, found. What has been said respecting the recent soundings of Captain Howell exhibits this fact clearly.

Further, upon examining the horizontal curves of equal depth on Captain Howell's recently prepared map, going out as far as a depth of 350 feet, we find that, from the crest of the bar to 100 feet depth, the greatest amount of deposit is made east of the axis or mid-line of the pass prolonged; between 100 feet and 200 feet depth the greatest amount of deposit is made west of that line, and between 200 and 350 feet the greatest amount of deposit is made east of that line. Further, the investigations into the currents made under Captain Talcott's direction in 1838 for the very purpose of ascertaining whether there was a littoral current, failed to detect its existence off any of the passes, the investigations in the case of the Southwest Pass extending seven miles seaward of the bar.

The very shape of the delta is indicative of the absence of such current. Its increase in the direction of the mouths of the passes, and the existence of such areas of water as Blind Bay, Garden Island Bay, and East and West Bays, which would have been gradually filled in the course of the delta formation by deposit if such current had existed, all point to its absence.

The investigations carried on under my direction, in 1851 and subsequently, show, with sufficient precision for any application to engineering purposes, what the nature, direction, and force of the currents of the Gulf are (as distinguished from the currents of the river-water) off the mouths of the Mississippi River. The effect of these currents upon the passes, their mouths and bar-formations, was discussed in the chapter of the report treating of that subject, and was fully considered in preparing the part entitled "Experimental theory of the formation of the bars."

These Gulf-currents are due to changes of the level of the Gulf, owing to tides and winds, and their resulting effect (together with that of the waves) upon the passes, their bars, and their sea-deposit, are all shown by the actual position of the passes and the conditions existing at their mouths; and there is no ground whatever for anticipating any modification of their action by building jettees; they will neither carry away from nor bring to the bar or the bottom of the Gulf any more earthy matter if jettees should be built than they do now, and their influence upon the jettee system is absolutely nothing.

The prominence which has recently been given to the effect of a littoral current in connection with the jettee system is derived entirely from the influence attributed to it in the case of the improvement by jettees of the Sulina branch of the Danube; and because the South Pass is the smallest of the passes of the Mississippi River, it seems to be assumed that the conditions of the Sulina will be found at the South Pass.

The Sulina branch of the Danube carries off one-fourteenth part of the volume of that river, and its mouth lies about midway between the mouths of the two main branches, the mouths of the Kilia branch being about fifteen or twenty miles north of it, and of the St. George branch being about the same distance south of it. The Kilia branch carries off

two-thirds of the volume of the Danube, the St. George one-third, from which the Sulina takes its supply.

The discharge of the Danube, in flood, is about 333,000 cubic feet per second; in low water, about 111,000 cubic feet per second. The discharge of the Sulina, in high water, is about 24,000 cubic feet per second; in low water, about 8,000 cubic feet per second.

The South Pass of the Mississippi discharges, in high water, about 83,000 cubic feet per second, and in low water about 25,000 cubic feet per second, and carries to the sea ten times as much earthy matter as the Sulina branch, almost the same quantity as the Kilia branch, and nearly two-thirds as much as the whole Danube.

The small quantity of earthy matter carried to the sea by the Sulina branch, joined to the fact of the existence of a littoral current across its mouth, were the two causes which, in the judgment of Sir Charles Hartley, the engineer of the commission for the improvement of the mouths of the Danube, made the jettee system peculiarly applicable there and led to its success, the jettees causing the earthy matter in suspension to be carried out into the littoral current, which then carried a large part of it away.

This littoral current did not extend to the bottom of the sea or surface of the bar, but merely a few feet below the surface of the sea. It is stated that there is no tide in the Black Sea, the variations of the level of its surface being due to winds. At the mouth of the Danube the northeast winds, being not only the prevalent wind but nearly incessant, causes a littoral southerly current along the west shore, the mouths of the Danube being, in a northerly extension of the Black Sea, about one hundred and twenty-five miles wide. The discharge of the Kilia branch, on its way to the Bosphorus, after it has dropped its earthy matter, passes across the mouth of the Sulina branch and strengthens the littoral current derived from the wind.

Let us examine a little more closely into the facts of the Sulina improvement. I find, by a comparison of the Russian map of 1829, and the English map of 1857, of and off the Sulina mouth of the Danube, (see Minutes of Proceedings Institute Civil Engineers, vol. xxi, 1861–'62,) that the old (1829) inside 12-foot curve of the bar did not progress seaward during that time, but receded 250 feet, and worked to the northward that extent or more.

The old outside 12-foot curve (of 1829) in some places did not move out, in others moved eastward 200 or 300 feet, and in others twice as much. Its mean movement is 350 feet in 28 years, or 13 feet per year. The outside 15-foot curve on the old channel line, for the full width of the mouth of the river, did not move out appreciably. South of the natural channel the 15-foot curve moved out 800 feet in the twenty-eight years; north of the natural channel it moved out 500 feet in the twenty-eight years, the mean advance of the curve in the twenty-eight years being something less than 600 feet, or about 22 feet per year. The mean outward movement of the 30-foot curve, however, is 3,000 feet in twenty-eight years, or about 110 feet per year. It is evident, then, that this crest of the Sulina bar remained essentially stationary, so far as any outward movement is concerned, during the twenty-eight years that elapsed between the two periods of survey.

Further, the sea-shore line at the mouth of the Sulina is also stationary, and we do not find any recent delta formation at its mouth. The characteristic of a delta-forming river is the constant annual extension of the shores at its mouth, the constant advance of the crest of its bar and of the whole bar, and the constant annual advance of the deep

channel inside of and behind the bar. None of these characteristics are found at the mouth of the Sulina, which has long since ceased to be a delta-forming river.

But the Sulina bar has many of the characteristic conditions existing at the mouths of the little rivers emptying into the northern lakes, where the Engineer Department has constructed harbors by using two piers or jettees. Thus, at Chicago there was a depth of only two or three feet on the bar at the mouth of the Chicago River. Parallel piers were built there, and at the first spring flood following their construction a channel of considerable depth was scoured out. That was the commencement of the present fine harbor at that place. There is a shingly shore north of Chicago, and hence large annual accretions behind the north pier. The Chicago River is not muddy.

There is another distinguishing difference of characteristics between the Sulina bar and the bar of a delta-forming stream. During the flood condition of the Danube the crest of the bar of the Sulina is deepened by the current, but is shoaled again when the flood subsides. On the contrary, the crests of the bars at the mouths of the Mississippi are never materially deepened by the river flood, but the annual extensions of the bars seaward then take place, and these extensions or additions to the bars are as shoal as the crest, the shoalest part.

The quantity of earthy matter held in suspension and thus carried to the sea by the Sulina is also very small, compared to that of the South Pass of the Mississippi River, the smallest of the passes. In the case of the Sulina we perceive the efficacy of the littoral current moving southward; that is, toward the outlet of the Black Sea, the Bosphorus. It carries off the earthy matter while it is held in suspension, but does not remove the deposits made by the Sulina; for, as before stated, the littoral current does not extend downward to the sea bottom or shoal, but is found at the surface of the sea, and for a few feet below the surface, consequently it has no influence at all upon the earthy matter pushed along the bottom of the Sulina by its fresh-water volume, which moving matter is deposited where the fresh water rises on the salt.

Now, the earthy matter held in suspension by the Mississippi River is mainly kept in suspension by the horizontal and vertical irregularities of the bed, (see page 139, Report on Mississippi River,) which constantly stir it up so long as these irregularities exist. When these vertical and horizontal irregularities diminish, the quantity of suspended matter diminishes, some of it falling to the bottom; and when these irregularities cease altogether, the greater part of the suspended earthy matter begins to fall to the bottom. In the vicinity of New Orleans the material thus dropped, which is drifting along the bottom, is the same kind of material as the sediment held in suspension, no coarse material being carried or pushed by the river past this point. Below New Orleans the course of the river varies but little, and its cross-section becomes much more uniform than above; as a consequence the sediment falls to the bottom in much larger proportion in this section of the river than above.

The horizontal and vertical irregularities of the bed cease almost entirely where the Southwest Pass begins to widen, 7.3 miles from the crest of the bar, and from this point seaward the suspended sediment falls to the bottom at a nearly uniform but slowly decreasing rate for twenty or thirty miles. The greater part of it is deposited on the bottom of the Gulf between the crest of the bar and a point about ten miles seaward. Some of it is carried further seaward. A part, as above stated, is dropped upon the bar, commencing where the pass begins to widen, and,

during the high-water stage of the river, is pushed along, with the other earthy matter there, to the crest of the bar, and forms part of the material which extends the bar annually into the Gulf. When the river is in a low stage the earthy matter dropped on the bar remains there, subject only to the feeble Gulf currents of the salt water, which then flow in and out over the bar underneath the fresh-water surface-current.

It is perceived from this explanation that there are two separate, distinct bar-formations at the mouths of the Mississippi River; the one formed by the earthy matter pushed along the bottom of the river and bar, which is the formation known by every one as *the bar*, the obstruction to navigation; the other formed by that part of the earthy matter held in suspension, which lies where it was dropped outside, or seaward, of the first-described deposit, or bar.

Although this last deposit does not, itself, obstruct navigation directly, yet it plays a very important part in causing the obstruction, since it converts the deep water of the Gulf into shoal water, and thus prepares the bed upon which the annual advance of what is usually termed the bar, is made. The one bar is formed by being superimposed upon the other.

In the case of the Sulina improvement, the annual seaward accretions to the crest of the old bar, made by the earthy matter pushed along the bottom of the river, were always very small, and, as the jettees now throw the suspended earthy matter well into the littoral current, a large part of it is carried away from the mouth of the stream, and hence the shoaling due to the deposit of the remainder (which is not carried away by the littoral current) is much slower than formerly. The earthy matter pushed along the bottom of the river appears to have always been so small in quantity, as not to have had any controlling power over the bar formation. It is now carried by the action of the jettees (which extend into deep water) into comparatively deep water, and adds some additional material to the deposit made by the suspended earthy matter.

In the case of the mouths of the Mississippi River, even at the mouth of the smallest pass, the quantity of both kinds of deposit-matter is enormous, and there is no littoral current to carry the suspended matter away. Even if there were at the mouths of the Mississippi a littoral current of the force of that existing at the Sulina mouth of the Danube, (the most careful observations have, however, failed to detect the existence of any at all,) it would be utterly impotent to cause any material modification of the bar-formations.

It may be remarked here that the distance which the current of a delta river extends into a tideless or nearly tideless sea depends more on the volume of the river than the velocity of the current. The velocity of the current being the same in the one case with a small volume, and in the other with a large volume, in the first case the current will soon be neutralized, while in the other it will extend for miles into the sea before it is brought to rest.

From the foregoing it is apparent that the Sulina bar of the Danube has no resemblance to the bars at the mouth of the Mississippi River, and that what they have been dealing with in the improvement of the Sulina is a bar or shoal derived chiefly from the deposit of *earthy matter held in suspension* and not *earthy matter pushed along the bottom of the bed of the Sulina*.

A very important question connected with the jettee system is the rate at which the bar will advance under the influence of jettees. This, it seems to me, is not difficult of solution. The principles which should

guide the application of this system are enunciated in that portion of the report of Humphreys and Abbot upon the Mississippi River, submitted August 5, 1861, which treats of the mouths of the river, especially the sections under the captions of "*experimental theory of the formation of bars*," and "*recommendations for improving the navigation at the mouths*."

The following is extracted from the latter section, pages 455 and 456:

> The development of the laws which govern the formation of the bars has removed all uncertainty as to the principles which should guide an attempt to deepen the channels over them. The erosive or excavating power of the current must be increased relatively to the depositing action. This may be done either by increasing the absolute velocity of the current over the bar, or by artificially aiding its action. To the first class of works belong jettees and the closure of lateral outlets; to the latter, stirring up the bottom by suitable machinery, blasting, dragging the material seaward, and dredging by buckets. These plans are all correct in theory, and the selection from them should be governed by economical considerations.
>
> If the excavating power and depositing action of the Southwest Pass had been equal when the yearly advance of the bar was 700 feet instead of 338 feet, the least depth upon it would have been 21 feet. This increase of excavating power may be obtained by constructing two converging jettees, beginning where the depth of 22 feet is found, and extended to that depth outside the crest of the bar, which would give them a length of about 2.5 miles. The experience gained in the progress of the work should determine where the convergence should cease and the parallelism begin. The erosive action should be aided by first dragging and scraping the hard portions of the bar. The depth of 21 feet thus obtained must be maintained by the annual extension of the jettees 700 feet into the Gulf, and the reduction of the mud-lumps by suitable machinery whenever they begin to appear.

But it appears to be desirable to go somewhat more into detail in this explanation. Accordingly, taking the Southwest Pass as a model, and taking the dimensions of the careful survey of 1838, we find that it has a mean width of 1,200 feet and a mean depth of about 60 feet. About seven miles before reaching the crest of the bar the channel begins to widen and the depth to decrease, and they continue to do so until at the crest of the bar the width is 11,500 feet, and the mean depth, from having been 60 feet, is but 11.5 feet.

An addition of 338 feet is made to the bar every year along the whole line of the crest, 11,500 feet long. This is the annual extension into the Gulf. This addition or extension has the same mean depth of water on it as the crest, 11.5 feet. If we go back from the crest of the bar toward the point where the pass begins to widen, we shall find a depth of 21 feet in the channel-way, where it is about 6,000 feet wide.

The same bulk of earthy matter is, in a series of years, added to the bar annually, and if it be added to it on a line 6,000 feet long, instead of 11,500 feet long, the seaward length of the addition must be about twice as great, (the depth of water upon which this addition is made being substantially the same in each case;) that is, the bar, instead of being extended 338 feet into the Gulf annually will be extended twice that distance or about 700 feet.

If we refer to the channel where it is 25 feet deep, we find the width to be about 4,000 feet; and the mass of the annual addition to the bar being the same, the annual extension on a front of 4,000 feet, instead of being 338 feet, will be about 1,000 feet, and this will be about the annual extension of the bar for a depth of 25 feet if the jettees are suitably arranged for that depth. If they are at a greater distance apart, the depth will be less than 25 feet. If they are at a less distance apart, the depth will be greater, and, the addition to the bar being formed on a less front than 4,000 feet, will have a greater annual extension than the bar formed on that front. So that in applying jettees to permanently