

length, and presents in many places excessive width, reaching 2 miles at high-water and $1\frac{1}{2}$ miles at low-water.

The case is made still worse by the fact that the river at one place seems to be filling up a concave bend, thus giving rise to 5 miles of nearly straight low-water channel, some of which is nearest the convex high-water bank.

The work to be done here is to narrow the low-water river where it is now wide and nearly straight, to give that channel a regular form without great curvature or sudden changes of curvature, and to protect caving banks when that caving threatens the permanence of the improvement.

Should experience show that works of a light character—such as hurdle work, brush ropes, and very light brush dikes, whose object is to make the river drop its sediment, thus building itself its controlling works—may be largely used, the Board still do not estimate the cost of obtaining 10 feet of water at low river through this reach at less than \$600,000. Should substantial dikes be required throughout, this cost may be tripled.

The question whether these works in the bed of the river will not increase the height of floods above them may be asked. As the aim of the works is merely to give to the river in wide places its mean width, there seems to be no reason why floods in the improved portions of the river should exceed those where it has its average width. And it should be remembered that the absolute height of a flood in a wide place in the river cannot be less than in the first narrow place a few miles below; so that flood heights in wide places depend mainly on those of narrow places not far below.

If the work at Plum Point is undertaken, the appropriations should make sums available sufficiently large to complete the works before the river has had time to render them useless by its changes. And there should always be a considerable balance available, so that if the river in any way threatens the works with destruction or abandonment, the matter may be taken in hand without waiting some months for the action of Congress, thus giving ample time to the river to effect its injury.

8. The Board, therefore, recommends in sum, as follows:

1st. That an appropriation of \$600,000 be asked for the improvement of the Plum Point Reach.

2d. That the improvement be effected by narrowing the shoal and wide portions of the low-water river to about 3,500 feet, and by protecting caving banks where necessary.

This narrowing and limiting of the low-water river to be effected, if possible, by constructions of much lighter and cheaper character than those heretofore used, if, after thorough experiment, such shall be found efficient; if not, then, in last resort, by the ordinary dikes of brush and fascines, stone and gravel, used in such works in this country and Europe.

Respectfully submitted.

J. G. BARNARD,
Colonel of Engineers and Bvt. Maj. Gen.
Z. B. TOWER,
Colonel of Engineers and Bvt. Maj. Gen.
H. G. WRIGHT,
Lieut. Col. of Engineers and Bvt. Maj. Gen.
C. B. COMSTOCK,
Major of Engineers and Bvt. Brig. Gen.
CHAS. R. SUTER,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS, *Chief of Engineers.*

M 2.

EFFECT OF A PERMANENT LEVEE SYSTEM ON THE MISSISSIPPI BELOW THE MOUTH OF THE OHIO RIVER.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., January 27, 1879.

SIR: I have the honor to submit the inclosed copy of the report of the Board of Engineers on the improvement of the low-water navigation of the Mississippi River below Cairo, Ill., upon the "effect of a permanent levee system throughout the length of the river below the mouth of the Ohio, not only upon its low-water navigation, but also of the benefits it would confer in affording protection and giving needed facilities to shipping, commerce, and navigation in the high stages of the river"; and beg leave to invite attention thereto.

I concur in the views and conclusions of the Board, and, in view of the importance of the subject, respectfully suggest that the report be sent to the Speaker of the House of Representatives for the information of the Committee on Commerce.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.
Hon. GEORGE W. McCRARY,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

ARMY BUILDING, *New York, January 25, 1879.*

GENERAL: In reply to your letter of November 13, 1878, which invites "the attention of the Board of Engineers for the improvement of the low-water navigation of the Mississippi River to the consideration of the effect of a permanent levee system throughout the length of the river below the mouth of the Ohio, not only upon its low-water navigation, but also of the benefits it would confer in affording protection and giving needed facilities to shipping, commerce, and navigation in the high stages of the river," the Board have the honor to report their views as follows:

The letter presents the matter of the effects of a levee system in two aspects—

1. Its effects on low-water navigation.
2. The benefits it would confer in affording protection and giving needed facilities to shipping, commerce, and navigation in the high stages of the river.

In both these points of view it is referred to by the Hon. R. L. Gibson, M. C. from Louisiana, in his published letter to the President of the Board, a copy of which is appended (marked A); but while asserting strongly the benefits to be conferred by a complete levee system on low-water navigation, he is especially strenuous and elaborate in his expression concerning the benefits to be realized at high-water stages, for which stages, indeed, the levees, as hitherto designed, have exclusive reference. But this exclusive reference has been to protection of the lands from overflow. As "affording protection and giving needed facilities for shipping, commerce, and navigation," the levees have not been hitherto constructed, demanded, or projected.

To deal with the question whether there is any connection between levees and "facilities for shipping, commerce, and navigation" at high stages, we refer to the actual condition of things. We find that throughout all the extension of the Mississippi along which the levee system is practically efficient, and where the marginal lands are generally cleared and cultivated, the levees have been a valuable aid to commerce. Below the mouth of the Arkansas and as far down as the forts below New Orleans the levees have been long enough in existence to give evidence of their effects, direct and indirect. Immediately behind them are the cultivated lands, the plantations, whence come sugar, cotton, and other valuable staples. To each one of these plantations not only is the levee the protecting agent which renders their cultivation practicable, but it is, during floods, the landing place of the steamers, barges, or flatboats which bring their supplies and carry their productions away.

The levees thus become aids to commerce with the cultivated regions directly along the margins of the river; moreover, they allow the maintenance, which would otherwise be impracticable, of the numerous common roads leading back to, and bringing in the productions of, regions considerably removed. Railroads, of which there are already several, which, to cross the Mississippi or to reach its marginal cities, pass through the extensive swamp regions bordering the river, can only secure an unimpeded traffic during floods by raising their track above the level of the great floods, or by the protection of levees.

Our information does not justify us in maintaining that levees would have so important an influence as claimed in promoting flatboat navigation, though, doubtless, were the channel of the river regulated to a nearly uniform width, high-water outlets closed, and bank-overflow prevented, flatboat as well as all other kinds of navigation (flatboat more particularly) would be rendered easier, more rapid, and safer; but such a channel regulation involves, as will be shown, something more than levees. Flatboat navigation was formerly more important than now, and when levees above the mouth of the Arkansas were not in existence.

This kind of navigation has yielded to the superior facilities offered by the barge system and by the introduction of large freight-carrying steamers. Most of the flatboats now seen on the river come out of the Ohio and its tributaries, and are most numerous at about the time of the fall rise, a rise which never amounts to a "flood"; hence, at a stage in which the natural banks bound and furnish visible margins to the navigation channel.

In the lower river, through the regions where the margins are under cultivation, the levees are generally laid close to these margins, and afford, as has already been stated, useful facilities to commerce in making practicable the coming alongside of steamers and the receiving the products of the plantations and discharging freights for the use of the same or for the back country. In ordinary rises the natural banks are not overflowed, but when that happens in "flood" years, they serve a purpose in still defining the channel.

Above Vicksburg the caving of the banks and the general instability of the river are greater. To escape the inroads of bank-caving, and sometimes to cut off very elongated bends, the levees are often at considerable distance from the banks. In such cases they may not be seen at all from the river, or, if visible, would serve no useful purpose in defining the channel. They have not yet, indeed, throughout the upper portions of this section, been long enough and permanently enough maintained in existence to inspire confidence and give rise to a systematic cultivation of the marginal lands.

To sum up: The levees, where they have been permanently established, do, to a certain extent, afford protection and give needed facilities to commerce and navigation, and were they permanently established throughout the river, they would doubtless *develop* a large additional commerce and afford the kind of facilities just mentioned for its transaction.

2. THE EFFECTS OF LEVEES ON LOW-WATER NAVIGATION.

Levees have no direct action except when the water is high. Nevertheless, a connected levee system begins to act *before* the stage of actual bank overflow of the Mississippi is reached. The numerous creeks, or bayous, which partially drain the great swamp basins of the Saint Francis, Yazoo, and Tensas furnish inlets through which the water of the river begins to flood the swamps, even when several feet below the elevation of its natural banks. The levee system would therefore come into useful action before the natural banks were overtopped. And this would be the more usual extent of its action; for the "flood" years are on an average but one out of four or five.

That the confining of this usually escaping water in one channel, in ordinary as well as in flood years, would, in a general way, tend to deepen the bed, we do not doubt. But where the low-water navigation is bad, it is not because there has been a lack of water at high stages; it is because of inordinate width at those places, over which the river sweeps with no well-defined channel, or with channels shifting with different stages of the river and with different years.

From whatever cause this widening has had its origin, the result is the same—a shoal, or "bar," or bad low-water navigation. In most cases this inordinate widening seems obviously due to rapid caving away of the concave banks in the bends; in some cases great width is found between straight banks, suggesting (possibly) in the locality an unusually tough and unyielding bottom material. In general, however, the bottom material of these bars or places of bad low-water navigation is shifting sand or gravel. For more particular description of bar formation, growth, and movement, we refer to Major Suter's report "upon the improvement of the navigation of the Mississippi River between the mouth of the Ohio and New Orleans" Senate, (Ex. Doc. 19, part 7, Forty-third Congress, second session), made in response to the call of the Senate Select Committee on Transportation Routes. In this report there are enumerated 43 localities where less than 10 feet low-water channel depth may be found, and 13 where there may at times occur less than 5 feet. Elsewhere the navigation was good. Hence the improving of the low-water navigation of the Mississippi below Cairo consists mainly in the removal of these bars, or the excavation and the maintaining through them of channels of adequate depth and width. A glance at the sketches of the localities accompanying Major Suter's report, and especially of those of worst low-water navigation, as for instance the Plum Point Bars, is sufficient to show that levees, in the ordinary sense of the word, even if they come into action every high-water stage instead of only every "flood," would have little or no influence on the low-water navigation. They would leave to the river its inordinately great width and area of shifting sands, and exert little or no influence on channel formation. This would be the fact even if they everywhere followed closely the natural banks or margins of the ordinary high-water flow. But, as has already been remarked, the present system of levees, as actually built up to and above the mouth of the Ohio,

though now in very ruinous condition, in its upper portions, deviates not infrequently from the immediate banks to cut across bends or avoid the invasion of caving banks. In the more elaborate levee system designed by the commission of 1874, the great levees are laid, for the upper portions of the river, at greater or less distance from the immediate margins; and though an auxiliary system more closely following the banks is contemplated, the latter, like the present levees, must depart from the banks at many localities to avoid early destruction from caving.

On the other hand, closely adhering levees which in all high stages, whether of ordinary rises or "floods," shall confine the water which now escapes into the swamps, would, by an increased current action, accelerate the caving of banks in the bends and enhance the instability of bed which now not only makes the work of navigation improvement so difficult, but is one of the most formidable foes to a permanent levee system. To the caving of banks is also due the *snags* which form such serious obstructions to the navigation of the river.

The great obstacle to the improvement of the low-water navigation and to maintaining a levee system is one and the same for both, viz, the instability of the river from the caving of its banks. When this can be overcome by means not inordinately expensive (on which point we have treated more fully in our preliminary report on the subject of the low-water navigation of the river), we may expect a deepened channel, a lowered high-water surface, and a stable river, the margins of which shall be securely cultivated to the enormous development of the wealth and population of the region. We believe, therefore, that the levee system, if undertaken, should be matured and developed in connection with the navigation improvement.

Other and imperative duties of individual members have made impossible an earlier convention of the Board for the consideration of this subject.

Respectfully submitted.

J. G. BARNARD,

Colonel of Engineers and Bvt. Maj. Gen., U. S. A.

Z. B. TOWER,

Colonel of Engineers and Bvt. Maj. Gen., U. S. A.

H. G. WRIGHT,

Lieutenant-Colonel of Engineers and Bvt. Maj. Gen., U. S. A.

C. B. COMSTOCK,

Major of Engineers and Bvt. Brig. Gen., U. S. A.

CHAS. R. SUTER,

Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

A.

WASHINGTON, November 17, 1878.

SIR: The supplemental instructions of General Humphreys, the Chief of Engineers, issued on the 13th instant to the Board of Engineers for the Improvement of the Mississippi River, invite you "to the consideration of the effect of a permanent levee system throughout the length of the river below the mouth of the Ohio, not only upon its low-water navigation, but also of the benefits it would confer in affording protection and giving needed facilities to shipping, commerce, and navigation in the high stages of the river." The Constitution provides (article 1, section 8) that "Congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian tribes." That the grant of power over commerce is

complete and absolute should not excite surprise, when we reflect that it was mainly the object which led to the formation of the Federal Constitution. The first step was taken by Virginia on January 21, 1786, when she submitted to her sister States a formal proposition for the appointment of commissioners by each "to take into consideration the trade of the United States." And within one month after the Federal Government went into operation, under the Constitution, the First Congress passed "An act for the establishment and support of light-houses, beacons, buoys, and public piers," the object being, as recited in it, "to render navigation easy and safe."

At the outset there was some dispute among public men as to whether this power might be applied to internal improvements generally, but there never has been a doubt as to the unlimited jurisdiction of the Federal Government over commerce, and of its power to legislate for its benefit. For half a century there has been a decided concurrence of the views of the ablest American statesmen on this subject, and the government has expended large sums with the best possible results. Mr. Webster says, "Over whatever interests of the country this government may diffuse its benefits and its blessings, it will always be true as matter of historical fact that it had its origin in the necessities of commerce, and for its immediate object the relief of those necessities by removing their causes, and by establishing a uniform and steady system." Mr. Calhoun says, "These provisions furnish conclusive proof that the object of the power was the increased safety and facility of commerce." President Jackson says, "The practice of defraying out of the Treasury the expenses incurred by the establishment and support of light-houses, beacons, buoys, and public piers, within the bays, inlets, and harbors and ports of the United States, to render the navigation thereof safe and easy, is coeval with the adoption of the Constitution, and has been continued without interruption or dispute."

It may now be regarded as the fixed policy of the government, sanctioned by our ablest statesmen and made operative upon a large scale at every session of Congress, to protect and aid and facilitate commerce in every possible manner. The methods by which this may be done upon our ocean and lake fronts, and even upon the rivers in the uplands, have caused but little difference of opinion. Estimates and surveys have been made with regularity, and Congress has appropriated fabulous sums for their prompt and complete execution. Fortunately, there has been a happy concurrence between the engineers of the government and the law-making power. Nearly \$9,000,000, authorized to be expended under the direction of the War Department for the benefit of our commerce, for the improvement of our rivers and harbors, was voted at the last session of the present Congress. It is proposed now to expend nearly \$2,000,000 upon Harlem or East River, lying wholly within the State of New York, in addition to the large amount appropriated for the harbor of that great metropolis. But while the government is making these large expenditures with unstinted liberality for the commerce and trade on our ocean fronts and lakes and rivers in the uplands, not a dollar, in comparison, has been devoted to giving "ease and safety" or needed facilities to the commerce and trade upon that great inland sea from Cairo to the head of the passes—the highway fed by 15,000 miles of navigable streams, and bearing upon its bosom the commodities of eighteen States and 20,000,000 of people—the natural artery and outlet for the empire alike of the great Northwest. Why is this? It is simply because the government has failed to appreciate the necessities of this river and of the valley of the Mississippi. The moment the engineers agree as to the usefulness of levees, Congress, I believe, will vote the sums necessary for its improvement.

The question, therefore, submitted to your Board to determine, for the time being at least, is whether anything can be done in the direction indicated. You will observe that you are not requested to make any surveys or estimates. Many surveys and estimates for levees have already been made by distinguished engineers. What is needed now is your opinion as to whether levees will not subserve the commerce and trade upon the Mississippi River—are not, in fact, the proper and essential appliances to make its navigation "easy and safe," and will not render "needed facilities for shipping, commerce, and navigation in the high stages of the river." They would unquestionably prevent overflows. It is agreed by all engineers that overflows destroy the channel, or rather change it, so that, when the water subsides, it is difficult to ascertain the outline of the new channel; sand bars are formed and snags are deposited, so that the liability to accident and the dangers of navigation are greatly increased. An enormous tax is imposed upon the carriers of commodities in the higher rates of insurance, and in the necessities for more powerful machinery and boats, and in their frequent loss. It is estimated that the extra insurance alone amounts to not less than \$10,000,000 annually, a sum sufficient to make all the needed improvements.

The levees confine the water to its channel and indicate better than light-houses or beacons or buoys precisely where it is. But it must be borne in mind that much of the commerce and trade upon this river might be carried without the expense of steam. Before the destruction of the levees a vast business was done in flats and barges, for the current furnishes itself the propelling power. The people living upon

the banks purchased their supplies, from silk dresses and pianos to plows and wagons, their clothing, their groceries, their farming utensils and household goods, from the trading-boats, and fleets of these boats were seen in all the bayous and at every village and city. Of the single article of coal, millions of dollars' worth is shipped from Pittsburgh alone. Now, when the river is thirty or forty or fifty miles wide, an ocean torrent sweeping everything to destruction, what protection is there for this, the very commerce for which that great river should afford facilities, a commerce without any expensive vehicles, between the producer and consumer direct? The great West is seeking the markets of the world for her grain; but, while producing fabulous crops, the profits are so cut down or off by the cost of transportation that the people of that favored section, in the midst of an abounding land, are crying out for relief. Afford proper security by levees to the shipping, and barges and flats would carry their products half way to the European markets without loss, and at one-half the cost now exacted. In a very few years 100,000,000 of bushels of Western wheat will seek this route to the sea. It may be transported now at 8 or 9 cents per bushel, but with proper facilities the cost might be reduced to 3 or 4 cents, a saving of itself sufficient to bring comfort and wealth to the producers. The proposition I desire to submit is this: Levees establish the proper instruments to protect commerce and trade on the Mississippi River; they are continuous harbors or sheltering-piers; they are adapted to give the protection and facilities needed; they are the very "counters" along which the producers of the West and the people on the banks of the river make their exchanges. We do not ask for millions of dollars for the harbors at Memphis, Vicksburg, Natchez, Baton Rouge, and New Orleans; such expenditure is not needed as upon the lakes and sea-coast. We do not ask for an appropriation of millions to dredge out or blast out the channel, or to build dams or canals around rapids, as in the uplands. The Lower Mississippi requires different treatment. But that is no reason why it should receive none at all. The cost of these works, in proportion to the commerce and trade to be benefited, is insignificant. A tax of less than 1 per cent. upon the tonnage on the river would complete them in a short time. The river itself furnishes the propelling power to every keel launched upon it. Not a single man-of-war, not a sailor or soldier is required to protect the flag, as upon the ocean, from its headwaters to its mouth. The vast trade and commerce of the Mississippi Valley would be our reliance in war as it is in peace, beyond the reach of any enemy, and taxing the people of the country not a dollar for a navy to protect it.

It has been suggested that the States should agree among themselves, and devise a uniform and general system for the improvement of the river. It is evident that there should be uniformity, for if the levees were erected along the entire front of Louisiana, and Arkansas should not co-operate, they would be swept away in a single season of high-water. Yet there can be no agreement among the States, for the Constitution declares, "No State shall, without the consent of Congress, lay any duty of tonnage, keep troops or ships of war in time of peace, enter into any agreement or compact with another State." Anything short of a uniform and general system would be incomplete and useless. It is clear that unless the general government undertakes the work it cannot be accomplished. It is for the Board of Engineers to decide the question. The Federal Government has full jurisdiction over the river; it was acquired by treaty and it is owned by the government. The fact that the levees would confine the water to its channel, and thus prevent the overflow of its banks and the destruction and depopulation of the delta, strange as it may seem, is urged rather as a reason why the Federal Government should do nothing for the protection of the commerce and trade on the river. It is true that the levees would afford security to the people of the valley against the invasions of the river, and that an area of territory greater in extent than some of the States of this Union, surpassing any portion of our country in fertility and in the capacity to produce the great staples of corn, cotton, sugar, and rice, would be brought into cultivation and afford occupations and homes to millions of inhabitants.

General Abbot, United States Engineers, says: "The total area of the bottom-lands is about 32,000 square miles, of which a mere narrow strip along the main stream and its principal tributaries and bayous has been heretofore open to cultivation. Protected against the river and properly drained, this would render available at least 2,500,000 acres of sugar-land, or more than double the amount heretofore planted; about 7,000,000 acres of the best cotton-land in the world, capable of yielding a bale to the acre, and not less than 1,000,000 acres of corn-land of unsurpassed and inexhaustible fertility. The magnitude of the interests involved may be held to concern the whole country, and if the 'general welfare clause' of the Constitution can be invoked at all, surely it would apply here. Yet it cannot be that these considerations can have weight against the proper claims of trade and shipping and navigation. On the contrary, it may be urged with justice that the Federal Government, claiming and exercising control over the river, as a great national highway, should regulate it so as not to injure the people living upon its banks—a people powerless, individually or as States, to exercise any jurisdiction over the river. All jurisdiction is forbidden to the States. The very means which the adjacent States

might employ in order to establish a uniform and complete system of levees, are denied to them by the Federal Constitution. They can neither co-operate nor exercise their power over the subject when co-operation and joint jurisdiction are absolutely indispensable. The river is the property of the national government, held for the benefit of the whole country. The ownership is unquestioned, complete, and absolute. The doctrine that the owners of property should so use it as not to injure that of others is of universal application. *Sic utere tuo ut non alienum ledas* is a legal maxim familiar to all jurists and publicists, and held to be binding upon governments as well as individuals. It is clearly within the constitutional power and duty of the government, as well as promotive of the interest of the people of the whole country, that these vast regions should be protected from the devastations of the river by a uniform system of levees. We have bought vast tracts of country and conquered others in expensive wars. Why may we not bring the delta of the Mississippi within occupancy and settlement? It is true that a system of levees would not only give security against inundations that are destructive alike to the channel and navigation and trade upon the river, and to the industrious people cultivating the soil in the valley, but that it would form the most effective barrier against disease—epidemics equally fatal to the health of the country. But these views are foreign to the purpose of this communication. I desire now to speak altogether in the interest of commerce and trade, the navigation and shipping upon the river, and the means for benefiting and improving them."

I have forbore to weary you with any statements of facts showing the vast interests involved. You are familiar with the resources of the mighty valley. Nor have I ventured to urge upon you any theory for the treatment of the river. I beg, however, in conclusion, to invite your attention to the following extract from a report made by those distinguished statesmen, James Gadsden and James Guthrie, after a full investigation of the whole subject, in 1845, and submitted to Congress, with his approval, by John C. Calhoun: "Intimately connected with this subject is the improvement of the navigation of the Mississippi. The science of the engineer has been bewildered on the subject of the improvement of rivers. Those free from rock, and which, like the Mississippi, course through alluvial formations, inundating its banks, depositing and making the very soil through which they cut, are uncontrollable and most difficult of improvement. A great engineer in England, when substituting a canal for a river, is known to have exclaimed, in explanation, that 'rivers were made to feed canals.' The expenditures on the Mississippi, thus far, if reports are to be credited, have produced no results corresponding to the vast sums appropriated. When the channel has been straightened at one point, it has been lengthened at another, and obstructions or deposits in one bend have only been transferred in their removal to another. 'Sawyers' and 'planters' have in one season been reduced in number, to be replaced by the succeeding one. The only fact clearly established—and it is one to which attention should be particularly directed, as bearing with peculiar influence on the proposition submitted—is, that where the banks of the Mississippi have been leveed, and prevented from inundating the swamps, the spring rises are scarcely perceptible, and the surplus waters are discharged by deepening the bed; its current no longer able to rise and expand over a wider surface, they have to deepen the bed to furnish vent for the waters to be discharged. The reclaiming, therefore, the swamps, and confining the river to its bed, will deepen it, and do more to preserve unimpaired the navigation of the Mississippi than all the projects which have hitherto been devised or acted on for its improvement. The suggestion, however, is worthy of examination, and it is the stronger recommended, as it may accomplish a great object at comparatively little cost. The swamps of the Mississippi, now worthless, and made so by the inundations of that river, may be made, by their own reclamation, the instruments of improving the navigation of that stream." I have laid these views before you on account of the urgency of the case, and with the hope that you might be induced to take immediate action and give the country the benefit of your opinions without delay.

R. L. GIBSON,
Member of Congress from Louisiana.

General J. G. BARNARD,
Corps of Engineers.