

River from Portage City to Green Bay, a distance of 160 miles, as follows: Twenty-two locks, 11 dams, $7\frac{1}{2}$ miles of canal, including the $2\frac{1}{4}$ miles of canal connecting the two rivers at Portage. There were 18 locks on the Lower Fox, from Lake Winnebago to Green Bay, overcoming a total lift of 170 feet in a distance of 35 miles. Over this portion of the river navigation for steamboats had been created where, owing to the rapids, none had before existed.

It is difficult to specify the public benefit which has been derived from this portion of the work, but that it has been of very great benefit in developing the resources of Northern Wisconsin there can be no question.

The works on the Upper Fox have also done their share. For many years boats have passed through the canal connecting the Fox and Wisconsin Rivers, and the route has been used to a very considerable extent in passing boats through from Green Bay and points on the Fox River to the Mississippi River. That the improvement has been of great local benefit is certain. The main object of the work, however, as far as the general government is concerned, is to provide reliable water transportation between the Mississippi and the lakes, by which the transportation of bulky products can be cheapened.

The main articles are, going east, grain; going west, lumber and iron.

The full benefits of the route can only be known when the improvements are so far completed as to admit of through navigation at all stages of water. The works constructed by the State and the companies chartered by the State were, to a large extent, of a temporary character. When the government took possession they were in bad condition, as very little work had been done for several years, during which negotiations for the transfer of the work to the government had been pending.

The immediate replacing of several locks and dams was necessary, and extensive repairs to all the works, also the construction of five new locks on the Upper Fox to complete the system of slackwater navigation. All the work done by the United States has been with a view to permanency.

The work of improving the Wisconsin, by the United States, was commenced in 1871, and has been continued since that time, except in 1876 and 1877. The plan of improvement has been to confine the channel by means of wing-dams and dikes built of brush and stone, so as to obtain an increased depth of water.

Work was commenced on the Fox in 1873. The plan of improvement has been to rebuild the old locks and dams where required; to construct additional locks and dams, so as to complete the system of slackwater navigation; to make cut-offs, and deepen and widen the channel by dredging.

CONDITION OF WORK AND PROPOSED OPERATIONS.

On the Lower Fox, where the system of slackwater navigation was complete, 5 new masonry locks have been built to replace old locks; 6 new dams to replace old ones, and 1 new dam to replace old one at De Pere, about two-thirds completed. There remain 13 old locks and 2 old dams. The dams are in good repair and will last some years; one of the old locks is of masonry. The plan of operations contemplates the ultimate rebuilding of all the old locks, except that at Rapid Croche, which is of masonry. Some of them will last several years; others should be rebuilt as funds are provided.

On the Upper Fox there are 9 locks, including the guard-lock at the Wisconsin end of the Portage Canal; 4 of these are old locks, and 5 new,

built by the United States. There are 7 dams, two of which are old and 5 new. Of the latter, 1 at Eureka is permanent, and 4 of brush and stone, to be ultimately replaced by permanent structures. The old locks and dams are also to be rebuilt. These works complete the *system* of slackwater navigation on the Fox. The immediate work proposed is as follows: Completing De Pere Dam; building new lock at Little Chute; rebuilding retaining wall of canal at Appleton. This wall is of crib-work, filled with loose stone, built in 1853. The timber is very much decayed. It is proposed to replace this wall by stone masonry laid in cement mortar; quarrying and cutting stone for construction of new locks; probable construction of guard-gates at entrance to canal at Kaukauna and Appleton; strengthening canal banks; dredging the channel, principally in the Upper Fox; making cut-offs at the worst bends in the river; ordinary repairs of old locks for maintenance of navigation; construction of lock-tenders' dwellings. Boats will be employed in transportation of stone to lock-sites, attending dredges, &c.

On the Wisconsin River there have been built in all 152 dams, with a total length of 68,489 feet; 8,189 linear feet of bank protection; 1,294 snags pulled, and 6,156 leaning trees felled.

These works are in two sections, one from Portage City to a point below Merrimac, a distance of about 24 miles, and the other from near Lone Rock to Boscobel, a distance of about 30 miles.

The plan of improvement of this river having been referred to a Board of Engineers, it is thought best to suspend operations, except for maintenance of existing works, until the report of the Board is made and acted on. The work is now in such condition as will enable the Board to decide as to the practicability of the plan which has thus far been pursued.

PROGRESS DURING PAST FISCAL YEAR.

The accompanying reports of First Lieutenant F. A. Hinman, Corps of Engineers, and Assistant Engineers John Pierpont and C. A. Fuller, give the details of work during the past fiscal year.

The funds available and those asked for will be expended in carrying out the plan of operations above referred to. The order and time when each particular work will be done will be determined during the progress of the work, as shall be most advantageous. The amount of tolls collected during the year ending June 30, 1879, is \$2,993.58; required to be reported annually by act of Congress approved July 7, 1870.

The letter of March 17, 1879, calling for annual report, asks for specific statements on certain points, numbered from 1 to 10. These are given below in the same order.

The plan adopted for this work is, for the Fox River slackwater navigation by dams and locks, and for the Wisconsin the improvement of the natural channel of the river by means of wing-dams and dikes, so as to reduce the width of the river, where necessary, at low-water, and by thus confining the current secure an increase of depth by the scouring action of the current.

| | |
|---|----------------|
| Original estimated cost of work as now being carried on..... | \$3,745,663 00 |
| Amount appropriated since adoption of present project | 1,170,000 00 |
| Amount expended since adoption of present project, <i>i. e.</i> since July 1, 1875. | 915,356 27 |
| Amount, exclusive of former appropriations, required for entire and permanent completion of work..... | 2,575,663 00 |
| Amount that can profitably be expended during next fiscal year | 750,000 00 |

The nearest collection-district is Milwaukee, Wis.

The nearest port of entry is Milwaukee, Wis.

The amount of revenue collected at the nearest port of entry during the last fiscal year was \$93,813 36.

The object of this improvement is to establish a water-route between the Upper Mississippi and the lakes, by which transportation will be cheapened.

The arguments on this subject are fully given in the report of Maj. G. K. Warren, Corps of Engineers, Report of Chief of Engineers for 1868, page 357, and in the Report of the Select Committee on Transportation Routes to the Seaboard, United States Senate, 1874.

Work done by hired labor and purchase of materials in open market. The following papers are submitted with this report:

- No. 1. Annual report of Lieut. F. A. Hinman, Corps of Engineers, on Wisconsin River.
 No. 2. Annual report of Lieut. F. A. Hinman, Corps of Engineers, on Fox River, Portage to Governor's Bend Lock.
 No. 3. Annual report of Mr. John Pierpont, assistant engineer, on Fox River, Governor's Bend Lock to Lake Winnebago.
 No. 4. Annual report of Mr. C. A. Fuller, assistant engineer, on Fox River, Lake Winnebago to Green Bay.

Money statement.

| | |
|---|--------------|
| July 1, 1878, amount available..... | \$283,727 77 |
| Tolls received and deposited to credit of appropriation..... | 2,996 01 |
| Fuel sold to officers and deposited to credit of appropriation..... | 53 00 |
| Amount appropriated by act approved March 3, 1879..... | 150,000 00 |
| | \$436,776 78 |
| July 1, 1879, amount expended during fiscal year..... | 179,084 04 |
| | 257,692 74 |
| July 1, 1879, amount available..... | 257,692 74 |
| | 257,692 74 |
| Amount (estimated) required for completion of existing project..... | 2,575,663 00 |
| Amount that can be profitably expended in fiscal year ending June 30, 1881..... | 750,000 00 |

WISCONSIN RIVER.

REPORT OF LIEUTENANT F. A. HINMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
 Milwaukee, Wis., July 1, 1879.

SIR: In accordance with your order of the 25th of April last, I have the honor to submit the following report of operations on the Wisconsin River improvement for the fiscal year ending June 30, 1879:

The field-work of the survey of the river, referred to in my last annual report, was completed early in July from Portage, Wis., to dam No. 12, 1875 (just below Dekorra, Wis.), a distance of 8½ miles, after which it was discontinued.

In pursuance of your order of July 11, work was resumed on the river, in accordance with the plan heretofore pursued. It first became necessary to repair a number of the boats which had been used on the Fox River improvement, and also to build several new ones, which were transferred to this work as fast as completed.

Actual work on the repairs of dams was commenced July 30. As the facilities increased, the parties in the field, necessarily small at first, were enlarged, so that by the 1st of September two construction parties quite well equipped were at work. This season but one construction party has been at work and only since June 4.

The channel of the river improved as the repairs progressed; it straightened out some in several places and returned to about the same course as when the dams were formally intact. It is comparatively free from snags and leaning timber from Portage City to Allen's Flats, the portion worked over last year.

Dredge No. 4 removed 140 linear feet of the timber and stone dam near the Portage City Lock, after which a dam was built just opposite to the said lock; all of which has had the effect to divert the channel over toward this lock and to vastly improve the river part of the approach to it. A shore protection was built at this point to keep the river from breaking into the canal; another was built just below it on the same side of the river.

The lowest elevation of the surface of the water at Portage was in August; the gauge then recorded 0.8' below zero; the highest stage was in May, the gauge reading being 5.3' above zero. The greatest difference between high and low-water for the year was therefore 6.1'.

Low-water prevailed from the 1st of August to the middle of September; this was probably due, in a great measure, to the fact that the natural flow of the water was impeded by the closing dams, built by lumbermen for reservoirs, at the headwaters of the river, to float down logs. However, with the water at zero (the lowest water of 1872), there was a channel of at least 4 feet in depth for a distance of about 5 miles between Portage and the mouth of the Baraboo River. It is possible that the low stage of water this spring can be attributed not only to the dry season, but also to the closing-dams for reservoirs, as newspaper accounts stated that the dams were closed. If it could be arranged so that the water would be collected in the reservoirs during freshets only, navigation on the improved part of the river would not be injured, and probably the lumbering interests would not suffer.

On pages 4, 13, and 28 of the reports of Capt. Charles J. Allen, Corps of Engineers, contained in House Ex. Doc. No. 54, Forty-fifth Congress, third session, much of interest will be found in relation to this matter. Two of the dams referred to are described therein.

Three scows 14' by 45' by 30" were built late in the fall. Three scows of similar dimensions, and also the scow Merrimac, and the steam-scow Boscobel were hauled out and repaired during the winter. The latter was condemned for use as a steam-scow and was converted into a scow. Two quarter-boat hulls were also condemned; the cabin of one was placed on the large scow that was built at Dubuque in the winter of 1874 and 1875; the other cabin was placed on land at the boat-yard, and will be used for a store-house and work-shop until a new hull shall be constructed for it.

Preparations were made last winter to build new hulls for the machinery of the old stern-wheel steam-scows Boscobel and Dekorra, also, one large scow, two small scows, and one quarter-boat hull. The iron and lumber for the same were ordered and are now on hand, and the machinery has been modified for side-wheel steam-scows; nothing further was done, as it was deemed best to defer their construction for the present.

Experiments were made during the several stages of the river from high to low to ascertain the amount of sediment carried in suspension. The water was taken from the channel of the river at various depths. The amount obtained each time from 32 gallons of water that had stood from 12 to 24 hours scarcely filled a small flat envelope 2" by 1". The composition of the deposit was about the same in every case, viz, fine sand, sawdust, and alluvial matter. No water was collected on very active bars where the sand could be seen boiling up in large quantities. This tends to show that the river is a comparatively clear stream, and that the sand is not generally carried in suspension in large quantities (except on very active bars), but is rolled or pushed along the bottom and its vicinity by the current to form or change bars.

Last October I left Portage on the steam-scow Boscobel to inspect the lower section of the river between Richland City and Boscobel, where no work has been done since 1875. The river was found to be in about the same condition as that part of the upper portion (described in my last annual report) that has received the same attention; and the channel was in about the same location as in 1875. But little could be seen of the dams in the vicinity of Lone Rock bridge that were built in 1871 and that have not been maintained since.

The elevation of the surface of the river at Muscoda was 2.4 feet above the lowest water of 1872 at the time of my inspection.

I found a deep channel at every drawbridge. The Chicago and Northwestern Railroad Company has completed the rebuilding of its bridge at Merrimac; each of the two draw spans has a clear water-way of over 80 feet in width. The superstructure of the draw spans and also that of the two spans adjoining on the north of the wagon-bridge at Sauk have been rebuilt of iron. The clear water-way of each of the two draw spans of the wagon-bridge at Boscobel was measured and found to be 60 feet wide.

The scraper (quite similar to Long's) with teeth bolted on was used without any good results, but, on the other hand, bad results have followed its use.

The sand bars in this river vary in length and breadth and may be of a size from 1 to 20 acres in area. The sand lies on the bottom by its own weight, and when stirred up will lodge again after the scraper goes by it. The estimated amount scraped off of a bar at one time is about one-fifth of a yard, which amount removed from a bar will not deepen the water perceptibly.

The current must be strengthened in order to successfully move a bar, and this is done best by contracting the channel. There have been cases when after scraping for a time on a bar the boat was obliged to wind over a portion that she was previously able to run over with some difficulty propelled by her wheels. As yet we have not found a bar that could not be scoured out, neither have we found one that the scraper benefited.

* * * * *
 Last year the wages were less, and materials were cheaper than in former years; the working day was also longer than that of some of the previous years; therefore more work was accomplished per day at less cost than heretofore. The approximate

estimated cost of dam No. 1, 1878, at Portage, is \$2.05 per linear foot, and of shore protection No. 2, 1878, at Portage, \$1.43 per linear foot.

Lines of soundings were run this season in the channel of the upper section, between Portage and Dekorra, at six different stages of water varying from 0+0.3' to 0+5.3' on the Portage gauge, and another line will be taken at extreme low-water this season in order to ascertain, in a measure, how the channel is affected by the fluctuations in it.

There is no doubt that it benefits the channel to run a boat in it frequently. The steam-tug Winneconne, drawing 2.3', runs over the upper improved portion of the river often, but she is unable to pass below it when the elevation of the surface of the river is 0.3' above zero at Portage. There are yet a few shoal places in the upper improved portion that will require a little more work to scour them out. There are other shoal places in it due to new work that will probably improve in time.

My thanks are due to Mr. Ed. C. Hinman for his efficient services rendered in prosecuting the above work.

SUMMARY STATEMENT OF WORK DONE DURING THE YEAR.

| | Linear feet. |
|--------------------------------|--------------|
| Built 2 dams | 749 |
| Extended 7 dams | 1,769 |
| Removed 1 dam | 140 |
| Built 2 bank protections | 3,421 |

Pulled 79 snags.

Felled 339 leaning trees.

Repaired and maintained the work between Portage, Wis., and Allen's Flats, a distance of 9 miles.

Repaired and constructed boats, implements, &c., as required.

Very respectfully, your obedient servant,

F. A. HINMAN,

First Lieutenant, Corps of Engineers.

Maj. D. C. HOUSTON,
Corps of Engineers, U. S. A.

FOX RIVER.

REPORT OF LIEUTENANT F. A. HINMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 1, 1879.

SIR: In accordance with your order of the 25th of April last, I have the honor to submit the following report of operations on that part of the Fox River improvement under my charge for the fiscal year ending June 30, 1879.

1. PORTAGE CITY (GUARD) LOCK.

This lock is old and dilapidated, and showed signs of weakness during the last high-water. It received repairs as required from time to time, such as filling up settlements in the walls, replacing rotten timbers, &c. A new lock should be substituted for it, but as it is considered impracticable to do so at present it will be kept secure until the close of navigation; after which it will be thoroughly examined and repaired.

The canal portion of the upper approach to it is and has been unexceptionably good since the channel was diverted over towards it last year by a dam opposite to it in the Wisconsin River. On April 18 I found that the least depth of water in it was 1.1 feet greater than the depth on the miter-sill. Last month, at lower water, the depth was 0.7 foot greater. No dredging was done here, and no bar to speak of is noticed in the lower approach.

A few fender-piles should be placed on the south side of the upper approach in order to keep boats off the rocky point.

2. BOATS.

The repairs of dredges Nos. 1 and 4 were completed, after which the former proceeded to another section. Since the latter was repaired she has about doubled her former capacity for work.

A new hull, 100 by 32 by 5 feet, was built last fall for the land steam excavator, known now as Clam-shell Dredge No. 5. The hull is very strong; it has three Howe trusses and two bulkheads running longitudinally through it. The machinery was repaired and a new house built over it; in rear of this is a separate house for the crew. Like Dredge No. 4, she is able to dispose of the material dredged to good advantage, especially in deep cuts, and, having a large hull, she lists but from 4 to 6 inches when at work. She draws 18 inches on even keel, will work in water about 2 feet in depth, and can be towed easily. She is so constructed that her machinery can be easily rolled off and used on land, as formerly, if desired.

The steam-tugs Portage and Winneconne received light repairs besides being painted throughout. The steam-scow Boscobel was also temporarily repaired. The repairs of one large scow and two small scows were completed. Three large scows were rebuilt from the light water mark up, and two others of the same dimensions were constructed.

All the above boats except the dredges were transferred to the Wisconsin River improvement as fast as completed, where they worked last season. As a rule, boats were used on either river, as required.

The new boat-yard between the railroad bridges at Portage is finely located, the canal being on one side and a railroad track on the other. Dredge No. 5 was launched from this yard.

3. PORTAGE CANAL.

Dredge No. 4 widened the canal about 15 feet on the south side near the said lock, so that boats 95 feet long can turn there. She removed for this work about 100 cubic yards of material.

The old bridge at Wisconsin street becoming unserviceable was removed by the United States, and a new bridge built there by the city of Portage. It was completed last month. The superstructure is of iron and the substructure of masonry. With the draw open there is now a clear water-way of 50 feet at this point perpendicular to the axis of the canal, and vessels have no trouble in passing it.

To accomplish this work the canal level was drawn down this spring while navigation was closed.

4. FORT WINNEBAGO LOCK.

The Portage Canal and Governor's Bend levels were drawn down on the close of navigation last November, and low coffer-dams were built above and below this lock in order to thoroughly repair it. The repairs consisted of the following:

The diagonal gate straps were straightened and shortened so that the strain on them is transmitted in a single curved line, instead of two right lines and two curves, as before. The valve straps under water were all doubled, new bolts made for all valve connections, with nuts riveted on to prevent their working off. Fourteen additional toe-post straps were put on the upper and lower gates. The valve levers were straightened. All gates were calked and pitched. Leaks were stopped at both miter-sills. Excavations made at both lower hollow quoins; a row of transverse sheet-piles put in from hollow quoins to the back walls, and leaks stopped in side walls.

The old floor binders (some of which are in two pieces) were rebolted and 17 new ones (each composed of one piece) were put down over lower sills and bolted to them with 20" by 7" square iron drift-bolts, to hold down the floor which had sprung up in the center. The new ones were secured at either end by clamps bolted to the side walls, immediately over and at right angles to the floor binders; these clamps are of 6" by 8" timber on edge, the upper side being 10 1/2 inches above the top of the lower miter-sill. The height of water on this sill can always be made sufficient to give 5 feet of water on top of the clamps. An additional floor was laid and secured between the lower miter-sill and chord to stop leaks; the space between the upper arms of the lower gates (probably intended for a waste-weir but temporarily planked before the lock could be used) was replanked. The masonry at the upper gate recesses was cut away to clear the diagonal gate straps and valve-lever boxes. New hangings were placed on the upper gates, also new capstans for working said gates, and two old capstans were repaired and placed to operate the lower gates. The iron segments which were attached to the gates and worked by gearing were removed and spars and ropes substituted therefor. Six snubbing-posts were planted above the lock. The excavation was made for the north upper wing-wall extension, which wall was extended 40 feet on the bottom, 33.5 feet on the top. It is 7.5 feet high, and is built of dressed stone which were on hand. This wall will prevent considerable sand from washing into the lock in future.

The lock chamber and catch-basin above the upper gates were cleaned out.

On completion of the repairs the coffer-dams were removed and the levels raised.

5. GOVERNOR'S BEND LEVEL.

Last August dredge No. 4 removed the bar just below Fort Winnebago Lock, dredging therefor about 1,000 cubic yards of material. In May this bar had re-formed, and

was removed again by dredge No. 5, which took out about 2,400 cubic yards of material. The bed of the river at this point and below has been lowered several feet from time to time by dredging; therefore a breast-wall, composed of a condemned scow 60 feet long, stone, and sheet-piling, was built at the head of navigation in the river to maintain the natural river bed above and check the current somewhat (especially when the level is drawn down for any purpose), and thus prevent the rapid re-formation of the bar. The clear water-way is the same as at the dam at Governor's Bend, viz, 60 feet, and is sufficient to discharge the river at all stages. It is believed that this wall will help to diminish dredging at least for a time in this vicinity.

During portions of August and September dredge No. 4 worked on sections 4,018 feet long in the aggregate immediately above the Wisconsin Central Railroad draw-bridge, deepening and widening the channel, and cutting off shoal points. She removed for this work about 15,067 cubic yards. On September 7 she was transferred to another section.

This spring dredge No. 5 cut off three sharp points between the said bridge and Governor's Bend Lock, dredging therefor about 4,400 cubic yards of material, after which she was transferred (May 13) to another section.

There is now a good channel the full width of the river at least 4 feet in depth in the middle at any time on this level, which is sufficient for all boats at present navigating it. This level is fed from the Wisconsin River through the canal when required.

6. GOVERNOR'S BEND LOCK AND DAM.

Minor repairs were made to these works. A topographical survey was made of this vicinity preliminary to building a new lock and canal. Borings were also made; sand only was found.

The valuable services of Mr. Ed. C. Hinman rendered in prosecuting all the above works are hereby acknowledged.

Very respectfully, your most obedient servant,

F. A. HINMAN,
First Lieutenant, Corps of Engineers.

Maj. D. C. HOUSTON,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN PIERPONT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 1, 1879.

SIR: I have the honor to submit the following report of operations upon the improvement of that portion of the Fox River, Wisconsin, which has been in my charge during the fiscal year just closed. The section of river under consideration extends from Montello to Lake Winnebago and includes the construction and maintenance of works at Montello, Grand River, Princeton, White River, Berlin, and Eureka, and dredging in the river between the above limits.

The operations at each locality will be detailed in the order enumerated.

1. MONTELLO.

The lock and dam at this point are old structures, built by the Fox River Improvement Company, and will need either rebuilding or most extensive repairs before long. In November, 1878, the gates in a bulkhead at the north end of the dam were carried out by the water, but a temporary dam was built around the bulkhead, and the gates, which were never used, replaced with timber. The space above the timbers was filled in with brush and gravel, making the dam solid.

Before navigation opened last April the lock was repaired by putting new diamond blocks to each gate, new wooden barrels on the capstans, the gates stiffened by oak plank spiked vertically on the outer ends. The timber hollow quoins at the lower gates, which had rotted away above the water-line, were repaired, and the sides of the chamber replanked in places where the old planking had come off. Since making the repairs no difficulty has been experienced in working the lock, and none is anticipated during the present season of navigation.

2. GRAND RIVER.

On the 30th of June, 1878, a force was engaged coping the new lock with a course of 19" stone, brought from the quarry at Kaukauna. It was all laid by July 6, and afterwards backed by teams and scrapers with earth left from the excavation of the lock-pit. The temporary brush-dam put in the river at this point was found to have

settled so there was very little head at the lock when navigation opened last spring. A layer of brush-mats was sunk on the dam and the dam tightened with a backing of earth, increasing the head at the lock by nearly 1 foot, and holding good water to Montello.

3. PRINCETON.

In July and August, 1878, the coping laid in June was backed with earth brought from the canal bank above the lock on scows, and the wing-walls below the lock were capped with large flat stones from the Kaukauna quarry. On September 28, 1878, the construction of a house for the lock-tender was commenced, and completed December 21. It is a two-story brick-veneered structure, with a stone foundation resting on a wooden platform about 4 feet wide placed in a trench dug in the sand to receive it.

The brush in the temporary dam in the river settled down, leaving an opening between the brush and the crest timber bolted to the piles. Arrangements were made to repair it during the first part of October, 1878, and some brush taken to the place for the purpose, but the water in the river was so high it was found not only impracticable to place it to advantage but unnecessary, as the water remained high enough to meet all the requirements of navigation. This season the water has been quite low, and the dam will be repaired and tightened as soon as possible.

4. WHITE RIVER.

Early in July, 1878, the lower wing-walls were capped with Kaukauna stone. The brush in the temporary dam in the river settled as at Princeton away from the crest timber, and in September and October the work was partially repaired, but continually interrupted, and finally postponed on account of the high stage of water in the river. During low-water this spring the necessity of repairing the dam became apparent. A row of 2-inch plank about 8 feet long were placed on the dam, one end resting upon the crest timber and spiked to it, and the other on the brush above the dam, in deeper water, and the whole loaded with brush and stone. The work of backing with earth is now being carried on.

Propositions were received from two farmers, whose lands lie between the lock-site and public road, to deed a strip of land to the United States, provided a road be graded and one fence built.

The propositions were accepted, the work has been done, and the deeds executed, so there is now a good road and right of way two rods in width to the lock.

5. BERLIN.

The lock coping was backed with earth brought from the canal banks on scows during July, 1878.

The temporary brush dam-built the previous year was repaired with brush and stone, and a brush and stone levee built from the south end of the dam upstream for a distance of about 1,000 feet to protect the marsh from overflow and discharge the water over the dam. The present low-water has developed further settlement in the dam and levee, which will be repaired during the present working season.

A house for the lock-tender was built, the work commencing in August and concluding in November, 1878. It is substantially the same as at Princeton, except that, being built on higher ground, there is a cellar under the house, the foundation walls resting on clay. The house is provided with a cistern and a well which furnishes excellent water.

6. EUREKA.

The only work done here has been that needed for the maintenance of existing works. The coping of the lock has been repointed, and the truss of the navigable pass built the preceding year received two coats of paint. The low stage of water in the river during the early part of last May created a head at the dam of 26 inches, and under the pressure a boiling appeared below the pass, showing that the water had found its way under the foundation. The same thing occurred about a year before, but was stopped as well as possible with brush and stone. The repetition showed that the foundation was not safe and could not be relied upon to withstand the head of 5 feet which the dredging below the lock will ultimately cause.

The sheet-piling put in when the foundation was built, probably reaches to some pockets of quicksand such as were found in excavating the lock-pit, and the water, following down the piles, went through, causing the boiling below, and making several holes above. To permanently repair the damage and avoid its recurrence in future, a double row of 2-inch plank was placed along the whole upper face of the foundation of the pass, and after being fastened together with oak binders on each side, with small screw-bolts passing through and through, were all driven down at

once. The pile-driver was loaded on a scow, the hammer falling on the tops of the sheet-piles until they went under the water, when a follower was used.

The piles have all been driven so that they are from 12 to 13 feet below the sill of the pass, about twice as far as the original sheet-piling extended, and the boiling has ceased. The holes above the pass have yet to be filled with spalls and shingle sawdust.

7. DREDGING IN THE RIVER.

This has been the most extensive and important work done on this section of the river, and in order to show the results accomplished, I will give an account of the work done by each dredge separately, considering them in the numerical order in which they are designated.

No. 1. Dipper-dredge—Capacity of dipper, $\frac{1}{2}$ cubic yard.—The dredge reached Princeton Lock from Portage, where it had been undergoing repairs on the 10th of July, 1878, and worked at the upper and lower ends of the canal until the 7th of August, when it was sent to the Lower Fox. The dredge excavated 6,356 cubic yards at a cost of 3.3 cents per yard.

No. 2. Dipper-dredge—Capacity of dipper, about $1\frac{1}{2}$ cubic yards.—This is one of the old dredges received from the Fox River Improvement Company (No. 1 being the other), and at the beginning of the fiscal year was laid up at White River Lock, the hull being entirely rotten. During the latter part of September and first of October, 1878, the machinery was taken out and the hull stripped, the water being kept out by the pump-dredge, and on November 2 the machinery was taken to the lower river by the United States steamer Neenah and transferred to Mr. C. A. Fuller, assistant engineer. During the winter a new hull was built, and the dredge coming back to this section commenced work on a bar in the river about a mile above the village of Princeton on the 29th of May last. The dredge worked until June 7 and made one cut through the bar, excavating 4,986 cubic yards, at a cost of 2.4 cents per yard. The channel made was 939 feet long, 35 feet wide, with a depth varying from 7 to 8 feet, the spoil being deposited behind an old wing-dam in the river. On the 9th of June the dredge was towed by the United States steamer Portage to the work between Governor's Bend Lock and the mouth of Neenah Creek, where it is now employed. Up to this date the dredge has excavated 10,385 cubic yards, at a cost of 2.6 cents per yard. The dredge is self-propelling, having a stern wheel run by gearing from the main engines. Since reaching the present work 3 $\frac{1}{2}$ days have been lost from breakages, which seem to be necessary incidents in all dredges until the parts adjust themselves and work smoothly and harmoniously through usage.

No. 3. Dipper dredge, with sluice-scow and force-pump, for washing and discharging spoil. Capacity of dipper, 2 yards. The dredge went into commission in the early part of July, 1878, and on the 13th commenced removing a bar in the river just below Eureka Lock, which was formed by the erosion of the sides of the new channel, made the preceding summer, in connection with the permanent dam; 2,820 cubic yards of sand were excavated, at a cost of 3.1 cents per yard, when the dredge moved down the river to Delhi, removed two old cribs and 1,942 cubic yards of sand from the river, and passed on to Omro, where work between the bridges was commenced on July 24—24,436 cubic yards were excavated, at a cost of 2.04 cents per yard. The distance between the bridges is 1,350 feet, and a good channel, having a depth of 7 feet at low-water, was obtained. Upon the completion of this work, August 29, the dredge moved up to the "Key-hole," about a mile above Omro, and commenced work. The river at this point is divided by a marshy island, and while both channels were navigable at high-water, it was difficult to pass either at low. The south channel, as shortening the distance somewhat, was dredged out, making about 7 feet of water for a distance of 1,500 feet; 36,170 cubic yards were excavated, at a cost of 2.15 cents per yard. This work occupied the dredge until October 26, when it went to a shoal just above the railroad-bridge at Omro, excavated 8,168 cubic yards, at a cost of 2.3 cents per yard, and, on the 2d of November, moved up the river, removing 75 piles from a bend in the river at Harmon's Mill, a short distance above Berlin. The piles had been driven a number of years before, and had not only accumulated sand so that the dredge was obliged to excavate to reach them, but the tops of many of them pulled off before starting. The cost of removing them was 60 cents each. The dredge then went to Berlin Lock, excavated 1,000 cubic yards from the approach to the lower end of the canal, and, on the 9th of November, commenced to lay up. The material excavated at Omro and the Key-hole consisted of a mixture of clay and gravel, making exceedingly hard digging, and the dredge was found to need considerable repairs. These were finished December 21, and consisted mainly of new frictions, new canvas roof, new dipper-handle, stiffening pieces for the crane, a new lip to the dipper, and quite extensive repairs to the machinery. Upon completing the repairs, the dredge was laid up at Berlin Lock until April 21, 1879, when work was commenced on a cut-off to straighten the river between Berlin and White River locks. These were two sharp bends, which, taken together, made an S, the upper being known as Shipley's Bend, the lower, Willow

Bend, and they always caused a serious loss of time to boats going around them. A channel 100 feet wide has been made, cutting off both bends, the old river closed at the head of the new channel, and also at the crossing between the bends. The length of the new channel is 1,800 feet, while the distance around by the old river was 3,500 feet. The time gained, however, is of more importance than the distance, as a boat was obliged to back up and pole the bow around to make either of the old bends.

The total amount of earth excavated was 57,754 cubic yards, at a cost of 2.5 cents per yard. The thorough manner in which the dredge was repaired, as well as the first-class workmanship displayed in the original building about three years ago, is shown by the fact that from the 21st of April up to this date no time whatever has been lost from breakages. The total amount of material handled by the dredge during the fiscal year is 132,290 cubic yards, at an average cost of 2.3 cents per yard. Including the cost of the repairs made last November and December, the cost per yard for the whole year has been 3 cents.

No. 4. Clam-shell dredge—Capacity of clam, 1.8 cubic yards.—This dredge, which had been employed on the section of the river in charge of Lieut. F. A. Hinman, Corps of Engineers, U. S. A., reported to me for duty, and was put at work on a bar at the mouth of White River, on the 14th of September, 1878. By the 9th of October the bar and one between it and White River Lock, together with 31 large snags in the vicinity of the work, had been removed.

The amount of sand excavated was 14,292 cubic yards, costing 2.3 cents per yard. On October 10 the dredge commenced a cut-off at Maple River Bend, about $\frac{1}{4}$ mile below White River Lock. The cut-off was completed November 27. It is 100 feet wide and 1,400 feet long on the axis, while the distance around by the old river was 4,700 feet, with very shoal water. The prism excavated measures 42,021 cubic yards, and the work was done at a cost of 1.8 cents per yard. The dredge went through the cut-off four times, making a first cut 50 feet wide and about half the depth required, depositing all the spoil on one side. Another shallow cut was made alongside the first, the spoil being deposited on the opposite bank. The boom was then lengthened 8 feet and each cut made to the full depth, the longer boom enabling the dredge to cast behind the banks first thrown out. Deducting the time lost by changing the boom and from breakages, the entire excavation was accomplished in 35 days, giving a daily average of about 1,200 cubic yards. On October 24 the clam, working in soft material and carrying a heaped-up load nearly every time, excavated 2,281 cubic yards, the prism measuring 280' by 55' by 4'.

Upon completing this work the dredge was laid up for the winter at Berlin Lock. In the latter part of March, 1879, extensive repairs to the dredge were made, consisting of a new roof over the stern, new ears to the clam, new spud aft, new heater and repairs to boiler, new hoisting chains; the derrick was strengthened, and general repairs made to the machinery. Upon the completion of the repairs the dredge was towed by the United States steamer Winneconne to the mouth of Grand River, stopping a few hours on the way to remove an old crib from the river at Saint Marie. At the mouth of Grand River the dredge excavated 1,400 cubic yards of sand from the bar and closed up the old channel of the Fox, then worked her way up to Montello, arriving there and commencing work in the river below the lock on the 10th of May. The Montello River emptying into the Fox just below the lock, brings down such quantities of sand that there has always been a bar requiring periodical dredging. A dredge-bank has been thrown out extending down-stream from the point at the confluence of the two rivers a distance of 200 feet, so that the streams discharge in parallel lines, and the whole river below the dredge-bank, as well as each river at its sides, made so wide and deep that it will be many years before a repetition of the dredging becomes necessary. It is proposed torevet the dredge-bank with brush and stone to make it permanent.

The amount of material excavated up to this date is 51,059 cubic yards, which has cost 1.3 cents per yard, based upon the ordinary running expenses of the dredge, but as No. 4 could not have done the work unaided, the expense of the pump-dredge in washing back the spoil should be added, making the total cost 1.5 cents per yard. The dredge has excavated 108,772 cubic yards during the fiscal year, at a cost of 1.8 cents per yard. Including the repairs made to the dredge last spring, the cost per yard has been 3.02 cents.

No. 5. Clam-shell—Capacity of clam, $1\frac{1}{2}$ yards.—This dredge, together with the steamer Portage, came under my charge on the 12th of May last, in accordance with your instructions to Lieut. F. A. Hinman, Corps of Engineers, U. S. A., dated May 9, 1879, and after excavating 500 cubic yards above Governor's Bend Lock and 200 yards at the float bridge at Port Hope (done at the request of the town supervisors, as the bridge could not be opened wide on account of a bar), commenced work in the river between Governor's Bend Lock and the mouth of Neenah Creek on the 16th of May. At this place a cut-off nearly a mile long was made by the Fox River Improvement Company, and the river brought from one side of the valley to the other, but it was never very