

wide, and has filled up considerably, so that of late it has been almost impassable for boats.

The dredge worked here until the 7th of June, making the improved cut-off 100 feet wide and 6 feet deep, but at this date a fine compact sand was found too hard for the clam to penetrate, and the dredge having been replaced by No. 2, dropped down below Port Hope and commenced cutting off four sharp points that project into the river. The dredge is still engaged upon this work. While employed in the old cut-off below Governor's Bend Lock the dredge excavated 23,397 cubic yards, at a cost of 1.4 cents per yard, and below Port Hope 20,717 cubic yards, at a cost of 1.18 cents per yard.

No. 6. *Pump-dredge*.—Early in July a scow, 60 feet long, 16 feet beam at center, and 14 at the ends, was brought from the lower Fox by the steamer Neenah, the boiler from the old dredge No. 2 and a 9-inch centrifugal pump, with an engine of about 30 horse-power, placed upon it. The pump consists mainly of a cast-iron shell, inside of which are wings fastened to a horizontal shaft running lengthwise of the scow. The forward end of the shell is conical, the wings conforming in shape, and at the apex of the cone a flexible suction-pipe is attached, which passes over the bow of the scow into the water. The shell inboard of the wings is worm-shaped, and the water receiving its impetus from the revolution of the wings is forced through the worm and out the discharge-pipe at a height of about 10 feet above the deck, where it is received in wooden troughs and carried off by gravity.

The pump is worked by an oscillating engine; the pump-shaft, continuing beyond the pump, becoming the crank-shaft of the engine. The engine and pump are on the same bed and constitute a single machine. The machinery having been all placed, a cabin was built on the stern of the scow, and the whole roofed over, and on September 14 the dredge was tried on a bar near White River Lock. The design was to swing the suction-pipe back and forth on the bed of the river, gradually lowering it as the sand was discharged through the pump until the required depth was obtained; when the suction was raised the dredge moved a few feet ahead, and the operation repeated. To swing the pipe, a small derrick was erected on the bow of the scow, the suction-pipe suspended from the boom, and the latter swung by lines leading from its outer ends to the corner of the scow. It failed to work in a satisfactory manner, as the suction would buckle instead of following the boom, so a timber was run out from the bow of the scow and the suction-pipe made fast to it. The timber was hinged at the bow of the scow to allow a vertical motion, imparted by the derrick, and pivoted at the same point to allow a horizontal motion, the latter being given by a turn-table on the deck of the scow with a cogged segment on its face in which geared a pinion turned by a crank. Between the pinion and crank was an intermediate gearing to increase the power. The alteration was completed October 3, and from then until October 26, the dredge worked on a bar above White River Lock, excavating 2,910 cubic yards at a cost of 10 cents per yard. The spoil was all discharged through wooden troughs triangular in section, and made in lengths of 12 feet. Each length was supported by a small pontoon 12 feet long, 6 feet broad, and 2 feet deep, the trough running across the pontoon at its center and held up by posts. The troughs thus projected 3 feet beyond the pontoons at each side, so that when the fleet was in line there was an interval of 6 feet of open water between each pontoon. The material excavated was deposited behind an old wing-dam about 75 feet from the dredge. There were still two serious defects. The end of the suction, which was protected by a wire basket with openings of from 4 to 6 square inches in area, would become covered with grass, sunken chips, and turtles. When it became necessary to raise it from the water, the charge in the pump would be lost and considerable time lost in recharging. The second loss of time came from moving the scow, which had to be done by poles. The suction would go to the desired depth in from 10 to 15 minutes if not clogged, when it was necessary to move the scow ahead about 4 feet and hold it there, but in the constant current and generally high wind this was a work of great difficulty. During the best day's work of the dredge three-fifths of the time was consumed in moving. To overcome this, two pontoons, each 70 feet long, 6 feet wide, and 3½ feet deep, with grouzers in each end, were built. They were placed on each side of the dredge to act as guides, and were found to accomplish the desired object. By the time they were built it was so late in the season the dredge was laid up at Berlin Lock. It was found that the scow was being rapidly shaken to pieces by the oscillating engine making from 250 to 300 revolutions per minute, and in the latter part of February, 1879, a new hull 70 feet long, 20 feet wide, and 3½ feet deep, was commenced. It was completed May 17. To perfectly control the motions of the dredge a 2-inch shaft runs across the hull and projects over the sides about 1 foot. At each end is a spiked wheel over which runs an "endless" chain fastened at each end of the side pontoons. Motion is imparted to the spiked wheels by a gearing and capstan on the dredge, by turning which the dredge can be moved back and forth if its grouzers are raised and those of the side pontoons down, or the side pontoons moved if the position of the grouzers is reversed. The pontoons are held together at the stern by a timber extending from one to the other and lying back of the dredge hull, and at the bow by iron

clamps sliding in grooves made at the sides of the dredge, the clamps starting from the outside edge of the pontoon and hinged so that they are always in place whether the decks are at the same level or not. At the side of the dredge hull at the point of discharge, a frame-work is built out extending over the side pontoon, allowing it to move back and forth underneath, and to this frame-work the first small pontoon carrying the discharging-trough is fastened. All the small pontoons are held together in line, with the intervals of 6 feet between them as before, by two rows of plank, one at each end. Each row is composed of two layers of 2 by 8 plank, laid flatwise and breaking joints so as to make a continuous beam, and at each gunwale of the pontoons the beams are secured by iron clamps. By this arrangement it is a simple matter to lengthen or diminish the trough, as necessity requires, by adding or removing extra lengths, and the whole fleet being rigid moves with the dredge. When ready for work, the dredge hull and side pontoons are brought nearly in line, the grouzers of the side pontoons dropped and those on the dredge raised. The suction is then lowered and swung as before until the depth required is reached, when the dredge is moved by the capstan and endless chain as far as necessary for a new set, and the operation repeated until the dredge is about 40 feet in advance of the side pontoon, when the grouzers are reversed and the pontoons again brought into line.

The best results are obtained by digging as deep as possible, from 10 to 12 feet, allowing the sides to cave in, and keeping a steep bank in advance of the suction-pipe. The distance from the hull to the outer end of the suction is 20 feet, and the end of the suction passes over an arc, whose chord is 30 feet, when near the surface of the water, decreasing (to about 25 feet at 10 feet depth) as the pipe is lowered, since the radius of the arc is the base of a right-angled triangle, whose hypotenuse is the suction-pipe, and whose altitude is increasing. The suction end is left entirely open.

When the dredge was completed it was towed to a bar just above the bridge at Princeton Village, and worked until June 2, when the bar was removed, the spoil being deposited behind an old wing-dam 100 feet from the dredge. An old crib filled with stone was found under the sand, which interfered somewhat with the work, as it was necessary to stop the pump when stones entered that were too large to go through, and one had to be chiseled out, but no injury was done to the pump. Stones of from 8 to 10 cubic inches were pumped without difficulty. The amount excavated was 2,415 cubic yards, at a cost of 7½ cents per yard. June 4 the dredge commenced upon a bar just below "Leonard's Cut," about 2 miles below Montello, and excavated 1,540 cubic yards, at a cost of 6 cents per yard. On the 12th of June the dredge went to the work just below Montello Lock, and commenced washing back the banks thrown out by No. 4. The banks were too high for No. 4 to cast over, and in some places a new cut was desirable. The powerful 9-inch stream from the sand-pump washed back in two days 280 linear feet of bank that was 20 feet high, leaving it about 3 feet high at the edge of the water and sloping back from the river. The dredge was engaged upon this work until June 21, and washed back 1,320 linear feet of dredge-bank. On the 23d work below "Leonard's Cut" was resumed.

At this date the dredge has added 1,288 cubic yards to the 1,540 yards of excavation given above, the cost of the whole being 6 cents per yard, as before.

To accomplish the best results in dredging the suction should be kept crowded into the sand. As the swinging is now done by hand, this is impossible, but if operated by steam, a small pair of swinging engines being introduced for the purpose, the dredge would be more effective and less expensive to run, as part of the present crew could be dispensed with. In considering the work done by this machine and comparing it with that of the other dredges it should be remembered that the spoil is deposited at least twice as far from the dredge as the others can throw, and all the material touched is pumped through, while the others receive credit for a considerable amount of material which, stirred up by them, is carried away by the current. The total amount of material excavated during the year is 315,756 cubic yards, at a cost of 2.14 cents per yard, based upon the ordinary running expenses of the dredges while employed in digging.

Including the time lost from breakages, from laying up for the winter and fitting out in the spring, and from moving from point to point, expenses of boats in attendance, all repairs and superintendence, the dredging has cost 4.71 cents per cubic yards.

#### S. MISCELLANEOUS.

The steam scow Dekorra was employed to tend the dredges and distribute material until the middle of July, 1878, when it was replaced by the steamer Neenah. The latter was employed in boating stone from Kaukauna, supplying dredges, removing snags from Berlin level, and working on the dams until the close of the season. Since work was resumed last spring the side-wheel steamer Portage with two barges has been employed.

The steamer Winneconne was employed with me from April 14 to May 9, 1879, in locating the land needed for the proposed cut-offs between Portage and Oshkosh.

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2  
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76  
88

Seventeen cut-offs were surveyed, descriptions of the land made, and propositions to deed a right of way obtained from such owners as could be found.

I am indebted to Mr. J. W. Allen, jr., overseer for the energy and intelligence with which he has assisted me in the prosecution of the foregoing work.

Very respectfully, your obedient servant,

JOHN PIERPONT,  
Assistant Engineer.

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

REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

APPLETON, Wis., July 1, 1879.

SIR: I have the power to submit the following report of operations on the improvement of the Lower Fox River for the fiscal year ending June 30, 1879.

During the year the following new works were commenced, viz: A crib dam at De Pere, a stone lock at Little Chute, a retaining wall at Appleton Pier, and a quarry opened at Duck Creek.

Navigation was continued without interruption until closed by ice on the 30th of November. Necessary repairs having been made to the locks, navigation was resumed on the 24th of April, and has been continued uninterruptedly to the present time.

The following outline of operations at each point on the Lower Fox is respectfully submitted.

1. DUCK CREEK QUARRY.

Quarrying stone was commenced at this point August 3, and was continued until October 29, 1878, when work was suspended for the season. It was resumed on May 5, 1879, and is still in progress. During the working season there were taken out and hauled to the landing 273.3 cords of dimension stone, and 223.6 cords of large rubble. Of this amount, 2,877 cubic feet of dimension and 3,004 cubic feet of rubble stone were shipped to De Pere for building abutments to the dam. Stone cutting was begun at this point on November 4, 1878, and has been carried on daily to this date. 8,915.4 superficial feet of stone were dressed for a new lock, and 3,549.9 superficial feet were cut pitch-faced for the retaining wall at Appleton Pier.

2. DE PERE DAM.

Work was commenced August 12, 1878. Timber and timber bolts and stone for filling the cribs were purchased in open market. A cut, 20 feet in width, through the river bottom to bed rock was made by dredge No. 1. The stone required for building the abutments was received from Duck Creek, and dressed on the ground: 21 cribs, 50 feet by 28, by 10½ high; 4 cribs, 50 feet by 28, by 9.33 high; and 1 crib, 32.67 feet by 28, by 10.5 high, for the main dam; and 1 crib, 9 feet by 52, by 9.75, and 1, 9 feet by 52, by 8.5 high, for abutments, were framed, bolted, sunk in position, filled with stone, and the bottom timbers secured to the bed rock by iron bolts 3 inches in diameter and 3 feet in length; 140 cubic yards of cement masonry were laid in the abutments. The dam is 1,313 feet in length between the abutments, and was carried up to low-water mark at the date of suspension of work on the 23d of November.

Work was resumed on the 17th of June; sunken logs, clay, &c., were removed from the site of the connecting crib at the east end of dam, and a crib, 41 feet by 16, by 10 high, was framed, bolted, and made ready to be sunk in position.

The principal items applied to the construction of this work during the year are as follows, viz:

705,617 feet, board measure, pine lumber.  
64,449 pounds of iron drift and screw bolts.  
1,267.25 cords of stone filling.

3. DE PERE LOCK (OLD).

A house for the lock-tender was built.

4. LITTLE KAUKAUNA LOCK (OLD).

The upper wing walls were thoroughly repaired and slight repairs made to the gates.

5. RAPID CROCHE LOCK (OLD).

New spars were put on and some slight repairs made.

6. KAUKAUNA 5TH LOCK (OLD).

One new gate was constructed and hung.

7. KAUKAUNA 4TH LOCK (NEW).

The coping-stones of recesses, hollow quoins, and corners were doweled, and the joints pointed with Portland cement. Hand-rails were put on the upper gates; 161 cubic yards of clay filling were placed in rear of right upper wing wall. This lock is completed.

8. KAUKAUNA 3D LOCK (NEW).

The coping-stones of recesses, hollow quoins, and corners were doweled, and the joints pointed with Portland cement. Hand-rails were put on the upper gates. This lock is completed.

9. KAUKAUNA 2D LOCK (OLD).

New spars were attached to the gates and slight repairs made.

10. KAUKAUNA 1ST LOCK (OLD).

New spars were attached to the gates and slight repairs made.

11. KAUKAUNA QUARRY.

The engine and pump were set up, and pumping was commenced August 1, 1878. Work was suspended for the season on the 29th of October and resumed on the 8th of May; 634.7 cords of dimension and rubble stone were quarried and hauled out. The steps and slope coping were dressed for Appleton 2d lock; 2,148.8 superficial feet of stone were dressed, pitch face, for Appleton Pier wall. Five steamboat loads of stone were sent to the Upper Fox.

12. LITTLE CHUTE COMBINED LOCKS (NEW).

The coping and steps of upper lock were doweled and pointed. Eight snubbing posts were made and placed. The steps of the lower lock were replaced and doweled. A portion of the lock-wall was repointed, and stone and clay filling placed in rear of and near the lower ends of the walls.

13. LITTLE CHUTE 2D LOCK (OLD).

The lower end of the south wall was re-laid in cement mortar; the south chamber wall and recess were replanked, and one gate was repaired.

14. LITTLE CHUTE LOCK (NEW).

The construction of a stone lock to replace the 1st and 2d Little Chute locks was commenced. About half of the amount of stone required for the walls was quarried at Kaukauna, transported to the lock site, and dressed. Crib coffer-dams were put in above and below the 2d lock, and a rubble wall was built, connecting the upper crib work with the upper end of the lock. Excavation in clay and rock for lock pit is progressing; 4,325 cubic yards of earth and spawls and 926.85 cords of stone have been removed therefrom. Two derricks have been constructed, and 350 cubic yards of sand delivered.

The following amounts of stone have been dressed for this lock:

2,176.7 linear feet 30 inches by 20 inches thick.  
1,682 linear feet 20 inches by 20 inches thick.  
311 linear feet 30 inches by 16 inches thick.  
264 linear feet 18 inches by 16 inches thick.  
170 linear feet 30 inches by 15 inches thick.  
39 linear feet 18 inches by 15 inches thick.  
42 hollow quoins 20 inches thick.  
51 round corner stones, 20 inches thick.

82  
8  
25  
47  
96  
8  
3.75  
9.2  
2.6  
0.76  
13.88

## 15. LITTLE CHUTE, FIRST LOCK (OLD).

A portion of the lock-walls was replanked, new coping put on, and the breast-wall repaired.

## 16. CEDARS LOCK (OLD).

A new capstan platform was built and slight repairs made to the lock-walls.

## 17. APPLETON FOURTH LOCK (OLD).

Four new diamond blocks were made, placed, and secured. Five snubbing posts made and set; the capstan, platforms, and coping repaired, and an accumulation of sawdust and refuse from mills removed from the lock.

## 18. APPLETON LOWER DAM (OLD).

The crest of this dam was raised and leveled; the timber abutments repaired; the open spaces between the spars planked, and brush mats and 960 cubic yards of clay and gravel backing placed. The dam is now in good condition, and will not probably require rebuilding for several years.

## 19. APPLETON THIRD LOCK (OLD).

A leak in the upper recess and south upper wing wall was stopped by planking and puddling. One hundred and sixty-six cubic yards of clay were put in, and an accumulation of sawdust and other mill refuse was removed from the lock.

## 20. APPLETON SECOND LOCK (NEW).

The doweling and pointing of the coping was completed; stone steps and slope coping were laid at the lower south end of the wall; a portion of the chamber walls was repointed, and clay filling made in rear of both walls near their lower ends. This completes the construction of this lock.

## 21. APPLETON FIRST LOCK (OLD).

One diamond block was made, placed, and secured, and a few slight repairs made.

## 22. REBUILDING APPLETON PIER WALL.

Work was commenced on May 8, 1879. Cofferdams were put in near the lower end, the water pumped out, earth and rock excavations made, and 424 cubic yards of masonry laid. The stone for this work is brought from the Duck Creek and Kaukauna quarries.

## 23. MENASHA LOCK (OLD).

Slight repairs were made to this lock.

## 24. DREDGING.

Dredge No. 1, after completing her work at De Pere dam, moved to Kaukauna, and removed the coffer-dams at the waste weir in the first level and dredged the canal down to the bridge above the 1st lock. She then removed two old docks and other obstructions from the channel below the Little Chute combined locks; dredged the canal above Appleton 4th lock, and raised the canal banks on both sides; deepened the channel immediately below the Menasha lock, and was laid up for the season on the 26th of November. Slight repairs having been made to the boat and machinery, she resumed work on the 25th of April. Since that date she has removed a coffer-dam from above the Little Chute 1st lock; has dredged the canal between Appleton 1st, 2d, and 3d locks; has deepened the channel of Menasha River; and has made a cut near the foot of Lake Winnebago 1,085 feet long and 2 feet deep. The cut is now 80 feet in width, with a depth of water of 6 feet.

## 25. REPAIRS TO BOATS AT OSHKOSH BOAT-YARD.

The steamer Crawford was hauled out and blocked up; a new hull and upper works built; the engines and boilers repaired; an outfit purchased; the boat launched; and named the Henrietta.

The old hull was thoroughly repaired, launched, and named Barge No. 1.

Dredge No. 2.—A new hull and upper works were built; the engines, dredge machinery, and boiler were repaired; an outfit was purchased, and the boat was launched and named Gabe Bouck.

Steamer launch General Meade.—A new hull was built; the boiler cased, and the engine repaired.

## 26. MISCELLANEOUS.

With the exception of slight repairs made to the abutment of the Kaukauna dam—none of the new dams—viz, Appleton, Cedars, Little Chute, Rapid Croche, and Little Kaukauna—have required any work on them during the fiscal year.

The waste weir in Kaukauna first level was taken out and the retaining wall at that point rebuilt.

The canal banks near Menasha lock, Appleton 2d and 3d locks, Kaukauna 4th lock, and De Pere lock were repaired and raised.

Twenty-five snags were removed from the channel of the river between Appleton and Little Kaukauna, and all drift-wood and *débris* from the dams.

All of the old locks, except the one at Rapid Croche, will have to be replaced by new ones. When replaced, I would respectfully suggest that the new ones be built in the following order: Appleton 3d lock; Kaukauna 1st; Appleton 1st; Menasha; Kaukauna 2d; Appleton 4th; Little Kaukauna; Cedars; Kaukauna 5th, and De Pere.

Very respectfully, your obedient servant,

C. A. FULLER,  
Assistant Engineer.

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

## APPLICATION OF MOVABLE DAMS IN THE IMPROVEMENT OF THE UPPER FOX RIVER, WISCONSIN.

Proceedings and report of the Board of Engineer Officers constituted by the following order:

[SPECIAL ORDERS No. 89.]

HEADQUARTERS CORPS OF ENGINEERS,  
Washington, D. C., August 9, 1878.

[Extract.]

I. A Board of Officers of the Corps of Engineers, to consist of Maj. W. P. Craighill, Maj. D. C. Houston, Maj. W. E. Merrill, will assemble at Cincinnati, Ohio, on the 28th of August, 1878, or as soon thereafter as practicable, to consider and report upon the feasibility and utility of the application of movable dams in the improvement of the Upper Fox River, Wisconsin.

By command of the Acting Chief of Engineers.

GEORGE H. ELLIOT,  
Major of Engineers.

The Board met at Cincinnati at 10 a. m. on the 13th of November, 1878.

Maj. D. C. Houston, the officer in charge of the improvement of the Fox and Wisconsin Rivers, submitted to the Board maps and drawings illustrating the character of the Upper Fox River at the locations where dams are needed. The method of improvement adopted on this river is that of slackwater navigation by dams and locks. There are 8 locks between Portage and Lake Winnebago, a distance of 104 miles, overcoming a total fall of about 40 feet. Near each lock there is a dam, except at the upper lock, which connects the canal from the Wisconsin to the Fox with the latter stream. The first two dams, commencing at the upper end, are crib-dams; the next four are built of brush and stone, and the lower dam near Eureka is a frame dam, with masonry abutments and a navigable pass closed by Boulé gates, supported by a draw-bridge. The five lower locks and dams have been built by the government since the purchase of the works of improvement from the

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3.8  
0  
3.25  
3.47  
12.96  
68.8  
96.75  
109.2  
122.6  
130.76  
103.88