APPENDIX.

Allegheny River Plan.

PIPE MAINS AND APPURTENANCES.

The pipe castings are estimated at 2½ cents per pound. The special castings are estimated at 3¼ cents per pound.

1. Low Service Mains.

4,670 feet of 36 inch Force Mains laid, a $21........ $ 98,070 00
Two 36 inch Check Valves set, a $2,200.................. 4,400 00
200 cubic yards Arch Culvert masonry, a $15........ 3,000 00
10,500 cubic yards Embankment, a $15........ 3,675 00
28,800 feet of 36 inch Distribution Main laid, a $16... 460,800 00
Six 36 inch Stop cocks, set, a $2,000.................... 12,000 00
270 cubic yards Arch Culvert masonry, a $15........ 4,050 00
2,000 " Embankment, a $15........ 700 00
9,000 feet of 12 inch Distribution Main laid, a $3.40.. 30,600 00
Five 12 inch Stop cocks, set, a $100..................... 500 00

$617,795 00

2. Middle Service Mains.

7,250 feet of 30 inch Distribution Main laid, a $11.75.. $85,187 50
Three 30 inch Stop cocks, set, a $1,000................... 3,000 00
1,150 feet of 24 inch Force Mains laid, a $9........... 10,350 00
Two 24 inch Check Valves, set, a $1,100.................. 2,200 00
315 feet of 24 inch Distribution Main laid, a $8........ 2,520 00
8,400 feet of 20 inch Distribution Main laid, a $7........ 58,860 00
Six 20 inch Stop cocks, set, a $400....................... 2,400 00
3,000 feet of 15 inch Distribution Main laid, a $4.50... 16,200 00
Two 15 inch Stop cocks, set, a $200....................... 400 00

$181,057 50

3. High Service Mains.

12,500 feet of 12 inch Main laid, a $3.50.............. 43,750 00
One 12 inch Check Valve, set, a $100................... 100 00
Eight 12 inch Stop cocks, set, a $100.................... 800 00

$44,050 00

$43,952 50

Add for Contingencies, Superintendence, etc., 10 per cent........ 84,350 50

$27,858 00
### BRILLIANT HILL RESERVOIR

**GRADING, SLOPE WALLS, &c.**

- Clearing and Grubbing: $300.00
- 5,277 cubic yards stone paving of slopes, 12 inches thick, $7.50: $39,588.00
- 110 cubic yards stone coping at top of slope, $18.00: $1,980.00
- 6,057 cubic yards concrete (6 inches thick on slopes and in bottom), $6.60: $39,666.60
- 20,600 cubic yards rubble (2 feet thick on slopes and 1 foot thick on bottom), $7.50: $15,375.00
- 130,000 cubic yards excavation, $30.00: $3,900.00
- 24,700 square yards dressing and seeding of outside slopes, $6.00: $148,200.00
- 3,000 linear feet of fencing, $60.00: $180.00

**MASONRY, &c.**

**INFLUENT CHAMBER.**

- 50 cubic yards excavation, $35.00: $1,750.00
- 17 cubic yards Masonry in foundation, $12.00: $204.00
- 198 cubic yards Rubble Masonry, $11.00: $2,178.00
- 18 cubic yards Ashlar, $18.00: $324.00
- 1/4 cubic yards Coping, $18.00: $54.00
- 27 cubic yards Stone Paving, $7.00: $189.00
- 4 square yards Brick Paving, $1.50: $6.00
- 84 feet of 36 inch Straight Pipe (37,380 lbs.), $24.00: $2,178.00
- 40 feet of Special Castings (18,000 lbs.), $34.00: $58.00
- 160 feet Waste Pipe, 8 inch diameter (8,560 lbs.), $24.00: $384.00

**CONNECTING WEIR.**

- 3,724 cubic yards Excavation, $35.00: $129,340.00
- 234 cubic yards Rubble Masonry, $11.00: $2,574.00
- 240 cubic yards Ashlar, $18.00: $4,320.00
- 19 cubic yards Coping, $18.00: $342.00
- 16 cubic yards Stone Paving, $7.00: $112.00
- 13 cubic yards Brick Paving, $12.00: $156.00
- 102 cubic yards Concrete in foundation, $6.60: $663.00

**RECAPITULATION.**

- Clearing, Slope Walls, &c., $120,020.00
- Influent Chamber: $13,465.75
- Connecting Weir: $180,167.00
- Add for Contingencies, &c., 10 per cent: $16,378.86
- **Total: $352,941.81**

### HILLAND AVENUE RESERVOIR

**GRADING, SLOPE WALLS, &c.**

- Clearing and Grubbing: $400.00
- 7,545 cubic yards Stone Paving of SlopEs, $7.00: $52,815.00
- 164 cubic yards Coping at top of SlopEs, $18.00: $2,947.20
- 12,900 cubic yards Concrete, $6.60: $84,240.00
- 32,216 cubic yards Puddle, $7.50: $241,422.00
- 175,000 cubic yards Excavation, $30.00: $5,250.00
- 29,900 Square yards Dressing and Seeding outside SlopEs, $6.00: $173,400.00
- 3,460 Linear feet of Fencing, $50.00: $173,000.00

**INFLUENT CHAMBER.**

- 50 cubic yards Excavation, $35.00: $1,750.00
- 17 cubic yards Masonry in foundation, $12.00: $204.00
- 198 cubic yards Rubble Masonry, at $11: $2,178.00
- 18 cubic yards Ashlar, $18.00: $324.00
- 1/4 cubic yards Coping, $18.00: $54.00
- 27 cubic yards Stone Paving, $7.00: $112.00
- 4 cubic yards Brick Paving, $12.00: $48.00
- 84 feet of 30-inch Straight pipe, 28,040 lbs., $24.00: $2,018.40
- 40 feet of Special Castings, 13,200 lbs., $34.00: $429.60
- 90 feet of Waste Pipe, 8 inches in diameter, 5,160 lbs., $24.00: $123,720.00

**Total:** $225,868.00
### Effluent Chamber

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>920 cubic yards Excavation, a $5c</td>
<td>$222 00</td>
</tr>
<tr>
<td>524 cubic yards masonry in foundation, a $12</td>
<td>$627 00</td>
</tr>
<tr>
<td>658 cubic yards Rubble masonry, a $11</td>
<td>$7,288 00</td>
</tr>
<tr>
<td>1,244 cubic yards Ashlar, a $18</td>
<td>$2,241 00</td>
</tr>
<tr>
<td>84 cubic yards Coping, a $18</td>
<td>$150 00</td>
</tr>
<tr>
<td>Brick Culvert 30 inches in diameter, 10,000 bricks, a $24 per thousand</td>
<td>$240 00</td>
</tr>
<tr>
<td>4 cubic yards Brick Paving, a $12</td>
<td>$48 00</td>
</tr>
<tr>
<td>8 cubic yards flagging of Gate Chamber, a $15</td>
<td>$120 00</td>
</tr>
<tr>
<td>12 cubic yards of Stone Paving at mouth of culverts, a $7</td>
<td>$84 00</td>
</tr>
<tr>
<td>Screens and Screen Frames over Effluent pipes</td>
<td>$225 00</td>
</tr>
</tbody>
</table>

**ReCAPitulation.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Chamber</td>
<td>$225,663 00</td>
</tr>
<tr>
<td>Effluent Chamber</td>
<td>$4,228 00</td>
</tr>
<tr>
<td>Add for Contingencies, Superintendence, &amp;c., 10 per cent</td>
<td>$241,186 00</td>
</tr>
</tbody>
</table>

**Total:** $266,804 00

### Herron Hill Reservoir

**Grading, Slope Walls, &c.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,762 cubic yards Stone Paving of Slopes, a $7</td>
<td>$23,834 90</td>
</tr>
<tr>
<td>39 cubic yards Coping, a $18</td>
<td>$702 00</td>
</tr>
<tr>
<td>1,560 cubic yards Concrete, a $6.50</td>
<td>$10,140 00</td>
</tr>
<tr>
<td>5,660 cubic yards Puddle, a $75</td>
<td>$4,245 00</td>
</tr>
<tr>
<td>30,730 cubic yards Excavation, a $30c</td>
<td>$9,219 00</td>
</tr>
<tr>
<td>12,900 cubic yards Excavation Shale, a $80c</td>
<td>$10,930 00</td>
</tr>
<tr>
<td>12,400 square yards Dressing and Seeding outside Slopes, a $6c</td>
<td>$744 00</td>
</tr>
<tr>
<td>Foot Bridge 48 feet long</td>
<td>$200 00</td>
</tr>
<tr>
<td>Effluent Well, Cast Iron, 30 in diameter and 24 feet long, 8,000 lbs, a $6c</td>
<td>$400 00</td>
</tr>
<tr>
<td>Three Valves and Valve Rods, a $50</td>
<td>$150 00</td>
</tr>
<tr>
<td>2,100 lineal feet of Fencing, a $6c</td>
<td>$1,050 00</td>
</tr>
</tbody>
</table>

**Total:** $49,504 00

Add for Contingencies, Superintendence, &c., 10 per cent $4,960 00

**Total:** $54,454 00

### Allegheny River Plan

**COST OF WORKS.**

- Pumping engines to be located at Negley's run. Water to be taken from the Allegheny River, at the head of Nine Mile Island, and conducted to engines through a brick conduit six feet in diameter.
- Masonry at Influent Chamber of Conduit, with Influent pipes, Gates and Screens $7,000 00
- 10,400 feet of Conduit six feet in diameter, a $17 278,800 00
- 12 Manholes, a $75 960 00
- Engine house and Pump Well at Negley's run 150,000 00
- Two pumping engines, a $150,000 300,000 00
- Engine house at Brilliant Hill 35,000 00
- Two pumping engines, a $35,000 70,000 00
- Engine house and engine at Ellsworth avenue and Neville street 25,000 00
- Brilliant Hill Reservoir 100,167 00
- Hilland Avenue Reservoir 265,304 00
- Herron Hill Reservoir 64,454 00
- Pipe mains and appurtenances 927,853 00

**Total:** $2,294,478 00

**Allegheny River Plan.**

**COST OF WORKS.**

- Pumping works to be located at Negley's run. Water to be taken from the Allegheny river in rear of the engine house about 800 feet above the mouth of Negley's run.
- Engine house and Pump Well at Negley's run $150,000 00
- Two pumping engines, a $150,000 300,000 00
- Engine house at Brilliant Hill 35,000 00
- Two pumping engines, a $35,000 70,000 00
- Engine House and engine at Ellsworth avenue and Neville street 25,000 00
- Brilliant Hill Reservoir 100,167 00
- Hilland Avenue Reservoir 265,304 00
- Herron Hill Reservoir 64,454 00
- Pipe mains and appurtenances 927,853 00
- One and one-half miles of Brick Sewer 2 feet in diameter 31,720 00

**Total:** $2,090,498 00
**Monongahela River Plan.**

**PIPE MAINS AND APPURTENANCES.**

1. **Low Service Mains.**
   - 4,650 feet of 36 inch Force Main laid, a $10 = $88,350.00
   - Two 36 inch Check Valves set, a $2,200 = 4,400.00
   - Arch Culvert and Embankment at Four Mile run = 5,000.00
   - 20,000 feet of 36 inch Distribution Main laid, a $16.00 = 320,000.00
   - Four 36 inch Stop Cocks set, a $2,000 = 8,000.00
   - 4,450 feet of 20 inch Distribution Main laid, a $6.40 = 28,480.00
   - Three 20 inch Stop Cocks set, $400 = 1,200.00
   - 9,000 feet of 12 inch Distribution Main laid, a $3.40 = 30,600.00
   - Five 12 inch Stop Cocks set, a $100 = 500.00
   - Total = $499,530.00

2. **Middle Service Mains.**
   - 8,250 feet of 30 inch Distribution Main laid, a $12 = 99,000.00
   - Four 30 inch Stop Cocks set, a $1,000 = 4,000.00
   - 12,150 feet of 20 inch Distribution Main laid, a $6.40 = 77,790.00
   - Eight 20 inch Stop Cocks set, a $400 = 3,200.00
   - 4,400 feet of 30 inch Distribution Main laid, a $11.50 = 50,600.00
   - Two 30 inch Stop Cocks set, a $1,650 = 2,000.00
   - 3,200 feet of 15 inch Distribution Main laid, a $4.50 = 16,200.00
   - Two 15 inch Stop Cocks set, a $200 = 400.00
   - Total = $253,160.00

3. **High Service Mains.**
   - 12,000 feet of 12 inch Mains laid, a $3.50 = 43,750.00
   - One 12 inch Check Valve set, a $100 = 100.00
   - Eight 12 inch Stop Cocks set, a $100 = 800.00
   - Total = $44,650.00

   Add for Contingencies, Omissions, Superintendence, &c., 10 per cent. = 7,974.00

   Total = $72,624.00

**ARTHUR AND CRAFT'S HILL RESERVOIR.**

**GRADING, SLOPE WALLS, &c.**

- Grubbing and Clearing = $250.00
- 6,856 cubic yards Stone Paving, a $7 = 47,992.00
- 141 cubic yards Coping, a $18 = 2,528.00
- 11,526 cubic yards Concrete, a $6.50 = 74,019.00
- 35,100 cubic yards Puddle, a 75c = 26,325.00
- 190,800 cubic yards Excavation, a 30c = 57,240.00
- 30,550 square yards Dressing and Seeding outside Slopes, a 5c = 1,528.00
- 4,720 linear feet of Fencing, a 50c = 2,360.00
   - Total = $219,657.00

**INFLUENT CHAMBER.**

- Total cost = 5,000.00

**EFFLUENT CHAMBER.**

- 2,600 cubic yards Excavation, a $5 = 7,000.00
- 180 cubic yards Masonry, a $12 = 1,680.00
- 1,316 cubic yards Rubble Masonry, a $11 = 14,470.00
- 420 cubic yards Ashlar, a $18 = 7,560.00
- 30 cubic yards Coping, a $18 = 540.00
- 120 square yards Brick Paving, a $1.50 = 180.00
   - Total = $25,124.00

**RECAPITULATION.**

- Grading, Slope Walls, &c. = $215,567.00
- Influent Chamber = 5,000.00
- Effluent Chamber = 26,124.00
- Total = $247,712.00

**WILKINS HILL RESERVOIR.**

**GRADING, SLOPE WALLS, &c.**

- 6,000 cubic yards Stone Paving, a $7 = 42,000.00
- 125 cubic yards Coping, a $18 = 2,250.00
- 8,340 cubic yards Concrete, a $6.50 = 54,310.00
- 26,000 cubic yards Puddle, a 75c = 19,500.00
- 180,000 cubic yards Excavation, a 30c = 54,000.00
- 24,400 square yards of Dressing and Seeding outside Slopes, a 5c = 1,204.00
- 4,520 linear feet of Fencing, a 50c = 2,260.00
   - Total = $175,724.00

**INFLUENT CHAMBER.**

- Total cost = $4,000.00

**EFFLUENT CHAMBER.**

- Total cost = $12,000.00

**RECAPITULATION.**

- Grading, Slope Walls, &c. = $175,724.00
- Influent Chamber = 4,000.00
- Effluent Chamber = 12,000.00
- Add for Contingencies, Superintendence, &c., 10 per cent. = 19,172.00
   - Total = $210,892.00
MONONGAHELA RIVER PLAN.
COST OF WORKS.

Pumping engines to be located at Four Mile run. Water to be taken from Pool No. 1, directly in rear of Engine House.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masonry, gates, &amp;c., at inlet to Conduit</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>41,700 lineal feet of Conduit, a $17</td>
<td>$70,900.00</td>
</tr>
<tr>
<td>32 Manholes, a $75</td>
<td>$2,400.00</td>
</tr>
<tr>
<td>Engine House and Pump Well</td>
<td>$150,000.00</td>
</tr>
<tr>
<td>Two Pumping Engines, a $150,000</td>
<td>$300,000.00</td>
</tr>
<tr>
<td>Engine House at Arthur and Craft's Hill</td>
<td>$35,000.00</td>
</tr>
<tr>
<td>Two Pumping Engines, a $35,000</td>
<td>$70,000.00</td>
</tr>
<tr>
<td>Stand Pipe</td>
<td>$40,000.00</td>
</tr>
<tr>
<td>Engine House and Engine at Ellsworth Avenue and Neville Street</td>
<td>$25,000.00</td>
</tr>
<tr>
<td>Reservoir—Arthur and Craft's Hill</td>
<td>$270,249.00</td>
</tr>
<tr>
<td>Reservoir—Wilkins Hill</td>
<td>$210,896.00</td>
</tr>
<tr>
<td>Reservoir—Herron Hill</td>
<td>$54,454.00</td>
</tr>
<tr>
<td>Pipe Mains and appurtenances</td>
<td>$877,074.00</td>
</tr>
</tbody>
</table>

**Total Cost** | **$2,748,973.00**

MONONGAHELA RIVER PLAN.
COST OF WORKS.

Pumping Engines to be located at Four Mile run. Water to be taken from Pool No. 2 and conducted to engines through a circular brick conduit six feet interior diameter.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine House and Pump Well</td>
<td>$150,000.00</td>
</tr>
<tr>
<td>Two Pumping Engines, a $150,000</td>
<td>$300,000.00</td>
</tr>
<tr>
<td>Engine House at Arthur and Craft's Hill</td>
<td>$35,000.00</td>
</tr>
<tr>
<td>Two Pumping Engines, a $35,000</td>
<td>$70,000.00</td>
</tr>
<tr>
<td>Stand Pipe</td>
<td>$40,000.00</td>
</tr>
<tr>
<td>Engine House and Engine at Ellsworth Avenue and Neville Street</td>
<td>$25,000.00</td>
</tr>
<tr>
<td>Reservoir—Arthur and Craft's Hill</td>
<td>$270,249.00</td>
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<tr>
<td>Reservoir—Wilkins Hill</td>
<td>$210,896.00</td>
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<tr>
<td>Reservoir—Herron Hill</td>
<td>$54,454.00</td>
</tr>
<tr>
<td>Pipe Mains and appurtenances</td>
<td>$877,074.00</td>
</tr>
</tbody>
</table>

**Total Cost** | **$2,082,873.00**

REPORT OF OTTO WUTH,

Analytical and Consulting Chemist, corner of Third avenue and Smithfield street.

PITTSBURGH, March 3d, 1871.

Gentlemen:—In September last you requested me to make a thorough analysis of the water from the two rivers enclosing the City of Pittsburgh, and from their principal contributaries, in order to ascertain the amount and character of the impurities in either, so as to establish their respective value for supplying the new City Water Works to be built under your direction.

Of each water you furnished me with two carboys, marked respectively, 5 and 6 (Monongahela), 7 and 8 (Allegheny), 9 and 10 (Kiskiminetas), 11 and 12 (Youghiogheny).

Having completed the analysis according to your wishes, I have now the honor to communicate to you the result of my researches.

With the exception of the water in 5 and 6, which contained some silicate of alumina (clay) in suspension, retaining a slight opaqueness, even after several weeks standing, all samples were perfectly clear; none of them showed the presence of oil, neither the waters themselves nor the diatiate therefrom.

Some of each sample I have kept until the present time, taking no particular care to exclude the influence of the atmospheric air, but they all are as fresh now as they were on the day I received them.

In 100,000 parts the different waters contain:
From the Youghiogheny at Alpsville, about twenty-one miles from Pittsburgh; September 22d, 1870.

Table showing Grains of Solid Matter in one U. S. gallon of water, in different cities in America and Europe.

<table>
<thead>
<tr>
<th>Source</th>
<th>City Supplied</th>
<th>Grains of Solid Matter in one U. S. Gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocton</td>
<td>New York</td>
<td>4.16</td>
</tr>
<tr>
<td>Schuylkill</td>
<td>Philadelphia</td>
<td>4.42</td>
</tr>
<tr>
<td>Long Island Streams</td>
<td>Brooklyn</td>
<td>1.97</td>
</tr>
<tr>
<td>Cochituate</td>
<td>Boston</td>
<td>2.25</td>
</tr>
<tr>
<td>Jones Falls</td>
<td>Baltimore</td>
<td>5.86</td>
</tr>
<tr>
<td>Potomac River</td>
<td>Washington</td>
<td>5.59</td>
</tr>
<tr>
<td>Passaic River</td>
<td>Jersey City</td>
<td>7.44</td>
</tr>
<tr>
<td>Patroon's Creek</td>
<td>Albany</td>
<td>4.72</td>
</tr>
<tr>
<td>Detroit River</td>
<td>Detroit</td>
<td>5.72</td>
</tr>
<tr>
<td>Lake Michigan</td>
<td>Chicago</td>
<td>8.01</td>
</tr>
<tr>
<td>Ohio River</td>
<td>Cincinnati</td>
<td>6.74</td>
</tr>
<tr>
<td>St. Charles River</td>
<td>Quebec</td>
<td>6.75</td>
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<tr>
<td>Thames River</td>
<td>London</td>
<td>17.97</td>
</tr>
<tr>
<td>Solna River</td>
<td>Fal whisky</td>
<td>10.60</td>
</tr>
<tr>
<td>Elbe River</td>
<td>Dresden</td>
<td>21.00</td>
</tr>
<tr>
<td>Loch Katrine</td>
<td>Glasgow</td>
<td>1.85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTE</th>
<th>Different analyses vary</th>
<th>from 1.22 to 5.00</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vary from 4.74 to 6.74</td>
<td>Great variations</td>
</tr>
</tbody>
</table>

Description of Engines.

By GEORGE M. COPELAND, Mechanical Engineer.

The Engine, the drawing of which is herewith presented, is of the Compound, or Double Cylinder variety, connected by the usual means to a pair of overhead beams, and through these, and the Connecting Rod, to the Crank and Fly-wheel shaft.

PUMP CONNECTION.

Connection to the Pump is made from near the opposite end of the beams from the cylinders, and just inside of (or nearer the centre of the engine than) the pin in the end of the beams, to which the connecting rod is attached.
The Pump, which is of the Thames-Diton kind, is placed in the pump well, nearly under the Crank, and is 48½" diameter, by 8' 3" stroke. The Trunk, or Plunger, is 34½" diameter.

CONDENSER.
The Condenser is placed directly under the larger Cylinder, and is connected with it by the usual exhaust pipe.

AIR PUMP.
The Air Pump is worked from a pin in the Beams, inside of the pin to which the connections from the crosshead of the smaller Cylinder are attached.

CRANK-SHIFT.
The Crank-Shift is situated at the opposite end of the Engine from the Cylinders, and carries a Fly-wheel weighing about 60,000 lbs.

CYLINDERS.
The two Cylinders are of different dimensions—the steam from the Boilers entering the small Cylinder, wherein it is cut off and expanded. At the termination of the stroke, the steam from the small cylinder escapes into the larger one, and is further expanded in it.

The effect from using the steam in this manner, instead of the ordinary method of employing but one cylinder and cutting off short to insure economy, is that, with the same initial pressure, the initial blow, or impact from the entering steam, is very much less in the case of the Compound than in that of the Single-Cylinder Engine.

The pressure throughout the stroke is likewise much more uniform, by which the power is more equally proportioned to the load, at all parts of the stroke. In the application of steam power to pumping purposes, this feature is especially desirable, as the load, or fluid, elevated is practically a dead lift, nearly uniform throughout the stroke, and is not of the elastic character as is the load for most manufacturing purposes, derived from the momentum of revolving portions of the mechanism.

A large measure of economy is claimed for the Double, over the Single-Cylinder Engine, which develops itself in practice.

DIMENSIONS OF CYLINDERS.
In the drawing presented, the Cylinders are 80" diameter by 10' stroke, and 64" diameter by 5' 6" stroke respectively. Upon further investigation, it may be desirable to modify these dimensions somewhat.

ACTION.
The steam from the Boilers first enters the small Cylinder, following the piston to about eight-tenths (8.10) of the stroke, when it is cut off and expanded during the remainder of the stroke of the small piston. At the termination of the stroke, the steam in the small Cylinder escapes into the larger one, and is further expanded in it—steam from the boilers at the same time entering the opposite end of the small Cylinder. After the steam in the larger Cylinder has performed its office, it escapes into the Condenser.

INITIAL BLOW.
In a Double-Cylinder Engine of the dimensions here given, and with the steam cut off at about eight-tenths (8.10) of the stroke in the smaller Cylinder, the expansion equals five times the original volume. With steam of the initial absolute pressure of thirty-six (36) lbs. per square inch, the initial blow is represented by 132,141.

With a Single Cylinder of 80" diameter by 10' stroke, and cut off at one quarter (¼) of the stroke, the expansion equals four times the original volume; and with the same initial absolute pressure of thirty-six (36) lbs. per square inch, the initial blow is represented by 168,390, being a difference of 36,249, or 27 per cent.

DIFFERENCE OF PRESSURES.
The maximum pressure brought to bear upon the Beam Pins, Beams, &c., in the use of the Double-Cylinder Engine, is represented by 132,141; and the minimum pressure by 63,141, or about 48 per cent. of the maximum pressure.

The maximum pressure upon the same parts, in the use of the Single-Cylinder Engine, and with the same initial pressure, is represented by 168,390; and the minimum pressure by 32,673, or about 19 per cent. of the maximum pressure.

PRESSURE.
The maximum pressure in the Double-Cylinder Engine is about 78 per cent. of that in the Single Cylinder; and the minimum pressure in the Double Cylinder is about 150 per cent. of that in the Single Cylinder.

CAPABILITY.
One engine is intended to be capable of lifting 12,000,000 gallons of water into the Low Service Reservoir in twenty-four hours, through a force main, as at present proposed, 36 inches diameter and 2,323 feet long, having a vertical elevation of 225 feet.
WEIGHT OF ENGINE.

The weight of one engine will approximate 400 tons.

BOILERS.

The Boilers, of which the accompanying drawing shows the general plan and arrangement, are of the internal fire box and drop flue class; and are seven (7) feet in diameter by twenty-eight (28) feet long. The waist, or that portion back of the fire box, is cylindrical, while the fire box portion is a semi-circle on the top, oval at the bottom, with a short straight section at the sides. The whole of the fire box portion, as also the back and front connections, will be stayed to an equivalent strength with the cylindrical portion.

STEAM DOME.

On the top of the Boiler is a Steam Dome, forty-two (42) inches in diameter, and four (4) feet high, to which the steam pipe is connected. Each boiler rests upon four (4) cast iron saddles, fitted to the under side of the Boiler, and supported by masonry.

FLUES.

The products of combustion, upon leaving the Furnace, pass through the upper tier of flues to the back connection at the rear end of the Boiler, returning through the lower tier of flues to the front connection, immediately behind the fire box, where they leave the interior, and pass under the waist of the Boiler to the flue leading to the chimney; having passed nearly three times the length of the Boiler before entering the latter flue.

NUMBER OF BOILERS.

Four (4) of these Boilers are expected to do the maximum work of one Engine, viz: to deliver 12,000,000 gallons of water into the Reservoir in twenty-four hours.

In the drawing herewith presented, six boilers are shown, with provision for two others. It is calculated that these six boilers, in connection with two engines, will deliver 18,000,000 gallons of water into the Reservoir in twenty-four hours, which is supposed to be all that will be required for some years to come.

The other two boilers can be supplied whenever the necessity for them arises, without any change in the buildings or boiler foundations. Each boiler will be supplied with a stop valve and safety valve, so that any one or more of them can be put out of use, for cleaning or repairs, without impairing the efficiency of the remainder.

The drawing of the Boilers shows the general arrangement of the flue leading to the chimney, the Boiler House, and the relation of the Boiler House to the Engine House.

These plans are not supposed to be accurate in all the details, and are only intended to give the general idea and the principal dimensions.

WEIGHT OF BOILERS.

Each Boiler will weigh about 30,000 lbs., exclusive of grate bars, safety and stop valves, &c.

WEIGHT OF ACCESSORIES.

The approximate weight of the Boiler accessories for six Boilers, including steam pipes, safety and stop valves, grate bars, floor plates in Boiler Room, and the necessary iron work for the Boiler foundations, &c., will be from 60 to 65 tons.

COST OF ENGINES AND BOILERS.

The cost of two Engines and six Boilers, erected complete and satisfactorily tested, will approximate $280,000.
Descent of the Allegheny River,
TAKEN FROM
ELLET'S REPORT ON THE MISSISSIPPI AND OHIO RIVERS.
Page 234.

| From Coudersport to Olean Point | 40 | 246 | 6 | 2 |
| Olean Point to Warren          | 60 | 216 | 4 | 4 |
| Warren to Franklin             | 70 | 227 | 3 | 3 |
| Franklin to Pittsburgh         | 130| 261 | 3 | 3 |
| Coudersport to Pittsburgh      | 290| 950 |   |   |

Elevations of the Allegheny River at Low Water.

<table>
<thead>
<tr>
<th>Location</th>
<th>Feet above Tide</th>
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<tbody>
<tr>
<td>Pittsburgh</td>
<td>699</td>
</tr>
<tr>
<td>Franklin</td>
<td>960</td>
</tr>
<tr>
<td>Warren</td>
<td>1187</td>
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<tr>
<td>Chautauqua Lake</td>
<td>1306</td>
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<td>Olean Point</td>
<td>1403</td>
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<tr>
<td>Mouth of Oswaya</td>
<td>1419</td>
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<tr>
<td>Smithport</td>
<td>1480</td>
</tr>
<tr>
<td>Coudersport</td>
<td>1649</td>
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