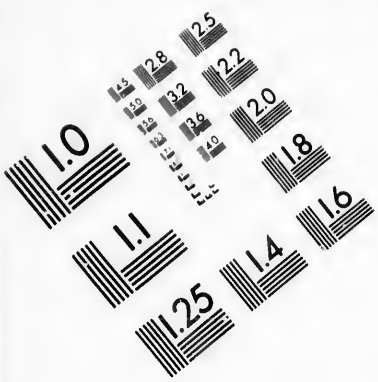

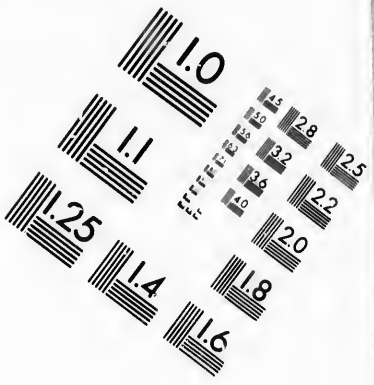

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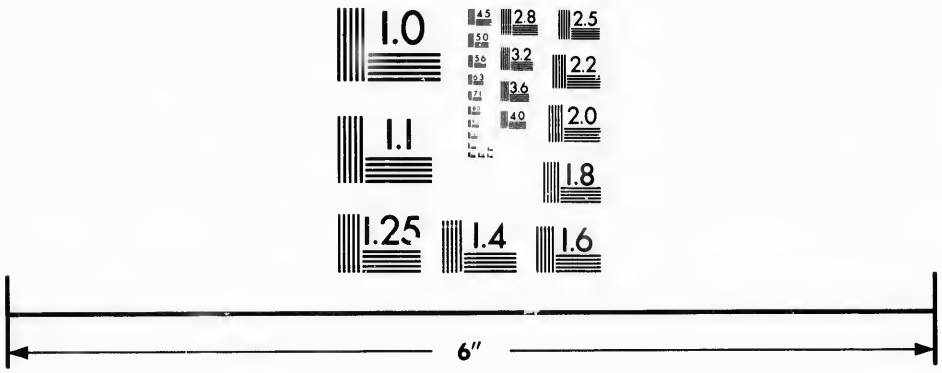

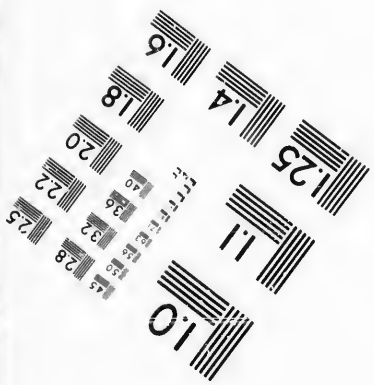

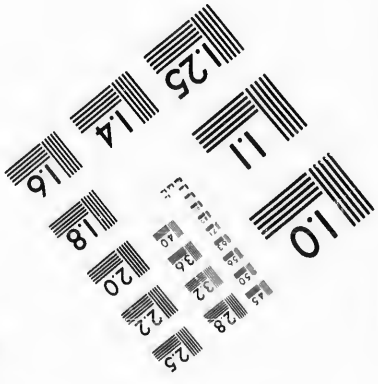

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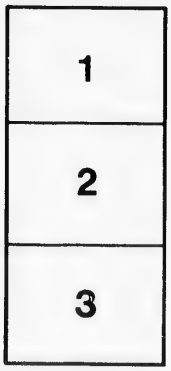
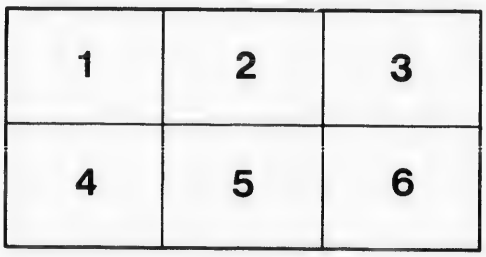




Reprinted from Journal of the New England Water Works Association, Vol. XIII., No. 4.

CLEANING A WATER MAIN IN ST. JOHN, N. B.

—BY—

WILLIAM MURDOCH, C. E.

Engineer Water Works.

The Day Print, New London, Conn.

CLEANING A WATER MAIN IN ST. JOHN, N. B.

BY WILLIAM MURDOCH, C. E., ENGINEER WATER WORKS.

The city of Saint John is supplied with water from two sources about 12 miles apart, the east side of the harbor, which contains the larger part of the population, taking its water from Little River, and the west side supply coming from Spruce Lake.

The east side mains are three in number, as follows: No. 1, laid in 1851, 12 inches diameter; No. 2, laid in 1857 and No. 3, laid in 1873, each 24 inches diameter. Neither of the pipes had ever been cleaned and Nos. 1 and 2 had not been varnished. No. 3 however, was coated according to Dr. Smith's process. The length of each main is $4\frac{1}{4}$ miles.

The reservoir from which the supply is taken is formed by damming the river with an embankment 300 feet in length and 20 feet high, causing the surface to stand at an elevation of 160 feet above H. W. datum in the harbor, whilst the summit of the city is 130 feet above datum and five miles from the reservoir. It will thus be seen that with a gravitation system, the pressure on the summit is very low; indeed, in zero weather, it has been known to disappear entirely and the water actually fall away from the pipes and leave them empty.

The two older mains had become so foul through internal incrustation that when No. 3 was shut off for repairs and the city depended on the other two pipes, all the portions at a height of 80 feet or more above datum, comprising an area of about 200 acres and containing a population of about 8500 souls, were without water. On the other hand, with No. 2 shut off and supply coming by Nos. 1 and 3, every pipe was full and water delivered at a level of 130 feet. This was an ample demonstration of the foulness of the old mains as compared with that last laid.

In the summer of 1897, the Common Council passed an order directing that the mains be cleaned, and preparations were forthwith begun. There being no hatch boxes on these pipes, such

fittings were designed and cast, and when they were placed in position the work of cleaning began. Meanwhile a scraper was designed and constructed in the workshops of the department, the pistons being of birch, built in layers crossing the grain and bolted together as shown in cut (Fig. 1). The spindle connecting the

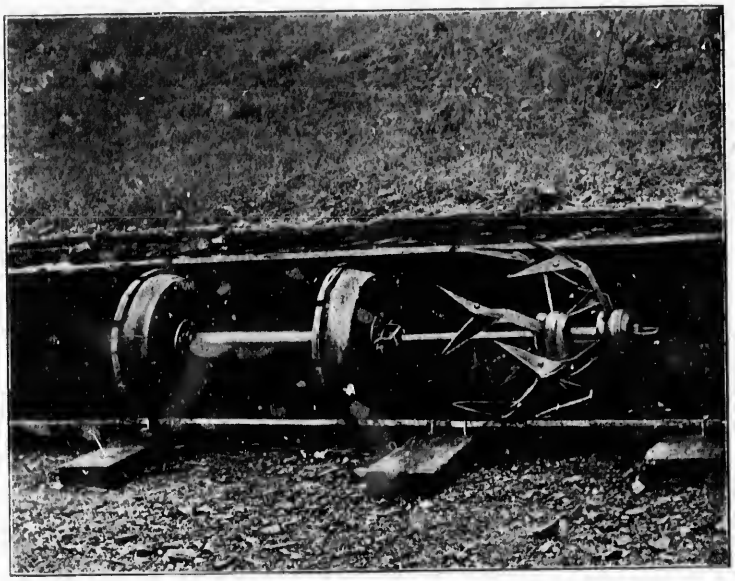


Fig. 1. First Scraper Used.

pistons is of 3 inch wrought iron pipe, and the flanges of the ordinary kinds screwed on and rivetted to prevent backing out and falling apart when inside the pipe. Projecting beyond the forward piston is an iron rod, fitted with two sets of radial arms, four in each set, sloping back, as shown in the photograph. During the operations in the year 1897 this style of arm and cutters was used, and with this we will first deal. Each arm consisted of one layer of No. 10, B. W. G. spring steel, two inches wide, and was fitted with a forged steel fish-tail scraper made of such a form that it passed over any hard obstructions and yet reduced the incrustation considerably with each cut.

The only main operated upon, thus far, has been No. 2, which

had an internal coating of tubercles varying up to about one inch in height, closely packed all over the interior surface of the pipe and resembling in appearance that of a coarse, pebbly walk. As soon as the first section, which extended from the reservoir toward the city, a distance of about 6330 feet, had been prepared with a hatch box at each end, the cleaner was sent through and given three runs in one afternoon, the time taken in each case being about 20 minutes.

There is one flushing branch near the middle of this section and another placed at Hatch Box No. 2 which had been set close to a main stop cock, (the said stop cock being shut tight). These flushing branches were left open in each case until after the apparatus had gone by. The water on such occasions was inky black, and after running about ten minutes weakened to the color of tea. In the evening when the operations were finished a two hours' run was given to clarify the water before opening the main stop cock and placing the pipe again into service.

Section No. 2 measures about 6,860 feet and reaches to the next main stop cock near the front of which Hatch Box No. 3 was placed. In order to give the first section another cleaning, the apparatus was run through both sections, a distance of about 13,200 feet. This time our cleaner came to grief, temporarily, in the following manner: The leathers, having worn out during the first cleaning, were renewed with a harder and stiffer quality than before, but they repeatedly caught in a new joint made while inserting the hatch box. Each time the lid was removed to ascertain why the cleaner did not start, it was found firmly fixed by this imperfect butt of the two pipe ends. After twice extricating it, and again finding it caught in the same way, a jack-screw was applied to push it past this obstruction, the lid was again put on, and the water let in at 4.05 p. m, and this time it started. At each of the five flushing stations the gate was left open fully ten minutes after the cleaner had passed, and then closed. As soon as the gate was closed the cleaner again proceeded, and the scraper, *with only one piston*, reached the end of its run at 5.25 p. m., having been one hour and twenty minutes going 2.5 miles; but when 50 minutes of total stoppages are reckoned, the machine was found to have been in motion 30 minutes. As stated, only the forward part of the cleaner arrived, and search had to be made for the remainder. Nothing was done on the following day, which was Sunday, the

castaway piston, which was lying obliquely somewhere in the pipe, having but partially obstructed the flow, and the water was left on until the Monday night following.

A receiving chamber unites Nos. 2 and 3 mains, near No. 3 hatch box, and they are controlled by stop-cocks on each side of the receiver. It was therefore an easy matter to reverse the current of water in No. 3 by closing the stop-cock at the dam and opening that at the receiver, as well as the flushing branches. This was done, and men were distributed along the line to listen for a rumbling noise, which at length was heard within about a quarter of a mile of Hatch Box No. 3, from which the cleaner had been extracted. The sound was followed along the line towards the reservoir until Hatch Box No. 2 was reached, when the derelict was taken out, after having travelled nearly a mile, and crossed a valley about 90 feet in depth. It was found that the pressure of the jack-screw in forcing the cleaner past the uneven joint had cracked one of the flanges, with the result that after having travelled about 2¼ miles, the cleaner fell apart. The forward part, comprising a piston and the scraper, pushed on, but the spindle attached to the rear piston fell to the bottom of the pipe, ploughed up some dirt, and finally became embedded and jammed. The reverse current striking the piston as it did, drove it back with the spindle trailing behind. The apparatus was repaired and three more runs made through this double section of 13,200 feet, on October 29th, without any further mishap, the time taken for each run, including 10 minutes' stoppage at each of the five flushing stations, having been from 1 hour 46 minutes to 1 hour and 55 minutes. The cold weather being on when the next castings arrived, cleaning operations were suspended for the season.

On testing the efficiency of the cleaned main by shutting off No. 3 from the reservoir to the receiving chamber, where both unite, and bringing the supply through Nos. 1 and 2, it was found that the pressure in the city was as good as when No. 2 was shut and the whole supply coming through Nos. 1 and 3, thereby showing that the capacity of No. 2 had improved to such an extent that, whereas with No. 1 it had formerly delivered to a height of 80 feet only, when unassisted by No. 3, and left 200 acres of the city containing 8,500 inhabitants without water, now the whole city could be supplied without the help of No. 3, and the water rise to

a height of 130 feet above high water. The general improvement in pressure, with all the mains on, was found to be about four feet.

The operation was resumed last summer, the first run having been made June 9th, 1898, with the same apparatus as in the preceding season. After carefully studying the action of the cleaner and giving it several runs, it was found that an improvement could be made in the scraper, which was accordingly done, and each arm fitted with a steel cutter that would not clog. It was also found that the arms could be stiffened without any risk of the machine sticking, and this was done also. The final outcome of all the improvements was an apparatus of which the cut on page 338 is a photograph.

This scraper cut through all the deposit to the bare iron, an inspection at the termination of the work having shown that only the scars or imprints of the tubercles remained on the interior surface of the pipe, and it was almost as smooth as when first made.

The whole amount of material removed was not measured, as the flushing branches deliver into the brooks, and the supply of water having been abundant, the dirt was generally carried off in liquid form, the color of the liquid becoming black as the cleaner approached within one thousand feet or so of the flushing station. An estimate may be had by bearing in mind that the average thickness of the deposit was fully three-quarters of an inch, and the length of the main 22,700 feet. It will thus be seen that about 330 cubic yards were removed.

In the Marsh Creek, at the terminal flushing pipe, quite an extensive bar was formed by the material discharged from the main, the dimensions being about 12 feet by 8 feet, but the current carried a large quantity away.

When flushing into Little River, by means of three different branches within one mile of Silver Falls, the water of the Falls assumed the color of strong coffee, and Major's Brook looked like a sewer at its confluence with the Marsh Creek, though it had received the flushings of the main 7,500 feet further up. These facts are given to show the impossibility of measuring the material taken out of the pipe.

At hatch box No. 3, where the cleaner was taken out fifteen times when cleaning the upper end of the main, 108 bushels of

Fig. 2. Improved Scraper Used in 1898.

heavy material, which would not flow off by the drain, remained, and had to be taken up in buckets as it accumulated, but all the more pulverulent scrapings were carried off in the drain, and, as stated, blackened the waters of the brook upwards of a mile away. At the other hatch boxes, where the current was much stronger, an aggregate of 44 bushels had to be hoisted out.

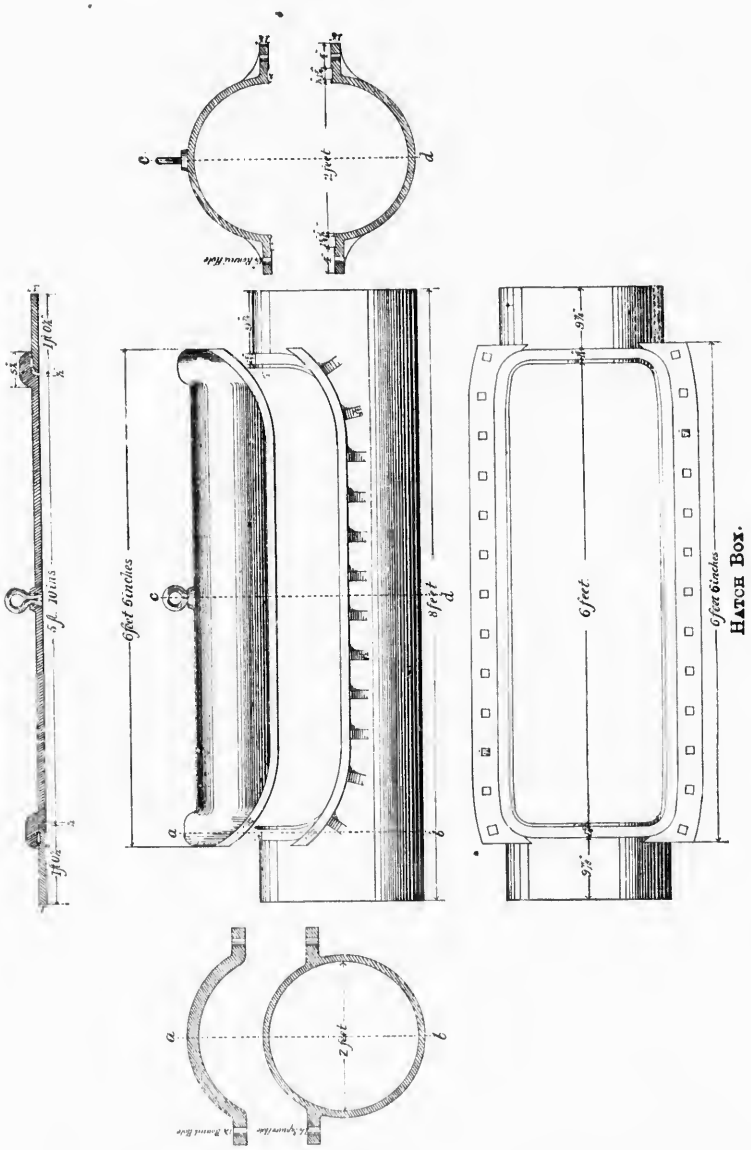
The improvement in pressure, ascertained in the same manner as at the end of the 1897 cleaning, viz.: by sending the whole city's supply through No. 1 and No. 2, and leaving No. 3 shut off during the test, amounted to eleven feet, that is to say, that the two pipes whose combined capacity before the cleaning began was only equal to that of raising the water 80 feet, can at the present time supply the whole district and deliver up to a level of 141 feet above high water datum in the harbor.

The lightness of the cleaner is a great advantage, the entire weight being but 263 pounds, and the bulky portion being made of wood, which weighs less than the water itself, it floated along with the water. This quality was well exemplified when the broken portion was taken from the main, as already related.

The hatch boxes are of cast iron, consisting of a section of pipe with the upper half removable, and secured in place by means of screw bolts and nuts, the flanges being gasketted with Tuck's 1¼-inch round packing, which adapted itself to all the inequalities of the casting, and to the curved form of the flange. Each one weighs about 3,300 pounds, and takes 26 square-necked bolts, besides 18 feet of Tuck's packing. On completing each one, the pit was walled up with dry rubble and covered with timber, outside the city. Inside the city, the covering was arched in masonry and cement, and an iron manhole left in the crown, the manhole being large enough to pass the cleaner through.

The force employed to operate the cleaner consisted of a foreman, one mechanic, two watchers, six assistants and two express teams and drivers. The watchers walked the line on the cleaner being started, and had no difficulty in following the sound outside the city, but on coming inside the city limits, the noise of the traffic drowned the sound of the cleaner, and all that remained was to watch and wait for its arrival at the terminal hatch box. Outside the city, the grating sound as it moved along was so plain that it could be distinctly heard at a distance of 40 feet, although the

FIG. 2. IMPROVED SCRAPER USED IN 1898.



HATCH BOX.

pipes have from three to six feet of covering. The duty of the teams was to transport the cleaner and men back to the first hatch box for each successive run. Men were placed at flushing stations to operate the stop-cocks—two men at each. Their duties were also to assist in operating and closing the hatch boxes and placing the cleaner.

The cost of the work was as follows:

Furnishing and placing in position nine 24-inch and four 12-inch hatch boxes, being the number required on all three lines of pipe	$3,468.95
Proportionate cost of installation, chargeable to No. 2 main	$1,513.15
Cost of one 24-inch cleaner	40.00
Total cost of operating cleaner	274.42

The runs made by the cleaner through the different sections in No. 2 main numbered fifty-seven in all, and the whole distance travelled was 94.5 miles, as follows:

From Hatch Box.	To Hatch Box.	Number of Runs.	Distance in Miles Each Run.	Total Distance in Miles.
No. 1	No. 2	10	1.2	12.0
No. 1	No. 3	16	2.5	40.0
No. 4	No. 5	11	1.0	11.0
No. 2	No. 3	9	1.3	11.7
No. 3	No. 5	11	1.8	19.8

It will thus be seen that the cost of cutting this main, providing and placing five hatch boxes, quarrying stone and walling therewith the pits containing them, restoring the surface of the ground and making the cleaner, amounted to $1,553.15, or $361.20 per mile, and the operating expense of cleaning the main, which measures 4.3 miles, was $6.38 per mile of pipe cleaned.

DISCUSSION.

MR. DEXTER BRACKETT.

In connection with Mr. Murdoch's very interesting and instructive paper, a brief description of similar work done on the Boston Water Works in 1886 and 1887 may be of interest.

The pipes laid in Boston from 1848 to 1868 were uncoated, and the interior surface of the pipes is covered with a coating of tub-

ercles from $\frac{3}{8}$ inch to $1\frac{1}{4}$ inch in thickness. This coating, as proved by Mr. Murdoch's statistics, very seriously affects the delivering capacity of the pipes, and, in the case of the smaller sizes, renders them practically useless for fire supply.

The pipes cleaned in Boston were not the supply mains, but the distributing pipes in the streets, the sizes cleaned being 6 inches and 12 inches in diameter. In cleaning these pipes the conditions were somewhat different from those of Mr. Murdoch, whose work was done on a pipe of larger size, where there were probably few, if any, service pipe connections. As many of the service stop-cocks project into the pipes from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch, it was necessary to have the scraper arranged so as to pass by such obstructions, and at the same time remove the coating of tubercles. The machine, which was very successfully used, consisted of a flexible central shaft about three and one-half feet in length, composed of coiled steel springs connecting small castings, to which were hinged two sets of steel scrapers, arranged radially around the shaft about twelve inches apart. The scrapers were kept against the sides of the pipe by coiled springs, which permitted them to turn back so as to pass taps or other obstacles. Back of the scrapers were two rubber pistons placed about two feet apart so as to ensure a pressure on the machine when passing branches. The scraper was operated in a manner very similar to that used by Mr. Murdoch, except that no hatch boxes were placed in the mains. A section was cut out of the pipe long enough to receive the scraper, which was then inserted, and the joints made with lead in the ordinary manner, except that clamp sleeves were used so that the section could be again easily removed and the scraper inserted if desired. A similar piece was cut from the pipe at the other end of the main to be cleaned, and the scraper was forced through the pipe by the ordinary water pressure, which varied from 30 to 45 pounds.

As occupants of buildings on the line of the pipes were without water while the work of cleaning was in progress, and as it was not thought advisable to pass the scraper through valves, the pipes were cleaned in lengths averaging 1,000 feet. The scraper generally passed through this distance in from three to four minutes, or about as fast as a man would walk. In a few instances the scraper was stopped by obstructions in the pipe, the one causing

the most trouble being lead which had run into the pipe at a joint. The water issuing from the open end of the pipe was the color of ink for from five to ten minutes after the scraper had passed through, and it was permitted to run until it became clear, after which the section of pipe was replaced and the valves opened. Some difficulty was experienced from the stopping of service pipes and house plumbing by rust forced into the pipes by the pressure of the water following the scraper, but this difficulty could be generally overcome by applying a force pump to the house plumbing and forcing the obstructions back into the main.

By this method the tubercles were removed from 58,000 feet of 6-inch pipe at a cost of 14 cents per foot, and from 20,300 feet of 12-inch pipe at a cost of 20.6 cents per foot. These prices include 5 cents per foot royalty paid for the right to use the scraper.

As was the case at St. John, a great improvement was made in the delivering capacity of the pipes by the removal of the coating of tubercles. Experiments were made to determine the friction in the pipes both before and after cleaning under different rates of discharge. The discharge was measured by means of a Deacon meter, and the friction head from readings of Bourdon gauges attached to the fire hydrants. Very great accuracy was not expected in these experiments, but they show very well the great loss in discharging capacity, caused by the coating of tubercles and the gain from the cleaning. It will be noticed that the discharge of the 6-inch tuberculated pipes was from 25% to 35% of the quantity which a clean-coated pipe might be expected to deliver under the same head, and that the discharging capacity of the pipe was more than doubled by the removal of the tubercles.

TUBERCULATED PIPE, 38 YEARS OLD—LENGTH, 525 FEET; ORIGINAL DIAMETER, 6 INCHES.

Observed Head. Feet per 1,000.	Velocity. Feet per Second.	Observed Discharge. Gallons.	Value of c in formula $v = c\sqrt{RI}$.	Calculated discharge of clean pipe under same h'd Darcy's formula.
1.30	0.38	33.3	29.5	120
2.50	0.57	50.0	32.2	165
6.90	0.95	83.3	32.3	275
14.40	1.13	100.0	27.1	395
19.20	1.32	116.6	27.1	455
25.40	1.51	133.3	26.8	525
33.80	1.70	150.0	26.1	600

SAME PIPE, AFTER CLEANING. LENGTH, 525 FEET; ORIGINAL DIAMETER, 6 INS.

Observed head. Feet per 1,000.	Velocity. Feet per Second.	Observed Discharge. Gallons per Minute.	Value of c in formula $v = c\sqrt{R\,I}$.	Calculated discharge of clean pipe under same h'd Darcy's formula.
2.70	0.76	66.6	41.5	170
1.50	0.95	83.3	68.8	125
1.50	1.13	100.0	82.5	125
3.80	1.51	133.3	69.4	205
4.20	1.70	150.0	74.2	215
6.50	2.08	183.3	73.1	265
9.40	2.46	216.6	71.8	320