not to cut the ditches too deep where the gravel is low so that the berm will not be built up higher than the graveled part of the road.

On our reconstruction or reclaiming work the length of the road to be graded as a unit depends upon local conditions. Inasmuch as the roads while being graded are almost impassable, it is desirable to work the road in short sections so that traffic interference will be reduced to a minimum. A length of one mile is recommended as a grading unit. On purely ditch work the roads are not torn up so much and we do our work in longer sections, sometimes as much as five miles.

Equipment for this work should be of the heaviest type of 12-ft. grader with special back-sloper not more than 2 feet in length, and not less than a 10-ton or "sixty" crawler type tractor. It is necessary that the equipment be operated efficiently. A good grader operator is a skilled mechanic and not an unskilled laborer. An operator always should be chosen because of his skill in operating grader machinery.

The grading crew consists of two machinery operators who receive a total of $9.00 per day and the assistant superintendent at $3.00 per day as helper to locate drains and remove mail boxes and any other obstructions. His wages are not included in the cost, as this labor is of a miscellaneous nature.

We kept an accurate record of the cost of the work in 1925 for labor, gas and oil, not considering depreciation or interest. Our cost per mile for reclaiming the 18¾ miles was from $43.57 to $75.00 per mile, or an average of $54.00. On drainage alone for 162¾ miles the average cost was $8.60 per mile of road.

MAINTENANCE OF GRAVEL STREETS

By E. D. Canatsey,
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The maintenance of gravel streets embodies a number of elements and conditions not encountered in the regular maintenance routine on county and state gravel roads.

The greatest difference is due to the use of road oil on streets. Instead of a thin carpet of loose gravel to work with the ordinary maintenance tools, we have a smooth, hard sur-

face. Instead of the "wash-board" surface to contend with, in dry, hot weather the oiled streets break in small, round, basin-shaped holes that quickly grow larger and more numerous. We call them pot holes. This evil of the oiled street is by far the most difficult problem to overcome.

Midwinter is the proper time to begin preparing the streets for oil. We will assume that the road bed and curb ditches have been properly constructed and maintained. While the streets are frozen solid is the best time to apply a very thin layer of good gravel. Apply it over the sections that show weakness of surface, that is where the pot holes are most numerous. This gravel should contain a minimum of sand and should all pass a one-inch screen, or better still the ¾-inch screen. The metal added at this time seems to stick where applied, and as the frost leaves the road bed the new gravel bonds and keys itself into the old surface. The use of the drag during the freezing and thawing weather over surfaces thus treated will obliterate the pot holes.

We usually apply the oil in the latter part of May after the heavy spring rains. The streets should be in first class condition before the oil is applied. A slight scarifying is best at this time. Formerly in Martinsville this scarifying was done with a specially constructed street harrow. This tool will scarify an inch or two of the old oiled surface, then with a grader a uniform surface can be made. The light scarifying allows the hot oil to penetrate faster and deeper than otherwise. The oil should NOT be applied when the ground is too cold or when there is much dust.

We apply the oil with a pressure tank distributor which has an inside burner. The temperature of the oil while being applied runs from 130 to 180 degrees F. Steam is applied to the tank car about six hours before the oil is pumped into the distributing tank.

We usually oil every other street, say east and west, then every other street north and south. About a week or ten days later the remaining streets are oiled. This allows traffic to avoid the freshly oiled streets to a certain extent.

An experiment was tried two years ago on four blocks where traffic was heaviest. Following the oil tank, torpedo sand (i. e., sand that passed the ¼-inch and is retained on a ⅛-inch screen) was spread on the hot oil, just enough to kill the flow and thicken the oil on the surface. This required about 10 cu. yds. per block, the streets being 40 feet wide. This showed good results, the oil was not tracked away much and a surface was obtained that was smooth and lasting. This torpedo sand is obtained from a local gravel plant

and is a by-product in getting out concrete material for the state.

New gravel streets usually take oil nicely the second year and can be easily maintained. With the older streets it is a different proposition. In Martinsville the oil used always runs from 50% to 70% asphalt. With the hot, dry weather and heavy traffic the aforesaid pot holes begin to show in all city gravel streets. It is useless to attempt to fill these holes with fresh gravel, as this seems to accelerate the grinding out of the holes. Light scarifying is necessary. The street harrow and horse-drawn grader is too slow and expensive.

Power Grader

The power grader with scarifier attached is a very successful tool. The machine used in our city has a ten-foot blade with the scarifier just ahead of the blade. To do light scarifying, use all eight of the teeth. If deep scarifying is required use only four teeth. The idea in scarifying the oiled street is to get enough of the oiled gravel to fill the holes. After scarifying, the blade is set at a slight angle to cast the material from the center. You will be surprised at the amount of black material the blade will gather after the light scarifying. This material will stay in the holes. The reason for setting the blade to cast outward is to flatten the crown. Most of our streets have too much crown.

The great advantage of the one-man, power grader can easily be seen. When scarifying or grading, the operator can stop at any time and back up as many times as necessary to fix a particularly bad spot in the street. By careful handling, the streets can be lightly planed with the blade and enough material carried along to fill all depressions. It is impossible to cut very deep without the danger of rolling up the entire oiled mat and spoiling the surface of the street.

When a street becomes extremely rough, it is always best to scarify the oiled surface thoroughly, then level up with the blade. The surface in such cases should be scarified to a depth corresponding with the bottoms of the deepest holes. The 1800-lb. dual wheels roll the surface down pretty well and the street soon looks as black as before. When planing the streets lightly to keep small holes filled, I prefer working from the center toward the edges, then if any excess material is left, work this back to the quarters, as this is the section that usually gets most of the wear and breaks first.

Reshaping Streets

Sometimes we have sections of streets that need re-forming entirely. In one case I have in mind the street was arched up in the middle of the block, at the alley, about 18 inches too high. We scarified the gravel about six inches deep, then with the blade this loose material was moved to the curb in a narrow ridge. This operation was repeated over and over until all of the gravel was transferred to the curbs. Then the sub-grade was scarified and ridged with the blade in the center of the street until the proper grade for the sub-grade was reached. This loose sub-grade material at the center was hauled away and the gravel was replaced with the power grader in even layers. When the job was completed the street was rolled down and smoothed by the big dual wheels of the grader. In this particular case the gravel was removed from one block of the street, about 60 cu. yds. of sub-grade material hauled away, and the gravel replaced in 15 hours. The force employed included one man with the power grader, two teams with drivers and two extra men. This piece of street was oiled about two weeks later and remained in good shape throughout the summer.

One word in regard to oiling, as there are some who oppose street oiling. There are two points to be mentioned on this subject that prove the value of street oiling, aside from the feature of preventing dust. The first is the saving in the wear on the surface. Two years ago we left gaps unoiled about 6 feet wide across the streets at sidewalk crossings. This was to give the pedestrians a place to cross without walking in the fresh oil. These unoiled strips in some cases wore down as much as 4 inches lower than the oiled sections adjoining. This gives some idea of the amount of road metal saved on our 22 miles of graveled streets in one year.

The other point is in the matter of water saved. Just before oiling, in late spring, water is used in great waste by the people living on graveled streets to keep down dust. The water superintendent's daily pumpage report shows a marked difference in water used before and after oiling. Either of these two points shows enough gained to prove oiling worth while.