We Cut The Cost Of Reconstruction By 50% And Reduced Maintenance Work

Revisiting a gravel road in Temple, New Hampshire

Soon after moving to New Hampshire I began to hear statements that went something like this, "In school I was taught that there were only four seasons; winter, spring, summer, and fall. Now that I've worked on New Hampshire roads for a while, I can assure you that there is one more season to reckon with, Mud Season." This season is all too real for road agents who often fight a losing battle to help the motorist on springtime gravel roads.

Last fall the town of Temple tried out a new approach to this old and costly problem. Road agent Tim Fiske, working with the Technology Transfer Center and the Road Agent Association, installed a non-woven geotextile fabric on a gravel road -- the towns people think of this road as a typical springtime mud hole. Tim invited us back to Temple this Spring to see the results of our labor. We were all very impressed!

On the first section of road, where no work was done, the mud was as expected, barely passable in a four-by-four. The second section of the road was reconstructed using conventional means. We found it to be rutted and potholed keeping traffic to about 5 mph. What happened to the section with fabric and only 4-inches of gravel? See the photos on p.4.

Don’t Forget About Frost Heaves

Design protection into your roads

Every year during the later part of the winter, roadways in the northern United States and in Canada put our automobile suspensions to the test. As spring approaches, the conditions of the roads worsen, and while students enjoy spring break, the roads experience what is known as spring breakup. Roadways in New Hampshire are posted with frost heave signs to warn motorists of roller coaster rides ahead. We know too well what effects frost heave has on roadways, but how does it occur? And, more importantly, how can it be prevented or at least minimized?

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Prior to the 1920s, frost heave used to be considered such a natural phenomenon that it was thought nothing could be done about it. In fact, little had to be done since most roads were left snow covered and automobiles and sleighs were allowed to ride and slide along. However, as automobiles became more prominent and roadways became busier, snow removal was required for safer and faster travel. During these earlier times, building and repair efforts had been focused on pavement improvements, however, with little attention given to the roadway base. Beginning in the 1920s, however, research was initiated to help understand the frost heave phenomenon. Why was it that for some roadway sections, the heave greatly surpassed the simple expansion that would result from the change from water to ice? Upon freezing, water increases in volume by about 9 percent. If a saturated soil composed of one half solid soil particles and one half water were to freeze, the expected expansion from the freezing of water would be on the order of 4.5 percent. This is a far cry from field observations of more than 65 percent expansion. How can this be? Research conducted in the 20s and the 30s by A. Casagrande on roadway sections in New Hampshire and by others throughout the country helped explain this phenomenon.

From controlled laboratory experiments and from test pits in the field, it was observed that ice lenses were responsible for the heaving of pavements. As soil is frozen from the surface downward, ice crystals are formed and eventually grow into ice lenses. These ice lenses are an accumulation of ice crystals and occur when water is supplied to the ice formations from either outside sources such as rain, melting snow, and leaky pipes; or from inside sources such as the ground water table and capillary rise. Capillary rise may be defined as the height water will rise through the soil above the water table location. The finer the pores (the space between the particles) in the soil, the higher the rise. For clays and silts the rise may be as much as 30 feet or more; for gravel, only a fraction of an inch. The important factor in capillary rise is not the size of the soil particles but rather the size of the pores. However, when soils are composed of fine particles, the pores are smaller than for soils made up of larger particles only. Therefore, particle size is somewhat related to void space. The size of the pores is also important since the smaller the pores, the lower the freezing point of the water in the pores. Consequently, large pores will freeze first.

A certain minimum of fines in the soil is necessary for frost heaving. For soils which are not very uniform (contain particles of various sizes), a minimum amount of 3 percent of material less than 0.02 mm by weight will favor frost heaving. For very uniform soils (all particles are the same size), a minimum of approximately 10 percent is required. The size 0.02 mm is quite small considering that clays and silts are materials which pass a sieve with a mesh size equivalent to 0.075 mm.

Even if the water table is several feet below the roadway, water may migrate to the roadway base and feed the ice lenses. If the underlying soil is a clay, which has low permeability, movement of water is very slow and may not provide a lot of moisture to supply the ice lenses. The worst soil for frost heave susceptibility is silt since its pores are very small – thus favoring capillary rise - yet its permeability is high enough to feed ice lenses as necessary. From field observations it was found that the frost heave was basically equal to the sum of the thickness of all ice lenses. The ice lenses primarily expand vertically since this is the path of least resistance, however, they will also grow horizontally to form lenses through soil cracks and fissures.

Another important factor in the formation of ice lenses and, therefore, frost heaving, is the rate at which the temperature changes through the soil. If winter starts very abruptly with severe cold snaps, then only the pores in the soil will freeze and ice lens formation will be almost non-existent. On the other hand, if the temperature is dropped slowly with cycles of freezing and thawing, then the formation of ice lenses and, consequently, frost heaving is at its best. After the first freeze the soil is somewhat broken up from the initial expansion and thus more permeable. With successive freeze-thaw cycles, water is fed through cracks and fissures and expansion occurs easily.

Now that we understand what causes frost heave, let’s summarize before looking at what can be done about it. All of the following components are necessary to cause frost heave:

1. Supply of water from inside or outside sources;
2. Initial soil saturation from capillarity;
3. Gradual decrease in temperature;
4. Minimum amount of soil particles less than 0.02 mm.

Figure 1 shows a cross-section of a sample of soil prior to freezing and after freezing. The final heave is basically equal to the sum of the various ice lenses. This phenomenon is also shown with some field measurements conducted by Casagrande. Figure 2 illustrates the relationships between cumulative temperatures, frost heave and frost penetration. The top of the figure represents the cumulative temperatures for the winter months in which degrees below 32°F are positive and degrees above 32°F are negative. As expected, the cumulative sum increases as winter progresses and then
decreases as spring approaches. Below the temperature diagram, heaving of the roadway slab is shown. The same trend as the cumulative temperature diagram may be observed with maximum heaving corresponding to maximum cumulative temperatures. Most interesting of all is the lower diagram showing the extent of the depth of frost below the top of the slab. It is essentially an inverted mirror image of the slab heaving. As frost penetrates the ground, ice lenses are formed resulting in heaving of the surface. This increases as long as the cumulative temperatures increase.

If a roadway subgrade has all of the four requirements for frost heaving, then spring time is usually disastrous. As the ground melts from the top down, water accumulates underneath the wearing course. Since this water is usually trapped between frozen soils, frost boils occur. That is, the soil will lose some of its compaction; and, because of its supersaturated state it will lose some of its bearing capacity. Consequently, the wearing surface will yield and fail under heavy traffic loads.

What are the potential solutions to frost heave problems? If any one of the four requirements for frost heave is not satisfied then heaving is not likely to occur. Unfortunately for roads in current use, partial or complete replacement is often the only effective solution. The subgrade should be a gravel base of thickness appropriate to the underlying soils; essentially, if the underlying soils are not free draining materials, then the gravel base should be extended to the full depth of frost penetration. Ideally, the gravel should extend to the bottom of the potential frost zone. Soil investigations should always be carried out to evaluate the underlying soil conditions. Also, the gravel should be over the total width of the road so that water entering the base may be expelled freely through the ditches.

The drainage of the subbase is most important. The water table should be kept well below the base and the water from capillary rise should be intercepted to minimize and prevent ice lens formation. Soils for subgrades with less than 3 percent of particles smaller than 0.02 mm should not favor capillary rise. Some mixing of the base material with underlying soils may occur during spring melt and high water season. This could be prevented by the installation of a geotextile or sand liner below the gravel. This would act as a barrier to the fines. Also, some methods of soil treatment are available which reduce the freezing point and reduce the soil permeability and capillary rise. These techniques of using admixtures, however, may be rather expensive.

Rapid snow removal during winter is also very important, since snow is a good insulator. The faster the ground fully freezes, the less frost heave will result. Pavements are usually good conductors and will help accelerate the freezing process. Finally, frost heave in itself is not usually a real problem if it is uniform, it is the differential movements which always distress our structures. If the roadway was uniformly lifted by frost heave, cracking of the pavement would be less likely.

References:

The above article was written for Road Business by Jean Benoit, Ph.D. Dr. Benoit is an associate professor of civil engineering at the University of New Hampshire specializing in geotechnical engineering.

Figure 2: Curves showing the relation of cumulative temperature, frost heaving, and frost penetration (Reproduced from Dr. A. Casagrande's discussion of A New Theory of Frost Heaving, Proceedings of The Highway Research Board, Part I, pp. 168-172, 1931).
a gravel road in Temple...
continued from p. 1

We could hardly believe it ourselves, but the section of road where we used the geotextile fabric and only 4 inches of crushed gravel on top was as smooth as the day we installed it. How does something like this work? The principle behind the design is basic, keep the gravel separate from the mud and muck. Think of it this way: What do you get when you mix a bucket of gravel and a bucket of mud? ...a bigger bucket of mud! By installing a geotextile fabric we were able to keep the gravel on the top of the road and stop it from penetrating and mixing with the base.

Tim Fiske summed it up best when he said, "by using this fabric I can cut my construction costs in half and substantially reduce the tremendous amount of maintenance that goes into a gravel road." There have been claims that a gravel road built in this manner will last for seven to eight years with little to no maintenance. We'll keep you posted as we continue to follow this test section.

All of these pictures are from the same "boggy" gravel road in Temple, New Hampshire. ABOVE LEFT: Where we did not do anything to the road we ended up with a typical New Hampshire spring mud hole. BOTTOM LEFT: Where we reconstructed the road using conventional means, severe rutting and potholing occurred. BOTTOM RIGHT: When a geotextile fabric was installed with 4-inches of crushed gravel laid on top, the road remained stable and the surface remained as smooth as the day it was laid out.
Road Graders - Purchase Or Contract Out?

Towns might want to consider the cost of owning a grader to the cost of contracting out

Road graders are expensive to buy and expensive to operate and maintain. Towns might consider comparing those ownership costs with the cost of contracting with someone else to maintain town roads. Town officials could use the following procedure to compare costs.

First, determine the economic life of the machine. Economic life relates to the total stream of costs associated with the unit through time. Since eventually we'll have to break down costs to an hourly basis, it's important to determine the number of hours the road grader is used in a normal year. For purposes of this discussion we'll use 1,000 hours per year.

Determine the annual costs for the following seven items and divide by 1,000 to obtain a per-hour cost. Add each of the per-hour costs to obtain a total per-hour cost. The total per-hour costs can then be compared to the per-hour costs of the contractor’s service.

1. Depreciation: Using the straight-line method we can calculate as follows, assuming 15 years estimated life.

\[
\text{Cost} \times \frac{\text{salvage life}}{\text{estimated life}} = \frac{\text{annual}}{15 \text{ years (estimated life)}} = \text{depreciation}
\]

2. Fuel, oil, and grease: The better the town records are, the easier it is to come up with a cost for this item.

3. Maintenance and repair: Again, good records help. Some include major repairs here but others say that overhauls, for example, should be considered a capital expenditure. Include here the cost of parts and any charges to repair, replacement parts and the like.

4. Interest costs: If the town has accumulated sufficient cash in an equipment fund, do not include this item as a cost. If the new grader would be purchased using borrowed money, then determine interest costs.

5. Insurance: Records over the life of the present vehicle are helpful plus, of course, finding out from the town insurer what the premium would be on a new piece of equipment.

6. Wages and fringe benefits: Calculate the wages and fringe benefits costs attributed to operation and maintenance.

7. Overhead costs: Overhead costs are estimated to run between 9% and 12%. It is possible to come up with a more exact figure, but a good rule of thumb is to use 10%.

In addition to economic life considerations, towns should weigh other matters in their deliberations. For example:

1. Would the town’s liability be more or less if road work were contracted out?

2. Would the contracting service be available at any time for emergencies or unforeseen situations?

3. Are the contractor’s operators as qualified as the town’s? Would the same operator maintain the roads or would a number of operators do the work over a year’s time?

4. What degree of supervision would be required in either case?

5. Would a contract arrangement free a town employee to do other work?

6. If repair and maintenance of a town-owned grader has been troublesome, would a contract situation relieve the town of those headaches?

7. Consider downtime costs. A contractor may have a second machine more readily available to perform needed work.

8. There’s a certain pride of ownership (a morale factor) accompanying ownership, this should be considered.

Grab Your Coffee Can: Figure Lost Gravel Cost

Question: How would you like to save $50,000 per motor grader operator per year?

Answer: Train your operators to properly pick up windrows of gravel.

Some do-it-yourself coffee can research by the Nebraska T² Center’s Ed Wootton led to a $50,000 conclusion.

As he watched motor grader operators at work, Ed wondered about the cost of the gravel lost off the toe of moldboards as windrows were picked up. So he measured one foot in the ditch and put all the spilled gravel he found in that area in a coffee can. When he weighed the can he found he had two pounds of gravel (which he says is a very minimal loss - often it is much more).

At the rate of 2 pounds per foot, the gravel loss is 10,560 pounds in one mile. If an operator grades 20 miles in a day, he loses 105.6 tons. At $3.65 per ton, the dollar loss is $385.44 per day.

If the operator works 22 days per month and devotes half of his time to this job during the year, the total dollar amount of lost gravel is $50,878 - two and a half times the salary of an average operator.

The main cause of this loss, Ed says, is improper blade angle.

"We know there are other factors in the loss, such as wind and water loss and heavy traffic," Ed says, "but the chief cause is improper procedures."

The spilled gravel is partially retrievable by pulling up the slopes, but that is time-consuming and costly, and "you don't get it all."

Here is Ed’s formula, if you want to measure your own losses:

1. Weigh gravel collected from one foot of ditch
2. x 5,280 (feet per mile).
3. x number of miles per day per machine.
4. x number of days worked per year.
5. x number of machines used.
6. + by 2000 (to get number of tons).
7. x cost per ton of gravel.

Blading Aggregate Surfaces

Surface Material

The surface of unpaved roads is composed of a mixture of coarse aggregates and fine material (fines). The fines prevent voids from occurring in aggregate mixtures. Fines are like cement holding the aggregate together. Dust indicates that fines are blowing away. Insufficient fine material prevents the formation of a hard-wearing surface.

Smoothing

- Road surfaces are smoothed by dragging. Dragging disturbs the road surface as little as possible.

![Tilt moldboard to get dragging action](image)

- Smoothing is usually performed when aggregates and fines are moist. The technique may be used in dry weather to remove excess loose aggregate from the road surface. Moisten the aggregate prior to blading a dry road.
- Using the curve of the grader’s moldboard to get a dragging or rolling action helps compact the road surface as it is bladed.
- Dragging speed depends on the grader, tire pressure and road surface condition. Excess speed causes the grader to bounce, making satisfactory results impossible to achieve. Normally, three miles per hour in second gear is advised.

How to Smooth the Road Surface

- Make sure the grade blade is in good condition.
- Shift moldboard so end of blade is placed at road edge and beginning of shoulder.
- Tilt moldboard forward for a dragging, rather than cutting, action.
- Angle moldboard about 30° to 45° and spread loose material toward center of road.
- Lean or tilt front wheels 10° to 15° in direction the aggregate is rolling across blade.

![Tilt front wheels slightly](image)

- To prevent aggregate from drifting onto ends of bridges, culverts, intersections and railroad crossings, periodically blade the road surface against traffic flow.
- Keep a shovel handy. Stop to repair poor surface drainage conditions, holes or rutted areas.
- Never leave a windrow of aggregate at the edge of the road. It will prevent water from draining and may create a false ditch, reducing the road width.

When Blading Straight Sections-Maintain a Crown

- Raise the blade-end nearest the center of the road so that it is higher than the other end.
- Use crown gauge and set the blade to obtain a 1/2" per foot cross-slope. A crown 1/2" per foot, on a road with surface width of 20 feet, is a crown five inches high.

![Crown gauge mounted on control panel](image)

When Blading Curved Roads-Maintain Super-elevation

- Use crown gauge to set and adjust the blade correctly.
- About 50 to 100 feet before the curve, eliminate surface crown by gradually raising the blade-end nearest the outside curve edge.
- At the point where the curve begins, the outside curve edge should be at the same height above the center of the road as the inside curve edge is below center.
- Blade the outside edge of the curve higher than the inside edge: Superelevate or bank the road. Do not blade a crown on the curved part of the road.
- Slope shoulder on the superelevated part of the road downward from the road edge to ditch.
- Gradually change the road surface back from superelevation to crown.

Reshaping

- Weather, traffic and insufficient maintenance can scatter aggregates, flatten crowns, make potholes and deep ruts, and produce a washboard-like surface. These conditions cannot be corrected by smoothing the surface — the aggregate base must be reshaped.
Reshaping remixes the aggregate base to obtain a correct blend of fines and aggregates. When remixing, additional aggregates and fines may be needed on shoulders and in rough or washed-out places.

- Reshaping cuts away washboard ridges and breaks up potholes
- After the aggregate base is remixed, it is bladed to obtain a smooth road surface and a proper crown. Traffic will compact the base and form a smooth wearing surface.
- As with smoothing, reshaping is performed when the aggregate is moist. If reshaping is done in dry weather, water must be added to moisten the aggregate.

Scarifier helps break crust

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Run-off and Erosion Control Guidelines for Highway Crew Leaders

Eroded ditch banks and clogged streams and culverts often reduce the effective life of a road

During highway construction and maintenance activities, greater attention can be given to environmental and long-term cost considerations. Accelerated run-off and soil erosion can cause pollution of land and water. Private property values and citizens’ rights are often adversely affected.

Failure to practice conservation increases maintenance costs. Digging and/or cleaning road ditches without conservation considerations leads to accelerated soil erosion. Eroded ditch banks and clogged streams and culverts often reduce the effective life of road improvements.

The Resource Conservation and Development Area of New Hampshire and the Carroll County Conservation District are seeking input from state and local road crews, contractors, and town officials on the need for and use of a pocket-sized handbook, Run-off and Erosion Control Guidelines for Highway Crew Leaders. Our objective is to develop a handbook that addresses the needs of the people who perform roadside maintenance and construction.

The survey attached to this newsletter has been designed to enable you to tell us if this type of booklet could be helpful and what information you feel should be included. Please fill out the survey, detach it, fold it with the address on the outside, place a stamp on it, and put it in the mail.

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How To Reshape Aggregate Road Surfaces and Shoulders

- Check to see if more aggregate or fines need to be added to surface and shoulders, particularly in rough or washed-out places.
- Tilt moldboard so that it is in cutting position.
- Angle moldboard at about 30° to 45°. Using a mixing action, move and roll aggregate toward center of road.
- Lean or tilt front wheels 10° to 15° from the vertical into direction aggregate is rolling across blade.
- Blade with enough pressure to cut shoulders and washboard ridges.
- Scarifying, when necessary, should go as deep as the average pothole or washboard—usually two to three inches.
- Watch blade action closely. Adjust the controls as needed for good cutting and mixing action.
- Check to see if more passes in the same direction are needed to cut to the bottom of potholes and ridges.
- Windrow remixed aggregate to center of road.
- Distribute aggregate evenly over roadway edges and shoulders.
- Blade material into a crown.
- Blade shoulder so that slope to the ditch is at least equal to that of the road.

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Do not scrape aggregate off a hilltop

Do not pile loose aggregate in a valley

Adapted from: Blading Aggregate Surfaces, National Association of County Engineers, 1988.
Who Uses Their Snowplow Hitch In The Summer?

The pickup mounted grader/rake system -- keeping small jobs simple

Russ Lanoie of Conway, NH has spent a long time thinking how to setup a piece of equipment which could simplify general grading and site cleanup by being easily transportable and ready to work at a moments notice. He wanted something that could keep small jobs simple by eliminating the need to trailer a piece of construction equipment to work a site. Also, Russ wanted to use his existing equipment, if possible, to minimize costs.

The answer to Russ's problem was to specially mount a rake to the front of his pickup. "After all," says Russ, "if the pickup could plow snow, it should be able to handle a rake."

The pickup mounted rake has worked extremely well for Russ and he now has several rakes in service for loggers and road crews. The town of Conway owns one of the earlier model rakes and according to Bud French, town highway foreman (447-6661), the pickup mounted grader/rake "is a great piece of equipment." Recently, Russ announced the introduction of an adapter kit to fit the York Model RE 8' rake which he has found to be the rake most suited for pickup mounting. With his adapter and the standard York rake (originally designed for rear mounted tractor use) almost any 3/4 or one ton snowplow equipped truck can now be easily adapted for year round purposes.

According to Russ, some of the benefits of the new rake system are as follows:

1. Mounts on existing snowplow hardware, using all components except plow blade -- eliminates purchasing mounting and control hardware reducing costs to less than 1/4 of the cost for a rear truck mounted rake system and to about 1/2 the cost of a trailing rake.

2. Mounts in front of truck -- it can be easily seen by the operator and it allows debris removal without the operating vehicle having to drive over debris. Also, the debris can be pushed off the work area without the truck leaving the work surface.

3. Total operation from drivers seat -- using standard snowplow controls, the system allows the operator to remain in the truck resulting in faster operation than trailing rakes. Also, the system assists with worker productivity by enhancing driver comfort in foul weather.

4. Is carried by operating vehicle when not in use -- allows for faster transport to and from work sites and simplifying turning around in confined areas.

5. Can be power angled from side to side -- using snowplow quick switch cylinders provides the operator with flexibility in the placement of windrow or debris.

6. Can be used to plow heavy wet snow in the early and latter parts of the season -- prevents damage to soft road surfaces.

7. Is easier on the truck than a snowplow -- this is true in most cases because the rake is lighter and times spring easily over obstructions.

8. Components are standard -- all of the components that are subject to wear are available through either the snowplow or rake dealer.

9. Exclusive feathering action permits simple tine depth setting from the operators seat -- provides control of weight on tines to create a unique grading action for varying conditions and materials. Also, makes it possible to finely spread material at the end of a pass rather than leaving a pile like a drag rake.

"Other things that make this system attractive," claims Russ, "are that the truck can still be used for other functions at the same time -- including pulling a trailing rake or carrying a load. It has proven very useful for emergency repairs by leveling tailgate spread loads in the place of a motor grader or loader. Finally, because the rake system is so simple to use, almost anyone who is familiar with snow removal operations will readily adapt to this new grader/rake system."

If you are interested in more information about the pickup mounted grader/rake system, Russ Lanoie can be reached by calling 447-5266 or by writing to: Alternative Systems Design/Construction, Conway, NH 03818. -- Do you have an invention or new approach to road maintenance and construction? We would like to hear from you, just call the Technology Transfer Center at 1-800-423-0060. --
Daily Maintenance of Motor Graders

Pre-Start Check

Tires

☐ Check air pressure. (Note: Maintaining correct pressure will ensure maximum service life.)
☐ Look for excessive wear, uneven wear, cuts, sidewall damage and loose or broken lug nuts.
☐ If fitted with directional tread ties, be sure they are mounted correctly. Stand at front of motor grader. The four rear tires should be mounted with maximum traction when blading. Tires on front steering axle should be mounted with the point of the tread pointing upward. This reduces wear and provides better steering ability.
☐ Report any problems to supervisor.

Moldboard

☐ Check for loose nuts and bolts.
☐ Inspect cutting edge and end bits for wear or cracks.
☐ Report worn cutting edge and end bits to supervisor so arrangements for reversal or replacement of blade can be made.
☐ Check blade linkage for damage and for loose or missing bolts.

Scarifier

☐ Inspect for broken or worn teeth.
☐ Follow agency guidelines for replacement of broken or worn teeth.

Circle (Rotation) Ring

☐ Inspect circle top face and side shift bar.
☐ Clean daily with diesel fuel and lubricate according to manufacturer's specifications if working under extremely dirty conditions.

Fluid Leaks

☐ Look for wet spots or stains on the ground under the equipment.
☐ Look above spots to locate source of leak.
☐ Look at or feel inside of wheels for brake fluid leaks.
☐ Inspect the circle attachment, scarifier, and steering cylinders for hydraulic leaks. (Hydraulic leaks are most often found at cylinder rod seals or hose connections.)
☐ Examine hydraulic hoses for cracks, kinks, and pinched areas.
☐ Look for oil and fuel leaks around filter bowl seals and hose connections. (Feel bottom of oil and fuel filter bowls for leaks.)
☐ Examine radiator hose, hose connections, and radiator for damage that could cause leaks.

Fluid Levels

Caution: The cooling system operates under pressure which is controlled by the radiator cap. It is dangerous to remove cap while system is hot. If removing cap is absolutely necessary, thoroughly cover it with a cloth or other protective means. Turn cap slowly to first stop and allow pressure to escape before removing cap completely.

☐ Check radiator coolant level. (Coolant should be at level required for the particular piece of equipment as specified by equipment manufacturer or supervisor.)
☐ Check engine oil level and cleanliness. (If oil is below proper level on dipstick, do not run the engine until the proper type and amount of oil is added. If oil appears dirty, arrange for servicing through supervisor.)
☐ Check hydraulic fluid level. (Indicator can be either a dipstick or a site gauge. (If fluid is low, add proper type and amount.)

Air Filter System

Note: Never operate the engine without the air filter element in place.

☐ Inspect dry type cleaner.
☐ Check indicator gauge that warns when to clean or replace filter.
☐ If replacement is necessary, use a new element or a serviced element that has been vacuum cleaned and inspected by specialized shop equipment.
☐ If replacement element is not available, remove element and tap on palm of hand. (Do not pound it on a hard surface as this could damage element.)
☐ If tapping does not remove dust, use compressed air if available. Direct air up and down the pleats. Blow from the inside to the outside.
☐ Check to see if element is clean by placing a light bulb inside and viewing the light's penetration through the pleated paper of the element. If light bulb is not available, hold element toward the sun and view the penetration of sunlight passing through pleated paper from the outside of the element to the inside.
☐ Reinstall element making sure the housing is correctly sealed. (This ensures proper air filtration through system.)

Caution: A plastic precleaner can be easily damaged by hitting it against a hard surface when trying to clean it.

☐ Inspect the precleaner bowl if so equipped, (Daily cleaning of precleaner reduces clogging of air cleaner element.)
☐ Empty accumulated material.
☐ Wipe bowl clean.

continued on p. 10
Warm-Up Check

Before Starting Engine

- Verify that all personnel are clear of equipment.
- Ensure that all attachments are grounded.
- Check that all control levers are in the neutral position.
- Make sure that parking brake is engaged.

Checking the Engine

- Start the engine.
- Allow engine to warm up for five to ten minutes even in hot weather. (This allows the oil pressure to build up and lubricate all moving engine parts. The engine reaches its operating temperature and the coolant begins to circulate.)
- If equipment uses air pressure, this warm-up allows the air compressor to build pressure in the air tank.
- Listen to the engine. (If anything unusual is heard, shut the equipment down and notify supervisor.)
- Check the panel gauges or indicator lights to be sure they are registering in the normal range. (Gauges should approach normal range as engine warms up.) Gauges include: ammeter, oil pressure, fuel, temperature, air pressure (if applicable), and any additional gauges.

Hydraulic Attachments

Caution: Before performing these checks, be sure all personnel are still a safe distance from the equipment.

- Lift moldboard. (Does it lift smoothly from the ground position?)
- Check circle rotation by rotating the moldboard through the circle (toothed ring controls blade angle.)
- Check the blade side shift (the movement to right or left).
- Check blade tilt (the forward lean or pitch of the blade).
- Lift the scarifier. (Does it lift smoothly?)
- Do all control levers function properly?

Engine Hour Meter

- Read the hour meter and record the number of hours. (Hour meter records the number of hours that equipment has worked. The number of hours registered determines when equipment is due for periodic preventive maintenance.)

Steering

- Check steering. (Look for a smooth, even response when control is moved.)
Brakes

☐ Release parking brake and put motor grader in motion.
☐ Apply the foot brake. (Brakes should feel solid.)
☐ If brakes do not hold or if they need to be pumped, shut down the equipment and notify supervisor.

Backup Alarm

☐ After warm-up, place transmission in reverse to check operation of backup alarm (if so equipped).

Daily Operating Check

Noises

☐ Listen for unusual engine and equipment noises. (Unusual noises may indicate a component failure.)

Gauges

☐ Check gauges during operation since they will indicate any changes in operation. (If any gauge reads in the danger zone, shut down, inspect system, and notify supervisor.)

Changes

☐ Report any changes in performance to supervisor.

Shutdown Check

Refueling

Caution: Do not smoke or have an open flame in area.

☐ Be sure all fueling equipment is clean to prevent contaminant from entering fuel tank.
☐ Fill fuel tank to minimize water condensation between uses.

Cleaning Equipment

☐ Clean daily build-up of dirt or materials off the equipment.

Parking

☐ Park on a level surface if possible.
☐ Set the parking brake.
☐ Lower all hydraulic attachment until their full weight rests on ground. (This secures equipment and prevents injuries to anyone tampering with equipment while it is parked.)

Engine Cool Down

☐ Allow engine to idle for five minutes before shutting down. (This reduces pressure in the hydraulic system that could cause leaks or damage to seals or hoses.)
☐ Work levers and steering wheel to relieve additional hydraulic pressure.
☐ After engine has cooled down, turn key to “off” position and remove from switch.

Hour Meter Readings

☐ Record hour meter reading. Check against time recorded at startup (this check determines if meter is working properly).

Lubrication

Follow manufacturer’s guidelines for proper lubrication procedures. Proper lubrication will extend the life of the equipment.

☐ Use a grease gun to lubricate mechanical joints. (Marking lubrication points makes them easier to identify.)
☐ Lubricate water pump shaft grease fitting if so equipped.
☐ Daily lubrication of moldboard lifts and linkage and steering points on the front end is required when grader is in use.

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We Need Your Input

Connecticut's T² Center is developing a common sense easy to use Local Roads Superintendent's Handbook for the first-line road supervisor.

To make the handbook a practical and effective resource, the authors need real life examples of human relations experiences and how they were resolved. Possible situations could relate to: employee use of drugs and alcohol, discrimination, employee complaints and discipline, performance evaluations, employee motivation, handling public complaints, improving productivity, how to hire good employees, etc. Send your experiences to:

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About This Publication

Road Business is a local roads Technical Newsletter. It is written for New Hampshire's town and city employees who are responsible for planning and managing low volume roads. Send comments, questions, or suggestions to:

Technology Transfer Center
University of New Hampshire
Department of Civil Engineering
Durham, NH 03824

The Idea Store

Pennsylvania has recently received a grant from FHWA to produce ten videos of innovative ideas discovered by municipal workers. These tapes will be distributed nationwide. We need your ideas!

For each idea we need four things:

1. Who - we would like to identify the author and give him or her their own copy of the tape.

2. What - send us pictures, videos, slides, tapes, or whatever is needed to "see" the idea.

3. Why - what operation was modified and why was the modification done.

4. How - send in the instructions of how to accomplish the idea, a step-by-step procedure.

Send your ideas to:

Catherine Swatek
PENNDOT, Research & Special Studies
905 Transportation & Safety Building
Harrisburg, PA 17120
Phone: 717-787-6567

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