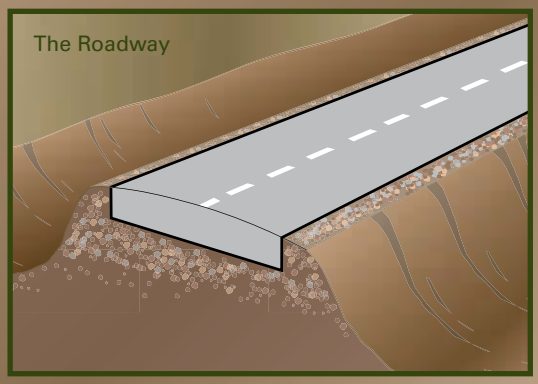
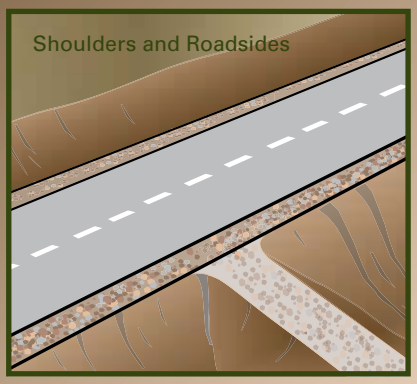
Alaska

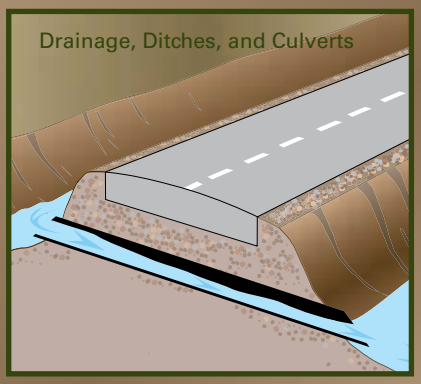
Highway Maintenance and Operations Handbook

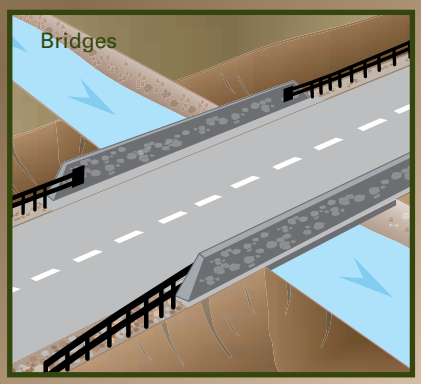
July 2014

Alaska Department of Transportation and Public Facilities









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Alaska Highway Maintenance and Operations Handbook

February 2014

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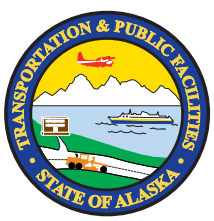

IOWA STATE UNIVERSITY
Institute for Transportation

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List of Common Abbreviations and Acronyms

AASHTO	American Association of State Highway Transportation Officials
CDL	commercial driver's license
DOT&PF	Department of Transportation and Public Facilities
EPA	Environmental Protection Agency
ESCP	Erosion and Sediment Control Plan
FHWA	Federal Highway Administration
HMA	hot mix asphalt
ISTEA	Intermodal Surface Transportation Efficiency Act
LOS	level of service
LTAP	Local Technical Assistance Program
M&O	Maintenance and Operations
MUTCD	Manual on Uniform Traffic Control Devices
NACE	National Association of County Engineers
PCC	portland cement concrete
RWIS	road weather information systems
TEA-21	Transportation Equity Act for the 21st Century
TRB	Transportation Research Board

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Skorseth, K. and A.A. Selim. 2000. Gravel Roads Maintenance and Design Manual. Washington, DC: Federal Highway Administration and South Dakota Local Transportation Assistance Program.

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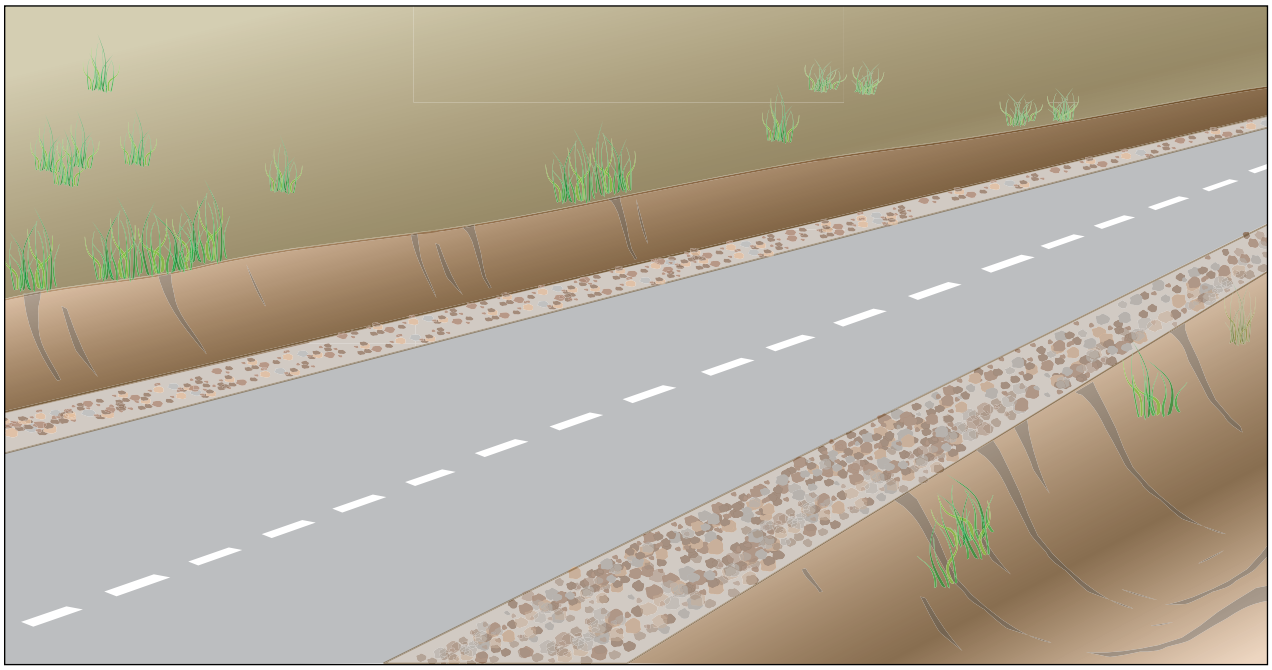
Chapter 1:
Introduction



chapter contents

Welcome to the Alaska Highway Maintenance and Operations Handbook (AHMOH) developed by the Institute for Transportation at Iowa State University for the Alaska Department of Transportation and Public Facilities (DOT&PF), Statewide Maintenance and Operations (M&O). This handbook provides general guidelines for the department's highway maintenance workers in one convenient source. It is being distributed to maintenance supervisors to use as a general training tool with their crews.

This handbook is a guide for desirable maintenance activities to keep Alaska's highway transportation facilities safe and efficient. It helps establish uniform operating procedures and guidelines, while recognizing limitations dictated by, at times, limited resources and budgets. The judgment of trained staff has and will continue to be instrumental in the success of all maintenance and operations efforts.

This handbook has been prepared and adopted under authority of Alaska Statutes 19.05.10 and 19.10.160 and supersedes all prior DOT&PF highway maintenance and operations handbook(s).

M&O Organization and Responsibilities

Alaska's transportation system lies within one of the harshest and most challenging environments on the planet. Alaska is a land of extremes, with temperatures ranging from 100°F to -80°F and snowfalls as high as 974 inches at Thompson Pass. Eighty percent of the state is underlain by ice-rich permafrost. Maintenance activities are conducted in a geographically diverse climate ranging from maritime to arctic.

Alaska's M&O forces are organized geographically within three regions: Southeast, Central, and Northern. There are three regional M&O managers, one in Anchorage (Central Region), Fairbanks (Northern Region), and Juneau (Southeast Region), each supervising the maintenance activities within the region and reporting to the respective regional director.

The M&O staff is responsible for the day-to-day operation and maintenance of the state's transportation system, which includes over 5,600 miles of state-owned roadways, 2 international airports, 253 rural airports, 845 bridges, and 720 state-owned and/or managed buildings. Maintenance personnel are stationed at 80 maintenance facilities across the state, ranging from Ketchikan in southeast Alaska to Barrow on the north slope to Adak in the Aleutian Islands.

Responsibilities of M&O include all the activities to keep our state's highways, bridges, airports, buildings, and harbors in good condition and safe for the traveling public. These include pavement maintenance and preservation, highway and airport anti-icing and deicing, snowplowing, snow hauling, avalanche hazard reduction, vegetation management, guardrail repair, sign maintenance, street/traffic light repair, drainage structures, fence maintenance, airport lighting repair, airport rescue and firefighting, airport security, and facility repairs. Responsibilities also include responding to all emergency/weather-related situations such as snow and ice removal, fallen trees, mud and landslides, and roadway/airport flooding.

Public and employee safety is the highest priority and must be considered in every decision and activity affecting the highway system. The goal is to maintain the highway system as near as practicable to its originally constructed or subsequently improved condition.

The Alaska DOT&PF and its employees should take pride in and continue to strive for excellence in preserving the integrity of our highway system.

A properly functioning highway system is essential to the well-being of the state of Alaska, its citizens, and commerce. A comprehensive maintenance program and well trained maintenance personnel are critical to the safe, clean, reliable, and efficient operation of the highway transportation system.

RULE OF THUMB

Public and employee safety is the highest priority.

What We Do, Who We Are

In every activity, M&O staff should keep the following principles in mind.

Mission: Keep Alaska Moving through Service and Infrastructure

To do this, we

- Provide for the safe and efficient movement of people and goods.
- Provide statewide access and connectivity.
- Provide access for exploration and development of Alaska's resources.

Alaska DOT&PF Core Values

Based on our history and shared commitments for the future, the values that will guide our activities are as follow:

- **Integrity**: Ensure honesty, dependability, loyalty, and a high ethical standard.
- **Excellence**: Personal and department commitment to continually improve individual, team, and organizational knowledge, performance, and methods to provide superior service and products.
- **Respect**: Positive regard for colleagues and customers.

Vision

- We will strengthen our efficiencies and effectiveness at planning, designing, constructing, operating, and maintaining all modes of transportation.
- We will strengthen our transparency, accountability, innovation, and quality of service.
- We will work as a team, maintaining strong, healthy communications internally and externally.
- We will promote service-based management of state-owned transportation assets and facilities.
- We will expand the reach of the transportation system to serve the needs of all Alaskans.

Strengths

We will accomplish our goals because we have the following:

- A strong work ethic
- Experience, expertise, knowledge
- Dedicated workforce
- Quantity and quality of assets
- Interesting challenges
- Opportunities for growth
- Pride of accomplishment
- Good people
- Willingness to lead

Through our service, we will fulfill our purpose.

Overview of This Handbook

Information in this handbook is organized into seven chapters. Each chapter is intended to stand alone.

The first two chapters present introductory information and suggestions to help road workers communicate effectively with the public.

The next three chapters address road maintenance topics "from the center line out"—the roadway, shoulders and roadsides, and drainage—which is how maintenance activities are generally prioritized and budgeted.

The final two chapters cover bridge maintenance and winter maintenance.

The handbook focuses on the "why" and "how" regarding performing various maintenance activities. In general, each chapter is organized as follows:

- Safety tips, in conjunction with the Alaska DOT&PF Safety Manual and relevant Task Analyses contained therein
- Characteristics of good maintenance (the "why")
- Optimum timing and conditions for maintenance
- Maintenance activities (the "how")
- Bibliography

General Guidelines for Alaska's Road Maintenance Workers

Several important concepts are repeated in chapters of this handbook and are worth stating here:

Always follow Alaska DOT&PF standards, policies, and procedures. Every station/camp in Alaska is unique in many ways. They contain unique terrain, soil and erosion conditions, available maintenance materials, weather patterns, and responsibilities to citizens. In general, the suggestions in this handbook are based on common best practices. However, they may not apply in all locations or all situations.

Most operating procedures, best practices, and methods of conducting roadway maintenance activities are similar; however, it is recognized that not every operation is the same. Always check with your supervisor and follow your departmental standards, policies, and procedures.

RULE OF THUMB

Follow standards.

Notify AK Digline.

Train workers.

Set up work zones.

Notify Alaska Digline (call 811 or 1-800-478-3121). Agencies are required by law to notify Alaska Digline up to 15 days (20 days in remote areas) in advance of any surface excavation project, large or small. Alaska Digline will notify the owners/operators of any underground utilities, who will dispatch personnel to the area to mark the location(s) of underground facilities so that maintenance workers can avoid damaging those assets.

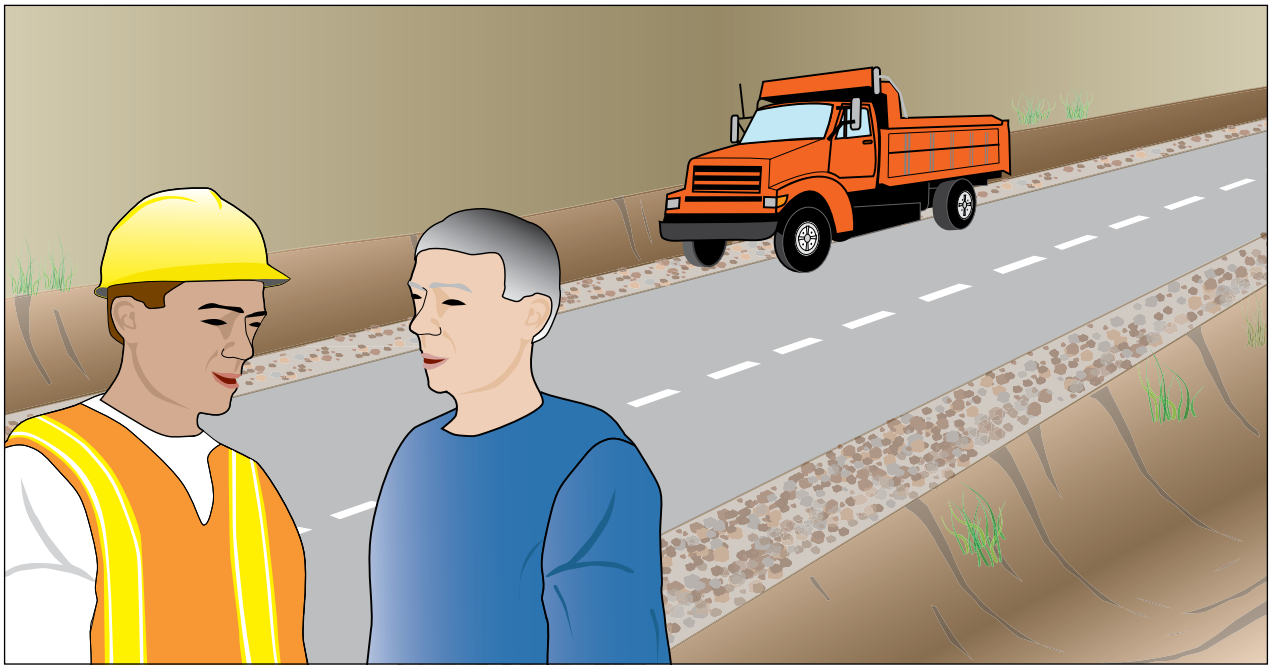
Train workers and use quality control measures. Quality control and a well trained work crew ensure that the best equipment and materials are used on the job and that sound engineering principles, along with agency policies and procedures, are followed.

Quality control involves monitoring and adjusting maintenance processes to comply with plans, agency policies, contract specifications, and good practices. Quality control begins with checking that all needed equipment and materials are on site and meet specifications and that they are used as intended according to instructions and specifications. Routine inspections are also an important part of quality control. Equipment manuals may contain checklists that describe a pre-use inspection.

Make sure the work crew is in the best position to ensure quality control at the site when materials are incorporated and equipment is used. Ask your supervisor to define your quality control activities and responsibilities.

Set up appropriate work zones. A well designed and properly signed/marked work zone helps keep maintenance workers and motorists safe. Set up work zones as described in *Alaska Sign Design Specifications* (ASDS) using traffic control devices described in the *Alaska Traffic Manual* (ATM).

Chapter 2:
Interaction with the Public



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Interacting with the public may be the most important part of your work. You are the face of your organization to the public. When you do your job well and interact effectively, people trust and believe in you and your agency.

In general, when you are asked a work-related question, be professional. Share only the agency's official position or information. Answer as thoroughly and efficiently as you can. When a question is outside your area of responsibility or competence, refer the questioner to your supervisor. It's also a good idea not to share opinions about agency operations or policies when you are on duty, only relay facts as you know them.

In general, any communication with the media should be referred to a supervisor or agency media expert. An excellent reference for interacting with the media is the Alaska DOT&PF's Managing Media Interviews Like a Pro!

This chapter briefly describes some of the many situations in which maintenance workers may interact with the public, what citizens expect from you, and some typically useful responses. The chapter concludes with some key points for communicating effectively with the public.

Typical Interactions with the Public

People have been known to contact maintenance workers at any time of the day or night. The following scenarios are typical:

- You're conducting routine snow removal, and an adjacent property owner flags you down with a question about winter maintenance schedules.
- You're refueling at a local business, and someone at the next pump asks you about the state's fuel budget.
- You are flagging for a routine maintenance activity and a motorist asks about details of the work or tells you about a pothole on their road.

What Do Citizens Want to Know?

People contact maintenance workers for a variety of reasons:

- To find out how road dollars are being spent. They may want to know about annual maintenance budgets or the cost of a specific project.
- To learn how certain maintenance procedures are done. Some people find road work interesting and are curious.
- To understand the background or rationale behind road-related decisions made by the DOT&PF. Some citizens see maintenance workers as a communication link to elected officials and/or higher level staff within road agencies.
- To learn about employment opportunities at the local maintenance facility.
- To lodge a complaint or to describe a problem they've noticed or experienced.

What Should Citizens Expect from You?

Citizens should be able to expect the same treatment from you that you expect from others:

- Honesty, courtesy, and respect
- Good service and dedication to your job
- Reference to a supervisor or media expert, if appropriate
- Provision of (or reference to) handouts/pamphlets, such as information about 511, http://511.alaska.gov/alaska511/mappingcomponent, or about Alaska Digline, www.akonecall.com/

RULE OF THUMB

Document all questions or comments from the public and report them to your supervisor.

What Should Citizens Not Expect from You?

Sometimes people have unrealistic expectations about the kinds of information you can provide. They may want information or a service from you that is the responsibility of another person, department, or even agency.

In these situations, you can be most helpful by referring them to your supervisor or someone who is responsible for their concern. See the next section.

Suggestions for Responding Effectively

Remember, your responses reflect on your agency. Be courteous and professional.

It is always helpful to document all questions or comments from the public and report them to your supervisor.

Sometimes just listening can be useful. But silence can also be misunderstood as inattention, disagreement, or anger. Be sure to respectfully acknowledge all comments or questions.

Useful Communication Tools

Cards. In some agencies, maintenance workers carry cards with contact information or various services. When citizens have questions, workers can use the card to refer them to appropriate staff or offices. Figure 2–1 shows a sample card.

Door knockers. Another useful communication tool is a door knocker: a flyer to hang on house doorknobs. Door knockers can be especially useful for answering questions/providing information in advance of specific road maintenance activities that may be disruptive to local residents.

Specific information for a contact card or door knocker would normally be produced at a regional level.

Have a question for Alaska DOT&PF?
Call one of the individuals listed below for assistance.

Ocie Adams
Office of the Commissioner/
Transportation Management
and Security
ocie.adams@alaska.gov
907-465-6940

Todd Hanley
Heavy Equipment Training Coordinator
todd.hanley@alaska.gov
907-269-5613

Diana Rotkis
Statewide Fleet Manager
diana.rotkis@alaska.gov
907-269-0787

Jim Horn
State Pavement Management
Engineer
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907-269-6200

Daniel R. Monteleone
Statewide Safety, Security &
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Coordinator
dan.monteleone@alaska.gov
907-269-6323

Figure 2–1. Sample referral card

Gestures, expressions, and vocal inflections also communicate. Be aware of what your body language is saying, especially in situations that may be tense for you and the citizen.

If a question is about something you can answer, respond.

If a question is outside your area of responsibility or competence, refer the question to whoever is responsible (see "Useful Communication Tools" above).

Following are some effective responses to questions or requests for information:

- "That's a good question. I don't know the answer, but let me refer you to someone who is more knowledgeable on that topic."
- (After responding to a question for which you know the answer:) "Have I answered your concern?"
- "Thanks for your interest."

RULE OF THUMB

If you can fix it, respond.

If you don't know the answer, pass the question on to someone who does so they can respond.

Key Points

The following suggestions for interacting with the public are just good business practices. You may want to review this list with your supervisor and fellow maintenance staff and come up with your own suggestions:

Always be professional, respectful and non-evasive.

Know your agency's work rules and maintenance policies and procedures.

If you don't know an answer, say so. Refer the questioner to your supervisor or other appropriate person.

When you're asked a question, **share only the facts**. Don't represent your opinion as your agency's position or policy.

Do not share your personal opinion. Do not argue. A good question to ask yourself is, "Do I want this conversation on the front page of the newspaper?"

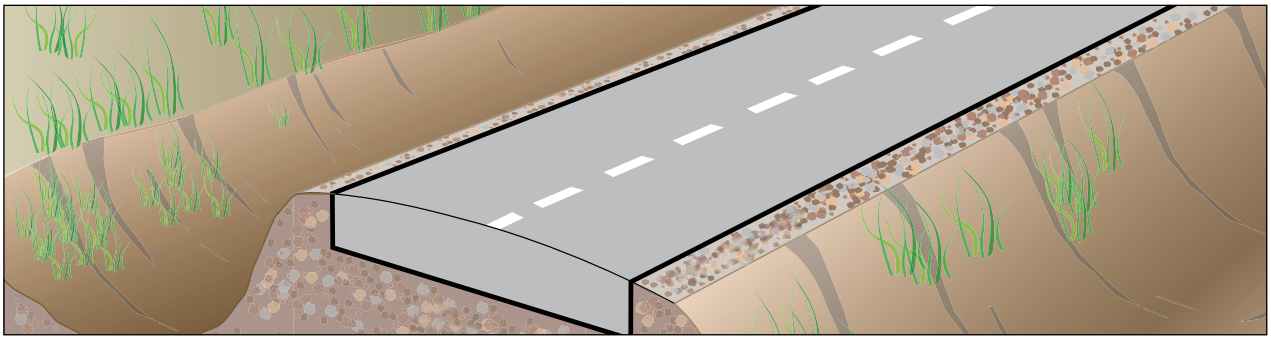
Be loyal to your agency. If you disagree with a policy or position, take it up with your supervisor, not with someone outside the organization, especially the media.

Have information for appropriate contacts readily available.

Don't take questions or complaints personally. You are a symbol of the organization, much like the referee in a sporting event, and comments are not about you personally.

Document all questions or comments from the public and report them to your supervisor.

Chapter 3:
The Roadway



chapter contents

The function and mission of Maintenance and Operations is to preserve, maintain, and operate the Alaska State Highway System in a condition that is reasonably safe and as close as practicable to its constructed configuration. Highway maintenance programs are developed to offset the effects of weather, organic growth, deterioration, traffic wear, damage, and vandalism.

Generally, roadway maintenance work is prioritized by both road classification and also from the centerline out to the right-of-way line. However, for the sake of efficiency, it is sometimes better to complete a lower priority maintenance activity rather than stop to take care of a short-term, normally higher priority activity, unless traffic safety or the structural integrity of the roadway mandates immediate attention. For example, if a crew has been gathered from adjacent areas for a chip seal or an asphalt overlay patching operation, it may be better to complete the project rather than stop to do some isolated pothole patching.

The organizational structure of roadway maintenance personnel indicates the range of decisions that can be made at each organizational level or that require referral to higher authority. Local managers determine relative priorities, methods, and procedures for accomplishing maintenance and operations activities and are usually available to give instructions for dealing with changing and emergency conditions. This chapter provides information about road classifications, levels of service, and range of maintenance activities that are used to provide the best possible roads for Alaska's citizenry.

The department is responsible to the Federal Highway Administration (FHWA) in the performance of maintenance activities as outlined in 23 CFR 1.27 and 633.208.

Federal Functional Classification of Alaska's Highways

The federal functional roadway classification levels for Alaska roadways are interstate, principal arterials, minor arterials, major collectors, and minor collectors. In addition, there are forestry and parks roads (Department of Natural Resources), Indian Nations roads, U.S. (Forest Service, Corps of Engineer, Army, Navy, Coast Guard, Fish and Wildlife, Bureau of Land Management) roads, National Park Service roads, and local roads in the boroughs cities, and other local agencies jurisdictions. Of the over 16,600 certified miles of public roadways in Alaska, the DOT&PF is responsible for the maintenance and operation of 5,608 miles (as of 2011).

The functional classification assigned to a roadway is important, as it is one of the initial considerations in the design of the highway and access control on that highway. It is also one of many factors considered in evaluating projects for statewide transportation improvement and rehabilitation projects.

For purposes of roadway maintenance, however, roadways are classified by surface type: gravel, concrete, or asphalt. Maintenance procedures for these surface types are discussed in the following sections, according to Priority Levels.

Granular Surfaced Roads

Safety Tips for Maintaining Granular Surfaced Roads

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual (see Maintenance Stabilization of Unpaved Roads Task Analysis).

Suggested personal safety gear

- **Highly visible apparel**
- **ANSI/ISEA 107-2004 Class 2 top for daytime; Class 2 top and Class E bottom during night or flagging or setting up traffic control devices; and Level 2 retroreflective material.**

Advance preparations

- **Be properly trained and familiar with all equipment, especially motor graders.**
- **Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site.**
- **Perform pre-use check of equipment including lights, blades, and hydraulic system, making sure the warning lights are approved and activated.**
- **Make sure motor graders have slow-moving vehicle emblems attached to rear of the vehicle.**

During operations

- **If road is open to traffic during maintenance work, use proper temporary traffic control, including flaggers if needed, as described in the Alaska Traffic Manual.**
- **For more extensive repair activities, consider short-term road closures with proper signing.**
- **Wear highly visibly apparel whenever out of vehicle.**
- **Do not allow riders in motor graders.**
- **Avoid backing large equipment and trucks without a spotter.**
- **Remove all temporary traffic control devices immediately when no longer needed.**

An adequate crown and good drainage are critical for smooth, safe granular surfaced roads (generally called gravel or rock roads, no matter what kind of granular material, or aggregate, is on the surface). But gravel roads do not hold their shape well, even under normal traffic and weather conditions. Heavy loads, like some large trucks or equipment, and water from rain and melting snow and ice are especially hard on granular surfaced roads. Therefore, such roads must be regularly and properly maintained, as shown in figure 3–3.

RULE OF THUMB

If you can drain it, you can maintain it.

The primary objectives of maintenance on granular surfaced roads are to provide adequate water drainage away from the surface and a comfortable, safe riding surface for vehicles. Another objective on roads with high traffic volumes or adjacent to residential dwellings may be to control dust.

Maintenance activities cover the traveled portion of the roadway through the shoulder. For a more thorough discussion of shoulder maintenance, see chapter 4.

Characteristics of a Well Maintained Gravel Road

A well maintained granular surfaced road will have the following characteristics (see figure 3-1):

- The road has a four to six percent crown with good crust and effective drainage.
- Granular material is distributed at an even depth across the road.
- Granular material is well graded (that is, an even distribution of fine and course materials).
- There are no or few potholes, washboards, ruts, secondary ditches, or other problems.

Figure 3–1. New granular surface (LTAP-SD)

Optimum Timing/Conditions for Maintenance

If possible, conduct maintenance operations on gravel roads when moisture is present. Soft, wet surface material is much easier to move, cut, and re-compact than hard, dry material and makes it easier to cut out problems like potholes.

In Alaska, moisture conditions are generally best for maintenance in the late spring through early fall. Conditions are also good during the first two or three days after a summer rainfall.

RULE OF THUMB

In general, to determine if a gravel road is moist enough for routine maintenance activities squeeze a handful of the surface material. If it holds its shape, the material is moist enough. See figure 3–2.

If it doesn't hold its shape, then it is not moist enough. See figure 3–3.

Then pack the material against your other hand. If the other hand gets wet, the material is too wet.

Figure 3–2. Moisture test: wet

Figure 3–3. Moisture test: too dry

Some maintenance areas may have varying recommended periods with adequate moisture levels for gravel road maintenance. Check with your area supervisor, and follow that advice.

The following times are just general guidelines.

Spring

- Restore the crown early in the spring.
- Repair problem areas such as potholes and washboarding.
- Avoid operating heavy equipment on saturated roads and in "frost boil" locations.

Summer

- Replace surface materials.
- Maintenance grading—restoring proper superelevation on curves, cutting vegetation, etc.—may be necessary, even in dry conditions.
- Apply dust control to selected locations; check your local policy.

Fall

- Perform final blading before winter and prepare for snow removal.
- Double-check for windrows and remove them.

Winter

- Suspend routine blading when freezing conditions persist.
- Conduct snow removal activities when needed.

RULE OF THUMB

After each rain, start blading at a different roadway route in your area of responsibility so that you will eventually cover the entire mileage. Do not go in the same direction on your route every time, if possible, unless dictated by policies related to sight distance and safety.

RULE OF THUMB

Be aware that little-used gravel roads and gravel roads with dead ends and no residents are frequent targets of illegal dumping, especially if they appear to be poorly maintained. Don't ignore those roadway segments.

Maintaining Dry or Frozen Gravel Roads

Even if a gravel road is dry or frozen, some routine maintenance—for example, blading, regrading curve superelevations, repairing secondary drainage ruts, and removing vegetation—may be necessary. Again, check with your supervisor, and follow those recommendations.

Definitions

Crown

In general, the surface of a gravel road should gradually slope from its lowest level at the shoulders to an elevated point, or crown, along the center line. An adequate, A-shaped crown is important for drainage. A crown slope range between three to six percent is generally optimum for Alaska's roads.

The actual crown slope will vary, depending on roadway width, soil types, and local conditions. In general, wider roads require more crown slope than narrower roads. If a gravel road has too little crown slope, water from rain or

melted snow will collect on the road surface and soften the crust, which can lead to severe rutting and potholes under traffic. If there is too much crown slope, motorists may drive in the middle of the road because they feel as if their vehicles might slip off the road, especially when snow or ice is present.

Situations may exist in which less than three percent or more than six percent crown is desirable. Always follow your area maintenance foreman's recommendations.

Crust

The crust is the top two or three inches of roadway that has been compacted into a dense, tight mass with an almost impervious surface.

An adequate crust requires a good blend of stone (if available), sand, and fine particles. See figure 3–6. Aggregates with too few fines will not form a crust, and excess fines will make the road slick in wet weather. Fractured or crushed stone is preferred to round gravel because the fractured surfaces will lock together. The crust material must be compacted at optimum moisture content—not too much, not too little—in order for the fines and larger materials to bond adequately.

Drainage

Drainage is the process of moving surplus groundwater or surface water by gravity or mechanical pumping. Water flows wherever gravity takes it. Roads need good drainage to accommodate the flow of water away from the center of the road. Otherwise, water will pool on or below the road surface, weakening the crust and causing the formation of potholes, washboards, or other problems. A road with poor drainage will eventually require major reshaping and extensive maintenance.

Maintaining good drainage on gravel surfaced roads is achieved by properly constructing and maintaining the crown and crust. Maintaining drainage on shoulders and in ditches is addressed in other chapters of this manual.

Alaska DOT&PF must meet certain state and federal regulations related to roadway runoff. The requirements will affect the amount and type of drainage maintenance performed. Check with the Regional Environmental Coordinator to review these requirements prior to initiating drainage maintenance. Permits, if required, can often take from one to three months to process.

Riding Surface

Riding surface is the smoothness or roughness motorists feel in the road. Maintaining a smooth, safe riding surface is achieved initially by properly constructing and maintaining the crown and crust, uniformly distributing appropriate gravel materials, and eliminating potholes, washboards, and other surface problems with routine maintenance practices.

Superelevation

At a curve, superelevation is the banking or sloping of a road upward from the inside of the curve to the outside, expressed in feet per foot (or meters per meter), or percent. A proper superelevation enables vehicles to maintain a consistent speed through the curve. (The banked ends of racing tracks represent an exaggerated super elevation.) See Blading at Curves later in this chapter.

Note: Not all curves must be superelevated. Check with your supervisor.

Windrow

A windrow is formed of excess gravel material left along the length of the shoulder, usually after blading. Windrows may cause secondary ditches to form, which can lead to erosion. Also, if a vehicle strays into a windrow, the driver may lose control. Windrows can also contribute to the formation of snow drifts in the winter, also causing driver problems.

Maintenance Activities

A primary maintenance activity is to maintain the crown and provide effective surface drainage. This can require special care in special situations, like intersections, railroad crossings, etc. Other activities include adding new materials and repairing problem areas.

Maintaining the Crown

Maintain the crown as a straight line from shoulder to centerline. The cross section should look much like the pitch of a roof, or a flat A shape. See figure 3–4. Blade the crown to the final desired slope so that, after adding new material and resurfacing, there will be a uniform layer of granular material on the road.

Cross slope is based on approximately one-half inch rise per foot, or about five percent from the edge of the roadway to the center. Cross slopes com-

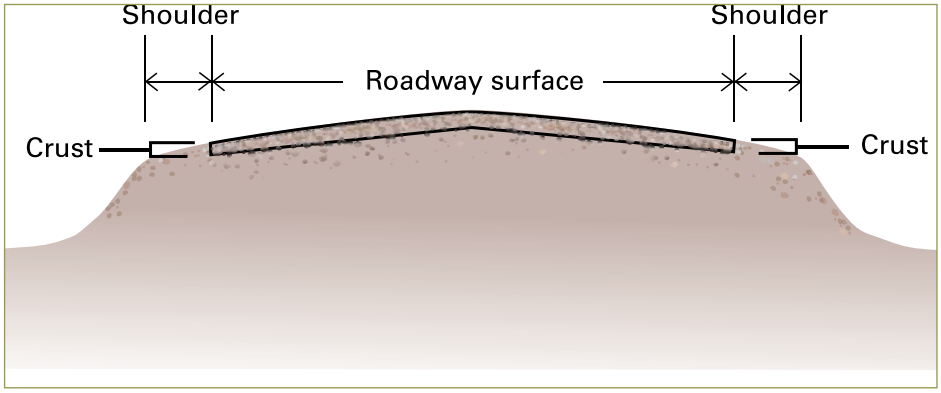


Figure 3–4. The cross section

RULE OF THUMB

While operating a motor grader, you may be able to use a cup of coffee to estimate the road's slope. Set the cup on a flat surface, and eyeball the angle between the surface of the coffee and the rim of the cup. (A slope meter should be your final guide.)

monly range from four to six percent. On newer grades with higher traffic counts, the slope should approach six percent because the crown tends to get "beaten out" of the road under traffic.

By using a slope meter, as in figure 3–5, the operator can measure the crown slope. Sophisticated electronic slope controls are also available for motor graders.

The road in figure 3–6 does not have adequate crown, and water ponds on the road after a rainfall or snow melt.

Make sure the roadway edge is the same height as (not lower than) the top of the foreslope to the ditch, as shown in figure 3–7. This is critical for preventing the formation of secondary ditches.

Figure 3–5. Slope meter

Figure 3–6. Poor crown shape

Figure 3–7. Foreslope height

Adjust the angle and position of the moldboard, depending on the job at hand. For most blading purposes, rotate the moldboard to a horizontal angle of about 30 to 45 degrees. See figure 3–8.

To cut out ridges, washboards, and potholes, put the moldboard in the cut position. See figures 3–9 and 3–10. Be sure to put enough pressure on the blade to maintain your cut. Button bits are used in blades in certain areas of gravel roads to gently scarify or cut irregularities from roadway surfaces.

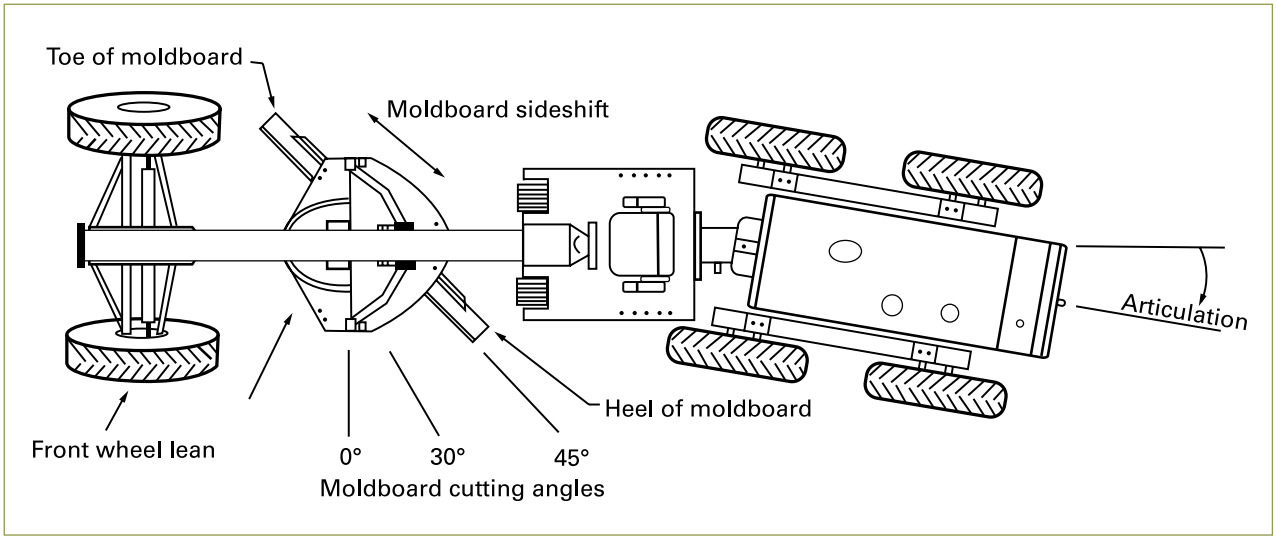


Figure 3–8. Angle of the moldboard (Adapted from LTAP-SD)

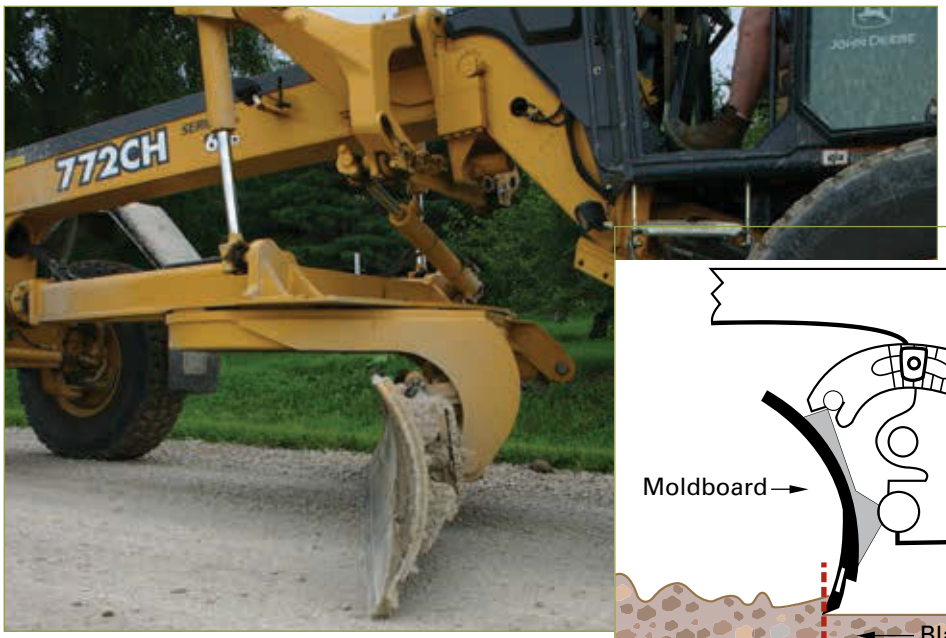


Figure 3–9. Moldboard in the cut position for regular grading

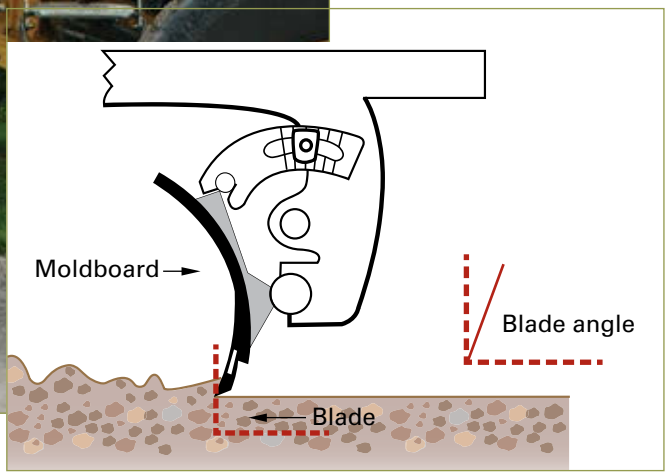


Figure 3–10. Moldboard in the cut position for regular grading (Adapted from LTAP-SD)

For heavier grading, tilt the moldboard back. See figure 3–11.

To create a compaction roll that levels the road and helps shape the crown, tilt the moldboard forward until the blade is perpendicular to the road. See figures 3–12 and 3–13. Move and roll the aggregate in a mixing action away from the shoulder and toward the center of the road.

To bring fine materials back across the road, the blade should be in the "float" position (if that feature exists on your grader). That is, there should be no down pressure except the weight of the blade. To do this, simply turn off the pressure to the blade.

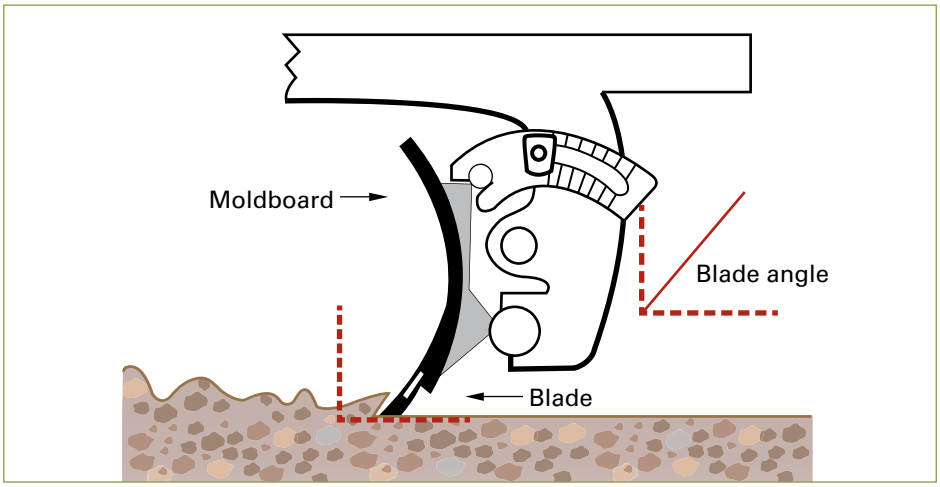


Figure 3–11. Moldboard tilted backward for heavier grading or more aggressive cutting (Adapted from LTAP-SD)

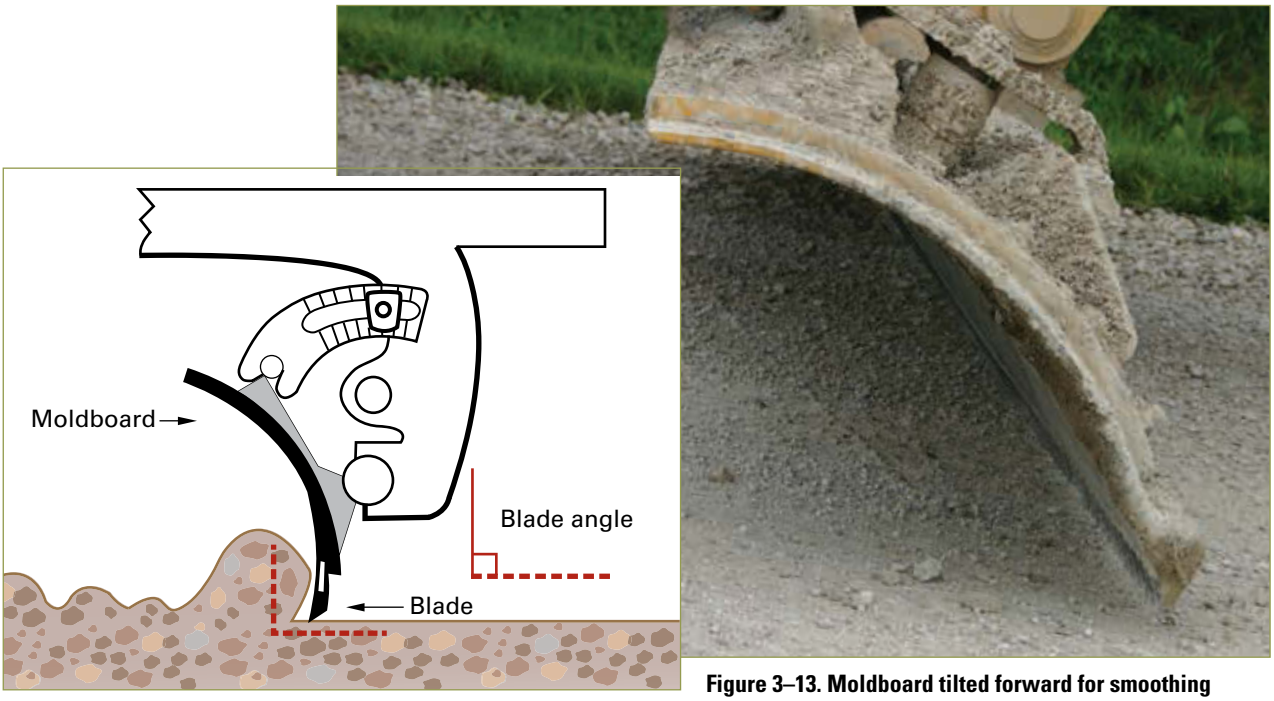


Figure 3–12. Moldboard tilted forward for smoothing (Adapted from LTAP-SD)

Figure 3–13. Moldboard tilted forward for smoothing

Blading in Special Situations

Take special care at driveways, curves, intersections, railroad crossings, and bridges.

Blading at Driveways

On a road with driveways, blade the road at a constant grade, then go back and fix the driveway areas by grading to a low point at the ditch line in the driveway. See figure 3–14.

Leaving a windrow across a driveway may cause small vehicles to get stuck. Leaving a windrow on a hill will cause a secondary ditch to form, resulting in erosion in the roadway surface. Excess water on the slope may result in sliding. See figure 3–15.

Figure 3–14. Driveway meets the road

Figure 3–15. Slope slide from excess water

Blading at Curves

In general, there should be little or no crown in a superelevated curve. If the curve is to be superelevated, use the following procedure: As you approach the curve, transition from crown to superelevation, beginning about 250 feet before the curve. As you leave the curve, transition back to a regular crown about 250 feet after the curve.

A commonly accepted maximum superelevation on gravel roads is approximately six percent. A superelevation higher than six percent can be dangerous, especially where snow and ice can make roadways slippery. A higher superelevation also tends to cause aggregate to migrate to the bottom of the slope, or the inside of the curve.

Blading at Intersections

Before blading to shape a gravel intersection, determine if it is controlled or uncontrolled for traffic. If traffic on the side road has to stop or yield to traffic on the through road, it is a controlled intersection.

Controlled intersections should be bladed as shown in figure 3-17(a). Maintain the crown on the major road through the intersection. Gradually eliminate the crown on the side (intersecting) road, beginning approximately 100 feet before the intersection. At the point of intersection, the side road is virtually flat to match the major road surface.

RULE OF THUMB

You will have a near-perfect superelevation if you merely extend the five-percent cross slope from the inside of the curve across the entire width of the roadway. See figure 3–16.

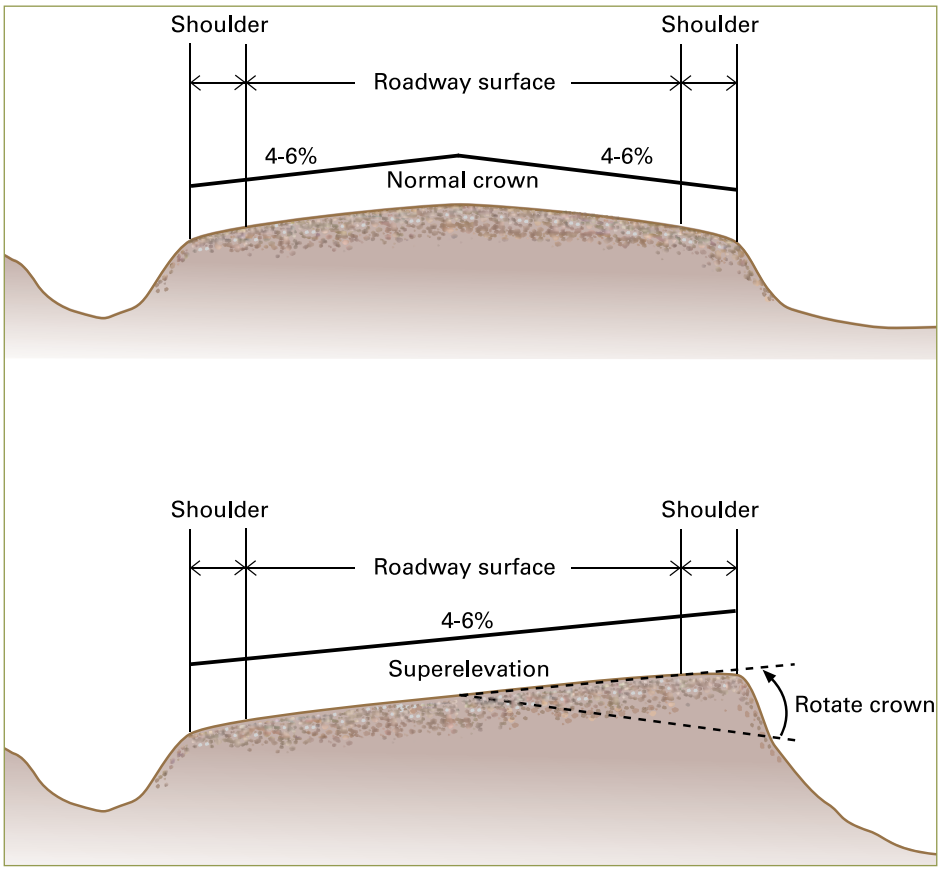


Figure 3–16. Normal crown (top) and superelevation (bottom)

Uncontrolled intersections should be bladed as shown in figure 3-17(b). Gradually eliminate the crown on both intersecting roads, beginning approximately 100 feet before the intersection. The intersection itself becomes virtually flat, allowing vehicles to pass through from any direction without feeling a noticeable hump or dip. Be careful not to make the intersection lower than the approach roadways so that water collects there.

Blading at Railroad Crossings

At railroad crossings, eliminate the crown slope on both sides of the crossing for a distance of 20 to 30 feet.

Be careful not to blade aggregate onto the rails, which could cause a train to derail. After blading, brush all loose aggregate off the track immediately.

Blading at Bridges

Bridge approaches may need more frequent attention than other parts of the roadway because this area is difficult to drain and the subbase beneath the crust is prone to settling, leaving potholes and undesirable settlement at the bridge abutment.

If a bridge deck is crowned, gradually adjust the slope of the roadway's crown to match the slope of the bridge's crown. If the bridge does not have a crown, gradually eliminate the road crown to meet the elevation of the bridge deck.

Take care not to drag too much rock onto the bridge deck during blading operations, and sweep off excess gravel material immediately following blading.

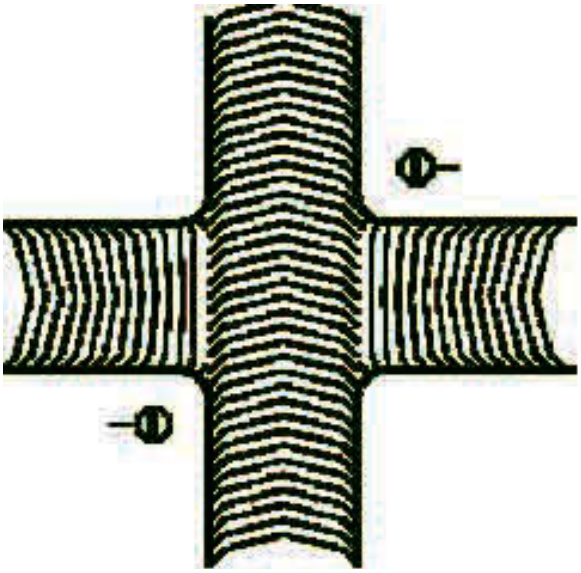


Figure 3–17(a). Proper shape of a stop- or yield-controlled intersection. Notice the through road retains its crown slope. Side roads, which have stop or yield signs, are shaped to match the edge of through road. (South Dakota *Gravel Roads Maintenance and Design Manual* 2000)

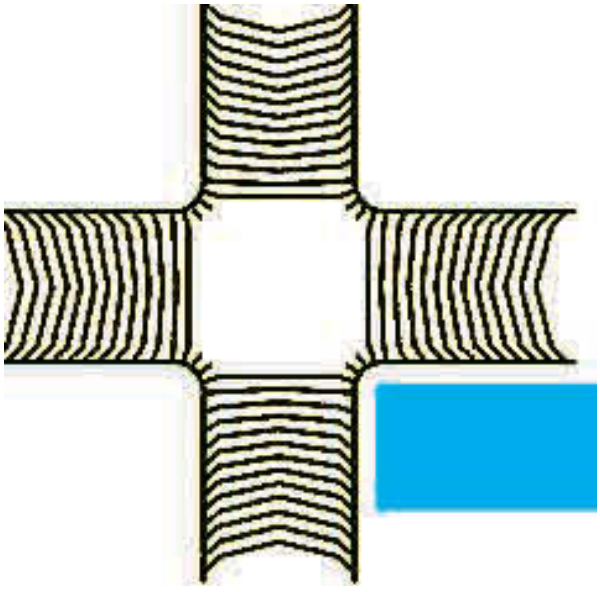


Figure 3–17(b). Proper shape of an uncontrolled intersection. Notice that the crown slope is gradually eliminated from all directions approaching the intersection. (South Dakota *Gravel Roads Maintenance and Design Manual* 2000)

Adding/Distributing Gravel Material

Traffic on a gravel surfaced roadway gradually throws the gravel material off the roadway and/or pulverizes it to dust away. Adding new surface material to gravel roads is therefore a regular maintenance activity.

Before adding new material, prepare the road surface by scarifying it lightly. Scarifying helps blend the old and new materials together and ensure a good bond between them. See figure 3–18. Be careful not to cut out the full crust when scarifying.

When the new material is delivered by truck, it should be placed as uniformly as possible on the road with a minimum of gaps between truckloads. See figure 3–19.

When using belly dump trucks, the material should be placed in a temporary storage windrow in a consistent manner and, if necessary, then use the motor grader blade to distribute the material uniformly across the roadway. Be sure to maintain proper crown slope.

After all the gravel material is spread evenly over the roadway, normal traffic will generally compact the crust. However, if rollers are available, create a hard crust by compacting the surface with rollers. You may need to add water during this operation. See figures 3–20 and 3–21.

Figure 3–18. Scarifying

Figure 3–19. Placing new material on the roadway

Figure 3–20. Adding water (optional)

Figure 3–21. Compacting the new material (optional)

Spreading New Material

New gravel is normally delivered to the roadway in trucks. To spread the material uniformly, the truck driver should strategically dump the rock while the truck is rolling. Here's how:

With front hoist dump body—First, set the tailgate chains on the dump body to control the rate of spread, maintaining a gap of approximately 9 to 15 inches. As you approach the area needing material, begin raising the dump body. At the appropriate location, trip the tailgate and continue raising the dump body, traveling at the appropriate speed for the desired rate of discharge. See figure 3–22.

Figure 3–22. Placing new material on roadway (optional) (LTAP-SD)

When the load is fully discharged, lower the dump body, allow the tailgate to engage, and head for your next load. Be sure to watch for overhead obstructions such as utility lines or bridges during dumping.

With belly dump body—First, set the gate stops on the belly dump body to control the rate of spread, maintaining a gap of approximately 9 to 15 inches. At the appropriate location, trip the gate switch and continue traveling at the appropriate speed for the desired rate of discharge. When the load is fully discharged, close the gates and allow them to engage, and head for your next load.

Achieving the proper speed and tailgate/belly gate settings is largely a matter of experience and feel. Skilled dump truck drivers usually watch their RPM meter instead of their speedometer.

Storage windrows

After new gravel has been delivered to the site, it may be useful to use a motor grader to move it to the side of the road for short-term (one day or less) storage until you can spread it evenly across the road. If material is stored in such a manner, you should mark with traffic cones or a like device to alert motorist of the windrow presence. If windrow is left during the night, it should be marked with barricades or barrels with warning lights.

Storing material temporarily like this keeps it out of the way of traffic, making it easier for vehicles to use the road while you're blading. It also promotes mixing of the old and new materials.

However, never store material at the side of the road for any length of time; see the problems associated with windrows described on page 23.

Some agencies prohibit the use of storage windrows during extremely dry periods. Consult your supervisor before using this technique.

Repairing Problem Areas

Do not simply fill problem areas (e.g., potholes and washboarding) with more gravel material, except as a temporary repair. Doing so results in non-uniform levels of gravel across the road, causing the problems to reappear quickly and becoming very expensive. Following are instructions for repairing different types of problem areas:

Secondary Ditches

Secondary ditches are a common occurrence on a gravel surfaced road, especially in hilly terrain. They generally form when vegetation or windrows at the top of the foreslope obstruct the flow of water from the roadway to the ditch, causing water to collect at the road's edge and drain along the surface, eventually creating a channel. In addition, motor grader blading can inadvertently create secondary ditches if the operator is not careful. See figure 3–23.

Prevent the formation of windrows and vegetation growth by blading carefully and maintaining the edge of the road level with the shoulder and/or the top of the foreslope. Be careful not to cut a ditch with the end of the blade.

Secondary ditches should be corrected as soon as possible after a rainfall. Also correct secondary ditches in the spring when there is little vegetation and plenty of moisture. Create a new crown, making sure that the edges of the road are level with the top of the foreslope so that water can flow directly off the road down the foreslope and into the ditch.

Figure 3–23. Secondary ditch

Washboarding

Washboarding is a series of close ridges or corrugations across the road, roughly perpendicular to traffic. This may occur under any of the following conditions: See figure 3–24.

- Where traffic frequently starts and stops; for example, at intersections.
- When the motor grader is operated too fast during blading. Driving too fast may cause the blade to bounce and cut ridges at an angle across the road. It can also cause the grader to "duck walk"; that is, one end of the blade catches the surface while the other end rises above the ground, and then the second end will get caught in the surface while the first rises.
- If there are too many large particles and not enough fines, the large particles may roll together creating piles or washboards.
- Where drainage rills or rivulets form on super elevation curves, or where drainage across the road causes erosion.
- Where crust or crown is inadequate and good drainage is not provided.

RULE OF THUMB

Vehicle start-stop locations on steep hills may be especially prone to washboarding. In such locations, it may be helpful to reduce the top size of the aggregate. Finer material knits together better and may help reduce the formation of washboards.

To prevent washboarding, operate at three to five miles per hour during blading and follow good maintenance practices regarding material size and distribution, moisture, and compaction.

To correct washboarding and reduce recurrence, cut the entire ridged area out of the road surface down to the bottom of the corrugated area. See figure 3–25. Reconstruct the location, carefully remixing and compacting fine and course materials. You will usually have to make about four passes with the motor grader to get to the bottom of the corrugated area and blend the material adequately. Adequate moisture content is critical.

Figure 3–24. Washboarding (LTAP-SD)

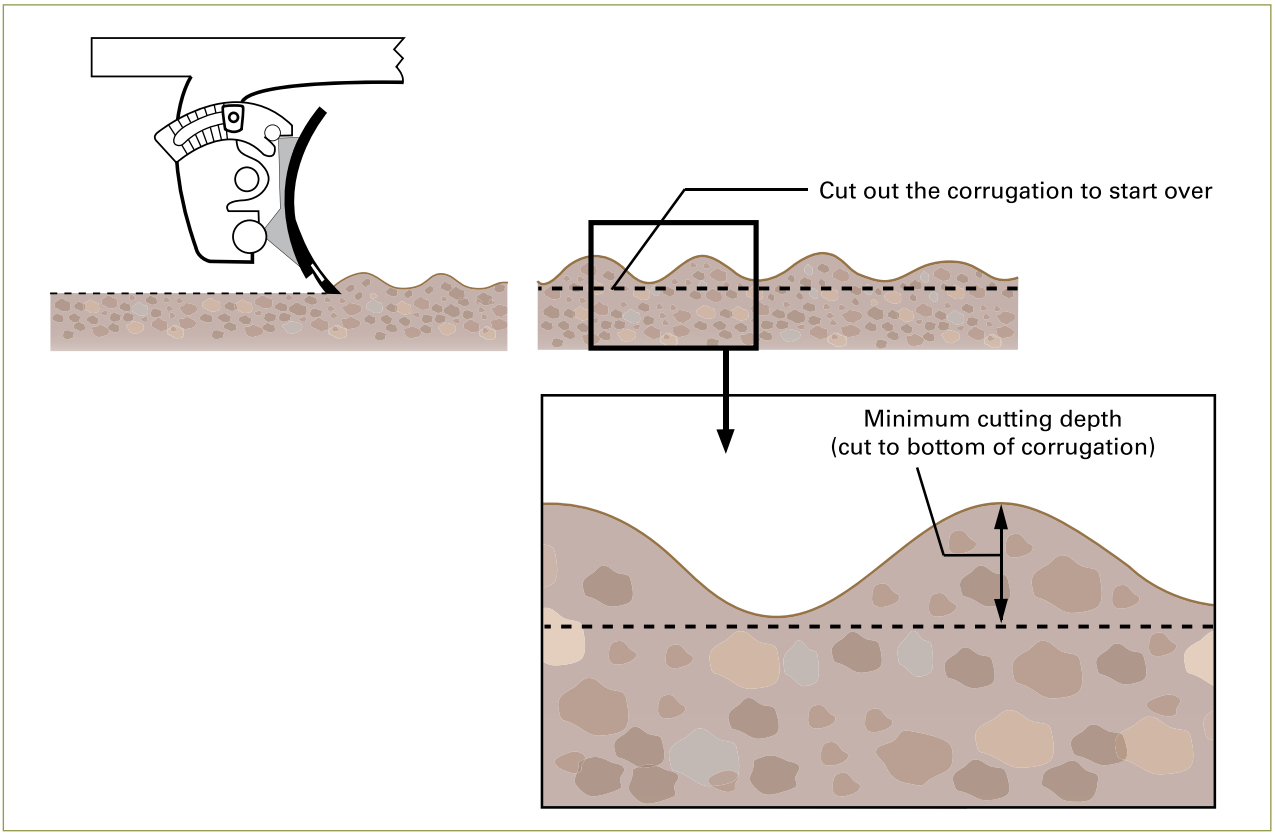


Figure 3–25. Cutting out a washboard (Adapted from LTAP-SD)

Potholes

Potholes occur where water pools and does not drain properly. See figure 3–26. Prevent potholes by maintaining adequate crown on the roadway.

Perform temporary repairs of potholes by filling them with aggregate. Such repairs will not last long, however. For a permanent repair, locate and repair drainage problems related to the potholes, then restore the area by cutting out the pothole (similar to repair of washboarding), placing additional gravel material, then blading and compacting the surface.

Rutting

Sometimes rutting occurs in the center of the road when traffic in both directions uses the middle of the road as a left tire lane, moving material off the area and creating a rut. Rutting may also be caused by poor drainage. See figure 3–27.

To prevent rutting, make sure the crown slope is maintained at between four and six percent, the aggregate sizes are evenly distributed, the surface material is spread at an even depth across the road, and the material is appropriately compacted with adequate moisture content.

To correct rutting and prevent it from recurring, cut out the ruts, place additional gravel material, then blade and compact the surface.

RULE OF THUMB

When cutting out large areas of washboarding, potholes, or ruts you may need to use a scarifier to cut deep into the crust and remove the surface defect.

Figure 3–26. Potholes

Figure 3–27. Rutting

Providing Dust Control

All gravel surfaced roads, whether natural gravel or crushed stone, will produce dust under traffic. The amount of moisture in the area has a great effect on the amount of dust. The type of material also has a major impact. Crushed stone develops the most dust. Glacial gravel, with highly plastic clay, is less prone to developing dust.

Applying dust control products on higher-volume gravel surfaced roads may be cost effective. In addition to reducing dust, such products can help keep small gravel particles on the road and prevent larger stones from being moved to the side of the road, thus reducing the need for blading.

Applying Dust Control Products (or dust stabilizers)

Following are some general tips:

- Make sure the road has a uniform crown slope (between three and six percent) and good drainage.
- Do not compact the road surface before application. In fact, scarify a minimum of one to two inches of the road surface, leaving a uniform depth of loose material across the road.
- Do not apply if rain is forecast. Rain will wash away the product and you may have to reapply.
- If using a new product, you may want to experiment first by treating a 500 to 1,000-foot test section. This will allow you to see how the product works before applying it to the entire roadway.
- Select an application rate and stick to it throughout the entire application process. This will leave you with a consistent roadway.
- Treat one side of the road and then immediately treat the other side to achieve a consistent application.
- After application, immediately open the road to traffic. Traffic will pack the product into the road surface material.

Some manufacturers of dust control products recommend not blading the surface at all after applying the products. Blading will break the bond that the product has made with the gravel on the roadway.

Moisture Considerations

To be effective, dust control materials should be applied when the road surface material is moist. The optimum moisture level is 13 to 18 percent.

Figure 3–28 shows a roadway with this amount of moisture.

Figure 3–28. Adquate moisture for applying dust control material

Kinds of Dust Control Materials

The most common types of dust control materials, or stabilizers, used on roadways are chlorides, resins, natural clays, and vegetable oils.

Chlorides are the most common (and generally the least expensive) types of dust control materials. Calcium chloride can be used in either a flake or a liquid form and is very effective, if properly used. Magnesium chloride is available in a liquid form and is also very effective if properly used. Its advantage is that it is much less corrosive than calcium chloride, and variations in market availability and prices can make it a very practical product.

Preferred application rates vary from 4 to 8 tons per lane mile.

Never apply chlorides to dry gravel. Moisture is necessary to help the chlorides penetrate the road surface and coat the gravel material. Without moisture, chlorides aren't effective, and you will have to reapply.

Resins (lignin or tree sap) are available under various commercial names. They work best when incorporated into the gravel surface. They provide cohesion to bind particles together.

Natural clays like bentonite will still develop dust in dry weather. They are somewhat difficult to transport and to mix with gravel surface material.

RULE OF THUMB

If potholes or other surface defects appear after dust control material has been applied, you may need to blade the road for safety reasons. Since blading will effectively remove much of the dust preventative, always check with your supervisor first.

Maintaining Gravel Streets

Some communities have gravel streets, where drainage is managed through side ditches along the length of the street. Gravel streets are more common where traffic volumes and speeds are very low and where there is little, if any, truck traffic.

The following information highlights special considerations for urban settings.

Generally, the purpose of urban gravel-way maintenance is to do one or more of the following:

- Remove moderate to severe potholes.
- Replace surface material that has washed out.
- Control or restore the surface elevation and drainage features.
- Provide dust control.

Used Motor Oil is Not for Dust Control

It is illegal to use motor oil or used crankcase oil as dust control material. These waste products contain heavy metals and other hazardous materials and may pollute the environment. If you see oil on the road, notify your supervisor.

Rejuvenating Dust Control Treatments

Calcium chloride and magnesium chloride are water friendly. After a rain, you can do touch-up maintenance on a gravel road treated with chlorides, and the dust-control properties will be rejuvenated. The same is not true for roads treated with resins, clays, and vegetable oils.

Pre-Maintenance Activities

- Locate all manholes, intakes, water valve boxes, and other conflicting utility features.
- To keep rock out of the storm sewer system, remove intake grates and cover the openings with fabric, plastic, or wood. (Hold the covering in place with the grate.)
- Locate potential obstacles to avoid during maintenance activities. Such obstacles may include the following:
- Parked vehicles
- Overhead wires, cables, and branches
- Telephone poles
- Garbage cans

Maintenance Activities

- On narrow gravel streets, you may have to place material under the grader, between the wheels (instead of along the side), so that material does not end up in lawns. (Have a plan for retrieving windrows.)
- When adding material to a roadway, take care not to drastically raise the elevation of the final surface, which could force rain water or runoff into garages and back yards.
- When applying any dust control to the gravel surface, blend the dust control material into the gravel with the blading action.
- After shaping the final surface profile with the grader, roll the edges with either the grader or with truck tires. This compacts the flow line and gives a more finished look to the street.
- Use shovels or brooms to clean alley approaches of residual rock.

Follow-Up Activities

When maintenance activities are finished, remove the protective coverings from intakes, clean the intake area, and replace the grates.

What's an Appropriate Crown?

The crown on urban gravel streets is generally lower than in rural locations—about two to three percent.

Watch for Obstacles

Equipment operators maintaining city streets are often working in confined areas, sometimes in the vicinity of parked vehicles, utilities, or other obstacles. In such situations, take extra care and be aware of your surroundings.

Asphalt Pavements

Safety Tips for Maintaining Asphalt Surfaced Roads

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual (see Asphalt Pavement Maintenance Task Analysis).

Suggested personal safety gear

- Hard hat (if visiting an asphalt production plant or whenever there is a potential overhead hazard)
- Heavy gloves
- Hard-toed footwear for working around hot asphalt
- Ear protection (for working around noisy equipment like jack hammers)
- Safety glasses with side shields
- Highly visible apparel

Advance preparations

- Be properly trained and familiar with all equipment and materials.
- Know procedures for emergency treatment of burns from hot asphalt.
- Be trained in avoiding heat-related illnesses, like heat exhaustion.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site. Keep fire extinguishers available at all times when using a fired kettle.
- Make sure the warning lights on work vehicles are in proper working order.

During operations

- If road is open to traffic use proper temporary traffic control, including flagger(s) if needed, as described in the Alaska Construction Manual and the MUTCD, part 6.
- Consider temporary road closures if traffic can be diverted.
- Wear highly visible apparel when you're not in a vehicle.
- Be aware of and take steps to avoid heat-related problems like heat stress and exhaustion as well as hypothermia and frost bite. See DOT&PF Task Analysis and Alaska Physical Agent Data Sheets (PADS).
- Follow manufacturer's recommendations and use caution when heating and using asphalt materials.
- Do not park work vehicles or equipment on both sides of the road.
- Be aware of construction equipment, especially backing trucks, paver, and rollers.
- Try to establish eye contact with operator before approaching equipment.
- Ensure that all obstructions and unnecessary temporary traffic control devices are removed from the road well before darkness.
- Use proper lifting techniques or request assistance to lift heavy objects.
- Workers should be provided periodic breaks and rest room accommodations.
- Remove all temporary traffic control immediately when no longer needed.

Traditional maintenance treatments for hot-mix asphalt (HMA, or simply asphalt) pavements include sweeping, crack sealing, pothole patching, full-depth patching, and applying thin maintenance surfaces like seal coats and asphalt overlays. A well maintained asphalt roadway is shown in figure 3–29.

Although financial and manpower restrictions can create exceptions to the rule, maintenance of "newest surfaces first" should prevail to prolong pavement life to the fullest extent. Eventually this should become a natural progression, as the older surfaces have already been maintained.

Characteristics of a Well Maintained Asphalt Pavement

- The roadway cross slope provides effective drainage.
- There are no unsealed cracks, alligator cracks, potholes, washboards, or ruts.
- There is little to no ponding following rain and/or ice melt.
- Surface water does not move to the subgrade.

Optimum Timing/Conditions for Maintenance Activities

Conduct maintenance operations on asphalt roads under dry to drying weather conditions. Water and asphalt are never a good combination.

Spring/Summer/Fall

Most asphalt maintenance activities can be conducted during the late spring, summer, or early fall. Conditions may vary so check the material manufacturer's instructions before applying.

Figure 3–29. Well maintained asphalt road

RULE OF THUMB

Conduct road inspections for adequate surface drainage during or immediately following a rainfall, when problems with drainage, sealed and unsealed cracks, and ponding of petroleum byproducts can be readily identified. Cracks are very prominent as the pavement surface is drying.

RULE OF THUMB

Progressive rutting (rutting that continues to grow deeper and wider) can be a result of poor subbase, very poor mix, or road design that is inadequate for actual loads. If progressive rutting is present, use of a surface treatment such as slurry seal should be avoided until the ruts become dormant or no longer grow.

Winter

Asphalt maintenance is seldom done during the winter. (Normally only cold mix is placed for the purpose of temporarily managing potholes during the winter.)

Asphalt Pavement Distresses

The key to effective asphalt pavement maintenance is first to identify the pavement distresses (described below) and then determine the most effective maintenance activity (described in the next section).

Typical distresses include ruts, cracks, centerline cracking, Lateral temperature cracking washboards, and potholes.

Rutting

Ruts are surface depressions that run parallel to traffic and are located in the wheel path. See figure 3–30.

Causes may vary, but in Alaska studded tires are a major contributor to rutting. Other causes include the following:

- Poorly designed mix. If the pavement has risen around the edges of the rut and above the surrounding surface, the rut is most likely caused by a poor mix. The uplift is a result of traffic pushing the asphalt to the edges of the wheel paths.
- Failure of the subbase. If there are longitudinal cracks in the rut, the rut is most likely caused by structural failure of the subbase. The pavement is being pushed down into the base or subbase.
- Poor compaction. If the rut is not accompanied by uplift on the edges or longitudinal cracking, the rut is a result of poor compaction during construction and the traffic vehicle loading has compacted the asphalt.

Figure 3–30. Rutting on an asphalt street

Cracks

Cracks develop over time due to flexing pavement and temperature changes that cause expansion and contraction. Full-depth cracks allow water to move through the pavement and infiltrate the roadway base and subbase. Infiltrated water decreases the load carrying capacity of these supporting layers. If not repaired or prevented, this cracking effect will grow, leading to deformation of the pavement, potholes, and ultimately the degradation of the pavement surface. Centerline cracking can be due to poor asphalt adhesion or inadequate compaction during asphalt laydown. If these occur, they should be treated with a crackseal application.

Fatigue Cracking

Fatigue cracks are a series of interconnected cracks in early stages of development that occur in areas, such as wheel paths, that are subjected to repeated heavy traffic loadings. See figures 3–31 and 3–32. These cracks develop into many-sided, sharp-angled pieces, usually less than one foot long on the longest side. In later stages, the cracks characteristically develop an alligator scale pattern.

Figure 3–31. Fatigue cracking (CCEE/ISU)

Figure 3–32. High-severity fatigue cracking (CCEE/ISU)

Block Cracking

Block cracking is a pattern of cracks that divides the pavement into approximately rectangular pieces. Rectangular blocks range in size from approximately 1 to 100 square feet. See figure 3–33.

Alligator Cracking

Alligator cracks are interconnected cracks that have the appearance of alligator scales. See figure 3–34. Alligator cracking is typically found in wheel paths and is normally accompanied by rutting. Alligator cracks form in areas of repeated heavy traffic loads that cause high stress in the bottom of the pavement. This stress cracks the pavement and the cracks propagate to the surface. The surface cracks begin with hairline longitudinal cracks and, as the pavement ages, the cracks begin to interconnect.

Reflection Cracks

Reflection cracks are cracks in an overlay that have "reflected" upward from cracks or joints in the overlaid pavement below. See figure 3–35.

Figure 3–33. Block cracking (CCEE/ISU)

Figure 3–34. Alligator cracking

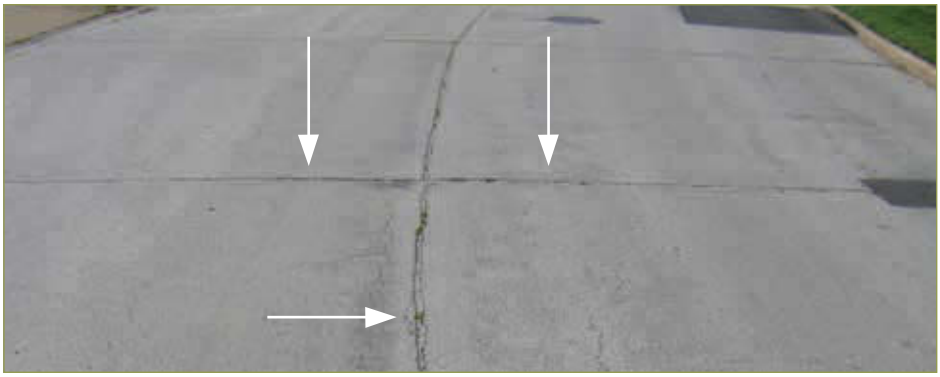


Figure 3–35. Reflection cracking (CCEE/ISU)

Washboards

Washboards or faulting are a series of deformations in the road running transversely, generally starting as reflective cracks and progressing to serious deformation when impacted by significant commercial traffic, such as loaded trucks. See figure 3–36.

Potholes

Potholes are bowl-shaped depressions of various sizes in the pavement surface, with a minimum width of three inches. See figure 3–37.

For purposes of classification, low-severity potholes are less than one inch deep, moderate potholes are from one to two inches deep, and high severity potholes are greater than two inches deep.

Generally potholes form when water becomes trapped beneath the pavement surface. (Water can infiltrate through cracks or poor drainage.) In the winter, the sub-surface water freezes and expands upward against the pavement. When the ice melts in the spring, it leaves a void under the pavement, and vehicle loads are not transferred to the base and subbase. Vehicles add more stress until the pavement surface collapses into a depression, which will grow as traffic breaks the edges.

Figure 3–36. Washboards (CCEE/ISU)

Figure 3–37. Pothole in asphalt pavement

Selecting a Maintenance Activity

After pavement distresses have been identified, determine the most effective maintenance activity. See table 3–1.

Selecting the most effective maintenance activity involves several factors:

1. Type and extent of distress
2. Roadway classification and traffic volumes
3. Cost of treatment
4. Availability of qualified staff and/or contractors
5. Availability of quality materials
6. Quality of the pavement and base material
7. Time of year for maintenance
8. Review of pavement maintenance records

Records should include the following:

1. Routine maintenance activities
2. Pavement base and subbase design
3. Pavement section boundaries
4. Pavement age
5. Type and extent of previous maintenance treatments
6. Traffic volumes
7. Environmental impacts

Routine Maintenance Activities

The goal of routine maintenance is to prevent or delay more serious pavement distresses. Routine maintenance includes regular roadway sweeping and crack sealing.

Table 3–1. Distresses and Maintenance Activities for Asphalt Pavements

Distresses	Maintenance Activities				
	(Routine) Crack Sealing	Surface Patching	Full-Depth Repair	Seal Coat Repair	HMA Overlay
Ruts			X		X
Cracks	X			X	X
Washboards			X		X
Potholes		X	X		

Street Sweeping

Sweeping removes dried, caked mud, abrasives, and other debris from the road surface. Clean road surfaces help keep drains clean, make travel safer for bicyclists, improve visibility of pavement markings, and promote good surface drainage.

Crack Filling and Sealing

Crack filling and sealing prevents water from infiltrating through the pavement into the base and subbase. Typically, cracks should be treated on a regular schedule such as every other year, or as needed.

The following instructions are general guidelines. Check with your supervisor and follow your local policy before starting any work.

See Safety Tips on page 36 and Alaska DOT&PF task analysis for Crack Sealing Activities and Inspection.

Preparing for Filling and Sealing (Optional preparation guidelines)

Use an air compressor and an air wand to clean cracks of dirt, dust, and remnants from sawing or routing. Contamination in a pavement crack will cause poor sealant bonding.

Applying the Sealant

After all cracks are blown clean by blowing them out and, if necessary, sometimes using a heat lance to get rid of any moisture, then seal the cracks:

1. Apply sealant at a temperature of 350°F– 410°F with the delivery hose and wand of the melter applicator. Take appropriate safety precautions when handling this hot material.
2. Pour an even bead of sealant into the crack no higher than ½ inch above the pavement surface. If it's higher, it could be damaged by snow plows or street cleaning equipment, and it may flow over the pavement surface.
3. To remove excess sealant, run a U-shaped squeegee or sealing shoe over the bead to flatten the sealant over the crack, move the sealant to the bottom of the crack, and remove excess sealant. The squeegee creates a U-shaped seal, allowing for contraction and expansion of the pavement during pavement temperature changes. See figure 3–38.
4. Keep traffic off the newly crack sealed surface until it has cured and set up. This will minimize tracking of material and allow for maximum adhesion to the surface. On occasions where this is not feasible, a light coating of sand spread over the sealant will act as a blotter and allow opening the street to traffic sooner.

Figure 3–38. Crack sealing

Asphalt Repair/Rehabilitation Maintenance Activities

Surface Patching

Surface patching is an interim repair method for potholes until more costly restoration can be programmed in the maintenance schedule. See figure 3–39.

The following instructions provide a general overview. Check with your supervisor and follow your local policy before starting any work. See figure 3–40.

Preparing for Surface Patching

1. Have all temporary traffic control installed before starting work.
2. Before patching, if possible correct drainage problems that likely caused the pothole formation, to prevent recurrence. Ensure a proper base is in place.
3. Make sure vehicle warning lights are on.
4. Use a shovel, broom, air hose, or mechanical sweeper to clean the area to be patched. In fact it is preferable to wash out the area to be patched to avoid having a dusty surface. The area must be clean and free of water, debris, and other loose material before patching.

RULE OF THUMB

If deterioration is 25 percent or less of the total pavement thickness, apply a surface patch.

If deterioration is more than 25 percent of the total pavement thickness, apply a full-depth repair.

Placing the Patch

After the area to be patched is clean and dry, place the surface patch.

1. Fill the pothole with patching material until it is slightly higher than the surrounding surface area.
2. Smooth the area with a shovel or lute, leaving the patch slightly higher than the adjacent surface.

Figure 3–39. Surface patch and full-depth repair (CCEE/ISU)

3. Compact the patch using a hand tamper, truck tire, or vibratory roller. The patch should now be consolidated and flush with the pavement surface.
4. Clean the area of any residual debris and haul it away.

SAFETY

See Safety Tips on page 36 and Alaska DOT&PF task analysis on Asphalt Maintenance.

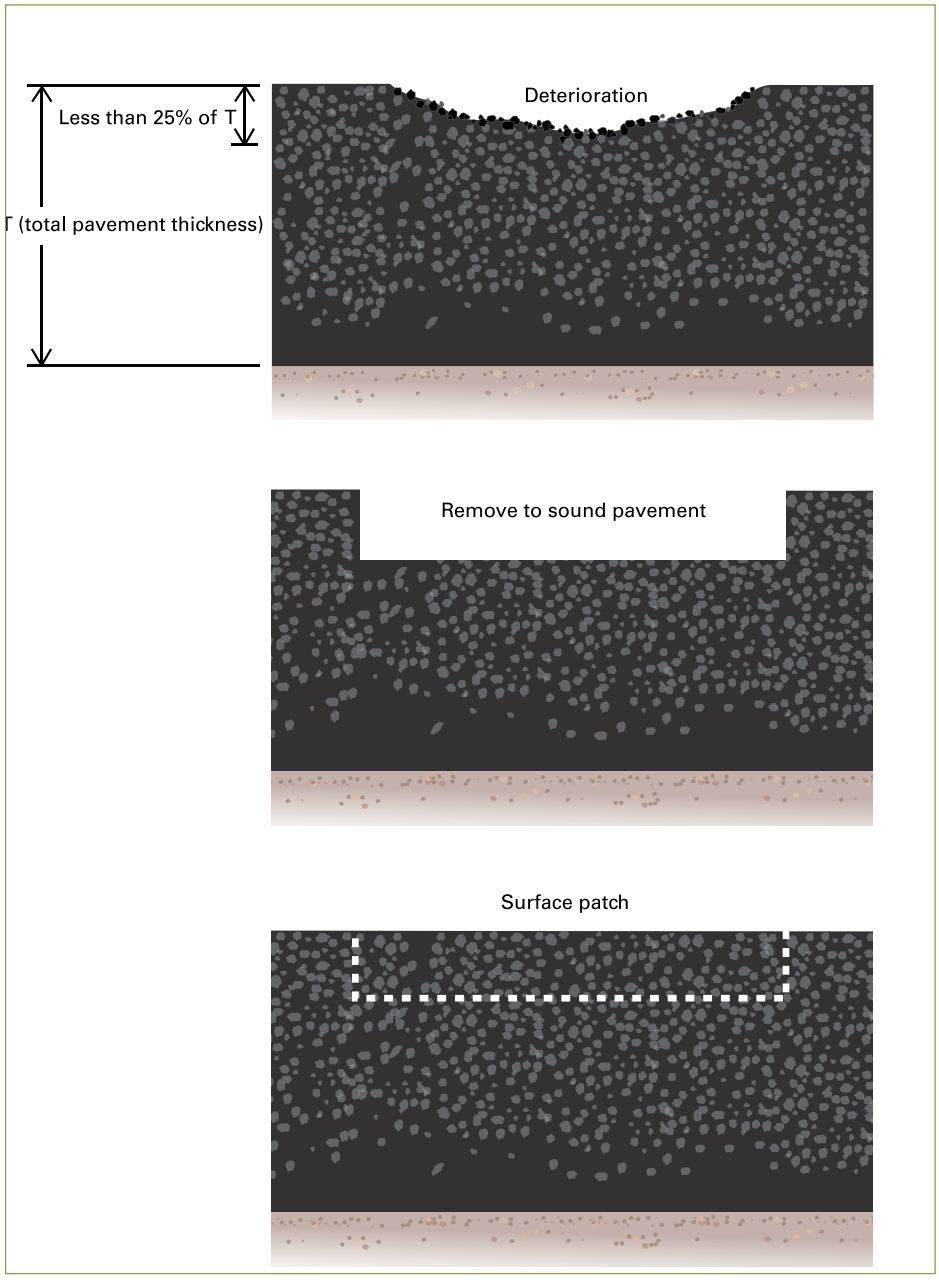


Figure 3–40. Procedure for placing surface patch

Patching Materials

An all-season patch material will work well in most conditions, including wet; however, dry conditions are always preferable.

Special products are available for cold-weather pavement patching and for use in adverse weather conditions. Such products cure rapidly and have good flexibility for withstanding extreme changes in temperature. Before applying these products, make sure pavement is frost free, dry, and free of coatings, dirt, oil, or other contaminants. Saw cut the perimeter of the patch to a minimum depth of ½ inch. Remove loose and deteriorated pavement. After applying the patch material, compact with truck tire or small roller.

Full-Depth Repair

This is a more permanent repair for distresses, like potholes, that are larger and/or deeper than surface degradation. It involves removing and replacing the distressed section of pavement for the full thickness of the pavement. See figure 3–41.

Preparing for Full-Depth Asphalt Repair

1. Use proper temporary traffic control as shown the Alaska Construction Manual and the MUTCD, part 6.
2. Make sure the warning lights on work vehicles are operating.
3. Saw cut around the area to delineate area to be removed.
4. Remove material with a jack hammer, picks, shovels, broom, air hose, or mechanical sweeper.
5. Clean and dry the excavated surface after removing deteriorated pavement material
6. Apply a tack coat to the edges of the existing pavement.

Placing a Full-Depth Repair

1. Obtain properly designed hot mix patch materials and place while mix temperature is high enough to allow desired compaction
2. Place in layers or lifts of approximately 2-inch thickness.
3. Compact each lift with a vibratory roller.
4. Reapply pavement markings if appropriate.
5. Allow traffic to drive on repair when the new asphalt is cool enough to touch.

Seal Coats

A seal coat is an application of an asphalt binder followed by covering with a layer of small aggregate. It is used to fill cracks and low spots, waterproof the surface, and/or provide a smooth wearing course for traffic. It is not intended

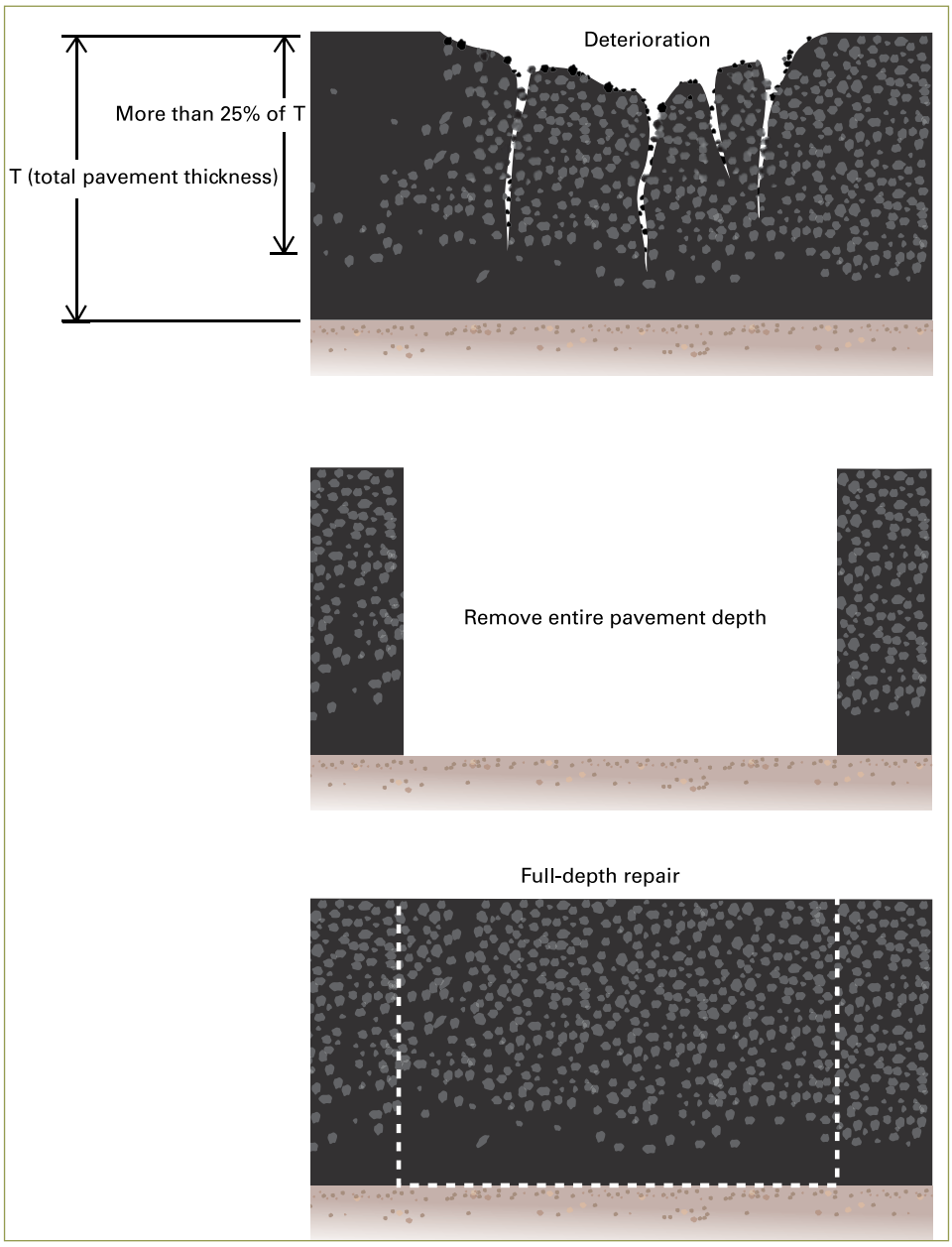


Figure 3–41. Procedure for full-depth asphalt repair

See Safety Tips on page 36 and Alaska DOT&PF Safety Manual task analysis for Asphalt Pavement Maintenance.

to repair major distresses or structural deficiencies. Seal coats can also be known as chip seals, tar and rock (informal description), oil and rock, and surface seal.

A newer surface treatment called micro surfacing has been developed in recent years that can provide an excellent option for addressing many road surface defects. Explicit details and guidelines for the proper use and application of seal coats may be found in chapter 7 of the Asphalt Surface Treatment Manual: www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_01_03.pdf.

A good seal coat should have the following characteristics:

- An adequate crown (slope) on the roadway for good drainage.
- Few unsealed cracks, alligator cracking, potholes, or ruts.
- Little to no dust during or immediately after application.
- A smooth tight surface with little or no bleeding or raveling. (Bleeding of the asphalt binder to the pavement surface may be caused by a too high application rate of asphalt binder. Raveling—a rough, pitted surface due to loss of aggregate—may be caused by damage from traffic or road equipment, oxidation of the surface, or poor original application or design.)

SAFETY

See Safety Tips on page 36 and Alaska DOT&PF task analysis on Bituminous Surface Treatment Activities and Inspection.

Materials

The two materials used for seal coats are binder (asphalt) and aggregate. See figure 3–42. Binders consist of either asphalt cutbacks or asphalt emulsions.

- Asphalt cutbacks are a mixture of asphalt binder and a cutter (naptha or kerosene). Once applied, the cutter evaporates leaving the asphalt binder behind. Cutbacks are not commonly used due to environmental concerns.

Figure 3–42. Asphalt binder and aggregate are used for seal coats

- Asphalt emulsions are mixtures of asphalt binder, water, and a surfactant soap. The soap suspends the asphalt in the water until application. The water then evaporates leaving behind the asphalt binder. Emulsions are generally thought to be more environmentally friendly but are susceptible to freezing in cold weather. See figure 3–43.
- Aggregates normally used for seal coats are crushed quartzite, stone, and/or pea sized gravel. See figure 3–44.

Figure 3–43. Binder (CCEE/ISU)

Figure 3–44. Gravel aggregate (CCEE/ISU)

Optimum Timing/Conditions for Applying Seal Coats

A new seal coat should be placed before structural distresses have occurred in the existing asphalt pavement or on a properly prepared stone base.

Application should not take place during cold/wet weather. The binders used for seal coat construction cure faster in hot, dry weather. Chipping and seal coat construction is normally not planned past August 15 near Fairbanks when temperatures begin to drop or the likelihood of rain increases. Areas south of that may extend their seasons slightly.

Seal coating should be delayed if wind speeds are high. Wind affects the spray pattern from the distributor truck and can blow dust and other debris onto the uncovered binder. Wind will also cause the binder to cure faster, decreasing the time available between binder spraying and aggregate application.

Preparing for Seal Coat Application

1. Complete pre-seal coating maintenance activities, like crack sealing or patching.
2. Select and install proper temporary traffic control as recommended by the Alaska Construction Manual and the MUTCD, part 6.
3. Ensure all equipment is on site and functioning properly (check the equipment manuals):
   - Power broom
   - Distributor truck
   - Chip spreader
   - Pneumatic tire roller
   - Sufficient dump trucks for aggregate hauling
4. Ensure the materials are on site or readily available. The aggregate should be clean and dust free.
5. Sweep and clean the pavement to remove debris. See figure 3–45. Remove vegetation from cracks.
6. Cover utility access lids with construction paper so the material does not adhere to the lid.

Placing a Seal Coat

1. Using a distributor/applicator truck, spray the pavement with the binder.
   - Use roofing paper to make a sharp line across the pavement when starting and stopping application.

Figure 3–45. Cleaning the existing pavement surface (CCEE-ISU)

- Align the binder applicator with the center line of the road. Align the nozzles and set the spray bar height as appropriate. See figure 3–46.
- If using a slow setting emulsion or cutback, spray approaches or intersection radii first. If using a rapid setting emulsion, spray approaches and radii after the main road.
- Apply only as much emulsion or cutback as the chip spreader will be able to cover with a load of aggregate. Calibrate this distance by measuring the length the chip spreader travels on one load of aggregate.

2. In general, apply the aggregate using a chip spreader before the binder has set, within one and one half minutes after it has been applied. See figure 3–47.
3. Roll the aggregate with a pneumatic tire roller closely behind the chip (aggregate) spreader. See figure 3–48.
4. Make at least three complete coverages of the roller on the newly spread aggregate surface.
5. Do not start and stop the roller quickly. This will cause displacement of the aggregate.
6. After several days (or when the surface has properly cured), sweep off excess unbound aggregate and maintain the surface with additional cover aggregate as necessary and where needed. Repair any failed areas before striping.

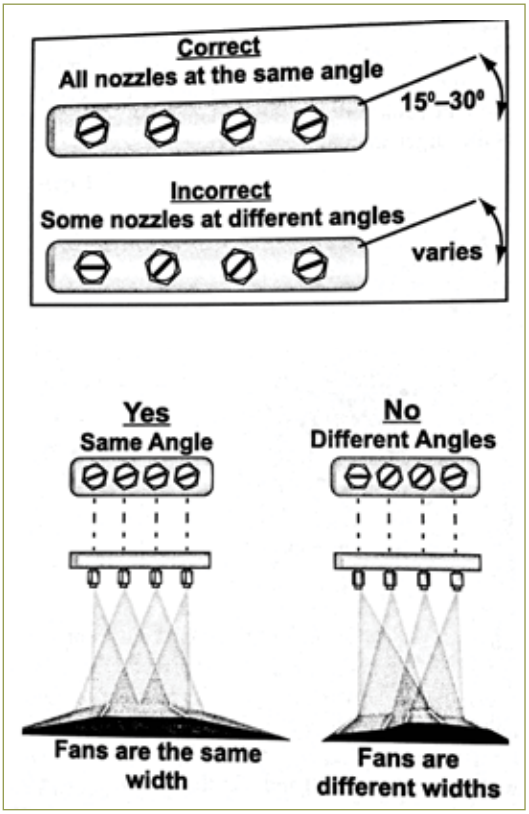


Figure 3–46. Align nozzles at same spray angle

Application Rates

Application rates will vary, depending on materials used and the condition of the surface. The following rates are guidelines:

Binder. Application rate varies by emulsion type. See Tables 3–3, 3–4, and 3–5.

Figure 3–47. Test for binder set (CCEE/ISU)

The thickness of binder applied should be approximately 50 to 70 percent of the thickness of the aggregate. If the pavement is smooth with few voids, the application rate will be lower. If the pavement is rough with lots of voids, the application rate should be higher.

Aggregate. Application rate varies by cover coat size and emulsion type. See Tables 3–2, 3–3, and 3–4. The aggregate should thoroughly cover the binder without excess. If the aggregate is not covering the binder, increase the aggregate application rate. If excess aggregate is visible, decrease the aggregate application rate. (Excessive aggregate (unbound aggregate) will be kicked up by traffic and may damage vehicles. Excessive aggregate leads to additional cost, cleanup, dust, and disposal.)

Note that both aggregate spreader and the distributor need to be calibrated for the intended application rates (see pages 51–56 of the Asphalt Surface Treatment Manual for procedures).

Seal Coat Operations

Before construction, the **supervisor** or **distributor truck driver** can ensure that

- Temporary traffic control is in place.
- The aggregate is on site.
- The distributor truck is properly functioning with all of the nozzles properly aligned and cleaned and the spray bar at the right height.
- The pavement has been swept.
- Other equipment (chip spreader, roller, aggregate truck, and sweeper) is on site, calibrated and is prepared to begin construction.

Figure 3–48. Pneumatic tire roller

RULE OF THUMB

A simple test for binder set is to throw a handful of chips across the newly applied binder.

If the chips stick to the binder, it is time to apply the aggregate. See figure 3–47.

However, if the binder begins to form a wave in front of the aggregate spreader, wait briefly for the binder to set up a little. (Binder waves cause corrugations in the seal coat.)

If the chips bounce, the binder has set and the chips won't adhere. Reapplication of binder will be needed.

During construction, the **distributor truck driver** should

- Maintain a proper distance in front of the chip spreader.
- Record the asphalt binder left in tank.

Before construction, the **chip spreader operator** can ensure that

- The gates are properly opened and aligned in order to apply a uniform aggregate spread.
- The belts, feeds, and augers are working properly

During construction, the **chip spreader operator** should

- Maintain communication with the distributor truck operator.
- Tell the distributor truck operator when to stop because the chip spreader is running out of aggregate. This will prevent areas of binder from sitting too long.
- Watch the operation to ensure the application is consistent and there are no streaks.
- Make sure aggregate is clean and free of debris.

Before work begins, the **pneumatic tire roller operator** ensures that the tires are at the specified air pressure, typically 45 psi or higher.

During the work, the **roller operator** should

- Check to see if too much binder has been applied, causing the seal coat to bleed, or if not enough binder has been applied, causing the aggregate not to stick to the pavement.
- Check to see if the proper amount of chips is applied evenly over the surface.
- Make sure the roller is not changing directions too quickly, causing the aggregate to come unbound from the binder.

Foremen/workers can ensure that

- The distributor application is consistent and not streaking.
- The chip spreader has a consistent application rate and is applying the aggregate roughly one pebble thick. If the aggregate is piling up in front of the aggregate fall, the application rate should be reduced

Cleaning Up

1. Install proper warning and speed plates to warn motorists of conditions.
2. Pick up all unneeded traffic control signs the next work day after the seal coat has been installed.
3. Clean the work zone and each driveway and parking area of debris.

RULE OF THUMB

To check for proper binder application rate, remove a few stones that have been embedded in the binder by the pneumatic roller. About 50 to 70 percent of the aggregate should be coated with binder.

If the tires on the chip spreader or roller are picking up aggregate, there's too much binder for the amount of aggregate. Decrease the binder application rate or increase the aggregate application rate.

Table 3–2. Expected Range of Application Rates and Allowable Tolerances for Seal Coat AST

Material Type	Expected Range of Application Rate	Allowable Tolerance
CRS-2 or CRS-2P*	0.20–0.35 gal/yd^2 0.9–1.6 L/m^2	0.4 gal/yd^2 ± 0.18 L/m^2
Cover Aggregate◊	20–26 lb/yd^2 11–14 kg/m^2	1.3 lb/yd^2 ± 0.7 kg/m^2

* Depending on the amount and type of polymer used, application rates for both emulsified asphalt and cover aggregate may be significantly outside the ranges indicated.
◊For aggregate size reference highway specification 703-2.05.

Table 3–3. Expected Range of Application Rates and Allowable Tolerances for Double-Layer AST

Material Type	Expected Range of Application Rate	Allowable Tolerance
For the First Layer:		
CRS-2 or CRS-2P	0.35–0.51 gal/yd^2 1.6–2.3 L/m^2	0.04 gal/yd^2 ± 0.20 L/m^2
Cover Aggregate	41–50 lb/yd^2 22–27 kg/m^2	2.4 lb/yd^2 ± 1.3 kg/m^2
For the Second Layer:		
CRS-2 or CRS-2P	0.51–0.60 gal/yd^2 2.3–2.7 L/m^2	0.04 gal/yd^2 ± 0.20 L/m^2
Cover Aggregate	20–26 lb/yd^2 11–14 kg/m^2	1.3 lb/yd^2 ± 0.7 kg/m^2

Table 3–4. Expected Application Rate andAllowable Tolerances for High Float AST

Material Type	Prescribed (starting) Application Rate	Allowable Tolerance
HFMS-2s	0.75 gal/yd^2 3.4 L/m^2)	0.04 gal/yd^2 ± 0.18 L/m^2
Cover Aggregate	75 lb/yd^2 41 kg/m^2	2.6 lb/yd^2 ± 1.4 kg/m^2

Hot Mix Asphalt (HMA) Overlay

A hot mix asphalt overlay is a new layer of asphalt (generally 1.5 to 3 in./lift thick) over an existing pavement or prepared stone base. Overlays can protect and add some strength to the existing pavement structure, reduce the rate of deterioration, and improve deficiencies like ride quality.

RULE OF THUMB

Everyone is responsible for quality control of the operation.

Overlays should not be applied to seriously distressed pavement systems without expert advice regarding the causes and possible solutions for the distress.

In lieu of a simple overlay, cold in-place recycling can provide a good option for addressing surface defects in addition to placement of an overlay.

Preparing for a Hot Mix Asphalt Overlay

1. Have all temporary traffic control installed before starting work.
2. Mill out tapers (two-inch wedges) at both the start and stop points of the overlay to produce a smooth tie-in to the existing pavement. See figure 3–49.
3. If possible, lay tack paper to avoid overspraying of tack coat on adjacent pavement. Place temporary cold mix ramps to maintain traffic flow without a major bump.
4. Take special care to ensure that drainage will be maintained (e.g., Place a wedge of new overlay on the intersecting side road or mill in to avoid ponding of drainage).
5. Remove loose material and water from deteriorated areas. Clean, patch, and compact. (See Full-Depth Repair on page 46.)
6. Replace any failed areas of curb or shoulder.

Figure 3–49. General milling operations

7. Make sure all manholes and intakes are working properly in urban areas.
8. Also in urban locations, count the number of risers and lids needed for manholes, water, gas, and monument castings. Inventory, check for fit, and place on site the day before the overlay is to be installed. Contact measurements to locate all utilities in case they get buried and need to be dug out.

Other Possible Preparations:

9. Notify residents in advance when preparation work and overlay will be performed on their street or road.
10. Cut back any low hanging tree limbs that equipment could break loose and that may contaminate the overlay material.

Day before the Overlay

1. Sweep the roadway. Remove any grass and water in pavement cracks.
2. Call the asphalt plant and let them know your tonnage requirements.
3. Using the haul distance plus a time allowance for unloading, try to match the rate of paving to the rate of delivery. (This may require "on the fly adjustments" during the project.)
4. Notify police, fire, and transit of roadway closure if traffic is not maintained.

Placing the Hot Mix Asphalt Overlay

1. Have all temporary traffic control installed before starting work.
2. Spray the paving machine with release agent and heat the screed to operating temperature.
3. Remove any temporary ramps and tack paper.
4. After the roadway has been cleaned, apply a tack coat at the proper rate to assure proper bonding of the new overlay to the existing pavement or base. Tack coat should set before overlay. The type of tack can make a difference in colder weather.
5. Contact the asphalt plant and have trucks loaded and dispatched to the project.
6. Identify areas where leveling courses need to be placed to fill in low spots, and pave as needed. This may be done by placing an adequate amount of mix material for the leveler, spreading it with the blade of a motor grader, and then rolling as necessary to compact the material.
7. Make sure all risers and lids are in place if working in an urban area.
8. At the beginning of the section to be overlaid, set up the paver to run the finish course. Set the heated screed on a lath to place the desired mat elevation.
9. Get all paver personnel in position with their tools.

RULE OF THUMB

Asphalt Overlay Depth

Asphalt will compact approximately 20 percent after rolling. So if the layer being placed is to be 2 inches thick, the mix passing out from under the screed should be about 2½ inches deep to allow for this compaction.

Laying Asphalt on Curb Edge

Placing asphalt along a curb edge takes more hand work than placing asphalt on a non-curbed roadway. Most driveways need a wedge placed at the opening to keep water from ponding. When constructing these wedges, the correct amount of hot mix asphalt must be added to force water past the drive. The upper edge of the wedge should be squared off and tapped with a lute, then compacted before the mix cools.

Estimating Tonnage

On the final finish course pass, the supervisor needs to be aware of the tonnage going through the paver and the distance the paver travels per load. This will help in estimating the tonnage needed in the last truck load for the project.

10. Back the first truck up to the paver. When contact is made, raise the truck box before the tailgate is tripped to deliver the mix to the paver hopper. This dumping procedure will cause the mix to slide against the tailgate. Upon tripping the gate, the mix will flood the hopper and reduce the amount of segregation that appears behind the screed.
11. An alternate method of providing a more uniform supply of asphalt mix to the paver is by using belly-dump trucks to haul the mix and then placing it as a windrow in front of the paver near the center of the lane width being paved. A pickup machine may be inserted into the equipment train to pick up the windrow and uniformly deliver it to the paver.
12. If the truck needs to be pulled away from the paver after loading (due to incline or some other reason), before the paver starts make sure the mix has not spilled on the road surface and accumulated in front of the paver tracks. Remove any spills. Otherwise the paver will ride on this material, and the pavement surface will be irregular. Also, be careful not to back trucks into the paver at too high a speed. Striking the paver with a loaded truck will cause a ridge to be formed in the new surface behind the paver.
13. During paving, the hopper on the paving machine should be full at all times to ensure a constant flow of materials to the screed. In addition, the augers that move the mix in front of the screed should be turning most of the time so that the mix is uniform in composition before compaction. Keep the plant aware of any major breakdowns that force you to stop paving.
14. Compact the asphalt overlay lift with a double drum roller (breakdown roller) and a steel-wheeled roller (finish roller). The breakdown roller provides weight and energy to compact the mix; it should be operated as close as possible behind the paver, but not so close that the mix is rutted or disturbed. The finish roller removes the tracks left by the breakdown roller and should be as close as possible behind it without tearing the surface.
15. In order to establish a satisfactory roller pattern that yields the desired density, it is sometimes necessary to use a consultant testing service to measure the in-place density of the lift being laid. If the minimum desired density is not obtained, then the rolling pattern can be adjusted or more rollers added and the density resampled until it meets or exceeds the minimum.
16. After paving and rolling operations have concluded, be sure the overlay has cooled before adding temporary traffic markings and allowing use by traffic.
17. Replace permanent pavement markings after allowing overlay to cool and before complete opening of the roadway.

See Safety Tips on page 36 and Alaska DOT&PF task analysis Asphalt Kettle and Distributor.

Cleaning Up

- Remove all traffic control signs immediately after the overlay has been completed.
- Clean the work zone, driveways, parking areas, sidewalks, and shoulders of debris and excess asphalt.

For More Information

A series of pamphlets called Pavement Preservation Checklist Series developed by the Foundation for Pavement Preservation and the Federal Highway Administration provides useful information on the construction of seal coats and other thin maintenance surfaces.

The pamphlets also define various quality control techniques for different surfaces and include quality control checklists. The pamphlets are available from the Alaska LTAP (T2) library. Contact (907) 451-5320, david.waldo@alaska.gov.

Portland Cement Concrete Pavements

Safety Tips for Maintaining Concrete Surfaces

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual (see Concrete Pavement Maintenance Task Analysis).

Suggested personal safety gear

- Hard hat
- Safety glasses with side shields to protect eyes
- Ear plugs or muffs (for use around jack hammers or other noisy equipment)
- Protective gloves for handling fresh concrete, to avoid skin irritation
- Heavy boots with hard-toe protection
- Rubber boots if you will be standing in fresh concrete
- Highly visible apparel

Advance preparations

- Be properly trained and familiar with all equipment.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site.
- Be trained in avoiding heat-related illnesses, like heat exhaustion.

During operations

- If road is open to traffic use proper temporary traffic control, including flaggers if needed, as described in the Alaska Traffic Manual and the Alaska Construction Manual.
- Wear highly visible apparel when not in a vehicle.
- Do not park vehicles and equipment on both sides of the road.
- Be aware of and take steps to avoid heat-related problems like heat stress and exhaustion.
- Use proper lifting techniques or request assistance to lift heavy objects.
- Workers on foot should always be aware of backing equipment.
- Workers should be provided periodic breaks and rest room accommodations.

Traditional maintenance treatments for portland cement concrete (PCC, or simply concrete) pavements include routine sweeping and cleaning, joint and crack sealing, temporary repair with asphalt, joint repair, mud jacking, and surface and full-depth repairs.

Characteristics of a Well Maintained Concrete Pavement

- The roadway cross slope provides effective drainage.
- There are no unsealed cracks or joints.
- Little to no standing water follows rain and/or ice melt.
- No differences in elevation between adjacent concrete sections. See figure 3–50.

Optimum Timing/Conditions

The timing and type of patching depends on the condition of the pavement and the temperature. Patching should not be conducted when air temperature is below freezing. If the newly placed concrete patching material is not of proper temperature, it will not cure properly and lose strength.

Some regions have guidelines for allowable moisture content as well as proper air and ground temperatures for placing concrete. Check with your supervisor before starting this work.

If properly protected from the elements, concrete can be placed and cured in most environmental conditions; however, concrete should be placed in cold and/or wet conditions only if necessitated by extreme needs.

Figure 3–50. Well maintained concrete pavement

RULE OF THUMB

Concrete should never be placed on frozen or saturated subgrade, nor placed in weather conditions that would allow the mix to freeze without adequate protection to prevent that from happening.

Most types of concrete maintenance treatments can be placed during the late spring, summer, or early fall. Conditions for maintenance vary according to the treatment type and pavement conditions.

Concrete patching can be done in the winter if needed. Fresh concrete needs to be protected from frost and freezing until it gains the required strength. Practically speaking, this means that the subgrade and the concrete adjacent to the patch must not be frozen.

If the air temperature is expected to fall below 40°F in the 72 hours following paving, the American Concrete Pavement Association recommends covering the new pavement with insulating blankets, mats, or foam sheets. Consider using high early concrete mix. (It is hotter during curing). Use of cold mix asphalt as a temporary measure may be preferable.

Concrete Pavement Distresses

The key to effective concrete pavement maintenance is first to identify the pavement distresses (described below) and then determine the most effective maintenance activity (described in the next section).

Cracks

Cracks develop or expand over time due to temperature changes that cause expansion and contraction. Some joints/cracks are part of the design and construction process (e.g., cracks that form at joints), and some develop randomly as the pavement is stressed, generally with a spacing of about 15–20 feet.

Cracks allow water to infiltrate the pavement base and subbase, potentially decreasing the base load-carrying capacity. If not repaired or prevented, this cracking effect will grow, leading to deformation of the pavement and ultimately the degradation of the pavement surface and structure.

Cracks that develop because of pavement stresses include transverse cracks, longitudinal cracks, D cracks, and map cracking.

Transverse Cracks

Transverse cracks run across the pavement, perpendicular to the shoulder. See figure 3–51.

Longitudinal Cracks

Longitudinal cracks run parallel to the shoulder. See figure 3–52.

D (Delamination) Cracks

D cracking occurs at pavement cracks and joints where adjacent sections intersect. The failure is due to poor quality aggregate in the original concrete mixture. See figure 3–53.

Map Cracking

Map cracking is a pattern of interconnected random cracks that indicate insufficient pavement thickness and/or failure in the subbase. See figure 3–54.

Although some cracking in PCC pavements is designed and anticipated, much cracking deterioration is due to excess loading, deficient materials, and/or poor construction techniques.

Joint Deterioration/Spalling

Joints are sawed in new pavement to induce cracking at desired locations. This helps relieve stresses and prevents random cracking. Joint deterioration like spalling is caused when water and debris fill the joint space, putting pressure on the concrete edges. Spalling can also be caused by too much water in the mix when the fresh concrete was placed. See figure 3–55.

Figure 3–51. High-severity transverse cracks (FHWA)

Figure 3–52. High-severity longitudinal cracks (FHWA)

Figure 3–53. High-severity D cracks (FHWA)

Figure 3–54. Map cracking (FHWA)

Scaling

Scaling is the deterioration of the upper ⅛- to ½-inch of the concrete slab surface and may occur anywhere on the pavement. It may be caused by deicing chemicals, too much water in the mix, or inadequate application of curing compound. See figure 3–56.

Figure 3–55. Spalling (FHWA)

Figure 3–56. Scaling (FHWA)

Pavement Settlement

Individual pavement sections sometimes settle, particularly bridge approach panels. A slab with tilted or uneven panels may indicate that subbase materials have migrated from beneath the slab or that inadequate compaction of the base occurred.

Faulting

Faulting is a difference in elevation across a joint or crack. This is caused by the settlement of one or both of the slabs or by rocking of the slabs as heavy vehicle traffic moves across the joint or crack. See figure 3–57.

Pumping

Pumping is the seeping or ejection of water and subbase material from beneath the pavement through joints and cracks. In some cases, detectable deposits of fine material eroded (pumped) from the support layers are left on the pavement or shoulder surface and stain the surface.

Corner Breaks

A corner portion of a section may separate from the slab along a crack that intersects the adjacent transverse and longitudinal joints at an approximately 45-degree angle. The length of the sides varies and may extend up to one-half the width of the slab on each side of the corner. This distress is also commonly caused by passage of heavy loaded vehicles, inadequately designed pavement thickness, and/or poor support base support. See figure 3–58.

Figure 3–57. Faulting (FHWA)

Figure 3–58. Corner break (FHWA)

Pavement Failure

A pavement is considered to have failed when the deterioration of the concrete becomes so severe that the only option for restoration is to remove and replace the pavement.

Maintenance Activities

Maintenance activities include routine maintenance such as street sweeping and joint and crack filling or sealing. Repair and rehabilitation activities include temporary surface repairs, joint repairs, mud jacking, surface patching, and full-depth patching. See Table 3–6.

Table 3–5. Distresses and Maintenance Activities for Concrete Pavements

Distresses	Maintenance Activities					
	Routine					
	Joint/Crack Sealing	Surface Patching	Temporary Repair	Joint Repair	Mud Jacking	Full-Depth Repair
Cracks	X					X
Joint Deterioration/Spalling	X			X		X
Blowups			X			X
Scaling		X	X			
Pavement Settlement			X		X	
Faulting			X		X	
Pumping				X		
Corner Breaks				X		X
Pavement Failure						X

Since most maintenance on open roadways is conducted under traffic, refer to proper references such as the Alaska Traffic Control Manual or the Manual on Uniform Traffic Control Devices (MUTCD) for proper temporary traffic control procedures.

The goal of routine maintenance is to prevent or delay major pavement distresses. Check with your supervisor, and follow your local policy.

Road/Street Sweeping

Sweeping removes dried, caked mud, abrasives, and other debris from the road surface. See figure 3–59. Clean road surfaces help keep joints and drains clean, improve visibility of pavement markings, and make travel safer for bicyclists. See HMA comments for this activity.

Joint/Crack Sealing

Joints in concrete pavement are usually sealed during the initial construction process. Periodically, they will need to be cleaned and resealed to keep them free of water and sediment and to protect the subgrade from water intrusion. Random cracks, too, may need to be sealed or resealed.

The work will generally be done on an as-needed basis. It is usually completed in the spring or fall when temperatures are moderately cool and the joints are open. The following instructions are general guidelines for both joints and random cracks. For example, you may or may not be instructed to use backer rods. Check with your supervisor, and follow your local policy.

Preparing for Joint/Crack Filling

1. Rout or saw-cut joints to remove existing sealant and other materials and to provide clean, uniform surfaces for filler material to adhere to and a reservoir for sealant. Rout joints to a width of ½ inch and a depth of ¾ to 1 inch, or per your supervisor's instructions. See figure 3–60.

Figure 3–59. Street sweeper (WDM)

Figure 3–60. Routing cracks (WDM)

2. In some agencies, you may then be instructed to sandblast the joints.
3. Use an air compressor and an air wand to clean joints of dirt, dust, and remnants from sawing/routing and sandblasting. Contamination in a joint will cause poor sealant bonding. See figure 3–61.

Applying the Sealant

After all joints are clean, finish the process (see figure 3–62):

1. If using backer rods in joints, place the rod to the proper depth to ensure the correct shape of the sealant reservoir. On road surfaces where surface milling or grinding is planned at a later date, the backer rod and sealant should be installed so that the sealant is approximately ¼ inch below the road surface after grinding is complete.
2. Apply sealant according to specifications and the manufacturer's recommendations. The joint will be filled with a concave bead (∪). The shape factor generally ranges from 1:2 to 2:1, depending mainly on the elasticity of the sealant material. Be guided by the type of material and the specifications for determining the proper shape factor.

Temporary (Asphalt) Repair

For areas experiencing scaling, faulting, pumping, or blowups, a temporary repair using asphalt may be appropriate:

1. Blow out joints with compressed air.
2. Remove broken concrete and square up the sides of the area.
3. Apply a tack coat.
4. Place an asphalt wedge and compact it.

SAFETY

See Safety Tips on page 58.

RULE OF THUMB

For the sealant to adhere adequately, the surfaces of the joint must be completely clean and dry. Run your finger along the joint wall to test for cleanliness and dryness.

Figure 3–61. Cleaning joints before applying sealant (WDM)

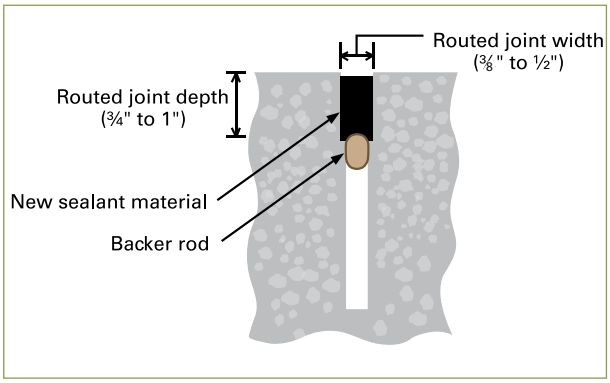


Figure 3–62. Joint with backer rod and filler

For severe and recurrent pumping, installing longitudinal drains along the pavement can be effective, if the base is sufficiently drainable.

Joint Repair

For corner breaks, spalling, and D cracking, repair the area using a concrete or asphalt mix:

1. Saw cut, break out, and remove loose material, leaving the faces of the remaining area near vertical. A cutting torch or saw may be necessary for cutting pavement reinforcement. Normally the steel network is not reestablished when surface or partial depth patching.
2. Clean the hole with compressed air to remove moisture and debris.
3. Fill the hole with concrete mix, normally delivered by a ready-mix operation.
4. Consolidate the mix with a vibrator (or roller for asphalt).
5. Screed and finish the surface, but do not add free water. (Adding free water to the surface dilutes the cement paste, and the surface is likely to scale off in the near future.)
6. Cure the concrete by covering with a liquid curing compound and plastic or wet burlap. The burlap should be kept wet until the initial concrete strength is
developed.

See Safety Tips on page 58.

Partial Patching

Apply a partial patch to repair corner breaks, scaling, D cracking, and construction joint deterioration where the depth of deterioration is less than 50 percent of the total pavement thickness. See figure 3–63.

1. Mark the area to be patched two to three inches outside the distressed area.
2. Remove surface concrete with light- to medium-weight jack hammers to avoid damaging the sound concrete on the bottom layer of the pavement slab. Remove any existing reinforcement as needed.
3. Sandblast exposed concrete and clean the area with compressed air.
4. Place a form for reestablishing the shoulder edge, if appropriate.
5. In reinforced pavement, reestablish the reinforcement by overlapping and tying or welding with either a double-face 4-inch weld or a single-face 8-inch weld.
6. Brush cement or epoxy grout along the patch edges.
7. Before the grout has set, place low-slump concrete patch material and consolidate it with adequate mechanical vibratory screeds.
8. Texture and cure the concrete. Apply a double application of white pigmented curing compound.

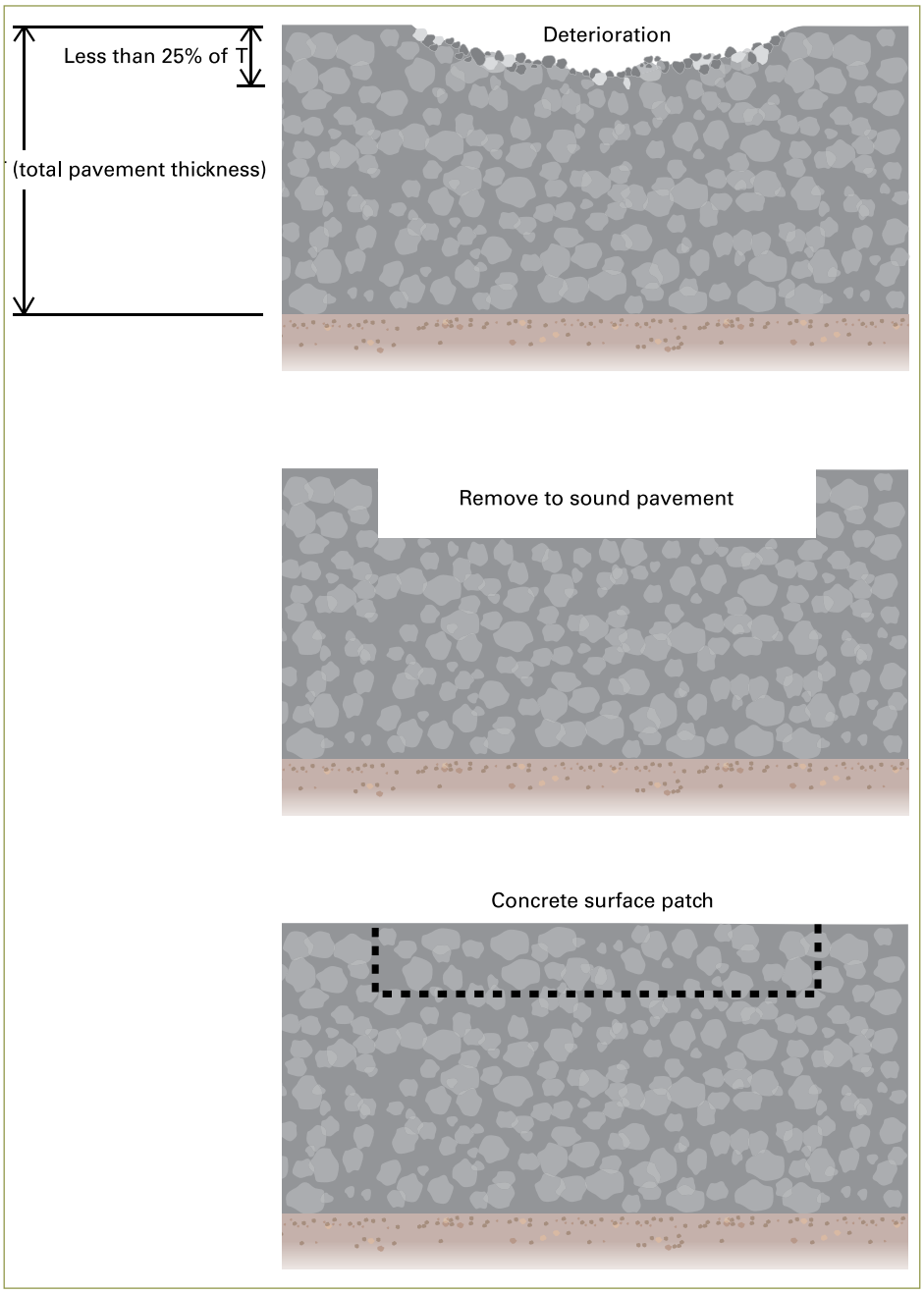


Figure 3–63. Concrete surface patching

RULE OF THUMB

If deterioration is 50 percent or less of the total pavement thickness, apply a surface patch.

If deterioration is more than 50 percent of the total pavement thickness, apply a full-depth repair.

Alaska Digline (811)

Alaska law requires that anyone planning any form of excavation must contact the Alaska One Call notification system (1-800-478-3121) at least 48 hours in advance so that utilities can be located and marked. Always consult your supervisor before conducting any excavation, which may include mudjacking and full-depth repair.

Full-Depth Repair

Apply a full-depth repair for corner breaks, scaling, D cracking, construction joint deterioration, and localized distresses where the depth of the deterioration is greater than 50 percent of the total pavement thickness or covers a large area. See figure 3–64.

1. Mark the area to be patched two to three inches outside the damaged area.

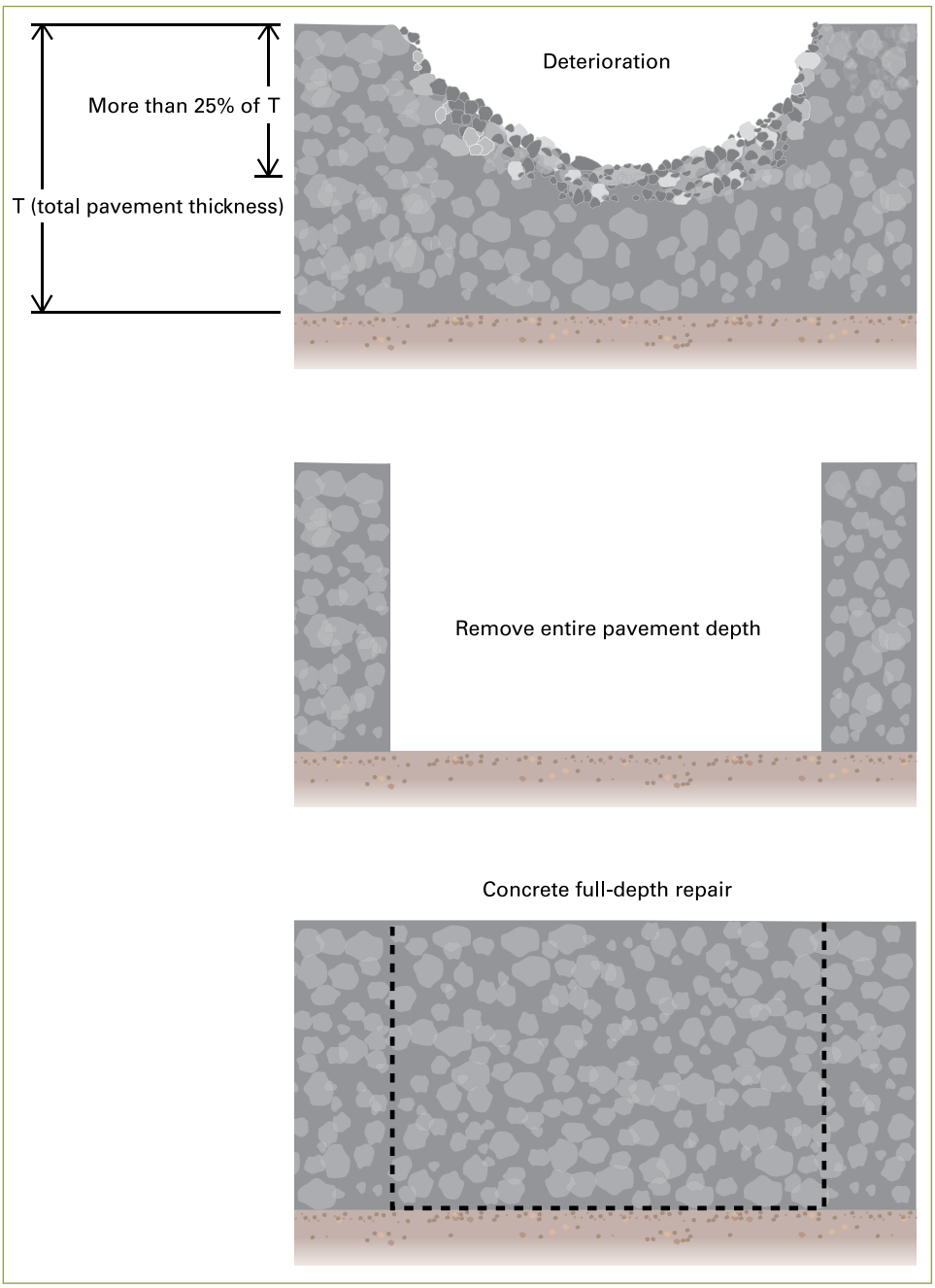


Figure 3–64. Concrete full-depth repair

2. Saw cut and remove full depth of concrete slab without damaging adjacent pavement sections. See figure 3–65.
3. Remove any unsound base or subbase. If a pre-cast patch is to be used, the base or subbase needs to be restored and compacted. If a serious drainage problem exists, it should be corrected with transverse, lateral subdrains, etc.
4. Other than with a pre-cast patch, place a form for reestablishing shoulder edge.
5. Sandblast exposed concrete and clean area with compressed air.
6. Use epoxy coated dowel bars and deformed rebars for load transfer in all full-depth repairs.
7. Place low-slump concrete with adequate mechanical vibratory tools. See figure 3–66.
8. Texture and cure the concrete properly.

See Safety Tips on page 58.

Mud Jacking

Mud jacking raises and adjusts a slab that has settled. Workable material is pumped through holes drilled in the concrete slab. The material exerts sufficient pressure on the lower side of the slab to raise it to an elevation even with adjacent pavement sections.

1. Examine the site and determine low spots by using line or elevation levels as appropriate. Look for the points of water intrusion into the pavement and where the subbase material has been deposited.
2. Drill approximately 2-inch diameter core holes through the concrete slab at selected locations, or use preformed holes or previously drilled holes as appropriate.
3. Starting at the downhill portion of the underlying void and working up, begin pumping the mud jack mix into the predrilled holes. As the mixture raises the slab to the desired elevation or the void fills to capacity, move uphill to the next set of drill holes. It's important to lift the slab uniformly to avoid cracking it.
4. Plug each hole temporarily once the hose is removed. Use a plastic plug or a burlap bag until the mixture has cured.
5. After the entire slab area has been adjusted to grade, clean out each hole and refill with a fast-setting cement grout.
6. Reseal any cracks and joints.

Figure 3–65. Removing full depth of slab (WDM)

Figure 3–66. Placing concrete

Blowup Repair

Blowups often occur at the end of the day, and a temporary asphalt patch may be applied initially to level the pavement. Later a crew will return and place a full-depth patch. When the permanent repairs are made, it is important that room be left for future pavement expansion or there will likely be another blowup at the same location.

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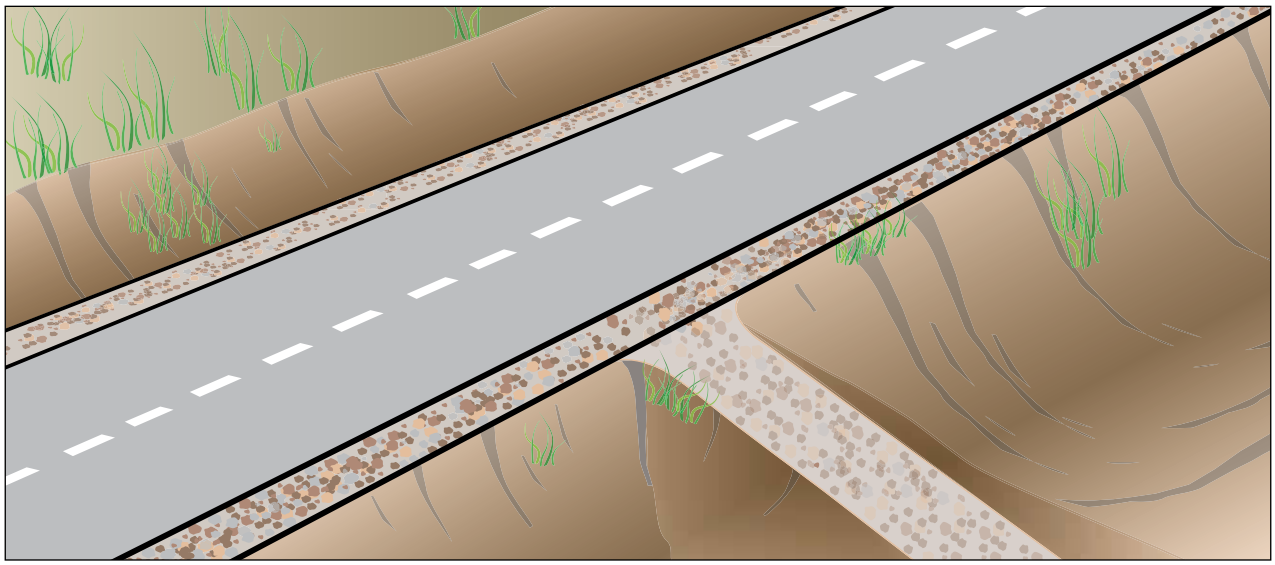
Chapter 4:
Shoulders and Roadsides



chapter contents

Safety Tips for Maintaining Shoulders and Roadsides

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual (see Maintenance Stabilization of Unpaved Roads Task Analysis).

Suggested personal safety equipment

- Highly visible apparel
- ANSI/ISEA 107-2004 Class 2 top for daytime; Class 2 top and Class E bottom during night or flagging or setting up traffic control devices; and Level 2 retroreflective material.
- Hardhat (when exposed to danger of overhead injury)
- Eye and ear protection
- Hard toed footwear
- Long sleeve shirt and full leg pants
- Heavy gloves
- First aid kit
- Insect repellent

Advance preparations

- Be properly trained and familiar with equipment.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site.
- Be sure all work vehicles have approved and activated warning lights.

During operations

- Use temporary traffic control, including flagger(s) if needed, as described in the Alaska Traffic Manual supplement to the Manual on Uniform Traffic Control Devices, and remove devices immediately when no longer needed.
- Check sight distance for approaching traffic before starting work and adjust advance warning signs as needed.
- Do not park vehicles and equipment on both sides of the roadway.
- Do not back equipment into traffic lanes without a spotter.
- Keep open roadway clear of loose aggregate and other debris.
- Do not leave edge drop-offs unprotected overnight.
- Be properly trained for operating equipment such as mowers, chain saws, etc.
- Wear and use proper PPE when operating or working around chain saws and other tools/equipment.
- Wear back protection when lifting heavy objects.
- Operate mowers in direction of traffic.
- Use guards on mower decks to avoid throwing rocks and debris onto roadway.

Shoulders are adjacent to and flush with the roadway and are considered an extension of the roadway. Shoulders serve several purposes. They

- Provide lateral support for the roadway.
- Expedite surface runoff from the roadway.
- Provide space for maintenance and construction equipment and activities.
- Provide a safe area for vehicles that accidentally leave the roadway and, in emergencies, accommodate slow-moving or stopped vehicles.
- Accommodate bicycles and pedestrians where no sidewalk is available.

Shoulders may be the same material as the roadway but not necessarily. Shoulders may be earth, gravel, or paved with asphalt or concrete.

Keeping the shoulders and all the roadside area clear and free of all types of obstructions is of primary importance to proper road maintenance activities. Typically, this process involves the removal of brush, weeds, trees, boulders, and accumulations of sand around guardrails. In addition, any potentially hazardous objects that have been placed by the public may need to be removed (or moved out of the clear zone or right-of-way).

The roadside should be maintained such that it contributes to the safety and pleasure of the public while preserving and protecting the adjacent natural environment

RULE OF THUMB

To properly drain water, shoulders should meet flush with the driving surface and slope slightly away from the driving surface.

In general, shoulders narrower than eight feet should slope about ¾-inch per foot, and shoulders wider than eight feet should slope about ½-inch per foot. This amount of slope allows water to flow away from the roadway but not fast enough to cause erosion.

Characteristics of Well Maintained Shoulders and Roadsides

In general, a well maintained shoulder is flush with the roadway driving surface (that is, it is not higher or lower than the adjacent roadway), slopes slightly away from the driving surface, and has no erosion problems. See figure 4–**1**.

Although we should strive for a zero edge drop-off (between the shoulder and driving surface), many agencies generally consider an edge drop-off greater than two inches to be excessive. Consult your supervisor and follow Alaska DOT&PF policy.

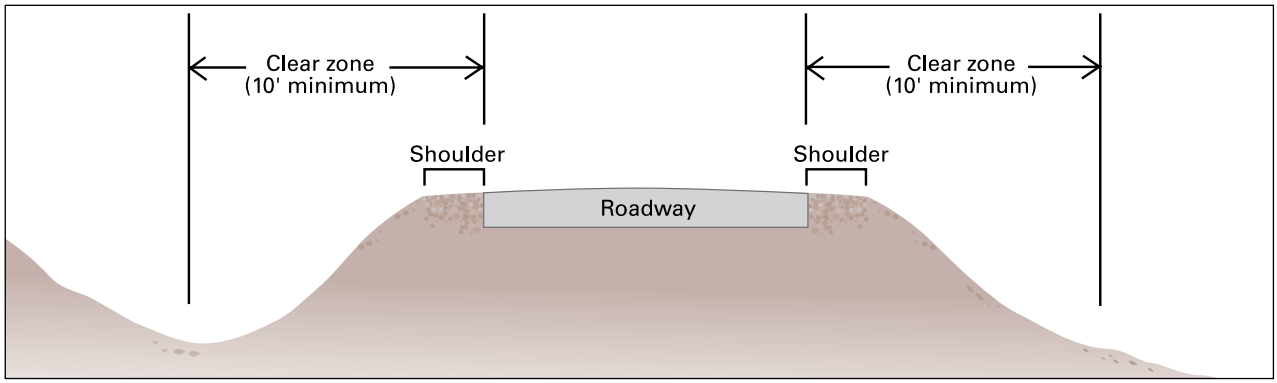


Figure 4–1. Well maintained shoulders

In general, a well maintained roadside should contain only desirable vegetation, be mowed to proper height, and be without significant growth of noxious weeds, undesirable vegetation species, or volunteer tree and brush growth. Growth of large, woody vegetation can obstruct signs and hide wildlife which can present a hazard to passing traffic on the roadway.

In addition, a safe roadside should not contain potentially hazardous obstacles within the clear zone, such as large trees and rocks/boulders. Significant erosion and lack of proper vegetative cover should be addressed with proper maintenance. Encroachments by property owners onto public right-of-way must be avoided.

Roadside signs should be highly visible, day and night, and in compliance with the Alaska Traffic Manual or the Manual on Uniform Traffic Control Devices (MUTCD).

Optimal Timing/Conditions for Maintenance

Optimal timing and conditions for maintaining shoulders depend on whether the shoulder is gravel, asphalt, or concrete. (Consult the appropriate sections in chapter 3.)

Most common roadside activities dealing with vegetative cover such as planting, mowing, and controlling undesirable plants are accomplished during the growing season. Other routine activities, such as tree and brush trimming or removal, can be scheduled during suitable conditions at other times of the year as well.

Shoulder and Roadside Maintenance Issues

In general, shoulders experience the same maintenance issues, and require the same maintenance activities, as do roadways made of the same material. (See chapter 3 for specific information about maintaining various roadway surfaces.) The following deficiencies are unique to shoulders:

- Low shoulders, or shoulder (edge) drop-off. See figure 4–2. Drop-offs create a safety hazard to drivers and allow water to penetrate into the subgrade. Drop-offs are among the top crash-related conditions and a common source for tort claims against agencies that maintain roadways.

  Most edge drop-offs result from poor drainage, erosion of uncompacted shoulder materials (when the shoulder is earth or gravel), or settlement (when the shoulder is paved with asphalt or concrete).

Clear Zone

As defined in the AASHTO Roadside Design Guide, a clear zone is the total roadside border area, starting at the edge of the traveled way, available for use by errant drivers. This area can also be described as an unobstructed, traversable roadside area designed to enable a driver of an out-of-control vehicle to stop safely or regain control.

- High shoulders. High shoulders create a safety hazard to drivers and restrict drainage away from the roadway. Earth shoulders that were originally flush with the adjacent roadway may, over time, become too high. Vegetation in the shoulder collects sediment and gradually breaks down, raising the level of the earth.
- Erosion. Shoulder erosion can cause (and may be caused by) poor drainage. Earth or gravel shoulders with steep slopes may be particularly prone to erosion. Erosion in the foreslope and/or backslope can present maintenance concerns if the degradation becomes significant. Minor rills should not pose a major problem, but more serious erosion could become a potential safety hazard for mowers and, in foreslopes, for run-off-road vehicles.

  Filling of eroded areas, blading when needed, and reseeding may be warranted. Be sure to use soil for backfill which will support vegetative growth. Reoccurrence of erosion in a particular location may require extraordinary measures, such as placement of medium size crushed stone or erosion control matting over the eroded area to stabilize the slope. (Erosion in a ditch is addressed in chapter 5.)
- Shoulder vegetation. When vegetation is allowed to grow on earth shoulders, it can inhibit drainage, create secondary ditches, cause snow to drift, and create unsafe conditions for vehicles that leave the roadway.
- Roadside vegetation. These activities are the most common roadside maintenance tasks, consisting of routine mowing and control of evasive vegetative species by either mowing or use of chemicals as prescribed in agency policies and procedures. Ask your supervisor or refer to the appropriate section later in this chapter for more details.
- Secondary ditches. Secondary ditches can form in shoulders from excessive throw-off of material from gravel roads, when heavy vehicles travel near or on the shoulder, or when there is a lack of proper shoulder maintenance. Secondary ditches can cause many roadway problems that may result in the need to rebuild the roadway. See chapter 5.
- Fixed-object improvements within the clear zone (like fences, utility poles, or culvert headwalls). Such objects can be safety hazards.

RULE OF THUMB

When dealing with fixed-object improvements in the shoulder, the appropriate treatment is generally to remove, relocate, retrofit, shield, or delineate, in this priority order. Consult your supervisor, and follow your agency's policy.

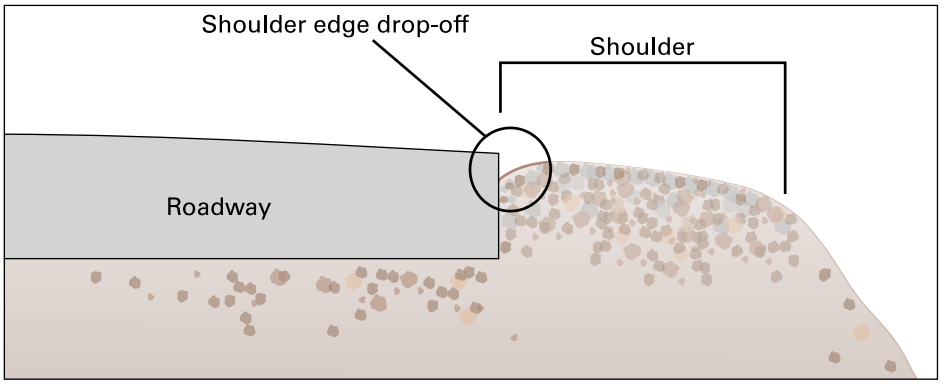


Figure 4–2. Shoulder edge drop-off

- Right-of-way control. These duties consist of receiving and processing access permits, monitoring the right-of-way for unauthorized encroachment by property owners, and removal of unlawful or unsafe features such as advertising, non-breakaway mailbox supports, retaining walls, etc. Addressing these items must be handled in a diplomatic manner since the public is involved. More details on this topic are included in the next section. (Refer to advice and guidance for dealing with the public in chapter 2.)
- Sign management. The Alaska Traffic Manual contains specific recommendations and requirements for agencies regarding the installation and maintenance of roadway signing. Nighttime visibility, influenced primarily by the level of retroreflectivity of the traffic control device sheeting, is a major concern. See figure 4–3. New regulations for sign retroreflectivity will require a program to meet the assigned minimum levels. More on this topic can be found later in this chapter and the reference listed above.
- Driveways. Driveways provide access from the roadway to adjacent land uses. Be aware of the area where the driveway interconnects with the shoulder. Be careful that maintenance operations do not negatively impact adjacent property owners. Figure 4–4 shows the proper drainage point for a driveway.

Figure 4–3. Retroreflective shoulder marker

Routine Shoulder Maintenance Activities

The following issues should be considered for routine maintenance of shoulders:

Repairing Edge Drop-Off, Erosion, and Secondary Ditches

Refill, reshape, and compact earth and gravel shoulders in accordance with the original design. Paved shoulders, either concrete or asphalt, will need to have a fillet placed next to the roadway where the edge drop is excessive. Asphalt is most commonly used material for this activity.

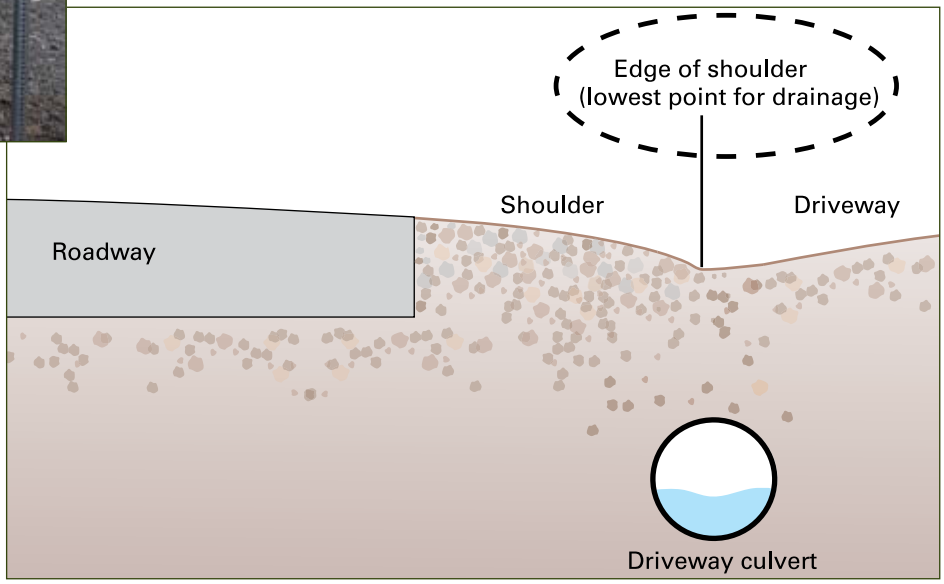


Figure 4–4 Drainage point for driveways

Repairing High Shoulders

Shoulders higher than the adjacent pavement should be reshaped and compacted. If vegetation in the shoulder is part of the problem, use a mechanical mixer to break up roots and follow with blading.

Mowing

Mow earth shoulders regularly. Consult your supervisor, and follow your agency's policies and procedures.

Managing Obstacles in the Clear Zone

Agencies must manage fixed-object improvements (like fences, utility poles, or culvert headwalls) located on the shoulder and within the clear zone. The goal is to eliminate collision hazards. If you see fixed objects in the clear zone, notify your supervisor.

Routine Roadside Maintenance Activities

The following issues should be considered for routine roadside maintenance:

Animal Remains/Wildlife

Animals killed by motor vehicles are usually removed by the Department of Public Safety. When large animals such as moose or deer have been hit, move the animal to the shoulder of the road, using care to protect yourself from injury. Make sure the animal is dead before attempting to move it. Flailing hooves can cause severe injury or death. Contact the Department of Public Safety and notify them of the location. If the animal cannot be removed from the traveled way, utilize emergency flagging techniques for control of traffic and don't leave the location until relieved by the DPS personnel.

Repairing Erosion

Major rapid runoff events, whether due to quick and severe spring melting or following very heavy rainfall, can result in rills in foreslopes, ditches, and backslopes that often are deep. Such erosion will only worsen over time, creating a hazard for motorists. Timely repair will normally avoid that situation and will cost less than more extensive restoration later. Figure 4–5 shows repair activities for extreme erosion of an embankment; figure 4–6 shows early erosion of the foreslope.

Figure 4–5. Erosion- slide repair of roadway embankment

Figure 4–6. Erosion of the foreslope should be repaired before it becomes extreme

Driveway Reviews and Approvals

Property owners and developments along public roadways need access to those roads for desired utilization of that property. Rights to that access are normally acquired through a permitting process which can be a major responsibility of a maintenance agency. Review of permit requests, determination of needed requirements (culvert size and length, slopes, etc.), and recommendations for approval are important aspects of efficient and safe right-of-way control. The duties involved in this activity include the following:

Know which access restrictions apply to each roadway. When property is acquired for road construction, access rights are often included in the purchase agreements. When reviewing access permit requests, any previously acquired access rights must be honored, even if many years old.

Even if access rights are not acquired, many details of a permit application must be thoroughly reviewed, often at the site. One of the most important details is sight distance along the roadway on both sides of the requested access. Even if anticipated use of the access point is minimal, poor visibility for drivers of entering traffic can result in serious safety concerns in the future, with few options for improvement at that time.

Other details to review are drainage needs, driveway width, side slopes of the proposed driveway, and grade of the access toward or away from the road:

- Will a pipe be needed to continue drainage in the ditch and, if so, what size and what material?
- Will the side slopes be sufficiently flat not to present a hazard for errant roadway vehicles?
- Will the grade of the new entrance be so steep as to present operational problems for entering or exiting vehicles?
- Would that grade result in drainage or eroded material washing onto the roadway?

All of these questions and possibly others should be examined and answered to the satisfaction of the roadway authority before the permit is granted.

During construction of the new driveway, monitor the work to be sure it is built according to the agreed design details in the permit.

Always remember that construction of the requested new driveway may be the responsibility of the property owner, but any deficiencies in the original design as listed above could become continuing maintenance problems for the agency. Typical details may be found in the construction manual and design and engineering services may be contacted for cases involving unusual or special circumstances.

Right-of-Way Encroachment

Since most right-of-way on public roadways borders private land, interaction with the public is common. Always remember that *use of public right-of-way by private landowners without a permit is restricted, if not prohibited*. Beyond that, misuse of public property by landowners can be a safety concern and result in unsightly conditions if not monitored consistently.

Installation of non-breakaway mailbox supports, construction of retaining walls, parking of personal vehicles, or storage of private property on public property should be discussed with property owners and removal requested. See figure 4–7.

Figure 4–7. Abandoned vehicle in right of way interferes with snow clearance and is a safety hazard

Non-compliance by owners should result in more serious action by the agency, with proper notice. Appearance of these or similar potentially hazardous obstructions within the right-of-way should be reported to a supervisor.

Roadside Trash Removal

A clean roadside should be a goal of all maintenance offices, but trash pick-up is not generally considered a high priority compared to other pressing roadway needs. However, if not scheduled routinely, accumulated trash can result in an unsightly roadside and a potential hazard for mowers.

Some agencies have instituted an Adopt a Highway program whereby civic minded groups, churches, and even citizens volunteer to pick up roadside trash. Using appropriate permitting and safety apparel/procedures, these programs can be a cost saving asset for maintenance agencies and can increase public awareness of littering and public pride in the natural beauty of highways. See www.dot.state.ak.us/stwdmno/aah/.

Rock and Landslide Cleanup

The incidence of large rocks and landslides on roadways (or other debris on roadway) can seriously impact the safety and mobility of the traveling public and must be addressed as an emergency occurrence on most roads. See figure 4–8. While these situations occur unexpectedly, maintenance agencies can respond in a professional manner by having a plan in place in advance.

A response plan might include the following action items:

- Have a list of notification contacts on hand to notify of necessary lane restrictions, closures, and possible detours (including 511). Be sure to include the news media and even local citizens if possible.
- Make note of locations where rock falls and/or landslides have occurred in the past and may be likely to happen again. Erect permanent warning signs to advise the traveling public of these locations using Alaska Traffic Manual approved signs. Have temporary traffic control devices on hand to address potential needs, such as lane restrictions or closures. Common devices might include appropriate regulatory and warning signs and barricades. Detour signing and potential detour routes should be reviewed and approved in advance for any locations where closures are a possibility. More on temporary traffic control can be found in the Alaska Traffic Manual.
- Depending on the importance of the roadway impacted, schedule clean-up activities as soon as possible. Locate needed equipment, operators, and disposal sites for debris as near to the incident location as possible to reduce haul times.
- Use all appropriate safety precautions and equipment for maintenance personnel and motorists.
- Be sure to advise all interested parties and the news media when full traffic accommodations are restored.

Sidewalk and Bicycle Path Maintenance

Pedestrian sidewalks, bicycle facilities, and recreational trails must be properly maintained for safe and convenient use by the public, but with a lower priority than the roadway. Common maintenance might include snow removal, gravel removal, sweeping, disposal of downed brush or tree limbs after a storm, and patching of deteriorated or damaged sections. Always be sure your agency has responsibility for maintenance of these facilities, however, as the maintenance of sidewalks might be the responsibility of a city or property owner.

If it is concluded that your agency does have maintenance responsibility, be sure crews are well rested before undertaking this work, especially if they have been engaged in snow removal or clean-up activities on roadways for several hours.

An emergency declaration might be necessary to authorize use of state equipment and staff for clean-up on private property following a storm.

Figure 4–8. Limited mobility due to (a) trees, (b) rock slides, and (c) debris

When authorized and required, a timely response to pedestrian and bicyclist needs can result in good public relations and a safer environment by avoiding the need to use an open roadway for those transportation needs.

Permanent Sign Management

Signs and other traffic control devices are important elements of roadway safety for the driving public; therefore, proper and timely maintenance of these devices is equally important. The Alaska Traffic Manual contains both recommendations and requirements for maintenance of traffic control devices with major emphasis on minimum retroreflectivity levels for most signs.

A good management program for permanent signs should have several elements including, but not limited to, inspection, maintenance, inventory control, and liability exposure. While most of these responsibilities might be assigned to specific staff, in fact all maintenance staff can provide a valuable contribution to this effort by observing sign and other traffic control device condition and visibility, both day and night, and reporting any deficiencies to a supervisor.

These inspections could be scheduled, conducted, and documented formally once or twice annually or informally as part of other routine maintenance activities, but either manner of inspection will be an asset to any sign management program. While not specifically required, a formal inventory of signs and other traffic control devices in electronic format can be a valuable asset for any transportation agency.

An inventory can be started with very basic information and added to in the future as time and finances allow. In addition to the sign blank, sheeting and post material types, an inventory can be used to record sign installation

Minimum Retroreflectivity Standards

The Federal Highway Administration has established rules that require all agencies to adopt and employ procedures for ensuring that most roadway signs within their jurisdictions comply with minimum established retroreflectivity standards. Both management methods and assessment methods for this purpose are available for agencies to consider. Among the management methods are blanket replacement, expected sign life, and comparison signs. Assessment methods include visual inspection (nighttime), retroreflectometer measurements, and consistent parameters. A combination of these methods is also acceptable. Each method has advantages and disadvantages, so each agency should thoroughly review the requirements and details of each option along with capabilities and assets of the agency before making a final decision on this important issue. Training, reference materials, and advice should be available from the Federal Highway Administration and Local Technical Assistance Program. For more details about retroreflectivity standards, consult the Alaska Traffic Manual.

dates, maintenance activities, and inspections, including nighttime visibility checks as described in the sidebar.

Obtaining a complete initial inventory and building a database can be a costly undertaking, but the long term benefit of this resource for asset management will pay for that investment many times in the future.

Vegetation Management

Control of roadside vegetation is important for preserving the integrity of the traveled way and maintaining motorist safety. Vegetation management can be an integrated program, using chemical, biological, cultural, and mechanical methods. The Alaska DOT&PF adopted an Integrated Vegetation Management Plan in June of 2013 that addresses most areas of concern, materials, treatment methods and reporting requirements. It is available online at www.dec.state.ak.us/eh/docs/pest/PermitsIPMs/ADOT&PF%20IVMP%20%28June%202013%29.pdf.

Use of herbicides for the control or elimination of roadside vegetation is regulated by the Department of Environmental Conservation, Division of Environmental Health. When applying to water, a special use permit, and in some cases a public hearing, is required before any application of a pesticide (and in some instances herbicides). All manufacturers' label instructions must be followed. All applicators and supervisors must be certified. Most Regions have chosen to use manual or mechanical methods of control due to the strong environmental concern.

Biological control uses living organisms that destroy the host plant. Insects, diseases, and foraging animals are examples of biological control. Cultural control uses such things as fertilizers to promote growth of desirable plants. In areas with sufficient moisture, fertilizer will enhance the competitive ability of grasses to crowd out encroachment by weeds, brush, and trees.

Mechanical mowers are used to maintain turf and erosion control grasses. Mowing should be used as an integral part of the roadside management program. However, repeated mowing of grasses in unfertilized and dry areas will cause thinning and reduce the competitive capabilities of the grasses, thus allowing trees, brush, and weeds to become established.

Invasion and infestation of exotic weedy plant species, such as vetch (Vicia cracca), is a concern in some areas of Alaska, and control of these pests should be part of a roadside maintenance program. Vetch is most likely to spread into areas where natural vegetative control has been removed (like construction areas or natural disasters such as forest fires). Successful control efforts usually involve mowing before the plants have flowered or spot spraying. Be sure to consult with plant experts at the AK DOT or the Cooperative Extension Service (CES). An excellent reference is the aforementioned Integrated Vegetation Management Plan of the Alaska DOT&PF.

Trimming and removing excess woody vegetation (e.g., volunteer trees and brush) is important for maintaining safety and an aesthetically pleasing

roadside. Besides improving sight distance for drivers, benefits of this activity may include decreasing snow drifting problems, providing an area for snow berms to be winged during the winter, removing potential hiding places for large animals near the roadway, reducing safety hazards for run-off-road vehicles, and reducing the need for clean-up of woody vegetation following a major storm.

The months of July, August, and September are the most effective periods in which to cut trees, brush, and shrubs. Re-sprouting of trees or shrubs will be minimized if cutting takes place in the summer, after the spring growth period is complete. However, this work can also be scheduled during winter months when opportunities for other maintenance work are limited. Removal of trees or brush in wetland areas may require a permit. (Refer to Chapter 5 for more information on permitting).

It is important to select cutting equipment that is properly designed and suited for the vegetation and terrain involved. Chain saws, axes, and other cutting equipment may be used to selectively remove individual plants or parts of plants. Standard mechanical mowers, motor grader mounted cutters, and/or Hydro Ax are the primary methods employed to remove undesirable trees, brush, and weeds. Dead or leaning trees within or immediately adjacent to the right-of-way should be felled by experienced operators.

Always work with a helper and never attempt to remove a tree alone. Be sure to wear appropriate personal protective equipment and apparel.

Before burning brush, trees, slash, or other waste, check with the local fire department to obtain the appropriate permit(s). Wait for suitable weather conditions and follow the conditions in the permit when burning.

Best Management Practices for Invasive Plants

1. Clean vehicles and equipment regularly. When returning to the maintenance station, clean vehicles and equipment using a pressure washer, paying special attention to wheel wells, areas behind the bumper, and other spaces that are likely to catch vegetation or seeds.

2. Revegetate disturbed areas with native, local, and/or non-invasive plant species. Vigorous non-invasive perennial grass species may prevent invasive plant species. Contact DOT&PF environmental analyst or the Alaska Plant Materials Center for assistance with seed mixtures for your location.

3. Avoid contaminated areas. Do not travel through contaminated areas, park, or stage equipment in these areas.

4. Work from uninfested to infested areas. Perform maintenance activities starting in uninfested areas and moving towards infested areas. Managing uninvaded areas first ensures that invasive weeds do not contaminate equipment and move to new areas. Generally, areas away from

towns are uninfested.

5. Coordinate with local groups that are managing invasive species. Opportunities to complement efforts exist where weed managers are targeting a species or infestations in an area.

6. Time mowing to prevent seed production of invasive plants. With some invasive plant species, it may be necessary to mow more than once in the summer.

7. Use certified weed-free materials, including gravel, hay/straw, and erosion control tubes, whenever possible. This is especially important when working near sensitive habitats such as streams, rivers, and wetlands or areas that are known to be weed free. Contact your local Soil and Water Conservation District and/or the Division of Agriculture Plant Materials Center for local supplies of certified weed-free material.

8. Identify locations of known invasive plant infestations and plan maintenance activities accordingly. Mowing, ditching, and other disturbance activities should occur prior to the plants setting seed. Contact the Cooperative Extension Service for timing information if you are unsure.

9. Record and report locations of invasive plants that are new to a particular area at www.uaf.edu/ces/ipm to record and report your finding.

10. Scout for invasive plants prior to performing maintenance activities. New infestations can move into an area, and the only way to know is to scout areas prior to working in them.

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Federal Highway Administration (FHWA). 2009. *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.* Washington, DC: United States Department of Transportation, Federal Highway Administration.

Hallmark, S.L., T.J. McDonald, D. Veneziano, J.L. Graham, K.M. Bauer, R. Patel, and F.M. Council. 2006. *Safety Impacts of Pavement Edge Drop-Offs*. Washington, DC: AAA Foundation for Traffic Safety.

Souleyrette, R., T.J. McDonald, Z. Hans, A. Kamyab, T. Welch. 2001. *Paved Shoulders on Primary Highways in Iowa: An Analysis of Shoulder Surfacing Criteria, Costs, and Benefits*. Final Report. Ames, IA: Center for Transportation Research and Education.

ADDITIONAL RESOURCES

Alaska Construction Manual, www.dot.state.ak.us/stwddes/dcsconst/assets/pdf/constman/const_allmanual.pdf

Alaska Safety Manual, www.dot.state.ak.us/stwddes/dcsconst/pop_constman.shtml

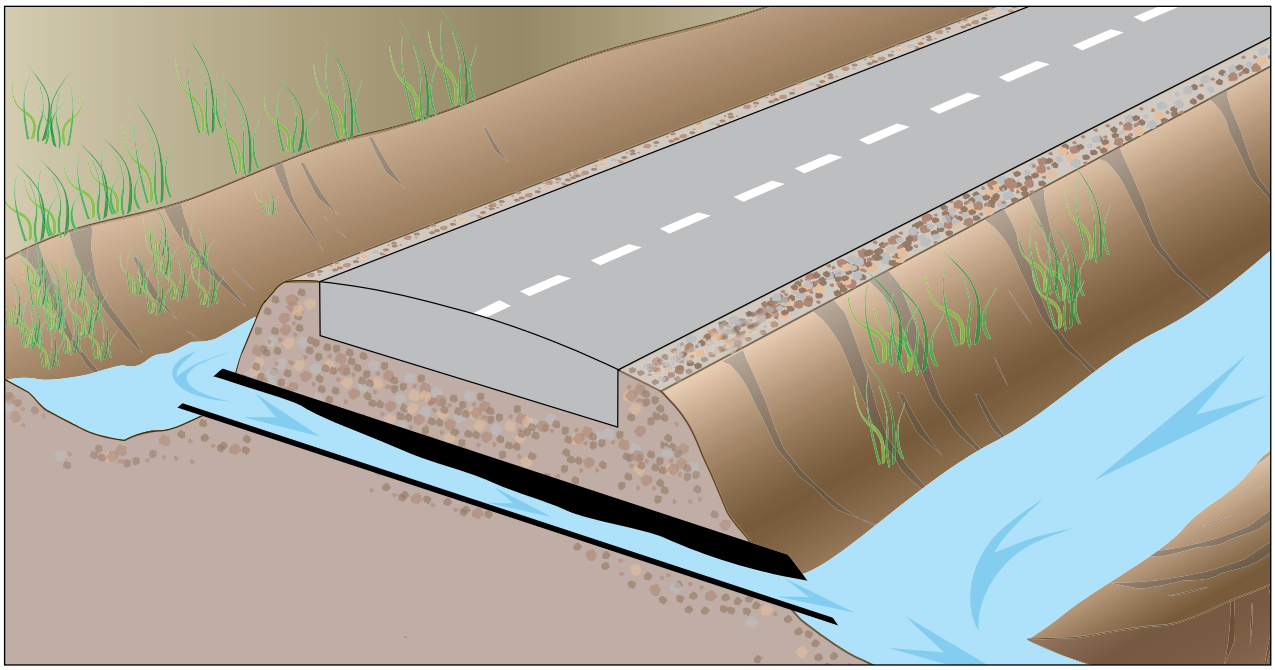
Alaska Traffic Manual, www.dot.state.ak.us/stwddes/dcstraffic/atmintro.shtml

Alaska Traffic Manual supplement to the Manual on Uniform Traffic Control Devices, www.dot.state.ak.us/stwddes/dcstraffic/pop_traffmansup.shtml

Alaska DOT & PF *Integrated Management Plan*, www.dec.state.ak.us/eh/docs/pest/PermitsIPMs/ADOT&PF%20IVMP%20%28June%202013%29.pdf

Alaska Digline, Inc. (811), 1-800-478-3121, www.akonecall.com

Chapter 5:
Drainage, Ditches, and Culverts



chapter contents

Safety Tips for Maintaining Drainage, Ditches, and Culverts

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual (see Culvert Installation/Activities/Inspection and Inventory Task Analysis).

Suggested personal safety equipment

- Hard hat
- Safety glasses
- Heavy gloves
- Hard-toed boots
- Highly visible apparel (ANSI Class II minimum)

Advance preparations

- Be properly trained in principles of excavation safety and be thoroughly familiar with equipment.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site.
- Locate all utilities before starting work. Call Alaska Digline (811 or 1-800-478-3121) to locate any underground utilities.
- Review the appropriate Material Safety Data Sheet (MSDS) for any suspected hazardous materials to be encountered.
- Coordinate with M&O Environmental Analysts for assistance and/or permitting needs for your work.

During operations

- If road is open to traffic use proper temporary traffic control, including flagger(s) if needed, as described in the *Alaska Traffic Manual* Supplement and the MUTCD..
- Remove all temporary traffic control immediately when no longer needed.
- Wear highly visible (ANSI class II, minimum) apparel when out of your vehicle.
- When excavating, make sure a competent person trained in excavation safety is available at the work site.
- Do not enter a trench or excavation over four feet deep (with certain soils, a lessor depth may be specified) without proper shoring and/or sloping.
- Locate escape routes to use in emergencies.
- Employees on foot must use caution when working around heavy equipment.
- Be aware of loose material, excavation drop-off hazards, and obstructions.
- Keep work area free from debris, with ample room to perform duties.
- Use proper precautions when working in extremely hot or cold conditions.
- Use proper lifting techniques, get help, or use equipment when needed for lifting.
- Properly dispose of all salvaged materials.

There's an old saying that the three most important elements in road maintenance are drainage, drainage, and drainage.

Water on or under the roadway is the single most significant cause of damage to that facility. Problems related to water drainage can include rutting, cracking, potholes, erosion, washouts, heaving, flooding, and premature failure of the roadway structure. The goal of good drainage maintenance is to ensure the continuation of adequate hydraulic capacity of manmade and natural drainage facilities in the right of way. Proper drainage maintenance will permit the intended use of the roadway, prevent damage to the highway structure, and protect adjacent property from damages.

To prevent water-related problems and help ensure a roadway achieves its designed service life, you need to do three things:

- Get water off the road.
- Get water out of the road.
- Get water away from the road.

The solution: a good drainage system. Such a system includes several elements, all of which must function properly and be well maintained:

1. Surface drainage (roadway crown, shoulders, foreslope and backslope, and ditches). See figure 5–1.
2. Subsurface drainage (pavement drainage layer, under drains/edge drains).
3. Inlet drainage structures (primarily in urban areas).
4. Culverts (primarily in rural areas).

Figure 5–1. Ditch with good drainage

The Alaska DOT&PF must meet certain state and federal regulations related to highway drainage. Those requirements impact the timing, scope, and type of drainage maintenance necessary. Be sure to review those requirements with the Regional M&O Environmental Staff or the Regional Environmental Manager before beginning maintenance activities. If permits are required, processing could require one to three months before approval is received, however it may only take a day or two. The M&O Environmental Analyst will be able to coordinate this with the relevant agencies.

Characteristics of Good Drainage

A successful drainage system will drain water away from the road in an adequate amount of time, as shown in table 5-1. Refer to AASHTO Design Guide and SOA DOT Blue book.

Elements of Good Surface Drainage

Roadway Crown

A road's crown should have sufficient slope from the pavement centerline to the edge to be sure water will effectively drain off the roadway surface. When the slope is too flat, water can pond on the surface and migrate through joints and cracks into the pavement and/or under the surface. This can lead to pavement cracking and potholes. Water that doesn't drain off the roadway can also present a safety hazard to motorists by introducing the possibility of hydroplaning.

Maintenance workers can affect the crown on gravel roads only. In general, a crown between four and six percent is recommended for gravel roads. See chapter 3 for more information.

Shoulders

To aid in drainage, shoulders should be flush with the adjacent roadway, slope slightly away from the roadway, and have no erosion problems or secondary ditches. Earth shoulders should be mowed in accordance with local agency policies and procedures. See chapter 4 for more information.

Table 5–1. Quality of Drainage Determined by Dissipation Time

Drainage Quality	Time for 50% Dissipation
Excellent	2 hours
Good	1 day
Fair	1 week
Poor	1 month
Very poor	(Water will not drain)

Slope

Slopes are normally referred to by the ratio of the run to the rise. For example a 4:1 slope is four feet horizontal distance to one foot vertical distance (run to the rise). Slopes can refer to either side slopes or ditches or longitudinal slope of ditches or culverts.

The degree of ditch foreslope and backslope is determined by design standards (e.g., AASHTO's Roadside Design Guide, also known as the "green book"; and the Alaska Highway Preconstruction Manual - http://www.dot.alaska.gov/stwddes/dcsprecon/assets/pdf/preconhwy/preconstruction_all.pdf) and local conditions (e.g., cohesive soils, or rights of way). Local conditions may require that slopes be designed and constructed steeper or flatter than the design guides suggest.

Whatever slope has been designed and constructed should be maintained at the same ratio of run to the rise.

Ditches

Ditches collect drainage runoff from the road surface. A well maintained, smooth-flowing ditch will be free of heavy vegetation (tall grass, trees, cattails, etc.) and standing water, with enough grade (slope) to ensure self-cleaning and continuous flow. (Ditches with flat percent-of-grade allow residue or debris to settle and fill in the ditch. If sediment accumulates, water may erode a new path outside of the ditch area.) However, grasses and vegetation in a ditch can help to prevent erosion, assist in removing pollutants from runoff, and minimize the need for corrective excavation. Performance targets for ditch and culvert drainage are shown in Table 5-2.

Some ditch work may also need environmental permitting if there are wetlands present. M&O Environmental Staff will be able to determine if permitting is needed, or may be able to confirm that the work fits the Corps' "Ditch Maintenance Exemption." Excessive erosion of ditches can be addressed by lining with rocks, broken concrete, or other stable and heavy materials. Rubbish and other debris should be removed from ditches, including trees and brush. If ditches are located on the top of cut slopes, these should also be maintained with their original shape and capacity.

Culverts (Underground Pipes)

Culverts are well maintained when the flow line and the design slope from inlet to outlet still exist, no sections have settled, all joints are tight and not separated, metal culverts or pipes are not excessively rusted, any curtain walls are not exposed, and the downstream channel has not started to erode.

Consult with Regional M&O Environmental staff prior to conducting culvert work, so they can determine if a permit is necessary. If permitting is required, M&O Environmental Staff will be able to coordinate this, and the process may only take a few days. Additionally, maintenance of stream culverts typically involves obtaining a fish habitat permit from the Alaska Department of Fish

Table 5–2. Drainage Performance Targets

Performance Target	Performance Target Description	Illustration
A (Excellent Drainage)	Culvert, Inlets and ditches are structurally sound and unobstructed. They are kept free of silt, debris and vegetation and 90 percent of the cross section is unobstructed. Ditches have little to no scour or erosion and no standing water evident. Structures are unobstructed and functioning as intended.	
B (Good Drainage)	Culverts, inlets and ditches are structurally sound and unobstructed. They are kept free of silt, debris and vegetation and 75 percent of the cross section is unobstructed. Ditches show minor signs of scour or erosion and small amounts of standing water evident. Structures are functioning.	
C (Fair Drainage)	Culverts, inlets and ditches are showing minor to moderate restrictions. 50 percent to 75 percent of the cross sections are unobstructed. Ditches show signs of small amounts of erosion and a moderate amount of standing water due to uneven cross section. Structures are functioning but limited during normal storm events.	
D (Poor Drainage)	Culverts, inlets and ditches are showing large amounts of restrictions. Less than 50 percent of the cross sections are unobstructed. Large sections of ditches show signs of deep erosion and large amounts of standing water due to uneven cross section. Structures are not functioning as intended.	
E (Failing Drainage)	Culverts, inlets and ditches are more than 50 percent restricted. Large sections of ditches show signs of deep erosion and large amounts of silt filled ditches. Large amounts of standing water due to very uneven cross section. Small to large sections of road flooding during storm events. Structures are not functioning as intended.	

and Game. Stream culverts larger than 48 inches should be reviewed by the Hydrology Unit for sizing/capacity and M&O Environmental staff will coordinate this, as well as the permitting process.

Inlets to Drainage Structures

With well maintained inlets, the inlet structures are straight and true, any marking devices are in place and visible, and the surrounding pavement and joints are sound and water tight. The inlets are free of debris and silting, and adjacent vegetation is not impeding the ditch drainage flow.

Elements of Good Subsurface Drainage (Underdrains)

A subsurface drainage system intercepts and carries water from beneath the pavement to appropriate drainage features, like ditches or storm drains. An excellent indication that this system is well maintained and in good working order is the absence of "frost heaves" in the roadway surface during the winter months.

The elements of typical subsurface drainage system include a granular drainage layer and subdrains (underdrains and edge drains).

Granular Drainage Layer

A well maintained granular drainage layer is uniform in thickness, the width detailed in the plans and specifications, and of the proper material gradation.

Underdrains/Edge Drains

A well maintained system of transverse and longitudinal drainage pipes effectively intercepts and carries water out of the granular layer. Underdrains carry water from the granular drainage layer to edge drains. Edge drains are installed under shoulders, longitudinally adjacent to the pavement. See figure 5–2.

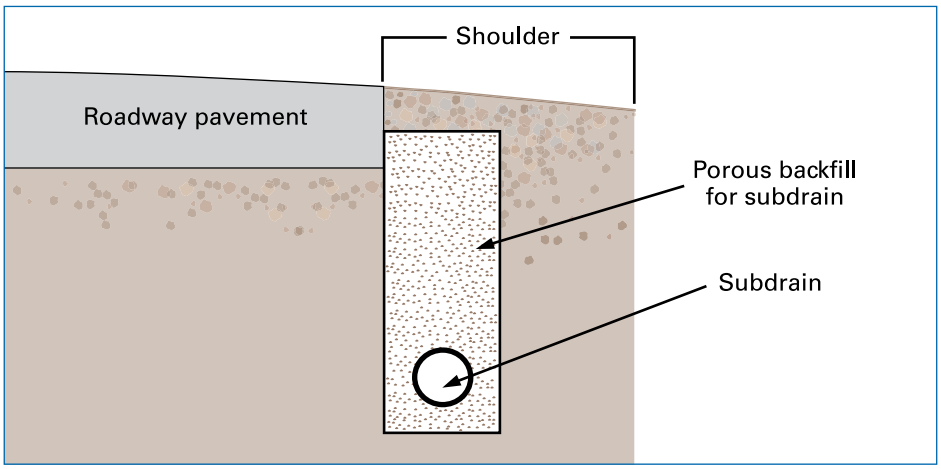


Figure 5–2. Edge drain

Edge drains can be constructed during roadway construction or sometimes added later. Perforated pipe is installed in a trench parallel to the roadway, which is then backfilled with an open-graded aggregate. Caps of impervious soil are placed on top of edge drains to prevent contamination of the granular aggregate. Filters or fabrics may also be used to prevent fine-grained soil from clogging the open-graded aggregate or the pipe itself.

Water from the underdrains is collected in a non-perforated edge drain pipe that discharges into a roadside ditch or a storm sewer system.

All subdrains should maintain the flow lines and their designed slopes. The outlet water flow should be clear and uniform, indicating that erosion is not occurring and the system is not clogged.

Optimal Timing/Conditions for Maintenance

The drainage system should be closely observed after a major storm event, when the effectiveness of the system will be most evident. In addition, culverts and other drainage features should be inspected on a routine schedule as directed by the policies and procedures of your agency. The results of these inspections should be recorded in a database.

Maintenance activities are generally scheduled when there will be the least damage to these features. For example, ditch cleaning will be scheduled when water in the ditch has dissipated (if possible) and there is some stability in the soil to support the weight of equipment. In addition, your supervisor will likely schedule regular drainage system maintenance, perhaps semiannually or in conjunction with drainage or roadway improvements.

Drainage Maintenance Activities

Maintenance operations include activities that focus on the road surface and then move out to the roadway edge and subsurface. Several activities related to surface and subsurface drainage are common to both rural and urban environments. (Activities specific to these differing environments are discussed separately later in this chapter.)

Surface Drainage Maintenance Activities

For information about maintaining crowns on gravel roads and shoulders, see chapters 3 and 4.

Maintaining Ditches

Motor graders and excavators are commonly used to clean ditches. Be careful not to create a steeper ditch grade than needed. A too-steep grade may accelerate runoff enough to seriously erode the ditch. A too-flat grade will not drain properly, as shown in figure 5–3.

Subsurface Drainage Maintenance Activities

The granular subsurface layer, underdrains, and edge drains must be maintained.

Maintaining Granular Drainage Layer

Few routine maintenance activities are generally necessary for the granular drainage layer. As long as it stays clean and undisturbed, it will function as intended.

However, maintenance crews do need to be careful of the granular drainage layer when performing other maintenance activities. One of the best examples is full-depth pavement patching. When the deteriorated pavement is removed, the granular drainage layer is exposed. It is very important that this layer is not disturbed and or contaminated with dirt, etc., which would reduce its effectiveness.

Maintaining Subdrains

Few routine maintenance activities are generally associated with underdrains and edge drains. As long as drains are clean and undisturbed, they will function as intended.

However, maintenance crews do need to be careful of these drains when performing other maintenance activities, like repairing shoulder edge drop-offs, grading foreslopes, and backslopes, and ditch-cleaning operations. Be aware of the location of drains and outlets and be careful not to damage them. If drains become plugged, they can be cleaned by flushing with high pressure water or with flexible sewer rods and/or commercial cleaning equipment, such as Roto-rooter.

Figure 5–3. A flat ditch may not drain properly

Urban Drainage Systems (Storm Sewers)

Drainage issues unique to urban situations include water draining from the pavement to a curb and gutter or shoulder and then into a storm sewer system or ditch. (Curb and gutter inlets and storm sewers are also used in rural areas where shoulders and foreslopes on roads are easily eroded or backslopes are too steep to maintain a ditch. Sometimes a curb and gutter system will be used on the low side of horizontal curves to control erosion of the shoulder material and to manage edge drop-offs.)

Paved Curbs and Gutters

Curb and gutter units collect runoff water from the pavement and direct it to inlets (intakes). Maintenance activities include keeping curbs and gutters clear of debris and silt so that water can run freely to the inlets.

Inlets, Storm Drains, and Manholes

With enclosed drainage systems, water is collected from the curb and gutter by inlets and funneled through storm drains into an underground storm sewer. Storm sewer runs are connected by inlets (one storm drain) and manholes (where two or more storm drains meet) which, in addition to funneling water into the storm sewers, allow personnel to access the storm sewer.

Maintenance activities include the following:

- Remove debris and silt from inlets so that water can freely enter the storm sewer.
- Make sure the pavement around inlets and manholes is sound and has water-tight joints, which prevents deterioration of the structure. See figure 5–4.
- If the storm sewer lines feature a very flat slope, clean and flush them regularly.
- Clean all drains regularly. If they are too flat, excavation and realignment to a grade that promotes good water flow may be needed.

Figure 5–4. Water-tight joints at an inlet

Rural Culverts

Culverts provide drainage under driveways, roads, slopes, and adjacent areas. The grade and direction of flow should conform as closely as possible to that of the water being conveyed. See figures 5–5, 5–6, and 5–7.

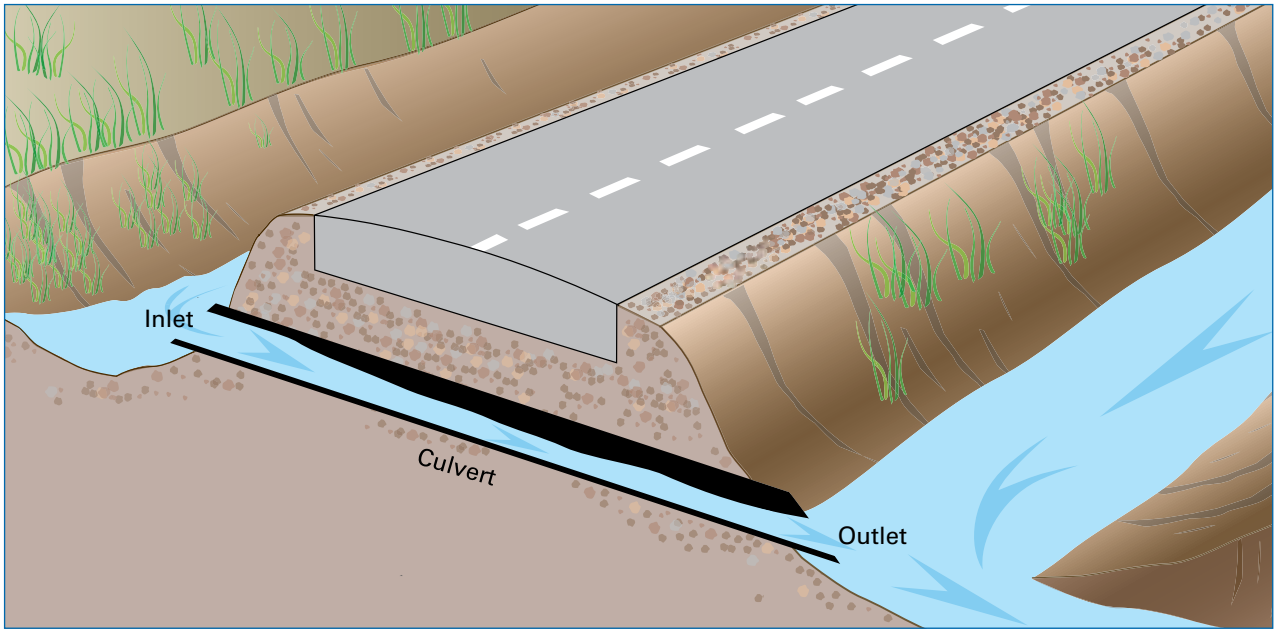


Figure 5–5. Culvert (profile view)

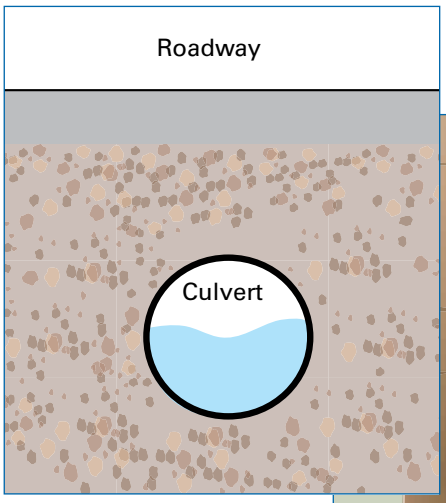


Figure 5–6. Culvert (section view)

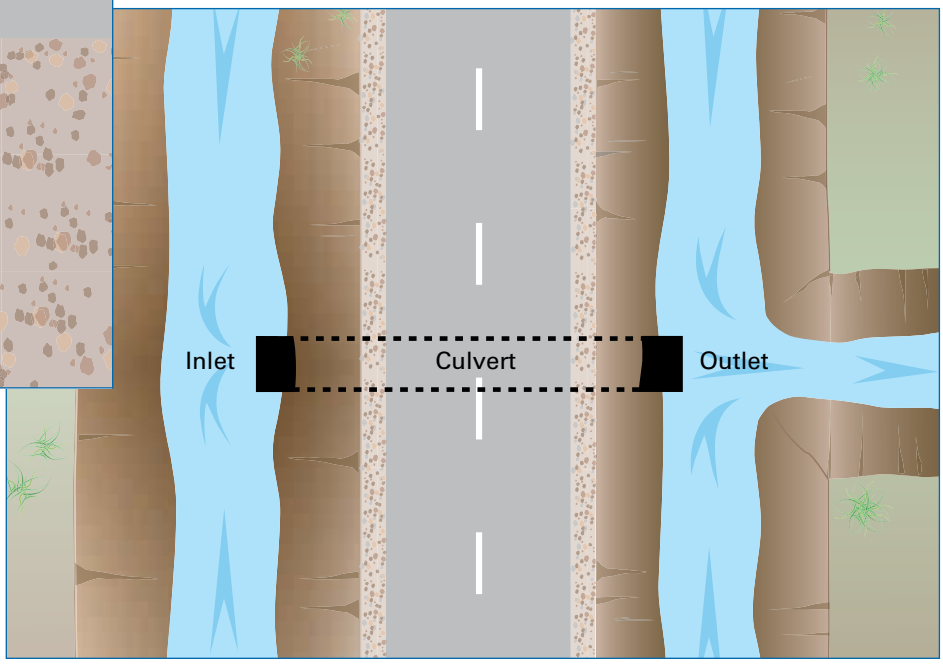


Figure 5–7. Culvert (plan view)

Culvert Observation Activities

Culverts are major drainage structures. Culvert failure can be catastrophic, perhaps causing serious injury or even death, as well as costly restoration or reconstruction.

State employees are generally not responsible for extensive culvert inspection and repair. However, as you drive over culverts in your jurisdiction or work in their vicinity, you can and should be aware of the signs of culvert stresses or other problems and report them immediately to your supervisor.

Signs of potential problems could include the following:

- A dip in the pavement over a culvert (could indicate settlement or a structural problem).
- High water lines following a storm (may indicate a drainage problem).
- Accumulated debris and/or signs of bank erosion upstream or downstream in the channel (may indicate a drainage problem).
- Debris on fence lines or backslopes.
- Erosion around the headwall or outlet.
- Wet ditches or vegetation (may indicate standing water).

Maintenance Issues for Culverts

Some basic housekeeping/maintenance activities as directed by your supervisor may be required.

Clogs and Silting

Culverts may become clogged because debris accumulates at the culvert inlet or outlet. Filling with silt may also occur when the grade is too flat and the flow is restricted.

To solve the debris/silt problem, conduct these maintenance activities:

- Intercept debris upstream by using a well designed barrier.
- Clean the culvert frequently, making sure debris can pass through cleanly.
- Steepen the culvert grade to promote self-cleaning (a more costly option).

Scour

Scour is erosion from drainage water in a roadway ditch or a stream channel.

Scour may occur at culvert inlets if choked with debris. Remove the debris to restore water flow. Another possibility is that the inlet capacity is simply inadequate. The makeup of the drainage area may have changed since the culvert's construction. In this case, the culvert will have to be reconstructed to provide a larger opening/capacity (a more costly option).

At outlets, scour occurs when a large volume of water is discharged at a high velocity. See figure 5–8. When heavy scour occurs at outlets, curtain walls

may be undermined. Repair the scour by backfilling the eroded area with suitable material, then placing riprap, broken concrete, or bituminous material to protect the outlet from further damage.

Abrasion

Culvert floors and sidewalls gradually deteriorate as a result of debris and sediment flowing through. Inspect culverts at regular intervals for abrasive wear. Consider forming and paving a new invert or inserting a culvert liner, as directed by your supervisor.

Corrosion (Rust)

Metal pipe culverts experience corrosion when the protective coating is worn away by abrasion. Common maintenance is to replace the culvert or to insert a culvert liner. Consult your supervisor.

In concrete culverts, reinforced steel can be subject to corrosion in locations with very acidic water. There is no routine maintenance activity for this problem. When the deterioration becomes severe, a culvert liner or major repair of the culvert will be required.

Leakage

Leakage occurs when culvert sections separate at the joints. This is caused by movement of the embankment material or by faulty construction joints. Water leaking out of joints may erode the surrounding material, causing the joints to separate even more and, eventually, undermining the structure itself. Regularly inspect culverts for leaks, and repair the joints as needed.

Cracks

Cracks may occur in culvert collars, cut-offs, and wing walls. Repair these defects using a sand-cement mortar containing an anti-shrinking additive.

RULE OF THUMB

Acidic water conditions (e.g., near a feedlot or other source) may require the use of plastic or concrete pipes or special coating instead of corrugated metal culverts.

Figure 5–8. Debris accumulation at culvert

Damaged Culvert Ends
Metal culvert ends are most susceptible to damage, possibly by heavy equipment passage. Remove the damaged sections by excavating the backfill and cutting off and replacing them.

Frozen Culverts
Culverts should also be checked during the winter for icing problems. Thawing pipes or other measures may need to be used to keep the culvert open in the winter. Report frozen culverts to your supervisor.

Bank Protection

Maintenance personnel should be alert for erosion, scour, undermining, or washout of highway embankments or structures due to storms, floods, or wave action. Water courses, drainage ways, and embankments should be protected against danger due to high water or erosion. Protection materials/methods include stone riprap, grouted riprap, sacked concrete riprap, slope paving, pile revetments, retaining walls and cribs, rock and wire mesh (gabions), and vegetation. Check with the M&O Environmental Analyst(s) in your Region prior to beginning work.

RULE OF THUMB

The primary concept behind all drainage law: "Do no harm." Don't flood anyone, don't cause erosion by sending water rushing downstream, and don't divert water from the natural flow.

Dry Wells

Dry wells are constructed to drain standing water where natural outlets for surface water are not available. Dry wells should be inspected periodically, and the drain rock should be replaced if water no longer percolates into the soil.

Fish Streams

A fish habitat permit is required from the Habitat Division of the Alaska Department of Fish and Game before entering or performing any work below the ordinary high water mark or that may affect the waters of any fish stream, including vehicular crossings. The first step is to check with M&O Environmental Staff prior to initiating work. Usually, local Fish and Game fishery biologists are not delegated the authority to issue fish habitat permits.

Wetlands

Contact the M&O Environmental Staff regarding any of your operations that may impact streams, rivers, ponds, lakes, or wetlands. Permits are usually required when working in these areas.

The Corp of Engineers now considers chips from brush chippers "fill" when deposited in wetlands. There should be no dumping of any kind in any wet/damp area.

Drainage Laws

Construction General Permit coverage from the Alaska DEC may be required for larger maintenance projects that disturb >1 acre. Generally, maintenance work is exempt from needing CGP coverage as "maintenance only" activities. Best Management Practices are always necessary, such as seeding disturbed area with a native perennial grass seed mix or utilizing other erosion and sediment control devices as needed. M&O Environmental Staff can advise on this when consulted. Prior to culvert work in a stream, maintenance personnel should check with M&O Environmental Staff to obtain any required permits and to determine whether a fish habitat permit will be required from the Habitat Division of the Alaska Department of Fish and Game.

Erosion and Sediment Control Plan (ESCP)

The Transportation Equity Act for the 21st Century reauthorizes the Intermodal Surface Transportation Efficiency Act (ISTEA). Section 1057 of ISTEA requires the United States Secretary of Transportation to develop erosion control guidelines for states to follow when designing and constructing federal-aid highway projects.

On July 26, 1994, in Federal Register Volume 59, No. 142, 37935-37939, the FHWA published a final rule revising 23 CFR 650, Subpart B, Erosion and Sediment Control on Highway Construction Projects. The revision formally adopts Volume III of The AASHTO Highway Drainage Guidelines 1992 as the standard for all projects funded under Title 23, United States Code. The adoption of the AASHTO Highway Drainage Guidelines fulfills the requirement of Section 1057 of ISTEA.

To comply with FHWA direction and 18 AAC, DOT&PF adopts the AASHTO Highway Drainage Guidelines, Volume III, as modified by Section 1120.4. of the Alaska Highway Preconstruction Manual http://www.dot.alaska.gov/stwddes/dcsprecon/assets/pdf/preconhwy/preconstruction_all.pdf and Chapter 16 of the Alaska Highway Drainage Manual, which is available online at: http://www.dot.state.ak.us/stwddes/desbridge/pop_hwydrnman.shtml

Notify Alaska Digline (811 or 1-800-478-3121) before beginning any excavation. Agencies are required by law to notify Alaska Digline at least 15 days (20 days in remote areas) in advance of any surface excavation project, large or small. Alaska Digline will notify the owners/operators of underground facilities, who will dispatch personnel to the area to mark the location(s) of underground utilities so maintenance workers can avoid any damages.

If you might divert drainage, make sure affected property owners have signed a release and that there's minimal likelihood that the diversion will cause any property damage.

However good general drainage guidelines to follow are:

- Don't divert drainage from the natural flow
- Don't increase runoff or back up drainage onto other property
- In essence, cause no harm to others with drainage work

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American Association of State Highway and Transportation Officials (AASHTO). 2011. *Roadside Design Guide*, 4th edition. Washington, DC: AASHTO.

AASHTO.1997. *Highway Safety Design and Operations Guide*, 3rd edition. Washington, DC: AASHTO.

Federal Highway Administration (FHWA). 2009. *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways*. Washington, DC: United States Department of Transportation, Federal Highway Administration.

ADDITIONAL RESOURCES

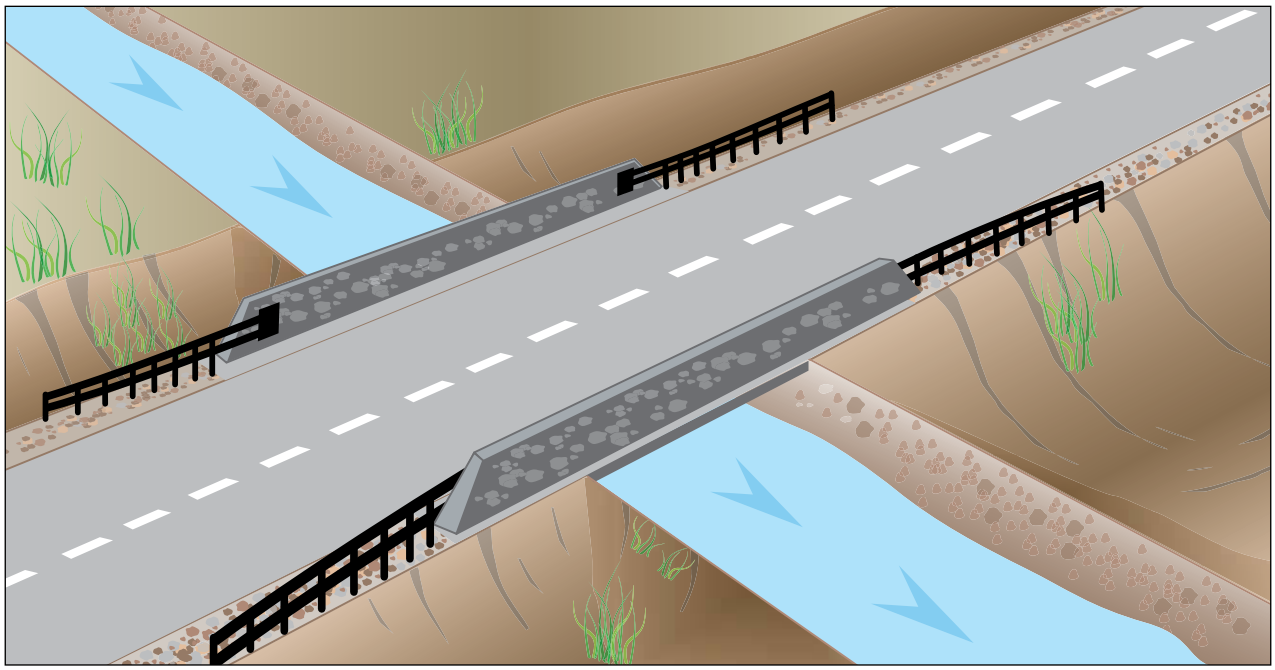
Alaska Construction Manual, www.dot.state.ak.us/stwddes/dcsconst/assets/pdf/constman/const_allmanual.pdf

Alaska Safety Manual, www.dot.state.ak.us/stwddes/dcsconst/pop_constman.shtml

Alaska Traffic Manual, www.dot.state.ak.us/stwddes/dcstraffic/atmintro.shtml

Alaska Digline, Inc. (811), 1-800-478-3121, www.akonecall.com

Chapter 6:
Bridges



chapter contents

General Safety Tips for Maintaining Bridges

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual. (See also DOT&PF Bridge Deck Cleaning, Expansion Joint Maintenance, Hand Rail Maintenance, Jacking and Inspection, Inspection of Existing Bridges Task Analyses.)

Suggested personal safety gear

- Snug-fitting clothing to avoid snagging
- Heavy gloves
- Hard-toed footwear
- Hard hat
- Ear protection
- Safety goggles or glasses with side shields
- Highly visible apparel (ANSI Class II minimum)

Advance preparation

- Be properly trained and thoroughly familiar with equipment like pile driver, backhoe, high-reach bucket, jack-hammer, etc.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available at the work site.
- Make sure work vehicles are equipped with approved and activated warning lights.
- Review Material Safety Data Sheet (MSDS) for all hazardous materials that might be encountered during work.
- Take extra precautions to prevent heat and cold stresses when working in hot or cold temperatures.
- Locate all utilities before starting work. Call Alaska Digline to locate any underground utilities

During operations

- If the road is open to traffic use proper temporary traffic control as described in the Work Zone Safety Handbook.
- Wear appropriate safety gear and highly visible apparel whenever you're out of your vehicle.
- Don't climb on structures without proper safety devices such as tie-offs, safety rails, and/or netting.
- Use proper lifting techniques or request assistance to lift heavy objects.
- Do not walk or work under suspended loads.
- Keep work areas free of loose materials and tools.
- Keep unnecessary personnel away from the work area.
- Remove all temporary traffic control immediately when no longer needed.

Bridges and other large structures carry vehicles, trains, people, fluids, gases, or communications facilities over and under roadways. In addition, they may also support large signs, traffic signals, luminaires, and similar items.

A bridge failure, while not common, can be catastrophic. It can cause injury or death to the public or maintenance staff and can be very expensive to restore.

Road maintenance workers are generally not responsible for extensive bridge inspection and repair, which is handled by the Bridge Inspection Office of the Alaska DOT&PF. However, as you drive over bridges in your jurisdiction or work in their vicinity, you can and should be aware of the signs of bridge stresses or other deficiencies and report problems immediately to your supervisor. See figure 6–1. Any serious deficiencies or problems should be reported immediately to the Regional District Superintendent or Regional Maintenance Manager. A higher level of contact is the Statewide Bridge Section of the Alaska DOT&PFin Juneau.

You may also need to perform some basic bridge housekeeping/maintenance activities as directed by your supervisor. Many of these activities are addressed in this chapter.

Characteristics of Well Maintained Bridges

Well maintained bridges have the following characteristics:

- The operating width is the same as when the bridge was constructed.
- Structural members are free from damage and corrosion and are in the same alignment as when they were built.
- The deck is free of debris and deterioration.
- Expansion joints are in good condition. Nothing should be sticking up that might catch a plow.
- All traffic control devices are in place, well maintained, and visible.
- The channel is free of serious erosion and trash, and the structural members are clear of debris.
- The bridge railing is in good condition, and any approach guardrail is in place and properly aligned and at the proper height for designed performance.
- Approach paving provides smooth access to the bridge deck for the motoring public.

Optimum Timing/Conditions for Maintenance

Most routine bridge maintenance will be conducted during the spring, summer, and fall. Some activities, like breaking up ice jams or removing debris affecting water flow, may be performed in the winter.

Inspections

Refer to Alaska DOT&PF Safety Manual Task Analysis "Inspection of Existing Bridges."

Federal regulations require that all major highway structures be inspected by a crew under the supervision of a professional engineer, at intervals not exceeding two years. In Alaska, this is performed by the Bridge Inspection Office in Juneau. Conditions often change in less than two years, however. During the course of day-to-day operations, maintenance personnel should be alert for settlement, washout, collision damage, and other problems and should notify their supervisor as appropriate. If the noted deficiencies are serious issues or such that imminent failure of the structure is possible, the supervisor, and then in turn the Statewide Bridge Section, should be notified immediately.

Maintenance crews are expected to maintain or repair minor bridge approach settlements, approach guardrail damage, plugged bridge drains, and other items. Records of defects found and repair action taken, when, and by whom, should be sent to the Chief Bridge Engineer. Copies of the reports should be kept on file until the deficiency is corrected. Some of the major activities are listed below.

Figure 6–1. Observe bridge conditions when you are in the vicinity

Bridge Maintenance Activities

Consult your supervisor and perform routine bridge maintenance activities as directed. Any work on a bridge needs to be reported to the M&O environmental staff for any needed permits. Such activities may include the following:

Approach Maintenance

Potholes in roadway approaches, whether paved or unpaved, should be filled. Approaches should be the same elevation as the surface of the bridge to prevent excessive impact stress loading on the bridge and discomfort for motorists.

Also see Blading at Bridges in chapter 3.

Guardrail Maintenance

Remove overgrown vegetation from under and around guardrails. If sand or other debris has built-up in front of or under beam guardrails over the winter, this material must be removed to allow the guardrail to function as designed when struck by an out-of-control vehicle. Consult your supervisor for the proper design elevation of the top of the guardrail and clearance below the bottom of the rail. In addition to removal of debris, adjustment of the guardrail may be needed to restore design elevation.

Bridge Cleaning

Refer to Alaska DOT&PF Safety Manual Task Analysis "Bridge Deck Cleaning."

Clean decks in the spring to remove salt and dirt. Clean decks, piers, abutments, and expansion joints. Before washing, remove and properly dispose of accumulated debris. You may be asked to blow incompressible debris like

Figure 6–2. Overgrown vegetation at guardrail

sand from the joints. Remove salt, dirt, and debris to an upland site. Do not contaminate streams or other water with these materials.

Concrete Bridge Deck Repair

Refer to Alaska DOT&PF Safety Manual Task Analysis "Concrete Bridge Deck Maintenance."

Delamination of concrete bridge decks is usually first noticeable over the steel reinforcing bars (re-bar). It is generally caused by chloride ions that infiltrate the concrete deck, migrate to the bars, and corrode them. When steel corrodes, it expands up to eight times its original volume, pushing up on the concrete. Eventually the bond between the concrete and the re-bar is broken, and cracks develop in the concrete deck. Cracks will continue to develop until pieces of the concrete deck come loose.

The broken areas are like tooth decay; they will spread until the damaged areas are removed and filled with new material.

To determine the extent of delamination, drag a log chain over the deck. There will be a distinct hollow sound where the concrete deck has delaminated and is deteriorating. Mark this area with paint from a spray can. Be sure to check the entire bridge deck.

Remove the delaminated concrete with jack hammers and/or hand tools. Remove all of the deteriorated deck down to sound concrete. (You may find that the deterioration has developed under the re-bars. Care must be exercised not to break the bond with adjacent good sections by using too large a chipping hammer.) Thoroughly clean the area with an air compressor and power and hand brooms. Make sure rusty steel rebar and pre-stressing strands are cleaned of rust before patching or re-grouting. Be sure to remove all broken, spalled, and delaminated concrete. If you are repairing the deck in the winter, place a temporary asphalt patch. (See Temporary (Asphalt) Repair under Concrete Pavement in chapter 3.) If the weather is moderate or warm, placea concrete surface patch. (See Surface Patching under Concrete Pavement in chapter 3.) Before placing a concrete patch, apply a grout or bonding agent to the existing, cleaned surface to bond the new concrete to the existing concrete deck. Check with your supervisor and follow the DOT&PF policies and procedures as well as the bonding agent manufacturer's instructions.

Finally, cure the new concrete by covering it with a liquid curing compound, plastic, or wet burlap, as directed by your supervisor. Curing allows the concrete to develop the required strength before traffic is allowed on the repaired area. "High early strength" cement allows PCC to cure quickly and provide a hard durable surface.

Steel Grid Bridge Deck Repair

Replace or repair broken welds or clips and any bent members. Be sure damaged areas are thoroughly cleaned of rust before welding. All welding is to be performed by a certified welder.

Wood Bridge Deck Repair

Refer to Alaska DOT&PF Safety Manual Task Analysis "Timber Bridge Decking Maintenance and Inspection."

Clean sand and gravel off the deck. If you observe loose or broken bridge deck timbers that cannot be easily repaired, notify your supervisor immediately. Both loose and broken planks can create a hazard for drivers.

If the plank(s) is/are loose, tighten them immediately with existing or new bolts or nails.

If the plank(s) is/are loose, tighten them immediately with existing or new bolts or nails.

If the plank(s) is/are broken, remove and replace them immediately. Determine the number of planks to be replaced, and measure the lengths required. Bring new bridge planks to the site and cut them to length using a chain saw. Drill bolt holes in appropriate locations, and attach the planks to the girders and stringers with new bolts.

When the maintenance activity has been completed and the bridge deck is secure, report to your supervisor. Documenting the timing of maintenance repairs can be critical in liability lawsuits.

Curb and Railing Repair

Refer to Alaska DOT&PF Safety Manual Task Analysis "Bridge Handrail Maintenance."

Repair any deteriorated, cracked, spalled, broken, or damaged members. Tighten any loose nuts and bolts, and replace missing nuts and bolts.

Expansion Joint Maintenance

Refer to Alaska DOT&PF Safety Manual Task Analysis "Bridge Expansion Joint Maintenance."

Routine maintenance activities of expansion joints might include cleaning of accumulated debris, re-attachment of loose parts, replacement of expansion joint material, and occasionally painting. To work effectively, expansion joints must move freely in differing temperatures to prevent excess pressure on the bridge backwall; maintenance may be needed to ensure this movement continues. This is especially important when re-attaching loose plates. Be sure not to weld or bolt plates so as to restrict the intended movement. Before beginning work to replace joint material, be sure the proper replacement is on hand.

Bridge Substructure Maintenance

Refer to Alaska DOT&PF Safety Manual Task Analyses "Concrete Bridge Super/Sub Structure Maintenance," Timber Bridge Super/Sub Structure Maintenance and Inspection," and "Bridge Jacking Activities and Inspection."

Minor maintenance of bridge substructures might include re-attachment or replacement of damaged and/deteriorated members, cleaning, and possibly re-painting. Placement or repair of riprap or revetment may also be required. Major repairs are generally scheduled and undertaken by specialized crews, who are trained and equipped for that work.

Paint

If any painted members exhibit cracking, peeling, fading, and the presence of rust or algae, re-paint as needed, using paint approved for that purpose. Be sure areas to be re-painted are thoroughly cleaned and dry and that temperatures are suitable before applying paint. Verify that lead paint is not present prior to it's removal. Work with lead based paint should be done by qualified personnel.

Debris Removal

Remove debris or excess vegetation from the bridge approach and bridge deck, under the bridge, and in the waterway. Do not leave debris where it will be picked up during the next high water flow.

Bridge Observation Activities

As described earlier in this chapter, required complete inspections of large structures are accomplished about every two years by trained staff from the Statewide Bridge Section; however, valuable contribution to the safety and satisfactory condition of bridges can be made by road maintenance workers as part of their routine activities.

During the course of regular road maintenance activities, you should routinely observe the general condition of bridges in your jurisdiction, as described in the next section. Conduct these observations on an ongoing basis, during all seasons of the year.

Report any potential problems to your supervisor. Defects, damage, erosion, or other serious flaws in bridges need to be addressed quickly.

When traveling on a road and approaching a bridge, pay attention. Carefully observe the general condition of the roadway nearing and leaving the bridge, the traffic control and safety devices, the bridge approach surface, and the bridge deck and structural members, if visible. Park safely and look over the edge of the bridge to see if there is any debris in the channel or erosion and debris around the structure.

Following are some suggestions of specific conditions or problems to watch for.

General Conditions

When conducting a maintenance inspection, particular attention should be given to the presence of materials that might pose a fire hazard or restrict access for maintenance activities around or under the bridge. The lower

chords on truss bridges should be cleaned off so a thorough inspection can be made of these fracture-critical members. Brush and trees should be removed from under and around the bridges.

Watch for "campers" building shelters or fires under bridge structures. Promptly notify the local law enforcement agency for removal.

Bridge Approach

On gravel road approaches to bridges, look for the following potential problems:

- Poor crown transition from the road to the bridge deck (see Blading at Bridges in chapter 3).
- Too much aggregate and/or inadequate crust on the bridge approach, so that the aggregate migrates onto the bridge deck. See figure 6–3. Aggregate on the bridge deck may effectively narrow the operating width of the bridge for drivers.
- Standing water or erosion at the shoulder line.

On paved road approaches to bridges, look for the following potential problems:

- Pavement distresses and excessive cracking
- Joint failures
- Erosion at the pavement edges
- Cracking or settlement of approach slabs
- Poor condition of expansion joint where the pavement meets the bridge deck
- Poor surface transition onto the bridge deck

Figure 6–3. Gravel on bridge deck

Guardrails and Shoulders

Look for the following potential problems:

- W-beam guard rail sections badly bent out of shape
- Loose bolts
- Loose, broken, or rotted wooden posts
- Bent or badly off-line steel posts
- Inadequate shoulder width behind the guardrail, providing poor support for the posts and especially the end section
- Eroded holes or ruts under the guardrail that vehicle wheels could drop into
- Insufficient height or clearance of the guardrail
- Overgrown vegetation under and around the rail

Traffic Control Devices

Be sure that all regulatory and warning devices required for the bridge are in place, e.g., load limit signs, horizontal and/or vertical clearance signs, speed limit signs, closed bridge signs, object markers, and delineators. Report any observed damage or deficiencies to your supervisor. Refer to the Alaska Traffic Manual. See figure 6–4.

Bridge Structure

Deck

On timber decks, look for the following potential problems:

- Loose nails, spikes, or other fasteners
- Openings between planks over abutments and piers which allow debris to sift through
- Split, worn, broken, or decayed planks

Figure 6–4. Visible object markers at a bridge

(To repair wood bridge decks, see Bridge Maintenance Activities earlier in this chapter.)

On concrete decks, look for the following potential problems:

- Cracking
- Leaching
- Exposed reinforcing
- Scaling
- Potholes
- Spalling
- Other evidence of deterioration

(To repair concrete deck surface, see Bridge Maintenance Activities earlier in this chapter.)

On steel decks, look for the following potential problems:

- Corrosion
- Unsound welds
- Loose welds where the deck is fastened to the stringers
- Dirt collected in open-grid decking on top of stringers
- Deteriorated paint

Structural Members above the Deck

Trusses

Observe the condition of trusses by sighting along the roadway rail or curb and along the truss chord members. Look for truss misalignment, either vertical or horizontal. Bent trusses may reduce the bridge's operating width and/or reduce the structure's soundness. Note any members damaged by vehicles. During observations, clean tops of members of accumulated bird guano or other foreign matter. Report bent or damaged steel, deflection, cracking, vibration, and deterioration due to rust. Particular attention should be given to pinned joints at hinges. Any excessive rust, vibration, missing nuts, or looseness should be immediately brought to the attention of the designated bridge maintenance representative.

Figure 6–5. Well aligned bridge trusses

Expansion Joints

Loose, banging, or jammed expansion joints should be noted. Check the presence and condition of the joint material. Also check to see if water is leaking through the joints.

Under the Bridge

Pay attention to the condition of the underside of the deck, the structural members, the piers and columns, the slope protection, and the waterway; see figure 6–6.

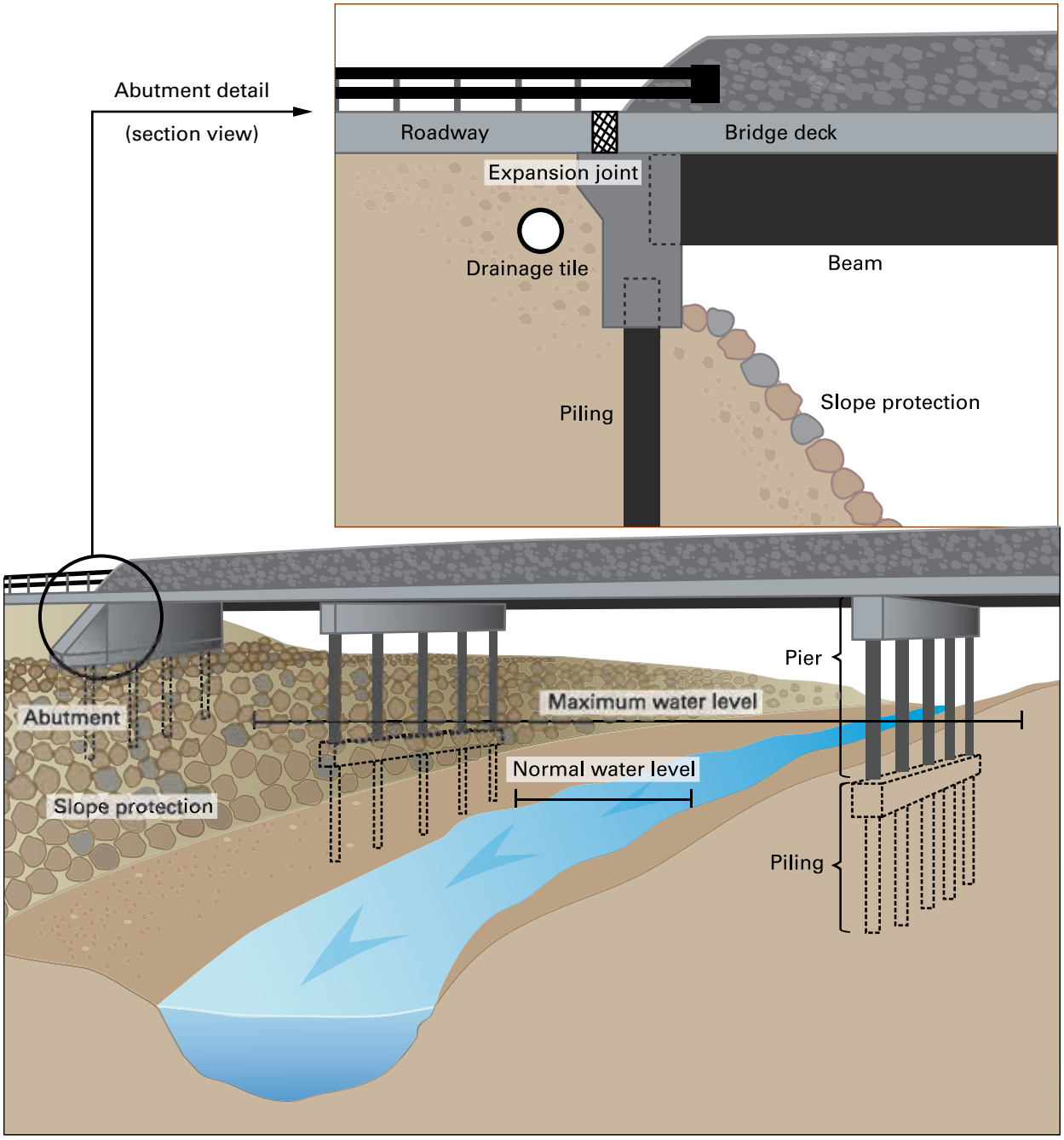


Figure 6–6. Elements to observe under the bridge (Adapted from Ettema, et al.)

Underside of Deck

Look for the following potential problems:

- Seepage (see figure 6–7)
- Calcium deposits
- Cracks in the deck
- Exposed reinforcing

Abutments, Piers, Column, and Backwall

Look for the following potential problems:

- Erosion at the bottom of the pier columns (see figure 6–8)
- Deteriorated concrete in the columns
- Any tilting, bulging, or other deterioration of any type
- Pier caps that are cracked or out of alignment
- Piers that are damaged due to ice or other debris

Bearings
Check for cracks, broken steel, broken or missing anchor bolts, and the condition of elastomeric pads and grout pads. Check if there is room for thermal expansion and contraction. Clean bearings if needed.

Bridge Deck Drains
Ponded water on the bridge deck can turn to ice and become a traffic hazard as well as accelerate deck deterioration. Be sure the deck drains are clean and extend below the lower flange of the girders.

Figure 6–7. Evidence of deck seepage (Lee Co.)

Structural Members under the Bridge

Structural members found under the bridge include the beams, which may be steel or pre-stressed concrete, and the abutments and backwalls. Look for the following potential problems:

- Steel beams that are corroded, discolored, or bent from being hit (see figure 6–9)
- Pre-stressed beams that are cracked or have pieces missing, particularly on the bottom flanges
- Backwalls that are eroded or pushed out of alignment (see figure 6–10)
- Abutments that are deteriorated or have erosion problems or leaking deck joint
- Wood piling cracking or splitting in any substructures
- Bearings that are corroded or frozen up due to rusting

Bridge Slope Protection

The purpose of bridge slope protection is to control erosion and vegetation growth under the bridge. For paved slope protection, look for the following potential problems:

- Broken panels (broken panels may not need to be replaced if they are seated firmly and generally conform to the slope)
- Cracks (although cracks themselves are not detrimental to the performance of slope protection, they should be sealed to prevent water intrusion, which may cause settlement and/or sliding of the panels)

If repairs become too costly, consider replacement of paved slope protection with riprap or revetment.

Figure 6–8. Erosion around base of piers (Ettema, et al.)

For riprap or revetment slope protection, look for the following problems:

- Bare areas
- Exposed fabric
- Erosion
- Inadequate rock size that does not resist erosion

Drainage Systems

If drainage system deteriorate or distress is observed, the system should be repaired or replaced as necessary to prevent further damage.

Figure 6–9. Corroded, discolored steel beams (Lee Co.)

Figure 6–10. Abutments, bearings, and backwall with erosion and corrosion problems (Lee Co.)

Waterways

Log or ice jams at piers or pile bents cause scour, which in some cases could result in failure. All bridges with piers or bulkheads in streams with a debris problem should be checked during and after floods, and any debris should be removed as soon as possible to prevent potential bridge failure. Bank protection (riprap, etc.) should be checked to ensure that it is adequate to prevent scour or erosion. In-water work of this type usually requires an Alaska Department of Fish and Game fish habitat permit. Check with the DOT&PF Regional Environmental Coordinator prior to beginning any repair work.

Look for the following potential problems along the waterway:

- Debris collecting near piers (see figure 6–11) or in the stream channel (see figure 6–12). (Debris accumulations may cause scour, redirect the stream channel, apply excessive hydraulic loads, or become a fire hazard. They should be removed as soon as possible.)
- Damage to wing dikes, etc., which protect the bridge or control the streambed. (Such damage should be scheduled for repair as soon as possible.)
- Sand and gravel bars that divert water flow and perhaps cause scour.

For More Information

For in-depth bridge inspection courses, see http://dot.alaska.ecatts.com/lmsShowClass?classId=410&month=4&year=2012&id=.

Figure 6–11. Debris collected around a pier

Figure 6–12. Debris in river channel (LTAP-IN)

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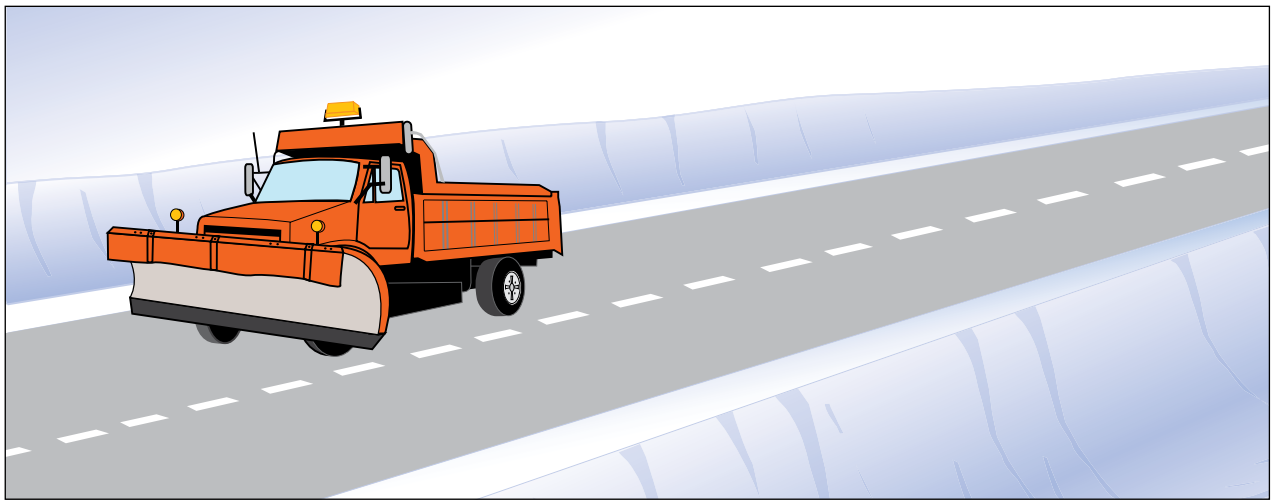
ADDITIONAL RESOURCES

Alaska Digline, Inc. (811), 1-800-478-3121, www.akonecall.com

Chapter 7:
Snow and Ice Control



chapter contents

Safety Tips for Snow and Ice Control

Always check with your supervisor and follow the safety policies and procedures in the Alaska DOT&PF Safety Manual. (See also Cold Weather Safety, Sander, Sander Tailgate, Snow Plow, Vehicle Operations and Grader Task Analysis.)

Suggested personal safety gear

- Layers of clothes, extra gloves, heavy boots
- Shovel and ice scraper
- Flashlight for night operations
- Sunglasses for glare
- Water and/or hot liquid

Advance preparation

- Be properly trained and thoroughly familiar with all equipment and chemicals.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available in your vehicle.
- Be in good physical condition with adequate rest.
- Perform a pre-trip safety check of truck and equipment. Make sure the vehicle has adequate warning lights in good working order.
- Make a practice run of assigned route to check for obstacles and potential problem areas.
- Know the contact procedures for reporting crashes or equipment breakdowns.

During operations

- Dress in layers with heavy boots.
- Wear highly visible apparel when out of your vehicle.
- Plow at appropriate speed.
- Watch for pedestrians and other vehicles.
- Don't back up without a spotter.
- Operate wings carefully.
- Make sure warning lights are activated.

Today's motorists—and the needs of our economy—demand that roads be open and reasonably safe in almost any kind of weather. A road department's ability to remove snow efficiently and open roads quickly is often the standard by which the department is judged. Winter road maintenance is so important that many local governments size their entire road maintenance program—that is, the number of maintenance employees, the number and kind of vehicles, etc.—to accommodate winter maintenance activities. Snow and ice control is often a major budget item for many local governments.

Snow and ice control operations have two goals. First, make roadways passable. Second, provide adequate pavement friction to allow vehicles to brake, turn, and accelerate safely. This chapter discusses how road workers can help agencies meet these goals. Topics include preparing for winter operations, snow and ice control strategies, chemicals for anti-icing and deicing, enhancing friction, and post-storm activities.

Ten Commandments for Snow Fighters

1. Thou shalt present thyself to thy job physically and mentally fit and properly clothed for any emergency in order to withstand the rigors of thy task.
2. Thou shalt always inspect thy lights, windshield wipers, defrosters, flares, and other safety equipment before entering thy cab.
3. Thou shalt know thy spreading and plowing routes, as well as the performance of thy spinner and the life of thy plow blade.
4. Thou shalt faithfully remain alert in order to avoid guardrails, headers, stalled cars, manhole covers, railroad tracks, and mailboxes. Otherwise thee may smite thy windshield with thy head.
5. Thou shalt contain thy temper, even though cars and trucks pass thee on both sides and tailgate thee too close for comfort. Anger only multiplies thy prospects of coming to grief by accident.
6. Thou shalt use thy radio as briefly as possible—assuming thee is fortunate enough to have one. Remember thy fellow workers may need to communicate in an emergency.
7. Thou shalt interrupt the flow of power to thy spreader before attempting to free any foreign objects or blockage if thee treasures thy fingers.
8. Thou shalt render thy truck and spreader out of gear and stoutly set thy brakes before dismounting from thy cab.
9. Thou shalt govern thy speed according to conditions, else thee may wind up with thy truck upside down.
10. Thou shalt mind thy manners on the roadway, clearly signal thy intentions, and remember that it is more blessed to give than to receive.

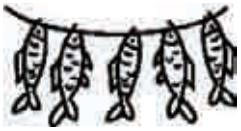
[Adapted from the National Local Technical Assistance Program/Salt Institute. Source: Rural & Urban Roads, 1980]

The purpose of this chapter is to promote the understanding of the tools, best practices, and limitations for snow and ice control. It will also help you understand when to use and when not to use these tools and practices. In addition, it encourages progressive changes in snow and ice control practices that will help you reduce salt/sand use and other environmental impacts while meeting the safety and mobility needs of roadway users. Improved practices such as anti-icing, pre-wetting, and pretreating are emphasized. Also included are standard best practices of a quality snow and ice control program.

For more information, see Alaska Department of Transportation and Public Facilities, Central Region Standard Operating Procedures for Winter Road Maintenance. Remember, however, that a one-size-fits-all approach will not work for the broad range of winter road conditions Alaska experiences. Different strategies are needed for different districts and different conditions. We encourage you to continue to test, document, and refine the practices recommended in this chapter. An April 2013 study by Western Transportation Institute at Montana State University for AASHTO was a revision of chapter 8, NCHRP 25-25(04). It presents information on recommended practices and strategic planning for reduced chemical usage and highlights innovative DOT best practices and programs that achieved reductions or improved environmental outcomes. It can be reviewed at http://maintenance.transportation.org/Documents/nchrp%2020-7_Task%2013Revised%20Chapter%208%20with%20Summary%20of%20Research.pdf.

A supervisor should seek information on weather and highway conditions to assist in making decisions. In addition to Alaska DOT&PF data, information about the progress of storms or pavement conditions may be volunteered by the public or solicited from other agencies, such as the police department. Reports of highway conditions from external sources should be weighed in relation to current priorities and activities of the crews.

Throughout the chapter you will find environmental tips, designated by a fish symbol. These tips are provided to help you reduce environmental impacts from snow and ice control operations.



Priority Levels

Priority Levels provide the basis for dispatching operators and equipment so they can effectively perform snow and ice removal and control operations. In addition to Alaska DOT&PF data, information about the progress of storms or pavement conditions may be volunteered by the public or solicited from other agencies, such as the police department. Seek information on highway conditions to assist making decisions.

Reports of highway conditions from external sources should be weighed in relation to current priorities and activities of the crews. Deviations from established Priority Levels may be necessary to react to unique or isolated

conditions. One example may be the need to keep open a school bus route during a heavy snow occurrence.

The following definitions represent the desired winter maintenance Priority Levels for all roads maintained by the Alaska DOT&PF. Every Alaska DOT&PF maintained road will be designated a winter maintenance Priority Level. The designated Priority Level defines the level of snow and ice activities that shall be implemented on the route.

The following guidelines for Priority Levels represent the minimum manpower and resource allocation when general area-wide weather conditions are of such duration and intensity as to demand full deployment of department resources. The roadway surface condition goals stated below represent the desired end product.

The actual performance in achieving these goals will vary due to the dynamic nature of winter weather. Storms vary widely in their characteristics, and winter maintenance activities may deviate temporarily from the descriptions below based upon the timing, intensity, duration of the storm, temperature, humidity, wind conditions, and the nature of the precipitation. While winter storms may at times temporarily overtake snow and ice control operations, the conditions below describe the objectives that the maintenance crews continue to strive to obtain.

It is important to note that some lower Priority Level designated roads may be treated as higher level roads in order to maximize operational efficiencies.

It is also important to note that not all maintenance areas have roads in each Priority Level. Rural maintenance stations may only have Priority Levels III and IV roads in their area.

Priority Level I

A Priority Level I designation applies to major high-volume, high-speed highways, expressways, minor highways, and other major urban and community routes designated by the District (these routes may or may not include school bus routes, school roads, medical center roads, and airport roads). All safety corridors are included in this Priority Level. Priority Level I routes are always the number-one priority.

- As soon as resources allow following the storm, good winter driving conditions (Performance Target A; see Table 7–1) should prevail.
- Appropriate snow control operations usually begin before two (2) inches or more snow has accumulated.
- Anti-icing may be performed on these routes prior to the storm.
- Sanding operations should begin when ice or compact snow conditions are evident and immediately after plowing, as conditions permit.
- When effective, apply chemicals or abrasives, separately or in combination, to enhance traffic safety.

- Overtime may be authorized during a storm event to keep the route passable and following the storm to complete cleanup and to provide good winter driving conditions.
- Sidewalks adjacent to Priority Level I routes should be maintained to provide safe passage and the usability of sidewalks during and after adverse winter weather conditions.
- Bike paths adjacent to Priority Level I roads may or may not be plowed or cleared of snow as determined by the Regional Maintenance and Operations Director/Chief. These facilities do not have snow removed until spring when thaw is imminent either due to funding constraints, or public preference to leave snow pack on path for hiking, skiing, dog sledding, or other recreational activities.

Priority Level II

Priority Level II is assigned to routes of lesser priority than Priority Level I roads based on traffic volume, speeds, and uses (these routes may or may not include school bus routes. school roads, medical center roads and airport roads). Typically routes in this Priority Level are major highways and arterials connecting communities.

- As soon as resources allow following the storm, fair to good winter driving conditions (Performance Target A/B; see Table 7–1) should prevail.
- Appropriate snow control operations usually begin after two (2) inches or more snow has accumulated and after Priority Level I sections of highway have been appropriately cleared.
- Sanding operations should begin when ice or compact snow conditions are evident and Priority Level I sections of highway have been appropriately cleared.
- When effective, apply abrasives to enhance traffic safety on steep grades, curves, bridge decks and approaches, intersections, known high accident locations, etc.
- In the Southeast Region, due to milder temperatures, some anti-icing on these routes may be performed.
- Overtime may be authorized during a storm event to keep the route passable and following the storm to complete cleanup and to provide fair winter driving conditions.
- Sidewalks adjacent to Priority Level II routes should be maintained to provide safe passage and the usability of sidewalks during and after adverse winter weather conditions as resources allow. Snow removal operations should begin after Priority Level I sidewalks have been cleared.
- Bike paths adjacent to Priority Level II roads may or may not be plowed or cleared of snow as determined by the Regional Maintenance and Operations Director/Chief. These facilities do not have snow removed until spring when thaw is imminent, either due to funding constraints, or

public preference to leave snow pack on path for hiking, skiing, dog sledding, or other recreational activities.

Priority Level III

Priority Level III is primarily assigned to major local roads (collector roads) in larger urban communities or as determined by the District Superintendent.

- As soon as resources allow following the storm, fair winter driving conditions (Performance Target B/C; see Table 7–1) should prevail.
- Appropriate snow control operations should begin after Priority Level I and Priority Level II sections of highway have been completed. In some cases, because of the snowfall duration, these roads may become nearly impassable before they are plowed.
- The primary goal will be to remove excess snow from the travel lanes and shoulders during regular working hours.
- Sanding operations should begin when ice or compact snow conditions are evident and Priority Level I and Priority Level II sections of highway have been adequately attended.
- Generally, abrasives are only applied at specific locations (i.e. steep grades, curves, intersections, bridge decks, etc.) to enhance traffic safety.
- Overtime is generally only authorized to address significant safety concerns as determined by the District Superintendent.
- Sidewalks adjacent to Priority Level III routes should be maintained to provide safe passage and the usability of sidewalks after adverse winter weather conditions as resources allow. Snow removal operations should begin after Priority Level I and Priority Level II sidewalks have been cleared.
- Bike paths adjacent to Priority Level III roads may or may not be plowed or cleared of snow as determined by the Regional Maintenance and Operations Director/Chief. These facilities do not have snow removed until spring when thaw is imminent, either due to funding constraints, or public preference to leave snow pack on path for hiking, skiing, dog sledding, or other recreational activities.

Priority Level IV

Priority Level IV applies primarily to minor local roads as determined by the District Superintendent. These roads typically provide residential or recreational access.

- As soon as resources allow following the storm, fair winter driving conditions (Performance Target C; see Table 7–1) should prevail.
- Remove snow during the storm only when manpower and equipment are not being utilized to clear other higher Priority Level routes. These routes may be impassable (Performance Target D/F; see Table 7-1) for an

extended period of time until resources are available to plow the travelway.

- Winter maintenance shall be accomplished during regularly scheduled working hours on these routes. Overtime is generally not approved for maintenance on these routes.
- Chemicals and/or abrasives are not used unless hazardous conditions exist and are approved by the Regional M&O Director/Chief.
- Remove snow on sidewalks adjacent to Priority Level IV routes only when manpower and equipment are not being utilized to clear other higher Priority Level routes. These sidewalks may be impassable for an extended period of time until resources are available.
- Bike paths adjacent to Priority Level IV roads may or may not be plowed or cleared of snow as determined by the Regional Maintenance and Operations Director/Chief.

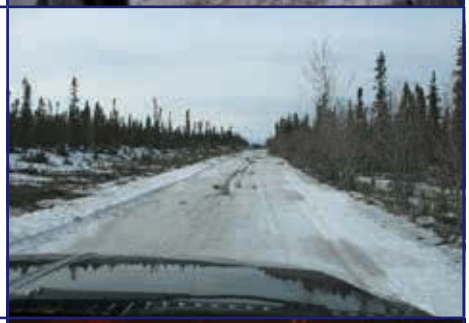
Priority Level V

Priority Level V applies to roadways that are designated as "No Winter Maintenance" routes.

- No winter maintenance activities are performed on these roads except as approved by the Regional Maintenance and Operations Director/Chief.
- Maintenance activities generally cease mid-October, and spring road openings generally begin during the first part of April.
- Sidewalks and bike paths adjacent to Priority Level V roads are not plowed or cleared of snow. These facilities do not have snow removed until spring when thaw is imminent, either due to funding constraints, or public preference to leave snow pack on path for hiking, skiing, dog sledding, or other recreational activities.

Each maintenance area shall have a written policy defining each route's priority and performance target, as shown in Table 7–1. The District Superintendent shall review and approve, in writing, priorities for each maintenance area under his/her authority.

Table 7–1. Highway Winter Performance Targets

Performance Target	Performance Target Description	Illustration
A (Good Winter Driving Conditions)	Bare pavement is the primary goal. Good winter driving conditions exist when snow and ice have been removed from the driving lanes and excessive loose snow has been removed from the shoulders and centerline of the highway. Short sections of ice and packed snow are acceptable and can be expected within the driving lanes between the wheel paths, as well as on centerline. Bare pavement may not be possible in the Northern and Central Region's during periods of extreme cold weather. Generally loose snow has been cleared and traction is good for most vehicles properly equipped for winter driving. If required for traction, 100% of roadway has sand present.	
B (Fair to Good Winter Driving Conditions)	Roads are passable with varying conditions. Drivers may encounter some standing water, packed snow, and icy patches covering the surface. Generally loose snow has been cleared from the travelway and traction is adequate for most vehicles properly equipped for winter driving. If required for traction, sand is applied to hills, curves, intersections, and bridge decks. Performance target B represents a fair to good level of service, which ranges from targets of bare pavement as much as possible on higher-standard or highly traveled highways to snowpack or icy conditions on northern region roads as well as on lower-standard or low-volume roads. Traffic moves at reduced speed, with isolated slowdowns or delays.	
C (Fair to Poor Winter Driving Conditions)	Roads are generally passable with varying conditions. Drivers may encounter some standing water, loose snow, snow drifts, packed snow, and icy patches covering the surface. Patches of snow or ice exist even on the highest-standard roads, and these conditions may degenerate to predominately snow-packed or icy conditions throughout, with accompanying slowdowns or delays. On lower-standard or low-volume roads the surface is snow-covered (up to 2") with substantial traffic delays.	
D (Poor Winter Driving Conditions)	Travel is challenging for most vehicles properly equipped for winter driving. Moderate snow accumulation on roads may be up to 4". Performance target D represents a marginal level of service where traffic moves slowly with substantial delays. Traction is marginal even for vehicles properly equipped for winter driving.	
E (Hazardous Winter Driving Conditions)	Travel is not advised. Considerable snow accumulation on roads may be 4" or more. Drivers may encounter snow drifts, berms, freezing rain, and glare ice. Traction is extremely poor even for vehicles properly equipped for winter driving.	

Basic Concepts

Three concepts are important to keep in mind regarding winter road maintenance activities: weather, pavement temperature, and dilution of material.

Weather

Knowing existing and potential weather conditions is very important for a successful snow and ice control operation. Six pieces of information are especially valuable:

1. Start of precipitation
2. Type of precipitation
3. Total precipitation expected
4. Expected event length
5. Wind conditions (speed, gusts, directions)
6. Air temperature trend

Monitor the weather closely so that you are available and prepared to act early in storm situations. Sources of information include the following:

- Talk to neighboring agencies and share information on conditions.
- Subscribe to a value-added meteorological service (VAMS). These are useful for viewing weather forecasts.
- Check the National Weather Service website, http://www.weather.gov/ (then click on AK area).
- Check all available weather sources.

Pavement Temperature

Most weather stations measure temperature and other conditions 30 feet above ground, which means these conditions can differ substantially from pavement temperatures. Thus, use the pavement temperature—not the air temperature—to determine your application rate.

You'll notice changes in pavement temperature first on bridge decks; pavement temperatures will also be lower in shady and mountain areas.

There are two ways to measure pavement temperatures: with sensors or with the Road Weather Information System (RWIS).

Sensors can be hand-held or truck-mounted. Hand-held infrared laser sensors are pointed at the pavement to get a pavement or surface temperature while your vehicle is stopped or moving slowly. Truck-mounted temperature sensors measure pavement or surface temperatures while your truck is moving. Ideally, every agency should own at least one truck-mounted unit.

RWIS (www.roadweather.alaska.gov) is an Internet service provided by Alaska DOT&PF and available to everyone. The RWIS is a predictive system

that consists of a network of towers and temperature sensors embedded in state highways.

If you do not have road sensors in your truck, look up the road temperature for the closest state highway on RWIS. This will give you an idea of the local road temperatures.

Dilution: The Cause of Refreeze

An ice control material (usually brine) will work until dilution causes the freeze point of the brine to equal the pavement temperature. At this point, the material will stop melting the ice, and you may experience refreeze if pavement temperatures are dropping. This process is *"dilution of solution."*

How long an application will last depends on five factors: pavement temperature, application rate, precipitation, beginning concentration, and chemical type. These factors explain why one application rate will not fit all storm events.

Snow and Ice Control Strategies

There are three general strategies for snow and ice removal/control:

- Anti-icing—applying chemicals to prevent snow and ice from bonding to pavement.
- Plowing—removing accumulated snow and ice from pavement.
- Deicing—applying chemicals to break the bond between snow/ice and pavement.

Generally speaking, anti-icing is used immediately before or at the beginning of a storm. Plowing is conducted when the storm is active or while the wind is still blowing. Deicing is conducted after the storm and when snow and ice are frozen solid to the roadway surface.

RULE OF THUMB

If snow is blowing across and off the road, consider carefully before applying anti-icing chemicals that may cause snow to stick to the roadway.

Which Strategy to Use?

Not all agencies use all three snow and ice control strategies. The Alaska DOT&PF is moving towards a proactive anti-icing strategy whenever possible. We see this as a major efficiency and cost savings measure and want to encourage it where feasible. Many agencies use a flexible combination of these strategies before, during, and after each particular storm. For example, it is common to simultaneously plow snow and apply salt or other chemicals. Any of these strategies may be combined with application of abrasives (see Enhancing Friction later in this chapter). Consult your supervisor with any questions you may have.

Knowledge of past storms, as well as accurate predictions about the timing, duration, and severity of imminent storms, helps maintenance supervisors make informed decisions about which strategies and materials to use, chemical application rates, and frequency of treatment.

Current and predicted pavement temperatures are the most important data for selecting appropriate snow and ice control strategies. The effectiveness of deicing chemicals is directly related to pavement temperature, not air temperature.

Importance of Forecasting

A winter maintenance program is only as good as your agency's ability to accurately predict the onset of a winter storm. It is critical to know when a storm will arrive and how air and pavement temperatures are changing along with wind direction and velocity. Accurate information about pavement temperatures is especially critical for selecting appropriate materials. Salt brine, for example, becomes less effective as the temperature approaches 18°F. (See Materials Selection, later in this chapter.)

For reliable forecasts tailored to your jurisdiction, access the Alaska DOT&PF's extensive road weather information system (RWIS) network and value-added meteorological service. In addition, it is useful to establish a network of local contacts—maintenance supervisors in neighboring jurisdictions—who can provide real-time information about an approaching storm.

Before Winter

Take some time before the winter season to plan your routes and learn the plowing policies. A little planning up-front can help you do a more efficient job in keeping the roads safe.

Policies

- Make sure you have a plowing policy and meet to discuss it. The policy should include Priority Levels for all roadways in your jurisdiction.
- Inform your citizens of policies.
- Learn to record the type and volume of materials you apply on each shift. Be prepared to analyze and make adjustments to your process based on what you learn.

Route Planning

- During the fall, inspect and make sure ditches, culverts, and surfaces are free from obstructions and ready for the spring melt.
- Remove potential snow traps, such as tall grasses, that will catch snow and cause it to accumulate.
- Drive the assigned routes prior to winter to identify critical areas and determine the most efficient way to cover the routes.
- Inventory all the areas prone to drifting and have a plan to manage them.
- Know your routes. Plan which way you will start.
- Be flexible. Conditions could change the way you plow your route.

Equipment Adjustments

Adjustment is an essential procedure to ensure good sanding and other material application patterns. Adjust the gate, auger, and spinner as needed to ensure good sanding and salt patterns are achieved. Flow rates and/or pump speeds can also be adjusted for brine or other liquid anti-icing agents.

Snow Storage Sites

Snow storage sites need to be inspected prior to the start of the winter plowing season. Any debris or potential sources of runoff pollutants need to be removed before roadway snow removal starts.

Salt and Sand Storage

Inspection of the storage sites for salt and sand needs to be performed prior to the winter plowing season. The quantity of salt and sand needs to be documented to ensure there is enough for the start of plowing season. Any obstructions or debris that would impede the loading or movement of trucks on the site need to be removed prior to the start of the season.

Employee Training

Prior to commencing winter road maintenance, staff should be briefed on winter maintenance standard operating procedures. Supervisors also have access to a variety of training videos for various aspects of maintenance operations. New staff or policy changes shall also prompt training and review of procedures.

Before the Storm

Before a storm, proactive tactics like anti-icing may be feasible.

Anti-Icing

Anti-icing—applying chemical freezing-point-depressant materials to the pavement before a storm to prevent snow and ice from bonding to the pavement—is a proactive approach that should be first in a series of strategies for most winter storms.

Anti-icing is often the most cost-effective and environmentally safe practice in certain winter road maintenance situations.

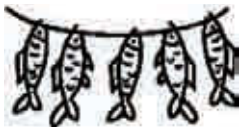
Anti-icing requires about one-fourth the material required for deicing at only about 10 percent of the cost, making it the least expensive option for improving traffic safety. Anti-icing is effective and cost-efficient when used correctly and approached with realistic expectations.

Summary of Anti-Icing Benefits

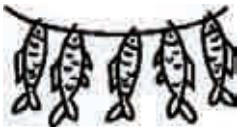
- Anti-icing is a proactive approach to winter road maintenance. It forms a bond-breaker between the pavement surface and the snow and ice layer

RULE OF THUMB

Removing ice or snowpack after it forms (deicing) takes ten times more energy than preventing ice formation (anti-icing).



which melts snow more quickly and reduces the chance that ice will form and bond to the surface.



- Anti-icing returns road surfaces to normal faster, resulting in fewer accidents and delays.
- Reduced use of sand on the road results in cost savings and reduced environmental impacts.
- Snow and ice control cost savings result in benefits to the department and the public.
- Improved winter roadway conditions result in safer driving conditions for motorists.
- Lower accident rates benefit the public. Colorado experienced an average decrease of 14 percent in snow- and ice-related crashes during a 12-year study utilizing the anti-icing process on the interstate system in the Denver metro area. On US 12 in Idaho, once anti-icing was implemented, accidents were reduced by 83 percent each year compared to years before the start of the pilot program.

Considerations for Anti-icing

RULE OF THUMB

The surface can re-freeze if precipitation or moisture on the pavement dilutes the chemical, or if temperatures drop below the effective temperature of the anti-icing chemicals.

- Anti-icing is often effective for heavy frosts.
- Anti-icing prior to forecasted frost events helps to eliminate or minimize frost formation. Under some conditions, one anti-icing treatment has proven effective for multiple days and over weekends, and can sometimes treat two frost events.
- Anti-icing works best when combined with accurate road weather information.
- Early application is particularly important for frost or light freezing drizzle.
- Liquids, such as salt brine, are the most efficient anti-icing material and may be applied days in advance of an event.
- Pretreated salts will work at lower application rates closer to the expected event.

What to Do

- For best results, apply only with stream nozzles to maintain some bare pavement between sprayed areas to reduce slipperiness. Fan spray is not recommended.
- Schedule applications on bridge decks and critical areas if temperature and conditions could produce frost or black ice.
- Consider spot-applications on hills, curves, intersections, and turn lanes if predicted conditions warrant.
- Use the appropriate chemical for your pavement temperature range.
- Apply an anti-icing product during non-rush-hour traffic periods.

- When frost on the shoulder starts to move into the travel lanes, reapply anti-icing product.

What not to Do

- Do not apply anti-icing chemicals with fan sprayers.
- Don't anti-ice under blowing conditions and in areas prone to drifting. Be aware of areas that are prone to wind issues. Application of brine in advance of a dry, blowing snow can be counterproductive and result in surface icing.
- Reapplication isn't always necessary if there is still a residual. The residual effect can remain for up to five days after application if precipitation or traffic wear-off does not dilute the initial application.
- Remember that the surface can refreeze when precipitation or moisture in the air dilutes the chemical.
- Don't apply magnesium chloride ($MgCl_2$) or calcium chloride ($CaCl_2$) to a warm road (above 28°F pavement temperature). It can become slippery and cause crashes!
- Don't apply before predicted rain.
- For the first application or after a prolonged dry spell, apply liquids at half the rate (not half the concentration). On dry roads, liquids tend to mix with oil from vehicles and cause slippery conditions.
- Don't apply too much or the roadway may become slippery. Less is better. Always follow application recommendations.

Anti-Icing Preparation Checklist

- Order chemicals including additives and provide for proper chemical storage.
- Inventory equipment.
- Test/calibrate application equipment.
- Make sure communication channels are functioning. Establish inter-agency agreements. Share your plans with the media.
- Understand your agency's policies and procedures regarding level of service (LOS), peak traffic levels, and operations.
- Plan routes and conduct dry runs to identify trip length and time, obstacles, and trouble spots.

Anti-Icing Guidelines

1. Apply anti-icing material immediately before or just as a storm begins to prevent bonding of snow or ice to the pavement.
2. Use accurate pavement temperature and other road weather information to decide when to begin applying chemicals.

3. Anti-icing is often effective for heavy frosts. Early application of chemicals is important for frost or light freezing drizzle.
4. Apply with stream nozzles so the material is distributed directly on the vehicle wheel paths.
5. Schedule applications on selected sections of the roadway (e.g., bridge decks) if the temperature and conditions could produce frost or black ice.
6. Consider spot applications on hills, curves, and intersections.
7. Apply material during low-traffic periods if possible.
8. When frost on the shoulder begins moving into the traveled lanes, reapply chemicals.

Anti-Icing Training

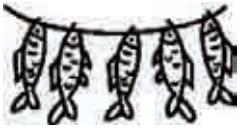
The American Association of State Highway and Transportation Officials (AASHTO) has developed an interactive, self-directed training program to help road maintenance personnel understand and implement anti-icing effectively. The Anti-Icing/RWIS Training package is available to members of the National Association of County Engineers (NACE) free of charge. You can order your copy, through Alaska's Local Technical Assistance Program, (907)451-5320, david.waldo@alaska.gov . Cities can borrow the Anti-Icing/RWIS Training package from Alaska LTAP or by contacting the Heavy Equipment Training Coordinator.

Equipment

- An anti-icing unit usually consists of a transport vehicle with tank.
- Fan spray is not recommended.

RULE OF THUMB

Because pretreating and prewetting cause material to stick to the road, 20 to 30 percent less material is used, saving money and reducing environmental impacts.



Pretreating and Prewetting Salt and Sand

Dry material bounces or blows off the road, so dry material should be pretreated or prewet before it is spread on the roadway. Liquids also increase salt's effectiveness by jump-starting the melting process. Depending on the liquid used, it can lower salt's effective working temperature. Prewet abrasives will refreeze quickly to the road surface and create a sandpaper-type surface, which can cut abrasive use by up to 50 percent in cold temperatures.

Additional benefits include less material accumulating under guardrails, on shoulders, and in storm drains. Environmentally, pretreating and prewetting help reduce chemical and sand levels in waterways and particulate matter in the air. Both practices reduce the total amount of materials needed, which helps reduce negative environmental impacts. Other benefits are reduced costs of roadway sweeping and storm drain cleaning because less sand is used.

Pretreating is mixing a liquid into the stockpile of salt or sand before it is applied. Unlike prewetting, it does not require equipment changes and requires no new capital investment for equipment. You can also switch from

dry application to wet application immediately; just turn down the application rate.

Prewetting is adding a liquid to the salt and or sand as it is being applied, either at the spinner or through a soaker pipe in the auger box. Although prewetting requires some equipment changes, it provides flexibility to switch the chemical makeup, depending on conditions. Prewetting our sand is the direction we want to go.

Pretreating Sand Stockpiles

- Pretreat the stockpile to keep it flowable.
- Add 4 percent to 5 percent salt by weight to ton of sand to keep flowable. More may be required in colder regions.
- For best results, store the stockpile under cover.
- Because leach risk at a stockpile is increased, store it covered on an impervious pad if possible and as funding allows.

Prewetting Onboard

- Salt brine, calcium chloride, magnesium chloride, and acetates may be used as prewetting agents.
- The optimal application rate is 8 to 14 gallons/ton for salt brine.
- Prewetting with other chemicals at the spinner can help reduce the application rate.
- Below 15°F, salt brine is less effective than other liquids and may freeze hoses and valves.
- Salt brine should be mixed at 23.3 percent.

Enhancing Friction

Sand and other abrasives improve vehicle traction on snow and ice-covered roads. (Even dry or prewetted salt improves traction briefly after it is spread.) Abrasives can be used at all temperatures, but their use is especially important when it is too cold for chemical deicers to work. Since abrasives must stay on the surface to be effective, they should not be used when they will be covered with more snow or when they will be blown off quickly by traffic. Heavy traffic reduces the effectiveness of abrasives, requiring repeated application.

Sand is the most commonly used abrasive, but slag, cinders, and bottom ash from power plants are also used.

Sometimes deicing chemicals are mixed with sand. The sand gives immediate traction, and the chemicals melt the snow either immediately or when the temperature rises. However, to be effective the chemical must remain on the pavement, which is difficult to achieve in most cases. Mixing salt with sand reduces the salt's melting effectiveness.

A minimum amount of salt (50 to 100 pounds of salt per cubic yard) must be mixed with abrasives to keep them unfrozen and usable. Prewetting sand with liquid deicing material is also effective. The chemical helps to anchor the sand into the ice surface, makes the sand easier to load from the stockpile, and causes the sand to spread more evenly from mechanical spreaders.

During the Storm

During a storm, road maintenance tactics change from proactive to reactive.

Deicing

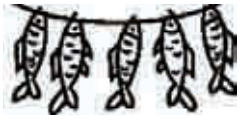
Deicing is a reactive operation in which a deicer material is applied to the top of an accumulation of snow, ice, or frost that is already bonded to the pavement surface. Deicing generally costs more than anti-icing in materials, time, equipment, and environmental damage.

Removing ice that has already bonded to the pavement can be difficult, and removing it mechanically can damage equipment and roads. Generally, enough ice must be melted chemically to break the bond between the ice and the pavement, which requires larger quantities of chemical than anti-icing.

- Use an appropriate amount of salt. Most oversalting can be prevented by using good judgment in selecting application rates and truck speed.
- It is not necessary to melt all the snow or ice on the road with salt. This is an overuse of materials. Apply just enough to loosen the bond between the road and the ice so it can be plowed off.
- Pre-wetting salt reduces the amount of salt and can speed up its effectiveness.

Using Abrasives

Use sand and other abrasives when temperatures are too cold for deicing chemicals to be effective. But be aware that sand does not melt anything. It provides temporary traction, and only when it is on top of snow and ice. It is important to remember that sand also infiltrates sewers, ditches, and streams.



A 5 percent salt/sand mix is generally utilized by the department. If mixed in the wrong concentrations, salt reduces the effectives of sand, and sand reduces the effectiveness of salt.

- Use abrasives in slow-moving traffic areas such as intersections, curves, hills, and turn lanes.
- Salt is ineffective in the majority of Alaska's climate zones, so sand or alternative chemicals are predominantly utilized.
- Sand is not cheap when you consider the handling, clean-up, and disposal costs.

Standard Practices

- Know the pavement temperatures and trends to help you use the right application at the right time.
- Below 20°F, utilize the appropriate tools for the weather on curves, hills, and intersections.
- Adjust spinner speed to the lowest setting possible, except at intersections.
- Drive at the lowest possible speed—17 to 25 mph—slightly faster if prewetting.
- When practical, don't let traffic dictate your speed. Keep it slow to keep material on the road.
- Apply deicers in the center of the road or high side of the curve.
- Turn off auger when stopped, even briefly.

RULE OF THUMB

If snow is blowing across and off the road, let the wind help with snow removal. In these cases, be careful not to wet the pavement surface by adding chemicals that will cause snow to begin sticking and creating slick spots on the roadway.

Material Application Rate Guidelines

Make it a goal to reduce material application rates to the minimum that will keep roads safe. You can reduce rates by using proactive anti-icing strategies before a storm, then following these guidelines during the storm:

- Sand/salt mix isn't advised but may help in some situations such as freezing rain.
- Always plow before applying chemical. For reapplication, start with the lowest rate in the range.
- High traffic volumes will work sand into the snow and aid in traction, so use a lower rate.
- Higher traffic speeds will blow sand off the road and hinder melting, so increase use of prewetted materials.
- Use sand for short-term traction only. It will never melt anything.
- For application on a single lane, cut rates in half. For an 18-foot-wide road, use three-fourths of the listed rate (i.e., multiply rate by 0.75).

Loading/Hauling

- Set up and load on a level surface whenever possible.
- Maintain loading area. Keep it clear and smooth.
- Don't overload. Avoid spilling on units.
- Remove loose material from the exterior of the dump body.
- Watch for co-workers/pedestrians in or near the loading area.

Snow Blowing

Using a snow blower is a very effective method to get rid of large amounts of snow. As long as you have room to do so, blowing snow off the road into open areas is the quickest and most efficient way to get rid of it. If you are in a confined area and you are able to windrow the snow, loading trucks with a snow blower is much quicker than a loader. Here are some considerations for performing these types of snow removal operations.

- Always be aware of your surroundings. The blowing snow can cause major damage or injury so always know where you are launching it.
- The spinning ribbons can also be very dangerous. If you cannot see in front of you, stop and wait until you can. Many things can be buried in snow berms so if you are suspicious of debris, again, stop and try to verify that the snow is clean.
- Anytime an operator needs to get out of the snowblower, before exiting the machine, make sure the ribbons and auger are completely shut down.
- Try to blow the snow with the wind when possible. If you have to blow into the wind, keep your chute low to prevent too much blow back.
- When blowing snow into trucks, make sure you have a plan with the drivers before you start. Having communications between the blower operator and the drivers through two-way radios is important so you can make quick adjustments as you are proceeding. Lack of communication can result in damage and or injury.
- During snow blowing operations, try to use signs or sign boards to let the public know of the work being done.
- If you need to replace any broken sheer pins, shut down the whole machine, remove the key, and take it with you while performing the maintenance.

Effective Use of Plows

Snow plowing is and will continue to be our number one tool for snow and ice control. Plow to remove snow and loose ice before deicing applications. If snow accumulates before or after applications, plowing directly before your next application will minimize product dilution.

RULE OF THUMB

Minimize dilution of deicing chemicals by plowing immediately before applying the chemicals.

- Plow first before applying deicers to avoid dilution of chemicals and to reduce sanding quantities.
- Coordinate plowing activities to eliminate windrows at intersections and prevent plowing off another operator's material.
- Never plow or blow snow over a bridge into the water or onto traffic below.
- Remove snow from roads as quickly as possible to reduce compaction (see figure 7–1); use of underbody blades helps remove compacted or slushy snow.

- Make use of carbide plow blade edges.
- Adjust blade angle to maximize cutting efficiency or snow-throwing capabilities.
- Do not push or blow snow off a bridge into the water or onto traffic below (see bridge plowing section below).
- Use underbody (belly) blade to help remove compacted or slushy snow.
- Plowing in tandem is very effective in cleaning a road in a single pass. When using this method, the trucks should stay close together to avoid leaving berms in the driving lanes. Staying close also deters vehicles from trying to pass the trucks when it isn't safe to do so.
- There are times when splitting the trucks up to plow separate routes is a better option. One lane open on several roads during a storm helps keep traffic moving. This depends on the severity of the storm and the resources that are available.

RULE OF THUMB

Many agencies have snow ordinances that describe when snow plowing will be conducted and designate snow routes. Consult your supervisor, and follow your agency's policy.

Different Types of Plows and Their Uses

Depending on your fleet, there are different pieces of equipment that can be used for a variety of winter conditions. The plow truck is the most common and it has been versatile and efficient in keeping our roads safe. Listed below are the attachments and their uses for this piece of equipment. These can also be viewed in the Snow Plow Orientation DVD which has been widely distributed throughout Alaska DOT&PF. If you need a copy, contact your Training Coordinator.

Figure 7–1. Truck plowing on highway

- Reversible Front Plow - This allows operators to cast the snow left or right, giving them the flexibility to change directions depending on the situation. With this implement you should be cautious of your speed and where the snow is flying. This could cause white out conditions for the traveling public.
- One Way Plow - As the name implies, you can only plow one direction with this type of plow. Although it is not as versatile as the reversible plow, it is still a vital piece of equipment and in the right conditions, very effective. Due to the height of this plow, the operators visibility is limited. Things to watch out for are pedestrians, parked vehicles, mailboxes, guardrails, railroad tracks, and expansion joints on bridges.
- Underbody Plow or Belly Blade - This plow is very effective because, in most cases, the operator is able to apply down pressure. With this feature you are able to peel up compacted snow as well as scrape off slush. The blade is located underneath the vehicle so it is hard for the operator to see it. You should always be aware which way the blade is angled and the location of the ends of the blade. Always know where the snow is going so you can avoid obstacles such as pedestrians and vehicles. Be aware of how much down pressure is being applied especially when approaching railroad tracks, bridges, and manholes that may be sticking up. In all of these cases you should relieve the pressure on the blade and even lift it slightly off the ground to avoid hitting these obstacles. Failure to do so can cause damage to the infrastructure and equipment and can even cause injury to the operator. This blade is only meant to plow going forward so be sure to raise it if you are backing up.
- Wing Blade - This blade enables the operator to plow a wider path. It can also be used for benching which makes room to put more snow in the future. With this blade located towards the rear of the vehicle, it is difficult to see it. It also hangs out farther than any of the other attachments so being aware of your surroundings is extremely important. Having a beacon at the end of this blade helps others to see it. Even with the lights, vehicles have been known to pass the truck not knowing the wing blade is down. Always be ready to make evasive maneuvers to avoid having an accident.
- Sander - This spreads the sand or salt which provides traction for those traveling on the roadway. With the changing situations, you may need to adjust the settings to provide adequate coverage on the road. Shut your sander off well in advance of approaching vehicles to avoid spraying them which could cause damage.

For all of these attachments, several of the techniques are the same.

- When coming to railroad tracks or joint on bridges, you should slow down and angle and lift your blade as much as needed to avoid contact with obstacles.
- Use caution when plowing snow drifts. They can be very hard and damage your equipment and possibly injure the operator.

- If plowing downwind and across the oncoming lane, always watch for approaching traffic and lift your blades well in advance to avoid hitting a vehicle with snow.
- Stay alert and aware of your surroundings at all times. There are obstacles everywhere including animals. Hundreds of moose are killed every year by motorists along Alaskan highways.

Plowing Procedures for Low-Speed Roadways

Accepted sanding and plowing practices on low-speed roadways include the following:

- Drive a reasonable and safe speed.
- When approaching bridges and overpasses, slow down.
- If there is room on the deck, operators may store snow on the bridge/overpass. After the snow event is done, snow will be collected from these areas and hauled to designated snow storage sites.
- Use motor grader and wing to push snow back and make room for next storm. See figure 7–2.
- On bridges where the bridge rails are more open, operators are to slow down and manipulate the blade so the snow is pushed straight or carried across the bridge or overpass. When operators are clear of the bridge or overpass, the blade should then be re-set at an angle to cast off snow to the shoulder. Bridge length may prohibit or reduce the effectiveness of this practice in large snow events.
- On overpasses with sidewalks, the snow will be pushed or blown straight ahead until the end of the overpass. When operators clear the bridge or overpass, they may at that time angle the blade or blower to remove snow off of the sidewalk or pathway.
- Use the minimum amount of sand needed to keep the roadway safe and passable for road users and minimize traffic incidents.

Figure 7–2. Motor grader clearing shoulder

Plowing Procedures for High-Speed Roadways

The speed and volume of traffic on high-speed roadways is sometimes prohibitive to slowing down to perform any of the methods mentioned above. It would be a safety issue to slow down to speeds that would allow operators to store snow on the bridge/overpass or to push snow straight across the bridge/overpass and cast off after they are clear of the structure. The slower speed could impact the safety of other vehicles on the roadway. See figure 7–3.

Figure 7–3. Vehicle rear ending grader

Not sanding on the bridges and overpasses is not an option. Bridges and overpasses are some of the most dangerous areas on roadways, and it is essential they are kept free of snow and ice to minimize traffic accidents. Follow these procedures:

- Drive at reasonable and safe speeds.
- Slow down at bridges and overpasses as much as traffic speeds allow. By slowing down in these areas, the castoff of sand into waterways is reduced or eliminated.
- Slow down at overpasses to reduce the amount of snow cast over, due to the safety hazard of possibly hitting vehicles or trail users.
- In some situations it may be sufficient to slightly raise or adjust the angle of the implement while proceding over the bridge threshold.
- On overpasses with sidewalks, the snow will be pushed or blown straight ahead until the end of the overpass. When operators clear the bridge or overpass, they may at that time angle the blade or blower to remove snow off of the sidewalk or pathway.
- Use the minimum amount of sand needed to keep the roadway safe and passable for road users.
- During nighttime operations, when other vehicles may not be present on the roadway, operators are to perform operations at slower speeds as described in the above section Plowing Procedures for Low Speed Roadways.
- Utilize an advance warning vehicle to warn oncoming traffic and when you need to cross over centerline. See figure 7–4.
- Station foremen should survey their sections and post directives outlining which crossings and bridge thresholds are in good enough condition to allow at-speed plowing and those that require adherence to the primary procedure.

Public Safety/Operator Safety

- Perform your required CDL pre- and post-trip inspections.
- Make sure you're mentally and physically prepared to drive.
- Clean lights, windows, and signs frequently.

- Perform your snow removal procedures with traffic as much as possible. Avoid sudden moves. Be alert to all surroundings, including other vehicles. See figure 7–5.
- Demonstrate courtesy toward other drivers and pedestrians.
- Be aware of spinner discharge at all time.
- Avoid pushing snow over bridge rails and onto roads and into streams below.
- Be alert to hazards such as downed power poles, stop lights, overhead structures, power lines, etc.

Figure 7–4. Use of advanced warning vehicle for more efficient snow removal

Figure 7–5. Blowing snow with traffic

- Be extremely cautious when plowing over railroad tracks and expansion joints on bridges.
- Be aware of changing braking capabilities from a loaded box to an empty one.
- Keep others informed of changing conditions.
- Assist/report stranded motorists as necessary.
- Be aware of wind conditions and potential problems. Snow clouds can form during any plowing operation. Even a very light snow cloud can temporarily block out any lighting configuration and increase chances of being hit from the rear.
- Reduce your speed to minimize snow clouds.
- Don't plow just to plow.

Keeping Records

During snow and ice control operations, equipment operators may be required to record their activities. Such records can serve two purposes: They help staff track and manage current operations, and they provide information to help supervisors and operators improve future operations.

The information to be reported on trip tickets will vary from agency to agency. Check with your supervisor. Sample information includes the following:

- Operator's name
- Vehicle ID
- Date(s) and duration of shift
- Description of roads treated
- Beginning and end times of each treatment cycle
- Treatment locations and time if not done on a prescribed cycle
- Type of treatment performed on each cycle or run
- Road and traffic conditions observed on each cycle or run
- Percentage of roads cleared, by classification
- Total personnel in the field
- Inventory of equipment and operational status
- Inventory of materials
- Number and extent of breakdowns, and future availability of equipment
- Accumulation of overtime
- Snow accumulation
- Planned operations

After the Storm

After the storm, when snow and ice control operations have ended, evaluate what was done, how well it worked, and what could be changed to improve operations.

- Attend a post-storm meeting in the shop to evaluate your operations.
- Look for opportunities to try new and improved practices.
- Understand the storm conditions and the target Priority Level for each route.
- Refine your procedures and material use based on observations.
- Share observations to improve operations and learn from each other.
- Report any hazards such as low-hanging branches, raised utilities, snow accumulation on bridges, or other potential problems.
- Clean and check all equipment.

Good documentation helps you use less material, reduce costs and environmental impacts, and run a more effective snow and ice control program. Unless you document and chart, you can't measure what you are doing.

- Accurately record your material use at the end of your shift. Use the Maintenance Management System to record and track your work and observations.
- Turn in documentation forms to your supervisor.

Figure 7–6. Avalanche

Avalanches

Extra caution should be exercised in areas prone to avalanches. See figure 7–6. Follow these general guidelines for Alaska DOT&PF employees working in avalanche areas as referenced in the DOT&PF Safety Manual, chapter 19.1.

Normal Snowplow Operations in Avalanche Areas

Normal snow removal in avalanche areas during periods of possible avalanche hazard should be performed as rapidly as possible with minimum exposure time. Alaska DOT&PF employees should carry a rescue beacon and have it on transmit whenever there is danger of an avalanche affecting a highway. No stopping or stepping outside of vehicles in the avalanche hazard areas shall be permitted. Operators will not turn around in avalanche areas. Efforts should be made to minimize the number of trips in avalanche areas.

Avalanche Debris Removal

Immediately after an avalanche has affected a highway, the local Alaska DOT&PF Avalanche Forecaster or Maintenance and Operations Station Foreman shall assume the role of Avalanche Supervisor. If an Avalanche Forecaster or Maintenance and Operations Station Foreman is not present, the senior employee shall assume the role of Avalanche Supervisor until a qualified Avalanche Forecaster or Foreman arrives. The Avalanche Supervisor will have control over traffic, public safety, and DOT&PF employee safety in the avalanche area. When Alaska State Troopers or local police are available, immediately delegate public safety authority to them.

Immediately notify the District Superintendent of the area involved.

After a snow avalanche has occurred, the chance of a second avalanche occurring is usually quite high; therefore, the avalanche hazard area should be observed closely to ascertain the possibilities of another avalanche before putting any personnel or equipment in the avalanche area or adjacent avalanche paths. If visibility is limited and the avalanche path cannot be evaluated satisfactorily, then removal of the avalanche debris shall be postponed until the avalanche hazard has decreased naturally or with explosive interventions (if available), or until it is considered safe by a qualified Avalanche Supervisor.

When conditions dictate that the highway will be closed for a significant time period, suitable signs and public notification shall be posted and the road shall be barricaded with locked gates and/or staffed by Alaska DOT&PF employees to prevent any vehicles from by-passing the closure.

When it has been determined by the Avalanche Supervisor that avalanche debris can be removed safely, then personnel and equipment can be moved onto site for snow removal only after the following conditions have been sufficiently met:

1. Hazard assessments have been made by trained and experienced personnel. In addition to avalanche risks, other hazards like downed power lines, broken gas lines, or any other potential hazards to workers must be assessed prior to engaging personnel. If the scene is not safe then wait until suitable interventions can be applied to make it safe.
2. Lookout(s) or spotters shall have sufficient visibility and be able to be located in safe and suitable locations for observing the entire avalanche area and all personnel engaged in debris removal operations. Lookouts or spotters shall be equipped with visual and audible methods of signaling all personnel working in the avalanche area.
3. Communications are established for all personnel working in avalanche area on a clear communication channel and a clear alarm terminology has been acknowledged by all parties, i.e., "Avalanche…Avalanche… Avalanche."
4. Escape plans and escape routes have been verified by all personnel working in the avalanche area. Ensure that all obstacles are clear from escape routes, sufficient traction is present, and the escape route is suitable for the speed of the slowest piece of equipment.
5. Safety zones are clearly identified and located in areas big enough for all personnel and equipment and in a survivable location if additional avalanches occur. Rescue equipment and teams should be stationed in the safety zone.

All personnel not essential for safety, traffic control, debris removal, and supervision shall be removed from the area by the Avalanche Supervisor or delegated law enforcement officer.

Avalanche debris removal shall be performed only during daylight hours or when sufficient visibility is available to observe for additional avalanches, or when considered safe by a qualified Avalanche Specialist. Equipment utilized shall be the largest and fastest available, including rental equipment. Fast removal equipment is essential to minimize the risk to the operators. The Avalanche Supervisor will identify safety zones to all personnel.

RULE OF THUMB

The highest priority in avalanche rescue is to prevent further accidents.

Through cuts or trench cuts in avalanche debris are hazardous and will fill up with even small slides. Immediately daylight the low side of a cut and preferably keeping the low side daylighted during debris removal.

When a bulldozer is available, make a top cut on the high side across the avalanche debris to provide an escape route during removal.

Avalanche Rescue Operations

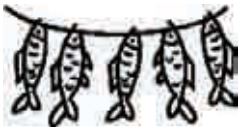
Immediately after an avalanche, it shall be determined if anyone is trapped in the debris requiring rescue. Avalanche burial is a medical emergency. If a person is possibly trapped, the Alaska State Troopers shall be notified immediately. Alaska DOT&PF personnel can make a hasty search and attempt rescue only if safety of the rescuer is provided first. Safety factors shall be weighed against humanitarian instinct.

In coordination with responsible rescue agencies, Alaska DOT&PF personnel may assist in the rescue plan in any way requested by the Avalanche Incident Commander or Rescue Leader as long as safety of DOT&PF personnel is provided for first. As soon as the responsible rescue agency can assume control, DOT&PF control of the rescue operation should be relinquished. It is necessary that there only be one Avalanche Incident Commander or Rescue Leader in charge of a rescue operation.

After Winter

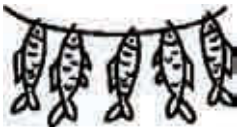
At the end of the season, take care of your equipment and remaining material stockpiles:

- Clean and maintain the truck, tanks, brine-making systems, and pumps according to manufacturer specifications.
- Place all piles on an impervious pad and cover them when possible. This includes salt and salt/sand mixes. Locate piles away from water bodies and berm to prevent migration of material.



End-of-season review of plowing and sanding practices helps to create stronger understanding of the efficiency of winter maintenance procedures:

- Inspect bridges to determine if best management practices for sanding and plowing are being observed.
- Large quantities of material in streams may warrant review of procedures and possible cleanup to reduce impacts to waterways.



Street Sweeping

In the spring, sand that has accumulated on the road must be removed to improve safety for drivers and pedestrians. Different methods are employed, depending on the drainage of the roadway. Curb-and-gutter roads require different methods than open channel or ditched roadways.

For More Information

At the end of this guide are several appendices that provide additional resources for winter road maintenance. These appendices were developed for the (Iowa) Local Roads Maintenance Workers Manual:

Appendix A: Snow Fence Installations

Appendix B: Snow and Ice Control Equipment Checklist

Appendix C: Snow Plow Checklist

Appendix D: Snow and ice Removal Pre-Trip Checklist

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Minnesota Local Road Research Board (LRRB). 2005. *Minnesota Snow and Ice Control: Field Handbook for Snowplow Operators.* Manual Number 2005-1. St. Paul, MN: Minnesota Local Road Research Board.

Salt Institute. 1991. *The Snowfighter's Handbook: A Practical Guide for Snow and Ice Control.* Alexandria, VA: Salt Institute.

ADDITIONAL RESOURCES

For fish stream and mapping information visit the Alaska Department of Fish and Game's Anadromous Fish Streams Interactive Maps, www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?adfg=maps.interactive

http://maintenance.transportation.org/Documents/nchrp%2020-7_Task%2013Revised%20Chapter%208%20with%20Summary%20of%20Research.pdf

Revised Chapter 8, Winter Operations and Salt, Sand and Chemical Management of the NCHRP Report 25-25(04) Environmental Stewardship Practices, Procedures and Policies for Highway Construction and Maintenance "PRIVILEGED DOCUMENT"

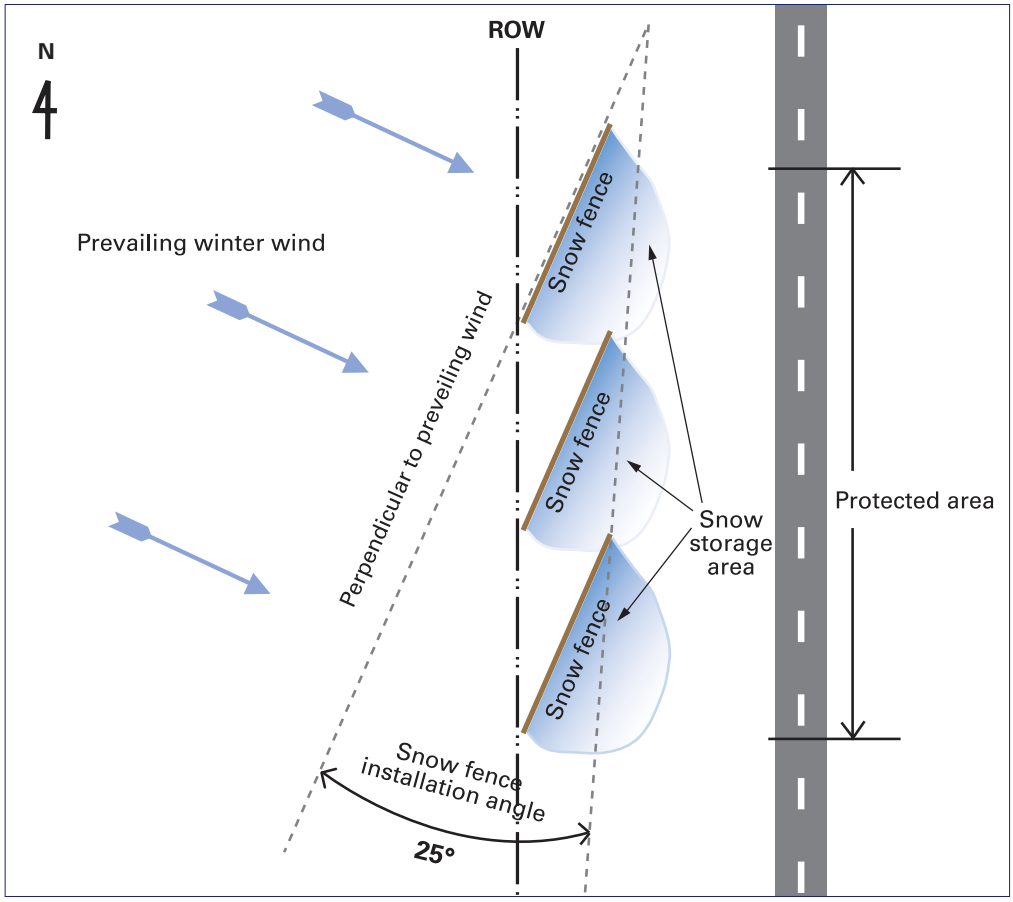
Statewide M&O and Alaska T^2 Snow Plow Orientation Video

Street Sweeping Management Plan: Anchorage MS4

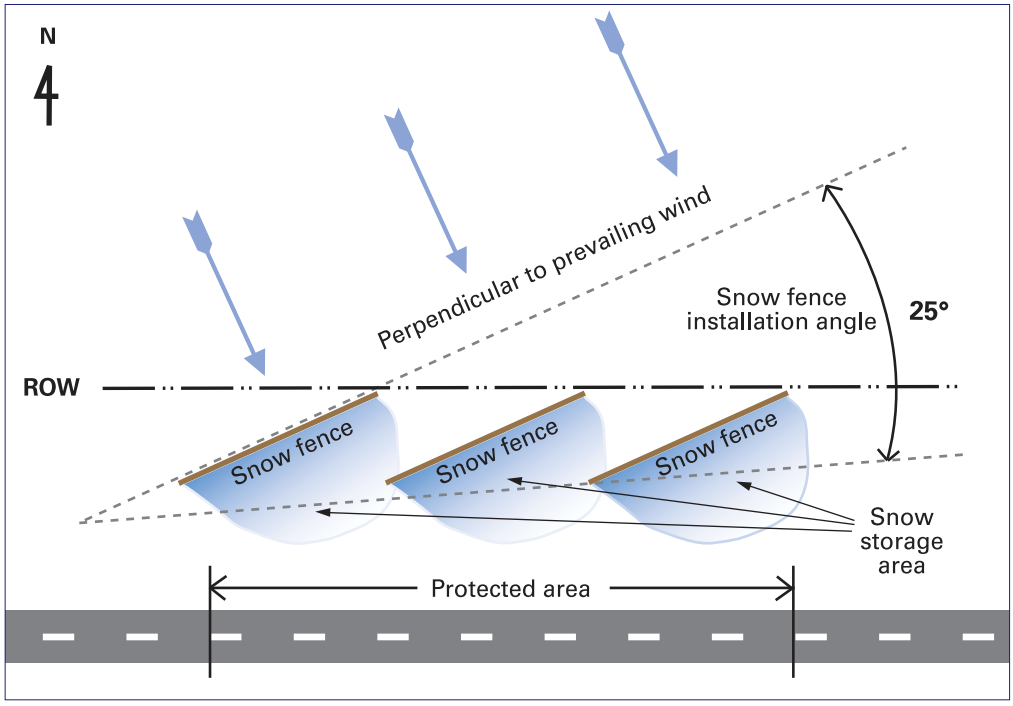
T^2 Wetlands training

Emerging Practices in Winter Highway Maintenance, Alaska DOT&PF, www.dot.state.ak.us/stwdmno/winter_maintenance.pdf

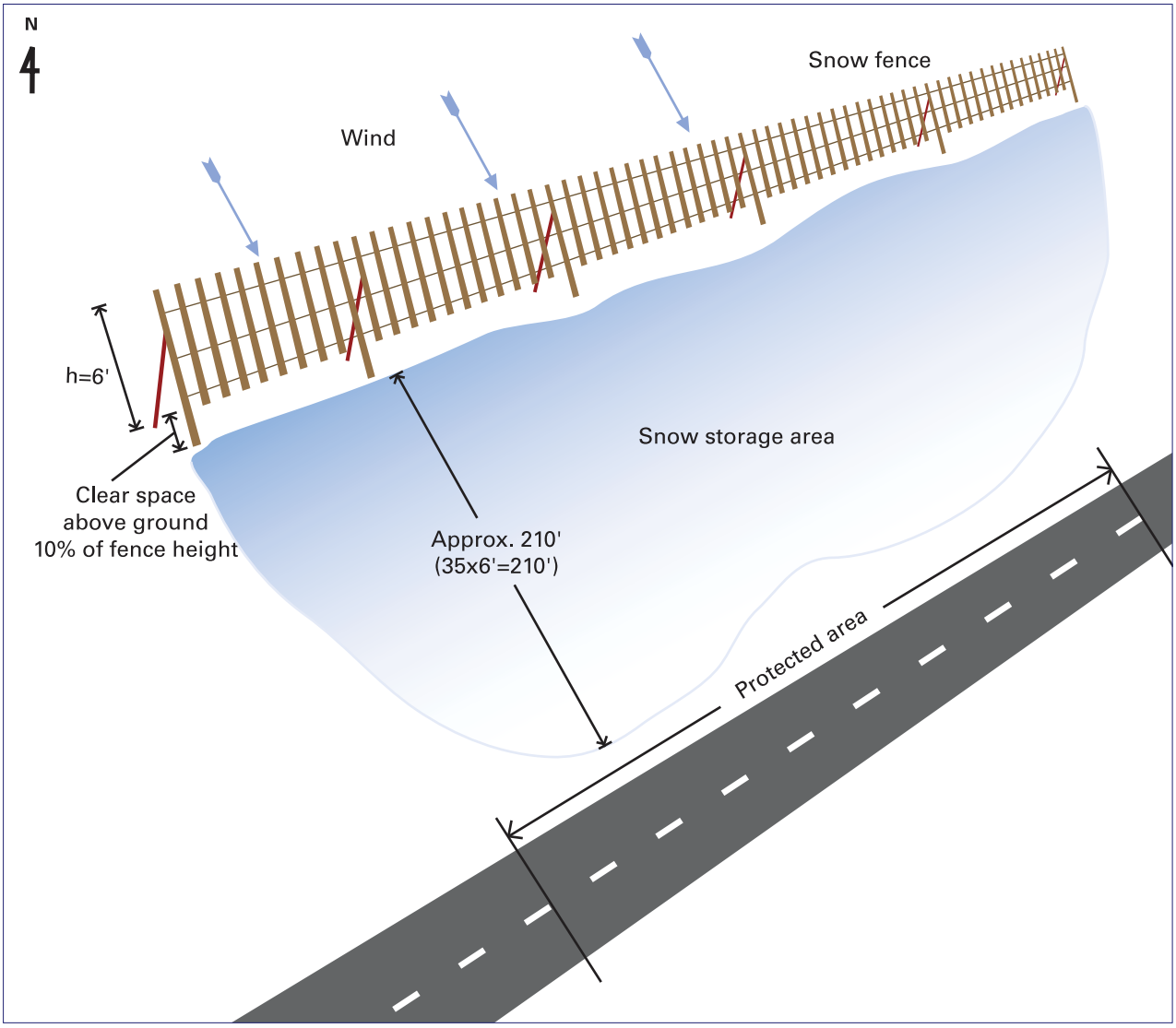
From (Iowa) Local Roads Maintenance Workers' Manual (June 2006), Appendix B: Snow Fence Installations



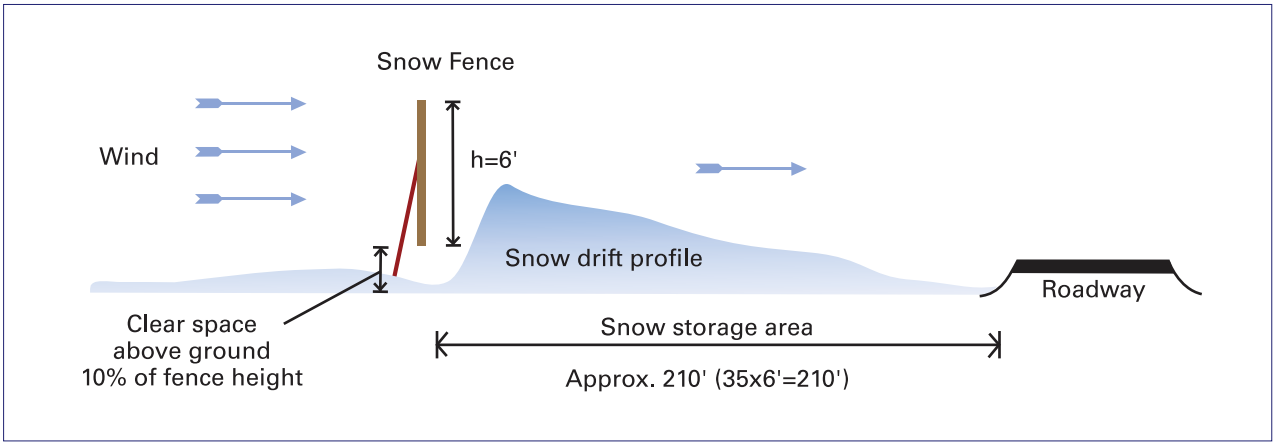
Snow fence location on north/south roadway



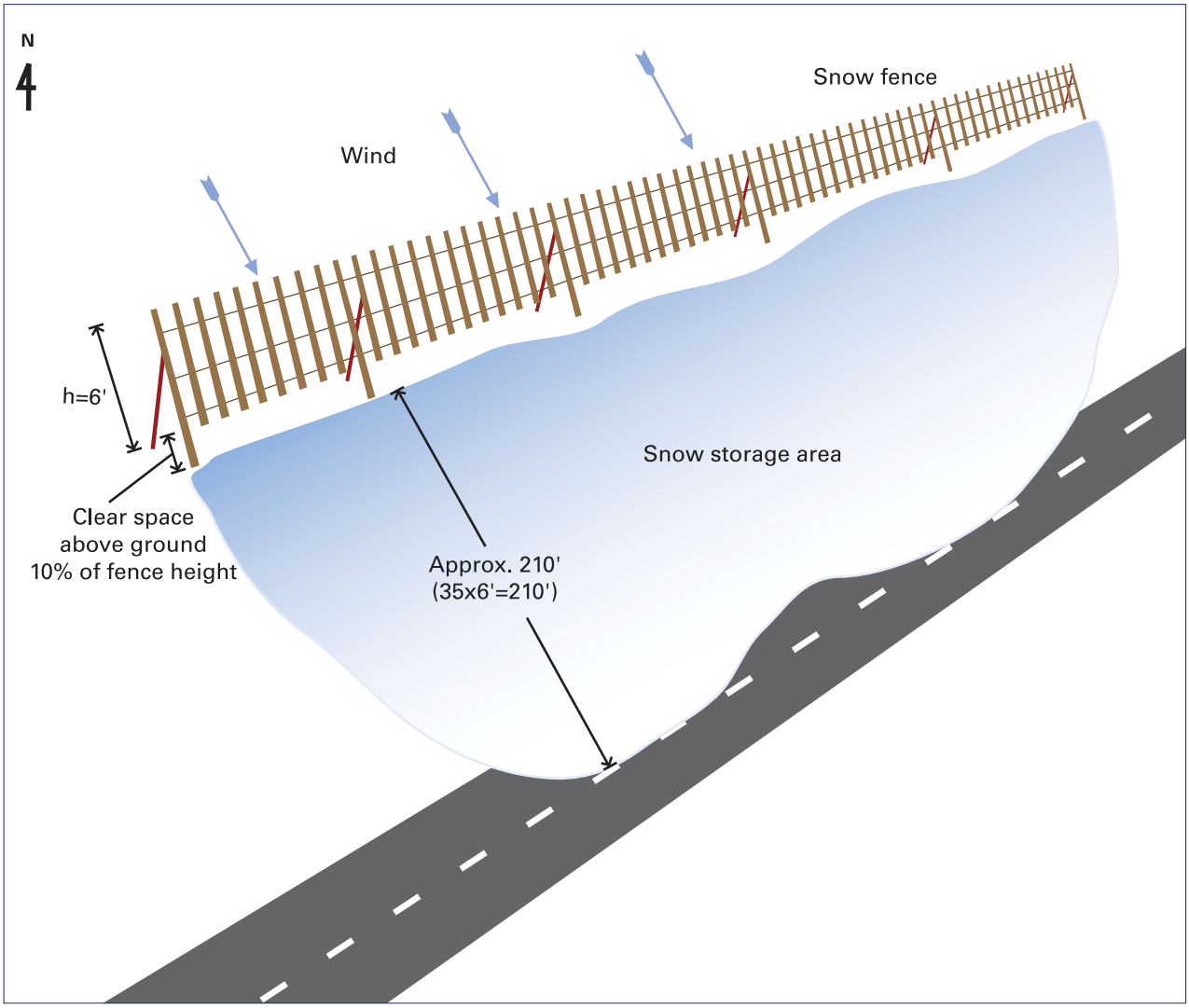
Snow fence location on east/west roadway



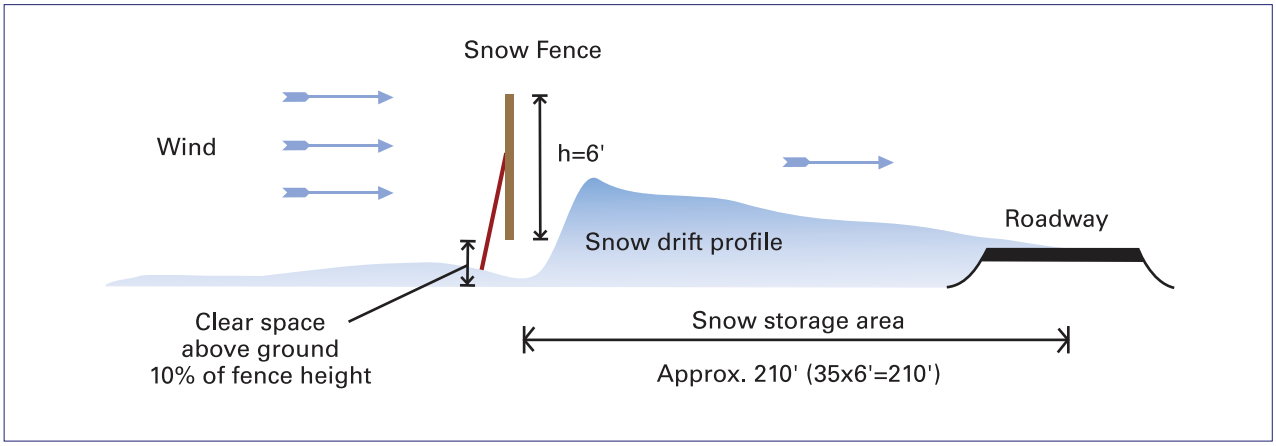
Proper snow fence installation (profile view): more than 35xh from roadway



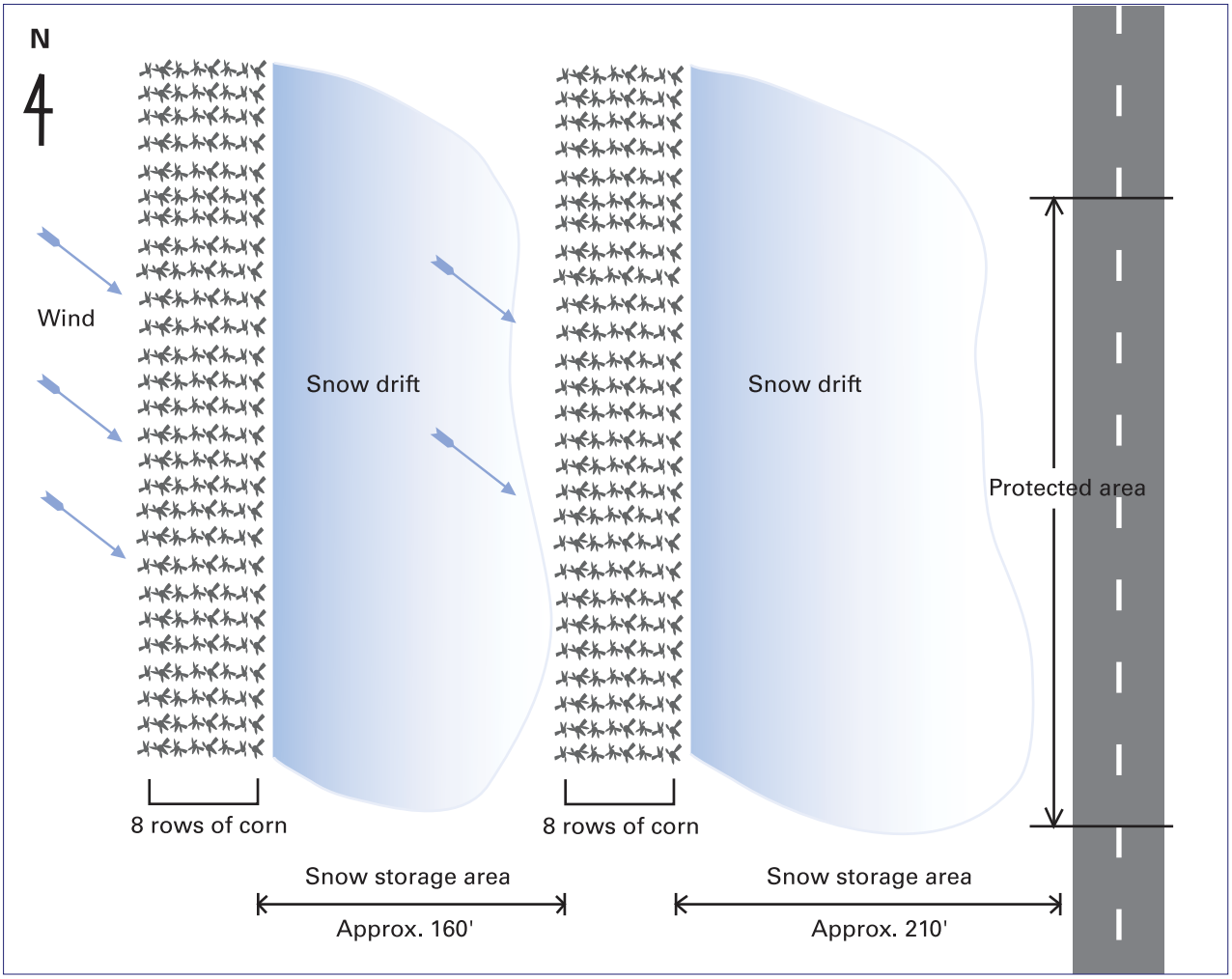
Proper snow fence installation (diagram view): more than 35xh from roadway



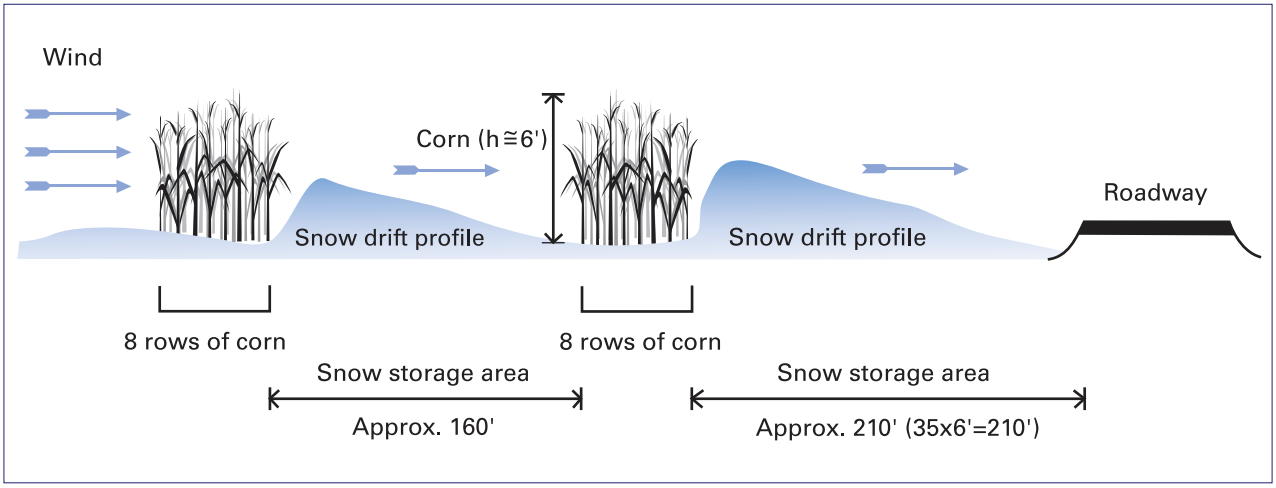
Inproper snow fence installation (profile view): less than 35xh from roadway



Inproper snow fence installation (diagram view): less than 35xh from roadway



Corn rows as a snow fence (plan view)



Corn rows as a snow fence (diagram view)

Snow and Ice Control Equipment Checklist [from (Iowa) Local Roads Maintenance Workers' Manual (June 2006), Appendix C]

Spreaders

- ☐ Inspect pumps, hoses, controls, and fittings.
- ☐ Check spinners, augers, and auxiliary engines.

Hydraulic spreader controls

- ☐ The two major components are the pump and the controls, whether manual or automatic. Operators should become familiar with spreader controls. Understand how the auger, or conveyor, and the spinner react at various settings.

Snow plow blades

- ☐ Carefully inspect blades after each use. If blade wear is excessive it may damage the moldboard. Snow plow blades do not wear evenly and should be replaced when they are worn at any point.

Electrical equipment

- ☐ Inspect and service all lighting and electrical equipment regularly, including wiring and sockets.
- ☐ Carry ample stocks of parts for rotating flasher units, including lenses and lamps.

Safety equipment

- ☐ Make sure there are flashlights, flares, flags, safety vests, and first-aid kit in truck cabs.
- ☐ Don't start a run without securing your seat belt.

Plan for emergencies

- ☐ Know the locations and telephone number of emergency repair and refueling stations.
- ☐ Skilled personnel should be on hand in garages during storms to promptly carry out minor repairs.

  Replenish spare parts inventory immediately following storms, or at the first opportunity.

Snow Plow Checklist [from (Iowa) Local Roads Maintenance Workers' Manual (June 2006), Appendix D]

Tires and wheels

- ☐ After the truck has been inside overnight, inspect wheels for oil and/or fluid leaks.
- ☐ Look for tire damage (e.g., deep cuts or severe weather wear). Tire tread should be a minimum of ⅛ inch.
- ☐ Inflate tires to the pressure indicated on the sidewalls.
- ☐ Make sure wheel lugs are tight and check to see if they have recently slipped. A mark to the side of each wheel lug is a good indication that the wheel has spun. Some mechanics center the valve stem between two lugs, then by just looking at the stem they can tell if the wheel has spun.
- ☐ Check the axle bolts for tightness.
- ☐ Look for leaking around the wheel seals.

Hoses

- ☐ Check for oil leaks along each hose and around each fitting.
- ☐ When the box is raised for hose inspection, make sure the box stops are in place. Lower the box onto the stops before beginning inspection.
- ☐ Hydraulic hoses should not be pinched or rubbing against another surface. Make a note of these potential problem areas.

Lights

- ☐ Amber warning lights mounted above the truck cab are on when the truck is operated.
- ☐ Make sure brake lights work properly.
- ☐ Check both high and low beams of head lights, chassis head lights, and higher plow lights.
- ☐ Turning signals must work properly.
- ☐ Check clearance lights, both in front of the cab and front rear corners of the dump box. (These lights help drivers see how wide your vehicle is.)
- ☐ Check spinner lights. They allow operators to see the material being spread.
- ☐ Check strobe lights, which help motorists see the truck when bad weather interferes with visibility.
- ☐ Check to see that all reflectors are in place: amber in front and red in back.

Under the hood

- ☐ Change fuel filters at the beginning of the winter season.
- ☐ Check for water in the fuel water separator and drain.
- ☐ Look for fuel leaks along the fuel lines and on the garage floor.

Engine oil

- ☐ Check the oil level.

- ☐ Check the color of the oil. A chocolate milky color could indicate anti-freeze is getting into the oil.
- ☐ Smell the oil. A burned smell may indicate engine overheating.
- ☐ Look around the engine compartment for oil leaks. (Small amounts of oil in and around an engine are normal.)

Engine coolant system

- ☐ Check the radiator coolant level and add coolant if necessary.
- ☐ Check for coolant leaks around hose connections.
- ☐ Look for wet spots on the radiator and garage floor.
- ☐ Inspect the fan belts for frays and cracks and report the problem areas.
- ☐ If the truck has a manual transmission, get under the truck and remove the transmission plug. The fluid level should be level with the check or fill plug.
- ☐ If the truck is an automatic transmission, check the transmission fluid level. Add transmission fluid if necessary, but don't fill beyond the full mark.

Truck toolbox

- ☐ Check the condition of tire cables or chains. Mount them to be sure that they fit.
- ☐ Make sure the toolbox contains a hand shovel, towing chains, extra plow and wing pins, extra pin safety clips, and any tools you may need out on the road.

Truck cab

- ☐ Keep the cab clean, with no loose items like pop cans, bottles, or log chains.
- ☐ Make sure the fire extinguisher is properly mounted and fully charged.
- ☐ Make sure the following items are in the cab: ice scraper, wisk broom or snow brush for brushing snow off your lights, flashlight, well-stocked first-aid kid (with CPR mask), and emergency reflector kit.
- ☐ Check the safety belts, making sure the locks work.
- ☐ Check the two-way radio and make sure the display or power light turns on.
- ☐ Check the dash lights and gauges to make certain they are all working.
- ☐ Make sure that you have accident report forms.
- ☐ Check the windshield for serious damage. Report any problems.
- ☐ Check the wiper blades for damage or aging.

Mounting brackets

- ☐ Check all brackets to make sure they are secure and that all bolts are in place and tight.

Heating and defrosting system

- ☐ As the engine heats up, make sure all heater fan speeds are operational and that the heat produced is adequate to keep windows clear.

Snow and Ice Removal Pre-Trip Checklist [from (Iowa) Local Roads Maintenance Workers' Manual (June 2006), Appendix E]

Under the truck

- ☐ Leaks on floor
- ☐ Wires or hoses hanging down

Under the hood

- ☐ Oil and coolant
- ☐ Water separator
- ☐ Belts and hoses
- ☐ Signs of leaks
- ☐ Washer fluid level

Outside the truck

- ☐ Left mirror brackets
- ☐ Hydraulic diverter valve for proper position
- ☐ Lights and reflectors
- ☐ Left rear wheels, tires, hub, and springs
- ☐ Tailgate chains or supports for proper adjustment
- ☐ Sander doors for proper position
- ☐ Left rear wheel, tire, hub, and springs
- ☐ Sander hoses, fittings, and mountings
- ☐ Right rear wheels, tires, hub, and springs
- ☐ Wing for mountings, hoses, etc.
- ☐ Hydraulic tank sight glass
- ☐ Exhaust system
- ☐ Right front wheel, tire, hub, springs, and shock
- ☐ Plow for mountings, leaks, blades, and frame
- ☐ Left front wheel, hub, springs, and shock

Inside the cab

- ☐ Horn
- ☐ Mirror alignment
- ☐ Steering
- ☐ Wipers and washers
- ☐ Gauges
- ☐ Clutch operation
- ☐ Lights
- ☐ Brakes (including parking brake) and brake lights
- ☐ Backup alarm and backup lights
- ☐ Turn signals

- ☐ Heater and defroster
- ☐ Dump vibrator
- ☐ Radio for operation
- ☐ Brine application system
- ☐ Hydraulic functions of plow and wing
- ☐ Fuel level
- ☐ Miscellaneous items (shovels, toolbox, tire chains, tow chains, etc.)
- ☐ Personal items
- ☐ Loose items in cab
- ☐ Start engine
- ☐ Turn on sander and check auger and spinner