2013 Alaska Pavement Report

Alaska Department of Transportation and Public Facilities

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Cover photo is by Steve Rzepka, ADOT&PF.

Longitudinal cracking. Photo by Jim Horn, ADOT&PF.

Juneau road rehabilitation. Photo by Peter Metcalfe.

Introduction

The Department of Transportation and Public Facilities maintains 5,609 centerline miles of highway, 3,737 of which are paved. The combined area of the state's paved airports (excluding Ted Stevens and Fairbanks International) equals 2,560 acres, or about four square miles. These pavements represent a significant capital investment and a continuing expense for maintenance and preservation, amounting to one of the largest recurring investments made by the department.

Department spending has averaged over $85 million annually to restore, rehabilitate, and resurface roads and highways, reaching a high of over $104 million in 2012. Projected funding for airport pavement rehabilitation and preservation projects totals approximately $40 million annually through Federal fiscal year 2016. Special appropriations from the state general fund in fiscal years 2010 and 2012 were designated to begin reducing a backlog of deferred highway pavement maintenance..

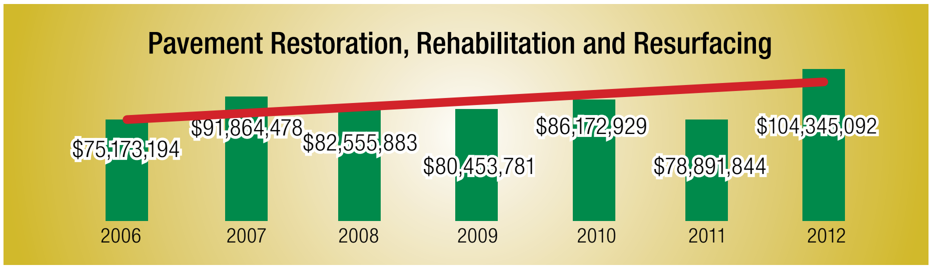
Kodiak Runway 25 under Reconstruction. Photo by Robert Greene ADOT&PF

In this report you will learn about the conditions, unique to Alaska, that contribute to pavement wear.

You will also learn about the department's program for pavement management, including how the department collects data on pavement conditions, how it uses the information to determine priorities, and the expansion of data collection efforts. The report documents advances made by the department's pavement and materials engineers; it contains graphic data displaying both point-in-time information and trends; and it touches on materials science and pavement-related research.

The department is in the initial stages of implementing asset management practices for the preservation of highways, airports, bridges, and other infrastructure. Over time, this holds the promise of improving the lifecycle costs of the transportation system.

While this is not a technical report, it does contain some technical and 'trade' terms. Please refer to the Glossary in Appendix 'A' for the definition of technical terms and 'terms of the trade' encountered in the report.



ADOT&PF Division of Program Development

Challenges

Trends affecting pavement management include funding levels, reducing the inventory of deferred maintenance, high costs for materials and construction, and the relentless effects of weather and climate.

Alaska Climate

Alaska's climate is among the most challenging in the nation for maintaining safe, long-lasting pavement surfaces. Extreme cold, freeze-thaw cycles, frost heaves, thawing permafrost, and seasonally high runoff all complicate the department's work.

In addition to arctic and sub-arctic conditions, the Statewide Maintenance Chief has chronicled the effects of climate change on a range of department operations. Overall warming temperatures threaten to expand the seasonal thawing of the permafrost layer beneath paved airports and highways, a trend that will likely lead to increasingly higher maintenance costs, new design solutions, and higher construction costs.


Bob Edgett Performing Crack Sealing on the Richardson Highway. Photo by Lisa Idell-Sassi ADOT&PF

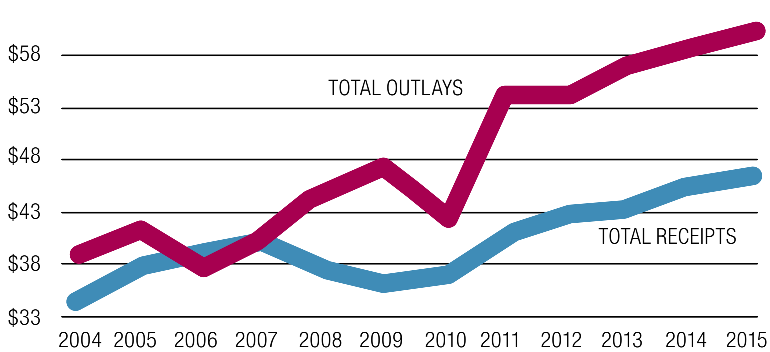
Funding Issues

The Federal Highway Trust Fund no longer earns enough revenue to fund state highway programs at the current level of need. The principal source of funding for the department's pavement program, the Trust is funded by the 18.4 cents-per-gallon federal motor fuel tax, which has remained the same since 1993, and covers only about 44% of transportation system needs. Additionally, the total number of miles driven annually by American motorists has declined in recent years, while overall vehicle fuel efficiency has improved. Recent data also indicate that fewer young people are buying cars or getting driver's licenses.

The fund has been depleted in each of the last four federal fiscal years, with Congress making up the shortfall with over $40 billion in general fund revenues since 2008. Historically, the department has used federal funds for pavement maintenance and preservation. To the extent these funds decline a combination of other funding sources, along with more efficient management and proven preservation practices will be needed to fill the gap.

Highway Trust Fund: Receipts and Outlays Discrepancy

Billions of Dollars

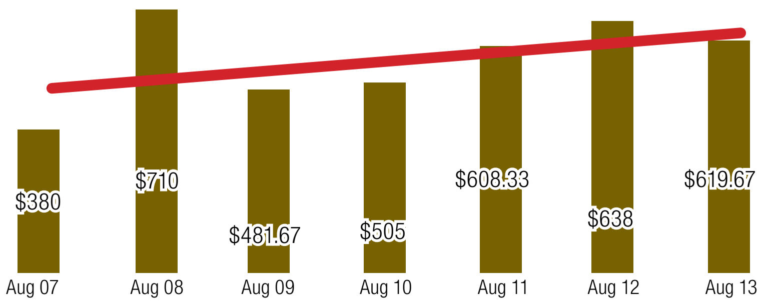


AASHTO – the American Association of State Highway and Transportation Officials

The federal highway funding authorization adopted in 2012, Moving Ahead for Progress in the 21st Century, or MAP-21, will also affect highway paving and pavement management to the extent that federal funding is now focused first on National Highway System routes, and secondarily on state and local routes.

Federal airport funding is also tightening up. The Federal Aviation Administration's (FAA) Non-Primary Entitlement program, which pays for essentials such as runways, taxiways and aprons, lighting and hazard abatement, has been reduced 56%, along with significant cuts in agency discretionary funding. While not directly pavement-related, these reductions contribute to increased demand for remaining funds, with a 'downstream' effect on funding available for a variety of activities including pavement management.

Index Price of Asphalt Materials



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Transition to Asset Management

Transition to an asset-based pavement preservation program can begin on highway sections where the pavement is already in good condition, while older highway sections must be rehabilitated or reconstructed to achieve a condition suitable for ongoing preservation. The department must time the transition realistically to account for a backlog of deteriorated roads, or seek additional funds to bring the backlog to a good condition. The department's asset management effort is not just directed at pavement, but more comprehensively involves the coordination of pavement and bridge maintenance management, along with other activities, to maximize the benefits of available funding on a more system-wide basis.

Cost of Materials

The department calculates asphalt material prices bi-weekly by averaging the cost from several sources. Prices fell about 7% from an index price of $666.67 per ton in the first two weeks of June 2012, to $619.67 for the last two weeks of August 2013. The price index can fluctuate dramatically, with a low of $376.67 (2007) and a high of $710 (2008), over the past six years. The price index in the graph above averages $563 per year and is trending gradually upward.

Photo by Jim Horn, ADOT&P.

Pavement Program Components

Department managers find cost-effective strategies for constructing, preserving, maintaining, and upgrading safe pavement surfaces on the state's highways and airports. Pavement management is a balance between public safety and comfort, continuing maintenance of good surface conditions, and lowest lifecycle costs. Performance standards for pavement in MAP-21, the 2012 highway authorization bill, will help assure good pavement conditions on National Highway System routes.

Alaska Pavement Design

Highways

The pavement policy of the Federal Highway Administration requires that highway pavement be designed "to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner." The regulations do not specify the procedures each state must follow. Instead, each state transportation department is expected to use a design that is appropriate for its conditions.

The Alaska Flexible Pavement Design Manual, published in April 2004, establishes policies and design guidelines for the paved surfaces of Alaska's highways. The manual, along with a software program, replaces a collection of pavement design tools previously used by the department's engineers. The manual recognizes that poor foundation conditions and other geotechnical problems typical of Alaska can profoundly affect pavement performance regardless of other factors such as pavement layer thicknesses or materials quality.

Department pavement engineers, who understand Alaska's conditions, continually seek out geographically and regionally suitable pavement treatments. Materials engineers work with department and university researchers to continually improve pavement performance through better pavement design, construction, and preservation techniques.

FAA ADVISORY CIRCULAR 150/5320-6E

Airport pavements are constructed to provide adequate support for the loads imposed by airplanes and to produce a firm, stable, smooth, all-year, all-weather surface free of debris or other particles that may be blown or picked up by propeller wash or jet blast. In order to satisfactorily fulfill these requirements, the pavement must be of such quality and thickness that it will not fail under the load imposed. In addition, it must possess sufficient inherent stability to withstand, without damage, the abrasive action of traffic, adverse weather conditions, and other deteriorating influences. To produce such pavements requires a coordination of many factors of design, construction, and inspection to assure the best possible combination of available materials and a high standard of workmanship.

Airports

The FAA has established comprehensive guidelines for airport pavements in Advisory Circular 150/5320-6E, dated September 30, 2009 (see the accompanying highlighted text). These guidelines are mandatory for all projects funded through the federal Airport Improvement Program (AIP), the primary source of airport funding for Statewide Aviation. Projects funded with revenue from the Passenger Facility Charge program must also meet the guidelines in the circular.

Materials Engineering

Pavement engineers routinely solicit design and engineering help from technical specialists. Design measures that resolve drainage problems, foundation problems, slope stability and erosion usually require consultation with the regional materials staff. Regional materials engineers also assist with designs that address uniquely Alaskan problems, such as ice-rich permafrost and muskeg, and with the associated use of specialized materials such as polystyrene insulation and geo-synthetics. Additional information regarding the role of the department's materials staff is addressed later in this report.

Lifecycle Cost Analysis

The Alaska Flexible Pavement Design Manual and associated software will soon include a lifecycle cost analysis (LCCA) component. The LCCA is intended to analyze several design options, ideally selecting the option with the most optimal lifecycle costs. The analysis, which is meant to help engineers choose the most cost-effective alternative, will not necessarily recommend the least expensive up-front design, but rather the alternative with the lowest overall lifetime costs. Thus, an alternative that is more costly up-front but results in longer pavement life at a lower unit cost will be preferred.

Pavement Management and MAP-21

Moving Ahead for Progress in the 21st Century Act, or MAP-21, establishes the federal requirement for state departments of transportation to implement asset management, including strategies for pavement preservation. The Act defines pavement preservation in Section 116 and asset management in Section 119.

Asset management planning is required for the National Highway System—states must meet minimum standards for Interstate and NHS routes. Section 150 of the Act requires the federal Department of Transportation to prepare performance measures by April 1, 2014. These measures are expected to include pavement roughness. Each state has until April 1, 2015, to set state-based performance standards that meet federal requirments. States must also submit annual reports to federal DOT on the progress in achieving these standards.

The state Pavement Management/Preservation Engineer, the department's technical expert in these matters, is responsible for producing the annual assessment, reporting pavement conditions for the state's roads and airports, and maintaining the department's pavement management system (PMS) database. The PMS helps field staff and department management develop project recommendations to preserve and repair the state's paved assets.

Pavement Engineering

The statewide pavement engineering Group within the statewide materials section provides technical advice and engineering services for the design, construction, and maintenance of Alaska's roadway and airfield pavements. The group prepares publications such as the Asphalt Pavement Inspector's Manual, the Alaska Flexible Pavement Design Manual, and the Asphalt Surface Treatment Guide, and works with the department's research section on studies that include the Cost-Effectiveness of Hard Aggregates, Warm-Mix Asphalts, and Cost-Effective Rut Repair Methods. All of these efforts are directed at extending pavement life.

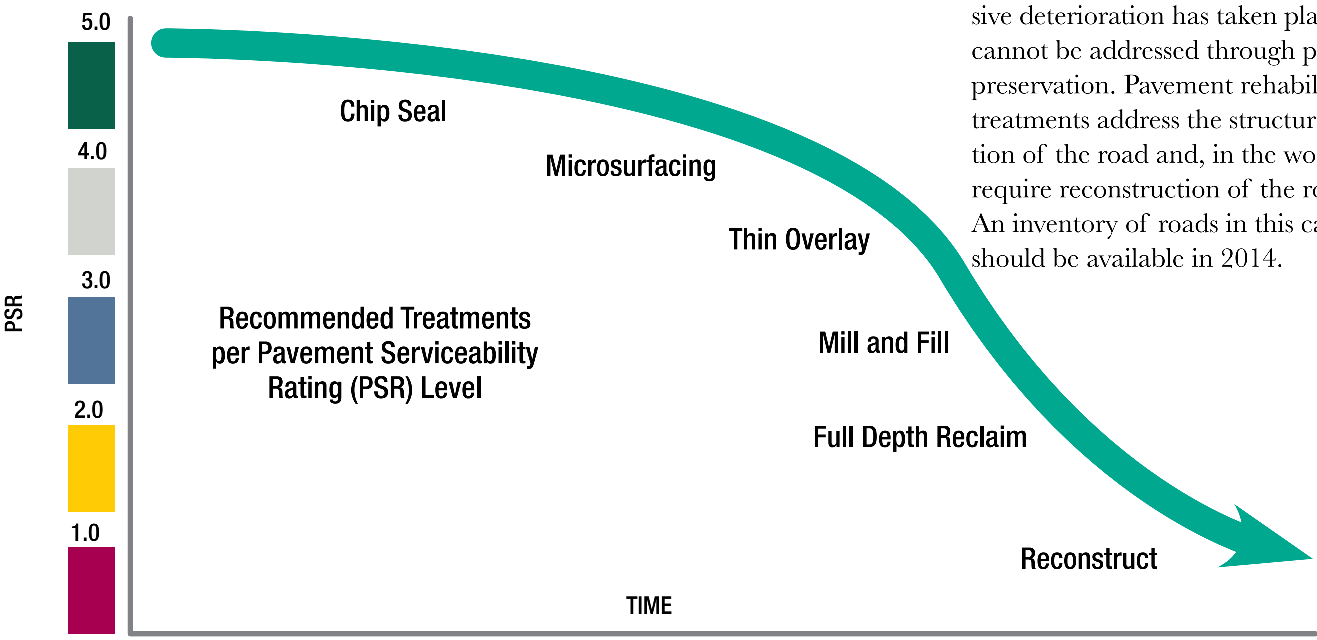
Pavement Preservation

Pavement preservation treatments improve the overall condition of the road and retard the overall rate of deterioration. These treatments are relatively inexpensive when compared to reconstruction or rehabilitation. Common preventative maintenance treatments in Alaska include crack sealing and filling, chip sealing, and milling off and replacing the top surface of roadways. Preservation strategies are required under the provisions of MAP-21. A backlog of paved roads in poor condition must be rehabilitated or reconstructed before they can become good candidates for an asset-based preservation strategy.

Historically, the department has taken a "worst first" approach and rehabilitated or reconstructed roads in a failing (or failed) condition, but is now in a multi-year transition to an asset management approach based on preserving roads already in excellent or good condition.

Pavement Rehabilitation

Pavement rehabilitation treatments are typically applied to roads when extensive deterioration has taken place that cannot be addressed through pavement preservation. Pavement rehabilitation treatments address the structural condition of the road and, in the worst case, require reconstruction of the roadway. An inventory of roads in this category should be available in 2014.



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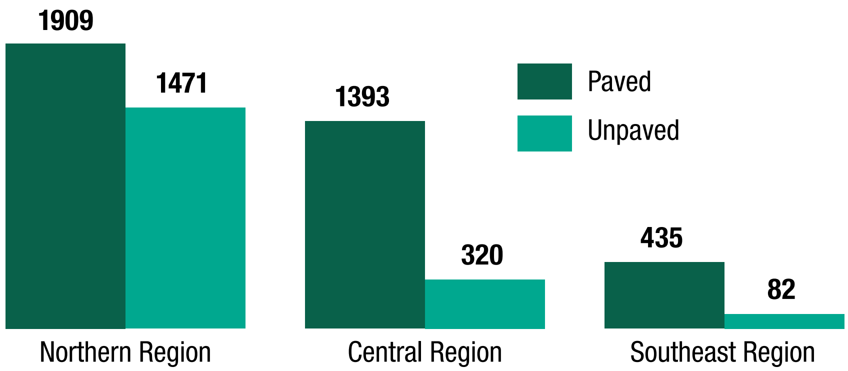
Reconstruction Backlog

The reconstruction backlog comprises all lane miles that need rehabilitation and that cannot be effectively improved through preservation type treatments. Currently, many of department's roads fall into the reconstruction backlog category.

Support Services

Numerous other sections within the department support the work of the pavement management/preservation engineer. These groups include the statewide and regional materials engineers, the Statewide Maintenance Chief, regional maintenance staff, the Office of Research, Development and Technology Transfer (RD&T2), the Office of Asset Management, and planners at both the regions and at headquarters.

Paved and Unpaved Road Miles by Region
All Road Classifications, number of miles



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Egan Expressway, Juneau. Photo by Peter Metcalfe.

Pavement Wear

All pavements deteriorate with time. A well-constructed Alaska road, under normal road conditions, starts deteriorating right after construction and typically will begin to show signs of aging in two to five years.

Traffic Density & Load

A high-volume route like the Glenn Highway between Anchorage and the Matanuska-Susitna Borough, or a route like the Klondike Highway into Skagway, which will carry heavy ore trucks from the Yukon, face much higher demands than low-volume routes serving residential areas. The department builds roads and highways for heavier loads in high traffic areas and on known haul routes to reduce wear and extend pavement life. For example, Glacier Highway in Juneau has been strengthened to accommodate gravel and cement trucks using the materials site at Lemon Creek. Likewise, the Klondike Highway, previously strengthened in the 1980s, will be strengthened a second time to accommodate ore trucks up to 100 tons in weight. Other highways are being evaluated to assess the impact of potential gas lines.

Environmental Conditions

In addition to traffic density and vehicle weight, environmental factors also contribute to pavement wear, particularly permafrost conditions, which are recurring and expensive to correct, mitigate, or avoid. Water infiltration and impaired drainage create problems over time. Water penetrates into the road foundation from the shoulders and through surface openings such as around patches and cracks. All of these sources of water may transport particles from the base material that makes up a road's foundation. Sunlight and oxygen react with petroleum products, which ages asphalt by breaking it down. This aging process weakens the binding ability of the asphalt, contributing to the loss of aggregate. It also makes the asphalt brittle over time, which leads to cracking.

Airports do not experience the same patterns of loading as highways, but are subject to the relentless effects of weather, climate, aging, and regular aircraft loading. It is important to apply regular surface treatments to lessen the effects of weathering and oxidation of the asphalt, which causes it to become brittle, leading to cracking, raveling, water penetration, and destabilization. Regular crack sealing, especially in the early stages, prevents water infiltration, thus extending the life of the paved surface much longer than when crack sealing is not applied.

Thawing permafrost represents another persistent problem, particularly in the Northern Region. Permafrost is addressed later in a separate section of the report.

Construction Conditions

Design and construction deficiencies-can result in premature deterioration of asphalt pavement. A number of factors can lead to early failure including insufficient or improperly compacted base material below the asphalt; over or under compaction of asphalt; improper temperature of asphalt when applied; poor drainage; or some combination of these factors. Pavement

Chip Sealing on the Dalton Highway.
Photo by Harold Kremer ADOT&PF

Landslide on Rezanof Drive, Kodiak Photo by Todd Dorman, ADOT&PF

that is constructed and maintained properly wears out slowly and can potentially last up to 25 years or more when properly preserved. The department works closely with contractors to improve specifications and construction techniques, to extend the life of pavements.

Catastrophic Events

Natural events can affect pavements swiftly, even catastrophically. Standing water from plugged culverts can saturate and destabilize road embankments. Avalanches and falling debris can damage and break up road and highway surfaces. Damage to roads and airports is caused by river flooding, storm surges and high tides in coastal communities, and throughout Alaska earthquakes are an ever-present threat. Such acts of nature can be highly disruptive to the traveling public and expensive to fix. The department will continue to identify and adopt strategies, from slope stabilization to improved hydrological practices, to protect against sudden and damaging events.

Regional Conditions

Each of the department's three regions faces unique conditions and factors related to pavement wear and tear. Proper drainage, important in all regions, maintains the integrity of embankments and the paved surfaces they support. Pavement maintenance and preservation at locations off the road system are both costly and time-consuming.

Northern Region must deal with permafrost, which annually affects between 650 and 1,000 centerline miles of highway and results in maintenance costs that have averaged $11 million annually over the past eight years. The primary effect associated with thawing permafrost is isolated differential settlement, harming the roadway pavement surface and adversely affecting the drainage patterns vital to maintaining solid roadway structures. Embankments over permafrost generally deteriorate faster than the asphalt pavement surfacing, resulting in an expensive loss of useful pavement life, up to as much as twenty years in some cases. Northern region maintenance crews spend three to four months on average each year on pavement preservation and maintenance activities. Maintenance issues related to permafrost thawing, discussed in more detail later in this report, are expected to become more problematic to the extent that permafrost thaw continues or increases, while funding remains static or declines.

The greater Anchorage area, within the department's central region, is the most intensively traveled portion of the state's highway system. Here, rutting is the most prevalent factor in highway pavement wear. High use of studded tires, which are allowed for up to seven and a half months out of the year, contribute to rutting more than any other factor. Other issues include sub-base saturation caused by inadequate drainage, extreme rain and snow events and failing culverts; and slope stability issues where roadway alignment follows cliffs, canyons, and steep vertical drops and cause shoulder sloughing, wind erosion, and road bed slippage.

Southeast Region is unaffected by permafrost and has relatively low traffic volumes, although the use of studded tires in Juneau leads to rutting on Egan Drive. To a lesser extent, rutting can also occur on highways in Ketchikan and Sitka. Pavement wear in Southeast typically is caused by weathering and fatigue, cracking the asphalt surface, leading to moisture infiltration, roughness, and potholing.

Highways

Pavement Management for Alaska's road system involves the automated collection of pavement conditions on approximately 4,100 lane-miles of highway per year, typically over a four-month period between June 1 and September 30.

Inspection and Data Collection

Recent technological advances in road profiling equipment and computer software allow the department to collect and store a wealth of data that is used to more effectively and efficiently manage pavement assets.

Field data is collected with an inspection vehicle known as a Road Surface Profiler (RSP). Seven lasers are mounted on the front bumper of the vehicle: two in each wheel path, one in the center, and two pointing to each side. Two accelerometers assist in calculating pavement smoothness, and on-board GPS units determine the exact position of the equipment as the data collection vehicle travels down the roadway. Rapid recording of laser reflection off the pavement surface provides data to evaluate rutting and smoothness. The GPS unit ensures that all data is location-specific, with photographs being taken continuously and tagged with GPS coordinates.

Data quality relies on calibration of the testing equipment to the exacting standards of ASTM International (formerly known as the American Society for Testing and Materials). This organization is a globally recognized leader in the development and delivery of international voluntary consensus standards. ASTM standards (ASTM D 5340-12) are also used to determine the Pavement Condition Index of airports (see next section).

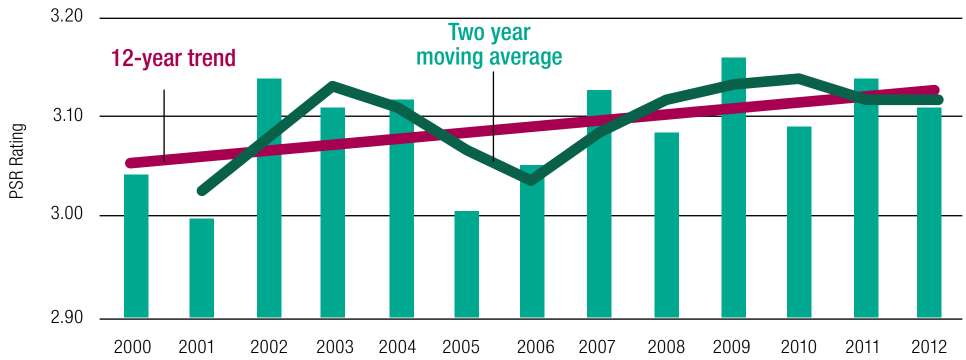
The department did not collect comprehensive data on cracking until 2012. A May 2010 assessment prepared by the Federal Highway Administration recommended collecting cracking data on a network, or system-wide, basis at the same time rutting and roughness data is collected. Collection of cracking data on a network basis is now a data requirement for the FHWA's Highway Performance Monitoring System (HPMS), a national-level highway information system that includes data on the extent, condition, performance, use, and operation of the nation's highways.

The inclusion of network cracking data during road inspections ensures a more accurate representation of the overall condition of the state's highways and a more comprehensive analysis using the PMS. Due to the high cost associated with this type of data collection, however, a system using HPMS guidelines and LTPP (Long-Term Pavement Performance) standards, was implemented during 2012 on the Interstate Highway sections of the National Highway System. A visual inspection, this effort was expanded to include the non-Interstate sections of the NHS in 2013.

Future consideration should be given to collecting pavement-related data on shoulders, on- and off-ramps, bike and pedestrian paths, and other road-related paved surfaces.

Longitudinal Cracking. Photo by Jim Horn, ADOT&P.

Pavement Serviceability Rating (PSR) Statewide Average
2000-2012



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Data Storage and Analysis

The department has collected data under a contract with Dynatest Consulting, Inc., using Road Surface Profiling (RSP) equipment. The collected highway surface data is downloaded to the Performance and Economic Rating System (PERS) software, which stores the data for every section of Alaska's road network. A typical section is 1-mile in length, but may be longer or shorter depending on roadway structural differences or physical boundaries such as bridges. Examples of the types of data stored in PERS are:

- General sectional information, such as numerical identification, number of lanes, road classification, pavement type, functional class, etc.
- Traffic data (vehicles per day) and equivalent axle loadings.
- Structural data showing materials and thicknesses forming the support system of the roadway.
- Surface data with rutting and with IRI (International Roughness Index) indicators used to calculate remaining life.
- Modeling information allowing the engineer to account for varying conditions by modifying the formulas.
- Past construction and maintenance data.

PSR Ratings Guide

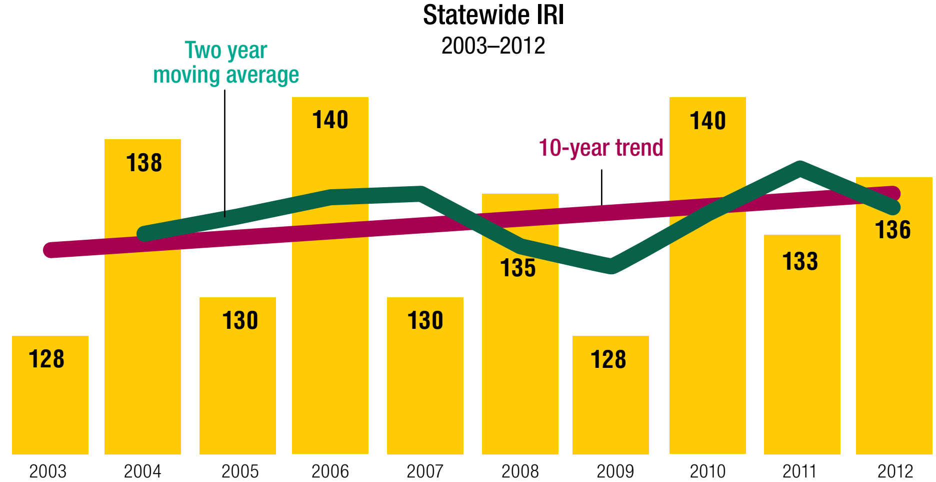
>4.0		Very Good
<4.0	> 3.5	Good
<3.5	> 3.1	Fair
3.4		**2017 Statewide Goal**
<3.0	> 2.6	Marginal
<2.6		Poor

Engineering analyses can be performed using PERS data and its built-in software. For example, it can calculate remaining service life and establish a Pavement Serviceability Rating (PSR) for each section of pavement based on roughness (using the International Roughness Index, see below) and rut depth. PERS is useful in identifying projects for preventive maintenance, rehabilitation, or other action, but does not have the capability to recommend preservation strategies. It is essentially a stand-alone, or 'silo' system, housing static data. Management software is available to greatly improve the analytical capability of PERS, but acquisition has been deferred pending the completion of an asset management implementation study.

Using rutting and roughness data, the department's Pavement Management System produces a list of prioritized projects, including the appropriate remediations. The list is distributed to the regions, where actual priorities for pavement work may differ from the statewide list with particular attention to safety.

The PMS has an important role to play in the Department's transition to asset management. It can help establish goals, illustrate the consequences of alternate investments, provide "what if" scenarios, and deliver other analyses to guide both policy-making and budgeting for pavement preservation. As the department shifts from a traditional maintenance approach to one that incorporates preservation, the capabilities of the PMS will become more fully realized. The PMS and the Maintenance Management Systems will ultimately become linked, allowing the integration of maintenance activities and merger of data on priorities, alternatives, and costs.

Statewide IRI
2003–2012



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Pavement Condition Ratings

In 2012, the department added the collection of data on cracking, consistent with FHWA requirements, to rate conditions of highway pavements. Cracking now joins three other metrics long used by the department:

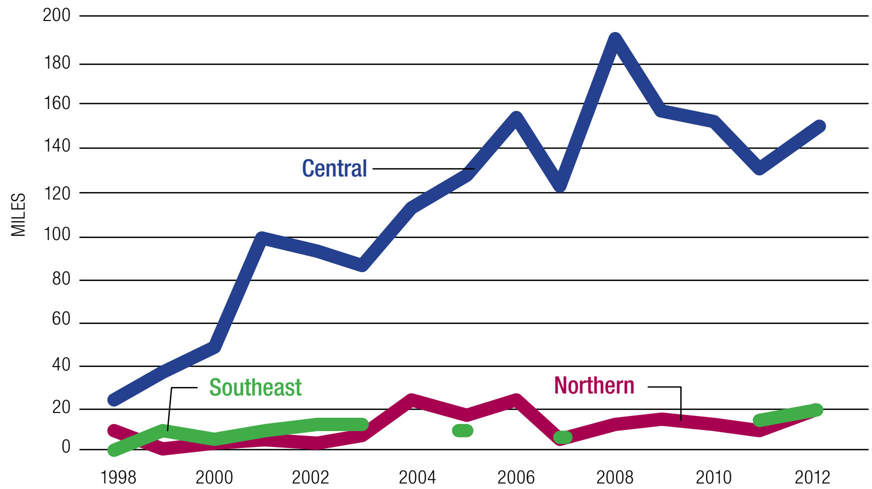
- roughness, using the international roughness index (IRI);
- rutting, or the longitudinal groves worn in the pavement by tires, especially studded tires; and
- pavement serviceability rating (PSR), which combines roughness and rutting into a single measure.

Using visual inspection methods, the department collected cracking data on a network or system-wide basis for the first time in 2012. The continued collection of cracking data, in 2013 and beyond, will more fully reveal its scope, and help spot trends and patterns that can improve both maintenance and programming.

The IRI provides a standard for calculating pavement smoothness. The index measures pavement roughness, expressed as vertical displacement and reported in inches per mile. In simple terms, it is the up and down movement of the road surface over the length of one mile. The FHWA has established a guideline setting the IRI at 170 inches or less per mile for an acceptable road surface and 95 inches or less per mile for surfaces in good condition. It is the department's goal for new construction to achieve an IRI of less than 60 inches per mile.

The higher the IRI number, the rougher the ride. Since its introduction in 1986, IRI has become the road roughness index most commonly used worldwide for evaluating and managing road systems. A newly constructed road should be expected to have an IRI of between 60 and80 inches/mile or better. Studies have proved that smoother roads with a lower initial IRI:

Total Centerline Miles with Rut Depths
> 0.5 inches



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- have lower roughness levels in the 10 years following construction;
- have lower cracking levels in the 10 years following construction; and
- have lower average maintenance costs in the 10 years following construction.

Also, smoother pavements reduce fuel consumption, vehicle operating costs, and driver fatigue by minimizing tire bounce and load impacts. Increasing smoothness by 25% results in an almost 10% increase in pavement longevity.

Rutting is a depression or groove worn into a road or path by the travel of wheels. In Alaska, paved roads are especially vulnerable to the high use of studded tires. Another method of rut formation on asphalt roads, called plastic deformation, is caused by heavy loads. This usually forms a lip or ridge along the sides of a rut and can be seen sometimes at intersections where cars sit or move slowly.

Pavement ruts are of concern for at least two reasons: accumulated water in the ruts can penetrate the pavement and damage structural integrity of the materials beneath the asphalt surface; and ruts can affect driver safety by adversely influencing steering control. The department trigger for rutting rehabilitation is a rut depth of ½ inch; rut depths of 3/4 inch or greater require immediate rehabilitation.

Annual Performance Target

The department and the state Office of Management and Budget have set an annual performance target to increase Alaska's Pavement Serviceability Rating (PSR) to 3.4 by October 2017. Established in the "1995 Status of the Nation's Surface Transportation System: Condition and Performance

– Report to Congress," the PSR is a national standard for reporting surface transportation condition and performance. Using a 0-5 rating, where 5 is perfect and 0 is failed, the PSR is calculated mathematically using the IRI and rut depth. The average PSR for 2007 – 2011 was 3.12 (fair), compared to the 2011 rating of 3.2. The department's specific performance target, to increase the Pavement Serviceability Rating to 3.4 by October of 2017, replaces the earlier target of a PSR of 3.3 by October 2012. This rating has shown slow but steady improvement since 2006, when the PSR was 3.0, to a 2011 rating of 3.2.

The challenges in reaching the target rating of 3.4 are primarily due to rutting caused mostly by the use of studded tires, and smoothness factors affected by surface irregularities such as unevenness due to frost and ice heaves, depressions caused by thawing, surface cracks that develop during extremely low temperatures, and potholes.

Permafrost prone areas are a special challenge, requiring engineers to design for the delicate balance between freezing and thawing.

Thermal cracking typically appears at a rate near 50 cracks per mile, exceeding 100 cracks per mile in the Northern Region. This results from asphalt shrinking in all directions in cold temperatures, and breaking in a fairly uniform manner.

Road Conditions in 2012

Overall, measured by the Pavement Serviceability Ratings, Alaska road conditions deteriorated slightly between 2011 and 2012, dropping from a PSR of 3.15, to 3.1, although the 10-year trend has shown gradual improvement of the PSR.

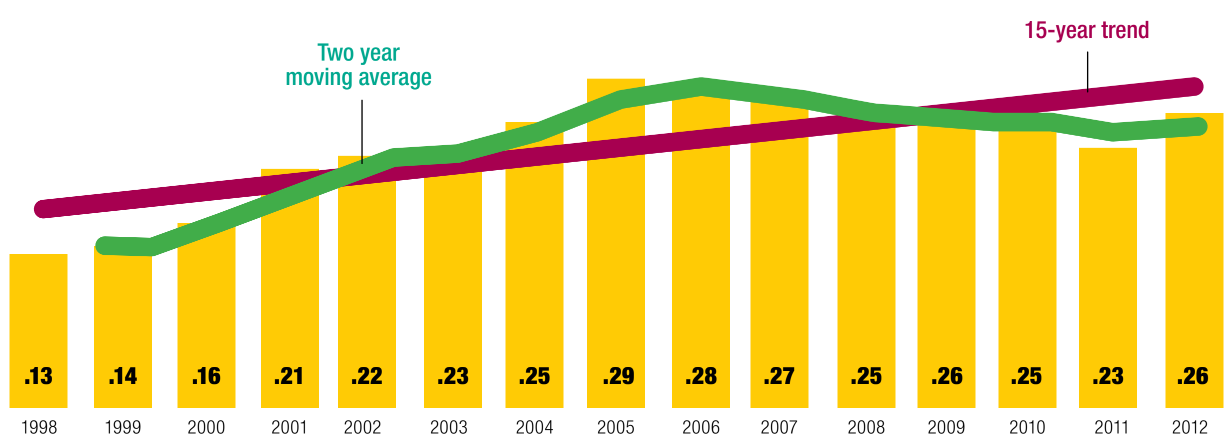
The IRI is within acceptable standards, but is affected by irregularities in the pavement such as cracks, potholes and frost heaves, which create a higher number of inches per mile of roadway. For the state's major highways this number is 107 inches per mile, but when the lesser, but more heavily traveled roads, are included, the number increases. It is the department's goal to keep this value as low as possible on all routes. The average rut depth increased very slightly in 2012. Cracking data was collected late in the summer of 2012. The significance of the 2012 cracking data is not immediately apparent since this is the first year this data has been collected comprehensively, and no historical comparison exists. Because crack data collection is now programmed as an annual task, patterns and trends in pavement cracking will become clearer over the next several years.

As additional miles of highway pavement are brought up to good condition, the performance measure for PSR will reflect both improved conditions and the implementation of preservation-based standards. Raising the target over time to a PSR of 3.6 or higher, would avoid more costly treatments, consistent with pavement asset management practices.

PSR data has been digitized and is now displayed graphically using Google Earth.™ Appendix B displays a map showing the 2012 pavement serviceability ratings on the state's National and Alaska Highway systems. The PSR ratings may also be viewed at

http://www.dot.state.ak.us/stwdmno/pvmtmgt/, then clicking on the "2012 PSR" link.

Statewide Rut Conditions
Depth in Inches



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Paving on Geist Road. Photo by Chris Cavallo ADOT&PF

Airports

For airport pavement design, department engineers rely on the Federal Aviation Administration's advisory circular, which provides guidance on soils, sub-grades, rigid and flexible surfaces, overlays, designing for frost and permafrost conditions, and other factors. The department has considerable staff experience mitigating the effects of permafrost in airport design.

Inspection and Data Collection

Annually, the department performs visual pavement condition surveys on approximately one-third of the 56 paved airports in the state-wide aviation system, not including Ted Stevens Anchorage International Airport, which is managed separately under the international airport system. Fairbanks is also in the international system but is included in the statewide pavement management system.

Conditions are rated according to U.S. Army Corps of Engineers Pavement Condition Index (PCI) methods as described in FAA Advisory Circular, AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements. The department's Pavement Management Engineer visually inspects runway pavements to identify the severity and extent of the pavement distress. The inspection is of random, statistically chosen samples that yield a 95% confidence level of accuracy.

The PCI is a scientific-type approach based on the rigorous engineering standards of ASTM International, in ASTM standard D 5340-12 the Standard Test Method for Airport Pavement Condition Index Surveys. The inspection data is entered into the software that calculates a PCI, employing a rating scale of 0 to 100, with 100 for newly-laid pavement, and a PCI of 0 for a completely failed pavement.

The department follows state guidelines for PCI, which call for a minimum PCI condition rating of 70 for runways and 60 for taxiways and aprons. Climatic variations, funding shortfalls, and remote locations present a continuous challenge for the preservation, maintenance, and construction needs of rural airports.

Data Storage and Analysis

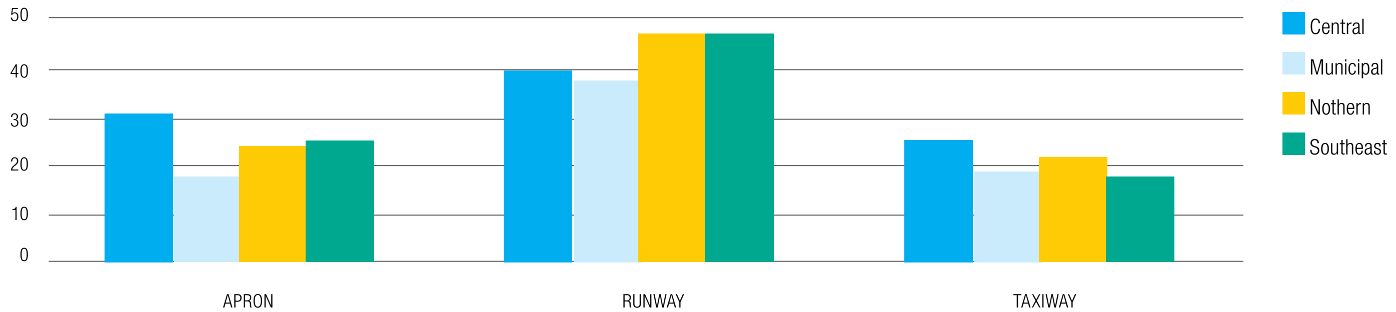
Pavement condition data is fed into the MicroPAVER database along with pavement age and construction/maintenance histories. The system generates Pavement Condition Index values, which are included in annual reports and maps showing the condition of runways, taxiways and aprons. The MicroPAVER system can also be used to update previously entered data, predict future pavement conditions (including deterioration), and develop project budget and budgeting scenarios.

Pavement Condition Ratings

The airport PCI provides general recommendations and strategies for pavement maintenance and project work along with PCI maps for multiple years. The system recognizes that pavement preservation is most efficient and cost effective when done at higher condition ratings. When the PCI falls below minimums, it is most cost-effective to contract for pavement re-construction or rehabilitations. The compelling need for safe operations,

Cracking at the Palmer Airport. Photo by Jim Horn ADOT&PF.

Percent of Pavement Below Standard
Based on Airport PMS Data as of 2012, on a total paved area basis
ADOT&PF Engineering and Design Services



coupled with inadequate funding, sometimes requires that maintenance work be performed on some pavements in lower condition categories rather than pavements in better condition.

Recommended pavement treatments are based on PCI ratings and fall into three categories:

1. Maintenance (surface repair) – restoring or keeping existing pavements in serviceable condition.

- Airport surfaces with a PCI of 85 to 100 are considered in excellent condition and require only routine maintenance.
- Airport surfaces with a PCI of 84-70 are considered in very good condition and require preventative maintenance such as crack sealing and surface sealing.
- Airport surfaces with a PCI of 69-60 are considered in good condition and require corrective maintenance, which includes more aggressive crack sealing and/or patching.

2. Rehabilitation (structural) – Restoring or improving the ability of the pavement to carry loads.

- Airport surfaces with a PCI of 59-40 are considered in fair condition and are candidates for rehabilitation including milling out and replacing asphalt, overlays and reclamation.

3. Reconstruction (removal and replacement) design or construction of new pavement to meet requirements.

- Airport surfaces with a PCI of 39 or below are considered failed, and are candidates for reconstruction or new construction.

Appendix F is a map showing color-coded PCI ratings for the Bethel airport based on a 2009 inspection. To see the PCI ratings for other airports in the state, go to http://www.dot.state.ak.us/stwdmno/pvmtmgt/index.shtml and open "Airport Data Mapping." Google Earth will open showing selected Alaska airports with a two or three digit PCI rating. Zoom in on the number to see a detailed PCI rating of that airport.

Annual Performance Target

Legislative standards for airport pavement condition are displayed in the graphic below. Unlike highway pavement, no performance measures for airport pavements have been established by the Office of Management and Budget.

Legislative Standards for Airport PCI

Runways	Taxiways and Aprons	Action
100-70	100-60	Preventative Maintenance
69-40	59-40	Corrective Maintenance
39-0	39-0	Reconstruct

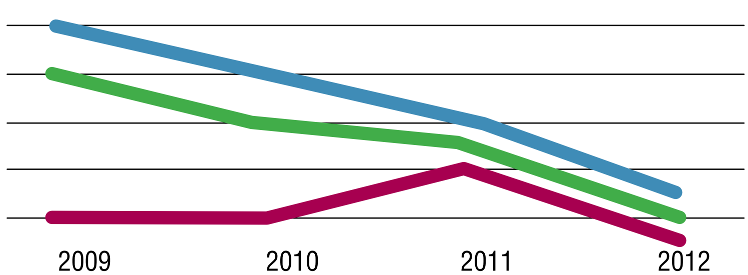
Parking apron at the Fairbanks International Airport. Photo by Eunkyoung Hong.

Airport Pavement in 2012

The most common distresses for airport pavements are weathering, cracking and raveling. The PCI for airport runway and taxiway pavements has been on a downward trend for several years, typically declining a point or two on average per year. The PCI for airport aprons had been improving somewhat, but declined incrementally in 2012. The graph (below) illustrates the average general downward trend in PCI for all airport pavements over the last four years.

While rutting typically is not an issue, snowplowing and using mechanical sweepers to broom snow and ice from paved surfaces may be stressful and can accelerate the effects of weathering. Generally speaking, airports with jet service have a higher maintenance priority than smaller airports with 'prop' service; however, every effort is made to assure that all paved airports are maintained at an acceptable level of service.

Pavement Condition Index, 2009-2012
PCI Value



	2009	2010	2011	2012
Taxiway	72	70	68	65
Apron	70	68	67	64
Runway	64	64	66	63

THE ORDER OF CARE FOR AIRPORT PAVEMENTS

Preventative Maintenance includes crack sealing, crack filling, surface sealing and minor patching with hot or cold mix. It is used to prevent further deterioration of the pavement. Preventative maintenance will typically raise the PCI by 5 to 10 points.

Corrective Maintenance is used when pavement distresses such as depressions, swells, raveling, and high severity cracks are found. It is used to repair localized pavement failures generally by patching, and may require placing a seal coat to repair oil spills, raveled areas, or severe grader scrapes. Corrective maintenance can bring the pavement conditions up to minimum standards.

Stop Gap Maintenance work is performed on substandard pavement areas to get them to last until project work can take place. It may include patching, sealing and filling that is intended to maintain minimum serviceability but will have only small effect on the PCI. Stopgap maintenance is not considered a cost effective use of funds but is necessary when project needs are delayed.

Rehabilitation involves work on the existing pavement, followed by an overlay all done under contract. Work on the existing surface may include planing the surface smooth, patching and filling crack prior to overlaying. Rehabilitation will bring the PCI back up to 100; its performance is dependent on the quality of the asphalt overlay.

Reconstruction involves removal and replacement of the existing pavement. If the need for this occurs prematurely, then improvement of the structural section is warranted. That may include increasing the pavement thickness and/or stabilizing the base and sub-base materials. This is project work that will bring the PCI back up to 100.

Paving at Wiley Post Airport, Barrow" Todd Hughes ADOT&PF

Pavement Asset Management

Pavement management practices are changing throughout the country as states and municipalities seek to optimize their investments.

MAP-21 Requirements

MAP-21, the highway authorization bill signed into law on July 6, 2012, requires state departments of transportation to prepare risk-based performance management plans "to improve or preserve the condition of the assets and the performance of the (national highway) system."

The bill requires the Secretary of Transportation to publish rules by April 1, 2014, establishing:

- Minimum standards for states to use in developing and operating bridge and pavement management systems.
- Performance measures, similar to the Pavement Serviceability Rating (PSR) for Interstate and NHS pavement condition and performance.
- Minimum conditions for Interstate pavements.
- States are required to establish targets for these measures within one year of the final rule on national performance measures.

Cost Efficiencies

Prior to MAP-21, state departments of transportation, including ADOT&PF, began evaluating asset management as a long-term approach to preserve assets in a cost-effective manner. Use of accurate, current condition data and sophisticated analysis techniques help identify optimal preservation strategies. In an era of declining funding, and with significant "in-place" investments in roads, bridges, and airfields, the department is beginning the transition to an asset management approach over the traditional "worst first" approach.

The transition to pavement asset management is underway even as the department deals with a significant backlog of deferred maintenance, where failure to act could result in unsafe roads and airfields. This poses the challenge of simultaneously bringing the underperforming pavements to a good condition while spending money to preserve pavements that are already in good condition, before they deteriorate. The transition will entail several years. The appropriation of additional funds to address deferred maintenance needs, as in fiscal years 2010 and 2012, when the Alaska State Legislature appropriated $18.3 million, would help assure a more timely transition.

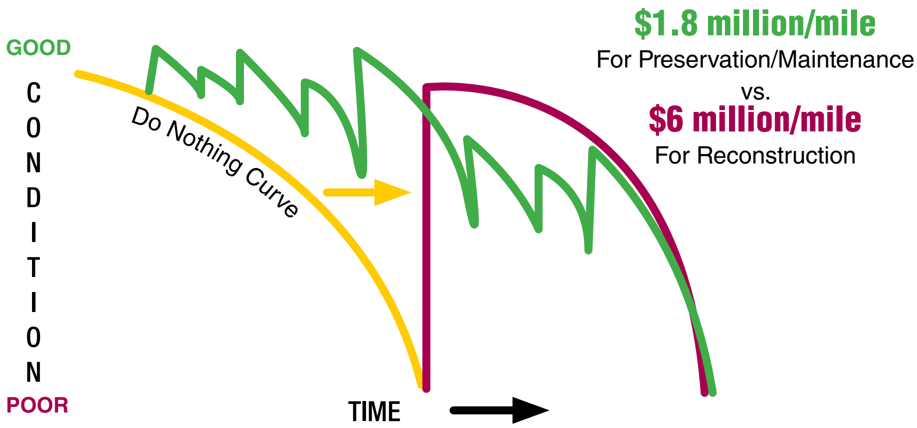
Pavement Management System (PMS)

The PMS is capable of supporting an asset-based approach to pavement management, but the full potential of the program to forecast the costs and consequences of various alternatives has yet to be fully realized. In May 2013, the department created the Quality Improvement Section, which includes Asset Management, the asset management work plan, and an integrated data management system, all of which contribute to building a more robust asset-based pavement analysis.

The advantage of implementing an asset management program for preserving highway and airport pavements is apparent in the graph titled Condition and Treatment on page 21. As the graph shows, a preservation-based approach, where pavements are preserved through early surface treatments, provides con-

Pavement repair ahead, on the road to Homer. Photo by Kathleen Metcalfe.

Condition and Treatment
(Build vs. Maintain)



ADOT&PF Design and Engineering Services

siderable cost efficiencies compared to the more traditional "worst first" approach, where pavements deteriorate to a degree that more expensive remediation, or even reconstruction, is required.

An effective pavement preservation program will address pavements while they are still in good condition and before the onset of serious damage. By applying a cost-effective treatment at the right time, the pavement is restored almost to its original condition. The cumulative effect of systematic, successive preservation treatments is to postpone costly rehabilitation and reconstruction.

Additionally, performing a series of successive pavement preservation treatments during the life of a pavement is less disruptive to uniform traffic flow than are the long closures normally associated with reconstruction projects. Many preservation treatments can be done in off peak hours, with less disruption to drivers.

Quality Assurance Report Card

Maintenance engineers have recently prepared the Quality Assurance Report Card, based on 1,000 random samples of pavement taken from highways across Alaska. Using summer highway maintenance service levels as an example, department maintenance engineers have determined per-unit costs to maintain highway pavement (as well as culverts, ditches, guardrails, traffic signs, and vegetation) to meet each of the five performance targets. Thus, the cost for maintaining identified high volume routes at performance target "A" can be quantified on a per-unit basis, establishing a clear relationship between budget amounts and maintenance outcomes.

The Report Card provides a basis for identifying priorities, assigning work, and linking budgets to measurable results. The 2012 Quality Assurance Report Card below shows the existing service level based on samples taken statewide. The report card shows the existing service level (the letter "C") as well as the proposed service level (the letter "P"). Maintenance staff has identified unit costs for each category and service level, so, for example, the cost of improving the International Roughness Index (IRI) from service level "C >" to service level "B" can be quantified.

Maintenance staff has started to use the report card to allocate deferred maintenance funding. By knowing asset conditions and trends, the department can reallocate funding and staff time, and focus on meeting identified service levels for specific assets, such as pavement.

Alaska Department of Transportation and Public Facility
Quality Assurance Report Card

	Service Level A				Service Level B				Service Level C				Service Level D				Service Level F			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Gravel Surface Material										P							C→			
Cracks						P			←C											
Allegator Cracking						←CP														
Potholes						P		←C												
Pavement Striping										P					C					
Pavement Marking										P								C		
Pavement Rutting						P					←C									
Pavement IRI								P				C→								
Culverts						P							C							
Ditches	←C					P														
Guardrail Panels						P	C→													
Guardrail Ends						P										C→				
Guardrail Height						P						C→								
Traffic Signs						P											C→			
Vegetation Management - Hydro Axe						P				C→										
Vegetation Management - Side-Arm Mowing						P								C→						
Vegetation Management - Standard Mowing						P								C→						

C= Existing Service Level (2012) P= Proposed Service Level   ADOT&PF Statewide Maintenance and Operations

Materials Engineering & Technology

The department's Materials Section provides specialized technical assistance and engineering services for the design, construction, and maintenance of Alaska's highway and airfield pavements.

Hard Aggregates

The Materials Section has been particularly interested in addressing wheel rutting, a problem endemic to Anchorage, as well as in Juneau, caused primarily by studded tires. In a series of reports prepared from the early 1990s forward, and as the result of examining the practices of Scandinavian countries, the department has concluded that hard aggregates improve pavement performance and lengthen pavement service life by resisting wear from studded tires.

Hard aggregate of a type suitable for use on the road surface is not readily available in the state, although efforts to locate an in-state source continue. Aggregate hardness is measured by using the industry-standard Nordic Abrasion Test. Local aggregates test at 12, while hard aggregates must test at 8 or below. The cost of importing hard aggregate from the large, industrial pit operation in DuPont, Washington, is more than offset by the savings that result from a longer-lasting road surface. Department research has consistently shown that the use of harder aggregates conforming to Nordic Abrasion specifications can increase pavement performance by 1.4 to 1.9 times in the Anchorage and Juneau areas respectively. On Egan Drive in Juneau, the use of hard aggregates has improved pavement performance by 2.5 times.

Recently completed hard aggregate studies have identified and profiled Alaskan material sources, including one at Cantwell, that may provide suitable material cost-effectively to the Anchorage bowl. The studies have contributed to the pending implementation of a statewide hard aggregate use policy for high-volume roads in 2014.

Construction Technologies

New technologies using infrared sensors and GPS readings have been installed as after-market additions to paving equipment to improve the construction of asphalt surfaces. These technologies are expected to become standard in a new generation of pavers and compactors. The Pave-IR system, developed by the Texas Transportation Institute, uses a transverse bar with 10 infrared temperature sensors immediately behind the paver; the Pave-IR software collects and displays the asphalt mix's thermal profile in real time as the paving train progresses. This ensures uniform asphalt temperatures across the width of the paving and the correct compaction temperature during placement. Evidence has shown that uniform paving and compaction temperatures lead to a longer-lasting road surfaces.

"Intelligent compactors" were recently introduced to improve the laying of hot-mix asphalt and soils. This technology consists of an accelerometer positioned on or in the roller drums to measure the response of the underlying materials to the compaction forces being applied by the drum. An on-board computer analyzes accelerometer readings to evaluate the compaction levels and uniformity of the materials. The rollers are also equipped with GPS technology that establishes the roller drum locations. A color-coded display provides location, operation, and measurement data in real time that helps the roller operator achieve the needed coverage over the full pavement area in both daytime and nighttime conditions.

New surfacing treatments for highways are gaining acceptance, but must be evaluated carefully for their applicability in Alaska. In ultra-wear, or

Intelligent compactor rolling asphalt at the Sitka Airport. Photo by Steve Saboundjian, ADOT&PF

Material transfer vehicle applying asphalt at the Sitka Airport.
Photo by Steve Saboundjian, ADOT&PF

dura-wear treatments, an emulsion is applied to the pavement surface, then covered immediately with an ultra-thin lift of hot-mix asphalt that seals and waterproofs the surface. Micro-surfacing, first developed in Germany in the 1960s and now widely used, utilizes a precise mixture of graded aggregate, asphalt emulsion, water, and mineral and polymer fillers that is made and applied to existing pavements by a specialized machine that carries all components, mixes them, and spreads the aggregate on the road surface. Use of these surface treatments is limited in Alaska, as they do not sufficiently withstand the rigors of climate and studded tires.

Alaskan asphalt paving operations have seen an increased use of material transfer vehicles, which reduce mix segregation and allow the placement of a thermally uniform asphalt mat. This ultimately minimizes future pavement distress such pot-holing and cracking. When the transfer vehicle is used to transfer the hot-mix from a windrow or a hauling truck to the paver, infrared thermal camera imaging shows a uniform mat temperature behind the paver, which leads to longer-lasting road surfaces.

Sustainable Materials

The Materials Section has studied the use of rubberized hot-mix asphalt (RHMA) in the Anchorage area as an alternative to conventional hot-mix asphalt and as a regionally appropriate alternative to the use of hard aggregates. Department lab research has demonstrated that RHMA may outperform conventional hot mix asphalt for studded tire wear. The research indicates that, despite its higher cost, roadways paved with RHMA have a lower lifecycle cost than those paved with conventional hot mix asphalt. Typically, rubberized hot-mix asphalts are used in the Anchorage area, while hard aggregates are used in Juneau. Rutting is not an issue on roads in the Interior region where thawing permafrost, addressed in a separate section below, is a constant and growing issue.

As aggregate material sources become scarcer and more cost-prohibitive, the re-use of existing pavement material has gained significant attention. Reclaimed asphalt pavement (RAP) is now routinely used in the construction of new pavements. Likewise, more sustainable asphalt mixes have come into use. For example, warm-mix asphalt (WMA), which is produced at lower temperatures than conventional hot-mix and consequently requires less fuel to bring it to a working temperature, is now being used. WMA also takes less time and effort to compact at the job site, resulting in reduced operating hours (and fuel use) for compaction equipment.

The department continues to employ small-scale tests under Alaska conditions to examine innovative surfacing treatments and technologies for their cost and suitability. Only when these test sections are successful, based on realistic lifecycle costing, are larger-scale projects undertaken. Materials staff expects that up to 25% reclaimed asphalt pavement will be allowed in certain asphalt mixes. Permissive warm-mix asphalt (WMA) specifications will allow a number of additives and technologies to be used in paving projects. Many innovations now in regular use such as WMA, hard aggregates, rubberized asphalt, and others, resulted from department staff monitoring techniques worldwide to identify those with potential benefits to Alaska.

Recently, specifications were developed to allow the use of recycled glass in roadway projects. Up to 10% crushed glass (pieces less than 3/8-in in size), may be used in pavement base, subbase, and embankment construction with a few limitations.

Research

The department's Research, Development and Technology Transfer (RDT2) section and the Alaska University Transportation Center at the University of Alaska-Fairbanks, undertake pavement-related research projects with the goals of reducing the cost, increasing the life, and improving the performance of pavements.

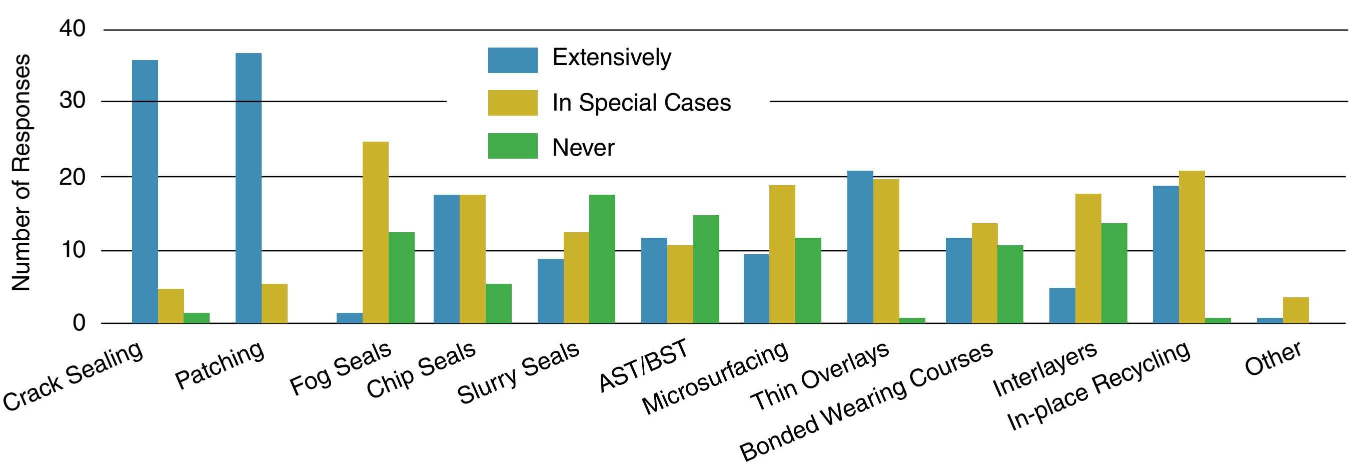
The department's materials engineers work closely with researchers at the university identifying research needs and collaborating on research projects. These projects have included the development of more stabilized base courses, new mix test methods to improve mix designs and the predictability of their performance, and techniques to more accurately monitor the performance of warm-mix asphalt..

Pavement research, mindful of the requirements in MAP-21 and consistent with the implementation of pavement asset management, has recently focused on the concept of preserving highways in their existing good condition, and reducing the need for costly and time-consuming rehabilitation and reconstruction projects. The research, which culminated in the publication in November 2012, of "Develop Guidelines for Pavement Preservation Treatments and for Building a Pavement Preservation Program Platform for Alaska," focused on appropriate pavement preservation strategies for cold regions and under Alaska conditions. This effort provided valuable decision trees and models for preservation projects. Much of this research will be incorporated into an updated pavement management system being examined by the department. It will help determine valuable information on expected life extensions of various treatments, best time to apply treatments, and true life-cycle costs of a pavement.

In preparing the report, released jointly by the Alaska University Transportation Center and the California Pavement Preservation Center, researchers distributed a survey on pavement preservation to pavement experts throughout the cold regions of the world. The survey results from 43 respondents show that patching and crack sealing are the most frequently used pavement treatments, all of which have been used in cold regions for at least thirty years.

The departmental research section is scheduled to undertake a project on thermal cracking. The purpose of this research is to assess the actual performance of recently constructed highway projects that used asphalt pavements modified to reduce low temperature cracking. Because modified asphalts add to the cost of paving projects, it is important to determine if they will result in reduced cracking. This knowledge can be used in planning future paving projects to achieve the lowest possible life-cycle costs.

Extent of Treatments Used



Permafrost

Permafrost is rock or soil material that has remained below 32 degrees Fahrenheit for two or more years. Alaska is the only state in the U.S. that must deal with permafrost and its effects on paved highways and airports.

Permafrost underlies a significant portion of the state's roads and airports, particularly in northern, western and interior Alaska. The department has constructed roads, airports and buildings on permafrost for many years, gaining considerable knowledge and experience in design, construction, and maintenance. At the time many transportation improvements were designed and built, localized permafrost degradation resulted from construction and disturbance, and, except for construction-related thawing and restabilization, permafrost was otherwise considered stable based on historic temperature data.

Should the rising temperatures experienced in the state continue as a long-term trend, department engineering and maintenance staff anticipate continued thawing of permafrost on all National Highway System routes, typically in areas of discontinuous permafrost where subsurface temperatures are already at, or very near, 32 degrees Fahrenheit.

There are abundant references to rising temperatures and associated costs, but little has been written on the specific costs of thawing permafrost. University of Alaska-Fairbanks Doctoral candidate in Civil Engineering, Eunkyoung Hong, in her 2012 dissertation titled "Permafrost Settlement Caused by Climate Warming in Alaska and the Estimation of Its Damage Costs for Public Infrastructure," concluded that approximately $106 million would be added annually to public infrastructure costs (maintenance and construction) in Alaska from 2010 to 2015 because of thawing permafrost, with just over 60% of this cost associated with airports and highways.

ISER, the Institute of Social and Economic Research at the University of Alaska-Anchorage, prepared a report in 2007 stating that the costs attributable to all aspects of climate change could add $3.6 to $6.1 billion to the maintenance and replacement costs of civil infrastructure between now and 2030. Roads and airports, followed by water and sewer utilities, will account for most of these additional costs according to the report. In a 2008 update, the authors estimated the (then) replacement value of transportation systems (roads, airports, railroad, bridges and harbors) at $33.215 billion.

Pavement restoration, rehabilitation, and resurfacing cost the department over $100 million in 2012, and averaged $85 million annually for the past seven years. Each year, about $11 million is spent for remediation of roads in the Northern Region damaged by thawing permafrost.

In addition to the annual remediation of permafrost-affected roads, a maintenance activity, the department also designs road segments to maintain permafrost in a frozen state, using engineering practices that include thermosyphons, air convection embankments and sheets of polystyrene insulation.

Thawing of permafrost, Stampede Road. ADOT&P archives.

Researchers from the UAF, through the Alaska University Transportation Center and the College of Engineering and Mines, and department engineers, have worked with peers in the Yukon Territory monitoring the Beaver Creek Experimental Area. Created by the Yukon Department of Transportation, this area consists of twelve highway sections where techniques for stabilizing permafrost can be tested and compared to a control section where standard (i.e., historic) construction practices were used.

Finally, the department, with the Western Federal Lands Division in the FHWA in the lead, has begun a study that will examine the vulnerability of Alaska's roads, bridges, airports and other improvements to climate and weather events such as increased storm frequency and intensity, thawing permafrost, coastal storm surges, rising sea levels, and high runoff volumes. The goal of the study is to identify engineering designs and standards that promote the adaptability and resilience of assets.

Juneau road work. Photo by Peter Metcalfe

Closing

With the nation's highway system substantially built, national surface transportation priorities are making a transition from adding new capacity and new routes, to preserving the highways and bridges already in place. In Alaska, where the highway system remains under-developed, a transition to preservation over the construction of new routes and additional capacity could prove problematic in meeting the needs of a state still in the pioneering phase of transportation development.

The national emphasis on pavement preservation will, on the other hand, help assure that paved surfaces on the state's National Highway System routes are brought up to, and maintained, in good condition. Within 18 months of the enactment of MAP-21, or by April 1, 2014, the Secretary of the federal Department of Transportation, in consultation with the states, is required to establish performance measures for pavement condition on the National Highway System. Within one year of the final rule on performance measures, or by April 1, 2015, states are required to set performance targets in support of those measures.

While not a requirement of MAP-21, the promulgation of standards, or targets, for pavement on the Interstate and National Highway Systems could "lead by example" for the preparation of like standards for Alaska Highway System routes and on higher volume local street and roads. This "spillover" effect could help to assure a higher level of performance for all of Alaska's road and highway pavements to the extent they can be brought to, and maintained in, an overall good condition.

Good pavement matters to everyone. Pavements that are in good condition mean safer driving, reduced fuel consumption and vehicle wear, and lower long-term preservation costs. Highway and airport surfaces in good condition are essential, both for safety and the efficient movement of goods and people. If we do our job right, you will not notice the road while driving. We hope this report has informed and educated you about the work we do to maintain safe, paved surfaces throughout Alaska.

Appendices

Longitudinal Cracking. Photo by Jim Horn ADOT&PF

Appendix A

Glossary of Terms

Aggregate
Any combination of one or more sand and rock particles, either natural or crushed, from very fine to large rocks. It is selected because of its characteristics for a specific purpose, such as sand, gravel, crushed stone, ballast, etc., and used for mixing in specific proportions.

Asphalt
A black cement-like substance typically obtained as residue in petroleum distillation. Asphalt imparts controllable flexibility to mixtures of mineral aggregates, with which it is usually combined. Although semisolid at ambient temperatures, asphalt may be liquefied by applying heat, dissolving it in petroleum solvents of varying volatility, or emulsifying it. Asphalt is often modified with additives, such as polymer, to impart particular performance characteristics. It is also referred to as asphalt cement, or asphalt binder.

Asphalt Concrete
Also referred to as asphalt concrete pavement (ACP), hot mix asphalt (HMA), flexible pavement, and hot bituminous pavement. It is the material most commonly used for surfacing roadways and airports in Alaska that are subject to high traffic, 5,000 vehicles or more per day. It is a high-quality, controlled, hot mixture of liquid asphalt cement and graded aggregate, thoroughly compacted into a uniform dense mass.

ASTM E-950
Formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. ASTM E-950 is the organization's test method, or quality assurance and control, for the accuracy of the data collected by road profiling equipment.

Banding
Using a crack sealing material, banding completes the crack sealing process by adhering the crack seal material to either side of the crack.

Centerline Mile
The length of a highway regardless of the pavement width or the number of lanes.

Chip Seal
A chip seal or "single-shot" asphalt surface treatment involves spraying emulsified asphalt material on the roadway, followed immediately by a thin stone cover. This is compacted as quickly as possible to create adherence between the asphalt and the aggregate cover. The chips (or stones) range from 3/4-inch aggregates to sand and are predominately one size. It produces an all-weather surface, renews weathered pavements, improves skid resistance and lane demarcation, and seals the pavement.

Class I Highways
Part of the National Highway System designated by Congress that, in Alaska, includes the Glenn Highway, Parks Highway, Alaska Highway, Seward Highway, Dalton Highway, Richardson Highway, Klondike, Haines and Glacier Highways in Southeast, intermodal ferry and airport facilities and other routes.

Cracking
The separation of the pavement surface, caused by fatigue; failure of the asphalt to bind properly, temperature changes, turning movement of vehicles and other factors. Cracks are categorized as working (move horizontally at least 0.1" or more) or non-working.

Crack Sealing
Pavement maintenance operations, cleaning out cracks, and using asphalt materials to fill and seal cracks to impede infiltration of moisture into the supporting layers. Modern crack sealing compounds contain rubberized agents to help maintain flexibility even at very low temperatures.

Deferred Maintenance
The practice of postponing regular maintenance activities in order to save costs, meet budget-funding levels, realign budget priorities, meet emergencies, etc. The consequence of deferred maintenance is the likelihood of higher 'unit costs' in the future.

Full Depth Reclamation
An alternative to full reconstruction, it is a pavement rehabilitation method in which the asphalt pavement layer and a predetermined amount of underlying material are crushed and blended in place to produce a base course. A new asphalt surface course is then installed.

High Float Surfacing
A a special form of asphalt surface treatment that consists of a single, heavily applied layer of high-float emulsified asphalt, followed by a single layer of dense-graded, crushed cover aggregate. This is one of the department's low-cost alternatives for primary and maintenance paving.

International Roughness Index
An international standard for measuring pavement smoothness. The index measures pavement roughness in terms of the number of inches per mile that a laser, mounted in a specialized van, jumps as it is driven across the road system. The lower the IRI number, the smoother the ride.

Lifecycle Cost
The total cost to construct, operate and maintain an asset over its lifetime.

Microsurfacing
Pioneered in Germany and now widely used, microsurfacing uses a precise mixture of graded aggregates, polymer-modified emulsion and set additives to seal the pavement surface, fill wheel ruts and correct minor surface irregularities. It is cost-efficient, provides an excellent wearing course and requires less material and energy consumption than conventional hot mix asphalt.

Mill and Fill
The removal of existing pavement surface with a milling machine and hauling the milled material to an off-site location. New asphalt mix, often containing some recycled asphalt pavement (RAP), is installed to replace the milled out material.

Nordic Abrasion Test
A proven method of measuring aggregate hardness and abrasion resistance.

Permafrost
Rock or soil material that has remained frozen for two or more years.

Pavement Serviceability Rating
A national observation-based standard for reporting highway condition and performance using a 0-5 rating, where 5 is perfect and 0 is essentially impassible. It essentially combines data gathered for roughness and rutting into a single rating.

Pavement Structure
The combination of select material, sub-base, base, and surface course placed on a sub-grade to support the traffic load and distribute it to the roadbed (42 inches below the asphalt concrete layer).

Emulsified Asphalt or Asphalt Emulsions
Asphalt emulsions (or emulsified asphalt) are composed of asphalt particles suspended in water with a surface-active agent (variously called surfactant, chemical, soap or emulsifying agent) to stabilize the suspension. Emulsifying the very viscous asphalt allows it to be easily pumped, transported and applied at ambient temperatures, making emulsions ideal for use at remote locations while saving energy and providing safer worker conditions. Because emulsions are water based, they are also eco-friendly when compared to hot mix asphalt, hot asphalt cement or asphalt cutbacks. Asphalt emulsion application techniques, including chip seals, slurry seals and cape seals, have been used for many years.

Preservation
"A program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations." Source

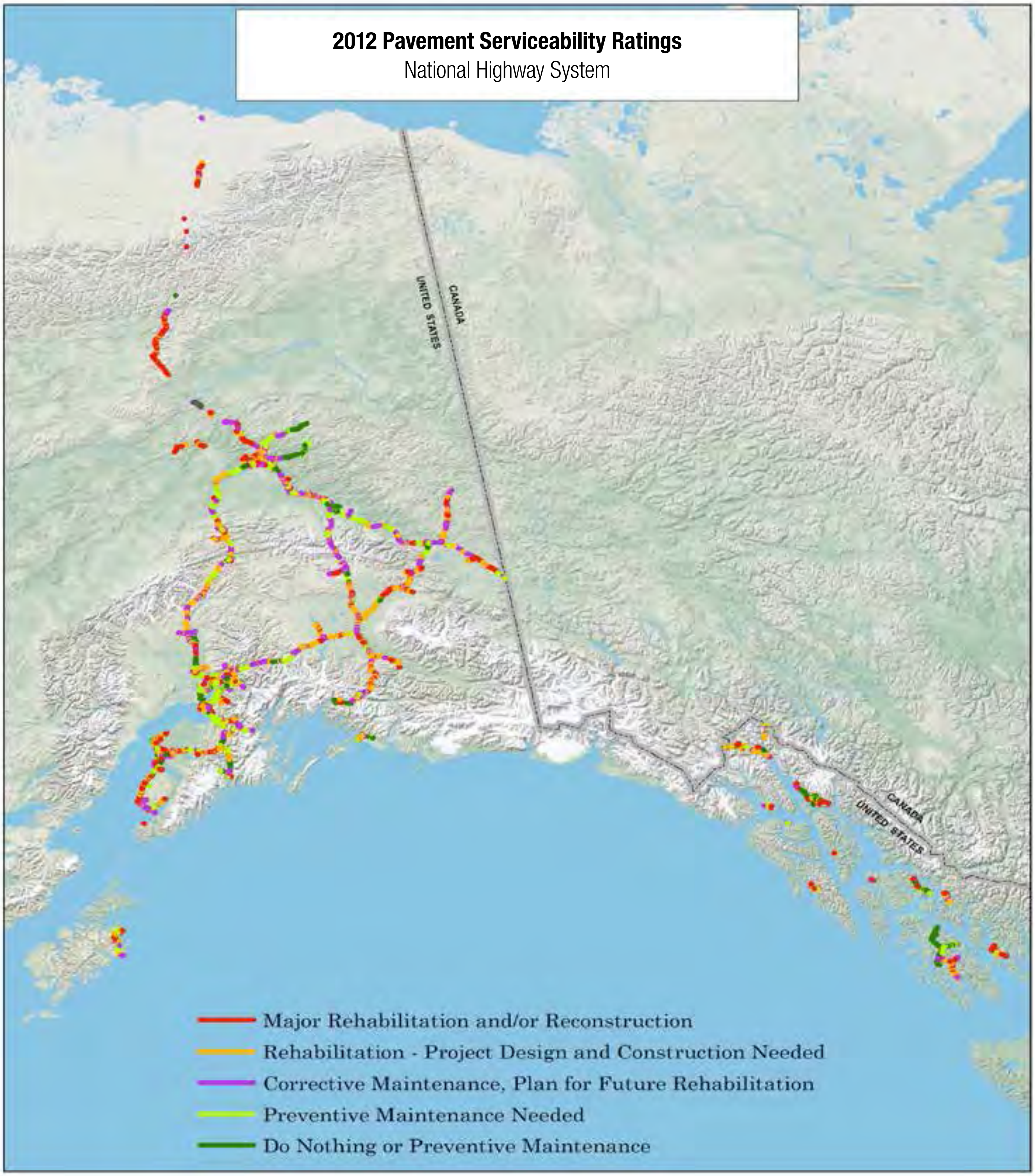
FHWA Pavement Preservation Expert Task Group

Raveling
The loss or dislodgment of surface aggregate particles from the edges inward or the surface downward. It is caused by lack of compaction, construction of a thin lift during cold weather, dirty or disintegrating aggregate, too little asphalt in the mix, or overheating of the asphalt mix. Studded tires can also contribute to raveling.

Rutting
A longitudinal depression of the pavement structure in the wheel paths that can be caused either by pavement structural deficiency, inadequate compaction of the granular base, or by mix instability. Use of studded tires is a significant contributor to rutting in Alaska.

Roughness
Thee ride quality of the roadway, typically measured through the International Roughness Index (IRI) and expressed in vertical displacement over a distance (e.g. inches/mile).

Appendix B



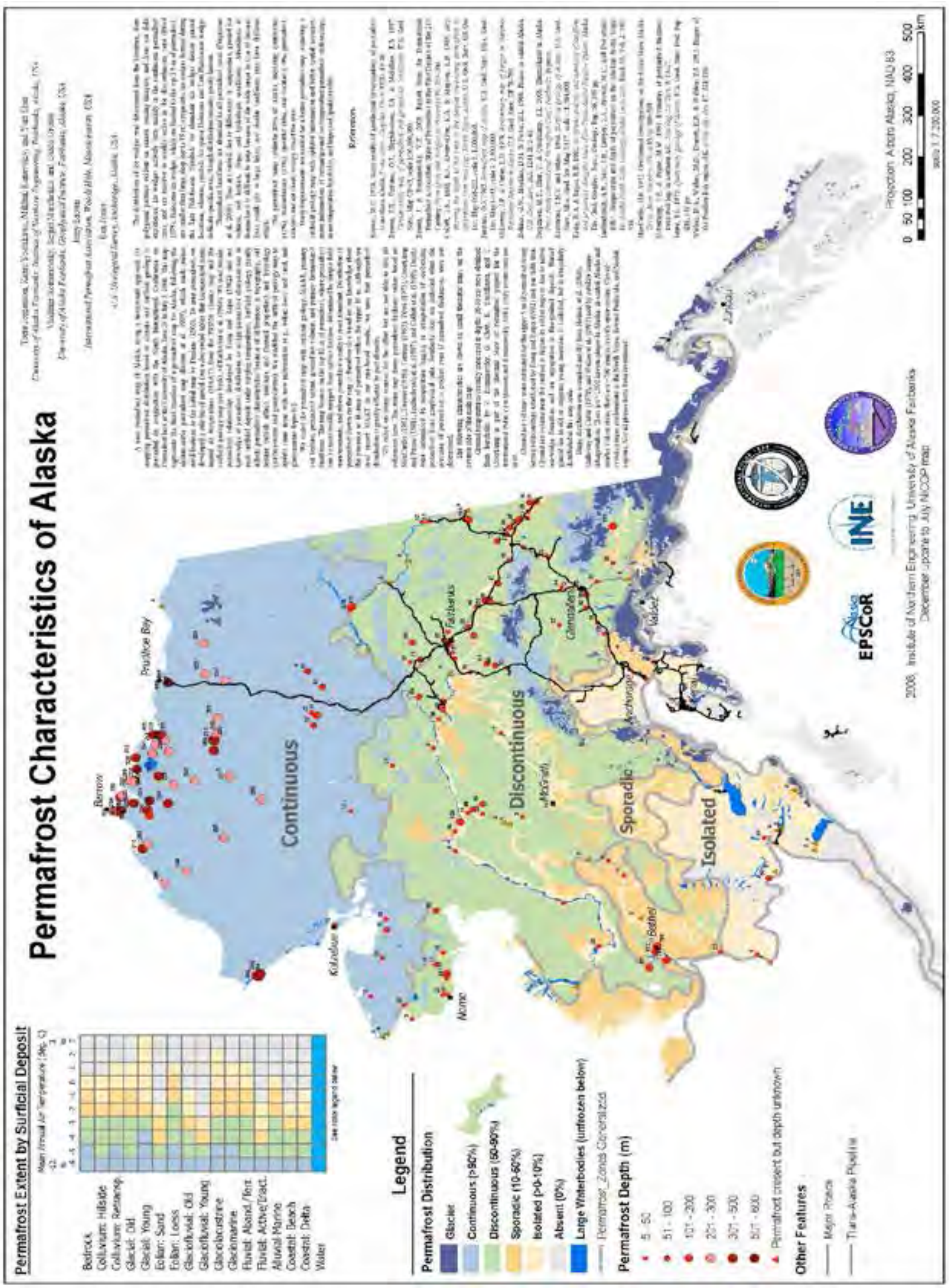
2012 Pavement Serviceability Ratings
National Highway System
CANADA
UNITED STATES
CANADA
UNITED STATES
Major Rehabilitation and/or Reconstruction
Rehabilitation - Project Design and Construction Needed
Corrective Maintenance, Plan for Future Rehabilitation
Preventive Maintenance Needed
Do Nothing or Preventive Maintenance

Appendix C

Barrow Airport Pavement Condition Index Map

Appendix D

Permafrost Regions of Alaska



Alaska Department of Transportation
and Public Facilities