Appendix A

Pavement Surface Friction Treatments
PAVEMENT SURFACE FRICTION TREATMENTS

BACKGROUND:

Surface friction is an important pavement property for vehicle control and stopping. Wet pavement surfaces are of specific interest as they exhibit lower friction than when the pavement is dry. There are many factors that determine the amount of friction required at each location such as; speed limit, geometrics, surface drainage, texture, and aggregate properties. Standard pavement items, with approved aggregates, generally provide adequate wet friction for most locations. As pavements age the surface friction properties may change by loss of texture, aggregate polishing, or non-pavement issues such as changes in speed limits, traffic patterns or drainage issues. Corrections must be made at locations where it has been determined there is a lack of wet friction. The treatments listed here represent potential remedies.

A surface friction treatment may not be the best long-term solution for correcting geometric conditions. Straightening a curve, flattening a hill, providing additional signing, or removing vegetation to improve sight distance may eliminate the need for future surface friction treatments. Providing a surface friction treatment in response to poor geometric conditions may result in increased speed that reduces or negates the benefit of the treatment.

The treatments outlined here may lose effectiveness as they wear over time and all pavement surfaces will be candidates for repair, grinding, overlay, or replacement eventually.

Assistance with the application of these surface friction treatments is available from the Office of Pavement Engineering, the Office of Construction Administration, and the Office of Materials Management.

DEFINITIONS:

Friction: The force that resists relative motion between two objects in contact. For pavements, it is the force between the tire and the pavement that allows acceleration, deceleration, and directional control.

Friction Demand: The amount of friction needed at a given location to safely maintain vehicle control.

Macrotexture: The observable surface finish of the pavement, i.e. smooth and tight vs. rough and open.

Microtexture: The fine-scale texture of the individual aggregate particles. Microtexture is not necessarily visible to the naked eye.

Polishing: The loss of microtexture.
INTRODUCTION:

Long-term pavement surface friction treatments are categorized into tiers 1, 2, or 3 with the higher numbered tier expected to provide higher wet friction. Short term treatments are not assigned a tier. The purpose of the tiers is to help guide the designer toward an appropriate long-term treatment. Not all treatments within a tier are equal so it may not always require moving to a higher tier to provide the needed frictional properties. The exact treatment selected for a location is based on engineering judgement of the friction demand, existing pavement conditions, needed longevity of treatment, cost, etc.

Tier 1: Tier 1 treatments are standard specification items using standard materials. These treatments are appropriate when there is no expectation of higher friction demand, but the existing surface no longer possesses adequate friction.

Tier 2: Tier 2 treatments add special aggregate or aggregate blends to provide enhanced friction or reduced polishing potential. These treatments are appropriate for locations where there is higher friction demand or where tier 1 treatments may not provide the needed friction based on experience or engineering judgement.

Tier 3: Tier 3 consists only of Supplemental Specification 888 High Friction Surface Treatment (HFST) and chip seals using slag aggregate. Tier 3 treatments provide the highest level of friction resistance and are appropriate for the most demanding locations.

SURFACE FRICTION TREATMENTS:

I. Short Term Treatments

When there is the need to improve the frictional properties of the pavement as soon as practical or a temporary improvement is needed before a long-term treatment is applied, micro planing using Supplemental Specification 897 Pavement Fine and Micro Planing may be used. SS897 is for asphalt surfaces only. It may be possible to perform this work using in-house forces. Similar work could be performed on concrete surfaces but diamond grinding, diamond grooving, or both is preferred for concrete.

Micro planing mechanically abrades the surface to provide increased macrotexture. Micro planing may also improve microtexture by exposing new aggregate surfaces, but polishing aggregates will continue to polish after micro planing.

The surface resulting from micro planing typically deteriorates at a faster rate and aggregate polishing is accelerated after planing. These surfaces normally need to be
II. Long Term Treatments

A. Tier 1

Tier 1 treatments consist primarily of a new surface using standard specification items. Tier 1 treatments are appropriate as the first long-term treatment for most locations. Tier 1 treatments are also appropriate, in many cases, in locations where a tier 2 or 3 had been applied previously but, because of pavement deterioration, a new surface is being placed. When repaving tier 2 and 3 locations, the designer should review the sites to ensure the location does not have increased friction demand that necessitates another tier 2 or 3 treatment or if tier 1 is sufficient.

Below are brief discussions of each of the tier 1 treatments.

1. Asphalt pavements (C&MS Items 424, 441, 442, and 443)

A new asphalt surface using any of the standard specification items with proper construction techniques and approved materials is expected to provide the necessary wet weather friction for most locations.

A new asphalt surface may be placed with or without planing the old surface. Placing a new asphalt surface by contract, with or without planing, is more cost effective as part of a larger project rather than a spot treatment.

Items must be properly specified based on the section’s traffic counts and other considerations. Refer to PDM Section 400 for more information on asphalt pavements. Refer to PDM Sections 400 and 550 for more information on Item 424 Fine Graded Polymer Asphalt Concrete.

2. Concrete pavements (C&MS Items 451 and 452)

A new concrete pavement using either of the standard specification items with proper construction techniques and approved materials is expected to provide the necessary wet weather friction for most locations.

Replacing the existing pavement with concrete pavement for no other reason than to provide wet weather friction is unlikely to be a cost-
effective solution. There may be other considerations such as a high stress area that would make this a more attractive solution.

Refer to PDM Section 300 for more information on concrete pavements.

3. Microsurfacing (C&MS Item 421)
Standard microsurfacing is widely known to provide good wet weather friction. Microsurfacing may be placed along an entire roadway section or at spot locations if there are enough locations in reasonable proximity to make a viable project.

Refer to PDM Section 550 for more information on microsurfacing.

4. Chip Seal (C&MS Item 422)
Properly constructed chip seals with approved materials provide more macrotexture for wet weather friction than most other treatments. Chip seals may be placed along an entire roadway section or at spot locations if there are enough locations in reasonable proximity to make a viable project. Spot locations may be more suitable for chip sealing using in-house forces rather than by contract.

Refer to PDM Section 550 for more information on chip seal. The traffic level restrictions for chip seals still apply when used as a friction treatment.

5. Diamond Grinding (C&MS Item 257)
Diamond grinding may be used on concrete surfaces to remove a thin layer of the existing surface, expose new aggregate surfaces, and provide a new texture. Diamond grinding is not recommended with polishing aggregates.

Diamond grinding may be used on asphalt surfaces but is typically a shorter-term treatment in these applications.

Diamond grinding may be performed as a stand-alone treatment or in combination with diamond grooving. Because of the equipment mobilization costs, diamond grinding is more appropriate for longer applications.

Refer to PDM Section 550 for more information on diamond grinding.
6. Diamond Grooving (SS 889)

Diamond grooving may be used on asphalt or concrete surfaces to improve macrotexture. Diamond grooving has no effect on microtexture. It may be used as a stand-alone treatment or in combination with diamond grinding. Diamond grooving may be used a spot treatment or in longer applications.

Refer to the supplemental specification and designer notes for more information on diamond grooving.

B. Tier 2

Tier 2 treatments are primarily new surfaces using traprock or slag aggregates. Traprock and slag are hard, durable aggregates that resist polishing. Slag aggregates also exhibit high microtexture. Tier 2 treatments are appropriate for documented locations where tier 1 treatments have been tried, where polishing is a known issue, or other locations determined by engineering judgement. Locations identified for tier 2 treatments may also be candidates for geometric changes.

Below are brief discussions of each of the tier 2 treatments.

1. Asphalt with 60% slag

This item requires that 60 percent of the coarse aggregate and 50 percent of the fine aggregate consist of air cooled blast furnace slag (ACBFS). ACBFS may not be economically available throughout the state. There are no standard specifications for this item, but example plan notes are available. This can be used with asphalt items 441 and 442 only. This has been used as an option with traprock when polishing was the primary concern.

A new asphalt surface may be placed with or without planing the old surface. Placing a new asphalt surface by contract, with or without planing, is more cost effective as part of a larger project rather than a spot treatment.

2. Asphalt with 60% traprock

This item requires that 60 percent of the coarse aggregate and 50 percent of the fine aggregate consist of igneous diabase trap rock from Ontario. Traprock may not be economically available throughout the state. There
are no standard specifications for this item, but example plan notes are available. This has been used as an option with ACBFS when polishing was the primary concern.

A new asphalt surface may be placed with or without planing the old surface. This can be used with asphalt items 441 and 442 only. Placing a new asphalt surface by contract, with or without planing, is more cost effective as part of a larger project rather than a spot treatment.

3. Microsurfacing with 50% traprock (C&MS Item 421)
   Item 421 Microsurfacing, Surface Course (FR) requires that 50 percent of the aggregate consist of igneous diabase trap rock from Ontario. The percentage of traprock is limited to 50 percent in order to have the proper limestone fines to react with the emulsion. Traprock may not be economically available throughout the state.

   Microsurfacing with traprock may be placed along an entire roadway section or at spot locations if there are enough locations in reasonable proximity to make a viable project.

4. Asphalt with 100% slag
   This item requires that 100 percent of the coarse aggregate and 50 percent of the fine aggregate consist of ACBFS. ACBFS may not be economically available throughout the state. There are no standard specifications for this item, but example plan notes are available. This can be used with asphalt items 441 and 442 only. This has been used as an option with traprock when polishing was the primary concern.

   A new asphalt surface may be placed with or without planing the old surface. Placing a new asphalt surface by contract, with or without planing, is more cost effective as part of a larger project rather than a spot treatment.

5. Asphalt with 100% traprock
   This item requires that 100 percent of the coarse aggregate and 50 percent of the fine aggregate consist of igneous diabase trap rock from Ontario. Traprock may not be economically available throughout the state. There are no standard specifications for this item, but example plan notes are available. This can be used with asphalt items 441 and 442 only. This has
been used as an option with ACBFS when polishing was the primary concern.

A new asphalt surface may be placed with or without planing the old surface. Placing a new asphalt surface by contract, with or without planing, is more cost effective as part of a larger project rather than a spot treatment.

6. Rubberized Open Graded Friction Course (SS 803)

While rubberized open graded friction course is specifically designed to provide wet weather friction, ODOT has had difficulty with snow and ice removal and does not recommend its use. Refer to PDM Section 400 for more information on rubberized open graded friction course.

C. Tier 3

Tier 3 treatments are appropriate for documented locations with high friction demand, particularly spot locations where only isolated areas require treatment. Locations identified for tier 3 treatments may also be candidates for geometric changes.

Below are brief discussions of each of the tier 3 treatments.

1. High Friction Surface Treatment (SS 888)

A high friction surface treatment (HFST) consists of an epoxy resin and calcined bauxite aggregate. As the name implies, HFSTs are a proven treatment to provide high wet pavement friction. An HFST is a relatively expensive but long-lasting treatment and is recommended for pavements in good condition only. HFSTs are most appropriate in spot locations such as curves, ramps, or intersection approaches.

Do not place an HFST on any pavement scheduled for rehabilitation within three years or any pavement exhibiting surface debonding.

Locations scheduled for rehabilitation where a previous HFST exists may or may not require re-installation of the HFST. The reasons for the initial installation should be considered and engineering judgement applied to determine the appropriate tier treatment for the rehabilitation.

Refer to the supplemental specification and designer notes for more information on HFST.
2. Chip seal with slag

Chip seal using slag aggregate is an experimental treatment with promising but very limited results. It may become an option for longer segments needing a tier 3 treatment. The traffic level restrictions for chip seals still apply when used as a friction treatment.

D. Other Options

As mentioned previously, geometric improvements may reduce the friction demand and eliminate the need for any other treatment. New or additional signage or removing vegetation to improve sight distances may also be effective in some situations.

In some locations the problem may be excessive speed rather than lack of wet friction. These locations are better suited to additional warning signs or other measures to reduce speed rather than a surface friction treatment. Full lane transverse rumble strips in accordance with the Traffic Engineering Manual Section 1400 are an option to alert drivers to slow down.

SEGMENT LIMITS OF SURFACE FRICTION TREATMENTS

The segment limits of a pavement surface friction treatment depend in part on the treatment selected. Some treatments are more appropriate for longer sections of roadway while others are spot treatments. Whatever treatment is selected, it is important to ensure the treatment encompasses the area of inadequate friction and extends through the area of higher friction demand.

SUMMARY AND FUTURE DIRECTION

ODOT has tools to objectively measure available wet pavement friction. Friction demand, however, is subjective and requires engineering judgement. The tiers and treatments listed here are intended to assist in the subjective analysis and help the designer determine an appropriate treatment for the needed friction demand.

ODOT is collecting data to possibly determine the expected wet pavement friction provided by the various treatments and researching ways to objectively determine friction demand ranges. Future updates to this appendix may relate treatments or tiers with ranges of friction demand.

The ODOT Highway Friction Management Program document is available at O:\Planning\Highway Friction Management Program. Questions about the friction management program should be directed to the Office of Technical Services.
The form shown on the following pages is for submitting friction management remediation plans to the Office of Pavement Engineering for approval. The form is available electronically at O:\Pavement\Friction. Questions about the form or any of the pavement friction treatments should be directed to the Office of Pavement Engineering.
# Friction Management Remediation Plan

## Location Information

<table>
<thead>
<tr>
<th>District:</th>
<th>County:</th>
<th>Route:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin SLM:</td>
<td>End SLM:</td>
<td>Location:</td>
</tr>
<tr>
<td>Direction (use Up for ramps): Up</td>
<td>Down</td>
<td>Both</td>
</tr>
<tr>
<td>Location Description:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Testing Information

<table>
<thead>
<tr>
<th>Skid Testing Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skid Testing File Name(s):</td>
</tr>
<tr>
<td>Other Objective or Subjective Test Results File Name(s):</td>
</tr>
</tbody>
</table>

## Reason for Testing: (check all that apply)

- Long Term Monitoring
- Known Location Requiring Enhanced Friction
- Crash History (include summary of crash history, wet vs. dry crash data)
- Roadside Damage (guardrail damage, evidence of running off road, etc.)
- Public Request/Complaint
- Law Enforcement Request
- ODOT County Forces Request
- Other (describe): |

## Site Investigation

<table>
<thead>
<tr>
<th>Surface Material:</th>
<th>Year Surface Placed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Project Number (if any):</td>
<td>Surface JMF(s) (if any):</td>
</tr>
<tr>
<td>Crack Sealed: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Type(s) of Crack Seal:</td>
<td>Year(s) Placed:</td>
</tr>
<tr>
<td>Amount of Crack Seal:</td>
<td></td>
</tr>
<tr>
<td>Additional Surface Information:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADT:</th>
<th>Truck ADT:</th>
<th>Approach Roadway Speed Limit: mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisory Speed (if any): mph</td>
<td>Lane Width: ft</td>
<td>Paved Shoulder Widths: ft/ft</td>
</tr>
</tbody>
</table>

Geometry: | Curve | Tangent | Other (describe): |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius of Curve: ft</td>
<td>(Google Earth can be used to estimate)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Warning Devices: Advisories Speed Sign
## Remedial Action Plan

**Treatment(s):**
- Microplaning/Diamond Grinding
- Microsurfacing
- Asphalt
- High Friction Surface Course
- Improved signing, striping, lighting, etc. (any non-pavement treatments)
- Other (describe): [Blank]

**Surface Course Pay Item:** [Blank]  
**Pay Item Description:** [Blank]

**Special Aggregate:**
- Trap Rock
- Slag
- Other (describe): [Blank]

**Geometric Improvement:**
- Yes
- No

**Approximate date for applying remedial action:** [Blank]

**Any other information, description or clarification of the remedial action:** [Blank]

---

### Remedial Action – Short Term

If the remedial action above is a long-term fix that may not be initiated for months or years, describe any plans for an immediate or short-term fix:

[Blank]

---

**OPE Notes:** [Blank]