Pavement Rehabilitation Manual

VOLUME II: TREATMENT SELECTION

MATERIALS BUREAU
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
PAVEMENT REHABILITATION MANUAL

VOLUME II: TREATMENT SELECTION

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PART 1: INTRODUCTION
PART 1: INTRODUCTION

This book on selection of treatments is Volume II of the Materials Bureau’s Pavement Rehabilitation Manual. It is to be used in conjunction with Volume I: Pavement Evaluation, published in June 1990 and revised in February 1992 and May 1993. Volume II shows how pavement and/or shoulder distress data, collected in accord with procedures outlined in Volume I, are used to select rehabilitation alternatives, develop strategies and life-cycle costs for those alternatives, and choose proper rehabilitation alternatives. This volume completes the Pavement Rehabilitation Manual. New developments and additions will be handled through the Department’s Engineering Instruction process.

Part 2 ("Treatment Guidelines and Typical Sections") is a compilation of current Department pavement rehabilitation treatments, ranging from preventive maintenance to total reconstruction. Included are guidelines maximizing each treatment’s effectiveness based on pavement condition (distress levels), and typical section drawings listing work items necessary for success of each treatment. Service lives have been estimated for all treatments based on current experience and engineering judgment. Refinements of these estimates may be necessary as treatment performance histories are developed.

Short isolated areas within a proposed project may exhibit pavement distresses dissimilar to those found on the project in general. It is thus likely that more than one pavement rehabilitation treatment will be required on a project.

Part 3 on life-cycle-cost analysis presents a methodology for comparing treatment costs, the goal being to select a present and future treatment strategy for a pavement with the wisest use of funds. Also included in this chapter are information sources for specification items and costs.

Volume II also contains as Part 4 a model report on pavement evaluation and treatment selection, to give the user an example of format and methodology.

With these "tools" the user can select alternatives and plan a treatment strategy for each alternative. These strategies can then be compared for cost effectiveness and final selection. Once completed, performance of the selected strategy should be followed to verify service life assumptions, learn the influence of variables, and refine the analysis for future rehabilitation strategies.

Users of this Manual are cautioned that selection of a rehabilitation strategy should not be based on existing pavement condition alone. Other less obvious deficiencies, such as unfavorable soil conditions and inadequate drainage characteristics, may have a profound effect on strategy selection and project scope. Also, design and/or construction constraints and maintenance concerns and capabilities must be considered during the selection process.
It is thus recommended that technical assistance be solicited from those regional and/or Main Office units having expertise in these areas during the selection process.

The general procedure for treatment selection includes ten steps:

1. Review the condition report generated by following procedures in **Volume I: Pavement Evaluation**.

2. Solicit information from regional and/or Main Office units that could influence treatment selection.

3. Select appropriate initial treatment alternatives based on pavement condition and the treatment guidelines presented here.

4. Eliminate any initial alternatives that are inappropriate due to design, construction, or other constraints.

5. Develop a treatment strategy for each alternative using expected service life of the initial treatment and projected future treatments.

6. Determine costs of all initial and future treatments using prices from past projects or estimates for new items.

7. Compare total costs of the alternative strategies, using the methods presented here.

8. Perform a "Sensitivity Analysis" if desirable.

9. Select the best treatment strategy based on cost and other factors.

PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

Rigid Pavement
Flexible Pavement
Flexible-Over-Rigid Pavement
Pavement Widening
Flexible Shoulder
PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

This part of Volume II is divided into three sections representing three pavement types: rigid, flexible, and flexible-over-rigid. Each section is further divided into four categories for various pavement treatments: Preventive Maintenance, Corrective Maintenance, Pavement Rehabilitation, and Pavement Reconstruction. Finally, treatments for pavement widening and treatment categories for shoulder maintenance and repair are discussed.

1. **Preventive Maintenance.** Treatments undertaken in advance of a critical need or of accumulated deterioration to avoid such occurrences and reduce or arrest the rate of deterioration, thus, allowing roadway surfaces to achieve their desired service lives. As a secondary benefit, these treatments correct minor defects and may improve roadway strength, friction, rideability and/or appearance for up to 8 years.

2. **Corrective Maintenance.** Treatments correcting existing deficiencies, upgrading the roadway surface for up to 8 years or until other more-extensive treatments are needed.

3. **Pavement Rehabilitation.** Treatments intended to extend service life of a roadway surface 8 years or more. To be effective, treatment selection is critical and should be based on amount and severity of existing pavement distress.

4. **Pavement Reconstruction.** Treatments to be considered when condition of the existing pavement is such that it can no longer serve a useful purpose, when design constraints preclude rehabilitation, or when a life-cycle-cost analysis reveals that reconstruction is the most appropriate solution.

Each pavement treatment guideline is presented in the following format;

1. Conditions For Use
2. Constructability
3. Performance
4. Expected Failure Modes
5. Expected Service Life

Except for reconstruction treatments, a typical section drawing is shown for each pavement treatment, listing appropriate repair items necessary for developing treatment costs. For reconstruction treatments, the Department's standard typical sections should be used to develop costs.

"Expected Service Life" in these guidelines is based on past research and current performance experience. It is appropriate for highways with Average Annual Daily Traffic counts (AADTs) of 12,000 to 35,000 with about 5-percent trucks. Service life should be
adjusted for highways with traffic outside these limits. Some guidelines are meant only for low-volume roadways, as noted under "Conditions For Use."

The ideal method to change or correct service life is by referring to a pavement work history file. A uniform statewide work history file is being developed as part of the Department's Pavement Management Initiative. Lacking this, similar treatments on highways carrying similar traffic volumes should be observed to estimate service life. Pavement performance for the various treatments should be followed and added to a work history file for future decision-making. Service life adjustments should be made using as many facts as possible, following a logical process and saving the information for future use.

Pavement deterioration results from the environment and traffic, but some treatments are not expected to change significantly with traffic. For instance, sealed or filled joints or cracks should not change, as their performance is based on temperature-induced movement and not traffic. However, traffic and environment affect other treatments and adjustments in their service lives are appropriate.

Part 4 ("Model Pavement Evaluation Report") in this volume shows a service life adjustment. In this example, estimated service life was decreased when overlay treatment thickness was reduced.

Thickness dimensions for asphalt overlays in the guidelines are considered nominal. Minor adjustments to these thicknesses are appropriate when local practice and performance dictate. However, caution is advised in reducing thicknesses. A thickness found in the guidelines should always be used as a minimum on interstate system roadways.
RIGID PAVEMENT
TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
Joint and Crack Filling
Joint and Crack Sealing

Corrective Maintenance
Joint and Crack Sealing With Spall Repair
Joint and Crack Sealing With Spall Repair and Grinding
Joint and Crack Sealing With Spall Repair, Grinding,
   and Full-Depth Segment Replacement

Rehabilitation
Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement
Bonded Concrete Overlay
Sawed and Sealed Asphalt Concrete Overlay (3")
Sawed and Sealed Asphalt Concrete Overlay (4")
Asphalt Concrete Overlay (5") Preceded by Cracking and Seating
Asphalt Concrete Overlay (6") Preceded by Rubblizing

Reconstruction
Full-Depth Portland Cement or Asphalt Concrete
Joint and Crack Filling

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals or filler, or slab cracks never sealed or filled.
2. Medium-severity pavement/shoulder separation.
3. Other distresses at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Restricted by temperature and moisture.
   b. Cracks must be clean for the filler to be effective.

Performance
1. Reduces incompressibles and water infiltration.
2. Helps to achieve desired pavement service life.

Expected Failure Modes
1. Fillers fail in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life
2 years
2. Typical Section

1. Clean and fill longitudinal and transverse joints.
2. Clean and fill slab cracks.
3. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Joint and Crack Sealing

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Other distresses at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

Performance
1. Retards development of spalls and faults from incompressibles and water infiltration.
2. Needed to achieve desired pavement service life.

Expected Failure Modes
1. Seals fail in adhesion or cohesion.

Expected Service Life
8 years
2. Typical Section

1. Clean and seal longitudinal and transverse joints.
2. Rout, clean, and seal slab cracks.
3. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Joint and Crack Sealing With Spall Repair

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Other distresses at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

Performance
1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

Expected Failure Modes
1. Sealing
   a. Seals fail in adhesion or cohesion.

2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

Expected Service Life
1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
2. Typical Section

1. Mill and patch spalls with rapid-setting concrete patching materials.
2. Clean and seal longitudinal and transverse joints.
3. Rout, clean, and seal slab cracks.
4. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Joint and Crack Sealing With Spall Repair and Grinding

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Medium-severity transverse joint faulting.
5. Other distresses at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

4. Grinding disadvantages
   a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
   b. New joint seal reservoirs must be created.
   c. High reinforcing mesh damages grinding equipment.

Performance
1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

3. Grinding
   a. Restores ride by removing faults (also improves pavement friction).

Expected Failure Modes
1. Sealing
   a. Seals fail in adhesion or cohesion.
2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

3. Grinding
   a. Traffic causes faults to return.

*Expected Service Life*
1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years

2. Typical Section

1. Mill and patch spalls with rapid-setting concrete patching materials.
2. Grind faults.
3. Clean and seal longitudinal and transverse joints.
4. Rout, clean, and seal slab cracks.
5. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Joint and Crack Sealing With Spall Repair, Grinding, and Full-Depth Segment Replacement

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
5. Medium-severity transverse joint faulting.
6. Infrequent settlements, heaves, and/or blowups.
7. Other distresses at the none or low-severity level.
(Note: Distresses 2,3,4, and 6 are repaired with full-depth rapid-set cement concrete)

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.

3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.

4. Grinding disadvantages
   a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
   b. New joint seal reservoirs must be created.
   c. High reinforcing mesh damages grinding equipment.

5. Full-depth segment replacement disadvantages
   a. Requires special preparation, equipment, and materials.

Performance
1. Sealing
   a. Retards spall and fault development from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.

2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.

3. Grinding
   a. Restores ride by removing faults (also improves pavement friction).
4. Full-depth segment replacement
   a. Restores structural integrity by replacing cracked and displaced pavement.
   b. Restores ride by replacing lost or displaced pavement.

*Expected Failure Modes*
1. Sealing
   a. Seals fail in adhesion or cohesion.

2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

3. Grinding
   a. Traffic causes faults to return.

4. Full-depth segment replacement
   a. Fails in the same manner as any portland cement concrete pavement.
   b. Adjacent pavement failure may propagate into new segment.

*Expected Service Life*
1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years
4. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section

1. Full-depth segment replacement with cement concrete.
4. Clean and seal longitudinal and transverse joints.
5. Rout, clean, and seal slab cracks.
6. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement

1. Treatment Guidelines

*Conditions For Use*
1. Failed joint seals.
2. Infrequent high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Other distresses at the none or low-severity level.
   (Note: Distresses 2, 3, 4, and 5 are repaired with full-depth rapid-setting cement concrete)

*Constructability*
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
2. Sealing disadvantages
   a. Restricted by temperature and moisture.
   b. Requires intensive inspection.
   c. Slab cracks difficult to follow for routing and sealing.
3. Spall repair disadvantages
   a. Restricted by temperature and moisture.
   b. Sounding required to detect delaminations for spall repair.
   c. Requires intensive preparation of the spalled area.
4. Full-depth segment replacement disadvantages
   a. Requires special preparation, equipment, and materials.

*Performance*
1. Sealing
   a. Retards development of spalls and faults from incompressibles and water infiltration.
   b. Needed to achieve desired pavement service life.
2. Spall repair
   a. Restores ride by replacing lost material.
   b. Needed to achieve desired pavement service life.
3. Full-depth segment replacement
   a. Restores structural integrity by replacing cracked and displaced pavement.
   b. Restores ride by replacing lost or displaced pavement.

*Expected Failure Modes*
1. Sealing
   a. Seals fail in adhesion or cohesion.
2. Spall repair
   a. Loss of material due to cracking, delamination, or surrounding pavement failure.

3. Full-depth segment replacement
   a. Fails in the same manner as any portland cement concrete pavement.
   b. Adjacent pavement failure may propagate into new segment.

*Expected Service Life*

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section

1. Full-depth segment replacement with cement concrete.
3. Clean and seal longitudinal and transverse joints.
4. Rout, clean, and seal slab cracks.
5. Clean and fill pavement/shoulder joint.
   (See Flexible Shoulder Treatment Guidelines and Typical Sections)
Bonded Concrete Overlay

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium- and high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium- and/or high-severity transverse and/or longitudinal joint spalling and/or medium- and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium- and/or high-severity wheelpath rutting.
7. Other distresses at the none or low-severity level.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement concrete)

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Uses normal concrete paving techniques.
   c. Rapid-strength-gaining concrete mixes are available.

2. Disadvantages
   a. Overnight lane closures are required.
   b. Achieving bond is critical.
   c. Sandblast cleaning is required, dust control is difficult.
   d. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction, and cross-slope.
2. Increased thickness adds structural capacity, if required.
3. Less susceptible to rutting than asphalt concrete overlay.

Expected Failure Modes
1. Sealer failure leading to spalls and blowups.
2. Underlying unrepaird cracks may reflect.

Expected Service Life
20 years with joint/crack resealing at 8-year intervals.
2. Typical Section

1. Mill out spalls.
2. Scarify 1/4", sandblast.
3. Clean pavement.
4. 3" cement concrete bonded overlay.
5. Saw and seal concrete over existing joints.
6. Asphalt concrete or cement concrete shoulder.
Sawed and Sealed Asphalt Concrete Overlay (3")

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse and/or longitudinal joint spalling and/or medium-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium- and/or high-severity wheelpath rutting.
7. Other distresses are at the none or low-severity level.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Sawcuts must be properly located over underlying transverse joints.
   b. Sealers must be installed properly.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.

2. Saw and seal
   a. Controls reflection cracking.
   b. Seals keep water out of the pavement structure, preventing further joint distress.
   c. Seal must be maintained to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes
1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/or rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.

2. Saw and seal
   a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.
3. Full-depth repairs
   a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

*Expected Service Life*

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section

1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
9. Asphalt concrete binder (1-1/2").
10. Asphalt concrete top (1-1/2").
11. Saw and seal new surface over existing transverse joints.
Sawed and Sealed Asphalt Concrete Overlay (4"")

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Infrequent medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Medium-severity transverse joint faulting.
7. High-severity wheelpath rutting.
   (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closure not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Sawcuts must be properly located over transverse joints.
   b. Sealers must be installed properly.
   c. 4" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.
   b. Increased thickness bridges patched spalls.
   c. Multiple-course placement results in smoother ride.

2. Saw and seal
   a. Controls reflection cracking.
   b. Seals keep water out of the pavement structure, preventing further joint distress.
   c. Seal must be maintained to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes
1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/or rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.

2. Saw and seal
   a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.
3. Full-depth repairs
   a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

Expected Service Life
1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section

1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
9. Initial asphalt course, asphalt concrete top (1").
10. Asphalt concrete binder (1-1/2").
11. Asphalt concrete top (1-1/2").
12. Saw and seal new surface over existing transverse joints.
Asphalt Concrete Overlay (5") Preceded by Cracking and Seating

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
(Note: Distresses 3 and 5 are repaired with full-depth asphalt concrete)

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Traffic can be maintained on the cracked and seated portland cement concrete pavement.
   d. Common rehabilitation technique.

2. Disadvantages
   a. Cracking and seating may create additional unexpected spalls.
   b. Has potential to disrupt culverts and underground utilities.
   c. 5" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Asphalt concrete overlay
   a. Restores ride, friction, and cross-slope.
   b. Increased thickness adds structural capacity and bridges patched spalls.

2. Crack and seat
   a. Minimizes reflection cracking.
   b. Reduction of reflection cracks keeps water from pavement structure.
   c. Crack filling may be necessary to achieve desired overlay service life.

3. Full-depth repairs
   a. Restore structural integrity.
   b. Needed to achieve desired overlay service life.

Expected Failure Modes
1. Asphalt concrete overlay
   a. Oxidation, ravelling, and/or rutting.
   b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
   c. Failure to maintain reflection cracks may lead to multiple cracks and potholes.

2. Full-depth repairs
   a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.
   b. Undowelled cement concrete repairs may heave causing bumps.
Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.

2. Full-depth repairs: life of the overlay with bump milling as necessary.

2. Typical Section

1. Full-depth segment replacement with cement or asphalt concrete.
2. Crack and seat existing pavement.
4. Clean and fill joints and cracks.
5. Clean and fill pavement/shoulder joint.
6. Shim faults and wheel ruts.
7. Clean pavement.
8. Tack coat.
10. Initial asphalt concrete course, asphalt concrete binder (2").
11. Asphalt concrete binder (1-1/2").
12. Asphalt concrete top (1-1/2").
Asphalt Concrete Overlay (6") Preceded by Rubblizing

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Does not damage utilities.
   c. Compaction and overlay use standard techniques.
   d. Spall repair and full-depth replacement are not necessary.
   e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone.

2. Disadvantages
   a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
   b. Positive drainage is required.
   c. 6" thickness may be a problem for vertical clearance and appurtenances.
   d. Most roadway features will require adjustment.
   e. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance
1. Restores ride, friction, and cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keep water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

Expected Failure Modes
1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals.
2. Typical Section

1. Install edge drain.*
2. Remove asphalt patches and/or overlays.
3. Rubblize and compact existing pavement.**
4. Patch depressions with crushed stone.
5. Asphalt concrete base (3").
6. Asphalt concrete binder (1-1/2").
7. Asphalt concrete top (1-1/2").

* An alternative to edge drain installation is a daylighted crushed stone shoulder replacing the existing shoulder.

** Pavement may also be widened with crushed stone matching the thickness of the rubblized pavement.
Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use
1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Frequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.
9. Realignment is contemplated.
10. Existing profile must be maintained.
11. Extensive utility replacement is necessary.

Constructability
1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Traffic can be maintained on the initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of existing pavement.

Performance
1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes
1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life
1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.
FLEXIBLE PAVEMENT
TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
Crack Sealing
Crack Filling
Single-Course Overlay (1" to 1-1/2")

Corrective Maintenance
Single-Course Overlay (1" to 1-1/2")
Hot In-Place Recycle (1" to 1-1/2")
Cold Milling and Replacement (1" to 1-1/2")

Rehabilitation
Two-Course Overlay (3")
Cold Milling With Single-Course Overlay (≥3")
Hot In-Place Recycle With Single-Course Overlay (3")
Cold In-Place Recycle With Single-Course Overlay (4-1/2")
Multiple-Course Overlay (≥4")
Cold Milling With Multiple-Course Overlay (≥4")
Cold In-Place Recycle With Multiple-Course Overlay (6")

Reconstruction
Asphalt Concrete Pavement Construction Above Existing Grade
Full-Depth Portland Cement or Asphalt Concrete
Crack Sealing

1. Treatment Guidelines

   Conditions For Use
   1. Failed seals or full-width transverse cracks were never sealed.
   2. Cracks are at the low-severity level.
   3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
   4. Other distresses are at the none or low-severity level.

   Constructability
   1. Advantages
      a. Can be done one lane at a time.
      b. Overnight lane closures not required.
   2. Disadvantages
      a. Requires intensive inspection.

   Performance
   1. Seals out water and incompressibles.
   2. Retards development of additional cracks and potholes.
   3. Needed to achieve desired pavement service life.

   Expected Failure Modes
   1. Sealer fails in adhesion or cohesion.

   Expected Service Life
   5 years
2. Typical Section

1. Rout, clean, and seal transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.
Crack Filling

1. Treatment Guidelines

Conditions For Use
1. Failed seals or filler or cracks were never filled.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or medium-severity cracking.
4. Other distresses are at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Cracks must be clean for the filler to be effective.

Performance
1. Reduces incompressible and water infiltration.
2. Retards the development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

Expected Failure Modes
1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life
2 years
2. Typical Section

1. Clean and fill cracks and pavement/shoulder joint.

Note: The crack filling operations in wheelpaths will be limited to a single intermittent (not to exceed 20 feet) longitudinal crack. Multiple cracks and alligator cracking in the wheelpaths shall not be filled. Spray patch (surface treatment), micro-surfacing, armor coat, or other similar treatments shall be used as a preventive maintenance treatment in these instances.
Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

*Conditions For Use*
1. Low-severity cracking.
2. Infrequent ravelling, and/or medium-severity cracking.
3. Low-severity wheelpath rutting and/or widening dropoff.

*Constructability*
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common maintenance technique.

2. Disadvantages
   a. Crack filling is required to achieve service life.

*Performance*
1. Restores ride and friction.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

*Expected Failure Modes*
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

*Expected Service Life*
8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Clean and fill cracks and pavement/shoulder joint.
2. Clean pavement.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").
Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

*Conditions For Use*

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, raveling, medium and/or high-severity cracking.
3. Medium-severity wheelpath rutting and/or widening dropoff.

*Constructability*

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts are required to achieve service life.

*Performance*

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

*Expected Failure Modes*

1. Reflective cracking, oxidation, cracking, potholes, raveling, and rutting.

*Expected Service Life*

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat
6. Truing-and-leveling
7. Asphalt concrete top course (1" to 1-1/2").
Hot In-Place Recycle (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
   d. Maintains existing profile.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance
1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Hot in-place surface recycling (1" to 1-1/2").
Cold Milling and Replacement (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no trueing-and-leveling.

2. Disadvantages
   a. Millings must be disposed or recycled.

Performance
1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Cold mill existing pavement surface (1" to 1-1/2").
2. Mill and patch high-severity cracks and ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").
Two-Course Overlay (3"")

1. Treatment Guidelines

*Conditions For Use*

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and raveling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

*Constructability*

1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closure not required.
   c. Common rehabilitation technique.

2. Disadvantages
   a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
   b. 3" thickness may be a problem for vertical clearance and appurtenances.

*Performance*

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

*Expected Failure Modes*

1. Reflective cracking, oxidation, cracking, potholes, raveling, and rutting.

*Expected Service Life*

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").
Cold Milling With Single-Course Overlay (≥3"")

1. Treatment Guidelines

Conditions For Use
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Minimal increase in profile elevation.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Millings must be disposed or recycled.

Performance
1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Cold mill existing pavement surface (≥1-1/2").
2. Mill and patch high-severity cracks and ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete inlay course (≥1-1/2").
5. Asphalt concrete top course (1-1/2").
Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance
1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Hot in-place recycle (1-1/2"").
2. Asphalt concrete top course (1-1/2"").
Cold In-Place Recycle With Single-Course Overlay (4-1/2"

1. Treatment Guidelines

*Conditions For Use*
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have less than 4000 AADT per lane.

*Constructability*
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Truing-and-leveling may be required.

*Performance*
1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

*Expected Failure Modes*
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

*Expected Service Life*
15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").
Multiple-Course Overlay (≥4")

1. Treatment Guidelines
   
   Conditions For Use
   1. Infrequent settlements and heaves.
   2. Corrugations, slippage cracks, and ravelling may be present.
   3. Other distresses may be high-severity.

   Constructability
   1. Advantages
      a. Can be done one lane at a time.
      b. Overnight lane closures not required.
      c. Common rehabilitation technique.

   2. Disadvantages
      a. Crack filling, shimming wheel ruts, and truing-and-leveling are required.
      b. Overlay thickness may be a problem for vertical clearance and appurtenances.

   Performance
   1. Restores ride, friction, cross-slope.
   2. Adds structural capacity.
   3. Maintenance required early in overlay life to fill or seal reflective cracks.

   Expected Failure Modes
   1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

   Expected Service Life
   15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").
Cold Milling With Multiple-Course Overlay (≥4")

1. Treatment Guidelines

Conditions For Use
1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of millings.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Cold mill existing pavement surface (≥1").
2. Mill and patch ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete inlay and/or strengthening course (≥1"), multiple courses required for lifts >4".
5. Asphalt concrete binder course (1-1/2").
6. Asphalt concrete top course (1-1/2").
Cold In-Place Recycle With Multiple-Course Overlay (6"")

1. Treatment Guidelines

Conditions For Use
1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have less than 4000 AADT per lane.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage inlets will damage the recycling equipment.
   b. Truing-and-leveling may be required.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.
2. Typical Section

1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").
Asphalt Concrete Pavement Construction Above Existing Grade

1. Treatment Guidelines

Conditions For Use
1. Corrugations, slippage cracks, and ravelling may be present.
2. Other distresses may be high-severity.
3. Existing pavement has low grade line with frost heaves and/or drainage problems over a substantial portion of its length.

Constructability
1. Advantages
   a. Uses standard techniques.
   b. Traffic can be maintained on initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight lane closures may be required.
   b. Traffic has to be maintained on gravel fill.
   c. Higher grade line may be difficult to transition into existing facilities.

Performance
1. Ride, friction, and structural capacity of a new pavement are realized.
2. Better drainage and mitigation of frost problems are achieved.
3. Cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes
1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals.
2. Typical Section

1. Scarify existing pavement and shoulder.
2. Construct and compact new fill and subbase.
3. Construct new pavement and shoulder.

Note: If distance between bottom of the new pavement and surface of the old is less than 12", then the old pavement should be removed.
Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use
1. Corrugations, slippage cracks, and ravelling may be present.
2. Infrequent settlements and heaves.
3. Other distresses may be high-severity.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability
1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Traffic can be maintained on initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of the existing pavement.

Performance
1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve desired pavement service life.

Expected Failure Modes
1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life
1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.
FLEXIBLE-OVER-RIGID PAVEMENT
TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
Joint and/or Crack Sealing
Joint and/or Crack Filling
Single-Course Overlay (1" to 1-1/2")

Corrective Maintenance
Mill and Patch Joints and/or Cracks
Single-Course Overlay (1" to 1-1/2")
Hot In-Place Recycle (1" to 1-1/2")
Cold Milling and Replacement (1" to 1-1/2")

Rehabilitation
Two-Course Overlay (3")
Cold Milling With Single-Course Overlay (≥3")
Hot In-Place Recycle With Single-Course Overlay (3")
Cold In-Place Recycle With Single-Course Overlay (4-1/2")
Multiple-Course Overlay (≥4")
Cold Milling With Multiple-Course Overlay (≥4")
Cold In-Place Recycle With Multiple-Course Overlay (6")
Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5")
Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

Reconstruction
Full-Depth Portland Cement or Asphalt Concrete
Joint and/or Crack Sealing

1. Treatment Guidelines

Conditions For Use
1. Failed seals or full-width transverse cracks were never sealed.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
4. Other distresses are at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
2. Disadvantages
   a. Requires intensive inspection.

Performance
1. Seals out water and incompressibles.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

Expected Failure Modes
1. Sealer fails in adhesion or cohesion.

Expected Service Life
5 years
2. Typical Section

1. Rout, clean, and seal sawed-and-sealed transverse joints and/or full-width transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.
Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use
1. Failed seals or filler or low-severity cracks were never filled.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or medium-severity cracking.
4. Other distresses are at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
2. Disadvantages
   a. Joints and cracks must be clean for the filler to be effective.

Performance
1. Reduces incompressibles and water infiltration.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

Expected Failure Modes
1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life
2 years
2. Typical Section

1. Clean and fill sawed-and-sealed transverse joints, cracks, and pavement/shoulder joint.

Note: The crack filling operations in wheelpaths will be limited to a single intermittent (not to exceed 20 feet) longitudinal crack. Multiple cracks and alligator cracking in the wheelpaths shall not be filled. Spray patch (surface treatment), micro-surfacing, armor coat, or other similar treatments shall be used as a preventive maintenance treatment in these instances.
Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
1. Low-severity cracking.
2. Infrequent ravelling, and/or medium-severity cracking.
3. Low-severity wheelpath rutting and/or widening dropoff.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common maintenance technique.

2. Disadvantages
   a. Crack filling, is required to achieve service life.

Performance
1. Restores ride and friction.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.
2. **Typical Section**

1. Clean and fill cracks and pavement/shoulder joint.
2. Clean pavement.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").

**Note:** If existing overlay has sawed-and-sealed transverse joints that have performed as intended (no secondary cracking), then the new overlay should be sawed and sealed.
Mill and Patch Joints and/or Cracks

1. Treatment Guidelines

Conditions For Use
1. High-severity full-width transverse and/or longitudinal cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
3. Other distresses are generally at the none or low-severity level.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.

2. Disadvantages
   a. Careful inspection required to match existing pavement elevation.

Performance
1. May improve ride.
2. Prevents water infiltration.
3. Extends pavement service life.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
5 years
2. Typical Section

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
   1. Low-severity cracking.
   2. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
   3. Medium severity wheelpath rutting and/or widening dropoff.

Constructability
   1. Advantages
      a. Can be done one lane at a time.
      b. Overnight lane closures not required.
      c. Common rehabilitation techniques.
   2. Disadvantages
      a. Crack filling and shimming wheel ruts are required to achieve service life.

Performance
   1. Restores ride, friction, and cross-slope.
   2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
   1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
   Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.
   Sawed and sealed joints: 8 years
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat.
7. Asphalt concrete top course (1\" to 1-1/2\").

Note: If existing overlay has sawed-and-sealed transverse joints that have performed as intended (no secondary cracking), then the new overlay should be sawed and sealed.
Hot In-Place Recycle (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low- or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
   d. Maintains existing profile.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance
1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Hot in-place recycling (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from the underlying transverse joints, then new overlay should be sawed and sealed.
Cold Milling and Replacement (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use
1. Low-severity cracking.
2. Infrequent settlement, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.
5. May not be appropriate if the remaining asphalt concrete thickness after milling is too thin or otherwise unsuitable to remain.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Maintains existing profile.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of the millings.

Performance
1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Cold mill existing pavement surface (1" to 1-1/2").
2. Tack coat.
3. Asphalt concrete top course (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Two-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Common rehabilitation technique.
2. Disadvantages
   a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
   b. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Cold Milling With Single-Course Overlay (≥3"")

1. Treatment Guidelines

Conditions For Use
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.
5. May not be appropriate if the remaining asphalt concrete thickness is too thin or otherwise unsuitable to remain.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Minimal increase in profile elevation.
   d. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of the millings.

Performance
1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.
Sawed and sealed transverse joints: 8 years
2. **Typical Section**

1. Cold mill existing pavement surface (≥1-1/2").
2. Tack coat.
3. Asphalt concrete inlay course (≥1-1/2").
4. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.

2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Smoke emissions may prohibit use in residential areas.
   c. Requires some virgin asphalt concrete.

Performance
1. Restores ride, friction, cross-slope.
2. Improves longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Hot in-place recycling (1-1/2").
2. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Cold In-Place Recycle With Single-Course Overlay (4-1/2"

1. Treatment Guidelines

*Conditions For Use*
1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have less than 4000 AADT per lane.

*Constructability*
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.

2. Disadvantages
   a. Manholes or drainage units will damage recycling equipment.
   b. Truing-and-leveling may be required.

*Performance*
1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

*Expected Failure Modes*
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

*Expected Service Life*
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Multiple-Course Overlay (>4"")

1. Treatment Guidelines

Conditions For Use
   1. Infrequent settlements and heaves.
   2. Corrugations, slippage cracks, and ravelling may be present.
   3. Other distresses may be high-severity.

Constructability
   1. Advantages
      a. Can be done one lane at a time.
      b. Overnight lane closures not required.
      c. Common rehabilitation technique.

   2. Disadvantages
      a. Requires crack filling, shimming wheel ruts, and truing-and-leveling.
      b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance
   1. Restores ride, friction, cross-slope.
   2. Adds structural capacity.
   3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
   1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
   Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

   Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Cold Milling With Multiple-Course Overlay (≥4"

1. Treatment Guidelines

Conditions For Use
1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no truing-and-leveling.

2. Disadvantages
   a. Must dispose of millings.
   b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Cold mill existing pavement surface (≥1").
2. Tack coat.
3. Asphalt concrete inlay and/or strengthening course (≥1"), multiple-course required for lifts >4".
4. Asphalt concrete binder course (1-1/2").
5. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Cold In-Place Recycle With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use
1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have less than 4000 AADT per lane.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Overnight lane closures not required.
   c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
   a. Manholes or drainage inlets will damage recycling equipment.
   b. Truing-and-leveling may be required.
   c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance
1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life
Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.
Sawed and sealed transverse joints: 8 years
2. Typical Section

1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.
Remove Flexible Overlay, Crack and Seat
With Multiple-Course Overlay (5"")

1. Treatment Guidelines

   Conditions For Use
   1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
   2. Infrequent settlements, heaves, blowups.
   3. Slab cracks and/or infrequent separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
   4. Corrugations, slippage cracks, and ravelling may be present.
   5. Utilities not present.
      (Note: Distresses in 2 are repaired by replacing segments with asphalt concrete before overlay.)

   Constructability
   1. Advantages
      a. Can be done one lane at a time.
      b. Traffic can be maintained on the cracked-and-seated portland cement concrete pavement.
      c. Common rehabilitation technique.

   2. Disadvantages
      a. Cracking and seating may create additional unexpected spalls.
      b. Has potential to disrupt culverts and underground utilities.
      c. 5" thickness may be a problem for vertical clearance and appurtenances.

   Performance
   1. Asphalt concrete overlay
      a. Restores ride, friction, cross-slope.
      b. Increased thickness adds structural capacity and bridges patched spalls.

   2. Crack and seat
      a. Minimizes reflection cracking.
      b. Absence of reflection cracks keeps water from pavement structure.
      c. Crack filling may be necessary to achieve desired overlay service life.

   Expected Failure Modes
   1. Oxidation, ravelling, and/or rutting.
   2. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
   3. Failure to maintain reflection cracks may lead to multiple cracks and potholes.
   4. Full-depth asphalt concrete repairs may rut, shove, and heave causing local premature failure.

   Expected Service Life
   15 years with full-width transverse crack sealing at 5-year intervals.
2. Typical Section

1. Remove existing asphalt concrete overlay.
2. Crack and seat existing concrete pavement.
4. Clean and fill joints and cracks.
5. Shim faults and wheel ruts.
7. Initial asphalt concrete course (2").
8. Asphalt concrete binder course (1-1/2").
9. Asphalt concrete top course (1-1/2").
Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use
1. Medium- and/or high severity full-width transverse, longitudinal, and edge cracking.
2. Corrugations, settlements, heaves, slippage cracks, and raveling may be present.
3. Slab cracks and/or separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
4. Utilities are present.
5. Widening is contemplated.

Constructability
1. Advantages
   a. Can be done one lane at a time.
   b. Does not damage utilities.
   c. Compaction and overlay use standard techniques.
   d. Spall repair and full-depth replacement are not necessary.
   e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone that is compatible with rubblized pavement.

2. Disadvantages
   a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
   b. Positive drainage is required.
   c. 6" thickness may be a problem for vertical clearance and appurtenances.
   d. Most roadway features will require adjustment.
   e. Lane closure may be required for extended periods.
   f. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance
1. Restores ride, friction, cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keeps water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

Expected Failure Modes
1. Oxidation, raveling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals.
2. Typical Section

1. Remove existing asphalt concrete overlay.
2. Install underdrain.
3. Remove asphalt patches.
4. Rubblize and compact existing concrete pavement.
5. Patch depressions with crushed stone.
6. Initial asphalt course: asphalt concrete base (3").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: An alternative to underdrain installation is a daylighted crushed stone shoulder replacing the existing shoulder.
Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use
1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
2. Slab cracks and/or a significant number of separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
3. Blowups, settlements, and/or heaves may exist.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability
1. Advantages
   a. Uses standard techniques.
   b. Rapid-strength-gaining cement concrete mixes are available.
   c. Interim traffic can be maintained on the initial courses of asphalt concrete.

2. Disadvantages
   a. Overnight and/or long-term lane closures are required for cement concrete pavement.
   b. Must remove and dispose of the existing pavement.

Performance
1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes
1. Asphalt concrete pavement
   a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

2. Portland cement concrete pavement
   a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life
- Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
- Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.
RIGID, FLEXIBLE, OR FLEXIBLE-OVER-RIGID PAVEMENT WIDENING TREATMENT GUIDELINES AND TYPICAL SECTIONS

Portland Cement Concrete

Asphalt Concrete
Portland Cement Concrete

1. Treatment Guidelines

Conditions For Use
1. Settlements, heaves, blowups, and slab cracking do not exist or have been repaired by full-depth segment replacement.
2. Other distresses are at the none or low-severity level.
3. Cores of existing concrete pavement show no cracking or mortar deterioration and adequate compressive strength. Cores are necessary at the widening edge to ensure that longitudinal joint ties will bond and tie.

Constructability
1. Advantages
   a. No overnight lane closures required, if excavation amount equals replacement within the work day and rapid-setting concrete is used.
   b. Common construction materials and techniques.

2. Disadvantages
   a. Drill for longitudinal tie holes needs a 3-ft wide excavation to operate.

Performance
1. Matching thickness, widening will provide structural capacity similar to the existing pavement.
2. Joint sealing needed to achieve widening service life.

Expected Failure Modes
1. Sealing
   a. Seals fail in adhesion or cohesion.

2. Widening
   a. Fails in same manner as any cement concrete pavement.

Expected Service Life
1. Joint sealing: 8 years

2. Widening: equals or exceeds existing pavement service life up to 30 years.
2. Typical Section

1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Drill holes and install longitudinal joint ties.
4. Place transverse load-transfer devices.
5. Place new concrete.
6. Construct and seal longitudinal and transverse joints.
7. Construct new shoulder.

Note: If flexible-over-rigid pavement is being widened, the cement concrete and asphalt concrete pavements are matched in thickness. Joints in the asphalt concrete are sealed in the same manner as those in the existing pavement.
Asphalt Concrete

1. Treatment Guidelines

Conditions For Use
1. Settlements and heaves do not exist or have been replaced.
2. Full-width transverse cracking or edge cracking do not exist.
3. Cores of existing overlaid cement concrete pavement show cracking, mortar deterioration, or low compressive strength.
4. Other distresses are at the none or low-severity level.

Constructability
1. Advantages
   a. No overnight lane closures required, if excavation amount equals replacement within the workday.
   b. Common construction materials and techniques.

2. Disadvantages
   a. Narrow-width widening difficult to compact.

Performance
1. Widening has structural capacity similar to the existing pavement, when pavement and subbase thicknesses are matched.
2. Longitudinal joint between the widening and existing pavement must be sealed to achieve expected service life.

Expected Failure Modes
1. Seals fail in adhesion or cohesion.
2. Pavement/widening longitudinal joint separation.
3. Water infiltration weakens subbase, causing widening dropoff, multiple cracking, and potholes.
4. Fails in same manner as any flexible pavement.

Expected Service Life
15 years with full-width transverse crack sealing at 5-year intervals.
2. Typical Section

1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Tack-coat existing pavement edge.
4. Place and compact asphalt concrete.
5. Rout and seal longitudinal joint.
6. Construct new shoulder.

Note: If no subbase exists, a minimum 8" subbase should be placed under the new widening. If open base is encountered in the existing pavement, widen only with open base.
FLEXIBLE SHOULDER TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance
  Pavement/Shoulder Joint and/or Crack Filling
  Surface Treatment

Corrective Maintenance
  Asphalt Concrete Wedging
  Surface Treatment

Rehabilitation
  Single- or Multiple-Course Asphalt Overlay

Reconstruction
  Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel
Pavement/Shoulder Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use
1. Failed filler, or joints and cracks never filled.
2. Pavement/shoulder separation is at the medium-severity level.
3. Deterioration, consisting of a single crack, is at the low-severity level.
4. Other distresses are at the none or low-severity level or are infrequent.

Constructability
1. Advantages
   a. Overnight lane closure not required.

Performance
1. Prevents water infiltration from weakening the base, thus retarding development of additional distress.

Expected Failure Modes
1. Filler fails in cohesion or adhesion.

Expected Service Life
2 years
2. Typical Section

1. Clean and fill cracks and pavement/shoulder joint.
Surface Treatment

1. Treatment Guidelines

Conditions For Use
1. Multiple-crack deterioration at the medium-severity level.
2. Low-severity pavement/shoulder separation may also be present.
3. Other distresses are at the none or low-severity level.

Constructability
1. Advantages
   a. Overnight lane closures not required.
   b. Can be done by closing only one traffic lane.

2. Disadvantages
   a. Difficult working next to barrier or guiderail.
   b. Shoulder should be wedged and patched as needed before surface treatment.

Performance
1. Retards deterioration.

Expected Failure Modes
1. Cracking, separation, surface oxidation, stone loss from plows and ravelling.

Expected Service Life
5 years
2. Typical Section

1. Clear shoulder.
Asphalt Concrete Wedging

1. Treatment Guidelines

*Conditions For Use*
1. Medium or high-severity lane shoulder dropoff.
2. Other distresses at the none or low-severity level.

*Constructability*
1. Advantages
   a. Overnight lane closures not required.
   b. Can be done by closing only one traffic lane.
2. Disadvantages
   a. Pavement edge profile difficult to match.
   b. Compaction difficult due to roller bridging.

*Performance*
1. Eliminates pavement edge hazard.

*Expected Failure Modes*
1. Cracking, separation, and ravelling.

*Expected Service Life*
3 years
2. Typical Section

1. Clean shoulder.
2. Tack coat.
3. Asphalt concrete wedging.
Surface Treatment

1. Treatment Guidelines

Conditions For Use
1. Multiple-crack deterioration at the medium-severity level.
2. Pavement/shoulder separation and dropoff may also be present.
3. Shoulder deformation is in the none category.

Constructability
1. Advantages
   a. Overnight lane closures not required.
   b. Can be done by closing only one traffic lane.

2. Disadvantages
   a. Difficult working next to barrier or guiderail.
   b. Shoulder should be wedged and patched as needed before surface treatment.

Performance
1. Retards deterioration.

Expected Failure Modes
1. Cracking, separation, surface oxidation, stone loss from plows and ravelling.

Expected Service Life
5 years
2. Typical Section

1. Clean shoulder.
3. Requires asphalt concrete wedging and/or patching as a pretreatment.
Single- or Multiple-Course Asphalt Overlay

1. Treatment Guidelines

Conditions For Use
1. Roadway condition dictates an asphalt overlay. Shoulder may be repaired by carrying same-thickness overlay across it, or reconstructing the shoulder. Shoulder condition dictates this choice.

Constructability
1. Advantages
   a. Overnight lane closures not required.
   b. Can be done at same time with same items as roadway paving.

Performance
1. Depends on overlay thickness and condition of existing shoulder.

Expected Failure Modes
1. Asphalt oxidation, ravelling, and pavement/shoulder joint cracking.

Expected Service Life
1. Single course: 8 years
2. Multiple course: 15 years
2. Typical Section

1. Clean shoulder.
2. Tack coat.
3. Single- or multiple-course asphalt overlay.

Note: May require asphalt concrete wedging as a pretreatment.
Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel

1. Treatment Guidelines

Conditions For Use
1. High-severity deterioration consisting of multiple cracks and potholes.
2. General shoulder deformation present.

Constructability
1. Advantage
   a. Common construction technique.

Performance
1. Provides life of a new shoulder.

Expected Failure Modes
1. Cement concrete (only adjacent to concrete pavement)
   a. Pavement/shoulder joint sealant failure, water infiltration, and cracking.

2. Asphalt concrete or bituminous-stabilized gravel with asphalt concrete top course
   a. Asphalt oxidation, ravelling, cracking, separation, and dropoff.

Expected Service Life
1. Cement concrete: 30 years
2. Asphalt concrete: 15 years
3. Bituminous stabilized gravel with asphalt concrete top course: 15 years
2. Typical Section

1. Reconstruct with portland cement concrete (if adjacent pavement is concrete, then concrete shoulder tapers from 9" to 6").
2. Reconstruct with asphalt concrete (3" or 4").
3. Reconstruct with bituminous-stabilized gravel (3") and asphalt concrete top course (1").