



# Bridge Preservation Guide

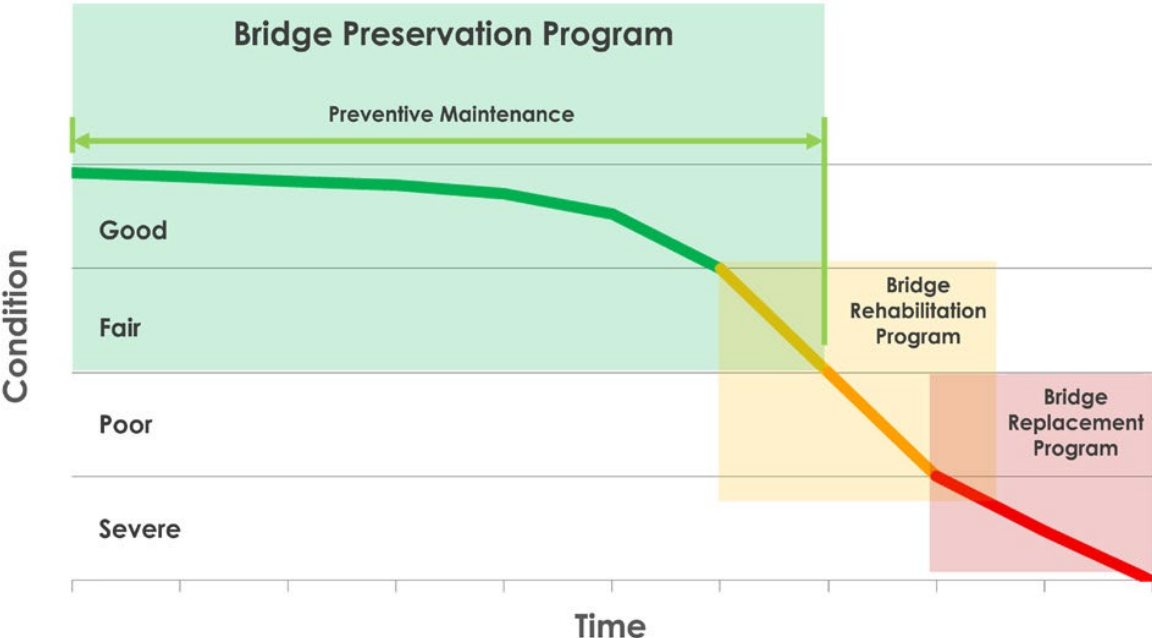
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# Introduction

MaineDOT is responsible for capital and maintenance of all federally defined bridges on public ways and all minor spans on state highways and state aid roads. The current average age of these structures is 55 years. Bridges are typically designed for a 75-year lifespan and culverts a 50-year lifespan. Newer structures are often built incorporating more corrosive resistant materials with the intent of achieving a 100-year life span. For bridges to reach their intended design life, regular maintenance and preservation activities must be performed. Bridge preservation is any work that preserves or extends the useful life of a bridge or bridge component.

As a bridge's condition deteriorates from Good to Fair to Poor, the cost to restore the bridge to Good condition dramatically increases. Bridges on higher priority roadways in Poor condition tend to demand most of the available funding. This creates a funding cycle wherein it becomes impossible to accomplish all desired preservation activities.

An ideal bridge program provides the correct cost-effective treatment, applied at the correct time, to preserve and extend the useful service life of every bridge. However, there is insufficient funding to accomplish this ideal preservation scenario. MaineDOT must prioritize bridge projects that will provide the most benefits by maintaining the correct balance between funding bridge replacements, bridge rehabilitations, and bridge preservation.



# Goals and Strategies of Bridge Preservation

The main goal of a preservation program is to maximize the useful service life of bridges in a cost-effective way. To meet this goal, many of the strategies are aimed at applying the appropriate bridge preservation treatments and activities at the proper time, resulting in longer service lives at an optimal cost. Asset preservation is one of the tools used to achieve an overall transportation investment strategy. Goals are then developed to address the priorities of the Department.

MaineDOT's Bridge Preservation Goals are as follows:

- Maintain bridges in a “state of good repair” using low-cost effective strategies that deliver the best benefit-cost ratio
- Implement timely preservation treatments on structurally sound bridges to promote optimal life-cycle cost and extended service life.
- Reduce the need for major rehabilitation and replacement.
- Limit adverse impacts to traffic operations and stakeholders.
- Promote and support budgeting of preventative maintenance activities.
- Establish performance goals and monitor progress related to bridge preservation.
- Maximize the benefits and effectiveness of long-term investments required to maintain bridges in Good condition.
- Capture preservation treatment history and cost so life cycle modeling accuracy can be continuously improved.

**“An ounce of prevention is worth a pound of cure.” – Benjamin Franklin**

MaineDOT will use data driven strategies to achieve its bridge preservation goals. This approach is aimed at applying the appropriate bridge preservation treatments and activities at the proper time.

The strategies include:

- Regular analysis of bridge inventory data to establish conditions and trends related to performance and condition deterioration.
- Develop, review, and update criteria for eligible preservation activities.
- Define preservation program and project needs.
- Develop Project/Program level estimates of needed financial resources.
- Prioritize, plan, and perform preservation treatments.
- Group preservation and maintenance projects to promote economy and minimize the inconvenience to the public.
- Identify preservation needs that complement maintenance, repair, and rehabilitation actions and timeliness.
- Secure approval and support from key stakeholders in the use of State and Federal funding for systematic preventative maintenance and preservation activities.
- Consider preservation at the bridge design phase.
- Monitor and measure performance of preservation program.
- Report and improve preservation program.

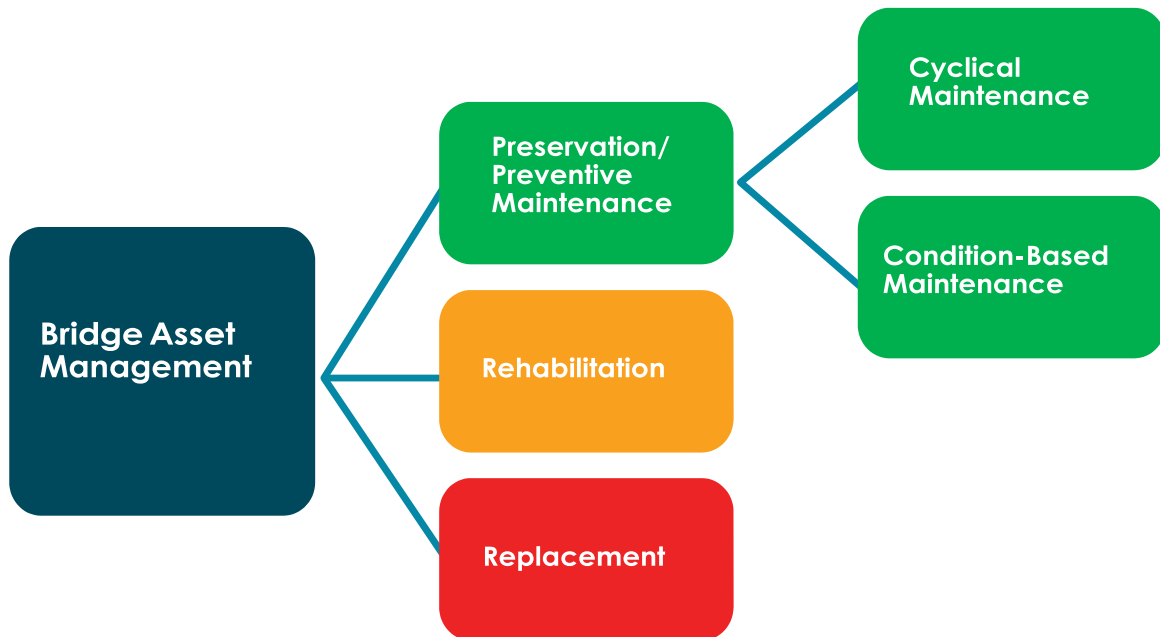


# Asset Management Plans

Ideally, all bridges would have an independent asset management plan (AMP). MaineDOT has developed or is developing AMPs for bridges with high replacement costs (Forever Bridges), bridges on the US-Canadian border, and bridges deemed historically significant.

## Bridge Preservation Actions

This Guide promotes the systematic and timely preservation of all bridges in the inventory. It focuses on bridge preservation actions that relate to preservation and preventative maintenance. These actions can be broken into two categories, Cyclical and Condition Based Activities.



# Bridge Preservation Goals, Objectives, and Performance Measures

## ***Levels of Service***

Levels of Service (LOS) are developed for preservation and maintenance activities. The LOS help establish departmental performance measures that are evaluated annually in the Bridge Maintenance Division Annual Report and periodically in the Keeping Our Bridges Safe (KOBS) Report. A list of current LOS can be found on the MaineDOT Intranet website.

<http://mdotweb.state.me.us/mo/los/index.php>

## **Condition Based Objectives**

Condition based preventative maintenance activities are performed on bridge elements as needed when identified through the bridge inspection process, during the annual cleaning process, or through general asset review.

## **Cyclical Activities Objectives**

Cyclical based activities are performed at pre-determined intervals and aim to preserve existing bridge element conditions. These types of activities may not improve the condition of a bridge or its components directly but will decrease its rate of deterioration.

Cyclical preservation activities are tracked in AssetWise™, MaineDOT's bridge inspection and asset software program. Annually, bridge preservation needs are sent to the Regions to be prioritized for inclusion in the Work Plan.

## ***MaineDOT Customer Service Levels***

MaineDOT sets its bridge priorities, objectives and goals based on the Highway Corridor Priority (HCP) the bridge is carrying or spanning and Customer Service Levels (CSL) relating to bridge function and condition. Bridge CSLs include Bridge Reliability, Bridge Condition, and Posted Bridges. MaineDOT's goal is to maintain a CSL of C or better for all its bridges and minor spans. The CSLs are evaluated annually in the Bridge Maintenance Annual Report and periodically in the KOBS Report.

## Bridge Reliability

Bridge Reliability CSL is pass/fail with an automatic fail if one or more of the major components of the bridge is in serious condition and/or if the bridge is scour critical. Below is the chart of the relative scale.

<b>Safety CSL = Automatic F</b>	<b>Ratings</b>
Superstructure Condition	≤ 3
Substructure Condition	≤ 3
Deck Condition	≤ 3
Culvert Condition	≤ 3
Scour Critical Bridge	≤ 3

## Bridge Condition

Bridge Condition CSL is created from the National Bridge Inventory (NBI) condition ratings. The bridge's lowest condition rating is used for the CSL. Below is the chart of the relative scale.

<b>Priority</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>F</b>
1	9-8	7	6-5	4	≤ 3
2	9-8	7	6-5	4	≤ 3
3	9-7	6	5	4	≤ 3
4	9-7	6	5	4	≤ 3
6	9-6	5	4	3	≤ 2

## Bridge Service

Bridge Service CSL is created based on a posted weight restriction on a sliding scale relative to HCP. Below is the chart of the relative scale.

<b>HCP</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>F</b>
1	Open				Load Posting
2	Open				Load Posting
3	Open		One Truck or Spacing	≥ 20 T	< 20 T
4	Open	One Truck or Spacing	≥ 20 T	10 T – 19 T	< 10 T
6	Open or One Truck or Spacing	≥ 20 T	10 T – 19 T	4 T – 9 T	3 T or closed



## **Work Plan Goals**

### **Capital**

The Capital section of the Work Plan aims to have 20% - 30% of bridge program funding assigned to projects with preservation related scopes.

## **Federal Goals**

### **MAP-21**

The Moving Ahead for Progress in the 21st Century Act (MAP-21) is a bill that transitions transportation asset management to a performance and outcome-based program. It requires states to invest resources in projects to achieve individual targets that collectively will make progress toward national goals. MAP-21 requires each state to maintain minimum thresholds for NHS bridges. No more than 10% of total NHS bridge deck area may be on structurally deficient bridges.





# **Bridge Preservation Program**

## ***Project Selection***

Candidate bridge lists are created from condition data, recommended work items, and past work history as recorded in the Bridge Inspection Program. Along with the goals and tools mentioned earlier, sound engineering judgement is used to prioritize recommended actions best suited for the bridge. Additionally, factors such as age, traffic control, detour lengths, AADT, etc. are considered when reviewing potential preservation treatments. A selected preservation treatment should maintain or extend the anticipated remaining service life of one or more of the elements in a bridge.

## ***Bridge Preservation Strategies***

### **Design**

Bridge preservation starts during the initial design of the structure. All aspects of the project must be thoroughly assessed with durability and maintenance in mind. Attention to detail is needed for the bridge to last the intended design life with minimal unnecessary maintenance required. Designs should incorporate preservation-friendly design details such as facilitating access to bridge components for inspection and maintenance activities, eliminating joints when possible, and taking into consideration construction sequences of future preservation and partial replacement activities. The initial investment that best facilitates future preservation actions will pay dividends throughout the life of the bridge.

### **Wearing Surface**

The bridge wearing surface is the first line of defense in preserving the deck. Cracking must be minimized to prevent water and chlorides from penetrating the deck. In addition, rutting and pavement erosion must be reduced to provide adequate rideability. Treatments to preserve and replace wearing surfaces are cost effectively performed when included within a highway paving project. To accomplish this synergy, wearing surface types and treatments should be coordinated with the pavement preservation plan for the highway corridor priority. Early communication is essential in coordinating the projects during initial design and throughout a bridge's life span.

The following are HCP based treatments recommended for projects incorporating new wearing surfaces.

HCP 1, 2, and 3

Waterproofing membrane and 3" bituminous pavement, concrete, or polyester polymer concrete

HCP 4 and 6

Concrete or polyester polymer concrete

Below are the bridge wearing surface preservation options for different highway treatments. The remaining service life of the deck or entire bridge should be considered when determining the preservation action.

Reconstruction, Rehabilitation, 1 ½" Hot Mix Asphalt (HMA) Overlay, 1 ¼" HMA Overlay, Mill and Fill, ¾" HMA Overlay, and Light Capital Paving (LCP)

1. Replace wearing surface down to deck with funding from Bridge Community or Region, or
2. Mill and fill pavement wearing surface

Ultra-Thin Bonded Wearing Surface and Cyclical Pavement Resurfacing (CPR)

1. Exclude bridges from this highway treatment

Municipally Led Paving Project

1. Replace wearing surface down to deck with funding from Bridge Community or Region, or
2. Mill and fill pavement wearing surface with funding from Bridge Community or Region

All wearing surface treatments should be curb-to-curb and not be overlaid unless approved by Bridge Maintenance Division management staff. Milled or recessed rumble strips and lane dividers should not be installed on bridges as they collect water and cause unnecessary vibrations that will damage the deck. Cost for bridges 500 feet and longer will be borne by the Bridge Community.

## **Joints**

Bridge joints are difficult to maintain and should be eliminated whenever possible. In situations where joints are required, the joint should be installed per the manufacturer's recommendations. The following guidance will help preserve the joint and the protected elements.

- Use concrete, Phoscrete™, or elastomeric concrete headers to armor and protect the joint steel.
- Use curtains or troughs to protect beam ends and bearings under open joints
- Pre-compressed, foam bonded joint seals (EMSEAL™, etc.) are a good alternative for rehab jobs where the service life of the joint is 10 years or less.
- Joint rehabs and replacements with an estimated service life of greater than 10 years should use either a gland or compression seal.
- Keeper bars should be used to hold the seal in place for compression style joints.

## **Structural Steel**

Structural steel requires either material chemistry alterations or protective coatings to manage deterioration. New bridges use either weathering steel, zinc-rich paint, galvanizing, or metalizing to protect the base steel.

The following guidance should be followed when determining a steel preservation system.

- Bridges over traffic should be coated with a protective system.
- Beam ends and bearings of weathering steel girders, including ones used in combination with integral abutments, should be coated with a protective system.

## **Cathodic Protection**

Using passive cathodic protection in concrete rehabilitations is an effective way to reduce the "halo effect." The "halo effect" is a recurring corrosion issue in the concrete adjacent to repaired areas. Passive cathodic protection alternatives that attach to the reinforcing steel include point and strip anodes. Zinc anodes can be used in concrete repairs and patches for any structural element to extend the service life of the repair. Stainless steel rebar is an alternative to cathodic protection in concrete repairs.

# Common Bridge Preservation Activities

Below are common activities used in MaineDOT's bridge preservation program. The frequency is estimated based on historical performance. These frequencies may need to be evaluated for the individual bridge.

## Wearing Surface

Bridge Component	Action	Maintenance Type	Frequency (years)
Wearing Surface	Mill and Fill	Cyclical	12
	Thin Polymer Overlay	Cyclical	12
	New Wearing Surface	Condition Based	25

### Mill and Fill

Scope: Removed pavement 1" – 1.5" from curb to curb and replace in-kind.

Desired Outcome: Improve rideability; diminish ingress of water/chlorides to deck.

Goal: Extend the service life of the wearing surface and deck.

Pre-Treatment Evaluation Tool: None

MaineDOT Maintenance Activity: 521 Repairing Wearing Surface

Level of Service: None

### Thin Polymer Overlay (TPO)

Scope: Add 3/8" polymer-based overlay to a concrete wearing surface.

Desired Outcome: Improve rideability; diminish ingress of water/chlorides to deck.

Goal: Extend the service life of the wearing surface and deck.

Pre-Treatment Evaluation Tool: Chain drag deck to determine the percent delaminated.

MaineDOT Maintenance Activity: 521 Repairing Wearing Surface

Level of Service: None

### Wearing Surface Replacement

Scope: Remove wearing surface down to the deck. Rehabilitate the deck, apply waterproofing membrane (if bituminous wearing surface is used), and install wearing surface.

Desired Outcome: Improve rideability; diminish ingress of water/chlorides to deck.

Goal: Extend the service life of the deck.

Pre-Treatment Evaluation Tools: Cores must be taken or Ground Penetrating Radar (GPR) must be used prior to programming the project to estimate the remaining service life of the deck and estimate deck patching required.

MaineDOT Maintenance Activity: 521 Repairing Wearing Surface

Level of Service: None

## Deck

Bridge Component	Action	Maintenance Type	Frequency (years)
Deck	Washing / Cleaning	Cyclical	1
	Seal Rail and Curbs	Cyclical	10
	Asphalt Plug Joint Rehab	Cyclical	7-8
	Joint Seal Replacement	Condition Based	10
	Header Installation	Condition Based	As Needed
	Joint Replacement	Condition Based	25

### Washing and Cleaning

Scope: Remove sand and other debris from the deck surface. Flush deck surface with water.

Desired Outcome: Remove deicing chemicals, sand, and debris from bridge.

Goal: Extend the service life of the wearing surface, curb, sidewalk, and deck.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 582 Bridge Washing

Level of Service: Bridge Washing ACT 582



### Seal Rails and Curbs

Scope: Apply silane or equivalent waterproofing agent to concrete bridge rail, curb, and fascia down to drip notch.

Desired Outcome: Waterproof concrete from water and salt intrusion.

Goal: Extend the service life of the concrete bridge rail, curb, sidewalk, and fascia.

Pre-Treatment Evaluation Tools: Infrared camera and sounding to ensure delaminations are not present and ready to spall.

MaineDOT Maintenance Activity: 580 Protective Coating

Level of Service: Protective Coating ACT 580

### Asphalt Plug Joint Rehab

Scope: Remove and replace mastic material. Replacement of plate may be required.

Desired Outcome: Seal the joint and ensure plate does not extend above the wearing surface.

Goal: Extend the service life of the plug joint.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 513 Repairing Bridge Joints

Level of Service: Repairing Bridge Joints ACT 513

### Joint Seal Replacement

Scope: Seal bridge joint.

Desired Outcome: Seal the joint and protect the beam ends and bearings below the joint.

Goal: Extend the service life of beam ends and bearings below the joint.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 530 Repairing or Replacing Bridge Joint Seals

Level of Service: Repairing Bridge Joints ACT 530



“Wrestling the anaconda.”  
– John Buxton

### Header Installation

Scope: Install or rehab joint header.

Desired Outcome: Protect the joint steel and improve rideability.

Goal: Extend the life of bridge joints and reduce the amount of joint repair.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 513 Repairing Bridge Joints

Level of Service: None

## Superstructure

Bridge Component	Action	Maintenance Type	Frequency (years)
Superstructure	Wash Beam End and Bearings	Cyclical	1
	Paint Beam End and Bearings	Cyclical	12
	Oil Beam Ends and Bearings	Cyclical	6
	Spot Paint	Condition Based	As Needed
	Full Paint	Cyclical	25
	Seal Concrete Beams	Cyclical	10
	Lubricating Bearing Devices	Cyclical	4

### Washing Beam Ends and Bearings

Scope: Remove sand and other debris from the bridge seats. Flush bridge seat with water.

Desired Outcome: Remove deicing chemicals, sand, and debris from bridge.

Goal: Extend the service life of the beam ends and bearings.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 582 Washing Bridges

Level of Service: Bridge Washing ACT 582

### Paint Beam Ends and Bearings

Scope: Apply paint to steel beam ends and bearings.

Desired Outcome: Keep water and chlorides from steel beam ends and bearings.

Goal: Extend the service life of steel beam ends and bearings.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 541 Painting Bridges

Level of Service: None





### Oil Beam Ends and Bearings

Scope: Apply Fluid Film™, NH Oil™, or equivalent to steel beam ends and bearings.

Desired Outcome: Keep water and chlorides from steel beam ends and bearings

Goal: Extend the service life of steel beam ends and bearings.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 580 Sealing Bridges

Level of Service: None

### Spot Paint

Scope: Apply paint to selected portions of the steel bridge elements (example: truss joint).

Desired Outcome: Keep water and chlorides from selected portions of steel bridge.

Goal: Extend the service life of high risk or maintenance portions of steel bridge.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 541 Painting Bridges

Level of Service: None

### Full Paint

Scope: Apply paint to steel bridge elements.

Desired Outcome: Keep water and chlorides from bridge or bridge elements.

Goal: Extend the service life of steel bridge elements.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 541 Painting Bridges

Level of Service: None

### Seal Precast Prestressed Concrete Superstructure

Scope: Apply silane or equivalent waterproofing agent to precast prestressed concrete superstructure elements.

Desired Outcome: Waterproof concrete to prevent water and salt intrusion.

Goal: Extend service life of precast prestressed concrete superstructure elements.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 580 Sealing Bridges

Level of Service: None

### Lubricating Bearing Devices

Scope: Apply lubricant to bearings. Restore proper movement if needed.

Desired Outcome: Allow bearings to translate and rotate within allowable limits.

Goal: Reduce stress and damage to bridge elements.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 511 Repairing or Replacing Main Support Members

Level of Service: None

## Substructure

Bridge Component	Action	Maintenance Type	Frequency (years)
Substructure	Seal Abutments and Piers	Cyclical	10
	Install Grout Bags	Condition Based	As Needed
	Seal Bridge Seats and Backwalls	Cyclical	10
	Point Masonry Abutments and Piers	Condition Based	As Needed

### Seal Abutments and Piers

Scope: Apply silane or equivalent waterproofing agent to abutments and piers within splash zones.

Desired Outcome: Waterproof concrete to prevent water and salt intrusion.

Goal: Extend the service life of the concrete abutments and piers.

Pre-Treatment Evaluation Tools: Prior to sealing, use infrared camera and sounding to ensure delaminations are not present and ready to spall.

MaineDOT Maintenance Activity: 580 Protective Coating

Level of Service: Protective Coating ACT 580

### Install Grout Bags

Scope: Install grout bags around or under substructure units.

Desired Outcome: Stabilize and protect substructure units from scour.

Goal: Extend the service life of the bridge and reduce risk during flood events.

Pre-Treatment Evaluation Tools: Underwater inspections to determine streambed elevations.

MaineDOT Maintenance Activity: 551 Maintaining Channels

Level of Service: None

### Seal Bridge Seats and Backwalls

Scope: Apply silane or equivalent waterproofing agent to bridge seats and backwalls.

Desired Outcome: Waterproof concrete to prevent water and salt intrusion.

Goal: Extend the service life of the bridge seats and backwalls. Reduce the quantity of rehabs.

Pre-Treatment Evaluation Tools: Infrared camera and sounding to ensure delaminations are not present and ready to spall.

MaineDOT Maintenance Activity: 580 Protective Coating

Level of Service: Protective Coating ACT 580

### Point Masonry Abutments and Piers

Scope: Insert stone and mortar in voided areas between stones.

Desired Outcome: Increase bearing area of stones.

Goal: Increase the stability of the stone foundation and reduce stress concentrations that could cause stone cracking.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 514 Repairing or Replacing Abutments; 516 Repairing or Replacing Piers

Level of Service: None

## **General**

Bridge Component	Action	Maintenance Type	Frequency (years)
General	Clear Brush	Condition Based	As Needed
	Remove Overburden	Condition Based	As Needed
	Remove Debris	Condition Based	As Needed

### Clear Brush

Scope: Remove trees, brush, and other vegetation from around the bridge.

Desired Outcome: Allow proper airflow and drying under the bridge. Allow inspection and maintenance access. Remove unwanted forces from the growth.

Goal: Extend the service life of the bridge components.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 334 Removing Brush

Level of Service: None

### Remove Overburden

Scope: Remove excess material from under the guardrail and behind walls.

Desired Outcome: Allow proper drainage around the bridge and prevent erosion.

Goal: Extend the service life of the walls and slopes adjacent to bridges.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 211 Ditching

Level of Service: None

### Remove Debris

Scope: Remove beaver dams and other debris that may impact bridge function.

Desired Outcome: Remove the cause of increased scour, overflow onto the road, and increased forces on bridge elements.

Goal: Prevent emergency situations and bridge closures.

Pre-Treatment Evaluation Tools: None

MaineDOT Maintenance Activity: 551 Maintaining Channels

Level of Service: None

# Definitions

## Work Plan

Annually published document wherein all work planned by the MaineDOT and its transportation partners is presented. This is a three-year plan that includes all capital projects and programs, maintenance and operations activities, planning initiatives, and administrative functions.

## Bridge Preservation

Actions or strategies that prevent, delay, or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their service life.

## State of Good Repair

Condition in which the existing bridge elements, components, or entire bridge are functioning as designed within their useful service life and are sustained through regular maintenance, preservation, and replacement programs.

## Systematic Preventive Maintenance Program

Planned strategy of cost-effective treatments to bridges that are intended to maintain or preserve the structural integrity and functionality of bridge elements and slow future deterioration.

## Preventive Maintenance (PM)

Planned strategy of cost-effective treatments that preserves the system, slows future deterioration, and maintains or improves the functional condition of the system without substantially increasing structural capacity.

## Cyclical PM Activities

Activities performed on a predetermined interval and aimed to preserve existing bridge element or component condition.

## Condition Based PM Activities

Activities that are performed on bridge elements as needed and identified through the bridge inspection process.

## Highway Corridor Priority (HCP)

Roadway importance based on statewide and regional economic development, federal functional classification, heavy haul routes, and amount of relative traffic.

### Customer Service Levels (CSL)

Customer-focused engineering measures used to track highway safety, condition, and serviceability. Levels are communicated in an A-F grading scale.

### Minor Span

A structure, including supports, designed principally to carry motor vehicles that is erected over a depression or an obstruction, such as water, a highway or a railway, and has an opening measured along the center of the roadway of more than 10 feet but less than 20 feet between the under-cropping of abutments or spring lines of arches or the extreme ends of openings for multiple boxes.

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