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* Indicates 11 x 17 sheet; all others are 8½ x 11.

INTRODUCTION - CHAPTER 32

This chapter establishes the practices and guidelines of the Structure and Bridge Division for the maintenance of VDOT's highway structures. It is intended to serve as both a standard for those familiar with bridge maintenance and as a primer/introduction to those who are new to the field. Because it is both a resource and a rule book it is longer than most chapters of the office practice. The current version addresses a broad array of bridge maintenance topics, including:

Recommended decision processes
Types of maintenance activities
Federal funding
Technical resources

The current version of the chapter is focused primarily on bridges with concrete decks, concrete or steel superstructures and concrete substructures. Future versions of the chapter will address culverts, timber decks and other types of structures commonly found in VDOT's inventory. Jacking and other maintenance activities will also be addressed.

It is intended that future versions will expand the informational role of the chapter by adding design aids and bridge management practices as well as links to standard details, standard special provisions and contract templates. The chapter will serve as a commonly utilized reference for bridge and maintenance engineers.

Throughout the document there are requirements to obtain the approval of the District Bridge Engineer. This requirement is included because the chapter will be used by many individuals, including consultants, Central Office employees and individuals in the Districts. While it is generally understood that the District Bridge Engineer has authority over the maintenance activities in his/her District, there are certain times when the designer should be certain that the matter has been elevated to the District Bridge Engineer's level.

For bid items required for work covered within this chapter, refer to VDOT's Manual of Structure and Bridge Division, Volume V - Part 2, Chapter 3.

It is expected that the users of this chapter will follow the practices and guidelines stated herein.

NOTE:
Due to various restrictions on placing files in this manual onto the Internet, portions of the drawings shown do not necessarily reflect the correct line weights, line types, fonts, arrowheads, etc. Wherever discrepancies occur, the written text shall take precedence over any of the drawn views.

PERFORMANCE MEASURES AND GOALS:

Performance Measure: The Structure and Bridge Division currently has a single formal Performance Measure that has been adopted by the Commonwealth Transportation Board:

- Limit the percentage of highway structures that are not Structurally Deficient to no less than 92%

The measure is tracked in Dashboard and other official documents relating to bridge performance. The Performance Measure addresses all VDOT-maintained structures and has been developed from unofficial submeasures of 97% of interstate structures, 94% of primary structures and 89% of secondary structures.

Performance Goals to Slow Deterioration Rates: A Performance Goal differs from a Performance Measure in that Performance Goals represent targets for each District to reach but are not formal requirements. The Performance Measure above establishes an important target for controlling the percentage of structures in poor condition. However, true system preservation should extend the service life of structures, which requires a balanced approach that places emphasis on structures in good, fair and poor condition. Accordingly, the following Performance Goals have been established by the Structure and Bridge Division:

- Maintain 90% of expansion joints in Condition State 1.

  The joint condition state Performance Measure emphasizes the importance of keeping moisture and salts from reaching bridge components located below the deck. Leaking bridge joints are the primary cause of bridge substructure and superstructure deterioration. Furthermore, many of the bridges that require premature replacement are allowed to deteriorate to poor condition primarily as a direct result of leaking expansion joints. Condition State 1 is defined by the FHWA's *Specification for the National Bridge Inventory Bridge Elements.* Joints in Condition State 1 are sound, functional, secure, do not leak and display minimal deterioration.

- Eliminate 2% of the expansion joints in each District in each fiscal year.

  Expansion joint elimination may be accomplished by making structures continuous for live load or by installing link slabs over piers or deck extensions at abutments.

- Perform maintenance activities on at least 6% of the Fair structures in each District in each fiscal year.

- Perform maintenance activities on at least 2% of the Satisfactory or Good structures in each District in each fiscal year.

  A structure is defined as "Fair" if the minimum General Condition Rating is 5. A structure is defined as "Satisfactory" if the minimum General Condition Rating is 6 and "Good" if the minimum General Condition Rating is 7. They have been established as easily understood goals for each District so that they can plan work in a manner that will improve system preservation. The numerical thresholds of 6% and 2% for Fair and Good structures were developed after a multi-year system preservation analysis of the existing inventory was performed. This analysis showed that if the new goals are reached the average quality of the highway structures (as measured by general condition ratings) will remain the same over time.

COMMON FHWA / VDOT BRIDGE-RELATED DEFINITIONS:

National Bridge Inventory (NBI) Structure: Any bridge or culvert having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes. It may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening. See Recording and Coding Guide for the Structure and Inventory of the Nation's Bridges, Report FHWA-PD-96-001(Recording Guide).

Non-NBI Structure: A structure that meets the requirements of current IIM-S&B-27, Bridge Safety Inspections. A structure is referred to as a "Non-NBI structure" if it is a bridge with a clear span opening (as defined above) of less than 20' or a culvert with an opening of greater than 36 square feet but not meeting the definition of an "NBI structure" given above.

General Condition Rating (GCR): Every structure begins to deteriorate from the completion of construction. Condition ratings have been established to measure deterioration levels of bridges in a consistent and uniform manner to allow comparison of the condition of bridges on a national level. According to the NBI policy, condition ratings are used to describe the condition of the existing, in-place bridge or culvert. Evaluation is for the materials-related, physical condition of the deck, superstructure and substructure components of a bridge and condition evaluation of culverts. GCR is a numerical system that ranges from 0 (worst condition) to 9 (excellent condition). Condition ratings are one-digit numbers given by the field inspector to the various components of a bridge or culvert. For guidelines about assignment and meaning of general condition ratings, refer to the AASHTO Manual for Condition Evaluation of Bridges. The ratings are based on objective criteria rather than opinion and are assigned values in accordance with the Recording Guide.

Appraisal Rating: A numerical rating system that is used to evaluate a bridge in relation to the level of service which it provides on the highway system of which it is a part. With this system a structure is compared to a new structure built to current standards. Appraisal ratings are provided for each structure. They are whole number values that vary from 0 (bridge closed) to 9 (superior to present desirable criteria).

Sufficiency Rating (SR): A formula developed by FHWA to allocate funds and to serve as a prioritization rating tool for the bridges in the United States. The sufficiency rating of a bridge varies from 0 (very poor) to 100 (very good). The formula considers the structural adequacy, functional obsolescence and level of service and essentiality for public use.

The sufficiency rating formula includes four components (S1+S2+S3-S4):

S1 = Structural adequacy and safety (55%)
- Superstructure, substructure, culverts and inventory ratings

S2 = Serviceability and functional obsolescence (30%)
- Rating reductions, roadway insufficiency, under clearances

S3 = Essentiality for public use (15%)
- Detour length, average daily traffic, STRAHNET highway designation

S4 = Special reductions (13% max, and used only when S1+S2+S3≥50)
- Detour length, traffic safety features, structure type (main span)

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Structurally Deficient (SD): According to the 23 CFR 650 D and as clarified by FHWA in its "additional guidance", a Structurally Deficient Structure is one that has:

1. A general condition rating of 4 or less for

   - Item 58 - Deck; or
   - Item 59 - Superstructures; or
   - Item 60 - Substructures; or
   - Item 62 - Culvert and Retaining Walls.

   (or)

2. An appraisal rating of 2 or less for

   - Item 67 - Structural Condition; or
   - Item 71 - Waterway Adequacy.

Functionally Obsolete (FO): According to the 23 CFR 650 D and as clarified by FHWA in its "additional guidance", a Functionally Obsolete Structure is one that has:

1. An appraisal rating of 3 or less for

   - Item 68 - Deck Geometry; or
   - Item 69 - Underclearances; or
   - Item 72 - Approach Roadway Alignment

   (or)

2. An appraisal rating of 3 for

   - Item 67 - Structural Condition; or
   - Item 71 - Waterway Adequacy.

FHWA's Additional Guidance on 23 CFR 650 D may be found at the following link:

http://www.fhwa.dot.gov/bridge/0650dsup.cfm

Any bridge classified as structurally deficient is excluded from the functionally obsolete category. See paragraph above for a link to the FHWA web site.

Deficient Structures: According to the FHWA, a structure is designated as "deficient" if it is either structurally deficient or functionally obsolete. A structure that is both SD and FO is identified as SD. The FHWA uses the combined deficient designation in the allocation of bridge funding per State.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Element Level Condition Data: Element-level data provide more detailed bridge condition information for bridge components. This data differs significantly from the General Condition Ratings (GCRs). Whereas GCRs are provided for four major structure components (deck, superstructure, substructure, culvert), element level data are gathered on many more structure elements (railing, joints, bearings, etc.). In addition to a higher level of detail, element level data are summarized using an entirely separate grading system. As mentioned above, under the NBI inspection program, bridge components are coded with GCRs of 0 (worst) through 9 (best). These ratings represent an **average** rating, which provides an overall indication of the general condition of the **entire** component being rated. The grading scale for element data works in the opposite direction, with 1 being the best and 3, 4, or 5 being the worst depending on the particular element. With element level data, bridge elements are rated in quantitative units and the element condition is distributed into various condition states. An element is a major component of a bridge (such as abutments, girders, piles, caps, etc.) that can be further subdivided by material type (such as prestressed concrete, timber, weathering steel, etc.). Each bridge will not have **all** the possible elements, and more likely will have under a dozen. Each element has a set of defined condition states. An element may have between three and five condition states. These states range from "new" to "badly deteriorated." Condition state language is **not** an attempt to define an element as good, fair or poor

Health Index: The Bridge Health Index is a 0-100 ranking system for bridge maintenance. The Health Index of any particular structure is calculated by dividing the sum of the current value of all the structure's elements by the sum of the total value of all the structure's elements. A Health Index of 100% indicates that all of the condition units of the structure are in the best possible condition state. A Health Index of 0% indicates that all of the condition units are in the worst possible condition state.

Federal Bridge Funding:

Types of Federal funding:

National Highway System (NHS) – Generally for construction, reconstruction, resurfacing, restoration and rehabilitation of segments of the NHS.

Interstate Maintenance (IM) – Generally for resurfacing, restoration, rehabilitation and reconstruction or new construction of mainline and ramp bridges and culverts. Crossings over existing interstate routes may be considered when part of a larger interchange project.

Surface Transportation Program – (STP) – Generally for construction, reconstruction, resurfacing, restoration and operational improvements for highways, including interstate highways and bridges on public roads of all functional classifications.

Highway Bridge Program (HBP) (Formerly the Highway Bridge Replacement and Rehabilitation Program – HBRRP) – For NBI structures only, generally for preventive maintenance, rehabilitation or total replacement of SD or FO bridges on any public road.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

The practices and guidelines set forth herein are also intended to assist the user in designing plans to meet Federal funding requirements. Preventive maintenance and repair and rehabilitation plans for NBI structures shall be developed in anticipation of the use of HBP funds. Rehabilitation versus replacement guidelines for considering the replacement of bridges with SR less than or equal to 50 and less than or equal to 80 are provided on File Nos. 32.06-1 and -2. In general, structures with SR between 50 and 80 are rehabilitation candidates, and structures with SR less than 50 are rehabilitation or replacement candidates. There are, however, exceptions to these ranges. In order to obtain Federal funding for replacement of a structure with an SR between 50 and 80, a life cycle analysis is required by FHWA.

If state funds or Federal funds other than HBP funds, such as IM, NHS or STP funds, are used, the restrictions in this chapter with respect to the SR do not apply. Federal IM, NHS and STP funds may be used on NBI as well as non-NBI structures. See current IIM-S&B-83, Bridge Touchdown Points, for additional qualifying criteria for project eligibility, as well as approach work items and safety appurtenances eligible for funding. See File Nos. 32.07-1 thru -3 (Federal Bridge Funding Spreadsheet) for additional Federal funding criteria.

10-year rule: A structure is ineligible for HBP funds for a period of 10 years after replacement or major rehabilitation work has been performed, regardless of whether funded by Federal-aid funds, State or local funds, private funds, or combination thereof. The 10-year rule does not apply to other Federal funds.

Repair: The remediation of damage or deterioration that affects the structural integrity of a bridge or culvert element.

Routine maintenance: Defined by AASHTO and accepted by the FHWA, it is maintenance work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service. This includes spot deck patching and crack sealing. The state is responsible for routine maintenance, so it must be funded with state funds.

Preventive maintenance: Defined by AASHTO and accepted by the FHWA, it is the planned systematic implementation of cost effective treatments to an existing roadway system and its appurtenances that preserve the system, retards future deterioration and maintains or improves the functional condition of the system without increasing structural capacity. Preventive maintenance work does not have a requirement to bring the structure up to current railing or geometric standards. See current Eligibility of Preventive Maintenance in Federal-Aid Projects letter concerning preventive maintenance and system preservation activities in Section 32.07.

Restorative Maintenance: The term "restorative maintenance" as used in this document applies to maintenance activities that are performed as a reaction to deterioration of bridge elements. This work is performed on an as-needed basis rather than on a regular schedule. Restorative maintenance is generally reactive rather than proactive. Restorative maintenance is different from planned preventive maintenance which is generally performed in order to slow the rate of deterioration of a structure or one of its elements.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Rehabilitation: Rehabilitation is defined as removing deficiencies or justifying their retention through the design exception process. This includes widening, replacement of the deck (both partial and complete), replacement of the superstructure and replacement of substructure elements if needed. Construction of a dual structure to alleviate a capacity deficiency is also considered to be a major rehabilitation. However, there is no requirement to build a dual structure to alleviate a capacity deficiency when replacing a deck on a bridge. Bridges incurring rehabilitation are subject to the 10-year rule for HBP funds. Highway structures that are structurally deficient or functionally obsolete with a sufficiency rating of 80 or less are eligible for rehabilitation using HBP funds unless the 10-year rule applies.

Replacement: Highway bridges and culverts that are structurally deficient or functionally obsolete with a sufficiency rating less than 50 are eligible for replacement or rehabilitation using HBP funds unless the 10-year rule applies. This chapter includes criteria that permit the replacement of a deficient bridge with a sufficiency rating greater than 50 when engineering and economic data support such an action.

Repair or Rehabilitation Candidate: VDOT uses the NBI General Condition Rating (GCR) criteria as an index to identify bridges and culverts that may need some type of repair or rehabilitation. Repair or rehabilitation work is generally performed on structures with a GCR of less than 6. Structures with any rated element possessing a GCR of less than 6 are eligible for consideration. VDOT also uses element condition data to determine repair or rehabilitation needs. Typically, condition states 1 and 2 would indicate no action or preventive maintenance activities, while condition states of 3 or greater indicate the need for restorative or rehabilitation activities.

All bridges and culverts require some level of maintenance; however, a GCR of less than 6 is used to identify those structures that require more than routine or preventive maintenance.

The VDOT Bridge Program includes the following:

- Preventive Maintenance (604 program)
- Painting (604 program)
- Restorative Maintenance (604 program)
- Rehabilitation (604 program)
- Replacement (603 program)

Examples of Preventive Maintenance – bridge cleaning, deck sealing, sealing joints, thin deck overlays and spot and zone painting.

Examples of Restorative Maintenance - deck patching, rigid deck overlays, reconstructing/closing joints, superstructure repairs, substructure repairs, fatigue retrofitting, scour repairs, cathodic protection and electrochemical chloride extraction.

Examples of Painting – Spot and zone painting, overcoating, complete removal and repainting.

Preventative Maintenance, Painting, and Restorative Maintenance are the components of the VDOT Bridge Preservation Program.

Examples of Rehabilitation – Superstructure Replacements, Deck Replacements, and Culvert Rehabilitation.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Repair or Rehabilitation Candidate (cont'd):

Work actions that are typically considered as rehabilitation and replacement are eligible for funding under the "traditional" provisions of the Federal Highway Bridge Program (Sufficiency Rating less than 80 and deficient for rehabilitation; Sufficiency Rating less than 50 and deficient for replacement).

The current Eligibility of Preventive Maintenance in Federal-Aid Projects letter from the FHWA to VDOT includes work actions that are typically considered as Preventive Maintenance, Painting, and Restorative Maintenance as eligible for funding under the Preventive Maintenance and System Preservation provisions of the federal Highway Bridge Program. See Section 32.07.

In general, rehabilitation and replacement candidates are structures having one or more components with a GCR of 4 or less, restorative maintenance candidates are structures having one or more components with a GCR equal to 5, and preventive maintenance candidates are structures having one or more components with a GCR of 6 or greater.

Preventive maintenance, painting, restorative maintenance, and rehabilitation activities are typically funded by maintenance (VDOT Program 604) funds. The federally recognized maintenance activities are listed in the following table, along with their associated VDOT activity codes and activity code descriptions.

Replacement activities are typically funded by construction (VDOT Program 603) funds through the Dedicated Bridge Fund.

	Activity Description in FHWA/VDOT letter Agreement for Planned Preventive Maintenance and System Preservation	VDOT Bridge Maintenance Activity Code	VDOT Activity Code Description
1	Seal or replace leaking joints, reconstruction of joint areas during joint replacement or elimination of deck joints	61704	Joint Rehabilitation
2	Thin bonded overlays	61703	Thin Overlay
3	rigid overlays	61705	Rigid Overlay
4	asphalt overlays with waterproof membranes	62708	Asphalt Overlay
5	Spot and zone pointing/coating of structural steel to include bearings for prestressed concrete members	62728	Paint
6	Painting/coating of structural steel	62728	Paint
7	Cathodic Protection (CP) Systems for Bridge Decks	none	None
8	Cathodic Protection Systems for Substructure Elements	none	None
9	Cathodic Protection Systems for Superstructure Elements other than decks	none	None
10	Electrochemical Chloride Extraction (ECE) Treatment for decks	none	None
11	Electrochemical Chloride Extraction Treatment for substructure elements	none	None
12	Scour countermeasures installation	62746	Repair Undermining
13	Removing large debris from channels	60740	Ordinary Maintenance
14	Retrofit of fracture critical members	62726	Steel Superstructure Repair
15	Retrofit of fatigue prone details	62726	Steel Superstructure Repair
16	Concrete deck repairs in conjunction with installation of deck overlays, CP systems, or ECE treatment	61701, 61703, 62705, 62708	Patching, overlays
17	Substructure concrete repairs in conjunction with installation of CP system in the bridge element, ECE treatment of the element, or gaJvanic anodes in the element (when there are several sources or experimental basis when only one source). (Includes substructure units with cathodic protection jackets.) Includes preventive maintenance of Piles using jackets in conjunction with Cathodic protection systems.	62745	Substr. Surface Repair
18	Application of concrete sealants, coatings, and membranes for surface protection of the concrete	60700	Ordinary Maintenance
19	Bridge cleaning and/or washing service - decks	60700	Ordinary Maintenance
20	Bridge cleaning and/or washing service - joints	60700	Ordinary Maintenance
21	Bridge cleaning and/or washing service - drains	60700	Ordinary Maintenance
22	Bridge cleaning and/or washing service - superstucture	60700	Ordinary Maintenance
23	Bridge cleaning and/or washing service - substructure horizontal elements	60700	Ordinary Maintenance
24	Concrete mat long the flow line of steel pipe culverts	62755	Surface Repair

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Bridge Preservation: A FHWA Bridge Preservation Expert Task Group has proposed the following formal definition of 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 life. Preservation actions may be preventive or condition-driven*." This definition has been endorsed by the AASHTO Subcommittee on Bridges and Structures, the AASHTO Standing Committee on Highways and the AASHTO Subcommittee on Maintenance.

The following commentary is also included in the bridge preservation definition -

Effective bridge preservation actions are intended to address bridges while they are still in good or fair condition and before the onset of serious deterioration.

An effective bridge preservation program: 1) employs long-term network strategies and practices that are aimed to preserve the condition of bridges and extends their useful life; 2) has sustained and adequate funding sources; 3) has adequate tools and processes to ensure that the appropriate treatments are applied at the appropriate time

An effective bridge preservation program may include, but is not limited to, the following components:

1. Qualifying parameters for bridge types and related conditions, i.e. bridge elements or components that are in fair to good condition such as concrete decks, coated steel elements, substructure elements in a marine environment, etc.
2. Appropriate treatments such as cleaning, installation of deck overlays, coating of steel elements, installation of cathodic protection and prevention systems, etc.
3. Regular needs assessment to identify, prioritize, and estimate the cost of planned work.

The FHWA has published a *Bridge Preservation Guide* that can be viewed at the following link:

http://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf

A preservation approach to maintaining a structure inventory will include performing preventive, painting, and restorative work actions that address structures while they are still in good or fair condition and before the onset of serious deterioration.

A balanced structure maintenance program will provide for preservation, rehabilitation, and replacement actions, and may be the most efficient and effective way to maintain and improve health of the structure inventory.

The following breakdown is recommended for the allocation of structure maintenance funds:

- Preventive Maintenance – 15% (Program 604)
- Painting – 10% (Program 604)
- Restorative Maintenance – 25% (Program 604)
- Rehabilitation/Small Structure Replacement – 50% (Program 604)

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Bridge Preservation (continued):

The exact breakdown of maintenance allocations will vary and will depend on the particular condition and needs of the structures in each district. The breakdown for a district may be determined by calculating the unconstrained needs using the Pontis Bridge Management Software, assigning work actions to a program (preventive maintenance, painting, restorative maintenance, rehabilitation/small structure replacement) and calculating the sum for each program.

Small structure replacements funded under Program 604 should be accomplished in accordance with the requirements of the current IIM-S&B-87 - Limitations on the Use of Maintenance Funding for Structure Replacement Projects.

Planned preventive maintenance should be performed on a schedule to be developed for each structure.

The following chart establishes a basis for scheduling planned preventive maintenance activities:

Preventive Maintenance Activity		Preferred Cycle (yrs)	System	Unit Of Measure	Eligible for Federal Reimbursement	Activity Description	Criteria
1	Bridge Deck Washing (Concrete)	1	All	SY	Yes	Includes the removal and disposal of debris and pressure washing of the bridge roadway surface, joints, sidewalks, curbs, parapet walls, drainage grates, downspouts, and scuppers.	All concrete decks and slabs that do not have asphalt overlay.
2	Bridge Deck Sweeping	1	All	SY	Yes	Includes the removal and disposal of debris and sweeping of the bridge roadway surface, shoulders, joints, sidewalks, and curb lines.	All concrete decks and slabs with asphalt overlay (not accounted for under the Bridge Deck Washing activity), metal decks, timber decks and slabs.
3	Seats & Beam Ends Washing	2	All	SY	Yes	Includes the removal and disposal of debris and pressure washing of the bridge seat, bearing areas, and 5 feet of beam-ends. Use 3 feet avg. seat width for estimation purposes.	All bridge seat and bearing areas to be cleaned, including abutment seats, pier seats, bearing devices, and the end 5 feet of beams and girders, and end diaphragms.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Bridge Preservation (continued):

Preventive Maintenance Activity		Preferred Cycle (yrs)	System	Unit Of Measure	Eligible for Federal Reimbursement	Activity Description	Criteria
4	Cutting & Removing Vegetation	2	All	EA	No	Includes cutting, removing and disposing of vegetation, brush and trees that are on, adjacent to, or under bridges.	For estimating purposes, only bridges that cross over waterways were considered. However, this activity can be planned and performed on any bridge or culvert as deemed necessary by the responsible manager in the district.
5	Routine Maintenance of Timber Structures	2	All	EA	No	Includes tightening and/or replacing fasteners such as those used on timber decks, railing systems, and other miscellaneous connections, sealing end sections of timber elements, such as deck boards, bent caps, railings, posts, etc.	All timber structures.
6	Scheduled Replacement of Compression Seal Joints	10	All	LF	Yes	Includes removal of existing joint material, surface preparation and installing new joint material.	In order to avoid double counting, to account for data currency in Pontis, and to be proactive in addressing the needs for this bridge element, only joints that are in good condition will be considered in the PM program. Joints that are not in good condition will be accounted for and addressed in Pontis (BMS).

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Bridge Preservation (continued):

Preventive Maintenance Activity		Preferred Cycle (yrs)	System	Unit Of Measure	Eligible for Federal Reimbursement	Activity Description	Criteria
7	Scheduled Replacement of Pourable Joints	6	All	LF	Yes	Includes removal of existing joint material, surface preparation and installing new joint material.	In order to avoid double counting, to account for data currency in Pontis, and to be proactive in addressing the needs for this bridge element, only joints that are in good condition will be considered in the PM program. Joints that are not in good condition will be accounted for and addressed in Pontis (BMS). (See explanation at end of table)
8	Cleaning and Lubricating Bearing Devices	4	All	EA	No	Includes removal and disposal of debris, and lubricating moveable bearings.	All bridges w/ moveable type bearings.
9	Scheduled Installation of Thin Epoxy Concrete Overlay	15	All	SY	Yes	Includes installing of new system and/or replacing existing overlay system.	Only concrete bridge decks that are in overall good condition are considered in this program.
10	Beam Ends Painting	10	All	EA	Yes	Includes preparing and over-coating the end 5 feet of painted steel beams or girders that are located under open joints, except for bridges with timber decks. Replace paint system at year 30.	For planning and budgeting purposes in this program, only steel members that are in overall good condition will be considered. Steel members that are not in good condition will be accounted for and addressed in Pontis (BMS).
11	Removing Debris from Culverts	5	All	EA	YES	Includes the removal and disposal of debris that is collected inside and/or at inlets or outlets of culverts.	All culverts except for those scheduled for replacement.

COMMON FHWA / VDOT BRIDGE RELATED DEFINITIONS (cont'd):

Bridge Preservation (continued):

Eligibility for Federal reimbursement is as indicated in the chart.

EXAMPLE: Pontis shows a condition- based need to replace a total of 5,000 LF of compression joint seal in FY 06 for a particular district. Pontis also shows that there is 1,000 LF of compression joint seal that is in good condition (state condition 1) in the same district. The proposed life cycle (frequency) in the PM program for this activity is 10 years. Therefore, for planning and budgeting purposes in the next fiscal year the district may budget for replacing a total of *5,100 LF of compression joint seal.

* 5,000 LF – Condition based replacement
  1/10 Year (1,000 LF) = 100 LF/Year – Non-conditioned based (Planned replacement)
  Total Replacement = 5,000 + 100 = 5,100 LF

Discussion of deck crack sealing: There are two distinct schools of thought on the application of gravity sealants to seal active deck cracks. Recent research has shown that this activity has, at best a very limited functional duration and is not a cost-effective maintenance technique for active cracks. However, some Districts have had good experience with the practice and have both practical and anecdotal evidence to support this position. This document does not recommend the use of gravity sealants on active cracks but recognizes that a valuable short-term maintenance activity for dormant cracks.

DECISION PROCESS:

General Overview: Sections 32.02 thru 32.06 apply to bridges with concrete decks (with or without overlays) that are identified by the District Bridge Engineer as repair/rehabilitation/ replacement candidates **or** prioritized by the Dedicated Bridge Fund or Interstate Priority Criteria and are intended to define a decision-making process that will assist the user in deciding which of the following options to consider (a flow chart of this process is provided on File No. 32.02-6):

- To simply repair the deck, superstructure and/or substructure and perform preventive maintenance activities to extend the service life of the asset or proceed with further evaluation
- To ascertain the need for deck and/or superstructure and/or substructure evaluations for bridges requiring further investigation into rehabilitation/widening vs. replacement
- To rehabilitate the deck (with or without widening) or replace it
- To rehabilitate the superstructure (with or without widening) or replace it
- To rehabilitate the bridge (with or without widening) or replace it

Rehabilitation is preferred over replacement whenever:

- A rehabilitated deck provides at least an estimated 20-year design life
- A rehabilitated superstructure/bridge with a deck replacement provides a non-posted structure with at least an estimated 40-year design life
- It is cost-effective within the guidelines of this chapter

Initial Evaluation: Information that is pertinent to the initial evaluation of a bridge includes, but is not limited to, the following items:

- Present and projected traffic counts (including the percentage of trucks),
- Present and previous inspection reports
- Work previously done to the bridge
- Existing or known scour, undermining, or settlement issues
- Estimated time of duration of repair/rehabilitation/replacement
- Alternate routes (permanent and/or temporary)/length of detour
- Maintenance and protection of traffic during repair/rehabilitation/replacement
- Load capacity of the bridge/effects on permit vehicles
- Functional adequacy of the bridge
- Condition and adequacy of the railings
- Design exceptions/waivers
- Current VDOT/FHWA Program Efficiencies Agreement (2007 and supplement) available at FHWA's VA Division website at http://www.fhwa.dot.gov/vadiv/policies.htm.
- Eligibility for bridge rehabilitation and/or replacement based on FHWA's "10-year rule" (reference: http://www.fhwa.dot.gov/legsregs/directives/fapg/0650dsup.htm).
- General condition ratings
- Element condition data
- Sufficiency Rating
- Health Index
- Evacuation routes

DECISION PROCESS (cont'd):

If the project moves beyond repair and develops into a rehabilitation, there may be additional relative issues requiring examination that may influence the decision to rehabilitate or replace the bridge. Examples of possible relative issues include, but are not limited to, the following items:

Relative Issues:

- Scour susceptibility
- Hydraulic inadequacy and/or poor stream alignment
- Unknown foundations
- Non-redundancy
- Fatigue prone and fracture critical details
- Alkali-silica or alkali-carbonate reactive aggregate in the deck, superstructure or substructure
- Accident history or potential
- Horizontal clearances
- Interstate overpass bridges with vertical clearances less than 16 feet (requires FHWA and DOD approval if not brought up to standard. Use Interstate Vertical Clearance Exception Coordination Form (available at http://www.fhwa.dot.gov/bridge/091799.htm). FHWA Division Office will coordinate with Surface Deployment and Distribution Command, Transportation Engineering Agency (SDDCTEA) which replaces the old Military Traffic Management Command, Transportation Engineering Agency (MTMCTEA))
- Substandard vertical and/or horizontal curves immediate to the bridge that cannot be adequately corrected later without replacing the bridge
- Planned development and local or regional future land use plans
- Functional classification and surrounding transportation network
- The Six (6) AASHTO Capacity Principles (pgs. 78-80 of the AASHTO manual "Geometric Design of Highways and Streets")
- Level of service provided by the subject bridge and immediate approaches is predicted to fall to a failing level of service within 10 years
- Level of service of the roadway beneath the subject bridge predicted to fall to a failing level of service within 10 years and/or any associated safety problems or substandard geometrics
- Bicycle paths and pedestrian accommodations
- Historical significance
- Overloads/effects on permit vehicles
- Over height vehicle collisions and available clearance for permit vehicles
- Environmental issues
- Ship collisions or U.S. Coast Guard issues
- Seismic considerations
- Social/political (example - restricting development by perpetuating substandard geometrics and/or height/weight restricted bridges)
- Life Cycle Cost Analysis (LCCA)
- Value Engineering
- Importance of route to commerce

Issues such as historical significance, environmental/Coast Guard or maintenance and protection of traffic may support or necessitate rehabilitation, while issues such as scour susceptibility, hydraulic inadequacy, accident history/potential, or redundancy (e.g. fracture critical) could be the deciding factor for replacement individually or collectively. Hence, it is important to assess all relative issues early in order to minimize or avoid unnecessary costs.

DECISION PROCESS (cont'd):

Rehabilitation and Replacement Cost Estimates:

The estimating of both rehabilitation and replacement costs is usually performed after all of the relative issues have been investigated. The rehabilitation estimate is more difficult to develop and shall be based on an in-depth study as outlined later in this chapter.

The rehabilitation (RH) and replacement (RP) estimates shall include all highway and project costs necessary to develop the complete cost estimate including the cost for the appropriate Maintenance and Protection of Traffic plan chosen for that alternate. However, in accordance with FHWA policy, this decision process utilizes the comparison of the rehabilitation and replacement cost portion of the project directly related to the structure assuming both are viable possibilities. This relative relationship is established in terms of the structure rehabilitation cost as a ratio of the structure replacement cost (RH/RP ratio).

Funding availability will play a major role in the final decision regarding what to do and when to do it. Rehabilitation and replacement projects may end up being programmed a number of years away. The designer will need to assess the minimum level of repairs necessary to keep the structure in a safe service condition during the interim. An accurate cost estimate of these repairs and/or other necessary interim needs will be important in prioritizing the programmed projects. For rehabilitation projects, the actual rehabilitation construction work will most likely not be done for several years and the estimate of quantities should have escalation projections to compensate for continued deterioration. Use the inflation rates in PCES provided by Financial Planning.

Life Cycle Cost Analysis:

Cost estimates for projects less than or equal to $2M may be based on the estimated cost of construction or a life cycle cost analysis. A life cycle cost analysis should be used when comparing alternatives of differing life expectancies and/or differing degrees of proficiency. For example, the elimination of joints in multiple simple span bridges by the use of joint closures or deck extensions have a longer life expectancy (the remaining life of the deck) and are more proficient in preventing moisture penetration than joint replacement, but have a higher initial cost. A life cycle cost analysis shall be utilized for projects costing more than $2M. See Life Cycle Cost Analysis Guidelines, File Nos. 32.06-3 thru -5.

New Designs:

New designs shall incorporate longer spans utilizing continuity, jointless concepts (i.e. integral abutments (full/semi), deck extensions and alternate backwall abutments, in accordance with VDOT's *Manual of the Structure and Bridge Division*, Volume V - Part 2, Chapter 17), corrosion resistant reinforcement, high performance steel, high performance low permeable concrete, VDOT prestress bulb-T sections, etc.

DECISION PROCESS (cont'd):

Clear Bridge Widths:

The minimum clear bridge widths (face to face of curb) for deck and superstructure replacements shall be in accordance with VDOT's *Manual of the Structure and Bridge Division*, Volume V - Part 2, Chapter 6. If these widths are unattainable without widening the substructure, then it shall be widened only to the extent that the bridge will not be functionally obsolete based on the 11-year ADT projected counts. This requirement applies to condition-driven projects (i.e. poor condition) when the widening is necessitated by this policy, but does not apply to NHS or Freeway Road Classifications.

Resurfacing, restoration, and rehabilitation (RRR) projects primarily involve work on an existing roadway surface and/or subsurface. The purpose of RRR projects can be to provide additional pavement strength, restore or improve the existing cross section, decrease noise characteristics, improve the ride of the roadway, improve bridges, or enhance safety.

The clear bridge widths of rehabilitation projects involving widening and replacement (where condition and capacity apply) shall be in accordance with VDOT's RRR Guidelines, Geometric Design Standards or VDOT's *Manual of the Structure and Bridge Division*, Volume V - Part 2, Chapter 6, as appropriate.

Unusual Conditions:

The decision making process, outlined in the following sections and illustrated in the decision tree on the next sheet, is based on normal or most probable condition relationships between the deck, superstructure and substructure. However, unusual relative conditions may exist that require evaluation by the bridge design engineer on a case by case basis as an overall condition assessment of the bridge is developed. Consideration needs to be given to deviating from this process as conditions warrant. The following cases are examples of structures with unlikely, yet possible, combinations of conditions that do not fit the norm:

- Deck and superstructure are both in good condition; however, substructure is in poor condition or susceptible to scour. In this case, replacement of one or more substructure elements could dictate partial/full rehabilitation or replacement of the bridge.

- Deck and substructure are in good condition; however, superstructure is in poor condition and the rehabilitation of the supporting members dictates replacement of the superstructure.

- Structure is well within the cost range of justifying rehabilitation; however, relative issues such as scour susceptibility, hydraulic inadequacy, accident history/potential, or redundancy (e.g. fracture critical) necessitate replacement.

For situations such as these, the order of investigation as recommended by this process may be changed resulting in savings of time and reduction in evaluation costs.

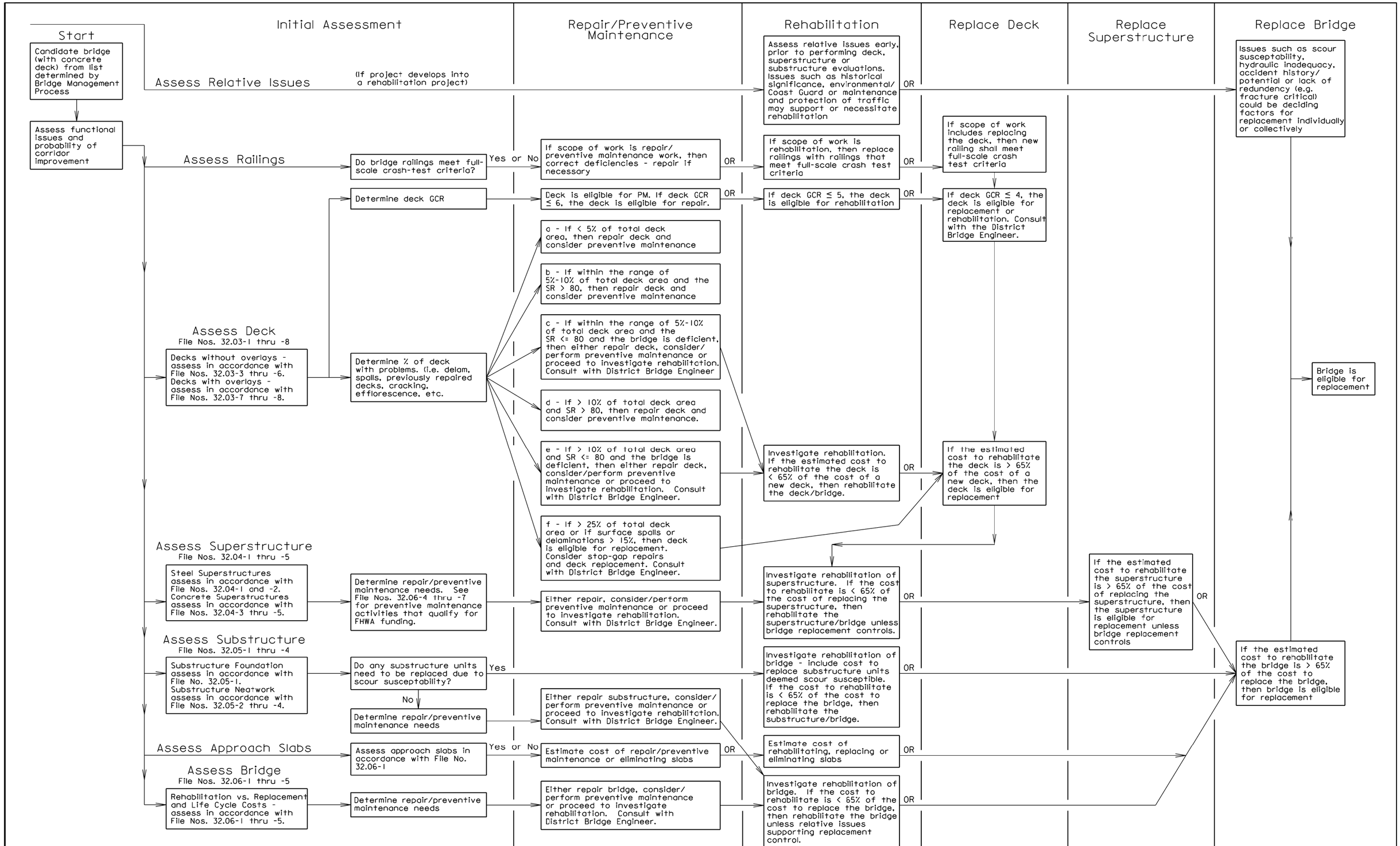
DECISION PROCESS (cont'd):

Federal Concurrence/Approval:

Federal concurrence/approval may be needed for large, unusual projects, and movable bridges. Reference the current FHWA/VDOT Efficiency Agreement available at:

http://www.fhwa.dot.gov/vadiv/policies.htm.

Documentation of all factors contributing to the final decision (calculations, tests, etc.) should be kept in the project file in the District Bridge Office.



MAINTENANCE AND REPAIR
BRIDGE REPAIR, REHABILITATION OR REPLACEMENT DECISION TREE

VOL. V - PART 2
DATE: 06Feb2012
SHEET 6 of 6
FILE NO. 32.02-6

CONCRETE DECK REPAIR, REHABILITATION OR REPLACEMENT:

The three primary load carrying components of a bridge are the deck, superstructure and substructure. The condition rating of the deck is one of the primary considerations in determining structural deficiency.

If the General Condition Rating of a deck is less than or equal to 4, the bridge is structurally deficient and eligible for HBP funding for rehabilitation or replacement. See November 1, 2007 FHWA Memorandum on Rehabilitation and Replacement of Bridge Decks at the following link:

http://www.fhwa.dot.gov/bridge/071101.cfm

Repair, rehabilitation and replacement of decks are defined below.

DECK REPAIR – Typically involves Type B or C patching, crack sealing, expansion joint reconstruction, expansion joint replacement, expansion joint elimination, concrete superstructure surface repair (bid item for non deck repairs, such as curb face, parapet, etc.), etc. as per VDOT Road and Bridge Specifications, section 412.03 (a). Concrete repair activities Type B or C patching and superstructure surface repair are normally considered routine maintenance and will not qualify for Federal bridge (HBP) funds; however, they do qualify for HBP funds as preventative maintenance <u>if</u> cathodic protection systems or electro-chemical chloride extraction are used or they are performed in conjunction with an overlay (Preventative Maintenance). Expansion joint replacement and all associated concrete repairs needed to replace and/or eliminate the joints are considered preventive maintenance activities and are eligible for Federal reimbursement.

DECK REHABILITATION – Typically includes any of the deck repair items along with eligible preventative maintenance activities (i.e. an overlay, cathodic protection or electro-chemical chloride extraction, expansion joint activities) and the repair, retrofit (e.g. using guardrail to reduce or eliminate curb) or replacement of deficient railings. Rehabilitation may also include replacing deck overhangs.

DECK REPLACEMENT – Typically determined by deck condition and cost comparison to rehabilitation, but may be dictated by other reasons such as the capacity of the superstructure (e.g. replacing a non-composite deck with a composite deck if adequate live load capacity is obtained). The presence of alkali-silica or alkali-carbonate reactive aggregate in the deck may dictate replacement. The corroded/deteriorated condition of the reinforcement may also dictate replacement.

ELIMINATION OF EXISTING EXPANSION JOINTS:

The designer shall investigate the feasibility of eliminating all deck expansion joints. Typically, issues requiring examination include, but are not limited to, the nature and condition of the bearings, bearing layout, adequacy of fixed bearings and corresponding piers to handle longitudinal forces, adequacy of fixed and expansion bearings to handle transverse forces, movement capability of expansion bearings that remain active, pier flexibility, structure symmetry with respect to location of fixed pier(s), the size of any remaining joints, etc.

Elimination of all existing pier joints by using joint closures is expected and is generally preferred in relation to the elimination of the abutment joints due to relative substructure repair costs. However, the nature of the bridge may dictate the feasibility of only removing some of the pier joints (i.e. excessive bridge length, degree of curvature, span lengths greater than 120 feet, etc.). When the elimination of all pier joints is not possible, provide deck continuity over substructure units with potentially higher relative repair costs such as tall column piers in the water as opposed to short piers on land.

Elimination of the existing abutment joints by using deck extensions is also expected; however, the issues relating to the nature of the bridge (as referenced for the piers) and the presence of existing approach slabs to remain in place may inhibit feasibility.

Justification for any remaining joints shall be provided via email to the Assistant State Structure and Bridge Engineer for Maintenance and posted in IPM.

When joints are eliminated, cost estimates for deck rehabilitation and replacement shall include all costs associated with the elimination of the existing joints (i.e. the cost of deck closures, parapet/rail closures and replacing, modifying or relocating the existing bearings, increasing the size of remaining joints, etc.) to accommodate the joint closures.

DECKS WITHOUT OVERLAYS:

TENTATIVE DECK ASSESSMENT:

The deck shall be tentatively assessed to the extent possible with available information including As-Built plans, repair plans, inspection reports, work done reports, previous deck evaluations (which may include rebar cover, half-cell potentials or chloride concentrations) and visual inspection, prior to proceeding with deck, superstructure or substructure evaluations. The available information may be sufficient to determine replacement of the deck and thus avoid unnecessary evaluation costs.

CONDITION STATE: (In consideration of total compromised deck area)

Start with investigating the condition state of the top of deck (Pontis Elements 12, 18, 22, 26 and 27 for decks; 38, 44, 48, 52 and 53 for slabs) and the bottom of deck (Pontis Element 359 for decks/slabs and Smart Flag 706 for overhangs) as reported in the most recent inspection report (Elements 13, 14, 39 and 40 apply to decks and slabs with asphaltic concrete overlays). Note that the definitions of all Pontis elements can be found in the current version of the VDOT Data Collection Manual and the VDOT Inventory Coding Guide available at:

VDOT Element Data Collection Manual:

http://www.virginiadot.org/business/resources/PONTIS_Element_Data_Collection_Manual_Modified_by_VDOT.pdf

VDOT Inventory Coding Guide:

http://www.virginiadot.org/business/resources/Coding_Manual.pdf

Condition states for these elements have predefined ranges of top surface areas (spalls, delaminations and patched areas) and bottom of deck areas including deck overhangs (not coinciding with surface issues) having moderate to heavy cracking and/or efflorescence as evidenced by information on hand (see ranges below):

Condition State	Definition
1	No Problems
2	$\leq$ 10% of Deck Area
3	> 10% and $\leq$ 25% of Deck Area
4	> 25% and < 50% of Deck Area
5	$\geq$ 50% of Deck Area

Add the sum of all previously repaired areas to the sum of the current damaged areas of the pertinent aforementioned elements and smart flag. This portion of the deck will be considered compromised.

DECKS WITHOUT OVERLAYS (Cont'd):

REPAIR AND REHABILITATION DECISIONS:

Repair, rehabilitation and replacement decisions should be made in accordance with the requirements below, which vary according to the degree the deck is compromised. For decks where repair is being considered, it is suggested that a field evaluation and more accurate estimation of the deck damage be performed. The level of detail required for the field evaluation shall be as determined by the District Bridge Engineer.

a) If < 5% of the total deck area is compromised, then repair the deck. Strong consideration should be given to applying an epoxy overlay as a preventative maintenance activity. Shy cover (< 2") as evidenced by deck patching or other means is also justification for performing an epoxy or rigid overlay on a new or existing deck.

The range of 5% to 10% of the total deck area, b) and c), is intended to allow field discretion/ decision to repair the deck or investigate rehabilitation further. However, if the deck GCR $\leq$ 4 (bridge is deficient), then, in addition to repair and rehabilitation, replacement of the deck may also be considered. The bridge deck is eligible for HBP funding for rehabilitation and replacement (November 1, 2007 FHWA Memo on Rehabilitation and Replacement of Bridge Decks).

b) If 5% to 10% of the total deck area is compromised, and the SR > 80, then repair the deck. Structure does not qualify for rehabilitation; deck patching will qualify for HBP funds as preventative maintenance if performed in conjunction with a cathodic protection system, electro-chemical chloride extraction, or an approved overlay.

c) If 5% to 10% of the total deck area is compromised and the SR $\leq$ 80, then repair the deck or investigate rehabilitation. If the structure is not deficient, then it is eligible for HBP funds as preventative maintenance. If the structure is deficient, then it is eligible for preventative maintenance and for rehabilitation.

d) If the compromised area is greater than 10% and less than or equal to 25% of the total deck area and the SR > 80, then repair the deck. Deck patching will qualify for HBP funds as preventative maintenance if performed in conjunction with cathodic protection, electro-chemical chloride extraction, or an approved overlay.

e) If the compromised area is greater than 10% and less than or equal to 25% of the total deck area and the SR is $\leq$ 80, then investigate rehabilitation. If the structure is not deficient, then it is eligible for HBP funds as preventative maintenance. If the structure is deficient, then it is eligible for preventative maintenance and for rehabilitation.

f) If the compromised area of the deck is greater than 25% of the total deck area or if surface spalls or delaminations are greater than 15% of the total deck area, then deck is eligible for replacement. Replacement is the preferred alternative.

Preventative maintenance shall be considered and is strongly encouraged for a) through e). Consult with District Bridge Engineer for recommendation.

DECKS WITHOUT OVERLAYS (Cont'd):

REPAIR AND REHABILITATION DECISIONS:

If the estimated cost to repair and overlay the deck plus the cost to repair, retrofit or replace the railings plus the cost to perform the deck evaluation exceeds 65% of the cost of a new deck, then deck is eligible for replacement. Replacement is the preferred alternative. Otherwise, proceed with performing a deck evaluation.

When deck replacement is indicated due to condition for concrete T-beam spans or concrete slab spans, a deck replacement may not be practicable, and a complete superstructure replacement may be required. In some instances, an option to a superstructure replacement for these type superstructures with severely deteriorated decks is to estimate the cost of removing the entire top surface of the deck to 1" below the top mat of reinforcing steel and place a concrete overlay and compare that cost to a complete superstructure replacement (in such cases verify the location of the top mat of steel and the need for temporary support prior to performing work).

DECK EVALUATION - DECKS WITHOUT OVERLAYS:

When conducting the deck evaluation, obtain the necessary data and samples for the four categories shown below and evaluate in order of priority. The District Bridge Engineer may change the priorities of investigation based on his or her knowledge of the bridge.

The deck evaluation priorities are as follows:

Priority 1: Perform visual, sounding, and concrete cover depth measurements to more accurately assess total of previously repaired areas, spalls and delaminations, bottom of deck areas including deck overhangs with moderate to heavy cracking, moisture and/or efflorescence (not coinciding with surface issues). Determine delaminations in accordance with ASTM D4580-03 (2007). If surface spalls or delaminations > 15% of the total deck area or the total of all damaged areas identified is > 25%, then replacement is the preferred alternative. Otherwise, go to Priority 2.

Priority 2: Evaluate half-cell potentials in accordance with ASTM C876-09 except that survey readings shall be taken on a grid pattern of 5 feet by 5 feet. If half-cell potentials are greater (more negative) than -0.35V for an area > 15% of the total deck area, then deck is eligible for replacement. Determine the areas with half-cell potentials > -0.35V that do not coincide with the Priority 1 areas. If total of Priority 1 and Priority 2 areas is > 25%, then replacement is the preferred alternative. If < 25%, then go to Priority 3.

Priority 3: Perform a chloride content survey. Chloride content tests, in accordance with AASHTO T 260-97 (2005), Procedure A, shall be performed on concrete samples taken from the deck at random locations and at the approximate depth of the top layer of the reinforcing steel subject to the following restrictions:

a) Samples shall not be taken in areas where, according to the results of the half-cell potential survey, reinforcing steel corrosion activity is high (readings more negative than -0.35V),
b) Samples shall not be taken in spalled or delaminated areas,
c) A minimum of 10 samples per bridge should be taken or, for bridges with three spans or more, four samples shall be taken in each span.

DECK EVALUATION - DECKS WITHOUT OVERLAYS (continued):

If chloride content exceeds 2 lbs. per c.y. for any measured area > 5 % of the deck, and the reinforcement is exhibiting advanced section loss, then replacement is the preferred alternative. If total of Priority 1, Priority 2 and Priority 3 areas > 25%, then the deck is eligible for replacement.

If replacement of the deck has not been determined as the preferred alternative after completion of the Priority 3 evaluation, then estimate the cost to repair and overlay deck with latex, silica fume, A4 or other approved hydraulic cement concrete or epoxy concrete (include the cost of electro-chemical chloride extraction if applicable). If the cost exceeds 65% of the cost of a new deck, then replacement is the preferred alternative.

If replacement has not been determined to be the preferred alternative, go to Priority 4.

Priority 4: Obtain core samples to perform petrographic analysis and compressive strength tests in accordance with ASTM C42/C42M-04.

Perform petrographic analysis. If petrographic analysis reveals that the concrete has a depth of carbonation that reaches the top mat of reinforcement, inadequate air void system, or contains alkali-silica or alkali-carbonate reactive aggregate, perform an engineering assessment with respect to the degree of the problem. This assessment shall include, but not be limited to, the following:

- Age of structure
- Physical evidence such as over cambering of spans and degree of map cracking
- Problems encountered when performing previous repairs
- Use of an impermeable overlay

Consult with District Bridge Engineer for recommendation.

Perform compressive strength tests. If tests reveal strengths less than the 28-day design strength of the deck concrete, then assess need to determine structural adequacy. Assemble the following information:

- Concrete 28-day design strength
- Concrete compressive strength
- Present and future ADT
- Present and future ADTT

Consult with District Bridge Engineer for recommendation to:

- Replace the deck or
- Proceed with structural analysis to determine if non-posted service for an estimated 20-year design life of the deck can be obtained.

If rehabilitation of the deck is not eliminated as an option by the above criteria, then the deck shall be repaired and overlayed with a latex, silica fume, A4 or other approved hydraulic cement concrete or epoxy concrete, unless superstructure replacement or structure replacement controls. Consult with District Bridge Engineer for overlay recommendation.

DECK EVALUATION - DECKS WITHOUT OVERLAYS (continued):

For decks where the most significant deficiency is extensive active full depth cracks, consider an asphalt overlay with waterproofing membrane or carbon fiber crack sealing treatment. Do not apply gravity fill crack overlay or epoxy crack sealers. See the current Special Provision for Sealing Linear Cracks in Concrete Decks and Overlays Using Epoxy and Carbon Fiber Mesh (Number S404H00). Additional information can be found at the following links:

A link to the web page where this Special Provision:

http://www.virginiadot.org/business/resources/const/07RevDiv_IV.pdf

A link to the "VDOT Guide Manual for Causes and Repair of Cracks in Bridge Decks":

http://www.virginiadot.org/business/resources/const/GuideManCrackRepair.pdf

DECKS WITH OVERLAYS ON BRIDGES DETERMINED NOT TO BE WIDENED:

Asphalt Overlays:

Evaluate the overlay for replacement. Determine if the asphalt overlay has an impermeable waterproofing membrane. If so, determine whether it has failed (evidence of moisture or efflorescence on bottom of deck).

If the asphalt overlay is in good condition and has an effective impermeable membrane, proceed with evaluating the deck in accordance with the applicable sections of File Nos. 32.03-3 thru -6, decks without overlays. Perform initial cost assessment utilizing available information.

If the asphalt overlay is not in good condition, schedule the evaluation during resurfacing if practical (check Residency Paving Schedule). Proceed with evaluating the deck in accordance with File Nos. 32.03-3 thru -6, decks without overlays with due consideration of available data and the underside of the deck.

If the estimated cost to repair and overlay the deck plus the cost to remove the asphalt overlay plus the cost to perform the deck evaluation exceeds 65% of the cost of a new deck, replacement is the preferred alternative. Otherwise, consult with District Bridge Engineer on whether to proceed with removing the overlay, mill the approaches and perform deck evaluation.

Re-evaluate cost of rehabilitating the deck based on the deck evaluation.

Rehabilitate or replace the deck.

Recommended actions for evaluation of concrete decks with asphalt overlays.

- Perform visual survey of underside of deck
- Perform visual survey of top surface of asphalt overlay
- Perform chloride content and/or carbonation/petrographic survey
- Consider NDE method of evaluation (GPR in accordance with ASTM D 6087 - 08, Impact Echo) – contact Research Council for consultation

Latex/silica fume/A4/other hydraulic cement concrete or epoxy concrete overlays:

Evaluate the deck in accordance with File Nos. 32.03-3 thru -6, decks without overlays. For top of deck, refer to previous inspection reports, previous deck evaluations and repair plans if available. Remove portion of any suspect overlay to evaluate deck top.

Evaluate the overlay for repair or replacement. Overlay is eligible for replacement if > 20% of the overlay is delaminated and/or spalled or cost to patch failed areas exceeds 65% of the cost of a new overlay.

DECKS WITH OVERLAYS ON BRIDGES DETERMINED TO BE WIDENED:

Multiple age decks:

Decks built with a significant difference in time between phases of construction often results in different maintenance needs for each phase. An example of this is, when the older portion needs replacing, the newer widened portion may just be entering the repair/overlay phase. More maintenance mobilizations/interruptions with smaller quantities could result in higher life cycle costs than for a deck built in a single time frame. For bridge projects with an estimated cost greater than $2M, these costs shall be included in the life cycle cost analysis. User costs for delays should also be considered. For projects less than $2M, consult with District Bridge Engineer. See the Life Cycle Cost Analysis Guidelines, File Nos. 32.06-3 thru -5.

Asphalt overlays:

Remove the asphalt overlay, mill the approaches and proceed in evaluating the deck in accordance with File Nos. 32.03-3 thru -6, decks without overlays, or perform an evaluation in accordance with File No. 32.03-7, "Recommended actions for evaluation of concrete decks with asphalt overlays." Consult with District Structure and Bridge Engineer.

Latex/silica fume/A4/other hydraulic cement concrete overlays:

For bridges that are to be widened, a very significant percentage of the perimeter of the concrete overlays will be disturbed by removing the adjacent deck in order to widen the structure, upgrade/replace the parapet/railing and reconstruct or eliminate joints by using joint closures and/or deck extensions where practical. Experience has shown that this disturbance will result in an increase in delamination of the existing overlay in these areas, even when the overlay is in good condition, leading to premature failure of the overlay. In consideration of this possibility, estimate replacing the existing overlay with another latex, silica fume, A4 or other approved hydraulic cement concrete overlay.

Proceed in evaluating the deck in accordance with File Nos. 32.03-3 thru -6, decks without overlays. Remove portion of any suspect overlay to evaluate deck top.

Epoxy concrete overlays:

Estimate the cost of removing and replacing the existing overlay with another epoxy concrete overlay or with a latex, silica fume, A4 or other approved hydraulic cement concrete overlay. Consult with District Bridge Engineer.

Proceed in evaluating the deck in accordance with File Nos. 32.03-3 thru -6, decks without overlays.

SUPERSTRUCTURE REPAIR, REHABILITATION OR REPLACEMENT - OVERVIEW:

The superstructure shall be tentatively assessed to the extent possible with available information, including As-Built plans, repair plans, inspection reports, work done reports, previous superstructure evaluations and visual inspection to determine repair/preventative maintenance needs.

Consult with District Bridge Engineer to decide if scope of work will be preventative maintenance, repair or rehabilitation prior to proceeding with any superstructure evaluation.

STEEL SUPERSTRUCTURES:

An evaluation of a steel superstructure should begin with a review of the condition states, as reported in the most recent inspection reports. In general, the following activities will be associated with each condition state as indicated below:

Coated Steel

Condition State	Definition*	Suggested Action
1	No active corrosion, coating is sound	None
2	Little or no active corrosion	Spot Paint
3	Surface or freckled rust is present	Spot/Zone Paint
4	Section loss due to active corr. does not warrant analysis	Repaint
5	Corrosion is advanced	Consider Replacement or Rehabilitation

Uncoated Steel

Condition State	Definition*	Suggested Action
1	Little or no active corrosion	Spot Paint
2	Surface or freckled rust is present	Spot/Zone Paint
3	Section loss due to active corr. does not warrant analysis	Repaint
4	Corrosion is advanced	Consider Replacement or Rehabilitation

*See VDOT's *Element Collection Data Manual* for full descriptions:

(http://www.virginiadot.org/business/resources/PONTIS_Element_Data_Collection_Manual_Modified_by_VDOT.pdf)

The evaluation of a coated steel superstructure involves the consideration of both the steel and coating system. In general, when the coating system is beginning to fail (Condition States 2 and 3) spot or zone painting is indicated as the preferred action. Once a coated structure reaches Condition State 4, or an uncoated structure reaches Condition State 3, a more extensive coating effort is required. Portions of coated structures in Condition State 5 or uncoated structures in Condition State 4 should be evaluated for rehabilitation or removal.

STEEL SUPERSTRUCTURES (cont'd):

For coated structures with a significant portion of the superstructure in Condition State 5 or uncoated structures with a significant portion of the superstructure in Condition State 4, estimate the cost of rehabilitating the existing superstructure (with or without widening) versus the cost of total replacement of the superstructure (with or without widening).

The cost analysis of rehabilitating the existing steel superstructure should include, but not be limited to, the following (as applicable):

- Rehabilitating or replacing the deck as determined under File Nos. 32.03-1 thru -8
- Effects associated with the elimination of deck joints
- Recoating of the structural steel if needed
- Repairing areas with section loss and retrofitting all fracture critical and/or fatigue prone details
- Strengthening, if necessary, to provide non-posted service for an estimated 40-year design life
- Replacing severely corroded or non-functional bearings
- Adding redundancy
- Temporary support of the superstructure due to rehabilitating or replacing the substructure (e.g. blocking and jacking to perform seat repair or towers to support the superstructure)
- Seismic retrofit if needed
- Replacing or eliminating approach slabs that extend over backwalls. In these cases, the joint material bears directly against bridge deck and end of approach slab. If settlement occurs, the joint opens up.

If the cost of rehabilitation (with or without widening) is less than 65% of the cost of a new superstructure, then rehabilitate the existing superstructure unless bridge replacement controls (see relative issues on File No. 32.02-2).

If rehabilitation is indicated as the preferred alternative, the designer must evaluate the structure for the feasibility of eliminating all deck joints, including joints at backwalls. If feasible, deck joints shall be removed in conjunction with the superstructure rehabilitation work. If joint elimination is determined to be not feasible, justification for any remaining joints shall be provided via email to the Assistant State Structure and Bridge Engineer for Maintenance and posted in IPM.

If the cost of rehabilitation (with or without widening) exceeds 65% of the cost of a new superstructure, then superstructure is eligible for replacement unless bridge rehabilitation controls (see relative issues on File No. 32.02-2). If replacement is indicated as the preferred alternative, the replacement superstructure must eliminate deck joints.

If the superstructure is not rehabilitated or replaced, then perform necessary repairs/preventative maintenance.

Consult with District Bridge Engineer.

CONCRETE SUPERSTRUCTURES:

Estimate the cost of rehabilitating the existing superstructure (with or without widening) versus the cost of total replacement of the superstructure (with or without widening). The cost analysis of rehabilitating the existing concrete superstructure should consider the following as applicable:

- Rehabilitating or replacing the deck as determined under File Nos. 32.03-1 thru -8
- Effects associated with the elimination of deck joints
- Repairing prestressed or reinforced concrete beams and concrete slab spans
- Impact strengthening of prestressed or reinforced concrete beams using carbon fiber reinforcement on bridges spans with a history or high potential of vehicular impacts
- Mitigating effects of alkali-silica or alkali-carbonate reactive aggregate
- Replacing severely corroded or non-functional bearings
- Adding redundancy
- Temporary support of the superstructure due to rehabilitating or replacing the substructure (e.g. blocking and jacking to perform seat repair or towers to support the superstructure)
- Seismic retrofit if needed
- Replacing or eliminating approach slabs that extend over backwalls. In these cases, the joint material bears directly against bridge deck and end of approach slab. If settlement occurs, the joint opens up.

If the cost of rehabilitation (with or without widening) plus the cost of performing a concrete superstructure evaluation is less than 65% of the cost of a new superstructure, then a concrete superstructure evaluation may be performed unless bridge replacement controls (see relative issues on File No. 32.02-2). Consult with District Bridge Engineer.

If rehabilitation is indicated as the preferred alternative, the designer must evaluate the structure for the feasibility of eliminating all deck joints, including joints at backwalls. If feasible, deck joints shall be removed in conjunction with the superstructure rehabilitation work. If joint elimination is determined to be not feasible, justification for any remaining joints shall be provided via email to the Assistant State Structure and Bridge Engineer for Maintenance and posted in IPM.

If the cost of rehabilitation (with or without widening) plus the cost of performing the concrete evaluation exceeds 65% of the cost of a new superstructure, then superstructure is eligible for replacement unless bridge rehabilitation controls (see relative issues on File No. 32.02-2). If replacement is indicated as the preferred alternative, the replacement superstructure must eliminate deck joints.

If the superstructure is not rehabilitated or replaced, then perform necessary repairs/preventative maintenance.

Consult with District Bridge Engineer.

CONCRETE SUPERSTRUCTURE EVALUATION:

An evaluation of a concrete superstructure should begin with a review the Condition States, as reported in the most recent inspection reports. In general, the following activities will be associated with each condition state as indicated below:

Prestressed Concrete

Condition State	Definition*	Suggested Action
1	Little or no deterioration	None
2	Minor deterioration	Monitor
3	Moderate deterioration	Evaluate and Patch affected Areas
4	Advanced deterioration	Consider Replacement or Rehabilitation

Reinforced Concrete

Condition State	Definition*	Suggested Action
1	Little or no deterioration	None
2	Minor deterioration	Monitor
3	Moderate deterioration	Evaluate and Patch affected Areas
4	Advanced deterioration	Consider Replacement or Rehabilitation

*See VDOT's *Element Collection Data Manual* for full descriptions.:

(http://www.virginiadot.org/business/resources/PONTIS_Element_Data_Collection_Manual_Modified_by_VDOT.pdf)

Evaluate the concrete superstructure to determine the condition of the concrete superstructure. Perform only those evaluations required to make an informed decision. The hierarchy of investigative needs is outlined below:

1. Perform detailed visual examination, including documentation and measurement of crack and spall locations and size as well as crack orientation. Make a judgment regarding the cause of any cracking. If cracks appear to be stress-induced (such as crack oriented at 45 degrees away from a support or cracks associated with a bridge strike) perform analysis of affected superstructure elements. Cracks and spalls caused by exposure to moisture and salts should be evaluated separately from stress-induced cracks. Chck prestressed elements for distress, excessive deflections or loss of prestress.

2. Sound and mark concrete surfaces to determine extent of delaminations.

3. Determine depth of cover of mild and prestressing steel.

4. Determine chloride content and/or carbonation depth in concrete. If indicated by visual evidence analyze for alkali-silica reactivity in the paste and aggregate.

5. If the strength of the concrete is suspect, such as may be the case with older, cast-in-place concrete tee beams, determine compressive strength of cores after careful determination of reinforcement locations.

CONCRETE SUPERSTRUCTURE EVALUATION (cont'd):

Perform an engineering assessment with respect to the degree of the problem. This assessment shall include, but not be limited to, the following:

- Age of structure
- Physical evidence from the investigation described above
- Problems encountered when performing previous repairs
- The practicality of remediation techniques, such as the use of waterproofing to limit the moisture content of the concrete

Consult with District Bridge Engineer for recommendation.

If compressive strength tests are performed and they reveal strengths less than the 28-day design strength of the concrete (or the assumed strength based on the vintage), then assess need to determine structural adequacy. Assemble the following information:

- Concrete 28-day design strength
- Concrete compressive strength
- Present and future ADT
- Present and future ADTT

Consult with District Bridge Engineer for recommendation to:

- Replace the superstructure or
- Proceed with structural analysis to determine if non-posted service for an estimated 40-year design life can be obtained.

Re-evaluate cost of rehabilitating the bridge (with or without widening) based on the concrete superstructure evaluation.

If the cost of rehabilitation (with or without widening) is less than 65% of the cost of a new superstructure, then rehabilitate the existing superstructure unless bridge replacement controls (see relative issues on File No. 32.02-2). The notes regarding joint removal on File No. 32.04-3 shall apply.

If the cost of rehabilitation (with or without widening) exceeds 65% of the cost of a new superstructure, then superstructure replacement is the preferred alternative unless bridge rehabilitation controls (see relative issues on File No. 32.02-2). The notes regarding joint removal on File No. 32.04-3 shall apply.

If the superstructure is not rehabilitated or replaced, then perform necessary repairs/preventative maintenance.

Consult with District Bridge Engineer.

CONCRETE SUBSTRUCTURE REPAIR, REHAB. OR REPLACEMENT:

OVERVIEW:

Substructure units should be examined for repair, rehabilitation or replacement on an individual basis. Furthermore, substructure foundations and neatwork shall be investigated independently. Substructures that exhibit instability shall be investigated by an engineer to determine the cause of the problem. Unstable foundations shall be evaluated for safety and a judgment must be made regarding the safety of the structure. Structures exhibiting slow deterioration or movement shall similarly be evaluated by an engineer for determination of cause. Cost/benefit of repair or remediation vs. structure replacement must be conducted. Substructure instability or failure caused by scour shall be investigated for hydraulic and hydrological vulnerability.

SUBSTRUCTURE FOUNDATIONS:

The initial investigation of substructure foundations shall include, but not be limited to the following, as applicable:

- For substructure foundations determined to be primarily on rock:
  - confirm integrity of foundations with respect to any differential settlement and/or undermining and/or footing deterioration.
  - estimate cost of any necessary repairs such as toe walls (walls formed alongside the footing that are cast monolithically with concrete placed beneath the footing to repair undermining) and include in rehabilitation estimate.
- For substructure foundations determined to be on firm material:
  - estimate cost of replacing any substructure unit where previous or calculated scour is at or below the top of the footing and include in rehabilitation estimate.
  - estimate cost of placing scour countermeasures at each appropriate substructure unit where previous or calculated scour is above the top of the footing and include in rehabilitation estimate.
- For substructure foundations on piling:
  - estimate cost of replacing any substructure unit where previous scour resulted in shifting or differential settlement of the footing and include in rehabilitation estimate.
  - estimate cost of placing scour countermeasures at each appropriate substructure unit where the previous scour has exposed the piling with no detrimental consequences and include in rehabilitation estimate.
- In addition, estimate the cost of a scour analysis of the existing bridge or superstructure replacement alternative and the cost of pile stability evaluations for each applicable substructure unit that will remain in place at this point. Include cost in rehabilitation estimate.

SUBSTRUCTURE NEATWORK:

The initial investigation of substructure neatwork shall include, but not be limited to, the following, as applicable:

- Determine substructure neatwork repair/preventative maintenance and rehabilitation needs based on information available and estimate cost.
- Estimate the cost of substructure neatwork evaluation.

Consult with District Bridge Engineer to determine if scope of work will be to repair or proceed with further evaluation.

Estimate cost of temporary support of the superstructure due to rehabilitating or replacing the substructure (e.g. blocking and jacking to perform seat repair or towers to support the superstructure). Include in superstructure rehabilitation, File Nos. 32.04-1 thru -5.

If superstructure rehabilitation/replacement cost plus the cost of substructure foundation rehabilitation plus the cost of scour analysis (if applicable) plus the cost of pile stability analyses (if applicable) plus the cost of substructure neatwork rehabilitation plus the cost of performing substructure neatwork evaluation exceeds 65% of the cost of a new bridge, then proceed to File Nos. 32.06-1 thru -5.

Otherwise, perform scour analysis (if applicable), substructure stability analyses (if applicable) and then re-evaluate substructure rehabilitation costs based on the analysis results.

If total of superstructure rehabilitation/replacement costs plus the cost of substructure foundation rehabilitation plus the cost of substructure neatwork rehabilitation plus the cost of performing the substructure neatwork evaluation exceeds 65% of the cost of a new bridge, then proceed to File Nos. 32.06-1 thru -5.

Otherwise, substructure neatwork evaluation may be performed unless bridge replacement controls.

Consult with District Bridge Engineer.

SUBSTRUCTURE NEATWORK EVALUATION:

For substructure units under continuous superstructures, perform visual and sounding surveys to determine amount and location of spalls and delaminations to determine repair quantities. Estimate cost and include in rehabilitation estimate.

For substructure units under joints, obtain the necessary data and samples as follows:

- Perform visual and sounding surveys to determine amount and location of spalls and delaminations to compute repair quantities. Mark all spalling and delaminated areas.

- Obtain the reinforcing steel cover, half-cell potentials, core samples and chloride samples from the representative areas for each substructure unit. For abutments, obtain information from backwall, seat and breastwall. For piers, obtain information from cap, stem, exterior and interior column.

SUBSTRUCTURE NEATWORK EVALUATION (cont'd):

The hierarchy of investigative needs is outlined below:

1. Perform detailed visual examination, including documentation and measurement of crack and spall locations and size as well as crack orientation. Make a judgment regarding the cause of any cracking. If cracks appear to be stress-induced (such as crack oriented at 45 degrees away from a support or cracks associated with a bridge strike) perform analysis of affected substructure elements. Cracks and spalls caused by exposure to moisture and salts should be evaluated separately from stress-induced cracks.
2. Sound and mark concrete surfaces to determine extent of delaminations.
3. Determine depth of cover of reinforcing steel.
4. Determine chloride content and/or carbonation depth in concrete. If indicated by visual evidence, analyze for alkali-silica reactivity in the paste and aggregate.
5. If the strength of the concrete is suspect, determine compressive strength of cores after careful determination of reinforcement locations.
6. If an unreinforced concrete substructure element is acting in flexure, determine if flexural cracking (if visible) requires remediation.

Evaluation of substructures should include a review of the Condition States, as reported in the most recent inspection reports. In general, the following activities will be associated with each condition state as indicated below:

Reinforced Concrete Condition States (Pontis Elements 201 through 243)

Condition State	Definition*	Most Common Suggested Action
1	Little or no deterioration	None
2	Minor deterioration	Monitor
3	Moderate deterioration	Evaluate and patch affected areas
4	Advanced deterioration	Consider replacement or rehabilitation

*See VDOT's *Element Collection Data Manual* for full descriptions:

(http://www.virginiadot.org/business/resources/PONTIS_Element_Data_Collection_Manual_Modified_by_VDOT.pdf)

When performing the substructure neatwork evaluation, evaluate potentially higher cost items first. If at any point the total rehabilitation cost exceeds 65% of the cost of a new bridge, then proceed to File Nos. 32.06-1 thru -5.

If the chloride content exceeds 4 lbs. per c.y. and/or extensive corrosion is evident in any of the representative areas, then close the deck joint, consider electro chemical chloride extraction, thermally sprayed galvanic anode (aluminum zincindium) or other approved galvanic cathodic protection system for the affected areas of the substructure unit and repair. Where it is determined that the joint cannot be closed, repair the joint, consider the protection systems, repair and waterproof the substructure neatwork. Include cost in rehabilitation estimate.

SUBSTRUCTURE NEATWORK EVALUATION (cont'd):

Recommend performance of one petrographic analysis per substructure unit. If petrographic analysis reveals that the concrete contains alkali-silica or alkali-carbonate reactive aggregate, then perform an engineering assessment with respect to the degree of the problem to determine if substructure units should be replaced. This assessment shall include, but not be limited to, the following:

- Age of the structure
- Physical evidence such as the degree of map cracking
- Problems encountered when attempting previous repairs
- Use of waterproofing to limit the moisture content of the concrete

Consult with District Bridge Engineer for recommendation and re-estimate rehabilitation and/or substructure unit(s) replacement costs.

Perform compressive strength tests. If tests reveal strengths less than the 28-day design strength of the substructure concrete, then assess need to determine structural adequacy. Assemble the following information:

- Concrete 28-day design strength
- Concrete compressive strength
- Present and future ADT
- Present and future ADTT

Consult with District Bridge Engineer for recommendation to:

- replace the substructure unit(s) or
- proceed with structural analysis to determine if non-posted service for an estimated 40-year design life can be obtained. Re-estimate rehabilitation and/or replacement costs.

Consider application of epoxy or other waterproofing coatings to protect newly repaired substructure neatwork.

All substructure surface repairs on federally funded projects shall include galvanic anodes for individual patches. The use of galvanic anodes is also strongly encouraged for state funded projects.

In no instance shall substructure surface repairs be performed under non-functional (leaking) joints.

APPROACH SLABS:

Assess top of approach slabs in the same manner as the deck. See File Nos. 32.03-1 thru -8. Consult with District Bridge Engineer to determine if scope of work will be to repair and/or proceed with further evaluation, replace or eliminate.

- Estimate cost for preventative maintenance or repair/rehabilitation of structurally adequate approach slabs

- Estimate cost for replacement or elimination of approach slabs that extend over the backwalls and are in contact with the joint (see File Nos. 32.04-2 and -3), are structurally inadequate, are shifting away from the abutments or are experiencing other forms of failure.

REHABILITATION VS. REPLACEMENT GUIDELINES:

The cost of rehabilitating the existing bridge (with/without widening) shall include, but not be limited to, the cost of following:

- Rehabilitation or replacement of decks and associated evaluation costs as determined under File Nos. 32.03-1 thru -8.

- Rehabilitation or replacement of superstructure and associated evaluation costs as determined under File Nos. 32.04-1 thru -5.

- Rehabilitation or replacement of existing substructure elements and associated evaluation costs as determined in File Nos. 32.05-1 thru -4.

- Rehabilitation, replacement or elimination of approach slabs.

- Rehabilitation, replacement or elimination of joints.

At this point, all relative issues need to have been evaluated and considered in the scope of rehabilitation and/or replacement alternatives. See File No. 32.02-2.

If the cost of rehabilitation (with or without widening) is less than 65% of the cost of a new bridge, then rehabilitate the existing bridge unless bridge replacement controls.

If the cost of rehabilitation (with or without widening) is greater than 65% of the cost of a new bridge, then bridge is eligible for replacement unless bridge rehabilitation controls.

Sufficiency Rating (SR) < 50:

For bridges where the decision process has determined that replacement is the appropriate alternative and the SR < 50 and the structure is deficient, HBP funds can be used at the normal 80/20 Federal-to-State split and the amount of HBP funding allowed for approach work shall be in accordance with current IIM-S&B-83, Bridge Touchdown Points.

REHABILITATION VS. REPLACEMENT GUIDELINES (continued):

Sufficiency Rating 50 ≤ SR ≤ 80:

With the concurrence of the FHWA, the decision process outlined in this chapter has been structured to allow VDOT greater flexibility in utilizing HBP funds for the replacement of bridges with a SR ≥ 50 and ≤ 80.

The decision authority for utilizing HBP funds when the SR exceeds 50 is as follows:

50 ≤ SR < 60 - District Structure and Bridge Engineer
60 ≤ SR < 70 – State Structure and Bridge Engineer
70 ≤ SR ≤ 80 – FHWA

In consideration of the inherent uncertainties of estimating practices, the cost percentage determinations between bridge rehabilitation (RH) and bridge replacement (RP) are broken down into the following three ranges:

- First Range: RH/RP ratio less than 0.65. Preliminary choice is rehabilitation. Relative issues must have been examined to ensure compatibility with rehabilitation.

- Second Range: RH/RP ratio between 0.65 and 0.75. Rehabilitation or replacement may be preliminary choice. Relative issues must have been examined to establish the appropriate preferred alternative.

- Third Range: RH/RP ratio greater than 0.75. Preliminary choice is replacement. Relative issues must again be examined for compatibility with replacement.

When the SR is greater than or equal to 50 and less than or equal to 80, then HBP funds can be used for replacements based on the ratio of 50 to the actual SR of the bridge. However, the amount of HBP funding allowed for approach work is less and shall not exceed 10 percent of the estimated cost of the bridge. Approach work in excess of 10 percent requires funding from a different source.

Example: Actual SR = 60
Normal Federal participation = 80%
50/60 x100 x 0.8 = 66.7%
Funding split – Federal HBP funds = 66.7%
State funds = 33.3%
Approach cost shall not exceed 10% of the estimated cost of the bridge.

For each structure that is replaced utilizing HBP funds when the SR is greater than or equal to 50 and less than or equal to 80, a brief summary of the Sufficiency Rating, Condition Ratings, relative issues and cost analyzes substantiating the decision shall be provided to the Assistant State Structure and Bridge Engineer responsible for maintenance and copies provided to Programming Division and FHWA in accordance with the VDOT/FHWA Program Efficiencies Agreement.

LIFE CYCLE COST ANALYSIS GUIDELINES:

A life cycle cost analysis should be used when comparing alternatives of differing life expectancies and/or differing degrees of proficiency. A life cycle cost analysis shall be utilized for projects costing more than $2M. Life cycle cost comparison shall be made for a projected 50-year period. The FHWA provides a life cycle cost primer, fact sheet and Technical Bulletin. Information is available at:

http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm

In an effort to maintain consistency within the life-cycle cost analysis, the following criteria shall be used when applicable:

Element	Presumed Maintenance during Usable Life	Presumed Life
Thin-bonded overlays*		15 years
Rigid Overlays*	2% at 10 years and 2% patching every 2 years thereafter until 20 years	25 years
New Decks	Type B patching will be 1% at 40 years and 1% patching every 2 years until overlayed. Overlay deck at 50 years. Estimate 2% patching at time of overlay.	50 years
Widened/Multiple Age Decks	Use 50% higher unit costs for Type B patching.	Varies by structure
Painted Steel Superstructure	Estimate zone overpaint at 20 years. Estimate repaint at 40 years.	40 Years
Weathering Steel Superstructure	Away from joints & fascia girders – no action. Fascia girders and under –joints – same as painted steel.	Indefinite (away from joints). 40 years where painted
Substructures Away from Joints	Assume 1-2% per 50 years	100 years
Substructures Under Joints	Assume 1-2 % per 15 years	50 years

*Include costs for Type B Patching prior to initial installation of overlays

LIFE CYCLE COST ANALYSIS GUIDELINES (continued):

Substructure of a bridge over land/highway or non-tidal waterways:

1. If the substructure unit is under an existing and future joint, a preventative measure of one of the following cathodic protection methods should be considered:

    a. If deterioration and contamination is minor, then consider embedded galvanic anodes (Vector, Sika, Euclid, etc.) to extend life of patch repairs.

    b. If deterioration and contamination is moderate , then consider using one of the following:

        i. Thermally sprayed galvanic anode (aluminum-zinc-indium) – Estimate initial cost and cost of redoing every 10 years plus cost of 2% patching each time.

        ii. Thermally sprayed zinc plus homectant – Estimate initial cost and cost of redoing every 10 years plus the cost of 2% patching each time.

    c. If deterioration and contamination is extensive, then consider cathodic protection systems of galvanic jackets or bulk zinc anodes.

2. If the substructure unit is under an existing joint but will <u>not</u> be under a future joint (*i.e.,* under deck closures, deck extensions, continuous superstructures, etc.), then estimate 2% patching plus the cost of a preventative measure (one time treatment) of one of the following:

    a. Electrochemical chloride extraction.

    b. Thermally sprayed zinc plus humectant - Estimate initial cost and cost of redoing every 10 years plus the cost of 2% patching each time.

    c. Thermally sprayed galvanic anode (aluminum-zinc-indium).

Substructure of a bridge over tidal waterways or under unsuitable joints :

Consider cathodic protection systems of galvanic jackets or bulk zinc anodes and coating of vulnerable areas.

		LIFE CYCLE COST TABLE						
		INITIAL CONSTRUCTION COST *	LIFE CYCLE COSTS (PRESENT WORTH)		INITIAL COSTS + MAINT. COSTS (PW)	INITIAL COSTS + USER COSTS (PW)	TOTAL PRESENT WORTH (Initial Cost + Life Cycle Costs)	
			MAINTENANCE	USER				
ALT.	DESCRIPTION	A	B	C	A + B	A + C	A + B + C	RANK
1								
2								
3								
4								

*** Initial construction costs include structural items, Right of Way and utility costs.**

FEDERAL BRIDGE FUNDING SPREADSHEET

Activity	BRIDGE (HBRRP or HBP)	STP	NHS	IM
Federal Share	80/20	80/20	80/20	90/10
	Except Interstate 90/10			
Bridge Safety Inspection (NBI (Highway) Bridge)	Yes	FA	NHS	Interstate
Bridge Safety Inspection (Non-NBI Bridge)	No	FA	NHS	Interstate
Ancillary Structures Safety Inspection	No	FA	NHS	Interstate
Special Bridge Inspection Equipment	Eligible only if fund Bridge Safety Inspection with Bridge Funds	--	--	--
Preventive Maintenance (PM) / System Preservation		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Approved PM List	Approved PM List	Approved PM List	Approved PM List
	BMS/Systematic Process	BMS/Systematic Process	BMS/Systematic Process	BMS/Systematic Process
Minor Rehabilitation		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR <=80			
Safety Project		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)	Also Safety Funds	Also Safety Funds	Also Safety Funds
	SR <=80			
Major Rehabilitation		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR <=80			
	10 year rule			
	Reasonable touchdown points	Project Limits	Project Limits	Project Limits
	Bring Bridge to Standard	Bring Bridge to Standard	Bring Bridge to Standard	Bring Bridge to Standard

FEDERAL BRIDGE FUNDING SPREADSHEET

Activity	BRIDGE (HBRRP or HBP)	STP	NHS	IM
Replacement		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR < 50			
	10 year rule			
	Reasonable touchdown points	Project Limits	Project Limits	Project Limits
Bridge Widening		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR <= 80			
	10 year rule			
	Reasonable touchdown points	Project Limits	Project Limits	Project Limits
	Bring Bridge to Standard	Bring Bridge to Standard	Bring Bridge to Standard	Bring Bridge to Standard
Painting	See PM / System Preservation Activity			
Seismic Retrofit	NBI (Highway) Bridge			
Installation of Scour Countermeasures	NBI (Highway) Bridge			
Application of Calcium Magnesium Acetate or Sodium Acetate/Formate and other non-corrosive deicing chemicals	NBI (Highway) Bridge			
	Deficient Bridge List (SD or FO)			
	SR <= 80			
Preliminary Engineering for "non-PM / System Preservation"		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR <= 80			
Preliminary Engineering for "PM / System Preservation"	PM of NBI (Highway) Bridge			
Eligible Approach Work	Reasonable touchdown points	Project Limits	Project Limits	Project Limits
Right-of-Way (ROW)	Bridge and Reasonable Touchdown Points	Project Limits	Project Limits	Project Limits

FEDERAL BRIDGE FUNDING SPREADSHEET

Activity	BRIDGE (HBRRP or HBP)	STP	NHS	IM
SPECIAL ITEMS:				
Replace Deficient Bridge with Fill		FA	NHS	Interstate
	NBI (Highway) Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge	NBI/Non-NBI Bridge
	Deficient Bridge List (SD or FO)			
	SR < 50			
	10 year rule			
	Deficient Bridge Removed from Inventory			
	Bridge & Reasonable touchdown points	Project Limits	Project Limits	Project Limits
Replace Ferryboat Service -- (Must have been in existence on January 1, 1984)	Submit Request	FA	NHS	--
		Project Limits	Project Limits	
Replace Low-Water Crossings (Prepared Fords)	Submit Request	FA	--	--
	Meet Federal Definition for Low Water Crossing	Project Limits		
Tunnels	Not Eligible	FA	NHS	Interstate
		Project Limits	Project Limits	Project Limits
LEGEND:				
Surface Transportation Program Funds = STP				
Interstate Maintenance Program Funds = IM				
National Highway System Funds = NHS				
Preventive Maintenance = PM				
National Bridge Inventory = NBI				
Federal Aid = FA				
Structural Deficient = SD				
Functionally Obsolete = FO				
NBI (Highway) Bridge = Length greater than 20 feet (see Federal Regulations)				

U. S. Department
of Transportation

**Federal Highway
Administration**

Virginia Division
(804) 775-3320

400 North 8th Street, Room 750
Richmond, VA 23219-4825

November 8, 2010

Re: ELIGIBILITY OF PREVENTIVE MAINTENANCE ON FEDERAL-AID PROJECTS

Mr. Malcolm T. Kerley, P.E.
Chief Engineer
Virginia Department of Transportation
Richmond, Virginia

Dear Mr. Kerley:

This is in response to your February 12, 2010 request regarding eligible activities for Preventive Maintenance and System Preservation (PM). You requested that FHWA review and approve the inclusion of additional items to the FHWA/VDOT's 2009 list of examples of PM eligible activities.

To be eligible under the "Preventive Maintenance and System Preservation" line item in the Statewide Transportation Improvement Program (STIP), activities must be clearly of a preventive measure as opposed to reacting once a corrective action is required. Projects that address deficiencies in pavement structure or increase the capacity of the facility are not considered preventive maintenance. In no way shall preventive maintenance type projects adversely impact the safety of the traveled way or its users.

We have reviewed your proposal as well as the 2009 and previous 2006 letter agreements between FHWA and VDOT. We have determined that the following examples or Preventive Maintenance work can be added to the 2009 list:

1. Cleaning of drainage facilities (area wide program)
2. Concrete Pavement Restoration (CPR)
3. Place concrete mat along the flow line of steel pipe culverts (Bridge-related PM activities)

From these, CPR is not an activity by itself. CPR is a term normally used to describe work that includes any combination of the following six activities: (1) Full-depth repair of slabs, (2) Partial-depth repair of slabs, (3) Load transfer restoration, (4) Joint resealing, (5) Diamond grinding, and (6) Slab under-sealing. Break and set is not considered a preventive maintenance activity. This work is an effective pavement rehabilitation technique that will increase the

structural capacity of the facility by adding additional layers of pavement. This methodology is usually implemented to extend service life of a corridor between 15-20 years.

Please refer to the attached list summarizing examples of eligible PM activities as described above. We will continue to work with VDOT in developing additional guidance and establishing Preventive Maintenance programs as well as a Heavy Maintenance (3R) programs for each District. We will also review project development procedures for maintaining or enhancing safety of the facilities for each of these categories. In all we recognize that a streamlining of project development procedures for PM and 3R type projects is necessary to sustain VDOT's current organizational restructuring.

Feel free to contact Mr. Daniel Camacho, Field Operations Team Leader, at 804-775-3355 if you have any questions.

Sincerely,

Irene Rico
Division Administrator

By: Daniel Camacho, P.E.
Field Operations Team Leader

cc:
Mohammad Mishahi, P.E., Emmet Hetzel, P.E., Rodolfo Maruri, P.E.

Attachments:
2010 Examples of Preventive Maintenance Eligible Activities

2010 Examples of Eligible Preventive Maintenance activities

General/ Resurfacing Activities

1. Corrosion protection activities (Area wide program)
2. Highway sign face cleaning (Area wide program)
3. Cleaning of drainage facilities (Area wide program)
4. Shoulder pulling and wedging for pavement edge drop-off mitigation
5. Any corrective and/or restorative activity which extends the service life of pavement for 5-15 years:
    a. Milling and replacement of pavement materials (< 2.0 inches)
    b. Addition of a layer or layers of paving (< 2.0 inches)
    c. Replacing surface treatment materials with plant mix asphalt
    d. Concrete Pavement Restoration (CPR) activities:
        i. Full Depth slab repair
        ii. Partial Depth slab repair
        iii. Diamond grinding
        iv. Load transfer restoration / dowel bar retrofitting
        v. Joint resealing
        vi. Slab under-sealing / jacking/grouting
    e. Thin concrete overlay
    f. Crack sealing of mainline asphalt pavement or shoulders
    g. Applying surface treatments to mainline asphalt pavement or shoulders:
        i. Chip seals
        ii. Slurry seals
        iii. Latex-micro surfacing
        iv. Thin friction course
    h. Thin hot mix asphalt overlay (< 2.0 inches)

Bridge Related Activities

1. Seal or replace leaking joints, reconstruction of joint areas during joint replacement or elimination of deck joints.
2. Deck overlays.
    a. Thin bonded overlays
    b. rigid overlays
    c. asphalt overlays with waterproof membranes
3. Spot and zone painting/coating of structural steel to include bearings for prestressed concrete members.
4. Painting/coating of structural steel.
5. Cathodic Protection (CP) Systems for Bridge Decks.
6. Cathodic Protection Systems for Substructure Elements.
7. Cathodic Protection Systems for Superstructure Elements other than decks.
8. Electrochemical Chloride Extraction (ECE) Treatment for decks.
9. Electrochemical Chloride Extraction Treatment for substructure elements.
10. Scour countermeasures installation.
11. Removing large debris from channels.[2]
12. Retrofit of fracture critical members.
13. Retrofit of fatigue prone details.
14. Concrete deck repairs in conjunction with installation of deck overlays, CP systems, or ECE treatment.
15. Substructure concrete repairs in conjunction with installation of CP system in the

bridge element, ECE treatment of the element, or galvanic anodes in the element (when there are several sources or experimental basis when only one source). (Includes substructure units with cathodic protection jackets.)[2] Includes preventive maintenance of Piles using jackets in conjunction with Cathodic protection systems.[2]

16. Application of concrete sealants, coatings, and membranes for surface protection of the concrete.
17. Bridge cleaning and/or washing service.
    a. Decks
    b. joints
    c. drains
    d. superstructure
    e. substructure horizontal elements.
18. Concrete mat long the flow line of steel pipe culverts.

NOTE: When eligible substructure work and/or painting/coating of ends of girders under joint locations that are leaking, then it is required to have contract the same or following year to seal the joints.