NHDOT Bridge Program

Definitions of Program Strategies and Terms

Approved By: L Robert Landry

L. Robert Landry, PE
Chair, NHDOT Bridge Management Committee

Date: July 31, 2018

NHDOT Bridge Program

Definitions of Program Strategies and Terms

(I) Introduction

This document provides an overview of terms and strategies generally used in discussions regarding bridges in New Hampshire. This includes the various types of bridges, condition ratings, life-cycles and costs, actions to improve bridge condition, and compilations of specific bridges based on their associated characteristics. These data can then be used to make decisions regarding how the available bridge funds can be allocated effectively to maximize the service life and minimize the life cycle costs for bridges on the transportation network.

(II) State-Owned Bridges

- **Definition** – This bridge list, updated annually, is comprised of all state-owned bridges having a span of 10 feet or greater, as defined in *RSA 234.2 Bridge Defined,* and spans greater than 20 feet per FHWA regulations. All bridges on this list are inspected in accordance with NHDOT procedures and the FHWA National Bridge Inspection Standards (NBIS). It includes bridges owned by:

    - NHDOT [including the Bureau of Turnpikes and the Interstate Bridge Authority (IBA)]
    - NH Department of Natural & Cultural Resources, Division of Parks & Recreation
    - NH Department of Environmental Services (NHDES)

    This state-owned bridge list can also be separated into the following categories:

    - Highway bridges
    - Non Highway Bridges such as:
        - Closed/bypassed historic bridges;
        - Railroad bridges over roadways; and
        - Some state-owned bridges that support other traffic (pedestrian & recreational uses)
            - Railroad bridges over non-highway features are not included at this time

    It may also be separated into these categories, as defined later in this document:

    - State Red List
    - Future Rehabilitation & Replacement (R&R) List (State)
    - Rehabilitation & Replacement (R&R) List (State)
    - Future Preservation List (State)
    - Preservation List (State)
    - Non-Essential Bridge List

    Other bridge lists may also be developed and utilized, as defined later in this document.

- **Department's Perspective** – The intent of this list is to ensure that specific data, including current inspection data, for all state-owned bridges are included in the Bridge Management System so that all data are current for reference and decision-making, as well as for reporting to the Federal Highway Administration (FHWA) on an annual basis as required by state and federal laws and regulations.

  This information is used as a reference for state-owned bridges for maintenance, preservation, rehabilitation, or replacement projects, and enables the NHDOT to determine the most effective and efficient use of the funding available for bridge projects.

(III) Types of Bridges – Five (5) Major Categories of Bridge Types

(A) Girder Bridges

- **Definition** – Girder bridges generally refer to bridges that have girders, beams, or slabs as the primary structural member supporting the roadway surface of the bridge. The girders are most often made of steel or concrete (reinforced or prestressed). The following classifications and abbreviations of girder bridges are included in this category:

  - BAIB – Bailey or similar bridge
  - BGB – Beam Girder Bridge
  - CS – Concrete Slab
  - CTB – Concrete Tee Beam
  - DPG – Deck Plate Girder
  - IB – I-Beams without Deck
  - IB-BP – I-Beams with Bridge Plank
  - IB-C – I-Beams with Concrete Deck
  - IB-G – I-Beams with Steel Grid
  - IB-S – I-Beams with Steel Plate
  - INVER – Inverset I-Beam/Concrete
  - JACK – Jack Arch Concrete on I-Beams
  - NEBT – Prestressed Bulb Tee
  - NEXT – Northeast Extreme Tee
  - PBB – Prestressed Butted Boxes
  - PIB – Prestressed I-Beams
  - PSB – Prestressed Spread Boxes
  - PSC – Prestressed Concrete
  - PTB – Prestressed Tee Beams
  - PVS – Prestressed Voided Slabs
  - SRF – Steel Rigid Frame
  - TPG – Thru Plate Girder

- **Department's Perspective** – Girder bridges are generally used for crossings that require spans ranging from 20 feet to about 250 feet. The NHDOT bridge inventory data compiled through December 31, 2017 includes the following information:

GIRDER BRIDGES	No.	Percentage Based on:			Deck Area* (Sq. Ft.)	Percentage Based on:		
		Total No. of Girder Bridges	Total No. of Bridges by Ownership	Total No. of Bridges in Inventory		Total Deck Area of Girder Bridges	Total Deck Area by Ownership	Total Deck Area In the Inventory
State (Non-Turnpike)	1,147	57%	58%	30%	6,528,490	63%	84%	51%
State (Turnpike)	147	7%	86%	4%	2,121,468	20%	91%	17%
Municipal (and Other)	709	36%	42%	18%	1,746,292	17%	68%	14%
Totals:	**2,003**	**100%**	N/A	**52%**	**10,396,250**	**100%**	N/A	**82%**

* Includes NH portion only of bridge deck areas for bridges shared with adjoining states.

(B) Truss Bridges

- **Definition** – Truss bridges refer to structures comprised of comparatively smaller individual vertical, horizontal, or diagonal structural members assembled to form a framework to create an overall larger rigid bridge structure able to span much longer distances than the individual members. These bridges typically have spans of 50 feet to 500 feet and tend to be older than the majority of bridges in the state. Also, truss bridges often require postings for vertical and horizontal clearance restrictions.

  It is also important to note that these older truss bridges were usually constructed at a time when the cost of labor was relatively inexpensive when compared to the cost of steel and other construction materials. For this reason, efforts to design and construct a cost effective bridge at that time generally focused on keeping the size and thickness of structural steel members as small as possible to save material while still meeting design loading requirements. Although this cost approach resulted in an economically efficient bridge, the thinner members could deteriorate quickly once deicing materials (road salt) were used, thereby compromising the structural capacity of the overall bridge.

  For this reason, older deteriorated steel truss bridges frequently require load restrictions and postings, which also affect users of the transportation network. Thus, any work activity performed on truss bridges is generally more extensive and more costly than similar categories of work performed on other types of bridges. In addition, rehabilitation or replacement often becomes the only viable solution to address the extensive deficiencies that can develop in truss bridges, especially when the costs associated with complete removal of lead based paint and repainting the entire structure are also considered.

  The following classifications and abbreviations of truss bridges are included in this category:

  - DT – Deck Truss
  - HT – High Truss
  - LT – Low Truss
  - SA – Steel Arch

- **Department's Perspective** – Truss bridges are generally used for longer bridge crossings or when the roadway profile and span of the bridge requires that the framework of the truss be above the bridge deck to achieve the required under-clearance below the structure. Spans can range from about 50 feet to several hundred feet in length. The NHDOT bridge inventory data compiled through December 31, 2017 includes the following information:

TRUSS BRIDGES	No.	Percentage Based on:			Deck Area* (Sq. Ft.)	Percentage Based on:		
		Total No. of Truss Bridges	Total No. of Bridges by Ownership	Total No. of Bridges in Inventory		Total Deck Area of Truss Bridges	Total Deck Area by Ownership	Total Deck Area In the Inventory
State (Non-Turnpike)	39	50%	2%	1%	217,654	43%	3%	2%
State (Turnpike)	2	3%	1%	0.1%	118,781	23%	5%	1%
Municipal (and Other)	37	47%	2%	1%	172,051	34%	7%	1%
Totals:	**78**	**100%**	N/A	**2%**	**508,486**	**100%**	N/A	**4%**

* Includes NH portion only of bridge deck areas for bridges shared with adjoining states.

(C) Moveable Bridges

- **Definition** – Moveable bridges are structures that have at least one span that moves via mechanical/electrical means to open a waterway and allow marine vessels to pass through while closing the roadway to vehicular traffic. The moveable spans are typically made of steel members and may swing or lift to open. The opening for vessels has horizontal clearance restrictions and may or may not have vertical clearance restrictions, depending on the type of moveable bridge.

  The following classifications and abbreviations of moveable bridges are included in this category:

  - BAS – Bascule Span
  - LIFT – Vertical Lift

- **Department's Perspective** – Due to the complexity of these bridges and their comparatively high costs for maintenance and operation, moveable bridges are considered to be High Investment Bridges (HIBs). The NHDOT bridge inventory data compiled through December 31, 2017 includes the following information:

MOVEABLE BRIDGES	No.	Percentage Based on:			Deck Area* (Sq. Ft.)	Percentage Based on:		
		Total No. of Moveable Bridges	Total No. of Bridges by Ownership	Total No. of Bridges in Inventory		Total Deck Area of Moveable Bridges	Total Deck Area by Ownership	Total Deck Area In the Inventory
State (Non-Turnpike)	4	100%	<1%	<1%	121,474	100%	2%	1%
State (Turnpike)	0	0%	0%	0%	0	0%	0%	0%
Municipal (and Other)	0	0%	0%	0%	0	0%	0%	0%
Totals:	**4**	**100%**	N/A	**<1%**	**121,474**	**100%**	N/A	**1%**

* Includes NH portion only of bridge deck areas for bridges shared with adjoining states.

(D) Timber Bridges

- **Definition** – Timber bridges refer to bridges whose primary structural members are made of wood/timber material. These bridges may be smaller spans of 10 feet or more, up to long multi-span timber covered bridges.

  The following classifications and abbreviations of timber bridges are included in this category:

  - CTC – Concrete Timber Composite
  - IB-W – I-Beams with Wood Deck
  - TB – Timber Bridge
  - TB-C – Covered Bridge
  - TB-CS – Timber Bridge Concrete Slab
  - TS – Timber Slab
  - TS-P – Prestressed Timber Slabs

- **Department's Perspective** – Timber bridges are typically older structures in rural locations with low traffic volumes. These bridges generally require more work than other types of bridges of similar size. Covered bridges in particular are not typically designed to carry modern vehicular loads. The NHDOT bridge inventory data compiled through December 31, 2017 includes the following information:

TIMBER BRIDGES	No.	Percentage Based on:			Deck Area* (Sq. Ft.)	Percentage Based on:		
		Total No. of Timber Bridges	Total No. of Bridges by Ownership	Total No. of Bridges in Inventory		Total Deck Area of Timber Bridges	Total Deck Area by Ownership	Total Deck Area In the Inventory
State (Non-Turnpike)	38	15%	2%	1%	52,714	20%	<1%	<1%
State (Turnpike)	0	0%	0%	0%	0	0%	0%	0%
Municipal (and Other)	221	85%	13%	6%	208,007	80%	8%	2%
Totals:	**259**	**100%**	N/A	**7%**	**260,721**	**100%**	N/A	**2%**

* Includes NH portion only of bridge deck areas for bridges shared with adjoining states.

(E) Culvert Bridges

- **Definition** – Culvert bridges usually refer to smaller structures, typically having a single span and ranging from 10 feet to 30 feet. These bridges are most often used to convey small waterways or recreational trails under the roadway. Multi-cell culverts may also be utilized where appropriate. These bridges may be made of reinforced concrete, stone masonry, or metal plates (steel or aluminum), and may or may not have roadway fill material placed above them.

  Many larger reinforced concrete structures are also included in the "culvert" bridge category, including rigid frames and concrete arches, and may be precast or cast-in-place. These bridges usually have single spans ranging from 30 feet to 80 feet, but much longer multi-span reinforced concrete bridges are also included. These bridges also may or may not have roadway fill material placed above them. These reinforced concrete structures typically have a much longer service life than metal culverts that often deteriorate rapidly.

  The following classifications and abbreviations of culvert bridges are included in this category:

  - CA – Concrete Arch
  - CACUL – Concrete Arch Culvert
  - CAR – Concrete Arch Rib
  - CB – Concrete Box
  - CB-P – Concrete Box-Precast
  - CP – Concrete Pipe
  - CPP – Concrete Polymer Pipe
  - CRF – Concrete Rigid Frame
  - CRF-P – Concrete Rigid Frame-Precast
  - MA – Masonry Arch
  - MA-CA – Masonry and Conc. Arch
  - MP – Metal Pipe
  - MP-A – Metal Plate Arch
  - MP-B – Metal Plate Box Culvert
  - MS – Masonry Slab

- **Department's Perspective** – Culvert bridges can be pipes, arches, frames, or boxes, and could be 3-sided or 4-sided, often depending on the environmental requirements for the crossing. The NHDOT bridge inventory data compiled through December 31, 2017 includes the following information:

CULVERT BRIDGES	No.	Percentage Based on:			Deck Area* (Sq. Ft.)	Percentage Based on:		
		Total No. of Culvert Bridges	Total No. of Bridges by Ownership	Total No. of Bridges in Inventory		Total Deck Area of Culvert Bridges	Total Deck Area by Ownership	Total Deck Area In the Inventory
State (Non-Turnpike)	762	51%	38%	20%	888,320	63%	11%	7%
State (Turnpike)	22	1%	13%	<1%	92,414	6%	4%	1%
Municipal (and Other)	721	48%	43%	19%	440,149	31%	17%	3%
Totals:	**1,505**	**100%**	N/A	**39%**	**1,420,884**	**100%**	N/A	**11%**

* Includes NH portion only of bridge deck areas for bridges shared with adjoining states.

(IV) Categories of Bridge Condition – Red, Yellow, and Green

- **Definition** – A specific category is assigned to each bridge to establish "groups" of bridges, based on their condition and/or use, as described below. These groups may be further separated into "highway" and "non-highway" bridge categories, as noted below. (See *Section VII Bridge Data* for additional information.)

  In accordance with the National Bridge Inspection Standards (NBIS) of the Federal Highway Administration (FHWA), the major structural elements (deck, superstructure, substructure, or culvert) of a bridge each receive a condition rating ranging from "9", representing "excellent" condition, and "0", representing a "closed" bridge that has failed due to the extremely poor condition of its major structural elements. A major bridge element is considered to be in "poor" condition when its NBIS rating is "4" or less and it is placed on the State's Red List.

  Inspection of all state-owned and municipally-owned bridges is managed by the Bureau of Bridge Design, in accordance with applicable state and federal laws and regulations. The NHDOT Bridge Inspection staff performs nearly all inspections, with inspections of complex and/or moveable bridges typically performed by engineering consultants.

  Highway Bridges:

  - "Red" – All bridges carrying highway traffic that have one or more major structural elements with an NBIS rating of "4 = Poor" or less. These bridges comprise a portion of the state/municipal Red Lists.

  - "Yellow" – All bridges carrying highway traffic that have all major structural elements with an NBIS rating equal to or greater than "5 = Fair" or "6 = Satisfactory".

  - "Green" – All bridges carrying highway traffic that have all major structural elements with an NBIS rating equal to or greater than "7 = Good".

  Non-Highway Bridges:

  - "Red" – All non-highway bridges, e.g., pedestrian, recreational, railroad over roadways, etc., that have one or more major structural elements with an NBIS rating of "4 = Poor" or less. These bridges comprise a portion of the Red List.

  - "Yellow" – All non-highway bridges, e.g., pedestrian, recreational, railroad over roadways, etc., that have all major structural elements with an NBIS rating equal to or greater than "5 = Fair" or "6 = Satisfactory".

  - "Green" – All non-highway bridges, e.g., pedestrian, recreational, railroad over roadways, etc., that have all major structural elements with an NBIS rating equal to or greater than "7 = Good".

- **Department's Perspective** – These categories (red, yellow, and green) are used to graphically depict and compare the relative number of bridges and deck area in each category. When displayed in this manner, this information is especially helpful in conveying the overall status of all bridges, and can be used to track and display this status over time to indicate statewide

trends in bridge condition. These trends can be used as a basis for the allocation of available bridge funds for specific bridge projects in the Department's 10-Year Transportation Improvement Plan.

(V) Life Cycle of All Bridges

- **Definition** – A time period during which a bridge structure deteriorates due to use and environmental conditions affecting the physical condition and integrity of its elements and its ability to safely remain in service for efficient movement of goods and services. This life cycle can be extended through routine maintenance, preservation, and rehabilitation efforts to address identified deficiencies to the extent possible within funding constraints.

- **Department's Perspective** – As each bridge ages throughout its service life, it ideally receives four different levels of work, planned at specific intervals and performed when needed, all of which have the goal of extending the safe and efficient service life of the bridge as long as possible. The specific activities being performed periodically during the bridge's life are based on the various bridge characteristics pertinent to each bridge type. (See definitions of bridge types.) Current cost data extracted from appropriate bridge projects for which bid amounts have been received are compiled to develop base values for the cost to perform each repair activity during the bridge's life cycle. In general, these efforts are described as follows:

    - Bridge Maintenance – These tasks are performed routinely to prevent conditions from developing that would accelerate bridge deterioration.

    - Bridge Preservation – These tasks are planned at specified intervals over the service life of each bridge type to prevent deterioration from developing or expanding. This work is generally developed in two different areas; Pavement Preservation and Bridge Preservation, with each addressing specific deficiencies and preservation needs.

    - Bridge Rehabilitation – These tasks are planned at specified intervals over the service life of each bridge type and address more extensive deterioration of the major bridge elements.

    - Bridge Replacement – This effort involves replacement of the superstructure (girders and deck) or replacement of the entire bridge structure.

  Additional detail regarding the specific tasks being performed and their associated time intervals is presented further below in *Section VI - Strategies for Addressing Bridge Deficiencies*.

(VI) Strategies for Addressing Bridge Deficiencies

There are many options that may be chosen to address any deficiencies identified in a bridge. In addition, selected activities may be performed at different time intervals, depending on the specific deficiency being addressed. This section presents further detail regarding the specific tasks being accomplished and the frequency they are being performed. (For additional information, please see *NHDOT Bridge Program – Recommended Investment Strategy*.)

As noted above in *Section V - Life Cycle of All State Bridges*, actions performed at specific intervals during the bridge's life have the goal of extending the safe service life of the bridge as long as possible, while also reducing the life cycle costs of the bridge. A more detailed explanation of the four types of activities that address bridge deficiencies are presented further below.

Inspection data and records for each state-owned bridge is reviewed to determine the condition of the major bridge elements (deck, superstructure, and substructure) as a basis for developing schedules of when specific work activities should be performed. For new bridges, these work schedules should be developed once the bridge is completed and then followed throughout the life of the bridge to obtain the maximum service life and the lowest overall life cycle cost of the structure.

For older in-service bridges, work schedules are developed for the current condition of the bridge with the goal of addressing immediate preservation and/or rehabilitation needs. Once these tasks are completed, further bridge work would follow the recommended schedules for the specific work activities as outlined above. By utilizing this approach to bridge work, a priority list can be created to outline the future investment needs for state-owned bridges. Based on this information, decisions can be made for the best use of bridge funding allocated through the 10-Year Plan process.

Safety - It is important to note that specific activities may also be performed in conjunction with other efforts – maintenance, preservation, rehabilitation, or replacement – to address any safety-related deficiencies identified at the bridge site. These efforts ensure that a bridge remains safe for use by all members of the traveling public that traverse over or under the bridge. This includes replacement of bridge guard rail, repairing/arresting cracked or damaged structural members, removal of or protection from spalling concrete, superstructure repairs to remove weight limit postings, and installation of scour countermeasures. These efforts are completed by either Bridge Maintenance or by Bridge Design through the use of private contractors, depending on the extent of work required.

(A) Bridge Maintenance – Routine Actions to Maintain Bridge Condition

- **Definition** - A long-term strategy that uses a variety of small efforts to maintain the good condition of the overall bridge. Ideally, these efforts are performed on an annual basis to address small items so that they do not compound over time to create more extensive deficiencies that are much more costly to address. This level of work is generally low-cost, requires minimal time, and generally has a minor impact on traffic, usually only requiring lane shifts or lane closures with alternating one-way traffic.

- **Department's Perspective** – Like most structures, bridges last longer when timely investments are made at prescribed intervals for appropriate maintenance and preservation activities. For each bridge type (girder, truss, moveable, timber, and culvert), schedules have been developed for specific activities to be performed that, through experience, are shown to extend the bridge's service life. Routine maintenance is of primary importance with moveable bridges due to the intricacies of their design and operation.

  Maintenance tasks should be performed routinely to prevent conditions from developing that would accelerate bridge deterioration. The annual tasks include: sweeping and washing the bridge to remove dirt, debris, and deicing (road salt) residue; sealing the bridge substructure to prevent road salt infiltration; cleaning of bridge drainage systems; clearing vegetation; etc. Maintenance tasks are usually performed by the NHDOT Bridge Maintenance Bureau.

(B) Bridge Preservation – Extending the Service Life of Bridges

- **Definition** - A long-term strategy that uses a variety of mid-sized efforts to preserve selected bridge elements in a cost effective manner with the goal of extending the service life of the bridge. These efforts are applied at specific time intervals so that the bridge is able to continually provide full service to the traveling public. This level of work is comparatively low-cost and may have minor or mid-level impacts on traffic. These efforts are either completed by the Bridge Design Bureau through the use of private contractors selected through the bidding process or they may be completed by the Bridge Maintenance Bureau.

- **Department's Perspective** – Like most structures, bridges last longer when timely investments are made at prescribed intervals for appropriate preservation activities. For each bridge type (girder, truss, moveable, timber, and culvert), schedules have been developed for specific activities to be performed that, through experience, are shown to extend the bridge's service life and reduce the overall life cycle cost. These activities are outlined in specific categories, as noted below:

  - Pavement Preservation – This includes crack sealing of the pavement or installing a 1" pavement inlay of the bridge wearing surface. These efforts should generally be performed every 5 years for crack sealing and every 10 years for pavement inlay, and are coordinated with other more extensive bridge preservation efforts. This work is completed as part of the Pavement Program administered by the NHDOT Highway Design Bureau.

  - Bridge Preservation – This work may include: repairs to the substructure; partial and full depth deck patching; replacement of the expansion joints; replacement of the waterproofing membrane and bridge pavement; and; rehabilitation of the bearings. These efforts should generally be performed every 20 years to coincide with the anticipated service life of bridge expansion joints, and are completed as part of the Bridge Preservation Program administered by the NHDOT Bridge Design Bureau. Painting of the structural steel is also considered a preservation effort.

(C) Bridge Rehabilitation – Improving the Condition of Major Bridge Elements and Items

- **Definition** – A bridge project that significantly improves the condition of the major elements of a bridge so it can continue to safely provide full service to the traveling public while keeping the underlying structure in place. This level of work is generally of considerable cost and has a notable impact on traffic, sometimes requiring roadway closures, detours, or temporary bridges. These efforts are generally completed by the Bridge Design Bureau through the use of private contractors selected through the bidding process. Rehabilitation of smaller bridges on less traveled roadways may be completed by the Bridge Maintenance Bureau. These projects are developed as part of the Bridge Rehabilitation and Replacement Program administered by the NHDOT Bridge Management Committee.

- **Department's Perspective** – A bridge rehabilitation project requires considerably more work than scheduled preservation efforts, but does not require a new superstructure or a completely new bridge (replacement). Rehabilitation activities include complete deck replacement, including replacement of the expansion joints and/or bearings, replacement of pavement and waterproofing membrane, and rehabilitation of the superstructure and substructure. Bridge rehabilitation must be planned well in advance of when the effort is needed to allow time for public involvement, development of contract plans and documents, and for the allocation of required funds.

  This effort is generally performed once during the life of the bridge, anticipated to be at the mid-point of the bridge's projected service life. This work is completed as part of the Bridge Rehabilitation and Replacement Program administered by the NHDOT Bridge Design Bureau. This level of effort is performed when major elements of the bridge need to be rehabilitated, typically when at least one component has deteriorated to "Poor" condition (NBIS rating of "4" or less), but there is still service life remaining in the other bridge elements being retained.

(D) Bridge Replacement – Complete Replacement of Bridge Superstructure or Entire Bridge

- **Definition** – A one-time project that completely replaces the superstructure (girders and deck) along with major rehabilitation of the substructure, or a project that replaces an entire bridge with a new structure. Bridge replacement efforts are nearly always completed by the Bridge Design Bureau through the use of private contractors selected through the bidding process. Replacement of smaller bridges on less traveled roadways may be completed by the Bridge Maintenance Bureau. These projects are developed as part of the Bridge Rehabilitation and Replacement Program administered by the NHDOT Bridge Management Committee.

- **Department's Perspective** – Bridge replacement is needed when the entire bridge or bridge superstructure has deteriorated beyond a cost-effective rehabilitation. This high-cost work has a significant impact on traffic and often requires closures, detours, or temporary bridges. While this level of work cannot be completely avoided, it can be significantly postponed by applying effective maintenance, preservation, and rehabilitation strategies. Bridge replacement must be planned well in advance of when the effort is needed to allow time for public involvement, development of contract plans and documents, and allocation of required funds.

  It is noted that a bridge may be replaced for reasons other than its structural condition, e.g., to provide additional area of the hydraulic opening for the waterway or additional vertical clearance for the roadway under the bridge. A bridge may also be replaced to address

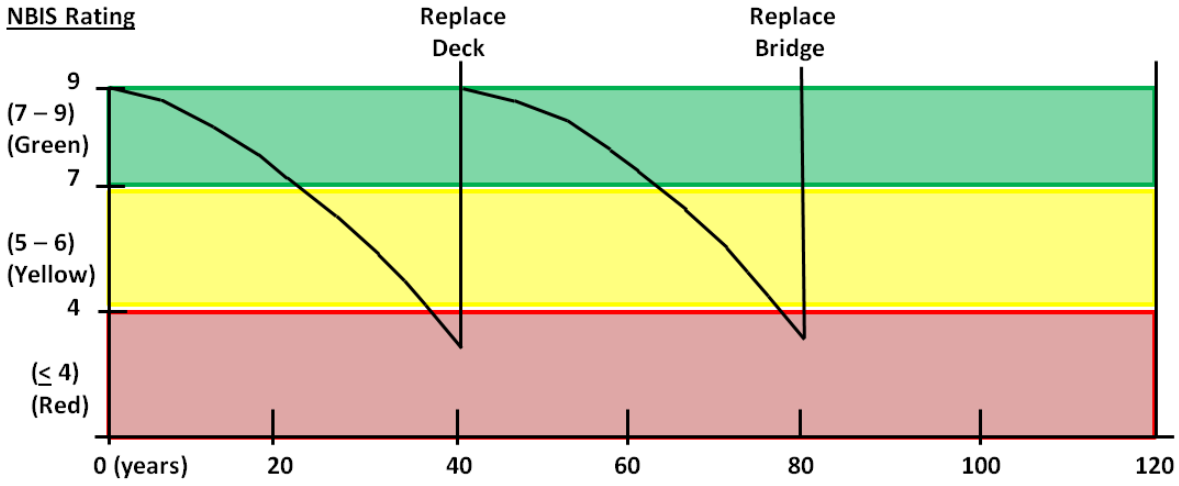
clearance restrictions, for roadway realignment, to expand or add travel lanes, or to address other safety or capacity issues.

(E) Benefits of Applying the Strategies to Address Bridge Deficiencies

As previously noted on page 7, the Bridge Design Bureau follows the NBIS to perform and determining bridge inspections and ratings, including the condition rating of major structural elements (deck, superstructure, substructure, or culvert) ranging from "9 = excellent", and "0 = closed". A major bridge element is considered to be in "poor" condition when its NBIS rating is "4 = Poor" or less, at which time it is placed on the State's Red List.

The following graphic depicts the typical life cycle and NBIS condition rating of the concrete deck over time for a typical bridge on which **only** maintenance work (sweep, wash, seal) and roadway preservation work (crack seal, pavement inlay) has been performed, and bridge preservation work (patch deck, replace expansion joints, bearings, etc.) has **not** been performed. As the bridge deck steadily deteriorates over time, it results in the life cycle of the deck being only 40 years.

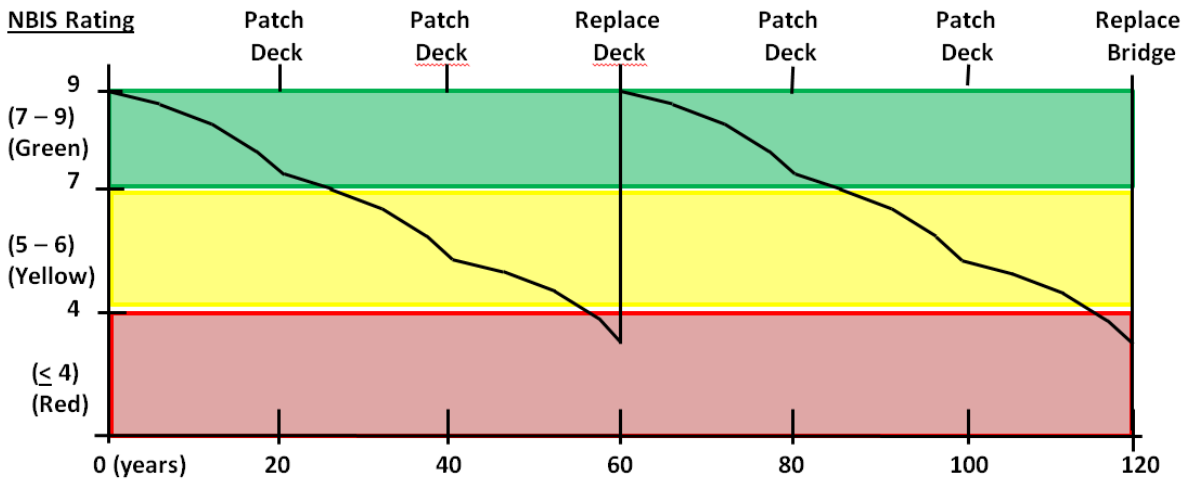
In addition, if deficiencies in the expansion joints are not addressed, leakage containing deicing salts will accelerate the deterioration of the bearings, abutments, and ends of the girders under the expansion joint. Further, since the bridge deck also serves to protect the girders and substructure, leakage of the expansion joints will cause these elements to also deteriorate more rapidly. Consequently, the overall service life of the entire bridge would be only 80 years due to accelerated rates of deterioration that result from lack of maintenance and preservation work to the deck, including the expansion joints.



Bridge Deck Condition over Time
(Girder Bridge – No Maintenance or Preservation Performed)

The following graphic depicts the projected life cycle and NBIS condition rating of the concrete deck over time for a typical girder bridge on which maintenance and preservation work has been performed in accordance with the NHDOT Bridge Management Committee's *Recommended Investment Strategy*. In this manner, the bridge deck remains in a state of good

repair, thereby extending the overall life cycle of the deck to 60 years, even though its condition and NBIS rating continue to decline between preservation activities.



Bridge Deck Condition over Time
(Girder Bridge – Scheduled Maintenance & Preservation Performed)

In reviewing the previous graphic, it can be seen that patching the bridge deck does not increase the NBIS rating for the deck. This follows the NBIS regulations which stipulate that the deck condition rating should not be increased, even though deteriorated concrete has been removed and replaced with "sound" concrete. The fact that the deck requires patching is interpreted to mean that the deck is still deficient. However, upon completion of the deck patching efforts, the deterioration rate of the deck has been slowed, so that the life cycle of the bridge deck can be extended to 60 years. This action also serves to protect the underlying structural components and extend their service life.

The NBIS condition ratings for the other major structural elements (superstructure, substructure) over time will follow a similar pattern, but the ratings will likely have different values as the major elements do not necessarily deteriorate at the same rate. Further, actions to address deficiencies may not be performed at the same time intervals. In general, the bridge deck will have the fastest rate of deterioration since it has more direct exposure to deicing materials (road salt) and overall wear from vehicular use.

A comparison of these two graphics shows the benefits in the overall performance of the bridge deck when timely maintenance and preservation activities are performed. Similar graphics would also apply to the condition and life cycle of the superstructure and substructure elements. A comparison of the financial investment required for each of these options would again demonstrate the significant cost savings that result from performing periodic maintenance, preservation, and rehabilitation activities rather than allowing a bridge to deteriorate prematurely.

(VII) Bridge Data

(A) Red List – Structurally Deficient Bridges

- **Definition** – A list of state-owned or municipally-owned bridges, updated annually, whose condition has deteriorated such that at least one major element (deck, superstructure, substructure, or culvert) is classified as being in "poor" condition (NBIS rating of "4" or less), and thus is categorized as "structurally deficient". The term "Red List" is defined in *RSA 234:25-a Red List Bridges* and corresponds to bridges having one or more major structural elements in the NBIS condition rating of "4 = Poor" or less. Red List bridges are still considered safe for use by the public, in accordance with any posted restrictions for weight. It is important to note that any bridge that cannot safely carry anticipated loads is down-posted to a safe load capacity, and any bridge that cannot safely carry loads of a reduced posting is immediately closed and barricaded.

- **Department's Perspective** – As each bridge ages, its condition will generally deteriorate over time due to exposure to the natural elements, deicing materials (road salt), and overall wear from use by the traveling public. A bridge is added to the Red List when it deteriorates to "poor" condition (NBIS rating of "4"), or less. Current state law (*RSA 234:25-b Inspection of Red List Bridges; Report*) requires that Red List bridges receive semi-annual inspections (two per year) for state-owned bridges and annual inspections (once per year) for municipal bridges. Bridges that are not on the Red List receive biennial inspections (once every two years), in accordance with FHWA requirements.

  The condition of the bridge may be improved and its service life extended through rehabilitation or replacement, depending on the severity of the deficiency. The rate at which bridges in "poor" condition are rehabilitated or replaced is directly dependent on the level of funding provided for this effort.

  It is the Department's goal to address the deficiencies in State Red List bridges in a timely manner, within funding constraints, to avoid safety concerns and/or unacceptable delays to emergency response vehicles, impacts to the traveling public or the overall transportation network, or other detrimental effects to the efficient movement of goods and services. Depending on the extent and severity of the deficiency, it is likely that extensive rehabilitation or complete replacement will be required to restore the bridge to full service and remove it from the Red List.

(B) Non-Essential State Bridge List

- **Definition** – A list, updated annually, of state-owned bridges on active highways whose closure has minimal impact to the state transportation network. These bridges generally have extremely short detours and low traffic volumes, and thus may be interpreted as providing minimal benefit to the state transportation system. It is important to note that any detour utilized will be on a state-maintained roadway having similar classification (quality) and functionality (capacity) to the roadway carried by the closed bridge.

  Due to their low use and obvious redundancy, when improvement activities are being considered (maintenance, preservation, rehabilitation, or reconstruction) the contribution of these bridges to the overall transportation network is evaluated to determine whether further investments of state resources are prudent.

All bypassed historic highway bridges that are open only for recreational use by the public are considered to be in the non-essential bridge category and will be reviewed as noted herein. If it is determined that a bridge is non-essential but will still remain in service, even temporarily, it is likely that only bridge inspections and safety-related maintenance activities will be performed.

- **Department's Perspective** – During the 1900s, the state transportation network was extensively developed and expanded to address the changing needs of the traveling public. As these roadways were improved to meet new design standards, the new roadways and their associated bridges were often constructed on new alignments, effectively bypassing segments of roadways and bridges, even though these bypassed segments were still used by the public. These relocations typically resulted in reducing the significance of the bypassed state-owned roadways and bridges so that they were no longer an integral part of the State's transportation system.

  As these bridges are identified, their non-essential status will be reviewed with the users and with the involved municipalities through an appropriate public forum. This effort will facilitate public input and discussion on the non-essential status to determine whether the specific roadway and/or bridge should be retained as part of the state transportation system, whether the ownership should be transferred to the municipality in which it is located, or whether it should simply be demolished and removed from the Bridge Inventory.

(C) Non-Highway State Bridge List

- **Definition** – This bridge group definition and list is intended to include all remaining state-owned non-highway bridges that are inspected by Bridge Design but are not part of any other NHDOT bridge list, such as:

  - Closed and bypassed historic bridges
  - Railroad bridges over roadways
  - Other bridges that carry non-highway traffic, i.e., pedestrians and/or recreational vehicles.

  Some of these bridges may be owned by state agencies other than the Department of Transportation.

  Closed or Bypassed Historic Bridges – These are bridges that typically have been bypassed by newer roadway realignment and construction. For this reason, they no longer carry vehicular highway traffic. Depending on their condition, they may be open for non-highway uses, or they may be closed and barricaded. Some of these bridges have recognized historic significance.

Example 1:	Dalton, NH – Lunenburg, VT 090/103
(Closed)	Whitcomb Bridge over Connecticut River
	Deck = "1"; Superstructure = "1"; Substructure = "1"; ("Closed; Failing")
	Bypassed historic bridge; Currently closed and barricaded.
Example 2:	Chesterfield, NH – Brattleboro, VT 040/095
(Closed)	Justice Harlan Stone Bridge
	NH Route 9 over Connecticut River
	Deck = "1"; Superstructure = "1"; Substructure = "1"; ("Closed; Failing")
	Bypassed historic bridge; Pedestrian Traffic Only.

NHDOT Railroad Bridges – These bridges are managed by the NHDOT Bureau of Rail & Transit and provide service on the state-owned NH Railroad line. Inspections, generally performed through the Bridge Design Bureau, are only performed for railroad bridges over highways.

Example 1: Conway 079/065
(NH RR) NH Railroad over Artist Falls Road
Deck = "8"; Superstructure = "8"; Substructure = "8"; ("Very Good")

Example 2: New Hampton 251/054
(NH RR) NH Railroad over Winona Road
Deck = "8=Very Good"; Superstructure = "7=Good"; Substructure = "7=Good";

NHDOT Recreational Bridges – These bridges are managed by the NHDOT. Inspections are performed through the Bridge Design Bureau.

Example 1: Franconia 134/085
(NHDOT Recreational) Bike Path over Lafayette Brook
Deck = "4=Poor"; Superstructure = "4=Poor"; Substructure = "5=Fair";

Example 2: Keene 122/099
(NHDOT Recreational) Recreation Trail over Ashuelot River
Deck = "7=Good"; Superstructure = "7=Good"; Substructure = "7=Good";

Recreational Bridges owned by other State Agencies – These bridges are managed by NH Department of Natural and Cultural Resources (NHDNCR) Division of Parks & Recreation or the NH Department of Environmental Services (NHDES). Inspections are performed through the Bridge Design Bureau.

Example 1: Lincoln 117/107
(Other Recreational) Basin Trail over Pemigewasset River
Deck = "7=Good"; Superstructure = "7=Good"; Substructure = "7=Good";

Example 2: Lincoln 142/109
(Other Recreational) Sentinel Pine Covered Bridge
Recreation Trail over Pemigewasset River
Deck = "7=Good"; Superstructure = "7=Good"; Substructure = "7=Good";

- **Department's Perspective** – A bridge on the Non-Highway List is not located on the highway system and therefore does not carry highway traffic. Some of these bridges may serve other transportation needs for railroads, pedestrians, or recreational users of these structures.

  Although these bridges do not carry highway traffic, they are regularly inspected and their condition is tracked and recorded. This effort ensures that these non-highway bridges are not overlooked, and that their structural integrity and safety are appropriately monitored. Bridges in this category may be preserved, maintained, rehabilitated, replaced, or demolished/removed, depending on their condition, use, and available funding sources, to ensure public safety.

(D) Future Preservation List

- **Definition** – A list of State bridges, updated annually, whose deck has an NBIS rating of "8 = Very Good" or "9 = Excellent".

- **Department's Perspective** – Bridges on this list are in a state of repair such that only maintenance efforts will be required in the near future, with anticipated preservation and rehabilitation efforts scheduled as appropriate for the bridge type. Based on this information, decisions can be made to schedule and program future bridge preservation funding, allocated through the 10-Year Plan process.

(E) Preservation List

- **Definition** – A list of State bridges, updated annually, having a deck NBIS rating of "5 = Fair" for less than 10 years, "6 = Satisfactory", or "7 = Good".

- **Department's Perspective** – Bridges on this list are in a state of repair such that preservation efforts will be required in the near future, with anticipated maintenance and rehabilitation efforts, based on the bridge type, scheduled per the *NHDOT Bridge Program – Recommended Investment Strategy*. Bridges within this list are ranked to determine the order in which their preservation needs should be addressed. Based on this information, decisions can be made to schedule and program bridge preservation funding, allocated through the 10-Year Plan process.

(F) Future Rehabilitation & Replacement List

- **Definition** – A list of State bridges, updated annually, meeting one or more of the following criteria:

    - Unacceptable chloride contamination determined through deck evaluation
    - Planned functional replacement (not related to condition of bridge)
    - Frequent expensive maintenance actions
    - Had two bridge preservation efforts since last deck replacement or had greater than 20% of full depth deck area patch in last deck preservation effort.

- **Department's Perspective** – Bridges on this list are in such a condition that preservation work is not appropriate, and they should only receive maintenance and safety related work. As their condition deteriorates further, rehabilitation and/or replacement activities can be completed as appropriate, after which maintenance and preservation work can be scheduled, as outlined above. Based on this information, decisions can be made to schedule and program future bridge rehabilitation and replacement funding, allocated through the 10-Year Plan process.

(G) Rehabilitation and Replacement (R&R) List

- **Definition** – A list of State bridges, updated annually, meeting one of the following criteria:

    - For any bridge: any major structural element with an NBIS rating of "4 = Poor" or less
    - For any bridge: a deck element NBIS rating of "5 = Fair" for more than 10 years
    - For fracture critical bridges: a superstructure element NBIS rating of "5 = Fair"
    - For multi-plate pipe structures: a culvert element NBIS rating of "5 = Fair"

- **Department's Perspective** – Bridges on this list are in such a condition that more extensive work is needed to restore them to "good" condition. These bridges are evaluated to determine the extent of rehabilitation activities, or whether replacement of the superstructure or of the entire bridge is warranted.

  A ranking of these bridges can then be developed to determine the order in which these deficiencies should be addressed. (See the *NHDOT Bridge Rehabilitation and Replacement Ranking Process* for more detail on the ranking criteria and the overall ranking process.)

  Upon completion of this work future maintenance and preservation activities can be scheduled, as outlined above. Based on this information, decisions can be made to also program bridge rehabilitation and replacement funding, allocated through the 10-Year Plan process.

(H) Bridge Painting List

- **Definition** – A list of State bridges, updated annually, that have steel members in their superstructure or substructure that are painted. In accordance with the AASHTO Guide Manual for Element Inspection , the condition of the paint protective coating is rated as being "1 = Good", "2 = Fair", "3 = Poor", or "4 = Severe". (These ratings apply to any protective coating for structural steel, including paint, galvanizing, weathering steel patina, or other corrosion inhibitor coating.) It is important to note that, for bridge elements, the "value" of the AASHTO paint ratings of "1" through "4" proceed, from "good" to "bad", in an opposite manner from the NBIS major element ratings of "0" through "9".

- **Department's Perspective** – Bridges on this list have a protective coating for steel in such a condition that efforts to address the coating deficiencies are warranted. Based on the condition of the coating, these bridges are ranked to determine the order in which they should be addressed.

  It is recognized that addressing deficiencies in the protective coating in a timely manner is more cost effective than replacing structural steel members, or the entire bridge superstructure, if the structural steel is allowed to deteriorate beyond the point of practicable repair. Based on this information, decisions can be made to schedule and program funding for bridge painting, currently provided through the Bridge Preservation efforts, as allocated through the 10-Year Plan process.

(I) High Investment Bridges (HIBs) – The Most Expensive Bridges in the State

- **Definition** – Any bridge, regardless of ownership or the type of roadway carried, that; has an existing deck area greater than 30,000 square feet; and/or; any moveable bridge. These bridges generally carry a large number of vehicles on a daily basis and/or serve as critical links between and within communities. Available detours of these bridges are usually long and/or are insufficient to accommodate the amount of traffic that would be detoured. The closure or loss of any one of these structures would create significant disruption to the traveling public and the overall efficiency of the state's transportation network. This type of bridge requires a significant financial commitment for its maintenance, preservation, and rehabilitation to successfully avoid the extensive disruption and extremely high cost of bridge replacement.

- **Department's Perspective** – The state has made a significant expenditure for the initial construction of High Investment Bridges (HIBs). The strategy for addressing the needs of HIBs is to ensure that these bridges can safely remain in service in a state of good repair as long as possible. Through this strategy, a bridge-specific detailed maintenance plan is needed for each HIB, including a higher priority ranking for all activities.

  HIBs are prioritized based on their high importance, regardless of the roadway tier on which they are located. While most HIBs are owned by the state, there are currently nine (9) HIBs that are municipally owned, such as the Loudon Road Bridge over the Merrimack River in Concord (Bridge ID: Concord 163/111).

(VIII) Summary

This overview presents the terms and strategies of the NHDOT Bridge Program. It includes the bridge types, condition ratings, life-cycles and costs, and actions to improve bridge condition. The various bridge lists describe characteristics and considerations for maintenance, preservation, rehabilitation, and replacement. These data are a basis for decisions to allocate bridge funds to effectively increase the overall condition rating of bridges in the state, to maintain and improve the transportation network, and provide mobility for its users for the delivery of goods and services throughout the state.