State of Good Repair (SGR) Program

Bridge Prioritization Formula

Current Formula for FY2018 Funding Round

Structure and Bridge Division

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Changes are shaded

August 31, 2018

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State of Good Repair (SGR) Overview

This document describes the scoring formula used to select bridges for funding under Virginia's State of Good Repair (SGR) program. The formula was developed to meet the Commonwealth Transportation Board's statutory obligation to develop a "priority ranking system" for the allocation of SGR funds. The Commonwealth Transportation Board's approval of the methodology met the requirements of the second enactment clause of HB 1887, Chapter 684 of the 2015 Acts of Assembly.

Bridges eligible for SGR funding are Structurally Deficient Structures in the National Bridge Inventory (NBI). The formula is based on five factors: Importance, Condition, Design Redundancy, Structure Capacity, and Cost Effectiveness.

SGR Bridge Prioritization Formula

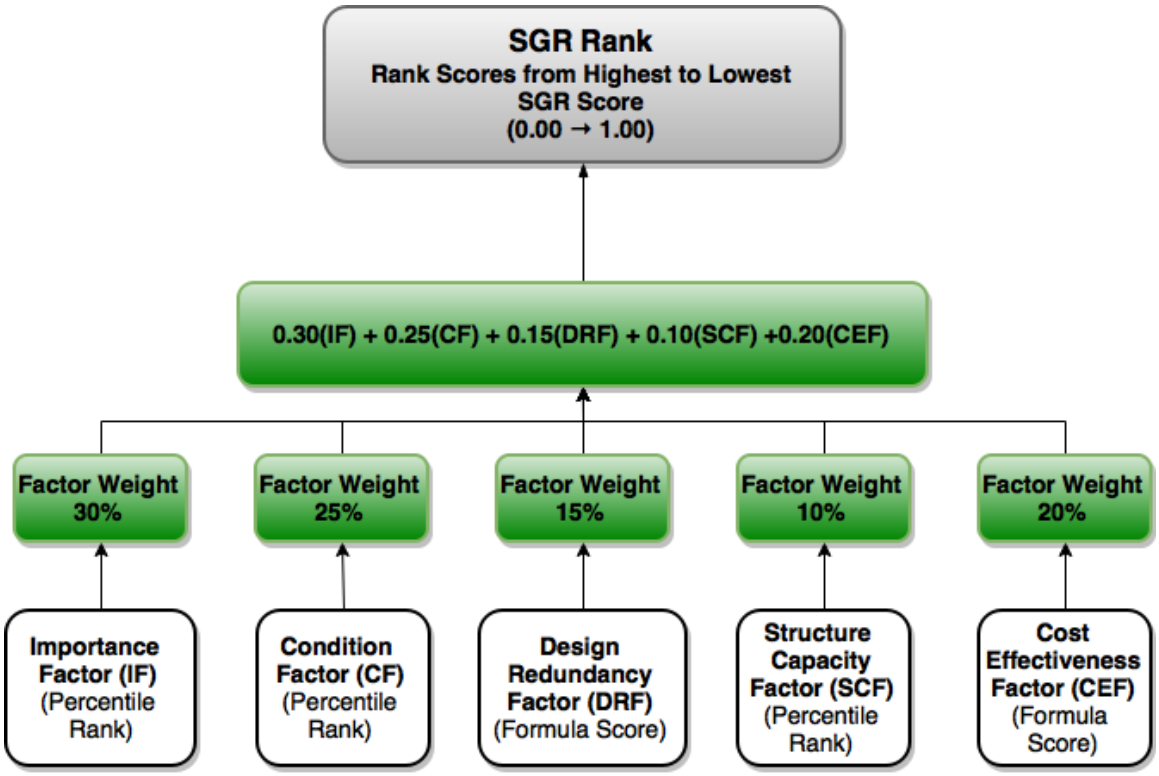
The State of Good Repair Program prioritization formula for bridges is comprised of five "factors" that measure importance, condition, redundancy, structure capacity, and cost-effectiveness. Each of these factors is multiplied by a "weighting" coefficient. The general form of the equation is:

Priority = a(**IF**) + b(**CF**) + c(D**RF**) + d(**SCF**) + e(**CEF**)

- Max = 1.0 (highest priority); Min = 0.0 (lowest priority)
- where a, b, c, d, e are weighting coefficients and ∑(a, b, c, d, e) = 1.0
- The methodology for computing each of the factors is described in the body of this document.

The formula is based on 5 unitless factors, each of which may vary from 0.00 to 1.00:

Figure 1 - MOPF Formula



IF = **Importance Factor -** measures the relative importance of each bridge to the overall highway network

CF = **Condition Factor –** measures the overall physical condition of each bridge based on the condition of each individual element

DRF = **Design Redundancy Factor -** measures four important risk factors: Fracture Critical (redundancy), Scour Susceptibility, Fatigue, and Earthquake vulnerability

SCF = Structure Capacity Factor- measures the capacity of the structure to convey traffic, including the effects of weight restrictions, vertical clearance and deck width

CEF = Cost-Effectiveness Factor - measures the cost-effectiveness of the required work

The factors only provide indication of relative significance. So, for example, a structure with a score of 0.62 is more significant than one with a score of 0.43 for the factor under consideration.

Coefficients are selected to prioritize agency goals and may be adjusted in future years by the CTB as priorities change. Coefficients currently in use are:

a = 0.30 (Importance)
b = 0.25 (Condition)
c = 0.15 (Design Redundancy)
d = 0.10 (Structure Capacity)
e = 0.20 (Cost-Effectiveness)

Importance Factor (IF)

IF = 0.30(**A**) + 0.10(**B**) + 0.15(C) + 0.20(**D**) + 0.05(**E**) + 0.20(**F**)

Each of the sub factors below are unitless and vary from 0 to 1.00:

- A = ADT Factor
- B = Future ADT Factor
- C = Truck ADT%
- D = Bypass Impact Factor – *measures effects of detours*
- E = National Highway System (NHS)
- F = Corridor of Statewide Significance

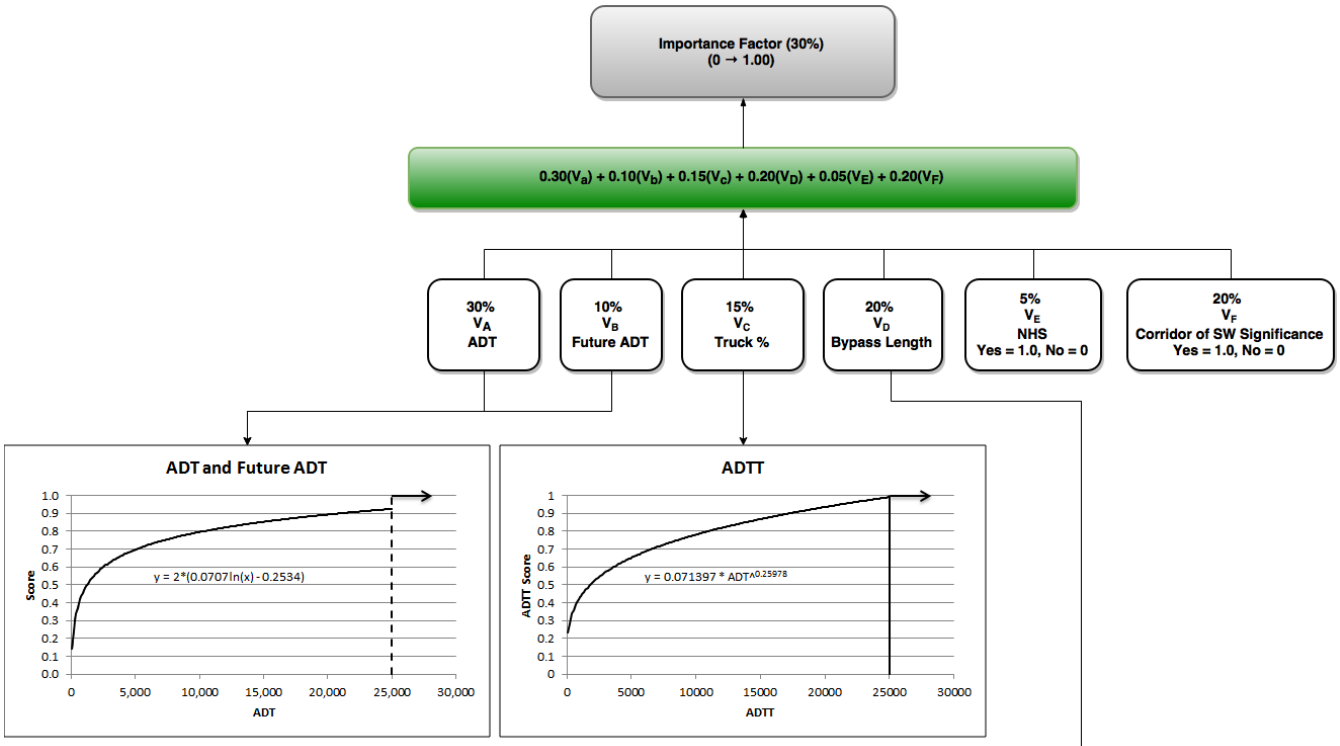
The subfactors for ADT, Future ADT, Truck ADT%, and Bypass Important Factor use a set of formulations developed as part of a study generated by the Virginia Transportation Research Council (VTRC). For more detail see "Methodology for Ranking Relative Importance of Structures to the Commonwealth's Roadway Network" – VTRC 16-R, April 2016 (link below).

http://www.virginiadot.org/vtrc/main/online_reports/pdf/16-r19.pdf

Details on the various data fields used in the IF sub factors are as outlined in the table below.

Federal Inventory Item No.	State Inventory Item No.	Inventory item title	Inventory item and abbreviation	Explanatory Variable related to inventory item
F29		ADTTOTAL	Total Average Daily Traffic (ADT)	ADT/LN, ADTT/LN, AGR(ADT), Bypass Impact
F30		ADTYEAR	Year of Average Daily Traffic (YADT)	AGR(ADT)
F114		ADTFUTURE	Future Average Daily Traffic (FADT)	
F115		ADTFUTYEAR	Year of Future Average Daily Traffic (YFADT)	
F109		TRUCKPCT	Average Daily Truck Traffic Percentage (ADTT)	ADTT/LN
F19		BYPASSLEN	Bypass Detour Length (BYP)	Bypass Impact, Access Impact
F12		ONBASENET	Base Highway Network (BHN)	Designated Networks
F100		DEFHWY	Strategic Highway Designation (STRAHNET)	
F110		TRUCKNET	Designated National Network (STAA)	
	S185	VA_HWY__SYS	Virginia Highway System (VSYS)	
F28A		LANES	Lanes on the Structure (LN)	ADT/LN, ADTT/LN

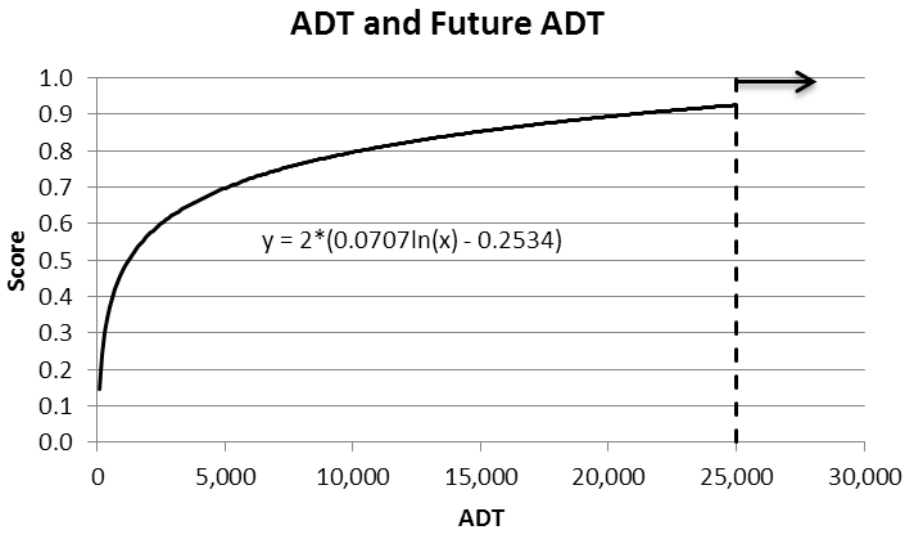
Figure 2 - Importance Factor



ADT_D	BYP_D (mi)					
	0	2	4	6	8.5	>8.5
85	0.06	0.18	0.24	0.29	0.44	0.56
175	0.11	0.23	0.29	0.34	0.49	0.61
300	0.15	0.27	0.33	0.38	0.53	0.65
525	0.19	0.31	0.37	0.42	0.57	0.69
1000	0.23	0.36	0.41	0.46	0.62	0.73
2200	0.29	0.41	0.47	0.52	0.67	0.79
5000	0.35	0.47	0.53	0.58	0.73	0.85
11000	0.40	0.53	0.58	0.63	0.79	0.90
25000	0.46	0.58	0.64	0.69	0.84	0.96
>25000	0.50	0.62	0.68	0.73	0.88	1.00

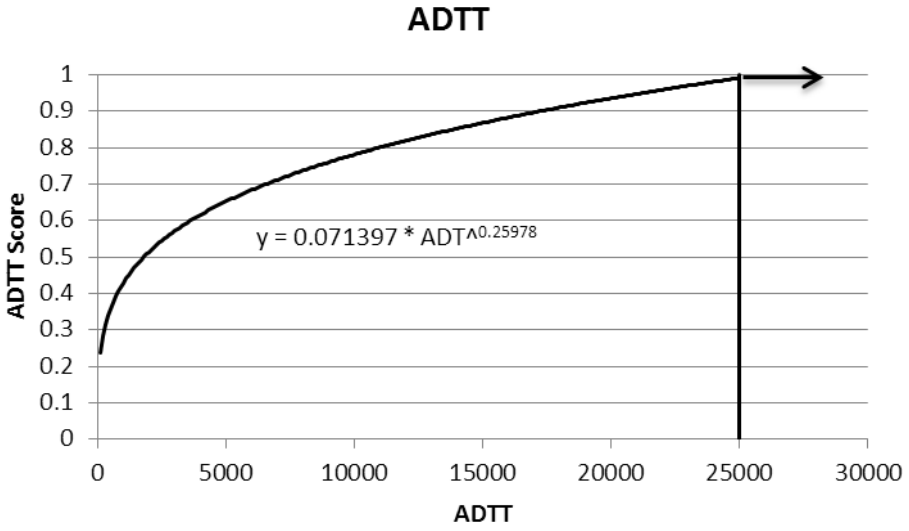
- **Sub Factor A and B** – Average Daily Traffic and Future Average Daily Traffic
  ADT and ADT Future values were organized into tenth percentiles and index values from 0 to 1.0 were assigned to each of the ten bins. From the trend-line, a continuous function for increasing index values was developed to correspond to increasing ADT and ADT Future values. ADT and ADT Future values below 50 were assigned an index value of 0 and values in excess of 25,000 were assigned an index value of 1.0. A step-function was adopted at the uppermost percentile because of the enormous range of ADT and ADT Future values above 25,000.

Figure 3 - ADT and Future ADT



- **Sub Factor C** Truck ADT%
  ADTT values were calculated based on the Truck Percent and ADT on the structure. ADTT values were organized into tenth percentiles and index values from 0 to 1.0 were assigned to each of the ten bins. From the trend-line, a continuous function for increasing index values was developed to correspond to increasing ADTT values. ADTT values below 50 were assigned an index value of 0 and values in excess of 25,000 were assigned an index value of 1.0. A step-function was adopted at the uppermost percentile because of the enormous range of ADT and ADT Future values above 25,000.

Figure 4 - ADTT



- **Sub Factor D** (Bypass Impact):
  - Interstate = 1.0

- Primary = 0.75
- Secondary, Urban, and Other = See table below.

The table below conveys the combined effect of a structure's ADT and its inventory Bypass in the potential event of closure of the structure to traffic. For more detail on the development of the table see "Methodology for Ranking Relative Importance of Structures to the Commonwealth's Roadway Network" – VTRC 16-R, April 2016.

Figure 5 - BYP (mi)

ADT_D	BYP_D (mi)					
	0	**2**	**4**	**6**	**8.5**	**>8.5**
85	0.06	0.18	0.24	0.29	0.44	0.56
175	0.11	0.23	0.29	0.34	0.49	0.61
300	0.15	0.27	0.33	0.38	0.53	0.65
525	0.19	0.31	0.37	0.42	0.57	0.69
1000	0.23	0.36	0.41	0.46	0.62	0.73
2200	0.29	0.41	0.47	0.52	0.67	0.79
5000	0.35	0.47	0.53	0.58	0.73	0.85
11000	0.40	0.53	0.58	0.63	0.79	0.90
25000	0.46	0.58	0.64	0.69	0.84	0.96
>25000	0.50	0.62	0.68	0.73	0.88	1.00

- **Sub Factor E and F,** the National Highway System and the Corridor of Statewide Significance, affect IF scores "as is" and are entered as 1 for "on" the network and 0 for "off" the network.

Condition Factor (CF)

CF = 1.0 – (Health Index/100)

For the time being, the Health Index (HI) as calculated by the BrM bridge management software is not reliable due to federally-mandated changes in the nature of the data that are used to calculate the index. VDOT is working to resolve this and intends to have the issue resolved prior to the next round of SGR funding. However, until in the interim, an approximate, Interim HI has been developed for use until the HI can again be calculated reliably and in an automated fashion. The interim HI uses a "Blended General Condition Rating (BGCR)" in lieu of an element-based calculation.

- B.GCR = Blended General Condition Rating = Bridge = 0.25(Deck GCR) + 0.35(Superstructure GCR) + 0.40(Substructure GCR) *for bridges*

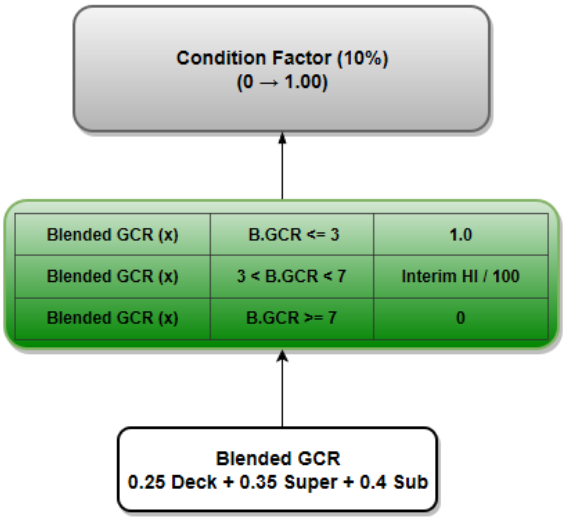
  OR

- B.GCR = 1.0(Culvert GCR) *for culverts*

  AND

- Interim HI = 100 – [100*(9 – B.GCR)^3)/(5.5^3))]

Figure 6 - Condition Factor

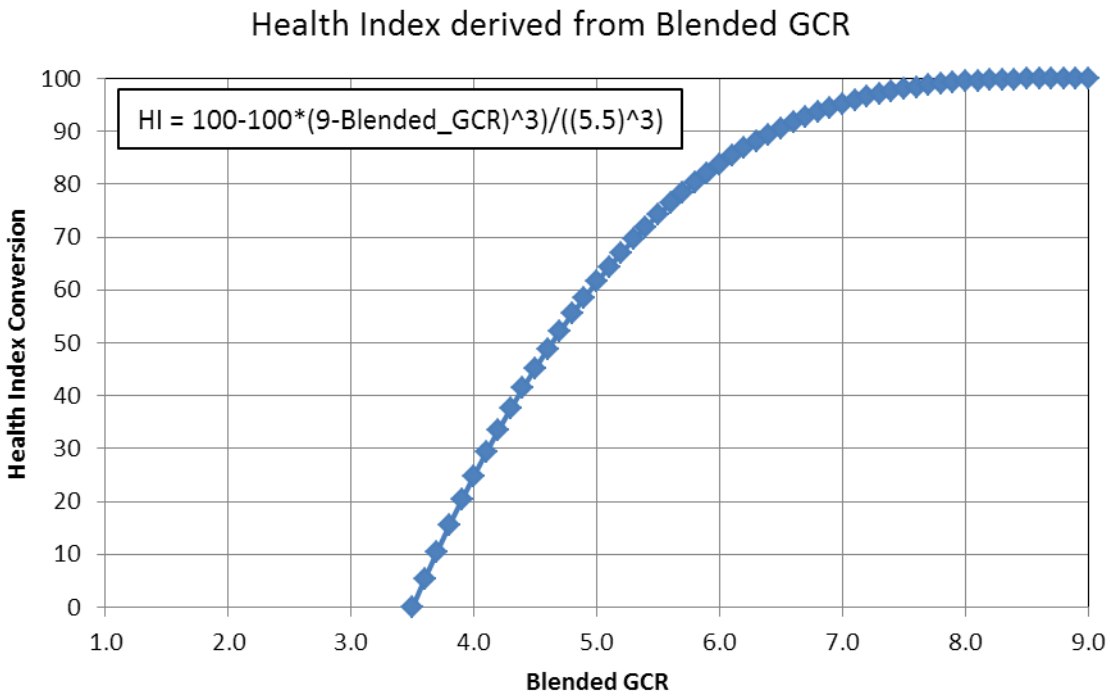


Previous Health Index in Dashboard (and Pontis 4.4)

The CF was previously based on the Health Index as published in VDOT's Dashboard. The Health Index in Dashboard is calculated in accordance with the AASHTO Pontis 4.4 Manual for the AASHTO CoRe Elements using element data from VDOT's Pontis 4.4 database. The Health Index in Dashboard is no longer stable since we have transitioned to AASHTO NBE elements and VDOT upgraded to BrM 5.2.

A graph depicting interim HI versus BGCR is provided below.

Figure 7 - Blended GCR vs. Interim Health Index



Future Use of Health Index

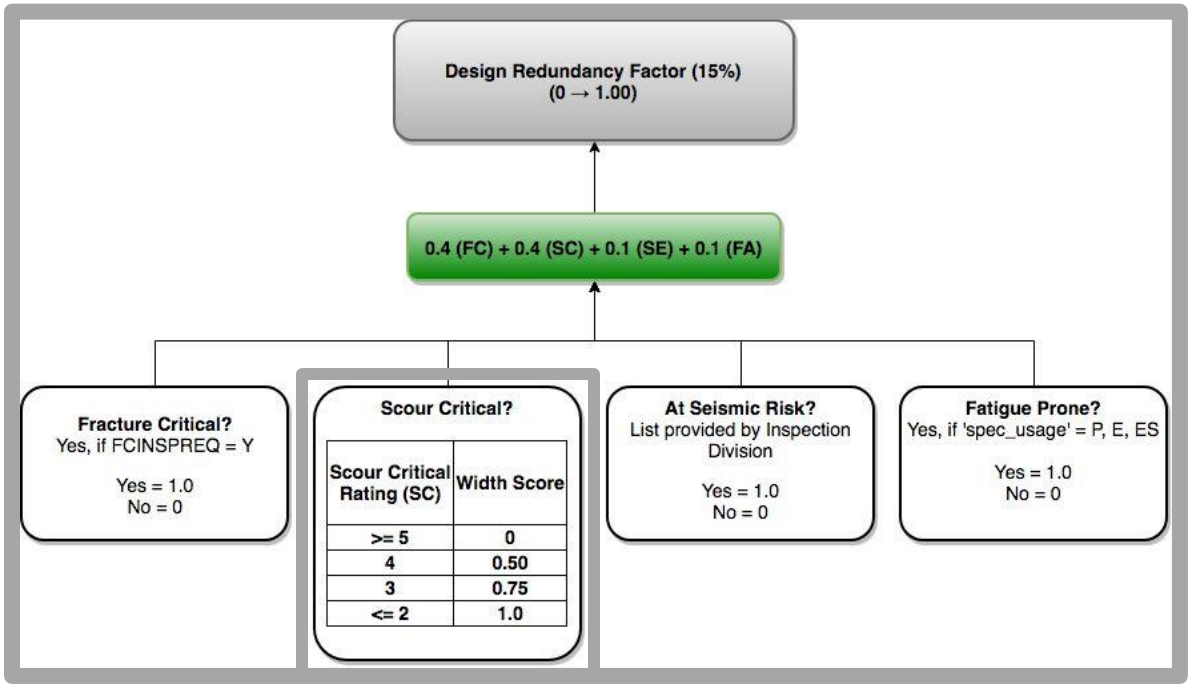
The S&B Division is in the process of calibrating a more rational and meaningful Health Index that is based on element level data, valuation, and service life. Ultimately, the Condition Factor will be based on the Health Index.

Design Redundancy Factor (DRF)

DRF = FC + SC + SE + FE

- FC = 0.40 if Fracture Critical
- SC = 0.40 if Scour Critical
- SE = 0.10 if Seismically vulnerable
- FE = 0.10 if Fatigue-prone details exist

Figure 8 - Design Redundancy Factor



FCINSPREQ = Federal Item 113 – Scour Critical Bridges

SCOURCRIT = Federal Item 92 – Critical Feature Inspection

Seismic Structure List – A legacy structure list provided by Inspection Division

SPEC_USAGE = State Item 12 – Special Use Code

P – Fatigue Prone

E – Electroslag welds

ES – Electroslag welds

Structure Capacity Factor (SCF)

SCF = 0.50(WRF) + 0.15(Waterway/Vertical Clearance Factor) + 0.35(Deck Width Factor)

- Weight Reduction Factor (WRF) = 0 to 1.0 score measuring ability of structure to carry Fire Trucks, Ambulances, School Buses and Design Vehicles
    - The Weight Reduction Factor measures the ability of structures to sustain important loadings of different varieties, including freight, emergency vehicles and buses. For more detail on the development of the WRF factor see "The Weight Restriction Factor: A Composite Score to Quantify a Structure's Current Load-Carrying Capacity in Commerce and Emergency Mobilization" – VTRC 16-R, April 2016.

- The Waterway Adequacy/Vertical Clearance (Federal Item 54) Factor measures the adequacy of vertical clearance for waterways, railways and trucks and may vary from 0 to 1.0. This factor takes into account the functional class of the roadway under the bridge (under record).

  The Functional Class of the roadway is one of the classes in the table below.

Rural		Urban	
Code	Description	Code	Description
01	Principal Arterial - Interstate	11	Principal Arterial - Interstate
02	Principal Arterial - Other	12	Principal Arterial - Other Freeways or Expressways
06	Minor Arterial	14	Other Principal Arterial
07	Major Collector	16	Minor Arterial
08	Minor Collector	17	Collector
09	Local	19	Local

- Deck Width Factor = 0 to 1.0 score measuring adequacy of deck width vs need

Figure 9 - Structure Capacity Factor

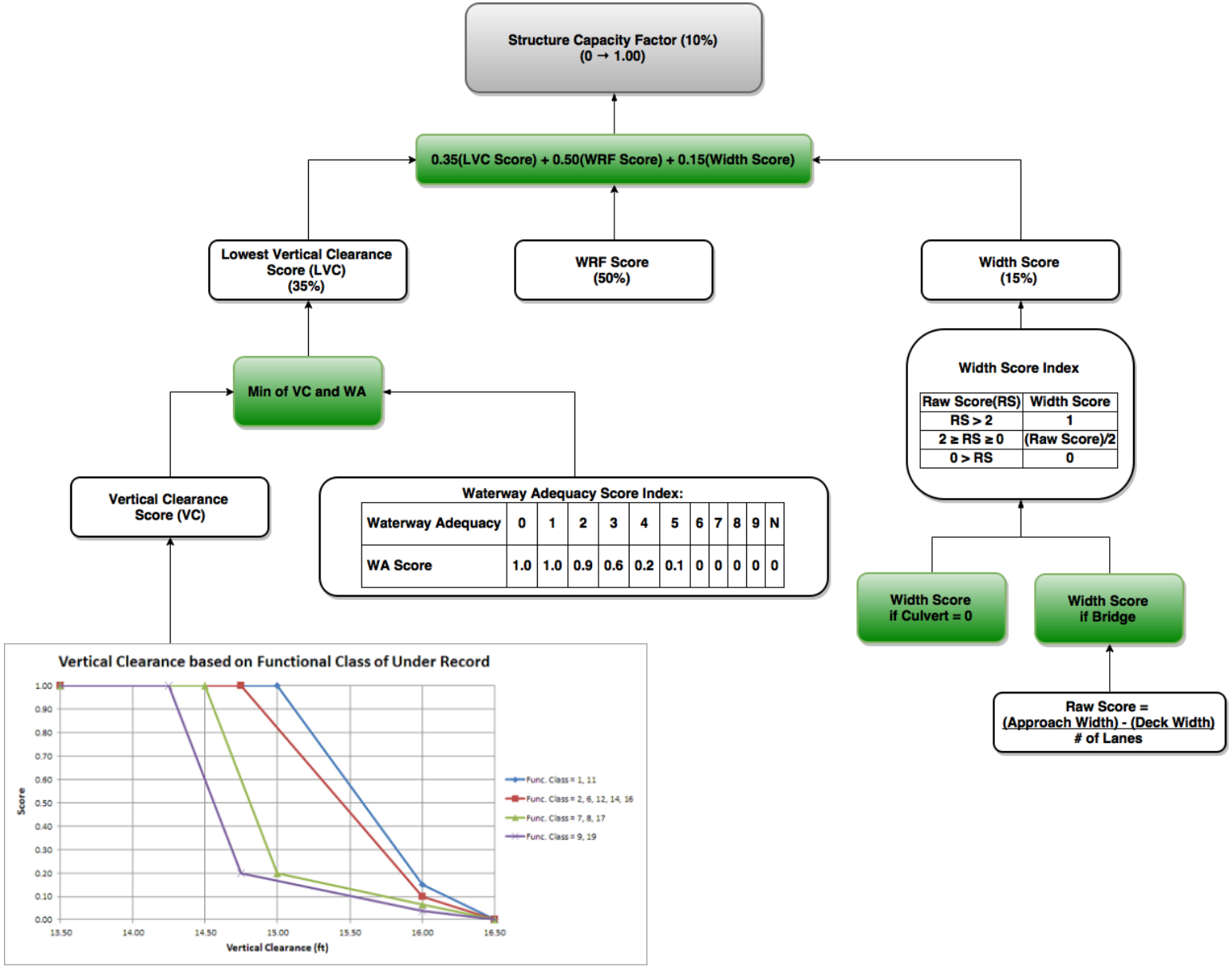
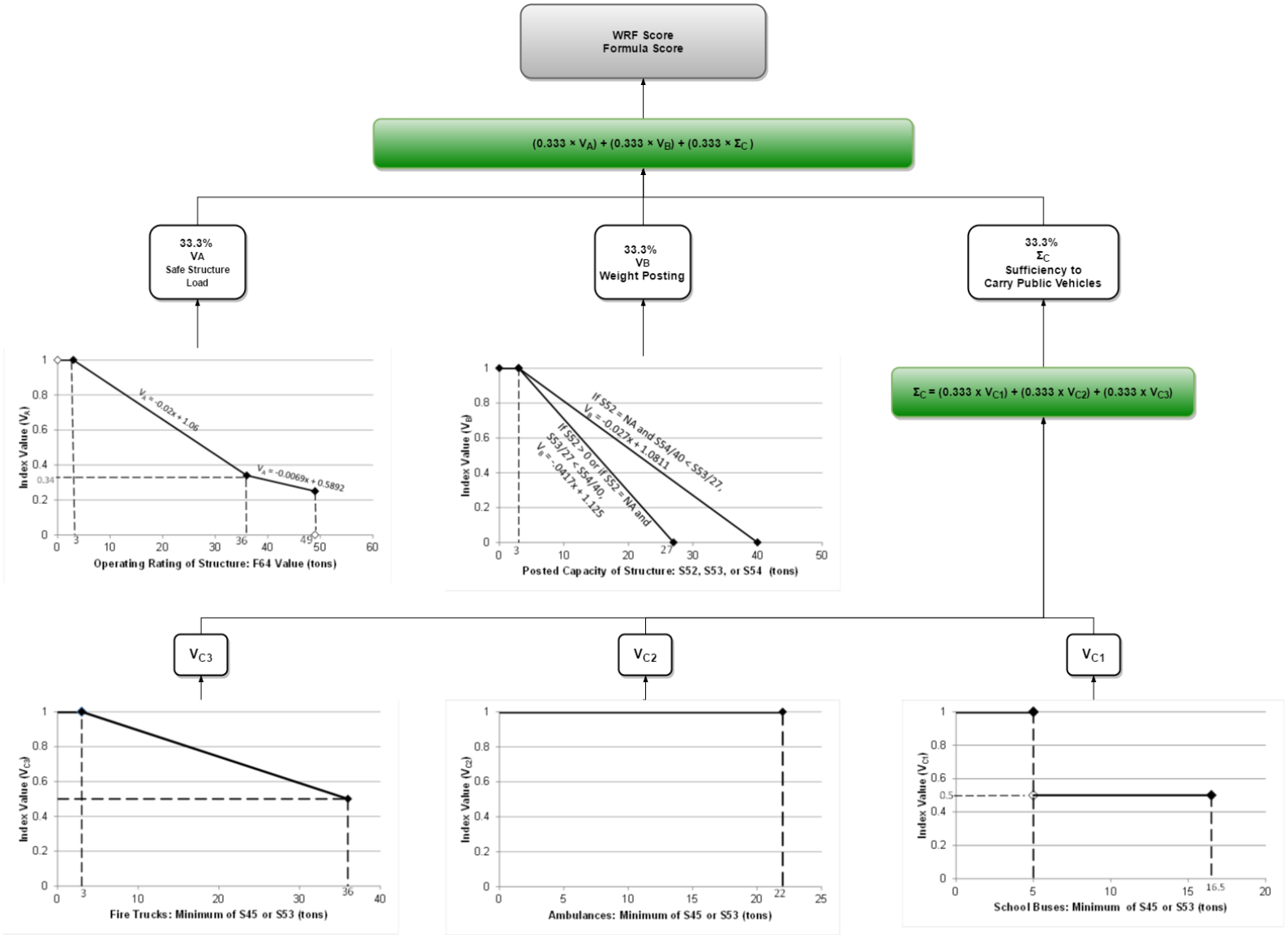


Figure 10 - WRF Score

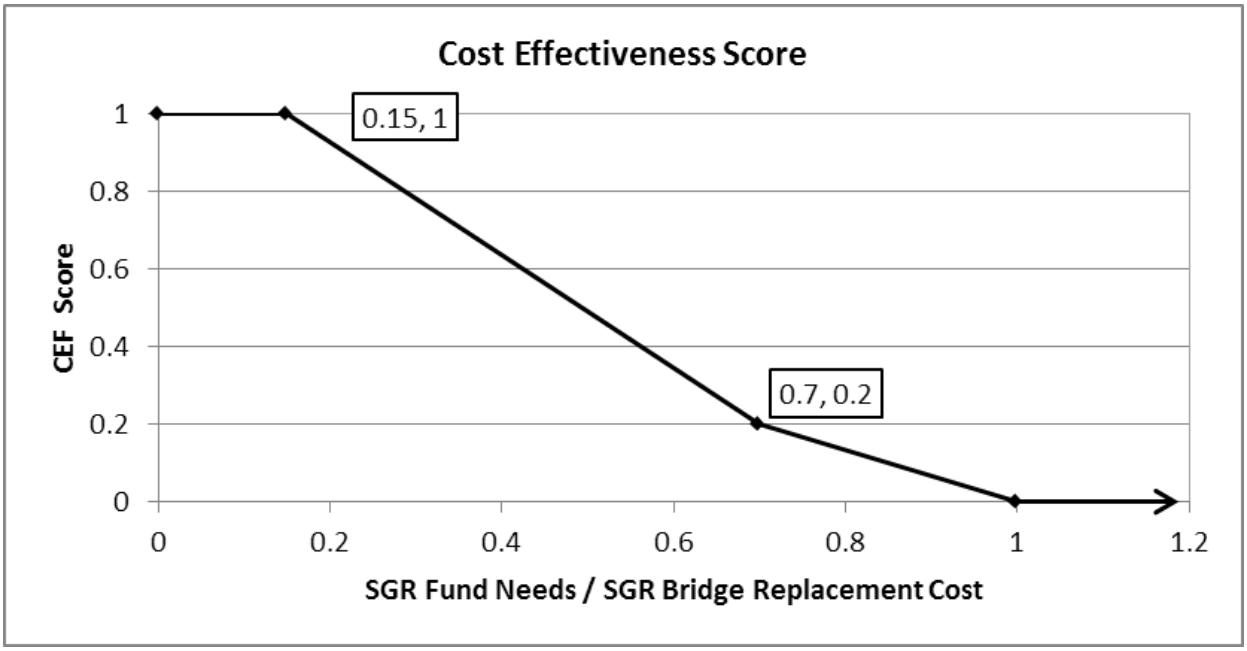


Cost-Effectiveness Factor (CEF)

CEF = a function of the ratio of Action Cost to Structure Replacement Cost

- **Action Cost = SGR Fund Request:** This is equal to the amount of SGR funding needed for the project (SGR Fund Request = SGR Project Cost Estimate - Other Funding)
- **SGR Bridge Replacement Cost Estimate:** Developed by bridge stewards and should include with estimates for preliminary engineering, right of way, growth, and construction inspection Estimates should be in general agreement with the Bridge Management System (BMS) estimates, which are based on statewide replacement cost averages.

Figure 11 – Cost-Effectiveness Score



Bridge stewards are responsible for providing the SGR Bridge Replacement Cost, the Total Project Estimate, and the Requested Funds. SGR Fund Request must equal the SGR Project Cost Estimate less other contributing funds. SGR Project Cost Estimates are based on actions recommended through the pre-scoping effort for SGR-eligible scope items as defined by I&IM S&B 95. When replacement is the recommended action the SGR Repair Cost Estimate will be equal to the SGR Bridge Replacement Cost Estimate. Estimated BMS costs are provided for reference. Central Office S&B, when appropriate, will review the scope and costs for quality control.

Smart Flags

Factors will be calculated in accordance with the formulas defined in this document. However, bridge stewards have the option of using "Smart Flags" to override some factors. Whenever Smart Flags are use, bridge stewards are responsible for developing supporting documentation, which should be available in the event of an audit. For VDOT-owned bridges the required supporting documentation must to be placed in district project file. For locality-owned bridges documentation must be submitted through the SMART Portal.

Smart Flag List

Summary of Override Exceptions for SGR Bridge Factor Scores (July 1, 2018)				
Smart Flag Code	**Applicable Factor**	**Short Description (SMART Portal)**	**Description of Smart Flag**	**Required Supporting Documentation (DBE must place supporting documents in the bridge file at the district office, note SGR program can be audited)**
IF-1 (Obsolete)	~~Importance~~	~~The intention is to abandon the structure.~~	~~If a district intends on abandoning the bridge and ultimately removing the bridge from the S&B Inventory, then the DBE may request that bridge be given an IF of 0.00.~~	~~1) Documentation indicating desire to close the bridge.~~ ~~2) Ideally, a schedule indicating how and when the bridge will be abandoned, and when the bridge will be removed from the S&B Inventory.~~
IF-2	Importance	Bridge is the only access to a community, hospital, school, military base, police station, fire station, or critical government facility.	The IF can be set to 1.00 if requested and the supporting document shows the following: - If a bridge is on a route that provides the only access (ie. no detour or alternative route) to a community, hospital, school, military base, police station, or critical government facility, or would hinder adequate emergency service access. A community may include a small number of houses or subdivision.	1) Map showing the location of the bridge, facility in questions, and surrounding area and the sole access route and that no detours exist.
IF-3	Importance	For Bridges with ADT < 100 and an acceptable detour exists, the DBE can request the Importance Factor be set to 0.	The IF can be set to 0.00 if requested and the supporting document shows the following: - The Bridge has an ADT < 100 and an acceptable detour exists.	1) ADT < 100 per BrM database, ADT from published information from the Traffic Engineering Division, or updated traffic counts. 2) Map showing an acceptable detour exists.
DRF-1	Design Redundancy	A fracture critical structure in which a fracture critical element is in Poor condition.	The DRF can be set to 1.00 if requested and the supporting document shows the following: - The Bridge has a Fracture Critical element that is in Poor Condition. For FC, see https://www.fhwa.dot.gov/bridge/120620.cfm; and Fed Item 92A	1) Inspection Report showing the Fracture Critical element is in Poor condition. 2) Safety Inspection Report, Fracture Critical Bridge Inspection Report, or Special Inspection Report shows that the Fracture Critical element is in Poor Condition.
DRF-2	Design Redundancy	Bridge has a history of vehicular impacts due to low vertical clearance.	The DRF can be set to 1.00 if requested and the supporting document shows the following: - The Fracture Critical element of a bridge has a history of any vehicular impacts due to inadequate vertical clearance. For FC, see https://www.fhwa.dot.gov/bridge/120620.cfm; and Fed Item 92A	1) Safety Inspection Report, Fracture Critical Bridge Inspection Report, or Special Inspection Report shows evidence of low height hits to the bridge and the Fracture Critical Element is in jeopardy of being hit. 2) Crash Reports showing evidence of the low height hits to the Fracture Critical element or nearby features indicating the Fracture Critical Element is in jeopardy of being hit.
DRF-3	Design Redundancy	Bridge is fracture critical and ADT is less than 1,000.	The FC subfactor score (of the DRF score) can be set to 0.00 if requested and the supporting document shows the following: - If the ADT of a Fracture Critical structure is less than 1,000. For FC, see https://www.fhwa.dot.gov/bridge/120620.cfm; and Fed Item 92A	1) ADT < 1000 per BrM database, ADT from published information from the Traffic Engineering Division, or updated traffic counts.
SCF-1	Structure Capacity	Bridge requires posting and carries an Interstate or Primary road.	The SCF can be set as follows, if requested and the supporting document shows that the bridge requires a posting: - a minimum SCF of 0.65 for a bridge on the Primary System - a SCF of 1.00 for a bridge on the Interstate System	1) Inspection Report with load rating showing the need to post the bridge.

SCF-2	Structure Capacity	A fracture critical element of a bridge that has significantly deficient vertical clearance.	The SCF can be set as follows, if requested and the supporting document shows that the If the Fracture Critical Element of a bridge has significantly deficient Vertical Clearance versus the Required Vertical Clearance for the Functional Class of the roadway below the bridge: - a minimum SCF of 0.50 for a bridge on the Secondary System - a minimum SCF of 0.75 for a bridge on the Primary System - a SCF of 1.00 for a bridge on the Interstate System For FC, see https://www.fhwa.dot.gov/bridge/120620.cfm; and Fed Item 92A	1) Inspection Report citing deficient vertical clearance and validated with BrM data.
SCF-3	Structure Capacity	Bridge has a history of accidents attributable to features of the bridge.	The SCF can be set to 1.00 if requested and the supporting document shows the following: - Bridge has a history of accidents attributable to features of the bridge.	1) Crash Reports showing evidence that features of the bridge caused the accidents.
CEF-1 (Superseded by CEF-3)	~~Cost Effectiveness~~	~~Bridge is a parallel bridge on the same route to another bridge that is also eligible for SGR funding (or already has been funded with SGR funding).~~	~~Regarding parallel structures on the same route (example: NB and SB bridge on the interstate) in which both are being considered individually for SGR funding. If it is more cost effective to complete the construction of both bridges concurrently and both bridges can be fully funded that funding round, the DBE may request that the lower scoring bridge be given a Cost-Effectiveness Factor (CEF) score so that it has an overall CEF score equivalent to the higher scoring dual bridge.~~ ~~If both bridges cannot be fully funded in the current round, then the DBE may request that the dual bridges be skipped as a unit until the next funding round.~~	~~1) Statement of intentions~~ ~~2) Supporting documentation indicating that it is more cost-effective to complete the bridge work on the dual bridges at the same time.~~
CEF-2	Cost Effectiveness	Bridge currently has legacy Dedicated Bridge Funds and needs SGR funds to fully fund the project.	The CEF can be set to 1.00 if requested and the supporting document shows the following: - If the bridge currently has legacy DBF funds and needs SGR funds to fully fund the project. DBE to review all DBF projects that are eligible for SGR funds, and request adjustments accordingly.	1) Project Pool has DBF funds on the project.
CEF-3	Cost Effectiveness	The bridge project can be combined with other SGR funded bridge projects that will result in significant cost savings through reduced overall mobilization, MOT, or other synergies due to combining projects into one project.	The Cost-Effectiveness Factor (CEF) for all the SGR eligible bridges in this group can be set to the CEF of the bridge in the group with the highest CEF if requested and the supporting document shows the following: - The bridge project can be combined with other SGR funded bridge projects that will result in significant cost savings through reduced overall mobilization, MOT, or other synergies due to combining projects into one project. - Bridges meeting this requirement are parallel/dual bridges, bridges in immediate sequence, or bridges that are part of a single interchange. - Sequential bridges shall be on a single route and shall not be more than 1 mile apart for bridges carrying Secondary System roads, 2 miles apart for bridges carrying Primary System roads, and three miles apart for bridges carrying Interstate System roads.	1) Supporting documentation indicating that it is more cost-effective to complete the bridge work on parallel/dual bridges, bridges in immediate sequence, or bridges that are part of a single interchange at the same time. 2) Evidence includes a comparison of the following showing that Option B below had significant cost savings over Option A below: a) The total cost for Project Cost Estimates for individual bridge projects that include the group of bridges. b) A Project Cost Estimate Cost for a project with the group of bridges.

SGR Background

The Virginia 2015 Acts of Assembly passed HB 1887 (Chapter 684), which set aside 45% of the § 33.2-358 for the State of Good Repair. The State of Good Repair is defined in § 33.2-369(A) as "improvement of deficient pavement conditions and improvement of structurally deficient bridges."

The code further states in § 33.2-369(B) the Commonwealth Transportation Board (Board) shall use funds to state of good repair purposes for (i) reconstruction and replacement of structurally deficient state and locally owned bridges and (ii) reconstruction and rehabilitation of pavements on the Interstate System and primary state highway system determined to be deteriorated by the Board, including municipality-maintained primary extensions.

The same code section requires the Board to allocate funds to all nine construction districts, with each district receiving a minimum of 5.5% and no more than 17.5% in a given year (allocation cap).

The Board can approve two waivers. The first waiver is the Board's ability to waive, under extraordinary circumstances, the allocation cap if a key pavement or bridge need is identified and requires funding. The second waiver is the Board's ability to allocate up to 20% of the funding to all nine construction districts' secondary pavements if VDOT has not met the established performance targets.

Finally in § 33.2-369(B) the state of good repair allocations must be prioritized based on needs as set out in VDOT's annual report (§ 33.2-232) and reported by the Commissioner of Highways by November 30th of each year. The prioritization process must consider (i) number, condition and costs of structurally deficient bridges and (ii) mileage, condition and costs of deteriorated pavements (§ 33.2-369(B)). The second enactment of HB1887 (Chapter 684) requires the prioritization process to be approved by the Board by July 1, 2016.

A link to the draft Commonwealth Transportation Board's State of Good Repair Prioritization Process Methodology is provided.

Selection Process Notes

Some items to note about the SGR project selection for this year are as noted below.

- Each district will be sent a scoring spreadsheet for its SGR-eligible structures, to be filled out and submitted as part of the SGR project selection process.
- As with the previous rounds, the SGR prioritization formula will be "pre-scored" by Central Office before being sent to the districts.
- Four of the factors (Importance (IF), Condition (CF), Design Redundancy (DRF), and Structure Capacity (SCF)) are based on condition and inventory data from BrM and in a general sense cannot be changed at the district level. However, the new methodology allows the district to Smart Flags in certain instances. The available Smart Flags are listed at the end of this document.
- Districts will be able to change all information used to calculate the Cost-Effectiveness Factor (CEF), including the SGR Bridge Replacement Cost, SGR Bridge Repair Cost and the SGR Fund Needs. The prepopulated Bridge Management System Analysis Level cost data from BrM is provided to the districts for reference.
- As in the previous round, districts will be able to remove projects from the SGR selection pool if they will be addressed with maintenance funds or if there are special circumstances associated with the structure that make it inappropriate for SGR consideration/funding. There will be a drop-down list of available options that districts may choose from in the "SGR Project Selection" field.