# State of the Structures and Bridges Report Fiscal Year 2015

July 1, 2015

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Virginia Department of Transportation

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# INTRODUCTION

This annually produced report summarizes the condition of the bridges and large culverts, ancillary structures (traffic control devices) that fall within the inventory of the Structure and Bridge (S&B) Division of the Virginia Department of Transportation (VDOT). The report also summarizes the bridge and large culvert and ancillary safety inspection program, and bridge-related financial information for the Commonwealth of Virginia. The report reflects the accomplishments for the 2015 Fiscal Year (FY2015) for VDOT and provides some historical trends. The Fiscal Year runs from July 1 through June 30.

VDOT inspects bridges and culverts that are part of the National Bridge Inventory (NBI), which includes structures on public roadways exceeding 20 feet in length. VDOT's S&B Division also inventories structures that do not meet the definition of NBI structures referred to as "non-NBI" structures in this report. Non-NBI structures include bridges measuring 20 feet or less in length and culverts having an opening of 36 square feet or greater. Culverts meeting the NBI and non-NBI requirements are called "large culverts" and as such are part of the S&B Inventory. Smaller culverts not meeting the above criteria are maintained and inspected by other VDOT Divisions and are not addressed in this report. All data used in the report is that reported at the end of FY2015 on June 30, 2015.

There are currently 21,084 structures (bridges and large culverts) located throughout the Commonwealth, of which 13,467 are NBI structures and 3,474 are NBI structures on the National Highway System (NHS). VDOT maintains 19,466 of these structures and 1,618 are maintained by localities and private owners. The inventory experienced a net increase of 87 structures during FY2015.

The majority of Virginia's bridges were designed with an anticipated design service life of 50 years, but with the adoption of new design guidelines and construction materials the anticipated service life for newly constructed bridges is 75 years. About sixty three (63.5%) percent of the structure inventory is 40 years or older thus placing them within 10 years of the end of their anticipated service design life. The anticipated service life of structures can be extended though preventative and proactive maintenance and major repairs and rehabilitation.

VDOT's global performance measure for structures is based on the percentage of Structurally Deficient (SD) structures in the Department's inventory. VDOT's goal is to have no more than eight (8%) percent of the structure inventory rated as SD. The number of SD structures in the VDOT NBI/non-NBI inventory at the end of the Fiscal Year was 1,310 (6.2%), of which 949 are NBI structures. During the Fiscal Year, the percentage of SD structures was reduced by 0.69% (using number of structures) or 0.43% (using deck area of structures). Nationally, 10.0% of the NBI structures were SD as of December, 2014.

A structure is defined as SD if one or more of its major components (deck, superstructure, substructure, or large culvert) is deficient which requires the structure to be monitored and/or repaired, or if it lacks adequate strength or waterway clearance. When one or more of a structure's major components have a General Condition Rating (GCR) of four (4) or less it is defined as an SD structure. The GCR is a nationally established numerical grading system with values that range from 0 (failed condition) to 9 (excellent condition). GCRs are

assigned to each major component of each structure during regular inspections and are reported in inspection reports. VDOT uses several performance indicators in the overall management of the structural inventory. These include the following: functional obsolescence (FO), structurally deficient structures, the number of posted structures, deficient deck area and the Health Index. These performance indicators are discussed in greater detail in the body of the report.

| Structure Type | Percentage By Major Components in Good or Fair Condition | | | |
|---|---|---|---|---|
| | Deck | Superstructure | Substructure | Culvert |
| Bridges | 97.7% | 93.7% | 97.4% | N/A |
| Large Culverts | N/A | N/A | N/A | 97.5% |

The Commonwealth's inventory includes 4,994 bridges and large culverts (23.7%) that are at risk of becoming Structurally Deficient. These structures have at least one major component (deck, superstructure, substructure or large culvert) with a GCR of five (5).

The bridge safety inspection program provides the basis for most of the Commonwealth's bridge maintenance and management decisions. During FY2015, VDOT inspected 10,414 bridges/large culverts at a cost of $29.1 million. Inspections on the majority of the structures are performed on a two year cycle. Data collected from inspections are used to evaluate each structure's safety and are used for decisions on planning, budgeting, and performance of maintenance, repair, rehabilitation and replacement of our structures. Underwater inspection QA/QC was performed on 8 structures at a cost of $18,000. The Federal Highway Administration (FHWA) conducted an annual National Bridge Inspection Standards (NBIS) Compliance Review from April 1, 2014 to March 30, 2015. A report was issued December 31, 2014. The Compliance Review consisted of a review of the statewide structures (bridges and large culverts) inventory/database and organization/procedures for safety inspections and a QA review of a sample of structures records and structure field reviews of the Salem and Culpeper Districts. The review found that the Department was in compliance with 22 of the 23 NBIS metrics and substantially compliant with the remaining 1 of the 23 metrics.

VDOT is also responsible for the inventory and inspection of 32,306 ancillary structures. VDOT's inventory includes five types of ancillary structures: Signs, Luminaires, Signals, High Mast Lights; and Camera Poles. VDOT inspected 2,573 of these structures in the fiscal year, at an approximate cost of $5.4 million. VDOT utilizes an inspection program to evaluate and monitor the condition of its ancillary structures. The data collected during inspections is the primary source of information for determining maintenance, repair and replacement needs for structural components. Inspections of the majority of the ancillary structures are performed on a five year cycle, but the required inspection interval varies depending on the purpose, condition and type of the structure. It is important to note that inventory and rating data reflect the condition of the structure as of its most recent inspection, and because there is a lag time of five or more years between inspections, the inspection data available at any given time do not necessarily provide a present indication of current conditions due to deterioration rates and possible repairs that occur in between.

The number of ancillary structures per district varies widely, from 13,302 (41.2% of the inventory) in the Northern Virginia District to 564 (1.7%) in the Culpeper District. Each ancillary structure is comprised of primary components. These components describe the structure and its support but not the attached appurtenances (sign panels, signals, lights, etc.). A parapet mount sign or a parapet mount luminaire has only one primary component while the other types of signs or luminaires have both "foundation" and "superstructure" primary components. Signals have either a "parapet" primary component or "foundation" and "superstructure" primary components. High mast light and camera poles have "foundation" and "superstructure" primary components. The percentages of the primary components that are in good or fair condition (statewide) are shown in the table below.

| Structure Type | Percentage of Primary Components in Good or Fair Condition | | |
|---|---|---|---|
| | Foundation | Parapet | Superstructure |
| Sign | 85.3% | 91.9% | 93.7% |
| Luminaries | 74.5% | 69.1% | 90.2% |
| Signal | 87.1% | 73.3% | 84.6% |
| High Mast and Camera Poles | 92.4% | N/A | 99.2% |

Whenever a primary component of an ancillary structure is assigned a poor rating, the inspector provides a descriptive note indicating the most significant cause for the rating. Anchor bolt problems and loose nuts are the most common reasons for foundations receiving poor condition ratings. For the parapet mounted signs and luminaires, the most frequently identified problems are the attachments of the ancillary structure to the bridge structure. There is a much broader set of conditions that cause superstructures to be rated as poor, but "damaged chord members" is the most common reason.

The Construction (603) program for VDOT was $1.4B and the Highway System Maintenance (604) Program was $1.9B.

The Structure & Bridge Division received approximately $106M in bridge specified funding in FY15 from the Construction (603) program. This is roughly 8% of total funds allocated to VDOT's Construction (603) Program. Expenditures in FY15 for the S&B Construction (603) Program were approximately $211M.

The S&B Division received approximately $171.6M in FY15 from VDOT's Maintenance (604) Program. This is roughly 11% of total funds allocated to the Maintenance (604) Program. These Maintenance (604) Program funds allocated to the S&B Division include funding for maintenance of the structure inventory as well as the structure and ancillary structure inspection programs. Expenditures for the S&B Maintenance (604) program were $185.4M. The calculated monetary need for bridge maintenance and construction significantly exceeds available funding. For example, $923 million was needed and $187 million was provided in FY2015. The calculated need is the amount of money required to meet the performance measures for structures. These performance measures were established using thresholds that, if met, would keep the inventory of the S&B Division steady at their current average overall condition ratings. The performance measures were determined through an analysis of the entire inventory over a multi-year period. The analysis utilizes condition data in addition to historical

deterioration curves and action-effectiveness scenarios to determine the most cost-effective interventions and the associated costs necessary for maintaining and improving the condition of Virginia's structures.

The availability of funding is the most significant factor in the condition of the inventory of the S&B Division. In recent years, the percentage of Structurally Deficient (poor) structures has steadily decreased, reflecting an apparent improvement in conditions of bridges and large culverts. However, while the number of structures in Poor condition has indeed decreased, the overall condition of the inventory has not improved. This slow decrease in overall condition ratings can primarily be attributed to the funding gap of $736 million in FY2015 between required and available funding. Allocated funds are often used to address structures in immediate need of repair or replacement, leaving less money than required for preventive and restorative maintenance.

Another significant factor affecting long-term performance relates to the selection of structures scheduled for replacement or major rehabilitation. In recent years, available funding in the 603 Construction Program has often led to the selection of smaller structures for replacement. This has resulted in a notable reduction in the number of structures in Poor condition. However, we are developing a larger backlog of larger bridges and more extensive rehabilitations due to the following current practices:

- selection of smaller, less expensive, structures for replacement and rehabilitation
- performing minimal repairs necessary to larger bridges in order to maintain a minimum GCR of 5 and avoid the status of being Structurally Deficient

The percentage of SD structures was reduced by 0.69% using the number of structures while there was a reduction of 0.43% using deck area of structures. The higher rate using number of structures indicates that structures with a smaller deck area are being selected for repair, restoration, major rehabilitation or replacement.

Structure deterioration occurs over a period of decades rather than months or years, so the results of short-term funding deficiencies will not necessarily be readily evident in near-term trends of conditions. However, over time, if the funding for bridge maintenance and replacement is not increased, we should expect to see significant degradation of the average structure conditions.

## BACKGROUND

In accordance with the Code of Federal Regulations, The Virginia Department of Transportation (VDOT) inspects bridges and large culverts that are part of the National Bridge Inventory (NBI), which includes structures on public roadways exceeding 20 feet in length. In addition to the federal inventory and inspection requirements, VDOT's Structure and Bridge Division also inspects and inventories structures on public roads that do not meet the definition of NBI Structures which are referred to as "non-NBI" structures in this report. These structures include bridges measuring 20 feet or less in length and culverts having an opening of 36 square feet or greater. Culverts meeting the above NBI and non-NBI requirements are called "large culverts". Large culverts and bridges are addressed in this report.

VDOT also maintains a large inventory of smaller culverts that do not meet the above criteria. These smaller culverts are not maintained by the Structure and Bridge Division and have a separate maintenance and inspection cycle. These smaller culverts are not addressed in this report.

VDOT is responsible for the inventory and inspection of 21,084 structures (bridges and large culverts). Of these structures, 13,467 are part of the National Bridge Inventory (NBI) and 3,474 are NBI structures on the National Highway System (NHS). VDOT maintains 19,466 of these structures and 1,618 are maintained by localities and private owners. All of the tables and figures in this report reflect the FY2015 accomplishments and are based on the inventory and condition data at the end of the Fiscal Year.

The estimated current value of Virginia's structure inventory for the Fiscal Year is approximately $44 billion. Note that this is not the same as the replacement value, which would be significantly higher. Chart 1A shows the distribution of bridges and large culverts by highway system.

Bridge and large culvert data in this report provide the condition and inventory information for all bridges and large culverts for which the Commonwealth of Virginia is responsible. VDOT is not responsible for non-NBI structures not owned and maintained by VDOT. Ancillary structures data provided is only for such structures that are owned and maintained by VDOT as VDOT has very limited information on such structures that VDOT does not own and maintain. Chart 1B includes the distribution of bridges and large culverts by the following custodians:

- VDOT (owned and maintained by VDOT)
- Localities (County, City and Town)
- Other (Local Toll, State Toll, Private, Railroad and Other State Agencies)

**Chart 1A – Distribution of Bridges and Large Culverts by System**

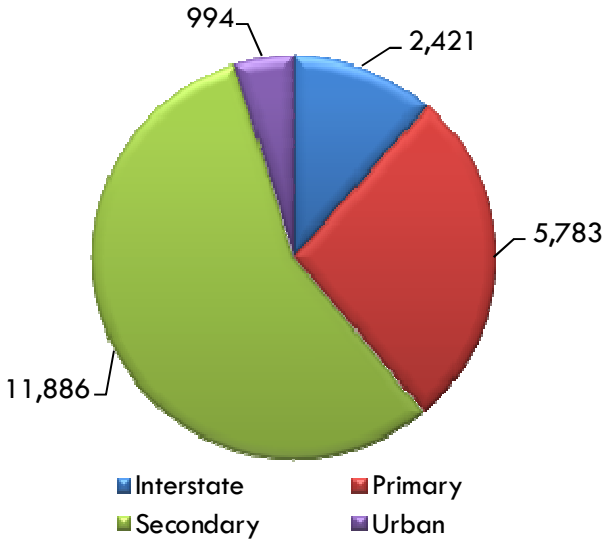
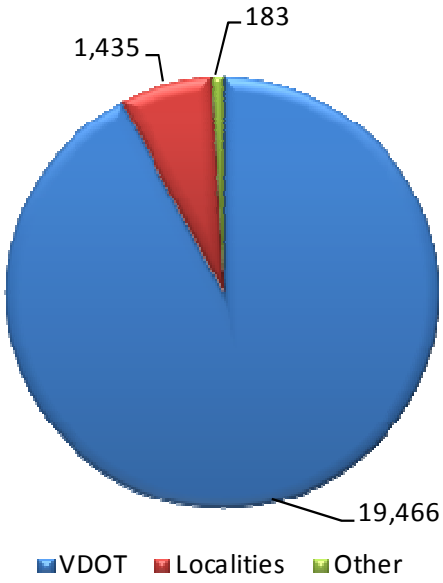



**Chart 1B – Distribution of Bridges and Large Culverts by Custodian**



VDOT is also responsible for the inventory, inspection and maintenance of 32,306 ancillary structures. VDOT's inventory includes five types of ancillary structures, three of which are further divided into subcategories:

1. High mast lighting structures
2. Camera pole structures
3. Signal structures
    - Span wire
    - Cantilever
    - Bridge-parapet mounted
4. Luminaires
    - Ground mounted (Luminaire)
    - Parapet mounted
5. Sign structures
    - Overhead span sign structures
    - Cantilever sign structures
    - Butterfly sign structures
    - Bridge-parapet mounted

Charts 2 and 3 indicate the distribution of the Ancillary structures by District and type.

**Chart 2 – Distribution of Ancillary Structures by District**

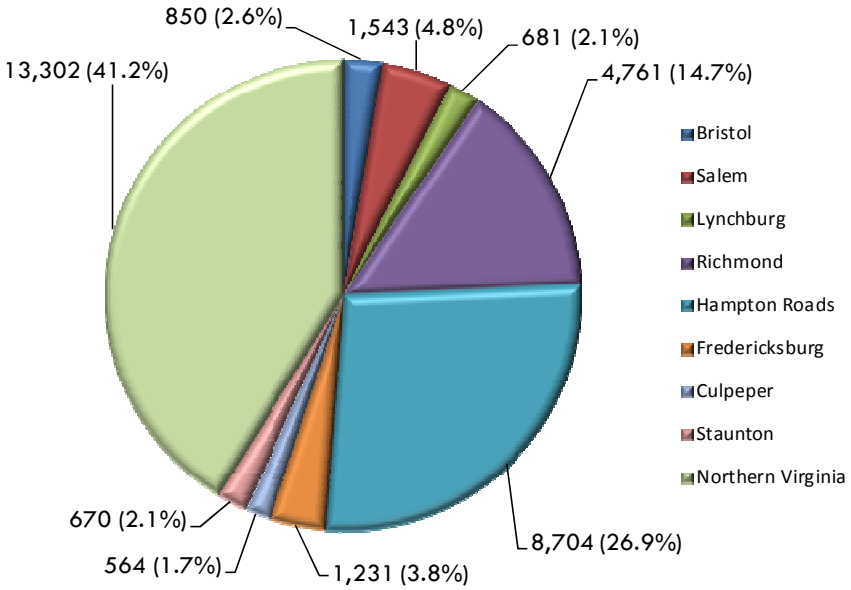
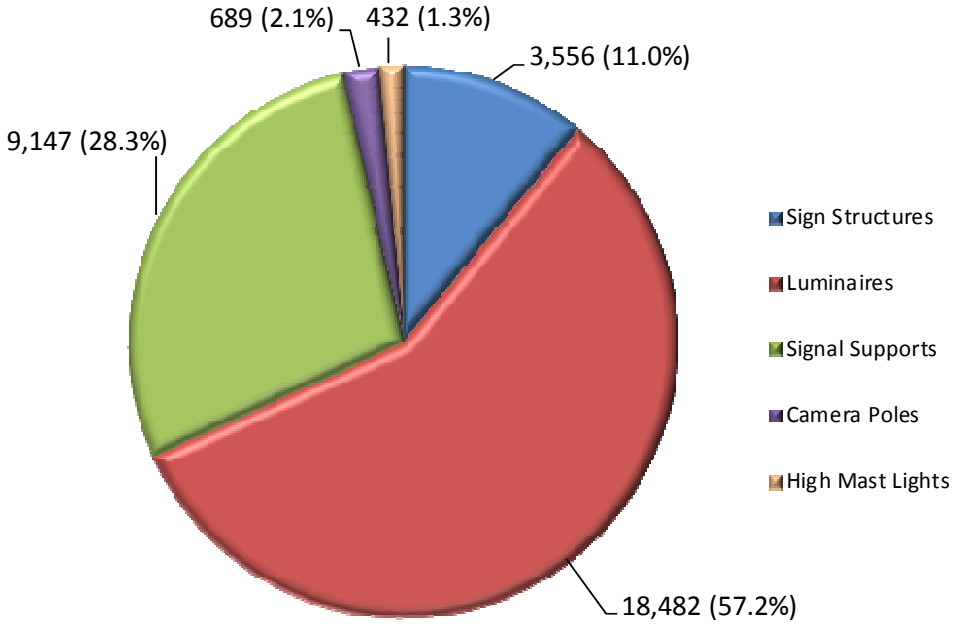



**Chart 3 – Distribution of Ancillary Structures by Type**



## Determining the Conditions of the Structures

VDOT uses its comprehensive inspection program to evaluate and monitor the condition of its structures. The data collected during inspections is used as the primary source of information for determining maintenance, repair and replacement needs. NBI structures receive detailed inspections at regular intervals not exceeding 24 months. The non-NBI bridges are inspected at intervals not exceeding 24 months, and the non-NBI large culverts are inspected at intervals not exceeding 48 months.

Inspectors use condition ratings to describe each existing structure. These condition ratings are based on the Federal Highway Administration's (FHWA) criteria. The condition assessments of the structures are performed by qualified inspectors, and all assessments are performed in accordance with the National Bridge Inspection Standards (NBIS) as well as VDOT's policies and procedures.

VDOT's inspection procedures and requirements are detailed in VDOT's Current Instructional and Informational Memorandum IIM-S&B-27, and the NBIS requirements in the Code of Federal Regulations.

VDOT inspects over 10,414 of bridges and large culverts annually, at an approximate cost of $29.1 million. This report summarizes the inventory and condition of Virginia's bridges and large culverts based on data at the end of the current fiscal year.

In addition to the specific data required by the NBIS, VDOT inspectors collect and record detailed structural element data, which is used in the operation of its Bridge Management System (BMS). The BMS information is used to determine current and future maintenance and preservation needs of the structures.

VDOT utilizes an inspection program to evaluate and monitor the condition of its ancillary structures. The data collected during inspections is the primary source of information for determining maintenance, repair and replacement needs for structural components.

VDOT utilizes an internally-developed inventory and inspection software system to maintain data on its ancillary structures. Inspections of the ancillary structures are usually performed on a five (5) year cycle, but the required inspection interval varies depending on the purpose, condition and type of the structure. At the time of each inspection an inspector assigns condition ratings to describe each of the major structural components of each structure. These condition ratings are based on criteria similar to the Federal Highway Administration's (FHWA) Bridge Inspection criteria. The condition assessments of the structures are performed by qualified inspectors, and all assessments are performed in accordance with VDOT's policies and procedures.

VDOT's ancillary structure inspection procedures and requirements are detailed in VDOT's Current Instructional and Informational Memorandums IIM-S&B-82 and IIM-S&B-90, and VDOT's "Traffic Ancillary Structures Inventory and Inspection Manual."

VDOT inspects over 2,573 of these structures annually, at an approximate cost of $5.4 million. This report summarizes the inventory and condition of Virginia's ancillary structures based on the inventory at the end of the fiscal year.

The inspection reports list repair recommendations for each structure. At the time of inspection the inspectors utilize their experience and judgment to determine the immediacy of the need for maintenance and to prioritize the recommended repairs accordingly. Many of VDOT's inspectors have completed FHWA's NHI training course "Inspection and Maintenance of Ancillary Highway Structures" and draw on this training when performing inspections.

## STRUCTURE INVENTORY

VDOT uses the AASHTOWare Bridge Management System to maintain data on all of the Commonwealth's highway structures. Tables 1 through 3 show the distribution of structures in each of the Districts by system. Unless otherwise stated, the data and charts shown in this report include both NBI and Non-NBI bridges and large culverts.

**Table 1 – Total Number of Bridges and Large Culverts**

| DISTRICT | Number of Structures (Bridges and Large Culverts) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 216 | 954 | 2,033 | 208 | 3,411 |
| Salem | 218 | 809 | 1,945 | 102 | 3,074 |
| Lynchburg | 0 | 661 | 1,395 | 58 | 2,114 |
| Richmond | 521 | 782 | 1,120 | 161 | 2,584 |
| Hampton Roads | 455 | 450 | 498 | 282 | 1,685 |
| Fredericksburg | 82 | 254 | 476 | 7 | 819 |
| Culpeper | 121 | 499 | 1,054 | 22 | 1,696 |
| Staunton | 429 | 828 | 2,137 | 108 | 3,502 |
| NOVA | 379 | 546 | 1,228 | 46 | 2,199 |
| **Grand Total** | **2,421** | **5,783** | **11,886** | **994** | **21,084** |

**Table 2 – Number of NBI - Bridges and Large Culverts**

| DISTRICT | Number of NBI Structures (Bridges and Large Culverts) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 164 | 520 | 1,114 | 205 | 2,003 |
| Salem | 140 | 451 | 1,133 | 95 | 1,819 |
| Lynchburg | 0 | 417 | 914 | 58 | 1,389 |
| Richmond | 365 | 580 | 843 | 159 | 1,947 |
| Hampton Roads | 375 | 366 | 371 | 277 | 1,389 |
| Fredericksburg | 45 | 176 | 302 | 7 | 530 |
| Culpeper | 85 | 240 | 686 | 17 | 1,028 |
| Staunton | 255 | 459 | 1,047 | 104 | 1,865 |
| NOVA | 285 | 396 | 772 | 44 | 1,497 |
| **Grand Total** | **1,714** | **3,605** | **7,182** | **966** | **13,467** |

**Table 3 – Number of NHS (NBI) - Bridges and Large Culverts**

| DISTRICT | Number of NHS (NBI) Structures (Bridges and Large Culverts) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 164 | 143 | 2 | 0 | 309 |
| Salem | 138 | 193 | 1 | 2 | 334 |
| Lynchburg | 0 | 227 | 0 | 0 | 227 |
| Richmond | 364 | 346 | 10 | 4 | 724 |
| Hampton Roads | 367 | 203 | 0 | 61 | 631 |
| Fredericksburg | 45 | 84 | 0 | 2 | 131 |
| Culpeper | 83 | 90 | 0 | 1 | 174 |
| Staunton | 251 | 100 | 0 | 0 | 351 |
| NOVA | 280 | 279 | 34 | 0 | 593 |
| **Grand Total** | **1,692** | **1,665** | **47** | **70** | **3,474** |

A large proportion (63.5%) of the Commonwealth's structure inventory is 40 years old or older. These structures have either exceeded or will soon exceed their originally anticipated design service life of 50 years. The percentage of structures equal to or greater than 40 years in age, by system, is as follows: 67.4% of the interstate, 67.1% of the primary, 62.0% of the secondary, and 51.8% of the urban system structures. The average age of all structures is 48 years. The age of Virginia's highway structures is depicted graphically in Charts 4 thru 6.

Bridges built prior to 2007 could be expected to have a service life of 50 years, but with improvements in design guidelines and construction materials the anticipated service life of bridges constructed since 2007 is 75 years. Improvements have included the following:

- Corrosion resistant reinforcement in 2009*
- Jointless bridge technology for new bridges in 2011*
- High Performance Concrete in all bridge elements in 2003*
- Three coat zinc-based paint in 1982 *
- Self-consolidating concrete for drilled shafts
- Latex modified concrete deck overlays (milling only) starting in the 1970's
- Epoxy deck overlays starting in the 1970's

  * Year of full implementation

In the near future, the Structure and Bridge Division will be implementing the following to further improve the durability of its structures:

- Low shrinkage, cracking and permeability concrete in deck
- Latex modified concrete overlays (the addition of hydrodemolition to milling)
- Hydrodemolition for patches and refacing of substructures
- Increased use of joint elimination when repairing and rehabilitating bridges
- Use of materials for large culverts that have shown good past performance
- Carbon fiber prestressing strands in prestressed concrete piles
- Lightweight concrete

A large portion of the inventory was constructed using older construction technology and is approaching the last quarter of useful service life. This period can be extended through preventative and proactive maintenance, major repairs and rehabilitation, and use of better materials and modifications to better details as part of such activities.

**Chart 4 – Cumulative Age Distribution of Bridges and Large Culverts**

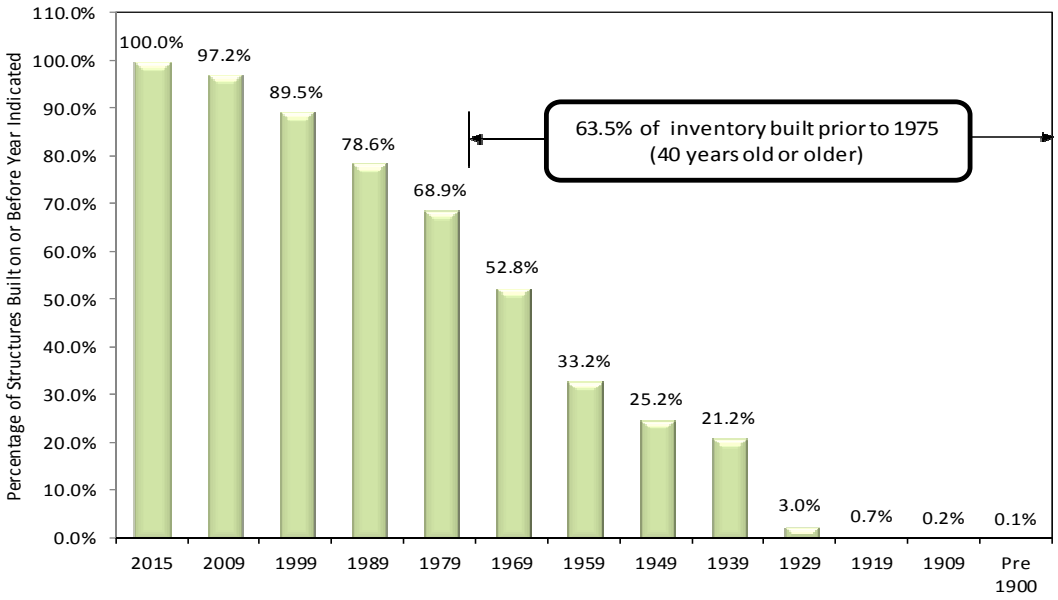



**Chart 5 – Average Age of Bridges and Large Culverts by District**

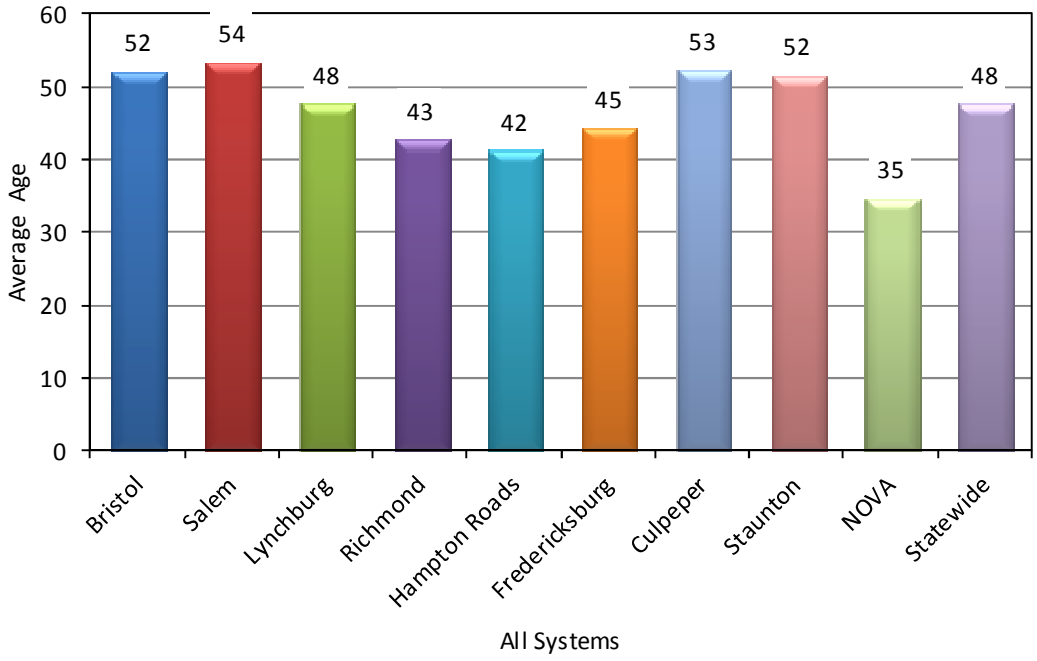
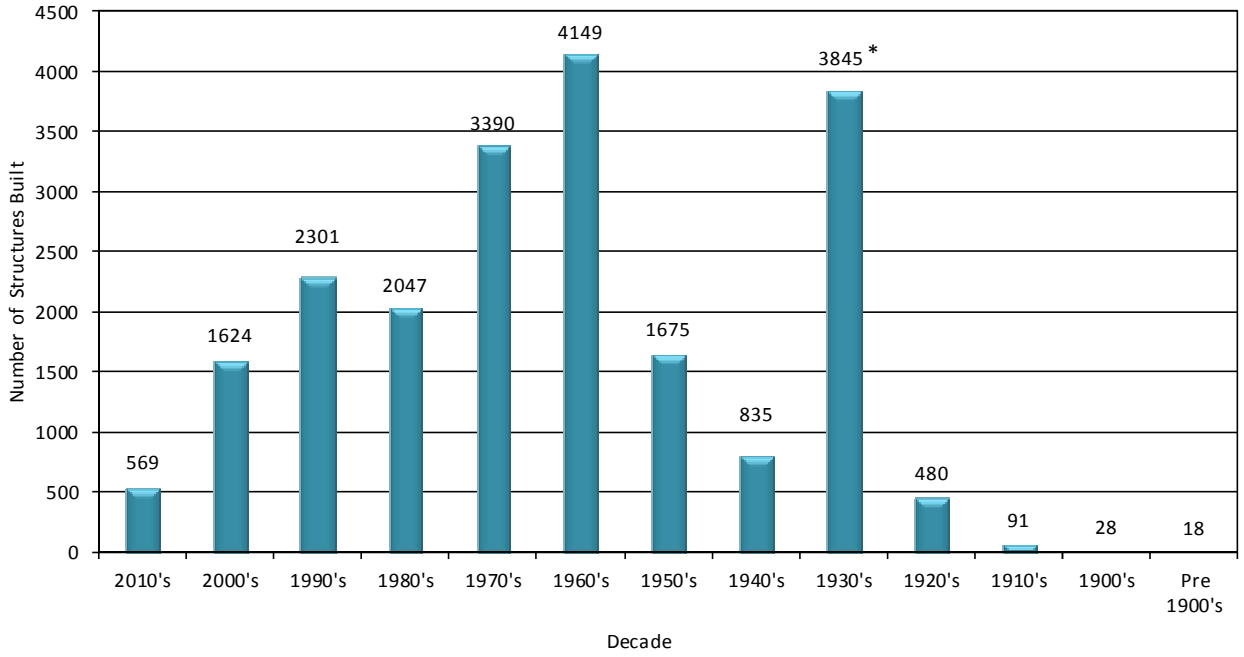


**Chart 6 – Number of Bridges and Large Culverts Built per Decade**




* County bridges added to the VDOT Inventory during this period with unknown construction dates. Those structures with unknown construction dates have been assumed to have been built in the 1930s.

Additional inventory information on bridges and large culverts can be found in Appendix A.

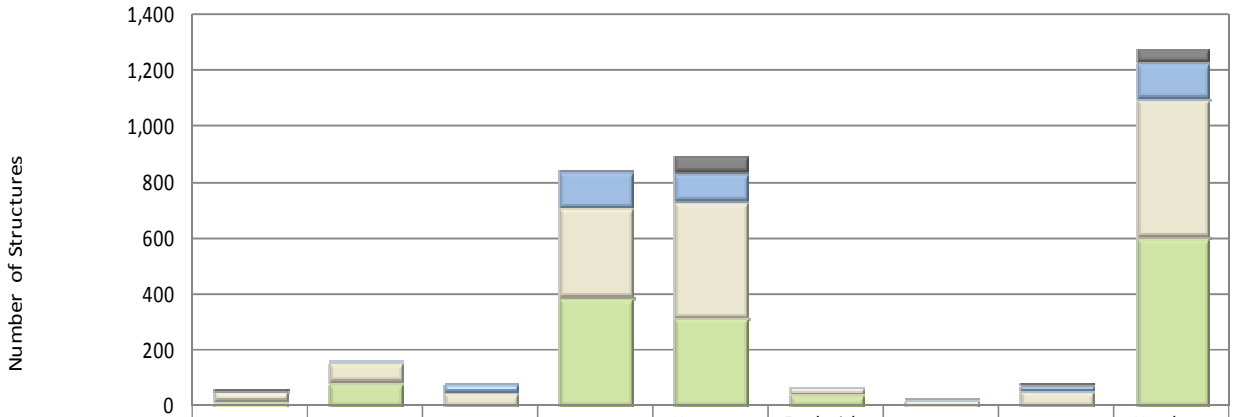
Table 4 below provides a summary of the total number and type of ancillary structures in each district. Similar information for the subcategories of each type of ancillary structure, along with pictures providing typical examples of each type of ancillary structure, is provided in Appendix B.

**Table 4 – Total Number of Ancillary Structures**

| DISTRICT | Number of Ancillary Structures | | | | | | Percent |
|---|---|---|---|---|---|---|---|
| | Sign Structures | Luminaires | Signal Supports | Camera Poles | High Mast Lights | Total | |
| Bristol | 71 | 457 | 245 | 76 | 1 | 850 | 2.6% |
| Salem | 172 | 821 | 537 | 13 | 0 | 1,543 | 4.8% |
| Lynchburg | 90 | 301 | 290 | 0 | 0 | 681 | 2.1% |
| Richmond | 847 | 2,277 | 1,532 | 105 | 0 | 4,761 | 14.7% |
| Hampton Roads | 895 | 6,855 | 522 | 145 | 287 | 8,704 | 26.9% |
| Fredericksburg | 72 | 439 | 718 | 1 | 1 | 1,231 | 3.8% |
| Culpeper | 39 | 158 | 367 | 0 | 0 | 564 | 1.7% |
| Staunton | 92 | 45 | 451 | 26 | 56 | 670 | 2.1% |
| Northern Virginia | 1,278 | 7,129 | 4,485 | 323 | 87 | 13,302 | 41.2% |
| **Statewide** | **3,556** | **18,482** | **9,147** | **689** | **432** | **32,306** | **100.0%** |

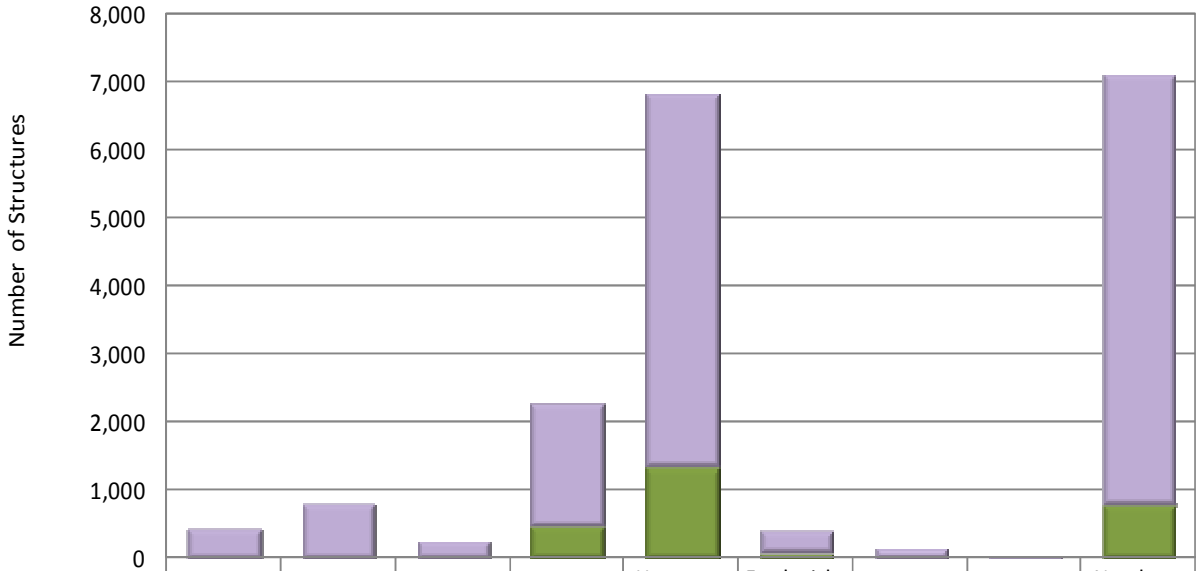
Charts 7 through 10 graphically display the total number of ancillary structures for each of the general structure types by subcategory and district.

**Chart 7 – Number of Sign Structures by Subcategory and District**



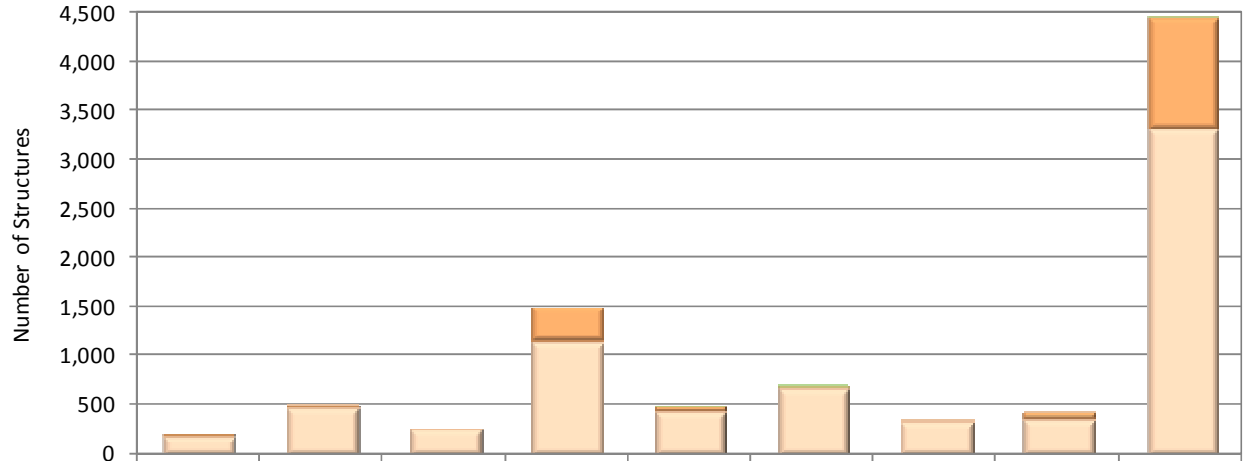

| | Bristol | Salem | Lynchburg | Richmond | Hampton Roads | Fredericksburg | Culpeper | Staunton | Northern Virginia |
|---|---|---|---|---|---|---|---|---|---|
| Butterfly | 10 | 0 | 5 | 1 | 57 | 0 | 3 | 15 | 52 |
| Parapet Mount | 1 | 6 | 29 | 133 | 99 | 1 | 10 | 16 | 127 |
| Overhead | 38 | 82 | 52 | 324 | 421 | 21 | 18 | 51 | 494 |
| Cantilever | 22 | 84 | 4 | 389 | 318 | 50 | 8 | 10 | 605 |
| Total | 71 | 172 | 90 | 847 | 895 | 72 | 39 | 92 | 1,278 |

**Chart 8 – Number of Luminaire Structures by Subcategory and District**




| | Bristol | Salem | Lynchburg | Richmond | Hampton Roads | Fredericksburg | Culpeper | Staunton | Northern Virginia |
|---|---|---|---|---|---|---|---|---|---|
| Luminaires | 455 | 797 | 301 | 1,769 | 5,494 | 361 | 158 | 45 | 6,338 |
| Parapet Mount | 2 | 24 | 0 | 508 | 1,361 | 78 | 0 | 0 | 791 |
| Total | 457 | 821 | 301 | 2,277 | 6,855 | 439 | 158 | 45 | 7,129 |

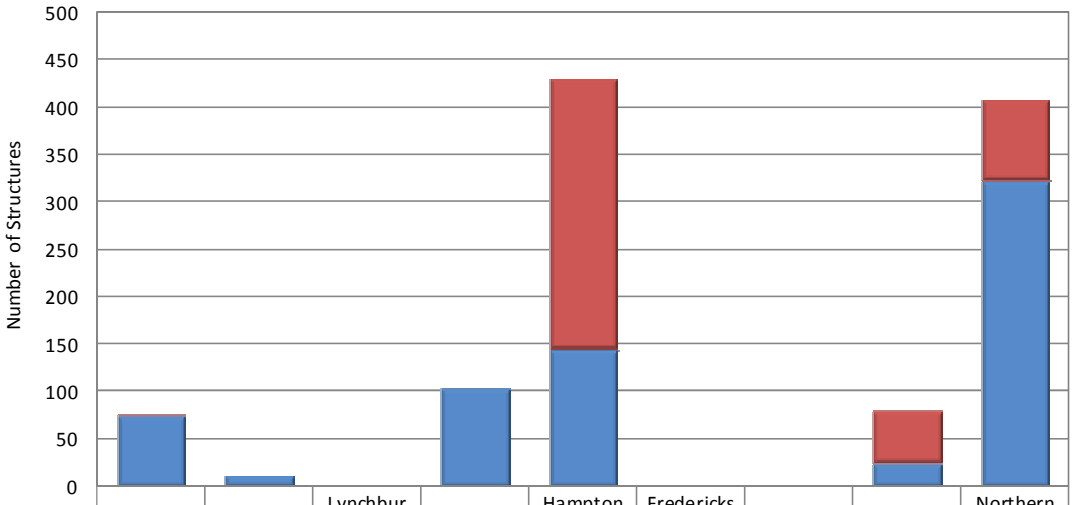
## Chart 9 – Number of Signal Structures by Subcategory and District




| | Bristol | Salem | Lynchburg | Richmond | Hampton Roads | Fredericksburg | Culpeper | Staunton | Northern Virginia |
|---|---|---|---|---|---|---|---|---|---|
| Other * | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 14 |
| Span Wire | 26 | 45 | 2 | 355 | 55 | 16 | 8 | 77 | 1,160 |
| Cantilever | 219 | 492 | 288 | 1,177 | 466 | 701 | 359 | 374 | 3,311 |
| Total | 245 | 537 | 290 | 1,532 | 522 | 718 | 367 | 451 | 4,485 |

*Other - Overhead and Parapet Mount Structures

## Chart 10 – Number of High Mast Lights and Camera Poles by Subcategory and District




| | Bristol | Salem | Lynchburg | Richmond | Hampton Roads | Fredericksburg | Culpeper | Staunton | Northern Virginia |
|---|---|---|---|---|---|---|---|---|---|
| High Mast Lighting | 1 | 0 | 0 | 0 | 287 | 1 | 0 | 56 | 87 |
| Camera Poles | 76 | 13 | 0 | 105 | 145 | 1 | 0 | 26 | 323 |
| Total | 77 | 13 | 0 | 105 | 432 | 2 | 0 | 82 | 410 |

## MEASURING PERFORMANCE

VDOT's system performance measure for bridge and large culvert structures is based on the percentage of structurally deficient structures in the Department's inventory. A Structurally Deficient (SD) structure has either of the following:

- a general condition rating (GCR) of poor (GCR of 4) or less for one or more of the following structural components: deck, superstructure, substructure or large culvert
- an appraisal rating of two (2) or less for the structural condition or waterway adequacy

These deficient structural components require the structure to be monitored and/or repaired. In some instances these structures have been posted to restrict the weight of vehicles driving on the structure. Appendix C provides definitions of the general condition ratings. Appendix C also provides comparative data on the average condition ratings by District.

VDOT's current goal is to have no more than eight (8%) percent SD structures for the entire state. Goals have also been established to limit the percentage of SD structures on each of the three highway systems. These goals apply statewide and to the Districts individually: three (3%) percent of Interstate system structures, six (6%) percent of Primary system structures, and eleven (11%) percent of Secondary system structures.

At the end of the FY2015, 6.21% percent (1,310 structures) of the total inventory was rated as SD. Tables 5a and 5b show the number of SD structures that were restored and those that fell into SD status during the fiscal year. Chart 11A graphically displays the current number and percentage of SD structures by District (District percentages are based on the number of structures in that particular District). Chart 11B provides the same information except only NHS (NBI) structures are shown. Chart 12 shows the current percentage of SD structures by Custodian. Chart 13A shows the nine year statewide trend for the percentage of SD structures. Chart 13B shows the nine year statewide trend for the percentage of structures in Good or Fair condition. These charts address all of the Commonwealth's structures, including those that are not part of the NBI. Appendix D provides more detailed data by highway system.

Appendix L shows the national trend of deficient structures from 2000 to 2014. National data is reported by the states at the end of March for the previous year and is not available until May or June of the following year. The data for Virginia shown in Appendix L only addresses the NBI bridges and large culverts, which does not include structures with a length 20 feet or less.

## Table 5a – Change in Number of Structurally Deficient Structures Between FY2014 and FY2015

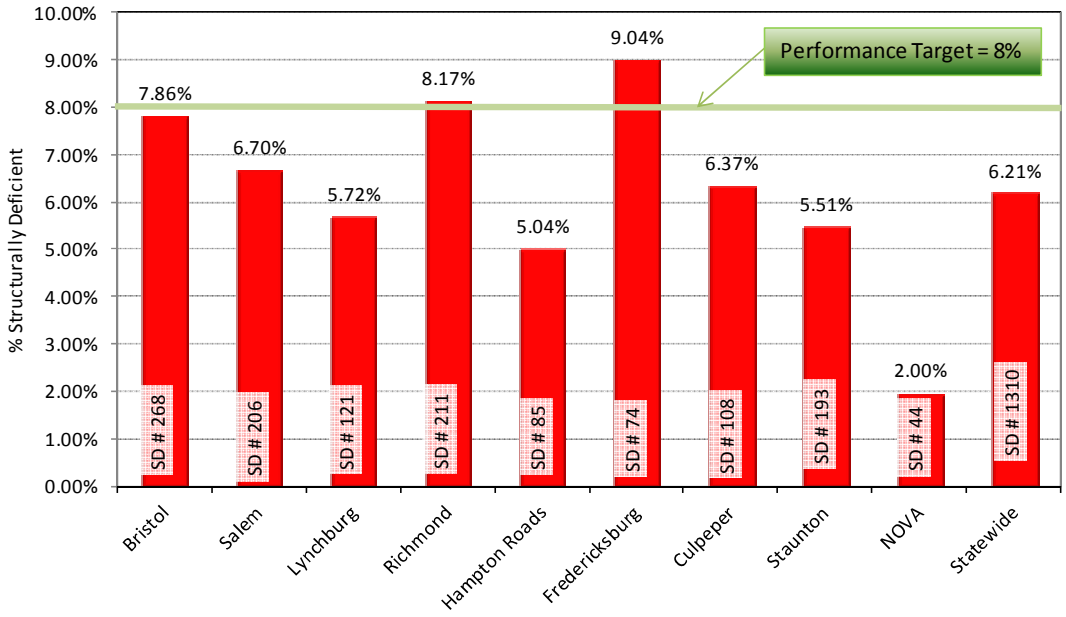
| DISTRICT | Structurally Deficient | | |
|---|---|---|---|
| | End of FY2014 | End of FY2015 | Change |
| Bristol | 300 | 268 | -10.7% |
| Salem | 245 | 206 | -15.9% |
| Lynchburg | 133 | 121 | -9.0% |
| Richmond | 241 | 211 | -12.4% |
| Hampton Roads | 89 | 85 | -4.5% |
| Fredericksburg | 74 | 74 | 0.0% |
| Culpeper | 117 | 108 | -7.7% |
| Staunton | 203 | 193 | -4.9% |
| NOVA | 51 | 44 | -13.7% |
| **Statewide** | **1,453** | **1,310** | **-9.8%** |

Note: Percentages are based on count of FY2015 inventory

## Table 5b – Change in Number of Structurally Deficient Structures During FY2015

| DISTRICT | During FY2015 | | | | |
|---|---|---|---|---|---|
| | Reduces No. of SD Structures | | | New SD Structures | Net Change |
| | Restored | Closed | Removed | | |
| Bristol | -45 | -3 | -4 | +20 | -32 |
| Salem | -49 | -2 | -10 | +22 | -39 |
| Lynchburg | -29 | -3 | -5 | +25 | -12 |
| Richmond | -38 | -3 | -11 | +22 | -30 |
| Hampton Roads | -9 | -2 | -1 | +8 | -4 |
| Fredericksburg | -4 | -2 | -3 | +9 | 0 |
| Culpeper | -12 | -6 | 0 | +9 | -9 |
| Staunton | -27 | -2 | 0 | +19 | -10 |
| NOVA | -4 | -3 | -2 | +2 | -7 |

## Chart 11A – FY2015 Percentage of No. of Structurally Deficient Structures by District




## Chart 11B – FY2015 Percentage of No. of NHS (NBI) Structurally Deficient Structures by District

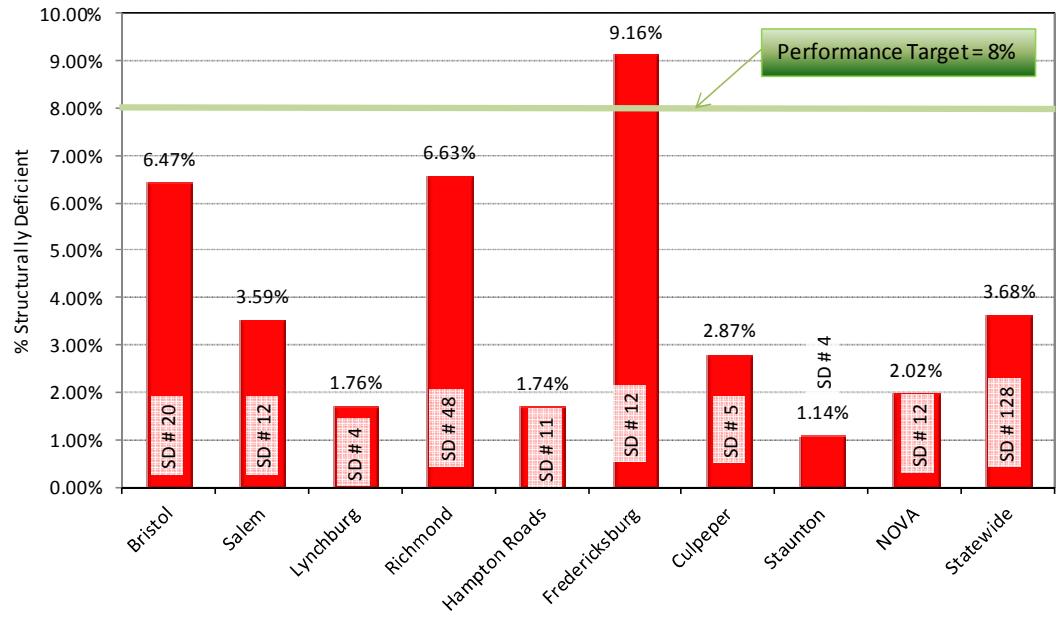
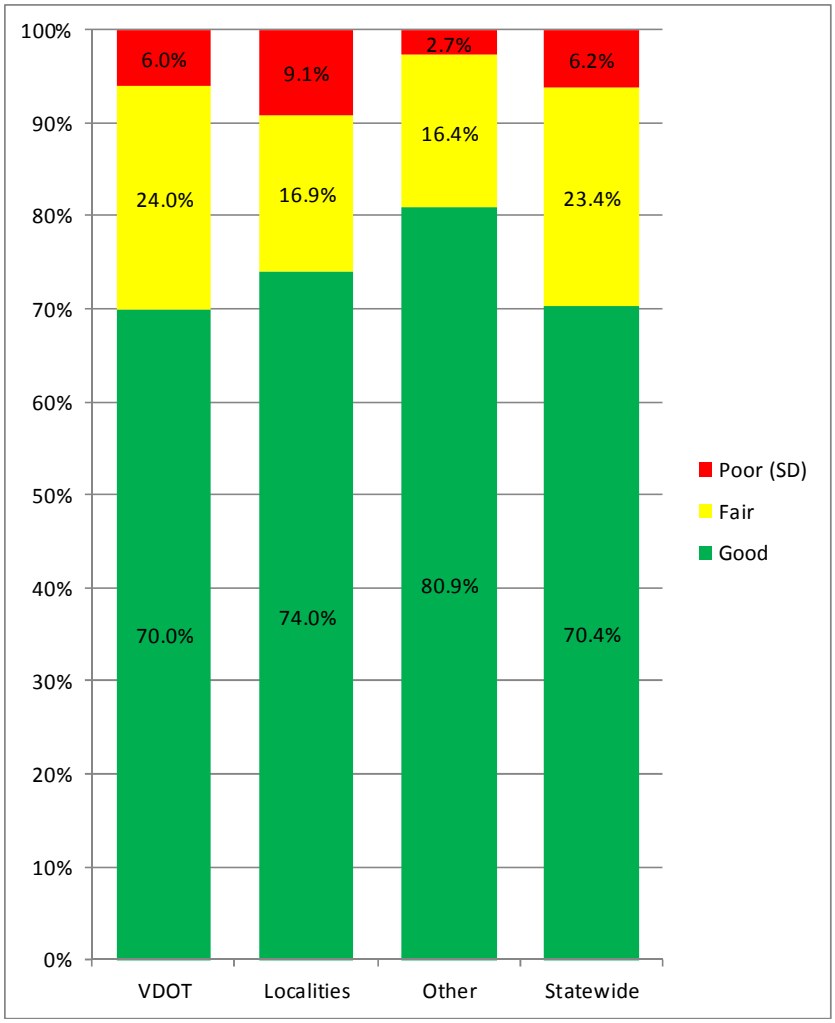
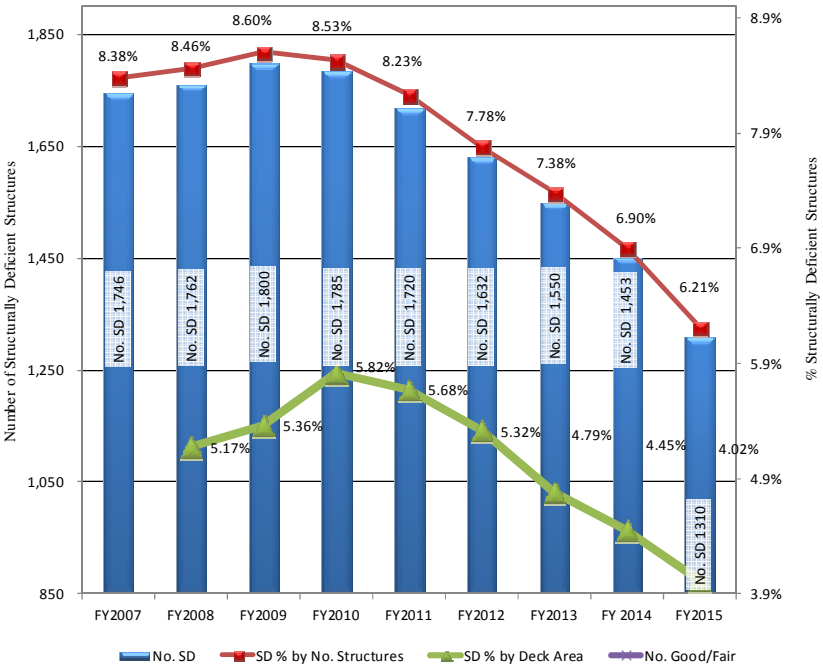


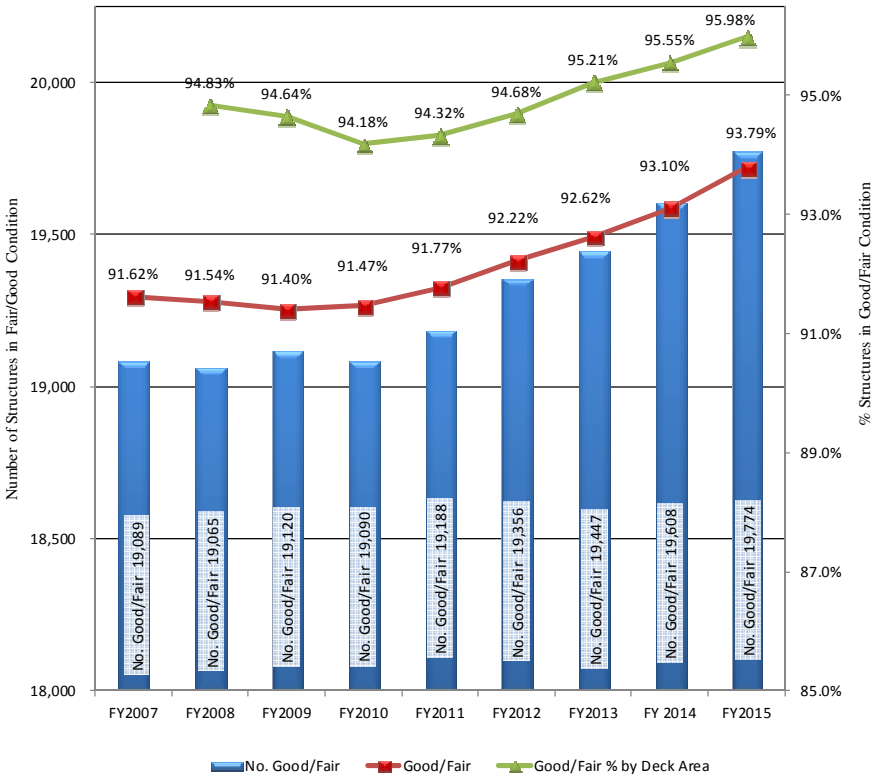
**Chart 12 – FY2015 Percentage of No. of Structurally Deficient Structures by Custodian**



## Chart 13A – Percentage of Structurally Deficient Structures Statewide (Nine Year Trend)




## Chart 13B – Percentage of Structures in Good or Fair Condition (Nine Year Trend)



In addition to the percentage of SD structures, VDOT also tracks other indicators to assist in the overall management of the structural inventory. These include: functional obsolescence (FO), structurally deficient structures, the number of posted structures, deficient deck area and the Health Index.

Appendix C compares general condition ratings by structure component and District. Appendix F shows the fiscal year performance measures based on the square footage area of the structures. Charts showing multi-year trends for these indicators statewide and for each highway system are given in Appendix E. The charts address all of the bridges and large culverts that comprise the Commonwealth's inventory, including those that are not part of the NBI. As discussed in Appendix G, the method of accounting for the number of structures by system has changed from previous years. Accordingly, graphs depicting data for specific highway systems show trend lines beginning in FY2009.

Statewide and District maps showing the location of each SD structure are located in Appendix H. Appendix I shows examples of items that can cause a structure to be functionally obsolete.

VDOT operates a Quality Assurance Program to help ensure that all of the inspections performed follow the national and VDOT requirements for the inspection of structures in the Commonwealth. Appendix J gives an overview of the Quality Assurance Program followed in the Commonwealth.

## VDOT's Future Performance Goals And Work Needs

Performance measurement has become an essential tool for making the best use of limited funds in a highly transparent and accountable manner. A sound performance measurement program cannot be implemented overnight. It requires years of work to identify and adopt a set of metrics that are meaningful, actionable and practical to measure.

VDOT performs an annual analysis in order to determine and report on the monetary needs for each of its assets. The monetary needs for any particular asset are defined as the amount of funding required to reach stated performance goals which maintain and improve the condition of Virginia's bridges.

The Structure and Bridge Division uses three sets of performance goals in determining its program's monetary needs. These performance goals address structures in various condition categories. True system preservation extends the service life of structures, which requires a balanced approach that places emphasis on structures in good, fair and poor condition. For consistency and ease of measurement, structures are placed in one of the three condition categories based on the minimum General Condition Rating (GCR) of each structure, as assigned during the structure's most recent safety inspection. As explained elsewhere in this report, the General Condition Rating is a numerical measurement of the primary components of each structure. Measured on a 0-9 scale, with 0 representing a failed structure, a General Condition Rating is assigned to each bridge's deck, superstructure and substructure at each inspection. large culverts receive a single GCR. The minimum GCR for each bridge or large culvert is used to define its condition category (good, fair or poor) as follows:

| | |
|---|---|
| **Good Structures:** | Minimum GCR ≥ 6 |
| **Fair Structures:** | Minimum GCR = 5 |
| **Poor Structures:** | Minimum GCR ≤ 4 |

The general work needs for a balanced approach to bridges in good, fair or poor condition are shown below and are noted in Chapter 32 of Volume 5, Part 2, of the VDOT Manuals of the Structure and Bridge Division:

- Maintain 90% of expansion joints in a Condition State of 1[1]
- Eliminate 2% of the expansion joints in each District in each fiscal year
- Perform maintenance activities on at least 6% of structures with a minimum GCR of 5 in each District in each fiscal year
- Perform maintenance activities on at least 2% of structures with a minimum GCR of 6 in each District in each fiscal year
- For each highway system no more than the following percentage of structures can be structurally deficient[2]

| | |
|---|---|
| **Interstates** | 3% |
| **Primaries** | 6% |
| **Secondaries** | 11% |
| **All** | 8% |

[1] *In addition to GCR, Condition States are assigned to various critical bridge elements during bridge inspections. Elements in good condition are assigned a condition state of "1", and higher numbers are assigned to elements in worse condition*

[2] *There is a very close, but not exact, correlation between "Poor" structures and "Structurally Deficient" (SD) structures. All poor structures (min GCR≤4) are SD, but about 5% of VDOT's SD structures are in fair or good condition but have received the SD designation due to insufficient waterway clearance or load capacity.*

The performance goals above were determined using an analysis of the annual transition of VDOT's structures from one condition classification to another. Recognizing that the bridge maintenance program requires a balanced approach, where the maintenance needs of structures in each of the three condition classifications are regularly addressed, the analysis sought to establish thresholds that would achieve the goal of maintaining the average GCR of the existing inventory over time. There is no unique solution for these goals (various combinations of thresholds for good, fair and poor could achieve the desired result of maintaining the average GCR). Prior to establishing the actual thresholds a transition study was performed to determine the number of structures whose minimum GCR either improves or deteriorates in any particular year. Since the goal of the study was to determine how individual structures deteriorate from the beginning to the end of a fiscal year (year-to-year), only those structures that existed at begining and end of the Fiscal Year were included in the study. The numbers of actual year-to-year transitions for the Fiscal Year is displayed in Chart 14, which depicts the number of structures that transition from one condition classification to another or move up or down within a condition classification. The initial study focused on the transition between 2009 and 2010, and the numbers were used to establish a baseline and develop achievable goals for each condition classification.

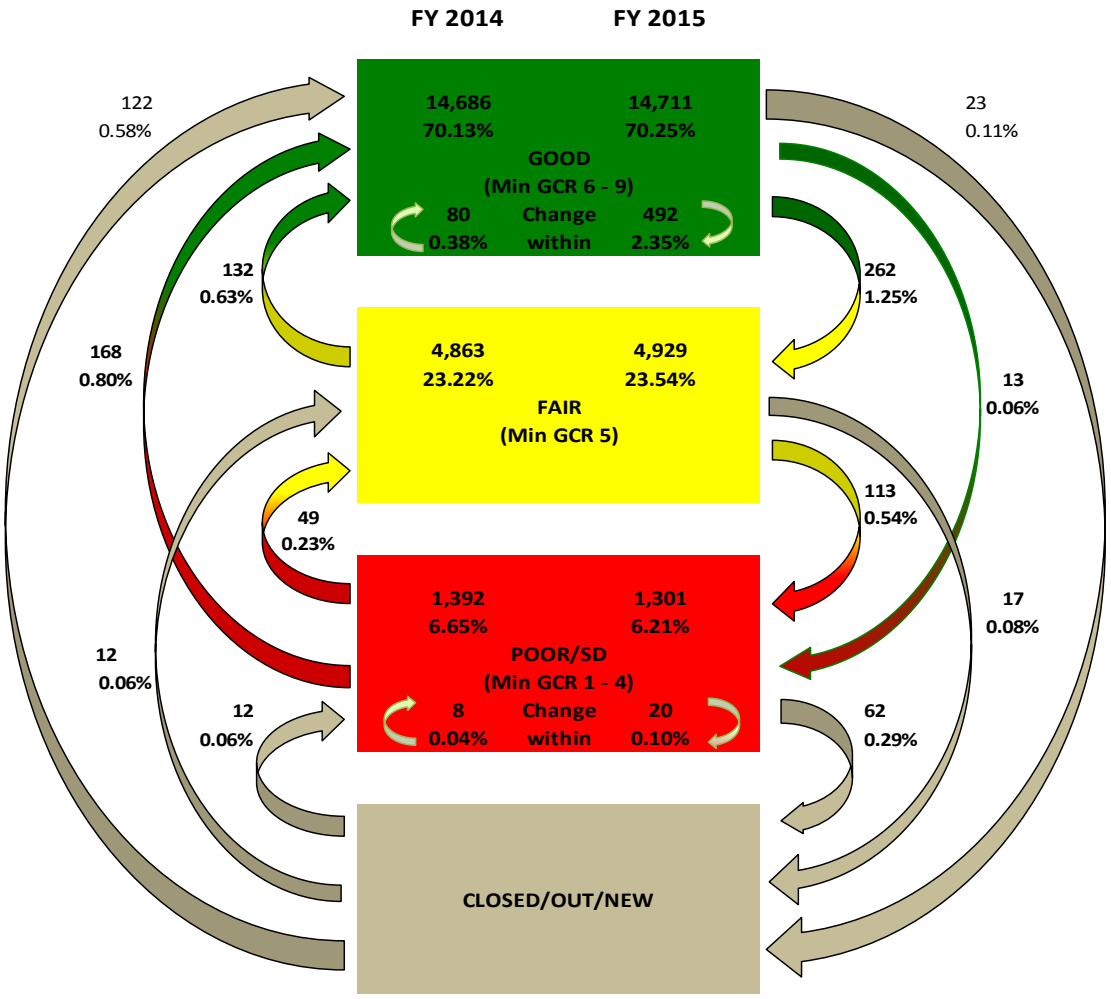
Based on the study, it was determined that system sustainability could be achieved with the goals shown above. Furthermore, these goals were deemed to be reasonably attainable with existing staff. However, the funding required to meet these goals remains significantly higher than that provided.

As shown in Chart 14, in the current Fiscal Year, 262 structures went from "Good" to "Fair" condition and 132 structures were improved from "Fair" to "Good" condition. This analysis utilized only structures that were present in the inventory at both the beginning and end of the Fiscal Year, thus eliminating any influence of new, replaced and closed bridges.

While early preservation actions are significantly more cost-effective, the maintenance program cannot focus exclusively on the better structures. The age and condition of the inventory, along with the needs of the traveling public, require that poor structures be repaired, rehabilitated or replaced. These very real constraints have led VDOT to adopt a balanced approach to bridge maintenance, which is reflected in the three sets of performance goals.

The establishment of performance goals for bridges has received a great deal of attention nationally, and the Federal Highway Administration and AASHTO have been working to establish consensus on the best guidelines and methodologies.

**Chart 14 – Annual Transitions of Good/Fair/Poor (SD) from FY2014 to FY2015**




The most recent federal highway legislation, MAP-21 establishes a minimum standard for NHS bridge conditions. If more than 10% of the total deck area of NHS bridges in a State is on structurally deficient bridges for three consecutive years, the State must devote National Highway Performance Program (NHPP) funds in an amount equal to 50% of the State's FY 2009 Highway Bridge Program apportionment to improve bridge conditions during the following fiscal year (and each year thereafter if the condition remains below the minimum). MAP21 also requires each state to establish and meet performance goals for its inventory for which there is an executive committee working on such performace goals. Nearly all of the AASHTO reports published to date have aligned closely with VDOT's approach, recommending a balanced approach to both maintenance and measurement of performance. More information about the national effort to understand performance measurement and goals may be found in the following links and documents:

DRAFT Report to the AASHTO Subcommittee on Bridges and Structures (SCOBS)
Topic: Development of National Performance Measures for Highway Bridges
Presentations concerning performance measures for bridges:
http://bridges.transportation.org/Documents/2014%20SCOBS%20presentations/Technical%20Committee%20Presentations/T-9_9_Bruce%20Johnson_National%20Bridge%20Performance%20Measures.pdf

## ANCILLARY STRUCTURES

Ancillary structures are rated using general condition rating definitions that are similar to those used in the FHWA's National Bridge Inventory System. General Condition Ratings (GCRs) are assigned based on a numerical grading system that ranges from 0 (failed condition) to 9 (excellent condition). Appendix K gives a brief description for each of the ratings and also provides illustrative examples.

At the time of each inspection, inspectors assign a GCR for each of the major structural components: foundation; parapet mounting; and superstructure. They do not rate the appurtenances supported by the ancillary structure such as sign panels, light fixtures and traffic signals.

In order to develop a general understanding of the condition of the ancillary structure inventory, the nine condition ratings have been combined into three categories: Good (GCR > 5), Fair (GCR = 5) and Poor (GCR < 5). Summaries of this analysis for the four general type structures are provided in Table 6 and Charts 15a through 15e.

**Table 6 – Minimum General Condition by Structure Type**

| Structure Type | Condition Categories (No. of Structures) | | | Minimum General Condition Rating (Percentage) | | |
|---|---|---|---|---|---|---|
| | Good | Fair | Poor | Good | Fair | Poor |
| Signs | 2,139 | 825 | 592 | 60.2% | 23.2% | 16.6% |
| Signals | 3,568 | 3,262 | 2,313 | 39.0% | 35.7% | 25.3% |
| High Mast Lights and Camera Poles | 853 | 177 | 91 | 76.1% | 15.8% | 8.1% |
| Luminaires | 6,582 | 6,083 | 5,817 | 35.6% | 32.9% | 31.5% |
| **Total** | **13,142** | **10,347** | **8,813** | **40.7%** | **32.0%** | **27.3%** |

**Chart 15a – Sign Structures by Minimum General Condition Rating**

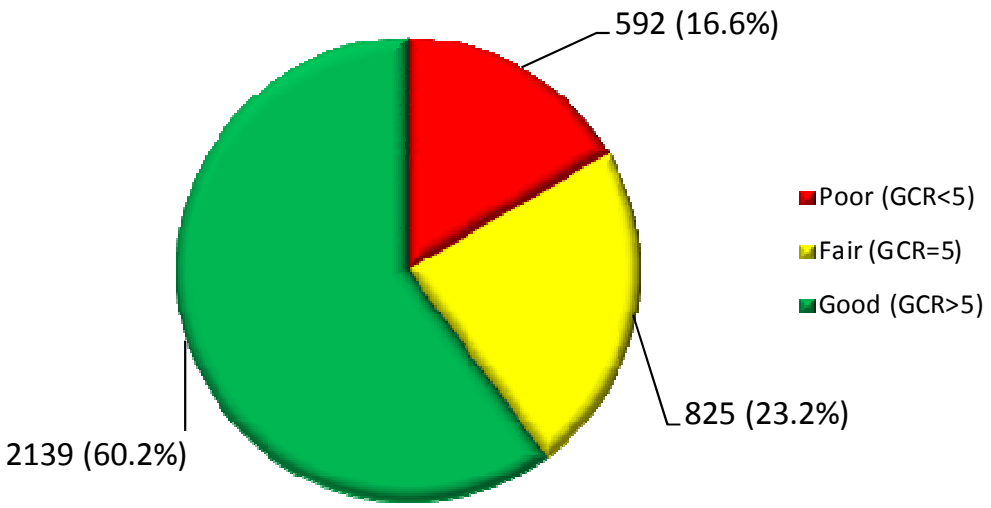



**Chart 15b – Signal Structures by Minimum General Condition Rating**

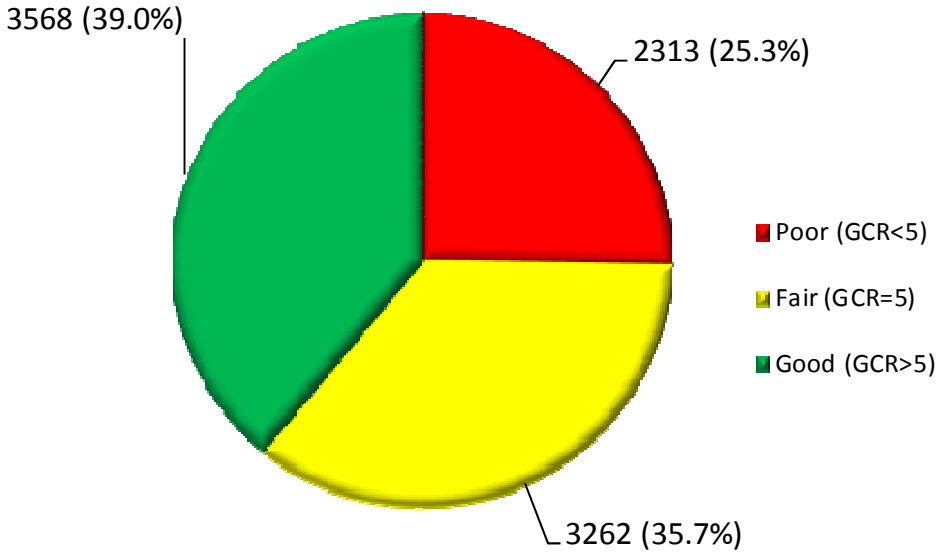


**Chart 15c – High Mast Lights and Camera Poles by Minimum General Condition Rating**

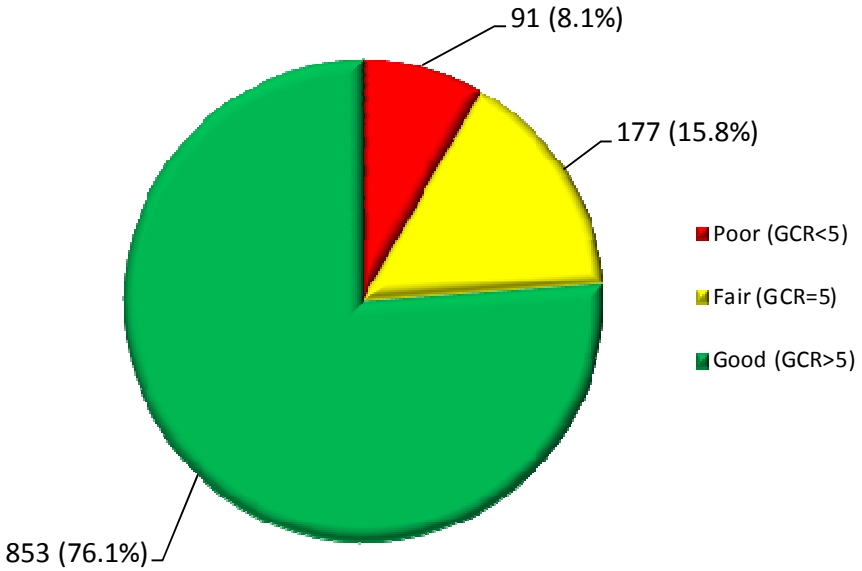



**Chart 15d – Luminaires by Minimum General Condition Rating**

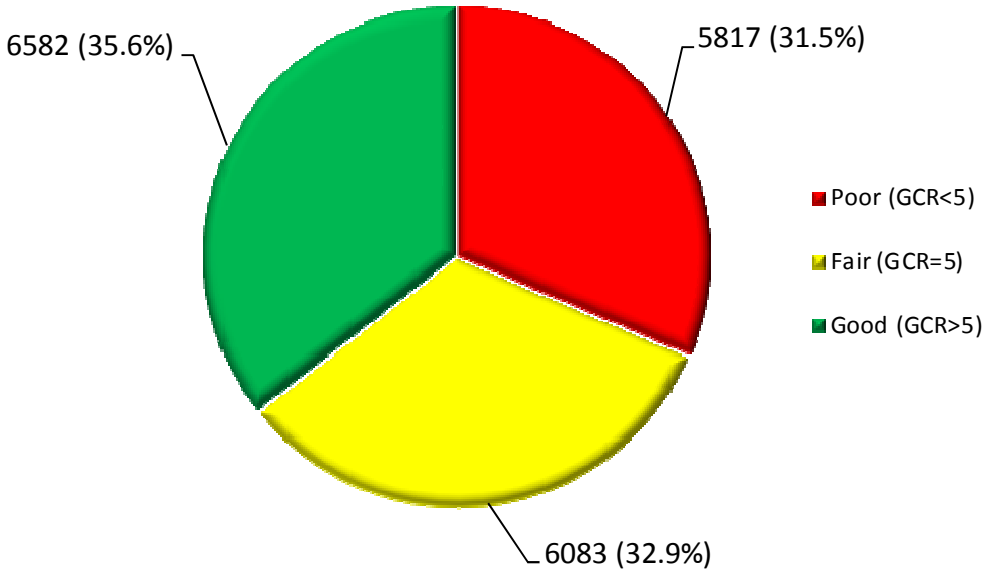
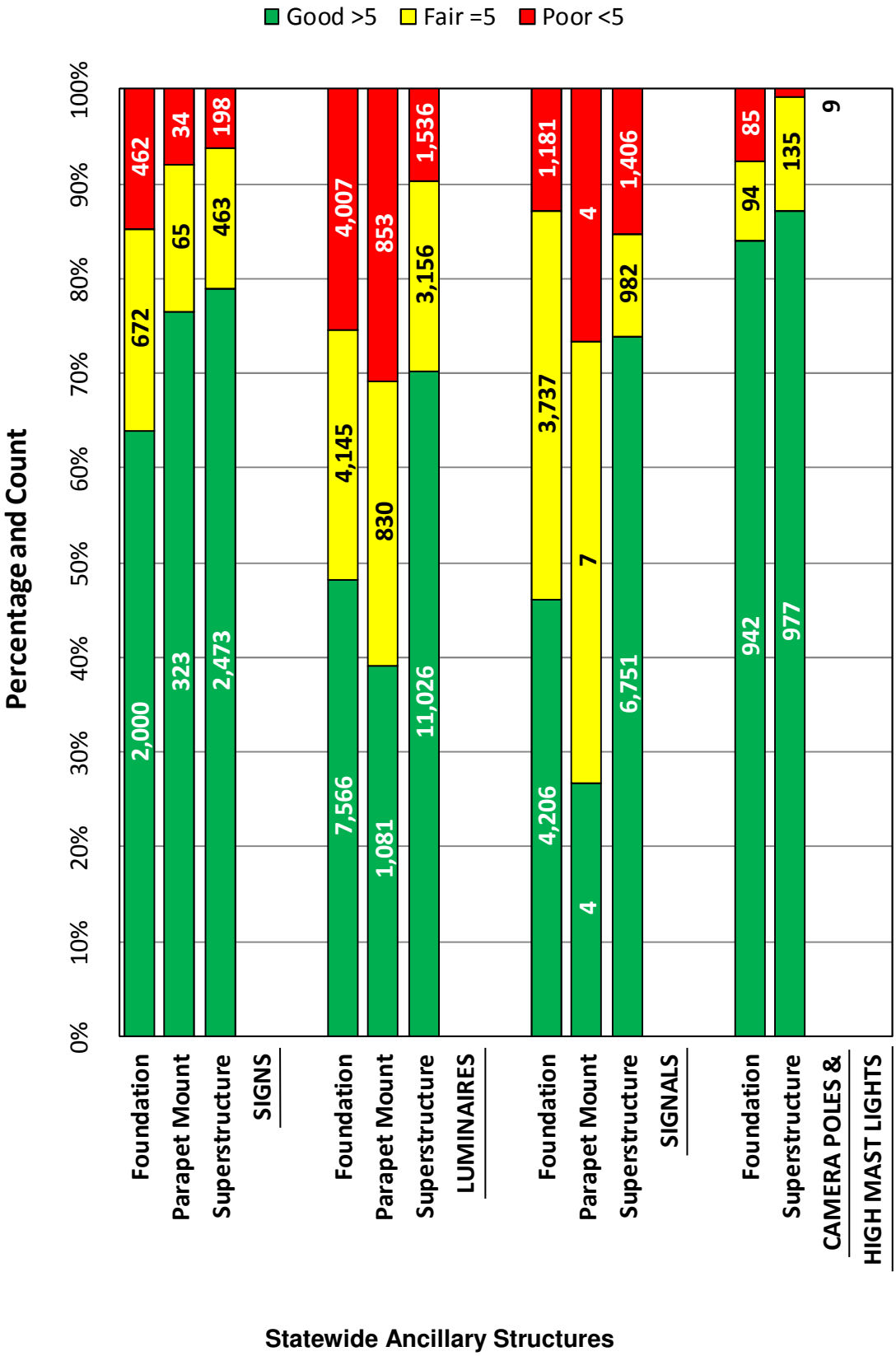



Chart 15e provides the condition of the ancillary structures by structural component by asset statewide. In Appendix K, other charts are presented to gain a more specific understanding of the conditions that cause structures to receive reduced GCRs.

**Chart 15e – Statewide Ancillary Structure Condition by Asset Type**



## VDOT's Structure & Bridge Program Funding

The S&B Division receives funding for bridge projects through two programs within VDOT: Highway System Acquisition and Construction (603) Program denoted hereafter as the Construction (603) Program, and Highway System Maintenance (604) Program denoted hereafter as the Maintenance (604) Program.

The S&B Division apportionment of the Construction (603) Program is primarily supported by a federal fund formerly known as the Highway Bridge Replacement Program (HBRRP), created in 1978 by the Surface Transportation Assistance Act. The HBRRP was established by the United States Congress to provide a funding source for the nation's in-service bridges. The original intent of the program was to fund bridge rehabilitation and replacement needs. In 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) was signed into law. SAFETEA-LU established extensive new resources and opportunities to fund bridge construction. Federal Funds apportioned as the HBRPP shall be allocated and obligated as required by federal law to eligible projects. The anticipated federal bridge allocations were taken out of the system formula to create what was known as the Dedicated Bridge Fund (DBF). Funding eligibility for bridge projects then extended beyond replacement and rehabilitation to include preservation activities.

On October 1, 2012, the federal government implemented a new funding program to replace SAFETEA-LU called MAP-21. MAP-21 created three funding sources for the S&B Construction (603) Program, denoted as NHPP-BR, STP-BR and STP-BROS.

NHPP-BR funds are designated for structures on the National Highway System (NHS).

STP-BR funds are the most flexible type funds. They can be used on any bridge project regardless of roadway classification or NBI status.

STP-BROS funds are mandated by the federal government and can only be used for bridges that are not on the NHS.

Along with the new Federal MAP-21 funds in FY2014, the Governor's Transportation Package of 2012 introduced new Commonwealth Transportation Board (CTB) funds in FY2014. The Virginia General Assembly directed 25% of the CTB funding to the Commonwealth's S&B Construction (603) Program for the period of FY2014 through FY2020. These are state funds contributing to the S&B Construction (603) Program. In FY2015, S&B Division received distribution responsibility for both MAP-21 and CTB Bridge funds. The CTB Bridge funds are being utilized to supplement program priorities. Recently, House Bill 1887 of the 2015 General Assembly Session replaced CTB Formula funding for the Construction (603) Program, which is set to sunset in FY2020, with a new formula beginning in FY2021. This formula will consist of 45% of state collected transportation revenues to fund a State of Good Repair need. State of Good Repair means improvement of deficient pavement conditions and improvement of structurally deficient bridges as stated in Code of Virginia Section §33.2-369. Projects expected to receive State of Good Repair funds will be ranked through a prioritization model established by VDOT Executive Management. The distribution of State of Good Repair funding to the S&B Construction (603) Program has yet to be fully determined.

For the S&B Construction (603) Program, S&B Division reports on projects that are funded by MAP-21 Federal bridge funds as well as bridge specific allocation of CTB Formula state funds, together hereafter referred to as Bridge Funding. The Construction (603) Program also has projects that contain structures which are funded by other Federal and State revenue sources, which includes Design Build Program projects that contain structures.

The eligibility of the different types of funding available to the S&B Construction (603) Program is shown in the table below:

| BRIDGE FUND ELIGIBILITY | | | | |
|---|---|---|---|---|
| | NHS (On System) | Non NHS (Off System) | NBI (> 20' Length) | Non NBI Structures (< 20' Length) |
| NHPP-BR | X | | X | X |
| STP-BR | X | X | X | X |
| STP-BROS | | X | X | |
| CTB BRIDGE | X | X | X | X |

Structures meeting the requirements are eligible for bridge program funds:

1. The bridge is deficient (structurally deficient)
2. No major rehab or reconstruction has been done to the bridge in the last 10 years regardless of the funding source or type that was used
3. Estimated project cost is less than $20 million
4. Only VDOT owned bridges through FY2020

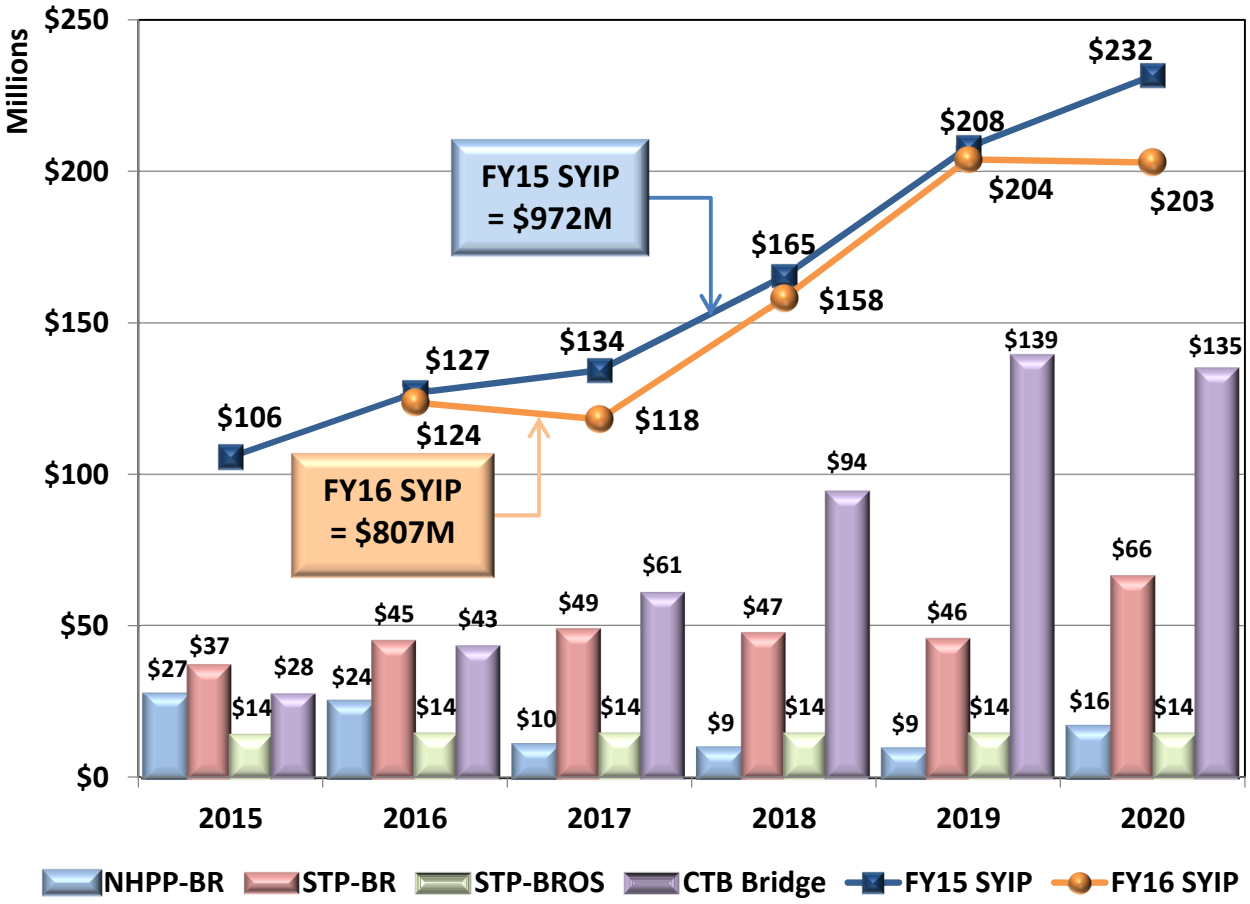
Federal funds for the S&B Construction (603) Program are apportioned to the S&B Division by the VDOT Infrastructure Investment Division (IID). NHPP-BR and STP-BR funding levels are apportioned at the discretion of the VDOT IID. The STP-BROS funding levels are set aside at no less than 15% of the State's Highway Bridge Program apportionment.

The S&B Division then distributes the bridge program funds among the nine (9) VDOT District Bridge offices based on a distribution formula developed by Central Office S&B Division. This formula allocates funds for each district based on the square footage area of deficient bridges and the number of structurally deficient structures that are not currently funded in each district. The Districts distribute their allocated funds based on structural priorities. A ranking formula was developed to aid in prioritizing the funding and programming of eligible projects. The formula considers the following equally weighted factors: Average Daily Traffic (ADT), Truck ADT, Weight Restrictions, Detour Length, Fracture Critical, Scour Critical, Structural Deficiency, General Condition Rating, Substandard Roadway Width; and Age. This methodology is monitored yearly for continuous improvement.

For FY2015, the S&B Division had $106M for the S&B Construction (603) Program to address structurally deficient structures.

Chart 16 below shows the funding levels of the Six Year S&B Construction (603) Program, a subset of the overall VDOT Six Year Improvement Plan (SYIP), beginning in FY2015 and projected funding for the FY2016 Six Year S&B Construction (603) Program. The column graphs show the breakdown of the FY2015 funds per Bridge Funding type (NHPP-BR, STP-BR, STP- BROS, CTB Bridge). The CTB Bridge funds are expected to sunset in FY2020, after which the S&B Construction (603) Program funding will adopt new state funding through State of Good Repair funding sources. FY2016 Six Year S&B Construction (603) Program in Chart 16 only depicts funds through FY2020 due to process currently under development to finalize distribution of FY2021 State of Good Repair funding.

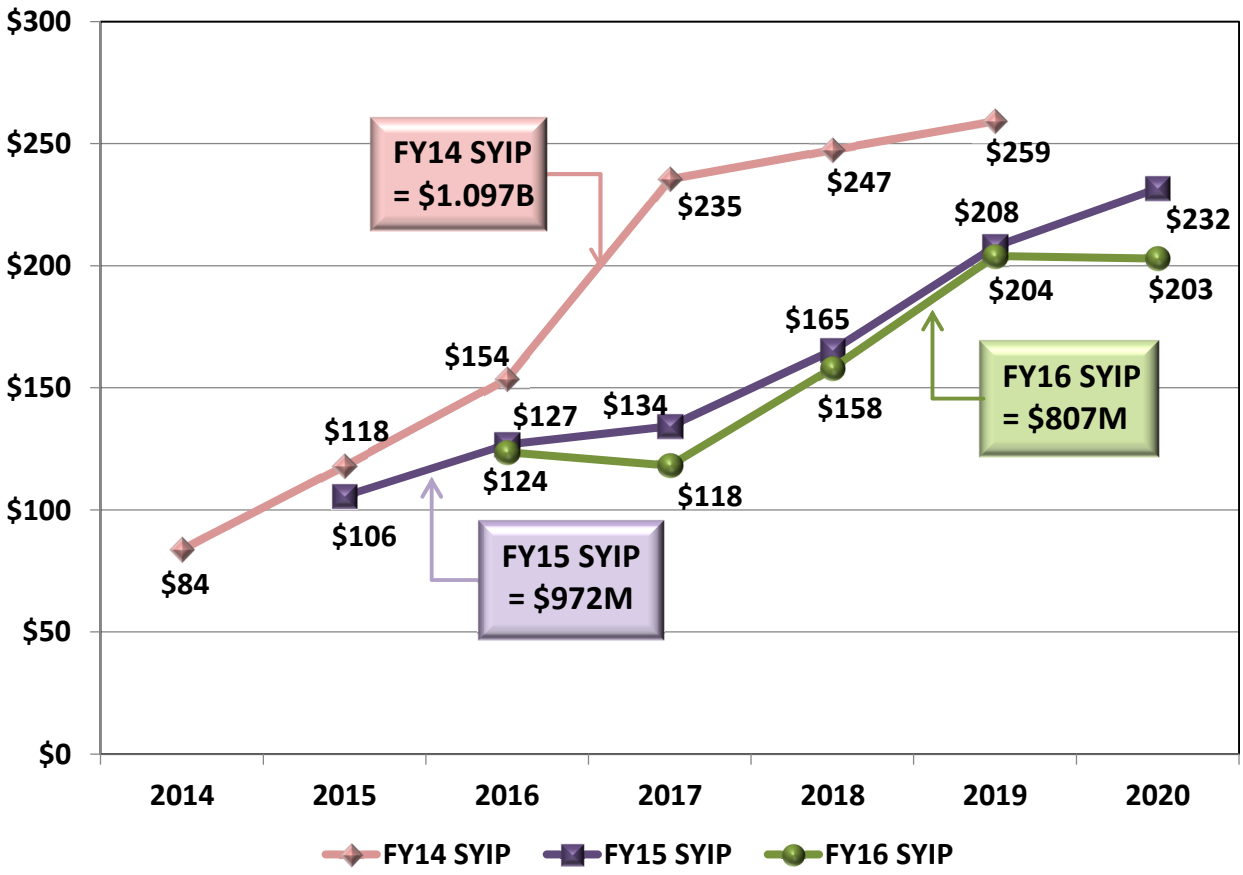
**Chart 16 – S&B Construction (603) Program Funding FY2015 SYIP vs. FY2016 SYIP**




The CTB Bridge funds made up approximately 51% of the FY2015 Six Year S&B Construction (603) Program. The majority of the CTB Bridge funds are expected in FY2018 through FY2020.

The three curves shown in Chart 17 compare the funding plans for fiscal years 2014, 2015 and 2016. Each curve displays the six-year improvement plan as it was established at the beginning of the fiscal year. FY2014 was the first year in which CTB Bridge Funds were programmed. FY2016 only depicts five years of funding, through FY2020, due to the ongoing process to finalize distribution of FY2021 State of Good Repair funding.

**Chart 17 – S&B Construction (603) Program Comparison from FY2014, FY2015 and FY2016**




Structure project expenditures are derived from the VDOT Cardinal Accounting System. These expenditures are grouped into three separate categories for the S&B Construction (603) Program reporting purposes (Bridge Funding Projects, Design Build Bridge Projects, Construction (603) Program Bridge Projects containing no Bridge Funding). The following assumptions were made in determining bridge related expenditures:

1. S&B Construction (603) Program Projects (Bridge Funding Projects)
2. Design Build program projects containing structures
3. All projects containing structures funded by means other than Bridge Funding (examples include CPR and GARVEE Bonds, CTB Formula Statewide funds, etc.)

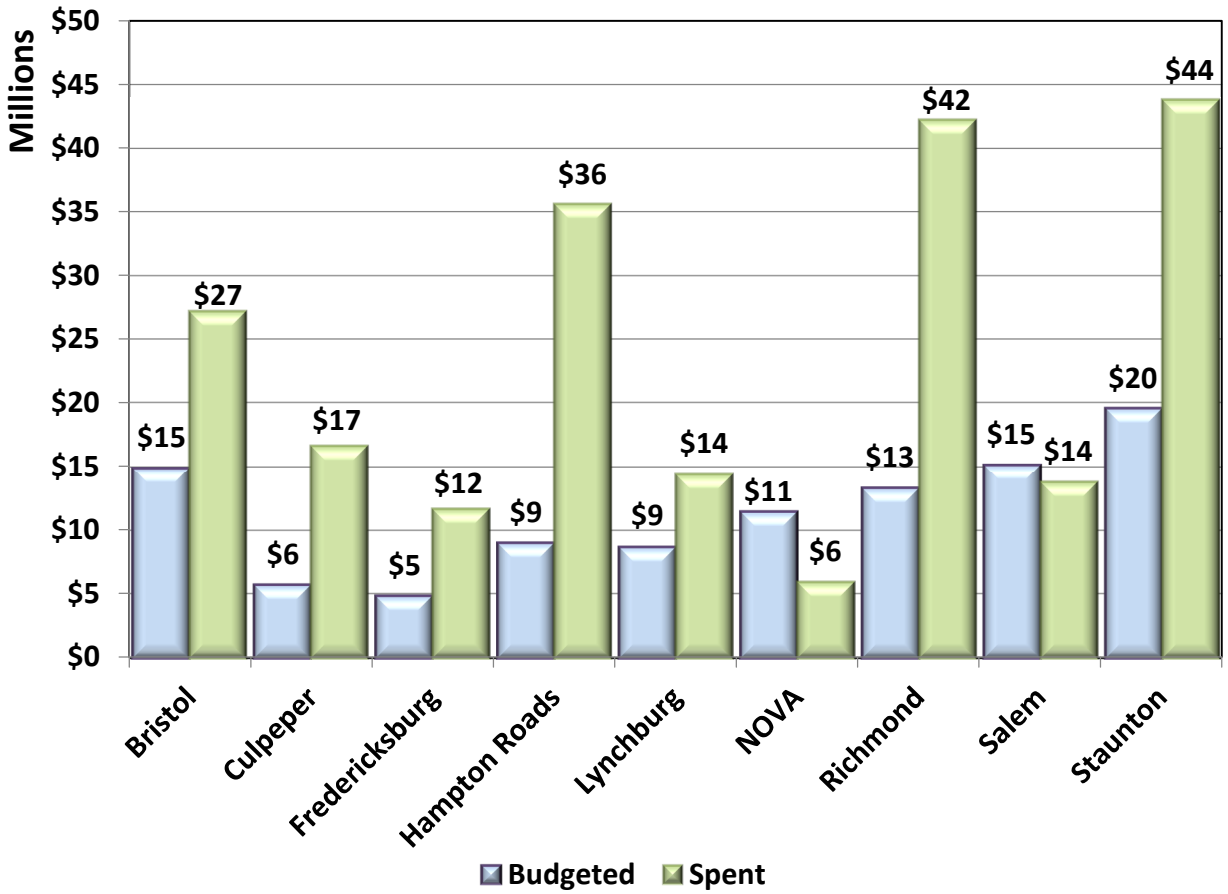
Category 3 was determined by using the Project Pool VDOT system to determine projects that contain structure work. As the Cardinal Accounting System used to capture expenditures is limited in its capacity to separate expenditures related to bridge work versus other work on projects, the assumption made in this report is to include all expenditures related to projects containing bridge work.

Approximate structure project expenditures based on data derived from the VDOT Cardinal Accounting System for FY15 were as follows:

1. $211M for Bridge Funding Projects
2. $224M for Design Build Projects containing bridges
3. $162M for Bridge Projects funded by other means

Chart 18 below shows the District distribution of the $106M allocated to the bridge program in FY2015 and actual expenditures for bridge projects in the S&B Construction (603) Program in FY2015. The program was budgeted for $106M and had $211M in total expenditures. Unspent funds are not lost but rather carry over with the project into the subsequent fiscal year. Differences between the anticipated pace of funding and the spent amounts are often the result of a difference between the anticipated pace of construction and the actual pace. For the same reason, some districts actually spent more than allocated, as funds from previous year(s) carried over on certain projects.

**Chart 18 – S&B Construction (603) Program FY2015 Budget vs. Expenditures by District**




The difference between budgeted and actual expenditures can be primarily attributed to the multi-year nature of the SYIP projects and should not imply that project budgets are being exceeded. Districts can transfer funds with other districts throughout the year to ensure statewide program funding effectiveness and efficiency.

## S&B Maintenance (604) Program Overview

The S&B Maintenance (604) Program is developed and managed by the District Bridge Offices in accordance with the Maintenance (604) Program. VDOT's Operations Planning Division (OPD) allocates these funds to each district maintenance office and the Central Office S&B Division every fiscal year in accordance with the direction of VDOT's Executive Management.

Allocations represent a suggested funding level for each of the activities that require Maintenance (604) Program funds. The allocations are based on a proportional formula that determines the suggested funding level based on the program needs as submitted in the Annual Needs Report by OPD. OPD generates the Annual Needs Report using estimates determined by the various responsible divisions. The term "allocation", as used in the process, does not represent an actual funding amount; it is a recommended funding level for particular activities and Cost Centers (CSCs). District Maintenance Managers (DMM) use the allocations as a guide to build budgets, which establishes the actual funding amount for each of the program areas for which the manager has funding responsibility.

The needs for the S&B Maintenance (604) Program are developed by the S&B Central Office staff. The reported needs do not represent the total funding required to improve all of the structures. S&B Division reports needs for the amount of money required to meet its performance goals. The S&B Division has implemented performance goals that address structures in "good", "fair" and "poor" condition. The total funding required to improve all of the structures is considerably higher than the amount required to meet the above-referenced performance goals.

The S&B Maintenance (604) Program budget in FY2015 was $171.6M. In recent years the calculated monetary need for bridge maintenance and construction has significantly exceeded available funding. The availability of funding is the most significant factor in the performance of the bridge inventory. The S&B Division's single performance measure limits the percentage of structurally deficient structures to 8%. In recent years, the percentage of structurally deficient (poor) structures has steadily decreased, reflecting an apparent improvement in bridge conditions. However, while the number of poor structures has indeed decreased, the overall condition of the inventory has not improved. This slow decrease in overall condition can primarily be attributed to the gap between required and available funding. Allocated funds are often used to address structures in immediate need of repair or replacement, leaving less money than required for preventive maintenance.

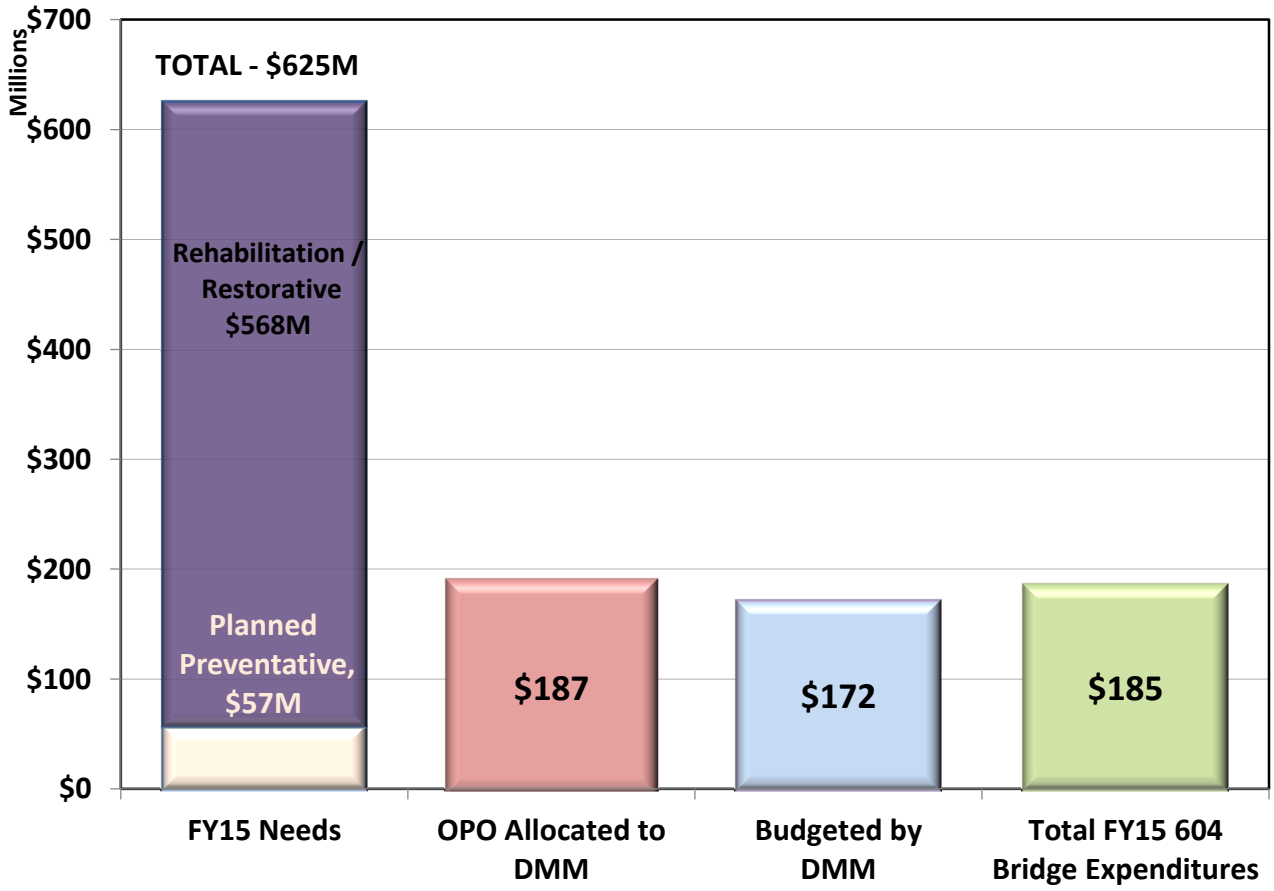
Another significant factor affecting long-term performance relates to the selection of structures scheduled for replacement or major rehabilitation. In recent years, available funding in the construction program has often led to smaller structures being selected for this work. This has resulted in a notable reduction in the number of poor structures. However, by selecting smaller, less expensive structures for replacement and rehabilitation, we are also developing a backlog of larger, more expensive structures that will soon require significant work.

Bridge deterioration occurs over a period of decades rather than months or years, so the results of short-term funding deficiencies will not necessarily be readily evident in near-term trends of conditions. However, over time, if the funding for bridge maintenance and

replacement is not increased, we should expect to see significant degradation of the average bridge conditions.

Chart 19 below compares the total amounts of the S&B Maintenance (604) Program needs, allocations provided to the DMM by the OPO, the actual S&B Division budget built by the DMM and the expenditures for FY2015.

**Chart 19 – FY2015 S&B Maintenance (604) Program Overview**

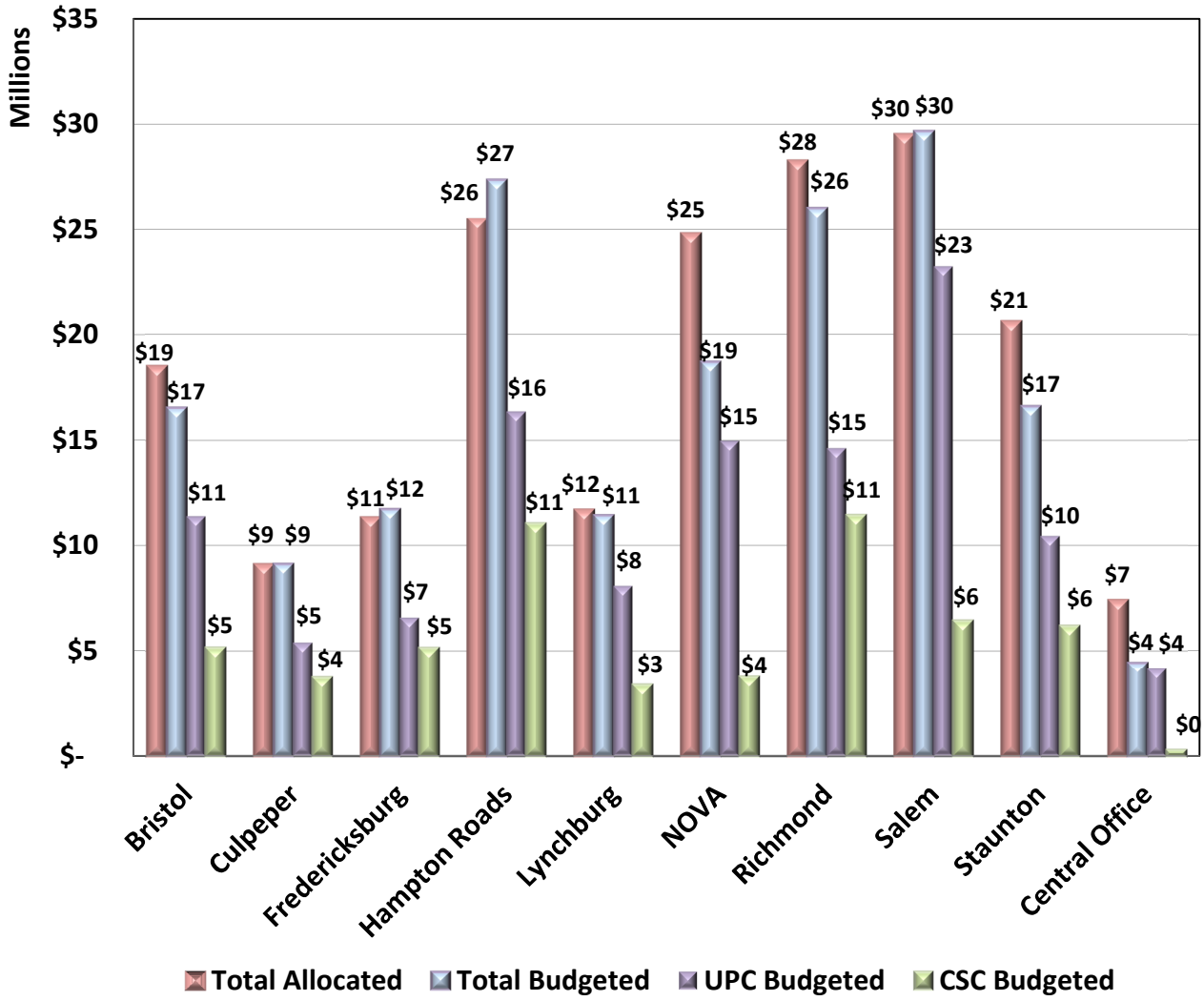



*DMM – District Maintenance Manager

*These values are for structural maintenance. Inspection, Replacement and Movable Bridge operations are not included in these values.

Chart 20 below provides a breakdown, by District, of the total S&B Maintenance (604) Program. This is typically around $130M per year. Inspection comprised $29.1M of the $171.6M budgeted by the DMM in FY 2015.

**Chart 20 – FY2015 S&B Maintenance (604) Program Distribution by District**




The S&B Maintenance (604) Program budget is built utilizing both CSCs and UPCs. The nature of CSC and UPC are such that it is possible for expenditures to exceed amounts budgeted. CSCs can pull funds from other Districts CSCs to accommodate expenditures in excess of budgeted figures. UPCs in the S&B Maintenance (604) Program behave similar to those UPCs funded in the S&B Construction (603) Program. Excess UPC expenditures can be primarily attributed to the multi-year nature of the SYIP projects and should not imply that project budgets are being exceeded.

Chart 21 below shows the bridge maintenance funds budgeted and spent per district for FY2015. In FY2015, the S&B Maintenance (604) Program was originally budgeted $171.6M and expended $185.4M.

**Chart 21 – FY2014 S&B 604 Maintenance Program Total Budgeted and Spent**

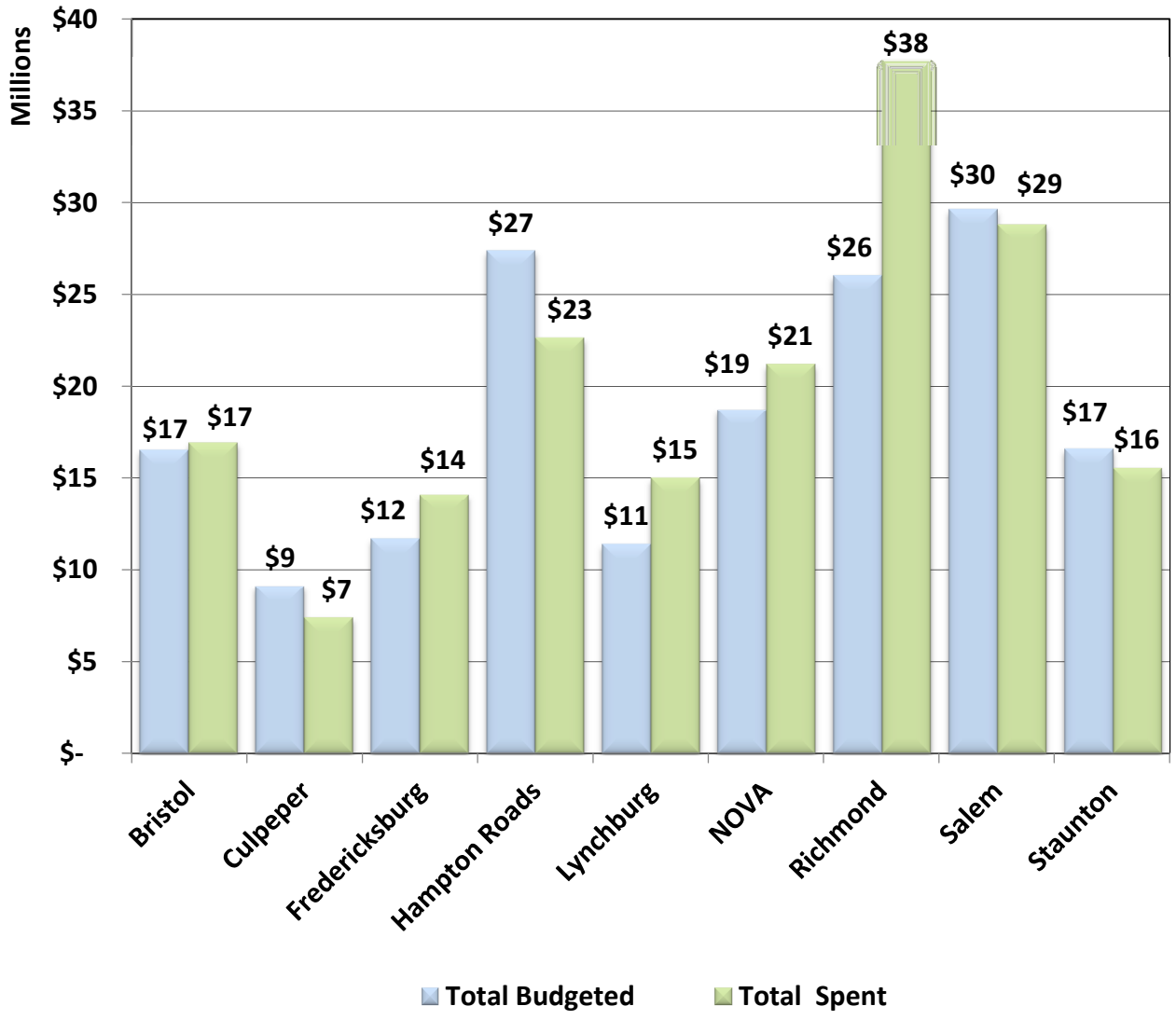


Chart 22 compares original budget and expenditures for district CSCs. Most of the budgeted funds not spent in the CSCs can be attributed to accommodating the high cost of snow removal for the districts during FY2015.

**Chart 22 – FY2015 S&B Maintenance (604) Program CSC Budgeted and Spent**

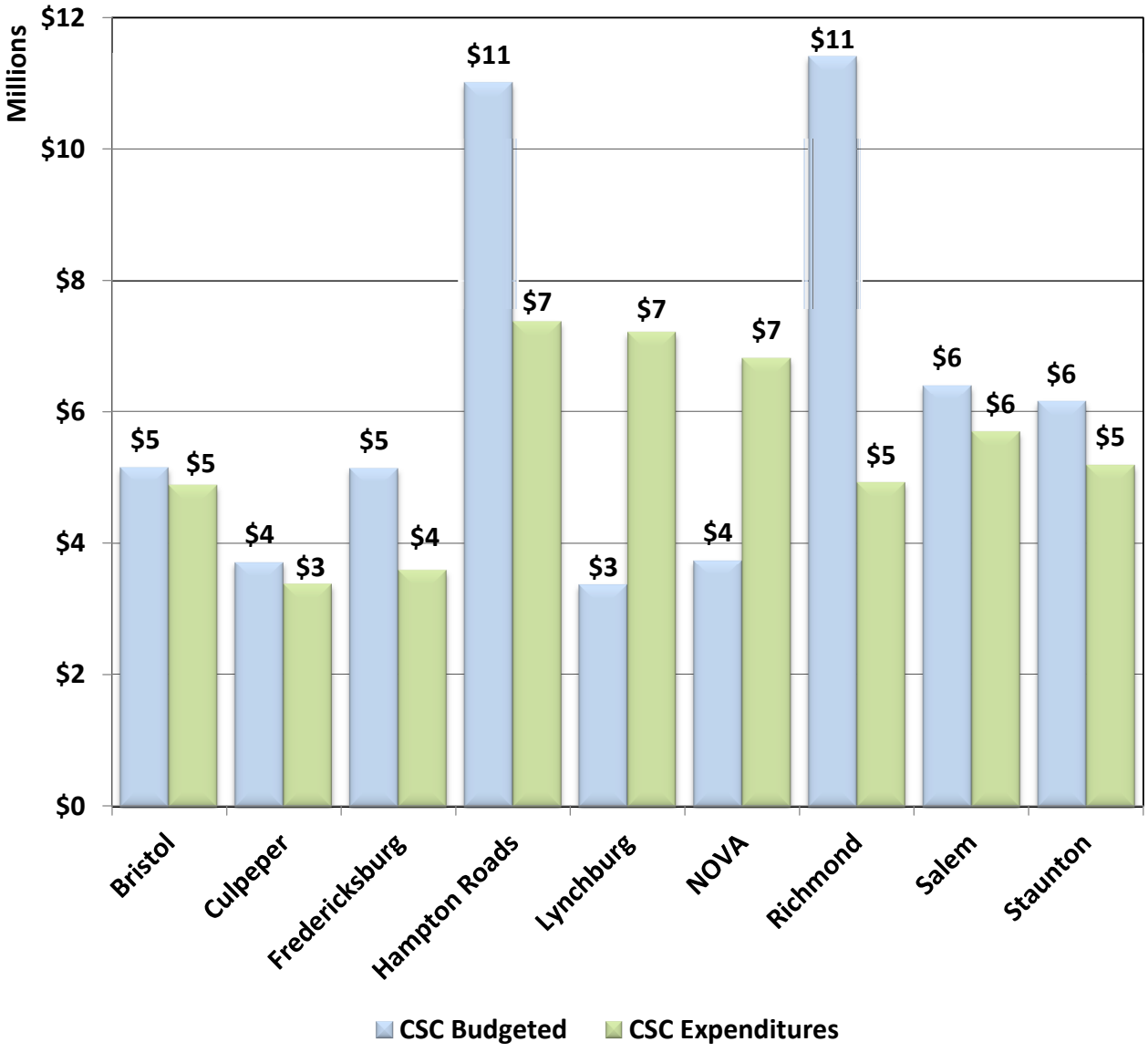


Chart 23 below illustrates the bridge maintenance UPC funds budgeted and spent per district for FY2015. The differences between amounts budgeted and spent can be attributed to the nature of UPCs. Maintenance (604) Program UPC project funding does not necessarily align with UPC project spending in the Construction (603) Program due to the classification of projects in each program. The funding is established by the project, which may take place over multiple fiscal years, and spending is tracked on an annual basis by fiscal year. A couple examples include Salem District's multiple superstructure replacement contracts that are funded with S&B Maintenance (604) Program funds and have not yet been awarded for construction. Therefore, these projects are not yet incurring charges. Another example is Richmond District, which is spending funds on contracts that are under construction and funded in previous fiscal years.

**Chart 23 – S&B Maintenance (604) Program FY2015 UPC Budgeted and Spent**

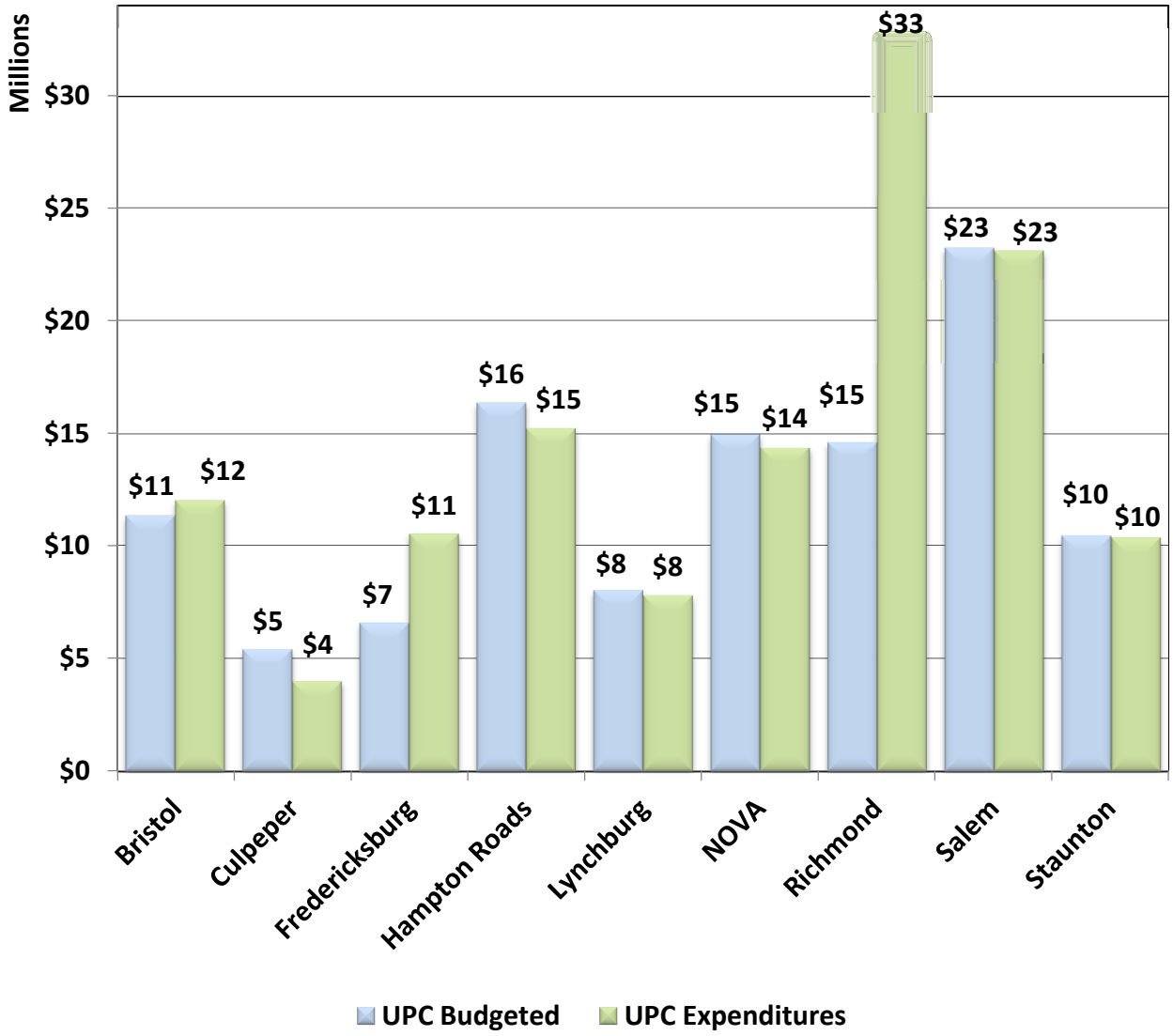
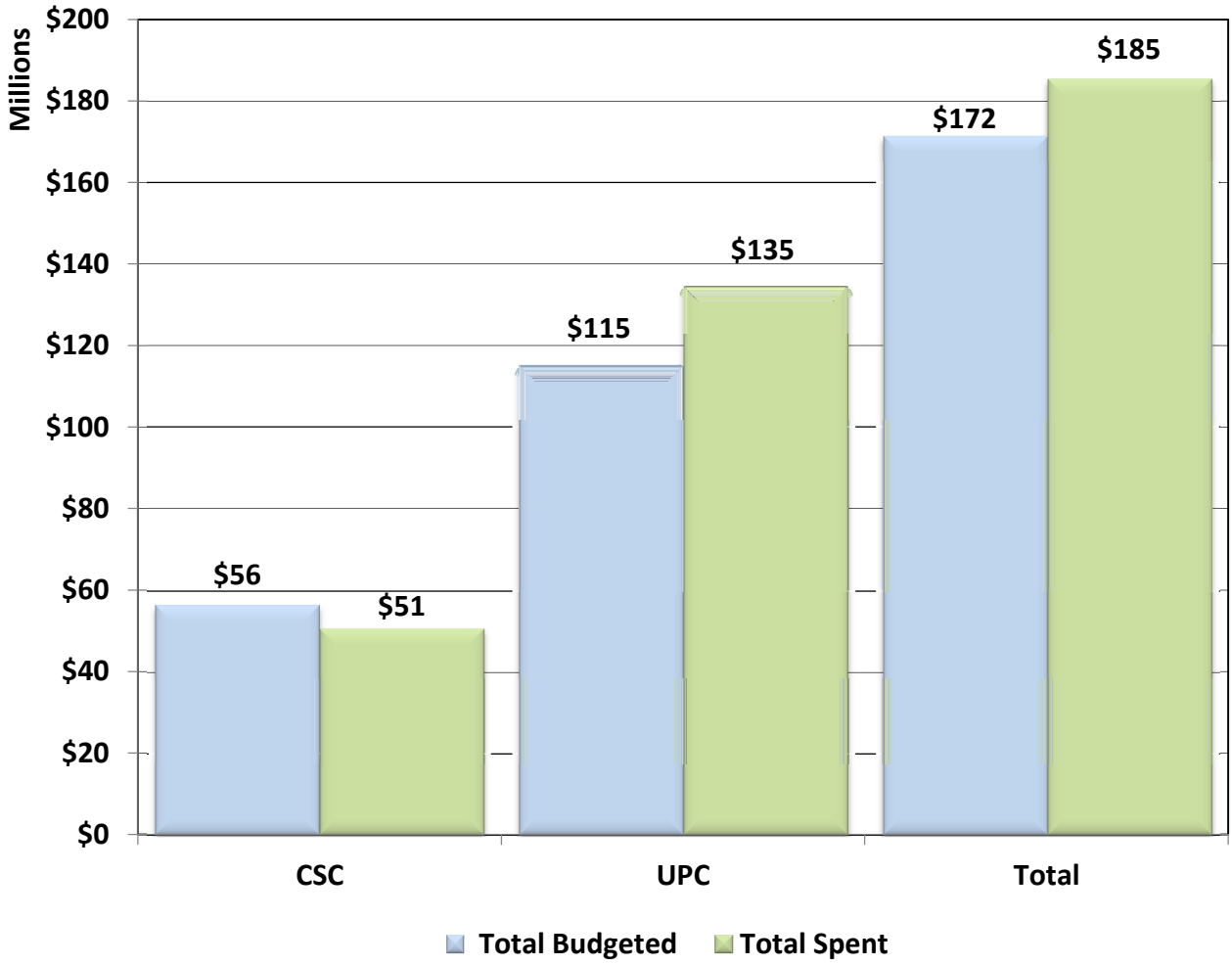


Chart 24 below displays the total S&B Maintenance (604) Program funds budgeted and spent for FY2015 by CSC and UPC.

**Chart 24 – FY2015 S&B 604 Maintenance Program UPC Budgeted and Spent**



## VDOT's Special Structures

VDOT has identified a group of structures with characteristics that warrant special consideration for maintenance, repair and funding. These structures are large and/or complex and play a critical role in the function of the transportation network. They include large fixed-span bridges, movable bridges and tunnels. A list of the structures is provided below:

| | STRUCTURE NAME | ROUTE CARRIED | DISTRICT |
|---|---|---|---|
| TUNNELS | Big Walker Mountain | I-77 | Bristol |
| | East River Mountain | I-77 | Bristol |
| | Hampton Roads Bridge Tunnel (HRBT) | I-64 | Hampton Roads |
| | Monitor Merrimac Memorial Bridge Tunnel (MMBT) | I-664 | Hampton Roads |
| | Elizabeth River Downtown Tunnel | I-264 | Hampton Roads |
| | Elizabeth River Midtown Tunnel | Rt. 58 | Hampton Roads |
| | Rosslyn Tunnel | I-66 | Northern Virginia |
| MOVABLE BRIDGES | Chincoteague Bridge | Rt. 175 | Hampton Roads |
| | High Rise Bridge | I-64 | Hampton Roads |
| | Berkley Bridge | I-264 | Hampton Roads |
| | Coleman Bridge | Rt. 17 | Hampton Roads |
| | James River | Rt. 17 | Hampton Roads |
| | Benjamin Harrison | Rt. 156 | Richmond |
| | Eltham Bridge | Rt. 30/33 | Fredericksburg |
| | Gwynn's Island Bridge | Rt. 223 | Fredericksburg |
| COMPLEX STRUCTURES | Varina-Enon Bridge | I-295 | Richmond |
| | Norris Bridge | Rt. 3 | Fredericksburg |
| | HRBT Approach Bridges | I-64 | Hampton Roads |
| | I-64 over Willoughby Bay | I-64 | Hampton Roads |
| | MMMBT approaches | I-64 | Hampton Roads |
| | James River Bridge Approach Spans | Rt. 17 | Hampton Roads |
| | High Rise Bridge Approach Spans | I-64 | Hampton Roads |
| | Pocahontas Parkway over James River | I-895 | Richmond |
| | Smart Road Bridge | Smart Rd. | Salem |
| | 460 Connector | Rt. 460 | Bristol |

These structures have one or more of the following traits that constitute critical features:

- High traffic in conjunction with high detour
- Critical and non-redundant link for communities with significant population
- Structural complexity
- High maintenance and/or operational demands

Operational and maintenance responsibility for the tunnels resides with VDOT's Operations Division, while responsibility for the movable bridges is shared between the Operations and Structure and Bridge Divisions. Fixed span structures are inventoried and maintained by the Structure and Bridge Division.

## APPENDIX A – ADDITIONAL INVENTORY INFORMATION ON BRIDGES AND LARGE CULVERTS

Tables A.1 through A.6 provide counts of the number of bridges and large culverts in Virginia. Tables A.1 and A.2 address the total statewide; Tables A.3 and A.4 address NBI structures; Tables A.5 and A.6 address Non-NBI structures. Charts A.1 through A.4 show the average age of structures by system and district.

**Table A.1 – Total Number of Bridges by District**

| DISTRICT | Number of Bridges | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 136 | 549 | 1,559 | 191 | 2,435 |
| Salem | 117 | 480 | 1,352 | 74 | 2,023 |
| Lynchburg | 0 | 365 | 799 | 40 | 1,204 |
| Richmond | 281 | 491 | 666 | 100 | 1,538 |
| Hampton Roads | 335 | 336 | 304 | 217 | 1,192 |
| Fredericksburg | 23 | 142 | 213 | 6 | 384 |
| Culpeper | 71 | 257 | 674 | 11 | 1,013 |
| Staunton | 205 | 508 | 1,385 | 65 | 2,163 |
| NOVA | 257 | 335 | 536 | 18 | 1,146 |
| **Statewide** | **1,425** | **3,463** | **7,488** | **722** | **13,098** |

**Table A.2 – Total Number of Large Culverts by District**

| DISTRICT | Number of Culverts | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 80 | 405 | 474 | 17 | 976 |
| Salem | 101 | 329 | 593 | 28 | 1,051 |
| Lynchburg | 0 | 296 | 596 | 18 | 910 |
| Richmond | 240 | 291 | 454 | 61 | 1,046 |
| Hampton Roads | 120 | 114 | 194 | 65 | 493 |
| Fredericksburg | 59 | 112 | 263 | 1 | 435 |
| Culpeper | 50 | 242 | 380 | 11 | 683 |
| Staunton | 224 | 320 | 752 | 43 | 1,339 |
| NOVA | 122 | 211 | 692 | 28 | 1,053 |
| **Statewide** | **996** | **2,320** | **4,398** | **272** | **7,986** |

**Table A.3 – Total Number of NBI Bridges by District**

| DISTRICT | Number of Bridges | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 136 | 420 | 986 | 188 | 1,730 |
| Salem | 113 | 367 | 901 | 73 | 1,454 |
| Lynchburg | 0 | 331 | 677 | 40 | 1,048 |
| Richmond | 278 | 461 | 606 | 98 | 1,443 |
| Hampton Roads | 335 | 328 | 280 | 216 | 1,159 |
| Fredericksburg | 23 | 134 | 189 | 6 | 352 |
| Culpeper | 71 | 168 | 514 | 10 | 763 |
| Staunton | 205 | 376 | 806 | 65 | 1,452 |
| NOVA | 257 | 300 | 438 | 17 | 1,012 |
| **Statewide** | **1,418** | **2,885** | **5,397** | **713** | **10,413** |

**Table A.4 – Total Number of NBI Large Culverts by District**

| DISTRICT | Number of Culverts | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 28 | 100 | 128 | 17 | 273 |
| Salem | 27 | 84 | 232 | 22 | 365 |
| Lynchburg | 0 | 86 | 237 | 18 | 341 |
| Richmond | 87 | 119 | 237 | 61 | 504 |
| Hampton Roads | 40 | 38 | 91 | 61 | 230 |
| Fredericksburg | 22 | 42 | 113 | 1 | 178 |
| Culpeper | 14 | 72 | 172 | 7 | 265 |
| Staunton | 50 | 83 | 241 | 39 | 413 |
| NOVA | 28 | 96 | 334 | 27 | 485 |
| **Statewide** | **296** | **720** | **1,785** | **253** | **3,054** |

**Table A.5 – Total Number of Non-NBI Bridges by District**

| DISTRICT | Number of Bridges | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 0 | 129 | 573 | 3 | 705 |
| Salem | 4 | 113 | 451 | 1 | 569 |
| Lynchburg | 0 | 34 | 122 | 0 | 156 |
| Richmond | 3 | 30 | 60 | 2 | 95 |
| Hampton Roads | 0 | 8 | 24 | 1 | 33 |
| Fredericksburg | 0 | 8 | 24 | 0 | 32 |
| Culpeper | 0 | 89 | 160 | 1 | 250 |
| Staunton | 0 | 132 | 579 | 0 | 711 |
| NOVA | 0 | 35 | 98 | 1 | 134 |
| **Statewide** | **7** | **578** | **2,091** | **9** | **2,685** |

**Table A.6 – Total Number of Non-NBI Large Culverts by District**

| DISTRICT | Number of Culverts | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 52 | 305 | 346 | 0 | 703 |
| Salem | 74 | 245 | 361 | 6 | 686 |
| Lynchburg | 0 | 210 | 359 | 0 | 569 |
| Richmond | 153 | 172 | 217 | 0 | 542 |
| Hampton Roads | 80 | 76 | 103 | 4 | 263 |
| Fredericksburg | 37 | 70 | 150 | 0 | 257 |
| Culpeper | 36 | 170 | 208 | 4 | 418 |
| Staunton | 174 | 237 | 511 | 4 | 926 |
| NOVA | 94 | 115 | 358 | 1 | 568 |
| **Statewide** | **700** | **1,600** | **2,613** | **19** | **4,932** |

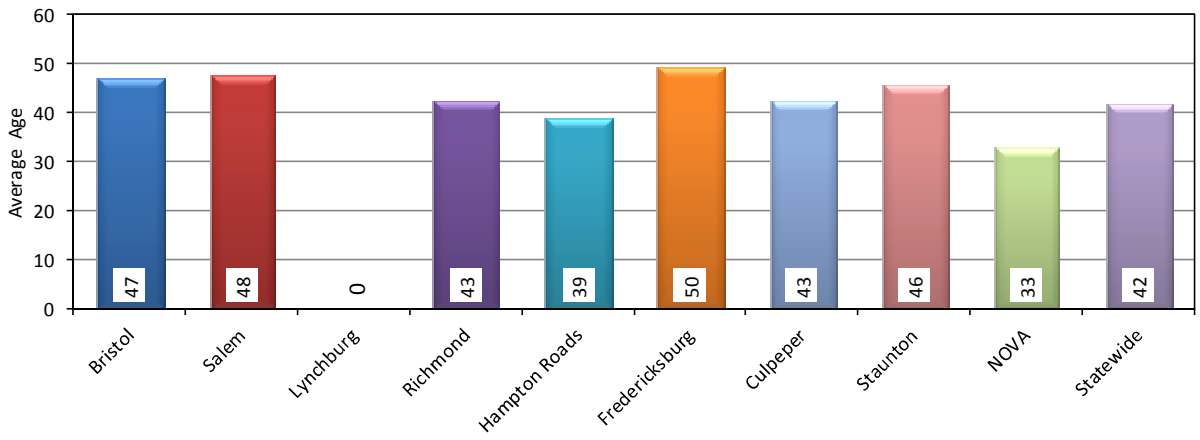
**Table A.7 – Total Number of NHS (Only NBI) Bridges by District**

| DISTRICT | Number of Bridges | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 136 | 113 | 2 | 0 | 251 |
| Salem | 112 | 167 | 1 | 2 | 282 |
| Lynchburg | 0 | 179 | 0 | 0 | 179 |
| Richmond | 277 | 270 | 8 | 3 | 558 |
| Hampton Roads | 331 | 179 | 0 | 56 | 566 |
| Fredericksburg | 23 | 59 | 0 | 2 | 84 |
| Culpeper | 70 | 53 | 0 | 1 | 124 |
| Staunton | 203 | 89 | 0 | 0 | 292 |
| NOVA | 252 | 214 | 32 | 0 | 498 |
| **Statewide** | **1,404** | **1,323** | **43** | **64** | **2,834** |

**Table A.8 – Total Number of NHS (Only NBI) Large Culverts by District**

| DISTRICT | Number of Culverts | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 28 | 30 | 0 | 0 | 58 |
| Salem | 26 | 26 | 0 | 0 | 52 |
| Lynchburg | 0 | 48 | 0 | 0 | 48 |
| Richmond | 87 | 76 | 2 | 1 | 166 |
| Hampton Roads | 36 | 24 | 0 | 5 | 65 |
| Fredericksburg | 22 | 25 | 0 | 0 | 47 |
| Culpeper | 13 | 37 | 0 | 0 | 50 |
| Staunton | 48 | 11 | 0 | 0 | 59 |
| NOVA | 28 | 65 | 2 | 0 | 95 |
| **Statewide** | **288** | **342** | **4** | **6** | **640** |

## Chart A.1 – Average Age of Interstate Structures by District




## Chart A.2 – Average Age of Primary Structures by District

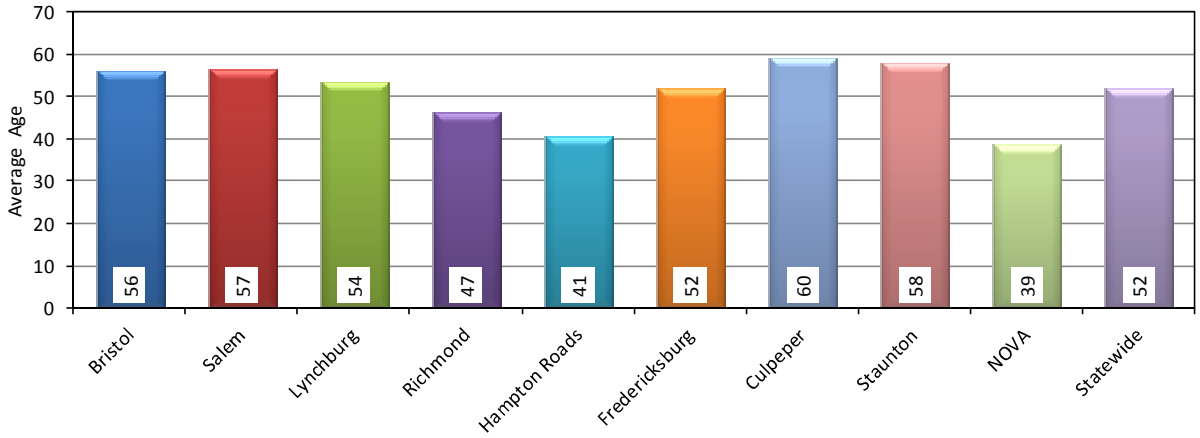


**Chart A.3 – Average Age of Secondary Structures by District**

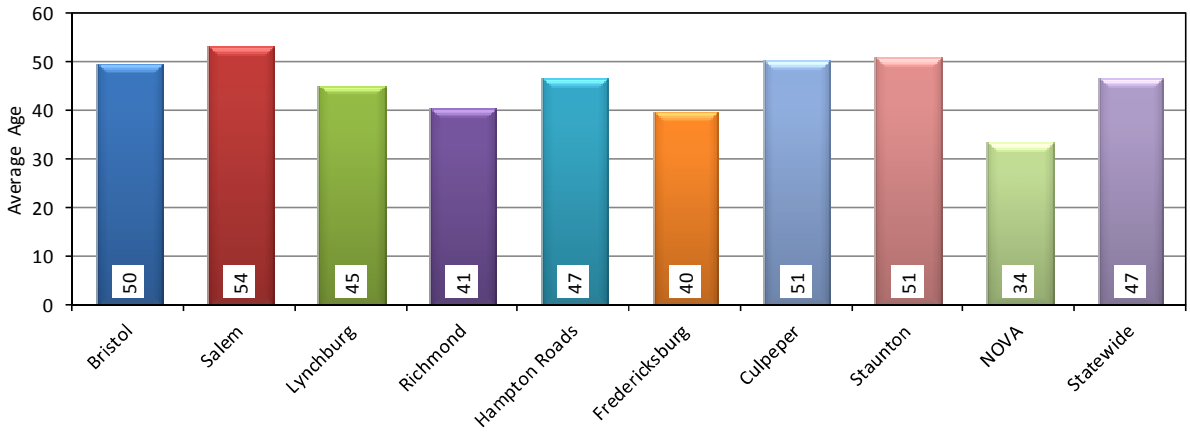
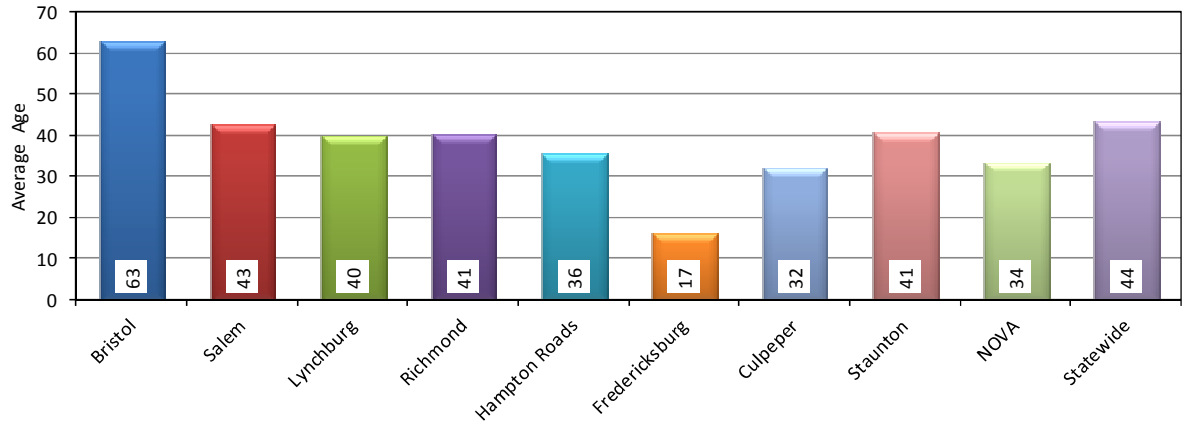



**Chart A.4 – Average Age of Urban Structures by District**



## APPENDIX B – ADDITIONAL INVENTORY INFORMATION ON ANCILLARY STRUCTURES

Tables B.1 through B.4 provide information for the subcategories of each type of ancillary structure. Figures 1 through 13 are pictures providing typical examples of each type of ancillary structure.

**Table B.1 – Total Number of Sign Structures by District**

| DISTRICT | Structure Type | | | | | Percent |
|---|---|---|---|---|---|---|
| | Cantilever | Overhead | Parapet Mount | Butterfly | Total | |
| Bristol | 22 | 38 | 1 | 10 | 71 | 2.0% |
| Salem | 84 | 82 | 6 | 0 | 172 | 4.8% |
| Lynchburg | 4 | 52 | 29 | 5 | 90 | 2.5% |
| Richmond | 389 | 324 | 133 | 1 | 847 | 23.8% |
| Hampton Roads | 318 | 421 | 99 | 57 | 895 | 25.2% |
| Fredericksburg | 50 | 21 | 1 | 0 | 72 | 2.0% |
| Culpeper | 8 | 18 | 10 | 3 | 39 | 1.1% |
| Staunton | 10 | 51 | 16 | 15 | 92 | 2.6% |
| Northern Virginia | 605 | 494 | 127 | 52 | 1,278 | 35.9% |
| **Statewide** | **1,490** | **1,501** | **422** | **143** | **3,556** | **100.0%** |

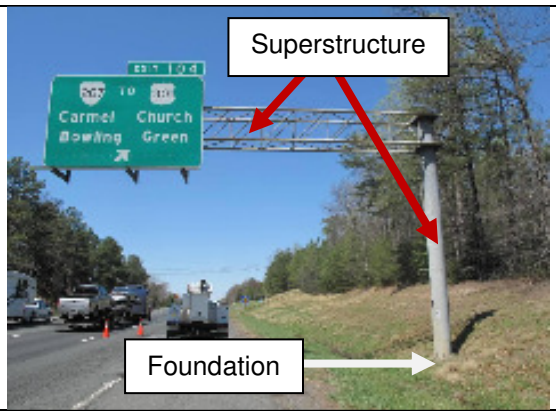



**Figure 1 – Cantilever Sign Structure**

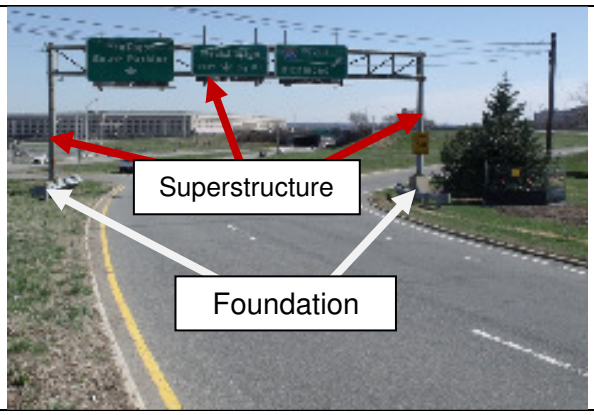



**Figure 2 – Overhead Sign Structure**

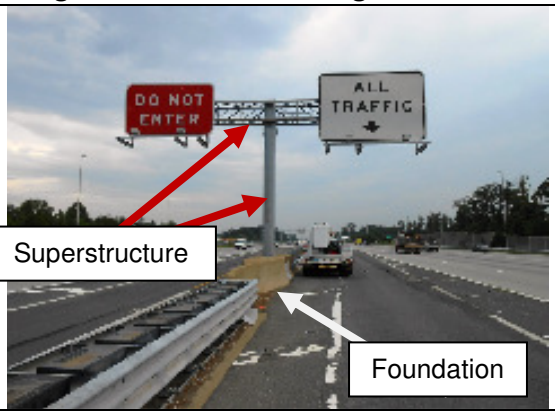



**Figure 3 – Butterfly Sign Structure**


**Figure 4 – Parapet Mount Sign Structure**
(Note that "Parapet-Mount' sign structures may also be attached to bridge girders in addition to bridge parapets)

**Table B.2 – Total Number of Luminaire Structures by District**

| DISTRICT | Structure Type | | | Percent |
|---|---|---|---|---|
| | Parapet Mount Luminaire | Luminaires | Total | |
| Bristol | 2 | 455 | 457 | 2.5% |
| Salem | 24 | 797 | 821 | 4.4% |
| Lynchburg | 0 | 301 | 301 | 1.6% |
| Richmond | 508 | 1,769 | 2,277 | 12.3% |
| Hampton Roads | 1,361 | 5,494 | 6,855 | 37.1% |
| Fredericksburg | 78 | 361 | 439 | 2.4% |
| Culpeper | 0 | 158 | 158 | 0.9% |
| Staunton | 0 | 45 | 45 | 0.2% |
| Northern Virginia | 791 | 6,338 | 7,129 | 38.6% |
| **Statewide** | **2,764** | **15,718** | **18,482** | **100.0%** |

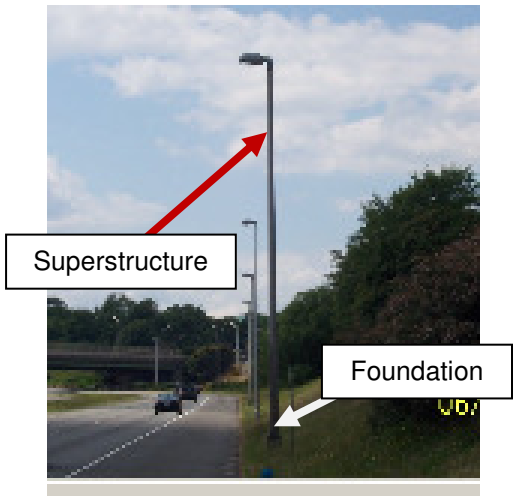



**Figure 5 – Luminaire Structure**


**Figure 6 – Parapet Mounted Luminaire Structure**

**Table B.3 – Total Number of Traffic Signal Structures by District**

| DISTRICT | Structure Type | | | | | Percent |
|---|---|---|---|---|---|---|
| | Cantilever | Overhead | Parapet Mount | Span Wire | Total | |
| Bristol | 219 | 0 | 0 | 26 | 245 | 2.7% |
| Salem | 492 | 0 | 0 | 45 | 537 | 5.9% |
| Lynchburg | 288 | 0 | 0 | 2 | 290 | 3.2% |
| Richmond | 1,177 | 0 | 0 | 355 | 1,532 | 16.7% |
| Hampton Roads | 466 | 0 | 1 | 55 | 522 | 5.7% |
| Fredericksburg | 701 | 1 | 0 | 16 | 718 | 7.8% |
| Culpeper | 359 | 0 | 0 | 8 | 367 | 4.0% |
| Staunton | 374 | 0 | 0 | 77 | 451 | 4.9% |
| Northern Virginia | 3,311 | 0 | 14 | 1,160 | 4,485 | 49.0% |
| **Statewide** | **7,387** | **1** | **15** | **1,744** | **9,147** | **100.0%** |

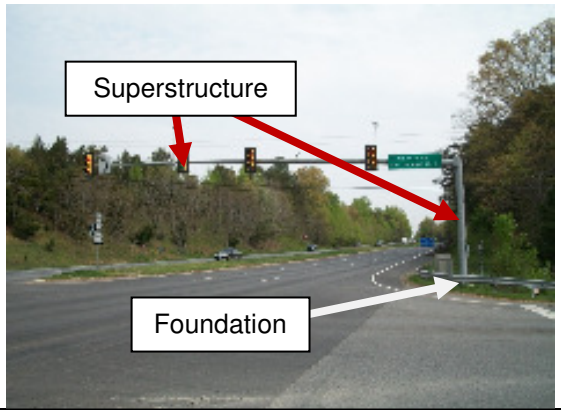



**Figure 7 – Cantilevered Arm Traffic Signal Structure**

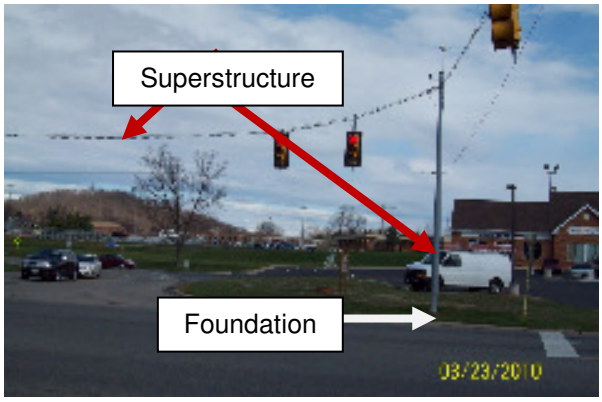



**Figure 8– Span Wire Traffic Signal Structure**

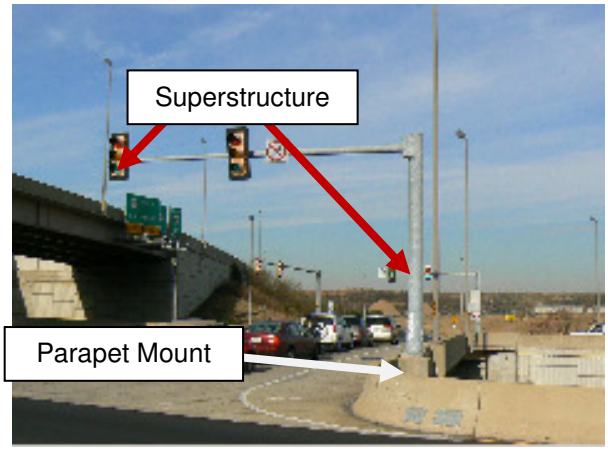



**Figure 9 – Parapet Mount - Traffic Signal Structure**

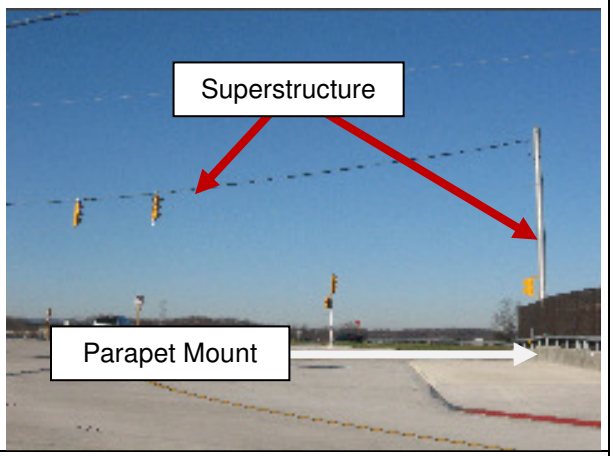



**Figure 10 – Parapet Mount - Traffic Signal Structure**

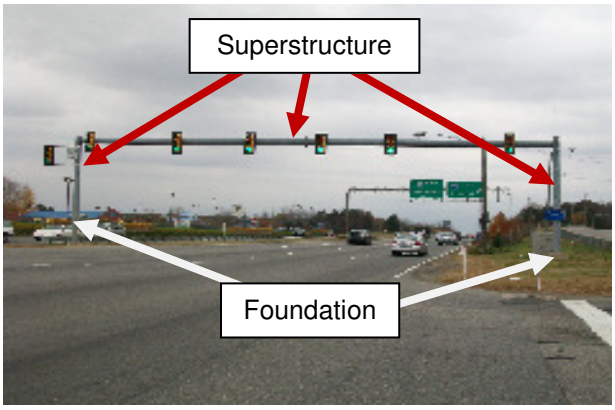



**Figure 11 – Overhead Traffic Signal Structure**

**Table B.4 – Total Number of High Mast Light and Camera Pole Structures by District**

| DISTRICT | Structure Type | | | Percent |
|---|---|---|---|---|
| | Camera Poles | High Mast Light | Total | |
| Bristol | 76 | 1 | 77 | 6.9% |
| Salem | 13 | 0 | 13 | 1.2% |
| Lynchburg | 0 | 0 | 0 | 0.0% |
| Richmond | 105 | 0 | 105 | 9.4% |
| Hampton Roads | 145 | 287 | 432 | 38.5% |
| Fredericksburg | 1 | 1 | 2 | 0.2% |
| Culpeper | 0 | 0 | 0 | 0.0% |
| Staunton | 26 | 56 | 82 | 7.3% |
| Northern Virginia | 323 | 87 | 410 | 36.6% |
| **Statewide** | **689** | **432** | **1,121** | **100.0%** |

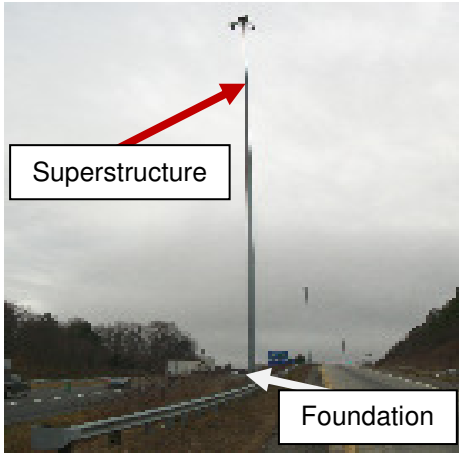



**Figure 12 – High Mast Light Structure**

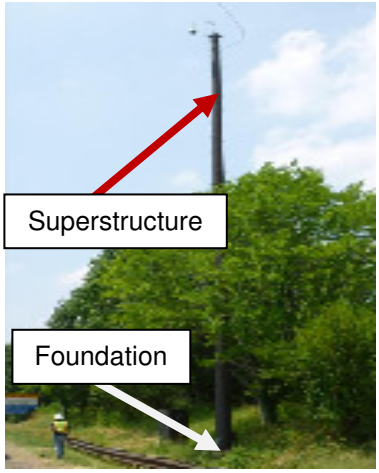



**Figure 13 – Camera Pole Structure**

## APPENDIX C– GENERAL CONDITION RATINGS (BRIDGES AND LARGE CULVERTS)

General Condition Ratings (GCRs): According to the National Bridge Inventory (NBI), General Condition Ratings are assigned by the structure inspection team after each bridge inspection. These ratings are included in each inspection report to describe the current physical state of the bridge or large culvert. Evaluation is based on the physical condition of the structure at the time of inspection. Separate GCR values are assigned to the deck, superstructure and substructure components of a bridge. A large culvert receives a single GCR. The GCRs are assigned based on a numerical grading system that ranges from 0 (failed condition) to 9 (excellent condition). The table below provides a description of the general condition ratings. The tables in the following pages provide illustrative examples of these ratings.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Failed | Imminent Failure | Critical | Serious | Poor | Fair | Satisfactory | Good | Very Good | Excellent |
| Structurally Deficient | | | | | | | | | |

| Code | Description |
|---|---|
| N | **NOT APPLICABLE** |
| 9 | **EXCELLENT CONDITION** |
| 8 | **VERY GOOD CONDITION**: No problems noted. |
| 7 | **GOOD CONDITION**: Some minor problems. |
| 6 | **SATISFACTORY CONDITION**: Structural components show some minor deterioration. |
| 5 | **FAIR CONDITION**: All primary structural elements are sound but may have some minor section loss, cracking, spalling or scour |
| 4 | **POOR CONDITION**: Advanced section loss, deterioration, spalling or scour. |
| 3 | **SERIOUS CONDITION**: Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present. |
| 2 | **CRITICAL CONDITION**: Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken. |
| 1 | **"IMMINENT" FAILURE CONDITION**: Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service. |
| 0 | **FAILED CONDITION**: Out of service - beyond corrective action. |

| Typical Examples of General Condition Ratings for Decks | |
|---|---|
| General Condition Rating | Example |
| 4 or less - (Poor Condition) Structurally Deficient |  Bridge Deck with advanced deterioration |
| 5 – Fair Condition (At risk of becoming structurally deficient) |   Bridge Deck with extensive cracking and patching |
| 6 – Satisfactory Condition |  Bridge Deck with minor to no deterioration |

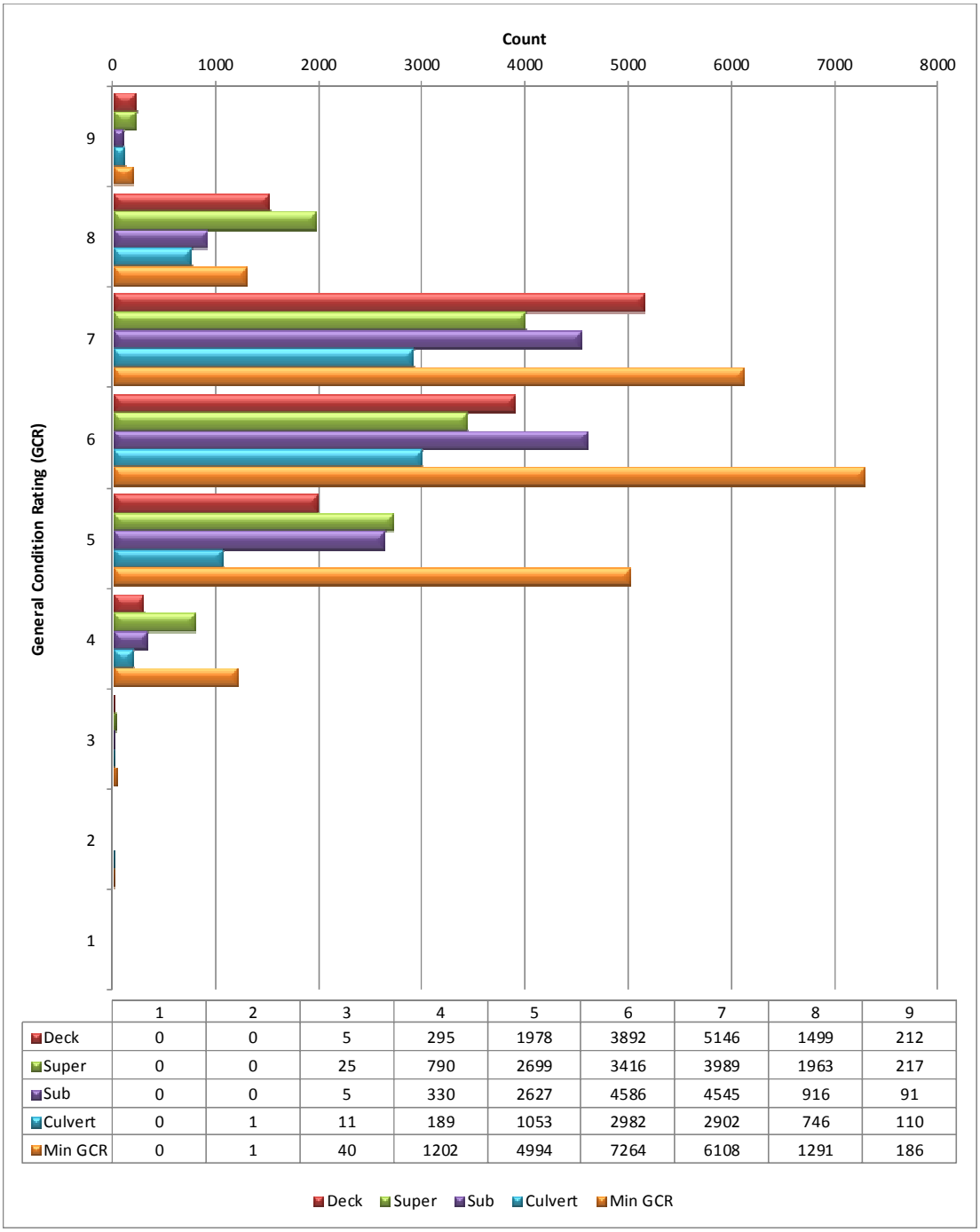
<table>
<tr><th colspan="3">Typical Examples of General Condition Ratings for Superstructure</th></tr>
<tr><td>General Condition Rating</td><td colspan="2">Example</td></tr>
<tr><td></td><td>Steel</td><td>Concrete</td></tr>
<tr><td>4 or less - (Poor Condition) Structurally Deficient</td><td>  <br>Bridge Superstructure with advanced section loss</td><td>  <br>Concrete Beam with major spalling (bottom of beam viewed from below)</td></tr>
<tr><td>5 – Fair Condition (At risk of becoming structurally deficient)</td><td>  <br>Bridge Superstructure with minor to moderate section loss</td><td>  <br>Spall on end of beam with exposed reinforcing with section loss</td></tr>
<tr><td>6 – Satisfactory Condition</td><td>  <br>Rust scale and minor section loss</td><td>  <br>Concrete Beam with localized spalling</td></tr>
</table>

| Typical Examples of General Condition Ratings for Substructure | |
|---|---|
| General Condition Rating | Example |
| 4 or less – (Poor Condition) Structurally Deficient |  <br>Bridge Substructure with advanced deterioration |
| 5 – Fair Condition (At risk of becoming structurally deficient) |  <br>Bridge Substructure with moderate cracks and deterioration |
| 6 – Satisfactory Condition |  <br>Bridge Substructure with minor cracks |

<table>
<tr><th colspan="3">Typical Examples of General Condition Ratings for Large Culverts</th></tr>
<tr><td>General Condition Rating</td><td colspan="2">Example</td></tr>
<tr><td></td><td>Steel</td><td>Concrete</td></tr>
<tr><td>4 or less - (Poor Condition) Structurally Deficient</td><td>  <br>Culvert with advanced section loss</td><td>  <br>Portion of center wall of box culvert missing</td></tr>
<tr><td>5 – Fair Condition (At risk of becoming structurally deficient)</td><td>  <br>Culvert panels separated</td><td>  <br>Culvert moderate deterioration</td></tr>
<tr><td>6 – Satisfactory Condition</td><td>  <br>Light rust along flowline</td><td>  <br>Culvert with minor cracks</td></tr>
</table>

The general condition ratings of Virginia's highway structures vary by region, system and age of structure. General condition rating data are provided in Charts C.1 – C.15 below

**Chart C.1 – General Condition Ratings for Bridges and Large Culverts by Component- Statewide**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Deck | 0 | 0 | 5 | 295 | 1978 | 3892 | 5146 | 1499 | 212 |
| Super | 0 | 0 | 25 | 790 | 2699 | 3416 | 3989 | 1963 | 217 |
| Sub | 0 | 0 | 5 | 330 | 2627 | 4586 | 4545 | 916 | 91 |
| Culvert | 0 | 1 | 11 | 189 | 1053 | 2982 | 2902 | 746 | 110 |
| Min GCR | 0 | 1 | 40 | 1202 | 4994 | 7264 | 6108 | 1291 | 186 |

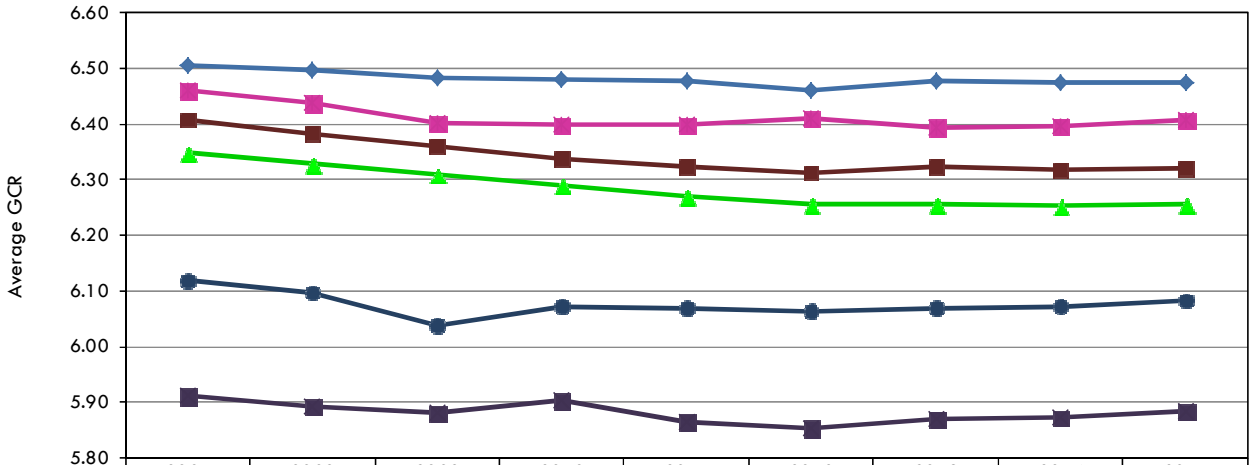
The Min GCR represents the minimum or lowest General Condition Rating (GCR) for the structure (lowest of the 4 component ratings for a particular inspection report; deck, superstructure, substructure, or large culvert)

## Table C.1 – Number of Components in Each General Ratings by System

| Highway System | Component | GCR | | | | | | | | | | Avg. GCR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Interstate | Deck | 7 | 48 | 524 | 605 | 225 | 16 | 0 | 0 | 0 | 0 | 6.27 |
| | Superstructure | 18 | 100 | 375 | 496 | 398 | 38 | 0 | 0 | 0 | 0 | 6.11 |
| | Substructure | 9 | 54 | 308 | 607 | 441 | 6 | 0 | 0 | 0 | 0 | 5.99 |
| | Bridge Min GCR | 7 | 34 | 208 | 528 | 598 | 50 | 0 | 0 | 0 | 0 | 5.72 |
| | Large Culvert | 0 | 20 | 287 | 546 | 142 | 2 | 0 | 0 | 0 | 0 | 6.18 |
| | Min GCR | 7 | 54 | 495 | 1,074 | 740 | 52 | 0 | 0 | 0 | 0 | 5.91 |
| Primary | Deck | 26 | 171 | 1,319 | 1,161 | 679 | 93 | 3 | 0 | 0 | 0 | 6.25 |
| | Superstructure | 30 | 368 | 1,097 | 1,048 | 756 | 155 | 10 | 0 | 0 | 0 | 6.24 |
| | Substructure | 19 | 151 | 1,264 | 1,248 | 700 | 81 | 1 | 0 | 0 | 0 | 6.22 |
| | Bridge Min GCR | 17 | 79 | 847 | 1,224 | 1,070 | 216 | 11 | 0 | 0 | 0 | 5.86 |
| | Large Culvert | 7 | 86 | 792 | 1,088 | 331 | 22 | 1 | 0 | 0 | 0 | 6.26 |
| | Min GCR | 24 | 165 | 1,633 | 2,311 | 1,401 | 238 | 12 | 0 | 0 | 0 | 6.02 |
| Secondary | Deck | 165 | 1,231 | 3,005 | 1,892 | 979 | 159 | 1 | 0 | 0 | 0 | 6.63 |
| | Superstructure | 150 | 1,428 | 2,240 | 1,690 | 1,428 | 540 | 11 | 0 | 0 | 0 | 6.40 |
| | Substructure | 48 | 646 | 2,686 | 2,513 | 1,378 | 215 | 2 | 0 | 0 | 0 | 6.31 |
| | Bridge Min GCR | 41 | 408 | 1,941 | 2,305 | 2,109 | 671 | 13 | 0 | 0 | 0 | 5.92 |
| | Large Culvert | 102 | 602 | 1,711 | 1,259 | 552 | 161 | 10 | 1 | 0 | 0 | 6.53 |
| | Min GCR | 143 | 1,010 | 3,652 | 3,564 | 2,661 | 832 | 23 | 1 | 0 | 0 | 6.14 |
| Urban | Deck | 14 | 49 | 298 | 234 | 95 | 27 | 1 | 0 | 0 | 0 | 6.40 |
| | Superstructure | 19 | 67 | 277 | 182 | 117 | 57 | 4 | 0 | 0 | 0 | 6.31 |
| | Substructure | 15 | 65 | 287 | 218 | 108 | 28 | 2 | 0 | 0 | 0 | 6.40 |
| | Bridge Min GCR | 11 | 25 | 215 | 226 | 164 | 76 | 5 | 0 | 0 | 0 | 5.95 |
| | Large Culvert | 1 | 38 | 112 | 89 | 28 | 4 | 0 | 0 | 0 | 0 | 6.57 |
| | Min GCR | 12 | 62 | 328 | 315 | 192 | 80 | 5 | 0 | 0 | 0 | 6.12 |
| All | Deck | 212 | 1,499 | 5,146 | 3,892 | 1,978 | 295 | 5 | 0 | 0 | 0 | 6.48 |
| | Superstructure | 217 | 1,963 | 3,989 | 3,416 | 2,699 | 790 | 25 | 0 | 0 | 0 | 6.32 |
| | Substructure | 91 | 916 | 4,545 | 4,586 | 2,627 | 330 | 5 | 0 | 0 | 0 | 6.26 |
| | Bridge Min GCR | 76 | 546 | 3,211 | 4,283 | 3,941 | 1,013 | 29 | 0 | 0 | 0 | 5.88 |
| | Large Culvert | 110 | 746 | 2,902 | 2,982 | 1,053 | 189 | 11 | 1 | 0 | 0 | 6.41 |
| | Min GCR | 186 | 1,291 | 6,108 | 7,264 | 4,994 | 1,202 | 40 | 1 | 0 | 0 | 6.08 |

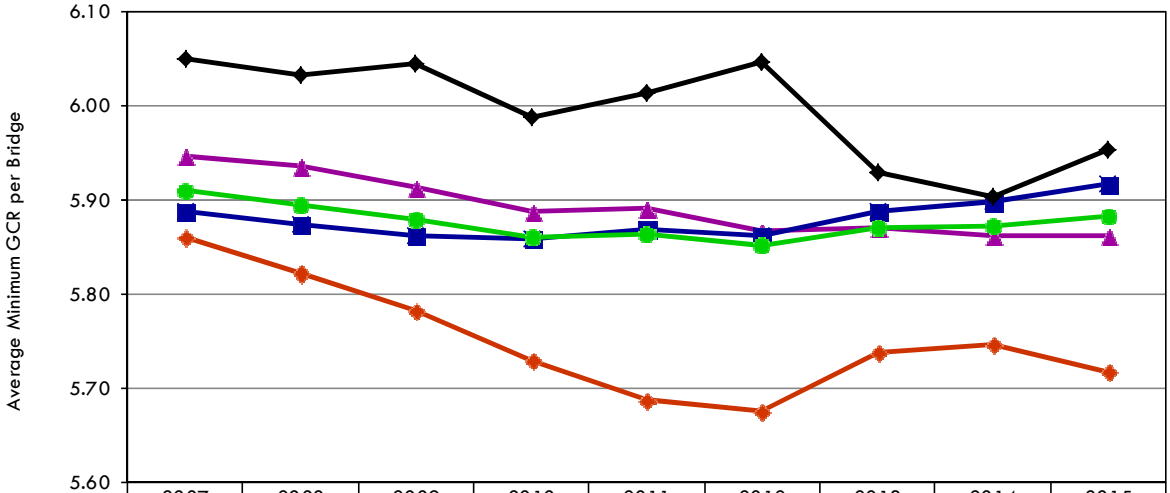
Trend lines showing the average general condition ratings of rated components are provided in Charts C.2 through C.14 below.

**Chart C.2 – Trends in Average General Condition Ratings by Component – Statewide**




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Deck | 6.504 | 6.496 | 6.482 | 6.480 | 6.476 | 6.461 | 6.477 | 6.475 | 6.476 |
| Super | 6.408 | 6.383 | 6.359 | 6.338 | 6.323 | 6.312 | 6.323 | 6.318 | 6.322 |
| Sub | 6.350 | 6.330 | 6.310 | 6.289 | 6.270 | 6.256 | 6.257 | 6.253 | 6.256 |
| Br Min | 5.912 | 5.892 | 5.882 | 5.904 | 5.863 | 5.853 | 5.871 | 5.873 | 5.884 |
| Culvert | 6.461 | 6.437 | 6.402 | 6.399 | 6.399 | 6.409 | 6.393 | 6.397 | 6.407 |
| Str Min | 6.120 | 6.097 | 6.039 | 6.073 | 6.068 | 6.063 | 6.068 | 6.071 | 6.082 |

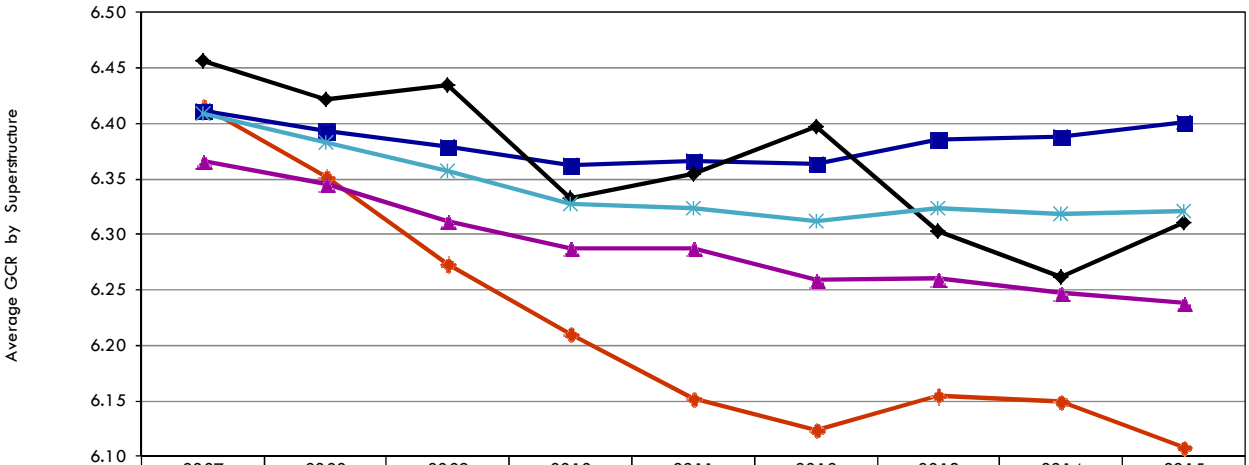
**Chart C.3 – Bridge Decks: Trends in Average General Condition Ratings by Highway System**




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Interstate | 5.861 | 5.823 | 5.784 | 5.730 | 5.689 | 5.676 | 5.739 | 5.747 | 5.719 |
| Primary | 5.947 | 5.936 | 5.914 | 5.888 | 5.891 | 5.867 | 5.872 | 5.862 | 5.862 |
| Secondary | 5.888 | 5.875 | 5.863 | 5.860 | 5.870 | 5.863 | 5.889 | 5.898 | 5.919 |
| Urban | 6.050 | 6.032 | 6.045 | 5.988 | 6.014 | 6.047 | 5.929 | 5.903 | 5.954 |
| Average | 5.912 | 5.895 | 5.879 | 5.862 | 5.864 | 5.853 | 5.871 | 5.873 | 5.884 |

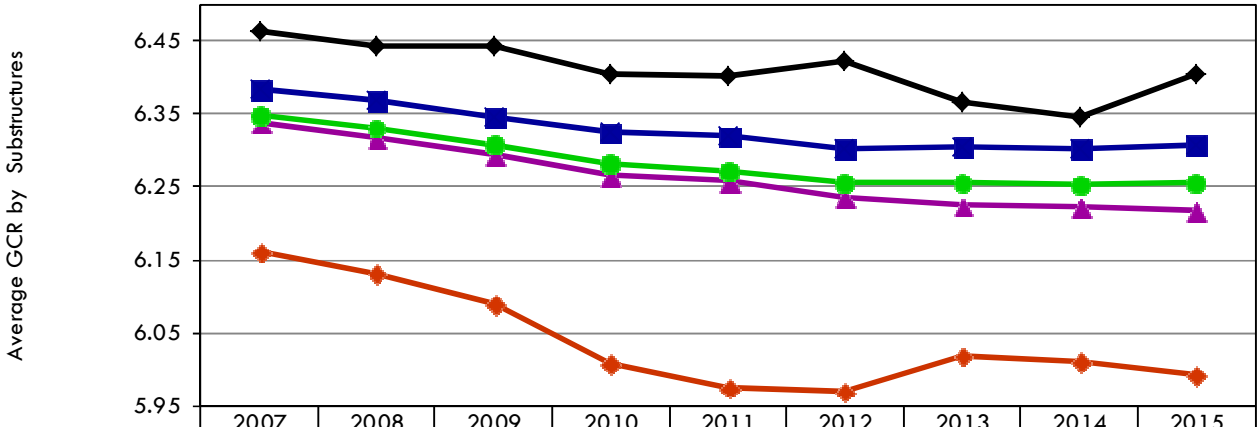
Fiscal Year

## Chart C.4 – Superstructures: Trends in Average General Condition Ratings by Highway System



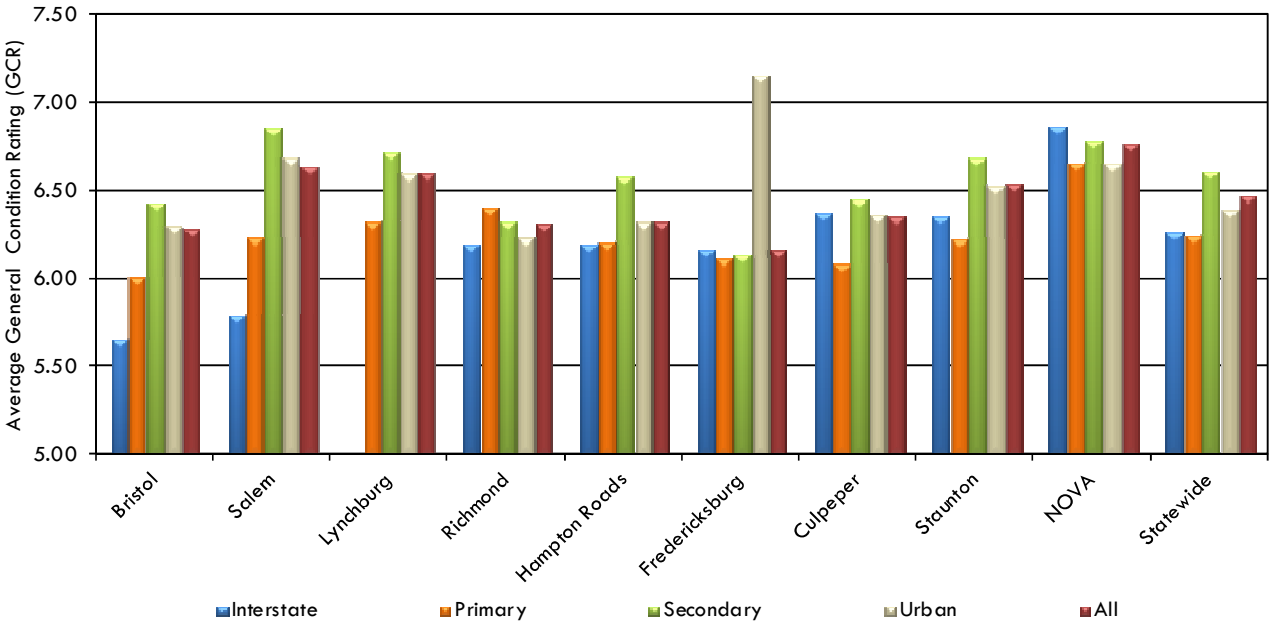

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Interstate | 6.415 | 6.352 | 6.273 | 6.210 | 6.152 | 6.124 | 6.155 | 6.149 | 6.109 |
| Primary | 6.367 | 6.346 | 6.313 | 6.287 | 6.288 | 6.259 | 6.260 | 6.247 | 6.239 |
| Secondary | 6.411 | 6.394 | 6.379 | 6.362 | 6.366 | 6.363 | 6.386 | 6.388 | 6.401 |
| Urban | 6.457 | 6.422 | 6.435 | 6.333 | 6.354 | 6.397 | 6.303 | 6.262 | 6.311 |
| Average | 6.408 | 6.383 | 6.357 | 6.328 | 6.324 | 6.312 | 6.323 | 6.318 | 6.322 |

## Chart C.5 – Substructures: Trends in Average General Condition Ratings by Highway System

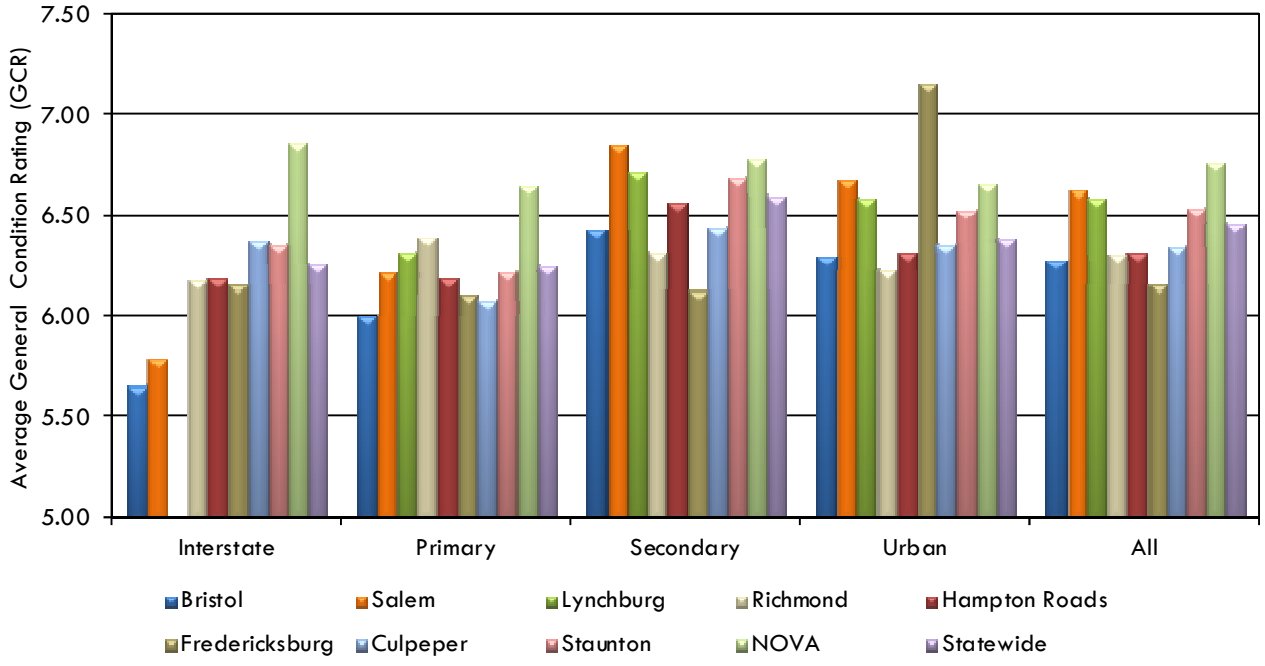



| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Interstate | 6.162 | 6.132 | 6.091 | 6.008 | 5.974 | 5.971 | 6.019 | 6.011 | 5.993 |
| Primary | 6.338 | 6.317 | 6.296 | 6.268 | 6.258 | 6.236 | 6.227 | 6.222 | 6.219 |
| Secondary | 6.386 | 6.369 | 6.347 | 6.326 | 6.319 | 6.303 | 6.306 | 6.303 | 6.308 |
| Urban | 6.465 | 6.443 | 6.443 | 6.404 | 6.402 | 6.423 | 6.366 | 6.346 | 6.404 |
| Average | 6.350 | 6.330 | 6.307 | 6.283 | 6.271 | 6.256 | 6.257 | 6.253 | 6.256 |

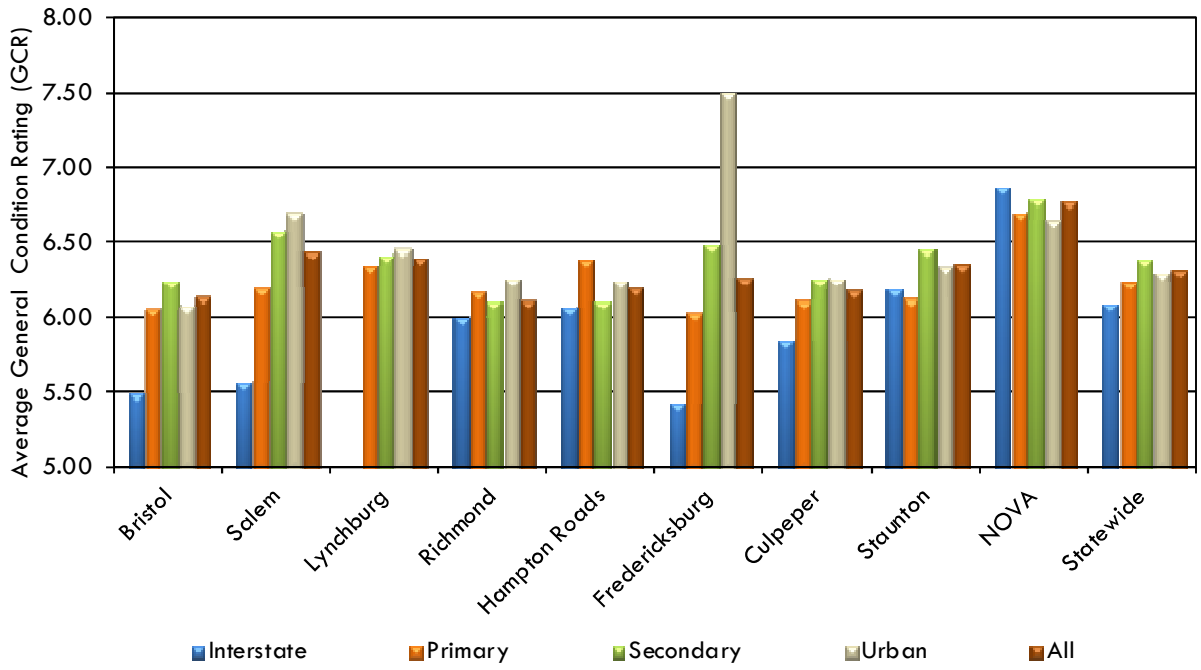
## Chart C.6 – Deck General Condition Ratings by District and Highway System




## Chart C.7 – Deck General Condition Ratings by Highway System and District



## Chart C.8 – Superstructure General Condition Ratings by District and Highway System




## Chart C.9 – Superstructure General Condition Ratings by Highway System and District

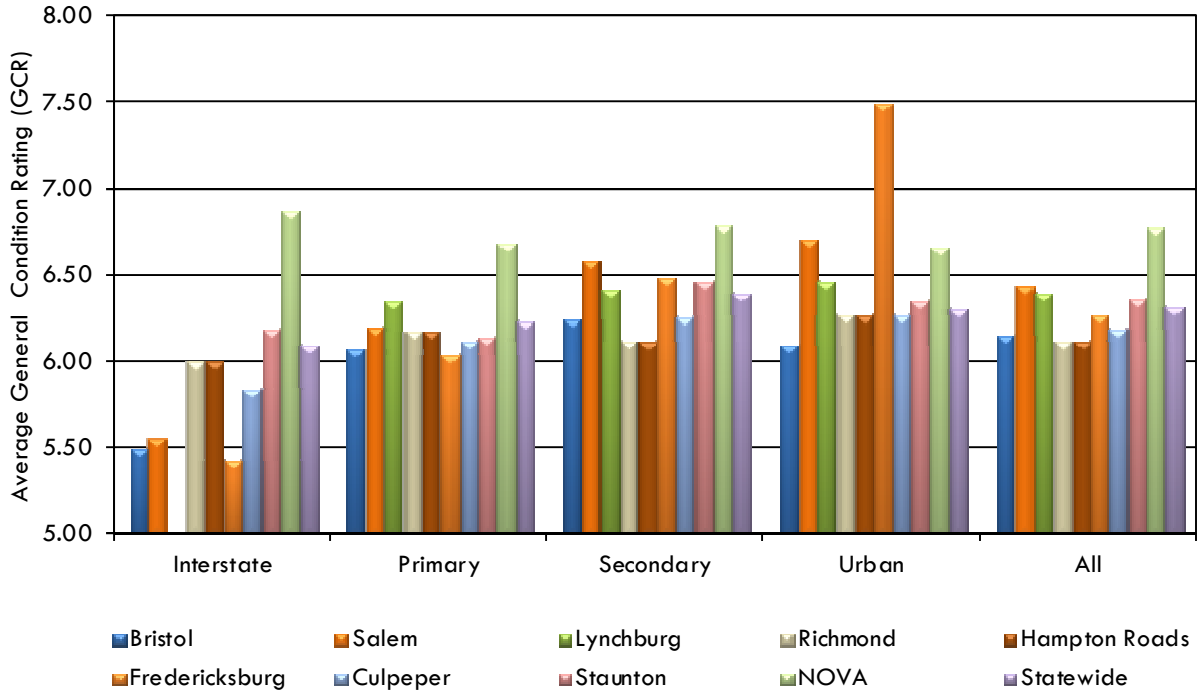


**Chart C.10 – Substructure General Condition Ratings by District and Highway System**

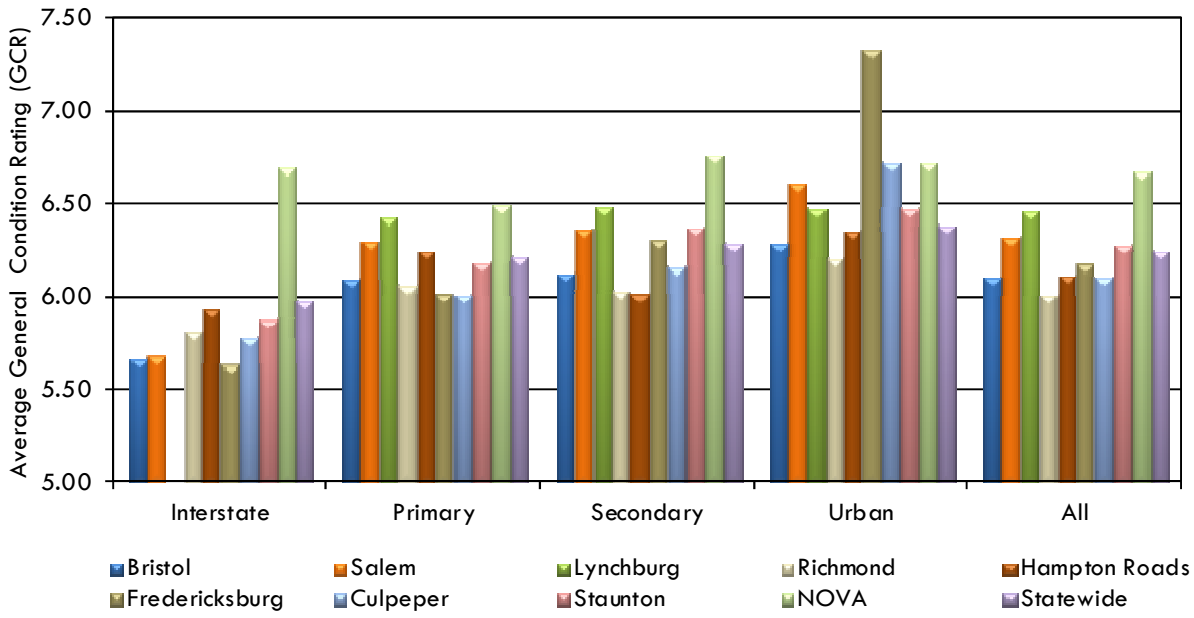



**Chart C.11 – Substructure General Condition Ratings by Highway System and District**

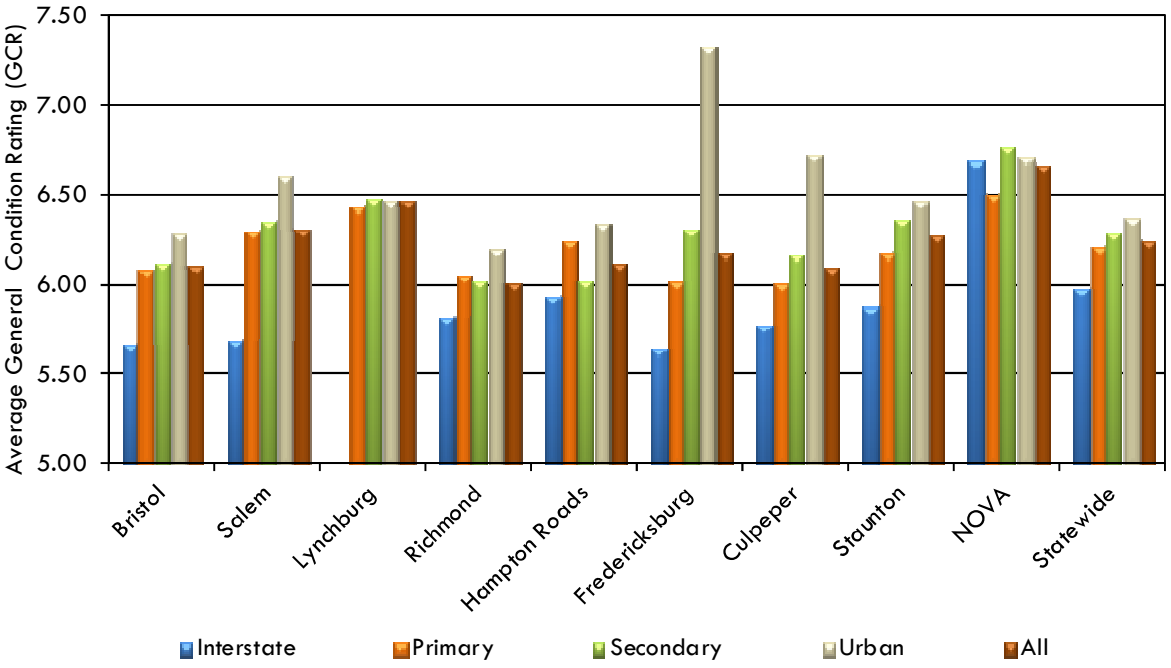


**Chart C.12 – Large Culvert General Condition Ratings by District and Highway System**

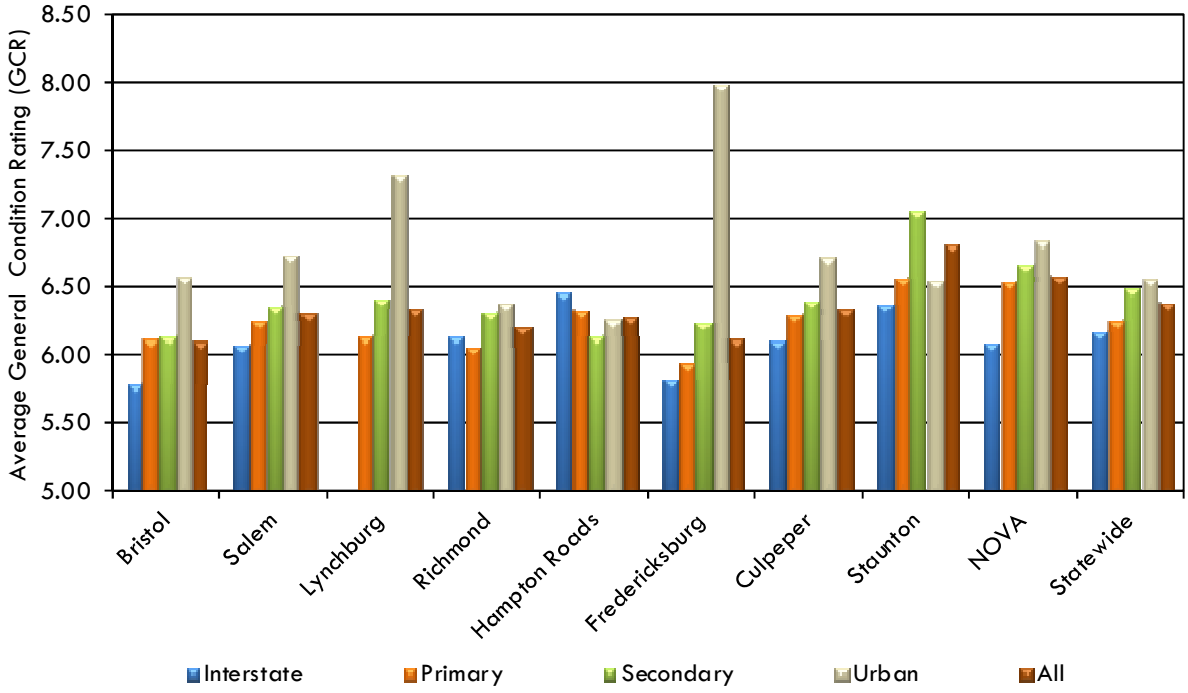



**Chart C.13 – Large Culvert General Condition Ratings by Highway System and District**

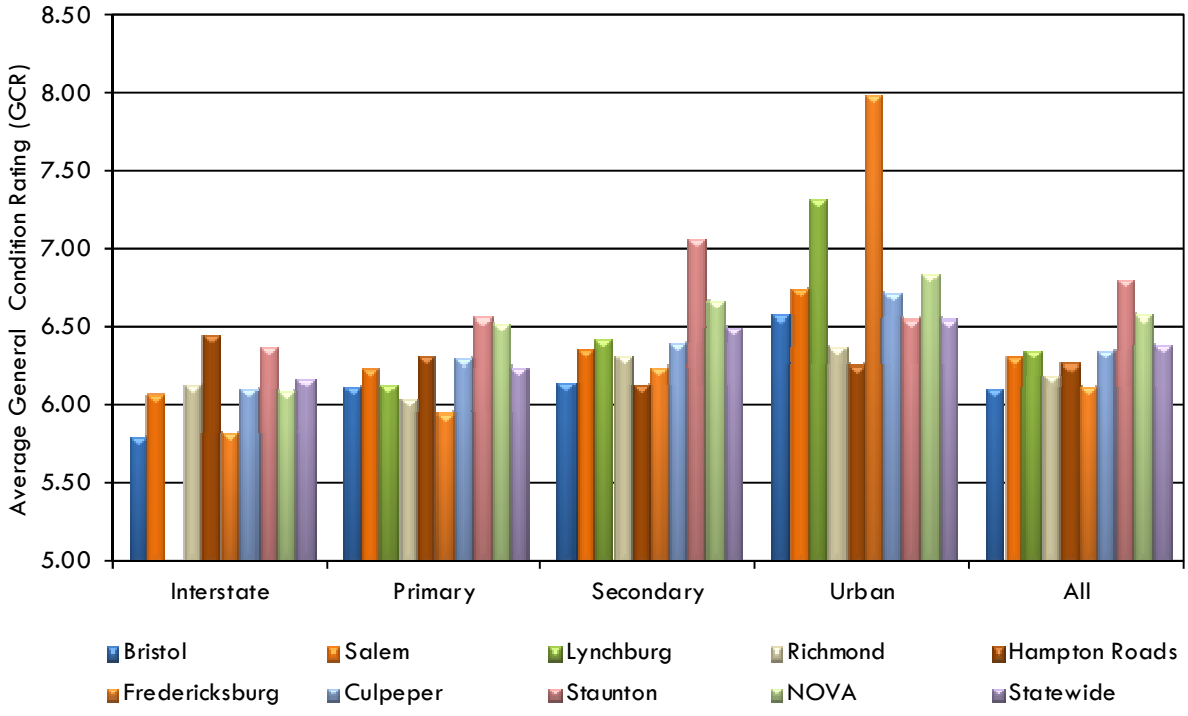


**Chart C.14 – Average Minimum General Condition Ratings for Bridges and Large Culverts by District and Highway System**

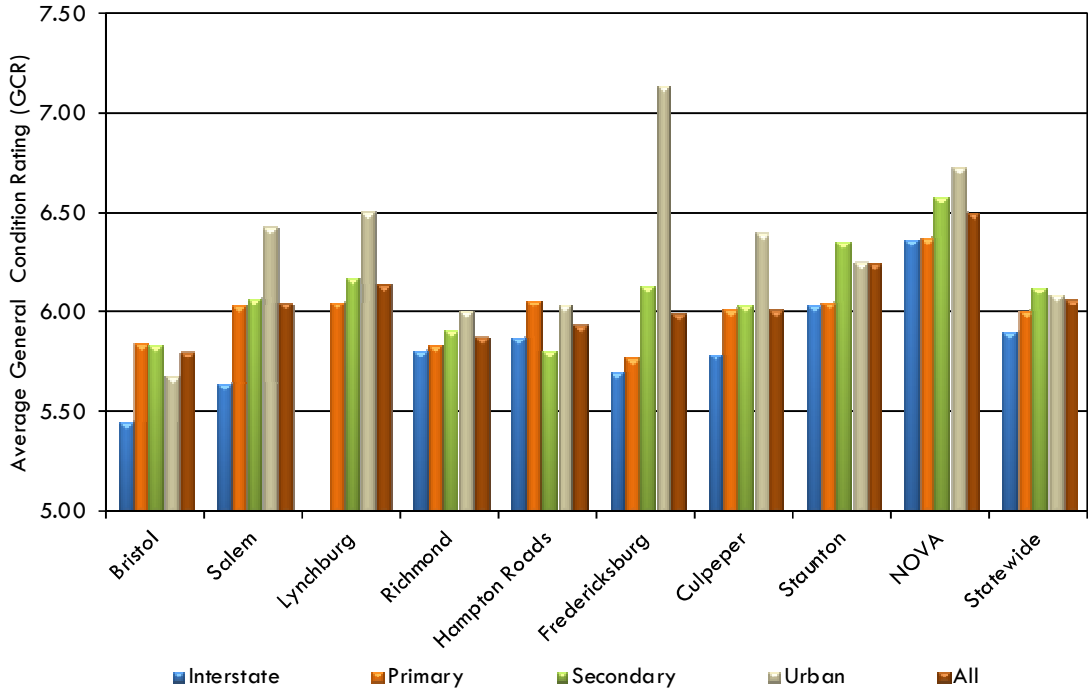
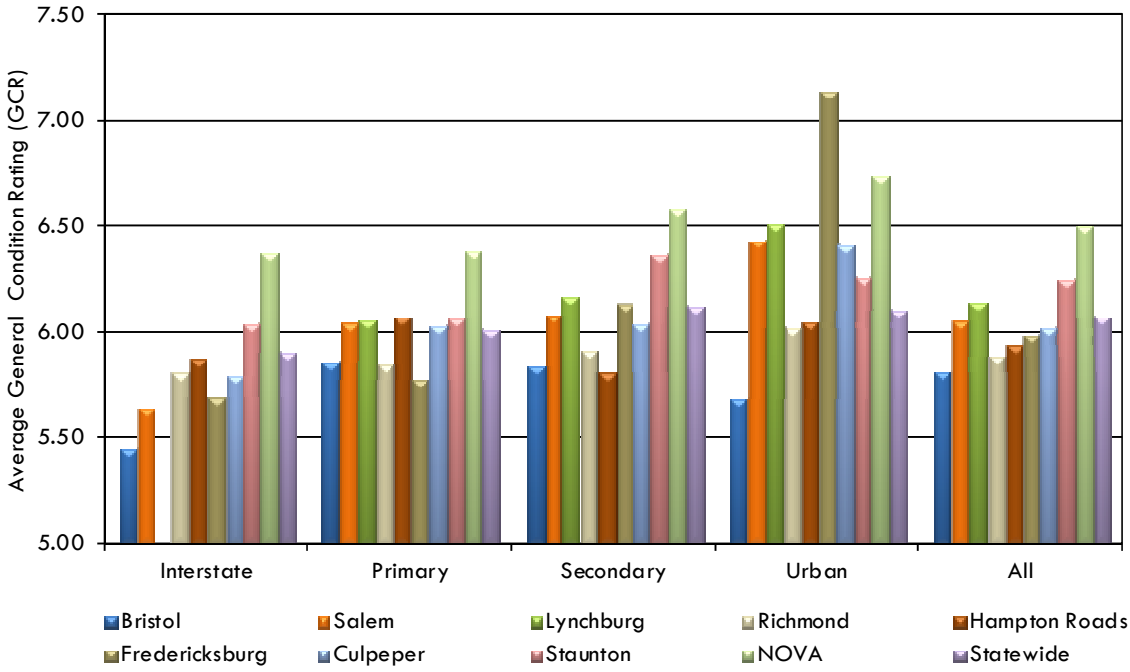



**Chart C.15 – Average Minimum General Condition Ratings for Bridges and Large Culverts by Highway System and District**



# APPENDIX D– INFORMATION ON STRUCTURALLY DEFICIENT STRUCTURES BY HIGHWAY SYSTEM

**Chart D.1 – Percentage of Number of Structurally Deficient Structures on Interstate System at End of FY 2015**

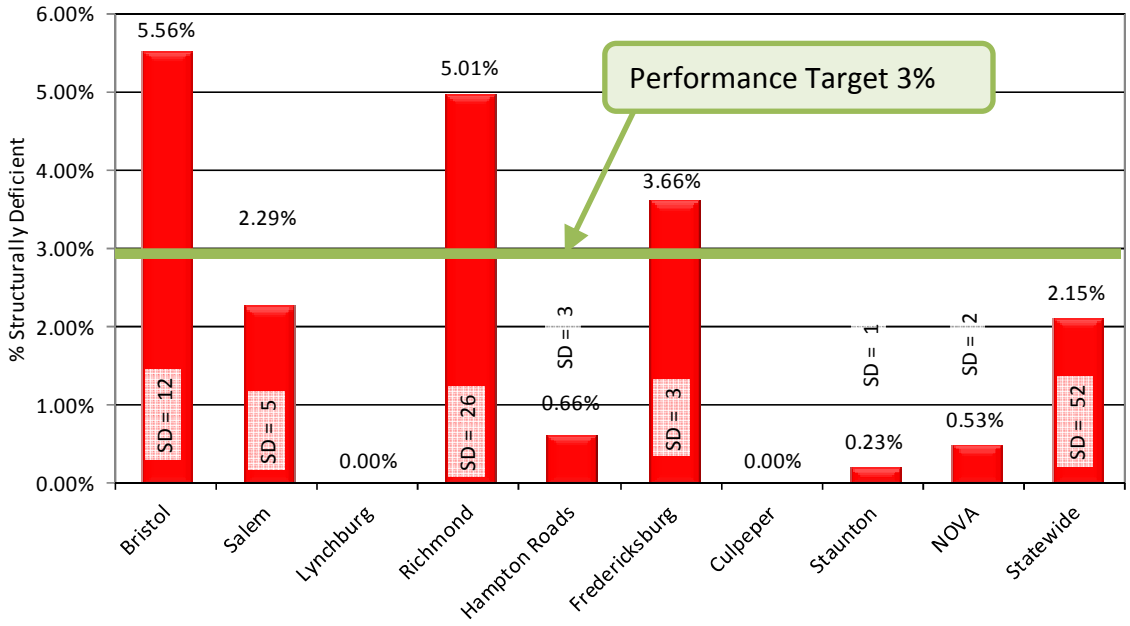
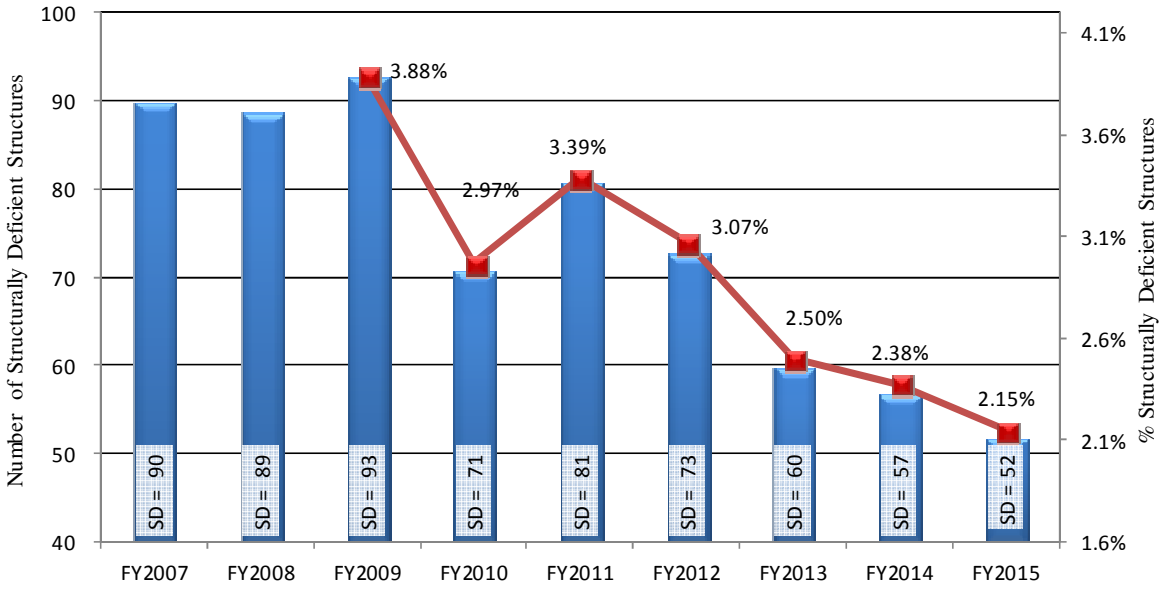



**Chart D.2 – Percentage of Structurally Deficient Structures Recent Trend for Interstate System**




*Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.*

**Chart D.3 – Percentage of Number of Structurally Deficient Structures on Primary System at End of FY 2015**

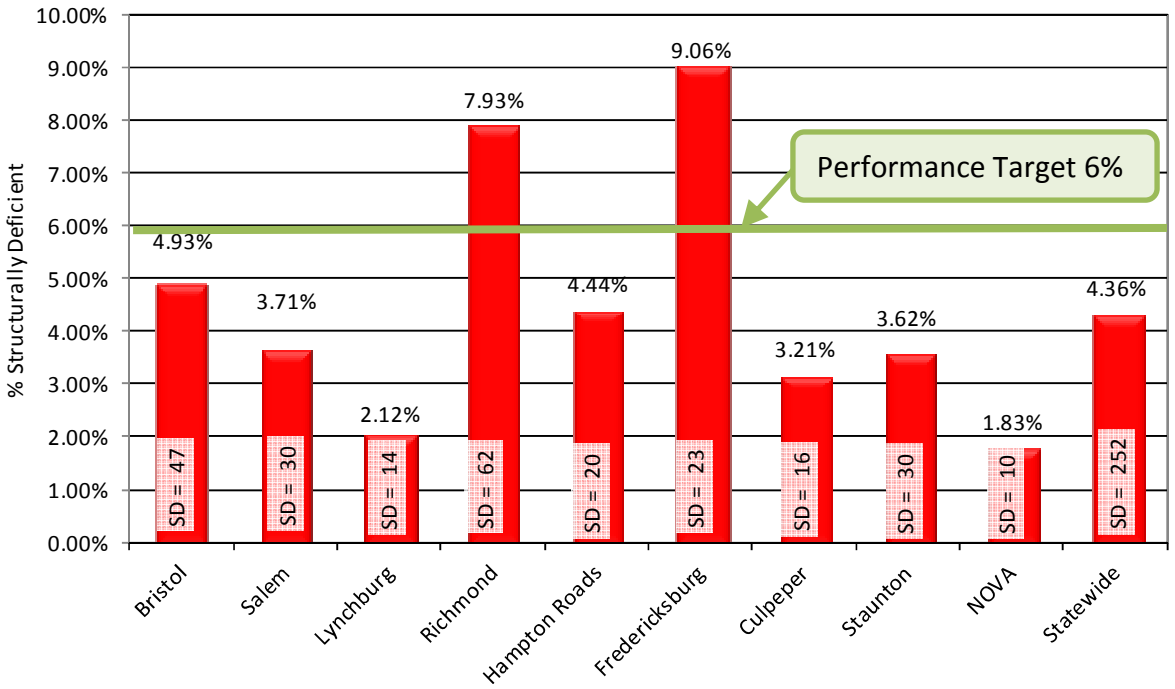
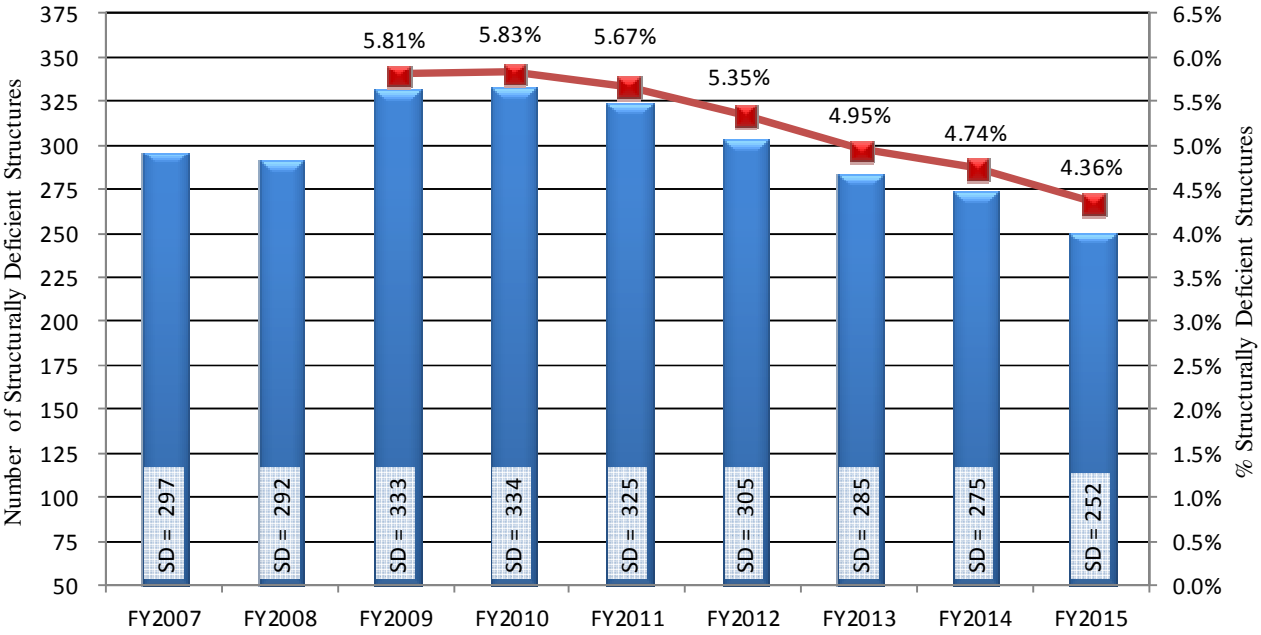



**Chart D.4 – Percentage of Structurally Deficient Structures Recent Trend for Primary System**




*Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.*

**Chart D.5 – Percentage of Number of Structurally Deficient Structures On Secondary System at End of FY 2015**

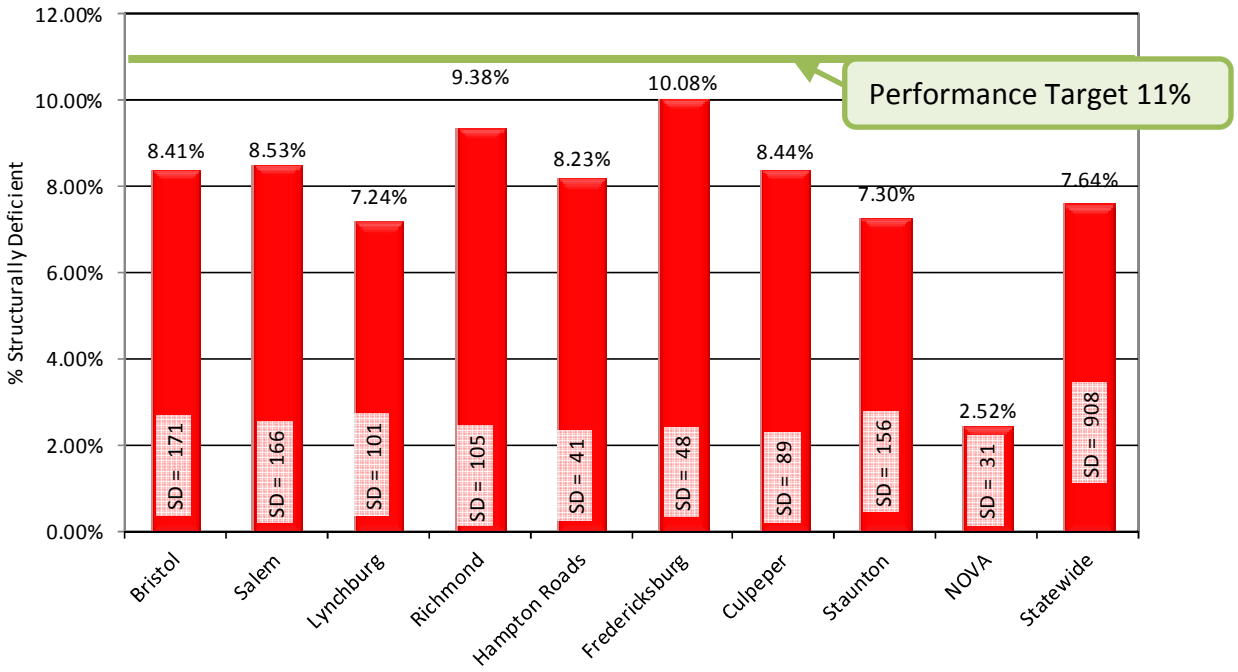
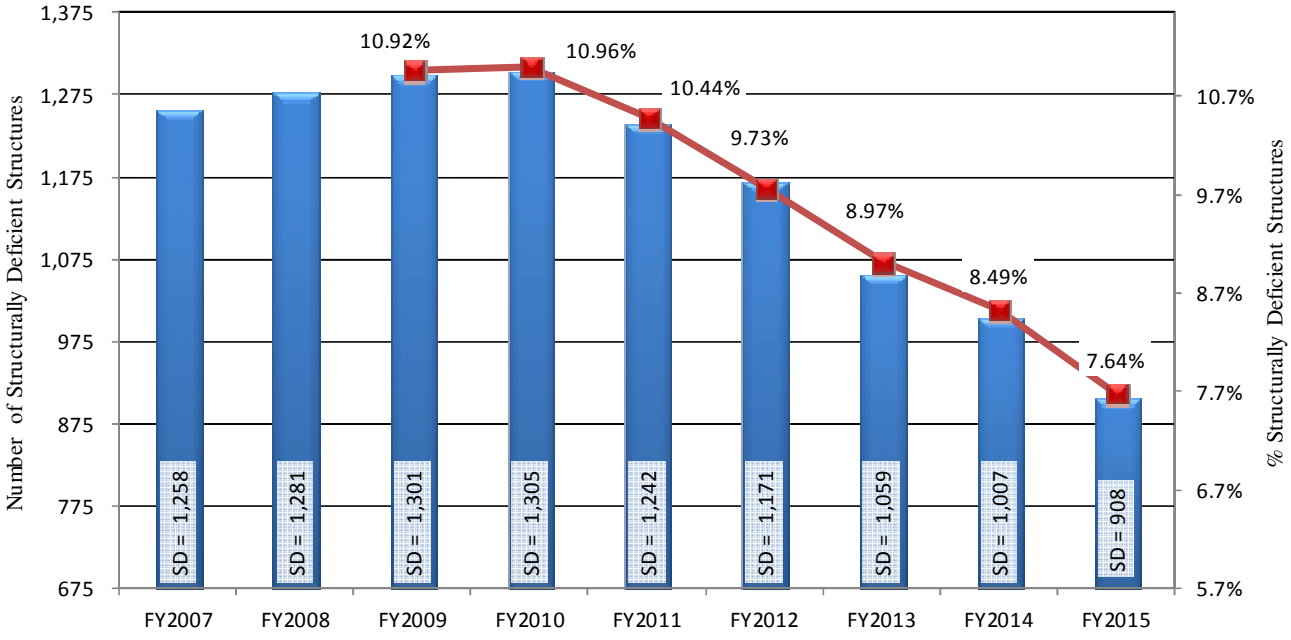
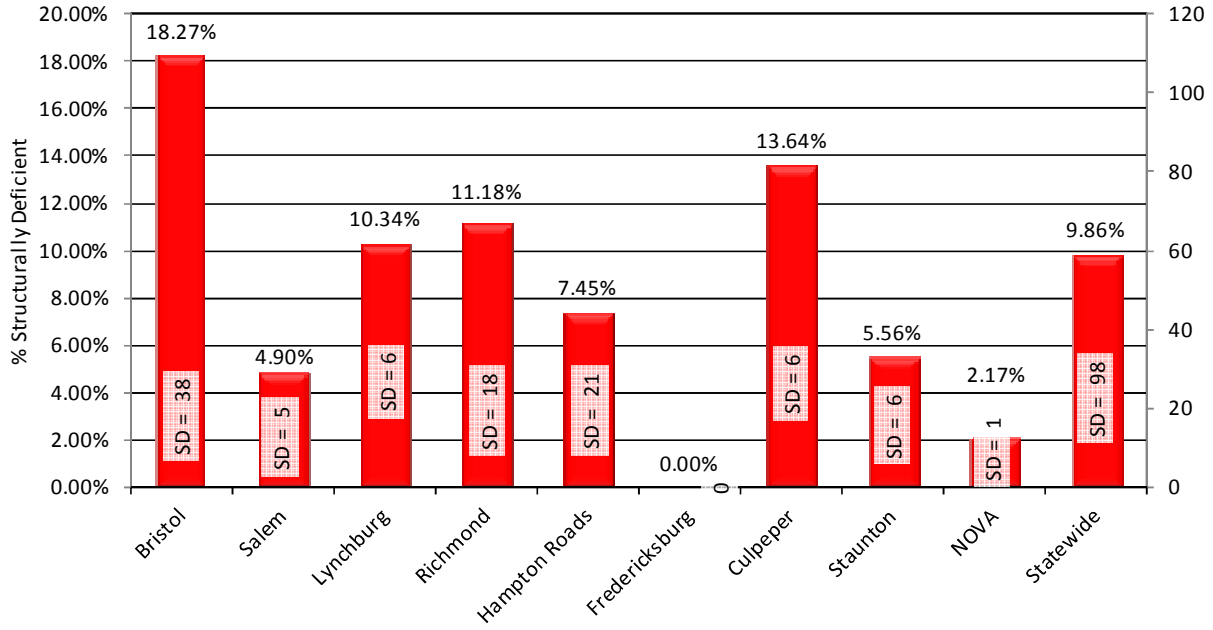



**Chart D.6 – Percentage of Structurally Deficient Structures Recent Trend on Secondary System**



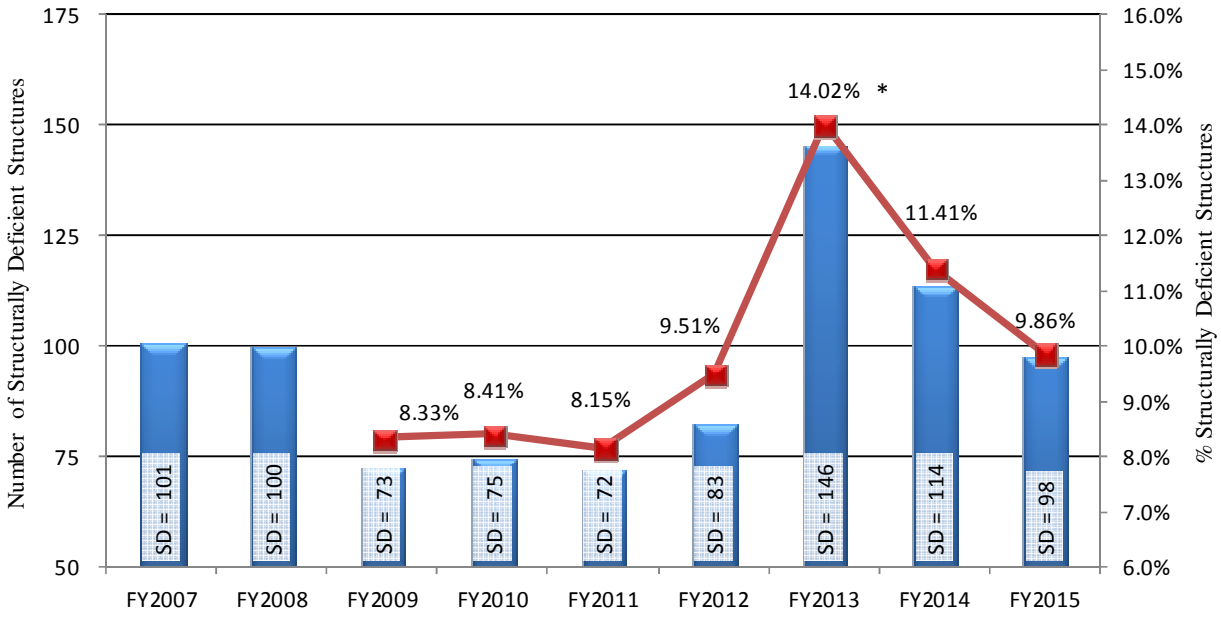

Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.

## Chart D.7 – Percentage of Number of Structurally Deficient Structures On Urban System at End of FY 2015




*Note: A number of structures were added in Buchanan County. See Appendix G for discussion.*

## Chart D.8 – Percentage of Structurally Deficient Structures Recent Trend on Urban System




Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.

** A large number of structures deficient were added in Buchanan County in FY2014. See Appendix G for discussion*

**Chart D.9 - Percentage of Number of Structurally Deficient Structures**
**NHS (Only NBI) Structures at End of FY 2015**

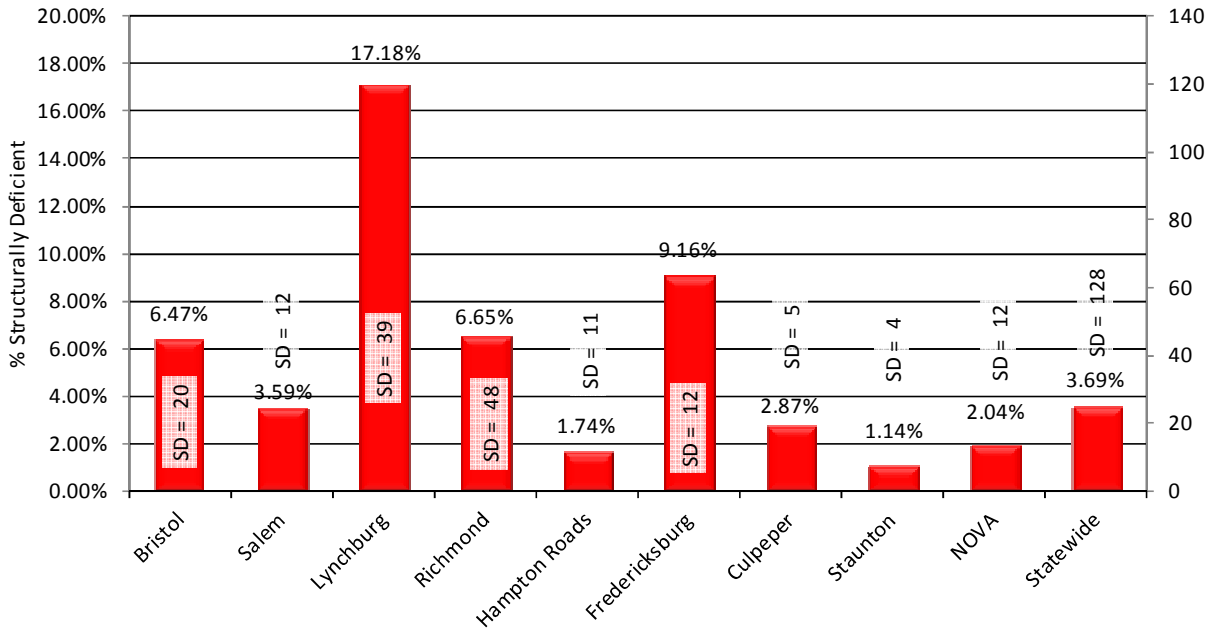
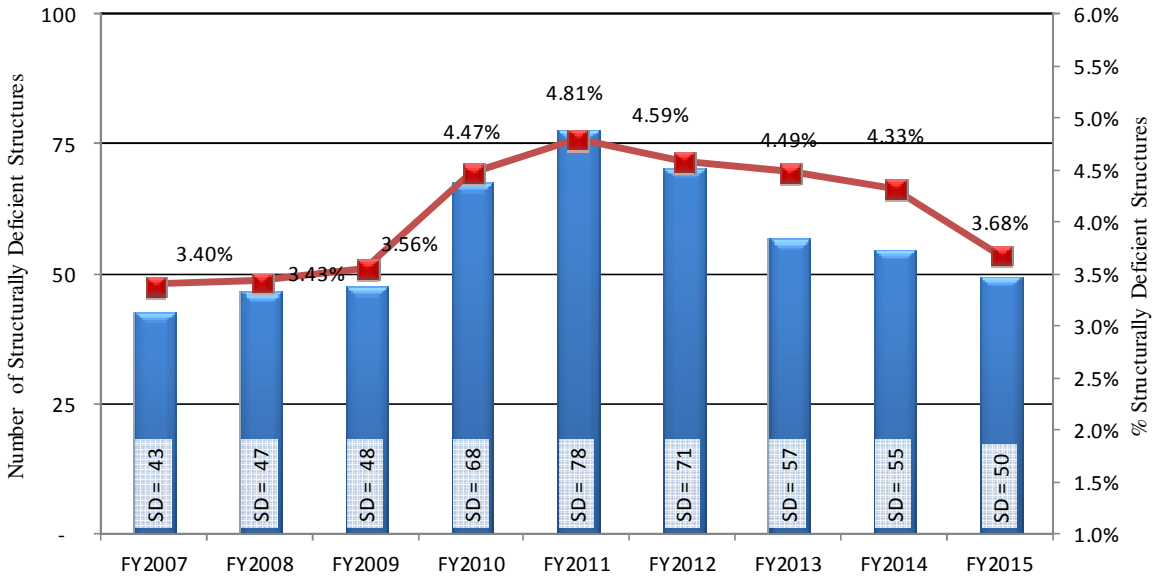
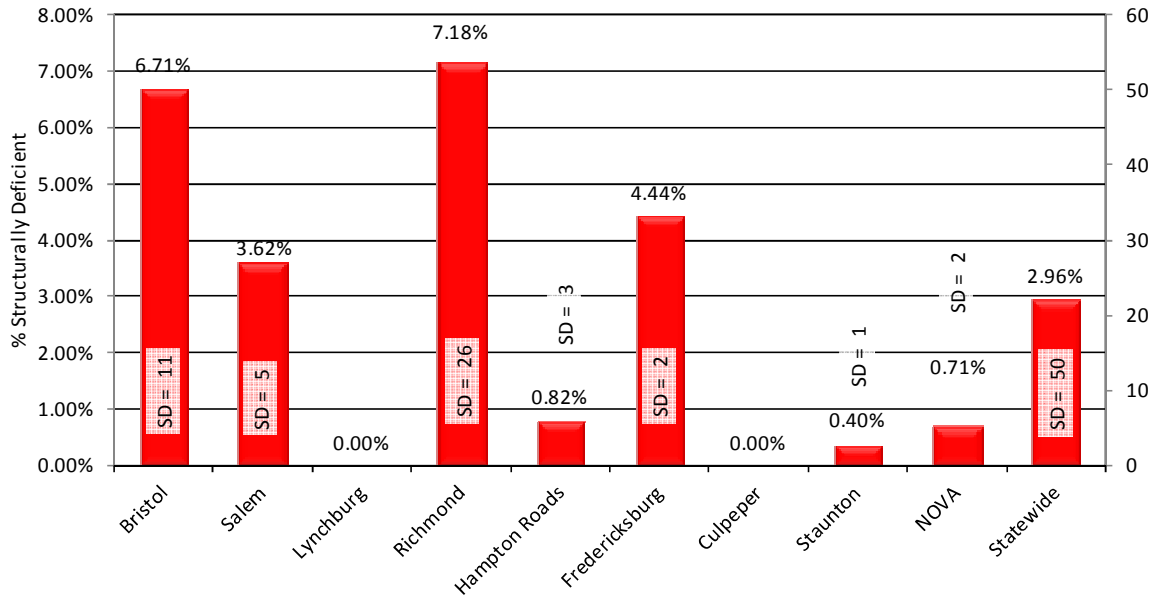



**Chart D.10 - Percentage of Number of Structurally Deficient Structures**
**Recent Trend for NHS (Only NBI) Structures**



## Chart D.11 – Percentage of Number of NHS (Only NBI) Structurally Deficient Structures on Interstate System at End of FY 2015




## Chart D.12 – Percentage of NHS (Only NBI) Structurally Deficient Structures Recent Trend on Interstate System

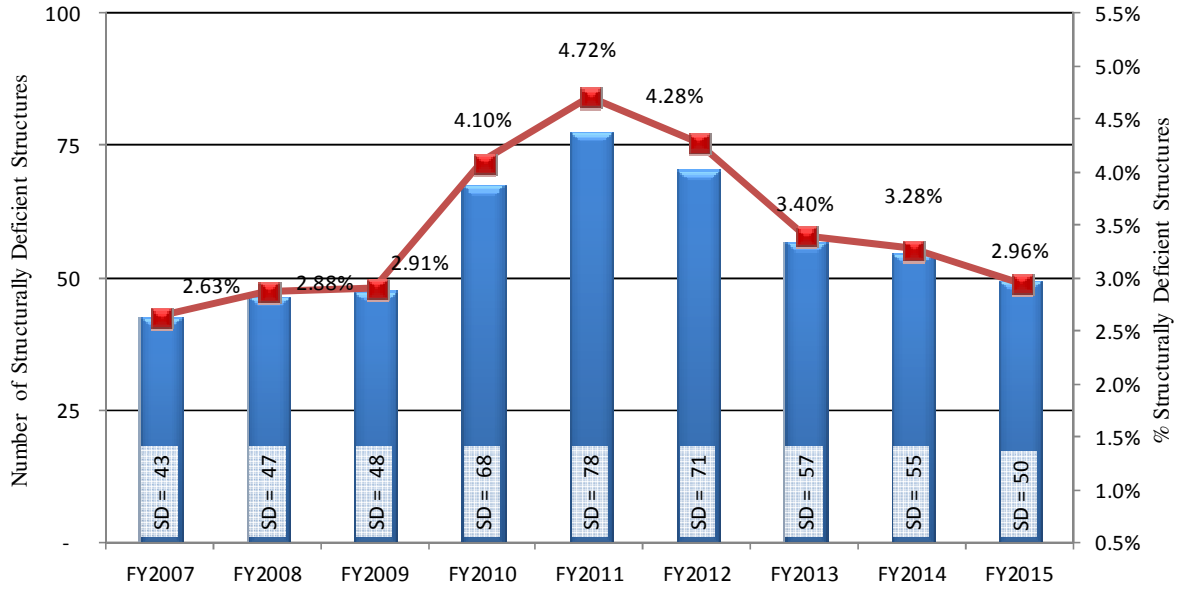


**Chart D.12 – Percentage of Number of NHS (Only NBI) Structurally Deficient Structures on Primary System at End of FY 2015**

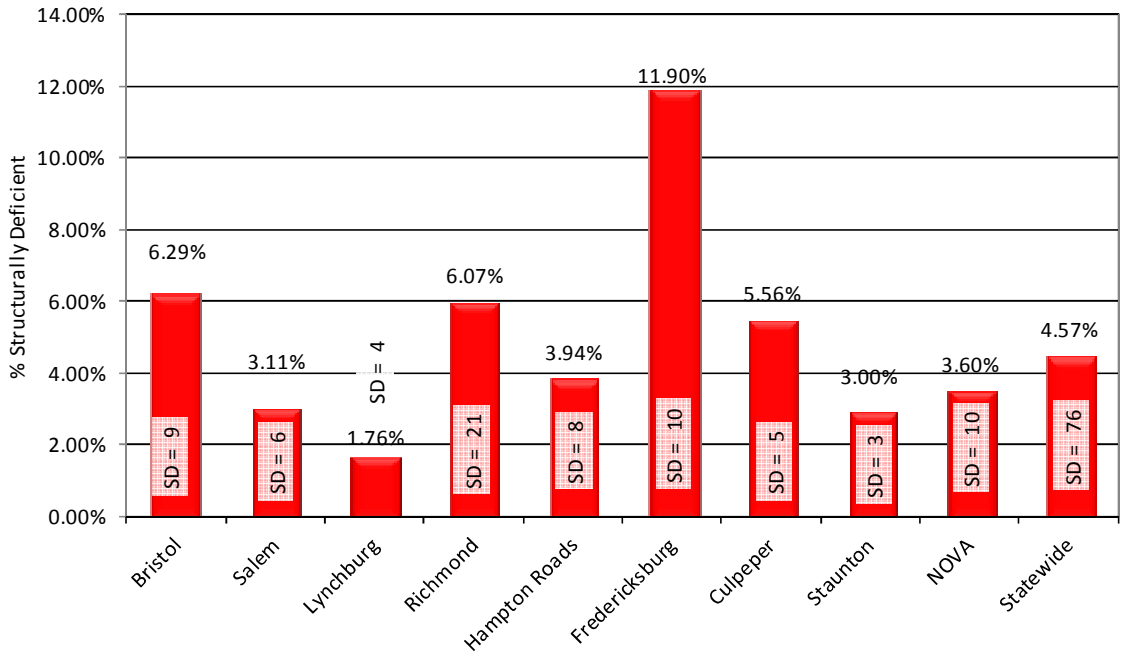
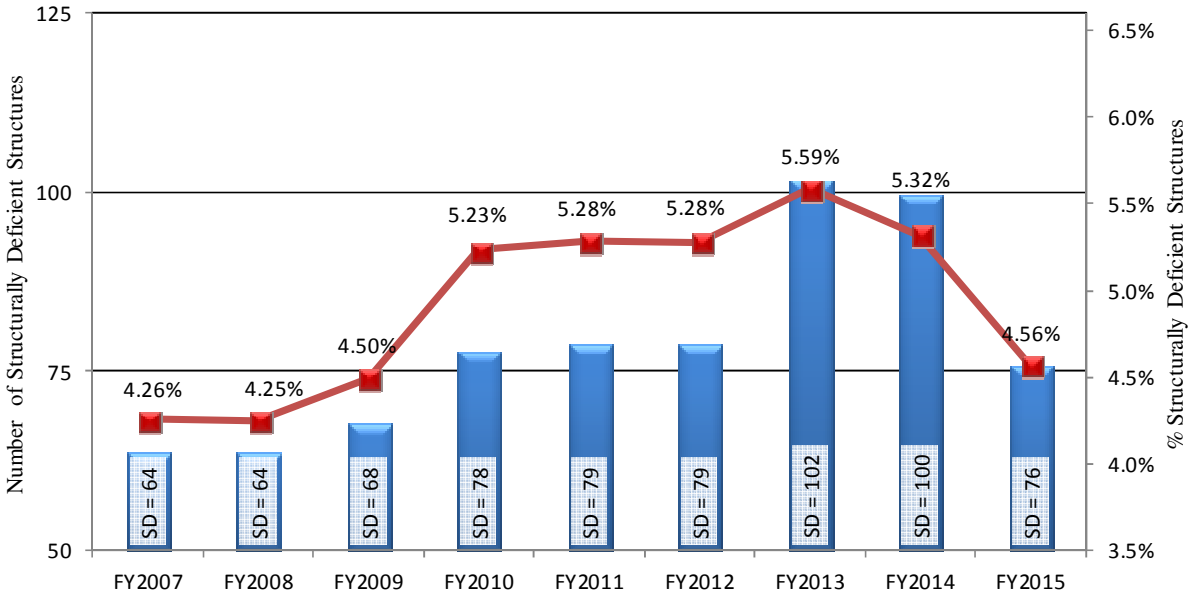



**Chart D.13 – Percentage of NHS (Only NBI) Structurally Deficient Structures Recent Trend on Primary System**



# APPENDIX E – OTHER PERFORMANCE INDICATORS

## FUNCTIONALLY OBSOLETE STRUCTURES

**A Functionally Obsolete (FO)** structure is one that has an appraisal rating of three (3) or less for the deck geometry, under clearance, approach roadway alignment, structural condition or waterway adequacy. An FO designation means that the structure was built to standards (deck geometry, load carrying capacity, clearances, or approach roadway alignment) that are less conservative than those used for new construction projects today.

Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.

**Chart E.1 – Number and Percentage of FO Structures**
**Recent Statewide Trend**

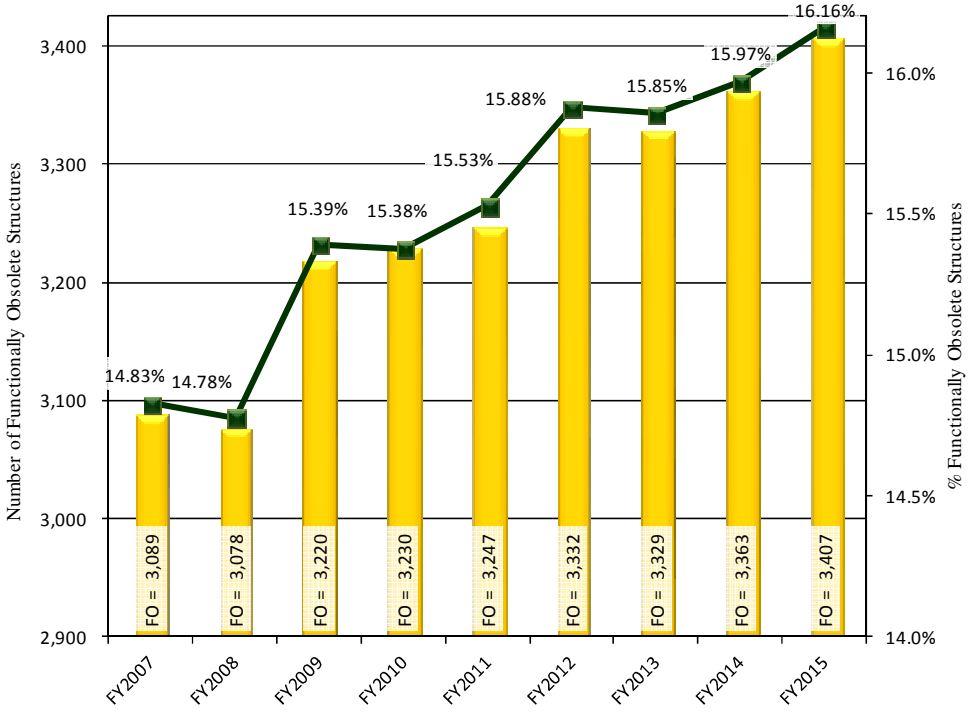



**Chart E.2 – Number and Percentage of NHS (Only NBI) FO Structures**
**Recent Statewide Trend**

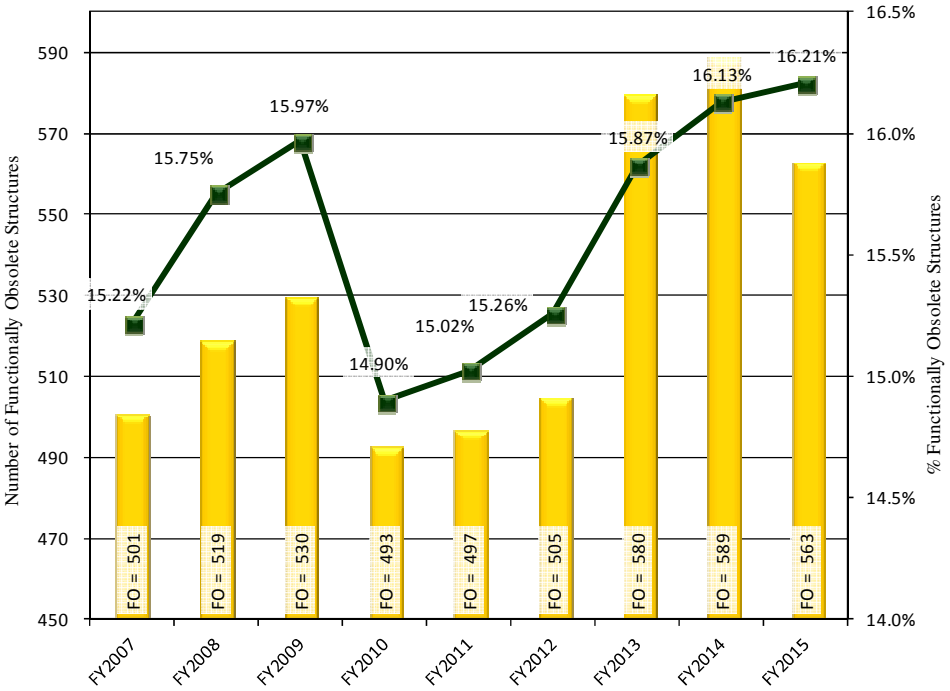


**Chart E.3 – Number and Percentage of FO Structures**
**Recent Trend on Interstate System**

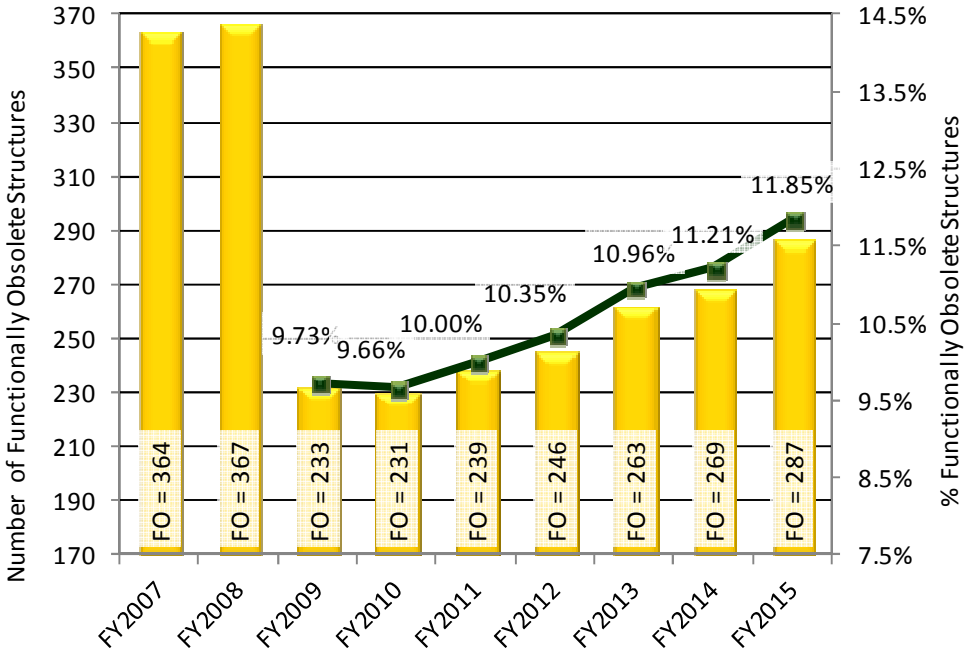



**Chart E.4 – Number and Percentage of NHS (Only NBI) FO Structures**
**Recent Trend on Interstate System**

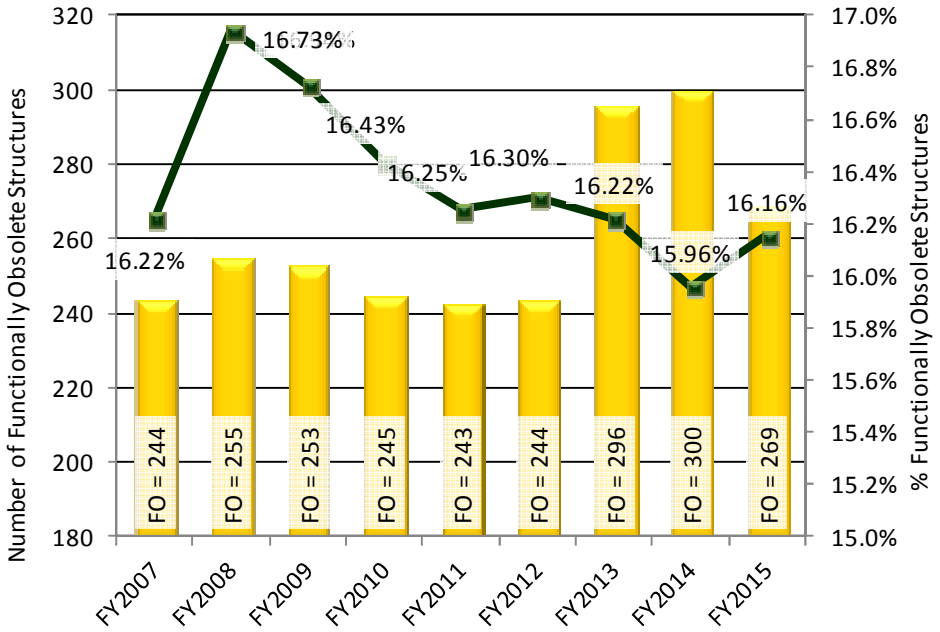


**Chart E.5 – Number and Percentage of FO Structures**
**Recent Trend on Primary System**

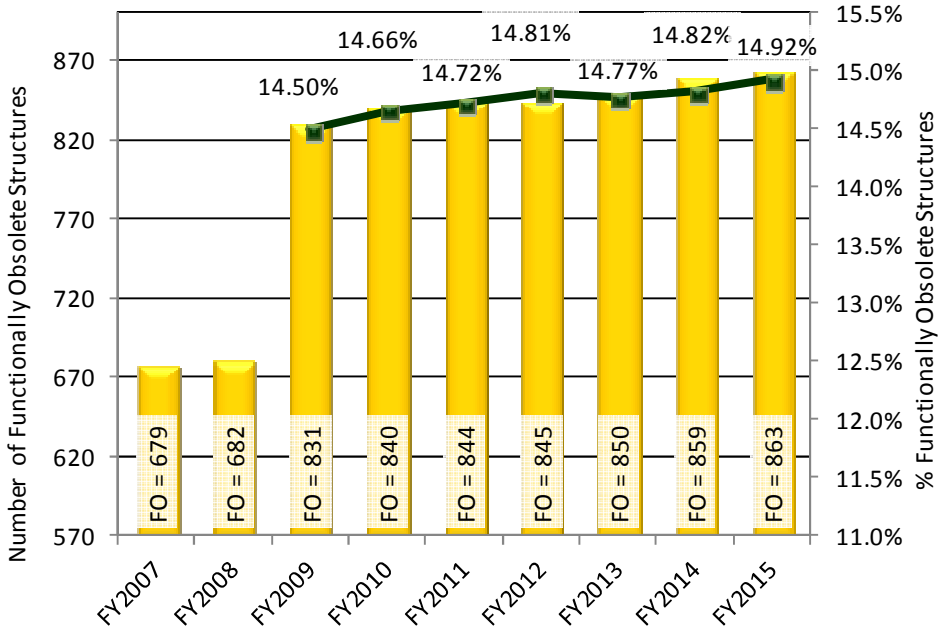



**Chart E.6 – Number and Percentage of NHS (Only NBI) FO Structures**
**Recent Trend on Primary Sytem**

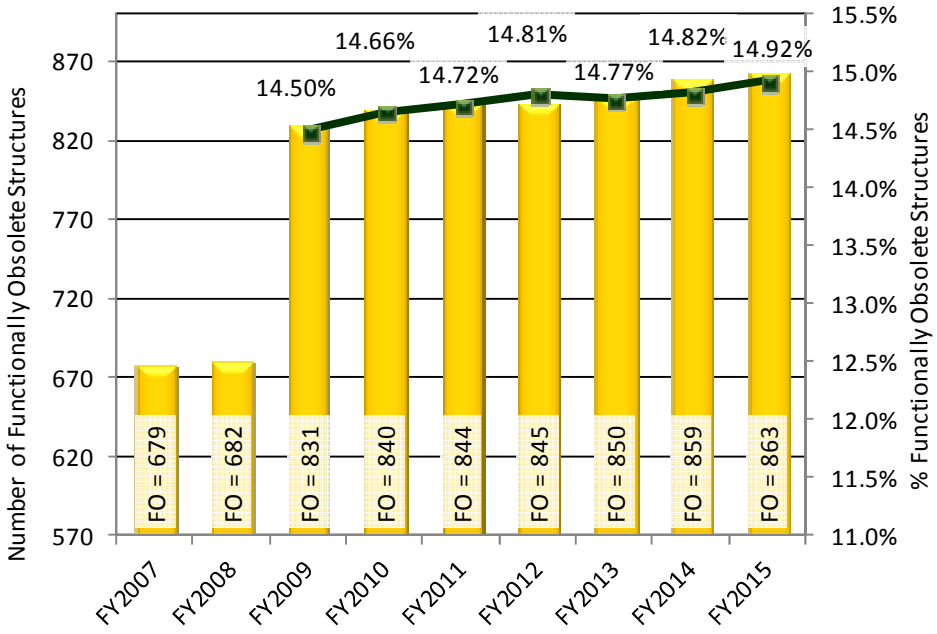


**Chart E.7 – Number and Percentage of FO Structures
Recent Trend on Secondary System**

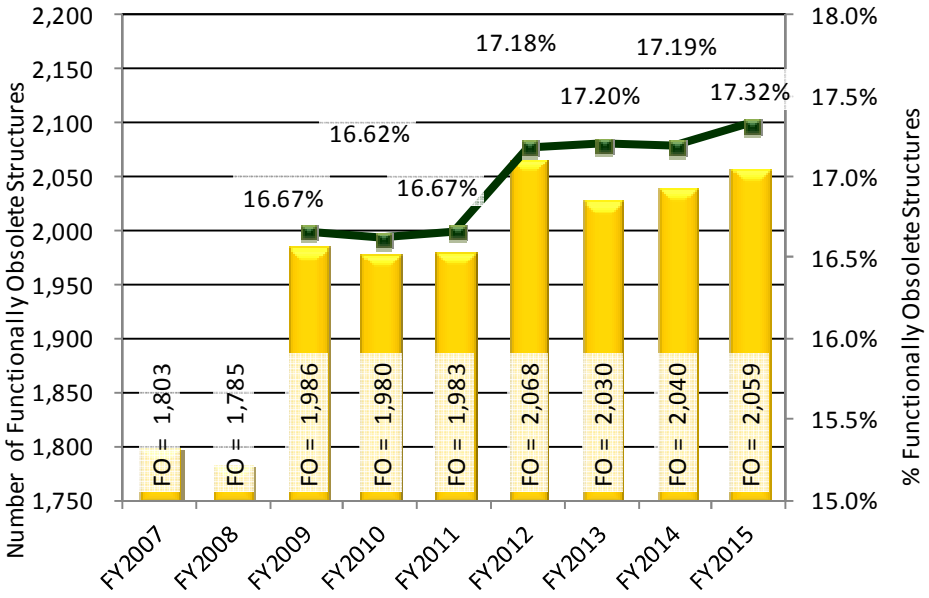
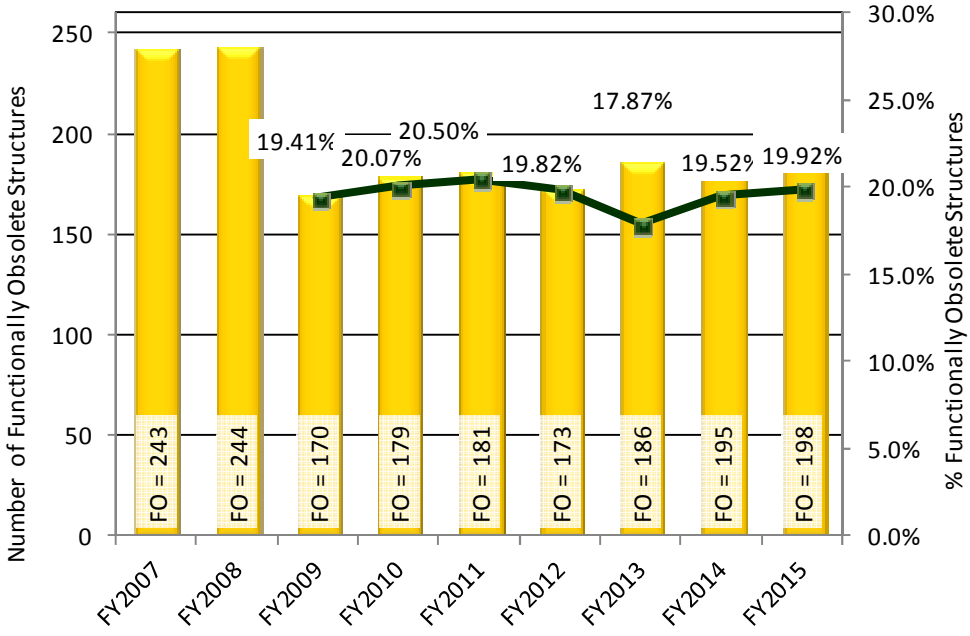



**Chart E.8 – Number and Percentage of FO Structures
Recent Trend on Urban System**

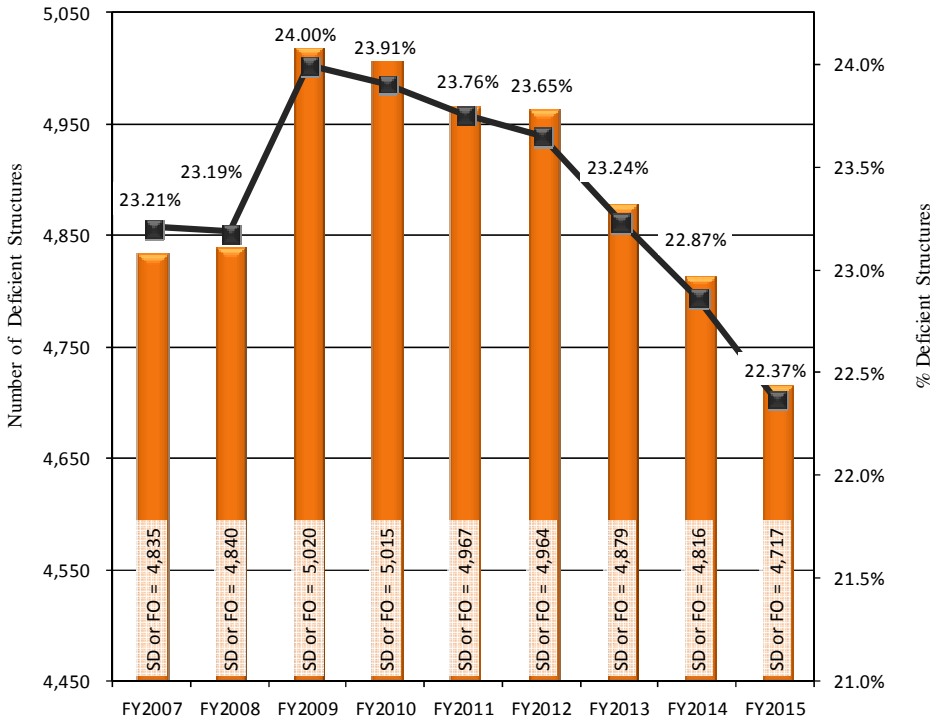


## DEFICIENT STRUCTURES

**Combining Structurally Deficient (SD) and Functionally Obsolete (FO) -** According to the Federal Highway Administration a structure is deemed "deficient" if it is rated either SD or FO. If a structure is both SD and FO it is designated as SD. All percentages are based on the number of bridges in the inventory during the fiscal year indicated, so it is possible for the number of SD or FO structures to increase from one year to the next while the percentage decreases.

Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.

## Chart E.9 – Number and Percentage of Deficient Structures
## Recent Statewide Trend




## Chart E.10 – Number and Percentage of NHS (Only NBI) Deficient Structures
## Recent Statewide Trend

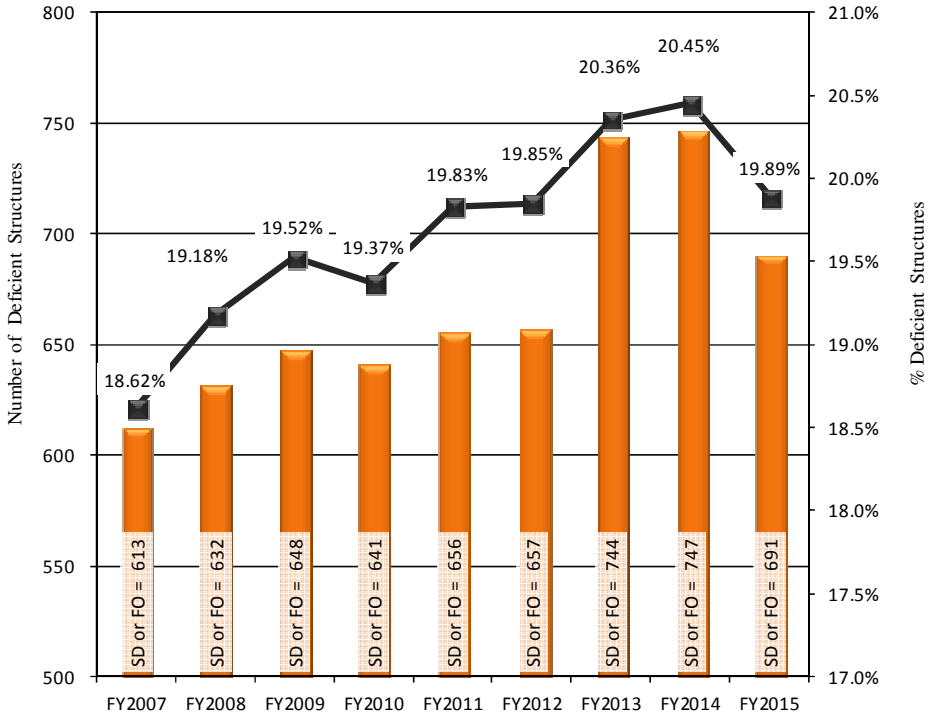


**Chart E.11 – Number and Percentage of Deficient Structures**
**Recent Trend on Interstate System**

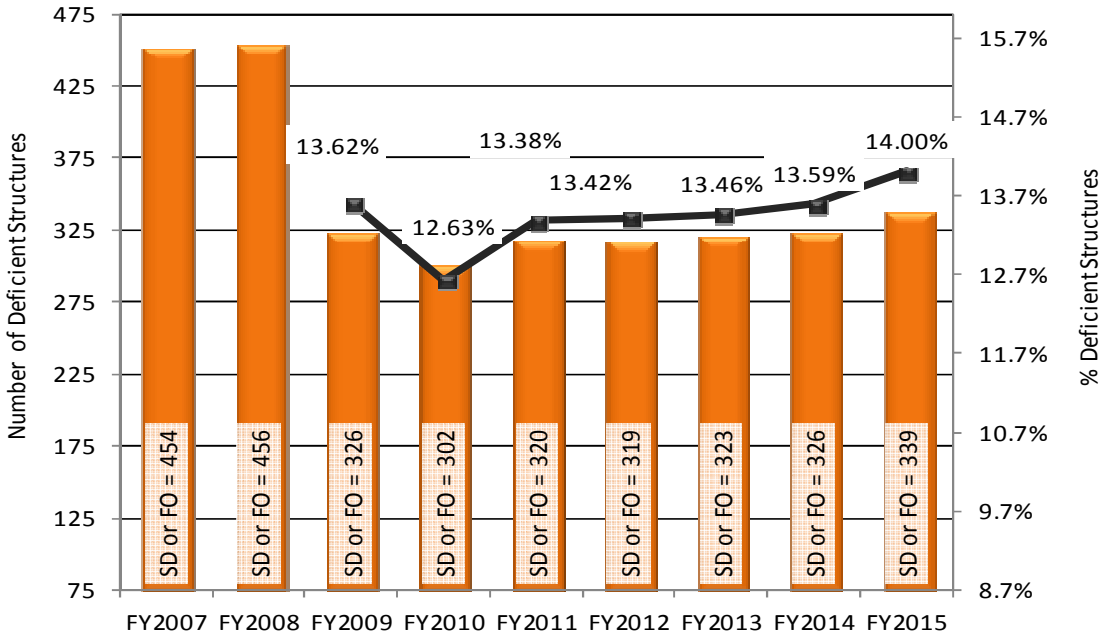



**Chart E.12 – Number and Percentage of NHS (Only NBI) Deficient Structures**
**Recent Trend on Interstate System**

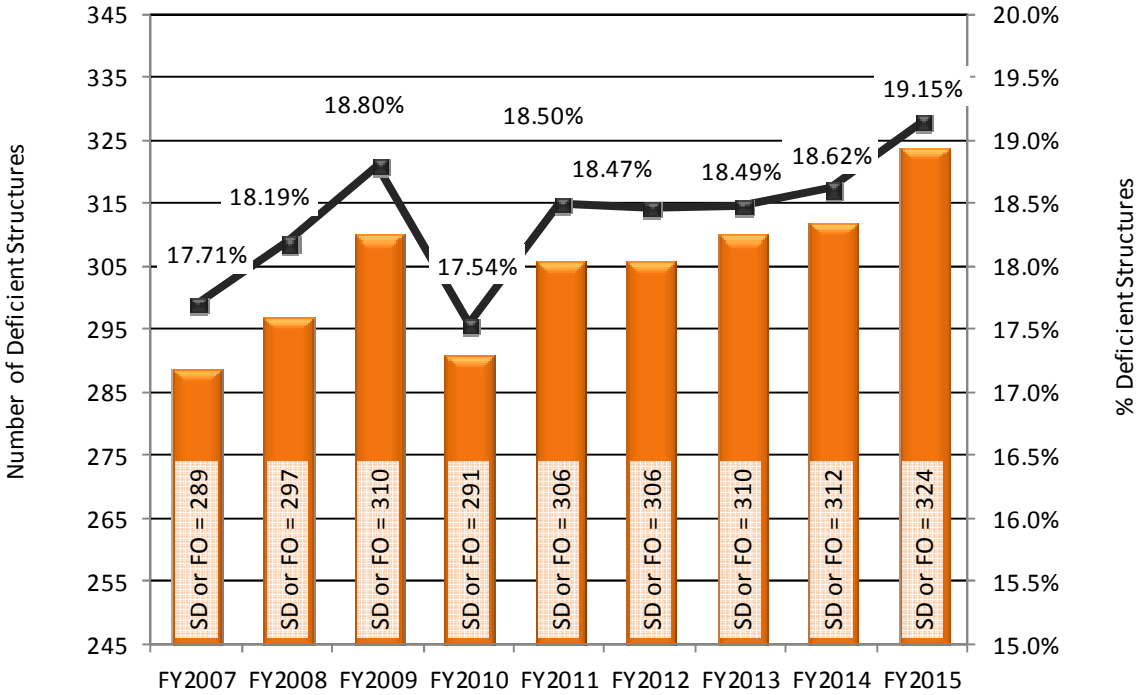


**Chart E.13 – Number and Percentage of Deficient Structures**
**Recent Trend on Primary System**

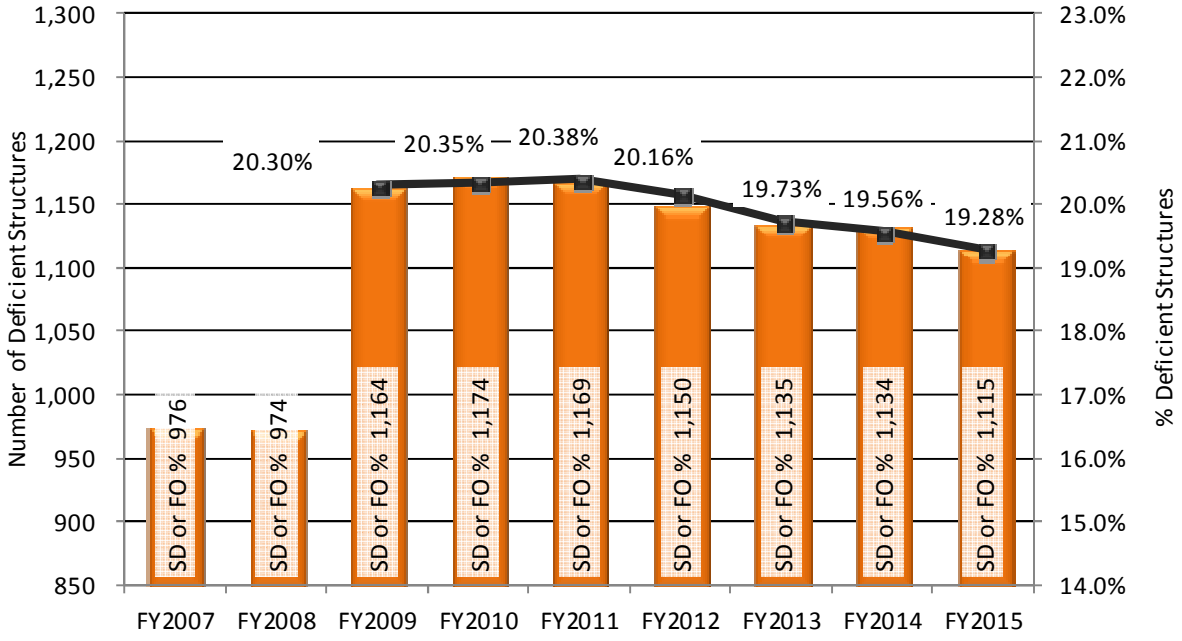



**Chart E.14 – Number and Percentage of NHS (Only NBI) Deficient Structures**
**Recent Trend on Primary System**

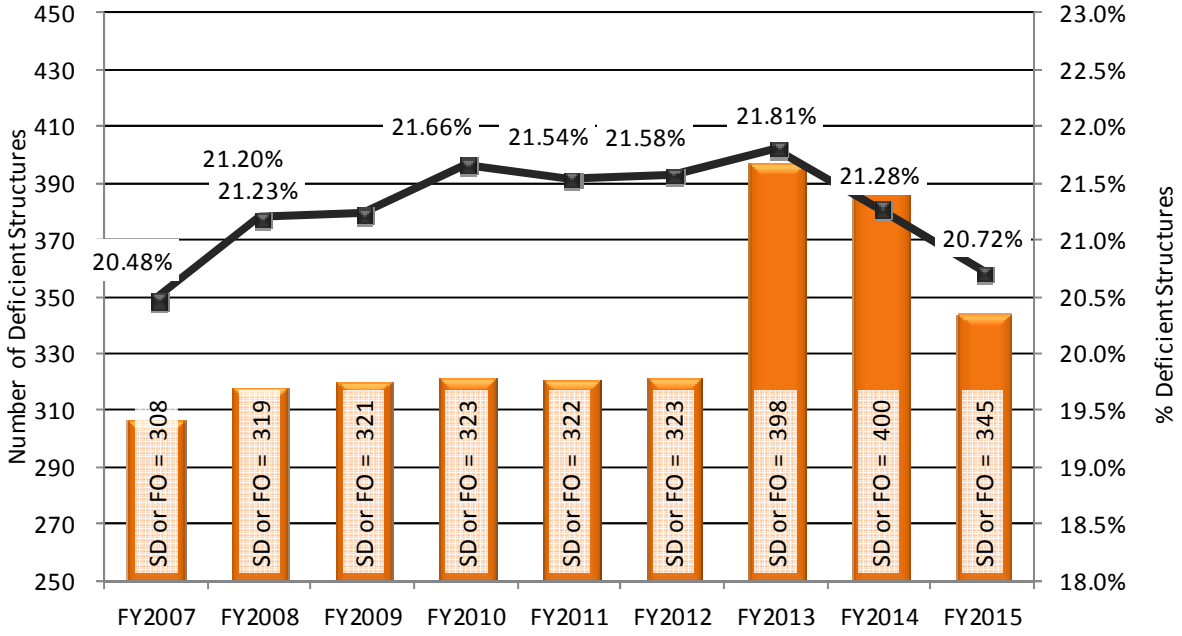


**Chart E.15 – Number and Percentage of Deficient Structures
Recent Trend on Secondary System**

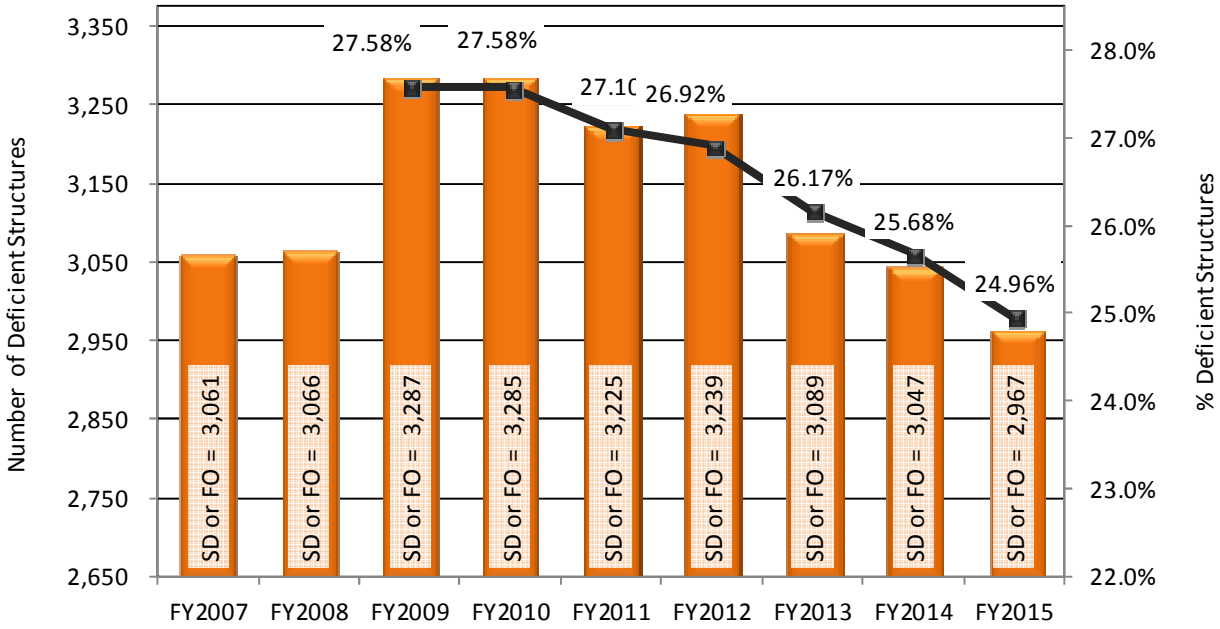
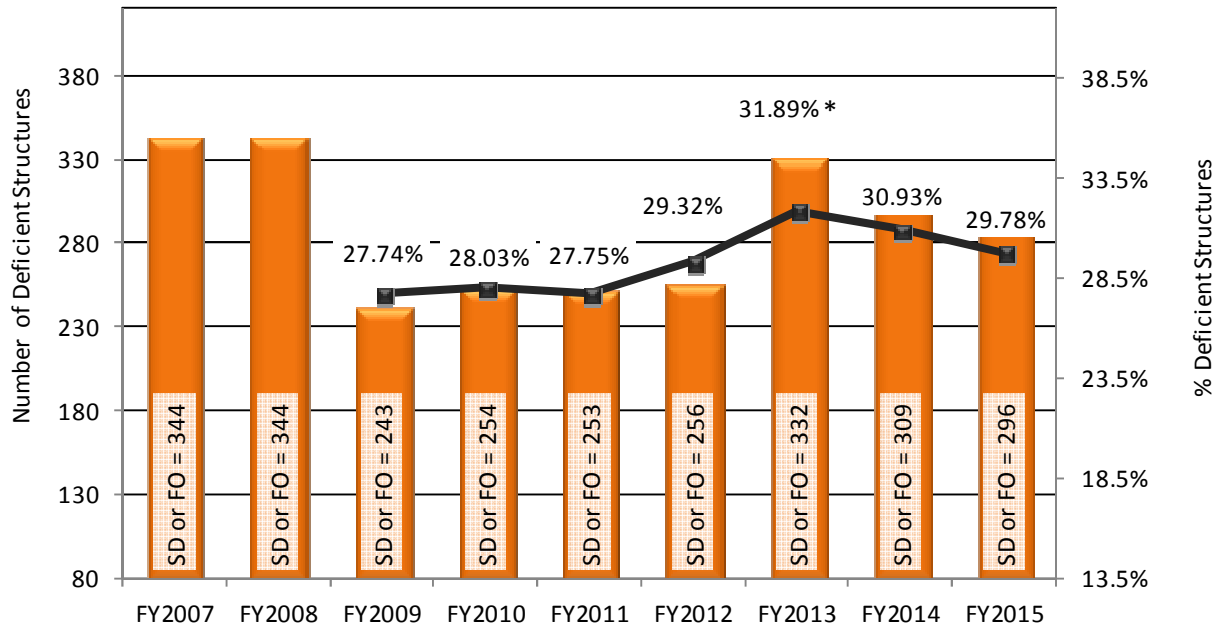



**Chart E.16 – Number and Percentage of Deficient Structures
Recent Trend on Urban System**




**Note: A large number of structures deficient were added in Buchanan County in FY2013. See Appendix G for discussion*

## WEIGHT-POSTED STRUCTURES

**Weight-Posted -** A weight-posted structure is one that has a rated load-carrying capacity less than the Virginia designated legal loads or the 45 ton blanket vehicle. Virginia legal loads are as follows:

- 27 Tons for a single unit
- 40 Tons for semi-trailers

Virginia's blanket vehicles are as follows:

- 57.5 Tons on 7 axles
- 45 Tons on 5 axles

Charts E.11 thru E.15 illustrate the number and percentages of posted structures statewide and by system.

Note: Method of accounting for the number of structures by system has changed from previous years. See Appendix G for discussion.

**Chart E.17 – Number and Percentage of Weight-Posted Structures
Recent Statewide Trend**

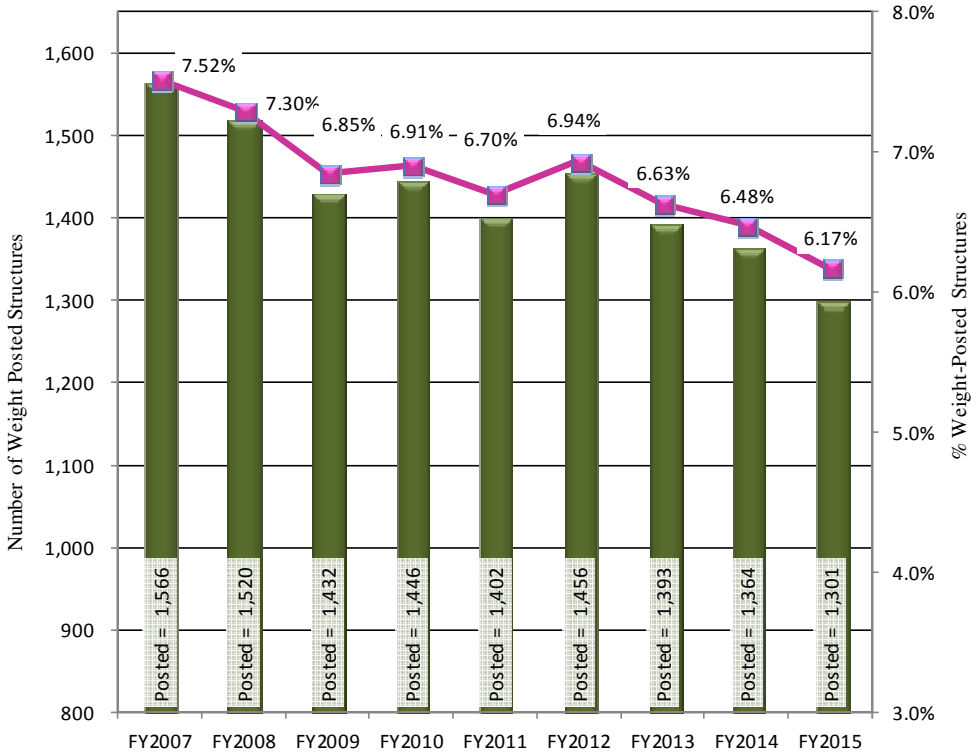



**Chart E.18 – Number and Percentage of Weight-Posted Structures
Recent Trend on Interstate System**

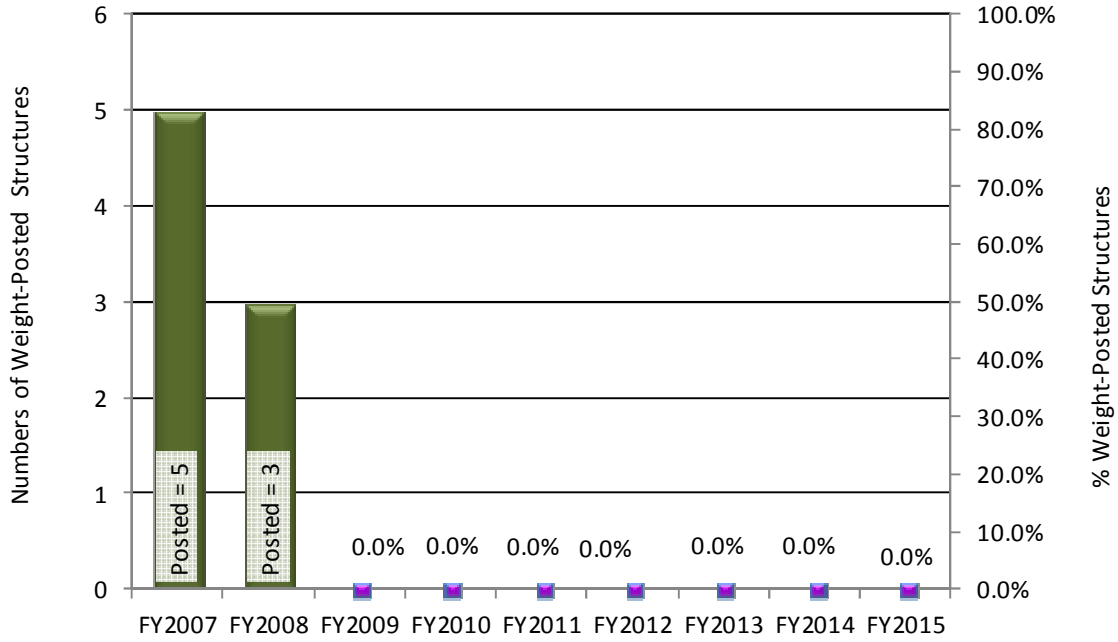


**Chart E.19 – Number and Percentage of Weight-Posted Structures
Recent Trend on Primary System**

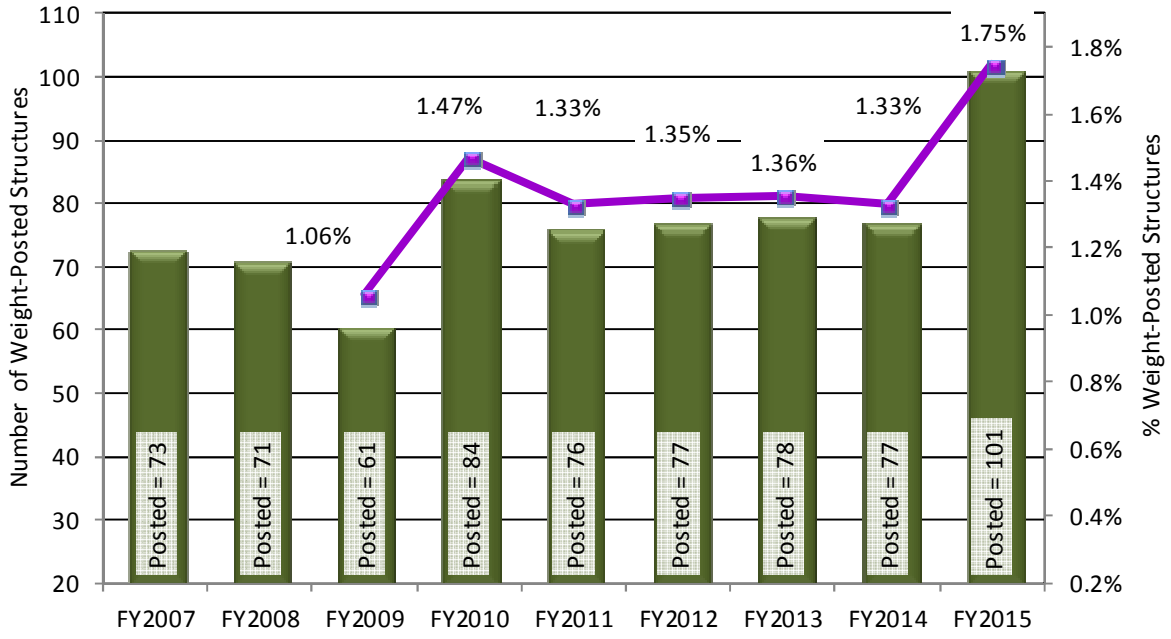



**Chart E.20 – Number and Percentage of Weight-Posted Structures
Recent Trend on Secondary System**

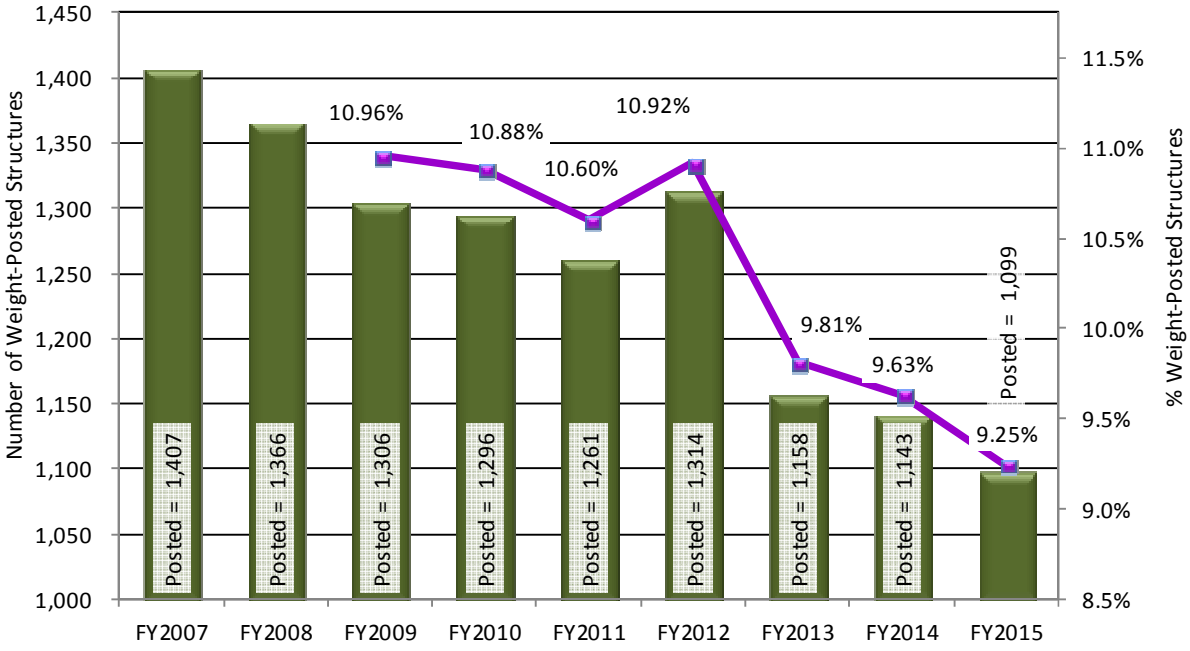
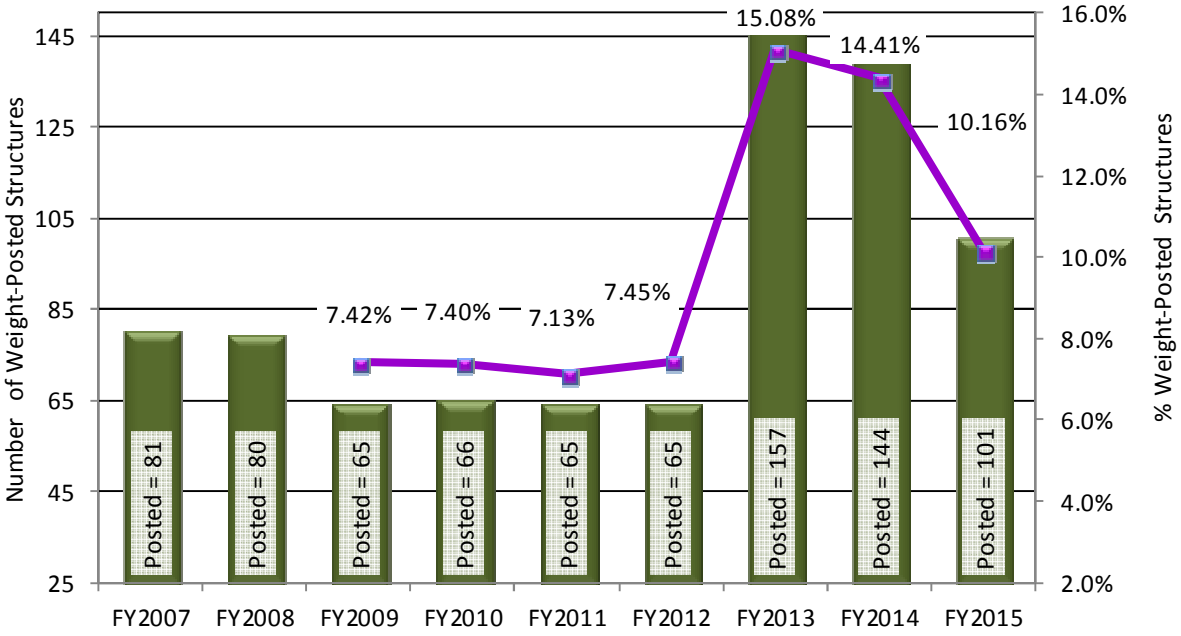


**Chart E.21 – Number and Percentage of Weight-Posted Structures
Recent Trend on Urban System**




*Note: A large number of deficient structures were added in Buchanan County in FY2012. See Appendix G for discussion*

## HEALTH INDEX MEASURE

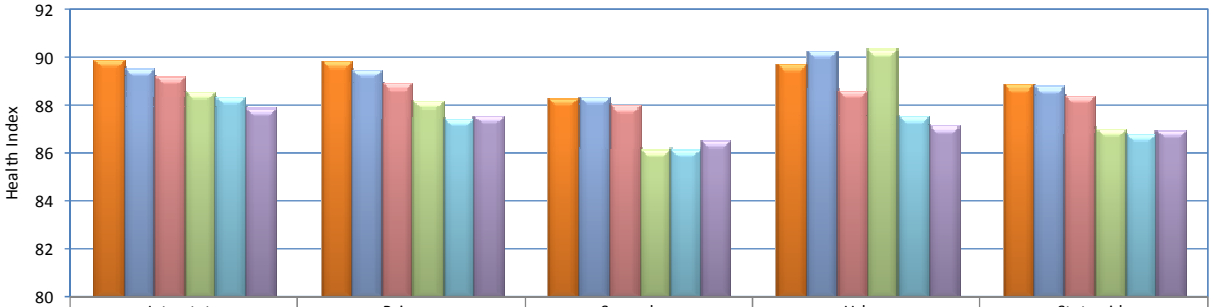
VDOT tracks a performance measure called the Health Index, which is calculated with the AASHTOWare Bridge Management System. The Health Index is calculated as the sum of the current value of all elements divided by the sum of total value of all elements. The current value is based on the quantity of the elements in each condition state. A Health Index of 100% indicates that all of the condition elements of the structure are in the best possible condition state. A Health Index of 0% indicates that all of the condition elements are in the worst possible condition state. Health index of an individual structure is calculated according to the formula following formula.

$$H = \frac{\sum_e CEVe}{\sum_e TEVe} * 100\%$$

where *CEVe* and *TEVe* are the **current** and **total element values of each element**.

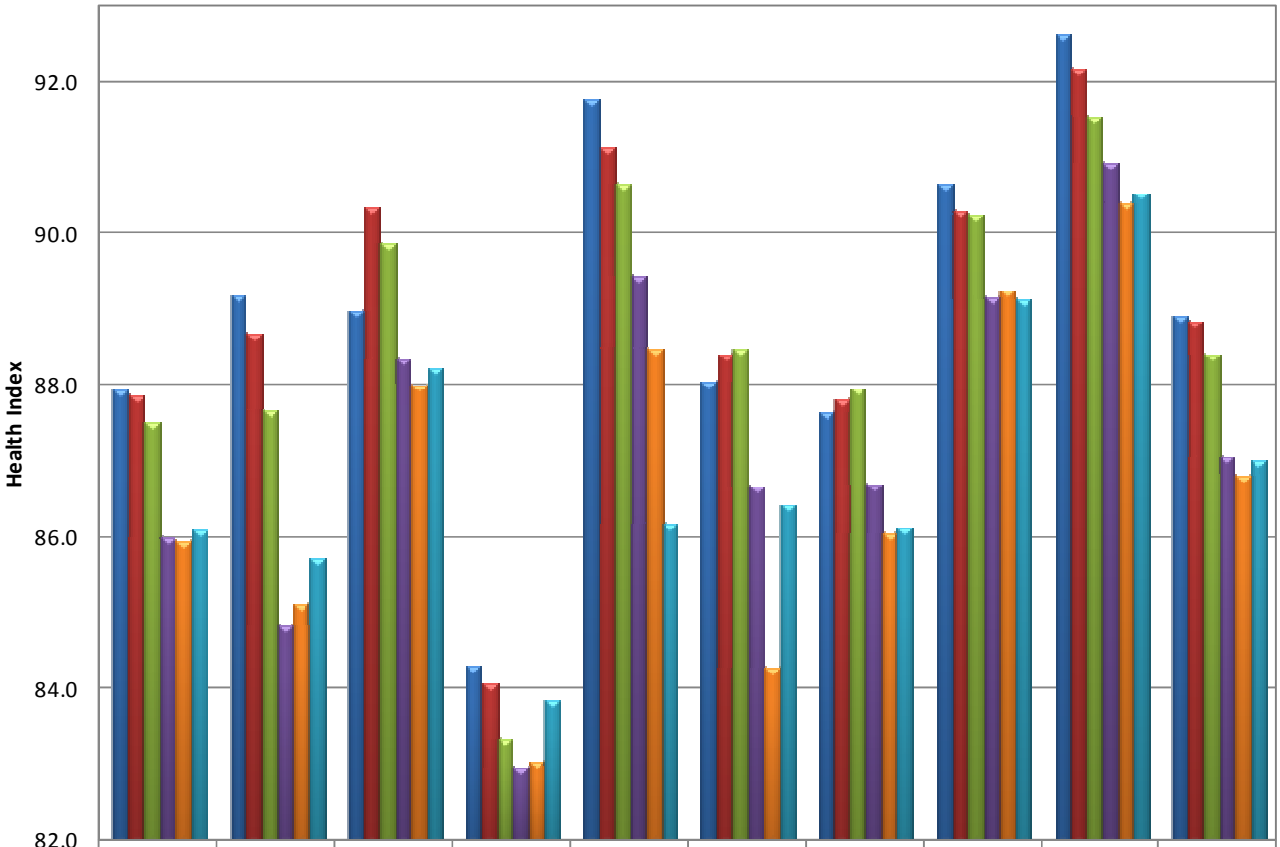
An element is a part of a bridge for which condition is assessed and work maybe recommended. Each bridge element can have up to five condition states. Each condition state categorizes the nature and extent of damage or deterioration of a bridge element. Condition state one is always defined as no damage. The higher the condition state, the more damage there is on the element. Condition states for each element have been precisely defined in terms of the specific types of distresses that the elements can develop. Charts E.22 and E.23 show the average Health Index (HI) by highway system and by District from FY2010 to FY2015. HI data for earlier years is not available.

**Chart E.22 – Average Health Index of VDOT Structures by System and Statewide**




| | Interstate | Primary | Secondary | Urban | Statewide |
|---|---|---|---|---|---|
| 2010 | 89.98 | 89.88 | 88.33 | 89.79 | 88.95 |
| 2011 | 89.59 | 89.56 | 88.43 | 90.35 | 88.88 |
| 2012 | 89.26 | 89.00 | 88.04 | 88.68 | 88.45 |
| 2013 | 88.64 | 88.24 | 86.21 | 90.42 | 87.07 |
| 2014 | 88.43 | 87.48 | 86.22 | 87.58 | 86.84 |
| 2015 | 87.93 | 87.61 | 86.58 | 87.18 | 87.02 |

**Chart E.23 – Average Health Index of VDOT Structures by District and Statewide**



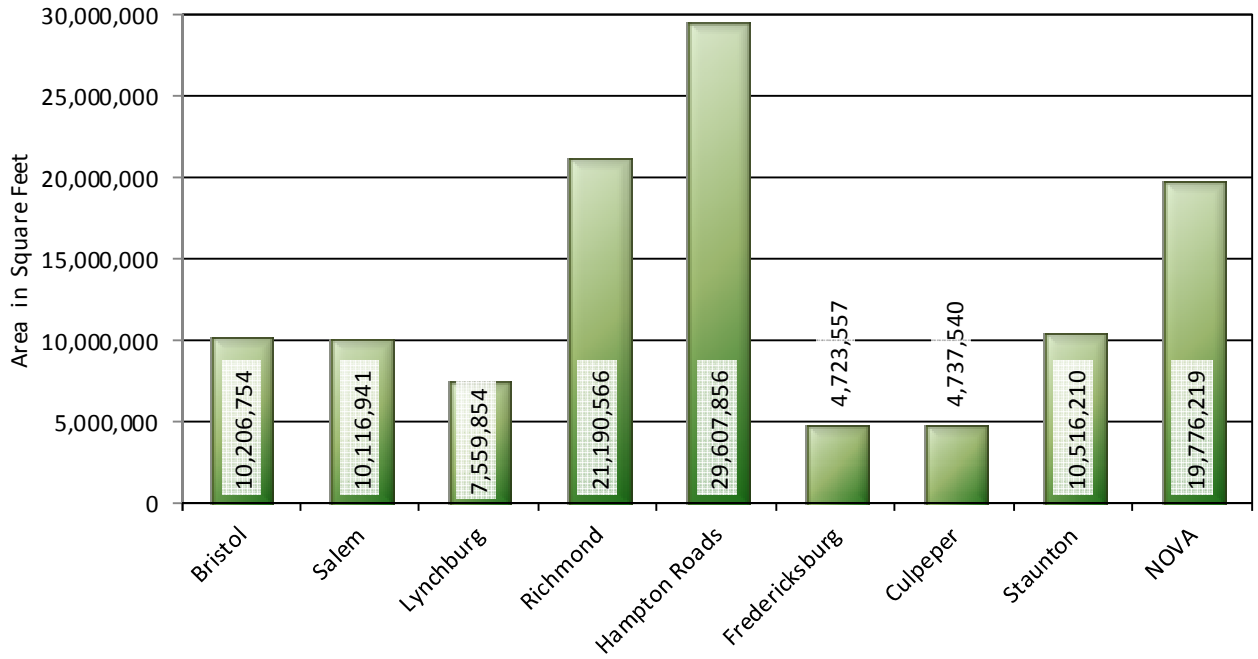

| | Bristol | Salem | Lynchburg | Richmond | Hampton Roads | Fredericksburg | Culpeper | Staunton | Northern Virginia | Statewide |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 88.0 | 89.2 | 89.0 | 84.3 | 91.8 | 88.1 | 87.7 | 90.7 | 92.6 | 89.0 |
| 2011 | 87.9 | 88.7 | 90.4 | 84.1 | 91.2 | 88.5 | 87.8 | 90.3 | 92.2 | 88.9 |
| 2012 | 87.5 | 87.7 | 89.9 | 83.4 | 90.7 | 88.5 | 88.0 | 90.3 | 91.6 | 88.4 |
| 2013 | 86.0 | 84.9 | 88.4 | 83.0 | 89.5 | 86.7 | 86.7 | 89.2 | 90.9 | 87.1 |
| 2014 | 86.0 | 85.1 | 88.0 | 83.1 | 88.5 | 84.3 | 86.1 | 89.3 | 90.4 | 86.8 |
| 2015 | 86.1 | 85.7 | 88.3 | 83.9 | 86.2 | 86.4 | 86.2 | 89.2 | 90.6 | 87.0 |

## APPENDIX F – STRUCTURE DATA BY AREA

**Table F.1 – Total Deck Area of Structures by District**

| DISTRICT | Deck Area of Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 1,803,280 | 5,458,796 | 2,659,204 | 285,474 | 10,206,754 |
| Salem | 1,688,097 | 4,718,123 | 3,062,367 | 648,355 | 10,116,941 |
| Lynchburg | 0 | 4,593,839 | 2,592,975 | 373,040 | 7,559,854 |
| Richmond | 6,469,257 | 9,668,822 | 3,879,905 | 1,172,583 | 21,190,566 |
| Hampton Roads | 10,828,130 | 14,543,399 | 1,282,349 | 2,953,977 | 29,607,856 |
| Fredericksburg | 618,553 | 2,804,809 | 1,238,207 | 61,988 | 4,723,557 |
| Culpeper | 1,048,753 | 1,838,166 | 1,761,096 | 89,525 | 4,737,540 |
| Staunton | 3,201,679 | 3,588,197 | 3,263,771 | 462,562 | 10,516,210 |
| NOVA | 6,472,137 | 6,426,975 | 6,381,478 | 495,628 | 19,776,219 |
| **Statewide** | **32,129,886** | **53,641,127** | **26,121,353** | **6,543,132** | **118,435,498** |

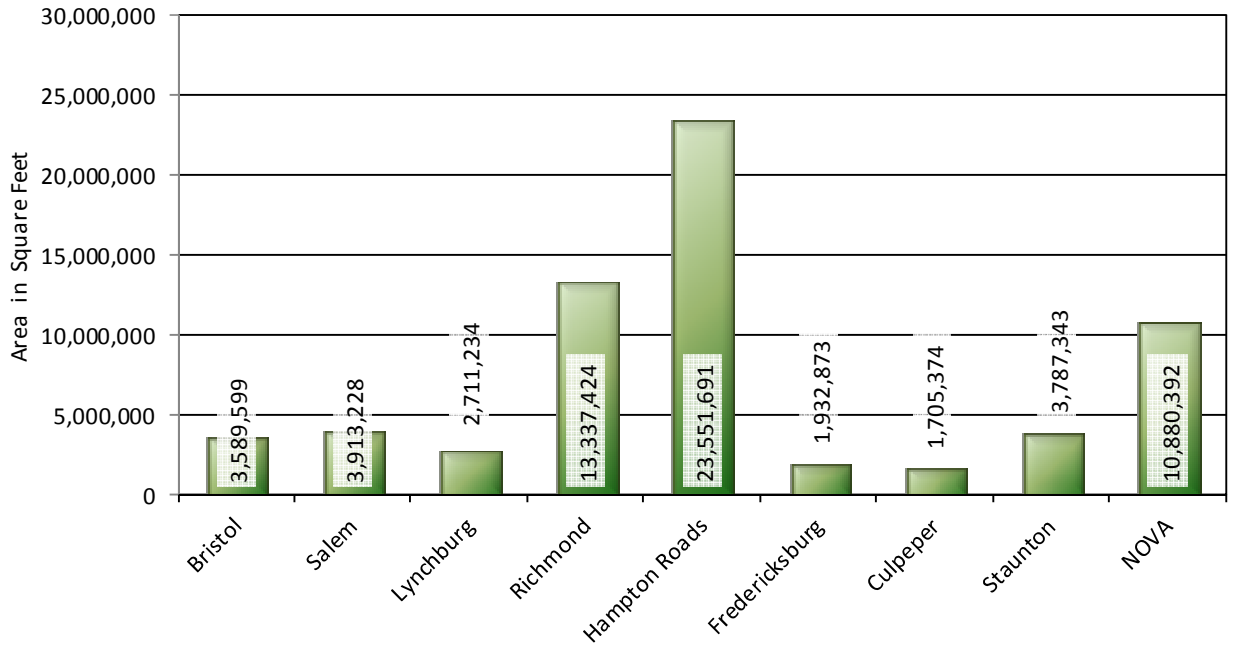
**Chart F.1 – Total Deck Area of Structures by District**



## Table F.2 – Total Deck Area of NHS Structures by District

| DISTRICT | Deck Area of Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 1,629,734 | 1,944,426 | 15,438 | 0 | 3,589,599 |
| Salem | 1,454,913 | 2,423,757 | 9,264 | 25,294 | 3,913,228 |
| Lynchburg | 0 | 2,711,234 | 0 | 0 | 2,711,234 |
| Richmond | 6,063,413 | 7,062,861 | 178,238 | 32,912 | 13,337,424 |
| Hampton Roads | 10,531,908 | 11,911,417 | 0 | 1,108,366 | 23,551,691 |
| Fredericksburg | 518,608 | 1,377,583 | 0 | 36,683 | 1,932,873 |
| Culpeper | 905,319 | 789,910 | 0 | 10,145 | 1,705,374 |
| Staunton | 2,709,149 | 1,078,194 | 0 | 0 | 3,787,343 |
| NOVA | 5,832,090 | 4,632,138 | 416,165 | 0 | 10,880,392 |
| **Statewide** | **29,645,133** | **33,931,520** | **619,105** | **1,213,401** | **65,409,159** |

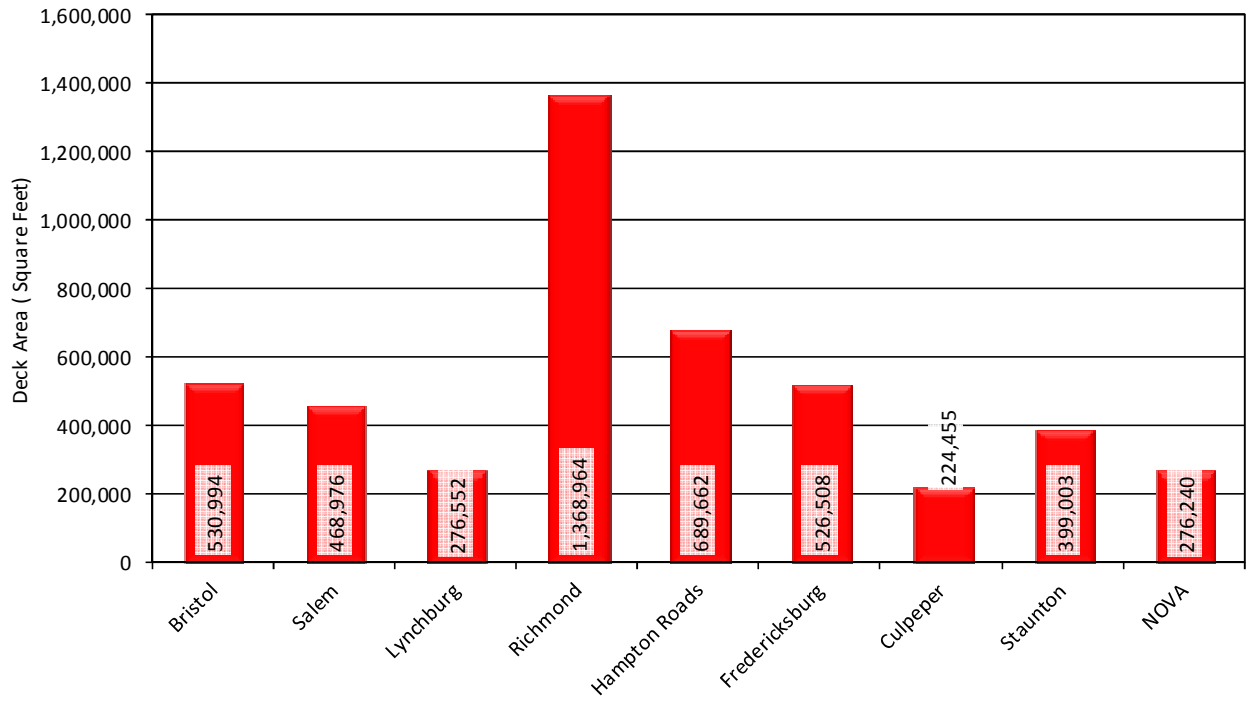
## Chart F.2 – Total Deck Area of NHS Structures by District



## Table F.3 – Total Deck Area of Structurally Deficient Structures by District

| DISTRICT | Area of Structurally Deficient Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 113,563 | 211,964 | 151,557 | 53,910 | 530,994 |
| Salem | 110,420 | 143,313 | 199,264 | 15,980 | 468,976 |
| Lynchburg | 0 | 135,917 | 123,586 | 17,049 | 276,552 |
| Richmond | 436,082 | 623,899 | 191,851 | 117,131 | 1,368,964 |
| Hampton Roads | 53,941 | 525,256 | 64,155 | 46,310 | 689,662 |
| Fredericksburg | 29,024 | 424,806 | 72,678 | 0 | 526,508 |
| Culpeper | 0 | 121,907 | 86,650 | 15,898 | 224,455 |
| Staunton | 36,281 | 186,827 | 155,587 | 20,308 | 399,003 |
| NOVA | 24,370 | 186,012 | 65,127 | 731 | 276,240 |
| **Statewide** | **803,680** | **2,559,903** | **1,110,455** | **287,316** | **4,761,354** |

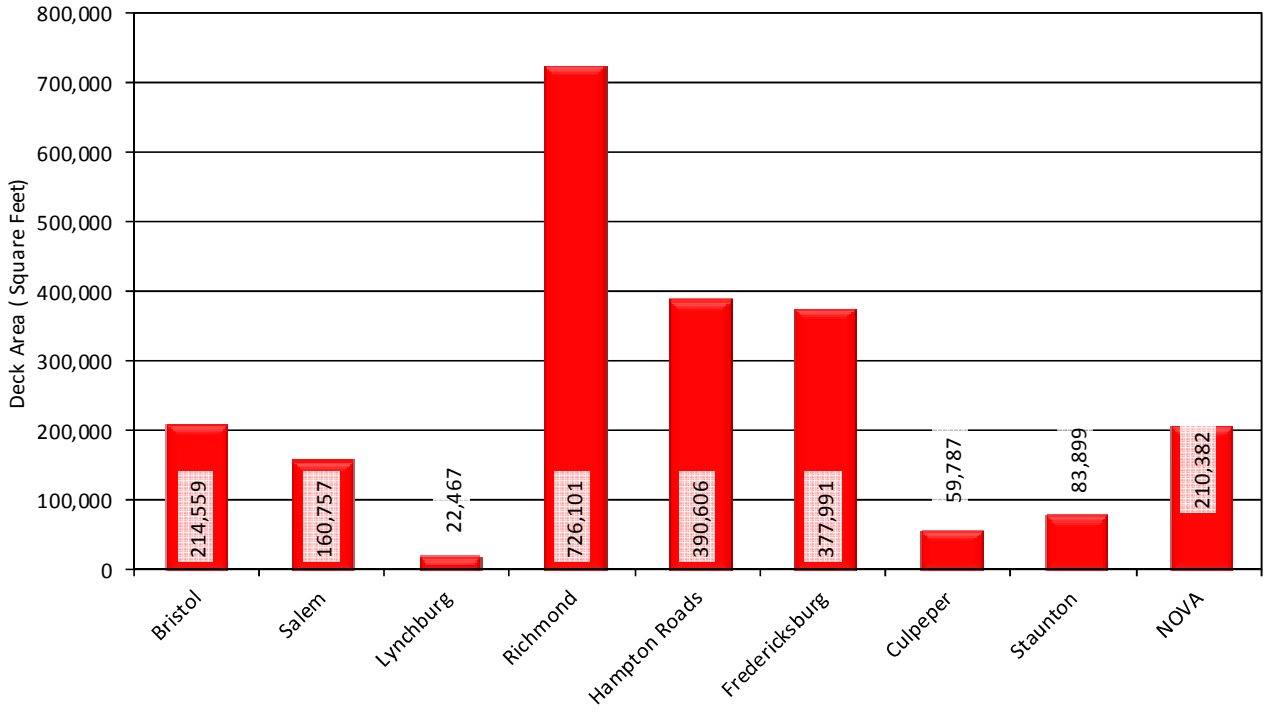
## Chart F.3 – Total Deck Area of Structurally Deficient Structures by District



## Table F.4 – Total Deck Area of NHS Structurally Deficient Structures by District

| DISTRICT | Area of Structurally Deficient Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 107,983 | 106,576 | 0 | 0 | 214,559 |
| Salem | 110,420 | 40,408 | 0 | 9,930 | 160,757 |
| Lynchburg | 0 | 22,467 | 0 | 0 | 22,467 |
| Richmond | 436,082 | 279,139 | 0 | 10,880 | 726,101 |
| Hampton Roads | 53,941 | 336,665 | 0 | 0 | 390,606 |
| Fredericksburg | 26,447 | 351,544 | 0 | 0 | 377,991 |
| Culpeper | 0 | 59,787 | 0 | 0 | 59,787 |
| Staunton | 36,281 | 47,618 | 0 | 0 | 83,899 |
| NOVA | 24,370 | 186,012 | 0 | 0 | 210,382 |
| **Statewide** | **795,523** | **1,430,215** | **0** | **20,810** | **2,246,548** |

## Chart F.4 – Total Deck Area of NHS Structurally Deficient Structures by District

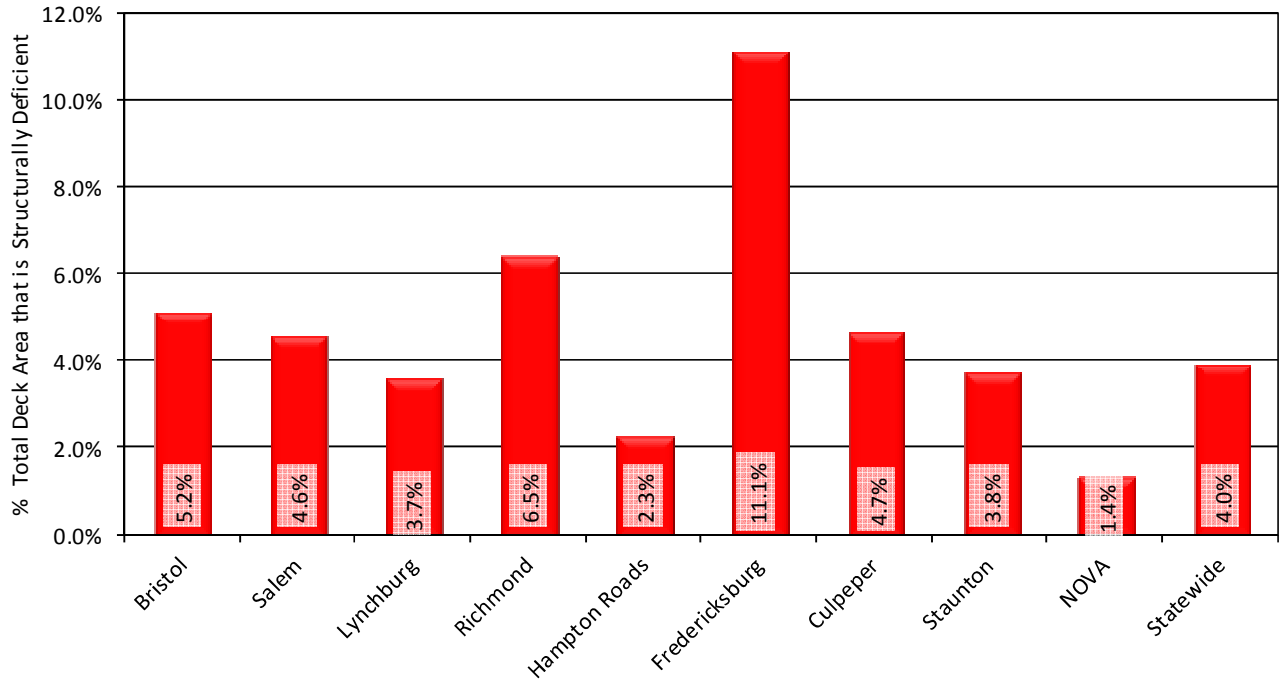


## Table F.5 – Percentage of Total Deck Area of Structurally Deficient Structures by District

| DISTRICT | Percent Area of Structurally Deficient Structures | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 6.3% | 3.9% | 5.7% | 18.9% | 5.2% |
| Salem | 6.5% | 3.0% | 6.5% | 2.5% | 4.6% |
| Lynchburg | 0.0% | 3.0% | 4.8% | 4.6% | 3.7% |
| Richmond | 6.7% | 6.5% | 4.8% | 10.0% | 6.5% |
| Hampton Roads | 0.5% | 3.6% | 4.9% | 1.6% | 2.3% |
| Fredericksburg | 4.7% | 15.1% | 5.0% | 0.0% | 11.1% |
| Culpeper | 0.0% | 6.6% | 4.9% | 17.8% | 4.7% |
| Staunton | 1.1% | 5.2% | 4.8% | 4.4% | 3.8% |
| NOVA | 0.4% | 2.9% | 1.0% | 0.1% | 1.4% |
| **Statewide** | **2.5%** | **4.8%** | **4.3%** | **4.4%** | **4.0%** |

Percentages are calculated by dividing the SD area for the District by the total area for the District by highway system (example - SD Bristol Interstate area divided by all Bristol Interstate area 118,195 / 1,820,736 = 0.065 or 6.5%)

## Chart F.5 – Percentage of Total Deck Area of Structurally Deficient Structures by District



## Table F.6 – Percentage of Total Deck Area of NHS Structurally Deficient Structures by District

| DISTRICT | Percent Area of Structurally Deficient Structures | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Total |
| Bristol | 6.6% | 5.5% | 0.0% | 0.0% | 6.0% |
| Salem | 7.6% | 1.7% | 0.0% | 39.3% | 4.1% |
| Lynchburg | 0.0% | 0.8% | 0.0% | 0.0% | 0.8% |
| Richmond | 7.2% | 4.0% | 0.0% | 33.1% | 5.4% |
| Hampton Roads | 0.5% | 2.8% | 0.0% | 0.0% | 1.7% |
| Fredericksburg | 5.1% | 25.5% | 0.0% | 0.0% | 19.6% |
| Culpeper | 0.0% | 7.6% | 0.0% | 0.0% | 3.5% |
| Staunton | 1.3% | 4.4% | 0.0% | 0.0% | 2.2% |
| NOVA | 0.4% | 4.0% | 0.0% | 0.0% | 1.9% |
| **Statewide** | **2.7%** | **4.2%** | **0.0%** | **1.7%** | **3.4%** |

## Chart F.6 – Percentage of Total Deck Area of NHS Structurally Deficient Structures by District

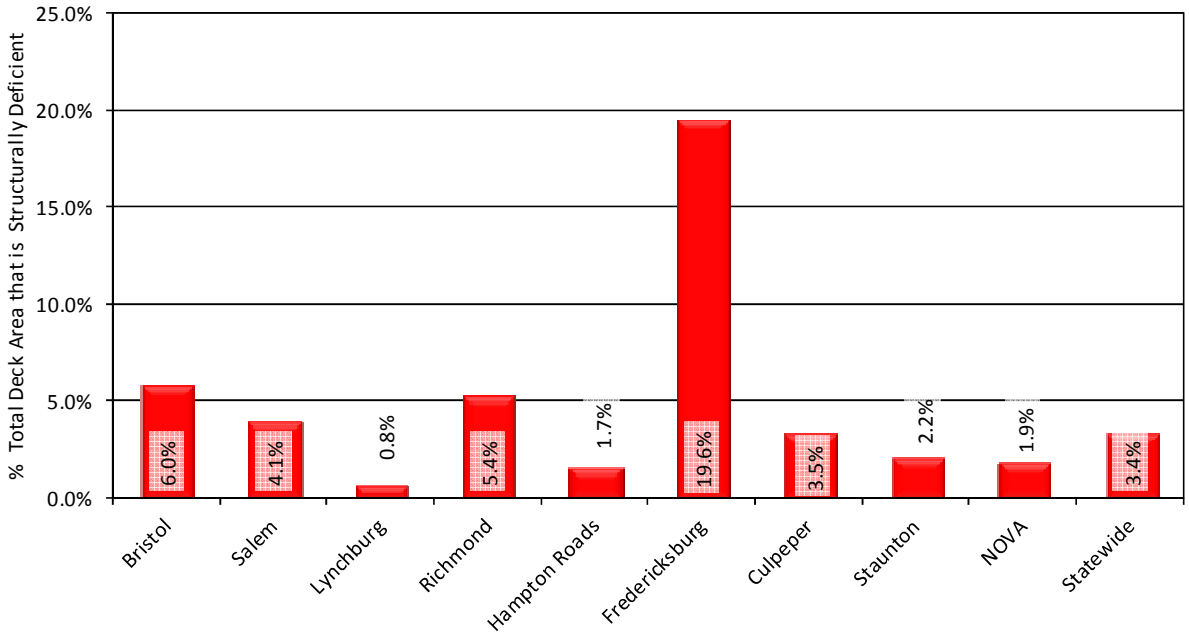


**Table F.7 – Total Deck Area of Functionally Obsolete Structures by District**

| DISTRICT | Area of Functionally Obsolete Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 269,197 | 958,507 | 285,296 | 42,360 | 1,555,360 |
| Salem | 199,372 | 819,759 | 546,874 | 216,226 | 1,782,232 |
| Lynchburg | 0 | 416,792 | 159,333 | 61,695 | 637,819 |
| Richmond | 1,101,402 | 1,858,628 | 361,340 | 304,934 | 3,626,304 |
| Hampton Roads | 1,684,800 | 4,418,442 | 111,830 | 640,839 | 6,855,912 |
| Fredericksburg | 51,437 | 549,050 | 127,156 | 4,375 | 732,019 |
| Culpeper | 6,192 | 95,405 | 232,871 | 12,195 | 346,663 |
| Staunton | 138,656 | 588,005 | 385,468 | 110,065 | 1,222,193 |
| NOVA | 2,585,644 | 1,686,890 | 1,783,549 | 175,611 | 6,231,694 |
| **Statewide** | **6,036,701** | **11,391,477** | **3,993,717** | **1,568,301** | **22,990,195** |

If a structure is both structurally deficient and functionally obsolete, structure is counted as structurally deficient only.

**Chart F.7– Total Deck Area of Functionally Obsolete Structures by District**

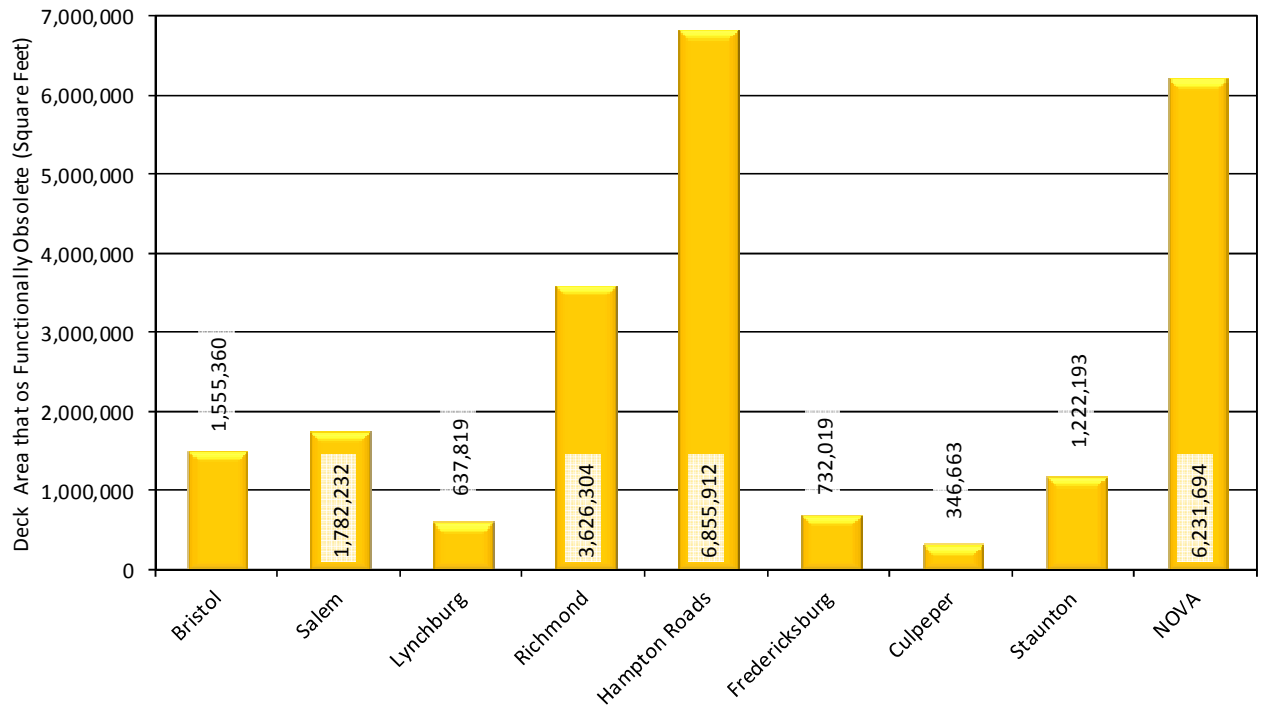
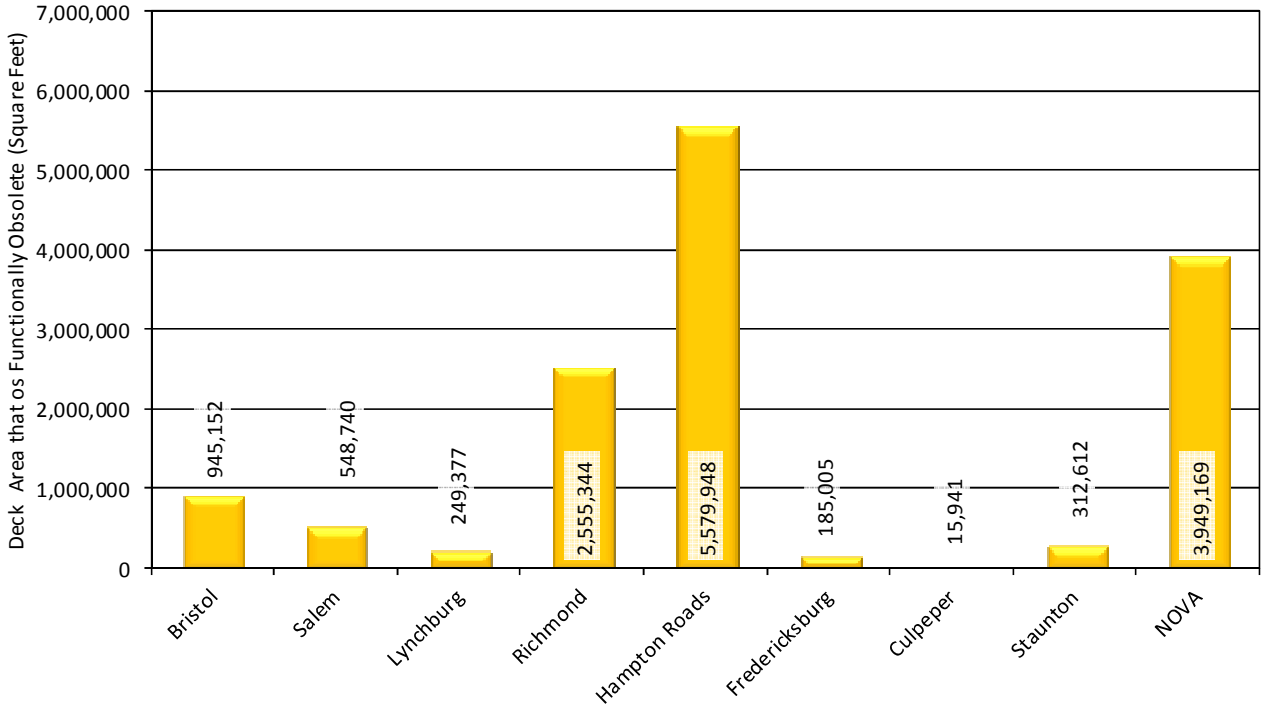


**Table F.8 – Total Deck Area of Functionally Obsolete NHS (NBI Only) Structures by District**

| DISTRICT | Area of Functionally Obsolete Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 267,081 | 678,071 | 0 | 0 | 945,152 |
| Salem | 199,372 | 340,104 | 9,264 | 0 | 548,740 |
| Lynchburg | 0 | 249,377 | 0 | 0 | 249,377 |
| Richmond | 1,092,765 | 1,434,716 | 24,514 | 3,348 | 2,555,344 |
| Hampton Roads | 1,648,332 | 3,927,751 | 0 | 3,865 | 5,579,948 |
| Fredericksburg | 51,437 | 133,568 | 0 | 0 | 185,005 |
| Culpeper | 0 | 15,941 | 0 | 0 | 15,941 |
| Staunton | 135,704 | 176,908 | 0 | 0 | 312,612 |
| NOVA | 2,500,012 | 1,256,765 | 192,393 | 0 | 3,949,169 |
| **Statewide** | **5,894,703** | **8,213,199** | **226,171** | **7,214** | **14,341,288** |

If a structure is both structurally deficient and functionally obsolete, structure is counted as structurally deficient only.

**Chart F.8– Total Deck Area of Functionally Obsolete NHS (NBI Only) Structures by District**

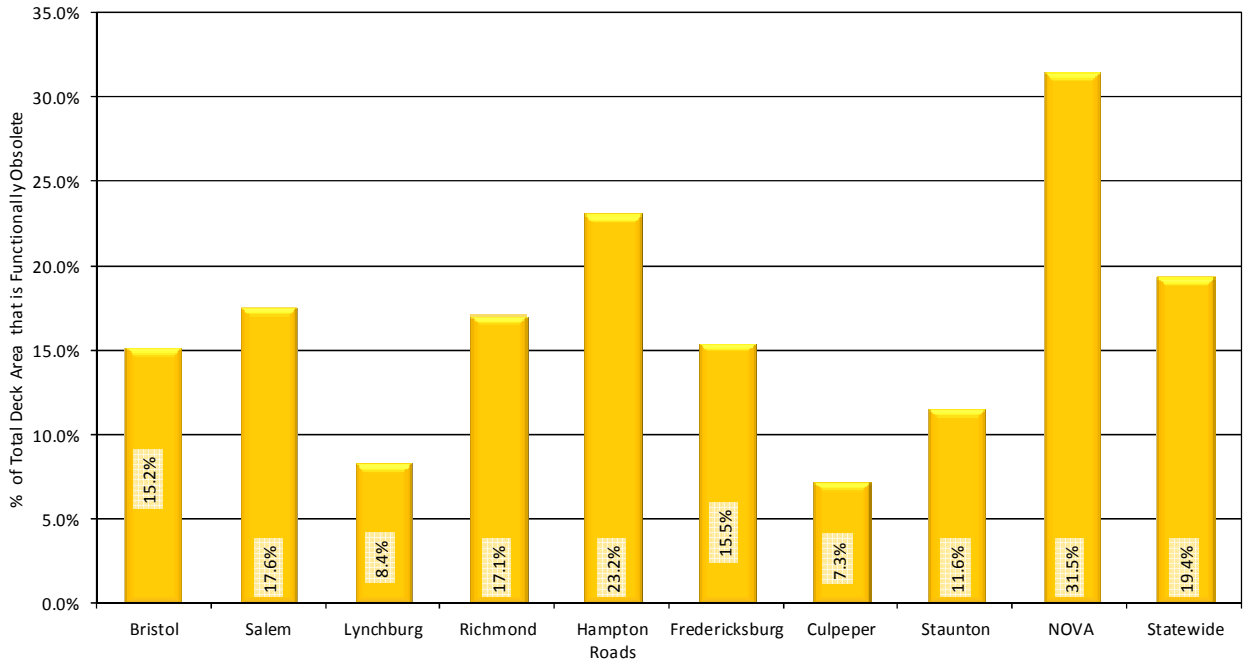


## Table F.9 – Percentage of Total Deck Area that is Functionally Obsolete by District

| DISTRICT | Percent of Deck Area that is Functionally Obsolete | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 14.9% | 17.6% | 10.7% | 14.8% | 15.2% |
| Salem | 11.8% | 17.4% | 17.9% | 33.3% | 17.6% |
| Lynchburg | 0.0% | 9.1% | 6.1% | 16.5% | 8.4% |
| Richmond | 17.0% | 19.2% | 9.3% | 26.0% | 17.1% |
| Hampton Roads | 15.6% | 30.4% | 8.7% | 21.7% | 23.2% |
| Fredericksburg | 8.3% | 19.6% | 10.3% | 7.1% | 15.5% |
| Culpeper | 0.6% | 5.2% | 13.2% | 13.6% | 7.3% |
| Staunton | 4.3% | 16.4% | 11.8% | 23.8% | 11.6% |
| NOVA | 40.0% | 26.2% | 27.9% | 35.4% | 31.5% |
| **Statewide** | **18.8%** | **21.2%** | **15.3%** | **24.0%** | **19.4%** |

Percentages are calculated by dividing the FO area for the District by the total area for the District by highway system (example - FO Bristol Interstate area divided by all Bristol Interstate area 235,737 / 1,820,736 = 0.129 or 12.9%)

## Chart F.9 – Percentage of Total Deck Area that is Functionally Obsolete by District



## Table F.10 – Deck Area of Deficient (SD & FO) Structures by District

| DISTRICT | Area of Deficient (SD or FO) Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 382,760 | 1,170,471 | 436,852 | 96,270 | 2,086,354 |
| Salem | 309,792 | 963,072 | 746,139 | 232,206 | 2,251,208 |
| Lynchburg | 0 | 552,709 | 282,919 | 78,744 | 914,371 |
| Richmond | 1,537,484 | 2,482,527 | 553,191 | 422,065 | 4,995,268 |
| Hampton Roads | 1,738,741 | 4,943,698 | 175,985 | 687,150 | 7,545,574 |
| Fredericksburg | 80,461 | 973,856 | 199,835 | 4,375 | 1,258,527 |
| Culpeper | 6,192 | 217,312 | 319,521 | 28,093 | 571,117 |
| Staunton | 174,937 | 774,832 | 541,055 | 130,372 | 1,621,197 |
| NOVA | 2,610,014 | 1,872,902 | 1,848,675 | 176,343 | 6,507,934 |
| **Statewide** | **6,840,381** | **13,951,379** | **5,104,172** | **1,855,618** | **27,751,550** |

## Chart F.10 – Deck Area of Deficient (SD & FO) Structures by District

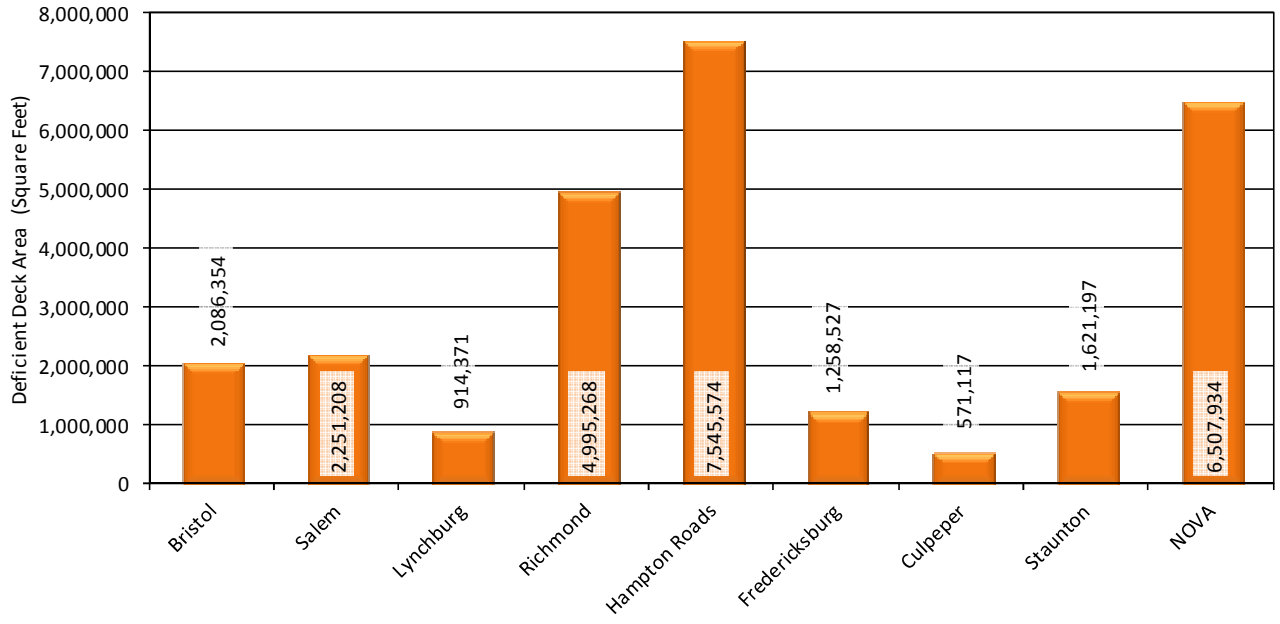
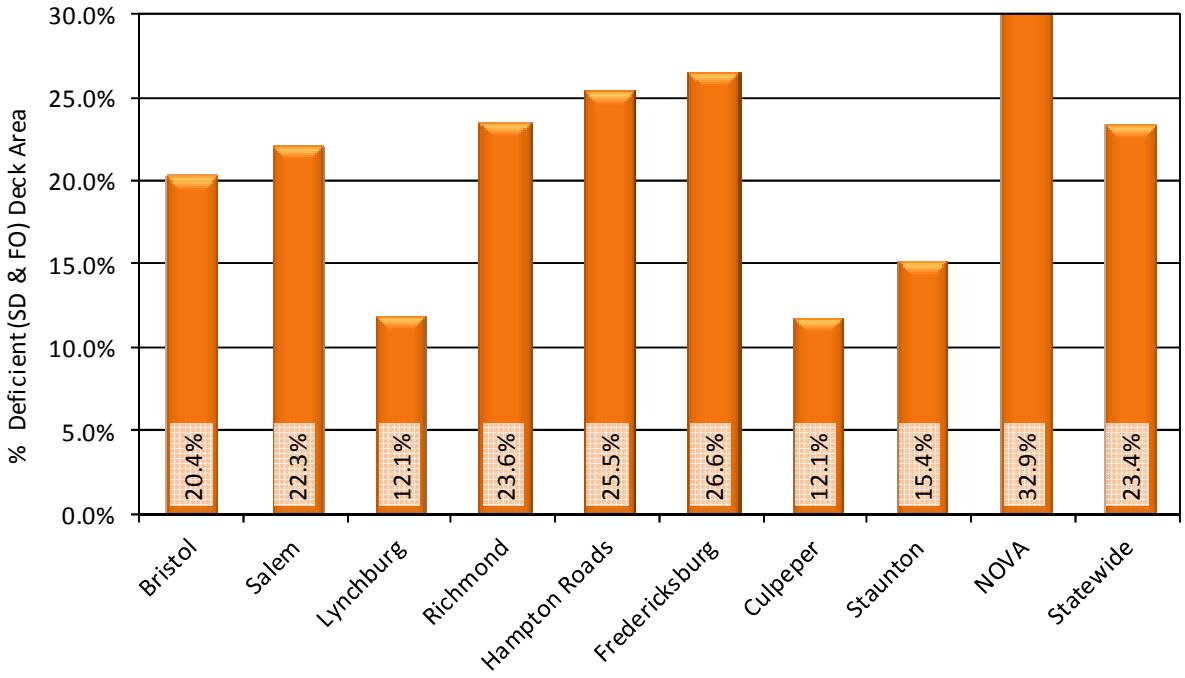


**Table F.11 – Percentage of Deck Foot Area that is Deficient (SD & FO) Structures by District**

| DISTRICT | Percent Deck Area of Deficient (SD or FO) Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 21.2% | 21.4% | 16.4% | 33.7% | 20.4% |
| Salem | 18.4% | 20.4% | 24.4% | 35.8% | 22.3% |
| Lynchburg | 0.0% | 12.0% | 10.9% | 21.1% | 12.1% |
| Richmond | 23.8% | 25.7% | 14.3% | 36.0% | 23.6% |
| Hampton Roads | 16.1% | 34.0% | 13.7% | 23.3% | 25.5% |
| Fredericksburg | 13.0% | 34.7% | 16.1% | 7.1% | 26.6% |
| Culpeper | 0.6% | 11.8% | 18.1% | 31.4% | 12.1% |
| Staunton | 5.5% | 21.6% | 16.6% | 28.2% | 15.4% |
| NOVA | 40.3% | 29.1% | 29.0% | 35.6% | 32.9% |
| **Statewide** | **21.3%** | **26.0%** | **19.5%** | **28.4%** | **23.4%** |

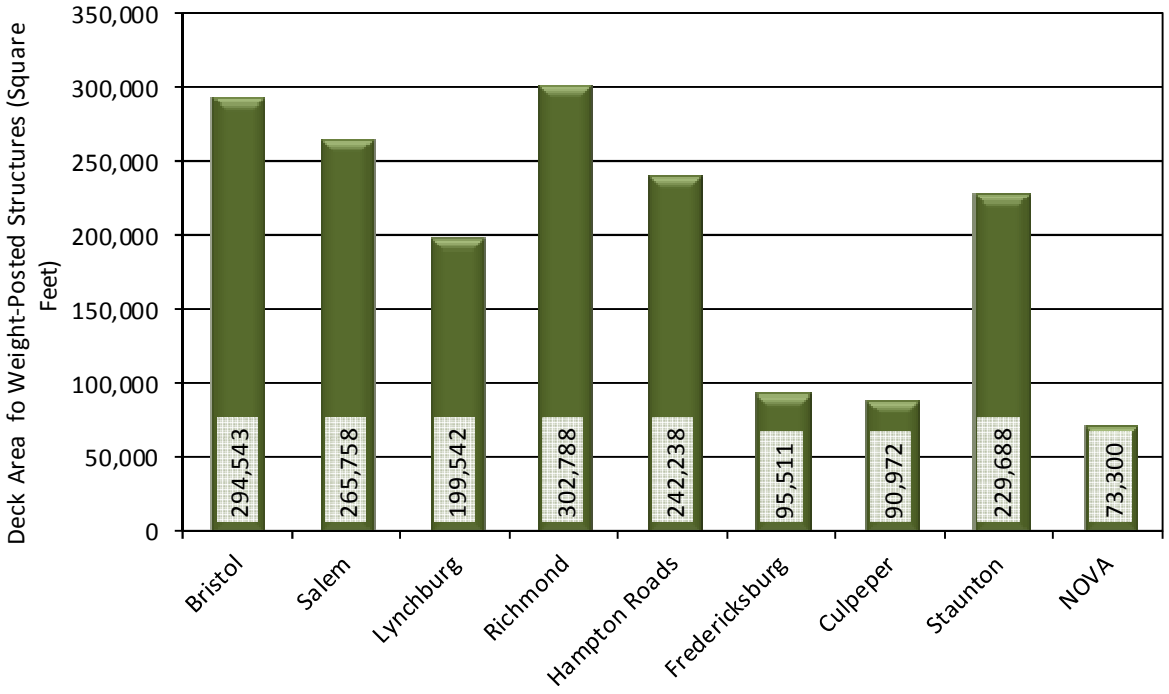
**Chart F.11 – Percentage of Deck Area that is Deficient (SD & FO) Structures by District**



## Table F.12 – Total Deck Area of Weight-Posted Structures by District

| DISTRICT | Deck Area of Weight Posted Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 0 | 76,835 | 161,072 | 56,636 | 294,543 |
| Salem | 0 | 16,486 | 242,086 | 7,186 | 265,758 |
| Lynchburg | 0 | 39,676 | 156,156 | 3,711 | 199,542 |
| Richmond | 0 | 112,990 | 167,523 | 22,276 | 302,788 |
| Hampton Roads | 0 | 137,328 | 72,272 | 32,637 | 242,238 |
| Fredericksburg | 0 | 63,119 | 32,392 | 0 | 95,511 |
| Culpeper | 0 | 19,160 | 66,820 | 4,992 | 90,972 |
| Staunton | 0 | 109,795 | 111,510 | 8,383 | 229,688 |
| NOVA | 0 | 44,850 | 27,719 | 731 | 73,300 |
| **Statewide** | **0** | **620,238** | **1,037,550** | **136,552** | **1,794,340** |

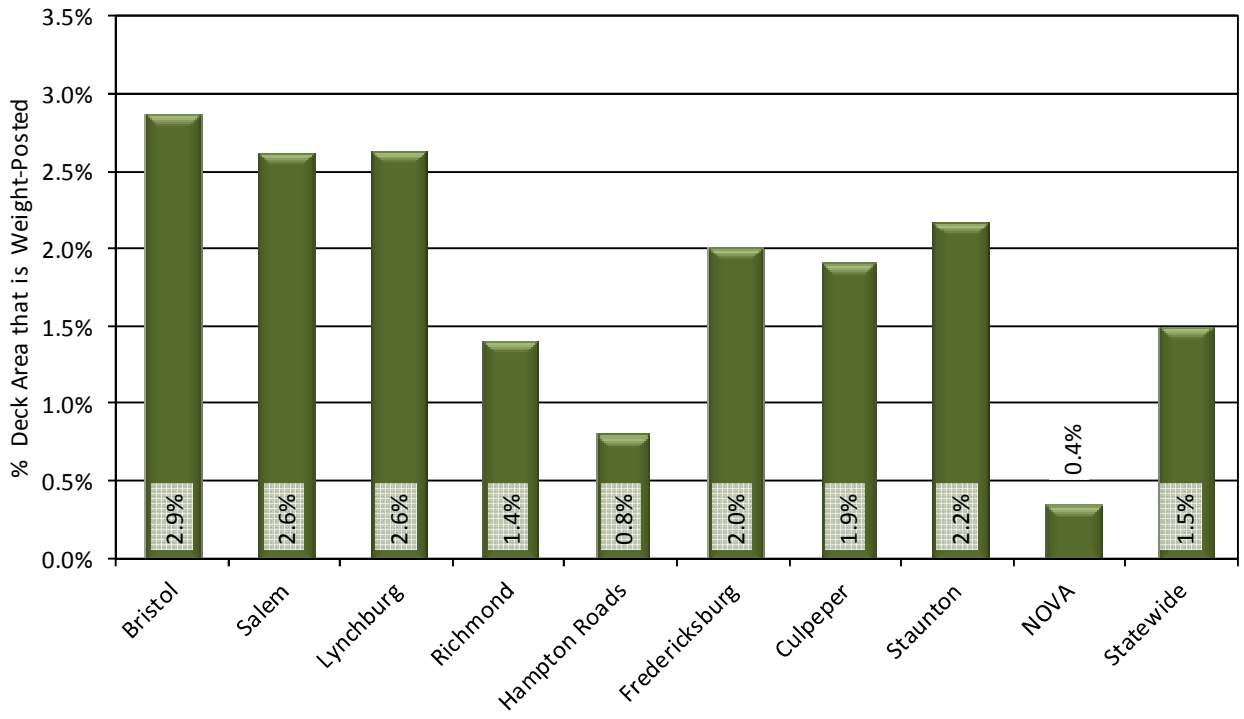
## Chart F.12 – Total Deck Area of Weight-Posted Structures by District



## Table F.13 – Percentage of Deck area that is Weight-Posted By District

| DISTRICT | Percent of Deck Area of Weight Posted Structures (Square Feet) | | | | |
|---|---|---|---|---|---|
| | Interstate | Primary | Secondary | Urban | Grand Total |
| Bristol | 0.0% | 1.4% | 6.1% | 19.8% | 2.9% |
| Salem | 0.0% | 0.3% | 7.9% | 1.1% | 2.6% |
| Lynchburg | 0.0% | 0.9% | 1.5% | 1.0% | 2.6% |
| Richmond | 0.0% | 1.2% | 4.3% | 1.9% | 1.4% |
| Hampton Roads | 0.0% | 0.5% | 5.6% | 1.1% | 0.8% |
| Fredericksburg | 0.0% | 1.2% | 2.6% | 0.0% | 2.0% |
| Culpeper | 0.0% | 1.0% | 3.8% | 5.6% | 1.9% |
| Staunton | 0.0% | 3.1% | 3.4% | 1.8% | 2.2% |
| NOVA | 0.0% | 0.4% | 0.4% | 0.1% | 0.4% |
| **Statewide** | **0.0%** | **1.9%** | **4.0%** | **2.1%** | **1.5%** |

## Chart F.13 – Percentage of Deck Area that is Weight-Posted per District



## APPENDIX G – INVENTORY CHANGES FROM PREVIOUS YEARS

Notes on Charts 13, D.2 – D.8, and E.1 – E.15: Some of the charts in the report provide multi-year trends for various performance measures. Inventory numbers provided in this report for the years 2007-2011 may vary from numbers provided in previous reports. This is due primarily to a change in the reporting period. Some previous reports were based on calendar year (January 1 through December 31) whereas more recent reports are based on the fiscal year (July 1 through June 30). This change was made to align the reporting period of the State of the Structures Report with the fiscal year and with reports developed by other divisions.

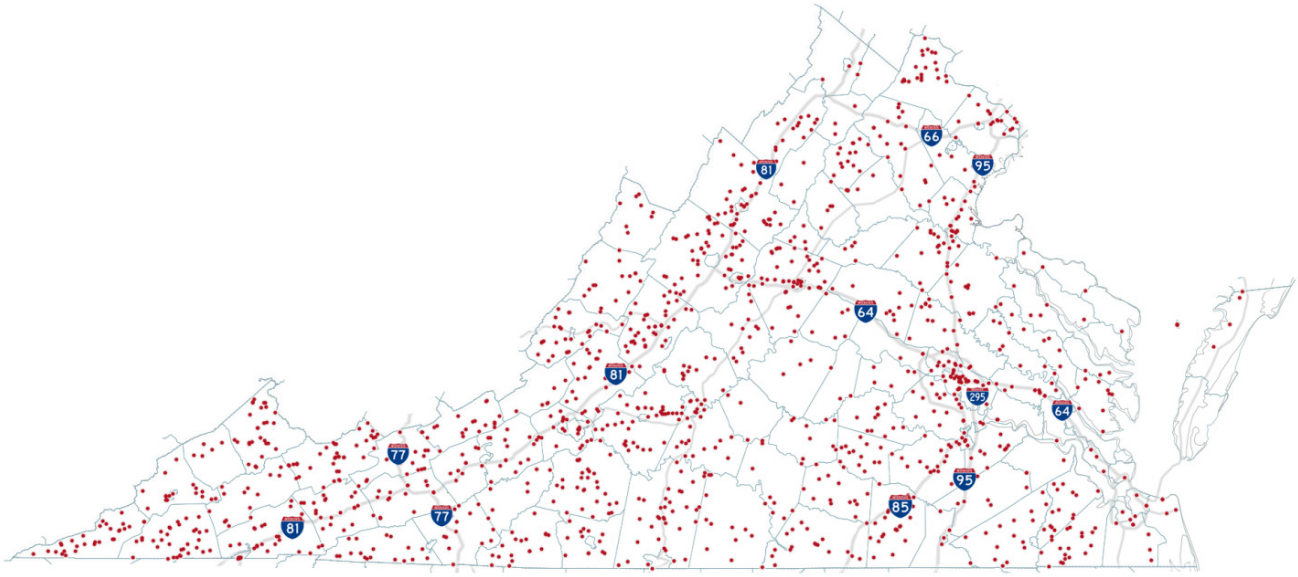
Other factors causing changes in inventory numbers for previous years between this report and previous reports include:

- Definition of Interstate Highway Bridges: From 2007 to 2009 Interstate overpasses were categorized as Interstate structures, and prior reports summarized the data accordingly. Values shown in this report for 2009 have been adjusted from those included in previous reports to reflect the removal of Interstate overpasses from the Interstate inventory. Values for 2007 and 2008 have not been adjusted due to a lack of sufficient data. Values for 2010 to the current report are based on the new criteria.
- Changes in bridge inventory: Until 2009, pedestrian and footbridge structures were included in the State of the Structures Report. They have not been included since the 2010 report. Pedestrian structures, when included, tend to provide misleading data regarding the number of SD and FO structures.
- Metropolitan Washington Airport Authority Structures are no longer reported as part of VDOT's inventory. This Authority owns these structures and reports directly to FHWA.
- In Fiscal Year 2012 VDOT added to its inventory 144 existing structures from Buchanan County in the Bristol District. Prior to FY2012 year these structures had not been included in VDOT's inventory. Buchanan County retains responsibility for these bridges.
- In Fiscal Year 2013 all the bridges that were added from Buchanan County in Bristol District had a change in the system type from Secondary to Urban, which is reflected in charts presented in the report.
- Since Fiscal Year 2013 VDOT has used both of the federal inventory fields, Year Built (F27) and Year Reconstructed (F106) to determine the actual age of the structure. Charts 4 to 6 reflect this change.
- In FY2014, VDOT transferred the ownership and maintenance responsibility for 15 railroad bridges to the Norfolk Southern (NS) Railway. As part of the agreement VDOT took over the ownership and maintenance responsibility of 31 highway bridges over railroad property from the NS Railway.

# APPENDIX H– LOCATIONS OF STRUCTURALLY DEFICIENT STRUCTURES

Statewide – Current Fiscal Year Structurally Deficient Structures

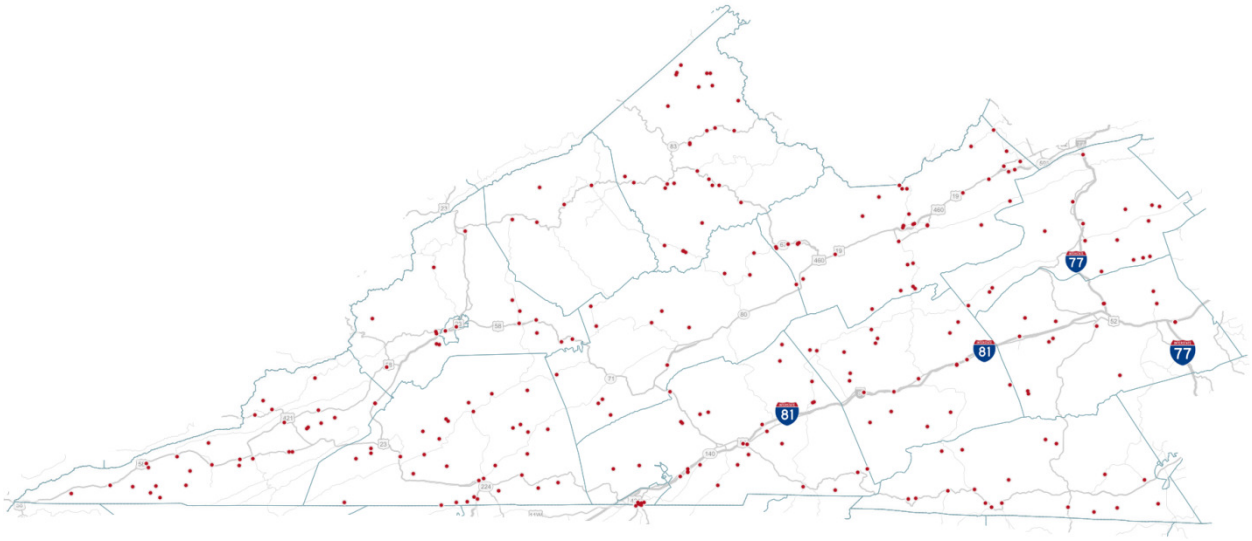
Total Number of Structures = 21,084
Number of SD structures = 1,310 (6.2%)
Total Square Foot Area of Structures = 118,432,003
Square Foot Area of SD Structures = 4,761,354 (4.0%)
Denotes SD Structure




STATEWIDE

Bristol District – Current Fiscal Year Structurally Deficient Structures

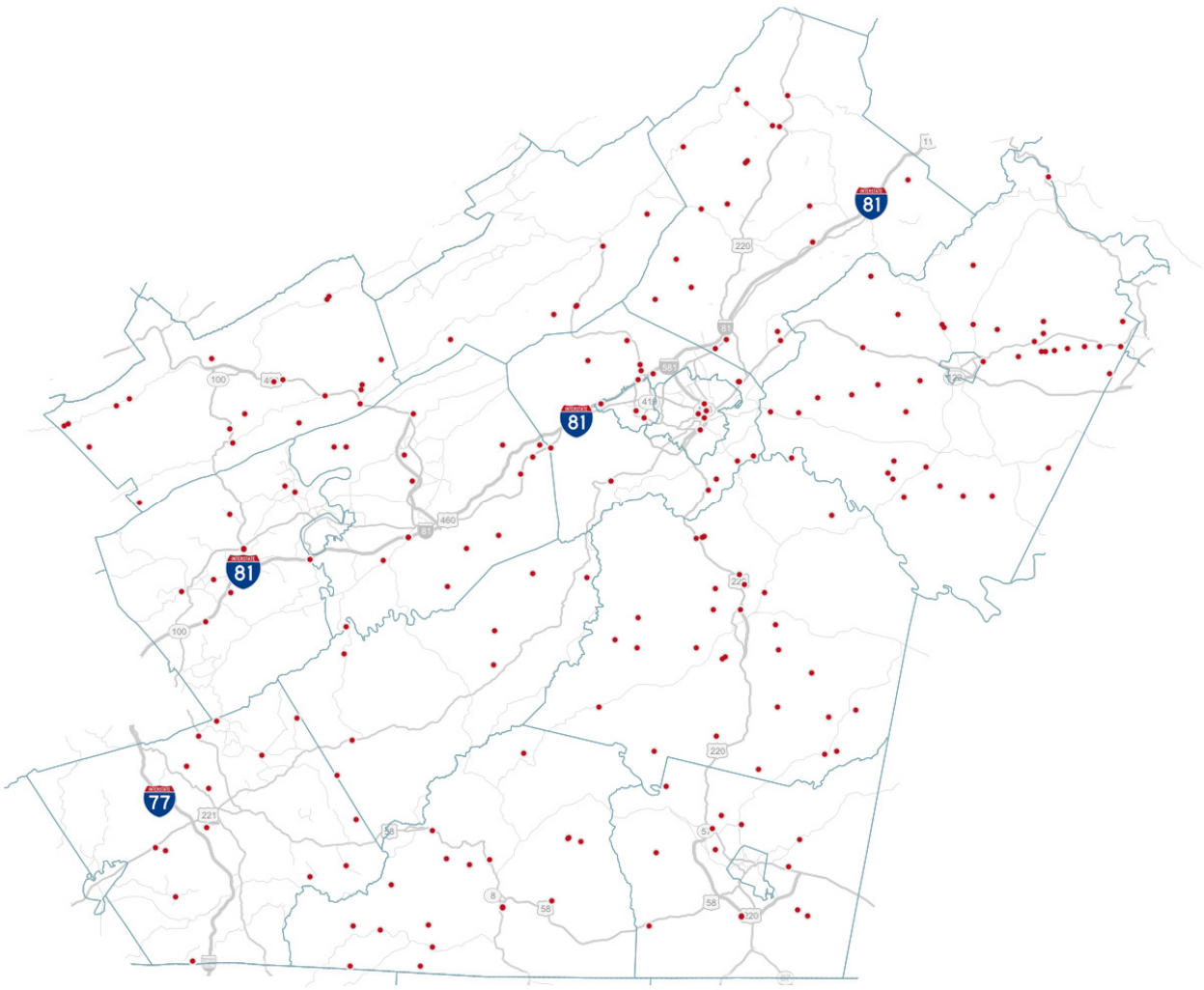
Number of SD structures = 268
Square Foot Area of SD Structures = 530,994
● Denotes SD Structure




BRISTOL

Salem District – Current Fiscal Year Structurally Deficient Structures

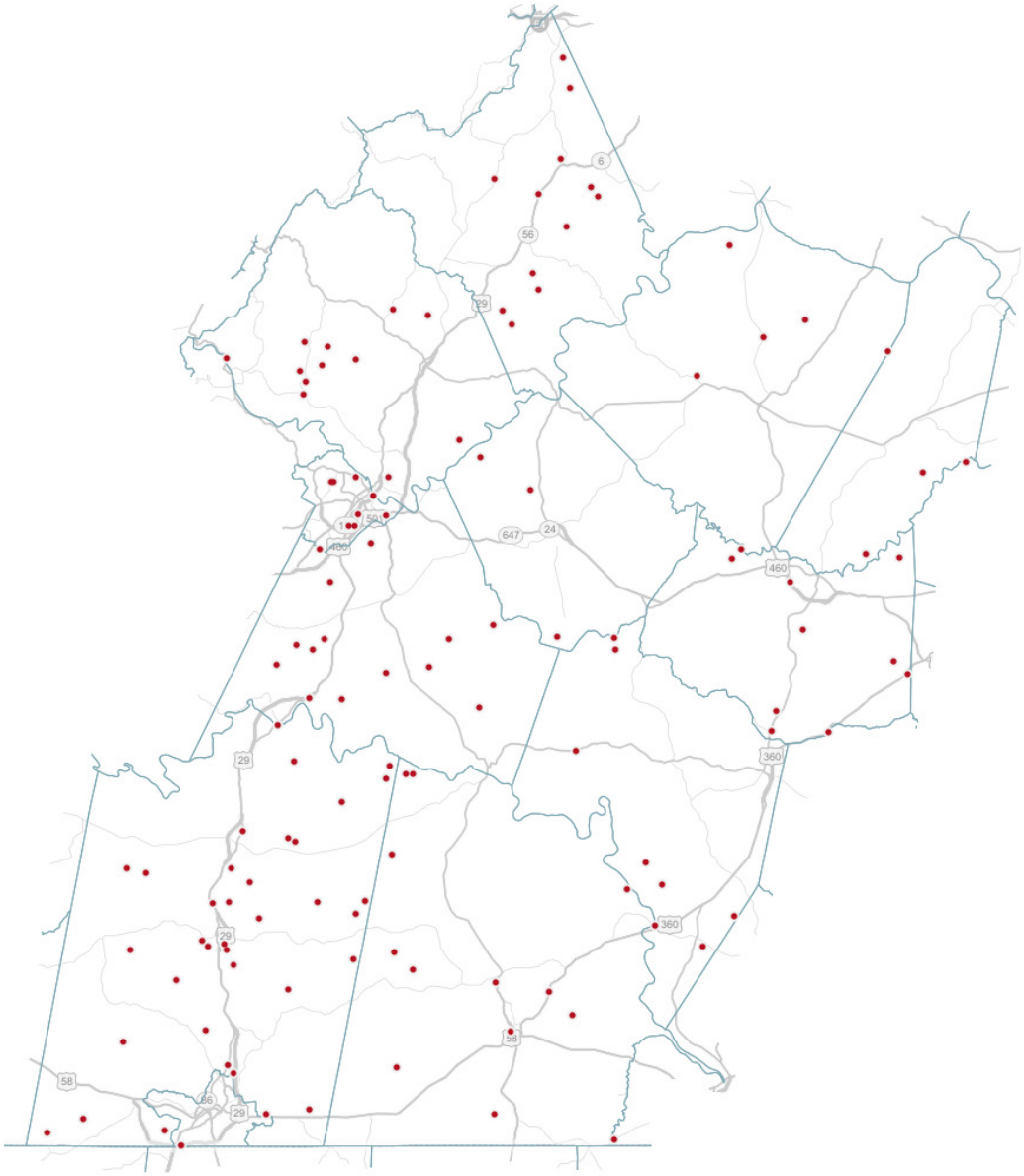
Number of SD structures = 206
Square Foot Area of SD Structures = 468,976
Denotes SD Structure




SALEM

Lynchburg District – Current Fiscal Year Structurally Deficient Structures

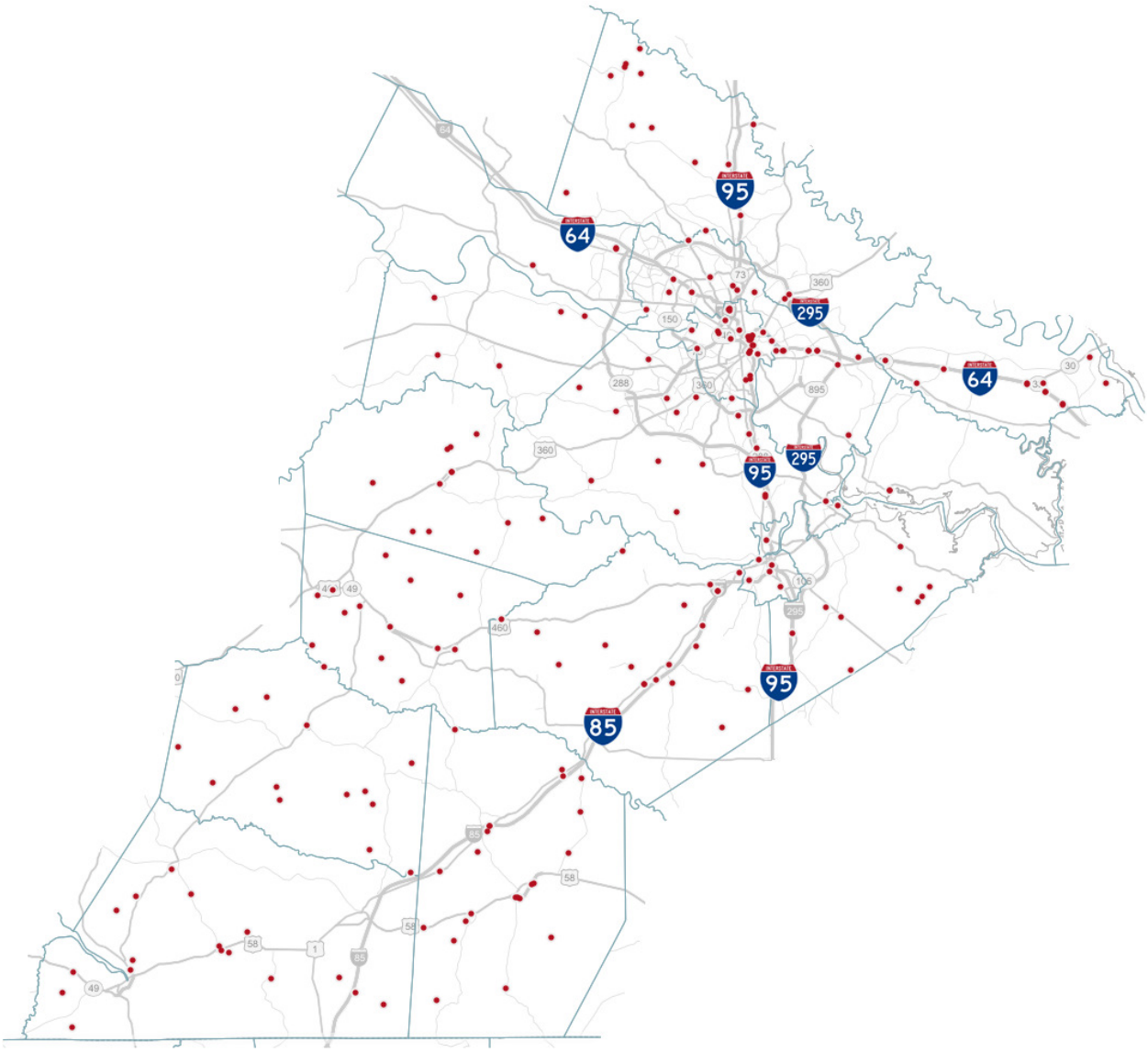
Number of SD structures = 121
Square Foot Area of SD Structures = 276,552
● Denotes SD Structure




LYNCHBURG

Richmond District – Current Fiscal Year Structurally Deficient Structures

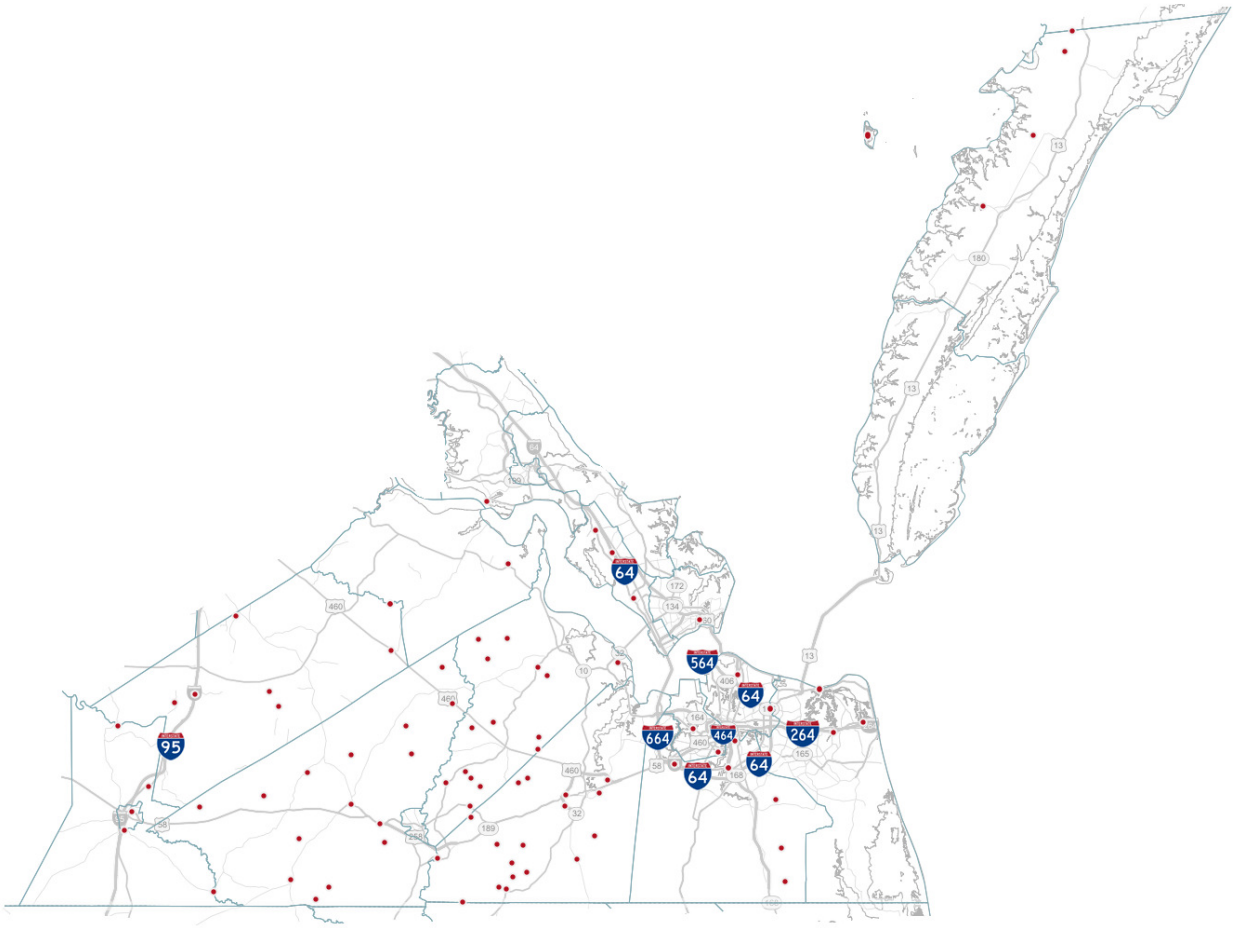
Number of SD structures = 211
Square Foot Area of SD Structures = 1,368,964
● Denotes SD Structure




RICHMOND

Hampton Roads District – Current Fiscal Year Structurally Deficient Structures

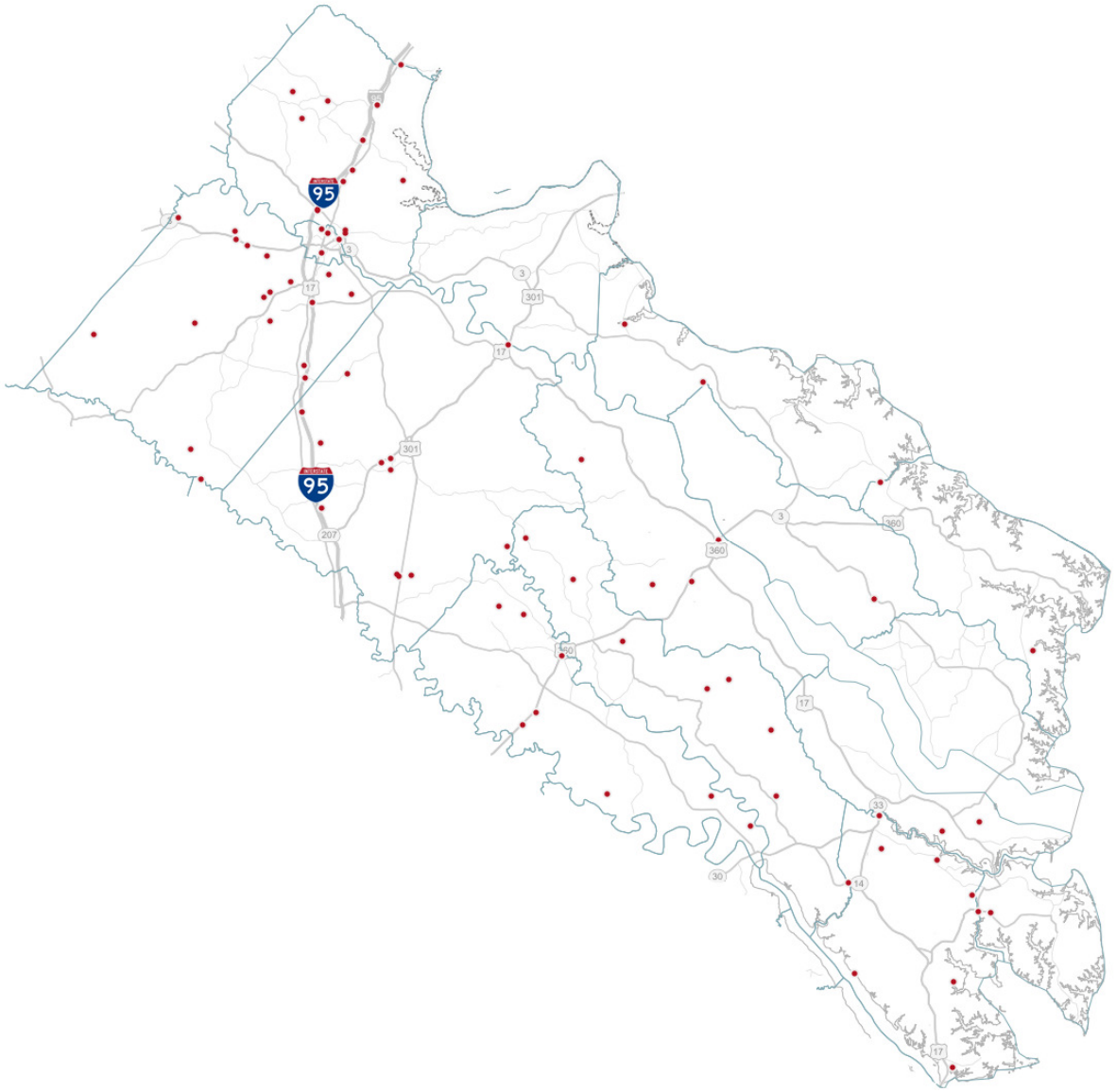
Number of SD structures = 85
Square Foot Area of SD Structures = 689,662
● Denotes SD Structure




HAMPTON ROADS

Fredericksburg District – Current Fiscal Year Structurally Deficient Structures

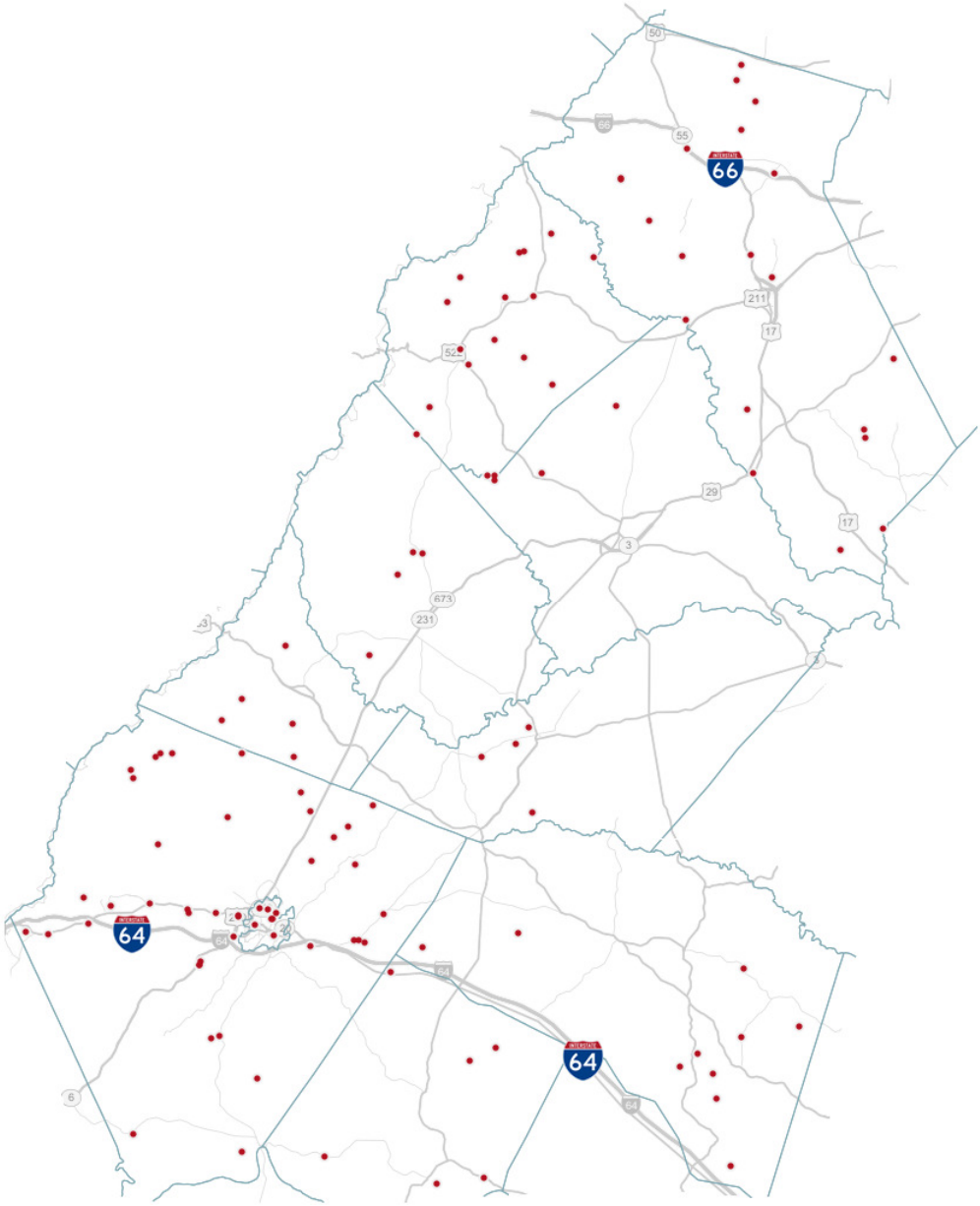
Number of SD structures = 74
Square Foot Area of SD Structures = 526,508
● Denotes SD Structure



FREDERICKSBURG

Culpeper District – Current Fiscal Year Structurally Deficient Structures

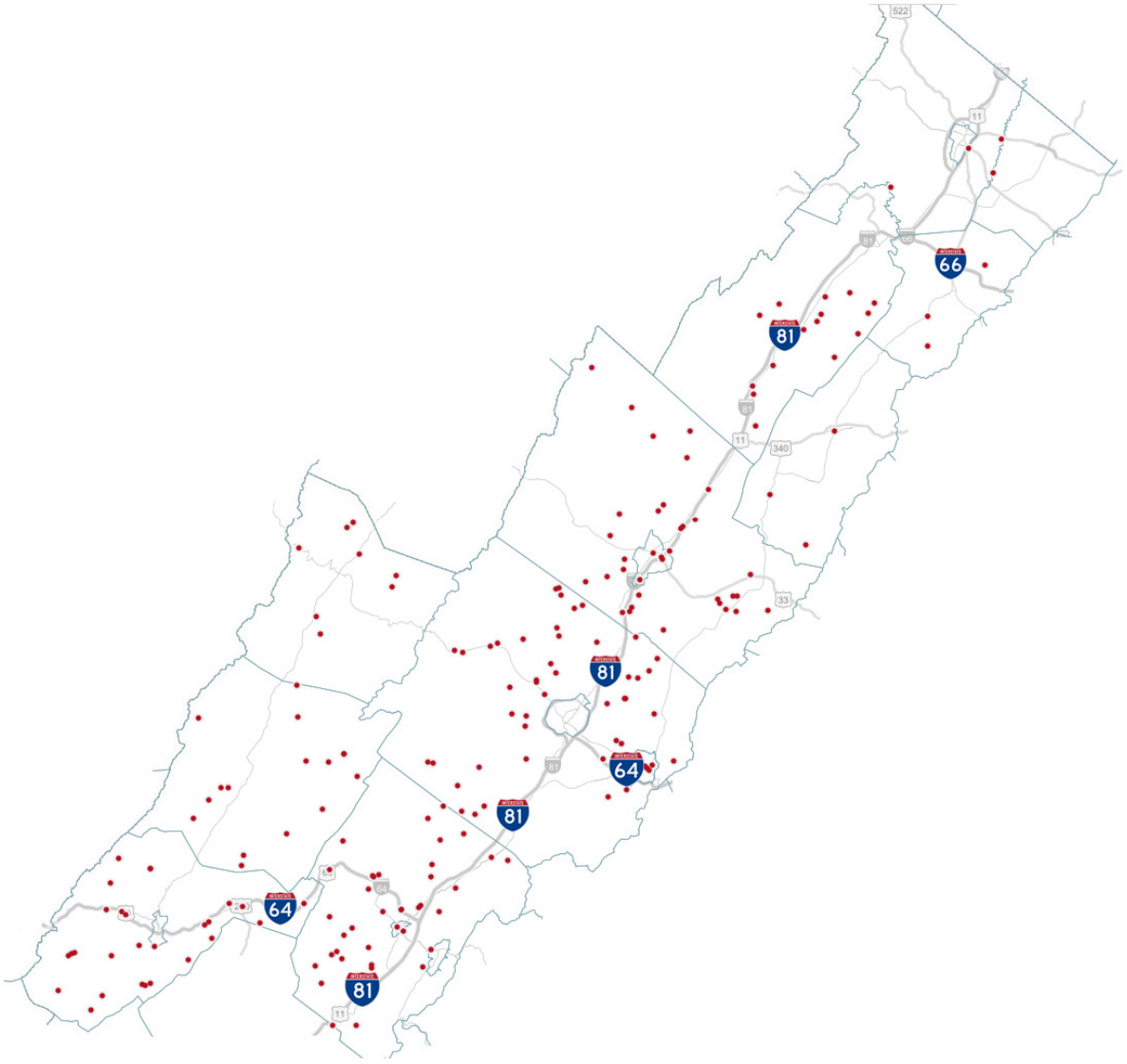
Number of SD structures = 108
Square Foot Area of SD Structures = 224,455
● Denotes SD Structure




CULPEPER

Staunton District – Current Fiscal Year Structurally Deficient Structures

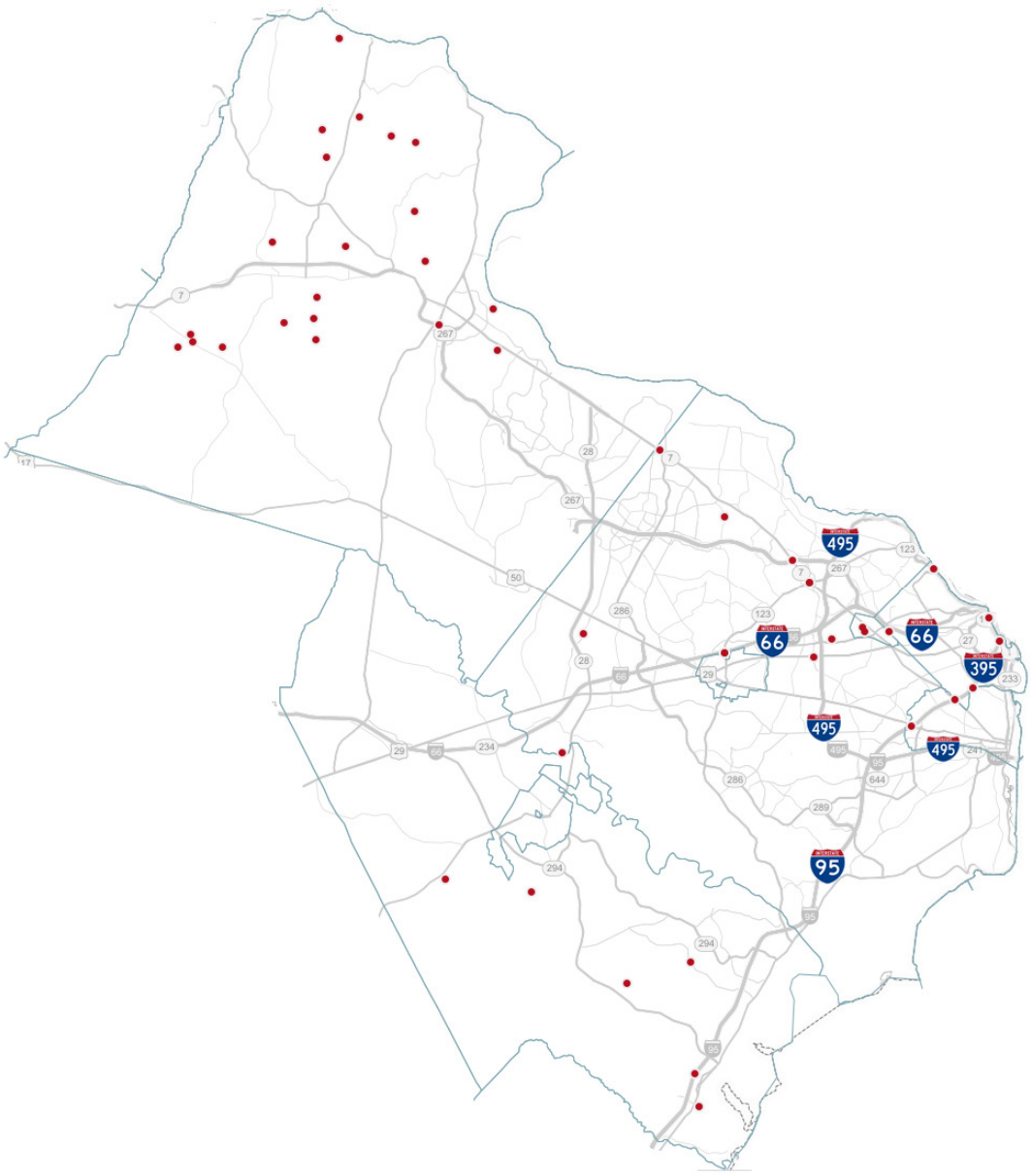
Number of SD structures = 193
Square Foot Area of SD Structures = 399,003
● Denotes SD Structure




STAUNTON

NOVA District – Current Fiscal Year Structurally Deficient Structures

Number of SD structures = 44
Square Foot Area of SD Structures = 276,240
● Denotes SD Structure




NOVA

## APPENDIX I – FUNCTIONALLY OBSOLETE CRITERIA

The table below provides visual examples of some of the criteria that cause a structure to be classified as Functionally Obsolete.

| Typical Examples of Functionally Obsolete Structures | |
|---|---|
| Appraisal Rating | Example |
| Deck Geometry<br>(No shoulder) |  |
| Water Adequacy<br>(Inadequate free board. Bridge is susceptible to overtopping and/or flooding) |  |
| Roadway Approach Alignment<br>(Sharp curve at the approach to the bridge requires substantial reduction in speed) |  |

| Typical Examples of Functionally Obsolete Structures | |
|---|---|
| Appraisal Rating | Example |
| Under Clearance<br>Vertical<br>(Inadequate under bridge vertical clearance) |  |
| Under Clearance<br>(Inadequate under bridge horizontal clearance) |  |
| Structural Adequacy<br>(Low bridge weight carrying capacity) |  |

## APPENDIX J – BRIDGE SAFETY INSPECTION QUALITY ASSURANCE PROGRAM

The structure (bridge and large culvert) safety inspection program provides the basis for most of the Commonwealth's maintenance and bridge management decisions. In Fiscal Year 2015, VDOT inspected 10,414 bridges/large culverts at an expense of $29.1 million utilizing in-house inspection staff and 16 consultant contracts. Also, VDOT inspected 2,533 ancillary structures at an expense of $5.4 million. There are a total of 16 consultant contracts as follows: 13 for bridge and large culvert Inspection; One (1) for ancillary structures inspection; One (1) of the statewide underwater inspection contract; and Three (3) contracts for load rating. Table J.1 shows VDOT's inspection practices for inspection frequency compared to the National Bridge Inspection Standards (NBIS) and includes the ancillary structures inspection requirements. Table J.2 shows the number of bridge, large culvert and ancillary structure inspections conducted by each District.

**Table J.1 – Inspection Practices**

| Standard | Inspection Frequency | |
|---|---|---|
| | NBIS | VDOT* |
| Bridges | 2 Year | 2 Year or 1 Year (SD or Posted) |
| Culverts | 2 Year | 2 Year (NBI) or 4 Year (Non-NBI) |
| Fracture Critical Structures | 2 Year | 1 Year |
| Fatigue Prone Details | 2 Year | 1 or 2 Year |
| Underwater | 5 Year | 5 Year |
| Sign Structures | No Requirement | 4 – 6 Year |
| Signal Structures | No Requirement | 4 – 6 Year |
| High Mast Lights Poles | No Requirement | 4 – 6 Year |
| Camera Poles | No Requirement | 10 Year |
| Luminaires | No Requirement | 10 Year |

*District Structure and Bridge Engineers may choose to inspect structures more frequently based on the conditions found during the inspections.

The accuracy, thoroughness and completeness of the bridge safety inspections are essential. The inspections are used to evaluate each structure's safety and are used for decisions on planning, budgeting, and performance of maintenance, repair, rehabilitation and replacement of our structures. Since 1991, it has been the policy of the Structure and Bridge Division (S&B) to provide rigorous quality control and quality assurance (QC/QA) of the structure safety inspection program. In January 2005, the National Bridge Inspection Standards (NBIS) portion of the Code of Federal Regulations was amended to require each state to "Assure systematic quality control and quality assurance procedures are used to maintain a high degree of accuracy and consistency in the inspection program. The QA program includes periodic field review of inspection teams, periodic bridge inspection refresher training for Program Managers and Team Leaders, and independent review of inspection reports and computations." The Structure and Bridge Division meets these NBIS requirements with its quality control and quality assurance programs.

**Table J.2 – Number of Inspection in 2015 Fiscal Year**

| District | Number of Inspections | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bridges | | Large Culverts | | Ancillary | | Total No. |
| | No. | Percent | No. | Percent | No. | Percent | Structures |
| Bristol | 1,338 | 18% | 333 | 11% | 4 | 0% | 1,675 |
| Salem | 1,168 | 16% | 439 | 15% | 38 | 1% | 1,645 |
| Lynchburg | 744 | 10% | 281 | 9% | 16 | 1% | 1,041 |
| Richmond | 828 | 11% | 416 | 14% | 349 | 14% | 1,593 |
| Hampton Roads | 656 | 9% | 168 | 6% | 16 | 1% | 840 |
| Fredericksburg | 252 | 3% | 196 | 7% | 293 | 11% | 741 |
| Culpeper | 560 | 8% | 259 | 9% | - | 0% | 819 |
| Staunton | 1,307 | 18% | 405 | 14% | 32 | 1% | 1,744 |
| NOVA | 598 | 8% | 466 | 16% | 1,825 | 71% | 2,889 |
| **Total** | **7,451** | **100%** | **2,963** | **100%** | **2,573** | **100%** | **12,987** |

In 2008, VDOT S&B developed Information and Instruction Memorandum (IIM) IIM-S&B-78, describing the bridge safety inspection QC/QA program which requires the following: In accordance with the NBIS, Program Managers and Team Leaders must successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course; within VDOT, all bridge safety inspection personnel will successfully complete the National Highway Institute (NHI) course 'Safety Inspection of In-Service Bridges' (FHWA-NHI-130055) within the first five years of employment in bridge inspection; VDOT S&B also requires inspection personnel successfully complete the NHI course 'Bridge Inspection Refresher Training' every three (3) years; underwater inspectors are required to fulfill the training requirements as set forth in the NBIS and the VDOT 'Dive Safety Manual'.

Both the Central Office and the Districts have a responsibility to review and validate inspection reports and inventory data. Discrepancies found during the field and office reviews performed by the both District and Central Office personnel are documented in a written report and shared with all parties involved. The Central Office conducted an annual QA review of all nine (9) district bridge inspection programs. Review of load ratings for a sample of bridges was a key component of the QA reviews. In addition, underwater inspection QA/QC field reviews are scheduled by the Central Office Underwater Inspection Engineer. Underwater inspection QA/QC was performed on 16 structures.

The Federal Highway Administration (FHWA) conducted an annual NBIS Compliance Review from April 1, 2014 to March 30, 2015 with a draft report provided on December 31, 2014. The Department had 45 days to address any deficiencies that were identified. The review consisted of a review of the statewide inventory/database/organization/procedures for structure (bridge and large culvert) safety inspections and a QA review of a sample of structure records and structure field reviews of the Salem and Culpeper Districts. The review found VDOT to be in compliance with 22 of the 23 NBIS metrics and substantial compliance for the remaining 1 of the 23 NBIS. The Department is establishing a QA/QC program for ancillary structures similar to the one currently in place for structure (bridge and large culvert) inspections.

## APPENDIX K – ANCILLARY STRUCTURES CONDITION RATINGS

General Condition Ratings are assigned by the structure inspection team after each ancillary structure inspection. These ratings are included in each inspection report and are used to describe the current physical state of the structure. Evaluation is based on the physical condition of the structure at the time of inspection. Separate GCR values are assigned to the foundation, bridge parapet mounting and superstructure components of the ancillary structure. The GCRs are assigned based on a numerical grading system that ranges from 0 (failed condition) to 9 (excellent condition). The table below provides a description of the general condition ratings for ancillary structures. The tables in the following pages provide illustrative examples of some of these ratings.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Failed | Imminent Failure | Critical | Serious | Poor | Fair | Satisfactory | Good | Very Good | Excellent |

**Ancillary Structure Condition Rating Table**

| Code | Description |
|---|---|
| 9 | **EXCELLENT CONDITION** |
| 8 | **VERY GOOD CONDITION**<br>No problems noted. |
| 7 | **GOOD CONDITION**<br>Some minor problems. |
| 6 | **SATISFACTORY CONDITION**<br>Structural components show some minor deterioration. |
| 5 | **FAIR CONDITION**<br>All primary structural elements are sound but may have some minor section loss, cracking, spalling. |
| 4 | **POOR CONDITION**<br>Advanced section loss, deterioration, spalling. |
| 3 | **SERIOUS CONDITION**<br>Loss of section, deterioration, spalling have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel may be present. |
| 2 | **CRITICAL CONDITION**<br>Advanced deterioration of primary structural elements. Fatigue cracks in steel may be present. Unless closely monitored it may be necessary to remove the structure. |
| 1 | **"IMMINENT" FAILURE CONDITION**<br>Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. The structure should be removed. |
| 0 | **FAILED CONDITION**<br>Out of service - beyond corrective action. |

## Examples of Foundations that are in Fair to Poor Condition

Rusted anchor bolts and missing nut

Leveling nut is loose and gap is too high

Loose anchor bolt with 1” gap between nut and base plate

Deteriorated and cracked grout

Deteriorated grout pad and cracked pedestal

Severely corroded anchor bolts exposed when grout has fallen away

## Examples of Foundations that are in Fair to Poor Condition

Corrosion with 1/8" deep pitting on breakaway couplers


Loose anchor bolt nut at luminaire base

## Examples of Bridge Parapet Mountings that are in Fair to Poor Condition

Failed mounting bolt (circled)

Twisted anchor clamp over the parapet

Failed bolt (circled) at parapet mount.

Two failed bolts (circled) at parapet mount

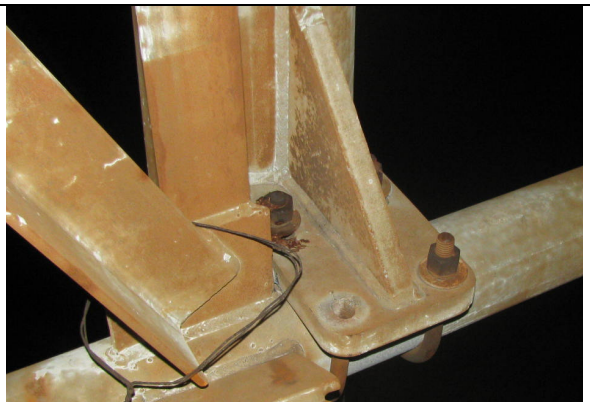
## Examples of Superstructure Elements that are in Fair to Poor Condition

Loose Bolt at splice plate.

Poor vertical hanger connection with the Z-bar

Damaged & bent flange of vertical hanger

Column torn and bent 3" at point of impact



U-bolt sheared at left front pole to bottom chord Connection

1-1/4" long vertical crack in pole along toe of weld at the bottom chord

## Examples of Superstructure Elements that are in Fair to Poor Condition

Section loss to the bottom of the pole.

4" vertical crack at the slip joint

1 1/2" gap between upper chord and connection strap

Missing bolt at wind beam to vertical hanger connection


6" crack in lower chord of luminaire

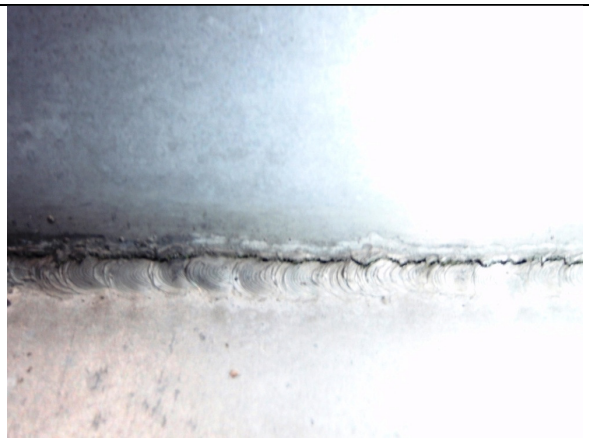
Two of four bolts loose in top chord connection to luminaire pole

## Examples of Superstructure Elements that are in Fair to Poor Condition


Lower arm of luminaire chord has a 3.5" fatigue crack in weld at connection to pole

Weld around upper chord to mounting plate connection 50% complete

Fracture in weld of lower arm tube to luminaire pole connection



Crack in luminaire bracket saddle to connection plate weld

Crack in orbital bracket of 2nd signal from right pole

Nut on strap bolt for signal from pole lacks 50% thread contact

Tables K.1a through K.3d give a summary of the current condition of the ancillary structures by structure type and the primary components or areas of the structure with average GCR.

### Table K.1a – Sign Structures by General Condition Rating*

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | | | | | | | | Average General Condition Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Good | | | | Fair | Poor | | | | | |
| | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Foundation | Cantilever | 56 | 100 | 475 | 315 | 318 | 78 | 72 | 32 | 1 | 43 | 5.84 |
| | Overhead | 43 | 129 | 425 | 343 | 328 | 110 | 101 | 19 | 0 | 3 | 5.91 |
| | Butterfly | 8 | 37 | 61 | 8 | 26 | 1 | 1 | 1 | 0 | 0 | 6.87 |
| | **Total** | **107** | **266** | **961** | **666** | **672** | **189** | **174** | **52** | **1** | **46** | **5.92** |
| Parapet | Parapet Mount | 1 | 18 | 145 | 159 | 65 | 19 | 10 | 0 | 0 | 5 | 6.05 |
| | **Total** | **1** | **18** | **145** | **159** | **65** | **19** | **10** | **0** | **0** | **5** | **6.05** |
| Superstructure | Cantilever | 60 | 127 | 642 | 338 | 226 | 33 | 14 | 43 | 7 | 0 | 6.36 |
| | Overhead | 57 | 145 | 593 | 378 | 229 | 50 | 44 | 3 | 2 | 0 | 6.38 |
| | Butterfly | 9 | 35 | 69 | 20 | 8 | 2 | 0 | 0 | 0 | 0 | 7.08 |
| | **Total** | **126** | **307** | **1,304** | **736** | **463** | **85** | **58** | **46** | **9** | **0** | **6.40** |

*A parapet mount structure has only one primary component rating at the parapet, while other types of sign structures have component ratings at foundation and superstructure. Signal structures have component ratings either at parapet or foundation and superstructure. High mast light and camera poles have both foundation and superstructure component ratings.

### Table K.1b – Luminaire Structures by General Condition Rating

| Location on Structure | # of Elements with General Condition Rating Indicated | | | | | | | | | | Average General Condition Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Good | | | | Fair | Poor | | | | | |
| | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| **Foundation** | 365 | 4,118 | 2,168 | 915 | 4,145 | 232 | 3,189 | 464 | 5 | 117 | 5.67 |
| **Parapet** | 32 | 347 | 417 | 285 | 830 | 56 | 758 | 30 | 2 | 7 | 5.21 |
| **Superstructure** | 416 | 3,997 | 5,209 | 1,404 | 3,156 | 229 | 1,120 | 53 | 5 | 129 | 6.41 |

## Table K.1c – Signal Structures by General Condition Rating

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | | | | | | | | Average General Condition Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Good | | | | Fair | Poor | | | | | |
| | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Foundation | Cantilever | 972 | 1,095 | 702 | 1,033 | 2,674 | 259 | 475 | 164 | 0 | 7 | 6.07 |
| | Span Wire | 27 | 72 | 70 | 235 | 1,062 | 88 | 98 | 81 | 0 | 9 | 5.07 |
| | Overhead | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5.00 |
| | **Total** | **999** | **1,167** | **772** | **1,268** | **3,737** | **347** | **573** | **245** | **0** | **16** | **5.88** |
| Parapet | Parapet Mount | 1 | 1 | 2 | 0 | 7 | 1 | 1 | 2 | 0 | 0 | 5.13 |
| | **Total** | **1** | **1** | **2** | **0** | **7** | **1** | **1** | **2** | **0** | **0** | **5.13** |
| Superstructure | Cantilever | 1,001 | 1,470 | 2,161 | 1,180 | 678 | 155 | 454 | 275 | 0 | 7 | 6.62 |
| | Span Wire | 28 | 85 | 469 | 357 | 304 | 194 | 125 | 180 | 0 | 0 | 5.39 |
| | Parapet Mount | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0.00 |
| | Overhead | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3.00 |
| | **Total** | **1,029** | **1,555** | **2,630** | **1,537** | **982** | **349** | **580** | **455** | **0** | **22** | **6.39** |

## Table K.1d – High Mast Light and Camera Pole by General Condition Rating

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | | | | | | | | Average General Condition Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Good | | | | Fair | Poor | | | | | |
| | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Foundation | High Mast | 1 | 81 | 274 | 178 | 75 | 50 | 10 | 20 | 0 | 0 | 6.22 |
| | Camera Pole | 0 | 14 | 335 | 59 | 19 | 4 | 0 | 1 | 0 | 0 | 6.77 |
| | **Total** | **1** | **95** | **609** | **237** | **94** | **54** | **10** | **21** | **0** | **0** | **6.43** |
| Parapet | High Mast | 0 | 99 | 429 | 30 | 127 | 3 | 1 | 0 | 0 | 0 | 6.71 |
| | Camera Pole | 2 | 13 | 356 | 48 | 8 | 1 | 0 | 0 | 0 | 4 | 6.82 |
| | **Total** | **2** | **112** | **785** | **78** | **135** | **4** | **1** | **0** | **0** | **4** | **6.75** |

Summaries of this analysis for the four general type structures are provided in Tables K.2a through K.2e and Charts K.1a through K.1g. Charts K.1a through K.1d present the minimum general condition rating by structure type and GCR percentages. In order to present meaningful graphs with appropriate vertical scales, Charts K.1e through K.1g provide separate displays for Districts with large inventories and those with smaller inventories.

**Table K.2a – Sign Structures by General Condition Category**

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | Total | % General Condition Rating Indicated | | |
|---|---|---|---|---|---|---|---|---|
| | | Good | Fair | Poor | | Good | Fair | Poor |
| Foundation | Cantilever | 946 | 318 | 226 | 1,490 | 63.5% | 21.3% | 15.2% |
| | Overhead | 940 | 328 | 233 | 1,501 | 62.6% | 21.9% | 15.5% |
| | Butterfly | 114 | 26 | 3 | 143 | 79.7% | 18.2% | 2.1% |
| | **Total** | **2,000** | **672** | **462** | **3,134** | **63.8%** | **21.4%** | **14.7%** |
| Parapet | Parapet Mount | 323 | 65 | 34 | 422 | 76.5% | 15.4% | 8.1% |
| | **Total** | **323** | **65** | **34** | **422** | **76.5%** | **15.4%** | **8.1%** |
| Superstructure | Cantilever | 1,167 | 226 | 97 | 1,490 | 78.3% | 15.2% | 6.5% |
| | Overhead | 1,173 | 229 | 99 | 1,501 | 78.1% | 15.3% | 6.6% |
| | Butterfly | 133 | 8 | 2 | 143 | 93.0% | 5.6% | 1.4% |
| | **Total** | **2,473** | **463** | **198** | **3,134** | **78.9%** | **14.8%** | **6.3%** |

**Table K.2b – Luminaire Structures by General Condition Category**

| Location on Structure | # of Elements with General Condition Rating Indicated | | | Total | % of Elements with General Condition Rating Indicated | | |
|---|---|---|---|---|---|---|---|
| | Good | Fair | Poor | | Good | Fair | Poor |
| **Foundation** | 7,566 | 4,145 | 4,007 | 15,718 | 48.1% | 26.4% | 25.5% |
| **Parapet** | 1,081 | 830 | 853 | 2,764 | 39.1% | 30.0% | 30.9% |
| **Superstructure** | 11,026 | 3,156 | 1,536 | 15,718 | 70.1% | 20.1% | 9.8% |

**Table K.2c – Signal Structures by General Condition Category**

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | Total | # of Elements with General Condition Rating Indicated | | |
|---|---|---|---|---|---|---|---|---|
| | | Good | Fair | Poor | | Good | Fair | Poor |
| Foundation | Cantilever | 3,802 | 2,674 | 905 | 7,381 | 51.5% | 36.2% | 12.3% |
| | Span Wire | 404 | 1,062 | 276 | 1,742 | 23.2% | 61.0% | 15.8% |
| | Over Head | 0 | 1 | 0 | 1 | 0.0% | 100.0% | 0.0% |
| | **Total** | **4,206** | **3,737** | **1,181** | **9,124** | **46.1%** | **41.0%** | **12.9%** |
| Parapet | Parapet Mount | 4 | 7 | 4 | 15 | 26.7% | 46.7% | 26.7% |
| | **Total** | **4** | **7** | **4** | **15** | **26.7%** | **46.7%** | **26.7%** |
| Superstructure | Cantilever | 5,812 | 678 | 891 | 7,381 | 78.7% | 9.2% | 12.1% |
| | Span Wire | 939 | 304 | 499 | 1,742 | 53.9% | 17.5% | 28.6% |
| | Parapet Mount | 0 | 0 | 15 | 15 | 0.0% | 0.0% | 100.0% |
| | Over Head | 0 | 0 | 1 | 1 | 0.0% | 0.0% | 100.0% |
| | **Total** | **6,751** | **982** | **1,406** | **9,139** | **73.9%** | **10.7%** | **15.4%** |

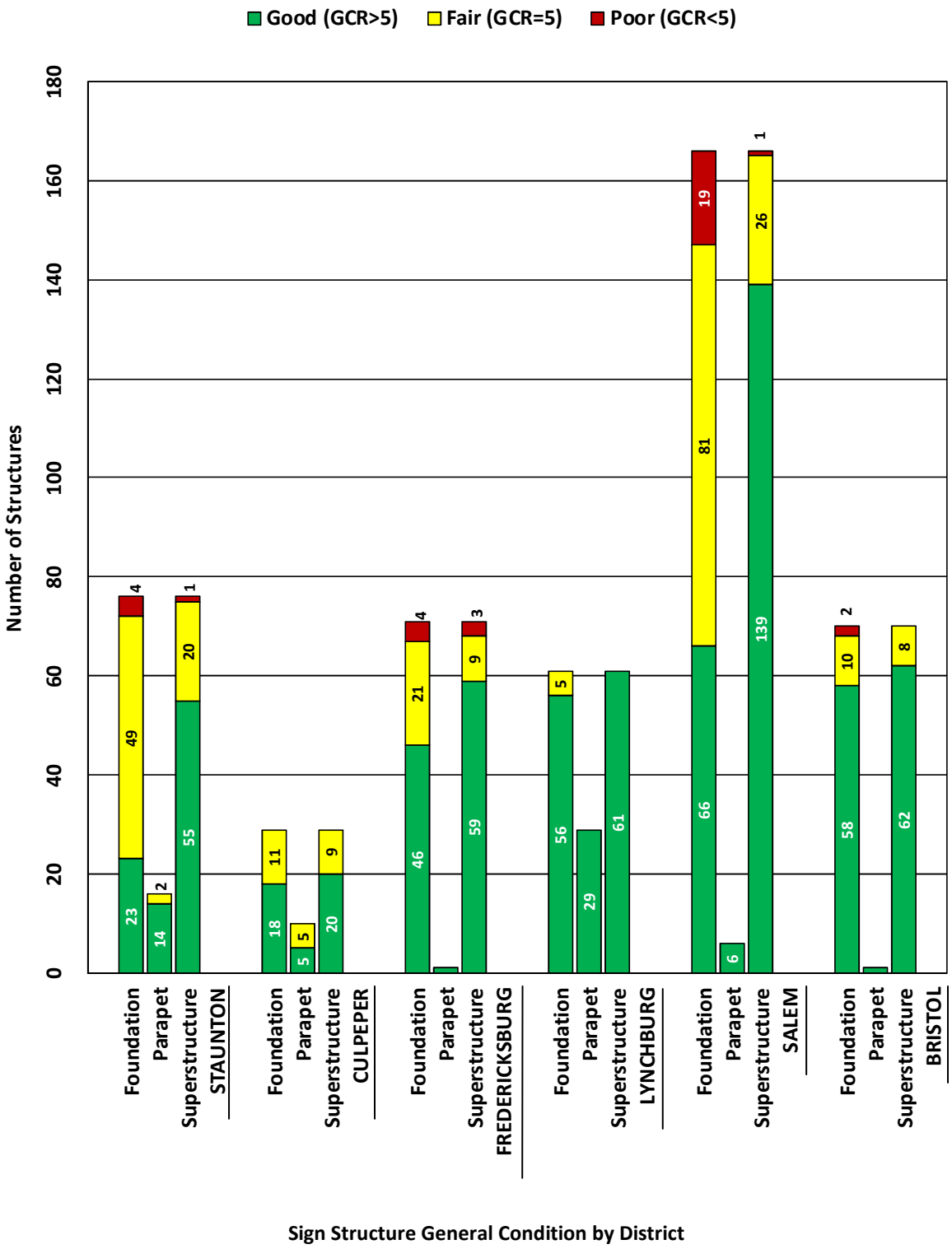
**Table K.2d – High Mast Light & Camera Pole Structures by General Condition Category**

| Location on Structure | Structure Type | # of Elements with General Condition Rating Indicated | | | Total | # of Elements with General Condition Rating Indicated | | |
|---|---|---|---|---|---|---|---|---|
| | | Good | Fair | Poor | | Good | Fair | Poor |
| Foundation | High Mast | 534 | 75 | 80 | 689 | 77.5% | 10.9% | 11.6% |
| | Camera Pole | 408 | 19 | 5 | 432 | 94.4% | 4.4% | 1.2% |
| | **Total** | **942** | **94** | **85** | **1,121** | **84.0%** | **8.4%** | **7.6%** |
| Superstructure | High Mast | 558 | 127 | 4 | 689 | 81.0% | 18.4% | 0.6% |
| | Camera Pole | 419 | 8 | 5 | 432 | 97.0% | 1.9% | 1.2% |
| | **Total** | **977** | **135** | **9** | **1,121** | **87.2%** | **12.0%** | **0.8%** |

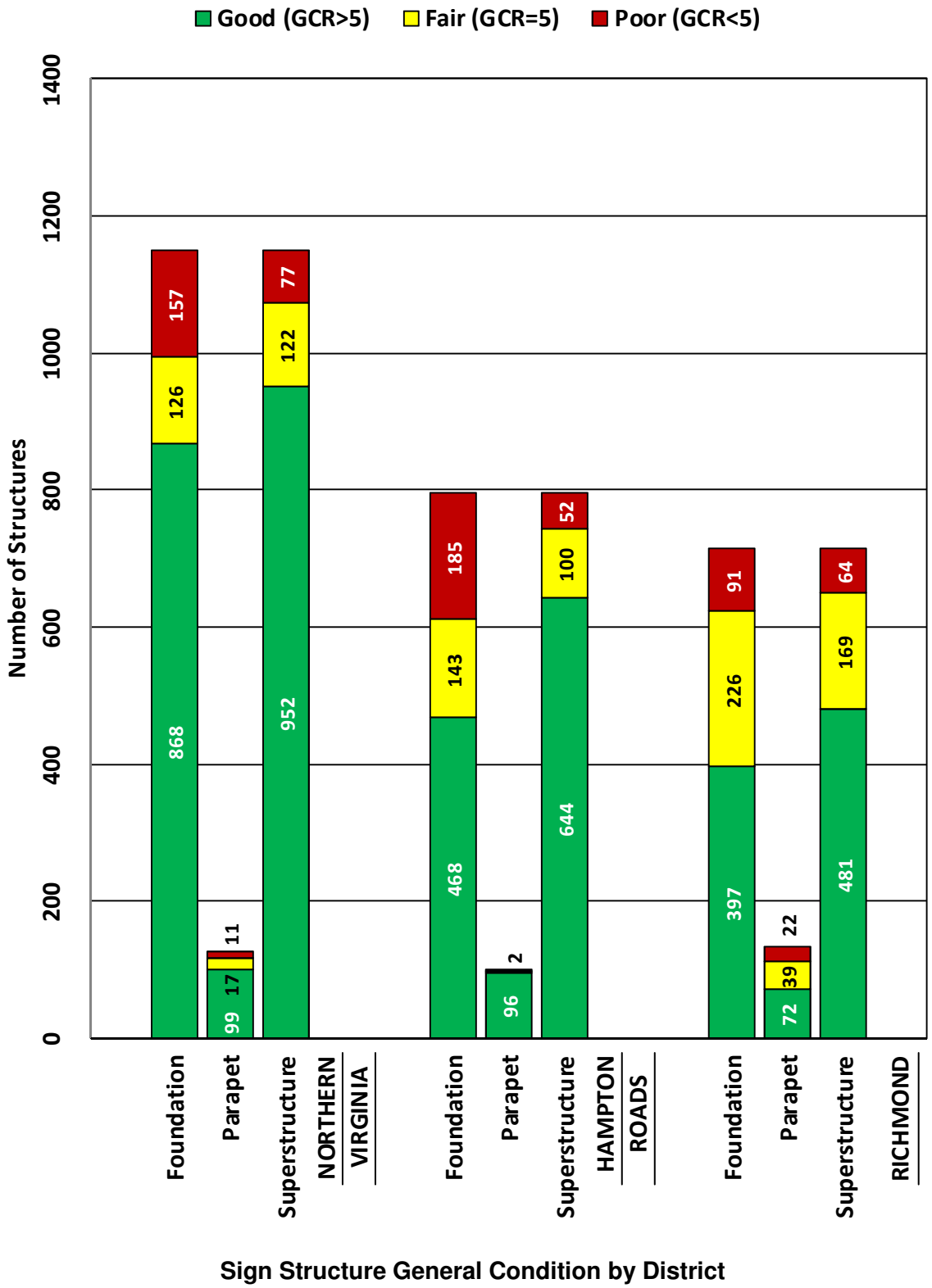
**Table K.2e – Minimum General Condition by Structure Type**

| Structure Type | Condition Categories (No. of Structures) | | | Minimum General Condition Rating (Percentage) | | |
|---|---|---|---|---|---|---|
| | Good | Fair | Poor | Good | Fair | Poor |
| Signs | 2,139 | 825 | 592 | 60.2% | 23.2% | 16.6% |
| Signals | 3,568 | 3,262 | 2,313 | 39.0% | 35.7% | 25.3% |
| High Mast Lights and Camera Poles | 853 | 177 | 91 | 76.1% | 15.8% | 8.1% |
| Luminaires | 6,582 | 6,083 | 5,817 | 35.6% | 32.9% | 31.5% |
| **Total** | **13,142** | **10,347** | **8,813** | **40.7%** | **32.0%** | **27.3%** |

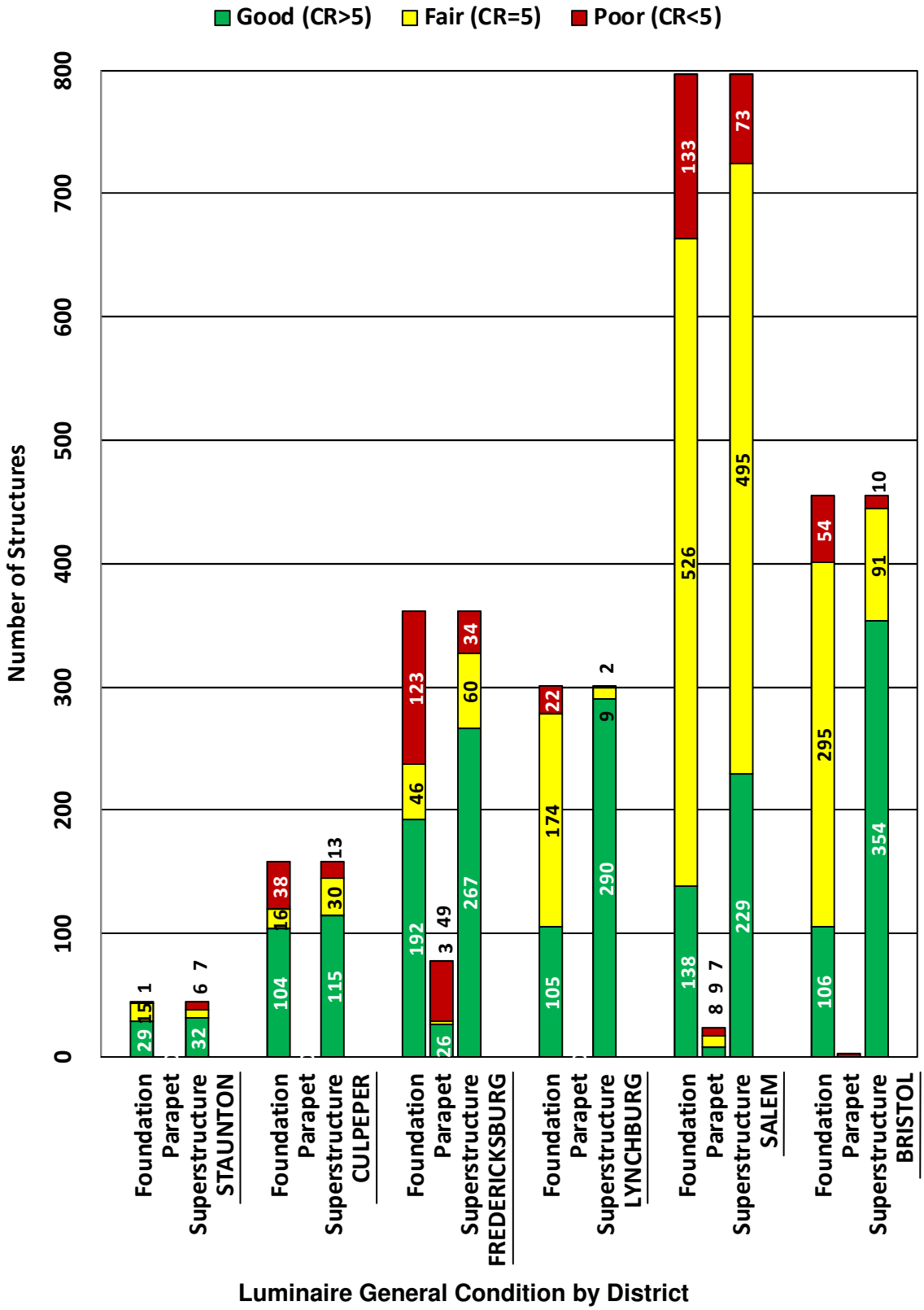
## Chart K.1a – General Condition of Sign Structures – Small Inventory Districts



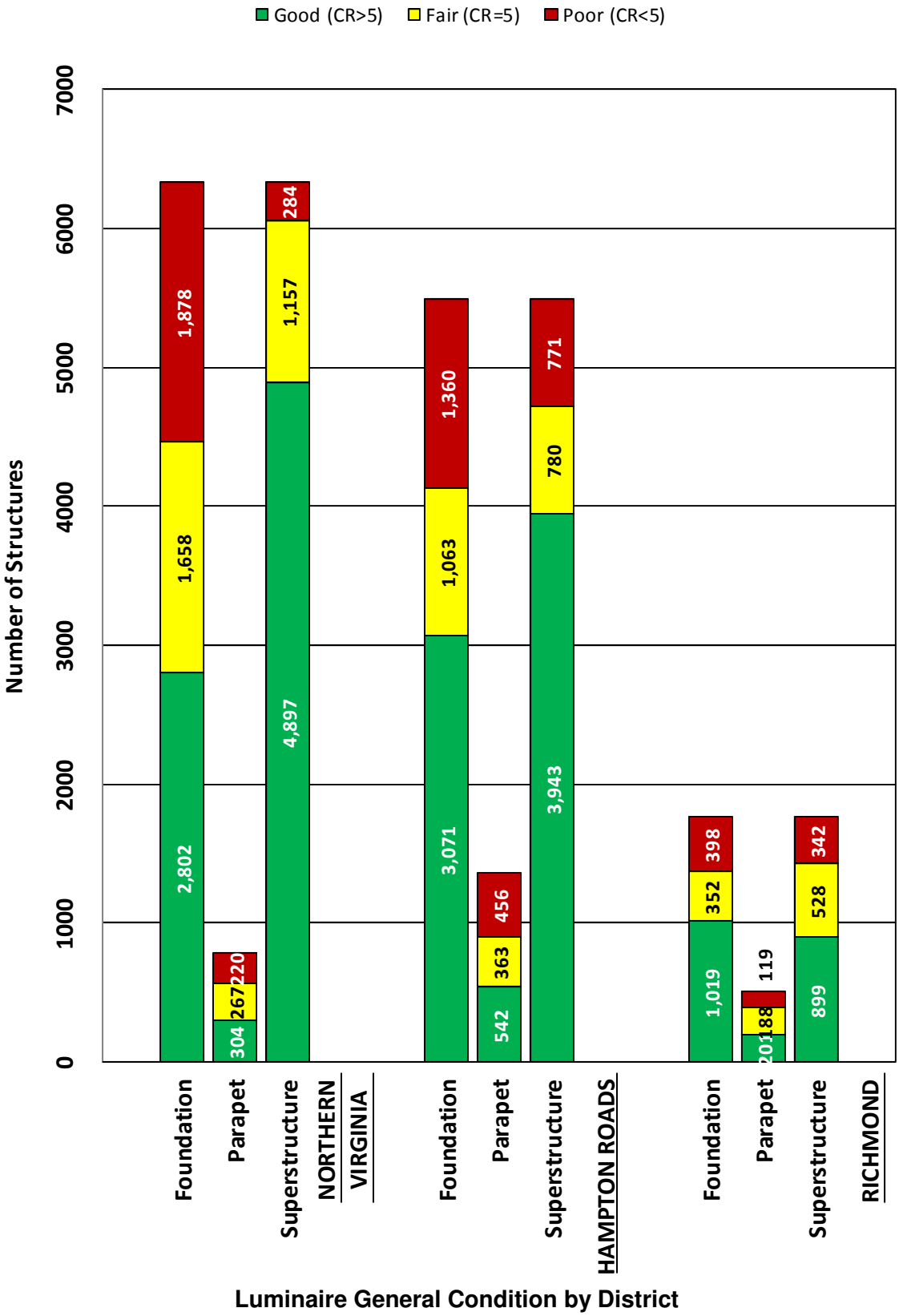
## Chart K.1b – General Condition of Sign Structures – Large Inventory Districts



## Chart K.1c – General Condition of Luminaires – Small Inventory Districts



## Chart K.1d – General Condition of Luminaires – Large Inventory Districts



## Chart K.1e – General Condition of Signal Structures – Small Inventory Districts

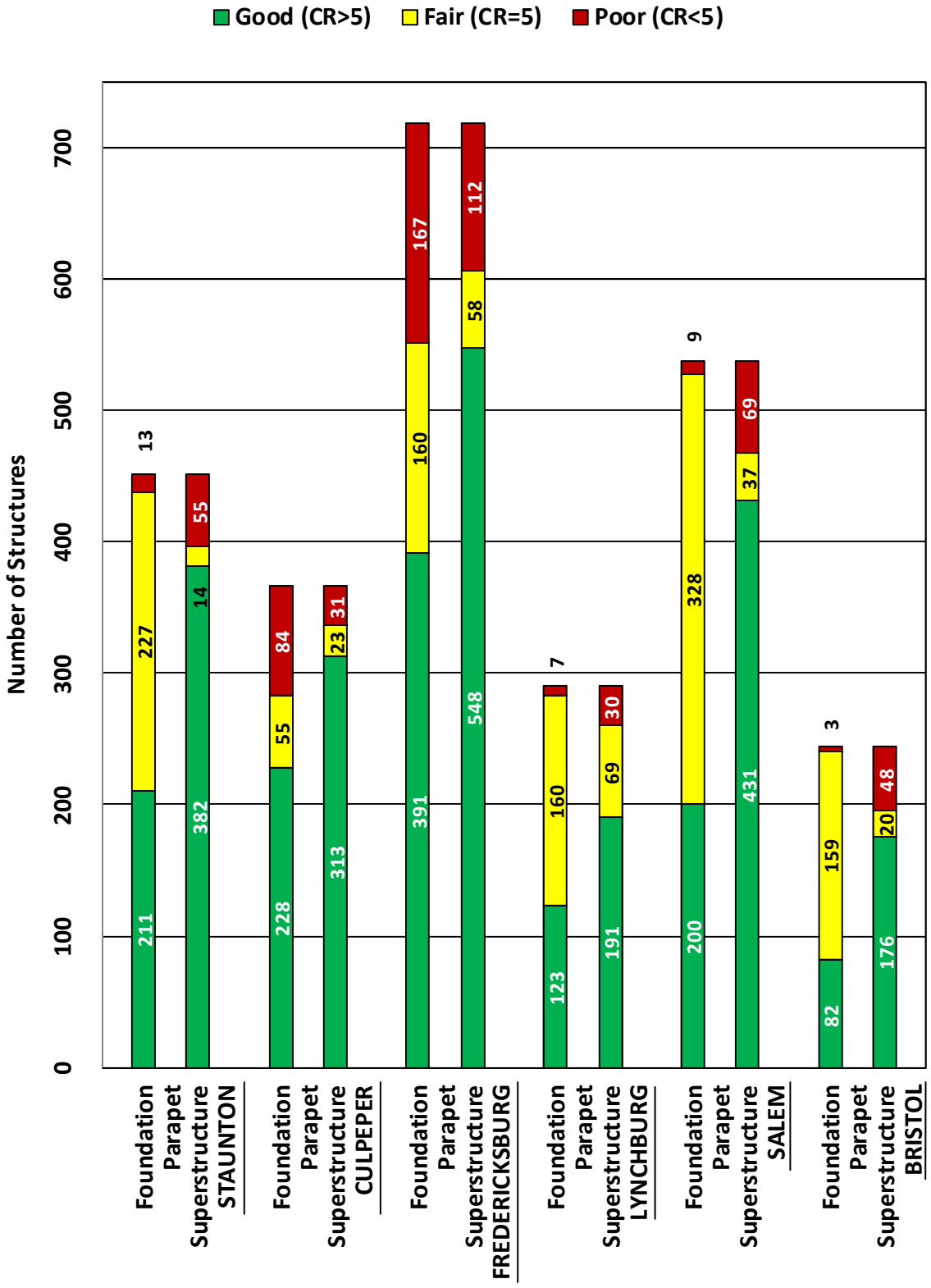


**Chart K.1f – General Condition of Signal Structures – Large Inventory Districts**

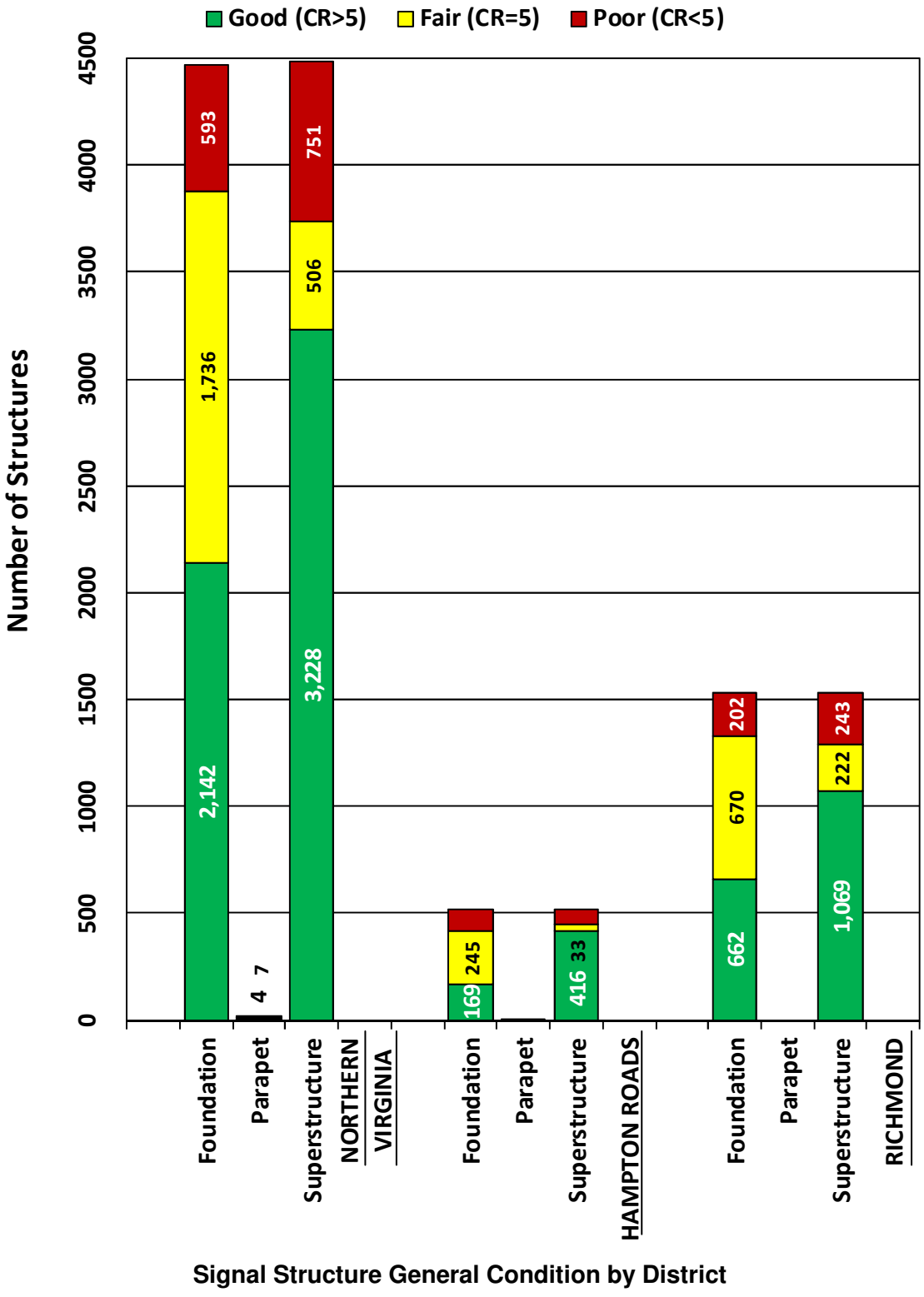
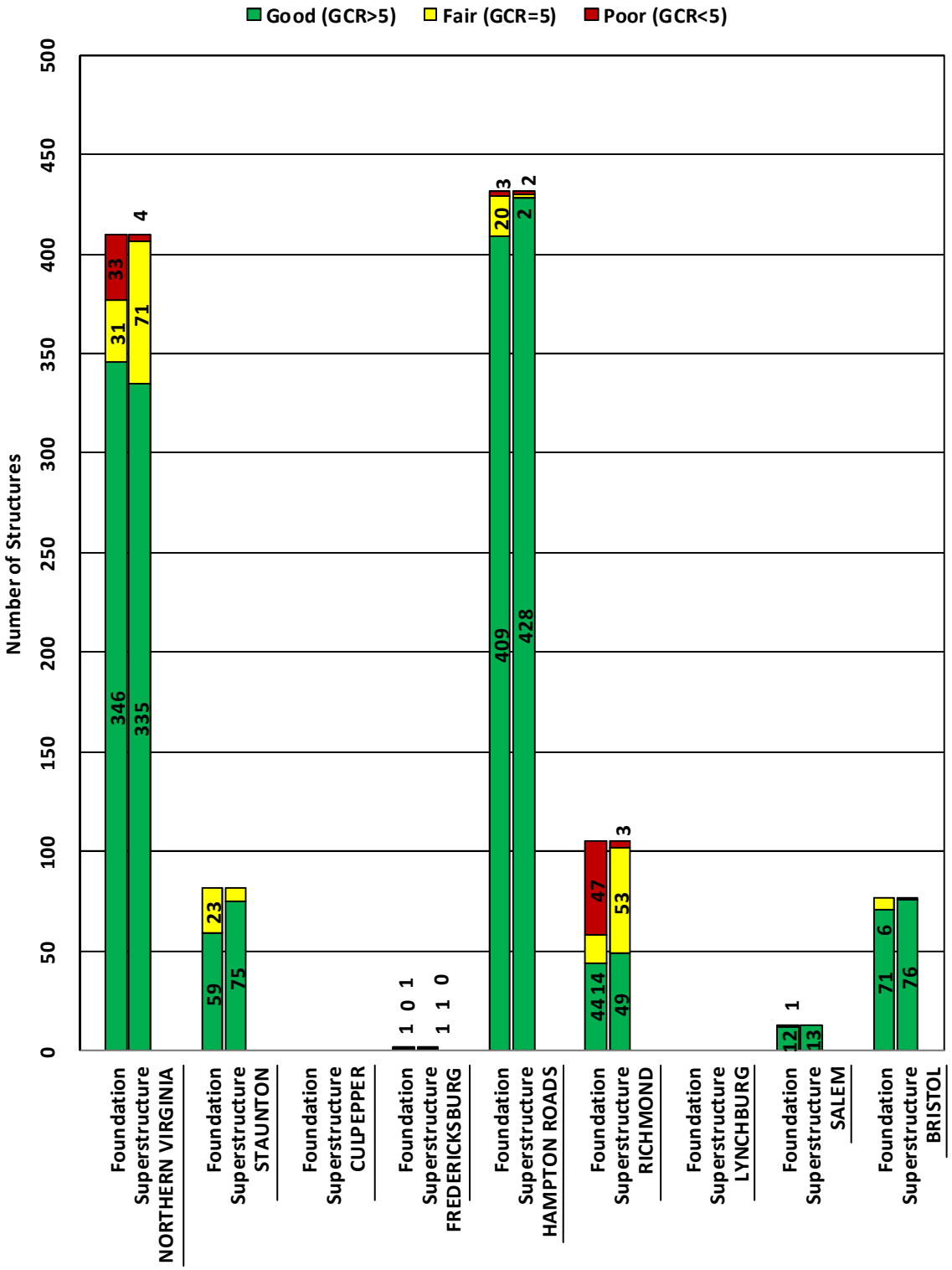


**Chart K.1g –Condition of High Mast Lights and Camera Poles– All Inventory Districts**



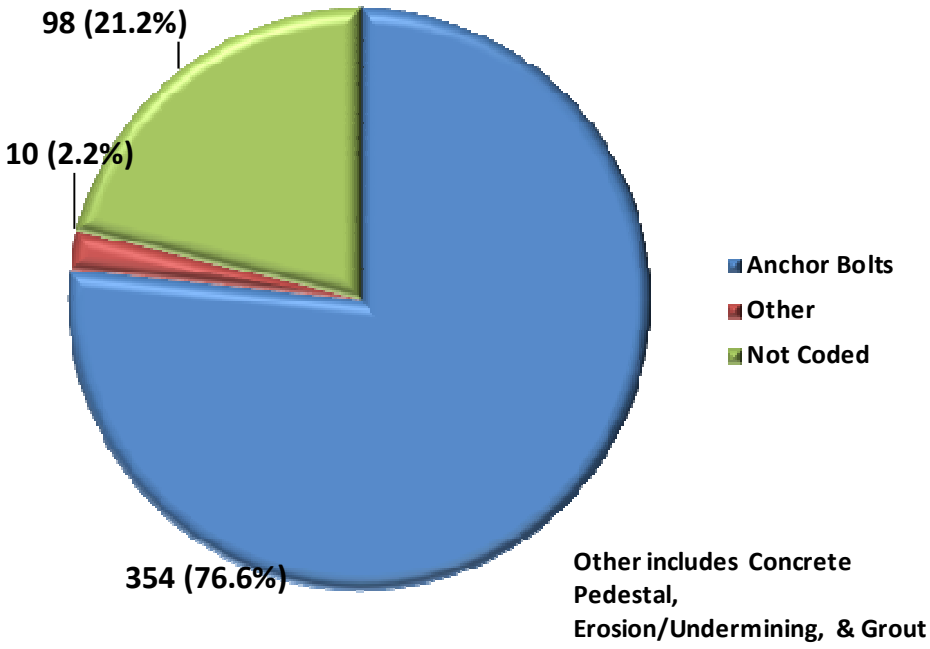

**High Mast and Camera Poles Structures Condition by District**

Charts K.2 through K.5, provided below, were developed in order to gain a more specific understanding of the conditions that cause structures to receive reduced GCRs.

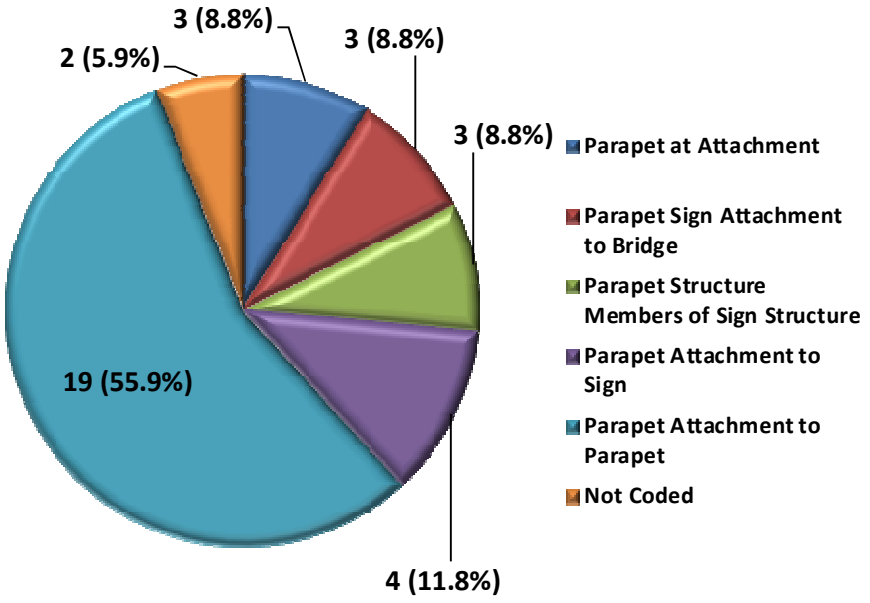
These charts identify the number and percentage of ancillary structures with significant identified problems and summarize the specific sources of those problems. Charts K.2.a through K.2.c address sign structures by foundation, parapet mount and superstructure. Charts K.3.a through K.3.c address luminaire structures by foundation, parapet mount and superstructure. Charts K.4.a and K.4.b address the signal structures by foundation, parapet mount and superstructure. Charts K.5.a and K.5.b address high mast light and camera pole structures by foundation and superstructure.

The charts below reflect tallies of all identified problems, so a structure with multiple problem areas will be represented more than once in any particular chart. Accordingly, the total number of structures in each chart will not necessarily agree with summaries provided elsewhere in this report.

**Chart K.2.a – Reasons Coded for Poor Sign Structure Foundation**



## Chart K.2.b – Reasons Coded for Poor Sign Structure Parapet Mounting




## Chart K.2.c – Reasons Coded for Poor Sign Structure Superstructure

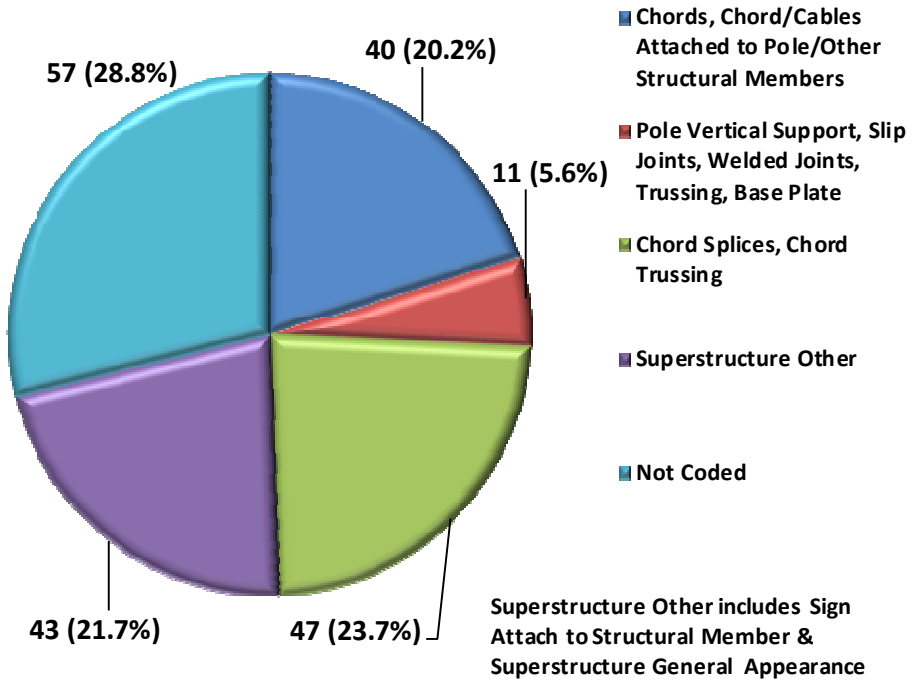


**Chart K.3.a – Reasons Coded for Poor Luminaire Structure Foundation**

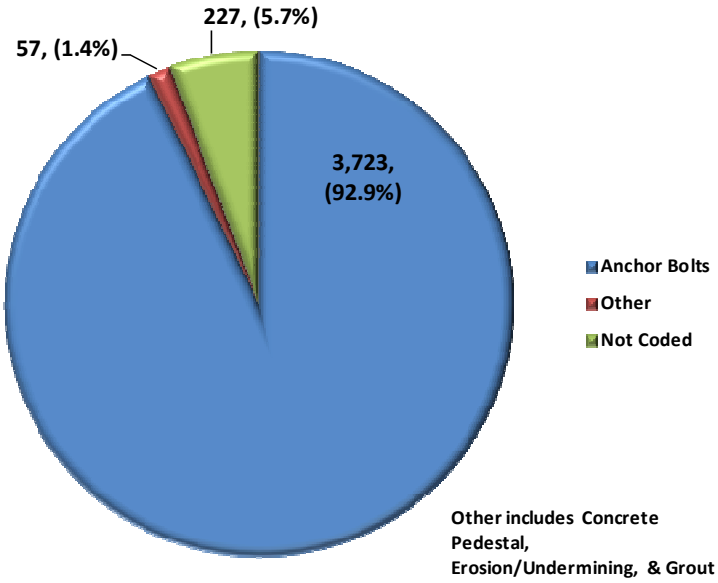
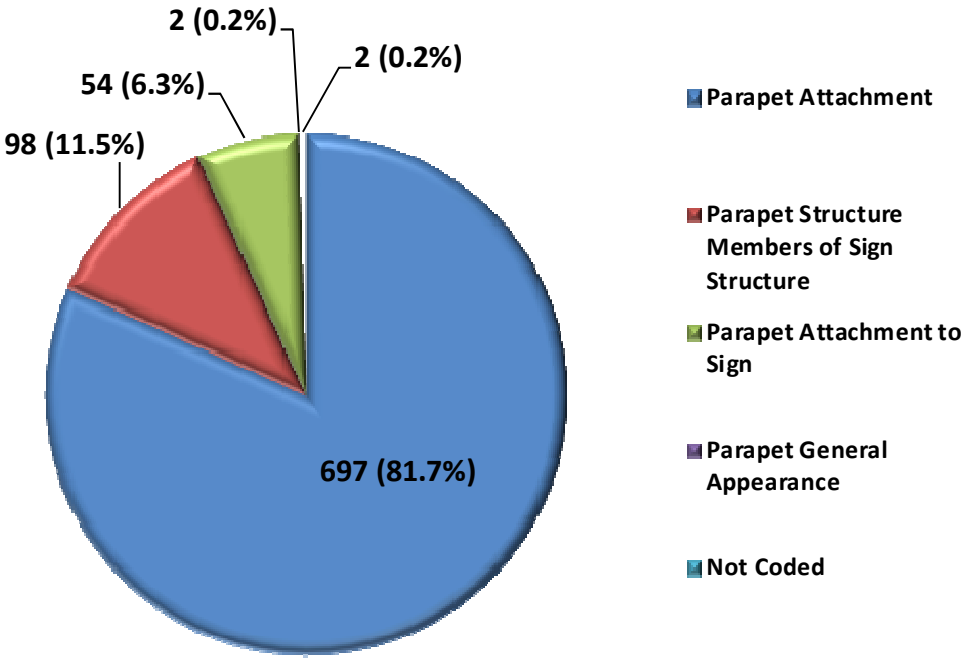
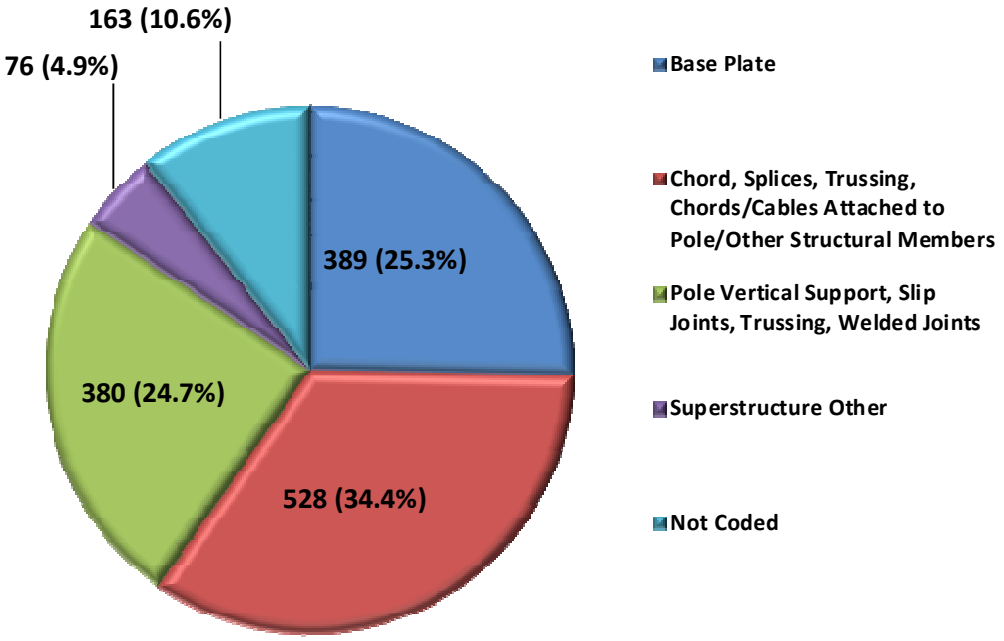



**Chart K.3.b – Reasons Coded for Poor Luminaire Structure Parapet Mounting**

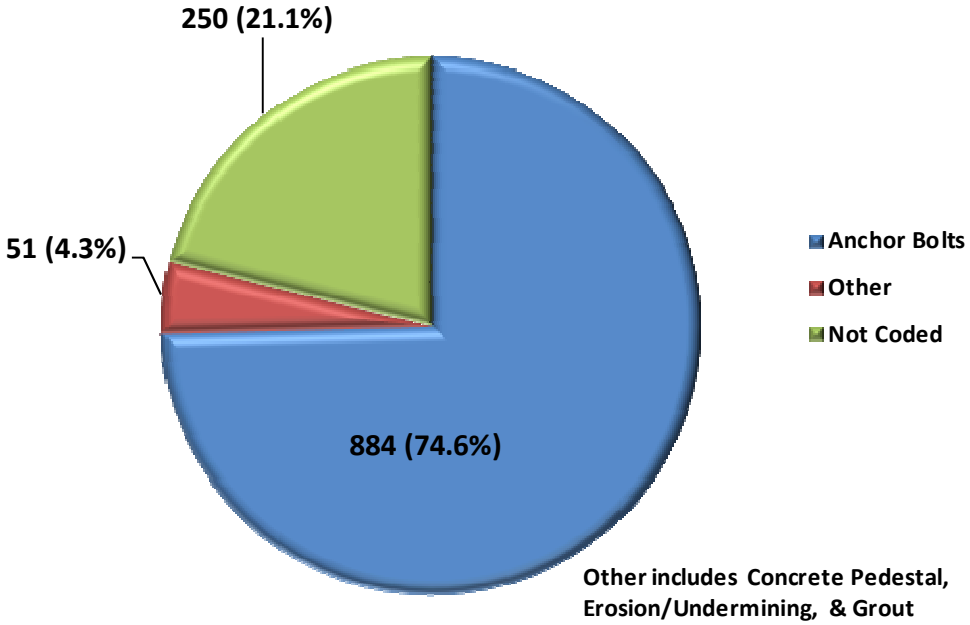


## Chart K.3.c – Reasons Coded for Poor Luminaire Structure Superstructure




Superstructure Other includes Sign Attach to Structural Member, Super General Alignment, & Super General Appearance

## Chart K.4.a – Reasons Coded for Poor Signal Structure Foundation




Other includes Concrete Pedestal, Erosion/Undermining, & Grout

**Chart K.4.b – Reasons Coded for Poor Signal Structure Superstructure**

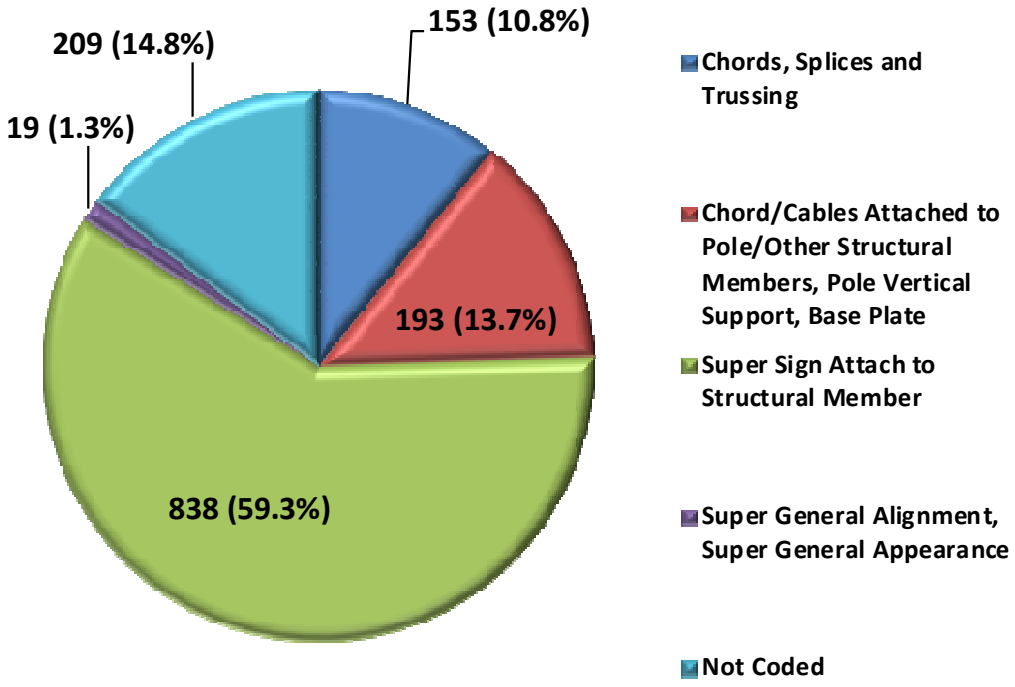



**Chart K.5.a – Reasons Coded for Poor High Mast Light and Camera Poles Foundation**

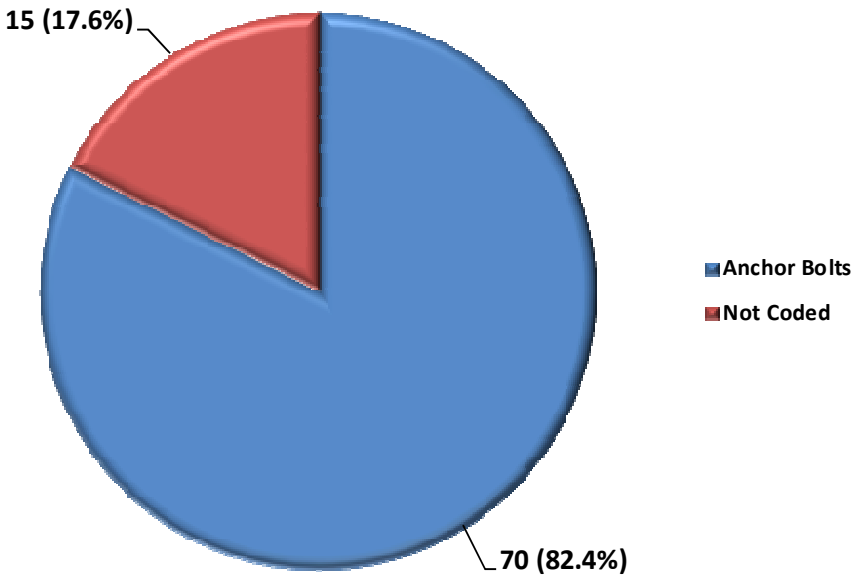
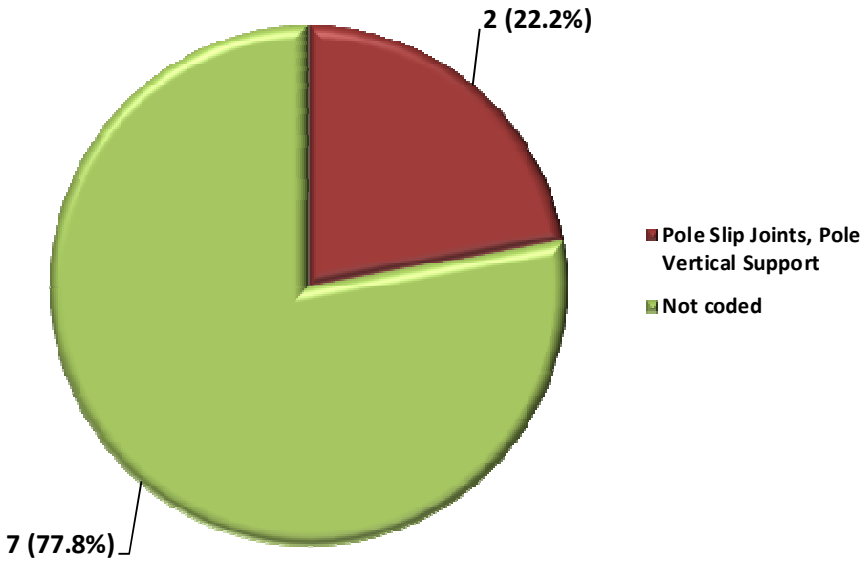


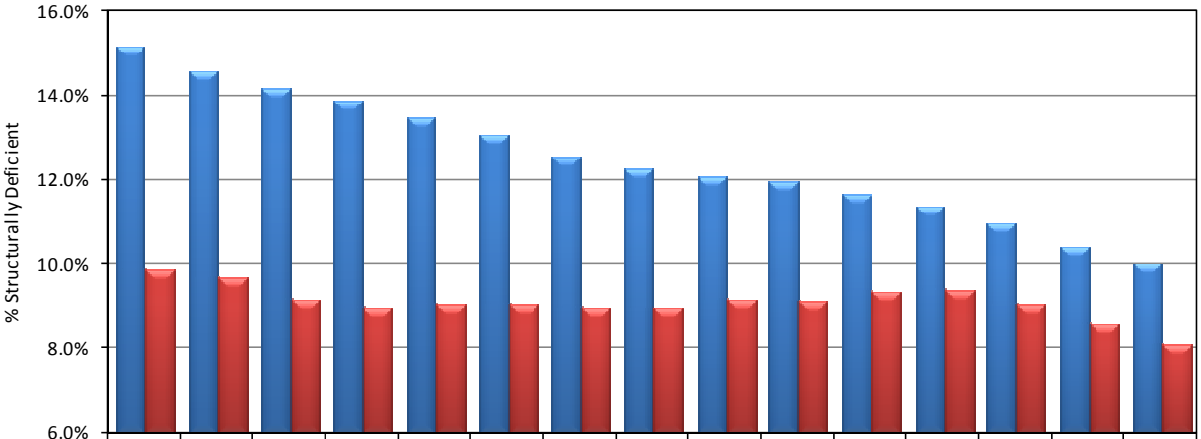
**Chart K.5.b – Reasons Coded for Poor High Mast Light and Camera Poles Superstructure**



## APPENDIX L – NATIONAL PERFORMANCE TRENDS

Every Year FHWA collects data of NBI structures from all the states. The National Bridge Inventory reports data by calendar year and the 2015 data will not be available until after April 2016. The following charts compare Virginia's percentage of deficient structures with the national average as reported by FHWA. Percentages are based on National Bridge Inventory structures only. See previous charts for percentages of the entire Virginia inventory.

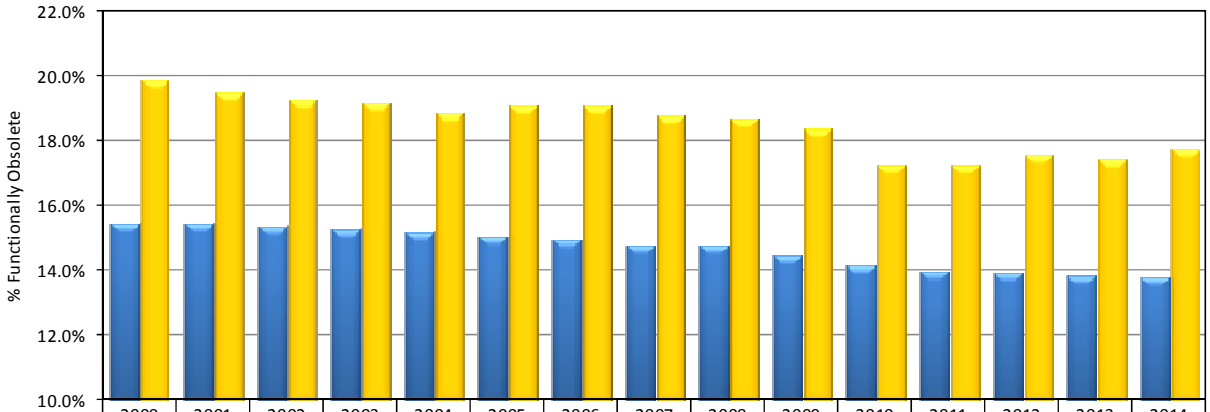
**Chart L.1 – Comparing Virginia's NBI Structurally Deficient (SD) Structures to the National Average**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National | 15.2% | 14.6% | 14.2% | 13.9% | 13.5% | 13.1% | 12.6% | 12.3% | 12.1% | 12.0% | 11.7% | 11.4% | 11.0% | 10.5% | 10.0% |
| Virginia | 9.9% | 9.7% | 9.2% | 9.0% | 9.1% | 9.1% | 9.0% | 9.0% | 9.2% | 9.2% | 9.4% | 9.4% | 9.1% | 8.6% | 8.1% |

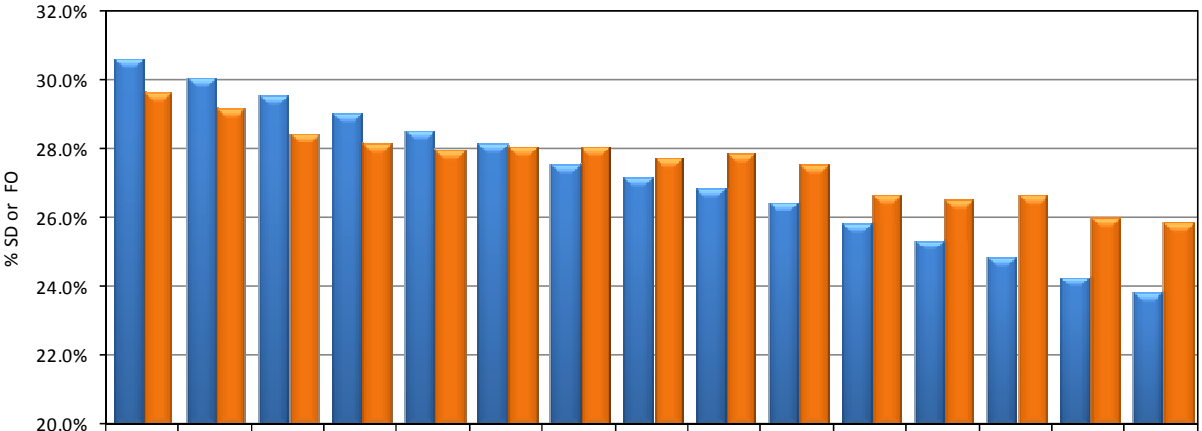
Note: Percentages are based on National Bridge Inventory structures only. See previous charts for percentages of entire Virginia inventory.

**Chart L.2 –Comparing Virginia's NBI Functionally Obsolete (FO) Structures to the National Average**




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National | 15.5% | 15.5% | 15.4% | 15.3% | 15.2% | 15.1% | 15.0% | 14.8% | 14.8% | 14.5% | 14.2% | 14.0% | 14.0% | 13.9% | 13.8% |
| Virginia | 19.9% | 19.5% | 19.3% | 19.2% | 18.9% | 19.1% | 19.1% | 18.8% | 18.7% | 18.4% | 17.3% | 17.3% | 17.6% | 17.5% | 17.8% |

## Chart L.3 –Comparing Virginia's NBI Deficient (SD & FO) Structures to the National Average




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National | 30.7% | 30.1% | 29.6% | 29.1% | 28.6% | 28.2% | 27.6% | 27.2% | 26.9% | 26.5% | 25.9% | 25.4% | 24.9% | 24.3% | 23.9% |
| Virginia | 29.7% | 29.2% | 28.5% | 28.2% | 28.0% | 28.1% | 28.1% | 27.8% | 27.9% | 27.6% | 26.7% | 26.6% | 26.7% | 26.1% | 25.9% |

Note: Percentages are based on National Bridge Inventory structures only. See previous charts for percentages of entire Virginia inventory.