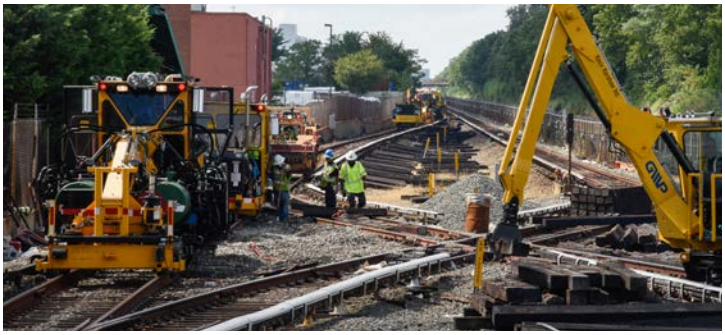
10-Year Capital Needs

Inventory and Prioritization

CY 2017- 2026 Needs



November 2016

Office of Planning


NoMa-Gallaudet U
New York Ave Station


metro

Contents

Acronyms

AVL — Automated Vehicle Location
AWIS — Automatic Wayside Inspection System
BIE — Brake In Emergency
CAD — Computer Aided Dispatch
CCTV — Closed-circuit Television
CDL — Commercial Driver's License
CENI — Metro Office of Chief Engineer, Infrastructure
CFA — Capital Funding Agreement
CFM — Converter Functional Modules
CFN — Call for New Investment Needs
CIP — Capital Improvement Program
CMNT — Metro Rail Car Maintenance
COMM — Metro Communications Department
COMSOL — (Not an Acronym, Software Company Name)
CNI — Capital Needs Inventory
CNG — Compressed Natural Gas
CPAC — Capital Program Advisory Committee
CTEM — Car Track and Equipment Maintenance
CY — Calendar Year
EOC — Executive Oversight Committee
ELES — Office of Elevators and Escalators
ENV — Metro Environmental Department
ESS — Metro Election Safety and Security Department
FIA — Fire and Intrusion Alarm
FMP — Fleet Management Plan
FTA — Federal Transit Authority
GDU — Gate Unit Driver
GMAC — Grounds Maintenance and Custodial Services
HVAC — Heating, Ventilation, and Air Conditioning
IGBT — Insulated Gate Bipolar Transistor
KIDS — Kiosk Information Display Systems
LCD — Liquid Crystal Display
LED — Light Emitting Diode
MACS — Multiagency Coordination System
MAP-21 — Moving Ahead for Progress in the 21st Century
MTPD — Metro Transit Police Department
NFPA — National Fire Protection Association
NTD — National Transit Database
NTSB — National Transportation Safety Board
PA — Public Address
PENTA — Penta Corporation
PIDS — Passenger Information Display Systems
PM — Project Manager
PRIIA — Passenger Rail Investment and Improvement Act of 2008
ROW — Right of Way
S&I — Service and Inspection
SGR — State of Good Repair
SME — Subject Matter Expert (Metro staff)
SOCS — Station Operation Consoles
SSPP — System Safety Program Plan
TAICA — Transit Asset Inventory and Condition Assessment
TAM — Transit Asset Management
TERM — FTA's Transit Economic Requirements Mode
TERM Lite — Local agency version of TERM federal
TRST — Metro Track and Structures Department
TSP — Transit Signal Priority
VMS — Vehicle Monitoring System
WMATA — Washington Metropolitan Area Transit Authority

CPAC and EOC Membership

Executive Oversight Committee

Eric Christensen

Joseph Leader

Barbara Richardson

John Thomas

Capital Program Advisory Committee

Ray Alfred

Lawrence Flint

Randall Grooman

Shyam Kannan

Paul Kram

Patrick Lavin

Andy Off

Angel Pena

Louis Viner

Darin Welt

Project Director

Shyam Kannan

Project Manager

Wendy Jia

Key Metro Assets

233 miles of revenue track

9 major rail yards

1,589 buses

19 miles of bridges

1,242 rail cars

9 bus garages

100 miles of tunnels

91 rail stations

675 paratransit vehicles

103 traction power substations

i. Executive Summary

The Washington Metropolitan Area Transit Authority (Metro) operates and maintains approximately $40 billion in physical assets (see Figure i-1) that support the second-busiest rail transit and sixth-busiest bus services in the United States (U.S.). Maintaining Metro assets in a state of good repair (SGR) is essential to delivering safe, reliable, and efficient transit services to millions of riders. However, this requires ongoing capital maintenance as well as periodic investments in rehabilitations and replacements. At the same time, Metro needs to keep up with modern technology, meet safety and other regulatory requirements, and support near-term system enhancements.

The Capital Needs Inventory (CNI) aims to capture and quantify Metro's existing and anticipated capital needs over a 10-year period to advance or maintain SGR of its assets, meet regulatory compliance, and invest in necessary enhancements to ensure a safe and modern system that will allow Metro to continue to support the region's economic competitiveness. It also provides useful information and insight to asset managers and regional funding partners to evaluate the unconstrained range of resources required to support Metro's needs.

This CNI estimates Metro's unconstrained capital needs to be approximately $2.5 billion annually in year of expenditure dollars (YOE) from 2017 to 2026. The total for these 10 years includes just over $17 billion in SGR needs, $7 billion in new investment needs, and $800 million in unallocated needs (see Figure i-2). Of the total needs, approximately $1.7 billion of SGR needs and $1.6 billion of new investment needs are necessary to address safety or compliance-related requirements.

Metro commenced this multi-year effort in the spring of 2016 with the following goals:

- Construct an objective, data-driven, and risk-based approach to estimate Metro's major rehabilitation and capital asset replacement/acquisition needs
- Build a prioritization methodology aligned with Metro's strategic goals and grounded in asset inventory and conditions assessments (see Figure i-3)
- Ensure that safety, service delivery, ridership, and asset conditions will drive investment prioritization in a quantifiable and data-driven manner

Summary of Existing Value by Asset Type

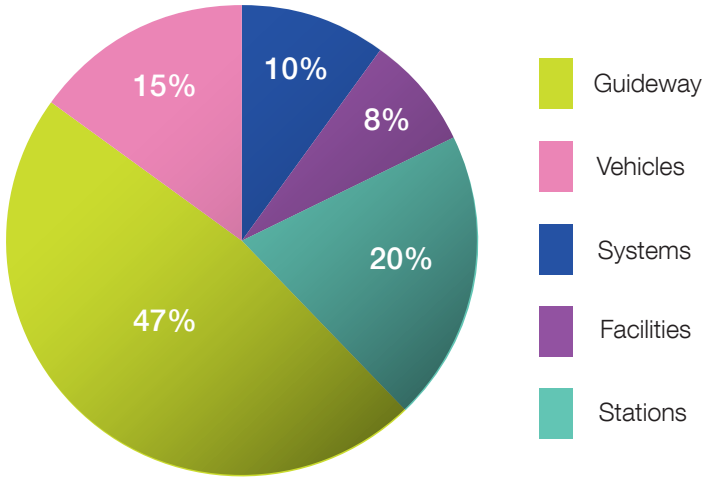


Figure i-1: Distribution of Metro's existing assets by asset type

Total 10-Year Combined Needs

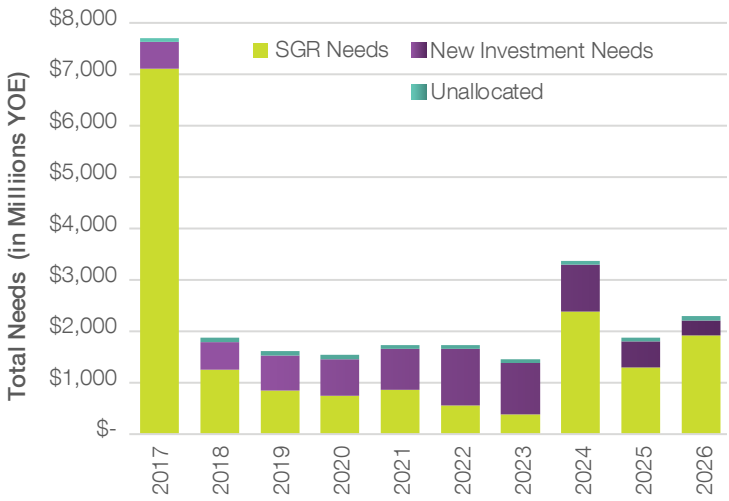


Figure i-2: Unconstrained 10-Year Combined Needs with Unallocated Capital

Figure i-3: CNI Criteria Alignment With Metro's Momentum Goals

- Construct a process that will support the construction and ongoing stewardship of a Transit Asset Management (TAM) plan as required by the Federal Transit Administration (FTA)
- Coordinate the CNI with ongoing improvements in Metro's capital programming management process, such that the CNI phase will identify investment needs by program category, the project development phase would evaluate feasibility and readiness, and the six-year CIP phase would program funds for transforming investment needs into actual projects.

As of the writing of this report, Metro's current asset condition assessment and prioritization is seven months into a multi-year effort. Asset inventories have been conducted at a high level and physical conditions for all of the assets and sub-assets will not be available until 2018. Metro estimates that over 55,000 individual assets require physical inspection, approximately half of which have already been surveyed. Due to the time required to conduct field inspections across the region and integrate data for decision making, system-wide efforts of this nature generally require two to five years. By 2018 Metro aims to complete its initial asset conditions assessment and use that information to update and improve the CNI.

The analysis for the CNI is unconstrained in terms of both time and cost. This means that the CNI assumes all capital needs can be addressed as they occur, regardless of Metro's actual capacity in terms of labor, procurement timing, access to right of way or budget.

The unconstrained needs illustrate the current amount of deferred capital needs Metro is facing while also planning for the new investment needs of the system. The CNI analysis is unconstrained to provide a complete and unaltered picture of needs that informs the Capital Funding Agreement (CFA) and Metro's capital budget process. Funding constraints and realistic investment scenarios will be evaluated in later phases of the CNI. All needs reported below are reported in YOE dollars, which includes a three percent cost inflation rate.

SGR Needs

SGR needs are defined as the replacement, rehabilitation, or annual capital maintenance of existing capital assets necessary for system preservation. From 2017 to 2026, Metro's SGR needs total $17.36 billion. This includes $6.66 billion in deferred capital needs as of 2017. Assets with deferred needs are either beyond their useful life, require replacement due to compliance requirements or are in poor condition. Once the backlog of deferred capital needs is addressed, the normal replacement or SGR needs for Metro average about $1.1 billion per year, as seen in Figure i-4.

Deferred capital needs include a variety of compliance related projects, which must be completed as a priority to meet FTA, National Transportation Safety Board (NTSB), or internal Metro standards or regulatory requirements. These priority items include the replacement of the 1000-series rail cars, installation of a new radio system and cellular infrastructure, and replacement of track circuits and power cabling where necessary. These deferred capital needs

Total 10-Year SGR Needs

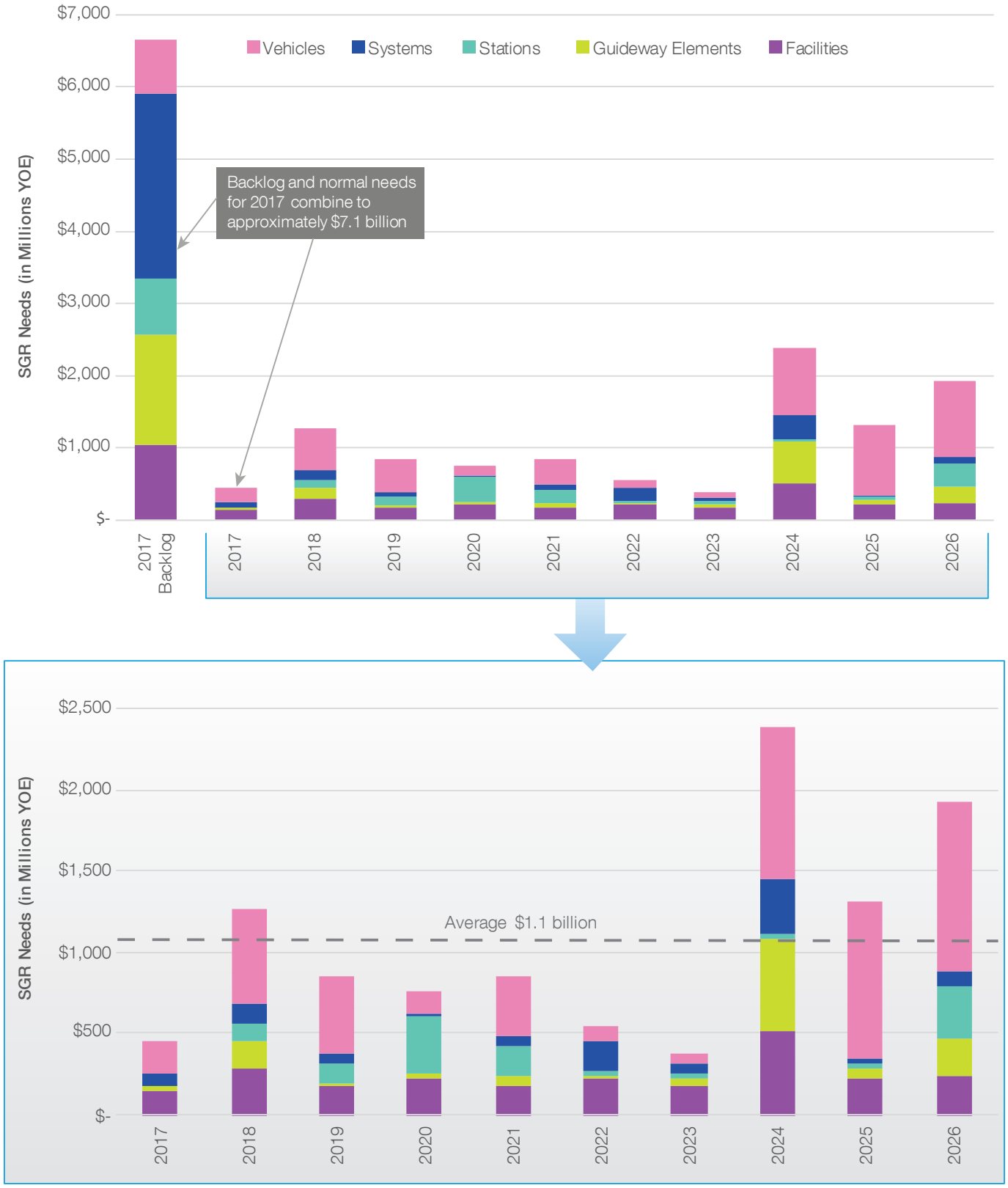


Figure i-4: Unconstrained 10-Year Total SGR Needs by Asset Type

comprise approximately 16 percent of Metro's total asset base of $40 billion. See Figure i-5.

In addition to compliance-related needs, from 2017 to 2018 there are other high priority SGR needs which should be addressed, including:

- Replacing power cable insulators on deep tunnels of the Red Line and other lines particularly where water intrusion occurs, which can disrupt service or cause the need for more frequent and costly repairs.
- Replacing worn components of track and tunnels on all lines, necessary for safety and service delivery.
- Upgrading the signaling system, which controls the movement and speed of trains, necessary for safe operations and on-time service delivery.

About a third of Metro's SGR needs are in vehicles. For example, the rail car fleet requires complete replacement of the 1000, 2000, 3000, 4000, and 5000 series during the period of the CNI, along with rehabilitations of all fleets to maintain SGR. See Figure i-6.

New Investment Needs

New investment needs were recommended by Metro departments to address enhancement of Metro's current assets or amplification of Metro's services. These needs either improve existing services with new technology, address compliance needs, increase functionality, or provide for service enhancements. The unconstrained new investment needs reported total $7.04 billion from 2017 to 2026. See Figure i-7.

Importantly, a critical subset of these investments address compliance requirements related to safety, security and environmental improvements. In total, $1.57 billion of the new investment needs submitted were designated as compliance, related to meeting a code or standard, complying with the results of an audit or investigation, or replacing technologically obsolete assets.

A majority of the new investment needs recommendations address remediation of hazards or crowding on the rail system in core areas. Crowded conditions in these areas have persisted since 2008 despite variations in system-wide ridership trends. By asset type, the largest

Level of Deferred Need as of 2017

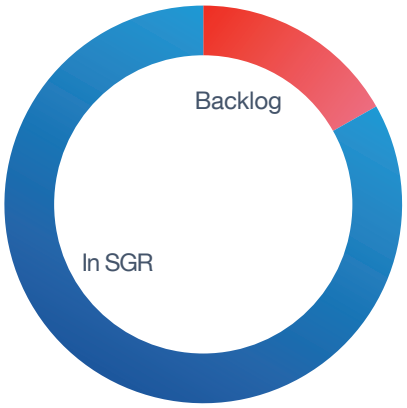


Figure i-5: High-level backlog (red is deferred need, blue is in SGR as of 2016)

Summary of 10-Year SGR Needs

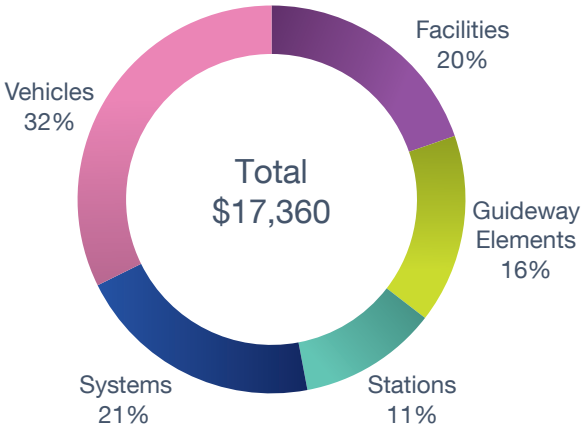


Figure i-6: Total 10-Year SGR Needs by Asset Type ($Million YOE)

Total 10-Year New Investment Needs

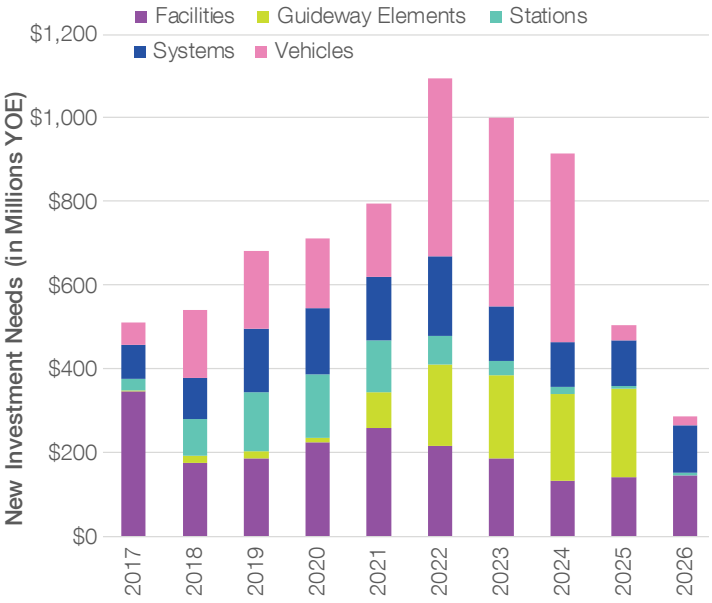


Figure i-7: Unconstrained 10-Year New Investment Needs by Asset Type

portion of new investment needs is in vehicles, mostly for implementing full eight-car train operations, followed closely by facilities. See Figure i-8.

Following the prioritization methodology detailed in Chapter 2, the highest priority new investment needs for the next two years are:

- Design improvements to Metrorail aerial structures to extend the fatigue life of the structure and reduce maintenance requirements at D & G Junction and Grosvenor bridges.
- Environmental compliance projects, including new installations or modifications to stormwater and wastewater pre-treatment systems, underground and aboveground tank systems, air emission control systems, and contamination remediation systems located at bus and rail facilities.
- Rehabilitation of fare gates to allow them to "fail safe" (or stay open) for evacuations if there is a loss of emergency power to the gates.
- Improvements at 11 on-street terminal locations to create bus stops that have covered waiting areas, are equipped with customer information electronic units, bus pullouts, electronic timetables, Americans with Disabilities Act (ADA) landing areas and improved pedestrian access, bus benches, and curb extensions.

Overall Needs

In addition to the SGR needs estimated based on Metro's existing inventory and new investment needs recommended by Metro departments, there is approximately $80 million annually of unallocated capital needs that cover a variety of activities. In general, these additional activities include regular repairs and maintenance and services (e.g., engineering).

The combined SGR, new and unallocated needs total $25.18 billion from 2017 to 2026.

SGR needs are approximately 69 percent of the total needs, with new investment needs at 28 percent and unallocated needs at 3 percent. See Figure i-9.

It is important to note that these capital needs are entirely unconstrained and amount to an average of $2.52 billion per year. As Metro does not currently have the capacity to fund or execute that level of capital program, the prioritization of these needs is critical to inform budget-level decision making.

Summary of 10-Year New Investment Needs

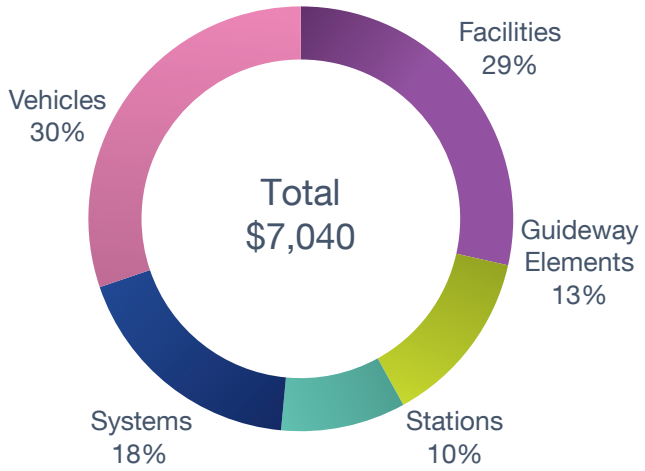


Figure i-8: Total 10-Year New investment needs by Asset Type (in Millions YOE)

Total 10-Year Combined Needs

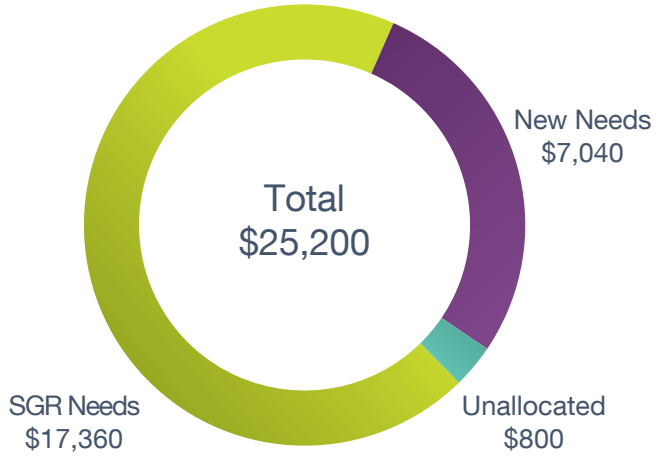


Figure i-9: 10-Year Total Needs (in Millions YOE)

Next Steps

A robust CNI is essential in understanding Metro's unconstrained asset investment needs for the next 10 years. It informs the levels of funding needed, both for advancing and achieving SGR and addressing critical improvements. This allows Metro to promote and enhance reliability for existing and new riders, adapt to new technology, and comply with safety directives, standards, and regulations.

Metro's capital program management is integrated with the CNI by inheriting its assessment as a starting point for identifying needs that warrant further evaluation and advancement into a project development and project readiness phase of capital programming. Consequently, the CNI helps management build an efficient capital budget. The relationship between the asset inventory and needs inventory phases of the work all the way through capital programming is summarized in Figure i-10.

Project Development

Metro's future Project Development process will use a stage gating approach to determine if projects are ready to enter the Capital Improvement Program (CIP) process. During this phase, capital needs are translated into the capital projects with a defined scope of work and evaluated for feasibility and readiness. The Project Development phase will also identify and include any efficiencies in cost and scope from coordinating interdependent projects. The needs identified by the CNI will be evaluated in this Project Development phase.

Refinement of CNI

This CNI represents the initial iteration of a new process at Metro for accurately examining its existing inventory and identifying investment needs proactively. Metro aims to complete its asset conditions assessment (TAICA) and use that information to update the CNI by 2018. Hence, the needs in this document are rough order of magnitude estimates which will continue to be refined as the CNI process matures.

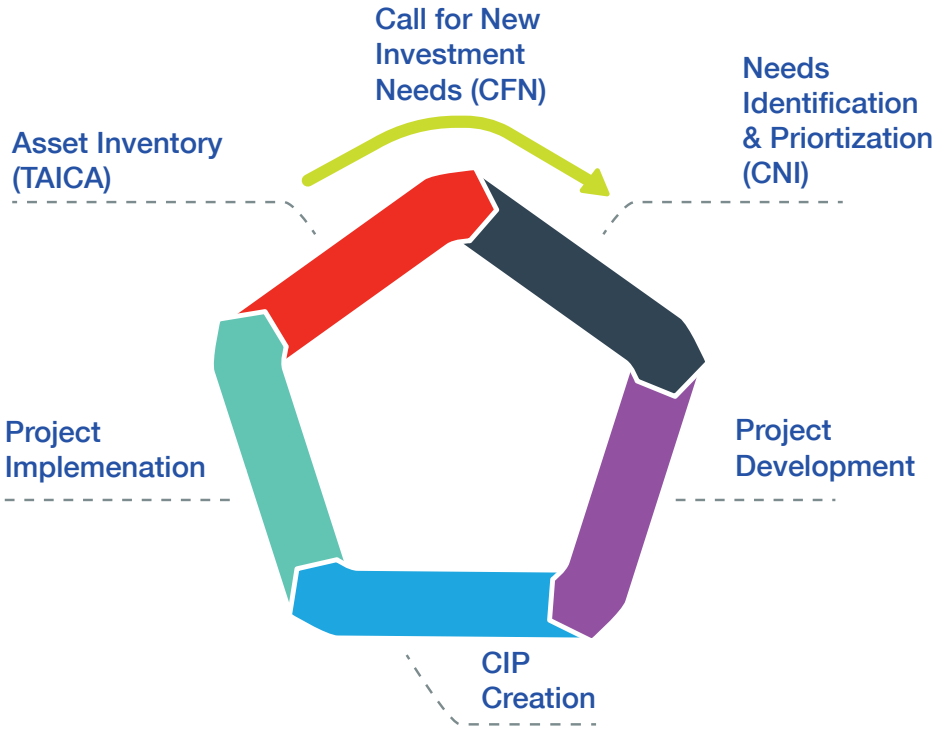


Figure i-10: Metro's Future Capital Program Management Process

1. Background and Overview

Metro operates and maintains approximately $40 billion in physical assets that supports one of the busiest transit systems in the U.S. Maintaining Metro assets in a State of Good Repair (SGR) is essential to deliver safe, reliable, and efficient transit services to hundreds of millions of riders each year. However, this requires ongoing capital maintenance as well as periodic investments in rehabilitations and replacements. Meanwhile, Metro must keep up with modern technology, meet safety and other regulatory requirements, and support near-term system enhancements.

1.1 Metro Overview

Metro is the primary transit provider for the national capital region. It was created in 1967 by an interstate Compact to plan, develop, build, finance, and operate a balanced regional transit system in the "transit zone," surrounded by the compact boundaries. See Figure 1-1.

Construction began on the Metrorail system in 1969. In 1973, four area bus systems were acquired and consolidated by Metro, and thus began Metrobus. Metrorail began operations in 1976. The newest addition to the rail network, the Silver Line, opened in 2014. Metro began its paratransit service, MetroAccess, in 1994.

Today, Metro operates the second busiest rail transit and sixth busiest bus network in the U.S. with an annual capital and operating budget of $3.1 billion.[1]

WMATA Compact Transit Zone

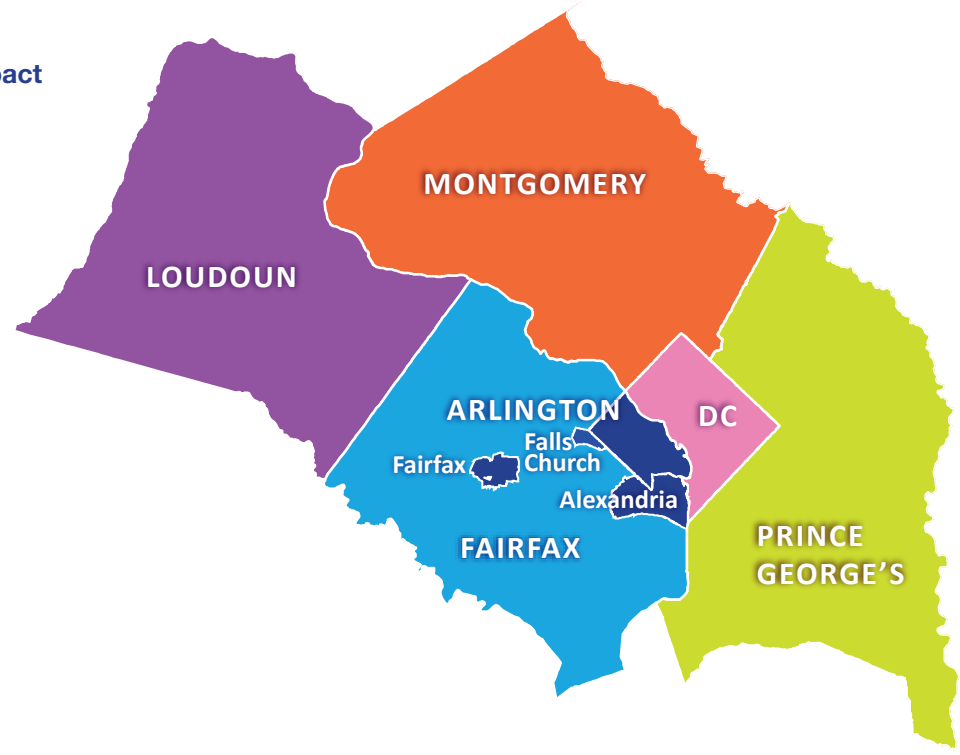


Figure 1-1: WMATA Compact Transit Zone

1 FY2016 Budget Book

1.1.1 Service Profile

Today, Metro serves a population of approximately 5 million within a 1,500-square-mile area. Metrorail has 91 stations in the service area within a 118-mile network (see Figure 1-2). Metrobus serves more than 11,000 bus stops, operates 173 lines, and 308 routes. MetroAccess provides door-to-door service for people whose disability prevents them from using Metrobus and/or Metrorail.

Metro's "transit zone" as defined by the Compact consists of Washington, DC; the Maryland counties of Montgomery and Prince George's; the Northern Virginia counties of Arlington, Fairfax, and Loudoun; and the Northern Virginia cities of Alexandria, Fairfax, and Falls Church. While most Metro riders come from within the service area, some Metro riders come from beyond the service area. The system draws riders as far as Baltimore County in Maryland and Stafford County in Virginia.

Metrorail Network

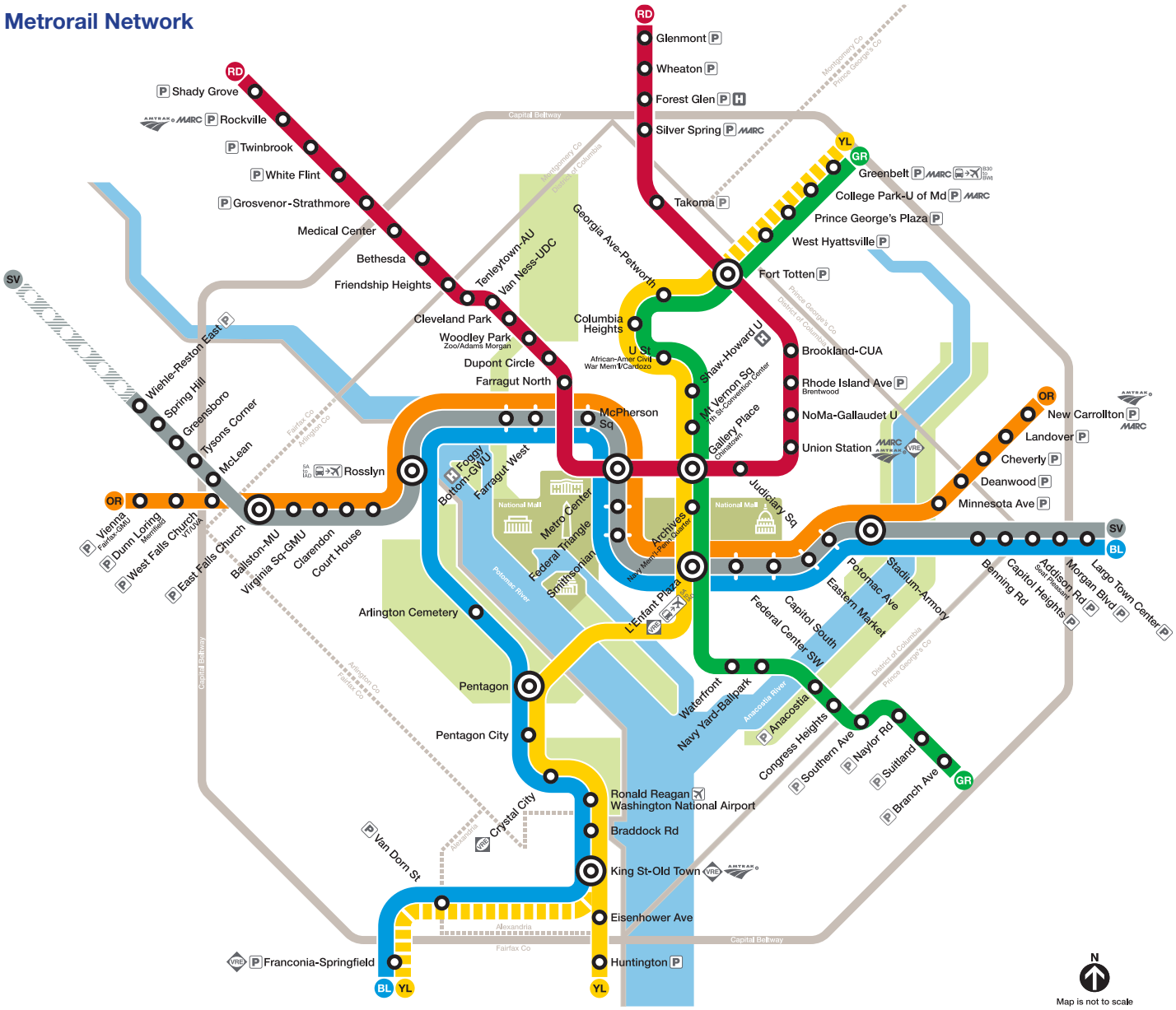


Figure 1-2: Diagram of Metrorail Network

1.1.2 Service Summary

Every day, Metrorail, Metrobus, and MetroAccess services provide critical transportation mobility and accessibility to the local population as well as visitors to the region. It serves as the backbone of all public transportation services in the national capital region. Importantly, 45 percent of those working in the center core of the region (DC and parts of Arlington County) use mass transit.[2] In May 2015, average weekday ridership reached 712,000 on Metrorail and 459,000 on Metrobus. However, both Metrorail and Metrobus ridership have been in decline for several years as the system's aging fleet and infrastructure contributed to increasingly unreliable service. As of the writing of this report, the decline in ridership continues; however, Metrorail and Metrobus ridership growth is anticipated to rebound when Metro restores more reliable service.

Based on the 2015 National Transit Database (NTD)—the most recent data available in this data source—all services combined, Metro provides:

- 411 million unlinked passenger trips per year, including 270 million on Metrorail, 139 million on Metrobus and 2 million on MetroAccess.
- Nearly 2 billion passenger miles, with 1.5 billion of those on Metrorail.
- Nearly 134 million annual vehicle revenue miles, a majority of which are also on Metrorail vehicles, with approximately 30 percent on buses and 14 percent on Access vans.

Metro's service offerings meet the diverse transit needs of the national capital region. According to the latest surveys[3], on a given weekday, more than 58 percent of Metrobus and 62 percent of Metrorail riders access their stops or stations by walking.

The majority of riders of Metrorail and Metrobus use the Metro system for commuter trips to-and-from work (see Figures 1-3 and 1-4). In addition, Metro transports passengers to educational, medical, entertainment, and social destinations as well as other opportunities.

Weekday Metrorail Trips, Destination Purposes

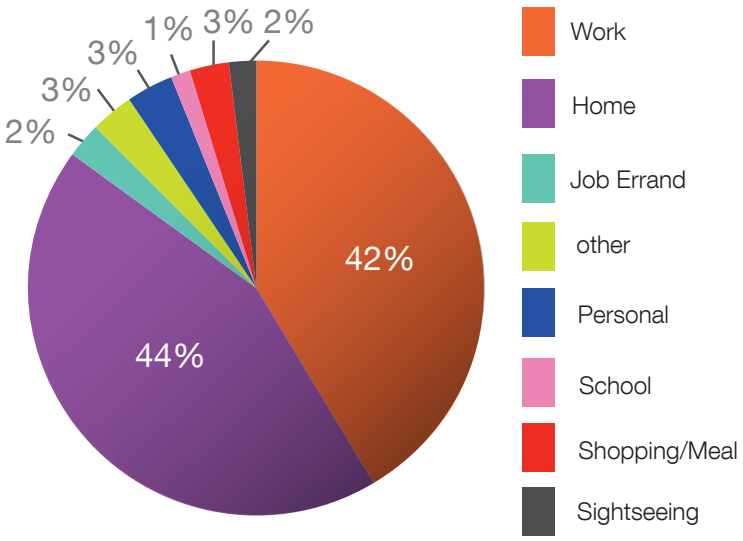
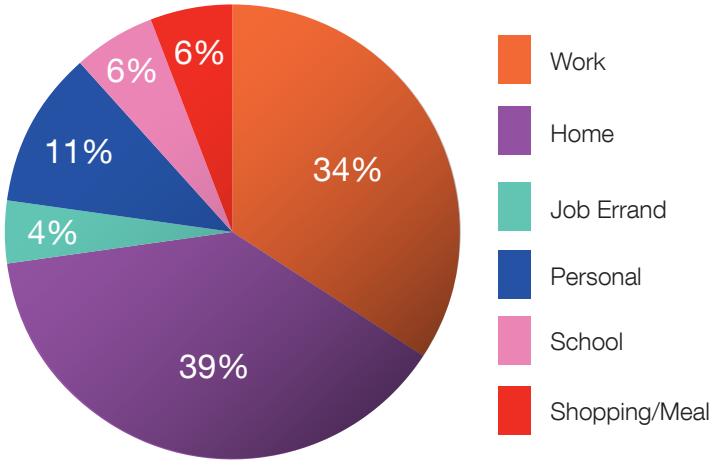


Figure 1-3: Typical Destinations of Weekday Metrorail Trips (2016 Metrorail Survey)

Weekday Metrobus Trips, Destination Purposes



Excludes late night

Figure 1-4: Typical Destinations of Weekday Metrobus Trips (2014 Metrobus Survey)

2 http://wmata.com/about_metro/docs/Metro%20Facts%202016.pdf?
3 Surveys for Metrobus and Metrorail are conducted regularly to study the ever-changing face of ridership, and to better serve Metro's customers. The most recent Metrobus survey was conducted in 2014 and the most recent Metrorail survey was conducted in 2016.

Metro's transit service is essential for minority and low-income communities as well as residents with disabilities. More than 50 percent of daily trips by Metrorail or Metrobus are taken by minority riders and close to 30 percent by low-income riders.

For customers that require specialized transportation services per Americans with Disabilities Act (ADA) guidelines, MetroAccess provides shared-ride and door-to-door paratransit service for people whose disability prevents them from using bus or rail. As of 2015, MetroAccess carried 2.3 million passengers annually.

1.2 Purpose of the CNI

The CNI aims to capture and quantify Metro's existing and anticipated capital needs during a 10-year period. These needs include costs to maintain assets in SGR, meet regulatory compliance, and invest in necessary enhancements or service amplifications. It also provides useful information and insight to asset managers and Metro's funding partners to evaluate the unconstrained range of resources required to support Metro's needs.

The CNI includes a needs prioritization methodology which is compliant with Federal Transit Administration's (FTA) Moving Ahead for Progress in the 21st Century (MAP-21) requirements for a Transit Asset Management (TAM) plan. It can also be used to frame discussions for the capital programming process and a new Capital Funding Agreement (CFA).

1.2.1 How We Got Here: Metro's Previous CNI Effort

Metro last produced a 10-year CNI in 2010 through a Call for Needs and a prioritization process that aligned with Metro's strategic goals. The 2010 CNI outlined more than $11 billion in total needs during 10 years (fiscal 2011 to fiscal 2020). The CNI included projects that focused on performance (approximately $7.6 billion and 67 percent of total needs) and customer/demand (approximately $3.8 billion and 33 percent of total needs). The findings of this effort informed the subsequent CFA, which covered approximately $6 billion of total needs for five years and included the Passenger Rail Investment and Improvement Act of 2008 (PRIIA) and jurisdictional matching funds.

With this support, Metro was able to embark on the MetroForward campaign, which was at the time the most ambitious capital reinvestment effort in Metro's history.

During the ensuing five years, best practices for capital asset management for transit properties nationwide matured and received additional attention from the FTA in the MAP-21 regulations, which now mandates a TAM plan for Metro and its peers.

Also during this time, Metro started to recognize the limitations in the previous CNI, which included:

- Lack of asset condition data: At the time the process was initiated, Metro did not have a comprehensive asset

411 million
unlinked passenger trips per year

Nearly
2 billion
passenger miles

Nearly
134 million
annual vehicle revenue miles

database with an inventory of asset conditions or useful lives, although some detailed data existed for certain asset types. Without a proper database consolidating Metro's asset inventory, a comprehensive analysis of investment needs was incomplete. Moreover, the lack of a central asset database or condition ratings led to individual departmental submissions that could not be verified.

- Qualitative prioritization approach: The evaluation and prioritization of asset needs were based on the qualitative assessment by management rather than driven by data. While the professional judgment for major asset categories reflected asset conditions at high levels, it yielded a product that was largely based on trade off analyses using strategic goals.
- Mix of assets and projects: The 2010 CNI attempted to propose individual projects rather than articulate asset based investment needs. This resulted in an itemized list of projects without proper attention paid to the overall asset needs and readiness of individual projects to enter into the Capital Improvement Program (CIP).

1.2.2 Where We Are Today: Toward a Modern CNI

The limitations to the 2010 CNI work and Metro's evolution toward executing sound business management principles warranted the construction of a new CNI process and product. Metro commenced this multi-year effort in the spring of 2016 with the following goals:

- Construct an objective, data-driven, and risk-based approach (see Figure 1-5) to estimate Metro's major rehabilitation and capital asset replacement/acquisition needs
- Build a prioritization methodology aligned with Metro's strategic goals and grounded in asset inventory and conditions assessments
- Ensure that safety, service delivery, ridership, and asset conditions will drive investment prioritization in a quantifiable and data-driven manner
- Construct a process that will support the construction and ongoing stewardship of a TAM plan as required by the FTA

Risk-Based Weighting of Criteria

Figure 1-5: Risk Based and Compliance

- Coordinate the CNI with ongoing improvements in Metro's capital programming management process, such that the CNI phase will identify investment needs by program category, the project development phase would evaluate feasibility and readiness, and the six-year CIP phase would program funds for transforming investment needs into actual projects.

The construction of a modern CNI has involved a number of process and product improvements that, while continuing to be implemented and refined, advances Metro's state of practice significantly.

- First, Metro has constructed an inventory of its capital assets building on previous asset management inventories and the initial phase of the Transit Asset Inventory and Condition Assessment (TAICA) program. Asset conditions are either provided by TAICA or calculated based on the age of the asset and FTA's empirically driven analysis of asset decay.[4] As Metro continues the TAICA effort, the asset database will be refined in the next two years to include more granular information at the sub-asset level as well as include complete physical conditions assessments for Metro's asset inventory.
- Second, the CNI incorporates a risk-based and data driven asset evaluation framework built on the FTA's Transit Economic Requirements Model (TERM) Lite. This means that the new CNI is driven by data on condition estimates, safety and security, service delivery, and ridership to determine the priority ranking of investment needs rather than professional judgment alone. Using TERM Lite as the basis, the CNI estimates the likelihood of asset failure based on condition and the consequence of that failure in terms of safety and security impacts, service delivery (i.e., reliability) and ridership. Asset failure indicates that an asset can no longer function as intended. Therefore, assets with a higher likelihood of failure and more significant impacts on safety, ridership, and service will receive a higher prioritization score under this methodology.
- Third, the CNI reflects both anticipated needs as well as compliance-based investment requirements, including corrective action plans recommended by FTA and the National Transportation Safety Board (NTSB), with a prioritization methodology that advances these critical safety or compliance needs to the top of the priority list. This allows decision-makers to clearly understand the magnitude of investment needs that are required for critical safety or compliance-related directives and the extent to which they demand funding attention.
- Fourth, any new investments that do not replace an existing investment are required to address a safety, compliance, or service delivery need in order to be considered for inclusion in the CNI. This means that the CNI focuses heavily on SGR needs rather than investments that are designed for system service amplification or enhancement alone.
- Fifth, the CNI supports four of the nine TAM plan elements required by the FTA's MAP-21 legislation—inventory of capital assets, condition assessment, decision support tools and investment prioritization.
- Finally, the CNI is now built as a "needs inventory" rather than a list of projects, and avoids confusion by doing so. This means that the CNI articulates assets and categories of assets that will require some level of investment and prioritizes these assets based on safety, ridership, and service delivery impacts. In conjunction

What is TERM Lite?

TERM Lite is the agency-level version of the Transit Economic Requirements Model (TERM), and is FTA's Capital Needs Analysis Tool that provides a national level analysis. TERM Lite is the tool designed for transit agencies to help them assess their:

- State of Good Repair (SGR) backlog (total dollar value and by asset type)
- Level of annual investment to attain SGR or other investment objective
- Impact of variations in funding on future asset conditions and reinvestment needs
- Investment priorities — by mode and asset type

Source: www.transit.dot.gov/sites/fta.dot.gov/files/TERM_Lite_Overview.pdf

4 FTA National Condition Assessment Studies, 1999 through 2006

with updates to the capital program processes, it directs Metro staff to identify projects that address these needs and move these through a project development and readiness evaluation before their consideration for inclusion in a CIP. This innovation allows Metro to manage dollars more wisely by engaging in project development and contract design prior to specifying dollar amounts for construction or acquisition and seeks to minimize programming inefficiencies as a result.

As of the writing of this report, Metro's current asset condition assessment and prioritization is seven months into a multi-year effort. Asset inventories have been conducted at a high level and physical conditions for all of the assets and sub-assets will not be available until 2018. Therefore, Metro is relying on the TERM Lite to provide a mostly age-based assessment of needs. By 2018 Metro aims to complete its asset conditions assessment and use that information going forward to update the CNI.

1.2.3 Relationship to Capital Program Management

A robust CNI is essential in programing Metro's asset investment needs during the next 10 years. It informs the levels of funding needed, both for advancing and achieving SGR and to address anticipated new investment needs that allow Metro to accommodate existing and new riders; adapt to new technology; and comply with safety directives, standards, and regulations.

Metro's capital program management is integrated with the CNI by inheriting its assessment as a starting point for identifying needs that warrant further evaluation and advancement into the project development and project readiness phases of capital programming. Consequently, the CNI helps management build an efficient capital budget with indicative projects for further scoping.

The existing asset data for the CNI is hosted in TERM Lite, while the new investment needs recommendations are held in the CFN database. Analysis of these databases is combined to determine needs and priorities under the singular CNI database (described in Chapter 2). The relationship between the existing asset inventory, new investment needs, needs inventory, and capital programming is illustrated in Figure 1-6 and described below in detail.

1. **Asset inventory:** Asset inventory is an asset management practice that consolidates an agency's assets and attributes in a centralized database and updates the attributes as assets are repaired, rehabilitated, and replaced over time. In 2012, Metro developed a draft asset inventory in TERM Lite based on a variety of asset databases and other financial and purchasing records. This initial inventory was updated annually through 2015. In 2016, Metro undertook the initial phase of the TAICA program to provide a physical inventory of assets and condition assessment. The initial CNI is based in part on TAICA data available in Phase 1 and will include more as TAICA matures.
2. **Call for New Investment Needs (CFN):** In order to address future growth in demand for Metro's services and improvement of current services with new technology, the CFN process identifies new assets for enhancement and amplification of service.

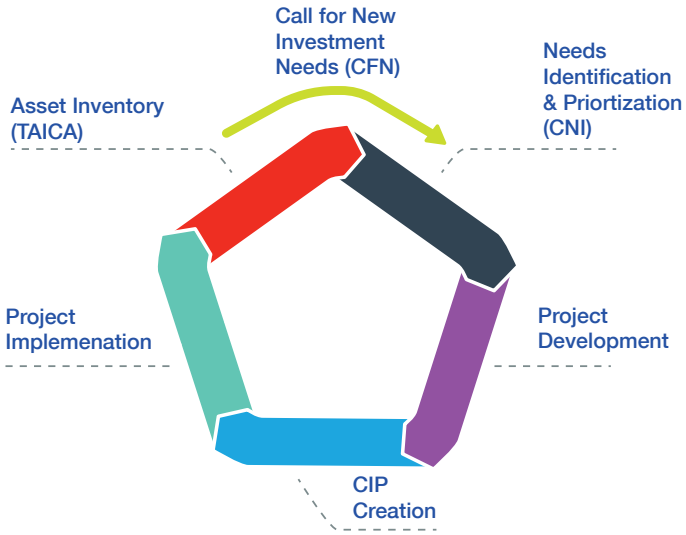


Figure 1-6: Metro's Future Capital Program Management Process

3. **Needs prioritization:** During this phase, capital needs are analyzed based on their linkages to Metro's strategic goals to determine the order and timeframe in which major asset rehabilitation and replacement actions should be taken. This CNI uses information gathered through recent updates of the TERM Lite asset inventory and the ongoing Phase 1 of TAICA to project the Metro's near-term investment needs at a higher asset level. These needs are combined with the CFN database to include new investment needs and rankings.
4. **Project development:** During this phase, capital needs are translated into the capital projects and evaluated for feasibility and readiness. Metro is currently developing a thorough Project Development process to manage the capital pipeline. For example, if a segment of track is identified for rehabilitation, the system components located along the track segment could also be identified for improvements and potentially be grouped with the track rehabilitation into one capital project. This capital project would then go through feasibility assessment, conceptual engineering, environmental review, and cost estimates.
5. **The CIP:** The CIP takes over the identified feasible projects from the project development phase, identifies available funding sources and procurement requirements, and recommends an implementation timeframe. Pending funding availability, these projects are then entered in the Metro's six-year rolling capital program to reflect Metro's spending commitments and priorities.
6. **Project implementation:** Once the project is funded in CIP, Metro completes final design, begins procurement actions, and finishes construction.

1.3 Summary of Existing Assets

Metro's current capital asset inventory is summarized in Figure 1-7. This inventory was compiled from numerous agency sources, including the TAICA Phase 1 effort[5], and represents existing assets Metro uses to deliver services (see Table 1-1). The inventory of existing assets does not include enhancement or service amplification assets, which are included separately as new investment needs.

All values are listed in 2016 dollars and include appropriate soft costs. Soft costs are an additional cost component to the actual (or neat) asset cost and are largely comprised of labor for design, installation and project management. As an example, soft costs for any asset on the right-of-way (ROW) has a soft cost of 38 percent, based on analysis of Metro's costs to construct rail infrastructure which also requires escorts to access ROW assets. Where soft costs are zero, the replacement costs given are assumed to be fully loaded with these additional costs.

Metro's inventory is broken down into the following transit asset categories:

- **Facilities:** Including maintenance facilities (major shops, and storage yards), administrative facilities, central control and equipment (maintenance and IT).
- **Stations:** Including rail stations, parking (lots and garages), bus shelters, bus transfer centers and bus loops.
- **Guideway:** Including track, structures (bridges, tunnels, and at-grade) and special structures (fencing and retaining walls).
- **Vehicles:** Including revenue (bus, rail car, and van) and non-revenue fleets (sedans, trucks, motorcycles, steel wheel, and specialties)

Summary of Existing Value by Asset Type

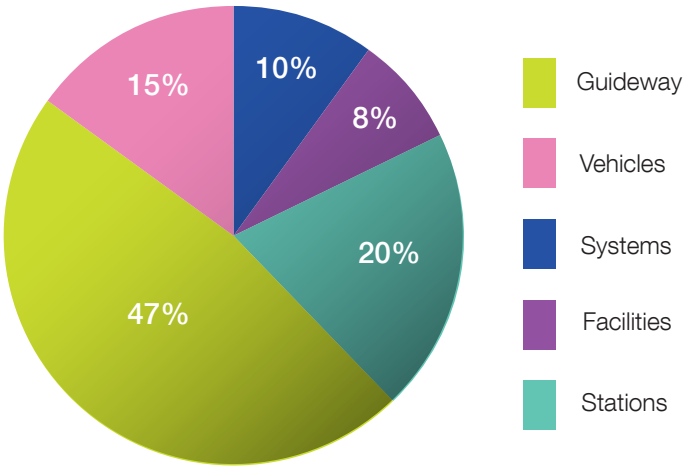


Figure 1-7: Distribution of Metro's existing assets by asset type

5 All data sources are summarized in Appendix A.1

Asset Types	Replacement Value (in Millions 2016) with Soft Costs	% of Asset Base
Facilities: Buildings	$1,540	3.9%
Facilities: Central Control	$110	0.3%
Facilities: Major shops	$290	0.7%
Facilities: Storage yards	$680	1.7%
Facilities: Equipment	$360	0.9%
Stations: Building	$5,030	12.7%
Stations: Parking	$1,870	4.7%
Stations: Elevator/ Escalator	$1,080	2.7%
Stations: Bus Shelters	$50	0.1%
Guideway: Structures	$17,490	44.1%
Guideway: Trackwork	$1,250	3.2%
Vehicles: Metrorail	$4,650	11.7%
Vehicles: MetroBus	$1,040	2.6%
Vehicles: MetroAccess	$40	0.1%
Vehicles: Non-Revenue	$320	0.8%
Systems: Communications	$340	0.9%
Systems: Electrification	$2,050	5.2%
Systems: Revenue Collection	$300	0.8%
Systems: Utilities	$180	0.5%
Systems: Train Control	$960	2.4%
Total	**$39,640**	**100.0%**

Table 1-1: Replacement Value of Existing Assets
Note: Individual items have been rounded to the nearest $10 million therefore totals may not sum due to rounding.

- **Systems:** Including electrification (traction power and distribution), train control, utilities (subway drainage, lighting and ventilation), fare collection (fare boxes, in-station equipment and central collection) and communications (passenger communications, radio, phone, and safety and security systems).

Track and structures ($18.74 billion), station buildings ($5.03 billion), and rail vehicles ($4.65 billion) combine to make up 71.7 percent of Metro's total asset base.

1.3.1 Revenue Fleet

The total value of Metro's current revenue fleet is $5.73 billion. A breakdown among the fleets used to serve Metro's three modes is presented in Table 1-2.

Metro's rail car fleet includes approximately 1,240 vehicles and is valued at $4.65 billion. The rail car fleet is currently undergoing replacement of the 1000-series with the new 7000-series rail cars, which means these values are a snapshot in time as of October 2016.[6] Most rail car series (1000, 4000, 5000, 6000, and 7000) were assigned an individual cost of $3 million and 10 percent soft costs, which equates to a total cost of $3.3 million per vehicle. The 2000 and 3000-series replacement costs are based on a new fleet of 8000-series rail cars, which are estimated
to cost $4.4 million each, as replacement costs are based on projected future procurement costs. Figure 1-8 provides a breakdown of rail car fleet by series.

The bus fleet includes 1,589 vehicles at a total value of $1.04 billion, which includes a mix of standard (from

6 Rail fleet inventory includes 7000-series replacement of 1000-series vehicles as of 10/18/16. Replacements occur weekly, and are ongoing through October 2017.

Mode	Number of Vehicles	Value (in Millions 2016)
Metrorail Revenue Fleet	1,242	$4,650
Metrobus Revenue Fleet	1,589	$1,040
MetroAccess Revenue Fleet	675	$40
Total	**3,506**	**$5,730**

Table 1-2: Summary of Fleet by Mode

Number of Rail Cars by Series

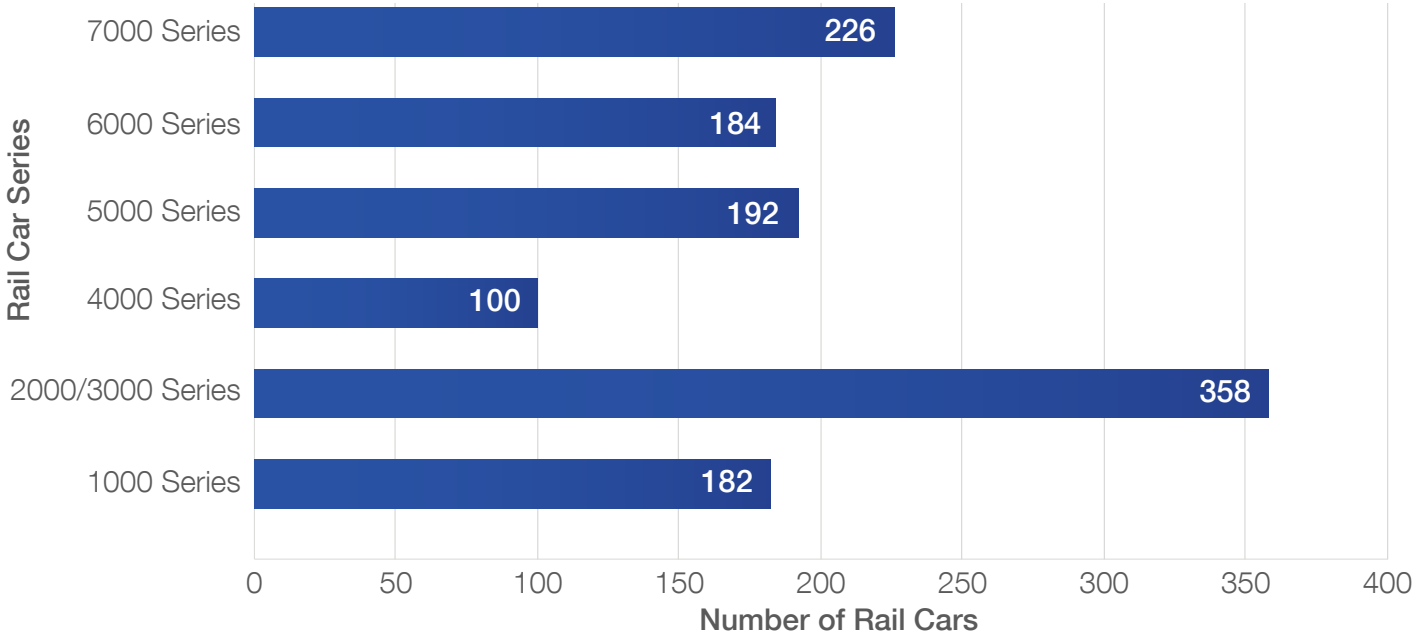


Figure 1-8: Summary of Metrorail Cars by Series

Number of Revenue Vehicles by Mode/Type

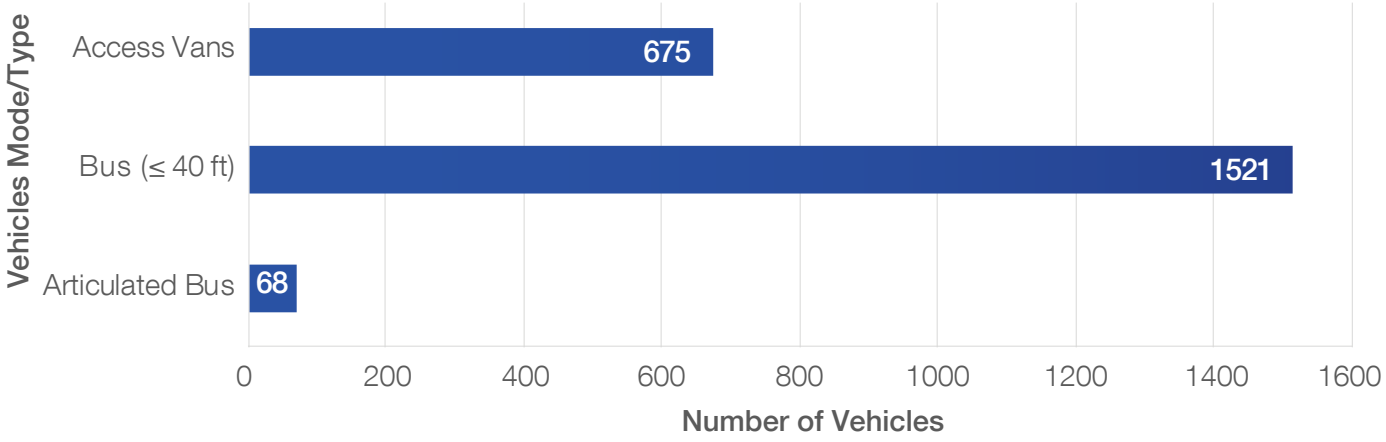


Figure 1-9: Summary of Revenue Vehicles by Mode and Metrobus type

$545,000 to $685,000 each, depending on fuel source) and articulated buses ($963,000 each). The breakdown of bus fleet by fuel type is: Diesel (255 vehicles), Compressed Natural Gas (CNG) (389 vehicles), and Hybrid (945 vehicles).[7] Going forward, Metro plans to continue replacement of the standard diesel fleet with newer and cleaner technologies.

The MetroAccess revenue fleet totals 675 vehicles at a total value of $45 million. Figure 1-9 shows the revenue fleet for Access and Bus.

Revenue fleet life cycles are based on the Fleet Management Plans (FMP) for each mode, as submitted to the FTA. Revenue fleet inventories were provided by TAICA. See Appendix A.2 for all life cycle information.

7 TAICA data as of July 20, 2016

1.3.2 Passenger Facilities

Metro operates 91 passenger rail stations, with 20 parking garages and 45 surface parking lots. In addition, Metro owns:

- Three bus loops with enclosed passenger facilities (at 14th Street, Chevy Chase Circle, and Calvert Street).
- 400 bus shelters.
- The new Silver Spring Transit Center (bus transfer area).

Of the approximately $6.8 billion in passenger facilities, rail station buildings comprise the largest portion of costs. See Table 1-3.

Metro's stations inventory includes 278 elevators and 618 escalators, along with revenue collection equipment (described under Section 1.6.7), and station components derived from Metro project managers and engineering staff who identified components that required replacement or rehabilitation. Stations were assigned soft costs of 22.7 percent based on analysis done for the Chicago Transit Authority (CTA) stations. The highest soft costs in the inventory are for station AC switchgears used to protect electrical equipment, which were assigned soft costs of 80 percent for outdoor stations and 94.5 percent for underground stations due to the high costs of installation.

Figure 1-10 is an example breakdown of the Franconia Springfield Metrorail Station inventory profile. In addition to the station building record, other components such as roof, break rooms, elevators, escalators, and parking garages are listed. Thus, all other station non-listed components, such as Heating, Ventilation, and Air Conditioning (HVAC) and platforms, are included in the station building category. In order to account for any components not listed explicitly in inventory, station buildings have a profile of rehabilitations to address these component replacements.

Figure 1-11 shows the highest-cost station (Metro Center—$260 million) and lowest-cost station (Franconia Springfield—$20 million). The average total station cost is $40 million.

Metro operates parking facilities at 44 Metrorail stations, with passenger parking facilities totaling $1.87 billion in value. See Table 1-4.

Passenger Facilities Components	Total Value (in Millions 2016)
Metrorail Station Buildings	$4,110
Bus Shelters	$40
Bus Loops	$10
Parking	$1,520
Elevator/Escalator	$1,080
Total	$6,760

Table 1-3: Replacement Value of Passenger Facilities Components

Franconia-Springfield Station Breakdown

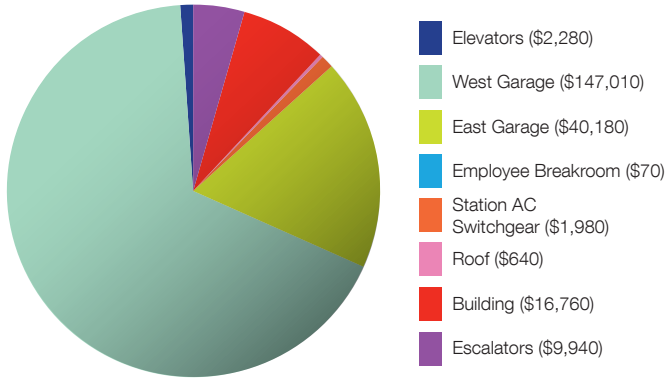


Figure 1-10: Sample Breakdown of Franconia-Springfield Station Components in Thousands of $2016 Dollars

Rail Station Value Ranges by Type

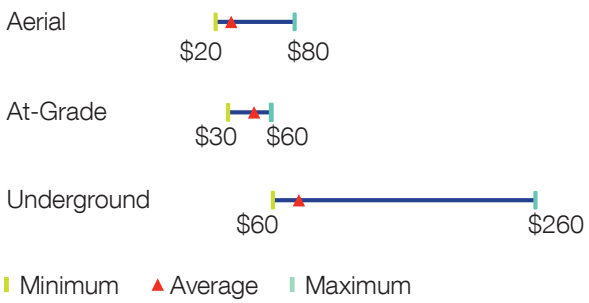


Figure 1-11: Rail Station Types by Value in Millions of 2016 Dollars

Parking Type	Value (in Millions 2016)
Garage	$1,410
Lot	$459

Table 1-4: Replacement Value of Parking Facilities

Guideway Element Type	Value (in Millions 2016)
At-Grade Guideway	$730
Cut & Cover Tunnel	$6,420
Tube Tunnel	$7,980
Rail Bridge	$1,890
Pedestrian Bridge	$30
Retaining Walls	$420
Fencing	$30
Total	**$17,490**

Table 1-5: Replacement Value of Guideway Elements
Note: Individual items have been rounded to the nearest $10 million therefore totals may not sum due to rounding

Track Type	Length (miles)	Value (in Millions 2016)
Revenue	233	$1,080
Non-Revenue	58	$160
Total	**291**	**$1,240**

Table 1-6: Replacement Value of Track Types

1.3.3 Guideway Structures

Metro guideway totals 133 miles, 100 miles of which is underground, along with 19 miles of rail bridges and 14 miles of at-grade. Additionally, Metro has 36 pedestrian bridges. With the majority of the Metrorail system located underground, water intrusion has had significant impact on the condition and wear of the guideway structures. Thus, about $90 million in investment need over the next four years has been included in the CNI to combat water intrusion. To account for the distressed state of underground elements, as well as some above-ground elements, TAICA condition ratings for aerials and tunnels and other guideway elements such as retaining walls and fencing were used to calculate effective useful lives. These assets are usually long-lived, however, due to wear and tear, this more nuanced approach to useful lives was necessary. Below is a summary of guideway elements. See Table 1-5.

1.3.4 Track

Metro operates more than 233 miles of heavy rail revenue track, which includes track running in each direction. This makes Metro the second longest heavy rail system in the U.S. Additionally, there are approximately 60 miles of track in use in Metro's maintenance and storage yards. Revenue track comprises 80 percent of total track, with non-revenue (yard) track making up the remaining 20 percent. See Table 1-6.

Metro operates about 95 miles of ballasted track, 127 miles of direct fixation, and 11 miles of tracks fixed to floating slabs of concrete. Floating slabs occur in underground stations and areas designed to limit the noise and vibration of trains arriving and departing. In addition to regular track types, Metro has 80 double cross overs and 34 single cross overs which allow trains to switch from one direction of the track to the other. Within the non-revenue track, Metro also operates 36 turntables to turn trains around within the yards.

Figure 1-12 illustrates the breakdown of revenue track by fixation type and crossovers, both single and double. Different fixation types have different cost points for track, with ballasted track being slightly less costly than track directly fixed to a concrete base such as direct fixation. Different geometry (e.g., whether or not the track is curved or straight) also dictates how long the track will last. Curves have a shorter useful life than straight sections, which is detailed in Chapter 4.

1.3.5 Electrification

Metro's electrification system is the fourth largest single asset group, and is critical to the function of the Metrorail system. Power is supplied by 103 traction power substations to energize about 237 miles of third rail (which is contacted by the rail cars for propulsion) and protective cover boards. In addition, there are approximately 50 miles of power cables, over 170 thousand insulators and over 1000 heaters to keep the third rail from freezing in the winter. The total value of Metro's complex rail electrification system is $2.05 billion.

1.3.6 Support Facilities

Metro provides maintenance and operational services for nine rail yards, nine bus garages (excluding the Royal Street garage that is currently undergoing replacement), and one MetroAccess storage facility at Industrial Road. Metro also owns a variety of support facilities to support administrative and Metro Transit Police Department (MTPD) services. See Tables 1-7 and 1-8.

These facilities are valued at just over $2.5 billion, including some large equipment such as train and bus wash systems, drop tables (used for the maintenance of rail car trucks or assemblies), water treatment facility, and compressed natural gas (CNG) fueling station. Additionally, facility equipment is accounted for separately and totals to $360 million.

Trackwork by Type

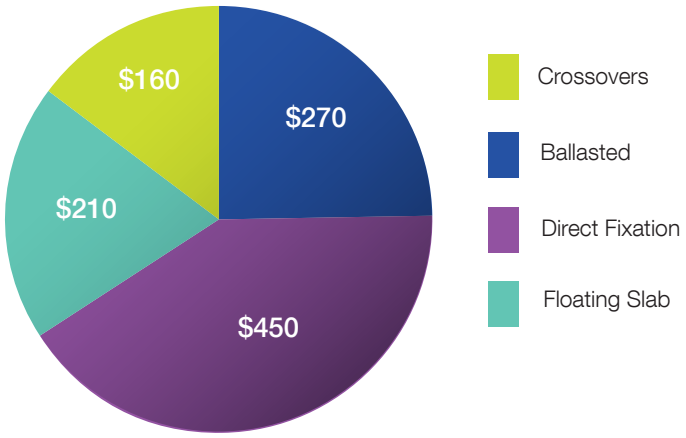


Figure 1-12: Replacement Value of Trackwork by Type in Millions 2016

Rail Yards
- Alexandria Yard
- Branch Ave. Yard
- Brentwood Yard
- Glenmont Yard
- Greenbelt Yard
- Largo Yard Ops
- New Carrollton Yard
- Shady Grove Yard
- West Falls Church Yard

Bus Garages
- Four Mile Run
- Landover
- Montgomery
- Northern
- Shepherd Parkway
- Southern Avenue
- West Ox
- Western
- Bladensburg

Administrative Facilities
- Carmen E. Turner Facility
- Jackson Graham Building
- District 1 Headquarters -MTPD
- District 2 Headquarters - MTPD
- Special Operations Division - MTPD
- Metro Supply Facility

MetroAccess Garage
- Industrial Road

Table 1-7: List of Metro Support Facilities

Building Type/Mode	Value (in Millions 2016)
Administrative	
Systemwide	$620
Bus	$540
Paratransit	$4
Maintenance	
Rail	$980
Bus	$360
Other	
Central Control	$110
Equipment (Maintenance)	$360
Total	**$2,980**

Table 1-8: Replacement Value Administrative and Maintenance Facilities
Note: Individual items have been rounded to the nearest $10 million therefore totals may not sum due to rounding

Asset Type	Value (in Thousands 2016)
CCTV	$6,060
Fuel Storage and Leak Monitoring System	$1,400
Chem/Bio Detection System	$6,130
Intrusion Detection System	$40
Emergency Exits	$5,820
Fire Protection Plumbing	$46,600
Subway Lighting	$33,660
Subway Pump Rooms	$27,750
Subway Ventilation	$37,750
Fan Plants	$4,770
Total	**$165,210**

Table 1-9: Replacement Value of Utilities and Communications Assets
Note: Individual items have been rounded to the nearest $10 thousand so totals may not sum due to rounding

1.3.7 Fire and Life Safety and Other Systems

Fire and life safety assets are included in FTA's utilities and communications asset categories. Fire and life safety assets include emergency exits ($6 million), fire-protection plumbing ($47 million), and ventilation ($43 million). The communications category includes closed-circuit television (CCTV) ($6 million), intrusion detection and fire alarms ($0.04 million), and fuel monitoring and chemical detection systems ($7.5 million). See Table 1-9.

Metro uses lighted display signs to provide passengers with their next arriving trains and information on services, alerts, and elevator outages. Passenger information and communication assets consist of Passenger Information Display Systems (PIDS) at each station and Kiosk Information Display Systems (KIDS). The replacement cost of these systems is $18 million. This value does not include all of the static signs at Metrorail stations and bus stops, which also require reinvestment. Static signage replacement and upgrades have been proposed as part of the CFN process, and are captured as enhancements to the current inventory. Fare collection assets, including fare gates and Ticket Vending Machines (TVMs) at stations, total $306 million. See Tables 1-10 and 1-11.

Asset Type	Value (in Millions 2016)
In-Station	
Cubic Station Operator Consoles	$4
Parking Meters	$13
Fare Gates	$146
TVMs	$102
On-Vehicle	
Fareboxes	$38
SmarTrip Software	$3
Total	**$306**

Table 1-10: Replacement Value of Revenue Collection Assets

Type	Value (in Millions 2016)
Passenger Information Display Systems (PIDS)	$15
Kiosk Information Display Systems (KIDS)	$3
Total	**$18**

Table 1-11: Replacement Value of Passenger Informations Systems

2. Methodology

Metro developed a new process to support the 2017 to 2026 CNI in order to be more transparent and data-driven than previous efforts. This new methodology is founded on current data documenting the age and condition of Metro's asset holdings including vehicles, stations, guideway, systems and facilities. The CNI is designed to yield an inventory of prioritized 10-year investment needs, where investment priorities are in close alignment with Metro's strategic objectives.

2.1 Overview

2.1.1 Methodology Overview

The foundation of the new methodology is a detailed inventory documenting Metro's complete asset holdings, including each asset's type, replacement costs, quantities, locations and remaining life. This asset inventory provides the basis to determine the timing and cost of asset rehabilitation or replacement investments and then to group those asset investments into related SGR reinvestment needs. At the same time, a parallel CFN process generates an inventory of known enhancement, compliance, or functional needs based on recommendations submitted by Metro departments. The SGR and CFN needs inventories are then combined to yield the complete listing of CNI needs. Finally, given that the combined investment needs documented in the SGR and CFN inventories are well in excess of the current funding level, the CNI also includes data fields and processes specifically designed to prioritize CNI needs with rankings based on each project's contributions to Metro's strategic objectives.

This and the following chapters of this report provide detailed descriptions of each of these elements of the 2017 to 2026 CNI process. After reviewing some key principles that guided CNI development, the remainder of this chapter focuses primarily on the criteria and scoring processes used to prioritize investment needs documented in the CNI database. The following chapters then cover the processes that feed the CNI database (as outlined in Figure 2-1), including asset inventory development and SGR needs assessment (Chapter 3), CFN needs identification (Chapter 4), total needs (Chapter 5), and finally prioritization results (Chapter 6).

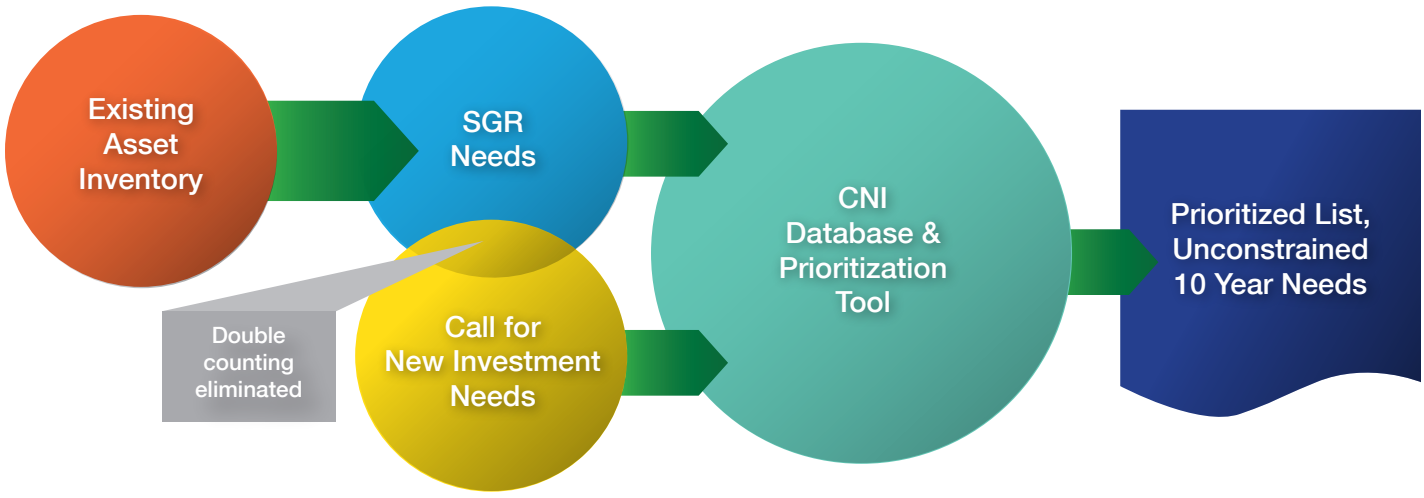


Figure 2-1: The CNI Process

2.1.2 Guiding Principles

Beyond the need to assess, document and prioritize Metro's total reinvestment needs, the current iteration of the CNI was also developed to attain several key objectives, including: meet the new MAP-21 TAM rules, align with Metro's strategic goals as laid out in Metro's Momentum Strategic Plan, and follow industry best practices.

Based on FTA guidance and review of approaches used by peer agencies, Metro developed a needs identification and investment prioritization approach that reflects best practices, including:

- Data-driven approaches that provide support for informed funding discussions
- Simple prioritization criteria with transparent measures for continuous use and communication with the public, ideally with no more than five or six criteria
- Asset condition information to provide priority for near-term needs

Upon developing the guiding principles, Metro's Capital Program Advisory Committee (CPAC), an interdepartmental committee responsible for guiding the process of prioritizing proposed capital needs, executed several rounds of deliberation and consensus-building in customizing CNI prioritization criteria for Metro. This resulted in the identification of four prioritization criteria that best align with those currently articulated by the current Board and General Manager/Chief Executive Officer (CEO).

2.2 MAP-21 Alignment

2.2.1 Alignment with MAP-21 Requirements

MAP-21 was passed by Congress on June 29, 2012. This federal transportation legislation specified, for the first time, new TAM requirements with which U.S. transit agencies must comply. Following multiple rounds of development and comment, in July 2016 the FTA published the final rule for TAM, specifying the actions required for compliance with the MAP-21 provisions.

The rule requires FTA grantees to develop asset management plans for their public transportation assets, including vehicles, facilities, equipment, and other infrastructure. The rule provides a definition of SGR; requires grantees to develop a TAM Plan, comprised of several specific elements; establishes TAM performance measures; and establishes new and revised annual reporting requirements to the NTD. Additional information regarding the TAM rules can be found at: www.transit.dot.gov/TAM.

TAM related performance targets and NTD inventory reporting requirements begin in January and October of 2017 respectively. TAICA will provide the data required to complete the new reporting requirements, while TAICA and the CNI will support development of a TAM Plan which is required to be complete by 2018.

Under this context, TAM means the strategic and systematic practice of procuring, operating, inspecting, maintaining, rehabilitating, and replacing transit capital assets to manage their performance, risks, and costs during their life-cycle in order to provide safe, cost-effective, and reliable service. To help meet this goal, FTA requires transit agencies to develop TAM Plans that include the nine elements described in the final rule as illustrated in Figure 2-2.

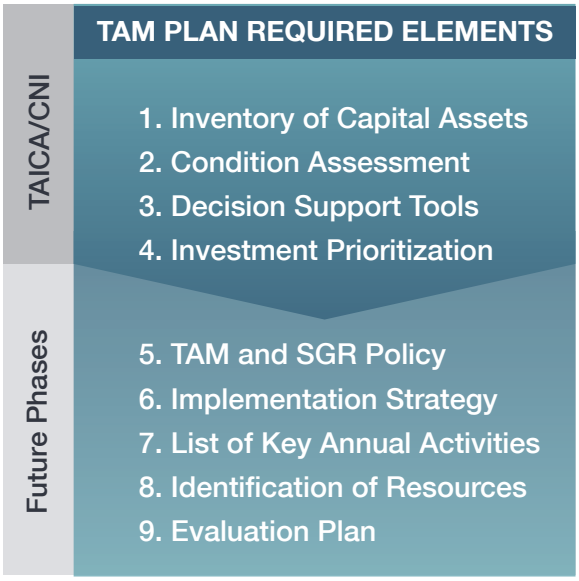


Figure 2-2: MAP-21 TAM Plan Requirements for Tier 1 Providers

These requirements are intended to enable the more effective and strategic use of federal transportation funds by focusing attention on identified national transportation goals. Metro's Capital Program Management process,

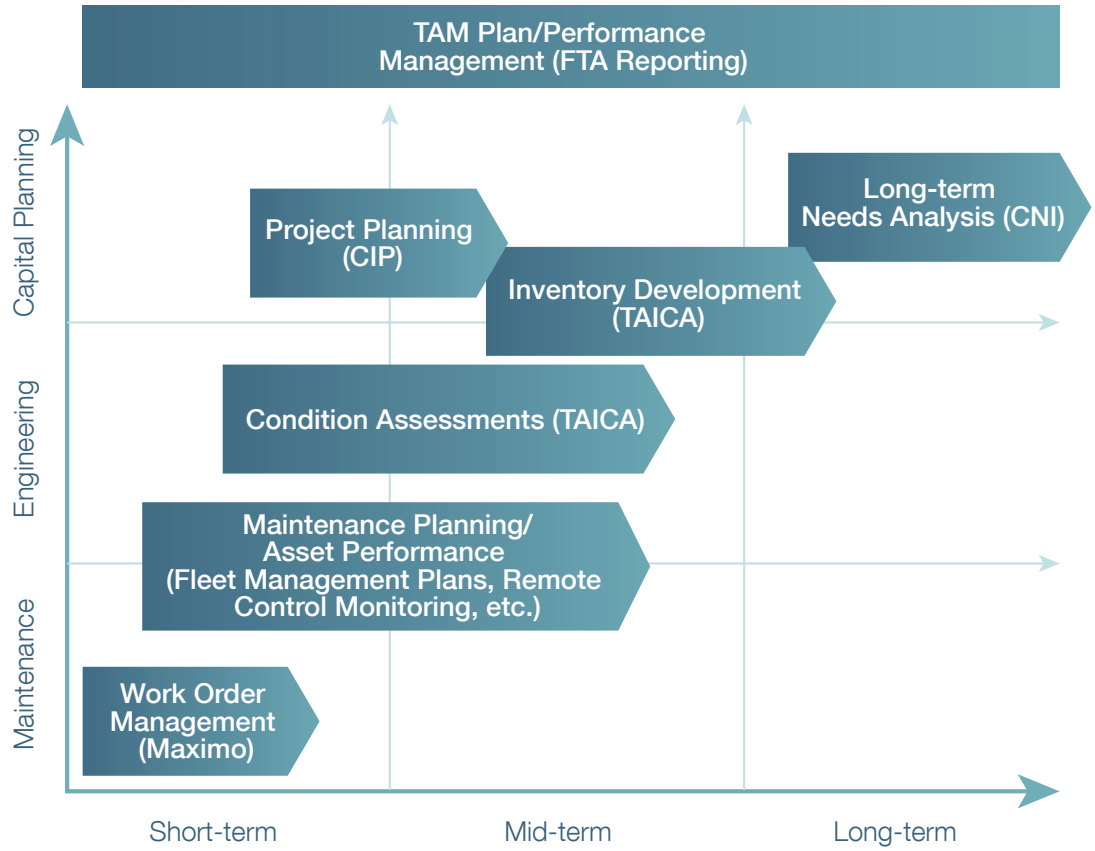


Figure 2-3: TAM Plan and Performance Management Process

including TAICA, and this CNI, will address at a minimum four of the required elements of the FTA's TAM planning requirements: Inventory of Capital Assets, Condition Assessment, Decision Support Tools, and Investment Prioritization.

2.2.2 Metro TAM Activities

In addition to the CNI activities, Metro has been working to develop a multi-pronged approach to ensuring compliance with all TAM federal requirements. In conjunction with the ongoing TAICA initiative, the CNI is a critical element of this compliance-assurance plan, as it will directly address and fulfill several requirements and interface with several others. As illustrated in Figure 2-3, TAM is cross-functional at Metro, with multiple departments and processes working together to deliver both TAM compliance and improvements to Metro's overall management of assets—becoming more proactive in maintenance and more informed regarding capital and operating expenses.

As an integral part of Metro's overall compliance strategy, the CNI further interfaces with other TAM requirements. The ongoing inventory and condition assessments being performed under the TAICA initiative provide input to the CNI. Furthermore, the application of TERM Lite and prioritization methods will be aligned in documentation and approach with respect to Metro's corporate Asset Management Policy and Asset Management Strategy. Lastly, the CNI and its resulting influence on Metro's adopted CIP in future years will impact Metro's SGR Performance Measures for applicable asset categories.

Finally, Metro recognizes that the FTA's compliance requirements are only one input into developing a robust and useful TAM program. For this reason, Metro continues to look to industry best practices and FTA guidance on improvements for their management of assets—including, but not limited to, incorporating risk assessments into the CNI.

Strategic Goals

1. **Build and Maintain a Premier Safety Culture and System:** Metro will create a safer and more secure transit experience for customers and employees.
2. **Meet or Exceed Expectations by Consistently Delivering Quality Service:** Metro will strive to provide reliable, accessible, clean, and customer-focused transit service.
3. **Improve Regional Mobility and Connect Communities:** Metro will serve as the region's transit planner, ensuring leadership for the future shape of transit in the region.
4. **Ensure Financial Stability and Invest in our People and Assets:** Metro will seek sufficient and stable funding while leveraging all of its assets wisely.

2.3 Metro Strategic Plan (Momentum) Alignment

As is best practice, the prioritization criteria Metro developed for the CNI were selected to closely align with the strategic goals laid out in Momentum, Metro's 10-year strategic plan, unanimously endorsed by its Board of Directors in June 2013 (see Figure 2-4). The CNI developed four evaluation criteria based on the four strategic goals.

Each criterion is defined based on the impact of an investment to either improve asset condition, which contributes to Metro's SGR, or the impact of an investment to mitigate asset-related risks. Therefore, the CNI investments are prioritized based on four approved elements:

- Asset Condition
- Safety and Security
- Service Delivery
- Ridership Impact

2.3.1 Prioritization Criteria

The prioritization process is designed to help evaluate the extent to which each proposed investment contributes to the four Metro strategic objectives identified in Figure 2-4. Following is a brief description of each of the four selected criteria and the scale on which investments are rated. All four criteria are scored on a common scale of 1 (lowest) to 5 (highest) using a variety of data-driven measures to determine the scores for an asset (see Figure 2-5).

Criteria Descriptions

The **Asset Condition** criterion reflects Metro's commitment to maintaining assets in a SGR. Asset condition scores are assessed using empirically based asset decay curves that use FTA's 5-point condition rating system (where higher condition ratings reflect newer assets in good to excellent overall condition while lower values reflect older assets in marginal or worn condition, see Figure 2-6). For purposes of investment prioritization, condition ratings are turned "upside down" such that assets in good condition receive low reinvestment priority scores whereas assets with low condition ratings received higher prioritization scores. Unlike other criteria, asset condition is recalculated in each year of the 10-year CNI analysis period based on the asset's age and decay curve, meaning as assets age their condition deteriorates and their priority for reinvestment increases. This dynamic scoring of condition follows the FTA's development of decay curves for the purposes of projecting future asset conditions.

The **Safety and Security** criterion reflects Metro's commitment to building and maintaining a premier safety culture and system. Metro used the MIL-STD-882E industry standard as a guideline to score the Safety and Security criterion for the CNI, as this is the standard required in Metro's System Safety Program Plan (SSPP). This standard guides a risk-based assessment that combines the severity and probability of potential hazards or incidents, to generate a combined safety or security score for each type of asset in Metro's inventory (see Appendix A.4). Unlike Asset Condition, scoring for Safety and Security is static, meaning that scores do not change based on the year of analysis.

The **Service Delivery** criterion is aligned with the agency's strategic goal to "meet or exceed expectations by consistently delivering quality service," and therefore captures both an investment's ability to meet customer expectations for service and reduce the risk of service failures/disruptions. Scoring for this criterion is based on an asset's percentage impact on customer satisfaction as

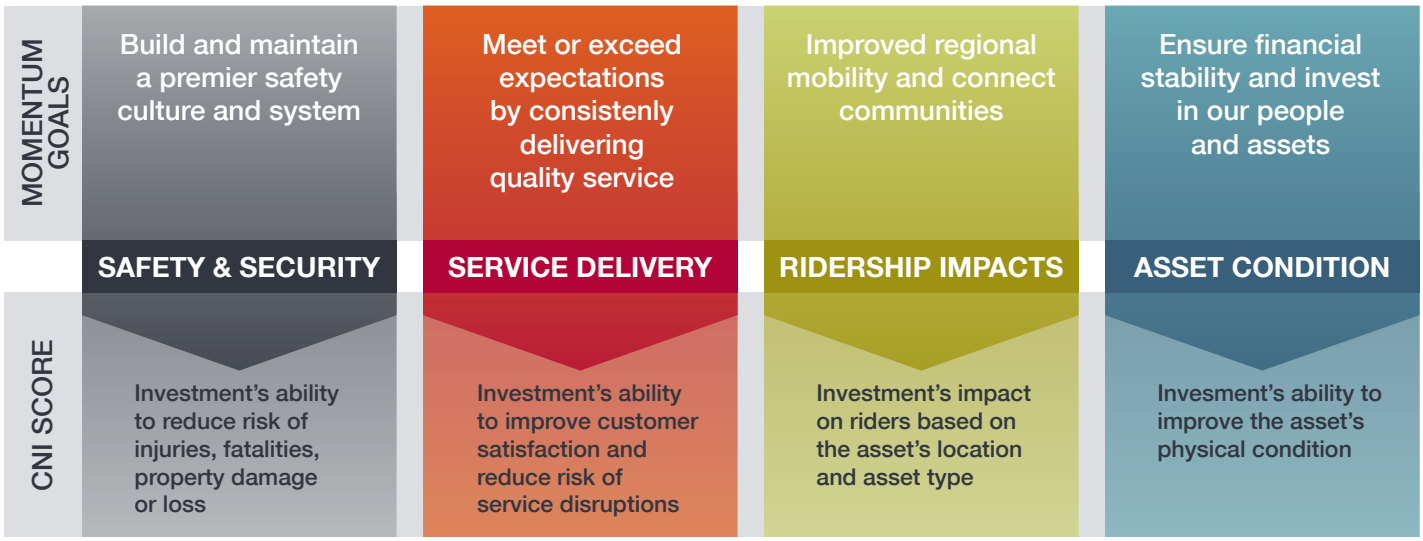


Figure 2-4: CNI Criteria Alignment with Metro's Momentum Goals

	DEFINITION	SCORING
ASSET CONDITION	The physical condition of the asset.	Based on the inverse of FTA Condition Rating, where in a scale of 1 to 5: 1 = Best Asset Condition 5 = Worst Asset Condition
SAFETY AND SECURITY	The degree to which asset reinvestment impacts the safety and security of passengers and employees.	Based on industry standard (MIL-STD-882E) risk assesment matrix, where in a scale of 1 to 5: 1 = Low Risk Assets 5 = High Risk Assets
SERVICE DELIVERY	The degree to which reinvestment improves customer satisfaction and service reliability or reduces risk of service failures.	Based on the age and the relative effect of the asset on service reliability, where in a scale of 1 to 5: 1 = Low Service Delivery Impact 5 = High Service Delivery Impact
RIDERSHIP IMPACT	The relative number of riders impacted by asset reinvestment.	Based on a logarithmic evaluation of the relative effect of the asset on ridership, where in a scale of 1 to 5: 1 = Low Ridership Impact 5 = High Ridership Impact

Figure 2-5: Prioritization Criteria

Figure 2-6: Inverted scoring for FTA condition

reported through Metro's quarterly customer survey. For example, assets that directly contribute to on-time service delivery received the highest score for this criterion as that measure has the highest impact on customer satisfaction. In addition, the level of impact on satisfaction is combined with the age of the asset to reflect the increased priority of reinvesting in older assets, in poorer condition, to improve customer experience.

Finally, **Ridership Impact** scores assigned higher priorities for those investments that benefit the most riders and are calculated based on the maximum number of weekday riders affected by an asset. Ridership levels are based on the mode an asset serves (access, bus, or rail) and the location of the individual asset in the system. To ensure that even areas with low levels of ridership receive priority, a logarithmic scale is used for this measure with the maximum set to about 700,000 riders—or the average weekday one-way trips of Metrorail. See Figure 2-7.

Assets that are not directly impacting riders, such as support equipment, are "discounted" for this element depending on how critical they are to ridership.

More information regarding the measures that support prioritization criteria is available in Appendix A.4.

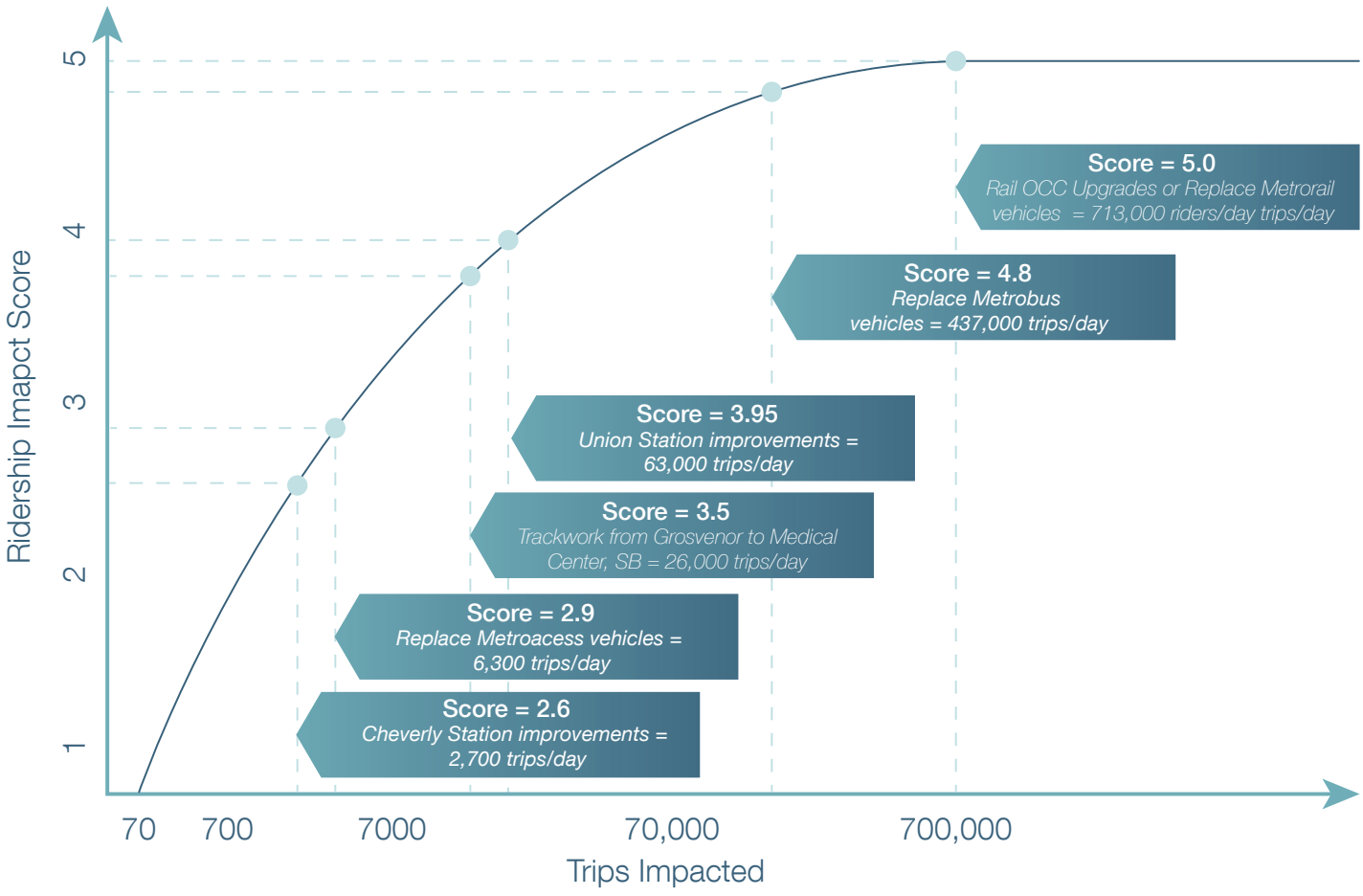


Figure 2-7: Example Ridership Impacts along Metro's Spectrum

2.3.3 Special Circumstances

In addition to the criteria scoring, Metro also identified individual assets or bundles of assets that have a higher priority due to compliance reasons, such as:

- Assets that have been damaged in accidents or have been identified through investigation or audit as requiring replacement
- Assets that no longer meet code, standard, or regulation
- Assets that are no longer fit for service due to technological obsolescence

Compliance actions include responses to NTSB recommendations, FTA audits, or internal Metro investigations. The specific treatment of these assets in scoring is described in Section 2.4.

2.3.4 New Investment Needs Adjustments

As new investment needs were submitted to the CNI via an online survey (see Chapter 4 for details), the data available for prioritization scoring differed slightly from the asset inventory data in the SGR list. The methodology described above applies to new investment needs based on primary asset types and locations with only moderate differences:

- Asset Condition: If a new investment need introduces an entirely new asset into service, the condition of those assets is assumed to be Excellent (i.e., low priority) as they do not contribute to current asset failure risks. The only exception is new assets that will address a known compliance issue (defined previously). In those cases, Asset Condition was assigned a range from Good to Adequate based on the type of compliance issue. Marginal or Poor conditions were not assigned to new investment needs, as that would double count the Marginal or Poor condition of the existing/SGR assets in inventory.
- Safety and Security: For normal new investment needs, Safety and Security scoring is based on the process described above. In the case of compliance projects, scoring for Safety and Security was escalated based on the specific type of compliance issue. Findings from FTA, NTSB, or internal Metro audits received the highest score, with all other compliance needs receiving the second-highest score.

2.4 Prioritization Weights

Metro developed a risk-based weighting approach to combine the four individual prioritization criteria into a single, overall asset prioritization score. Incorporating risk into prioritization is suggested by the FTA under MAP-21 rules to allow for agencies to understand the impact of asset failure on their services. The objective of the risk based approach is to assign the highest prioritization scores to those investments that are most likely to yield a significant reduction in the probability or severity of safety or service incidents.

Under the risk-based approach, Asset Condition is used as a proxy for the probability of asset failure. Therefore, it receives 100 percent of the weight for probability. The three remaining criteria—Safety and Security, Service Delivery, and Ridership Impact—all represent the consequences to Metro and its riders of asset failure over the forecast period (see Figure 2-8).

In the case that an asset has been designated for compliance action, the Asset Condition score, i.e., probability of failure, is increased to the maximum (5) to illustrate that the asset requires immediate replacement. The maximum consequence score also is out of 5 points. The total risk-based priority score is then converted to 100 points to better capture the variation in priority (see Figure 2-9).

The CPAC developed and reviewed multiple weighting scenarios for the CNI. These scenarios placed emphasis on one criteria over the others, or had relatively equal emphasis. By testing outputs of the CNI database repeatedly, and discussing Metro's and the region's priorities, the CPAC chose to use a Safety and Security focused weighting for the CNI—putting most of the weight on high-scoring assets under the Safety and Security criterion.

Risk-Based Weighting of Criteria

Figure 2-8: Risk Based and Compliance

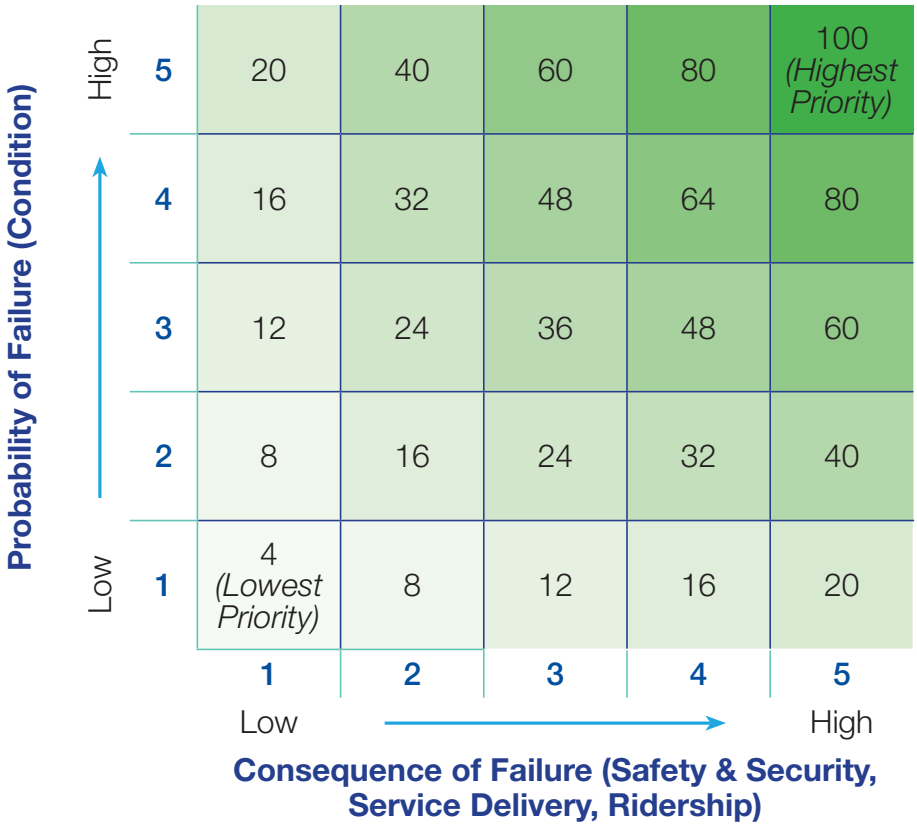


Figure 2-9: 100-point Scale Risk-based Prioritization

3. State of Good Repair Needs

The basis of Metro's SGR needs is a comprehensive inventory of existing assets. Each record in this inventory documents each asset's type, age, expected life, replacement cost and other attributes required to assess that asset's 10-year reinvestment requirements. Reinvestment types include:

- Rehabilitations that require capital maintenance (including major overhauls, renovations, or rebuilds)
- Replacement
- Annual capital maintenance (ACM)—generally occurs for larger assets such as tunnels or bridges, which require periodic infusions of capital to maintain SGR

All of the reinvestments in an asset are summed to represent its total SGR need. TERM Lite forecasts these needs based on each individual asset's age, useful life, replacement cost, and life-cycle policy regarding the timing and cost of rehabilitations or application of ACM. Cost inflation is also applied at three percent per year, so all values are in YOE dollars. Future versions of the CNI will be based on the observed physical condition of assets.

3.1 Summary of Inventory

Metro's inventory of existing assets began in 2012 as part of a pilot for the FTA's new inventory reporting requirements under MAP-21. Since that time, the data quality of the asset inventory has improved with new data sources and the TAICA program (see Table 3-1). Additional details for the sources of data for the current asset inventory are included in Appendix A.1.

As a multimodal agency, Metro has assets across all transit asset categories, as detailed in Section 1.3. Metro's asset base ranges from IT software with a useful life of three years to underground stations designed to last for 100 years. The useful life of an asset determines when an asset should be replaced and also how quickly asset condition will decay. Therefore, useful life is a key component of the CNI needs projection for SGR. In some cases, useful lives were adjusted in the existing inventory based on physical condition data from TAICA, which indicated faster decay rates than the original useful lives would suggest. For example, an asset at mid-life that TAICA found to be in poor condition must be considered at end of life in terms of investment needs.

The life-cycle policies of Metro's assets also vary widely, from multiple rehabilitations of elevators and escalators to improve their reliability and ensure they meet their useful lives, to MetroAccess vans that require no rehabilitation because they are replaced at four years. In contrast, Metro's bus fleet goes through a major overhaul at mid-life, with a set cost for each vehicle in order to reach a 15-year useful life. Assets with very long useful lives—50+ years—also have ACM needs which are generally less than 1 percent of the total replacement value and occur every year. Metro's bridges and tunnels require this kind of investment, ranging from 0.11 to 0.25 percent of total asset value, annually, to keep them in SGR. See Appendix A.2 for details on useful life and life-cycle policies.

In most cases, TAICA or asset owners (Metro staff responsible for an asset's maintenance or operation) provided the useful life and life-cycle policy for an asset. In some cases, this information was completed with research taken from industry standards, previous studies, or peer agencies. The same is true for asset replacement

values. Where replacement costs were available from Metro sources, including previous costing studies done for the FTA or current procurements, these are used in the inventory. A minority of assets required costing from external sources; all of these assumptions are noted in Appendix A.3.

The table below provides a high-level summary of the data quality of the current asset inventory by subcategory. Future updates of TAICA and the CNI will prioritize and address those areas where data quality is currently low.

The total replacement value of the existing inventory and other quantities are provided in Section 1.3.

Table 3-1: Existing Inventory Data Source Summary

Asset Type	Primary Data Source(s)	Quality of Data	Source Notes
Revenue Vehicles: Rail	TAICA, Fleet Management Plan (FMP)		• TAICA provided in-service dates as of October 18, 2016. • Costs, useful life (17-40 years depending on series) and life-cycle plans from FMP. • Additional rehabilitation plans submitted by Metro project managers.
Revenue Vehicles: Bus	TAICA, FMP		• TAICA provided in-service dates, costs, useful life (12 years for articulated, 15 years all other) and life-cycle plans.
Revenue Vehicles: Access	TAICA, Subject Matter Expert (SME)		• TAICA provided in-service dates and useful lives (four years). Costs from SME.
Non-Revenue Vehicles: All	TAICA		• TAICA provided in-service dates, costs, and useful life (five to 75 years depending on type).
Stations: Elevator and Escalator	Maximo, SME		• Elevator and escalator inventory updated to reflect replacements as of 2015. • Life-cycle plans and costs provided by Elevator and Escalator SME.
Systems: Fare Collection	Maximo, SME		• Fare collection equipment date built and quantities from Maximo. • Cost and useful life provided by Automatic Fare Collection SME
Facilities: Maintenance Equipment	TAICA		• TAICA provided in-service dates, costs, and useful life (1 to 40 years depending on type). • Some assumptions used to fill in costs and date built where similar equipment was in inventory.
Systems: Train Control	TAICA, SME		• TAICA provided interlocking, non-interlocking, and switch machine inventory with date built, costs, and useful life. • Additional track circuit data included based on Office of Chief Engineer, Infrastructure Services (CENI) input on total system cost.

Asset Type	Primary Data Source(s)	Quality of Data	Source Notes
Facilities: Buildings	LAND Asset List, National Transit Database (NTD) Pilot Submission		• LAND list of facility locations and types. NTD facility costs based on insurance values. • Life-cycle plans were based on industry standards or submitted by Metro project managers as component replacements.
Stations: Buildings	NTD Pilot Submission, SME		• NTD facility costs based on insurance values. Useful life provided by Engineering SME (underground 100 years, above ground 75 years). • Life-cycle plans from industry standards or submitted by Metro project managers as component replacements.
Guideway: Structures	TAICA, WMATA Construction Costs		• TAICA provided structure and special structure quantities (linear feet), date built, and conditions. • Condition is used to determine "effective useful life." • Costs and life-cycle plans estimated from Metro previous studies and project manager submissions.
Systems: Power	Maximo, TERM Federal Submission		• Combination of Maximo records (third rail) and previous Metro study for FTA's Rail Modernization Study (2009) for quantities, types, and costs. • Reviewed by Power Engineers for validity. Inventory updated to reflect replacements as of 2015. • Insulator locations, quantities, useful life, and costs provided by CENI.
Systems: Utilities	Maximo, SME		• TAICA provided with the exception of lighting records. • Useful life calculated based on TAICA data and condition scores (effective useful life range from 1 to 30 years). • Quantities and costs for some records are not included in TAICA Phase 1 data, and are filled in using assumptions.
Guideway: Trackwork	TAICA, WMATA Construction Costs		• Track converted from Maximo chain markers to inventory but with some gaps/overlaps. • Useful life estimated by Engineering (underground/tangent = 20 years; underground/curve = 10 years; above ground/tangent = 30 years; above ground/curve = 15 years). Original date built used for segments.
Systems: Communications	Maximo, SME		• In-service dates and costs assumed for whole systems: public address, fire and intrusion systems, and communication terminals. • CCTV and radio system costs estimated based on submissions from Metro project managers for upgrade/enhancement projects.

Note: Green indicates all internal and verified Metro data; yellow/green indicates some industry or Metro data has not been validated; yellow indicates use of some unverified data and gaps for key data components; orange indicates known gaps in a key data component that could not be updated; red indicates multiple known gaps in key data components. All gaps in data components are filled with Metro SME input first and industry sources as a last resort.

3.2 10-Year SGR Needs Estimates

Metro's SGR needs include $6.66 billion in deferred capital needs. Deferred needs include assets which require immediate reinvestment as they are past their useful lives or require rehabilitation or replacement due to compliance issues. In total, deferred capital needs comprise approximately 16 percent of Metro's total asset base.

The largest proportion of deferred capital needs are in major systems such as traction power and train control. Guideway elements, which include track, tunnels, bridges, and other structures make up the next largest portion of the deferred needs (see Figures 3-1).

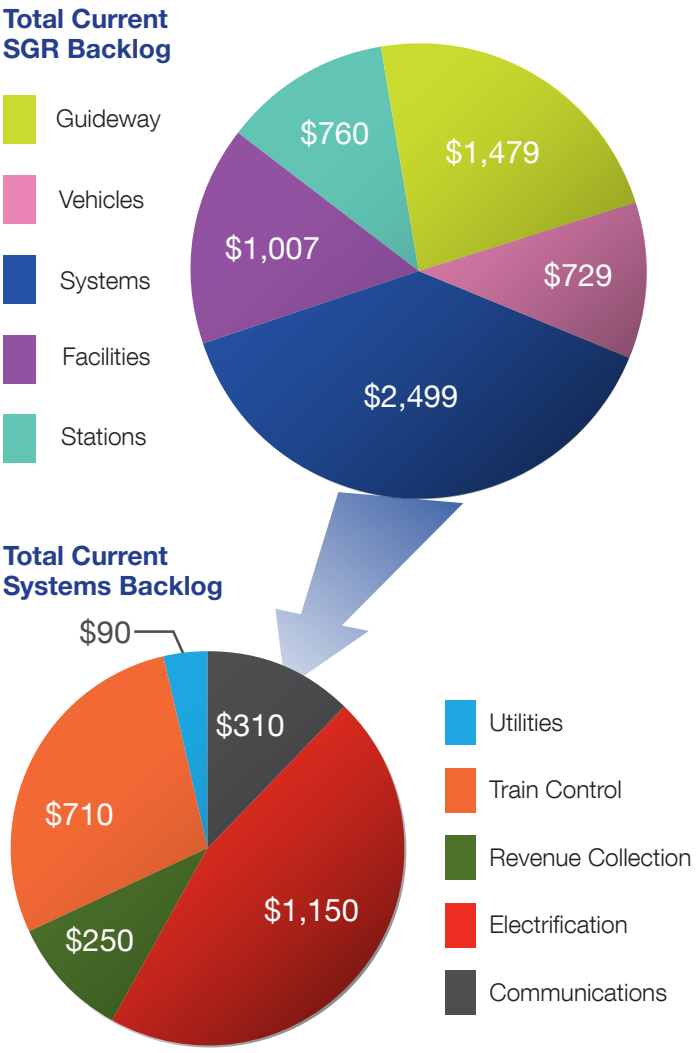


Figure 3-1: Total Cost of Current SGR Backlog in Millions 2016
Note: Individual items have been rounded to the nearest $10 million therefore totals may not sum due to rounding.

Deferred capital needs also include a variety of compliance related projects, which must be completed as a priority to meet FTA, NTSB, or internal Metro standards. Priority items include the replacement of the 1000-series rail cars, installation of a new radio system, and replacement of track circuits and power cabling where necessary.

During the period of the CNI, from 2017 to 2026, the total SGR needs are $17.36 billion, or $1.74 billion per year. This includes normal replacement, rehabilitation, and ACM once the deferred capital needs are addressed (see Figure 3-2). Major investments include replacement and rehabilitation of Metrobus ($1 billion), Metrorail ($4 billion) and MetroAccess ($148 million) fleets (see Table 3-2).

In addition to the $1.15 billion of electrification (e.g., traction power) assets in the deferred capital needs, there is an ongoing need to replace insulators in tunnels where there is water intrusion. Insulators in these environments wear out in 18 months to four years, instead of the normal 10+ years in dry environments. Regular replacement of these assets, along with heaters, composite, and cover boards for the third rail, increase the cost of electrification needs to $1.84 billion during the course of the CNI period, making electrification the second largest investment category for SGR.

The high cost of insulator replacements—a total need of $76 million—highlights the added benefits of investment in mitigating water intrusion in Metro's tunnels and maintaining the tunnels in SGR. Approximately $19 million is needed annually for tunnel capital maintenance with an additional $86 million specific capital investment to remediate conditions that are subject to significant water intrusion. These investments could reduce the need for insulator replacements alone by about $3 million per year in addition to capital savings for track, third rail, cabling, and other assets in tunnels which wear faster when wet.

Due to the short useful life of software, much of which is critical to delivery Metro's services, the third largest category of SGR needs is IT. In order to maintain the hardware and software that supports fare collection, communications, asset management, and financial

Summary of 10-Year SGR Needs

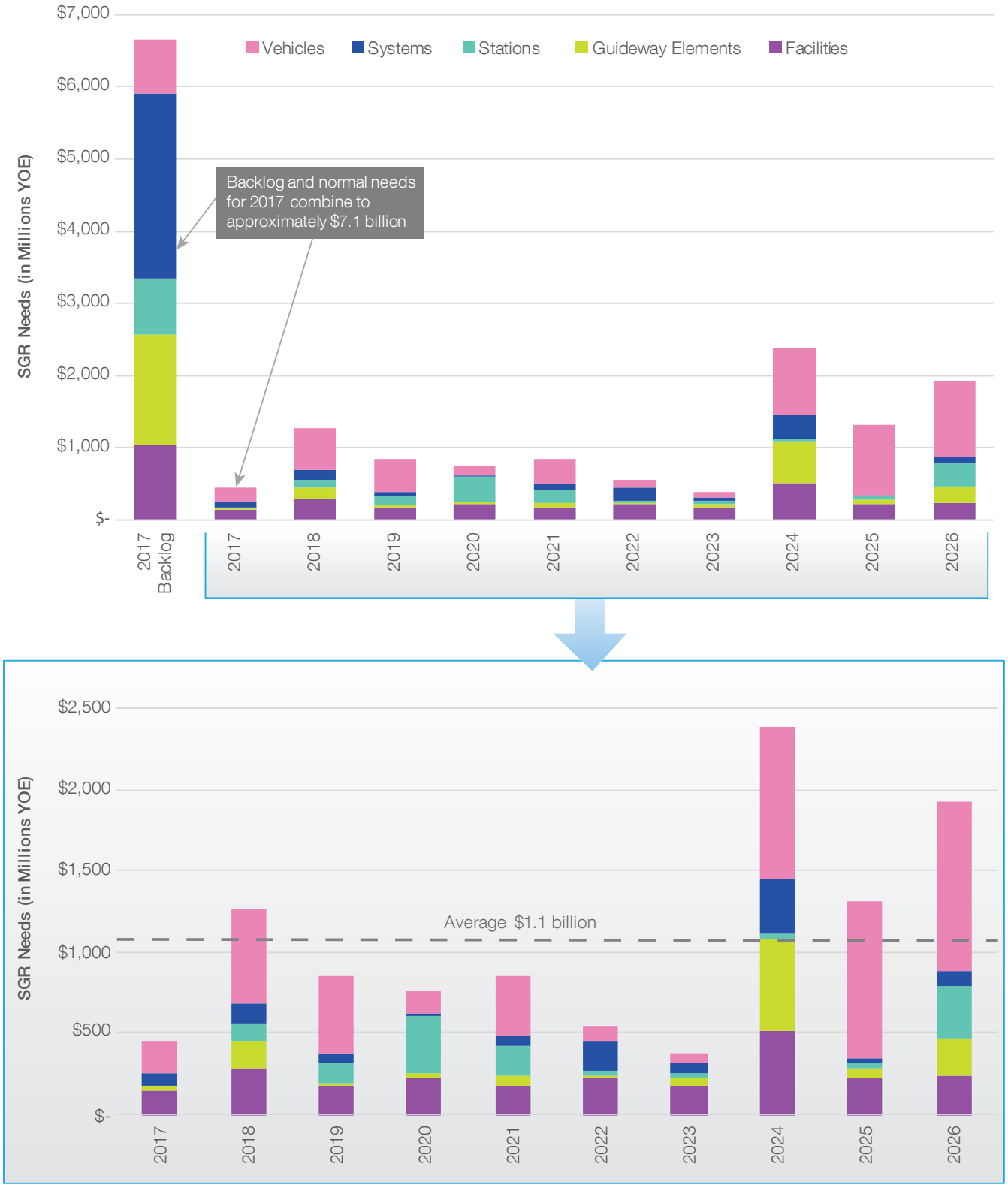


Figure 3-2: Unconstrained 10-Year Total SGR Needs by Asset Category

Asset Sub-Category	Total 10-Year Reinvestment (in Millions YOE)
Revenue Vehicles	$5,291
Electrification (traction power)	$1,842
IT/Network Systems	$1,287
Trackwork	$1,034
Elevators and Escalators	$965
Aerial Structures (bridges)	$944
Train Control	$925
Maintenance Buildings	$855
Passenger Parking	$747
Maintenance Equipment	$450
Storage Yards	$362
Communications	$352
Special Structures	$348
Administration Buildings	$348
Non-Revenue Vehicles	$316
Revenue Collection	$310
Underground structures (tunnels)	$272
Rail Stations	$237
Utilities (tunnels)	$160
At-Grade Structures	$141
Central Control	$110
Bus Shelters	$58
Bus Loops	$5
Other Facilities & Equipment	$5
Total	**$17,360**

Table 3-2: Annual SGR Needs by Asset Type

systems (among other things), Metro needs $1.3 billion in reinvestment. This includes maintaining and replacing assets that support field inspections of the rail system and the enterprise resource planning system (PeopleSoft).

Track also requires a large investment to replace components on a regular basis. In total, track requires just more than $1 billion in investment during the next 10 years. However, this analysis is based largely on full replacement and original construction dates which predate the SafeTrack program. As SafeTrack delivers component replacements, component-level inventory is required to capture its impact—which is currently not available in the CNI database. SafeTrack's improvement of track condition will be reflected in future TAICA and CNI updates by working closely with track and structures to determine the best method of capturing improved condition (see Figure 3-3).

Summary of 10-Year SGR Needs

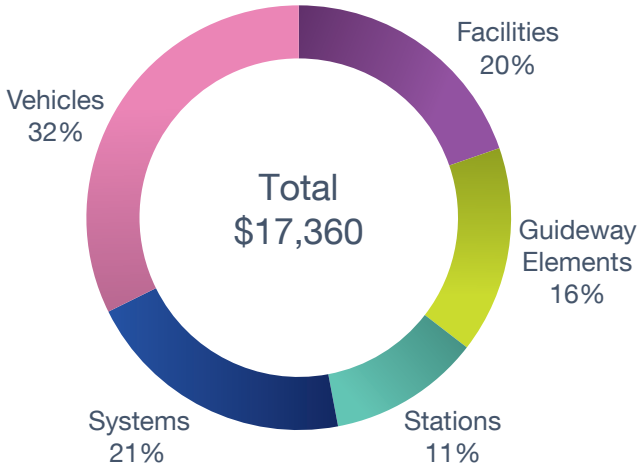


Figure 3-3: Total 10-Year SGR Needs by Asset Type in Millions YOE

3.2.1 Key Findings

The following summary of findings provides context for the SGR needs included in the CNI:

- Metro's SGR needs total $17.36 billion for 10 years, with the largest portion of needs in the current year driven by the estimated $6.66 billion in deferred capital needs.
- Average reinvestment following the backlog is much lower, at approximately $1.1 billion per year.
- Vehicles make up the largest portion of SGR needs by asset type, as most fleets will reach end of useful life during the CNI period.
- Electrification of the rail system is the second largest SGR need, in part due to increased rates of decay and failure in wet tunnel environments. Mitigation of water intrusion in Metro's tunnels can provide added capital savings across multiple asset categories by addressing this kind of accelerated decay.
- Major investments are also needed in IT and track, though track estimates in the CNI do not currently capture SafeTrack's progress of improving track conditions and require re-evaluation in the next iteration of the CNI.
- Metro needs $1.8B in SGR investment to be in compliance with NTSB, FTA, and other safety and security directives. The compliance based SGR needs include 1000 series rail car replacement, track circuits, intrusion detection system, central train control, power cable, train control cable, water intrusion project, subway lighting, tunnel ventilation, and radio system upgrades.

4. New Investment Needs

Metro conducted a CFN process in August 2016 to solicit information on new investment needs from Metro departments to meet safety and regulatory requirements, keep up with modern transit technology, and support system enhancements.

For the purposes of the CFN process, a new capital need was defined as an asset that meets one of the following conditions:

- Provides a completely new function for the Authority, one that neither replaces nor expands existing assets.
- Replaces an existing asset with a new asset that provides a new function or enhances the existing asset by demonstrably impacting safety, security, ridership, and/or service delivery.
- Amplifies the existing system services.

Replacement of an existing asset with a new asset that has a different function is considered a new need even if it is replacing an existing asset at the end of its useful life. Similarly, an enhancement or service amplification asset is considered a new need (i.e., an additional bus garage).

As with SGR needs, all new investment needs are inflated at a rate of 3 percent per year and are shown in YOE dollars.

4.1 CFN Overview

To gather new investment needs, Project Managers (PM) from across Metro's organization were selected by CPAC members to provide detailed information on new assets, justifications for them, and the required timing and costs for delivery. Metro's PMs entered the information that provides the list of new investment needs for prioritization in the CNI database.

Training and support was provided to ensure that PMs completed all of the required CFN website fields accurately. Following the closing of the submission period, Metro staff undertook an in-depth review of the submissions and followed up with PMs on items requiring clarification. The quality review of submissions resolved issues related to:

- Duplicate needs submitted by different departments
- SGR needs that also were captured as rehabilitation or replacement needs

Following review with PMs and Metro staff, duplicate needs were merged into one CFN submission and SGR needs were confirmed against the existing inventory and TERM Lite projection of needs. The final result was a list of 152 new investment needs for inclusion in the CNI. More details on the CFN data entry and review process are available in Appendix A.5.

4.2 10-Year New Investment Needs Estimates

The total, 10-year cost, for all the new investment needs is $7.04 billion. As seen in Figure 4-1, the majority of new investment needs (53 percent) have relatively low 10-year cost projections at $5 million dollars or less, while only a quarter of new investment needs cost more than $20 million. The most expensive new need, at $1.75 billion, is the expansion of the rail car fleet to operate with 100 percent eight-car trains instead of the current operations with mostly six-car trains. A new investment need related to compliance includes the installation of worker wayside detection systems at $7.6 million, which automatically alert wayside workers of approaching trains and train operators when approaching areas with workers on or near the tracks.

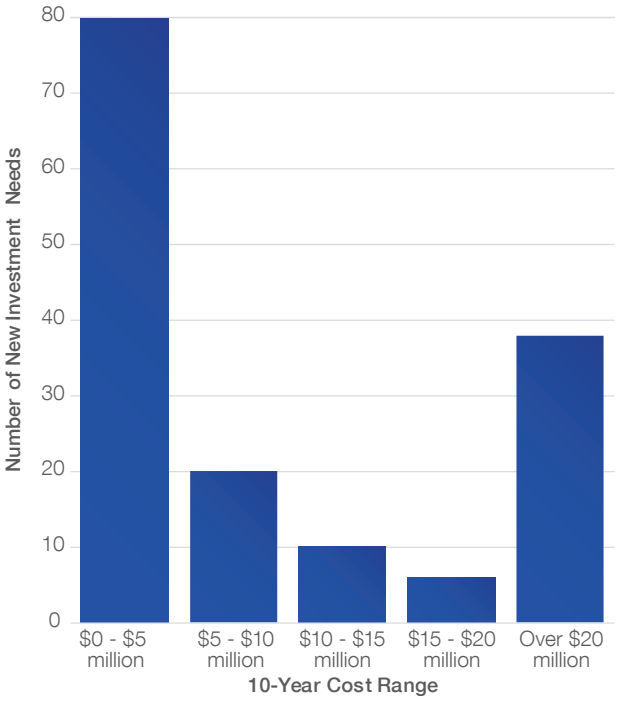


Figure 4-1: Distribution of New Investment Needs by 10-Year Cost in YOE

The annual new investment needs cost estimates incrementally increase through the year 2022 (See Figure 4-2). The large jump in costs in 2022 comes from two high-cost new investment needs, Rail cars to Operate Full Eight-Car Trains (ID 150) and Improving Safety/Reliability in the Blue, Orange, and Silver Lines Corridor (ID 137). Only 17 new investment needs have costs that extend into 2025 and 2026, which makes those years' costs more than 50 percent lower than the prior years. Separating the two high-cost projects from the remaining cost of new investment needs by year illustrates the impact of these two projects on the forecast for Metro's new investment needs (See Figure 4-3).

Vehicles and facilities comprise 30 and 29 percent of total new investment needs costs, respectively. It is worth noting, however, that 82 percent of the total costs of new vehicles come from a single project, the purchase of rail cars to operate full eight-car trains. High-cost new investment needs for facilities include:

- Expanding storage and maintenance facilities to support operation of full eight-car trains
- Building a central heavy repair and overhaul facility for Metrorail
- Building an expansion bus garage

The annual costs of new investment needs by asset category are fairly consistent across the 10-year period (See Figure 4-4). Facilities costs peak in 2017 and are thereafter relatively stable, while Guideway Elements new investment needs are greatest in terms of cost later in the CNI period, from 2021 to 2025.

4.2.1 Key Findings

The following summary findings provide context for the new investment needs in the CNI:

- The 152 new investment needs submitted by Metro's PMs have a total cost of $7.04 billion over 10 years.
- The majority of new investment needs (53 percent) have relatively low 10-year cost projections at $5 million dollars or less.
- Vehicles and facilities make up the largest portion of new investment needs by asset type, due to a handful of high-cost projects to expand Metro's rail and bus services, and ensure reliability on the Orange, Blue, and Silver Lines.
- The most-expensive new need is expansion of the rail car fleet to operate with 100 percent eight-car trains at $1.75 billion (in total, $2.9 billion in new investment needs were submitted for eight-car train projects, including the rail cars and ancillary costs for power upgrades and expanded maintenance facilities; all four phases of the eight-car train projects are interdependent needs).
- The CNI identifies $1.6 billion in new investment needs to comply with safety, regulatory, environmental, audit, or other directives.

Summary 10-Year New Investment Needs

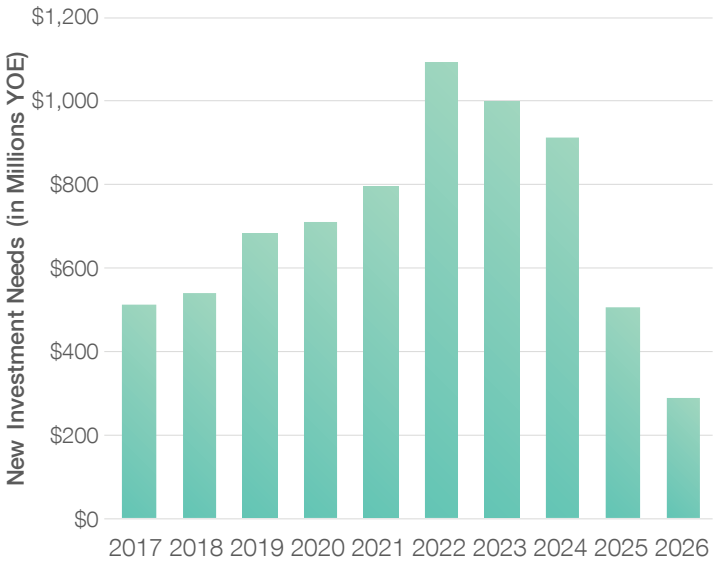


Figure 4-2: Total Costs of New Investment Needs by Year

Cost Impact of ID137 and ID150 on 10-Year New Investment Needs

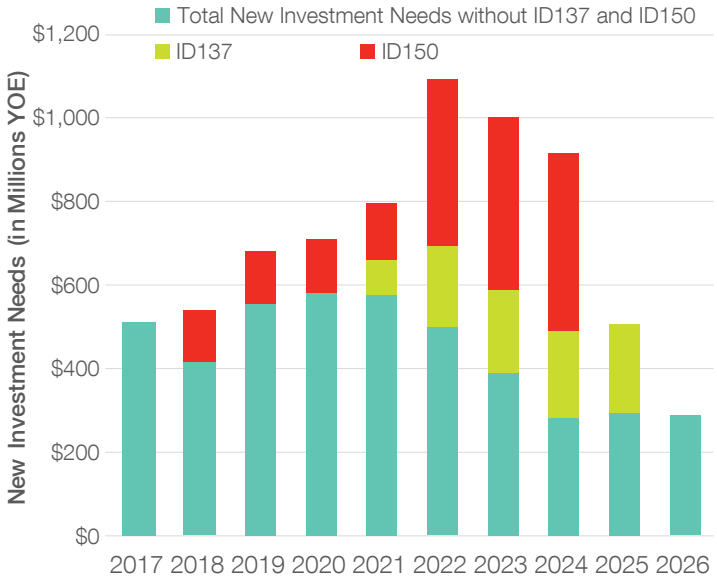


Figure 4-3: Total Costs of All New Investment Needs vs. Total Costs of New Investment Needs without New Need ID137 or ID150 (Orange/Silver/ Blue Safety or Eight Car Trains Needs)

Summary of 10-Year New Investment Needs

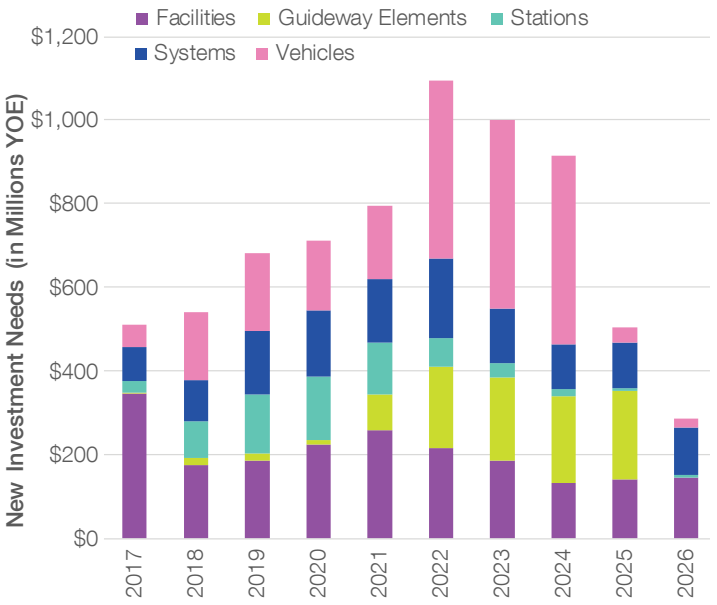


Figure 4-4: Annual Costs of New Investment Needs by Asset Category

5. Total Capital Investment Needs

The combined SGR, new investment, and unallocated needs total $25.18 billion from 2017 to 2026. Due to the level of deferred capital needs, the majority of needs occur in 2017. Averaging these needs over time, the level of need is $2.52 billion per year.

10-Year Total Needs

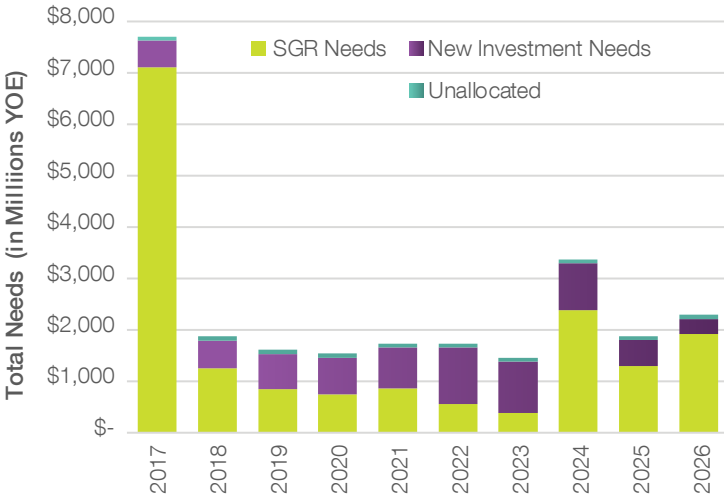


Figure 5-1: Unconstrained 10-Year Combined Needs with Unallocated Capital

In addition to the SGR needs estimated based on Metro's existing inventory and new investment needs submitted by PMs, there is approximately $80 million annually of unallocated capital needs that cover a variety of activities. In general, these additional activities include:

- Regular repairs and capitalized maintenance
- Consulting, IT, and engineering services
- Upgrades to Metro's stormwater management
- Signage replacements and improvements across the system

SGR needs are approximately 70 percent of the total needs, with new investment needs at 28 percent and unallocated needs at 3 percent.

The small percentage of unallocated needs are not prioritized for the CNI. As these costs represent a mix of SGR and new investment needs and generally do not align to an individual asset type, they fall outside the CNI database. Therefore, each iteration of the CNI will have to consider if there are new unallocated needs to include, or if some of these needs have been addressed and can be removed from the list.

5.1. Key Findings

While the CNI methodology attempts to address any overlap in SGR and new investment needs, there are some areas where double counting may be inevitable. As an example, replacement of electrification components for SGR includes equipment at traction power substations that would also be upgraded as part of the nearly $550 million in new investment needs for improving traction power to operate full eight-car trains.

Where new investment needs replace an existing asset with an improved or enhanced technology, there will certainly be cost savings—in terms of both labor and component costs—to addressing any SGR need with the new technology. Therefore, where high-ranking new investment needs (see Section 6.3) require existing assets to be replaced, Metro will consider the most efficient course of action to avoid making SGR reinvestments without taking into account potential new investment technologies.

6. Prioritization

It is important to note that the CNI is entirely unconstrained, in terms of both time and budget. Metro needs to substantially increase its capital funding and project delivery capacity above today's levels. As Metro does not currently have the funding necessary to address the 10-year CNI investments, the prioritization of these needs is critical to inform budget-level decision making. The prioritization methodology described in Chapter 2 provides Metro the ability to align these needs with current priorities.

6.1. Key Findings

The prioritization criteria and risk-based weighting approach is applied in the CNI database, with TERM Lite providing the engine to score and organize individual assets into grouped SGR needs. These grouped SGR needs are not equivalent to the scoped projects that would enter a project development process for review. Rather, they are bundles of coincident needs occurring in the same location and/or across the same asset type that require further input from asset owners to refine into scoped projects. Also, given that the 2017 to 2026 CNI is the first iteration of this methodology, the data and process require further improvements to generate more accurate SGR groupings.

As the score for an existing asset changes each year based on asset decay, the maximum score for the 10-year period of analysis is used to rank SGR needs. The ranking for new investment needs are static, as they involve adding new assets to Metro's inventory that have yet to decay.

In both cases—SGR and new investment needs—compliance is a driving factor for priority. For SGR, asset condition also is a key component, as assets with high wear and tear (such as Metro's tunnels and track) require annual interventions to maintain their condition.

Finally, there is no relationship between the total cost of a need and its priority score, since costs are not a factor in the CNI prioritization scoring. This can be observed in Figure 6-1, which, for scale purposes shows the new investment needs by priority score and costs less than $200 million.

6.2. SGR Needs

The highest-ranked SGR need is scored as 91 (out of 100) for replacement of insulators on the Red Line where water intrusion is constant, and insulators reach the end of their useful lives in 18 months to 2 years—requiring repeated replacement during the next 10 years. The lowest-ranked SGR need is scored as 27 for rehabilitation of MetroAccess's Industrial Road facility (storage lot). A majority of SGR needs score over 50 points.

Figures 6-2 illustrates that rail infrastructure and systems score the highest in terms of priority; while stations and facilities score the lowest. The highest scoring assets are in poor condition, which increases their risk of failure, and are critical to safety, service and ridership. Electrification systems, which make up the highest scoring systems assets, also have a Compliance component, as defective power cable replacement ($225 million) is required under an NTSB Safety Directive (R-5-35-e).

Other SGR asset replacements with a compliance requirement, most related to NTSB recommendations, include:

- 1000-series rail cars at a replacement value of $619 million (the delivery of 7000 Series rail cars to replace these cars is fully funded, ongoing throughout the CNI process, and will be completed by October 2017). The high scoring value of these replacements is included with all rail car reinvestments (over $4 billion) with a weighted average score of 75 out of 100 as seen in Figure 6-3A as Revenue Vehicles (Heavy Rail).
- As already noted, water intrusion is a common problem in Metro's tunnels. Therefore, mitigating water intrusion in underground structures ($86 million) is also required by NTSB (R-16-08), and ranks highly (scored an 85) along with the ongoing maintenance of tunnels.
- A variety of train control equipment requires reinvestment and upgrades including central control equipment ($110 million), track circuits ($127 million), and train control cabling ($254 million), which score

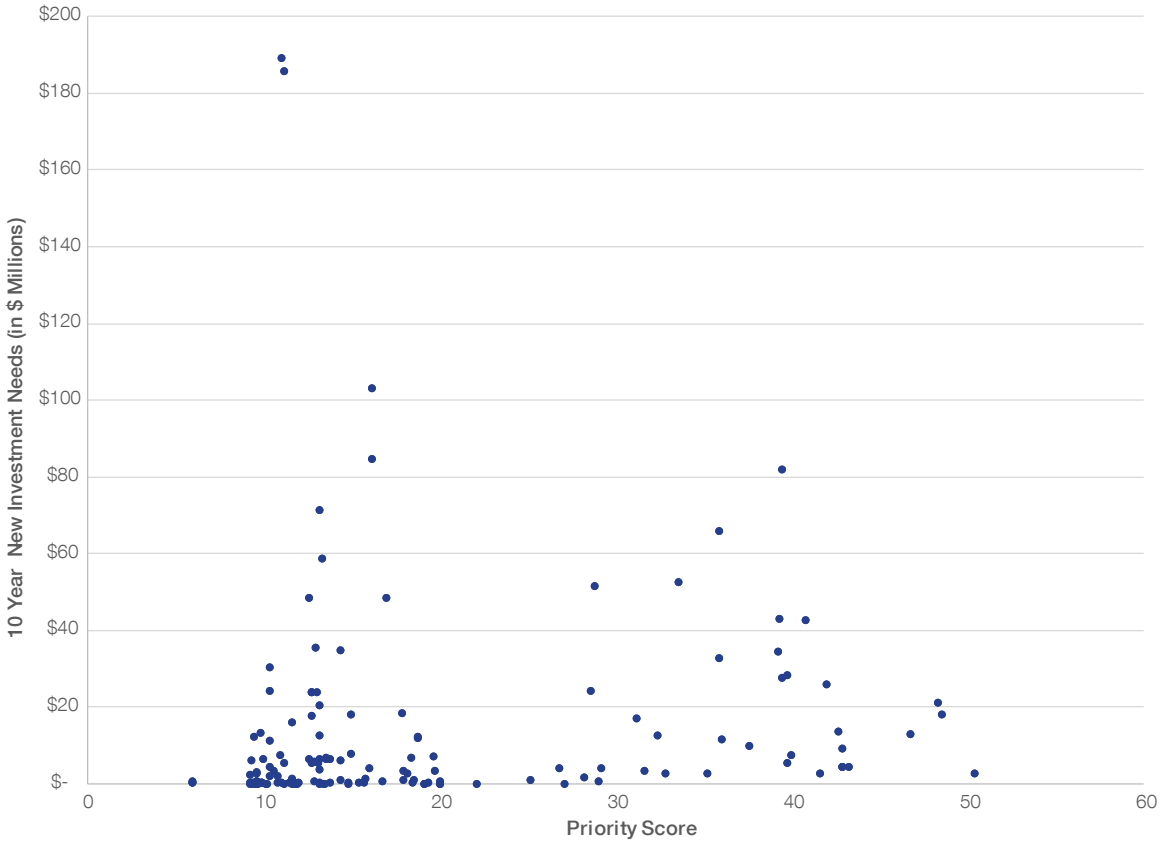


Figure 6-1: Priority Scores of 10-Year New Investment Needs

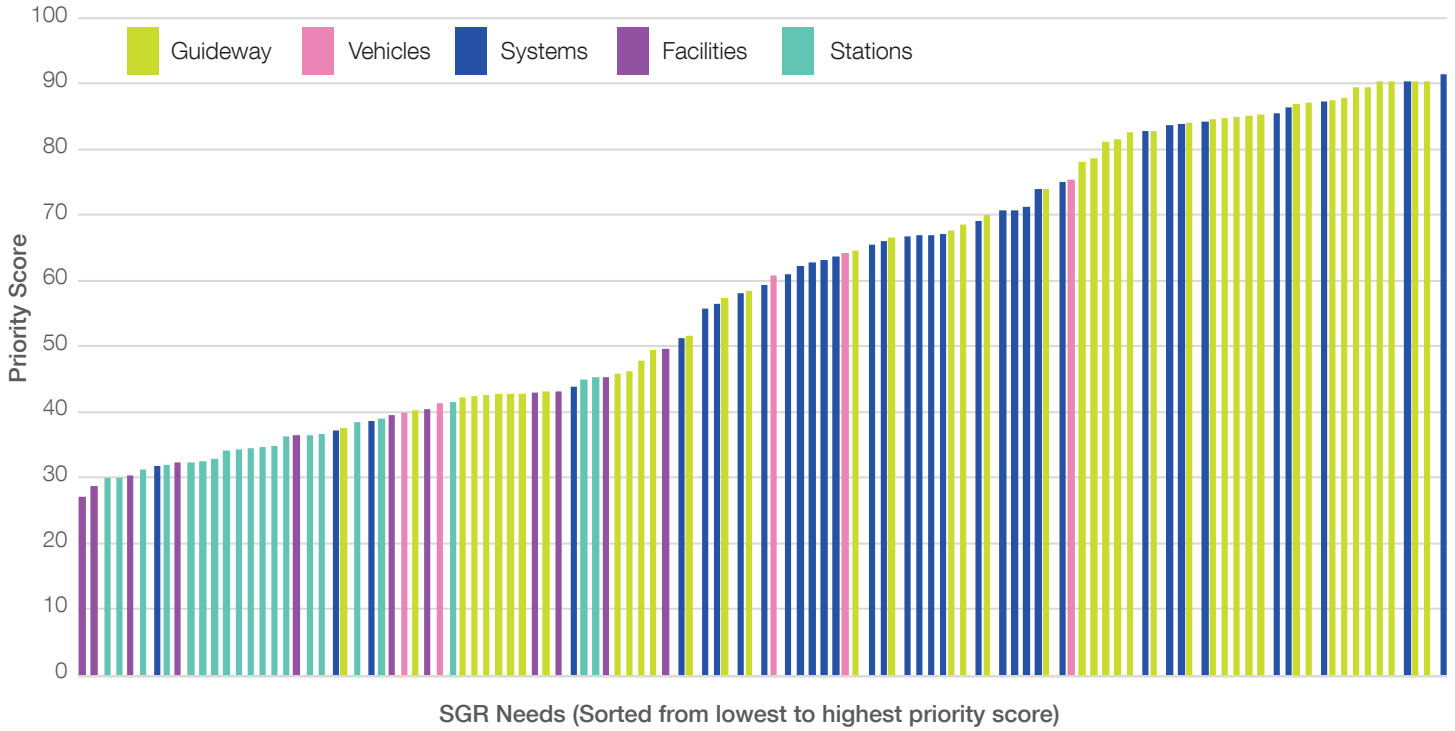


Figure 6-2: All SGR Needs Sorted by Priority Score

SGR Score: Above 75 Points

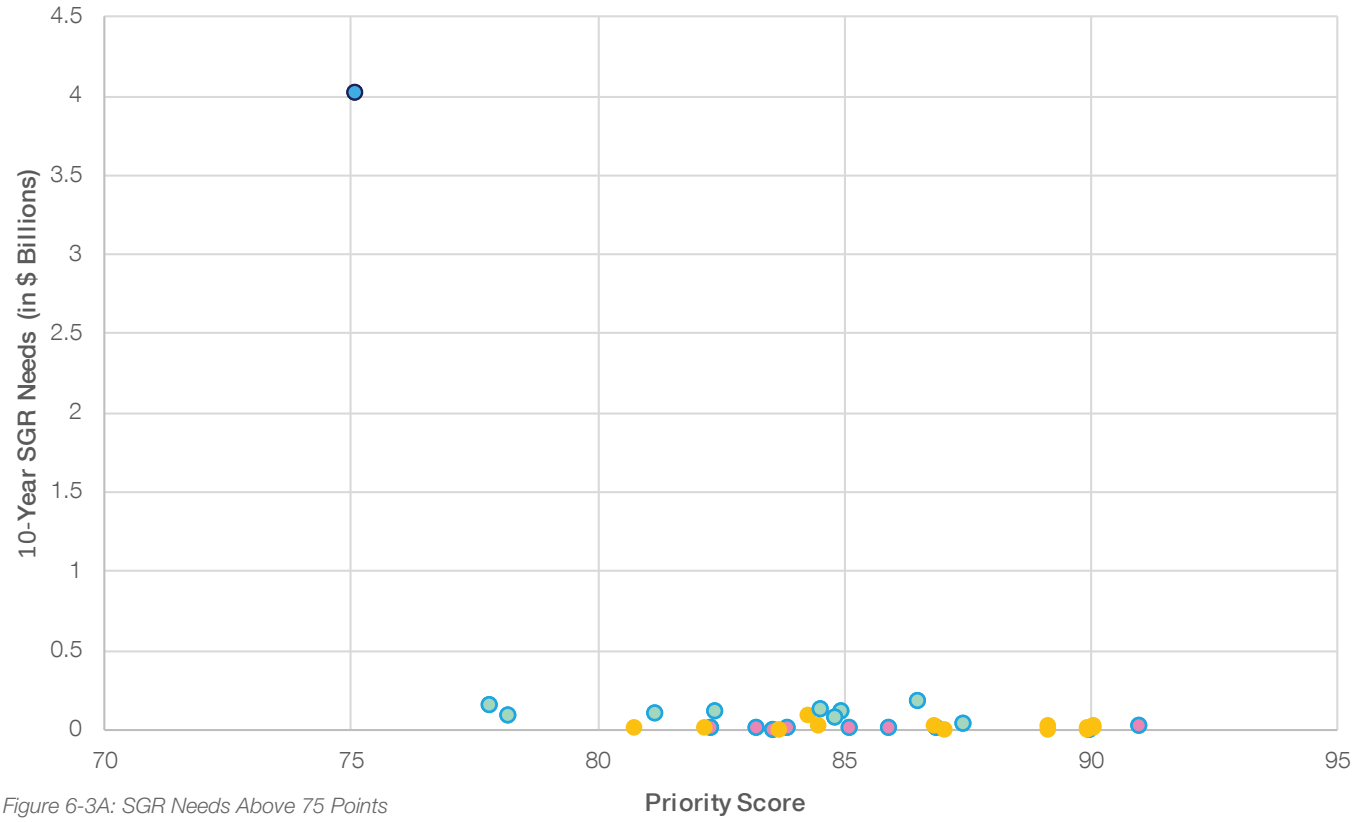


Figure 6-3A: SGR Needs Above 75 Points

SGR Score: 50-75 points

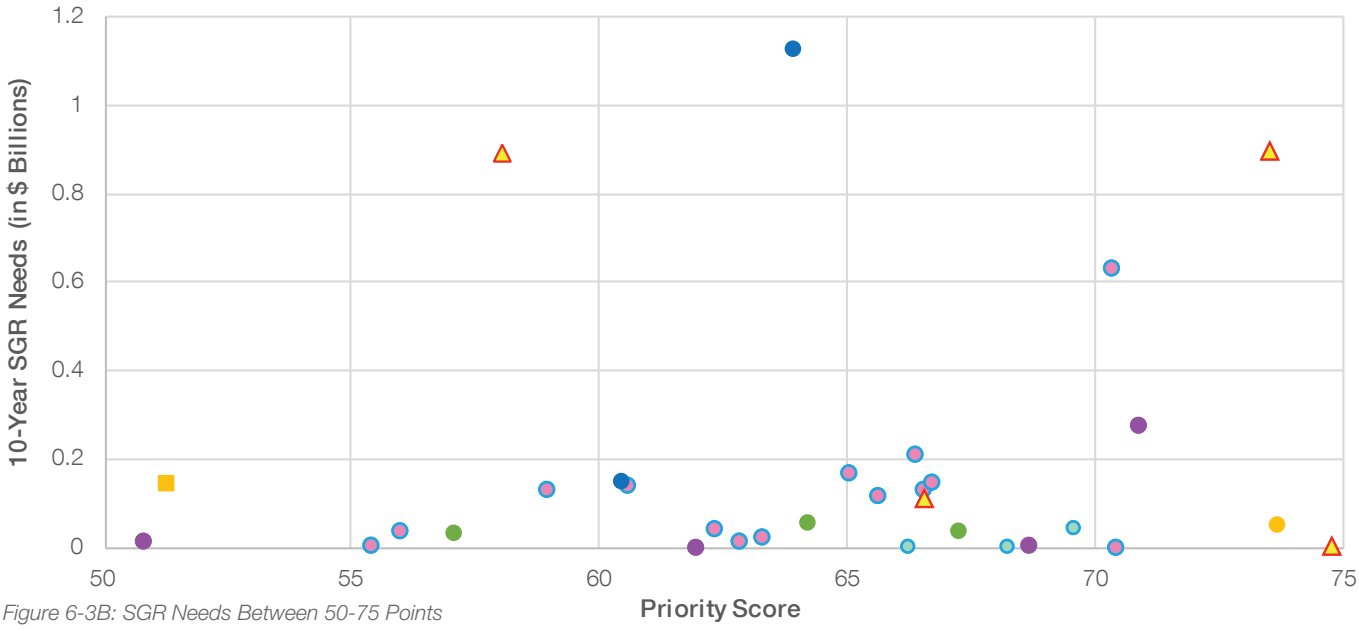
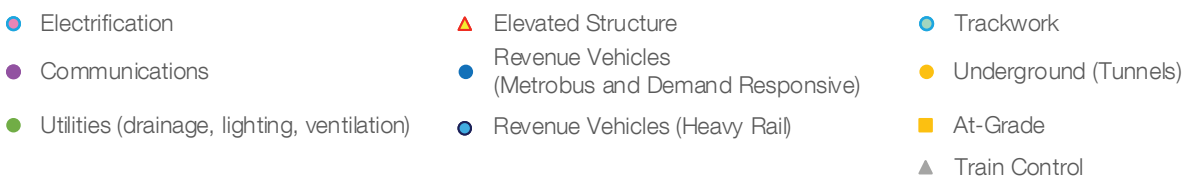


Figure 6-3B: SGR Needs Between 50-75 Points



between 65 and 75 points. The various train control needs can be seen in Figure 6-3B.

- Underground utilities also have Compliance requirements, related to replacing utilities such as lighting ($35 million) and ventilation systems ($44 million, which does not include costs to upgrade to National Fire Protection Association's (NFPA) 130, Standard for Fixed Guideway Transit and Passenger Rail Systems (as an engineering study is required to determine the level of additional cost needed to meet the standard).
- Two communications projects are also included as Compliance requirements:
  - Intrusion detection systems ($0.036 million) are included in a broader Communications grouping and scored a 51.
  - The radio system upgrade to be compliant with a 700MHz requirement and installation of cellular infrastructure in tunnels ($275 million) scored a 71.

In total SGR compliance needs are valued at $1,760 million and are ranked in the top half of needs. Bus and MetroAccess revenue vehicles are also in the top half of needs, as they are critical to safety, service reliability and ridership in their respective modes. The key difference in scoring for buses (at 63), Access vans (at 60) and rail cars (at 75) is the level of ridership they support. All revenue fleets require replacement over the course of the CNI, as their conditions decay to the end of useful life. As all fleets have the highest safety score (see Appendix A.4 for details), the Ridership Impact criterion is the differentiator in their priority scoring.

It is important to note that all of the highest scoring SGR needs are interdependent. This relationship is best illustrated by the highly ranked assets for electrification, tunnels (the top scoring guideway element) and trackwork (the next highest scoring guideway element). As described in Chapter 3, tunnels with persistent leaks create an environment where accumulated debris in the tunnels (including brake dust from rail cars) becomes electrically conductive. These conditions lead to stray currents or "arc tracking." Over time, cumulative degradation of the insulators caused by the arcing can create a short circuit that generates fire and smoke in tunnels. Stray current also accelerates the degradation of third rail, track (causing pitting) and track fasteners. The degraded conditions of assets within tunnels and their potential safety risks contribute to their high priority scoring, and repeated needs. Therefore, maintaining tunnels in SGR is mutually beneficial to all of the track assemblies and rail systems in the tunnel environments. This includes clearing the debris as well as permanently mitigating leaks. As most of Metro's rail system is underground (see Chapter 1.3.3), the significance of these needs for Metrorail's safe and reliable operations cannot be overstated.

The risk profile of SGR needs, with consequence on the Y-axis and probability on the X-axis in Figure 6-4, illustrates that electrification, track, train control, and tunnels are the highest risk (upper right hand corner). This translates to being the highest priority in the CNI. With the exception of track, these asset types all have Compliance components as well. The size of the circles in Figure 6-4 show the 10-year cost of the need.

The full list of SGR needs, in rank order, see Table 6-1. SGR needs are grouped by asset type, and in some cases by location. As an example, the linear assets which fall along Metro's rail system are all grouped by the location of their construction section (which roughly represents their vintage):

- Section A Red Line from Metro Center to Shady Grove (Red)
- Section B Red Line from Metro Center to Glenmont (Red)
- Section C from Metro Center to Huntington (Yellow/Blue)
- Section D from Metro Center to New Carrollton (Orange/Blue)
- Section E from Gallery Place/Chinatown to Greenbelt (Green)
- Section F from Gallery Place/Chinatown to Branch Avenue (Green)
- Section G from Benning Road to Largo Town Center (Blue)
- Section J/H from King Street to Franconia-Springfield (Blue)
- Section K from Rosslyn to Vienna/Fairfax-GMU (Orange/Silver)
- Section L from L'Enfant Plaza to Pentagon (Yellow)
- Section N from East Falls Church to Wiehle-Reston East (Silver)

Risk Profile of 10-Year SGR Needs (>$10M)

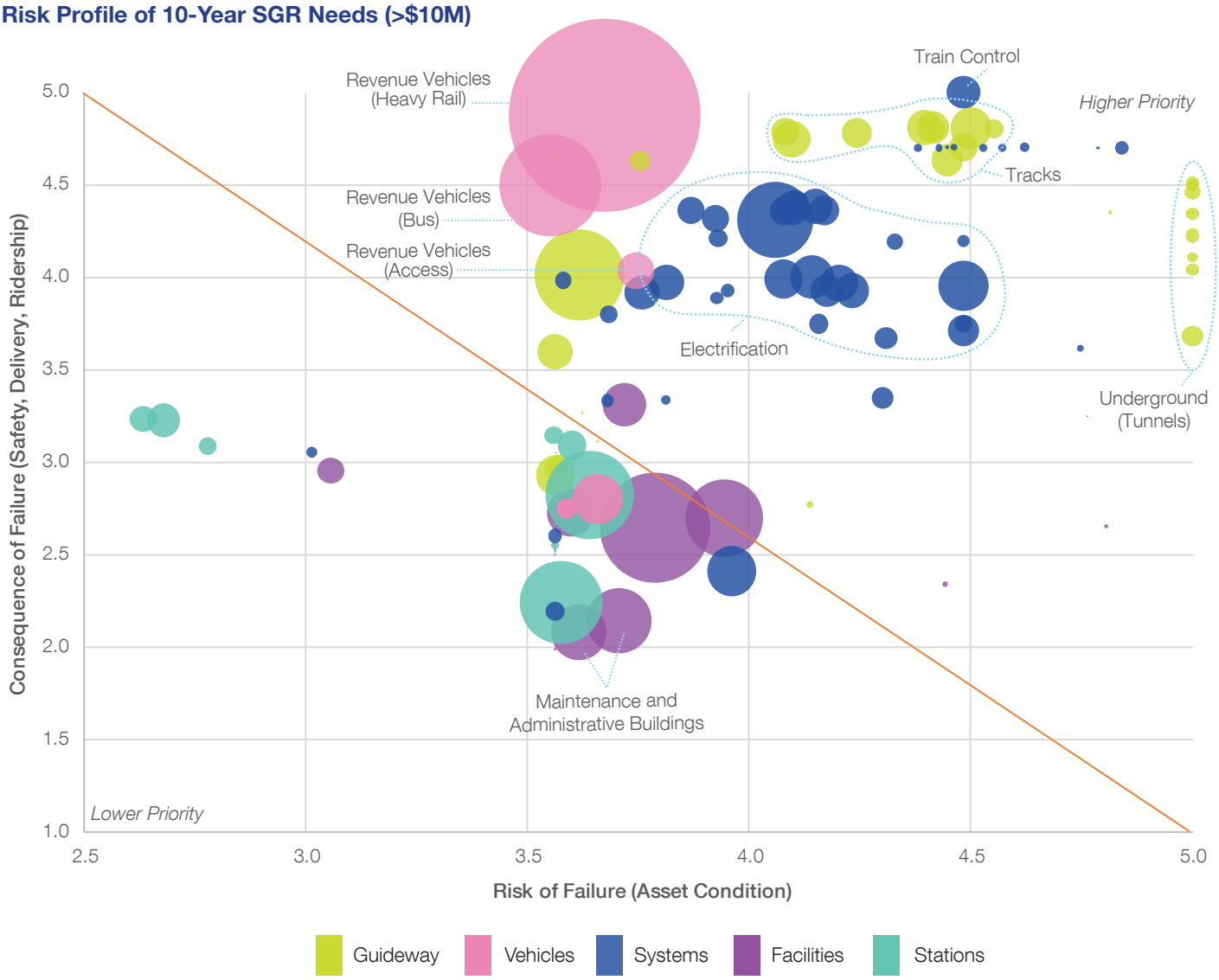


Figure 6-4: 10-Year SGR Needs

Grouped Need Description	Priority Score	Cost in Millions YOE
Electrification Distribution, Heavy Rail, A	91.01	$22.26
Underground, Heavy Rail, L	90.06	$9.52
Underground, Heavy Rail, F	90.06	$21.40
Electrification Distribution, Heavy Rail, L	89.99	$1.13
Underground, Heavy Rail, D	89.97	$11.48
Underground, Heavy Rail, E	89.17	$25.69
Trackwork, Heavy Rail, L	87.44	$40.20
Underground, Heavy Rail, J	87.05	$1.60
Electrification Distribution, Heavy Rail, B	86.89	$10.05
Underground, Heavy Rail, G	86.83	$17.73
Trackwork, Heavy Rail, A	86.53	$183.10
Electrification Distribution, Heavy Rail, K	85.94	$7.00
Electrification Distribution, Heavy Rail, D	85.11	$8.32
Trackwork, Heavy Rail, C	84.97	$111.75
Trackwork, Heavy Rail, D	84.83	$71.27
Trackwork, Heavy Rail, B	84.56	$129.83
Underground, Heavy Rail, C	84.48	$21.60
Underground, Heavy Rail, Water Intrusion	84.27	$86.26
Electrification Distribution, Heavy Rail, G	83.87	$5.24
Underground, Heavy Rail, N	83.72	$2.17
Electrification Distribution, Heavy Rail, J	83.59	$1.58
Electrification Distribution, Heavy Rail, E	83.25	$5.86
Trackwork, Heavy Rail, G	82.41	$108.70
Electrification Distribution, Heavy Rail, F	82.33	$7.03
Underground, Heavy Rail, K	82.18	$10.47
Trackwork, Heavy Rail, K	81.18	$99.00
Underground, Heavy Rail, B	80.78	$16.89
Trackwork, Heavy Rail, F	78.19	$84.06
Trackwork, Heavy Rail, E	77.82	$153.58
Revenue Vehicles, Heavy Rail, Modewide	75.10	$4,015.30
Signals/Interlockings, Heavy Rail, Switch Machine	74.73	$1.22
Underground, Heavy Rail, A	73.67	$47.39
Signals/Interlockings, Heavy Rail, Modewide	73.51	$897.29
Radio, Systemwide Assets, Compliance Upgrade	70.87	$274.69
Electrification Substations, Heavy Rail, L	70.39	$0.15
Electrification Distribution, Heavy Rail, Heaters & Power Cable	70.34	$630.56
Trackwork, Heavy Rail, J	69.54	$45.33
Cable Transmission System (CTS), Systemwide Assets, Modewide	68.65	$4.70
Trackwork, Heavy Rail, Yard Turntables	68.20	$2.91
Guideway Utilities - Lighting, Heavy Rail, Modewide	67.24	$34.67
Electrification Substations, Heavy Rail, C	66.71	$148.54
Centralized Train Control, Heavy Rail, Modewide	66.56	$109.84
Electrification Substations, Heavy Rail, D	66.54	$129.96
Electrification Substations, Heavy Rail, A	66.35	$208.51
Trackwork, Heavy Rail, N	66.22	$4.22
Electrification Substations, Heavy Rail, K	65.64	$114.86
Electrification Substations, Heavy Rail, B	65.05	$164.37

Table 6-1: 10-Year SGR Needs

Grouped Need Description	Priority Score	Cost in Millions YOE
Guideway Utilities - Ventilation, Heavy Rail, Modewide	64.21	$54.05
Revenue Vehicles, Motor Bus, Modewide	63.89	$1,127.29
Electrification Distribution, Heavy Rail, C	63.27	$19.85
Electrification Substations, Heavy Rail, 1	62.83	$12.77
Electrification Substations, Heavy Rail, G	62.31	$40.44
Phone System, Systemwide Assets, Modewide	61.95	$0.07
Electrification Substations, Heavy Rail, F	60.58	$138.59
Revenue Vehicles, Demand Response, Modewide	60.44	$148.04
Electrification Substations, Heavy Rail, E	58.96	$128.06
Elevated Structure, Heavy Rail, Modewide	58.04	$890.89
Passenger Communications Systems, Systemwide Assets, Modewide	57.63	$50.44
Guideway Utilities - Drainage, Heavy Rail, Modewide	57.07	$32.58
Electrification Substations, Heavy Rail, J	56.00	$33.27
Electrification Substations, Heavy Rail, Misc.	55.43	$4.10
At Grade, Heavy Rail, Modewide	51.26	$141.17
Communications, Systemwide Assets, Modewide	50.84	$10.65
Maintenance Equipment, Heavy Rail, Modewide	49.30	$206.24
Guideway Utilities - Safety, Heavy Rail, Modewide	49.05	$17.52
Special Structures, Heavy Rail, E (Fences and Retaining Walls)	47.34	$0.73
Special Structures, Heavy Rail, N (Fences and Retaining Walls)	45.89	$5.55
Special Structures, Heavy Rail, F (Fences and Retaining Walls)	45.51	$0.48

Grouped Need Description	Priority Score	Cost in Millions YOE
Bus Turnarounds, Motor Bus, Modewide	44.86	$5.21
Stations, Heavy Rail, Modewide	44.83	$57.95
Elevators, Heavy Rail, Modewide	44.54	$94.30
Communications Huts, Systemwide Assets, Modewide	43.49	$0.14
Maintenance Equipment, Systemwide Assets, Modewide	42.73	$1.42
Special Structures, Heavy Rail, B	42.69	$38.86
Maintenance Buildings, Heavy Rail, Modewide	42.48	$645.33
Special Structures, Heavy Rail, C	42.40	$26.57
Special Structures, Heavy Rail, D	42.39	$33.64
Special Structures, Heavy Rail, J	42.34	$2.20
Special Structures, Heavy Rail, A	42.21	$55.96
Special Structures, Heavy Rail, L	42.05	$1.91
Special Structures, Heavy Rail, K	41.76	$177.87
Escalators, Heavy Rail, Modewide	41.12	$855.04
Non-Revenue Vehicles, Systemwide Assets, Modewide	41.01	$271.82
Office Equipment & IT, Systemwide Assets, Modewide	40.02	$1,289.61
Special Structures, Heavy Rail, G	39.89	$4.30
Non-Revenue Vehicles, Heavy Rail, Modewide	39.47	$44.59
Maintenance Equipment, Motor Bus, Modewide	39.22	$242.58
Passenger Parking, Heavy Rail, D	38.62	$48.32
In-Station Revenue Collection, Heavy Rail, Modewide	38.23	$269.56
Stations, Heavy Rail, H	38.01	$0.84
Guideway Utilities, Heavy Rail, Modewide	37.08	$20.80

Grouped Need Description	Priority Score	Cost in Millions YOE
Safety and Security, Systemwide Assets, Modewide	36.81	$11.71
Stations, Heavy Rail, D	36.30	$5.34
Stations, Heavy Rail, G	36.06	$1.13
Maintenance Buildings, Systemwide Assets, Modewide	36.03	$75.15
Stations, Heavy Rail, K	35.94	$1.19
Stations, Heavy Rail, C	34.47	$117.67
Passenger Parking, Heavy Rail, A	34.35	$78.78
Passenger Parking, Heavy Rail, J	34.12	$4.44
Stations, Heavy Rail, B	33.99	$76.12
Stations, Heavy Rail, A	33.81	$34.48
Passenger Parking, Heavy Rail, G	32.46	$15.82
Stations, Heavy Rail, F	32.18	$0.23
Passenger Parking, Heavy Rail, K	31.90	$84.43
Maintenance Buildings, Motor Bus, Modewide	31.87	$455.27
Passenger Parking, Heavy Rail, C	31.63	$325.92
On-Vehicle Revenue Collection, Motor Bus, Modewide	31.30	$40.50
Passenger Parking, Heavy Rail, E	30.86	$77.89
Administrative Buildings, Systemwide Assets, Modewide	29.98	$329.89
Passenger Parking, Heavy Rail, F	29.59	$75.60
Passenger Parking, Heavy Rail, B	29.49	$35.93
Administrative Buildings, Heavy Rail, Modewide	28.30	$0.74
Maintenance Buildings, Demand Response, Modewide	26.77	$2.46

6.3. New Investment Needs

The highest-scoring new investment needs address compliance requirements (see Figure 6-5). However, most new investment needs scored below 20 points due to the risk-based approach of the CNI. Generally speaking, enhancement and service amplification assets that do not address a known risk will have low priority under this methodology. Therefore, while the range of new investment needs scores go from 6 to 50, more than half of the new investment needs score between 10 and 20 points; all projects with scores over 20 met a compliance requirement (see Table 6-2).

The highest-scoring was Facility and (On-Street) Terminal Improvements under the Chief Operating Officer and the Department of Bus Service. The rest of the top ten scoring new investment needs were submitted by the Engineering and Safety departments to address safety, security, and environmental compliance issues. Appendix A.6 includes details of new investment needs scoring and descriptions. The new investment needs that received the lowest priority scores were two facilities projects at Shady Grove Rail Yard: Expansion of Existing Office Space and New Maintenance Office Space.

The highest-ranked new investment needs to improve bus stop amenities at 11 terminals will comply with the Board-adopted policy on accessible bus stops and Metro standards in design and placement of bus stops. This project scored 50 (out of 100).

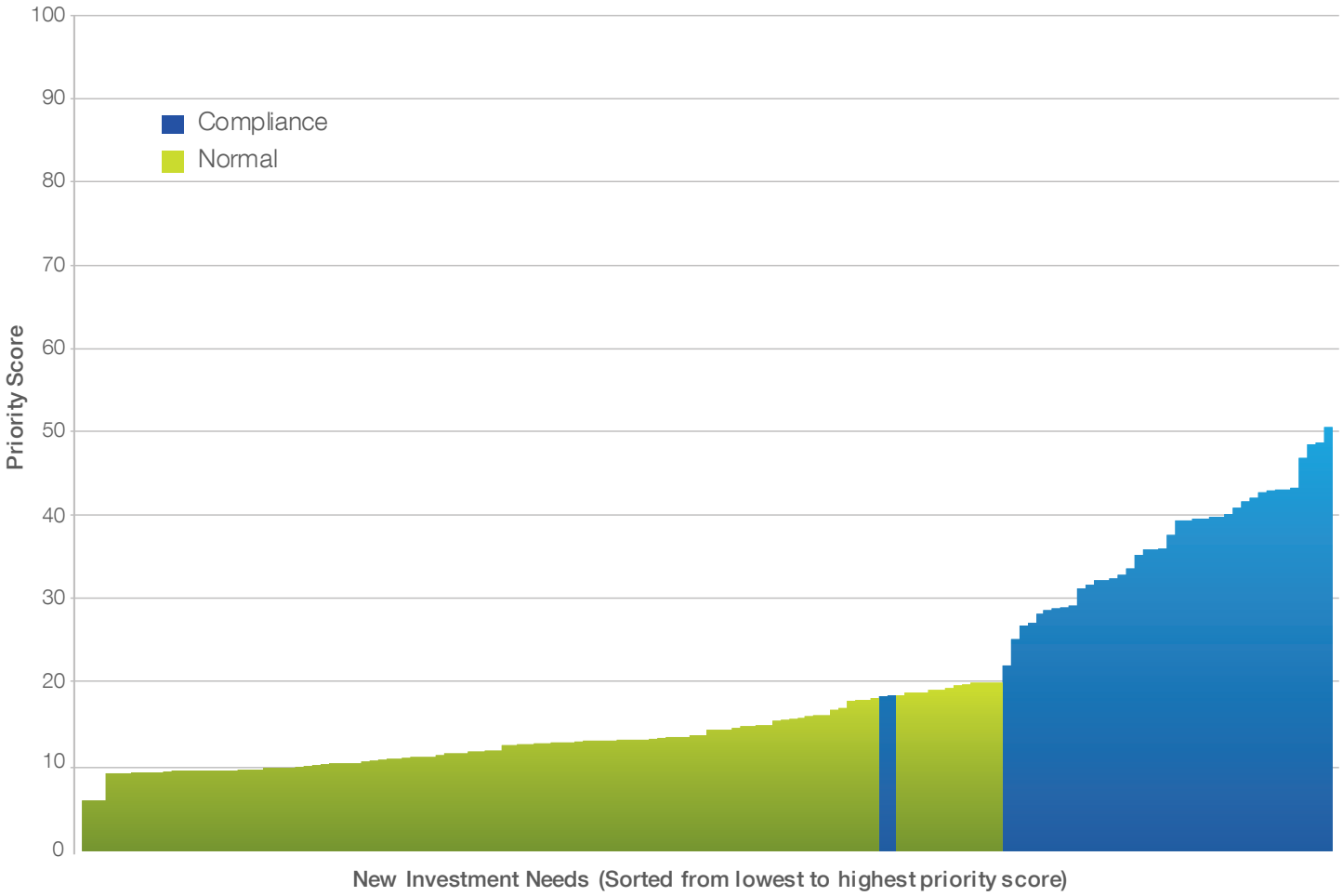


Figure 6-5: Priority Status of New Investment Needs

New Investment Need Description	Priority Score	Cost in Millions YOE
On-Street Bus Terminal Improvements	50.37	$2.69
Inspection and Repair of Anchor Bolts Plus Construction of Pier Structural Retrofits (Hammerheads) at Aerial Structures Located at Grosvenor and the Blue/Orange Junction.	48.51	$18.22
Environmental Compliance Projects (CIP0010) at WMATA Operations and Maintenance Facilities	48.30	$21.28
Relocation of High Voltage Cable out of Eisenhower Ave Aerial Structure	46.74	$12.94
Rehabilitation of Fare Gates to Correct Safety Issues	43.20	$4.38
Construction of a Remediation Building at the New Hampshire Avenue Chiller Plant	42.90	$9.11
Design & Construction of Pavement & Stormwater Management Structures at the 3421 Pennsylvania Drive Facility	42.90	$4.58
Design & Installation of a Sprinkler System at the Landover Material Supply Facility to Achieve Code Compliance	42.87	$4.31
Design and Procurement of a Vacuum Train for Tunnel Trash and Dust Removal	42.63	$13.64
Installation of a Pollution Prevention System at Track Fueling Areas (CIP0210)	42.00	$25.91
Installation of Safety Railings for Servicing of Equipment at the Top of Rail Cars at Service and Inspection (S&I) Facilities	41.58	$2.65
Rehabilitation and Replacement of Storage Tank Systems (CIP0011)	40.80	$42.57
Wayside Rail Track Worker Warning System	40.00	$7.63
Core Station Capacity Improvement - Engineering, Design and Construction of a Center Mezzanine at Union Station	39.72	$28.50
Core Station Capacity Improvement - Union Station Phase 0 - Entrance Relocation, Expanded Fare Gates, New Stairway	39.72	$5.40
Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Gallery Place Chinatown	39.48	$81.86
Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Farragut North	39.45	$27.67
Core Station Capacity Improvement - Feasibility Study, Engineering, Design and Construction of Various Capacity Improvements at Farragut West	39.30	$43.02
Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Foggy Bottom	39.24	$34.45
Rail Station Wireless Internet Deployment	37.60	$9.99
Vehicle Monitoring System (VMS) Replacement for 2/3K, 5K and 6K Metrorail Fleets	36.00	$11.75
MetroAccess Fleet Expansion Vehicles Procurement	35.88	$65.90
Procurement of an Additional MetroAccess Operating Garage and Command Center	35.88	$32.77
Closed-circuit TV (CCTV) Cameras in MetroAccess Vans	35.22	$2.64
Systemwide Bus Station Safety Program - Fences, CCTV, Emergency Call Boxes, ADA-compliant Ramps, PA Systems & Updated Signage	33.58	$52.57
Signage Updates for Emergency Responders	32.80	$2.81
HVAC Overhaul of 2K/3K Metrorail Fleet Including New EPA Compliant Refrigerant (R407C)	32.40	$12.57
Engineering, Design, and Construction of Tunnel Ventilation for Compliance with NFPA 130	32.20	$510.34
Energy Management - Upgrade of Obsolete Systems Identified in the Agency Wide Energy Audit	32.20	$358.43

Table 6-2: 10-Year New Investment Needs

New Investment Need Description	Priority Score	Cost in Millions YOE
Train Movement Detection System Installation at Car Wash Facilities	31.60	$3.29
Design Positive Train Stop System for Non Revenue Vehicles	31.20	$17.06
Replacement of 5000 Series Metrorail Car Electronic Switches/ Amplifiers to Power Traction Motors (Insulated Gate Bipolar Transistor (IGBT) and Gate Unit Driver (GDU))	29.20	$4.23
Takoma/Langley Transit Center Safety Program- Fences, CCTV, Emergency Call Boxes, ADA-compliant Ramps, PA Systems & Updated Signage	29.00	$0.56
Tunnel Fire and Smoke Detection System	28.80	$51.47
Fund for Various Sustainability Investments throughout the Agency	28.60	$24.32
Procurement and Customization of Tablets for Integration with Metrobus Computer Aided Dispatch and Automated Vehicle Location (CAD/ AVL) Systems	28.20	$1.59
MetroAccess Services Emergency Communications Center	27.08	$0.16
Development of a Local Station Management Handheld Device for Announcements (PENTA) plus Public Announcement System Software Upgrade	26.80	$4.24
Creation of a Surface Lot to Provide Driver and CDL Training	25.16	$1.13
Demolition of Rail Car Carwash Equipment at (CMNT) Brentwood Rail Yard	22.08	$0.13
Buy Rail Cars (P1) to Operate 100 Percent 8-Car Trains	20.00	$1,749.76
Air Supply Unit Trainline Synchronization to Reduce Brake In Emergency (BIE) Events	20.00	$0.66
COMSOL Multiphysics (Physics Modeling and Simulation Software Platform) Procurement	20.00	$0.03

New Investment Need Description	Priority Score	Cost in Millions YOE
Procurement of Vibration and Noise Data Analysis Software	20.00	$0.01
Bus Operators Security Shield Installation	19.77	$3.50
Tandem Wheel Lathe (w/Brake Disc Cutting Capability)	19.68	$7.29
Procurement of Portable 35-ton Rail car Jacks (New)	19.40	$0.21
Study of Overhauled Rail car Truck Footprint Measurements Over Time	19.16	$0.16
Procurement of a Calipri Wheel Profile Measuring Device	19.16	$0.01
Improve Train Control System to Run 8-Car Trains (P4)	18.80	$547.03
Improve Traction Power to Operate 100 Percent 8-Car Trains (P2)	18.80	$12.38
Bus Transit Signal Priority (TSP)	18.80	$12.09
Extension of Overhead Crane Track at Brentwood Rail Facility (CMNT) S&I	18.54	$1.10
Brentwood Rail Yard (CMNT) Demolition of Existing Paint Booth	18.48	$0.27
Four Mile Run Bus Division Renovations	18.38	$6.81
Installation of CCTV in Remaining 6000 Series Rail cars	18.20	$2.82
Procurement and Installation of Bus Back-up Camera Systems	17.97	$3.55
Vehicles for Micro-Transit (Alternative to MetroAccess Service) Public-Private Partnership	17.94	$0.97
Extension of the Pocket Track to Create a Blue/Silver Train Turnback at D&G Junction	17.86	$18.30
Bicycle & Pedestrian Facilities for Station Access: Capacity Improvements	17.00	$48.65
Reconstruction of the Service Roadway and the Roadway Crossing on Track 7 at Brentwood Rail Yard (CMNT)	16.74	$0.60

New Investment Need Description	Priority Score	Cost in Millions YOE
40 Foot Buses for Service Expansion	16.19	$102.97
Articulated Buses for Service Expansion	16.19	$84.83
Construction of Rail Yard Safety Handrails at Maintenance Pits	16.03	$4.08
New Communications Department (COMM ESS/ENV/FIA) Facility	15.80	$1.48
FM Global (Property Insurer) Non-Ignitable Liquids Mitigation Project: Fire Suppression System Enhancement and Expansion plus Removal of Aerosol Storage	15.73	$0.23
Expansion of Storage and Maintenance Facilities for 100 Percent 8-Car Trains (P3)	15.62	$602.14
FM Global (Property Insurer) Recommendations: Installation of Ignitable Liquids Risk Mitigation Systems	15.46	$0.48
Customer Information and Electronic Displays at Bus Stations	14.99	$17.96
Bus Loop (Turnarounds) Safety Enhancement Program and Station Upgrades	14.99	$8.04
New Carrollton Rail Yard (CMNT) - Install Access Ramp to the Blow-Pit Area	14.81	$0.40
FM Global (Property Insurer) Non-Ignitable Liquids Mitigation Project: Installation of a Hydrogen Detection System in the Battery Storage Room at Alexandria Yard	14.81	$0.01
Track or Station Expansions to Improve Safety and Reliability in the Blue/Orange/Silver Corridor	14.59	$893.97
Software Changes in the Converter Functional Modules (CFM)/ Propulsion System to Improve Rail Car Reliability	14.40	$6.17
Rail car LED Lighting Upgrade	14.40	$0.95
Bus Station Canopies at Stations and Transit Centers	14.39	$34.95

New Investment Need Description	Priority Score	Cost in Millions YOE
Creation of a Loading Dock at the Carmen Turner Facility Bus Heavy Overhaul Shop	13.79	$0.48
Short Term Capacity Improvements at Core Metrorail Stations	13.77	$6.61
Installation of Customer Facing CCTV Security Monitors in Buses	13.57	$6.69
Installation of a Pedestrian Warning System on the 1583 Bus Fleet	13.57	$6.48
West Falls Church Rail Yard (CMNT) Site Lighting at the Salt Dome	13.51	$0.02
Greenbelt Rail Yard (CMNT) Installation of an Exhaust Fan in the Brake Caliper Room in Building B	13.45	$0.01
Core Station Capacity Improvement- L'Enfant Plaza	13.36	$58.66
West Falls Church Rail Yard (CMNT) - Installation of an Oil/Grease Distribution System to the Periodic Inspection Area	13.21	$0.19
Shady Grove Service and Inspection Shop Upgrades (Restrooms, Locker Rooms, New Crane)	13.20	$12.78
Shady Grove Rail Yard (CMNT) -Install Access Ramp to the Blow-Pit Area	13.20	$0.42
Implementation of a Capital Project Planning Portal/Document Management System	13.20	$3.85
Core Station Capacity Improvement- Metro Center	13.18	$71.46
Installation of an Onboard Passenger Information System (Infotainment) in Buses	13.17	$20.67
Procurement and Installation of Mobile Wireless Routers to Implement Metrobus Guest Wi-Fi	13.17	$6.50
Car Track and Equipment Maintenance (CTEM) -Greenbelt Shop Extension	13.15	$5.54
Core Station Capacity Improvement- Dupont Circle	13.06	$23.76

New Investment Need Description	Priority Score	Cost in Millions YOE
Core Station Capacity Improvement-McPherson Square	12.94	$35.48
Hastus Scheduling Software for Bus	12.93	$5.77
Metro Transit Police Department (MTPD) Fleet Expansion	12.90	$0.54
Core Station Capacity Improvement-Smithsonian	12.78	$23.76
Design and Construction of a South Mezzanine at Bethesda Station	12.78	$17.72
Car Track and Equipment Maintenance (CTEM) - Branch Avenue Shop Expansion	12.75	$5.54
Core Station Capacity Improvement-Archives-Navy Memorial	12.71	$23.76
Parking Meter Replacement with Electronic Paystations	12.60	$48.65
Automatic Wayside Inspection System (AWIS) to Detect Wheel and Brake Profiles	12.60	$6.58
Development of Bus Engineering and Bus Maintenance Shop Floor Offices	11.99	$0.24
Security Cameras for Rail Yards	11.93	$0.19
Procurement of Vehicles for the Sign and Shelter Crew	11.79	$0.34
Support Vehicles for the New Andrews Bus Facility	11.79	$0.18
Greenbelt Rail Yard (CMNT) - Installation of Air Conditioning in the Paintbooth Break Room	11.65	$0.13
Dyanamic Advertising Signage with LCD Screens at Bus Stops	11.60	$15.91
Customer Information System for Stations and Vehicles	11.60	$1.32
Costumer Assistance (CA) Automated Service Desk	11.46	$0.37
Car Track and Equipment Maintenance (CTEM) and Heavy Overhaul Facility and Rail Yard	11.21	$185.66
Rail car Truck Spin Tester at Greenbelt Yard	11.16	$5.55
CMNT 20 Ton Flat Bed Truck	11.16	$0.13
Storage Area for Rail Car Wheels at the Brentwood Rail Facility (CMNT)	11.04	$0.27
New Bus Garage in the Silver Spring Area	11.02	$189.22
Branch Avenue Annex Facility to House TRST, GMAC, ELES and MTPD	10.95	$7.47
Support Vehicles for the New Cinder Bed Road Bus Facility	10.82	$0.34
Bus Station Restroom and Break Room Facility Program	10.79	$2.00
MTPD Facility Expansion at West Falls Church, Morgan Boulevard, and Shady Grove	10.60	$3.59
Carmen Turner Facility Parking Garage	10.40	$30.41
Building Automation System - Remote Monitoring and Control of Mechanical Systems	10.40	$24.32
Real Time In-Lane Variable Message Signs at Parking Facilities	10.40	$11.15
On-Site Solar Energy Generation at Various Facilities	10.40	$4.56
Retrofit Rail Stations to Add Employee Breakrooms	10.35	$2.10
Alexandria Rail Yard (CMNT) - Construct a Compressed Airline System to Enhance Rail car Maintenance Operations	10.21	$0.16
Greenbelt Rail Yard (CMNT) - Construct a Compressed Airline System in Building G, Electronic Shop 2nd Floor	10.15	$0.01
Shady Grove Rail Yard (CMNT) - Install a 25 Ton Overhead Bridge Crane	10.00	$6.37
Alexandria Rail Yard (CMNT) - Construct New Maintenance Office Space	9.91	$0.38

New Investment Need Description	Priority Score	Cost in Millions YOE
West Falls Church Rail Yard (CMNT) - Construct New Maintenance Office Space	9.91	$0.38
Greenbelt Rail Yard (CMNT) - Construct New Maintenance Office Space	9.85	$13.26
Greenbelt Rail Yard (CMNT) - Construct a New Maintenance Facility for 7k Cars	9.85	$0.37
New Carrollton Rail Yard (CMNT) - Increase Lighting in the Maintenance Facility	9.71	$0.22
New Carrollton Rail Yard (CMNT) - Construct New Maintenance Office Space	9.71	$0.17
Data Integration & Quality Tools Software Procurement	9.66	$0.84
Alexandria Rail Yard (CMNT) - Installation of an Oil/Grease Distribution System to the Periodic Inspection Area	9.61	$2.92
Alexandria Rail Yard (CMNT) - Construct an Extended Blow-Pit Area	9.61	$0.68
Alexandria Rail Yard (CMNT) - Construct a Concrete Apron for Maintenance Vehicle Loading	9.61	$0.25
Alexandria Rail Yard (CMNT) - Construct a Catwalk for 7K Car Roof Top HVAC Access	9.61	$0.15
West Falls Church Rail Yard (CMNT) - Construct a Concrete Apron on Track Lead for Maintenance Vehicle Loading	9.61	$0.10
West Falls Church Rail Yard (CMNT) - Extension of Existing Parking Lot	9.61	$0.07
Shady Grove Rail Yard (CMNT) - Extension of Existing Parking Lot	9.60	$3.00
Shady Grove Rail Yard (CMNT) - Construct a Catwalk for 7K Car Roof Top HVAC Access	9.60	$0.27

New Investment Need Description	Priority Score	Cost in Millions YOE
Systemwide Signage Updates (For Completion of Silver Line Phase 2)	9.45	$12.18
Build a Central Rail car Heavy Repair and Overhaul Facility	9.41	$373.05
New Carrollton Rail Yard (CMNT) - Extension of Existing Parking Lot	9.41	$0.38
New Carrollton Rail Yard (CMNT) - Expansion of Existing Office Space	9.41	$0.14
Renovations to Montgomery Bus Division Maintenance Area	9.36	$6.24
Brentwood Rail Facility (CMNT) - Buildout of a Hallway wall at the Administrative Office	9.24	$2.51
Brentwood S&I Rail Facility (CMNT) - Install Louvered Crank Style Windows	9.24	$0.25
Brentwood Rail Facility - Construct a Parking Garage on South Lot	9.24	$0.01
Alexandria Rail Yard (CMNT) - Expansion of Existing Office Space	6.01	$0.81
Shady Grove Rail Yard (CMNT) - Expansion of Existing Office Space	6.00	$0.38
Shady Grove Rail Yard (CMNT) - Construct New Maintenance Office Space	6.00	$0.37

Gap between Priority Status and Priority Scores

Name	Priority Score	Priority Status
Buy full 8-car trains to improve onboard and platform crowding issues.	20.00	Normal
Improve Air Supply Unit (ASU) synchronization of trains that use different vintage cars; this will increases breaking efficiency, and improve reliability and safety of train operation.	20.00	Normal
Purchased COMSOL Multiphysics software to allow effective design analysis for multiple engineering functions, including rail engineering.	20.00	Normal
Vibration and Noise data analyses software to enhance capability to identify on-train problems and efficiently find solutions.	20.00	Normal
Installation of bus operator security shields to provide additional security from assaults.	19.77	Normal
Installation of Tandem Wheel Lathe to improve cycle time of disc cutting and reduce the risk of miss-assembly during maintenance of rail cars.	19.68	Normal
Installation of portable 35-ton Rail car Jacks to facilitate more efficient and safe service of rail cars.	19.40	Normal
Installation of rail car truck footprint measurement to allow effective monitoring of rail car conditions and truck wear.	19.16	Normal
Use of Calipri Profile Measuring Device reduce time to measure rail wheel conditions during maintenance and help investigate discrepancies.	19.16	Normal
Improve Train Control System to allow full operation of 8-car trains to alleviate on-board and station crowding issues.	18.80	Normal
Improve Traction Power System to allow full operation of 8-car trains to alleviate on-board and station crowding issues.	18.80	Normal
Implement Transit Signal Priority (TSP) for buses, which improve on-time performance and travel time.	18.80	Normal
Extension of bridge crane at Brentwood Rail Facility to improve maintenance capacity of rail cars.	18.54	Normal
Demolition of existing paint booth at Brentwood Rail Yard to improve maintenance capacity.	18.48	Compliance
Four Mile Run Bus Division rehabilitation and renovation.	18.38	Compliance

Table 6-3: Summary of Gaps Between Priority Status and Score

Table 6-3 lists the two compliance-related new investment needs that are separated from the remaining 40 compliance new investment needs at the top of the scoring by a number of higher-scoring projects that are not related to compliance. The two compliance-related new investment needs with lower priority scores, Brentwood Rail Yard Demolition of Paint Room and Four Mile Run Division Renovations, both received low safety and security criterion scores while the other new investment needs ranked above them all had inherently high safety and security scores based on their asset type.

Figure 6-6 shows new investment needs by their risk profile and colored by their priority status. The size of the circles shows the 10-year cost of the need. The compliance needs have been given higher risk probability scores (2 and 3) and have medium-to-high risk consequences.

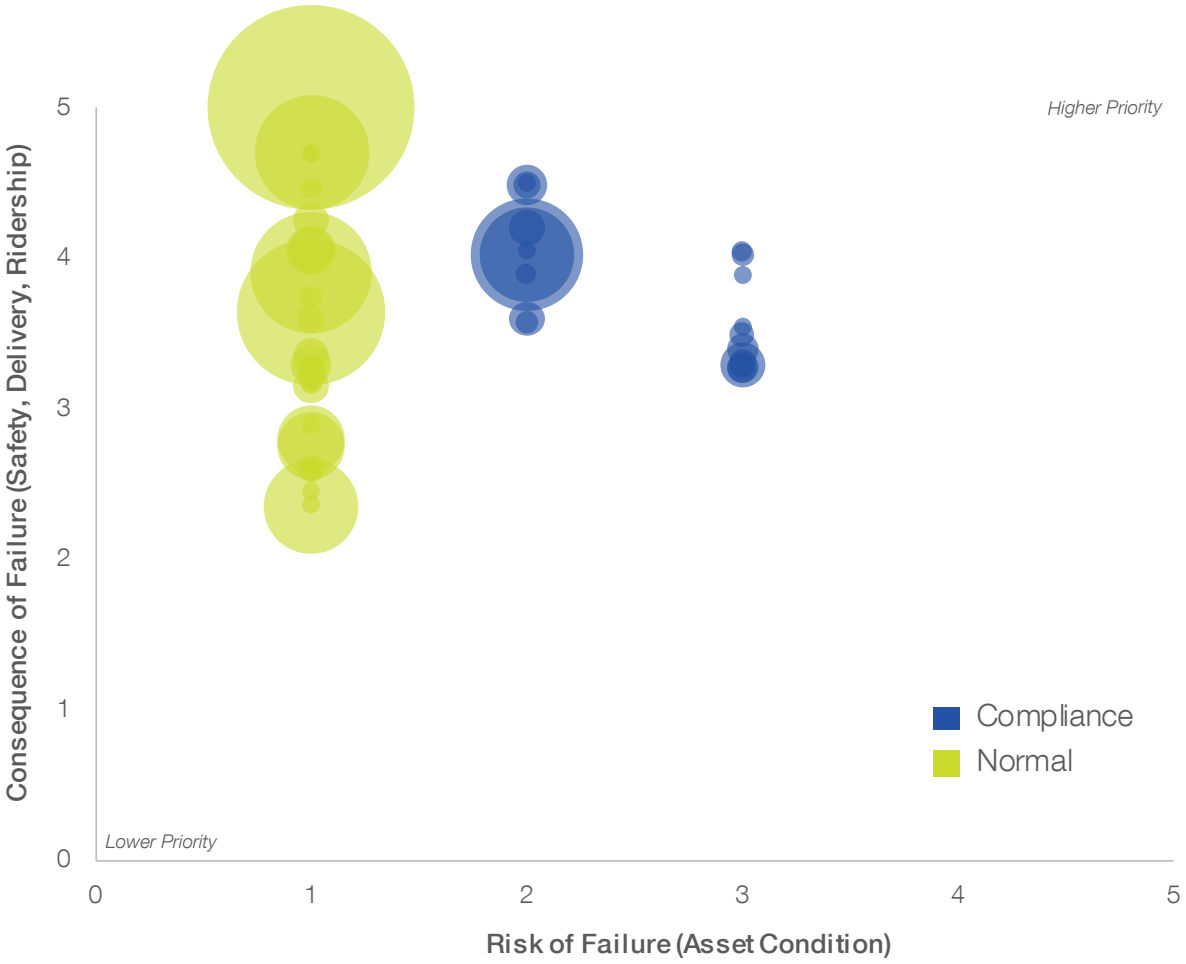


Figure 6-6: Risk Probability and Risk Consequence (only new investment needs with ten-year costs exceeding $10 million)

7. Glossary

Annual Capital Maintenance — yearly investment to preserve an asset in good working order.

Asset Management — a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based on information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair during the life-cycle of the assets at minimum practical cost.

Capital Asset — includes equipment, rolling stock, infrastructure, and facilities for use in public transportation and owned or leased by a recipient or sub-recipient of federal financial assistance.

Capital Need — represents a capital request to rehabilitate, replace, or add a group of assets to the system. Each capital need consists of a group of similar or interdependent assets.

Decay Curves — graphic representation of the relationship between an asset's condition and its age and type. TERM Lite's asset decay curves predict/forecast condition based on age and type.

Deferred Capital Needs — scheduled capital investment postponed or put off until a later time; equivalent to FTA's definition of backlog.

Facilities — buildings (excluding stations), major shops, storage yards, central control, and equipment necessary for operating the system.

Guideway Elements — trackwork and related structures including tunnels, tubes, aerials, platforms, retaining walls, and fences.

Moving Ahead for Progress in the 21st Century (MAP-21) — transportation and reauthorization bill signed into law on July 6, 2012. It is a policy and programmatic framework designed to create a performance-based surface transportation program for highway, transit, bike, and pedestrian programs.

New Need — assets that: 1. provide a completely new function, one that neither replaces nor expands existing assets; 2. replace an existing asset with a new asset that provides a new function or enhances an existing asset by demonstrably impacting safety, security, ridership, and/or service delivery; or 3. expand the existing system.

Rehabilitation — act of restoring an asset to its original state or a condition close to its original state.

Soft Costs — capital expenditures that are required to complete a project but that are not spent directly on construction or procurement. These expenses are incurred on professional services that are necessary to complete the project, which include, but are not limited to, project design, project management, legal work, and testing.

State of Good Repair (FTA/MAP-21 Final Rule, July 2016) — The condition in which an asset is able to operate at a full level of performance. Three objective standards define "full level of performance":

- The asset is able to perform its manufactured design function.
- The use of the asset in its current condition does not pose a known unacceptable safety risk.
- The asset's life-cycle investment needs have been met or recovered, including all scheduled maintenance, rehabilitation and replacements.

Stations — includes bus shelters, passenger parking facilities, and assets related to rail stations. Rail station assets include station buildings, elevators, escalators, station-specific electrification assets, and other related components. Passenger parking facilities include both surface lots and garages.

Systems — includes hardware and software assets necessary to operating the system. Types include: communications systems, electrification, revenue collection, train control, and utilities.

TERM Lite (Transit Economic Requirements Model) — local/state version of analysis tool designed to help transit agencies asses their SGR deferred capital needs (total dollar value and by asset type), level of annual investment to attain SGR or other investment objective, impact of variations in funding on future asset conditions and reinvestment needs, and investment priorities (by mode and asset type).

Useful Life — estimated lifespan of a capital asset, during which it can be expected to contribute to operations.

Vehicles — includes both revenue vehicles (rail cars, buses, and vans) and non-revenue vehicles.

A. Appendices

A.1 Information Sources

A.1.1 TAICA

Inventory data were provided for the following asset categories:

- Yard track
- Tunnels
- Aerials bridges
- Elevator and escalator replacement
- Some building components, including built-in equipment and specialties, fall protection, and pumps
- Electrification, including AC switchgear, DC switchgear, transformers, rectifiers, and other components
- Maintenance Equipment
- Non-revenue vehicles
- Revenue vehicles
- Fencing
- Retaining walls
- Train control assets, including wayside train-control and interlockings
- Utilities, including emergency exits, fan plants, fire-protection plumbing, pump rooms, and ventilation

Where TAICA inventory records were not complete, in terms of quantity, cost, or date built, assumptions were used to complete the records for needs analysis. These assumptions are listed in Appendix A.3.

A.1.2 New Investment Needs

New investment needs projects were submitted as per the process described in Appendix A.5 and generated a list of compliance, amplification or enhancement needs.

In some cases, submitted new investment needs were incorporated into the asset inventory for SGR as they addressed replacement or rehabilitation of an existing asset. First, new records were added to the existing inventory to account for assets not captured from other data sources for SGR. Second, existing records were adjusted to account for updates to cost or quantity.

A.1.3 Capital Needs Early Warning System

Metrorail Capital Needs Early Warning System (CNEWS) 2016 Annual Report assessed the capacity needs of the Metrorail system by examining crowding at escalators and stairs, on-board trains, on platforms, and through faregates. The report quantified how crowded the Metrorail system is today and how it will be by 2020, and identified some station capital needs that became part of the CNI's new investment needs.

The report forecast increases in walk ridership by station in the near-term, based on real estate development projects near Metrorail stations currently under construction or permitting. Using current (May 2015) ridership and this near-term (approximately 2020) ridership forecast, the report estimate line-level crowding on board trains using Metro's Line Load Application, and identified places where crowding exceeds 100 passengers per car. Using the Metrorail Capacity Analysis Tool, the report pinpointed times and places where platform crowding exceeded 7 square feet per passenger. Using an internal vertical circulation model (whereby riders are assigned to escalators and stairs based on their origin and destination, the report highlighted which stairs and escalators are used beyond their planning standard (V/C 0.5). Finally, the report analyzed where and when faregate arrays are used beyond their design capacity. 2015 and 2020 needs were estimated.

The report was a top-down comprehensive look at Metrorail crowding to identify capital needs and guide next steps, particularly for this CNI. The report was not an in-depth look at one specific station to craft solutions; rather, this report informed which stations are the highest priority for capital funds, and to ensure all station needs were noticed.

Metro plans to continually refresh the forecasts and utilization results in CNEWS as more data becomes available.

A.1.4 Maximo, PeopleSoft, Insurance Records, Other Internal Metro Sources

Below is a list of additional Metro systems from which data was provided:

- Metro IT department: complete inventory of Metro hardware, software, and useful lives, including Maximo Anywhere tablet and license costs (updated in 2016).
- Maximo: Trackwork, revenue collection (in-station and on-vehicle), tunnels, aerials, contact (third) rail, bus transfer dispensers, video recording equipment, cable transmission system, station PA system, PAX intercom system, phone system, intrusion-detection system, CCTV system, elevators, and escalators (updated in 2012 through 2015 and again in 2016).
- PeopleSoft (Fixed Asset Ledger): Dynamometers (updated in 2016).
- Metro CIP: Radio systems upgrade and cellular infrastructure project, line items, costs and timing (updated in 2016).
- WMATA Engineering: Inventory of AC switchgears in stations (updated in 2016).
- Metrorail infrastructure map (WMATA Engineering): Traction power substation locations and capacities (updated in 2016).
- Metro Insurance Records: Overall replacement value (insured) of Metro's major sites - facilities and stations (updated in 2012).

A.1.5 Previous Studies

Metro has contributed data to multiple industry studies or submissions regarding its assets. Metro's data from the studies below has been used to fill in date built, quantities, and costs where inventory records were not otherwise available.

- 2012 National Transit Database (NTD) Pilot/LAND Asset List (10/4/16 update): Facilities data including rail and bus yards and administration facilities.
- Rail Modernization Study (FTA, April 2009): AC switchgear, DC switchgear, transformers, traction power substations, and other electrification components.
- Full-Funding Grant Agreement (FFGA) (FTA, 2008) data: Silver Line station values.
- FTA Heavy Rail Transit Cost Study (2010): Central control, at-grade guideway.
- FHWA and FTA 2008 Status of the Nation's Highways, Bridges, and Transit: Condition & Performance, Report to the United States Congress. U.S. DOT, 2009: at-grade guideway, breaker houses, contact rail, power cable, wayside train control, and subway lighting (C&P, 2009).
- Takis Costing Study (2008): Guideway structure costs, trackwork costs, and infrastructure soft costs (completed for WMATA Engineering).

A.2 Useful Life and Life-Cycle Policies by Asset Type

Table A-1 summarizes the range of useful lives and rehabilitation (rehab) plans for Metro's asset types. It is important to note that useful lives are unique to individual assets, though many asset types will have similar useful lives. For example, Metro's bridges may all have designs that indicate a 50-year useful life but the environment and wear from use will vary for each individual bridge. The ranges of useful lives below illustrate:

- The effective useful lives based on condition assessments from TAICA versus the design/expected lives,
- The differences in environmental factors across the system (i.e., underground environments for tangent rail at 20 years or above-ground at 30 years),
- The impact of having a variety of make, model, or usage levels for various assets which impact their lifespan – as directed by Metro's asset owners, or
- The differences in type and use of maintenance equipment, ranging from small portable lifts or fall protection railings to large built-in systems like wheel lathes or vehicle washes.

The rehab costs provided in Table A-1 are as a percent of the total replacement cost of the assets. In some cases, an asset will have annual capital maintenance (ACM) instead of a defined rehab (which tend to be higher costs). Those asset types with ACM and the annual level of cost are detailed in Appendix A.3. The Table A-1 also shows underground tunnels with a 1-year useful life, which is meant to approximate ACM while also allowing for tunnel needs to be prioritized and grouped by TERM Lite. The replacement cost of these 1-year tunnels has been decreased to reflect the 0.11 percent ACM that would normally apply[1], instead of being listed at their full cost to replace.

1 Based on guidance from NYCT (2000) using annual expenditure rate / estimated tunnel value, considered a minimum of annual tunnel needs.

Table A-1: Useful Life by Asset Type

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Guideway Elements	Guideway	At Grade	Heavy Rail	50 years	0	N/A
Guideway Elements	Guideway	Elevated Structure	Heavy Rail	4 to 50 years	0	N/A
Guideway Elements	Guideway	Elevated Structure	Bridge	27 to 50 years	0	N/A
Guideway Elements	Guideway	Elevated Structure	Foot Walk	4 to 50 years	0	N/A
Guideway Elements	Guideway	Underground	Tunnel Heavy Rail	1 year (ACM)	0	N/A
Guideway Elements	Guideway	Underground	Tunnel Heavy Rail (water intrusion)	50 years	0	N/A
Guideway Elements	Guideway	Underground	Cut & Cover Heavy Rail	1 year (ACM)	0	N/A
Guideway Elements	Guideway	Underground	Tube	1 year (ACM)	0	N/A
Guideway Elements	Trackwork	Direct Fixation	Tangent	20 to 30 years	0	N/A
Guideway Elements	Trackwork	Direct Fixation	Curve	10 to 15 years	0	N/A
Guideway Elements	Trackwork	Floating Slab	Tangent	20 years	0	N/A
Guideway Elements	Trackwork	Ballasted	Tangent	20 to 30 years	0	N/A
Guideway Elements	Trackwork	Ballasted	Curve	10 to 15 years	0	N/A
Guideway Elements	Trackwork	Special	Direct Fixation Diamond Crossover	20 to 30 years	0	N/A
Guideway Elements	Trackwork	Special	Ballasted Diamond Crossover	30 years	0	N/A
Guideway Elements	Trackwork	Special	Direct Fixation Single Crossover	20 to 30 years	0	N/A
Guideway Elements	Trackwork	Special	Ballasted Single Crossover	30 years	0	N/A
Guideway Elements	Trackwork	Special	Floating Slab Single Crossover	20 years	0	N/A
Guideway Elements	Trackwork	Special	Floating Slab Double Crossover	20 years	0	N/A
Guideway Elements	Trackwork	Special	Turntable	14 to 46 years	0	N/A
Guideway Elements	Trackwork	Yard		70 years	0	N/A
Guideway Elements	Special Structures	Fencing		15 to 48 years	0	N/A
Guideway Elements	Special Structures	Retaining Walls		2 to 48 years	0	N/A
Facilities	Buildings			60 years	1	50%

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Facilities	Buildings	Administration		36 to 60 years	1	50%
Facilities	Buildings	Administration	Police	3 to 60 years	1	50%
Facilities	Buildings	Maintenance	Bus	50 to 60 years	1	50%
Facilities	Buildings	Maintenance	Rail Heavy Rail	60 years	1	50%
Facilities	Buildings	Building Components	Plumbing	15 to 42 years	0	N/A
Facilities	Buildings	Building Components	Drainage	25 years	0	N/A
Facilities	Buildings	Building Components	Access and Parking	29 years	0	N/A
Facilities	Buildings	Building Components	Elevators and Conveying Systems	35 years	2	33% each
Facilities	Buildings	Building Components	Built-in Equipment and Specialties	15 to 40 years	0	N/A
Facilities	Buildings	Building Components	Fall Protection	1 to 30 years	0	N/A
Facilities	Storage Yard	Rail	Heavy Rail	15 to 50 years	1	50%
Facilities	Storage Yard	Bus	Bus Parking	20 years	1	50%
Facilities	Buildings	Bus Turnaround Facility	(bus loops)	40 years	1	50%
Facilities	Equipment	Miscellaneous		15 years	0	N/A
Facilities	Equipment	MIS/IT/Network Systems	Software	1 to 10 years	0	N/A
Facilities	Equipment	MIS/IT/Network Systems	Computers/Hardware	2 to 8 years	0	N/A
Facilities	Equipment	MIS/IT/Network Systems	Mission Critical Software	3 to 8 years	0	N/A
Facilities	Equipment	MIS/IT/Network Systems	Mission Critical Computers/Hardware	5 years	0	N/A
Facilities	Equipment	MIS/IT/Network Systems	SmarTrip Software	7 years	0	N/A
Facilities	Equipment	Maintenance	Miscellaneous	10 years	0	N/A
Facilities	Equipment	Maintenance	Bus	1 to 40 years	0	N/A
Facilities	Equipment	Maintenance	Rail Heavy Rail	10 to 40 years	0	N/A
Facilities	Equipment	Maintenance	Pollution Treatment	30 years	0	N/A
Facilities	Equipment	Maintenance	Bus Washer	15 to 42 years	0	N/A
Facilities	Equipment	Maintenance	Train Washer	15 to 41 years	0	N/A
Facilities	Equipment	Maintenance	Vehicle Paintbooth	20 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Fuel Island	1 to 40 years	0	N/A
Facilities	Equipment	Maintenance	Dynamoneters	15 years	0	N/A
Facilities	Equipment	Maintenance	Lifts - Portable	1 to 20 years	0	N/A

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Facilities	Equipment	Maintenance	Lifts - Fixed	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Brake Lathe	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Fuel Tank	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Lifts - Fixed: In Floor	15 to 40 years	0	N/A
Facilities	Equipment	Maintenance	Lifts - Fixed: Parallelogram	20 to 40 years	0	N/A
Facilities	Equipment	Maintenance	Wheel Presses	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Turntables, Truck	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Air Compressor	15 years	0	N/A
Facilities	Equipment	Maintenance	Hoist	15 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Scrubber, Sprayer	10 to 25 years	0	N/A
Facilities	Equipment	Maintenance	Misc Equip	1 to 30 years	0	N/A
Facilities	Equipment	Maintenance	Crane	1 to 30 years	0	N/A
Facilities	Equipment	Maintenance	CNG Refueling Station	30 to 41 years	0	N/A
Facilities	Major Shops	Rail	Heavy Rail	25 to 50 years	1	50%
Facilities	Major Shops	Bus		50 years	1	50%
Facilities	Central Control			35 years	1	50%
Systems	Train Control	Wayside Train Control	Heavy Rail	25 to 40 years	0	N/A
Systems	Train Control	Wayside Train Control	Track Circuit	40 years	0	N/A
Systems	Train Control	Wayside Train Control	Train Control Cable	40 years	0	N/A
Systems	Train Control	Interlockings	Switch Machine	25 to 40 years	0	N/A
Systems	Electrification	Heavy Rail		35 to 40 years	0	N/A
Systems	Electrification	Substations	Miscellaneous	30 years	0	N/A
Systems	Electrification	Substations	Heavy Rail	20 years	0	N/A
Systems	Electrification	Substations	AC Switchgear	20 to 25 years	0	N/A
Systems	Electrification	Substations	DC Switchgear	20 years	0	N/A
Systems	Electrification	Substations	Transformer	15 years	0	N/A
Systems	Electrification	Breaker House	Heavy Rail	40 years	0	N/A
Systems	Electrification	Contact Rail	Contact Rail (third rail)	35 to 50 years	0	N/A
Systems	Electrification	Contact Rail	Heaters	7 years	0	N/A
Systems	Electrification	Power Cable	(insulators)	2 to 15 years	0	N/A
Systems	Electrification	Power Cable	Substations	40 years	0	N/A
Systems	Electrification	Power Cable	Contact Rail	40 years	0	N/A
Systems	Communications	Miscellaneous		10 years	0	N/A
Systems	Communications	Cable Transmission System (CTS)	Fiber Optic Cable Transmission System (FOCS)	10 years	0	N/A

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Systems	Communications	Cable Transmission System (CTS)	Nodes	10 years	0	N/A
Systems	Communications	Passenger Communications Systems	(PA and Intercom)	10 years	0	N/A
Systems	Communications	Passenger Communications Systems	Transit Passenger Information Systems (TPIS)	10 years	0	N/A
Systems	Communications	Safety and Security	Intrusion Detection System (IDS)	10 years	0	N/A
Systems	Communications	Safety and Security	CCTV	10 to 15 years	0	N/A
Systems	Communications	Safety and Security	Chem/Bio Detection System	20 years	5	Approx. 20% each
Systems	Communications	Phone System	Phone System	5 years	0	N/A
Systems	Communications	Radio	System	10 to 45 years	0	N/A
Systems	Communications	Communications Huts	Hut	25 years	0	N/A
Systems	Revenue Collection	In-Station	(Station Operator Consoles)	20 years	0	N/A
Systems	Revenue Collection	In-Station	Faregates	20 years	0	N/A
Systems	Revenue Collection	In-Station	TVMs	20 years	0	N/A
Systems	Revenue Collection	In-Station	Parking Meters	20 years	0	N/A
Systems	Revenue Collection	On-Vehicle	Fareboxes	15 years	0	N/A
Systems	Utilities	Miscellaneous		25 years	0	N/A
Systems	Utilities	Lighting	Subway	25 years	0	N/A
Systems	Utilities	Pump Rooms	Subway	15 years	0	N/A
Systems	Utilities	Fire Protection Plumbing	Subway	20 to 30 years	0	N/A
Systems	Utilities	Ventilation	Subway	20 years	0	N/A
Systems	Utilities	Fan Plants	Subway	20 to 37 years	0	N/A
Systems	Utilities	Air Conditioning/ HVAC	Subway	19 to 43 years	0	N/A
Systems	Utilities	Emergency Exits	Subway	25 years	0	N/A
Stations	Complete Station	Bus Stop Shelters	Bus	20 years	1	25%
Stations	Building	At-Grade	Center or Side Platform	100 years	1	25%

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Stations	Building	Elevated	Center or Side Platform	75 years	1	25%
Stations	Building	Underground	Center or Side Platform	100 years	1	25%
Stations	Building	Building Components	Interior	40 years	1	25%
Stations	Building	Building Components	Station Police Booth	40 years	5	20% each
Stations	Building	Building Components	Drainage	42 years	1	25%
Stations	Building	Building Components	HVAC	41 years	1	25%
Stations	Building	Building Components	Exterior	42 years	1	25%
Stations	Building	Building Components	Other	18 to 41 years	1	25%
Stations	Access	Elevators		35 years	2	33% each
Stations	Access	Escalators		35 years	2	33% each
Stations	Access	Parking	Garage	37 to 60 years	1	50%
Stations	Access	Parking	Lot	20 to 60 years	1	100%
Stations	Platform	Canopy	Heavy Rail	25 to 41 years	0	N/A
Vehicles	Revenue Vehicles	Heavy Rail	1000 Series	39 to 47 years	1	50%
Vehicles	Revenue Vehicles	Heavy Rail	2/3000 Series	38 to 41 years	3	50% / 1% / 0.24%
Vehicles	Revenue Vehicles	Heavy Rail	4000 Series	25 to 26 years	0	N/A
Vehicles	Revenue Vehicles	Heavy Rail	5000 Series	15 to 17 years*	1	0.13%
Vehicles	Revenue Vehicles	Heavy Rail	6000 Series	40 years	2	0.24% / 50%
Vehicles	Revenue Vehicles	Heavy Rail	7000 Series	40 years	1	50%
Vehicles	Revenue Vehicles	Bus	Articulated Bus (60 ft)	12 years	1	19% / 50%**
Vehicles	Revenue Vehicles	Bus	Bus (40 ft)	15 years	1	25% / 50%**
Vehicles	Revenue Vehicles	Bus	Bus (< 40 ft)	15 years	1	50%
Vehicles	Revenue Vehicles	Vans, Cutaways and Autos	Light-Duty Van	4 years	0	N/A

** The FTA and Metro's Board approved early retirement of the 5000 series railcars in June 2015.*

*** Depending on fuel type*

Category	Sub-Category	Element	Sub-Element	Useful Life Range	# of Rehabs	Rehab Cost(s)
Vehicles	Revenue Vehicles	Vans, Cutaways and Autos	Raised Roof Van	4 years	0	N/A
Vehicles	Non-Revenue Vehicles	Car		5 to 12 years	0	N/A
Vehicles	Non-Revenue Vehicles	Truck		5 to 12 years	0	N/A
Vehicles	Non-Revenue Vehicles	Special		6 to 75 years	0	N/A
Vehicles	Non-Revenue Vehicles	Locomotive, Switch		20 years	0	N/A
Vehicles	Non-Revenue Vehicles	Passenger Van		5 to 8 years	0	N/A
Vehicles	Non-Revenue Vehicles	Heavy Truck		12 years	0	N/A

A.3 Complete list of assumptions

Assumptions are only in use where TAICA data, Maximo records, or alternative Metro databases (sources of record) were not available or were modified to complete the updated existing asset inventory. All costs listed below are in 2016 dollars, unless otherwise noted. The following assumptions were made in compiling the asset inventory for the initial CNI, in addition to those listed in the body of the report:

- 60-foot Buses: Set useful life for 60-foot articulated buses to 12 years (FMP). 40-foot Buses provided with useful life of 15 years (Board policy, and Fleet Management Plan).
- Access Vehicles Costs: Costs of $71,000 per van ($2018 dollars) were used (confirmed by MetroAccess staff).
- Aerials (bridges and pedestrian walkways): TAICA records showed two different condition ratings, which were assigned to a percentage of the asset's length. Therefore, two inventory records were created for the asset, with lengths corresponding to the percentage assigned to the condition score. The effective useful life of the lower-scoring asset was calculated based on the condition score – to reflect accelerated decay, and earlier replacement need.
- ACM: To account for annual expenditures necessary to maintain assets in good working condition, annual expenditures of 0.25 percent of asset replacement value were programmed for the following asset types (with the exception of tunnels, see below note):
  - o Station elevators and escalators.
  - o Administration buildings (overall structures).
  - o Building components, including built-in equipment, drainage assets, elevators and conveying systems, fall protection, and plumbing.
  - o Maintenance facilities (overall structures).
  - o Aerials (rail bridges only, not including pedestrian walkways).
  - o Train control interlockings and wayside train control.
  - o Tunnels – annual capital maintenance set to 0.11 percent of asset value but modeled as annual replacement need to allow for prioritization as an SGR project group.
- Dampers (guideway utilities/tunnel ventilation system): For those records with missing costs, a cost of $102,000 per damper was used (TAICA PM, 9/21/16).
- Elevator/Escalator Location IDs: Records are assigned to rail station Mezzanine Locations. For stations with multiple Mezzanine Location IDs, inventory records were

divided evenly.

- Emergency egress hatches (guideway utilities/tunnel emergency exits):
  - o For records with missing quantities, quantity of 1 was assumed, as quantity data was missing for all records (TAICA PM, 9/21/16).
  - o For those records with missing costs, a cost of $31,000 per emergency egress hatch was used (TAICA PM, 9/21/16).
- Fan plants, pump rooms, and select ventilation assets (all guideway utilities): For assets with missing date built, median date in service of the same asset type in same tunnel section was used as assumed build date (TAICA PM, 9/21/16).
- Fan plants: For those records with missing costs, a cost of $7,700 per fan plant was used (TAICA PM, 9/21/16).
- Fences:
  - o TAICA records showed two different condition ratings, which were assigned to a percentage of the asset's length. Therefore, two inventory records were created for the asset, with lengths corresponding to the percentage assigned to the condition score. The effective useful life of the lower-scoring asset was calculated based on the condition score.
  - o Maryland Transit Administration Engineering estimate for 9' fences used for costs - $31.17 per linear foot.
- General Software (including PeopleSoft): Assumed annual capital need of $60 million for upgrading software, including 15 percent soft cost (WMATA Office of Management and Budget Services).
- In-Station Revenue Collection: Useful life set to 20 years (WMATA Support Services).
- Inflation: Annual inflation set to 3 percent (WMATA Planning).
- Insulators (electrification/distribution):
  - o Set the useful life of insulators based on location in tunnels with varying degrees of water intrusion – highest level of intrusion is 2 years, moderate intrusion is 4 years, and a dry environment is 15 years (WMATA Engineering).
  - o Replacement cost of insulators assumed to be $288 per unit (TAICA PM), "which is a fully-loaded cost, including labor for installation (derived based on total past expenditures out of the CIP).
  - o Quantity of insulators assigned to a location, including yards, based on proportion of track feet and total of 170,340 insulators on the system.
- Maintenance Equipment: Data provided by TAICA was missing install dates for two records and cost data for seventeen records. Two core drill unit records were missing install dates and were assigned install dates in line with the 38 core drill units in existing inventory. Industry estimates were used in place of missing cost data for seventeen records ranging from locomotives to aerial lifts.
- MTPD Radios: Costs of portable radio units was applied to assumed MTPD radio quantities - assumed total force of 645 and 20 percent spares for quantity.
- On-vehicle revenue collection equipment (fareboxes): Set useful life to 15 years (WMATA Engineering/Support Services).
- Phone Systems: Assumed that all individual phones cost $189 (2004 dollars) (equivalent to 4-line Cortelco with auto-attendant).
- PIDs (passenger communications): PIDs costs provided as a total of $15 million for upgrade and replacement (WMATA Planning).
- Railcar Costs: Assumed orders of 200 cars each year. Contracted cost schedule shows $2.8 million cost (2010 dollars) for this order size, which translates to $3 million in current (2016) dollars which was confirmed by WMATA staff (WMATA Planning, TAICA PM).
- Retaining Walls:
  - o TAICA records showed two different condition ratings, which were assigned to a percentage of the asset's length. Therefore, two TERM Lite records were created for the asset, with lengths corresponding to the percentage assigned to the condition score. The effective useful life of the lower scoring asset was calculated based on the condition score.
  - o Baltimore MTA Engineering estimate used for costs - $1,022.67 per linear foot.
- Silver Line Revenue Collection: All assets were assigned

a 2014 install date, except for TVMs, which were rehabbed. An install date of 1996 was used for all Silver Line TVMs to trigger scheduled replacement in 2021 (Automatic Fair Collection, Engineering).

- Silver Line Traction Power Substations (TPSS): Traction power substation equipment records were not available for the Silver Line, so the average cost for existing 6MW traction power substations ($9 million) were assumed to apply to all Silver Line TPSS, which are all 6MW.
- Silver Line Stations: Cost assigned based on Full-Funding Grant Agreement figures. Total costs for at-grade and aerial stations were listed, so an average was calculated for each Silver Line station based on type of $37.2 million (neat costs, without inclusion of soft costs).
- Soft Costs: Soft costs are applied to purchase price or neat replacement costs to reflect the labor (planning, design/engineering, installation, etc.) related to replacement. See Table A-2; asset types not listed in this table were assumed to have fully loaded costs provided (i.e., a soft cost rate of 0 percent).
- Stations Useful Lives: Elevated stations set to a useful life of 75 years, all other stations (subway or at-grade) assigned a useful life of 100 years (WMATA Engineering).
- Subway fan plants: For records with missing quantities, a quantity of 4 was assumed based on the median quantity of the other vent fans records (TAICA PM, 9/21/16).
- Subway pump rooms: for records with missing quantities, a quantity of 3 was assumed based on the median quantity of the other pumping rooms (TAICA PM, 9/21/16).
- Third Rail:
  - o Records at location B03-B99 were assumed to have a 2003 build date to coincide with New York Ave infill station construction (TAICA PM).
  - o Tunnel records were used to determine if third rail segments were above or below ground. Below-ground segments were assigned 35-year useful life, while above-ground segments were assigned 50-year useful life.
- Tunnels: TAICA records showed two different condition ratings, which were assigned to a percentage of the asset's length. Therefore, two TERM Lite records were created for the asset, with lengths corresponding to the percentage assigned to the condition score. The effective useful life of the lower-scoring asset was calculated based on the condition score.
- Tunnel fire lines (guideway utilities/fire protection): For records missing quantities, a length of 1422.5 linear feet was assumed, based on the median fire line length (TAICA PM, 9/21/16).
- Yard Automatic Train Control (ATC):
  - o Used original Yard facility install date as install date for ATC (TAICA PM).
  - o Assumed ATC in each yard costs $10 million to replace (TAICA PM).
- Yard Track: Costed as ballasted track and assigned a useful life of 70 years.

A.4 Prioritization Measures

Prioritization criteria are applied to individual assets based on the asset type, location (for ridership only), and individual asset condition score. The scoring routine is calculated by TERM Lite, which recalculates prioritization scores in each of the 10-year analysis period based on the asset's age and decay curve.

A.4.1 Safety and Security

Guidelines for Scoring

The Safety and Security criterion is scored based on MIL-STD-882E standard. This standard utilizes a risk assessment that combines severity and probability of potential hazards or incidents, to generate a combined safety or security score on a 24-point scale. The use of this standard is dictated in WMATA's System Safety Program Plan (SSPP).

Data Sources

The following qualitative information was used to score the Safety and Security criterion:

- Input from WMATA Safety and Security experts utilizing the 24-point scale from the MIL-STD-882E to determine where Metro's asset types fall in a risk assessment.

Table A-2: Soft Costs Table of Assumptions

Asset Category/Sub-Category	Soft Cost Rate	Source/Notes
Systems: Electrification - Substations	8.0%	Rate applies to the following equipment: AC switchgear, DC switchgear, transformers, amazite pads, rectifiers, and other components. Source: Rail Modernization Study, 2009
Vehicles: Revenue Vehicle - Heavy Rail	10.0%	Source: TAICA and WMATA Planning, 2016
Facilities: Central Control	15.0%	Source: Regional Transportation Authority (Chicago RTA), URS Cost Study, 2010
Facilities: Equipment - Pollution Treatment	15.0%	Rate applies to the Mississippi Ave. Water Treatment Facility. Source: Chicago RTA, URS Cost Study, 2010
Facilities: Equipment - MIS/IT/Network Systems Software	15.0%	Rate applies to software only, as it is derived from estimates for upcoming software upgrades. Source: WMATA Office of Management and Budget Services, 2016
Facilities: Buildings	22.7%	Rate applies to Administration and Maintenance buildings, Major Shops, Storage Yards, as well as major building components. Source: Chicago RTA, URS Cost Study, 2010
Stations: Buildings and Access	22.7%	Rate applies to Station buildings, bus shelters, parking facilities, elevators and escalators. Source: Chicago RTA, URS Cost Study, 2010
Systems: Electrification - Distribution	23.0%	Rate applies to contact rail, breaker houses, power cable, and other related assets. Sources: C&P, 2009
Systems: Train Control	23.0%	Rate applies to interlockings, power cable, wayside train control, and other related assets. Sources: Sources: C&P, 2009
Guideway Elements: Guideway	38.0%	Rate applies to tunnels, aerials and at-grade structures. Based on analysis of Metro's costs to construct rail infrastructure which requires design, analysis, planning, escorts on the ROW for any contractors, installation, and management. Source: Takis Costing Study, 2008
Guideway Elements: Special Structures	38.0%	Rate applies to fences and retaining walls. Based on analysis of Metro's costs to construct rail infrastructure which requires design, analysis, planning, escorts on the ROW for any contractors, installation, and management. Source: Takis Costing Study, 2008
Guideway Elements: Trackwork	38.0%	Rate applies to all track types, including special and yard. Based on analysis of Metro's costs to construct rail infrastructure which requires design, analysis, planning, escorts on the ROW for any contractors, installation, and management. Source: Takis Costing Study, 2008
Systems: Electrification - In-Station Substations (above-ground)	80.0%	WMATA Engineering cited increased installation costs for substations located in above-ground stations
Systems: Communications - Radio	85.7%	Applies to the radio systems project (upgrade to 700MHz). Based on project installation and labor costs provided by WMATA Office of Management and Budget Services, 2016
Systems: Electrification - In-Station Substations (underground)	95.5%	WMATA Engineering cited increased installation costs for substations located in underground stations

- Input from WMATA asset owners and specialists.
- Corrective Action Plan information.

Methodology

Scoring for Safety and Security is static, meaning that scores will not change based on the age of the asset or the year of analysis. These scores will remain constant for each asset type over time.

Due to limitations in existing empirical data sources, a qualitative, risk-based approach based on the MIL-STD-882E standard was used to develop asset type scoring for the Safety and Security criterion. Safety and security experts applied the probability and severity definitions to Metro's asset types (see Table A-3 and Table A-4), which was then verified by key asset owners.

The resulting 24-point score was rescaled to a 1 to 5-point score, as per Table A-5, to be consistent with the other criteria used in TERM Lite.

A.4.2 Asset Condition

Guideline for Scoring

Asset condition is a universal measurement for SGR and helps identify and prioritize reinvestment needs. The FTA's 5-point scale for asset condition is defined for all assets based on physical inspection. The general guidelines are as follows:

- Excellent (5): New or near new asset; no visible defects.
- Good (4): Asset showing minimal signs of wear; some (slightly) defective or deteriorated component(s).
- Fair (3): Asset has reached mid-life; moderately defective or deteriorated component(s); some asset types may be expected to have a condition of 3.0 or higher as a minimum standard acceptable condition (e.g., for Park & Ride lots, lot markings should be kept to a standard of 3.0 or better to ensure safe and efficient operations).
- Marginal (2) – Asset reaching or just past the end of useful life; increasing number of defective or deteriorated component(s) in need of replacement.
    - Condition 2 indicates asset (or significant portion of an asset) is close to, or in need of, rehab/replacement and should be considered a pending investment need.
    - Assets in this condition often show increasing maintenance needs, impacting higher O&M costs.
    - While the majority of an asset may be in good condition, an inspector should select condition 2 if a sufficient proportion of the asset is in condition 2 to indicate that a replacement/rehabilitation action is warranted.
- Poor (1) – Asset is past its useful life and in need of repair or replacement; may have critically damaged or broken components; assets in this condition may not be serviceable.

While the guidelines above are general, there will be specific scoring guidelines for each asset type and component developed by the TAICA project to ensure consistency and repeatability in scoring. Some TAICA scoring may also be based on performance histories, age, or functionality – as opposed to physical inspection.

Data Sources

As of the date of this report, complete TAICA data was not available for use in the CNI. Where TAICA physical condition data was available, that input was used to calculate "effective useful life" for assets. Otherwise, an age-based approach to predicting current condition scores was utilized in TERM Lite. This approach requires accurate information regarding the date an asset was put into service (from the inventory records) and its expected useful life (from TAICA or asset owner inputs). The methodology for estimating current and predicting future asset conditions based on age is described below.

Methodology

Asset condition scoring is dynamic, meaning that TERM Lite recalculates the priority score for each asset in each year of the 10-year period of analysis – based on progress down the modified decay curve described below.

Probability Levels

Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item.	Continuously experienced.
Probable	B	Will occur several times in the life of an item.	Will occur frequently.
Occasional	C	Likely to occur sometime in the life of an item.	Will occur several times.
Remote	D	Unlikely but possible to occur in the life of an item.	Unlikely, but can reasonably be expected to occur.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.
Eliminated	F	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.	

Table A-3: Description of Probability of Occurrence

Risk Assessment Matrix

Probability	Severity 1	2	3	4
A	5	5	3	2
B	5	4	3	2
C	4	3	2	1
D	3	2	2	1
E	2	2	2	1
F	0			

Table A-5: MIL-STD-882E-based Risk Assessment Matrix

Severity Categories

Description	Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss to or exceeding $10M.
Critical	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding $1M but less than $10M.
Marginal	3	Could result in one or more of the following: injury of occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding $100K but less than $1M.
Negligible	4	Could result in one or more of the following: injury of occupational illness not resulting in a lost work day, minimal environmental impact or monetary loss less than $100K.

Table A-4: Description of Severity of Occurrence

Current Condition Ratings

In the absence of TAICA data, TERM Lite uses decay curves developed by the FTA to estimate the current condition of Metro's assets. These asset decay curves were developed using empirical data obtained from on-site condition assessments conducted at over 50 transit agencies nationwide. Figure A-1 provides an example of how the FTA decay curve was developed for 40-foot buses.

Each dot in the scatter chart is the result of a physical inspection of a bus performed at a transit agency, including WMATA bus fleet vehicles, which were inspected by qualified engineers as part of the FTA's development of nationwide SGR analysis. "Best fit" relationships are derived between age and condition using regression analysis. The resulting decay curves are representative at the portfolio level, but may not represent the usage or the environment of usage of individual buses or sub-fleets.

Projecting Future Condition Ratings

In order to project condition forward over the 10 years of CNI analysis, TERM Lite progresses an asset down a "variable" decay curve each year that it ages. Each asset has a unique or "variable" decay curve as the slope and time to reach a condition score of 2.5 (end of life) varies and is determined by the useful life of that asset in inventory.

It is important that useful life is entered for individual assets, and not asset types, as the operating environment and maintenance regime for a specific asset may increase or decrease its useful life compared to assets of a similar make, model, and use. An example of the change in slope based on asset's useful life is illustrated in Figure A-2 comparing a 15-year bus to a 12-year bus.

A.4.3 Service Delivery

Guideline for Scoring

The Service Delivery criterion is aligned with the agency's strategic goal to "meet or exceed expectations by consistently delivering quality service" and therefore, captures both an investment's ability to meet customer expectations for service and reduce risk of service failures/ disruptions. The general guideline for the static component of the score for this criterion is based on an asset's percentage impact on customer satisfaction. Percentage impact on customer satisfaction greater than 20 percent warrants a score of 5 for related assets, an impact from 15 to 20 percent a score of 4, and the scale continues until 0 to 5 percent impact assets are given a score of 1. Further delineation is derived from modal data.

Data Sources

- Calendar year 2015 Customer Survey Results.
- Minutes of Delay–weekday (Metrorail), CY2015.

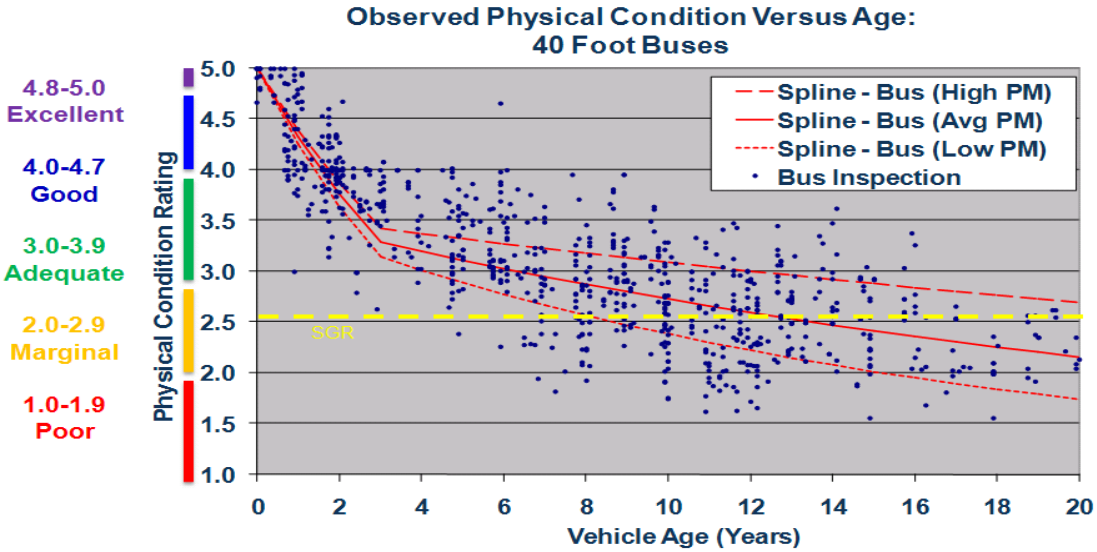


Figure A-1: FTA Developed Physical Condition vs. Age Decay Curve for 40-foot Buses[1]

1 The three different slopes of decay on the graph represent different levels of Preventative Maintenance (PM) done on the buses – i.e., buses with high levels of PM (High PM) decay slower than buses with low levels of PM (Low PM).

- Missed trips due to mechanical failure (Metrobus), CY2015.
- MACS failure rates (MetroAccess), CY2015.
- Ranking of supporting assets – by criticality to service, as determined by System and Facility Management Team, led by asset owners.

Methodology

The scoring for Service Delivery is dynamic, based on the static score described below and the asset's condition. The model will recalculate the priority score for Service Delivery in each year of analysis by combining the asset type score and progress along the individual asset decay curve. Figure A-3 shows an illustration of how the maximum priority score for Service Delivery will only be

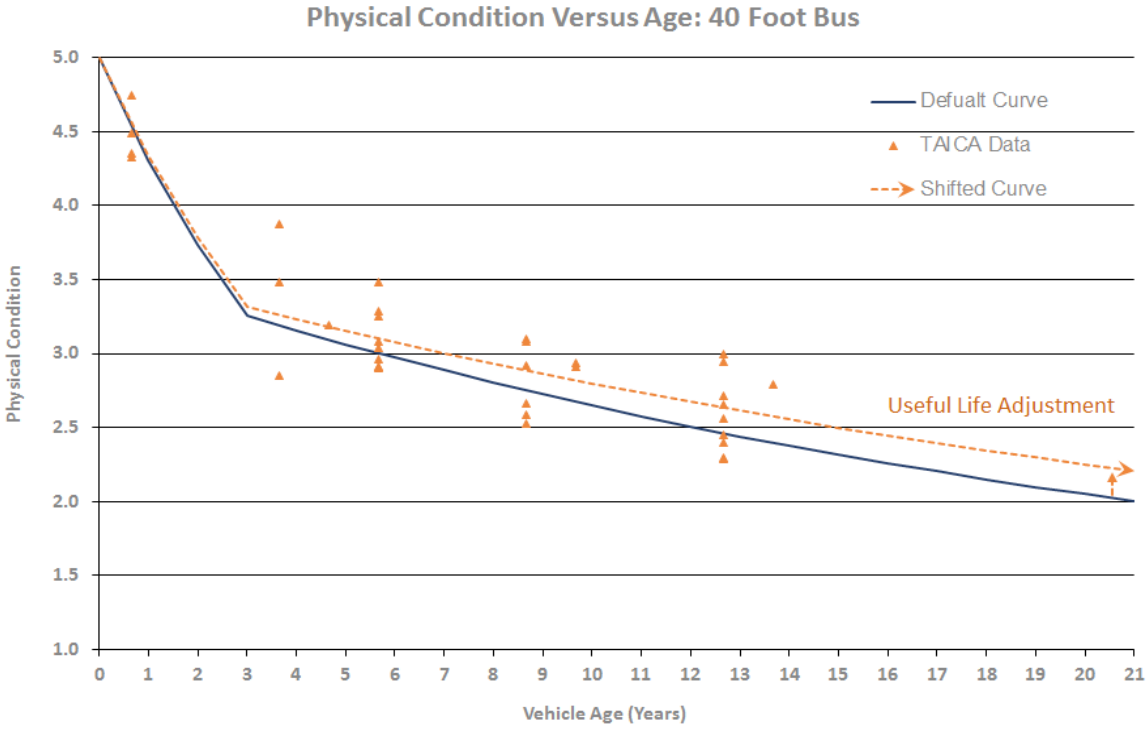


Figure A-2: Example Decay Curve Slope Variation between a 12-year bus and a 15-year bus

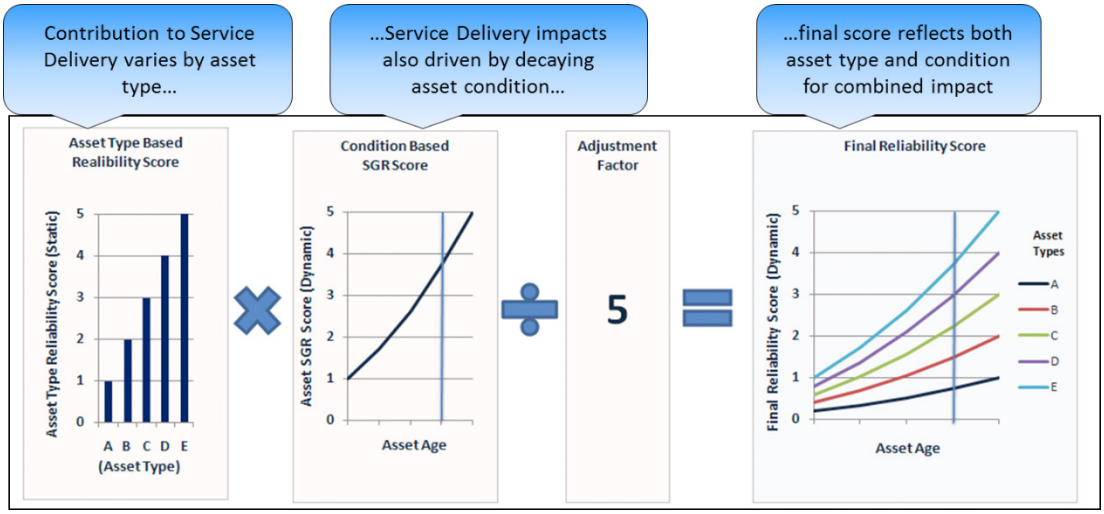


Figure A-3: Example of Dynamic Scoring Approach for Service Delivery Criterion

Survey Period	Metrobus	Metrorail	MetroAccess
2015 Q1	308	462	400
2015 Q2	339	432	
2015 Q3	339	432	400
2015 Q4	339	431	
Total	1,325	1,757	800

Table A-6: Customer Survey Satisfaction Responses (CY2015)

Metrorail Asset Types	Total Minutes Delay	Priority Score
Vehicles: Railcars	8,917	5
Systems: Electrification	3,245	5
Systems: Train Control	2,488	5
Guideway: Trackwork	2,329	5
Systems: Communications	186	4
Systems: Utilities	15	4

Table A-8: Total Minutes of Delay for Metrorail Assets

Metrobus, Metrorail, & MetroAccess Scores:	(high impact on satisfaction) 5	4	3	2	(low impact on satisfaction) 1
Percent impact on customer satisfaction	> 20%	20-15%	15-10%	10-5%	5-0%
Examples from CY15 aggregate results	Reliability for bus and rail	On-time Performance (OTP)	Rail signage & graphics, faregates, bus climate control	Train climate control, train cleanliness, station climate control, bus fareboxes, bus stop signage	Vertical transport (ELES), station lighting, paper signage, station/ train & bus announcements
	Distribute by: Minutes of Delay (Metrorail), Missed Trips (Metrobus), and Fleet Failures (MetroAccess)				

Table A-7: Scoring System for Service Delivery Criterion

reached when the asset is at the end of its useful life. The combined scoring approach reflects the increased impact of reinvesting in older assets, in poorer condition, to improve customer experience (as compared to replacing new with new).

Static Scoring Component

Metro's customer satisfaction survey is conducted quarterly, results for which include the percentage impact on customer satisfaction by related asset. The cumulative 2015 results of this survey are the guiding force for prioritizing assets in terms of service delivery. The number of survey responses for 2015 by quarter and in total are shown in Table A-6. If an asset type is only used seasonally, for example station cooling, then the survey results from the relevant quarter(s) alone are used in determining priority scores. In total the 2015 surveys had 3,882 responses (n value).

Impact ranges from 0 percent to 24 percent, and assets are assigned a 1 to 5 score based on their impact, with 5 denoting high impact on satisfaction and 1 denoting low impact on satisfaction. The scoring system is illustrated in Table A-7.

As noted in Table A-7, reliability for Metrorail (24 percent) and Metrobus (20 percent), as well as Metrobus on-time performance (OTP) (17 percent) have the highest impact on customer satisfaction. Using modal data, assets are

distributed between the scores of 4 and 5 based on their impact on reliability and OTP. Other assets will be ranked from 1 to 3 based on their impact on customer satisfaction.

Metrorail

As previously mentioned, asset-level data is used to further determine the asset criterion between scores 4 and 5. For Metrorail, weekday Minutes of Delay were used as the metric. The data included 3,731 recorded incidents, of which 1,359 were deemed non-asset related, leaving 2,372 asset-related delay records. The data were organized by their corresponding "Trouble" code then were grouped by their related asset.

Table A-8 shows the distribution of total Minutes of Delay by asset and the corresponding Service Delivery priority ranking. Total Minutes of Delay was used, because the measure captures both frequency and severity in comparison to average minutes, which captures only severity. There is a clear delineation between the magnitude of minutes of delay for Guideway: Trackwork (2,329) and Systems: Communication (186), which also marks the dividing line between assets ranked 5 and those ranked 4. For example, Table A-8 shows that rail assets scored a 5 include railcars, electrification, train control and track; whereas assets scored a 4 include communications and utilities. Assets ranked in the 1 to 3 range will be compiled from the survey results, which include signage, graphics, and onboard announcements.

Additionally, a list of supporting assets, which include critical assets and fire life safety (FLS) assets, was provided. Critical assets include railcar maintenance and support assets, public safety systems, and others. Assets that appear on both the critical asset list and the customer survey impact list are rated as they appear on the customer survey impact list. Critical support assets that are not on the survey impact list are assigned the same rating as their corresponding asset. For example, rail lifts will be assigned a 5 rating as railcars are also rated 5.

FLS assets include items related to safety/security systems and will thus be ranked as a priority under the Safety and Security criterion, and not prioritized highly here to avoid creating collinearity between the two criteria for FLS assets.

Metrobus

Similar to the Metrorail assets methodology, Metrobus asset rankings are driven by customer survey impact results. Assets related to reliability and OTP are assigned a score of 5 for Metrobus–as all missed trips were due to revenue fleet assets with low variability in average fleet failure rates. Meaning there was no delineation between assets causing different levels of service reliability. Therefore, in the case of Metrobus, revenue vehicles and supporting assets are ranked 5, while other assets will be assigned 1 to 3 rankings. Examples of bus assets in the 1 to 3 categories are listed in Table A-6, including bus fareboxes and bus stop signage.

Additionally, Metrobus supporting assets will be ranked in the same fashion as Metrorail assets.

MetroAccess

Among the items listed in the survey impact results, none are directly related to MetroAccess assets. Furthermore, failure data showed low variability among MetroAccess fleets, thus not allowing for differentiation. As a result, since the modal inventory is largely comprised of fleet and support assets that directly affect reliability and on-time-performance, the highest ranking of 5 will be assigned to all MetroAccess service assets.

A.4.4 Ridership Impacts

Guideline for Scoring

To measure impacts of asset changes to Metro riders, this criterion uses static scoring on a logarithmic scale to assign scores based on the number of weekday riders per day affected by the asset. General ridership impact guidelines are as follows:

- Severe Impact (5) – Greater than 700,000 trips/day affected
- Significant Impact (4.0 to 4.9) – Greater than 70,000 trips/day affected
- Moderate Impact (3.0 to 3.9) - Greater than 7,000 trips/day affected
- Slight Impact (2.0 to 2.9) – Greater than 700 trips/day affected
- Little Impact (0.0 to 1.9) – Less than 700 trips/day affected

The score is calculated using the ratio of the weekday riders impacted relative to a baseline set at the highest daily ridership for any mode in the system (proposed to be 713,000, representing daily Metrorail ridership). This baseline will apply to all modes—Metrorail, Metrobus, and MetroAccess—as a way of normalizing scores relative to the highest possible ridership. This ratio is scaled using log (base 10) to calculate the score. At the high end of the scale, any asset serving full system ridership (700,000 or more) will get a score of 5.0, such as the Rail OCC center. For vehicles, the average ridership per railcar or bus is calculated and multiplied by the total number of vehicles being replaced. For example, there are roughly 650 daily boardings for each railcar in the fleet. A project to replace 100 railcars would represent 65,000 trips and would yield a score of 3.95. The lower range of ridership will generally be for assets with an indirect impact on ridership (see discussion below about ridership adjustment factors).

It is important to note the low ridership impact score for MetroAccess vehicles will be offset by the high priority score for these vehicles under Safety & Security and Service Delivery (5).

Data Sources

To gather ridership data, several data sources were used for Metrorail, Metrobus, Metroaccess, and system-wide; detailed below:

- Metrorail
  - o Average weekday ridership mode-wide and by station and mezzanine (May 2015).
  - o Average weekday ridership by segment (station-to-station) from Metrorail Line Load Application (May 2015).
  - o Daily utilization and capacity of parking facilities by station (April 2016).
- Metrobus: Average weekday ridership mode-wide and by division and vehicle type (March 2016).
- Metroaccess: MACS daily trips served mode-wide (FY 2016).
- A system-wide total calculated by combining all modes.

Methodology

Ridership Impact scores are static (i.e., do not change over the 10-year period if analysis), and are calculated based on the most recent year of data available (as shown above).

Average weekday ridership is assigned to each asset category by location using a hierarchy based on number of users affected by the asset. Table A-9 describes the ridership levels that will be used and gives examples of assets that are aligned with each level.

Ridership Adjustment Factors

Not all assets at a given location contribute equally to ridership, or have the same impact on delivering service to riders. To account for these differences, ridership

Ridership Level	Asset Examples – Direct Ridership Impact	Asset Examples – Indirect Ridership Impact
System-wide	n/a	Administrative facilities, authority-wide IT systems, radio/phone
Metrorail – Mode-wide	Rail OCC, Rail cars	Central revenue collection facility, non-revenue vehicles and equipment
Metrorail – Segment	Mainline track, electrification, etc.	Ties, crossover, fencing, stand pipes, etc.
Metrorail – Station/ Mezzanine	Platforms, escalator, elevator	Lighting, HVAC, PA system, signage, parking, pedestrian walkways, bike access/storage
Metrorail – Division	n/a	Rail storage and maintenance facilities
Metrobus – Mode-wide	Buses	Shared facilities (heavy overhaul shop), bus OCC, bus systems (AVL), non-revenue vehicles and equipment
Metrobus – Division	n/a	Bus garage and maintenance facilities
MetroAccess – Mode-wide	Vans	Storage facilities

Table A-9: Summary of Ridership Levels and Corresponding Asset Examples

adjustment factors are applied to account for whether asset has a direct or indirect impact on riders. TERM Lite includes a "Ridership Adjustment Factor" for each asset type:

- 100 percent: Asset directly supports and is crucial to ridership.
- 1 percent: Asset does not directly support ridership.

The combination of the ridership impact value based on the asset's location multiplied by the adjustment factor generates the overall ridership score.

A.4.5 Priority Status

Inventory records in TERM Lite can be flagged to override normal priority scoring based on a variety of factors. There are three options currently built into the model for Priority Status for the CNI. The use of Priority Status is not meant to apply universally to all asset types, as the prioritization criteria do. Instead this field is meant to allow agencies to identify specific issues that may only apply to a handful of assets or locations, and will only apply once. After the assets that are flagged are replaced, they will revert to normal scoring for future replacements.

The Priority Status options are:

- Compliance – increases priority scoring up to 100 points.
  - o Identifies assets that require replacement due to:
    - Compliance issues – change in regulation or code or replacement required to be in compliance with standards.
    - Accidents or safety concerns – generally damaged or found to require replacement in an audit or investigation.
    - Technological obsolescence – no longer fit for service required by the agency.
  - o The model will generate the highest score possible within the normal range of 0 to 100 by multiplying the useful life of the asset by four to represent the age – increasing it well beyond useful life to force:
    - The highest possible asset condition score.
    - Immediate replacement need.
- Normal – no change to scoring.
- Exclude – no needs associated with this asset.
  - o Assets are being retired from service without replacement.
  - o Assets are not in use for transit services (i.e. vacant facilities that will be sold or demolished).

A.5 Call for New Investment Needs Process (CFN)

The CFN needs process was conducted through a customized web form that solicited all of the requisite information for evaluating and scoring new investment needs was completed by project managers from departments throughout WMATA. Project managers who received access to the web form were selected by their representative at the CPAC. The web form had skip logic that directed the user to fill in questions based on his/her categorization of the need as new, replacement, or expansion.

Preparation for the CFN process took place from April through June 2016, the project manager training and the CFN submission process took place in July through early August 2016, and follow-up and finalization of the new investment needs inventory took place from August through September 2016.

A.5.1 Project Manager Resources and Preparation

Prior to the opening of the CFN needs web from, training sessions were held to familiarize project managers with the web form and answer questions related to the CFN process. These sessions provided project managers with an overview of the CNI project, the role of the CFN needs in the CNI, and the content of the web form. A resource document, the CFN Guidelines and Frequently Asked Questions (FAQ) that explained conceptual questions and technical questions on the CFN process was also provided to project managers.

A help desk email was created and maintained to assist project managers with technical support and any questions about the process or the qualifications of a need. Project managers answered topical questions related to what to submit to the new investment needs process and questions on the web form content via the help desk email throughout the CFN needs submission period.

A.5.2 Submission Period

The web form opened for submissions from July 18th through August 5th, 2016. At the end of each day, the web form system automatically emailed an updated Excel spreadsheet of all of the submissions. Then, the submissions were transferred to a master Excel spreadsheet, which was used to review needs for duplicate submissions, needs that were covered in the existing inventory of state of good repair capital needs, and inconsistent information and any other items of concern or in need of clarification. The submissions started slowly with most days yielding between one to three submissions; during the last four days, 255 of 294 total submissions were sent (87 percent).

A.5.3 Submission Review

Following the closing of the submission period, a period of in-depth review of the submissions and follow-up with project managers on items requiring clarification (e.g., inconsistencies, missing information) was conducted. Several instances of needs that were duplicates or very similar submitted by different project managers and departments were also identified. After final review, a handful of additional duplicates were identified and resolved through phone calls and emails with the need submitters.

To gather missing information, with emphasis on cost figures and asset types, project managers were contacted via email. Those who had submitted more than seven needs were asked for a phone call to review missing information on their submitted needs. The master spreadsheet was subsequently updated with corrected information.

The last step in the submission review process was to cross-check the submissions against other SGR needs to search for overlap. Submissions that could be captured through the SGR process were moved out of the New investment needs database to be scored and evaluated as SGR Needs. The final result was a list of 152 confirmed New investment needs projects.

A.5.4 Submission Summary

Out of the 152 new investment needs, 99 new investment needs, or 65 percent of the total were submitted by project managers under the Chief Operating Officer, which includes bus and rail operations (see Figure A-4). Facilities, the asset category that includes buildings, storage yards, and equipment, constituted 42 percent (64 needs) of all the needs submitted by asset class (Figure A-5).

In terms of cost, 81 percent of the total ten-year costs or a total of $5.73 billion fall under the Chief Engineer (see Table A-10). Relatively higher cost needs falling under the Chief Engineer include the purchase of railcars and related improvements for full eight-car trains, tunnel ventilation projects, and building a central heavy repair and overhaul facility. New investment needs submitted by the Chief Operating Officer total $1.14 billion, or 16 percent of the total, with the most expensive being a new bus garage near Silver Spring, a CTEM maintenance and heavy overhaul facility, and expansion of the bus fleet.

When new investment needs are analyzed by asset category (see Table A-11), vehicles and facilities comprise 30 and 29 percent of total costs, respectively. It is worth noting, however that, 82 percent of the total costs of vehicles submitted through the new investment needs process stem from a single project, the purchase of railcars to operate full 8-car trains (ID 150). Highest cost projects falling within the facilities asset categories include expanding storage and maintenance facilities to run full 8-car trains, building a central heavy repair and overhaul facility, and a new bus garage.

The median ten-year cost for new investment needs is $4.3 million, however the average ten-year cost is $46 million.

Figure A-6 shows the distribution of new investment needs by priority score. Seventy-one percent of new investment needs received a priority score between 6 and 20 points, while 28 percent of new investment needs scored between 20 and 50 points. Only one new need, Facility and On-Street Terminal Improvements (ID 61, 50.37), received a priority score slightly over 50 points.

The distribution of new investment needs by priority score and chief demonstrate that many of the highly scored new investment needs fall under the Department of System Safety (SAFE), Chief Engineer, or the Chief Operating Officer (see Figure A-7). The distribution of new investment needs by priority score and asset category show a more mixed picture, with stations facilities scoring highly, however, facilities also dominate the lowest scored new investment needs (Figure A-8).

The seven projects with the highest ten-year costs are shown in Figure A-9. The majority of these higher costs needs fall near the median priority score of 14.40 and the average score of 19.25, two new investment needs fall well above the average. These projects include Railcars to Operate Full 8-Car Trains (ID 150), Improve Safety/ Reliability in the BL/OR/SV Corridor (ID 137), Expand Storage/Maintenance Facilities to Run 8-Car Trains (ID 147), Improve Traction Power to Operate 8-Car Trains (ID 149), Tunnel Ventilation (ID 25), Build Central Heavy Repair and Overhaul Facility (ID 135), and Energy Management through Obsolete System Upgrades (ID 316).

The individual new investment needs with the top ten highest scores are listed in Table A-12. All of these new investment needs have been given compliance status, which provided them with extra weight on top of the base score built from condition, safety, service delivery, and ridership impacts. Facilities assets comprise four of the top ten scoring needs, followed by systems and guideway elements, and vehicles and stations. Half of the top ten new investment needs were submitted under the Department of System Safety (SAFE). Out of the seven SAFE needs submitted through the CFN needs process, all but one scored 40 points or higher. Another four out of the top ten new investment needs were submitted under the Chief Engineer, Infrastructure (CENI). The highest scoring need was submitted by the Chief of Operations, Department of Bus Service (BUS).

All of the new investment needs with top ten priority scores cost below $30 million dollars (Figure A-10).

The new investment needs with the ten lowest scores are listed in Table A-13. None of these needs have a compliance component. Eight of the bottom ten new investment needs were submitted by the Department of Rail Operations. One of the rail needs, also by far the most expensive, comes out of the Chief Office of Engineering rather than the Chief Operating Office. The remaining two new need projects are out of the Department of Bus Service and the Department of Planning.

A.6 Detailed Investment Needs Listings

A.6.1 SGR Investment Needs

Detailed SGR needs are listed in Table A-14, sorted by Priority Score, including the asset type, mode and location groupings. Costs are in millions of YOE dollars and do not include ACM values for assets. ACM needs total $152 million over the 10-year period of analysis, and are only a need for those assets designated in Appendix A.3 as requiring “annual capital maintenance”.

A.6.2. New Investment Needs

New investment needs details are listed in Table A-15, with costs in millions of YOE dollars.

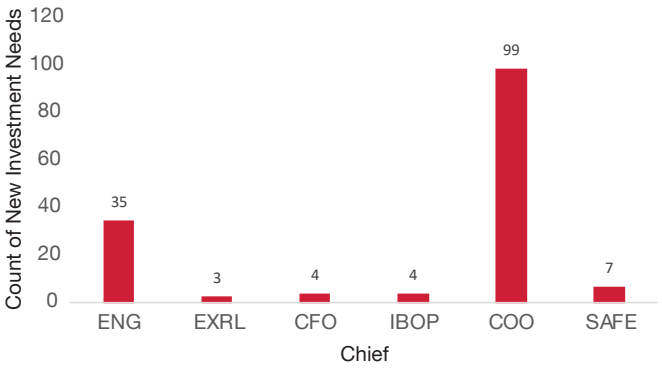


Figure A-4: Count of New Investment Needs by Chief

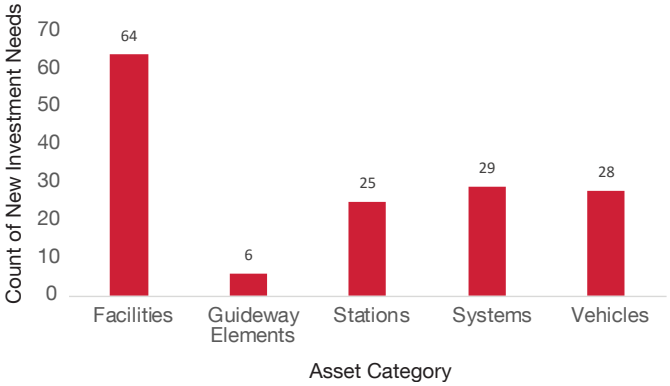


Figure A-5: Count of New Investment Needs by Asset Category

Asset Categories	Total Cost of New Investment Needs ($M YOE)	Percentage of Total
Vehicles	$2,130	30%
Facilities	$2,010	29%
Systems	$1,290	18%
Guideway Elements	$950	13%
Stations	$670	9%

Table A-11: Cost of New Investment Needs by Asset Category[1]

1 Ibid.

Chiefs	Total Cost of New Investment Needs ($M YOE)	Percentage of Total
ENG	$5,730	81%
COO	$1,140	16%
SAFE	$130	2%
EXRL	$20	0.3%
IBOP	$20	0.2%
CFO	$5	0.1%

Table A-10: Cost of New Investment Needs by Chief[1]

1 All costs are rounded to the nearest ten million.

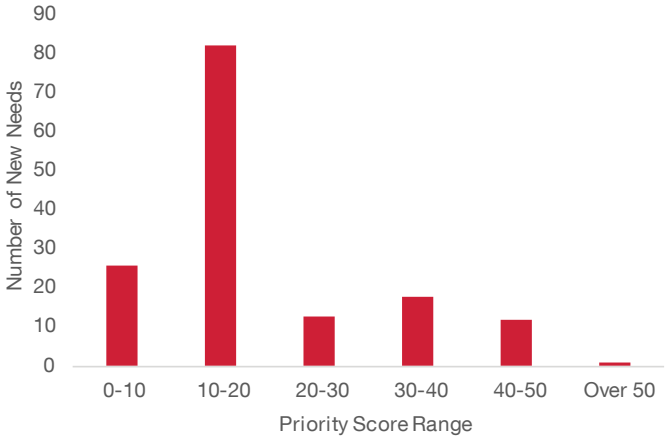


Figure A-6: Distribution of New Investment Needs by Priority Score

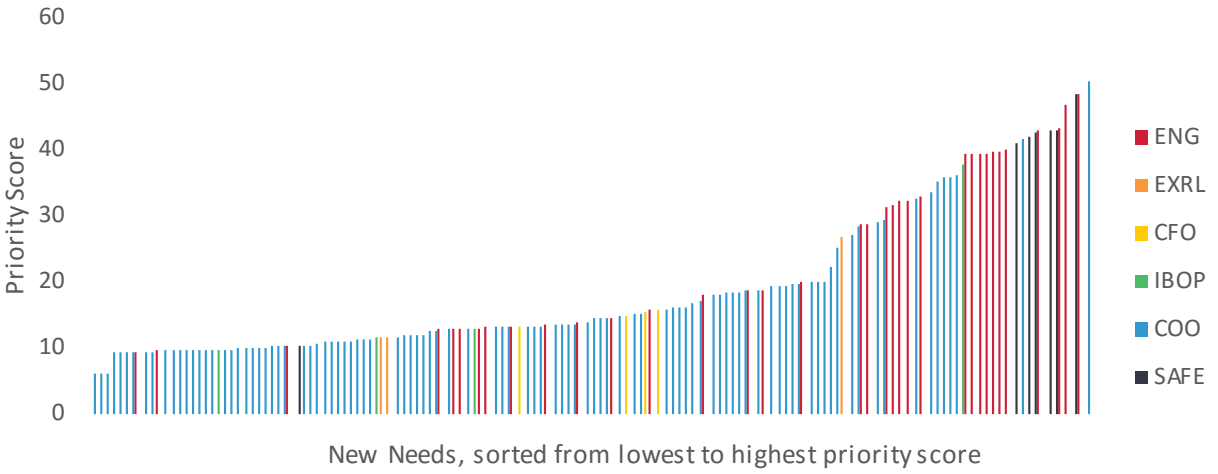


Figure A-7: Distribution of New Investment Needs by Priority Score and Chief

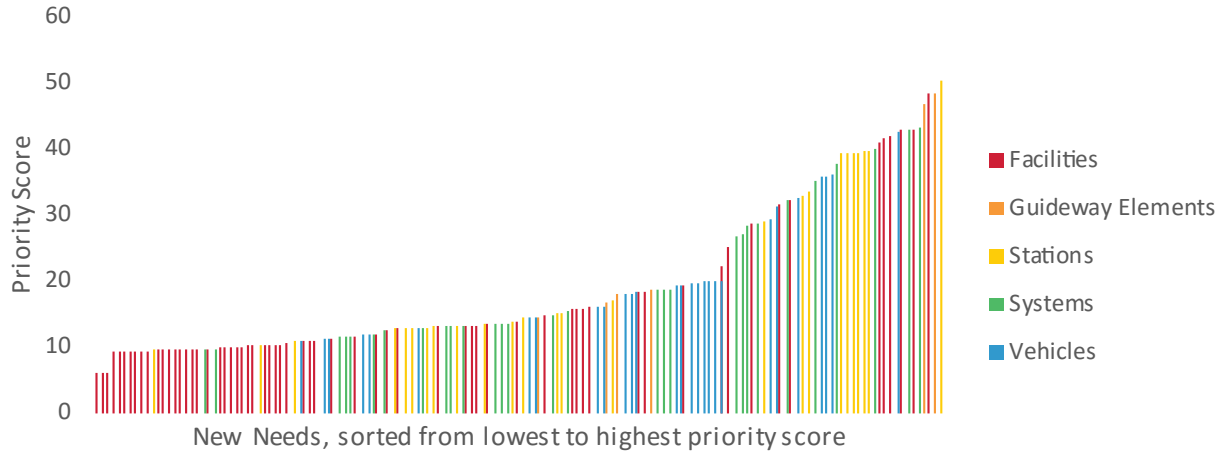


Figure A-8: Distribution of New Investment Needs by Priority Score and Asset Category

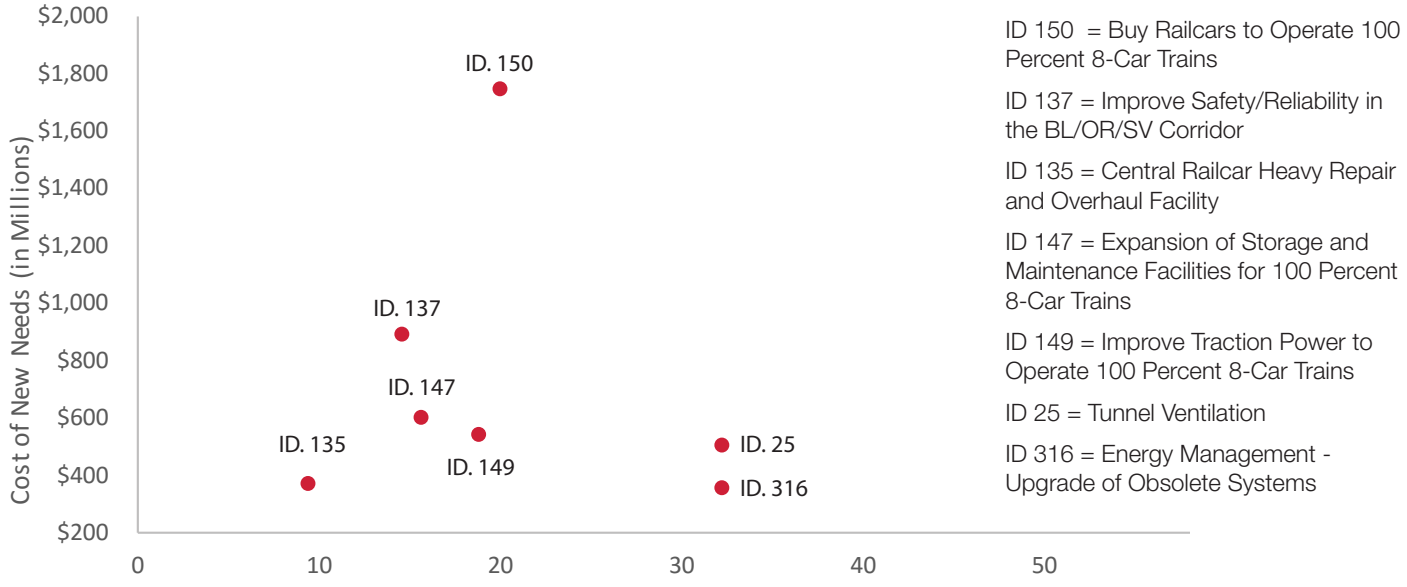


Figure A-9: New Investment Needs by Priority Score with Costs above $200 Million

ID	Name	Asset	Chief	Dept.	Priority Score	Ten-Year Total
61	Facility and On-Street Terminal Improvements	Stations	COO	BUS	50.37	$3,000,000
188	Ultrasonic Testing and Repair of Anchor Bolts of Aerial Structures and Hammer Heads at D&G	Guideway Elements	ENG	CENI	48.51	$18,000,000
6	Environmental Compliance Projects	Facilities	SAFE	-	48.30	$21,000,000
151	Relocation of High Voltage Cable out of Eisenhower Ave Aerial Structure	Guideway Elements	ENG	CENI	46.74	$13,000,000
246	Rehab Fare Gates and Correct “Fail-safe Closed” Issue	Systems	ENG	CENI	43.20	$4,000,000
198	Pavement & Stormwater Management at 3421 Pennsy Drive	Facilities	SAFE	-	42.90	$5,000,000
19	Remediation Building at New Hampshire Ave Chiller Plant	Systems	SAFE	-	42.90	$9,000,000
78	Install Sprinkler System to code compliance at Material Storage Facility	Facilities	ENG	CENI	42.87	$4,000,000
24	Vacuum Train for Tunnel Trash and Dust Removal	Vehicles	SAFE	-	42.63	$14,000,000
8	Pollution Prevention at Track Fueling Areas	Facilities	SAFE	-	42.00	$26,000,000
Total						$117,000,000

Table A-12: New Investment Needs with Top Ten Priority Scores

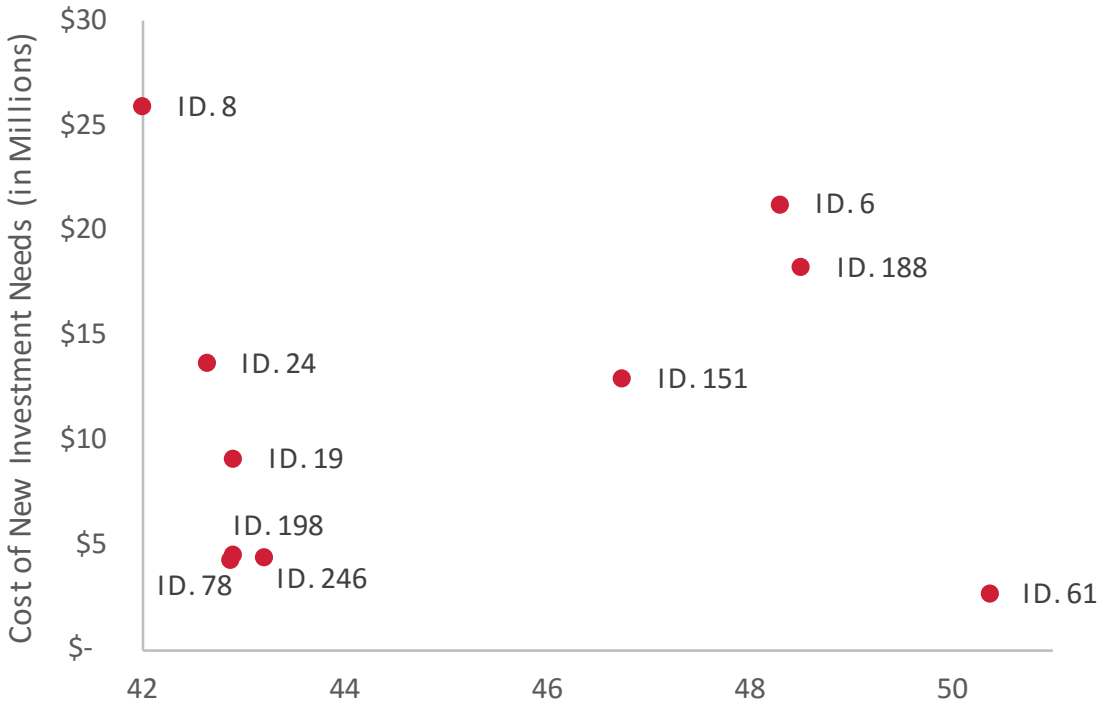


Figure A-10: New Investment Needs with Top Ten Priority Scores

ID	Name	Asset	Chief	Dept.	Priority Score	Ten-Year Total
187	New Carrollton Rail Yard (CMNT) Extension of existing parking lot	Facilities	COO	PLAN	9.41	100,000
195	New Carrollton Rail Yard (CMNT) Expansion of existing office space	Facilities	COO	RAIL	9.41	400,000
135	Build Central Heavy Repair and Overhaul Facility	Facilities	ENG	RAIL	9.41	370,000,000
297	Renovations to Montgomery Bus Division	Facilities	COO	BUS	9.36	6,000,000
12	Brentwood S&I Rail Facility (CMNT) Louvered crank style windows	Facilities	COO	RAIL	9.24	300,000
96	Brentwood Rail Facility Parking Garage on South Lot	Facilities	COO	RAIL	9.24	3,000,000
10	Brentwood Rail Facility (CMNT) administrative office buildout	Facilities	COO	RAIL	9.24	10,000
157	Alexandria Rail Yard (CMNT) Expansion of existing office space	Facilities	COO	RAIL	6.01	800,000
136	Shady Grove Rail Yard (CMNT) New Maintenance Office Space	Facilities	COO	RAIL	6.00	400,000
131	Shady Grove Rail Yard (CMNT) Expansion of existing office space	Facilities	COO	RAIL	6.00	400,000
Total						380,000,000

Table A-13: New Investment Needs with Bottom Ten Priority Scores

Table A-14: List of SGR Needs by Group Needs

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Electrification Distribution, Heavy Rail, A	4.84	4.70	91.01	$9.73	$-	$2.86	$-	$3.03	$-	$3.22	$-	$3.42	$-	$22.26
Underground, Heavy Rail, L	5.00	4.50	90.06	$0.83	$0.86	$0.88	$0.91	$0.93	$0.96	$0.99	$1.02	$1.05	$1.08	$9.52
Underground, Heavy Rail, F	5.00	4.50	90.06	$1.87	$1.92	$1.98	$2.04	$2.10	$2.16	$2.23	$2.30	$2.36	$2.44	$21.40
Electrification Distribution, Heavy Rail, L	4.79	4.70	89.99	$1.13	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1.13
Underground, Heavy Rail, D	5.00	4.50	89.97	$1.00	$1.03	$1.06	$1.09	$1.13	$1.16	$1.20	$1.23	$1.27	$1.31	$11.48
Underground, Heavy Rail, E	5.00	4.46	89.17	$2.24	$2.31	$2.38	$2.45	$2.52	$2.60	$2.68	$2.76	$2.84	$2.92	$25.70
Trackwork, Heavy Rail, L	4.55	4.80	87.44	$40.20	$-	$-	$-	$-	$-	$-	$-	$-	$-	$40.20
Underground, Heavy Rail, J	5.00	4.35	87.05	$0.14	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.17	$0.18	$0.18	$1.60
Electrification Distribution, Heavy Rail, B	4.62	4.70	86.89	$6.52	$-	$0.36	$-	$1.30	$-	$0.40	$-	$1.47	$-	$10.05
Underground, Heavy Rail, G	5.00	4.34	86.83	$1.55	$1.59	$1.64	$1.69	$1.74	$1.79	$1.85	$1.90	$1.96	$2.02	$17.73
Trackwork, Heavy Rail, A	4.50	4.80	86.53	$183.10	$-	$-	$-	$-	$-	$-	$-	$-	$-	$183.10
Electrification Distribution, Heavy Rail, K	4.57	4.70	85.94	$5.47	$-	$-	$-	$0.72	$-	$-	$-	$0.81	$-	$7.00
Electrification Distribution, Heavy Rail, D	4.53	4.70	85.11	$5.18	$-	$-	$-	$1.48	$-	$-	$-	$1.67	$-	$8.32
Trackwork, Heavy Rail, C	4.42	4.81	84.97	$111.75	$-	$-	$-	$-	$-	$-	$-	$-	$-	$111.75
Trackwork, Heavy Rail, D	4.42	4.80	84.83	$71.27	$-	$-	$-	$-	$-	$-	$-	$-	$-	$71.27
Trackwork, Heavy Rail, B	4.39	4.81	84.56	$129.83	$-	$-	$-	$-	$-	$-	$-	$-	$-	$129.83
Underground, Heavy Rail, C	5.00	4.22	84.48	$1.88	$1.94	$2.00	$2.06	$2.12	$2.18	$2.25	$2.32	$2.39	$2.46	$21.60
Underground, Heavy Rail, Water Intrusion	4.48	4.70	84.27	$86.26	$-	$-	$-	$-	$-	$-	$-	$-	$-	$86.26

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Electrification Distribution, Heavy Rail, G	4.46	4.70	83.87	$2.77	$-	$-	$-	$1.16	$-	$-	$-	$1.31	$-	$5.24
Underground, Heavy Rail, N	4.81	4.35	83.72	$0.19	$0.19	$0.20	$0.21	$0.21	$0.22	$0.23	$0.23	$0.24	$0.25	$2.17
Electrification Distribution, Heavy Rail, J	4.45	4.70	83.59	$1.58	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1.58
Electrification Distribution, Heavy Rail, E	4.43	4.70	83.25	$5.21	$-	$-	$-	$0.31	$-	$-	$-	$0.34	$-	$5.86
Trackwork, Heavy Rail, G	4.45	4.63	82.41	$108.70	$-	$-	$-	$-	$-	$-	$-	$-	$-	$108.70
Electrification Distribution, Heavy Rail, F	4.38	4.70	82.33	$4.13	$-	$-	$-	$1.36	$-	$-	$-	$1.53	$-	$7.03
Underground, Heavy Rail, K	5.00	4.11	82.18	$0.91	$0.94	$0.97	$1.00	$1.03	$1.06	$1.09	$1.12	$1.16	$1.19	$10.47
Trackwork, Heavy Rail, K	4.25	4.78	81.18	$99.00	$-	$-	$-	$-	$-	$-	$-	$-	$-	$99.00
Underground, Heavy Rail, B	5.00	4.04	80.78	$1.47	$1.52	$1.56	$1.61	$1.66	$1.71	$1.76	$1.81	$1.87	$1.92	$16.89
Trackwork, Heavy Rail, F	4.08	4.79	78.19	$65.50	$18.56	$-	$-	$-	$-	$-	$-	$-	$-	$84.06
Trackwork, Heavy Rail, E	4.10	4.75	77.82	$132.95	$20.63	$-	$-	$-	$-	$-	$-	$-	$-	$153.58
Revenue Vehicles, Heavy Rail, Modewide	3.67	4.87	75.10	$714.73	$512.30	$438.79	$6.91	$-	$-	$35.71	$772.44	$656.70	$877.73	$4,015.30
Signals/Interlockings, Heavy Rail, Switch Machine	3.89	4.81	74.73	$0.79	$0.09	$0.09	$-	$0.14	$-	$-	$-	$0.11	$-	$1.22
Underground, Heavy Rail, A	5.00	3.68	73.67	$4.13	$4.26	$4.39	$4.52	$4.65	$4.79	$4.94	$5.08	$5.24	$5.39	$47.39
Signals/Interlockings, Heavy Rail, Modewide	4.14	4.44	73.51	$733.40	$42.72	$0.27	$-	$-	$14.84	$23.12	$28.43	$-	$54.50	$897.29
Radio, Systemwide Assets, Compliance Upgrade	4.48	3.95	70.87	$274.69	$-	$-	$-	$-	$-	$-	$-	$-	$-	$274.69
Electrification Substations, Heavy Rail, L	4.51	3.90	70.39	$0.15	$-	$-	$-	$-	$-	$-	$-	$-	$-	$0.15

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Electrification Distribution, Heavy Rail, Heaters & Power Cable	4.06	4.31	70.34	$364.75	$-	$-	$-	$-	$-	$-	$265.81	$-	$-	$630.56
Trackwork, Heavy Rail, J	3.75	4.63	69.54	$9.05	$36.29	$-	$-	$-	$-	$-	$-	$-	$-	$45.33
Cable Transmission System (CTS), Systemwide Assets, Modewide	4.75	3.62	68.65	$4.70	$-	$-	$-	$-	$-	$-	$-	$-	$-	$4.70
Trackwork, Heavy Rail, Yard Turntables	3.56	4.79	68.20	$-	$0.22	$0.46	$0.86	$0.32	$0.17	$0.43	$-	$0.45	$-	$2.91
Guideway Utilities - Lighting, Heavy Rail, Modewide	4.48	3.75	67.24	$34.67	$-	$-	$-	$-	$-	$-	$-	$-	$-	$34.67
Electrification Substations, Heavy Rail, C	4.20	3.97	66.71	$118.91	$-	$-	$-	$-	$25.27	$-	$0.34	$-	$4.02	$148.54
Centralized Train Control, Heavy Rail, Modewide	4.48	3.71	66.56	$109.84	$-	$-	$-	$-	$-	$-	$-	$-	$-	$109.84
Electrification Substations, Heavy Rail, D	4.23	3.93	66.54	$98.06	$-	$-	$-	$-	$29.79	$-	$0.27	$0.28	$1.55	$129.96
Electrification Substations, Heavy Rail, A	4.14	4.00	66.35	$167.87	$-	$-	$-	$-	$32.56	$-	$-	$-	$8.08	$208.51
Trackwork, Heavy Rail, N	3.56	4.65	66.22	$-	$-	$-	$-	$-	$-	$-	$4.22	$-	$-	$4.22
Electrification Substations, Heavy Rail, K	4.17	3.93	65.64	$99.86	$-	$-	$-	$-	$15.00	$-	$-	$-	$-	$114.86
Electrification Substations, Heavy Rail, B	4.08	3.99	65.05	$122.06	$16.34	$-	$-	$-	$12.43	$0.98	$2.51	$-	$10.05	$164.37
Guideway Utilities - Ventilation, Heavy Rail, Modewide	4.31	3.67	64.21	$43.80	$6.28	$3.98	$-	$-	$-	$-	$-	$-	$-	$54.05
Revenue Vehicles, Motor Bus, Modewide	3.55	4.50	63.89	$147.93	$35.16	$12.92	$96.77	$297.05	$49.06	$10.32	$153.64	$212.25	$112.19	$1,127.29
Electrification Distribution, Heavy Rail, C	3.95	3.93	63.27	$5.54	$12.25	$-	$-	$0.97	$-	$-	$-	$1.09	$-	$19.85

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Electrification Substations, Heavy Rail, 1	4.04	3.88	62.83	$12.77	$-	$-	$-	$-	$-	$-	$-	$-	$-	$12.77
Electrification Substations, Heavy Rail, G	4.16	3.75	62.31	$35.21	$-	$-	$-	$-	$-	$-	$5.23	$-	$-	$40.44
Phone System, Systemwide Assets, Modewide	4.76	3.25	61.95	$0.03	$-	$-	$-	$-	$0.04	$-	$-	$-	$-	$0.07
Electrification Substations, Heavy Rail, F	3.81	3.97	60.58	$63.87	$-	$-	$-	$44.09	$17.16	$0.26	$8.94	$-	$4.27	$138.59
Revenue Vehicles, Demand Response, Modewide	3.74	4.04	60.44	$29.74	$8.45	$8.70	$-	$33.47	$9.51	$9.80	$-	$37.67	$10.70	$148.04
Electrification Substations, Heavy Rail, E	3.76	3.92	58.96	$82.07	$5.34	$18.36	$-	$-	$22.29	$-	$-	$-	$-	$128.06
Elevated Structure, Heavy Rail, Modewide	3.62	4.01	58.04	$441.47	$0.76	$1.54	$-	$30.84	$-	$-	$355.75	$34.71	$25.81	$890.89
Passenger Communications Systems, Systemwide Assets, Modewide	4.30	3.35	57.63	$31.82	$16.18	$0.53	$0.54	$0.63	$0.73	$-	$-	$-	$-	$50.44
Guideway Utilities - Drainage, Heavy Rail, Modewide	3.58	3.99	57.07	$1.39	$-	$2.46	$1.52	$1.57	$2.69	$15.13	$2.85	$1.76	$3.23	$32.58
Electrification Substations, Heavy Rail, J	3.68	3.80	56.00	$27.40	$-	$-	$-	$-	$5.36	$0.33	$-	$-	$0.18	$33.27
Electrification Substations, Heavy Rail, Misc.	3.56	3.89	55.43	$-	$-	$-	$4.10	$-	$-	$-	$-	$-	$-	$4.10
At Grade, Heavy Rail, Modewide	3.56	3.60	51.26	$-	$-	$-	$-	$-	$-	$-	$141.17	$-	$-	$141.17
Communications, Systemwide Assets, Modewide	3.81	3.34	50.84	$5.22	$1.15	$0.75	$1.22	$2.31	$-	$-	$-	$-	$-	$10.65
Maintenance Equipment, Heavy Rail, Modewide	3.72	3.31	49.30	$81.02	$18.21	$5.11	$11.97	$0.65	$13.11	$0.56	$53.83	$0.24	$21.54	$206.24
Guideway Utilities - Safety, Heavy Rail, Modewide	3.68	3.33	49.05	$10.54	$0.17	$-	$1.53	$1.75	$-	$2.67	$0.21	$-	$0.66	$17.52

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Special Structures, Heavy Rail, E	3.62	3.27	47.34	$0.73	$-	$-	$-	$-	$-	$-	$-	$-	$-	$0.73
Special Structures, Heavy Rail, N	4.14	2.77	45.89	$0.98	$-	$1.04	$-	$1.11	$-	$1.17	$-	$1.24	$-	$5.55
Special Structures, Heavy Rail, F	3.66	3.11	45.51	$0.48	$-	$-	$-	$-	$-	$-	$-	$-	$-	$0.48
Bus Turnarounds, Motor Bus, Modewide	4.57	2.45	44.86	$5.21	$-	$-	$-	$-	$-	$-	$-	$-	$-	$5.21
Stations, Heavy Rail, Modewide	3.56	3.15	44.83	$5.06	$5.21	$5.36	$5.52	$5.69	$5.86	$6.04	$6.22	$6.40	$6.60	$57.95
Elevators, Heavy Rail, Modewide	3.60	3.09	44.54	$42.90	$13.95	$3.89	$-	$7.89	$1.44	$1.20	$1.34	$7.51	$14.17	$94.30
Communications Huts, Systemwide Assets, Modewide	3.56	3.05	43.49	$0.14	$-	$-	$-	$-	$-	$-	$-	$-	$-	$0.14
Maintenance Equipment, Systemwide Assets, Modewide	3.56	3.00	42.73	$0.90	$0.48	$-	$-	$-	$-	$-	$-	$-	$0.04	$1.42
Special Structures, Heavy Rail, B	3.57	2.99	42.69	$9.52	$29.25	$-	$-	$-	$-	$-	$0.08	$-	$-	$38.86
Maintenance Buildings, Heavy Rail, Modewide	3.94	2.70	42.48	$296.57	$161.27	$0.05	$73.88	$0.04	$71.85	$0.45	$0.86	$1.06	$39.31	$645.33
Special Structures, Heavy Rail, C	3.56	2.97	42.40	$7.06	$-	$-	$-	$-	$-	$19.50	$-	$-	$-	$26.57
Special Structures, Heavy Rail, D	3.57	2.97	42.39	$7.97	$25.68	$-	$-	$-	$-	$-	$-	$-	$-	$33.64
Special Structures, Heavy Rail, J	3.63	2.92	42.34	$2.20	$-	$-	$-	$-	$-	$-	$-	$-	$-	$2.20
Special Structures, Heavy Rail, A	3.56	2.96	42.21	$1.94	$-	$-	$-	$-	$-	$-	$54.02	$-	$-	$55.96
Special Structures, Heavy Rail, L	3.57	2.94	42.05	$0.35	$-	$-	$-	$-	$-	$1.56	$-	$-	$-	$1.91
Special Structures, Heavy Rail, K	3.56	2.93	41.76	$5.71	$-	$-	$-	$-	$-	$-	$-	$-	$172.16	$177.87
Escalators, Heavy Rail, Modewide	3.64	2.82	41.12	$522.93	$83.96	$82.30	$-	$23.25	$7.64	$1.91	$3.94	$18.74	$110.37	$855.04
Non-Revenue Vehicles, Systemwide Assets, Modewide	3.66	2.80	41.01	$45.72	$17.05	$7.21	$26.61	$28.43	$34.45	$14.98	$14.75	$54.13	$28.49	$271.82

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Office Equipment & IT, Systemwide Assets, Modewide	3.79	2.65	40.02	$139.58	$86.72	$129.49	$100.92	$158.78	$112.49	$149.11	$109.82	$163.69	$139.03	$1,289.61
Special Structures, Heavy Rail, G	3.56	2.80	39.89	$0.29	$2.03	$-	$1.98	$-	$-	$-	$-	$-	$-	$4.30
Non-Revenue Vehicles, Heavy Rail, Modewide	3.59	2.75	39.47	$9.35	$2.50	$1.16	$7.16	$5.13	$4.19	$2.38	$1.28	$4.54	$6.89	$44.59
Maintenance Equipment, Motor Bus, Modewide	3.60	2.73	39.22	$60.62	$11.29	$15.99	$24.42	$16.56	$18.84	$13.51	$17.81	$29.18	$34.35	$242.58
Passenger Parking, Heavy Rail, D	4.46	2.17	38.62	$48.32	$-	$-	$-	$-	$-	$-	$-	$-	$-	$48.32
In-Station Revenue Collection, Heavy Rail, Modewide	3.96	2.41	38.23	$253.83	$1.01	$1.04	$1.07	$5.80	$-	$-	$6.33	$0.48	$-	$269.56
Stations, Heavy Rail, H	3.56	2.67	38.01	$-	$-	$0.08	$-	$-	$0.76	$-	$-	$-	$-	$0.84
Guideway Utilities, Heavy Rail, Modewide	3.56	2.60	37.08	$4.64	$1.59	$1.64	$1.69	$1.74	$1.79	$1.84	$1.90	$1.96	$2.02	$20.80
Safety and Security, Systemwide Assets, Modewide	3.01	3.05	36.81	$1.29	$4.18	$2.83	$1.84	$1.57	$-	$-	$-	$-	$-	$11.71
Stations, Heavy Rail, D	3.56	2.55	36.30	$1.84	$1.83	$1.67	$-	$-	$-	$-	$-	$-	$-	$5.34
Stations, Heavy Rail, G	3.56	2.53	36.06	$0.26	$0.15	$-	$0.71	$-	$-	$-	$-	$-	$-	$1.13
Maintenance Buildings, Systemwide Assets, Modewide	3.06	2.96	36.03	$72.43	$-	$-	$2.34	$0.06	$0.33	$-	$-	$-	$-	$75.15
Stations, Heavy Rail, K	3.56	2.52	35.94	$-	$-	$1.19	$-	$-	$-	$-	$-	$-	$-	$1.19
Stations, Heavy Rail, C	2.68	3.23	34.47	$2.37	$1.43	$0.08	$-	$17.34	$8.86	$-	$-	$-	$87.60	$117.67
Passenger Parking, Heavy Rail, A	3.78	2.28	34.35	$51.49	$-	$27.29	$-	$-	$-	$-	$-	$-	$-	$78.78
Passenger Parking, Heavy Rail, J	3.94	2.16	34.12	$4.44	$-	$-	$-	$-	$-	$-	$-	$-	$-	$4.44
Stations, Heavy Rail, B	2.63	3.24	33.99	$1.05	$1.31	$0.08	$-	$-	$-	$-	$-	$-	$73.68	$76.12
Stations, Heavy Rail, A	2.78	3.09	33.81	$1.02	$3.65	$0.15	$-	$1.47	$-	$-	$-	$-	$28.18	$34.48

Grouped Needs	Risk Prob. Score	Risk Consq. Score	Priority Score	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
Passenger Parking, Heavy Rail, G	3.81	2.13	32.46	$4.73	$-	$-	$-	$-	$-	$-	$11.09	$-	$-	$15.82
Stations, Heavy Rail, F	3.56	2.26	32.18	$-	$-	$0.23	$-	$-	$-	$-	$-	$-	$-	$0.23
Passenger Parking, Heavy Rail, K	3.54	2.26	31.90	$44.29	$-	$-	$40.14	$-	$-	$-	$-	$-	$-	$84.43
Maintenance Buildings, Motor Bus, Modewide	3.71	2.15	31.87	$416.96	$0.83	$11.55	$0.68	$0.84	$1.01	$1.97	$0.76	$18.36	$2.30	$455.27
Passenger Parking, Heavy Rail, C	3.50	2.26	31.63	$0.76	$-	$-	$296.85	$28.31	$-	$-	$-	$-	$-	$325.92
On-Vehicle Revenue Collection, Motor Bus, Modewide	3.56	2.20	31.30	$-	$15.92	$24.59	$-	$-	$-	$-	$-	$-	$-	$40.50
Passenger Parking, Heavy Rail, E	3.47	2.22	30.86	$52.85	$-	$-	$-	$-	$-	$25.04	$-	$-	$-	$77.89
Administrative Buildings, Systemwide Assets, Modewide	3.62	2.08	29.98	$2.27	$0.08	$1.35	$1.28	$1.62	$0.66	$2.03	$316.93	$2.18	$1.48	$329.89
Passenger Parking, Heavy Rail, F	3.32	2.23	29.59	$0.47	$-	$-	$-	$75.13	$-	$-	$-	$-	$-	$75.60
Passenger Parking, Heavy Rail, B	3.36	2.19	29.49	$14.34	$-	$-	$-	$21.59	$-	$-	$-	$-	$-	$35.93
Administrative Buildings, Heavy Rail, Modewide	3.56	1.99	28.30	$-	$-	$0.74	$-	$-	$-	$-	$-	$-	$-	$0.74
Maintenance Buildings, Demand Response, Modewide	2.83	2.36	26.77	$-	$-	$-	$-	$-	$-	$-	$2.46	$-	$-	$2.46

Table A-15: List of New Investment Needs by Project Grouping

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
61	On-Street Bus Terminal Improvements	Chief Operating Officer (COO)	3	4.20	50.37	Compliance	$-	$164	$537	$408	$421	$251	$446	$460	$-	$-	$2,686
188	Inspection and Repair of Anchor Bolts Plus Construction of Pier Structural Retrofits (Hammerheads) at Aerial Structures Located at Grosvenor and the Blue/Orange Junction.	Chief Engineer (ENG)	3	4.04	48.51	Compliance	$902	$4,644	$5,065	$5,217	$2,388	$-	$-	$-	$-	$-	$18,215
6	Environmental Compliance Projects (CIP0010) at WMATA Operations and Maintenance Facilities	Chief Safety Officer (SAFE)	3	4.03	48.3	Compliance	$1,857	$1,912	$1,970	$2,029	$2,090	$2,152	$2,217	$2,283	$2,352	$2,422	$21,284
151	Relocation of High Voltage Cable out of Eisenhower Ave Aerial Structure	Chief Engineer (ENG)	3	3.90	46.74	Compliance	$1,114	$3,825	$3,939	$4,057	$-	$-	$-	$-	$-	$-	$12,935
246	Rehabilitation of Fare Gates to Correct Safety Issues	Chief Engineer (ENG)	3	3.60	43.2	Compliance	$477	$1,366	$2,532	$-	$-	$-	$-	$-	$-	$-	$4,376
19	Construction of a Remediation Building at the New Hampshire Avenue Chiller Plant	Chief Safety Officer (SAFE)	3	3.58	42.9	Compliance	$955	$273	$7,879	$-	$-	$-	$-	$-	$-	$-	$9,107

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
198	Design & Construction of Pavement & Stormwater Management Structures at the 3421 Pennsy Drive Facility	Chief Safety Officer (SAFE)	3	3.58	42.9	Compli-ance	$371	$273	$3,939	$-	$-	$-	$-	$-	$-	$-	$4,584
78	Design & Installation of a Sprinkler System at the Landover Material Sup-ply Facility to Achieve Code Compliance	Chief Engi-neer (ENG)	3	3.57	42.87	Compli-ance	$955	$2,732	$619	$-	$-	$-	$-	$-	$-	$-	$4,306
24	Design and Procurement of a Vacuum Train for Tunnel Trash and Dust Removal	Chief Safety Officer (SAFE)	3	3.55	42.63	Compli-ance	$796	$273	$6,190	$6,376	$-	$-	$-	$-	$-	$-	$13,635
8	Installation of a Pollution Pre-vention System at Track Fueling Areas (CIP0210)	Chief Safety Officer (SAFE)	3	3.50	42	Compli-ance	$488	$503	$3,095	$5,217	$5,373	$5,534	$5,700	$-	$-	$-	$25,911
142	Installation of Safety Railings for Servicing of Equipment at the Top of Rail-cars at Service and Inspection (S&I) Facilities	Chief Oper-ating Officer (COO)	3	3.47	41.58	Compli-ance	$2,652	$-	$-	$-	$-	$-	$-	$-	$-	$-	$2,652
7	Rehabili-tation and Replacement of Storage Tank Systems (CIP0011)	Chief Safety Officer (SAFE)	3	3.40	40.8	Compli-ance	$3,713	$3,825	$3,939	$4,057	$4,179	$4,305	$4,434	$4,567	$4,704	$4,845	$42,567

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
171	Wayside Rail Track Worker Warning System	Chief Engineer (ENG)	2	5.00	40	Compliance	$796	$6,830	$-	$-	$-	$-	$-	$-	$-	$-	$7,625
210	Core Station Capacity Improvement - Engineering, Design and Construction of a Center Mezzanine at Union Station	Chief Engineer (ENG)	3	3.31	39.72	Compliance	$-	$2,732	$11,959	$12,317	$1,493	$-	$-	$-	$-	$-	$28,500
213	Core Station Capacity Improvement - Union Station Phase 0 - Entrance Relocation, Expanded Fare Gates, New Stairway	Chief Engineer (ENG)	3	3.31	39.72	Compliance	$2,520	$2,595	$281	$-	$-	$-	$-	$-	$-	$-	$5,396
199	Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Gallery Place Chinatown	Chief Engineer (ENG)	3	3.29	39.48	Compliance	$3,713	$3,825	$17,234	$17,751	$18,284	$18,832	$2,217	$-	$-	$-	$81,857
190	Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Farragut North	Chief Engineer (ENG)	3	3.29	39.45	Compliance	$2,652	$11,610	$11,959	$1,449	$-	$-	$-	$-	$-	$-	$27,670

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
193	Core Station Capacity Improvement - Feasibility Study, Engineering, Design and Construction of Various Capacity Improvements at Farragut West	Chief Engineer (ENG)	3	3.28	39.3	Compliance	$265	$1,967	$2,026	$12,172	$12,538	$12,914	$1,140	$-	$-	$-	$43,022
197	Core Station Capacity Improvement - Engineering, Design and Construction of Various Capacity Improvements at Foggy Bottom	Chief Engineer (ENG)	3	3.27	39.24	Compliance	$265	$3,278	$14,547	$14,984	$1,373	$-	$-	$-	$-	$-	$34,447
45	Rail Station Wireless Internet Deployment	Chief Internal Business Operations (IBOP)	2	4.70	37.6	Compliance	$2,387	$2,459	$2,532	$2,608	$-	$-	$-	$-	$-	$-	$9,986
155	Vehicle Monitoring System (VMS) Replacement for 2/3K, 5K and 6K Metroail Fleets	Chief Operating Officer (COO)	2	4.50	36	Compliance	$2,652	$4,480	$4,615	$-	$-	$-	$-	$-	$-	$-	$11,747
123	MetroAccess Fleet Expansion Vehicles Procurement	Chief Operating Officer (COO)	2	4.49	35.88	Compliance	$1,989	$2,185	$2,532	$2,608	$2,985	$3,382	$3,800	$4,077	$4,368	$4,845	$32,773

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
153	Procurement of an Additional MetroAccess Operating Garage and Command Center	Chief Operating Officer (COO)	2	4.49	35.88	Compliance	$11,670	$-	$12,381	$-	$13,135	$-	$13,934	$-	$14,783	$-	$65,903
77	Closed-circuit TV (CCTV) Cameras in MetroAccess Vans	Chief Operating Officer (COO)	3	2.94	35.22	Compliance	$2,639	$-	$-	$-	$-	$-	$-	$-	$-	$-	$2,639
326	Systemwide Bus Station Safety Program - Fences, CCTV, Emergency Call Boxes, ADA-compliant Ramps, PA Systems & Updated Signage	Chief Operating Officer (COO)	2	4.20	33.58	Compliance	$2,015	$12,085	$12,447	$12,821	$13,205	$-	$-	$-	$-	$-	$52,572
324	Signage Updates for Emergency Responders	Chief Engineer (ENG)	2	4.10	32.8	Compliance	$292	$765	$1,351	$406	$-	$-	$-	$-	$-	$-	$2,813
100	HVAC Overhaul of 2K/3K Metrorail Fleet Including New EPA Compliant Refrigerant (R407C)	Chief Operating Officer (COO)	2	4.05	32.4	Compliance	$1,814	$5,077	$5,677	$-	$-	$-	$-	$-	$-	$-	$12,568
25	Engineering, Design, and Construction of Tunnel Ventilation for Compliance with NFPA 130	Chief Engineer (ENG)	2	4.03	32.2	Compliance	$1.86	$1.91	$1.97	$3.48	$29.85	$73.79	$95.01	$97.86	$100.79	$103.82	$510.34

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
316	Energy Management - Upgrade of Obsolete Systems Identified in the Agency Wide Energy Audit	Chief Engineer (ENG)	2	4.03	32.2	Compliance	$31.83	$32.78	$33.77	$34.78	$35.82	$36.90	$34.84	$35.88	$40.32	$41.53	$358.43
270	Train Movement Detection System Installation at Car Wash Facilities	Chief Engineer (ENG)	2	3.95	31.6	Compliance	$3,289	$-	$-	$-	$-	$-	$-	$-	$-	$-	$3,289
276	Design Positive Train Stop System for Non Revenue Vehicles	Chief Engineer (ENG)	2	3.90	31.2	Compliance	$1,008	$3,551	$3,658	$3,768	$5,075	$-	$-	$-	$-	$-	$17,059
101	Replacement of 5000 Series Metrorail car Electronic Switches/ Amplifiers to Power Traction Motors (Insulated Gate Bipolar Transistor (IGBT) and Gate Unit Driver (GDU))	Chief Operating Officer (COO)	2	3.65	29.2	Compliance	$4,229	$-	$-	$-	$-	$-	$-	$-	$-	$-	$4,229
108	Takoma/ Langley Transit Center Safety Program- Fences, CCTV, Emergency Call Boxes, ADA-compliant Ramps, PA Systems & Updated Signage	Chief Operating Officer (COO)	2	3.63	29	Compliance	$561	$-	$-	$-	$-	$-	$-	$-	$-	$-	$561
156	Tunnel Fire and Smoke Detection System	Chief Engineer (ENG)	2	3.60	28.8	Compliance	$7,957	$8,195	$8,441	$8,695	$8,955	$9,224	$-	$-	$-	$-	$51,468

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
98	Fund for Various Sustainability Investments throughout the Agency	Chief Engineer (ENG)	2	3.58	28.6	Compliance	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$24,324
277	Procurement and Customization of Tablets for Integration with Metrobus's Computer Aided Dispatch and Automated Vehicle Location (CAD/AVL) Systems	Chief Operating Officer (COO)	2	3.53	28.2	Compliance	$663	$273	$-	$-	$-	$307	$-	$-	$-	$346	$1,590
82	MetroAccess Services Emergency Communications Center	Chief Operating Officer (COO)	2	3.39	27.08	Compliance	$159	$-	$-	$-	$-	$-	$-	$-	$-	$-	$159
179	Development of a Local Station Manager Handheld Device for Announcements (PENTA) plus Public Announcement System Software Upgrade	Chief External Relations (EXRL)	2	3.35	26.8	Compliance	$4,244	$-	$-	$-	$-	$-	$-	$-	$-	$-	$4,244
146	Creation of a Surface Lot to Provide Driver and CDL Training	Chief Operating Officer (COO)	2	3.15	25.16	Compliance	$477	$656	$-	$-	$-	$-	$-	$-	$-	$-	$1,133
4	Demolition of Railcar Carwash Equipment at (CMNT) Brentwood Rail Yard	Chief Operating Officer (COO)	2	2.76	22.08	Compliance	$133	$-	$-	$-	$-	$-	$-	$-	$-	$-	$133

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
150	Buy Railcars (P1) to Operate 100 Percent 8-Car Trains	Chief Engineer (ENG)	1	5.00	20	Normal	$-	$122.93	$126.62	$130.42	$134.33	$399.71	$411.70	$424.05	$-	$-	$1,749.76
217	Air Supply Unit Trainline Synchronization to Reduce Brake In Emergency (BIE) Events	Chief Operating Officer (COO)	1	5.00	20	Normal	$-	$658	$-	$-	$-	$-	$-	$-	$-	$-	$658
282	COMSOL Multiphysics (Physics Modeling and Simulation Software Platform) Procurement	Chief Operating Officer (COO)	1	5.00	20	Normal	$27	$-	$-	$-	$-	$-	$-	$-	$-	$-	$27
283	Procurement of Vibration and Noise Data Analysis Software	Chief Operating Officer (COO)	1	5.00	20	Normal	$12	$-	$-	$-	$-	$-	$-	$-	$-	$-	$12
44	Bus Operators Security Shield Installation	Chief Operating Officer (COO)	1	4.94	19.77	Normal	$1,724	$1,776	$-	$-	$-	$-	$-	$-	$-	$-	$3,500
286	Tandem Wheel Lathe (w/Brake Disc Cutting Capability)	Chief Operating Officer (COO)	1	4.92	19.68	Normal	$2,122	$2,185	$1,126	$1,855	$-	$-	$-	$-	$-	$-	$7,288
325	Procurement of Portable 35-ton Railcar Jacks (New)	Chief Operating Officer (COO)	1	4.85	19.4	Normal	$212	$-	$-	$-	$-	$-	$-	$-	$-	$-	$212
281	Study of Overhauled Railcar Truck Footprint Measurements Over Time	Chief Operating Officer (COO)	1	4.79	19.16	Normal	$15	$-	$-	$-	$-	$-	$-	$-	$-	$-	$15

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
284	Procurement of a Calipri Wheel Profile Measuring Device	Chief Operating Officer (COO)	1	4.79	19.16	Normal	$159	$-	$-	$-	$-	$-	$-	$-	$-	$-	$159
145	Improve Train Control System to Run 8-Car Trains (P4)	Chief Engineer (ENG)	1	4.70	18.8	Normal	$-	$3,278	$5,628	$3,478	$-	$-	$-	$-	$-	$-	$12,384
149	Improve Traction Power to Operate 100 Percent 8-Car Trains (P2)	Chief Engineer (ENG)	1	4.70	18.8	Normal	$21.22	$54.64	$112.55	$130.42	$104.48	$98.39	$25.34	$-	$-	$-	$547.03
262	Bus Transit Signal Priority (TSP)	Chief Operating Officer (COO)	1	4.70	18.8	Normal	$-	$1,812	$2,188	$1,802	$1,354	$2,130	$2,800	$-	$-	$-	$12,085
9	Extension of Overhead Crane Track at Brentwood Rail Facility (CMNT) S&I	Chief Operating Officer (COO)	1	4.64	18.54	Normal	$-	$-	$-	$1,101	$-	$-	$-	$-	$-	$-	$1,101
3	Brentwood Rail Yard (CMNT) Demolition of Existing Paint Booth	Chief Operating Officer (COO)	2	2.31	18.48	Compliance	$265	$-	$-	$-	$-	$-	$-	$-	$-	$-	$265
295	Four Mile Run Bus Division Renovations	Chief Operating Officer (COO)	2	2.30	18.38	Compliance	$424	$3,005	$3,377	$-	$-	$-	$-	$-	$-	$-	$6,806
158	Installation of CCTV in Remaining 6000 Series Railcars	Chief Operating Officer (COO)	1	4.55	18.2	Normal	$2,652	$164	$-	$-	$-	$-	$-	$-	$-	$-	$2,816

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
110	Procurement and Installation of Bus Back-up Camera Systems	Chief Operating Officer (COO)	1	4.49	17.97	Normal	$3,554	$-	$-	$-	$-	$-	$-	$-	$-	$-	$3,554
106	Vehicles for Micro-Transit (Alternative to MetroAccess Service) Public-Private Partnership	Chief Operating Officer (COO)	1	4.49	17.94	Normal	$968	$-	$-	$-	$-	$-	$-	$-	$-	$-	$968
141	Extension of the Pocket Track to Create a Blue/Silver Train Turnback at D&G Junction	Chief Engineer (ENG)	1	4.47	17.86	Normal	$-	$9,015	$9,285	$-	$-	$-	$-	$-	$-	$-	$18,300
209	Bicycle & Pedestrian Facilities for Station Access: Capacity Improvements	Chief Operating Officer (COO)	1	4.25	17	Normal	$4,244	$4,371	$4,502	$4,637	$4,776	$4,919	$5,067	$5,219	$5,376	$5,537	$48,648
11	Reconstruction of the Service Roadway and the Roadway Crossing on Track 7 at Brentwood Rail Yard (CMNT)	Chief Operating Officer (COO)	1	4.19	16.74	Normal	$-	$601	$-	$-	$-	$-	$-	$-	$-	$-	$601
269	40 Foot Buses for Service Expansion	Chief Operating Officer (COO)	1	4.05	16.19	Normal	$13,792	$14,205	$5,853	$6,028	$6,209	$6,395	$8,234	$6,785	$17,471	$17,995	$102.97
318	Articulated Buses for Service Expansion	Chief Operating Officer (COO)	1	4.05	16.19	Normal	$-	$-	$13,506	$13,911	$14,329	$14,758	$12,668	$15,657	$-	$-	$84,829

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
322	Construction of Rail Yard Safety Handrails at Maintenance Pits	Chief Operating Officer (COO)	1	4.01	16.03	Normal	$4,084	$-	$-	$-	$-	$-	$-	$-	$-	$-	$4,084
104	New Communications Department (COMM ESS/ ENV/FIA) Facility	Chief Operating Officer (COO)	1	3.95	15.8	Normal	$371	$546	$563	$-	$-	$-	$-	$-	$-	$-	$1,480
32	FM Global (Property Insurer) Non-Ignitable Liquids Mitigation Project: Fire Suppression System Enhancement and Expansion plus Removal of Aerosol Storage	Chief Financial Officer (CFO)	1	3.93	15.73	Normal	$231	$-	$-	$-	$-	$-	$-	$-	$-	$-	$231
147	Expansion of Storage and Maintenance Facilities for 100 Percent 8-Car Trains (P3)	Chief Engineer (ENG)	1	3.91	15.62	Normal	$39,784	$40,977	$42,207	$57,964	$44,777	$76,867	$47,504	$81,548	$83,995	$86,515	$602.14
31	FM Global (Property Insurer) Recommendations: Installation of Ignitable Liquids Risk Mitigation Systems	Chief Financial Officer (CFO)	1	3.87	15.46	Normal	$477	$-	$-	$-	$-	$-	$-	$-	$-	$-	$477
69	Customer Information and Electronic Displays at Bus Stations	Chief Operating Officer (COO)	1	3.75	14.99	Normal	$1,566	$1,613	$1,662	$1,712	$1,763	$1,816	$1,870	$1,926	$1,984	$2,044	$17,956

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
125	Bus Loop (Turnarounds) Safety Enhancement Program and Station Upgrades	Chief Operating Officer (COO)	1	3.75	14.99	Normal	$1,665	$578	$-	$1,819	$-	$1,930	$-	$2,047	$-	$-	$8,039
189	New Carrollton Rail Yard (CMNT) - Install Access Ramp to the Blow-Pit Area	Chief Operating Officer (COO)	1	3.70	14.81	Normal	$398	$-	$-	$-	$-	$-	$-	$-	$-	$-	$398
320	FM Global (Property Insurer) Non-Ignitable Liquids Mitigation Project: Installation of a Hydrogen Detection System in the Battery Storage Room at Alexandria Yard	Chief Financial Officer (CFO)	1	3.70	14.81	Normal	$8	$-	$-	$-	$-	$-	$-	$-	$-	$-	$8
137	Track or Station Expansions to Improve Safety and Reliability in the Blue/Orange/Silver Corridor	Chief Engineer (ENG)	1	3.65	14.59	Normal	$-	$-	$-	$-	$83.58	$193.71	$199.52	$205.50	$211.67	$-	$893.97
275	Software Changes in the Converter Functional Modules (CFM)/Propulsion System to Improve Railcar Reliability	Chief Operating Officer (COO)	1	3.60	14.4	Normal	$955	$-	$-	$-	$-	$-	$-	$-	$-	$-	$955
319	Railcar LED Lighting Upgrade	Chief Operating Officer (COO)	1	3.60	14.4	Normal	$1,591	$3,005	$1,576	$-	$-	$-	$-	$-	$-	$-	$6,172

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
192	Bus Station Canopies at Stations and Transit Centers	Chief Operating Officer (COO)	1	3.60	14.39	Normal	$-	$-	$394	$7,004	$7,214	$7,430	$7,653	$5,259	$-	$-	$34,954
287	Creation of a Loading Dock at the Carmen Turner Facility Bus Heavy Overhaul Shop	Chief Operating Officer (COO)	1	3.45	13.79	Normal	$477	$-	$-	$-	$-	$-	$-	$-	$-	$-	$477
204	Short Term Capacity Improvements at Core Metrorail Stations	Chief Engineer (ENG)	1	3.44	13.77	Normal	$1,273	$2,459	$2,532	$348	$-	$-	$-	$-	$-	$-	$6,612
26	Installation of Customer Facing CCTV Security Monitors in Buses	Chief Operating Officer (COO)	1	3.39	13.57	Normal	$2,652	$3,825	$-	$-	$-	$-	$-	$-	$-	$-	$6,477
127	Installation of a Pedestrian Warning System on the 1583 Bus Fleet	Chief Operating Officer (COO)	1	3.39	13.57	Normal	$2,166	$2,231	$2,298	$-	$-	$-	$-	$-	$-	$-	$6,695
257	West Falls Church Rail Yard (CMNT) Site Lighting at the Salt Dome	Chief Operating Officer (COO)	1	3.38	13.51	Normal	$16	$-	$-	$-	$-	$-	$-	$-	$-	$-	$16
229	Greenbelt Rail Yard (CMNT) Installation of an Exhaust Fan in the Brake Caliper Room in Building B	Chief Operating Officer (COO)	1	3.36	13.45	Normal	$7	$-	$-	$-	$-	$-	$-	$-	$-	$-	$7
249	Core Station Capacity Improvement-L'Enfant Plaza	Chief Engineer (ENG)	1	3.34	13.36	Normal	$5,623	$24,614	$25,352	$3,072	$-	$-	$-	$-	$-	$-	$58,661

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
247	West Falls Church Rail Yard (CMNT) - Installation of an Oil/Grease Distribution System to the Periodic Inspection Area	Chief Operating Officer (COO)	1	3.30	13.21	Normal	$186	$-	$-	$-	$-	$-	$-	$-	$-	$-	$186
107	Shady Grove Service and Inspection Shop Upgrades (Restrooms, Locker Rooms, New Crane)	Chief Operating Officer (COO)	1	3.30	13.2	Normal	$424	$2,459	$8,160	$1,739	$-	$-	$-	$-	$-	$-	$12,782
133	Shady Grove Rail Yard (CMNT) -Install Access Ramp to the Blow-Pit Area	Chief Operating Officer (COO)	1	3.30	13.2	Normal	$424	$-	$-	$-	$-	$-	$-	$-	$-	$-	$424
237	Implementation of a Capital Project Planning Portal/Document Management System	Chief Financial Officer (CFO)	1	3.30	13.2	Normal	$-	$1,119	$1,344	$1,385	$-	$-	$-	$-	$-	$-	$3,848
251	Core Station Capacity Improvement-Metro Center	Chief Engineer (ENG)	1	3.30	13.18	Normal	$265	$3,224	$3,320	$14,534	$14,970	$15,420	$15,882	$3,849	$-	$-	$71,465
172	Installation of an Onboard Passenger Information System (Infotainment) in Buses	Chief Operating Officer (COO)	1	3.29	13.17	Normal	$6,498	$-	$-	$-	$-	$-	$-	$-	$-	$-	$6,498

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
274	Procurement and Installation of Mobile Wireless Routers to Implement Metrobus Guest Wi-Fi	Chief Operating Officer (COO)	1	3.29	13.17	Normal	$2,016	$1,836	$1,891	$1,948	$2,006	$2,066	$2,128	$2,192	$2,258	$2,326	$20,666
60	Car Track and Equipment Maintenance (CTEM) -Greenbelt Shop Extension	Chief Operating Officer (COO)	1	3.29	13.15	Normal	$80	$5,464	$-	$-	$-	$-	$-	$-	$-	$-	$5,543
186	Core Station Capacity Improvement-Dupont Circle	Chief Engineer (ENG)	1	3.27	13.06	Normal	$-	$273	$2,251	$9,854	$10,149	$1,230	$-	$-	$-	$-	$23,757
200	Core Station Capacity Improvement-McPherson Square	Chief Engineer (ENG)	1	3.24	12.94	Normal	$-	$273	$3,377	$14,984	$15,433	$1,414	$-	$-	$-	$-	$35,481
218	Hastus Scheduling Software for Bus	Chief Internal Business Operations (IBOP)	1	3.23	12.93	Normal	$2,440	$1,639	$1,688	$-	$-	$-	$-	$-	$-	$-	$5,767
20	Metro Transit Police Department (MTPD) Fleet Expansion	Chief Operating Officer (COO)	1	3.23	12.9	Normal	$212	$-	$-	$-	$-	$332	$-	$-	$-	$-	$544
207	Core Station Capacity Improvement-Smithsonian	Chief Engineer (ENG)	1	3.20	12.78	Normal	$-	$273	$2,251	$9,854	$10,149	$1,230	$-	$-	$-	$-	$23,757
273	Design and Construction of a South Mezzanine at Bethesda Station	Chief Engineer (ENG)	1	3.20	12.78	Normal	$796	$7,922	$9,004	$-	$-	$-	$-	$-	$-	$-	$17,722

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
63	Car Track and Equipment Maintenance (CTEM) - Branch Avenue Shop Expansion	Chief Operating Officer (COO)	1	3.19	12.75	Normal	$80	$5,464	$-	$-	$-	$-	$-	$-	$-	$-	$5,543
185	Core Station Capacity Improvement-Archives-Navy Memorial	Chief Engineer (ENG)	1	3.18	12.71	Normal	$-	$273	$2,251	$9,854	$10,149	$1,230	$-	$-	$-	$-	$23,757
245	Parking Meter Replacement with Electronic Paystations	Chief Operating Officer (COO)	1	3.15	12.6	Normal	$4,244	$4,371	$4,502	$4,637	$4,776	$4,919	$5,067	$5,219	$5,376	$5,537	$48,648
321	Automatic Wayside Inspection System (AWIS) to Detect Wheel and Brake Profiles	Chief Operating Officer (COO)	1	3.15	12.6	Normal	$743	$4,371	$1,463	$-	$-	$-	$-	$-	$-	$-	$6,577
289	Development of Bus Engineering and Bus Maintenance Shop Floor Offices	Chief Operating Officer (COO)	1	3.00	11.99	Normal	$239	$-	$-	$-	$-	$-	$-	$-	$-	$-	$239
323	Security Cameras for Rail Yards	Chief Operating Officer (COO)	1	2.98	11.93	Normal	$-	$191	$-	$-	$-	$-	$-	$-	$-	$-	$191
72	Procurement of Vehicles for the Sign and Shelter Crew	Chief Operating Officer (COO)	1	2.95	11.79	Normal	$106	$76	$-	$-	$-	$-	$-	$-	$-	$-	$183
293	Support Vehicles for the New Andrews Bus Facility	Chief Operating Officer (COO)	1	2.95	11.79	Normal	$345	$-	$-	$-	$-	$-	$-	$-	$-	$-	$345

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
214	Greenbelt Rail Yard (CMNT) - Installation of Air Conditioning in the Paintbooth Break Room	Chief Operating Officer (COO)	1	2.91	11.65	Normal	$133	$-	$-	$-	$-	$-	$-	$-	$-	$-	$133
175	Dyanamic Advertising Signage with LCD Screens at Bus Stops	Chief External Relations (EXRL)	1	2.90	11.6	Normal	$650	$669	$-	$-	$-	$-	$-	$-	$-	$-	$1,319
177	Customer Information System for Stations and Vehicles	Chief External Relations (EXRL)	1	2.90	11.6	Normal	$15,914	$-	$-	$-	$-	$-	$-	$-	$-	$-	$15,914
205	Costumer Assistance (CA) Automated Service Desk	Chief Internal Business Operations (IBOP)	1	2.87	11.46	Normal	$366	$-	$-	$-	$-	$-	$-	$-	$-	$-	$366
70	Car Track and Equipment Maintenance (CTEM) and Heavy Overhaul Facility and Rail Yard	Chief Operating Officer (COO)	1	3.29	13.15	Normal	$0.08	$5.46	$-	$-	$-	$-	$-	$-	$-	$-	$5.54
280	Railcar Truck Spin Tester at Greenbelt Yard	Chief Operating Officer (COO)	1	2.79	11.16	Normal	$1,061	$1,639	$1,688	$1,159	$-	$-	$-	$-	$-	$-	$5,548
296	CMNT 20 Ton Flat Bed Truck	Chief Operating Officer (COO)	1	2.79	11.16	Normal	$133	$-	$-	$-	$-	$-	$-	$-	$-	$-	$133
97	Storage Area for Railcar Wheels at the Brentwood Rail Facility (CMNT)	Chief Operating Officer (COO)	1	2.76	11.04	Normal	$265	$-	$-	$-	$-	$-	$-	$-	$-	$-	$265

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
183	New Bus Garage in the Silver Spring Area	Chief Operating Officer (COO)	1	2.76	11.02	Normal	$-	$16,391	$16,883	$75,353	$80,599	$-	$-	$-	$-	$-	$189.22
115	Branch Avenue Annex Facility to House TRST, GMAC, ELES and MTPD	Chief Operating Officer (COO)	1	2.74	10.95	Normal	$530	$3,005	$3,939	$-	$-	$-	$-	$-	$-	$-	$7,475
17	Support Vehicles for the New Cinder Bed Road Bus Facility	Chief Operating Officer (COO)	1	2.71	10.82	Normal	$345	$-	$-	$-	$-	$-	$-	$-	$-	$-	$345
47	Bus Station Restroom and Break Room Facility Program	Chief Operating Officer (COO)	1	2.70	10.79	Normal	$-	$376	$387	$399	$411	$423	$-	$-	$-	$-	$1,995
29	MTPD Facility Expansion at West Falls Church, Morgan Boulevard, and Shady Grove	Chief Operating Officer (COO)	1	2.65	10.6	Normal	$106	$983	$113	$1,043	$119	$1,230	$-	$-	$-	$-	$3,595
83	Carmen Turner Facility Parking Garage	Chief Safety Officer (SAFE)	1	2.60	10.4	Normal	$743	$273	$10,130	$-	$-	$-	$-	$-	$-	$-	$11,145
124	Building Automation System - Remote Monitoring and Control of Mechanical Systems	Chief Operating Officer (COO)	1	2.60	10.4	Normal	$398	$410	$422	$435	$448	$461	$475	$489	$504	$519	$4,561
254	Real Time In-Lane Variable Message Signs at Parking Facilities	Chief Operating Officer (COO)	1	2.60	10.4	Normal	$2,652	$2,732	$2,814	$2,898	$2,985	$3,075	$3,167	$3,262	$3,360	$3,461	$30,405

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
313	On-Site Solar Energy Generation at Various Facilities	Chief Engineer (ENG)	1	2.60	10.4	Normal	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610	$2,688	$2,768	$24,324
41	Retrofit Rail Stations to Add Employee Breakrooms	Chief Operating Officer (COO)	1	2.59	10.35	Normal	$265	$765	$1,069	$-	$-	$-	$-	$-	$-	$-	$2,099
167	Alexandria Rail Yard (CMNT) - Construct a Compressed Airline System to Enhance Railcar Maintenance Operations	Chief Operating Officer (COO)	1	2.55	10.21	Normal	$159	$-	$-	$-	$-	$-	$-	$-	$-	$-	$159
226	Greenbelt Rail Yard (CMNT) - Construct a Compressed Airline System in Building G, Electronic Shop 2nd Floor	Chief Operating Officer (COO)	1	2.54	10.15	Normal	$8	$-	$-	$-	$-	$-	$-	$-	$-	$-	$8
122	Shady Grove Rail Yard (CMNT) - Install a 25 Ton Overhead Bridge Crane	Chief Operating Officer (COO)	1	2.50	10	Normal	$6,365	$-	$-	$-	$-	$-	$-	$-	$-	$-	$6,365
154	Alexandria Rail Yard (CMNT) - Construct New Maintenance Office Space	Chief Operating Officer (COO)	1	2.48	9.91	Normal	$-	$382	$-	$-	$-	$-	$-	$-	$-	$-	$382
234	West Falls Church Rail Yard (CMNT) - Construct New Maintenance Office Space	Chief Operating Officer (COO)	1	2.48	9.91	Normal	$-	$382	$-	$-	$-	$-	$-	$-	$-	$-	$382

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
216	Greenbelt Rail Yard (CMNT) - Construct New Maintenance Office Space	Chief Operating Officer (COO)	1	2.46	9.85	Normal	$371	$-	$-	$-	$-	$-	$-	$-	$-	$-	$371
221	Greenbelt Rail Yard (CMNT) - Construct a New Maintenance Facility for 7k Cars	Chief Operating Officer (COO)	1	2.46	9.85	Normal	$13,261	$-	$-	$-	$-	$-	$-	$-	$-	$-	$13,261
181	New Carrollton Rail Yard (CMNT) - Increase Lighting in the Maintenance Facility	Chief Operating Officer (COO)	1	2.43	9.71	Normal	$170	$-	$-	$-	$-	$-	$-	$-	$-	$-	$170
191	New Carrollton Rail Yard (CMNT) - Construct New Maintenance Office Space	Chief Operating Officer (COO)	1	2.43	9.71	Normal	$220	$-	$-	$-	$-	$-	$-	$-	$-	$-	$220
68	Data Integration & Quality Tools Software Procurement	Chief Internal Business Operations (IBOP)	1	2.42	9.66	Normal	$178	$667	$-	$-	$-	$-	$-	$-	$-	$-	$845
160	Alexandria Rail Yard (CMNT) - Installation of an Oil/Grease Distribution System to the Periodic Inspection Area	Chief Operating Officer (COO)	1	2.40	9.61	Normal	$252	$-	$-	$-	$-	$-	$-	$-	$-	$-	$252
168	Alexandria Rail Yard (CMNT) - Construct an Extended Blow-Pit Area	Chief Operating Officer (COO)	1	2.40	9.61	Normal	$159	$519	$-	$-	$-	$-	$-	$-	$-	$-	$678

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
169	Alexandria Rail Yard (CMNT) - Construct a Concrete Apron for Maintenance Vehicle Load-ing	Chief Oper-ating Officer (COO)	1	2.40	9.61	Normal	$-	$104	$-	$-	$-	$-	$-	$-	$-	$-	$104
176	Alexandria Rail Yard (CMNT) - Construct a Catwalk for 7K Car Roof Top HVAC Access	Chief Oper-ating Officer (COO)	1	2.40	9.61	Normal	$2,917	$-	$-	$-	$-	$-	$-	$-	$-	$-	$2,917
253	West Falls Church Rail Yard (CMNT) - Construct a Concrete Apron on Track Lead for Mainte-nance Vehicle Loading	Chief Oper-ating Officer (COO)	1	2.40	9.61	Normal	$66	$-	$-	$-	$-	$-	$-	$-	$-	$-	$66
259	West Falls Church Rail Yard (CMNT) - Extension of Existing Parking Lot	Chief Oper-ating Officer (COO)	1	2.40	9.61	Normal	$-	$148	$-	$-	$-	$-	$-	$-	$-	$-	$148
121	Shady Grove Rail Yard (CMNT) - Extension of Existing Parking Lot	Chief Oper-ating Officer (COO)	1	2.40	9.6	Normal	$265	$-	$-	$-	$-	$-	$-	$-	$-	$-	$265
126	Shady Grove Rail Yard (CMNT) - Construct a Catwalk for 7K Car Roof Top HVAC Access	Chief Oper-ating Officer (COO)	1	2.40	9.6	Normal	$-	$3,005	$-	$-	$-	$-	$-	$-	$-	$-	$3,005

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
278	Systemwide Signage Updates (For Completion of Silver Line Phase 2)	Chief Engineer (ENG)	1	2.36	9.45	Normal	$557	$929	$10,692	$-	$-	$-	$-	$-	$-	$-	$12,178
135	Build a Central Railcar Heavy Repair and Overhaul Facility	Chief Engineer (ENG)	1	2.35	9.41	Normal	$31,827	$32,782	$33,765	$34,778	$77,613	$79,942	$82,340	$-	$-	$-	$373.05
187	New Carrollton Rail Yard (CMNT) - Extension of Existing Parking Lot	Chief Operating Officer (COO)	1	2.35	9.41	Normal	$143	$-	$-	$-	$-	$-	$-	$-	$-	$-	$143
195	New Carrollton Rail Yard (CMNT) - Expansion of Existing Office Space	Chief Operating Officer (COO)	1	2.35	9.41	Normal	$-	$382	$-	$-	$-	$-	$-	$-	$-	$-	$382
297	Renovations to Montgomery Bus Division Maintenance Area	Chief Operating Officer (COO)	1	2.34	9.36	Normal	$424	$3,005	$2,814	$-	$-	$-	$-	$-	$-	$-	$6,243
10	Brentwood Rail Facility (CMNT) - Buildout of a Hallway wall at the Administrative Office	Chief Operating Officer (COO)	1	2.31	9.24	Normal	$-	$12	$-	$-	$-	$-	$-	$-	$-	$-	$12
12	Brentwood S&I Rail Facility (CMNT) - Install Louvered Crank Style Windows	Chief Operating Officer (COO)	1	2.31	9.24	Normal	$-	$-	$253	$-	$-	$-	$-	$-	$-	$-	$253
96	Brentwood Rail Facility - Construct a Parking Garage on South Lot	Chief Operating Officer (COO)	1	2.31	9.24	Normal	$-	$820	$1,688	$-	$-	$-	$-	$-	$-	$-	$2,508

Proj. Id	Project Name	Chief	Risk Prob. Score	Risk Conseq. Score	Priority Score	Priority Status	2017 Cost	2018 Cost	2019 Cost	2020 Cost	2021 Cost	2022 Cost	2023 Cost	2024 Cost	2025 Cost	2026 Cost	10 Year Total
157	Alexandria Rail Yard (CMNT) - Expansion of Existing Office Space	Chief Operating Officer (COO)	1	1.50	6.01	Normal	$-	$104	$703	$-	$-	$-	$-	$-	$-	$-	$807
131	Shady Grove Rail Yard (CMNT) - Expansion of Existing Office Space	Chief Operating Officer (COO)	1	1.50	6	Normal	$-	$382	$-	$-	$-	$-	$-	$-	$-	$-	$382
136	Shady Grove Rail Yard (CMNT) - Construct New Maintenance Office Space	Chief Operating Officer (COO)	1	1.50	6	Normal	$371	$-	$-	$-	$-	$-	$-	$-	$-	$-	$371