



King County Metro

**FACILITIES MASTER
PLANNING PROGRAM:**

**Operational Capacity
Growth Report**

Appendices

March 2019



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Appendix A: Base Capacity Demand Analysis

SECTION 1:

Introduction

To help inform where base capacity could efficiently be located, Metro conducted a countywide evaluation of base capacity demand for the METRO CONNECTS 2040 network.

The steps in the analysis were:

- Determine the bus demand for each route based on headways and runtimes from the 2040 METRO CONNECTS service network.
- Calculate the travel time necessary to reach each route start and end point from the existing bases and example base locations (deadheading).
- Determine the unconstrained demand at each base by assigning each route to its lowest-cost base or second-lowest-cost base based on the operational costs associated with deadheading.
- Reallocate demand based on known capacity constraints at each base to identify estimated demand ranges.

The results of the demand analysis are shown in the table below. The table also includes the current fleet assignment and current optimal base capacity as determined by the base capacity model (as of fall 2018). It also shows the estimated future optimal base capacity with the investments identified in this report. The table indicates a specific number, but base capacity is dynamic. It fluctuates depending on the types and ages of fleets in operation, the service being provided and the maintenance requirements. See page X of the main report for more discussion of base capacity determination. All of Metro’s bases are currently operating above efficient operations, as shown in Table 1. The operational capacity growth strategy will support system growth and ease current overcrowding.

Table 1. Base Demand by Geography

	Assigned Coaches Fall 2018	2018 Capacity at Efficient Operations	Proportion of Assigned Fleet 2018	Demand Analysis Results		Estimated Future Capacity at Efficient Operations ³	Proportion of 2040 Capacity
				2040 Unconstrained Demand ¹	2040 Constrained Demand ²		
East Campus (Bellevue and East Base)	378	345	24%	505–550	338–390	345	17%
Central Campus (Atlantic, Central & Ryerson)	757	650	47%	605–790	750–890	795	38%
North Base	202	175	12%	320–390	175–200	175	8%
South Campus (South & Future South Annex)	273	260	17%	250–410	410–510	510	25%
South King County Base	–	–	–	410–440	250–275	250	12%
Total	1,610	1,430	100%			2,075	100%
METRO CONNECTS 2040 Vision						2,145	

¹ Unconstrained demand represents the estimated number of buses that would be assigned to a base as its lowest-cost and second-lowest-cost option based on METRO CONNECTS 2040 Network

² Constrained demand represents the base capacity demand when space limits are imposed for East, North and South King County Base

³ Assumes the specific project investments identified in this report are implemented. The numbers represent the possible assignments base on lowest-cost and second-lowest-cost options.

Unconstrained and Constrained Demand

The first step in this analysis assessed unlimited or “unconstrained” demand for base capacity across King County based on minimizing deadheads. It showed that base capacity demand increases across the county. The greatest increase in demand occurs in South King County, largely attributed to anticipated service expansion in the area. A second analysis was conducted that took into account the known constraints on facility growth. North Base and East Campus (East Base and Bellevue Base) are both unable to grow significantly at this point because of neighborhood development. Additionally, although demand in South King County was shown to be up to 440 buses, Metro has identified a target base size at about 250-275.

With these constraints, the results of the second round of analysis shows that demand is distributed between Central and South Campuses. In this scenario, some buses would be assigned to bases other than their ‘first choice’ or most efficient base. However, analysis has also shown there are many routes with two options for efficient base assignment. A bus can be dispatched from either a base near its end point, a base near its start point, or somewhere along its route with relatively little effect on deadhead costs. With this in mind, Central Campus was found to offer the best combination of efficiency and flexibility, in that it can efficiently support many of the routes in Metro’s system. South Campus is the system’s second most flexible base location, as defined by the number of routes that could be assigned there as a first or second choice.

The analysis also suggests that there is future demand for more capacity in East and North King County, which Metro should consider as it plans for additional base expansion. It reinforces the importance of preserving existing base capacity against development pressure and of Metro’s ongoing commitment to optimize operations at North Base and East Campus.

Table 4 summarizes Metro’s review of potential locations for operational capacity growth.

	Optimization opportunity	Suitability	Availability	Network efficiency	Economy of scale	Community integration
East Campus	1	1	1	3	3	1
North Campus	1	1	1	3	2	1
Central Campus						
Atlantic/Central	3	3	2	3	3	3
Ryerson	1	2	1	3	3	3
South Campus						
South Base	2	1	1	3	3	3
Group Health property	3	3	3	3	3	3
South Annex property	3	3	3	3	3	3
Component Supply Center	3	3	2	2	3	3
New Base						
South King County	N/A	3	3	3	2	3

Key: N/A = Not applicable 1 Poor 2 Acceptable 3 Good

Other Factors in Siting a Base

The demand analysis based on deadhead costs is an important consideration in siting a base, but there are other factors to consider as well. Metro's operational capacity growth strategy was also informed by factors such as land cost and availability, jurisdiction support and community integration, and construction efficiency.

Size: Metro has identified its target base capacity to be 250 to 275 buses for expanded or new facilities. When bus bases exceed this size, operational challenges arise. If they are much smaller than this, they are less efficient. Some of the challenges are:

- Increased time for fueling, washing, and cleaning.
- High demand on inspection lanes.
- Long queues of buses waiting to check-in when they return to base.
- Traffic impacts on the surrounding roadways.
- Longer distances for operators to walk in order to get to and from their assigned vehicle.
- The need to acquire a very large site, which can be difficult to find.

Base Capacity Definitions. Metro defines base capacity in terms of level of service or operating conditions, ranging from efficient to unstable. Metro has established a target of operating bus bases at "efficient operations" or better. (See page X.)

- Efficient operations (optimal capacity) means that space is used effectively and daily operations can be performed efficiently.
- Constrained operations occur when a base is overcrowded. Daily operations become more congested and less efficient.
- Unstable operations occur when a base is consistently over capacity. Daily operations cost more, service quality deteriorates, and there is increased safe risk.

Planning for Additional Future Growth

The planned operational capacity growth investments will enable Metro to support near- and long-term service growth. However, Metro will need to continue to plan for additional growth to fully support the METRO CONNECTS vision.

By 2040 Metro will potentially be operating above optimal capacity if the METRO CONNECTS envisioned fleet growth is implemented on the projected timeline. To maintain stable operations into the future, Metro will need to continually look ahead to its projected capacity needs. It will need to track the rate at which it implements its service and fleet growth, the impact of bus electrification on base capacity, and its operational capacity investments over time to make sure they are all aligned.



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Appendix B: Policy Matrix

SECTION 1:

Introduction

The purpose of this memorandum is to summarize policy guidance, transit requirements, issues, and trends that affect Metro's capital program. This section was created to summarize the relevant policies that could affect the planning, design, and construction of capital programs.

Table 1. Potential Policy Implications on Capital Projects

Document Title	Description and Purpose	Requirements
<u>Feasibility of Achieving a Carbon-Neutral or Zero-Emission Fleet</u>	<p>An assessment of the feasibility of achieving either a carbon-neutral or zero-emission Metro vehicle fleet. Evaluates several alternatives to Metro's current practice.</p> <p>Goal for Metro to make significant new contributions to confronting climate change and promote ESJ.</p>	<p>Recommends transitioning to a ZEB fleet powered by renewable energy by sometime between 2034-2040.</p> <p>Focus early deployment of ZEBs in communities that are most vulnerable to air pollution.</p>
Transit Facilities Energy Plan	<p>Sets energy reduction targets and identifies future energy reduction tasks to meet targets. Identifies Metro's vision to reduce energy consumption at our facilities by 15% in 2015 and 20% in 2020.</p>	<p>Strategies include:</p> <ul style="list-style-type: none"> Measuring and managing energy use. Incorporating conservation practices into facility design, construction, and operation. Empowering employees to identify new ways to reduce energy use and save money.
<u>Strategic Climate Action Plan (SCAP)</u> Executive Staff and Climate Leadership Team	<p>King County's blueprint for climate action - provides "one-stop-shopping" for county decision-makers, employees, and the general public to learn about the County's climate change commitments.</p>	<p>Identifies priority actions that will lead to significant progress in achieving regional GHG reduction targets; and conveys opportunities to act on climate solutions to achieve social, economic, and environmental benefits for King County residents.</p>
Climate Preparedness – effort underway, Lara Whitely Binder (Metro)	<p>Planning efforts to help prepare for climate resilience.</p>	<p>Gathering information, data, checklists to help with site selection review (i.e., not in areas at risk for sea level rise or future flooding), and other design considerations.</p>
Green Building Ordinance	<p>Establishes requirement that all King County owned capital projects be consistent with the latest green building and sustainable development practices.</p>	<p>Defines a "LEED-eligible building" as a "...new construction project larger than five thousand gross square feet of occupied or conditioned space. All eligible new construction projects are required to strive for LEED Platinum certification (effective August 1, 2014). All eligible major renovation and remodel projects are required to achieve LEED Gold certification. All capital projects that are not eligible or are limited in their ability to achieve LEED certification (e.g., infrastructure projects) must incorporate cost-effective green building and sustainable development practices using the King County Sustainable Infrastructure Scorecard and strive to achieve a Platinum level.</p>



ct King County Metro Transit’s (Metro’s) facility planning in support of the development of base expansion projects. A matrix was developed to meet base expansion needs.

CROSSOVER PAGE FOR **TABLE 1: POTENTIAL POLICY IMPLICATIONS ON CAPITAL PROJECTS**

	Cost Impacts	Schedule Impacts	Process Impacts	Gaps
	Increased infrastructure costs- chargers, substations, and construction costs to upgrade facilities.	Sets out a timeline to achieve ZEB fleet – potential challenge to get infrastructure and base capacity in place.	Could affect how service is planned, where and when battery buses deployed.	
	Energy efficiency can reduce operational costs.	Sets timeline for energy use reduction - could affect upgrades to energy sources, timing of facilities.		
	Sets green building and energy efficiency requirements for facilities, incorporating green building into planning and project delivery early is critical to reduce incremental costs.	Sets a timeline for GHG reduction – could prompt certain projects on a specific schedule.	Need to consider green building early in planning; climate impacts in planning; consider resiliency planning – impacts including of sea level rise, flooding, and increased temperatures.	
	Including climate change resilient design could increase upfront cost to reduce risk of performance failure.			

Table 1. Potential Policy Implications on Capital Projects *CONTINUED*

Document Title	Description and Purpose	Requirements
State of Good Repair - Transit Asset Management Plan	This TAMP includes the policies, protocols, procedures, and actions necessary for Metro to align its operations to the Asset Management Policy issued by the General Manager.	The TAMP is a coordinated effort to maximize value from Metro’s available resources.
Strategic Plan for Equity and Social Justice: Facility and System Improvements	<p>The ESJ Strategic Plan is a blueprint for change, mutually created by King County employees and community partners.</p> <p>The EIR is a tool that merges quantitative data and community engagement findings to inform planning, decision-making, and implementation of actions that affect equity.</p>	<p>Addresses many facets of King County business, including: Develop facility and system improvements responsive to the values and priorities of residents and stakeholders, and achieve pro-equity outcomes.</p> <p>The EIR process should:</p> <ul style="list-style-type: none"> Consider organizational and cultural diversity. Include members who regularly engage with communities or connect with key stakeholders. Involved leadership. Engage SMEs.
Strategic Plan for Public Transportation (2015)	This plan describes a vision for the future of King County’s public transportation system, and sets objectives, goals, and strategies for getting there.	<p>Wide range of goals and policies providing guidance, including:</p> <ul style="list-style-type: none"> Operate vehicles and adopt technology that has the least impact on the environment and maximizes long-term sustainability. Incorporate sustainable design, construction, and O&M practices. Provide and maintain capital assets to support efficient and effective service delivery.
METRO CONNECTS: Long Range Plan (2017)	Metro’s vision for bringing more service, more choices, and one easy-to-use system over the next 25 years.	
King County Metro Transit Facilities Guidelines	A resource developed by Metro to help jurisdictions, property owners, developers, architects, landscape architects, and engineers involved with the design, permitting, and construction of Metro’s transit facilities. They describe the desired type and location of the diverse facilities, with the understanding that flexibility is often needed to work within a given environment.	
Transit Speed and Reliability Guidelines and Strategies	<p>This toolkit outlines strategies Metro can use to partner with jurisdictions and stakeholders to improve transit speed and reliability.</p> <p>Most relevant to in-the-field infrastructure and working with partners.</p>	
Labor and Union issues – no formal documents	Expectation that will involve stakeholders; for example, seek driver input in operator facility and base design.	

Notes:

% = percent

CMRS = Capital Management Reporting System

EIR = Equity Impact Review

ESJ = equity and social justice

GHG = greenhouse gas

LEED = Leadership in Energy and Environmental Design

	Cost Impacts	Schedule Impacts	Process Impacts	Gaps
	Sets requirements for SGR, and suggests which projects need to be done when to fulfill requirements. Could influence what investments are made when.	Identifies must-do maintenance projects that could affect scheduling of projects.		
	Potential for higher level of community outreach and engagement; investment in amenities to be a good neighbor.	Consider time for outreach, time to conduct EIR when developing project and program schedules.	Could affect public outreach requirements; planning steps; and hiring and contracting.	
			Provide policy guidance and foundation for doing business – efforts need to ensure consistency with policies.	
	Identifies substantial capital investment to support the long-range vision.			
			Provides guidance for design and specifications of facilities.	
			Need to ensure appropriate internal outreach during planning and design process of Metro facilities.	

O&M = operation and maintenance

SGR = state of good repair

SME = subject matter expert

TAMP = Transit Asset Management Plan

ZEB = zero-emission bus

The following tables provide details about each document listed in Table 1.

Strategic Plan for Public Transportation	
Summary	Policy document for Metro
Metro Owner and Contact	Metro Strategic Planning
Purpose and Objective	<p>This plan describes a vision for the future of King County's public transportation system, and sets objectives, goals, and strategies for getting there. There are six goals, each with multiple objectives and strategies, including for:</p> <ol style="list-style-type: none"> 1. Safety, Human Potential, Economic Growth, and Built Environment 2. Environmental Sustainability 3. Service Excellence 4. Financial Stewardship 5. Public Engagement and Transparency 6. Quality Workforce
Date	Last update: 2015
Cost Impact	Not applicable
Schedule Impact	Not applicable
Process Impact	Includes policies to guide capital.
Gaps	High level – not detailed.
METRO CONNECTS	
Summary	Metro's long-range vision through 2040. Calls for 70% more service, a fleet growth of 625 buses, and considerable investment in capital.
Metro Owner and Contact	Metro Strategic Planning
Purpose and Objective	To communicate Metro's long-range vision
Date	2016
Cost Impact	Extensive capital investment required to support the service vision.
Schedule Impact	Vision lays out a target schedule.
Process Impact	Not applicable
Gaps	Does not provide detail of how to achieve service or capital vision.



Feasibility of Achieving a Carbon-Neutral or Zero-Emission Fleet	
Summary	An assessment of the feasibility of achieving either a carbon-neutral or zero-emission Metro vehicle fleet. Evaluates several alternatives to Metro’s current practice of replacing diesel buses with diesel-electric hybrids and maintaining an electric trolley bus fleet. Assessment considers service needs, costs, necessary supporting systems, environmental results, and social equity benefits.
Metro Owner and Contact	Metro Capital Planning
Purpose and Objective	Recommends that Metro now make significant new contributions to confronting climate change and promoting ESJ by transitioning to a ZEB fleet powered by renewable energy, and by focusing early deployment of ZEBs in communities that are most vulnerable to air pollution.
Date	2017
Cost Impact	<p>Total life-cycle cash costs to Metro are percentages higher to transition to a zero-emission fleet rather than maintain the current fleet (Total Fleet Replacement Costs chart, p. 42).</p> <p>Battery-electric vehicles are currently within the same price range of diesel-hybrids, though price forecasts for the three types of batteries used in battery buses is expected to fall for the next 10 to 15 years.</p> <p>Charging infrastructure costs per battery-electric bus are currently 3 to 14 times higher than that of diesel-hybrids. However, the charging capital costs are dependent on the number of vehicles each charger can serve. Given the evolution of charging infrastructure and the current lack of standardization, there is a risk that equipment could become obsolete and challenges with scaling up the deployment of charging infrastructure could occur, making the costs less certain.</p>
Schedule Impact	<p>Assuming continued rapid development of battery bus technology to meet Metro’s service and operating needs, all future bus purchases and all new buses put into operation starting in 2020 would be zero-emission. To increase the environmental, climate change, and health benefits of this transition, Metro would seek to power these buses with renewable electricity. Through ongoing fleet replacement and expansion, Metro would commit to completing the transition to a zero-emission fleet by as early as 2034, or by 2040 at the latest, depending on technology requirements and other implementation considerations.</p> <p>Based on the current fleet plan, including committed purchases and a typical lifespan of 14 years, 2020 would be the first year Metro would purchase 60-foot battery-electric buses.</p> <p>In 2028 (the end year of the October 2016 Metro Fleet Plan), the Metro fleet would be approximately 68% zero emission. Following a 14-year replacement schedule, per common practice at Metro, the entire fleet could be transitioned to a zero-emission fleet by 2034.</p> <p>In January of 2017, Executive Constantine announced that Metro will acquire 120 all-electric battery buses by 2020, with 73 coming from Proterra.</p>

Feasibility of Achieving a Carbon-Neutral or Zero-Emission Fleet *CONTINUED*

<p>Process Impact</p>	<p>South Base prioritization:</p> <p>By prioritizing deployment of new ZEBs to routes originating at South Base, Metro could improve air quality and public health outcomes in low-income and minority (underrepresented communities of color), which historically have borne an undue share of vehicle emission and health impacts.</p> <ul style="list-style-type: none"> • Bases during transition period: Typical nightly maintenance and service cycle will require significant modification when there is a mix of fleet types (current refueling and cleaning cycle will work for only a portion of the buses at the base). • Power supply: Will be necessary to upgrade power delivery equipment to accommodate larger power requirements (5- to 10-year lead time to plan, design, expand, and construct facility and negotiate with utility). • Maintaining economy of scale: Plan recommends focusing deployment of initial three bus bases until a more critical number of battery-electric buses is reached among the entire fleet. Small fleets can be significantly more expensive to maintain, due to a lack of efficiency of scale. Bellevue Base is a recommended candidate to support continued deployment of fast-charge and short-range buses because of its service profile, ability to make use of common charging locations, and expertise gained during the battery-bus pilot testing period.
<p>Gaps</p>	<p>“Metro shall coordinate and provide emergency bus transportation and services, make buses available for King County emergency operations and return transit service to normal levels as soon as possible following an emergency or disaster. There are no specific minimum service level expectations for Metro in the event of a catastrophic event.” (p. 13)</p> <p>“The Service Guidelines analysis does not include a breakdown of zero-emission trips by low-income or minority status, nor does it consider air pollution vulnerability.” (p. 14)</p> <p>“The analyses looked only at bus scheduling and service design to determine the number of buses that could potentially transition to battery-electric buses. We did not consider other limiting factors such as available base capacity or space at layover locations needed for charging infrastructure. We assumed that both 40-foot and 60-foot battery-electric buses would be available. Currently Metro has tested 40-foot battery-electric bus technology, but the one model of a 60-foot battery-electric bus currently available has not yet proven it can meet Metro’s quality standards.” (p.25)</p> <p>Full-fleet conversion limited by availability and progression of battery technology: As battery technology progresses and bus range increases to 200 miles, over 90% of Metro’s service could be met. A range of 350 miles would be required for slow-charge buses to accommodate 100% of current operations, or bus schedules could be adjusted to accommodate buses with shorter ranges.</p> <p>Lack of consistency and standardization of charging infrastructure: Has direct impacts on the layout of maintenance base charging equipment. It also affects an agency’s ability to efficiently store buses on a base—especially if the agency is considering operating buses from multiple manufacturers that may not be able to share the same charging equipment.</p>



Transit Facilities Energy Plan	
Summary	<p>A document that captures Metro’s vision to reduce energy consumption at our facilities by 15% in 2015 and 20% in 2020.</p> <p>Metro will continue seeking opportunities to improve energy efficiency and conservation, and to decrease energy use in its facilities through:</p> <ul style="list-style-type: none">• Measuring and managing energy use• Incorporating conservation practices into facility design, construction, and operation• Empowering employees to identify new ways to reduce energy use and save money
Metro Owner and Contact	Metro Sustainability Program
Purpose and Objective	Purpose is to identify future energy reduction tasks. Our action plan highlights the actions and progressive steps to be taken over the next 6 years to meet the target of a 20% reduction by 2020.
Date	2014 and 2019
Cost Impact	Not applicable
Schedule Impact	Not applicable
Process Impact	<ul style="list-style-type: none">• Develop a capital and operating investment plan for energy-related tasks, and secure funding.• Proposed actions may include piloting programs and procedural changes, and monitoring impacts prior to systemwide implementation.• Implement audits (target two per biennium).• Expand gas and electrical submetering to all bases, and other relevant support facilities. Use submetering results:<ul style="list-style-type: none">• As a reporting tool• To gauge success on new actions• For real-time energy management and employee engagement• Develop a database to aid in the documentation, analysis, sorting, and reporting of energy usage; this is a continuous improvement process.• Develop an Energy Management Best Practices Plan for bases (adapted as needed for site-specific circumstances), Component Supply Center, and relevant support facilities.• Invest in technology and training to aid in monitoring, managing, reducing consumption, and reporting energy usage.
Gaps	Not applicable



Strategic Climate Action Plan, King County (SCAP)	
Summary	The SCAP is King County's blueprint for climate action and provides "one-stop-shopping" for county decision-makers, employees, and the general public to learn about the County's climate change commitments.
Metro Owner and Contact	Governance led by Executive's Office and Climate Leadership Team Approved by Council Metro Sustainability Program
Purpose and Objective	King County identifies priority actions that will lead to significant progress in achieving regional GHG reduction targets and conveys opportunities to act on climate solutions that achieve additional social, economic, and environmental benefits for King County residents.
Date	2015 2020 (planning will start in 2018-2019)
Cost Impact	Consideration early in planning and design avoids or reduces potential initial cost impacts. Life cycle assessment of costs, including social costs of greenhouse gas emissions, is critical to evaluation of overall costs.
Schedule Impact	Critical to consider green building and energy efficiency requirements early in the planning and design phase to maximize positive benefits and to avoid or limit schedule impacts.
Process Impact	<p>Reduce energy and water use in buildings and facilities, and produce and consume more renewable energy as follows: 2020 – Reduce energy use by 7.5% (compared to 2014 baseline); use renewable energy for 70% of operations; all LED lights.</p> <p>2025 – Reduce energy use by 10% (compared to 2014 baseline); use renewable energy for 85% of operations; 100% GHG neutral electricity for all government operations.</p> <p>Build and operate buildings to highest green building and sustainable infrastructure standings Achieve LEED Platinum or equivalent by 2020 for all County-owned facilities. Achieve net zero GHG emissions by 2030 for all County-owned facilities.</p> <p>Reduce construction and demolition waste, and reuse more materials by 85% by 2025 and zero waste by 2030.</p> <p>Meet the equivalent energy cost performance of the most progressive energy code in King County (i.e. 2015 Seattle Energy Code).</p> <p>Conduct large facility energy site assessment every 7 years.</p> <p>Ensure all buildings are energy star certified, excluding transit bases [...] and facilities for which there is not an Energy Star category.</p> <p>Conduct a life-cycle cost analysis of alternatives for capital projects with energy using equipment over \$250,000.</p> <p>Consider including the social cost of greenhouse gas emissions.</p> <p>All building capital projects over 200 ft² must consider future solar integration</p>
Gaps	

Notes: ft² = square foot (feet)
 LED = light-emitting diode

Transit Asset Management Plan (State of Good Repair)

Summary	This TAMP includes the policies, protocols, procedures, and actions necessary for Metro to align its operations to the Asset Management Policy issued by the General Manager.
Metro Owner and Contact	Metro Capital Planning Metro Transit Asset Management
Purpose and Objective	<p>The TAMP is a coordinated effort to maximize value from Metro’s available resources by providing:</p> <ul style="list-style-type: none"> • Informed, data-driven decision-making • Processes for the maintenance, repair, renovation, and replacement of assets • Improved financial planning and forecasting of funding requirements to enable timely maintenance and replacements • Business systems that support and integrates the strategic management of assets <p>The plan will ultimately enhance Metro’s ability to provide safe, cost-effective, reliable, and seamless service to our customers.</p>
Date	Next update: November 2018 (all language in matrix taken from 2018 draft)
Cost Impact	Can help inform budget decisions.
Schedule Impact	<ul style="list-style-type: none"> • Fleet: p. 22 Useful life benchmarks for Revenue and NRV Fleet. • Fleet asset replacement (pp. 26-28): The assessment generates a numerical 1-5 value, aligning with the FTA’s TERM scale. Any assets with a value less than 3 are considered out of repair and flagged for replacement. • FE&M Plan • FE&M asset replacement (pp. 33-35): The assessment generates a numerical 1-5 value, aligning with the FTA’s TERM scale. Any assets with a value less than 3 are considered out of repair and flagged for replacement. • Minimum SGR metrics for capital, established by PSRC (p. 39). Asset management team compares percent of assets out of SGR to the regional performance targets to determine minimum number of assets to be replaced. <p>TAMP also provides a pair of alternative options (better and best) to increase SGR. (p. 42)</p>
Process Impact	<p>Fulfillment of the vision and principles requires a robust TAMP that ensures an SGR for all transit assets. This TAMP ensures that Metro can meet or exceed the Puget Sound Regional Council’s Regional Transit Asset Management performance targets:</p> <ul style="list-style-type: none"> • Keep rolling stock in good repair with restricted fleet numbers at or exceeding ULBs, as follows: <ul style="list-style-type: none"> • <5% bus rolling stock at or exceeding ULB • <27% vanpool, vans, and electric trolley buses at or exceeding ULB • No rail rolling stock (cars or engines) at or exceeding ULB • <6% ferries and water taxis at or exceeding ULB • <21% NRVs at or exceeding ULB • Keep maintenance equipment in good repair: <ul style="list-style-type: none"> • <7% vehicle lifts and heavy equipment less than “3-Adequate” on the 5-point scale • No cranes or overhead lift equipment less than “3-Adequate” on the 5-point scale • Keep Metro facilities in good repair, as follows: <ul style="list-style-type: none"> • <10% of all maintenance and administrative facilities less than “3-Adequate” on the 5-point scale • No passenger facilities (terminals, transit centers) less than “3-Adequate” on the 5-point scale • <7% parking garages and park-and-ride lots less than “3-Adequate” on the 5-point scale
Gaps	

Notes:

< = less than

NRV = nonrevenue vehicle

FE&M = Furniture, Equipment, and Machinery Lifecycle Management

PSRC = Puget Sound Regional Council

FTA = Federal Transit Administration

TERM = Transit Economic Requirements Model

ULB = usable life benchmark



Green Building Ordinance and Sustainable Infrastructure Scorecard (2014)

Summary	Guidelines for Complying with the King County Green Building and Sustainable Development Ordinance
Metro Owner and Contact	Metro Sustainability Program King County Green Tools Program
Purpose and Objective	<p>The Green Building and Sustainable Development Ordinance 17709, adopted on December 9, 2013 (http://your.kingcounty.gov/solidwaste/greenbuilding/documents/green-building-ordinance-2013.pdf), requires that capital projects use either the LEED Rating System, Scorecard, or approved alternative green building rating system to integrate cost-effective sustainable development practices into infrastructure projects. In addition, it requires King County divisions ensure that capital projects staff obtain regular training in green building and sustainable development. Project teams are responsible for reporting on the green building strategies and training implemented.</p> <p>The ordinance defines a “LEED-eligible building” as a “...new construction project larger than five thousand gross square feet of occupied or conditioned space as defined in the Washington state energy code, which is chapter 51-11 WAC, or a major building remodel or renovation project.” A major remodel or renovation is further defined as “...work that demolishes space down to the shell structure and rebuilds it with new interior walls, ceilings, floor coverings and systems, when the work affects more than twenty-five percent of a LEED-eligible building’s square footage and the affected space is at least five-thousand square feet or larger. ”</p> <p>All projects not eligible to achieve LEED certification under the ordinance must complete a project scorecard at 30% design and project completion. Projects may use the King County Scorecard or a division-specific scorecard, if available.</p> <p>The King County Scorecard was developed using concepts that are the basis of the LEED rating system, adapted to more appropriately apply to non-LEED eligible infrastructure projects in King County. The resulting Scorecard includes nine sections, including a set of prerequisites; seven sets of credits (optional items) organized by key topics of sustainability; and an additional set of credits (also optional) for enhanced performance.</p> <p>Expanded guidance per the ESJ Strategic Plan was incorporated into the King County Scorecard to advance ESJ goals in capital projects.</p> <p>Guidance and tools are available on the King County Green Tools website.</p> <p>All projects must report and track annually their compliance with the green building ordinance in PRISM. Results are shared with the Executive Office and King County Council.</p> <p>Project design elements all projects should employ: Utilize all LED fixtures and lamps/ Install and expand sub-metering to support real-time data monitoring/ Use of King County Surface Water Design Manual unless permitting jurisdiction has more progressive standards</p> <p>Project should consider as price and performance allows: onsite renewable energy / alternative cement (i.e. fly ash and slag)/ water efficient fixtures and equipment/ Reduce potable water use/ Locally sourced sustainable materials.</p>

Green Building Ordinance and Sustainable Infrastructure Scorecard (2014) CONTINUED	
Date	2014
Cost Impact	Consideration and integration of green building early in the planning and design phases are critical to maximizing benefit and reducing costs.
Schedule Impact	Integrating green building into project planning from the earliest phases is critical to ensure it does not result in schedule delays or impacts.
Process Impact	<p>Green building is an integrative process from planning, design, implementation and operations of a facility. It is critical during the process that:</p> <ul style="list-style-type: none"> • Early in planning identify green building requirements and bring on expertise • Monitor projects throughout construction and operation to ensure facilities are achieving goals and scope changes to not threaten certification levels • Document and track throughout the process to ensure third-party certification • Contract specifications must align with project delivery requirements for green building and energy efficiency. • Green building and ESJ plan must be submitted at 30% completion and outcomes documents at substantial completion.
Gaps	

Notes: *Scorecard: King County Sustainable Infrastructure Scorecard*



Strategic Plan for Equity and Social Justice: Facility & System Improvements	
Summary	The ESJ Strategic Plan is a blueprint for change, mutually created by King County employees and community partners.
Metro Owner and Contact	Metro Equity and Inclusion Manager
Purpose and Objective	<p>The Plan is a blueprint for action and change that will guide our pro-equity policy direction; our decision-making, planning, operations and services; and our workplace practices to advance equity and social justice within County government and in partnership with communities.</p> <p>It advances pro-equity policies, systems, and practices in six areas of governance:</p> <ol style="list-style-type: none"> 1. Leadership, operations, and services 2. Plans, policies, and budgets 3. Workforce and workplace 4. Community partnerships 5. Communication and education 6. Facility and system improvements <p>Directs incorporation of ESJ considerations into the capital project decision-making and into the line-of-business planning process.</p> <p>GOAL 1: Infrastructure system master plans, including line of business and other strategic planning processes, include clear objectives to advance ESJ that are informed by and sensitive to priority populations and key affected parties.</p> <p>GOAL 2: Capital development policy, budgets, portfolios and programs are developed in accordance with community equity priorities, informed by a perspective on historic and existing inequities, and include a description of their contribution to improving equity in community conditions</p>
Date	2016
Cost Impact	May need additional resources to implement aspects of plan.
Schedule Impact	Integrating ESJ considerations into project planning from the earliest phases is critical to ensure it has the most benefit and does not result in schedule delays or impacts.
Process Impact	<p>By 2018:</p> <ul style="list-style-type: none"> • All infrastructure and facility master plans describe the intended ESJ outcomes for the system (a.k.a. the pro-equity version of the system). • All CIP program and portfolio budgets have evaluated and include a description of how ESJ considerations are advanced through project decisions—and provide guidance and direction on equity considerations and objectives on a project-by-project basis. • Communication and engagement efforts of all capital development programs and projects are culturally appropriate. • Funding sources (e.g., levies, bonds), siting, design, and construction of capital projects are responsive to the equity interests and priorities of historically disadvantaged communities.
Gaps	



King County

METRO

Facilities Master Planning Program: Operational Capacity Growth Report

March 2019

Appendix C: Workshop Report



SECTION 1:

Introduction

King County Metro Transit (Metro) held a Base Planning Workshop to provide a forum for idea generation to improve the operational capacity growth concept and strategy. The workshop spanned a half-day period, and involved the FMP contract consultant team, Metro employees from across the agency's departments, and subject matter experts (SMEs) across all disciplines of the transit industry. The workshop conversation resulted in the generation of concepts and strategies for the development and delivery of operational capacity growth needs.

SECTION 2:

Executive Summary

Workshop Background

As part of the Metro Facilities Master Plan (FMP) effort to develop a comprehensive base expansion Master Plan, King County Metro Transit (Metro) held a Base Planning Workshop to provide a forum for idea generation to improve the operational capacity growth concept and strategy.

The workshop spanned a half-day period, and involved the FMP contract consultant team, Metro employees from across the agency's departments, and subject matter experts (SMEs) across all disciplines of the transit industry. An attendee list is provided in the attached summary.

To derive the most value from the visiting SMEs, the Metro team led a full-day tour prior to the workshop of the operational and maintenance bases that services Metro's fleet:

- North Base
- Bellevue Base
- South Base
- Central Base
- Atlantic Base

This base tour added context to the workshop discussions and the feasibility of generated ideas.

Subject Categories

Identified by the FMP team as areas of interest before the workshop began, the following subject categories were the focus of workshop discussion and activities:

- Base Design and Operations
- Base Electrifications and Layout
- Implementation and Logistics
- Service Delivery and Long-range Planning
- Design
- Fleet

An SME was assigned to each subject category and led the discussion with Metro staff members who attended the workshop.

Affinity Exercise

Generating the most data during the workshop, the Affinity Exercise challenged attendees to document considerations in base design, and potential obstacles or barriers to the completion of the bases. After the initial idea generation, all attendees ranked importance of the documented considerations by voting on which points held greater value to the overall discussion. The top voted ideas appear first, followed by all other ideas recorded.

Base Tour Observations and Recommendations

Gathering summative thoughts from each of the SMEs after the Metro base tour, this Base Tour Observations and Recommendations list identifies potential obstacles to base expansion and recommends early action items.

Highlighted Early Action Items:

- Implement a more robust Asset Management Program.
- Develop Facility Design Standards and Metrics, preliminary standards could be part of the design programming for one of the first base projects.
- Complete the FMP as a guide for future expansion.
- Bone Yard and Skid Pads if relocated from current positions on bases, could alleviate immediate bus storage needs.
- Follow a Contract Delivery selection strategy (using, for example, design/bid/build [D/B/B], construction manager and general contractor [CMGC], public-private partnership [PPP]).

King County Metro — Facilities Master Plan Workshop Attendees

Alex Adams, King County Metro Transit (Metro)

Jennifer Altschuler, Metro

Diane Carlson, Metro

Carri Brezonick, Metro

Dave Crippen, Metro

Don Goodwin, Metro

Jonathon Bez, Metro

Dale Hartman, Metro

Jeff Garland, Metro

Elie Kourdahi, Metro

Liz Krenzel, Metro

Gary Kriedt, Metro

Carrie Lee, Metro

Pete Melin, Metro

Tina Rogers, Metro

Timothy Flanagan, Metro

FMP Internal Team

Lucien Bruno, Metro

Lisa Shafer, Metro

Jeffery Arbuckle, Metro

Ana Burns-Johnson, Metro

Chester Knapp, Metro

Consultant Team

Scott Witt, Jacobs Engineering Group Inc. (Jacobs)

Bill Tsiforas, Jacobs

Morgan Milner, Studio Meng Strazzara (SMS)

Debra Ashland, SMS

Amanda DeGiorgi, Jacobs

Stephen Silkworth, Jacobs

Ryan Abbotts, Jacobs

Greg Straight, Jacobs

Dan Speicher, Jacobs

Workshop Background

The Facility Master Plan (FMP) workshop was an opportunity to bring together Metro staff and a team of consultant experts to discuss Metro's near- and long-term operational capacity growth constraints and opportunities. This effort is part of a larger effort to develop an FMP.

Workshop Objective

The specific objectives of the workshop were to:

- Establish recognition of the opportunities facing Metro
- Establish a common understanding of the FMP, its intent and pathway, and the emerging operational capacity growth concept.
- Provide a forum for sharing ideas for improving the operational capacity growth concept and strategy.
- Capture the collective wisdom of the SMEs to improve the operational capacity growth concept and strategy.
- Develop a means to engage the SMEs beyond this workshop

Facility Master Plan

Metro initiated the development of an FMP to plan capital investments for the facilities needed to support METRO CONNECTS increased services by the year 2040. The FMP team began the project by baselining Metro's existing base facilities, current fleet, and level of service. Using the data generated from the baseline report, Metro developed a concept to increase base capacity through expanding existing facilities and building new facilities to satisfy the service expansion goal outlined in METRO CONNECTS.

Setting the Context

It was important to capture the entire planning context to understand the barriers, external or internal, which could influence future growth and the ability to meet service expansion by the target date of 2040. Through the medium of a full-day tour of Metro bases and a half-day workshop, the FMP team engaged a group of SMEs to share their input and ideas on Metro's anticipated growth.



SECTION 3

Workshop Summary

Metro staff from across the agency were included in the workshop, to encourage interagency knowledge-sharing, and to draw from the expertise of the SMEs in attendance. Lisa Shafer and Jeffrey Arbuckle set the context for the workshop, by giving brief presentations on the history of long-range and base planning at Metro, including the foundation of METRO CONNECTS. They also gave a presentation on the proposed operational and capacity expansion plan. Diane Carlson announced her transition into the role of Deputy General Manager for Capital at Metro and vocalized her support for the base planning efforts.

Facilitator Dan Speicher led the group in attendance through a series of interactive activities to identify considerations for the FMP team, and ideas for solutions to the obstacles of building and expanding Metro's facilities within a constrained timeline. Through the process, discussion focused on specific categories of interest to the base planning efforts. These subject categories were:

1. Base Design and Operations
2. Base Electrification
3. Program Delivery, Implementation, and Logistics
4. Service Delivery
5. Base Building Design
6. Fleet

Subject Categories Summary

The workshop conversation resulted in the generation of concepts and strategies for the development and delivery of operational capacity growth needs. These concepts and strategies were organized into seven categories listed in the following table. More detail is captured in the text after the table.

Category	SME Lead	Summary
Base Design and Operations	Stephen Silkworth	Provide flexibility, including: <ul style="list-style-type: none"> • Accommodate fleet change while maintaining legacy vehicles • Provide room for growth and shared staff needs • Link service to base capacity Consolidate common needs: <ul style="list-style-type: none"> • Parts warehouse • Body shops • Training
Base Electrification and Layout	Scott Witt	<ul style="list-style-type: none"> • Evolve a ZEB technologies and infrastructure needs • Synchronize the electrification effort
Program Delivery and Project Costs	Greg Straight	<ul style="list-style-type: none"> • Plan for extensive communication • Establish design standards • Determine the staffing approach • Determine delivery methods
Implementation and Logistics	Bill Tsiforas	<ul style="list-style-type: none"> • Plan for access to facilities • Develop an Asset Management Plan • Determine parts availability
Service Delivery, Long-Range Planning, and Linkages to Other Facilities	Ryan Abbotts	<ul style="list-style-type: none"> • Develop a framework to target and measure goals • Expand on partnerships • Develop a long-term employee mobility and access plan • Understand fleet on base vs. in the field
Design (Buildings)	Debra Ashland	<ul style="list-style-type: none"> • Provide flexibility (must fully fund a flexible design) • Support functions (decentralized or centralized) • Maximize usage of site for future expansion
Fleet	Amanda DeGiorgi	<ul style="list-style-type: none"> • Align capital timelines with service delivery timelines • Use parts availability knowledge to provide additional bay capacity in the short term • Determine trolley bus fleet remaining life and needs • Provide fleet standardization, including standardization of maintenance practices • Improve rooftop access on bases • Determine the additional service hours effect on the bus life cycle

Notes:

ZEB = zero-emission bus

Category Details

Base Design and Operations

Participants identified the following areas requiring additional exploration:

- Generate the ability to accommodate fleet changes while maintaining legacy vehicles; room for growth and shared staff needs; link service to base capacity.
- Consider consolidating the parts warehouse, body shops, and training facilities.
- Establish design standards for future base remodel or new design.
- Reduce fleet diversity, which will reduce the parts inventory; consolidate maintenance activities; and reduce the need for staff training on maintaining and driving the legacy fleet.
- Base need to be sustainable and environmentally sensitive to surrounding properties.
- Improve overall Assets Management System.
- Improve communication, which is key to meeting the program requirements.
- Provide an expanded and more detailed schedule as Metro moves forward (critical path).
- Expand the Conversion Capital Program, which may require an outside Program Manager Group.
- Consider possible construction delivery methods to meet the schedule. Different parts of the program may require different delivery systems: Design Bid Build (DBB), Design Build (DB), Private Public Partnership (PPP/P3).

Base Electrification and Layout

Participants identified the following areas requiring additional exploration:

1. Evolve ZEB technologies and infrastructure needs, including:
 - Transition plan for diesel equipment
 - Lay-by power storage (emergency power and cheaper late-night power)
 - Smaller vehicle chargers for non-revenue vehicles (NRVs) – type 2, employee vehicle charging stations
 - Base design (vertical vs. horizontal) and all electrical implications, including:
 - Coordination with vehicle manufacturers is recommended to develop early power schemes.
 - Significant power is anticipated for charging sizeable electric fleets; suggest advancing project to supply additional power due to potential lead time for permitting and supplier coordination.
 - Storage of batteries and reuse of batteries
 - Autonomous vehicle integration
 - Synchronize electrification effort, and develop faster information delivery process, including:
 - Early action of evaluating power availability to each of the campuses, including assessing how to supply redundant service.
 - Timeline: Acquire land, and build infrastructure (bring power to bases); buy buses; prepare buses for service; and hire and train staff.

Program Delivery and Project Costs

Program vs. Project

For clarification, the term *program* was used to define a collective set of individual, but related, *projects*. In our discussions, the program referred to METRO CONNECTS, and project references were essentially focused on the new bus maintenance facility.

Program and Project Objectives

The objective of the program and project delivery is to turn the concepts and objectives of Metro into a functioning facility. As is the case with all projects, the expectation is that the project is delivered on time and on budget. But successful projects require much more than completing construction on time and on budget. Discussions during this breakout session targeted early activities that can significantly enhance the likelihood of Metro commissioning a new bus maintenance facility that is viewed by all as being truly successful. The discussions are best categorized into the following four general topics:

1. Extensive Communication
2. Design Standards
3. Staffing Approach
4. Delivery Methods

1. Extensive Communication

Two-Way Communication – Is critical and needed among all departments.

Priorities – Need to establish realistic and meaningful priorities that are well-aligned with the agency. Having strong priorities will help the agency maintain focus during all phases of the program and when responding to unexpected circumstances.

Scope (objectives) – Clarify and agree to a scope. Discussed the hazards of successfully delivering the “wrong” project.

Policy – Policy conformance generally facilitates predictable project progression. Known policy challenges should be identified early and addressed as soon as reasonably possible.

Decision Making – Need to identify who will be making what decisions. The team can greatly influence the timeliness of getting critical decisions by providing concise but comprehensive information.

2. Design Standards

Use – The intent of the design standards is to establish general criteria to be used during the planning and design.

Scope Definition – Design standards can be used to confirm expectations of the agency, serve as guidance for Metro’s Capital Program Department, and provide direction to designers and construction contractors.

Updates – The standards should be developed and revised periodically; certainly, ahead of embarking on a new major capital program.

Methodic – The criteria should be established using a deliberate and methodic process that considers input from all affected departments.

Variations – Deviations may be made within the framework of the design standards to meet the requirements of a particular problem. Deviations, discrepancies, or unusual solutions should be reviewed by the same collective body that developed the design standards. Metro should maintain strict approval control for all variations.

3. Staffing Approach

Determine what Metro wants to look like as an agency during and after the program by answering the following questions:

- Does Metro want to build up design squads to complete final design packages suitable for procurement and construction?
- Would Metro rather hire SMEs?
- A combination of both?

Considerations:

- Labor costs
- Resource leveling
- Access to specialized resources
- Post-program demobilization

Agency staffing options:

- Full-Time Equivalent (FTE)
- Temporary Limited Term (TLT)
- Special Duty Assignments (SDA)

Staffing augmentation options:

- Program Management Consultant to perform as an extension of staff only, with no final design responsibilities
- General Engineering Consultant to serve as an extension of staff, but also completes some design and final design

4. Delivery Methods

The group did not spend too much time discussing the delivery methods. However, Metro should continue to consider the delivery methods as the individual projects evolve. Metro will need to make a delivery commitment once the concept and schedule are finalized. Delivery methods discussed during the breakout session included: DB, DBB, and P3.

DB and DBB delivery methods are likely the models that would serve Metro the best. The initial assessment by the Jacobs team tended to suggest that Metro would likely be happier with a DBB delivery for near-term work because of familiarity with the method. Also, development of detailed specifications may not lead to reduced schedule time for near-term efforts. There were no program operations noted during the site visit that made sense for a P3.

Implementation and Logistics

Access to Facilities – It is important for Metro to have access to their bases during the expansion or upgrades. Employee parking will be an issue, since there will be minimal parking available during construction. Metro will need to use transit or shuttles if temporary parking areas are established to get employees to the bases.

Asset Management Plan – The Federal Transit Administration (FTA) has published a final rule to define the term “state of good repair (SGR)” and to establish minimum federal requirements for transit asset management that will apply to all recipients and subrecipients of Chapter 53 funds that own, operate, or manage public transportation capital assets. This final rule requires public transportation providers to develop and implement transit asset management (TAM) plans.

TAM plans must include an asset inventory, condition assessments of inventoried assets, and a prioritized list of investments to improve the SGR of their capital assets. Standard scoring criteria for condition assessments for regional public transportation assets needs to be established. Metro needs to develop a road map to start advancing their maturity in the upcoming federal fiscal year and beyond. The TAM Plan is a starting point, with the goal being to lay out a path forward to better inform Metro decisions regarding the capital program and operations and maintenance (O&M) budgets. To this end, the plan must identify the resources and business processes needed to better manage Metro’s many assets throughout their life cycles.

Parts Availability – Government sector operations are driving change in the supply chain as they demand new levels of cost reduction while improving operational uptime and productivity. New, innovative solutions and advanced technologies are enabling supply chain management practices to have a cost-effective means of inventory management. Using software and standardization will make the operation more efficient and allow Metro to do what they do best (maintenance and repair). Also, providing Metro with the hardware (computers) needed and training is equally important for any new software or systems used for inventory management.

It was recommended by Metro to conduct a peer review with other transit agencies and to also perform an internal needs assessment. Details include:

- Metro needs to have the proper resources to implement such a system, and the Metro Capital Department agreed to pay for at least 1 FTE in the 2019/2020 budget.
- To help optimize operations level of service (LOS) 0 or less; Metro will need to have backup resources for optimization, which will include other Metro departments (e.g., trolley bus, power).
- Project Delivery Resources – An alliance of Metro employees, systems, and practices that harnesses the talents and insights of all participants to optimize project results; increase value to Metro; reduce waste; and maximize efficiency through all phases of design, fabrication, and construction.

Service Delivery, Long-range Planning, and Linkages to Other Facilities

The conversation for service delivery, long-range planning, and linkages to other aspects of Metro operations and service delivery were summarized into the following four categories:

1. **Framework to target and measure goals** – Participants identified the need to develop a clear framework for identifying goals; attaching meaningful targets to those goals; and having a supported, potentially celebrated, process for measuring the goals. This framework would be adopted agency-wide and apply to other facets of operations, capacity expansion, service delivery, and more. It is envisioned that this would be a consistent and recognizable way of measuring success. Goals and targets would be data driven and tangible.
2. **Partnerships** – Participants envisioned that success of operational and capacity expansion will require the active engagement of a wide range of internal and external resources. The engagement would be early and often, and provide a holistic sharing of data, information, and needs.
3. **Long-term employee mobility and access plan** – Daily activities should explore measures and programs for reducing employee (such as bus operator) drive-alone trips. Typically, operators are travelling outside of the peak service. These activities would focus on reducing the demand for onsite parking at campuses. Discussions included active vanpool matching, ride sharing, worker-driver shuttle programs, and more.
4. **Understand base vs. field needs**– Infrastructure requirements in the field could vary, depending on where and when electric service operates. Coordination will be needed to determine if any remote charging locations or additional facilities (e.g., layover, comfort station sizing) will be needed to support a different fleet mix.

Base Design (Buildings)

The FMP, beyond informing Base Design, recognizes the impact of the upcoming Capital Improvement Plan (CIP) budget process on the flexibility of the design for the future bases. This group recommends advocating for the County to commit to funding base flexibility, with the ability to include sustainability and other Metro initiatives into the design. In beginning of the basis of design, Metro should inventory the success and failures of the current base design, viewing these aspects through the lens of flexibility for future fleet and technology changes.

Base support functions and their associated facility needs must be addressed in the FMP. The discussion focused on the value of incorporating a holistic view of base design, which includes planning the location of support facilities. As an example, the Metro Police headquarters have moved into multiple interim facilities in the last 10 years due to a lack of planning effort surrounding Police facilities. Decisions on centralized or localized locations for these functions will impact the subsequent base designs.

To assist in making these decisions, Metro should appoint a small committee who will guide the design for Metro. To build consensus with other Metro staff, it will be important to remain transparent and communicate the opportunities for design input with those outside of the committee.

Fleet

Alignment of Capital Timelines

It is critical to align the FMP with fleet procurement plans in the same time horizon (assuming fleet procurement plans address service delivery timelines). Especially as Metro moves towards an electrified fleet, the best way to avoid delays and issues is to ensure that the FMP reflects the fleet plan and accommodates the technologies, quantities, maintenance needs, labor expertise, and parts storage related to the planned fleet.

Known parts availability issues can be tackled to provide additional capacity in the short term. This was observed specifically at North Base, where all the maintenance bays were in use, but many of those buses were taking up bays while waiting on parts. Bus parts can take up to 30 days to arrive, meaning the base has one less bay for 30 days. If parts arrived quicker and more reliably, buses would be in and out of maintenance bays faster, improving the maintenance capacity of the existing base, and allowing additional buses to be put onsite.

As Metro moves towards a zero-emissions fleet, it's important to review remaining life and needs for the trolley bus fleet. The trolley bus industry is shrinking, so it may become harder or more expensive for Metro to procure new trolley buses in the future.

In line with fleet standardization, the FMP should look at similarly standardizing maintenance practices and capabilities across the bases instead of having significantly unique processes, equipment, and practices.

In general, with the transit bus industry trending toward designs that have rooftop equipment, bases are going to need improved roof access (cranes, fall protection, mezzanines). The challenge with mezzanines will be finding a single height that allows access to all different types and heights of buses. The fleet will not likely be standardized to the level of all one height.

Implication of METRO CONNECTS on a Typical Bus Duty Cycle

Metro buses currently run heavily in the morning, park at layovers during the midday down period, and run heavily again in the evening before heading back to the base. With the METRO CONNECTS plans, it seems that these buses will be running heavier duty cycles throughout the day. Metro should look at what the implications will be on life-cycle maintenance and expected life. These changes may require a more structured fleet maintenance plan that considers reliability-centered maintenance (RCM) and midlife overhauls. This should also factor into fleet procurements and replacements. Under the new service delivery plan, buses may not last as long as they have historically at Metro.

Affinity Exercise

Each SME-led table brainstormed ideas related to a topic of base expansion. Each group was given an allotment of time to create a team name, and produce their ideas on large Post-It sheets. Every workshop attendee was equipped with seven dots to vote on ideas they believed would benefit from further exploration. The top voted ideas were the basis for the SME breakout session, with Metro attendees given the opportunity to discuss these ideas at a deeper level.

Group Work: 12th Man

Top Voted Ideas

- Life-cycle cost analysis
- Double-decker buses
- Component Supply Center (CSC), look for property downtown
- Centralized parts warehouse
- Add training and meeting rooms at bases
- Keep diesel at bases, and diesel and electric buses for emergencies
- Tools for mechanics
- More advanced hostling system
- Bus storage parking, multilevel parking (LA Metro), including:
 - Fleet management system
- South Base planned for electric buses and diesel

Other Ideas

- Staffing (off-hours, regular hours) for meeting fleet size increase across the board
- Different fleet types require additional maintenance concerns or requirements
- Consolidation of all buses to meet the current maintenance needs and future operations
- Separate body shop from paint shop
- Add computer and technology center at bases
- Electronic sign-in for employees at all bases
- Vacuum interior, and clean buses inside before washing
- Add bus washes at bases
- Charging stations at bus washes for cleaners
- Technology advances on batteries and chargers
- Different chargers for electric bus types
- Bellevue base does not have enough chargers for Proterra buses

Group Work: Blue Team

Top Voted Ideas

- Include Hazard Mitigation and Emergency procedures, including:
 - – Sea Level
 - – Flood Plain (South)
 - – Backup Power for Battery Bus
- Act on asset management now
- Look for centralized approach for building training facility
- Equity and Social Justice (ESJ): Ensure diverse workforce can access

Other Ideas

- Look at fleet mix to reduce burden and complexity
- Skid pad:
 - Accommodate trainer and trainee access, and getting fleet to site (interim)
 - Accommodate mix of fleet
 - Accommodate testing
- Look for transportation solutions for employees:
 - When picking location
- When operating at location
- Address known parts availability issue (and simplify fleet)
- Accommodate storage – Hybrid battery
- Include Green Building
- ESJ:
 - Mitigate negative impacts of (several) facilities in South King County
 - Ideally, seek to address and improve inequity

Group Work: Bright Ideas

Top Voted Ideas

- Build flexibility to allow for variety of bus types (start at Interim Base)
- How to speed up design process? Alternative delivery methods
- Fleet purchases need to include modifications to bases
- Double, second story bases, or multilevel bases for:
 - Offices
 - Dispatch
 - Storage
 - Electronics and components
 - Training
 - Breakroom
 - Gym and lockers
- Procurement changes in fleet – longer contract terms
- Pro-equity projects (ESJ)
- How to speed up design process:
 - Delivery Board
 - Early stakeholder input
 - Standardization and criteria
 - Green Building (LEED Platinum)

Other Ideas

- Where is equipment? How to access equipment? (includes lifts, fall protection, and lighting)
- Number of bus types affects bases: technology changes fast
- Need owner for bus design and criteria
- Trolley buses run off wire at bases (reduce infrastructure)
- Trolley buses – Replace with electric
- Baseline project
- Change expectations, don't change scope as project moves forward
- Need decisions that hold (to move the project forward)
- Definitive direction in a clear and timely manner
- Self-driving buses; hostling and automated
- Nonrevenue fleet could go to a different place
- Lease to NRV?
- Fleet administration – Use for NRV, too
- Maintenance Base work will happen at night with midday service; larger bases?

Group Work: B.U.S (Bring Us Space!)

Top Voted Ideas

- Managing fleet complexity:
 - Understanding the present state
 - Developing a standardization goal
- Fleet standardization (in progress)
- Clarity of goals (precision) from management with prioritization
- Communications (both internal and external)
- Evolving ZEB technologies, including:
 - Charging and hostling plan (intelligent)
 - Financial means
- Infrastructure (ZEB) (utilities)
- Proactively engaging with consultants and construction firms
- Immediately Hire project managers and project staff at Metro (experienced)

Other Ideas

- Recommendations
- Workforce development and expansion
- Integration of Operations, Vehicle Maintenance, Fleet Capital, Training
- Outreach to construction and consultant community
- Engage consultants more broadly, effectively
- Input of information from end-users
- Labor agreements and inputs
- Commercial complex financing
- Optimize use of existing Vehicle Maintenance's operations facilities (process improved)

Group Work: Team Clint

Top Voted Ideas

- Access to our facilities:
 - Add transit services to bases
 - Maximize during peak
 - Provide employee shuttles
- Partnerships:
 - Joint operating bases – sound transit, community transit, and Seattle Department of Transportation (SDOT)
- Link service with capacity (major impact by midday off-peak)
- Electric fleet and NRV
- Track what goes into capacity: Metrics
- Optimize Central Base Body works

Other Ideas

- Actual base operations
- Vanpool? Home charging?
- NRV – 650 vehicles, charging infrastructure prior to fleet procurement and maintenance of chargers
- Bus and NRV – battery life-cycle plan, to include deploy, rebuild, deploy, disperse, or reduce?
- Distribute employees among Ryerson, Central, and Atlantic Bases
- Keep lead at CB to coordinate
- NRV theory to work CSC
- Add two vehicle maintenance bays at CB
- Need CSC capacity to support by shifting new bus preparation to leased space

Base Tour Observations and Recommendations

The following list summarizes the March 13, 2018, Metro campus tour observations as identified by the SMEs and is subject to further discussion with Metro staff.

1. Clear Program Objectives – Continue to refine the agency’s objectives (for all aspects of O&M). This includes operational capacity, fleet mix, and standardization between campuses (if appropriate).
2. Prioritization – Consider prioritization of some early program needs (refer to comments and immediate actions in the following sections).
3. Zero Emission Goals – Consider careful and realistic evaluation of the zero emissions goals and timeline for fleet. Consider infrastructure needs for buses, vanpool, and NRV.
4. Consider Fleet Standardization – All of Metro’s operations would benefit from a reduced fleet mix— 15(or so) different buses create a burden on all facets of Metro’s operations.
5. Double-decker Buses – Discussed possible contracting out of maintenance options for double-decker bus service (it was later determined that contracting these services would likely violate the CBA).
6. Asset Management Program – Suggest implementing a more robust asset management program; includes inventory tagging.
**** Early Action Item ****
7. State of good repair – While Metro facilities staff are doing a good job with the facilities, the facilities are near or beyond their service life, have been heavily repurposed, and have lost many of their operational efficiencies.
8. Facility Design Standards and Metrics – Metro would benefit from having robust design standards. If not immediately available, Metro could consider developing preliminary standards as part of the design and programming validation process for one of the first base projects.
**** Early Action Item *** (If not already in progress)*
9. Facility Master Plan - (in progress).
**** Early Action Item *** (in progress)*
10. Bone Yard, Skid Pad – Suggest evaluating other options for the bone yards (shelter and bus) and the training and skid pad. These elements occupy prime real estate at the existing facilities and could help alleviate some of the immediate bus storage needs.
**** Early Action Item *** (in progress)*
11. Operations Training was very insistent that the skid pad remain available at the current facility.
12. BIM Modeling – Suggest developing a building information modeling (BIM) policy; consider evaluating what elements add value and what may have diminishing value. Build over time.
13. Future-proofing – Suggest developing a future-proofing policy; consider evaluating what elements add value and what may have diminishing value.
14. Contract Delivery – Should follow a delivery selection protocol as opposed to presuming a specific delivery method (consider different delivery methods such as DBB, CMGC, PPP).
**** Early Action Item ****
15. Ground Fueling – Consider reevaluating the under- and aboveground storage practices; especially in light of the zero emissions goals. Mobile fueling can be cost-prohibitive in the long term.
16. Parts Management – Parts not being available was found to have significant impacts at all facilities and most operations. Consider electronic catalogue availability (propensity of suppliers to not update hard copies). Reconsider spare parts and parts inventory philosophies (test and validate prior to building new facilities if possible).
17. Employee Transportation – Employee access and parking were identified for further review at all facilities. Consider transportation demand management and commute trip reduction strategies.
18. Master Program Schedule - Continue to refine the program master schedule contemporaneously.
19. Technology Policy - Confirm Metro and consultant staff are all familiar with the technology policy.

Base Tour – Initial Summary of Facilities and Operations

The following is a draft summary of base observations made by the SMEs during a tour of many of Metro's campuses and is not an exhaustive or comprehensive review of facilities.

NORTH BASE – Built 1991, 206 Buses (40- and 60-foot)

The North Base is the only base with covered parking. The base is recessed into the landscape, with retaining walls and nonrevenue parking over bus parking, with adjacent staff parking at grade. North Base handles 40- and 60foot articulated buses. Operations is above bus storage and spans between bus-enclosed parking and the vehicle maintenance building over exterior bus parking and circulation. The site is very compact, and there is no obvious expansion capability.

The following observations were made.

- Site at capacity
- Clean and well maintained
- Vintage in-ground lift equipment (needs upgrade); some portable lifts
- Use of post and chain to protect pits
- Two fuel, wash, cleaning, and fair retrieval bays
- Interior bus parking with ventilation issues
- Chassis wash bay with adequate lift
- Buildings appear sound and fair condition
- Concrete site pavement in fair to poor condition
- Discussion regarding access fixed mezzanine vs. safety harness and stairs
- Direct on and off ramp from highway
- Roof access by mobile ladders and fall protection
- Updated lighting in some areas (light-emitting diode [LED])
- Use of job cranes less practical in tight bays
- Body shop, bay, and paint booth
- Parts storage limited size
- Low headroom, with 8-foot-high ceilings
- Significant number of drawer units in parts room
- Old workbenches (steel, wood, mismatch)
- Bay size adequate
- Some discussion about the difficulty in modifying for electrical buses (storage and maintenance)

BELLEVUE BASE: Built 1983, 140 Buses (40-foot only)

This base is considerably smaller and has some new all electric buses, though several not out on routes during midday. Handles 40-foot buses only. Triangular site makes site less efficient for bus storage and circulation. All atgrade, reasonably flat site. This site is adjacent to the East Base that contains all articulated buses.

Other observations include:

- Site at capacity
- Clean and well maintained
- Portable lifts used in ground abandoned
- Very narrow bays; too tight for work being done
- Two fuel, wash, and cleaning separate structures
- Current electric buses operate from this site
- Chassis wash bay with adequate lift
- Buildings appear in fair condition
- Staff do not like parallelogram lift in chassis wash (drive-through)
- Chassis wash is coupled with automatic wash bay
- No dedicated body repair bay
- Small parts room inadequate; on second floor, so difficult to get to and low head room
- Charging station for electrical buses is out of commission
- Limited yard storage area
- Limited body repair
- The wire partition storage between bus bays is in the way
- Low height of infrared heating system causes issues
- Exterior bus shelter used for maintenance equipment storage
- Fuel and interior clean bay is not enclosed
- Limited number of repair bays for fleet size (4 currently, should have 6). Inspection bays are also used as repair bays to account for minimal repair bays.

SOUTH BASE: Built 1979, 279 Buses

General observations include:

- Site at **capacity but room** for expansion as configured
- Employee parking limited
- Expansion available south of the site in recently purchased property, which could be used for additional employee and bus parking
- This is adjacent to the CSC where parts are rebuilt and major body work occurs for all bases
- Modern storage system could save base space and space within CSC
- Due to CSC, parts are less of an issue on this site
- Adequately sized bays
- Vintage-type in-ground lifts
- CSC rebuilds all parts for the fleet at all bases; size and operation of CSC is larger than normal due to the diversity of vehicles in the fleet
- Building in fair condition
- Room west across the Marginal Way that could be used for another base; this would require relocating facility storage and bus stop pavilion construction shops
- No battery buses or trolley buses



CENTRAL BASE: Built 1990, 187 Buses (40- and 60-foot)

- Site overcapacity, shares with Atlantic Base
- Clean and well maintained
- Fueling, wash, and fare retrievals in separate building
- Bus parking and maintenance area adjacent to bus parking
- Hosteler building trailer
- Use of both vintage inground and portable lifts; some lifts removed from bays
- Small parts room inadequate; on second floor, so difficult to get to, and low head room
- Existing nonrevenue vehicle maintenance could be relocated to provide more space for Central Base, Atlantic Base, or both
- Employee parking across the street; some employee parking has been relegated to the City for Stadium Parking
- Appears chassis wash in newer structure and works better than some of the other bases
- Shares operation building with Atlantic Base

ATLANTIC BASE: Built 1941, 478 Buses (40- and 60-foot)

- Site near capacity; shares space with Central Base
- Clean and well maintained
- Shares operation building with Central Base
- Maintenance Shop remote from parking
- Electric trolley buses located and maintained here
- Existing nonrevenue vehicle maintenance could be relocated to provide more space for Central Base, Atlantic Base, or both
- Separate covered but open interior cleaning bay; very cold place to work and remote from maintenance building
- Pavement in very poor condition and scheduled for replacement



King County

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Facilities Master Planning Program: Operational Capacity Growth Report

March 2019

Appendix D: Delivery Methods Review

SECTION 1:

Introduction

This report provides an industry review of project delivery methods for King County Metro Transit (Metro) to consider in delivering their Strategic Operational Capacity Expansion Program. The methods evaluated are for delivering capital projects. This effort did not include a detailed analysis of Metro's current project delivery practices or attempt to evaluate specific known projects using a delivery method approach framework. The characteristics, advantages, and disadvantages presented in this document were developed based on the consultant's experience with the delivery methods and industry-developed materials. This evaluation was conducted to determine the long-term sustainability and potential efficiency of the various contracting methods specific to Metro.

The delivery methods considered in this report include the following:

- Design-Bid Build (DBB)
- Design-Build (DB), including Progressive DBB
- Construction Management / General Contractor (GC/CM)
- Public-Private Partnership (P3)

This review resulted in several recommendations from the development of this alternative project delivery review. Metro currently employs various delivery methods, such as DBB and GC/CM. All delivery methods are viable ways to complete projects. However, project goals must be carefully considered when evaluating the appropriate delivery method. Metro is interested in evaluating alternative delivery methods. A detailed review of Metro operations, including procurement, contracting, and staff, should be completed to understand the steps needed to align the organization to be able to use a new method. This includes developing a framework to evaluate each project to help determine favorable delivery methods. Metro is interested in ways to deliver projects faster. For example, a new bus base on an expedited schedule. Although methods other than what Metro employ today could be faster, there is a learning curve for a new delivery method that might not be appropriate for the near-term bus base.

SECTION 2:

Project Owner Evaluations and Considerations

All project delivery approaches can be viable methods for delivering projects. In the Puget Sound Region, there are industry professionals with extensive experience with different delivery methods, but there are some important internal (Metro) and external (legislative, local/national experience, and market environment) considerations that need to be understood to help inform the decision process. The following are important considerations Metro, as the project owner, should consider.

What is the final product being delivered and what are the goals around delivering that product?

For example, bus facilities across the country do not look the same. Agencies have different specifications, site conditions, vehicle types, and many other factors that make transit buildings unique. Highly customized facilities typically require extensive time spent on developing specifications to ensure that the owner is getting what they desire. Other project factors to consider are whether the project is a retrofit or new construction, whether the owner/agency is prescriptive or nonprescriptive, and whether the project would be integrated into existing systems, such as computer, inventory, and operations. Also, agencies should evaluate their objectives in project delivery such as lowest cost and reduced schedule.

Are there specific state requirements that affect project delivery?

Washington State does not preclude the delivery methods summarized in this report, such as characteristics, advantages, and considerations.

What is the technical competence and experience of in-house staff in addressing the type of technology being delivered with the project? Is there enough qualified staff to support the anticipated projects?

Metro should develop a plan for providing the level of support needed for the duration of the project and potentially what aspect may require additional development time. This could be accomplished through a mixture of qualified in-house staff and consulting support. It may require additional training for in-house staff. Even in cases where consultants are brought in, there is still project management support needed from staff.

What is the agency's experience with various delivery methods?

If an agency has typically relied on a traditional delivery method such as design-bid-build (DBB), they should consider whether they are positioned to apply alternative delivery methods. Metro's current delivery methods include DBB, GC/CM, and job order contracting. Metro should consider how willing and rapidly its agency would accept potentially different ways of doing business, such as contracting, procurement, and legal. Agencies should also consider their staff composition and any experience the agency and staff have with various delivery types.

The opportunities and effects of design changes are different with different delivery method, and there may be different impacts to the schedule and the cost. Agencies should consider their ability to make design decisions quickly for unforeseen conditions, and to communicate expectations early in the process and to commit to them.

What are the risk tolerances and financial contingency philosophies of the agency?

Agencies should consider their philosophy of paying more for price certainty (furthering the design process before going out for bid) or willingness to assume greater potential risk with the intent of saving money. This includes asking where risks reside. As the agency seeks approval for funding, they should consider how the approval reviewers evaluate appropriate contingencies for risk and their willingness to set appropriate levels.



What is the state of the contracting community?

Agencies should consider the experience of the contracting community with delivering the type of work. The purpose is to maintain competitiveness in the market and evaluate whether companies are interested, qualified, and available to respond to the request for proposal.

What is the availability, sources, and timing of funding?

Agencies should evaluate whether there are any restrictions on how money can be used to deliver projects and whether there are sufficient public funds to deliver the project. Agencies should evaluate whether there is opportunity for creative funding solutions, such as P3, to bring private equity. For example, would the project be attractive to private investment, including evaluating whether enough public funds are available for the project. This includes the internal willingness or contractual limitations to develop and explore creative funding through P3, which could bring private equity, and evaluating if the project is attractive for investment. Also, funding sources may be easier to use for some methods than others; current Federal Transit Administration (FTA) policy and procedures are generally orientated to DBB projects. There is some legislative support other methods such as DB and less for P3.

SECTION 3.

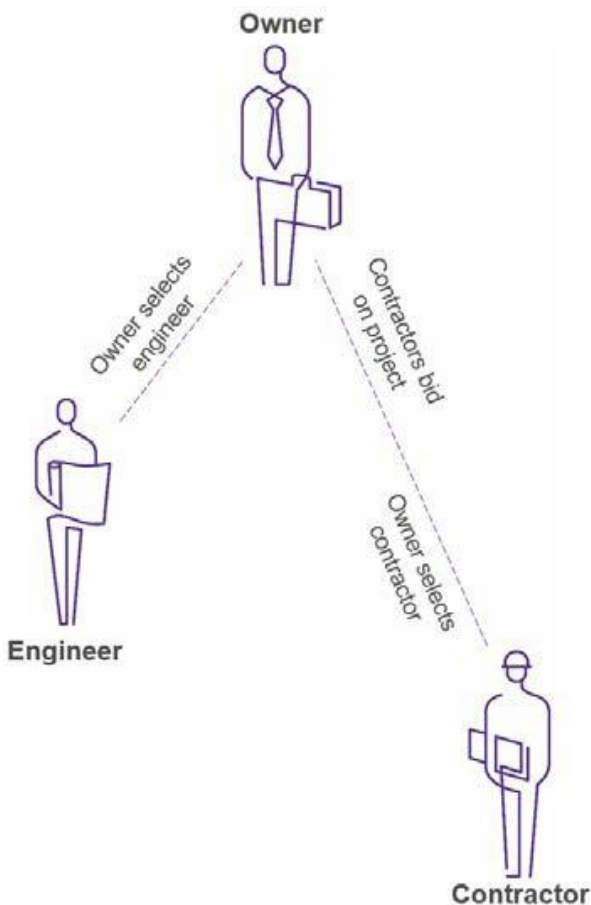
Delivery Method Alternatives

The following section summarizes the alternative delivery methods evaluated, which include:

- Design-Bid Build (DBB)
- Design-Build (DB)
- Progressive DB
- Public-Private Partnership (P3)
- General Contractor / Construction Management (GC/CM)

Design-Bid Build

Design-Bid Build (DBB) is when an owner selects and awards professional design services followed by a separate select and award process for construction services. This is the most “traditional” project delivery option in the United States and usually leads to the sealed bid, fixed price contract.



DBB Characteristics:

- Clearly defined sequential process
- Complete and coordinated drawings and specifications prior to advertisement for bid
- Engineer selected by quality-based selection (QBS), contractor selected by low bid
- May select pre-qualified bidders or open bid
- Aggressive bid competition for lowest price
- Single-point accountability for construction
- Design risk resides with owner, builder risk with contractor

DBB Advantages:

- Works well when owner wants control over the design
- Able to manage early risks while design is being advanced
- Helps reduce risk with difficult jurisdictional approvals
- Construction price based on competitive low bid
- Single point of risk acceptance
- Single point of contact/management
- Bid based on completed documents developed with owner, stakeholder, and public input
- Minimal owner time required for request for quote (RFQ) or request for proposal (RFP) development
- Standard specifications can be used

DBB Disadvantages:

- Dependent upon completed and coordinated documents
- Subcontractors' scopes overlap and open to interpretation
- Contractor fee and margins unknown
- Change orders are likely to occur and potential for claims increase
- Potential for adversarial relationships within project team
- Sequential process (procurement – design – construction) longest to complete
- Highest likelihood of claims, change orders, and schedule growth prior to bid
- Limits independent groups of people coming up with an efficient solution; no benefit of the contractor describing their efficiency in ways to build (i.e., lessons learned from contractors) and different ways based on their equipment

Design-Build

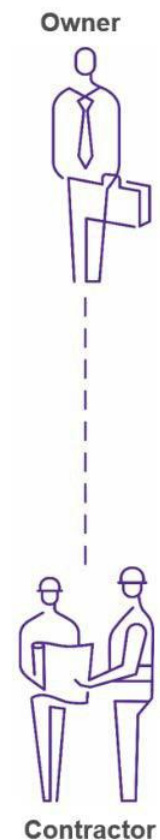
DB is when one entity or joint venture forges a single contract with an owner to provide both design services and construction services. The owner will typically take the design to 10 to 30 percent to define the project with enough detail.

DB Characteristics:

- Contractor and designer selected by best value (qualifications and price)
- Single-point accountability for design and construction
- Conducive to accelerated schedule
- Typically lower number of change orders
- Cost guarantee at bid opening
- Limited owner, stakeholder, and public involvement or influence during delivery
- Program or preliminary design produced by owner
- Contractor owns both design and builders risk

DB Advantages:

- Accelerates schedule – concurrent design and construction, fixed at bid
- Fixed price for predetermined scope at time of bid– interpreted by DB entity
- DB entity participates in pre-planning design phase
- Single point of responsibility avoids re-design time lost
- Simpler contract because dealing with one entity
- Can be faster end-to-end schedule because design and construction can overlap
- Best value-selection method will inherently foster good collaboration and innovation with designers and contractors
- Can shift risk to the contractor
- Fewer change orders
- Fewer owner resourced during oversight



DB Disadvantages

- Architect/Engineer (A/E) potentially conflicted and GC single-point of contact
- Higher owner contingencies needed
- Owner may not be able to control decision process
- Expectations and scope may not be fully met
- Delivery based on performance specifications or method specifications
- Adversarial relations may develop among project team
- Extensive owner time and expertise required during procurement
- May break out specialized design work
- Not necessarily the cheapest delivery method because of risk; owner will need to be very careful how to define who holds what risk (i.e., right of way, utilities, permits, geotechnical investigations, etc.)
- Save some soft costs on time and not necessarily go to 100 percent; not completely designed so may not have as-built sets
- Change orders are typically very expensive
- Delay in decisions for changes are magnified in terms of cost
- Functional coordination can suffer (i.e., optimizing internal layout)
- Need solid performance specifications (first set can take time, lots of lessons learned off first set)
- Delivery is complicated when matching new to existing (system compatibility; equipment, chargers, etc.)

For more confidence, a progressive DB, the DB goes to 60 percent and then bids for price (set a guaranteed price). A Progressive DB operates more like a GC/CM where the owner continues to have input and control of the design further into the design process. Theoretically, this leads to the lowest cost project.

Progressive Design Build

Progressive DB combines aspects of DB and GC/CM. The owner selects a DB team (contractor and engineer) through a QBS process. The contractor provides design phase assistance in evaluating costs, schedule, and implications of systems and materials. After owner buy-off on the solution during the validation phase (including approximately 60 percent complete design), contractor submits a guaranteed maximum price (GMP). The contractor assumes design risk.

Progressive DB Characteristics:

- Contractor-designer team selected by QBS, contractor margins on pre-construction services part of the selection requirements
- Design and construction schedules concurrent but offset
- Pre-construction services: cost estimating, value engineering (VE), quality assurance (QA), etc.
- Guaranteed maximum price (GMP): established at the end of the validation phase
- Scope can be competitively bid at subcontract level
- Contractor assumes design risk, construction risk is shared between owner and contractor
- Owner, stakeholder, and public involvement or influence during delivery

Progressive DB Advantages:

- Selection based on qualifications
- Simpler contract with one entity
- Contractor assumes design risk
- Contractor, owner, stakeholder, and public input during design (prior to GMP) provides constructability and VE support
- Does not require significant owner time during procurement
- Ability to assess where construction risks are best allocated - to owner or to contractor
- Owner maintains control of design process
- Negotiated GMP
- Can provide strong cooperation between design team and owner
- Possible competition at subcontractor level

Progressive DB Disadvantages:

- Delivery timeframe longer than DB
- Less competitive bidding environment because GMP is negotiated GC/CM pre-qualifies subcontractors
- GC/CM controls contingency not owner

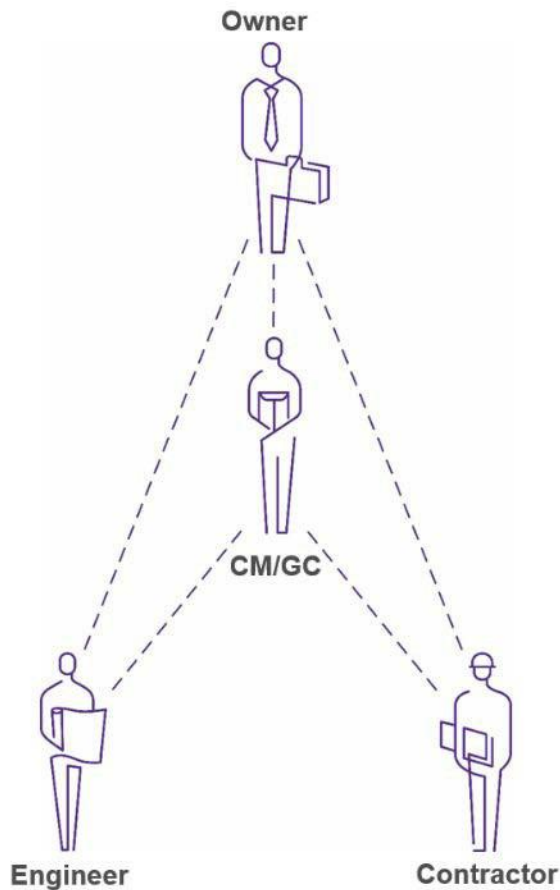
Public-Private Partnership

A P3 generically refers to aspects of design, build, operate, maintain, and finance. This is a delivery method that seeks outside equity where the owner could gain access to more funds initially. It could also provide the owner the opportunity to shift work elements to an outside contractor such as operation and maintenance (O&M) activities. Considerations for a P3 could include:

- Initial procurement could take longer than other methods (complex and expensive) depending on if you do not include some of the design, build, operate, maintain, or finance (usually add finance or O&M)
- Money typically has a higher interest rate compared to municipal bonds
- Need to verify whether O&M provided through P3 contract is more cost-efficient

General Contractor / Construction Manager

GC/CM is when the owner selects a construction manager to act as the general contractor with schedule and cost risk. The GC/CM provides design phase assistance in evaluating costs, schedule, and implications of systems and materials.



GC/CM Characteristics:

- Designer selected by QBS, contractor selected by QBS and margins on pre-construction services
- Design and construction schedules concurrent but offset
- Pre-construction services: cost estimating, VE, QA, etc.
- GMP: established during design development or after completion of construction documents
- Single-point construction accountability
- Scope competitively bid at subcontract level
- Self-perform some of work is option for GC/CM
- Risk is shared between owner and contractor

GC/CM Advantages:

- Selection based on qualifications
- Price competition at subcontractor level
- Contractor, owner, stakeholder, and public input during design (prior to GMP) provides constructability and VE support
- Delivery timeframe shorter than DBB and longer than DB
- Requires significant owner time during procurement
- Ability to assess where risks are best allocated - to owner or contractor
- Owner maintains control of delivery process
- Standard specifications can be used
- Get negotiated GMP. MACS and MINIMACS
- Can provide strong cooperation between design team and owner

GC/CM Disadvantages:

- Less competitive environment because guaranteed GMP is negotiated GC/CM pre-qualifies subcontractors (not always)
- Owner retains responsibility for design errors
- GC/CM controls contingency not owner
- GMP is negotiated before design complete requiring contingency
- No assurance of lowest possible price received
- Could have prolonged negotiations (if contractor does not give good price) may need to bid out
- From the beginning, need a very strong, experienced delivery lead
- Need contracting community that is going to be engaged and give competitive bid pricing
- Need to an effective way to deal with non-performance (takes more time or more expensive under this method). For example, incentives to deliver on-time, but not being met and no penalty
- GC supposed to control subconsultant: need to ensure GC is reviewing materials (may add time)

Delivery Method Comparison Summary

Table 1 summarizes the various delivery methods compared to key consideration. Green indicates the delivery method has more favorable conditions or advantages compared to other methods, yellow indicates mid-field impacts, and red indicates worse conditions.

Table 1. Delivery Method Comparison Summary

	DBB	CM/GC	DB
Schedule – Procurement	Green	Yellow	Red
Schedule – Design and Const.	Red	Yellow	Green
Opportunity for Schedule Growth	Red	Yellow	Green
Early Cost Precision	Red	Yellow	Green
Cost Control	See Next Slide		
Life Cycle Costs	Yellow	Green	Red
Risk Allocation	Yellow	Green	Green/Red
Qualified Contractor/Designer	Red	Green	Yellow
Owner/Stakeholder Involvement/Control	Green	Yellow	Red
Quality/Maintenance	Green	Green	Red

SECTION 4:

Recommendations


There are many ways to deliver complex and original projects for transit facilities, particularly bus maintenance and operations facilities or bases. This includes the standard DBB, DB, Progressive DB, P3, and other contracting arrangements that allow participation of the GC to be involved in design such as GC/CM. Each of these typically take approximately the same amount of time to complete from start to finish when agencies are equipped to deliver under each method. The primary difference is the level of control and the number and complexity of design and building contracts.

DBB provides the most control to the owning agency. DB can be the easiest to contract but has the least control on design, which is dependent on level of detail of preliminary “bridging documents” (produced by third-party) that define the project to allow contractor and their design team to hard bid the construction project. GC/CM is a method to team with the contractor and a separate design team. GC/CM provides project cost controls, and VE of the project throughout the design.

Increasing project schedule is not dependent on type of delivery system. Project time is more a function of avoiding the following difficulties in project development and construction:

- Not generating a detailed space needs program for the building and site
- Inadequate site selection or site confirmation
- A concept design that does not provide for future needs on selected site(s)
- Inadequate coordination with local utility and other local agencies with jurisdiction
- Poorly detailed 30 percent bridging documents if DB
- Changing design or changing major components at the end of design (i.e., second guessing design decisions made earlier)
- Inaccurate cost estimating and VE during design
- Not monitoring construction without adequate extended design services and construction management

Speeding up project delivery is best done after space programming, concept design, and site selection. It usually involves starting construction work before design completion. This can be done in any of the project contract forms: DB, DBB, or GC/CM. Typically for new construction, some site work can be started before design completion, such as, over-lot grading, utilities, and foundations. Procurement of some building components can be started early, such as structural steel, prefabricated building systems, and equipment. Some design elements that can be finished during building design include, signage, furniture, and all equipment not built-in or hard-wired to utilities. This approach requires multiple bidding packages be generated for early construction packages which will increase design and management costs, but potentially speed up project delivery. These construction efforts can be targeted for specific subcontractors and in some cases separate contracts like hazardous material remediation can also be completed.



For a new bus maintenance and operations facility or base it is suggested that the project be broken down into the following early design steps that may be contracted with the same or different firms within or outside the final base construction document design:

1. Space program for buildings, yard, and preliminary costs independent of the specific site. This should be a completed document in report format. Program should provide phasing for current and future needs (20 years into future) and match to a budget for each phase.
2. Site selection looking for new site matching program established in Item 1 above.
3. Concept design preliminary site and building plans (simple one-line diagrams) test fitting the operations on to proposed site. Coming up with optimum location for entrances, buildings, parking, circulation, and access to each. Evaluating utilities, project phasing, and updating costs are also components.
4. Implement some early work projects including: conceptual layout to get some of the simpler work (using same design team); site preparation; hiring a demolition contractor if existing buildings on site, acquiring access permits, utility coordination, remediation, over lot grading (rough), any advanced procurement for phases, and develop agency base specifications to shorten concept plan / preliminary design phase.
5. Start of formal design with typical phases and early bid packages depending on delivery type.





King County

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Facilities Master Planning Program: Operational Capacity Growth Report

March 2019

Appendix E: Metro Operational Capacity Growth Strategy Cost Estimate and Project Schedule Analysis

SECTION 1:

About this Report

This report summarizes the project cost estimates and schedules to support King County Metro Transit's Operational Capacity Growth Strategy identified in the Facility Master Plan Report (FMPR). Metro's long-range vision, METRO CONNECTS and related efforts, combined with the work conducted as part of this FMPR, informed the development of the overall strategy, which involved three primary steps:

1. Determine operational capacity needs by geography and timing
2. Identify opportunities to expand bus base capacity
3. Identify specific projects and implementation schedule

Project Review Process

To inform the strategy, Metro engaged a number of parties to provide input into the process and undertook the following steps:

- Brought together subject matter experts (SMEs) in base construction and operations
- Conducted peer interviews with four transit agencies
- Developed a baseline inventory of existing facilities
- Reviewed options for project delivery methods
- Pursued independent cost estimates for prospective investments
- Developed schedules for the overall program to meet the expected expansion

Development of these project schedules and cost estimates included subject matter experts (SMEs) with broad expertise in areas such as:

- Base Operations and Design
- Base Electrification
- Program Delivery
- Program Implementation
- Service Delivery
- Long-Range Planning
- Building Design
- Fleet Composition

These experts worked with Metro employees from across the agency, gathering to brainstorm ideas and visiting existing operation and maintenance (O&M) bases that service Metro's fleet, including:

- North Base
- Bellevue Base
- South Base
- Central Base
- Atlantic Base

SECTION 2:

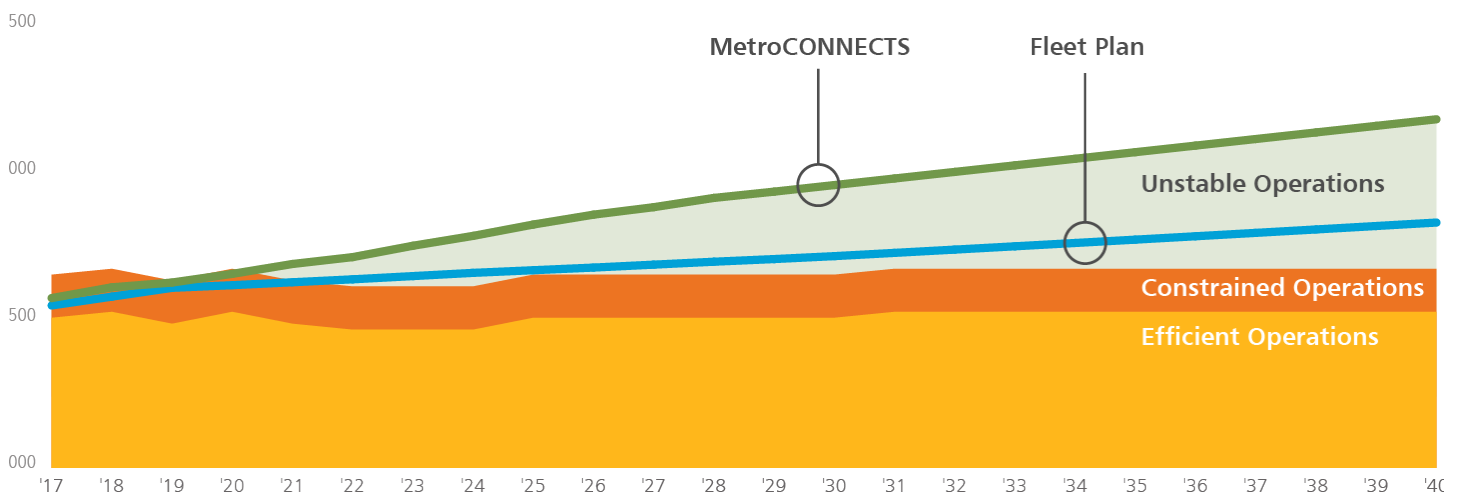
Project Target Dates

Development of these schedules and cost estimates were based on Metro's ability to deliver project improvements in the following timeline to meet projected increase of capacity needs. The date for the operational capacity growth needs were calculated by Metro comparing available base capacity and anticipated fleet growth. The target dates for opening facilities are as follows:

- South Annex Base (250 bus base): Target opening date of 2025
- South Interim Base (120 bus base): Target opening date of 2020
- Central Campus improvements: Target opening date of 2024 through 2026, depending on land acquisition and impacts of adjacent projects such as implementation of Sound Transit's ST3.

Target dates were set by the base capacity analysis to maintain operations that are not considered unstable as illustrated in Figure 1. They were developed by analyzing base capacity at existing bases and analyzing the future 2025 and 2040 bus systems to understand where demand for new bus O&M would be needed and when.

Figure E-1. Fleet Projection vs Existing Base Capacity



SECTION 3

Cost Estimates

Individual cost estimates were prepared based on minimal project definition. The cost estimates are Class 5 estimates per the Association for the Advancement of Cost Engineering International (AACE) estimate classification system. Class 5 estimates have a large level of inaccuracy corresponding to the project definition level and estimating methods used. An appropriate contingency is added consistent with industry practices and AACE guidelines to account for this.

Cost estimates prepared for the Operational Capacity Growth Strategy were developed from planning concepts with little to no design for site-specific conditions. These are often referred to as Rough Order of Magnitude costs. As these projects progress in development, updates to the cost estimates are recommended for programming costs; planning concept level projects typically carry higher contingency values than projects that have further progressed design. These projects lack design detail to cover specific quantity and materials, and less is known about site conditions. As design progresses, contingency values are typically reduced and cost estimates change from a general square foot cost, or placeholder costs. Attachment A provides the cost estimate project work sheets.

Cost Estimate Development

Vehicle O&M facilities are unique, one-of-a-kind projects, even between bases for the same transit agency. Facilities have similarities in operations, types of spaces, and equipment. However, bus base design varies in several ways, including:

- Building sites
- Fleet profile
- Operating conditions (described as efficient, constrained, unstable; or some agencies use level of service)
- Maintenance
- Site access
- Utility requirements
- Phasing
- Delivery method used to construct
- Bidding climates

Using a direct comparison of total construction costs from other bus bases can be deceiving because of factors effecting size, schedule, and cost, such as when the facility was constructed; funding sources; and cost estimate assumptions for construction, financing, engineering, and other soft costs. Project cost estimates for this Operational Capacity Growth Strategy were developed from the team's experience on transit maintenance facilities; assumed site locations; past King County Projects; and an understanding of Metro operations, procurement, and program cost assumptions. Elements of the cost estimate development included the following:

- Design-Bid-Build (DBB) procurement methods are assumed in all the cost and schedule estimates.
- Building costs were calculated using price per square foot values for building areas, such as maintenance bays, equipment, shops, warehouse, offices, and driver facilities. These values were multiplied by the corresponding quantity.
- Site costs were based on assumed demolition, grading, and available utilities for each project.

- Site amenities, such as fueling, wash, percent of landscaping, security, and pavement, were developed using price per unit or square foot costs. Unit costs were priced using:
 - Established national databases
 - Factors for specific locations
 - The team’s experience with bids and estimates from similar construction, building types, and amenities
 - The team’s experience specific to Metro
- Project soft costs are costs incurred by agencies outside the estimated construction costs. Soft costs can include costs for:
 - Planning and design
 - Special inspections
 - Project financing
 - Permits
 - Agency staff time
 - Moving expenses
 - Client paid or purchased equipment
 - Furniture and finishes
 - Other elements not included in the construction costs

The soft costs are not an exhaustive list and may require further comparison with King County budgeting policies.

Values Used in Cost Estimate Development

The rough order of magnitude costs for the Operational Capacity Growth Strategy projects include the following:

- Design Contingency was set at 40 percent. These contingencies allow for changes in projects assumption common as the design develops and contract documents are finalized. These changes can include project, such as the site program, layout, and material modifications. This is a recommendation based on the level of project definition.
- Design and Engineering fees were set at 25 percent.
- Owner construction contingency for unforeseen changes to the bid after award, change orders, or substitutions was set at 10 percent.
- Escalation cost assumption was 4 percent per year to the midpoint of construction. Although escalation rates are unknown, over long time periods, escalation costs have historically increased on average each year. The escalation amount is a recommendation only, and King County should apply their own escalation rate.
- An allowance was set for office areas furniture, equipment, and furnishings, such as:
 - Desks
 - Chairs
 - Tables
 - Modular furniture
 - Computers
 - Data wiring
 - Audio visual
 - Communication

This allowance was based on a percent of construction costs and established using a percentage of similar projects costs.

- Shop equipment costs were added to the square footage costs for maintenance areas. These costs were set as fixed equipment, items built into structures, and equipment needs for a maintenance facility. Vehicle wash and fueling are also included in these costs.
- Values were localized to King County prices. The unit costs are consistent with pricing reflected in recent contractor bids in Seattle, which adds a check to the reasonableness of the estimated costs. This is a key factor. as the Seattle construction market is busy, and prices are currently higher than in other parts of the United States (U.S.). This may not remain the case in the future and may have less impact on longer term projects.
- Utility allowances were set based on assumptions of utility needs to support the specific project. It was assumed that projects required utility improvements (gas, electrical, water, storm water, and sanitary), came from within surrounding streets or properties, and were sized to accommodate the proposed project. Electrification costs were developed separately to include assumed substation sizing based on vehicle manufacture power requirements, electrical connections, charge points or stations, and onsite charging structures.

This estimate does not include the following:

- Hazardous material removal and remediation costs.
- Cost increases due to project delays beyond the schedule shown.
- Shop equipment costs did not include costs for custom equipment.
- Bus fleet purchases.
- Some Metro internal costs, such as staff time involved during design or construction, moving expenses, project financial costs, and legal costs.
- Conditions that might drastically effect project pricing such as environmental catastrophe, significant tariffs, and long-term strikes.

Strategies for Impacting Costs and Operations

To minimize overall program costs and maintain service quality, Metro needs a multifaceted strategy for maintaining daily operations, while providing strategic expansion to accommodate fleet growth. Metro has already identified measures to reduce the cost of expansion. For example, Metro took early action to identify, evaluate, and acquire land that capitalized on appropriately zoned sites. Metro is also optimizing existing sites to maximize bus storage and improve efficiency in site circulation, fueling, wash, and maintenance. Metro's policy is to provide Leadership in Energy and Environmental Design (LEED) Platinum facilities. However, some facilities that Metro is considering are interim and may be excluded from certain King County and Metro policies.

SECTION 4:

Estimated Project Delivery Schedules

This section describes the schedule development assumptions and analysis of anticipated schedules for South Campus, the South Interim facility, and the South Annex Base. These projects were selected for schedule analysis because they are currently critical path projects to achieving Metro's Operational Capacity Growth Strategy through 2025. Central Base has expansion presently in-progress and on schedule to support the projected Operational Capacity Growth. Additional expansion efforts at Central Base and for a new South King County Base are not anticipated to be on the critical path at this time.

These schedules were developed to understand the impact of procurement and project timing assumptions. They were used to discuss approaches and develop program delivery recommendations.

Schedule Development

Project scheduling is an estimate of the time required to deliver a project from beginning, through construction, and to the start of operation. The following factors were used to develop baseline schedules for the Operational Capacity Growth Strategy:

- Length and type of project delivery methods for design and construction contracts, including agency procurement timelines and experience with delivery methods. For analysis, Design-Bid-Build (DBB) was assumed. A review of delivery procurement methods is addressed in the Delivery Methods Review memorandum developed for the FMP (see Appendix D of the Facility Master Plan Report (FMPR)).
- Potential for overlapping design tasks.
- Assumed complexity of the project, including lead times for equipment and materials.
- Permit processing and approval times for areas such as environmental, site, and building permits.
- Public and agency involvement.
- Funding availability and sources, as well as local labor, skill, and bidding conditions.
- Other factors, such as weather delays and unforeseen conditions.

Other important schedule development considerations include the following:

- **Float Time:** The estimated project schedules included a small allowance for delays in project delivery. This allowance for delay is commonly referred to as "float" time. Float time was added to project schedules and shown at the end of various subprojects. However, the delay that float time accounts for could occur at any time during the project schedule or in the entire program schedule.
- **Critical Path Schedule:** The critical path in a schedule defines the project elements that require completion of a subsequent task before the next task in the schedule can advance in the most efficient manner to meet the scheduled completion date. This sequential order of key project elements typically establishes the length of the overall schedule. Generally, a project's critical path progresses through contract procurement, design, demolition, and construction. The critical path is shown by the connecting lines in Figures 1 and 2. Project tasks not on the critical path could be adjusted within the project time line, provided their timing adjustment doesn't impact the critical path.

Project Delivery Methods

The development of schedules, project costs, and considerations assumed delivery of most major capital projects using traditional methods, such as Design-Bid-Build. The delivery methods considered as options for delivering Metro's capital projects included:

- Design-Bid-Build (DBB)
- Design-Build (DB), including progressive DBB
- General Contractor and Construction Manager (GC/CM)
- Public-Private Partnership (PPP or P3)

Many of these methods have been used by King County, but not by Metro. Metro's current delivery methods include DBB, GC/CM, and Job Order Contracting. Alternative delivery methods could be viable solutions for delivering projects, but Metro would need to carefully consider the goals and objectives, as well as internal and external factors to individual projects before determining the method. For example, DB is not necessarily the fastest method for delivering bus maintenance facilities because of the highly customized needs of each facility. The Delivery Methods Review (see Appendix D of the FMPR) provides a summary of project procurement methods' characteristics, advantages, and disadvantages.

Baseline Schedules for Operational Capacity Growth Strategy

The following two schedules include projects identified to support recommended alternative for their Operational Capacity Growth Strategy. During this study, many project schedule estimates were developed to assess different assumptions for project timing and delivery.

The schedules provide a foundation for understanding two major components: build and procurement schedule timelines, and their impact on the overall critical path for program delivery and achieving project target project dates. For analysis purposes, the “build” schedule assumed permitting, planning, design, and construction activities; and procurement included the processes for developing, awarding, and funding contracts to support work activities. This timing information is also used in the development of estimated project costs.

Other than delivery methods discussed in other sections of this report, there are ways to accelerate construction schedules, and these include the following. These methods typically need to be developed during design because they are based on time-specific evaluations and detailed design evaluations.

- Require contractor to work weekends and extended hours to meet completion date. With existing bidding climate and low availability of general contractors and subcontractors, this approach will currently be difficult to apply.
- Identify construction materials and equipment with long delivery dates that will affect contractor schedules. The Owner could pre-purchase these materials in a separate procurement contract and make them available to contractors at the time needed.
- Select building systems, framing, and façade that limit special fabrication, including limiting field fabrication.

Standard DBB Build Schedule with Short Procurement Schedule

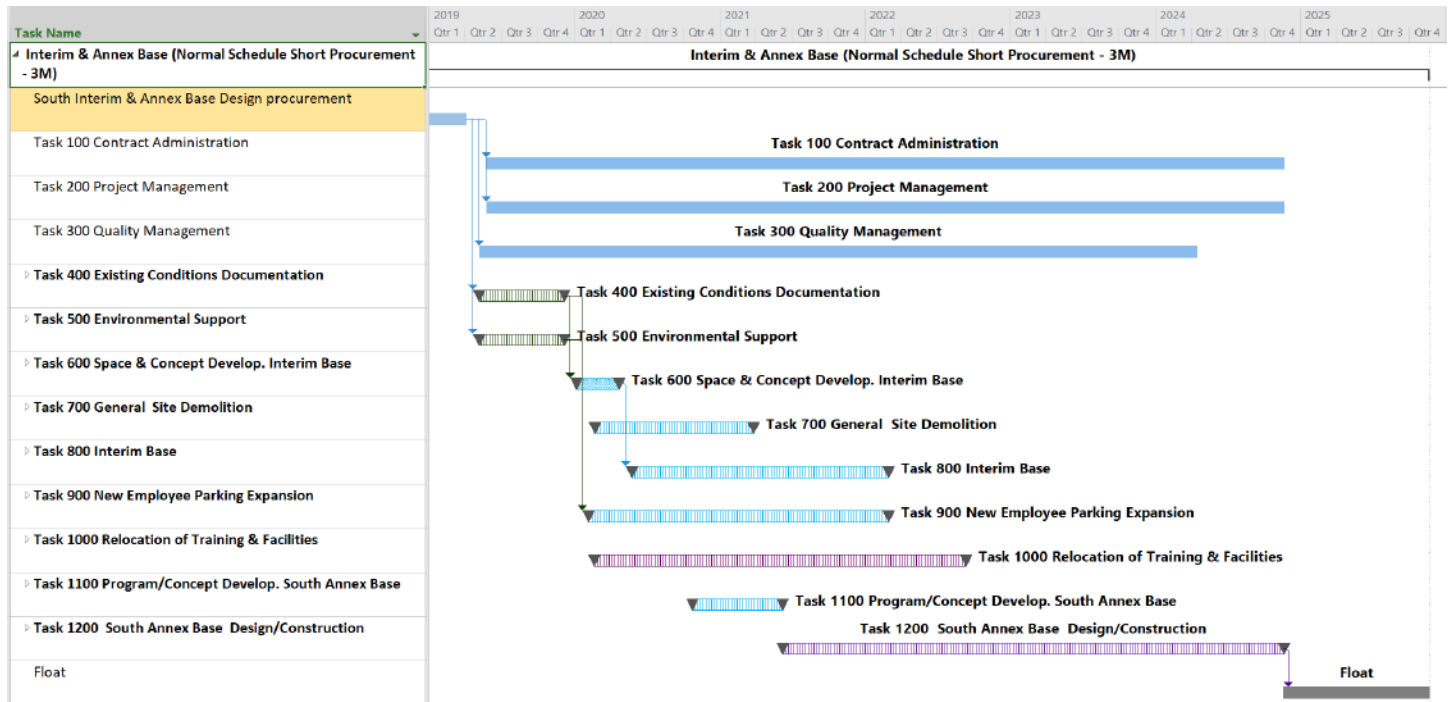
This schedule illustrates the program timeline, assuming a standard design and construction timeline for identified projects and a shorter (3-month) procurement time for construction packages (Figure E-2). This assumption results in the following dates for completion:

- Interim Base completed in early 2021
- South Annex Base completed in late 2025

Schedule Analysis Findings

- To achieve an Interim Base target of 2020, some early acceleration of design and preliminary construction packages were considered. This would introduce the risk of developing the Interim Base without a full understanding of South Campus’ overall program and work that could be related to activities occurring at South Annex Base and the future needs of the existing South Base.
- Shorten and fewer owner review periods also can help accelerate the design time but runs the risk of limited input into the final project, so this is not recommended for such a complex and integrated project.
- South Annex Base completed early in 2025. However, even small delays in procurement, design, or construction activities could result in this project missing the target opening date of 2025.

Figure E-2. Standard DBB Construction Schedule with Short (3-month) Procurement for South Campus



Standard DBB Schedule with Long Procurement Schedule

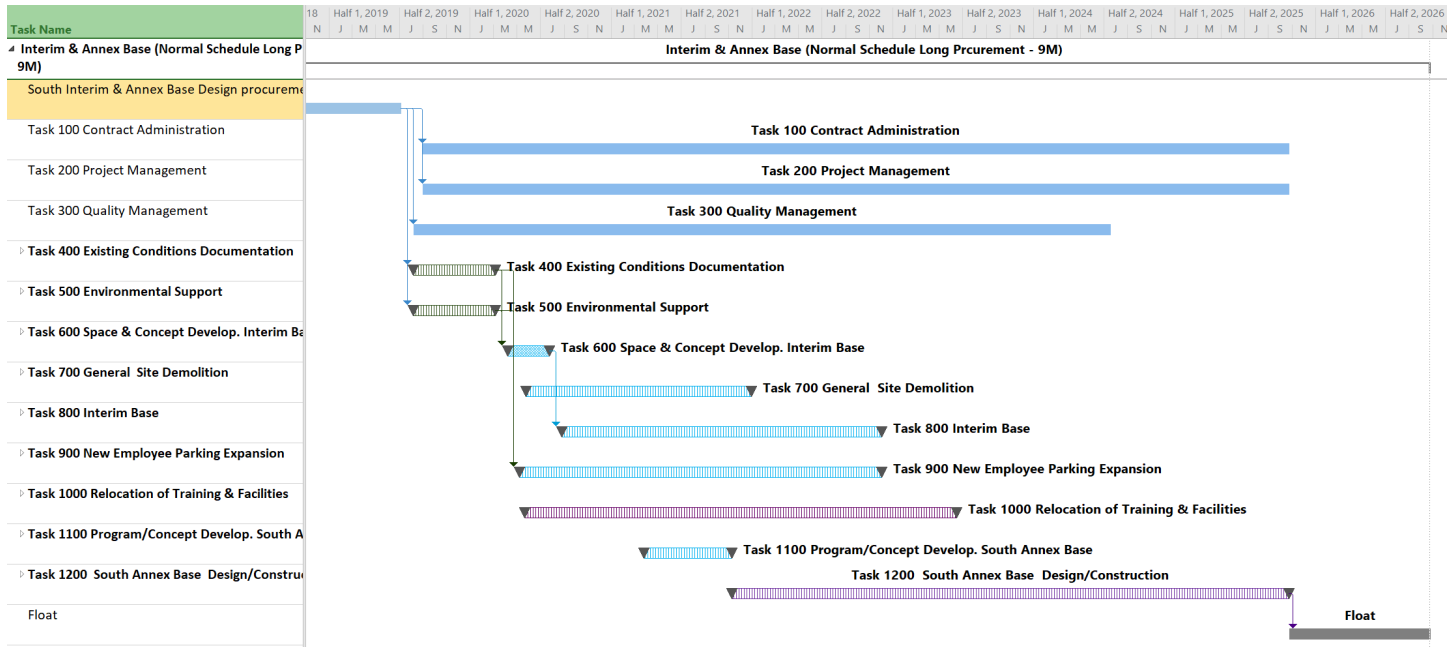
This schedule illustrates the program timeline, assuming a standard design and construction timeline for identified projects and a longer (9-month) procurement time for construction packages (Figure E-3). This assumption results in the following:

- Interim Base being completed in late 2022
- South Annex Base completed by mid-2026

Schedule Analysis Findings

- Early acceleration of Interim Base activities would not reduce schedule to target date of 2020.
- South Annex Base not completed on schedule. Early acceleration of projects would provide a schedule time reduction, but not enough to achieve the target opening date.
- Delivery methods other than DBB may reduce build time slightly but would likely add additional preparation and procurement time. The result could be a reduction of a few months in the project delivery, but there is risk that the schedule could be increased due to using a new method and the time since Metro delivered a complete base.

Figure E-3. Standard DBB Construction Schedule with Long (9-month) Procurement for South Campus



Value Engineering and Constructability

Another tool of monitoring budgets and assuring the best value solution for operations, materials, and systems is through a Value Engineering review at approximately 30 to 40 percent design. A final constructability review with construction professionals at 70 to 80 percent design will uncover potential issues, identify long lead items needing pre-purchase, allow smoother construction scheduling, and could improve sequencing that benefits Metro operations.

South Campus Delivery Findings

The findings of the schedule analysis include the following:

- A DBB process is the preferred approach for delivering the near-term projects at South Campus. It is a delivery method Metro and local contractors are familiar with. DBB will require an early and lengthy contract development process, and development of detailed bridging documents to ensure the quality of the project and that finished products meets Metro's needs. It is also recommended for assuring that bidders have enough information to submit responsible construction bids.
 - DB would not likely result in reducing the schedule length. This is because DB is a new method for Metro and would require longer procurement times and development of detailed specifications.
 - DB, because of the highly customized nature of bus bases, would not provide contractor teams with a lot of opportunity for innovation to reduce costs.
- This initial project process, coupled with the contractor's time to finish design and construction projects, will not significantly shorten the project for earlier delivery.
 - GC/CM approaches are best used to control project costs. This method could permit advancement of some minor site civil and demolition work prior to construction of the Interim Base or South Annex Base. Duration of the negotiation of contract terms and final bid, rarely shortens the project schedule.
- Attempting to shorten the overall schedule by overlapping design and construction phases increases the number of project procurement times and creates risk of additional costs or unexpected delays. Earlier design packages may require modification to fit the final design or contractor's scheduling.
- Identify long lead time equipment and materials and allow for early purchasing early to avoid construction delivery delay. This could include some steel elements, maintenance equipment, and electrical equipment, such as charging stations.
- Evaluate methods to reduce procurement times. To achieve project delivery dates, an approach that allows procurement from RFP to Notice to Proceed in as short as 3 to 4 months is desired. This can be accomplished with fixed methods of Service and Contractor selection procedures, standard services, procurement, and established and standard contracts to meet schedules.
- Evaluate methods to reduce the number of procurements, including establishing one design contract for the entire South Campus through 2025. It would be difficult to reduce the number of construction contracts because of the time between construction activities. Much of the planning, environmental, and design work could be done in succession and with one program delivery team to maintain consistency.
- Environmental review could lead to bundling of projects at South Campus, requiring a higher level of environmental analysis. This could add approximately 6 to 24 months to the schedule. Some at-risk design work could continue during the analysis.
- The development of project alternatives for the Operational Capacity Growth Strategy is still considered conceptual. Further data collection, such as survey, and design refinement for vehicle movements onsite, size of structures, utility locations, electrification assumptions, setbacks, and more are needed to tighten the schedule assumptions.



SECTION 5:

Recommendations

It is recommended that Metro consider following a standard DBB process with an accelerated procurement method to achieve the desired project completion targets (Figure E-2). Also, a single planning and design package with a prime engineering management firm overseeing a large team of subconsultant designers for specific design tasks is recommended. This approach eliminates procurement times for multiple design contracts. Because of the significant amount of capital investment, Metro would also require a significant increase in staff or additional support from the private sector. It is envisioned that the prime contractor could provide overall Engineering Management and could assist with shortening procurement activity by developing a standard common contract and developing procurement packages for long lead items.



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Appendix F:

Background Analysis
for METRO CONNECTS
Fleet Projections

Growth of Metro's System: Service and Fleet

METRO CONNECTS' 25-year vision for Metro's future assumes expanding the transit system incrementally over the years, in partnership with other transit agencies, cities, and WSDOT. When and where specific service investments will be made will be influenced by many factors, including the rate and location of new development, infrastructure investments by cities, and the buildout of Sound Transit's regional transit network. Successful operation of the METRO CONNECTS service network will rely on a network of capital investments to improve transit speed and reliability, provide for safe and comfortable passenger facilities, offer multi-modal options for riders to access the system, and establish appropriately sited support facilities.

Network growth and change over time

METRO CONNECTS includes service networks planned for 2025 and 2040. These networks are shown in Figures 1 and 2, respectively, and include the planned expansions to Sound Transit's light rail and bus rapid transit (BRT) network. The extension of the light rail network represents opportunities for Metro to restructure service in a manner that provides frequent connections to light rail stations, further leveraging the region's investment in high capacity transit. Transit service hours can also be reallocated to corridors with high transit demand that will not be served by light rail.

2025 Network

The 2025 network envisioned in METRO CONNECTS will require an additional 965,000 service hours—a 28 percent growth over the current service level. By that time, light rail will be extended to Redmond, Federal Way, and Lynnwood. Sound Transit BRT will be in place on SR 522 and I-405. Metro envisions restructuring its service to provide connections from neighborhoods to the light rail stations as they open. A new streetcar line connecting the existing South Lake Union and First Hill streetcars will be completed by the City of Seattle.

The METRO CONNECTS vision included implementation of 13 new RapidRide lines by 2025. This includes seven lines within the city of Seattle that are partially funded through the Move Seattle Levy. Additional frequent service is envisioned along dense corridors, providing connections to light rail. Metro and Sound Transit will continue to coordinate on the provision of express bus service throughout King County. Metro's local service network is envisioned to provide traditional fixed route service and also evolve to provide alternative services that are customized to various communities.

2040 Network

The 2040 service network envisioned in METRO CONNECTS will require 2.5 million service hours—a 71 percent growth beyond today's service level. It assumes a further expansion of light rail in King County, including service to Ballard, West Seattle, South Kirkland, and Issaquah. Bus service restructures would continue as new light rail service begins throughout the county.

Implementation of 6 additional RapidRide lines is envisioned between 2025 and 2040, resulting in a total of 26 lines countywide. Frequent service is envisioned to be further expanded, resulting in a large network of frequent routes. Expansion of express service is also planned, connecting growing communities of households with employment and education centers. The projected growth of the local service network is expected to provide more communities with fixed route and alternative service options.

Figure 1. METRO CONNECTS 2025 Service Network

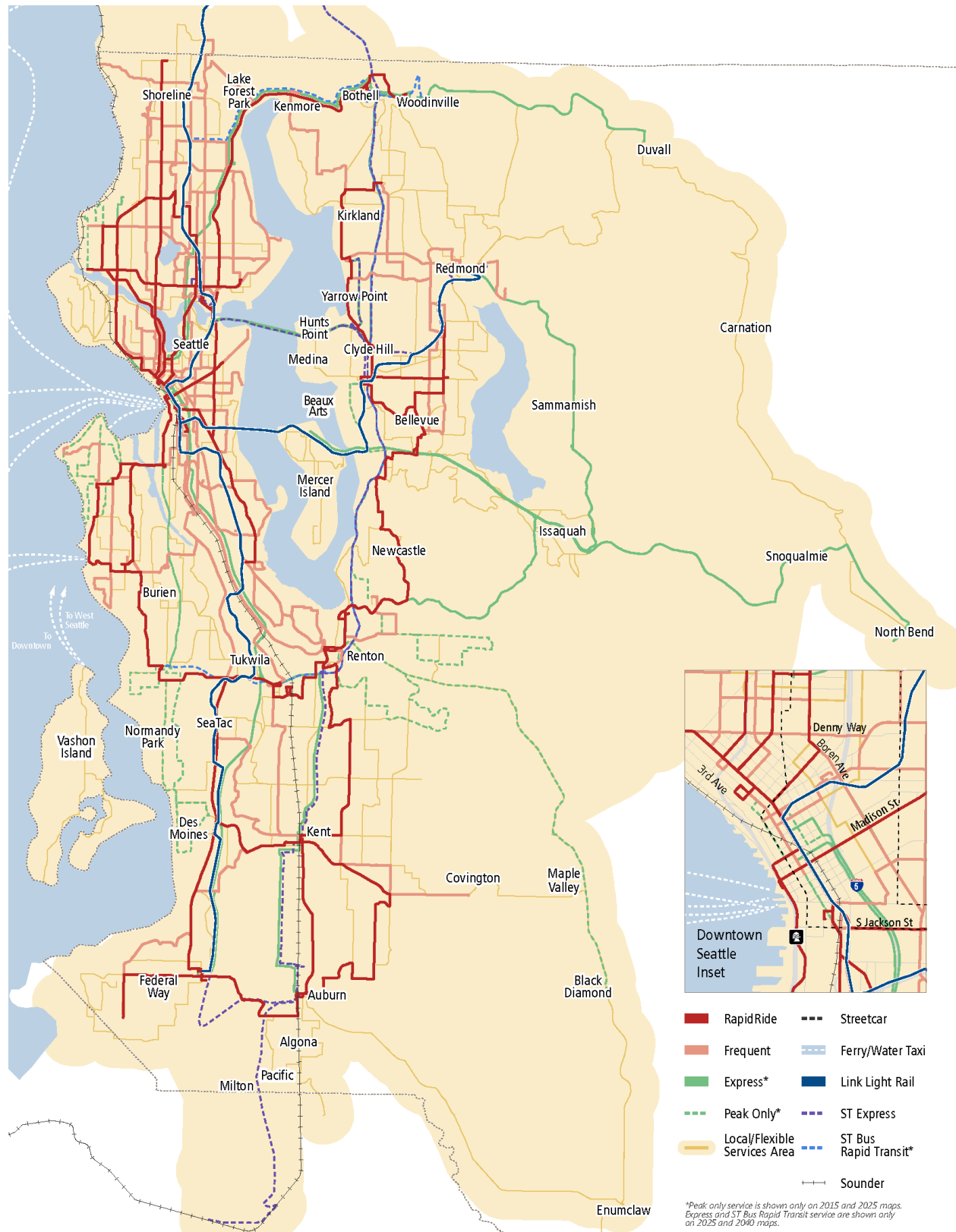
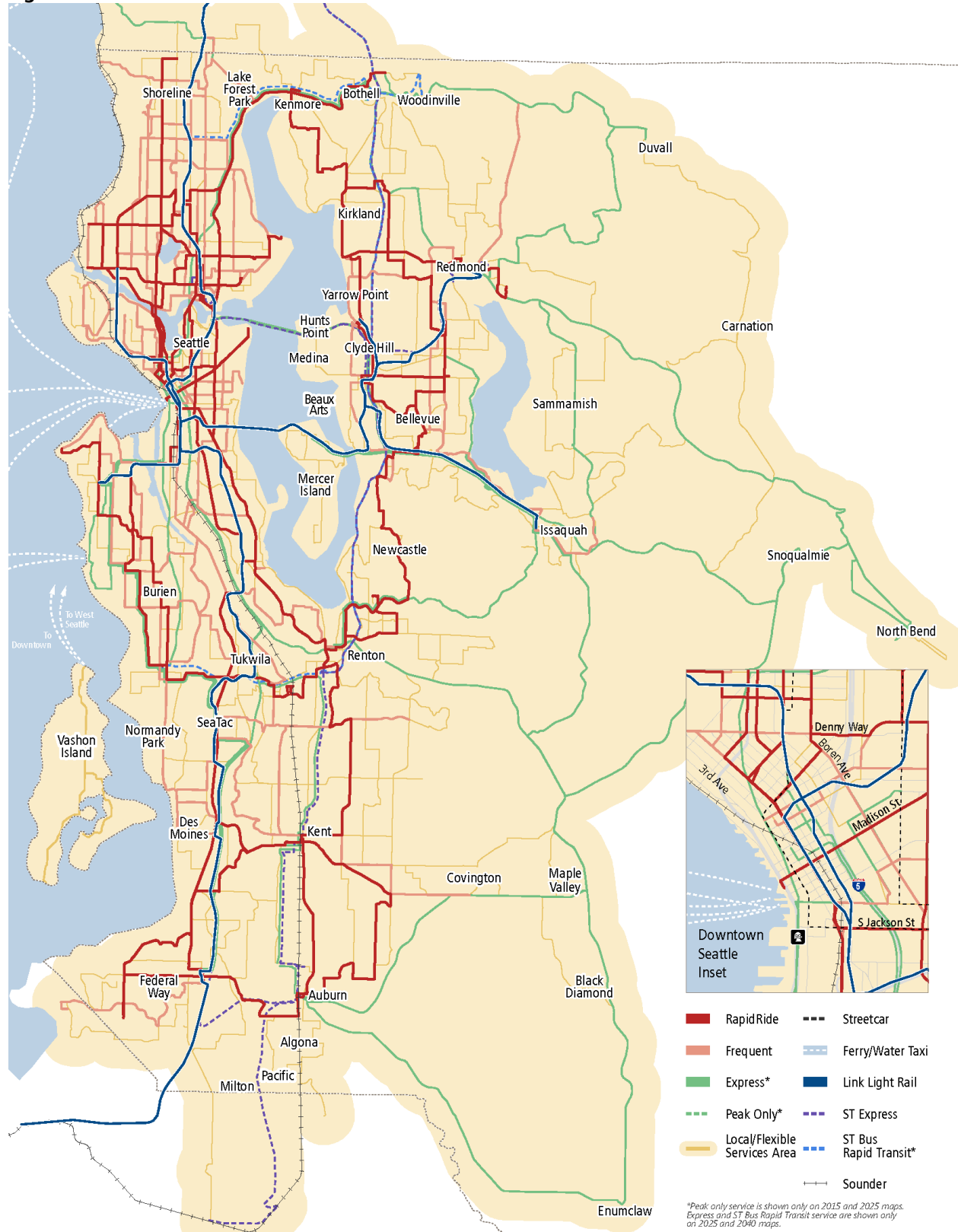


Figure 2. METRO CONNECTS 2040 Service Network



The overall amount of service Metro provides is planned to grow; additionally, the type of service Metro provides is planned to evolve. The future network envisions more two-way all-day service, shifting away from peak service. The future transit network also assumes a greater reliance on connections between services and systems, with an expectation that fewer Metro bus routes will serve downtown Seattle. The evolution of service is planned to occur over time. Figure 3 shows the planned service growth assumed in METRO CONNECTS from 2016 to 2040. Figure 4 shows the daily distribution of service hours in 2016, 2025, and 2040.

Figure 3. METRO CONNECTS Service Growth

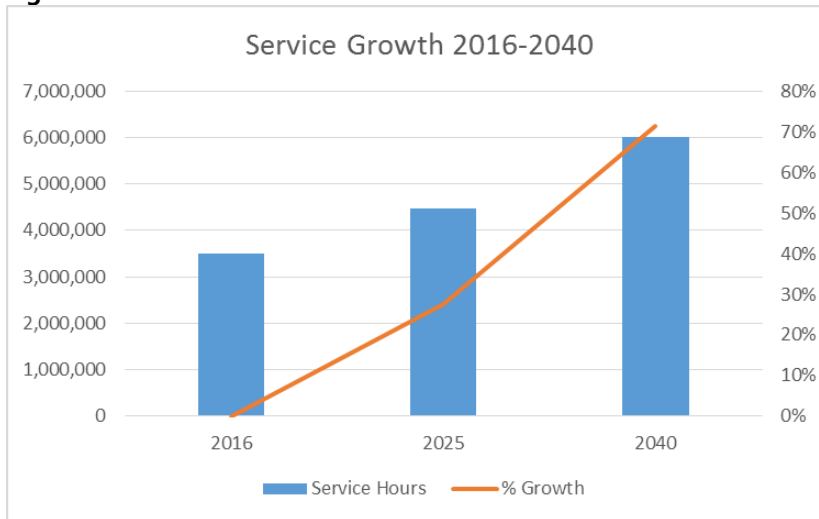


Figure 4. Daily Distribution of Service Hours



Associated Fleet Growth

As service grows and evolves the size of Metro's fleet will need to grow correspondingly. This fleet growth will impact Metro's facility needs.

Metro currently operates a bus fleet of approximately 1,400 vehicles, with a fleet mix of approximately 50 percent articulated buses and 50 percent standard buses (generally 40-foot buses). Metro will need to expand the size of its bus fleet to support the added service hours assumed in METRO CONNECTS. Metro also currently operates about 120 buses for Sound Transit¹.

Bus-Service Hour Calculation

Based on the current service configuration and split between peak and non-peak service, Metro currently estimates a need of one bus for approximately every 2,500 annual service hours provided. This assumption is based on historically high morning and evening peaks for bus service. In the planned 2025 and 2040 service networks, morning and evening service peaks would be less pronounced than they are today and service hours would be more evenly distributed throughout the day. The more even distribution of service throughout the day would shift the demand for new buses from one per every 2,500 hours to one per every 3,200 service hours.

This change is planned to occur gradually over the next 25 years and the rate of growth for the annual fleet projections reflects this transition. While the schedule for new service and service revisions will determine how quickly the ratio of peak to off-peak hours "flattens," there are two potential time periods where the service profile could change most significantly by 2025:

1. The initiation of service on the 13 new RapidRide lines identified in METRO CONNECTS. RapidRide service has similar headways for much of the day and extends late into the evening, which contrasts with today's peak period service emphasis.
2. The significant route restructuring associated with the beginning of ST2 Link light rail service in 2023 will allow Metro to shorten some of its long suburban peak-only routes to provide connections to light rail stations.

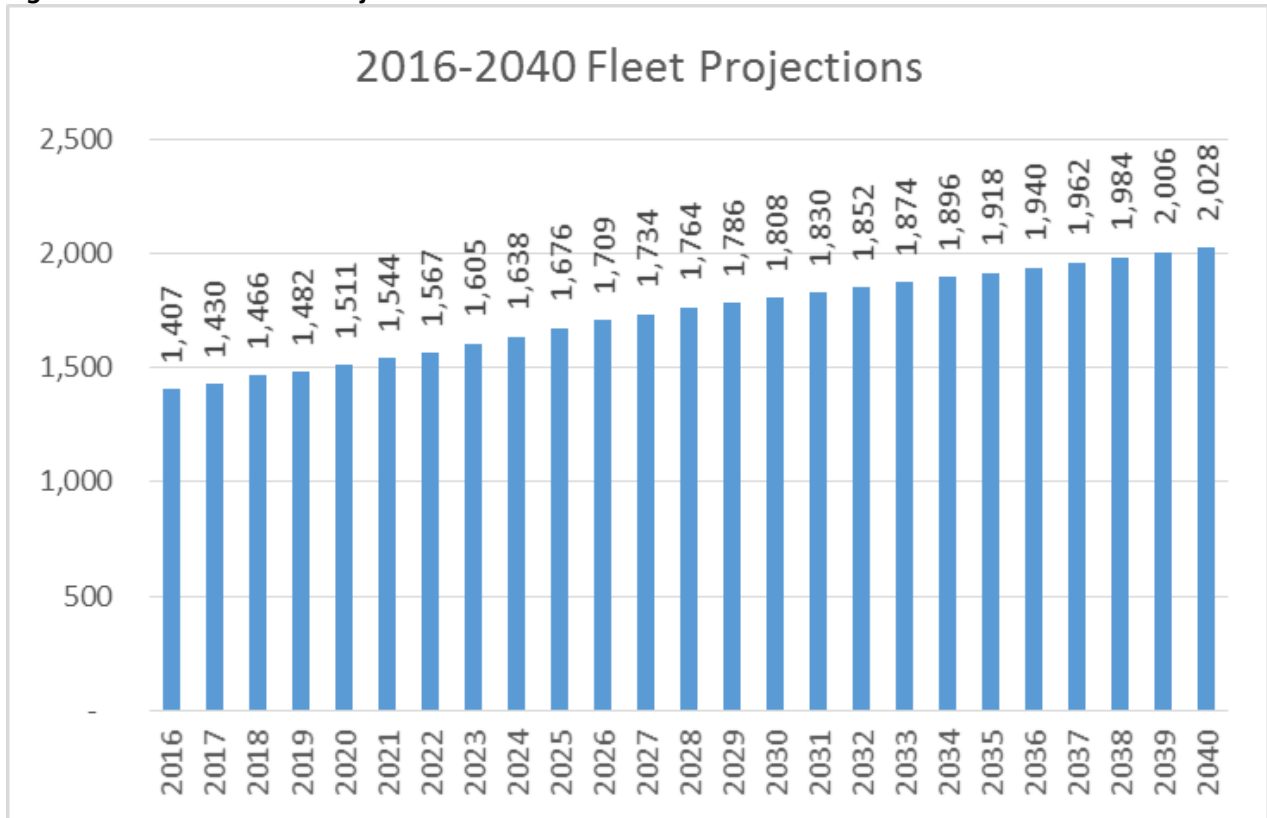
During the development of METRO CONNECTS, the number of additional buses needed to support the 2025 and 2040 service networks was calculated based on the amount of service hours needed to meet service levels². Metro's standard "reserve ratio" of 20 percent was applied to include the need for spare buses to ensure reliable service. Figure 5 shows the estimated Metro fleet needs by year³. It is assumed that future bus purchases will comprise a mix of 50 percent articulated buses and 50 percent standard buses. It is assumed that Metro will continue to operate an additional 120 buses for Sound Transit. This Sound Transit number is likely to change but rather than estimate a new assumption that may not be any more accurate, the analysis just carried forward the number that Metro had been operating. The Sound Transit fleet numbers are not included in Figure 5.

¹ This report does not assume any change in the Metro-operated Sound Transit fleet. This will need to be monitored over time and updated to reflect Sound Transit future bus fleet plans.

² Fleet size is an output from the Sound Transit Incremental Ridership Forecasting Model, which uses route length, average speed, and headway to estimate the number of buses needed. The output from the Sound Transit model was adjusted to account for a higher ratio of off-peak to peak service described above.

³ Metro's existing fleet plan (as of 2016) anticipates bus needs through 2028. It was developed prior to METRO CONNECTS and includes different assumptions about service growth and changes, thereby resulting in a discrepancy in fleet needs. The existing fleet plan anticipates slightly higher fleet needs through 2018 in response to a period of strong growth via returns on sales tax, which is not assumed to continue after the next biennium. METRO CONNECTS reflects a steady pace of sustained growth, resulting in the minor differences.

Figure 5. 2016-2040 Fleet Projections*



*does not include Metro-operated Sound Transit buses, assumed to be 120 buses



King County

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Appendix G:

Industry Best Practices
and Peer Agency Review

Executive Summary

King County Metro Transit (Metro) is developing a Facility Master Plan Report (FMP) to assist capital facilities investment planning. The FMP will enable Metro to strategically use available resources, identify areas for potential efficiencies, and develop an actionable capital investment plan for maintenance and storage facilities.

Metro initiated a review of best practices and strategies to inform Metro's future business practices and influence the type, size, and location of maintenance facilities that the County will need in the future. Peer agency reviews were conducted to identify how their long-range planning links to their capital planning, including frameworks or processes that helped determine capital planning activities. The industry review included interviews with the following four peer transit agencies:

1. San Francisco Municipal Transit Agency (SFMTA)
2. Los Angeles County Metropolitan Transportation Authority (LA Metro)
3. Denver Regional Transportation District (RTD)
4. Toronto Transit Commission (TTC)

Objectives of the peer agency reviews included identifying how their long-range planning links to their capital planning, including any frameworks or processes for determining capital planning activities.

Interviews were conducted with high-level managers at the peer agencies following a questionnaire template that covered:


- Operations
- Fleet maintenance
- Maintenance and storage facilities
- Vehicle financing and procurement
- Fleet planning

Interviews were conducted by phone and email. Other State of the Practice information was found by readily available data and research.

Summary of Key Findings

This document identifies key findings, which include:

- **Pressure to grow.** Peer agencies expressed the need to expand current activities and the difficulty in finding prime real estate in areas that provide service and operation characteristics supportive of efficient transit delivery. Some peers are considering expanding up on their bus bases since land is becoming scarce and expensive.
- **Battery Electric Bus Technology.** Each peer agency is planning to expand its electric bus fleet. Peer agencies are evaluating which battery-electric technology, or combination, to embrace; including charging at base, in-route, and at layover decision needs. However, all cited the need for advanced charging infrastructure to control power draw with a larger electric fleet. Some peer agencies are waiting for battery-electric technology to evolve before investing more significantly. Most identified aspirational goals to transition to fully electric fleets in the future. Peers anticipate that electric buses will require more space than a typical hybrid or diesel buses. This couple with general capacity needs have encouraged agencies to try to build in additional capacity to their systems.

- 
- **Contracting Services.** Peer agencies rely on more private contracts than Metro. This includes private contracts for the operation and maintenance of some or all aspects of the bus fleet. It also includes private contracts for the maintenance and repair work of bus fleet support vehicles, commonly referred to as nonrevenue vehicles.
 - **Green Building.** Peer agencies are implementing green building in different ways. The range of green building and sustainability investments included LEED (Leadership in Energy and Environmental Design) facility design, use of cisterns to collect rainwater for vehicle wash and landscaping, solar panels, green roofs and electric vehicle parking for employees. Agencies also cited 'good neighbor' efforts such as using building materials that help reduce noise and making sure to not have buses parked or queued on streets surrounding their bases.
 - **Project Delivery Methods.** Peer agencies are embracing project delivery and procurement methods other than the traditional design-bid-build. One agency had seen some reduced schedules with design build but not on the early bases.
 - **Automated Part Storage.** Peer agencies cited the benefit of enhanced part storage and management with automated part retrieval systems.
 - **Contracting Services.** Peer agencies rely on more private contracts than Metro. This includes private contracts for the operation and maintenance of some or all aspects of the bus fleet. It also includes private contracts for the maintenance and repair work of bus fleet support vehicles, commonly referred to as nonrevenue vehicles.

Introduction

King County Metro (KCM) is developing a Facilities Master Plan (FMP) to guide capital facility investment in order to support system growth envisioned in Metro CONNECTS.

The FMP will enable KCM to strategically use available resources, identify areas for potential efficiencies, and develop an actionable capital investment plan to support operational capacity growth. The FMP is intended to accomplish the following:

- Establish an accurate baseline inventory, including overall condition, of revenue fleet and associated maintenance and storage facility assets
- Identify current and forthcoming major capital funding needs required to alleviate capacity constraints, support service growth and bring facility assets to a state of good repair (SGR)
- Prioritize capital facility investments based on appropriate constraints (for example, assessed need, budget, environmental regulations, and public commitments)

1.1 Purpose

KCM has requested a review of best practices and strategies which will inform the County's future business practices and influence the type, size and location of maintenance facilities that the County will need in the future. Objectives of the peer agency reviews will be to identify how their long-range planning links to their capital planning, including any frameworks/processes for determining capital planning activities. The industry review included interviews with four peer transit agencies selected by KCM. Interviews with key personnel from these agencies occurred via phone in winter 2018. This report summarizes the results of the industry research and the agency interviews.

1.2 Approach

Interviews were conducted of high-level managers at the peer agencies following a questionnaire template that covered operations, fleet maintenance, maintenance and storage facilities, vehicle financing and procurement, and fleet planning. Interviews were conducted by phone and email. Other State of the Practice information was found by readily available data and research.

1.3 Participating Agencies

Based on a review of the initial list of transit agencies developed by Metro and the Consultant team, the following four agencies were selected to be interviewed. Agencies considered but not selected are also summarized below.

San Francisco Municipal Transit Agency (SFMTA)

SFMTA operates transit service as MUNI and was selected because:

- MUNI employs a large trolley system network like Metro: Muni has one of the largest systems in the US (333 trolley buses compared to Metro's 241 trolley bus fleet).
- MUNI is on the West Coast, provides transit service in a dense urban and suburban area, and transit operates on steep grades like the Puget Sound Region.
- MUNI has a similar number of employees compared to Metro.



Las Angeles Metropolitan Transportation Authority (LA Metro)

- LA Metro provides similar bus service (fleet size) as Metro, including extensive local, express and bus rapid transit services.
- LA Metro is on the West Coast and provides transit service in dense urban and suburban areas.
- LA Metro has similar plans with using on street buses as a feeder for light rail in the future and currently.
- LA Metro can provide insight into structured layover facilities.

Denver Regional Transportation District (RTD)

- Denver RTD has a similar service area and population to Metro’s service area.
- Denver RTD is taking innovative approaches to addressing layover in Downtown.
- They may be an agency with satellite parking for their coaches

Toronto Transit Commission (TTC)

- Significant investment in program to consider electrification of bus fleet
- Recently complete base master planning and fleet service level plans
- Large transit agency with potentially innovative approaches; international example.

Table 1-1 includes a comparison of the four agencies to King County Metro.

Table 1-1. Agency Comparison – data from the National Transit Database

Agency	City, State	Climate	Service Area (square miles)	Service Area Population	Annual Capital Expenditure	Number of Employees	Modes Operated	Fleet Size	Ridership by Mode (Weekday)	Ridership by Mode (Annual)	Annual Passenger Miles
King County Metro	Seattle Metro Area, Washington	Oceanic	2,134	2,117,125	\$165.2 million (2015)	4,730 (2015)	Bus	1,371	Total: 419,034 (2015)	102,302,980	618,636,709 (annual passenger miles)
							Streetcar	4		622,219	
							Trolleybus	241		18,769,283	
							Paratransit	372		1,012,647	
							Light Rail	205	227,645	72,207,726	58,264,171 (annual vehicle revenue miles)
							Commuter Rail	503	129,075	35,323,276	
							Bus	991	376,227	111,730,664	
							Paratransit	517	6,823	2,108,870	
							Ferry	2	4,464	1,253,167	
Denver RTD	Denver Metro Area, Colorado	Semi-arid, continental	2,340	2,876,000	\$373.64 million (2015)	2,813 (2017)	Bus	1,127	Total: 335,088 (2015)	75,502,787	585,200,793 (annual passenger miles)
							Light Rail	172		25,518,578	
							Commuter Rail	66			
							Paratransit	416		1,229,366	
							Light Rail	70			
							Paratransit	118			
LA Metro	Los Angeles County, California	Mediterranean	1,513	8,626,817	\$1,923.6 million (2015)	9,817 (2017)	Bus	2,304	Bus: 957,891 (2016)	334,381,438	2,253,459,695 (annual passenger miles)
							Bus Rapid Transit	46	Rail: 348,505 (2016)	8,597,667	
							Heavy Rail	104	Total: 1,439,259 (2015)	47,506,711	
							Light Rail	219		62,775,109	
							Bus Rapid Transit	108		20,089,991	
							Commuter Bus	456		12,627,870	

Agency	City, State	Climate	Service Area (square miles)	Service Area Population	Annual Capital Expenditure	Number of Employees	Modes Operated	Fleet Size	Ridership by Mode (Weekday)	Ridership by Mode (Annual)	Annual Passenger Miles
							Heavy Rail	5,282		2,662,421,226	
							Paratransit	2,045		6,641,883	
San Francisco Municipal Transit Authority (SFMTA)	San Francisco, California	Mediterranean	47.35	852,469	\$1,154.7 million	4,800	Diesel & Hybrid Bus	526	Total: 700,000 (2013)	Total: 222,991,005 (2013)	Not available
							Cable Cars & Historic Streetcars	86			
							Light Rail	151			
							Trolley Bus	333			
Toronto Transit Commission (TTC)	Greater Toronto Area, Toronto, Ontario, Canada	Humid continental	240	2,731,571	\$1,126 million (2015)	14,095 (2016)	Bus	1,926	Streetcar/Subway/RT Cars: 1,252,000 Bus: 1,437,200 Wheel-Trans/Community Bus: 10,779 (2016)	252,899,561	Not available
							Streetcar	265			
							Subway/RT Cars	868			
							Wheel-Trans/Community Bus	591			
									60,608,201		
										Subway: 221,620,993 RT Cars: 2,950,241	
										3,928,812	

Maintenance and Storage Facilities

This section contains an overview of maintenance and storage facilities approaches and considerations for handling buses returning from service, maintenance activities and facility location, parts storage and availability, expansion, and sustainability. Because of the wide range of approaches to maintenance and storage layout, equipment, and activities, this section does not represent an exhaustive review. While peer agencies have widely different experience and approaches with varying maintenance and storage approaches, there is a common theme across all topics of agencies attempting to develop more efficient, forward compatible, and cost-effective facilities.

2.1 Handling Buses Returning from Service

All transit agencies have a check-in process for buses, which generally includes a preliminary vehicle condition update (any warning lights or operator observed issues), fueling / recharging, cleaning, maintenance, vault pull, and other activities. Not all of these activities are performed daily, but for most agencies, the assignment of activities for buses occurs when the bus returns to base.

The peer review found the following:

- Many transit agencies have a peak coach return that queues off base onto adjacent roadways. However, this has not been causing significant issues with surrounding land uses. Peak bus return period was generally identified as 7 pm to 8 pm.
- One peer is exploring an automated process to manage returning coach traffic flow and lane assignments. This is referred to as a “smart yard” feature which helps assist buses in finding the correct place to park at the garages. The system analyzes and creates a work order if needed. One requirement with the system is that the entire garage needs to be mapped out. This means that all facilities must remain in the same place, and there is no chance to convert or change areas without re-mapping the whole garage.
- Metro’s check-in process does not include vault pull at check-in like peer agencies, this helps to reduce buses queuing at KCM bases.

2.2 Maintenance Activities and Facility Location

The sophistication of maintenance activities performed at base locations varied by agency, as well as approaches to parts management, storage, and where and what types of repair work were conducted. Depending on local contracting conditions, some transit agencies had varying levels of third party support services for services, maintenance, and repairs. A summary of the peer review follows:

- Many transit agencies have separate facilities for major overhauls versus running repairs.
 - One peer favors the close proximity of their divisions (bus bases) to the major repair facilities and often sends buses to the facility for major repairs.
 - Another peer agency cited having a central overhaul shop, with 20 miles being the furthest a bus needs to travel to reach the facility. This shop also has a “parts store”, where most unique parts are held. This created a better inventory control system, while the individual garages all still have basic parts needed.

- Contracting work can provide redundancy and alleviate space needs at existing bases. Contracting work can also help smooth out surges in maintenance needs. Varying levels of oversight by the transit agency are required depending on the complexity of the work being performed by contractors.
 - One peer contracts vehicle maintenance to third parties for part of its fleet. Companies bid on contracts to maintain vehicles at a contractor's site. Contractors receive training and certification from contracting transit agency.
 - Another peer agency has a body shop located off base that also provides for painting and structural repairs. Engine overhaul and mid-life overhauls are completed at a specific base. Tires and paratransit maintenance is contracted out.
- Activities not performed on a regular basis could be located offsite (not on a dedicated bus base) to provide additional capacity and consolidate services.
 - One agency noted using an off-site facilities to paint or wrap vehicles.
- Linking maintenance activities and schedule to fleet purchase is important. Large purchases of vehicles can create spikes in the ongoing maintenance schedule.
 - One agency noted that when it purchased 300 coaches at once, it found that all 300 vehicles are requiring maintenance at approximately the same time.
- Some agencies employ an early-action preventative maintenance approach:
 - One peer agency employs a preventative maintenance schedule, which they state has seen positive results in terms of reducing coaches out of service and longer up-times for buses in service. In years prior, there were 2,000 service requests that were over 30 days old at any given moment. That number has dropped to 200. In the same time frame, initially the ratio was 40-60 of scheduled to non-scheduled maintenance. That has now changed to 70-30. One simple thing that has led to this change is more robust regular maintenance checks upon coach return.
- General building function findings:
 - One agency is considering maintenance pits similar to local oil change stops: potential to protect the physical health of mechanics.
 - Another agency targets a 15-1 bus-hoist ratio. Both 30' hoists and 40' hoists are at each garage. Each garage has 210 to 310 buses with covered storage.
- Dedicated maintenance crews provide specialization and centralization of parts and services:
 - One agency has focused maintenance crews that specialize in aspects of bus maintenance and repair. For example, a crew works on brakes exclusively and results show that the crew is much more efficient than switching tasks. The agency stated the quality of service for the repair is also higher due to the specialization. Maintenance facilities are set up like a workflow chain, with all the specialized "shops" lined up.

2.3 Part Storage and Availability

Transit agencies are constantly working to achieve balance between part storage and part availability. Part storage requires space and sunk costs with inventory. Also, aging or unique vehicles often require agencies to have more parts on-hand because parts can be hard to find or have long delivery times. The level of

part tracking sophistication varies greatly by agency from simple paper logging and shelf part storage to complex electronic automated retrieval systems.

New automated systems provide convenient access with part lookup and vertical storage (to maximize the use of space):

- One agency employs an “Automated Maintenance Facility” where workers type in a part number electronically, and the automated forklift will retrieve the item. Parts of all sizes can be stored on pallets and retrieved automatically. The system even includes an electronic tracking of inventory and notifies staff when inventory is low.

2.4 Expansion

Nearly every agency expressed the need to expand current activities and the difficulty in finding prime real estate in areas that provide service and operation characteristics supportive of efficient transit delivery. Because of the focus on zero emission buses (ZEBs), agencies are faced with integration of a new technology into their current operation. This new technology will require a shift in how vehicles are handled on base, staff composition, space needs, and more. To address ZEBs, peer review agencies are in the early stages of considering where existing spaces can be repurposed or identify areas for a new base with enhanced support for ZEBs. A summary of the peer review found the following:

- Many transit agencies have not developed a holistic Capital Plan. Peer agencies noted that funds have been constrained and have been allocated to necessary repairs. As agencies require capacity, they are looking towards developed capital plans jointly with base expansion and transit asset management efforts.
 - One agency noted its attempt to locate bases in service areas to reduce the amount of deadhead service.
- Opportunity to explore innovative options during expansion.
 - One agency has a goal to develop “power neutral” facilities to support its full electric fleet goal of 2025. Because of available land and price constraints, new and rebuilt facilities could be designed to store coaches on the second floor (building up could be a more financially efficient solution in the future). Anticipate continued market competitiveness with other types of commercial/residential developments.
 - Another agency noted that it has labor agreements that do not permit layoff due to improved technological advancements; they retrain staff.
- Anticipate that future operations and technology changes may require more space (for example, it is likely that moving to an electric fleet will require more space than the same number of diesel or diesel-hybrid buses).
 - One agency noted a target to plan for 20% more space than is needed. Need to consider ways to future proof facilities (be forward thinking). The availability of a new base as a “spare” facility, has provided the agency the flexibility to complete bus base upgrades and address temporary losses of base capacity.
 - One agency noted that it is building a new base on an extremely accelerated time frame, which they believe was made possible by design build. However, the agency prefers a design-bid-build process because of its reduced cost efficiency and enhanced control over the design of the facility.

2.5 Sustainability

Peer agencies have been incorporating sustainability and context orientated elements into the design and upgrade of facilities. The level of investment in sustainability varied, but agencies did not have a minimum threshold for sustainability by project type. The summary of the peer agency found:

- One agency constructed a green room at facility recently build facility and is planning for a green roof at a facility underway. At this agency, LEED is not a required goal, but is considered when evaluating contractor's proposals.
- Another agency has a full team working on LEED facility design and ensuring projects meet a sustainability code
- A third agency constructed a 250-thousand-gallon cistern for collecting groundwater to use for bus washing and landscaping. Noise pollution is mitigated at various bases by using a special wall/flooring to reduce vibrations. Solar panels have been installed at many facilities with positive results.

2.6 Zero Emission Buses

Each peer agency is planning to expand their electric fleet. A summary of the peer agency review and activities with zero emission fleet follows:

- One agency reported having 36 electric coaches plus one electric shuttle. This agency does not use on-route charging: base charging needs to be in place before massive electric expansion can occur. Currently, all their facilities are maxed out of electrical capacity.
- This agency is planning for the retraining of diesel hybrid mechanics to become electric vehicle mechanics but this can take time. The union needs to provide different training and there have been issues filling the necessary electric bus mechanic roles.
- Currently, only one of their bases has an electrical charging set up. The charging stations are set up on internal pillars, with 30 charging stations for the 36 buses. The agency would like to implement smarter charging to control peak draw.
- A second agency is constructing all future bases to be "power neutral", with an eye on a full electric fleet by 2025. However, moving to an all-electric fleet is complicated by union issues.
- This agency is leaning towards the extended range slow charge buses but will wait to see how the technology changes.
- A third agency has a long-range goal of transitioning to an all-electric bus fleet. Initial projects will include converting some bus rapid transit (BRT) service to 60-foot electric articulated buses with charging stations at terminals. Their recent bus procurements have focused on replacing mechanically-driven components such as steering pumps and compressors with electric units.
- A fourth agency is conducting a study to determine which type of electric bus to bring into the fleet. As part of the study, they purchased 30 buses: 10 buses each from three different bus vendors. The agency's goal is to add 30 electric buses by Q1 2019, another 30 by Q1 2020, and to be fully electric by 2025. They are considering base charging and 40 foot coaches. .
- As part of the review, this agency is considering how to address power outages; including what service level they will provide and how they generate and store power.
- Their electric bus fleet is spread throughout 3 bases, based on wherever power is available. There are thoughts of making a future^h base fully electric