



King County Metro

FACILITIES MASTER PLANNING PROGRAM:

Operational Capacity Growth Report

Final

March 2019



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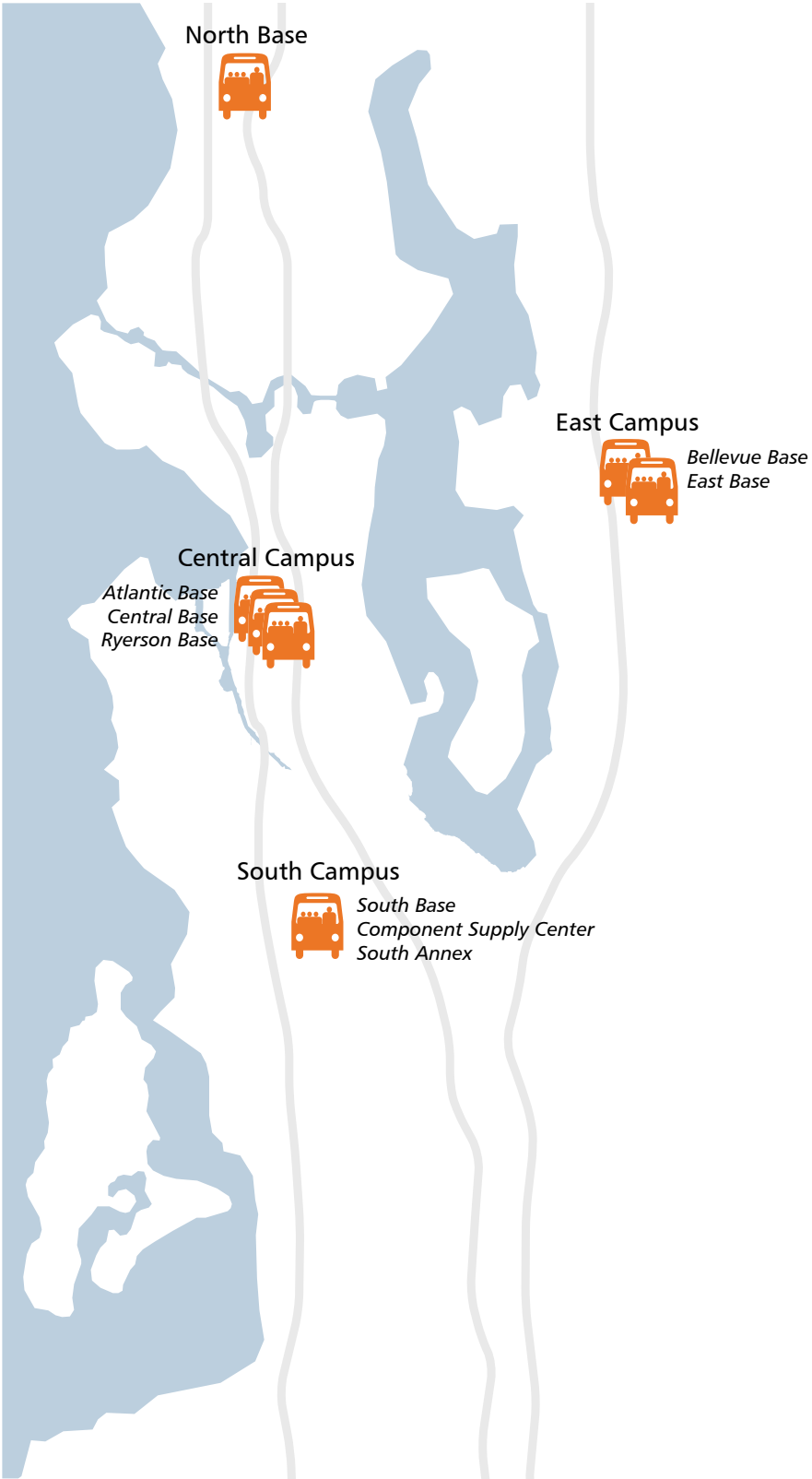
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The Operating Facilities Existing Conditions Report is available upon request.

Figure 1. Metro Bus Base Locations





SECTION 1:

Executive Summary

King County Metro has an urgent need to increase operational and bus base capacity. More capacity is needed to efficiently support near-term service demand, to accommodate the growth and enhancement of service envisioned in the METRO CONNECTS long-term plan, to accommodate the battery-electric buses and charging infrastructure coming in the near future, and to keep fleet and capital assets in a state of good repair.

This Operational Capacity Growth strategy outlines how Metro can meet facility capacity needs over the next 20 years—and can do so in ways that achieve significant advancements in social equity and environmental sustainability.

The strategy focuses mainly on projects at Metro’s Central Campus (Atlantic/Central/Ryerson bases), South Campus, and a new base anticipated to be in South King County. Metro determined these project areas provide the best options for achieving growth targets on the timeline needed. Metro will continue to seek opportunities to optimize operations at North Base and the East Campus. The projects and estimated construction times, costs, and capacity gains are listed below. Figure 2 shows the timeline and costs.

Central Campus

1. **Body shop conversion.** Convert four body shop bays to maintenance bays. (2022, \$20M*, capacity gain of 60 bus spaces from this and earlier optimization projects)
2. **Extend Central Campus.** Build a new facility on adjacent Metro-owned property. (2024, \$60M*, capacity gain of space for body shop, wellness center, and expanded transit safety and security system facilities)
3. **Expand Central Campus.** Acquire property to build additional bus facilities and parking. (2023–2025, \$159M, capacity gain of 90 bus spaces)

South Campus (Tukwila)

1. **Build an interim base.** Install temporary operating and maintenance structures and provide for battery-bus charging, adding bus capacity to support near-term fleet growth. (2020, \$33M*; cost estimate does not include an estimate for battery-bus charging infrastructure, capacity gain of temporary space for 125 buses)
2. **Upgrade a parking garage.** Convert a former Group Health garage for Metro use. (2019, \$3M*)
3. **Build a new permanent South Annex Base.** Relocate nonessential base functions, demolish or relocate existing structures, and build permanent facilities. (2025, \$337M*, capacity gain of space for 250 buses and operations, maintenance, and battery-bus charging functions)

New Base

1. **Build an additional new base.** Likely to be located in South King County to efficiently support future service growth. This base is being planned to be able to support a fully zero-emission electric bus fleet. (2030, \$480M*, capacity gain of space for 250 buses and operations, maintenance, and battery-bus charging functions)

North Base and East Campus

Near-term expansion in these areas is challenging. North Base is limited by a neighborhood agreement, and the East Campus is experiencing pressure from surrounding development as Link light rail expands.

1. Focus efforts on preserving and optimizing existing facility capacity against development pressure.
2. Consider alternatives such as building vertically as part of future planning efforts.

* These cost estimates were developed in the fall of 2018 by the consultant team.

The Need

All of Metro’s seven bases are currently operating beyond optimal capacity and are nearing the point of unstable operations—which means higher costs, deteriorating service quality, and increased safety risks.

Currently, Metro is unable to add new service that requires more buses, simply because there is no room to park or provide maintenance for additional buses. This affects Metro’s ability to meet growing ridership and to address service quality issues (overcrowded trips, for example). It also constrains Metro’s ability to support partners in their desires to expand service.

METRO CONNECTS envisions Metro service increasing by approximately 30 percent by 2025 and 70 percent by 2040. To meet this anticipated demand, Metro must increase its vehicle fleet by more than 40 percent—a total of 2,145 buses by 2040, or more than 620 buses over the 2016 fleet. Metro will need the equivalent capacity of two or three additional bases to support this service vision.

Metro facilities also need critical upgrades to support the agency’s goal to transition to a 100 percent zero-emission bus fleet by 2040. This conversion is critical to meeting the emissions reduction targets in the King County Strategic Climate Action Plan. The transition to a zero-emissions fleet will require significant renovation of Metro facilities while we continue to operate and expand service.

Advancing Social Equity and Environmental Sustainability

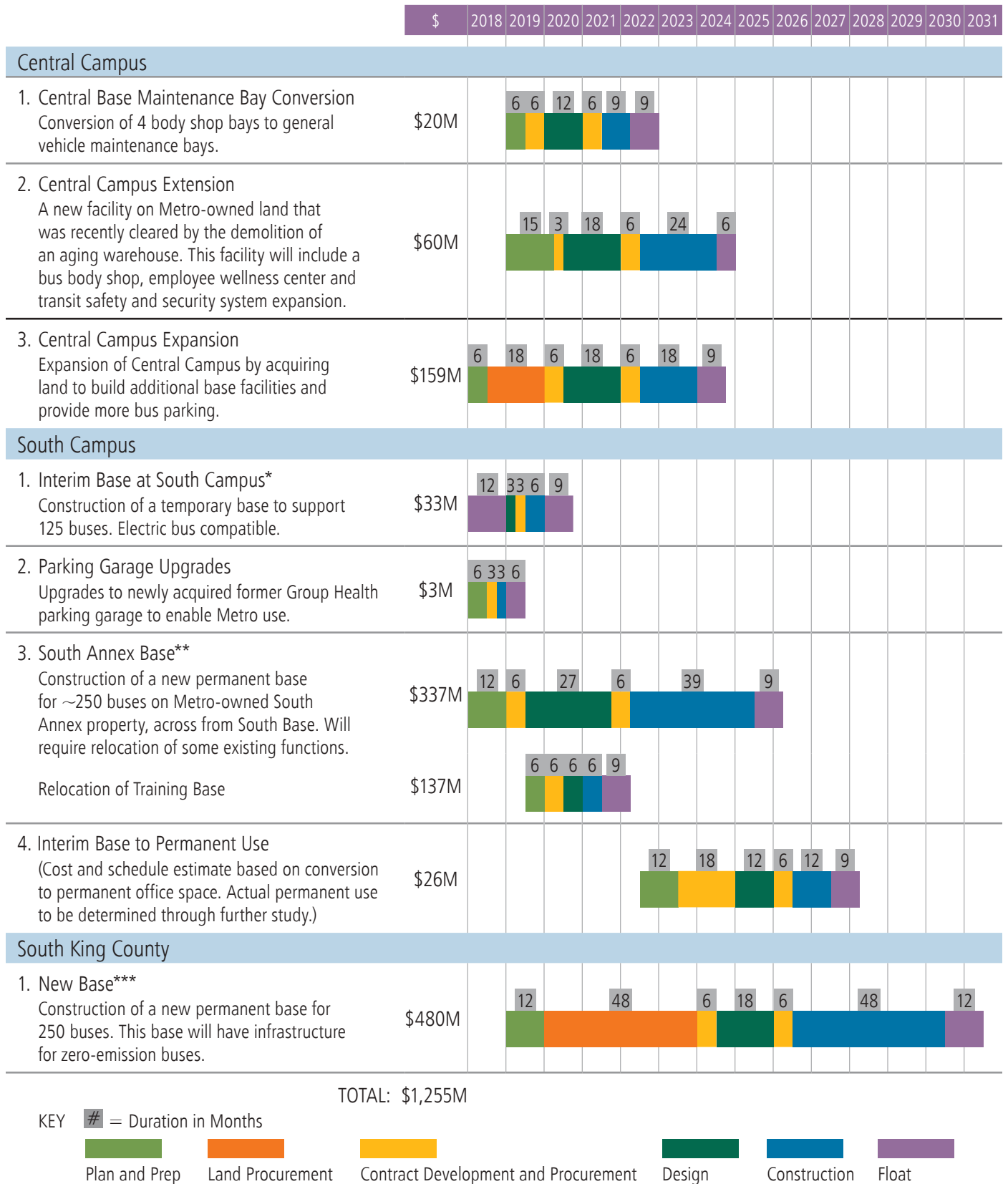
Metro will leverage its substantial investment in new base capacity to help achieve King County’s equity, social justice and sustainability goals, as articulated in the County’s Equity and Social Justice Ordinance and Strategic Implementation Plan, Green Building Ordinance and Strategic Climate Action Plan. Metro is already incorporating equity and social justice strategies into the capital planning process by conducting equity assessments on key projects.

Metro’s approach to delivering equity, social justice and sustainability goals in the optimization, expansion and construction of both new and existing transit facilities includes the following:

- **Engage community.** Metro will expand on its outreach process to work with community-based organizations to gather feedback from non-traditional participants, including people of color, low-income individuals and people with limited English proficiency, to surface concerns and incorporate input into decisions regarding base facilities and base locations.
- **Promote healthy people and places.** Metro’s new facilities will be designed to help enhance the environment and physical health in the neighborhoods they inhabit and maximize the health and productivity of employees. The new bases will also house Metro’s zero-emission fleet, reducing both pollution and noise impacts.
- **Incorporate green building and sustainability best practices and accountability.** Ensure projects are consistent with the latest green building and sustainable development standards, including third-party certification where applicable. Design, construct and operate facilities to use fewer water, energy and material resources, decrease life-cycle costs and reduce waste.
- **Provide community amenities.** Metro will work to incorporate desired community amenities in facilities that advance equity, such as aesthetic and artistic features, cultural and historical markers, and civic spaces that will benefit Metro employees and the community.
- **Catalyze economic development.** Metro’s new and expanded transit facilities will provide economic opportunities for long-term employment in the community and contracts that help advance equity and social justice goals, including increasing utilization of minority and women-owned businesses.
- **Measure equity impact, evaluate and adjust approach.** Metro will create equity-based metrics that will guide our decisions and document the effectiveness of our investments on meeting equity and social justice goals.

Refer to page 6 for more details about Metro’s approach to implementing equity and social justice goals and page 11 about priorities for sustainability and green building in the Operational Capacity Growth strategy.

Figure 2. Estimated Schedule for Operational Capacity Growth



* Cost does not include electrification infrastructure

** Includes \$200M for electrification

*** Project cost assumes all-electric bus base and includes land acquisition costs.

Cost estimates were developed in the fall of 2018 by the consultant team.



SECTION 2:

Introduction

This Operational Capacity Growth strategy was developed to guide Metro in increasing bus base capacity to support efficient operations, system growth, and the transition to a zero-emission fleet. The strategy is designed to advance social equity and environmental sustainability and to comply with federal and agency requirements for keeping facilities in a state of good repair.

Metro developed this strategy with the assistance of a team of consultants who have expertise in subjects such as base design and construction, program implementation, and project delivery. We also gained insight from a peer agency review process and from a Metro staff workshop, both summarized on page 29.

The strategy includes projects, high-level cost estimates and schedules, and consultants' suggestions about how to deliver projects in less time or at a lower cost. The report documents how the strategy was developed and identifies considerations going forward.

Future Planning

Metro has an urgent need to increase base capacity for its own fleet and the Sound Transit buses operated under contract, and the strategy presented here focuses on the most critical next steps.

This strategy supports envisioned system growth until 2040. By then, Metro's base capacity could again be constrained, and some of Metro's older transit facilities will be near the end of their lifecycle. To maintain stable operations into the future, Metro will need ongoing facility planning. Metro will need to track service and fleet growth, the impact of bus electrification on base capacity, and facility capacity investments over time to make sure they are all aligned.

Metro will continue to refine its fleet projections to inform more detailed capital planning as it further defines its service plans. Metro will also work closely with Sound Transit and other partners to understand their desired fleet and service projections.

Metro will also develop a transition plan over the next year to more clearly define the steps needed to convert to a zero-emission fleet.

Future plans will also address additional components of Metro's capital facility program, such as a new or expanded vanpool distribution center and additional maintenance facilities.


Policy Guidance

The Operational Capacity Growth strategy is guided by a number of policy documents.

The **METRO CONNECTS** long-term plan is the foundation for the strategy. METRO CONNECTS envisions service growth of approximately 30 percent by 2025 and 70 percent by 2040. Expected population and employment growth, Metro's ongoing work to make transit affordable and accessible to all, Sound Transit's expansion of the high-capacity rail network, and other major transportation improvements are key drivers of growth.

The envisioned service growth is expected to require a fleet of roughly 2,145 buses by 2040, including an assumed 120 Metro-operated Sound Transit buses — an increase of more than 620 buses over the 2016 fleet size. Metro will need the equivalent of two or three additional bases to support the METRO CONNECTS service vision. Without additional transit facility capacity, Metro will be unable to expand service.

Metro's 2017 **Feasibility of Achieving a Carbon Neutral or Zero-Emission Fleet** report sets a goal of converting the bus fleet to 100 percent zero-emission by as early as 2040 (Figure 4). Metro will make this transition by replacing retiring fleet with battery-electric buses, designing new facilities to support battery buses and retrofitting existing bases, once new facilities are operational.



This transition will require Metro to renovate bases while continuing to operate and expand service. Existing base capacity must be expanded to accommodate portions of each base being taken offline for up to one year.

The technology and equipment needed to operate and maintain battery-electric buses are evolving and have different operational considerations compared to existing bus types. The infrastructure necessary to support battery buses will likely occupy more space compared to fossil fuel buses. The amount of electricity required for a fully zero-emission fleet will be much greater and will likely be more concentrated at bus bases, in contrast to the electric trolley bus fleet's distributed power network.

The conversion to a zero-emission fleet is critical to meeting the emissions reduction targets in the 2015 **King County Strategic Climate Action Plan** (reduce countywide sources of greenhouse gas emissions, compared to a 2007 baseline, by 25 percent by 2020, 50 percent by 2030, and 80 percent by 2050). The climate action plan and the County's **Green Building Ordinance** define actions and targets that Metro's capital program will follow as it increases base capacity. These include:

- Strive for Leadership in Energy and Environmental Design (LEED) platinum certification in major new building construction projects; incorporate cost-effective green building and sustainable development practices using the King County Sustainable infrastructure scorecard into projects that are not LEED eligible or limited in their ability to achieve LEED certification.
- Meet the most progressive energy code in King County.
- Ensure that all electricity supplied for operations is greenhouse gas neutral by 2025.
- Consider solar integration.
- Mitigate the negative environmental, economic, health and social impacts of operation and renovation.
- Conduct a life-cycle cost analysis that considers energy costs and the social cost of greenhouse gas emissions.
- Incorporate the green operations and maintenance practices in King County's Green Operations and Maintenance Guidelines Handbook.

The cost estimates prepared for this report include costs for green building elements based on current policies. Policies and criteria related to sustainability will continue to evolve. All projects will plan for and adhere to these requirements, including the Green Building Ordinance scorecard.

King County's **Equity and Social Justice Strategic Plan** and Equity Review Process will guide Metro in developing and operating new and expanded transit facilities in ways that advance social equity.

Metro will use King County's Equity Review process, which uses quantitative and qualitative data to assess the downstream result of proposed projects, to identify opportunities to advance social equity through facility development.

Metro will conduct Equity Assessments on Portfolios and Programs, and Equity Impact Reviews for major capital projects, and develop and implement Equity Action Plans throughout the life of the projects. Progress will be scored using the Equity and Social Justice Credits within the Green Building Ordinance scorecard, as well as custom metrics designed to evaluate the effectiveness of the investments on advancing the County's Equity and Social Justice Strategic Implementation Plan. Portfolio Equity Assessments will be integrated within the process to prioritize programs and the projects within them.

Metro's **Transit Asset Management Plan** includes the policies, protocols, procedures, and actions necessary to align operations to the Asset Management Policy issued by the General Manager. The Transit Asset Management Plan recommends projects to address federal and agency requirements for state of good repair. It also provides direction for which projects should be completed and when to fulfill requirements.

A matrix in Appendix B summarizes policies with the greatest effect on developing project alternatives and associated costs estimates and schedules. Policy documents can be found by searching www.KingCounty.gov.

Advancing Equity and Social Justice in the Operational Capacity Growth Strategy

Metro is advancing equity and social justice through a number of steps in capital planning. Metro will develop and implement Equity and Social Justice Action Plans throughout the lifecycle of all projects detailed in this report to increase base capacity to support efficient operations, system growth and the transition to a zero-emission fleet. Progress will be scored using the Equity and Social Justice Credits within the Green Building Ordinance scorecard, as well as custom metrics designed to evaluate the effectiveness of the investments on advancing the County's Equity and Social Justice Strategic Implementation Plan.

Engage Community

Metro's approach will begin with community-centered, collaborative engagement that will surface concerns regarding facilities as well as opportunities for community enhancements. Metro will work through community-based organizations to gather input from non-traditional participants, using culturally-appropriate and transcreated outreach materials. In partnership with community-based organizations, Metro will use a wide range of non-traditional methods to ensure greater participation by people of color, low-income individuals, and people with limited English proficiency. Metro will engage with community at a high level, incorporating input into decisions regarding designing, siting, constructing, and operating new and expanded facilities. After facility locations are finalized, Metro will build a framework for ongoing partnerships with the selected communities that will last from planning through beginning of operations.

Minimize and Mitigate Impacts

Metro recognizes new base capacity identified in this strategy will be located mostly in South King County, where air quality and other measures of environmental and physical health are lower than in other areas of King County. Rather than increase these inequities, Metro's new facilities will be designed to help contribute to environmental and physical health in the neighborhoods they inhabit. The new facilities are intended to house Metro's zero-emission fleet, reducing both pollution and noise impacts. Metro will also review how to minimize traffic impacts, improving road conditions for the area and providing better traffic flow overall. As part of the traffic mitigation plan, Metro will also consider public transit solutions to improve access to transit facilities for Metro employees and the community.

Provide Community Amenities

Beyond minimizing impacts, Metro will work with the community to identify opportunities to leverage major county investments to advance equity. Metro will engage the community and potential partners to identify aesthetic and artistic features, cultural and historical markers and civic spaces that can feasibly be incorporated into project design.

Catalyze Economic Development

New and expanded bases will catalyze economic development, providing jobs during planning, construction, and operations. Newly developed equity and social justice criteria will create incentives in the procurement process for contractors to provide innovative concepts that help advance equity and social justice goals, including increasing utilization of minority and women-owned businesses.

Measure Equity Impact, Evaluate Results and Adjust Approach

From planning to post-implementation, Metro will create equity-based metrics that will guide our decisions and document the effectiveness of our investments on meeting equity and social justice goals. Metro will use a values-based, data-driven approach that quantifies how our investments can contribute to more equitable outcomes. Metrics will be used to supplement enhanced community outreach and ensure that Metro considers impacts and opportunities for those with the greatest needs. By conducting a holistic analysis, through the lifecycle of the project, Metro can ensure the capital investments made can support operations and amenities needed to deliver equity and social justice goals.

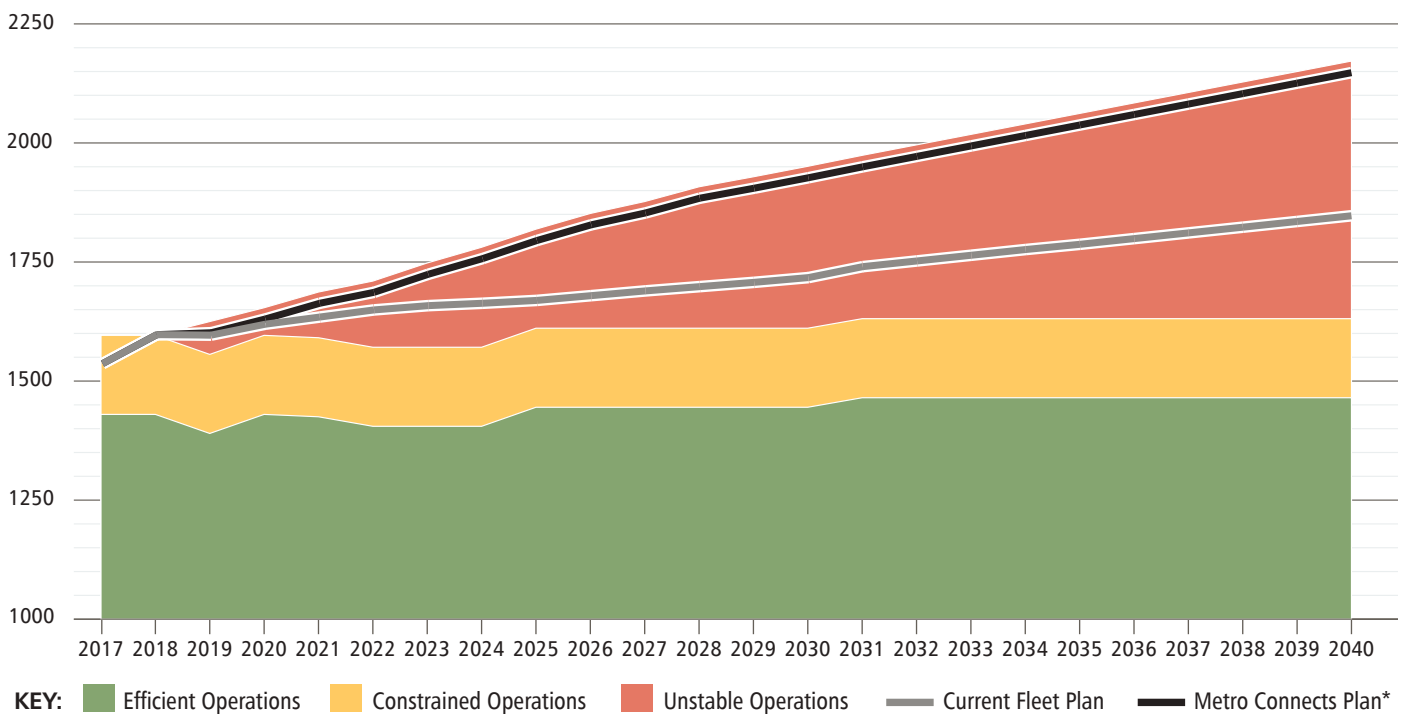
Existing Conditions

Metro currently operates seven bus bases that are strategically located to provide critical support services and serve riders across King County. These bases support a fleet of more than 1,600 buses, including 35-foot, 40-foot, and 60-foot coaches. Approximately 55 percent of the current fleet are 60-foot articulated buses. Metro’s fleet also includes 174 electric trolley buses and 120 Sound Transit buses.

All of Metro’s bases are currently operating beyond optimal capacity and are nearing the point of unstable operations (Figure 3). During the economic recession that began in 2008 and the period of slow ridership growth that resulted, Metro suspended planning for capital expansion for several years. Metro’s facility investments focused primarily on required maintenance and small expansion projects, including improvements at the Atlantic/Central/Ryerson Central Campus. In recent years, as the economy and ridership have improved, Metro has emphasized investment in service.

Current conditions make it difficult for Metro to add peak and other service that requires more buses, affecting Metro’s ability to meet increasing demand and limiting long-term system growth. This also impacts how Metro addresses service quality issues, such as overloaded trips or unreliable service, and constrains Metro’s ability to support partners in their desires to expand service. In addition, Metro’s bases need critical maintenance and upgrades to support a transition to a zero-emission bus fleet, both of which will affect capacity during periods of construction.

Figure 3. Fleet Projection vs Existing Base Capacity



* The METRO CONNECTS fleet projection was based on projected service hours and assumed Metro’s standard fleet reserve ratio of 20%

Understanding Base Capacity and Functions

Bus base capacity refers to the number of buses that can be supported and operated out of a base. Base capacity changes as service and fleet characteristics change. Service characteristics include the number of miles and hours of service operated and the number and types of buses dispatched. Fleet characteristics include the age and size of the buses in use.

To estimate base capacity, Metro uses a dynamic model that focuses on the number of buses that can be parked and the number of buses that can be maintained at a base. Factors not included in this model—such as bus parts, storage, fuel and wash buildings, driver report areas, administrative staff areas, vehicle maintenance, and employee parking—also affect capacity, but these become more important in base planning and programming.

The model accounts for the fleet mix assigned to each base and maintenance requirements of each fleet type, based on data from a two-year period.

- **Maintenance capacity.** Maintenance demand for each fleet type is measured by the number of repair hours per 1,000 service miles. Vehicle maintenance capacity is determined by the number of bays and mechanic work shifts at a base.
- **Bus parking.** The area required for bus parking is determined by the length of the buses, which varies by fleet type, plus space for bike racks and space for drivers and mechanics to safely walk around the buses. Electric trolley buses need more space between them than diesel or hybrid buses to allow for the trolley service equipment. Battery-electric buses are also likely to need more space for charging infrastructure.

The base capacity model determines whether a base's level of service or operating conditions are efficient, constrained, or unstable.

- **Efficient operation (optimal capacity) means space is used effectively for daily operations such as fueling, washing, and maintenance.** At this level, a base can accommodate increases in the number of assigned buses and continue to deliver bus service during routine facility maintenance.
- **Constrained operations occur as a base becomes overcrowded and daily operations become more congested and less efficient.** A base at this level may be able to accommodate small increases in the number of assigned buses and minor construction on a base. Projects that reduce the operating capacity of a base may require a decrease in service or temporary workarounds.
- **Unstable operations mean a base is over capacity.** Daily operations have higher costs, service quality deteriorates, and safety risks increase. At this level, a base would likely be unable to accommodate increases in buses or any reduction in base capacity during maintenance or upgrades.

Metro has established a target of operating bus bases at “efficient operation” or better.



Table 1. Summary of Metro’s Base Capacity

Base	Year Opened	Acres	Number of Buses (11/2018)	Efficient Capacity (Number of Buses)*	Constrained Capacity (Number of Buses)	% Over Optimal Capacity (11/2018)	Summary of Considerations
Central Campus			757	650	740	16%	
Atlantic Base	1941	14	315	255	300	24%	Only base that maintains electric trolley buses. Co-located with Central Base.
Central Base	1990	10	229	205	220	12%	Co-located with Atlantic Base.
Ryerson Base	1982	9	213	190	220	12%	Next to SODO busway.
East Campus			378	345	375	10%	
East Base	1978	17	229	205	230	12%	Houses Metro-operated Sound Transit buses; primarily supports articulated buses.
Bellevue Base	Re-opened 1998	8	149	140	145	6%	Limited to maintaining 40-foot and smaller buses. Supports 11 Proterra fast-charge battery-electric buses, and one fast charger. Stalled bus parking available.
South Campus			273				
South Base	1979	16 (South Base)	273	260	280	5%	Part of larger campus that includes Component Supply Center (CSC) and South Annex.
South Annex Base			–	–	–	–	
North Campus			202				
North Base	1991	12	202	175	205	15%	Community agreement limits base to 225 buses. Surrounded by residential area.
New Base			–	–	–	–	
Total		86	1,610	1430	1600	13%	

* Results of base capacity model analysis of fall 2018 fleet assignment; capacity number represents approximate upper limit of range



SECTION 3:

Operational Capacity Growth Strategy

This section describes the Operational Capacity Growth strategy that Metro developed to accommodate near- and long-term service growth, support efficient operations, and transition to a zero-emission fleet. It sets out an ambitious schedule, and there will be some periods of constraint along the way, even as Metro moves forward to implement the approach.

The strategy focuses on projects at Central Campus and South Campus as well as a new base, anticipated to be in South King County. Based on initial review, these project areas provide the best opportunities to achieve Metro's growth targets on the timeline needed. Metro will also continue to explore opportunities to optimize capacity at North Base and East Campus. In future planning, Metro will consider opportunities for co-development and building vertically.

The recommended projects are summarized below and further described in the pages that follow. More detail about how the strategy was developed can be found in Section 3 (Developing the Strategy, Schedule and Cost Estimates). Suggestions made by the consultant team to help speed up project implementation, including project delivery methods and resources, can be found on page 20.

Operational Capacity Growth Projects

Central Campus (Atlantic/Central/Ryerson bases)

1. **Convert Maintenance Bays (2022).** Convert four body shop bays to maintenance bays.
2. **Extend Central Campus (2024).** Build a new facility on Metro-owned land adjacent to Central Base with a body shop, wellness center, and expanded transit safety and security system facilities.
3. **Expand Central Campus (2023-2025).** Acquire property to build additional bus facilities and parking.

These projects build on an earlier Central Base project that demolished old buildings, relocated non-core functions, and implemented yard efficiencies, adding parking capacity for about 60 buses.

Find details about the Central Campus projects on pages 14–15.

South Campus

1. **Build an Interim Base (2020).** Install temporary operating and maintenance structures and provide for battery-bus charging, adding capacity for 125 buses to support near-term fleet growth. The temporary base would be retired when permanent base facilities are available.
2. **Upgrade Parking Garage (2019)** for Metro use.
3. **Build a New Permanent South Annex Base (2025).** Relocate nonessential functions, demolish or relocate existing structures, and build permanent facilities for yard, operations and maintenance, and battery-bus charging, adding capacity for approximately 250 buses.

Find details about the South Campus projects on pages 16–17.

New Base

1. **Build an Additional New Base.** Likely to be located in South King County to efficiently support future service growth. This base probably would have infrastructure for zero-emission buses only, and would offer new opportunities to create jobs, to lower health risks by reducing emissions, and to enhance service in communities that depend heavily on transit. This base would add capacity for approximately 250 buses on or after 2030.

Find details about the new base project on pages 18–19.

North Base and East Campus

North Base is currently limited by a neighborhood agreement, and the East Campus is experiencing pressure from surrounding development as Link light rail expands. Metro will continue to seek opportunities to maintain and optimize capacity in these areas.

1. Focus near-term efforts on preserving existing base capacity against development pressure and continue to optimize operations.
2. Consider alternatives as part of future planning efforts to support increased demand in North and East King County. Strategies to consider include seeking opportunities for innovative solutions to add operational capacity, such as building vertically and co-development with other functions (housing, for example).

Advancing Environmental Sustainability in the Operational Capacity Growth Strategy

Metro prioritizes sustainability in capital projects in order to support a healthier environment with improved air quality and resource conservation, stronger communities, financial sustainability through reduction of waste and life-cycle costs, and healthier work environments for our employees. Green building is an integrative process in the planning, design, construction and operations of facilities to maximize the positive and mitigate the negative impacts over the life cycle of a structure. King County's Green Building Ordinance (GBO) and the County's Strategic Climate Action Plan (SCAP) outline specific goals to reduce facility energy use, increase renewable energy consumption, encourage adoption of the highest green building standards, and reduce construction and demolition waste to landfills. This policy requires all new buildings and major modernizations to strive to achieve Leadership in Energy and Environmental Design (LEED) Platinum certification by 2020. Facilities where LEED certification is not applicable are required to meet an equivalent score with King County's Sustainable Infrastructure Scorecard, or other certification standards (such as Envision).

The Strategic Climate Action Plan sets out the following goals and targets:

- King County will reduce normalized energy use in county-owned facilities by at least 7.5 percent by 2020 and 10 percent by 2025, as compared to the 2014 baseline.
- By 2025, Metro will ensure all electricity supplied for operations is from renewable sources.
- Facilities will meet the equivalent energy performance of the most progressive energy code in King County (for example, 2015 Seattle Energy Code).
- Metro will implement a life-cycle cost analysis of alternatives for large capital projects with energy-using equipment. This will compare alternatives relative to historical energy use and energy code. The results will consider including the social cost of greenhouse gas emissions in addition to energy costs.
- All new facilities over 200 square feet must consider future solar integration.
- Construction and demolition contracts will specify diversion from landfills of 85 percent by 2025 and zero waste by 2030.
- By 2030, all King County projects shall achieve certifications that demonstrate a net zero greenhouse gas emissions footprint for new facilities and infrastructure.

The cost estimates prepared for this report include costs for green building elements based on current policies. Policies and criteria related to sustainability will continue to evolve. All projects need to accommodate these requirements and plan for them throughout the process.

Planning for Electrification

Metro set a goal of converting to a 100 percent zero-emission fleet by 2040. To meet this target, we will need to add and replace existing buses with electric trolley buses and battery-electric buses.

The battery-electric bus and charging infrastructure industry is rapidly developing. Battery-electric bus technology is in its infancy, and battery technologies, capacities, energy density, and charge power rates, as well as management schemes, are all evolving.

We know that electric buses' space and power requirements will differ from those of diesel-hybrid buses, but we don't fully know what those requirements will be. To adapt to innovations, Metro must plan for flexible use of space and consider both bus technology and electrification of base sites.

Bus Technology

Bus technology is foremost in the transition to a battery-electric fleet. Metro needs battery-electric buses that can meet its service requirements. Buses must be able to climb hills without sacrificing the number of passengers being carried, have options for 60-foot articulated buses to meet capacity requirements, have common charging standards, and be able to travel far enough to cover Metro's routes.

Metro has been testing fast-charge, 40-foot buses but is awaiting proven technology for extended-range 40- and 60-foot buses. A 60-foot battery-electric bus meeting Metro's specification is not currently available, although Metro just launched a year-long pilot of 40- and 60-foot extended-range buses in late 2018. Currently, we are considering providing mostly slow-chargers to support extended-range buses with a smaller percentage of fast-chargers on Metro bases.

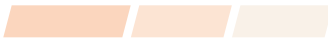
There are some challenges and considerations with the adoption of battery-electric buses:

- High demand for battery-electric buses in the U.S. can lead to bus delivery delays.
- Bus quality, documentation and training support can be inconsistent.
- Buses that can travel extended ranges require heavier batteries, may exceed roadway weight limits when carrying typical passenger loads, and may require different maintenance equipment.
- A battery-electric bus fleet will potentially require a higher spare ratio, at least in the early years, which in turn will affect the amount of base capacity needed.

Electrification of Base Sites

Electrification of Metro's facilities must consider several factors:

- **Challenges in quality, availability.** Metro and other transit agencies are experiencing failures with charging infrastructure and occasional long-lead times to receive repair parts.
- **Limited industry experience with large-scale applications of charging infrastructure.** In North America, transit agencies are conducting small-scale operational tests of charging infrastructure, including testing of multiple manufacturers. No transit agency has yet attempted to scale battery-electric buses to the size of an interim- (120 buses) and full-size (250 to 275 buses) base.
- **Lack of interoperability.** Charging infrastructure is not currently compatible between different manufacturers or vehicles.
- **Quick-charging versus extended range buses currently require different infrastructure.** This can affect where that infrastructure is located (at a base versus in the field), and how bus service is designed.
- **More space required.** Bases will likely require more room to house charging infrastructure.
- **Transit agencies will become major consumers of electricity** to support the charging of battery-electric buses.
- **The cost to deliver this infrastructure is hard to estimate** because the technology is evolving.
- **Large-scale power upgrades to existing or new sites will require careful timing and coordination** with power utility companies, permitting groups, and the communities whose support is needed to eliminate bus emissions from the routes served.



Metro as an Industry Leader

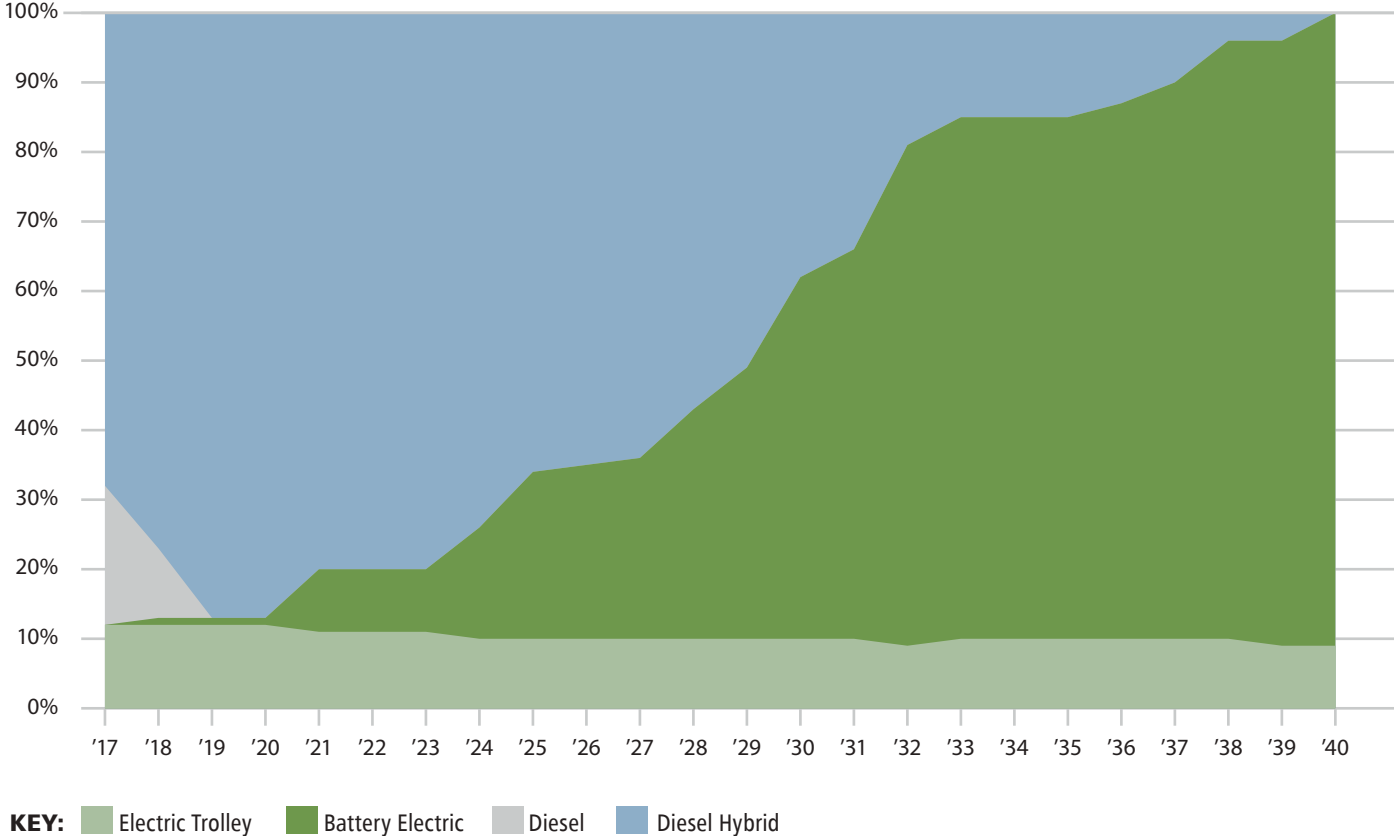
Metro is taking a major first step toward our zero-emissions target by planning for our interim 125-bus base to be ready for battery-electric bus operations in 2021. This base will support the planned purchase of 100 battery-electric buses by the end of 2020, and will place Metro at the forefront of developing large-scale battery-electric bus bases in North America.

This effort requires coordination with utility partners and local stakeholders to achieve successful on-schedule and on-budget completion by 2021. The lessons learned from this capital project will inform requirements for charging standards, safety, and design-and-construction methods. The lessons learned will facilitate 100 percent electric bus (battery/trolley) operations before 2040 and inform future projects. The new South Annex Base will also be built to support all-electric bus charging. Metro then plans to retrofit its existing bases for electric-bus charging.

2019 Zero-Emission Bus Transition Plan

Metro will develop a transition plan over the next year to further define our conversion to a zero-emission fleet. We will consider lessons learned from our current battery-electric bus pilot deployment, other large-city pilot projects, and industry literature research and from our involvement in industry groups such as International Bus Benchmarking Group, American Public Transportation Association, Electric Power Research Institute, and Society of Automotive Engineers.

Figure 4. Metro’s Transition to a Zero-Emission Fleet



This projection assumes maintenance of our existing trolley fleet.

Central Campus

The three Central Campus projects would increase operational capacity by approximately 150 buses—90 spaces from expansion of the campus footprint and 60 from optimization and maintenance bay conversion.

These projects will require land acquisition and construction of new facilities to add yard space, convert the body shop to maintenance bays, and build a replacement body shop, wellness center and transit safety and security system expansion.

1 Central Base Maintenance Bay Conversion

- Conversion of four paint and body bays to four vehicle maintenance bays
- Cost: \$20M*

2 Central Campus Extension

- Construction of body shop, wellness center, and transit safety and security system expansion
- Cost: \$60M*

3 Central Campus Expansion

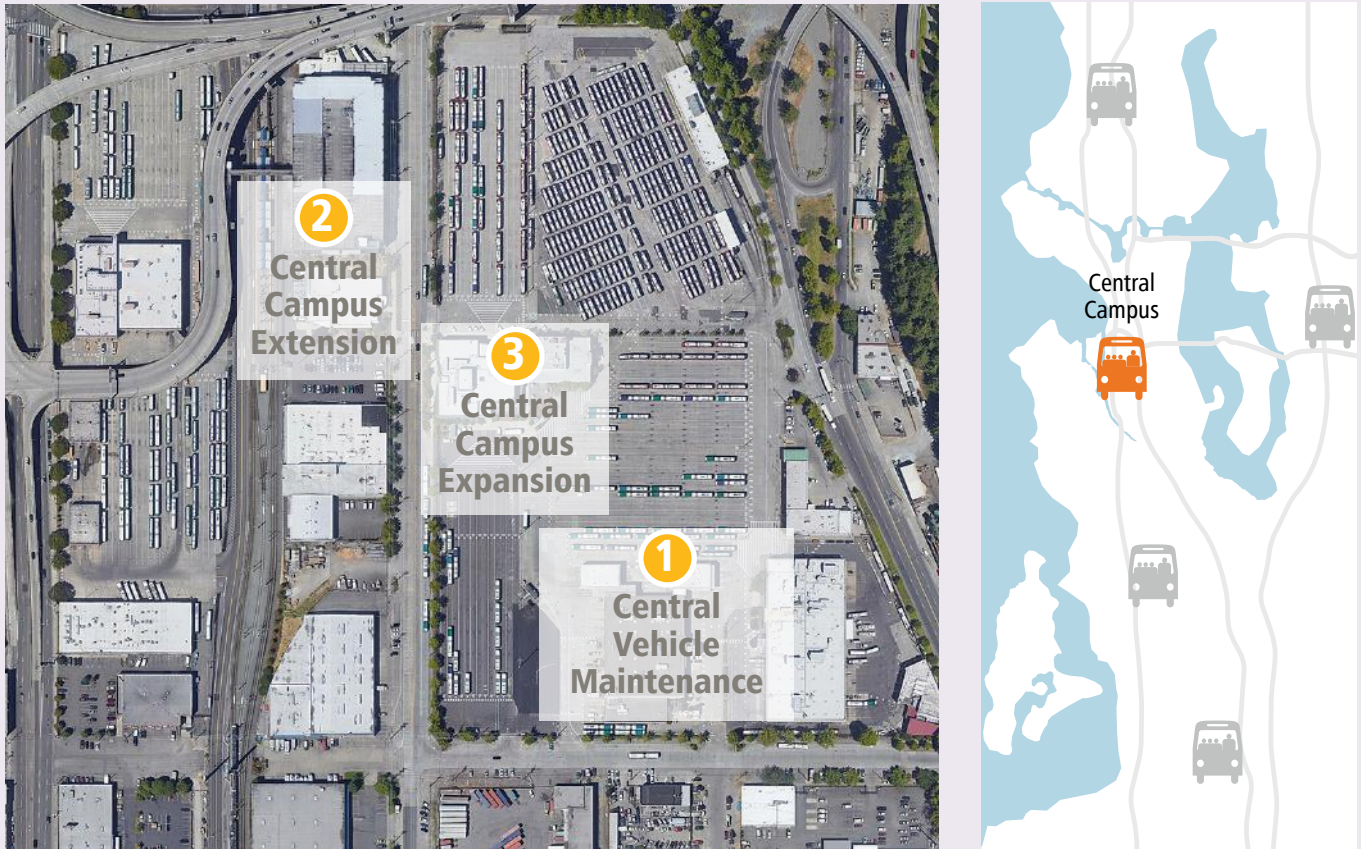
- Land acquisition and construction of bus facility
- Cost: \$159M (Metro estimate)

Central Campus Considerations

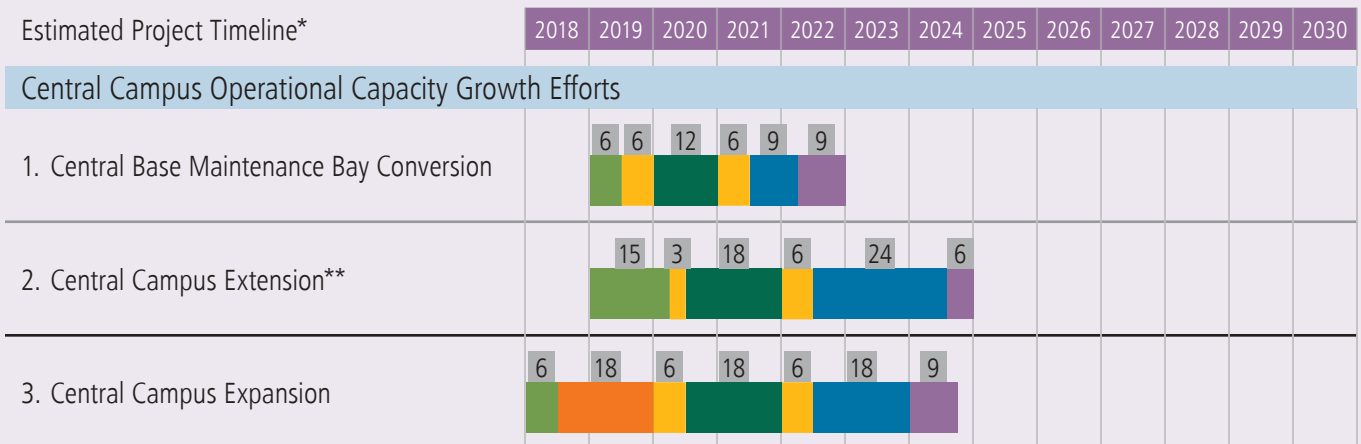
- The Central Campus Expansion will acquire property to build additional bus facilities and add parking for approximately 90 buses. The project is dependent upon property availability and cost.
- Sound Transit's ST3 West Seattle-Ballard Light Rail Extension is likely to impact the area and could impact property availability and project timing.
- The Central Base Maintenance Bay Conversion project completes a series of optimization projects and allows Metro to fully realize a capacity increase of about 60 buses.
- The Central Campus Extension will build a new facility on Metro-owned land recently made available by demolishing an aging warehouse.
- Metro will need to further consider the future mix of the electric bus fleet and the addition of battery-bus charging infrastructure to Central Campus.
- Additional operational capacity in the area may be needed during electrification.
- Some elements of the projects at Central Campus could lend themselves to an alternative delivery method that could potentially save time or money. Metro could evaluate available delivery methods to determine which method would provide the best balance of schedule, project cost, and project control goals.

* Cost estimates prepared in fall 2018 by consultant team.

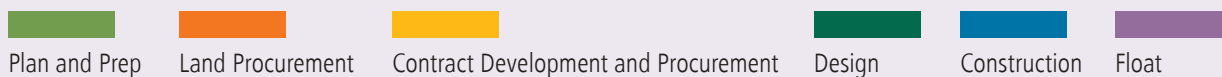
Figure 5. Operational Growth Strategy: Central Campus



Estimated Project Timeline*



KEY # = Duration in Months



* Estimated project timeline developed in fall 2018 by consultant team.

** Expansion timing dependent upon land cost and availability;

Sound Transit's ST3 West Seattle-Ballard Light Rail Extension will also potentially impact the area

South Campus

The South Campus strategy comprises several projects to increase operational capacity.

The major projects are a new permanent South Annex Base for approximately 250 buses by 2025, and a temporary Interim Base at the South Campus for 125 buses in 2020. The Interim Base will be built on recently acquired property and will require demolition of an office building and installation of temporary structures. Development of the South Annex Base will require relocating functions such as the Metro South Training facility, storage area, and historical fleet.

The Interim Base could later be converted to another use once the permanent bus base is completed.

1 Interim Base at South Campus

- Demolition and paving of Group Health office building and construction of facilities to support interim base needs
- Cost: \$33M* (does not include estimated cost of electrification)

2 Parking Garage Upgrades

- Retrofit parking garage for Metro use
- Cost: \$3M*

3 South Annex Base

- Planning, design, and construction of approximately 250-bus transit base on the South Annex Site
- Cost: \$337M* (includes \$200M for electrification**)

4 Interim Base Permanent Use

- Conversion of property to permanent use, to be determined
- Cost: \$26M* (representative project, assumes conversion to office and training facility)

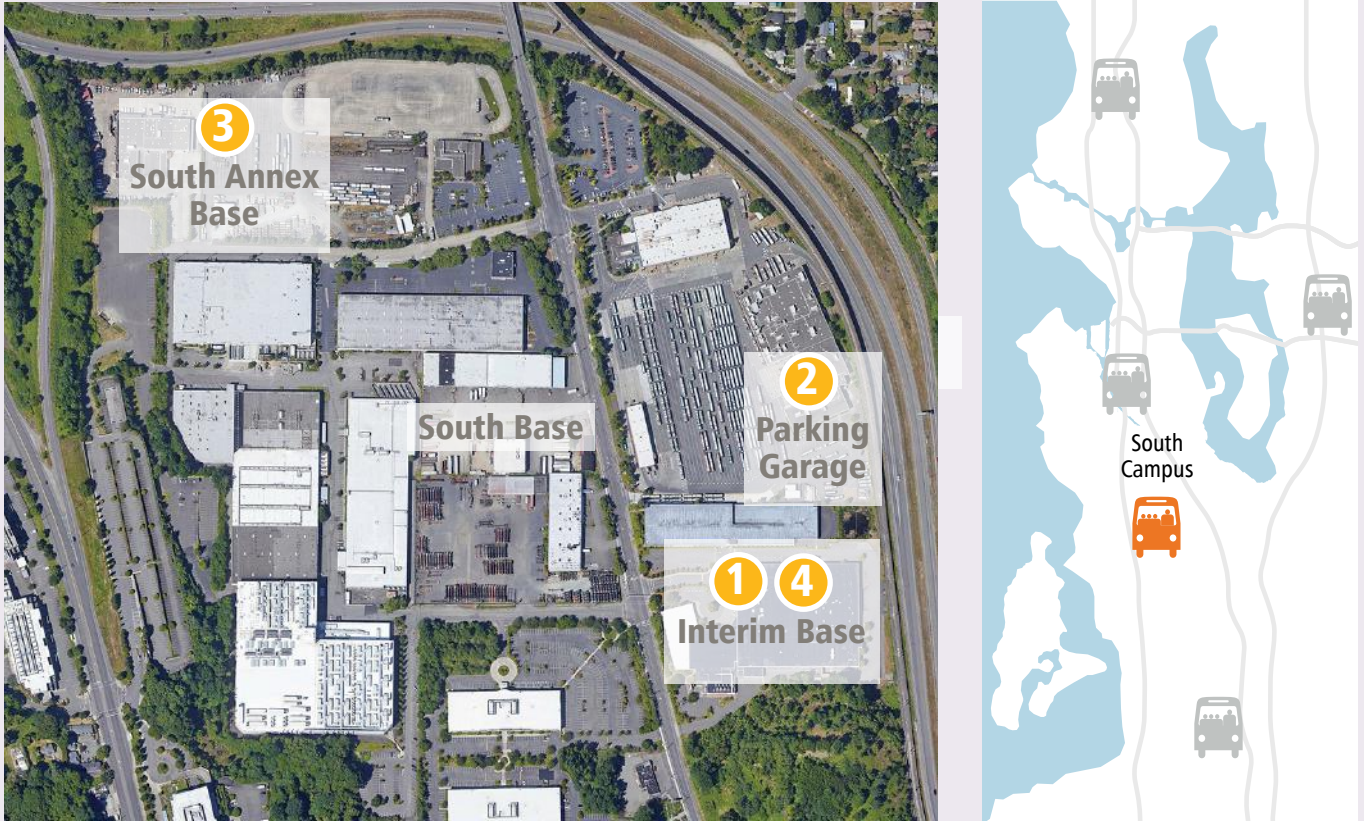
South Campus Considerations

- South Annex Base will be designed with the capability to support an all-electric fleet, but with flexibility to accommodate the fleet that is in operation at the time the base opens.
- To achieve the Interim Base target of opening in 2020, early work, such as demolition and grading, should be underway by 2019.
- Minor delays in contract development, procurement, design, or construction activities could delay the South Annex Base project timeline and lead to missing the target opening date of 2025.
- Future power needs for battery-electric buses could require considerably more electrical power to bases. Total future power demand for South Campus could be over 50 MW to support battery-electric buses.
- A standard design-bid-build project delivery method is likely the best approach for completing both the Interim Base and the South Annex Base on schedule. Metro does not yet have a history with other project delivery methods, which could cause delays for near-term projects.
- To decrease the number of contracts needed, Metro could consider delivering South Campus projects as part of a comprehensive design and engineering program contract. This approach could avoid potential delays associated with developing multiple separate contracts.

* Cost estimates prepared in fall 2018 by consultant team.

** Electrification includes provision of substations, power distribution, and charging infrastructure assumptions based on 2018 technology to support battery-electric bus fleet.

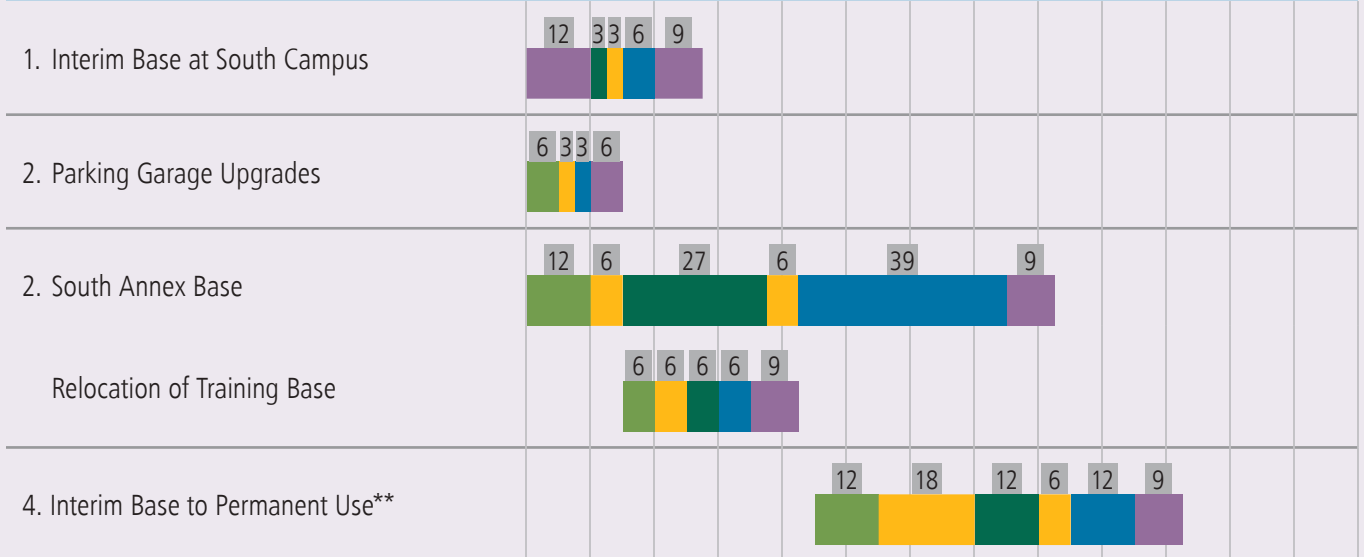
Figure 6. Operational Growth Strategy: South Campus



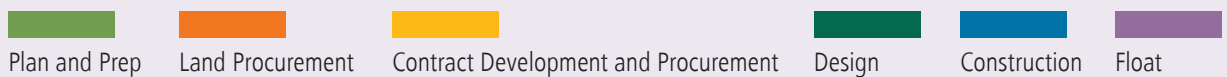
Estimated Project Timeline*

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

South Campus Operational Capacity Growth Efforts



KEY # = Duration in Months



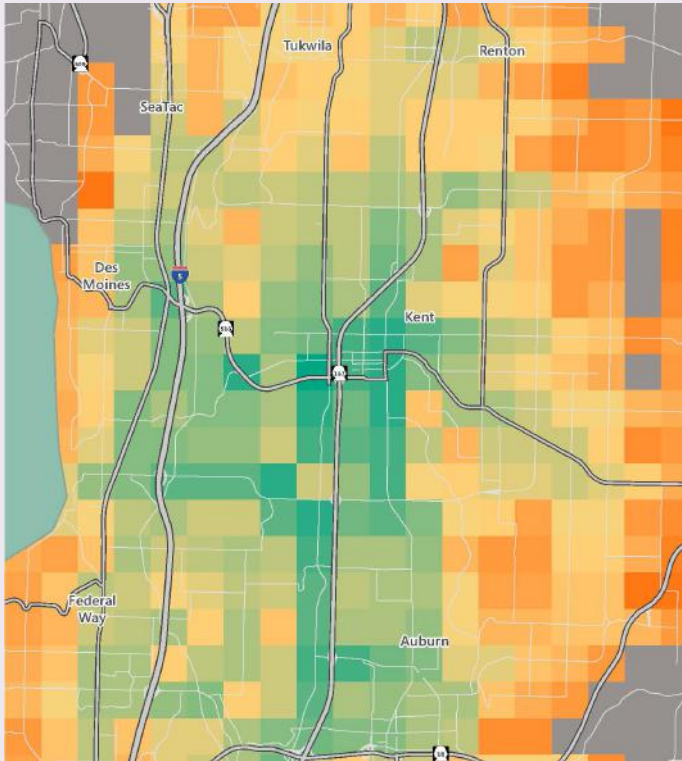
* Estimated project timeline developed in fall 2018 by consultant team.

** Timeline based on assumed conversion to office space.

New Base

Construction of a new permanent base, likely in South King County, will require siting, land acquisition, design, and construction. Metro plans to build a new base that is integrated with the surrounding community and built to high environmental standards.

It will be home to a battery-electric bus fleet that will be quiet and emission free. Construction and operation of the base will also bring economic and job opportunities to the area.



Travel Time
Assessment Map



Travel Time Assessment: This map shows the estimated travel time in minutes from every route end point included in the analysis to the center of each grid cell for different locations throughout South King County. The analysis focused on METRO CONNECTS 2040 routes that had start and end points south of Lake Washington. It estimated the bus demand for each route based on headways and run times and summarized the individual travel times associated with every route end point.

1 New Base

- Add new 250-bus base
- Cost: \$480M*

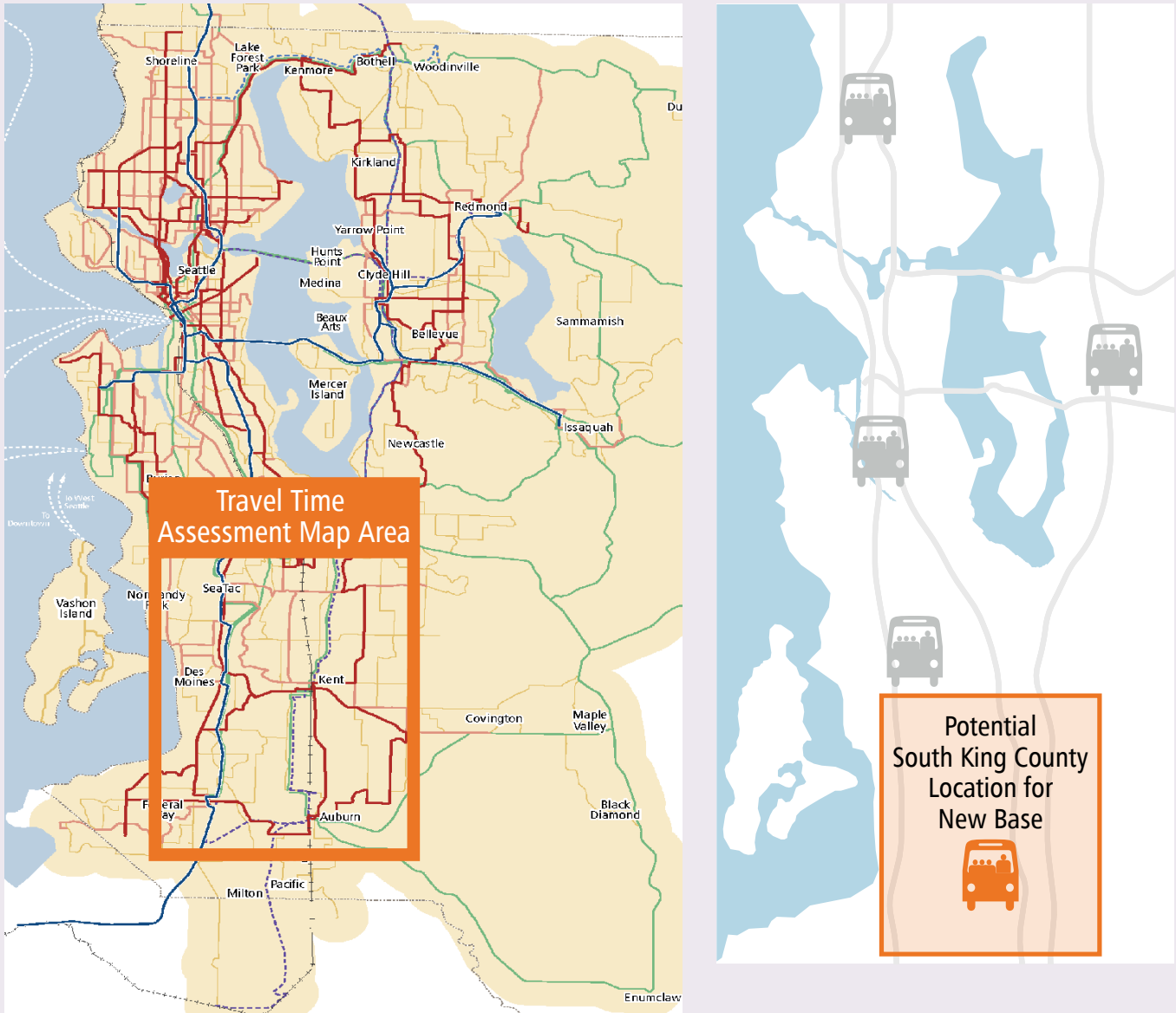
New Base Considerations

- The site will be located for efficient access to existing and future routes, likely in South King County.
- Construction will be timed to provide spare capacity while Metro retrofits existing bases for battery-electric buses. (New capacity: 250 buses during or after 2030)
- Because design and construction for a new base are projected to occur between 2024 and 2030, Metro has time to evaluate available delivery methods to determine which method would provide the best balance of schedule, project cost, and project control goals.

A new base could provide space for the displaced Safety & Training facility and historic fleet storage from South Campus.

* Project cost assumes all-electric bus base and includes land acquisition costs. Cost estimates prepared in fall 2018 by consultant team.

Figure 7. Operational Growth Strategy: New Base

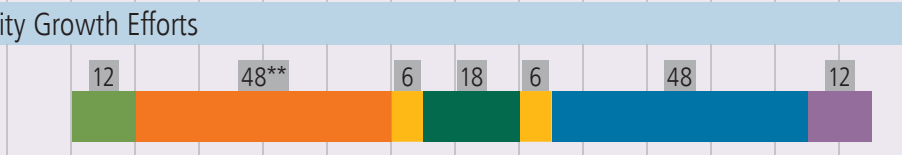


Estimated Project Timeline*

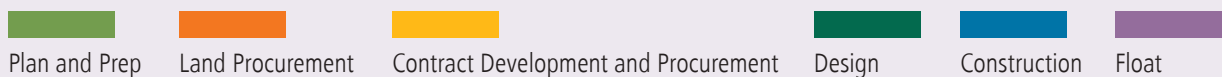
Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
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South King County Operational Capacity Growth Efforts

1. New Base



KEY # = Duration in Months




* Estimated project timeline developed in fall 2018 by consultant team.

** The land procurement phase is longer than customary because of the potential complexity of procuring a large parcel. It may require relocation of existing functions, seeking multiple parcels from different sellers and community engagement. It also includes alternatives analysis.

Key Considerations for Delivering Projects on Time

A key goal of the recommended strategy is to increase Metro's operational capacity as quickly as possible. Below are suggestions by the consultant team for delivering the projects on time, as well as the steps Metro is taking to implement these suggestions.

- **Using a traditional Design-Bid-Build is likely to be the most expedient approach for the near-term projects, up to and including 2025.** The Design-Bid-Build process is familiar and widely used at Metro, and would likely be the most expedient method to use for near-term projects. Future projects may be candidates for alternative project delivery methods, as mentioned below.
Metro's next steps: Metro is moving forward using the traditional Design-Bid-Build approach for the construction of the Interim Base at South Campus. The project is underway, and it is anticipated to be completed in the fourth quarter of 2020. Metro is in the process of analyzing various project delivery methods for the South Annex Base Project, which is scheduled to be completed by 2025. A decision on which delivery method is best for the schedule and the specifics of this project should come by the end of 2019.
- **Pursue opportunities to accelerate the contract development and procurement processes.** Metro should strive to keep the contracting process as short as possible, ideally about three to four months from request for proposal to contract execution. This may involve engaging Metro's procurement subject matter experts or King County Procurement early in the process to discuss contracting options available to best execute the project contracts in the shortest timeframe.
Metro's next steps: In March 2019, Metro will launch a two-year pilot project with King County Procurement to incorporate dedicated procurement resources to Metro. The pilot will look to streamline communication, incorporate procurement expertise early in the planning strategy, and identify procurement priorities among Metro's various contracts.
- **Establish one large design and engineering contract for all the improvements at South Campus.** One contract could cover multiple interrelated projects, avoiding the need to develop and procure multiple contracts and minimizing breaks between planning and design phases. This approach could also maintain continuity between projects and allow for flexible workflow prioritization through completion of design. The construction would likely need to be covered by a separate contract. Metro would need to consult with King County Procurement as early as possible to develop such an approach.
Metro's next steps: Metro is currently drafting a scope for a joint planning/design consultant for the South Campus and will engage King County Procurement to consider this approach. We intend to establish more comprehensive planning/design contracts for major programs going forward.
- **Develop a strategy for evaluating and implementing alternative project delivery methods.** Metro traditionally uses a Design-Bid-Build approach to project delivery. Other project delivery methods are available, such as Design-Build, General Contractor and Construction Manager, and Progressive Design-Build. They each have different advantages and disadvantages. Metro may want to develop a framework to evaluate which delivery methods would be appropriate and most expedient for which future projects.
Metro's next steps: Metro is analyzing alternative project delivery methods and is developing a framework to identify the appropriate project delivery method for projects within the Operational Capacity Growth Program. We are including experience with alternative delivery methods in criteria for new hires within the program to help further our internal understanding, as well as engaging consultants to assist in development of criteria to evaluate the effectiveness of alternative delivery on specific projects.

- 
- **Identify equipment and materials that have long lead times, and purchase early to avoid lengthy construction delivery schedules.** This could include some steel elements, maintenance equipment, and electrical equipment, such as charging stations.

Metro's next steps: For the Interim Base at South Campus, Metro has taken steps to order long lead items in advance to accelerate project completion and bring the base online as soon as possible. Metro will continue to consider this strategy for projects that are on a tight timeline. When Metro purchases items directly, it allows us to plan purchases earlier because we do not have to wait for a contractor to be awarded but we own the risk if the item does not work properly. Metro will also work to incorporate contract language that identifies items that may be beneficial to buy early.

- **Ensure adequate agency staffing to support a growing capital program.** The Operational Capacity Growth strategy entails a bigger capital program than Metro has undertaken in recent years. It is critical to ensure there are sufficient staff with the appropriate training and qualifications to support delivery of large-scale capital development. Metro may want to consider using consultant resources to supplement staff.

Metro's next steps: Metro is in the process of reorganizing and increasing its staff. We also plan to engage a consultant group on a work order contract to augment our staffing and skillsets in the areas where additional expertise or effort may be required.

- **Pursue multiple strategies for acquiring land.** To reduce the risks associated with purchasing property in a highly competitive market, Metro should pursue numerous strategies for identifying and acquiring land.

Metro's next steps: Metro is employing numerous strategies for identifying and acquiring land. In order to reduce the risks associated with purchasing property in a highly competitive market, Metro contracts with local brokers to provide insight into the current and speculative market for sales and leasing of suitable property. Lists of potential properties are vetted on an ongoing basis as they become available. Metro also monitors surplus real property notifications from King County and other public agencies for property suitable for base capacity growth. Metro also periodically works with other King County departments and other agencies such as City of Seattle, Sound Transit, and Port of Seattle to discuss opportunities for co-locating compatible functions or to lease/acquire property.

Factors to Consider in Base Development and Operations

Land Availability and Costs

The acquisition of property for a new or expanded base is a challenge. Land parcels must have adequate space, meet applicable zoning requirements, and have reasonable mitigation requirements. Expansion opportunities at Metro's existing facilities are limited by existing zoning and adjacent properties.

Metro continually monitors opportunities to acquire suitable property. We track markets for property to buy or lease, and monitor surplus real property notifications from King County and other agencies.

Although public agencies have the right to condemn property, Metro limits the use of this tool as much as possible, preferring to find available land from willing sellers. If condemnation is necessary, it can be a lengthy process and should be accounted for in project schedules.

The location, topography and amount of developable land are important considerations in land acquisitions. Larger, flat parcels are more readily available in outlying areas of King County, and are extremely scarce in urban areas. As industrial land is diminishing throughout the county, co-location with other King County departments or other agencies with similar property needs should be considered for cost efficiency.

With a decreasing supply of suitable land, Metro may also consider innovative opportunities for expansion, such as building vertically on existing bases. This type of construction can have an impact on existing operations, so the system must have enough capacity to support disruption during construction. Another potential innovation is co-development with other functions such as housing.

As development increases the cost and availability of property in King County, it is critical that Metro pursue needed property as soon as possible.

Permitting and Environmental Requirements

The process for obtaining environmental permits and approvals for a new bus base depends on a variety of factors, including the size and complexity of the project, land use and natural resource limitations, the use of federal or state funds, and the involvement of agencies with jurisdiction over the project. The development of project alternatives should consider all factors that will influence implementation schedules. Once the scope of the project has been clearly defined, an environmental strategy can be developed that accounts for permitting requirements, such as public and agency review, the presence of environmentally-sensitive areas, design documents, and mitigation needs.

Base Operations and Functionality

Metro has a combination of centralized functions and decentralized or distributed functions. The Component Supply Center provides centralized functions, such as major body repair and component fabrication for the entire system. Distributed activities at each base include inspections, light repairs, and ongoing maintenance. This approach has been developed over time as an efficient way to minimize duplication of certain services while ensuring that each base can function effectively. As Metro expands, existing and new bases would need to provide for similar operating and maintenance activities.

The size of Metro's existing bases ranges from eight to 30 acres. The size requirement of a bus base is dependent on the number of buses, types and sizes of buses, mix of other vehicles, maintenance facilities, driver support areas, and other functions on the property. Industry review and experience have shown that operational challenges arise when a bus base exceeds 250 to 275 vehicles. 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 surrounding roadways
- Longer distances for operators to get to and from their assigned vehicles

This report assumes continuing the current approach to centralized facilities for functions already centralized. The size of the new base is intended for a capacity of 250–275 buses.

This strategy also includes relocating certain flexible functions at South and Central campuses to create more space for buses. A flexible function is one that is not essential to daily bus operations and could be located somewhere other than a bus base. Options include finding space at existing Metro or other King County facilities, leasing facilities, or acquiring property. Permanent locations will require further study. Some functions could be included in new facilities.



SECTION 4:

Developing the Strategy, Schedule and Cost Estimates

The Operational Capacity Growth strategy was developed by Metro with the assistance of a team of consultants that included transit industry experts in base design and construction, program implementation, and project delivery.

A three-step process was used to develop the strategy, which included identifying the capacity need, identifying opportunities to increase capacity and developing and refining specific projects, schedule and cost estimates.

Step 1: Identify Operational Capacity Needs

Metro estimated the operational capacity demand for the METRO CONNECTS 2040 service network. Buses are ideally operated out of a location that is close to the start or end of service or along a route. This helps keep operating costs down by minimizing the amount of time buses need to be driven while out of service, otherwise known as “deadheading.”

This analysis considered:

- The number of buses needed for each METRO CONNECTS route based on headways and run times.
- The travel times between the projected route’s start and end points to Metro’s bases.

Findings

- **Increased service demands will require the equivalent capacity of two to three additional bases across the county.**
- **From the perspective of minimizing deadheads, South King County has the greatest demand for base capacity expansion.**
- **Many routes have multiple options for efficient base assignment with little impact to operational costs.** A bus can be dispatched from a base near its end point, a base near its start point, or somewhere along its route with little impact to operational cost.
- **Central and South Campuses offer the most flexibility** for fleet assignment in that there are a lot of routes that either start, end, or pass by them.
- **There is future demand for more capacity at North Base and East Campus** due to the overall growth in the system envisioned for 2040. Metro should consider this when planning for future base capacity.

More information about the demand analysis can be found in Appendix A.

Step 2: Identify Opportunities to Increase Operational Capacity

In comparing the operational capacity demand with the existing capacity, it is clear that Metro must increase operational capacity to meet future demand. As of November 2018, Metro’s system was about 13 percent above optimal capacity, with individual bases ranging from 5 percent to over 20 percent above capacity. (See Table 4). In this step, Metro considered four different approaches to increase base capacity.

Approaches to Increase Operational Capacity

- **Optimize capacity of existing facilities.** Increase capacity through efficiencies such as modifying facilities, modifying or improving operational practices, or creating additional space by relocating flexible functions to other locations. A flexible function is one that is not essential to maintaining daily bus operations and could potentially be located somewhere other than a bus base.

- **Expand facilities or build new facilities.** Increase capacity by expanding existing bus bases, building new facilities, or purchasing property to build new bases.
- **Lease facilities or property.** Use long- or short-term leases of temporary facilities to help offset capacity demand. This can help with ongoing capacity concerns or alleviate temporary crowding when improvements are made to current bases.
- **Address demand through contracting or partnerships.** Industry review and peer interviews found that some transit agencies contract with partner services for functions such as maintenance and service operation which can help alleviate agency capacity issues.

Findings

Based on review of the different approaches, the most promising option would be to optimize existing facilities and pursue expansion and leasing. Metro ruled out contracting at this time since contracting would be challenging or not possible under Metro’s existing labor contracts. It may be difficult to find organizations or partners who could offer the needed services.

Evaluating the Approaches

Metro’s findings were based on a multi-step review of its facilities and properties to determine which areas offered optimization or expansion opportunities. The following factors were considered in the review.

- **Optimization.** Consideration of opportunities to improve the use or efficiency of a facility or property.
- **Suitability for construction and operation of a base.** Factors to consider include accessibility, code requirements, zoning, environmental impacts, easements, size, and configuration.
- **Availability.** Factors include whether Metro owns the property, who owns the property if it’s not Metro, how many owners are involved, whether there are tenants who would need to be relocated, and the property cost and market availability.
- **Network efficiency.** Factors to consider include locations that minimize deadhead hours and provide good access to major highways and arterials.
- **Economies of scale.** There are measurable benefits such as opportunities for cost efficiencies and shared resources when bus bases are located near each other. Proximity to other Metro facilities and properties was considered.
- **Community integration.** Expanded and new facilities are ideally located in areas that are zoned for industrial use and are supported by the local community. Factors considered include surrounding land use, development patterns, and neighborhood characteristics.

Optimization Opportunities *(See Table 2 for details.)*

Central Campus and South Campus were identified as offering the best opportunities to create more space to park and maintain buses.

- **Central Campus.** Current optimization efforts at Central Campus include the demolition of the old Operations Building, demolition of an aging warehouse, the relocation of non-core functions to other sites, and the implementation of yard efficiencies. These improvements have added parking capacity for about 60 buses. Further optimization can be achieved by increasing the maintenance capacity of Central Base to support the increased parking capacity.
- **South Campus.** Review of the South Campus determined that the South Annex property could be repurposed to support the construction of a new base. The site is a suitable size and location, and the flexible functions currently located on South Annex could be relocated to other locations. A primary benefit of this approach is that it uses land Metro already owns, which can expedite the construction of a new base.
- **North Base and East Campus** were determined to have limited optimization opportunities at this time. Neither base houses flexible functions that could be relocated. Looking forward, expansion planning will include exploration of opportunities for innovative solutions, including building vertically and co-development with other uses such as housing.

Table 2. Optimization Opportunities

Flexible Function	Observations	Findings
Central Campus		
<p>Revenue Processing Center (RPC)</p> <p>The RPC counts and processes fares.</p>	<ul style="list-style-type: none"> Built in 1990; has ample service life left as a facility. Cash payments may become limited as fares transition to cashless. Hardened facility due to cash handling; could be difficult to find suitable space to lease for relocation. 	<p>Not recommended for relocation.</p> <p>It would be inefficient to demolish and rebuild RPC because of the potential for limited future need for cash handling. It would be difficult to lease a suitable facility for this purpose; thus, RPC should remain until the future of cash fares is clearer.</p>
<p>Non-Revenue Vehicle (NRV) Building</p> <p>This building includes maintenance bays for NRV and office space for central facilities and security.</p>	<ul style="list-style-type: none"> Built in 1990; has ample service life left as a facility. NRV building occupies a triangular portion of central yard. NRV function is critical to Metro operation and would have to be relocated. NRV function is multi-bay maintenance facility; it may be difficult to find suitable space to lease for relocation. 	<p>Not recommended for relocation.</p> <p>The NRV building occupies a triangular space of the Central Campus yard that would be inefficient to convert to bus parking, potentially offering limited returns in bus parking for the sizable expense of demolition and reconstruction of the facility.</p>
<p>Body Repair (within Central Base Vehicle Maintenance Building)</p> <p>This space provides body repair services to Metro buses.</p>	<ul style="list-style-type: none"> Built in 1990; has ample service life left as a facility. Part of the Central Base Vehicle Maintenance Building. Function can be relocated (as per Vehicle Maintenance leadership). Major Works to CSC body shop and minor work distributed across multiple bays. Conversion would create four additional vehicle maintenance bays adjacent to existing vehicle maintenance functions, creating efficiencies. 	<p>Recommended for potential temporary relocation with permanent future location in the Central Campus</p> <p>Body Repair Bays within Central Base offer prime opportunity to create additional vehicle maintenance space at Central Campus while permitting relocation of the work to alternate, existing facilities. Relocation is best provided on a temporary basis, as there is need for a long-term body shop solution in the Central Business District. This future facility could serve an expanded need as the fleet increases.</p>
<p>Ryerson Base</p>	<ul style="list-style-type: none"> No flexible or nonessential functions on the base. 	Limited opportunity for further optimization
South Campus		
<p>Component Supply Center (CSC)</p> <p>This space provides rebuild services for Metro bus components (such as engines and battery packs).</p>	<ul style="list-style-type: none"> Built In 1979; has limited expected service life remaining. CSC function is critical to Metro operation and would have to be relocated prior to decommissioning building. CSC function is multi-bay maintenance facility with specialized shops. May be difficult to find suitable space to lease for relocation. CSC functions are likely to evolve with deployment of electric buses, driving different facility needs than present; however, those needs are not currently definable. 	<p>Potential future action. Not recommended at this time.</p> <p>CSC is an ideal target for rebuilding as it is nearing the end of its service life; however, with the current evolutions in bus technology and the difference in component rebuild needs between diesel and electric vehicles, it is an inopportune time to complete a redesign/rebuild. Metro needs to better understand electric bus technology to define the needs of a future facility and thus recommends delaying any relocation, redesign or rebuild of CSC until more is known about long-term maintenance needs of electric buses.</p>
<p>South Annex</p>	<ul style="list-style-type: none"> Built in 1978; site of Safety and Training Building, yard space storage, and a bus training pad. Includes offices for Safety, Training, and Fleet Engineering staff. Includes classrooms and fleet engineering training bay. Includes yard space for storage and a training loop for bus operators. Site of Design & Construction Building B modular office. 	<p>Recommend relocating functions from South Annex to clear space for permanent base construction.</p> <p>Safety and Training and Fleet Engineering have outgrown their space. The Safety and Training Building is near the end of its useful life and these are functions for which it is feasible to find leased property to support.</p> <p>Stored items in the yard can be relocated without impeding daily operations.</p>
<p>East Campus</p>	No flexible or nonessential functions on the base.	Will continue to explore optimization and innovative approaches such as co-development and building vertically.
<p>North Base</p>	No flexible or nonessential functions on the base.	Will continue to explore optimization and innovative approaches such as co-development and building vertically.

Expansion Opportunities *(See Table 3 for details.)*

South Campus and Central Campus also offer the best opportunities for expansion on the timeline needed. South King County is the most promising location for a new base.

- **Central Campus.** The Central Campus offers opportunities to expand on both property Metro already owns, and on adjacent property Metro could acquire. With the clearing of the old warehouse on Sixth Avenue, there is available land that could be used for base support functions. The land use surrounding Central Campus is currently consistent with the construction and operation of a bus base. As noted in Step 1 of this analysis, the Central Campus was identified as an efficient base location with the flexibility to support near- and long-term service. There are also economies of scale in growing an existing campus.
- **South Campus.** South Campus offers expansion opportunities because Metro owns property that could be built upon, land use is consistent with construction and operation of a bus base, and there are economies of scale in constructing nearby facilities that Metro already owns and leases. There may also be opportunities to purchase or lease additional land in the area to support additional growth.
- **A New Base.** As noted, Metro needs capacity beyond what it can achieve by optimizing or expanding its existing properties. Given the base capacity demand and prospective land availability in South King County, it is logical for Metro to pursue property acquisition in that area.
- **Leased Property.** Metro is also pursuing opportunities to lease property to support operational capacity growth. Leased properties can be used for a range of purposes from parking coaches and non-revenue vehicles and providing office or training space for functions that are displaced as part of this strategy.

Similar to searching for leased property, Metro also explored opportunities to use surplus property from Metro and other King County departments. As the strategy was being developed, there were no properties that met the immediate needs for operational capacity growth. However, Metro will continue to monitor surplus properties as part of its overall land acquisition strategy.

Metro reviewed opportunities for physical expansion, such as expanding existing bus bases, building new facilities or using leased property, the results of which are below.

Table 3. Review of Expansion Approaches

Facility Location	Expand on Adjacent Property	Build New in New Location
NORTH BASE	<ul style="list-style-type: none"> A neighborhood agreement limits the bus parking to 225 buses. Unlikely to be able to expand on adjacent property, because of surrounding residential area and neighborhood agreement. 	<ul style="list-style-type: none"> There may be an opportunity to buy property in the north service area; however, there is a limited number of large parcels. The cost of real estate in north Seattle, Shoreline is moderately high for King County. Metro could explore other opportunities for future expansion in North King County to support long-term system growth.
EAST CAMPUS Bellevue Base East Base	<ul style="list-style-type: none"> Metro does not own any adjacent parcels. The surrounding areas are transitioning from light industrial to commercial and transit-oriented developments, largely due to the implementation of Sound Transit’s East Link rail extension. A third-party agreement in the Spring District limits the availability of land Metro could purchase. The cost of real estate in Bellevue is high for King County. 	<ul style="list-style-type: none"> There may be opportunities to buy property on the Eastside; however, there is a limited number of large parcels. The cost of real estate in Bellevue, Redmond, Issaquah, and other eastside communities is high for King County. Metro could explore opportunities for future expansion on the Eastside to support long-term system growth.
CENTRAL CAMPUS Central Base Ryerson Base Atlantic Base	<ul style="list-style-type: none"> Metro owns property and facilities adjacent to the Central Campus. With the clearing of the lot per the Atlantic/Central/Ryerson Master Plan, there is available land that could be used for base functions such as a paint and body shop. This would facilitate the conversion of the maintenance bays at Central Base. 	<ul style="list-style-type: none"> Metro will continue exploring opportunities for expansion at Central Campus. Metro will continue to watch for the sale of neighboring parcels for strategic acquisition. It is difficult to predict when parcels will become available for purchase.
SOUTH CAMPUS South Base South Annex Component Supply Center (CSC)	<ul style="list-style-type: none"> The recently purchased Group Health property and Metro’s South Annex provide opportunities for constructing new base facilities. Metro already owns both sites. 	<ul style="list-style-type: none"> The area of South Base as well as property further south offer strategic locations to support efficient bus operations as well as potential to support other flexible functions. Metro continues to scan the area for available property.
NEW BASE South King County	Based on analysis of the envisioned 2040 service network, a new location in South King County offers operational benefits.	<ul style="list-style-type: none"> Initial property review suggests there may be suitable property for purchase. Building a new base will provide long-term expansion and allow for battery-electric bus infrastructure to be implemented on a new site.

Step 3: Identify Specific Projects, Cost and Schedule

During this step, Metro defined more detailed project concepts with consideration of the findings of Step 2 and developed a projected schedule and costs. The Operational Capacity Growth strategy is projected to be implemented between now and 2040, as shown in Figure 8, to achieve stable operations at its bus bases with sufficient capacity to enable system growth and the transition to a zero-emission fleet. The development of the proposed projects, cost and schedule built upon a process which involved:

- A workshop to brainstorm ideas with Metro employees from across the agency and transit industry experts.
- Peer agency interviews and industry review.
- Input from subject matter experts from across all disciplines of the transit industry.
- Information gathering, including tours of five of Metro’s facilities: North Base, East Campus, Central Campus, and South Campus.

Project Schedule and Cost Estimates

The Operational Capacity Growth strategy includes a project schedule and cost estimates that were developed by the consultant team in fall 2018 with input from Metro staff.

Project Schedule

The schedule assumes a shorter contract development and procurement time for construction packages than Metro has typically achieved on past projects. The schedule and cost estimates are based on a traditional design-bid-build approach. Some projects might be implemented faster or for less money with an alternative delivery method, depending on the timing and type of project.

The schedule provides some contingency for delays in project flow, shown as “float” time. The addition of float time is intended to address the inevitable unexpected expenditure of time on complex capital programs involving multiple projects. Common schedule issues include unforeseen below-grade conditions, lengthy contract development and procurement, material availability, unexpected city development or public involvement requirements and necessary utility extension work.

Cost Estimates

The estimates are considered rough order-of-magnitude costs based on the project team’s knowledge of transit maintenance facilities, assumed site locations, past King County projects, and an understanding of Metro’s operations, contract development and the procurement process, and program cost assumptions. Building and site costs are based on square foot numbers established by using national databases and experience with bids and estimates from similar construction, building types, and amenities. The cost estimates prepared for this report include costs for green building elements based on current policies. Detailed information on cost estimates can be found in Appendix E.

These high-level cost estimates do not fully reflect the specific conditions that may apply to these projects. Vehicle-operating and maintenance facilities are unique projects that vary from facility to facility even within the same transit agency. Facilities have similarities in operations, types of spaces, and equipment, but the designs can vary based upon factors such as:

- Building sites
- Types of anticipated fleet
- Site access
- Utility requirements
- Timeline
- Phasing
- Delivery method used to construct
- Bidding climates

Peer Agency Interviews and Metro Facility Planning Workshop

Peer Agency Interviews

Metro conducted an industry review of best practices focused on maintenance facilities, transit asset management, fleet planning and maintenance, fleet electrification and technology. Metro interviewed key personnel from four peer transit agencies. The agencies selected were:

- San Francisco Municipal Transit Agency
- Los Angeles County Metropolitan Transportation Authority
- Denver Regional Transportation District
- Toronto Transit Commission



We learned from the peer agencies that they are:


- Evaluating which electric bus technology to embrace and whether to charge at base, in-route, and at layovers.
- Waiting for electric technology to evolve before investing. All agencies cited the need for advanced charging infrastructure to control power draw with a larger electric fleet.
- Relying on more private contracts than Metro.
- Embracing procurement methods other than the traditional design-bid-build.
- Benefiting from enhanced parts storage and management with automated part retrieval systems.
- Using different strategies for incorporating green building features into maintenance facilities.

Facility Planning Workshop

Metro held a Base Planning Workshop with Metro staff to generate ideas for improving the operational capacity growth strategy. The workshops included subject matter experts with national expertise in areas such as base operations design, base electrification, program delivery, program implementation, service delivery, long-range planning, building design and fleet composition. The workshop was an opportunity for staff from across the agency to brainstorm with each other and transit industry experts.

Key findings from the Base Planning Workshop include:

- Need to accommodate fleet changes while maintaining legacy vehicles.
- Adding an interim facility provides flexible space for incoming battery-electric bus fleet while bases are modernized.
- Align capital program timelines with fleet delivery timelines.
- Develop clear program objectives and establish standards early for design, fleet, and maintenance practices.
- Align facilities with fleet requirements, which includes reducing the complexity of the fleet mix. It is difficult to maintain numerous types of buses in current facilities.
- Allow for flexibility in facility design to include room for growth and shared staff needs.
- Consolidate common uses of the parts warehouse, body shops, and training.
- Evolve zero-emission electric bus technologies and infrastructure needs.
- Develop a standardized staffing approach for facilities.
- Select appropriate project delivery methods that work with the agency staffing.
- Develop a robust asset management plan that identifies when fleet is beyond its service life.
- Move towards a fully electronic part ordering, storage, and tracking process; consider the benefit of automated part retrieval systems.
- Develop a future-proofing policy to evaluate what adds value and what may have a diminishing value.
- Expand on partnerships.



The variations among facilities can make it challenging to develop standard cost estimates. Using a direct comparison of total construction costs from one base to another can be deceiving because of factors affecting size, schedule, and cost. These factors can include when the facility was constructed, funding sources, and cost-estimate assumptions for construction, financing, engineering, and other soft costs.

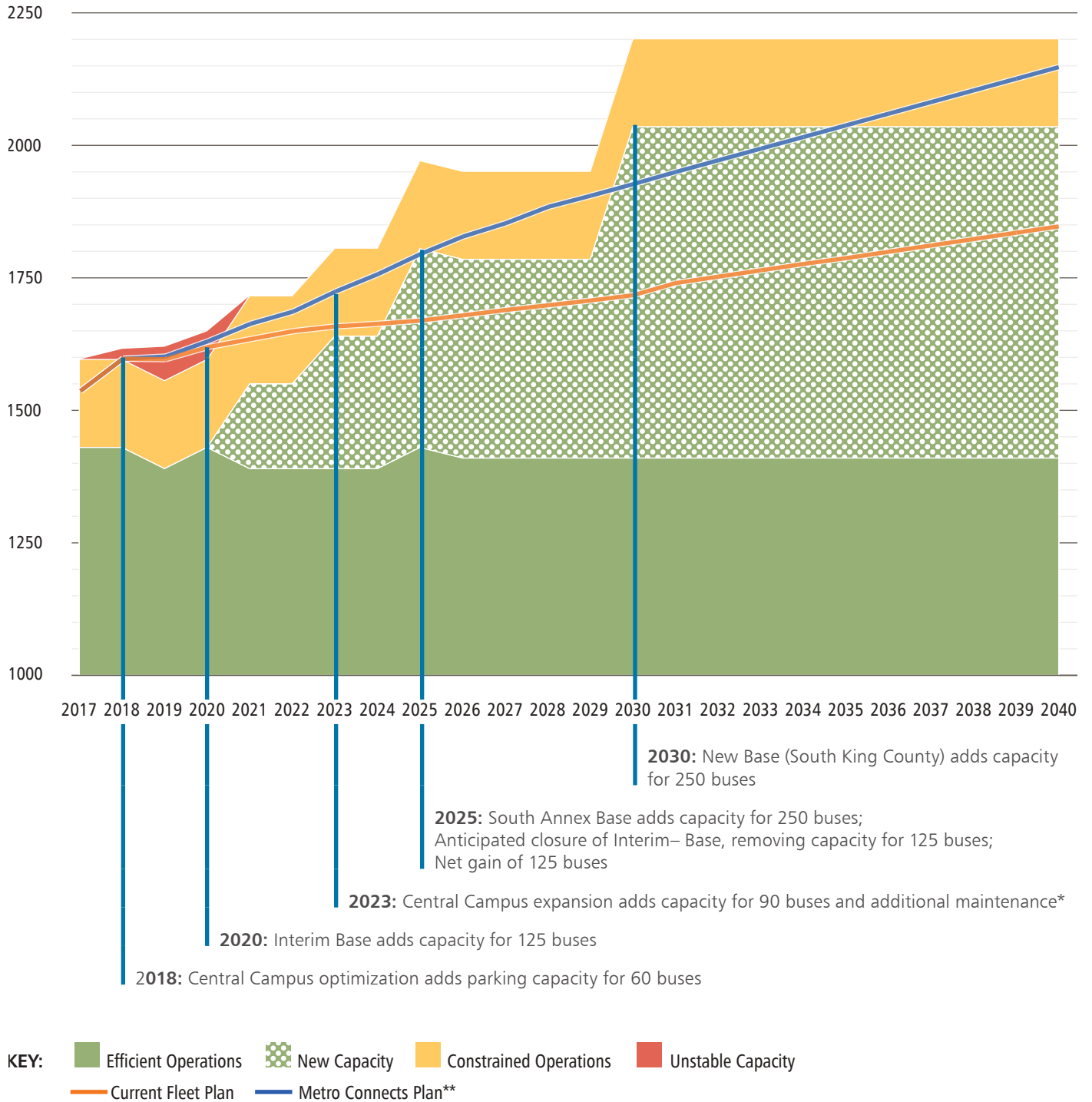
As these projects become further defined, updates to the cost estimates are recommended. Cost estimates for conceptual projects typically carry higher contingency values than projects that have further progressed in design. This is because concept projects lack design detail to cover specific quantity 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 to more detailed estimates.

Battery-electric buses need electric infrastructure for charging, which will require significant retrofitting or design work at Metro's existing facilities. This will need to be considered in more detail as the industry advances in the technology and infrastructure to support base electrification.

The battery-electric bus field is rapidly developing and changing with many traditional and nontraditional bus companies involved in the development of battery technologies for heavy vehicles. As technology continues to change, Metro will need to frequently reassess how it supports bus electrification. Flexibility in the use of space at Metro facilities will be needed to adapt to future innovation.

With the recommended expansion and modification projects, Metro will achieve stable operations at its bus bases with sufficient capacity in the system to enable system growth and the transition to a zero-emission fleet by 2030. Metro will likely need to consider additional expansion to efficiently support the envisioned growth for 2040.

Figure 8. Operational Capacity Growth Strategy



NOTES:

State of Good Repair affects capacity. Capacity reflects State of Good Repair and electrification efforts at all bases.

*The Central Campus Expansion is targeted for 2023, but it is dependent upon land availability and cost. Additionally, Sound Transit’s ST3 West Seattle-Ballard Light Rail Extension is likely to impact the area and could impact property availability and project timing.

**The METRO CONNECTS fleet projection is based on projected service hours and assumes Metro’s standard fleet reserve ratio of 20 percent.