Zero-Emission Vehicle Rollout Plan

Prepared for:

CALIFORNIA AIR RESOURCES BOARD

Prepared By:

wsp

SFMTA

Rollout Plan Revision History			
Revision Number	**Editor**	**Date**	**Notes**
0	Bhavin Khatri	05/14/21	Final release
1	Ivan Magana	07/06/22	Edits to Fleet Procurement schedule and Facilities schedule
2		08/08/25	Updates include general revisions to fleet procurement, incorporating paratransit vehicles, along with revised facility upgrade schedules and updated cost estimates.

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Acronyms & Abbreviations

BEB	Battery Electric Bus
CalEPA	California Environmental Protection Agency
CARB	California Air Resources Board
CEQA	California Environmental Quality Act
CNG	Compressed Natural Gas
DAC	Disadvantaged Community
DHEB	Diesel-Hybrid Electric Bus
DC	Direct Current
EV	Electric Vehicle
FCEB	Fuel Cell Electric Bus
FTA	Federal Transit Administration
ICEB	Internal Combustion Engine Bus
ICT	Innovative Clean Transit
kW(h)	Kilowatt (hour)
MME	Muni Metro East
NEPA	National Environmental Policy Act
NRV	Non-Revenue Vehicle
OEM	Original Equipment Manufacturer
O&M	Operations & Maintenance
OCS	Overhead Catenary System
PG&E	Pacific Gas & Electric
SMR	Steam-Methane Reform
SFPUC	San Francisco Public Utilities Commission
SFMTA	San Francisco Municipal Transportation Agency
WDT	Wholesale Distribution Tariff
ZE	Zero-Emission
ZEB	Zero-Emission Bus

1 Rollout Plan Summary

Agency Background	
Transit Agency's Name	San Francisco Municipal Transportation Agency
Mailing Address	1 S. Van Ness Avenue San Francisco, CA 94105
Transit Agency's Air District	Bay Area Air Quality Management District
Transit Agency's Air Basin	San Francisco
Total number of Buses in Annual Maximum Service	Fixed Route: 510 buses and trolley buses Demand Response: 111 vehicles[1]
Urbanized Area	San Francisco - Oakland
Population of Urbanized Area	3,364,862[2]
Contact information of general manager, chief operating officer, or equivalent	Julie Kirschbaum Director of Transportation 415.646.4304 julie.kirschbaum@sfmta.com
Rollout Plan Content	
Is your transit agency part of a Joint Group[3]	No
Is your transit agency submitting a separate Rollout Plan specific to your agency, or will one Rollout Plan be submitted for all participating members of the Joint Group?	N/A
Please provide a complete list of the transit agencies that are members of the Joint Group (optional)	N/A
Contact information of general manager, chief operating officer, or equivalent staff member for each participating transit agency member	N/A
Does Rollout Plan have a goal of full transition to ZE technology by 2040 that avoids early retirement of conventional transit buses?	Yes
Rollout Plan Development and Approval	
Rollout Plan's MTAB approval date	03-16-21
Resolution No.	210316-038
Is copy of Board-approved resolution attached to the Rollout Plan?	Yes (Appendix A)
Contact for Rollout Plan follow-up questions	Bhavin Khatri, PE, PMP Zero Emission Program Manager 415.646.2586 | bhavin.khatri@sfmta.com
Who created the Rollout Plan?	Consultant
Consultant	WSP

[1] NTD 2023 Annual Database Service (https://www.transit.dot.gov/ntd/data-product/2023-annual-database-service)
[2] ACS 2023 (https://censusreporter.org/profiles/40000US78904-san-francisco-oakland-ca-urbanized-area/)
[3] The ICT regulation defines a Joint ZEB Group or Joint Group (13 CCR § 2023.2) as two or more transit agencies that choose to form a group to comply collectively with the ZEB requirements of section 2023.1 of the ICT regulation.

2 Introduction

In accordance with the California Air Resource Board's (CARB) Innovative Clean Transit regulation (ICT regulation), the following report serves as the San Francisco Municipal Transportation Agency's (SFMTA) Rollout Plan to transition its transit and paratransit fleet to 100% zero-emission (ZE) by 2040.

2.1 Background

2.1.1 California Air Resource Board's Innovative Clean Transit Regulation

Effective October 1, 2019, the ICT regulation requires all public transit agencies in the state to transition from internal combustion engine buses (ICEBs) to zero-emission buses (ZEBs), such as battery-electric (BEB) or fuel cell electric (FCEB), by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be ZEBs based on its fleet size. This requirement applies to all vehicles with a Gross Vehicle Weight Rating (GVWR) above 14,000 lbs., including buses used for fixed-route services and certain vehicles in the paratransit fleet, such as the large cutaways. ICT regulation does not apply to electric trolley buses (ETB), but they are a part of the zero-emission category of vehicles.

To ensure that each agency has a strategy to comply with the 2040 requirement, the ICT regulation requires each agency, or a coalition of agencies, to submit a ZEB Rollout Plan before purchase requirements take effect. The Rollout Plan is considered a living document and is meant to guide the implementation of ZEB fleets and help transit agencies work through many of the potential challenges and explore solutions. Each Rollout Plan must include several required components and must be approved by the transit agency's governing body through the adoption of a resolution prior to submission to CARB.

According to the ICT regulation, each agency's requirements are based on its classification as either a "Large" or "Small" transit agency. The ICT defines a Large Transit Agency as an agency that operates in the South Coast or the San Joaquin Valley Air Basin and operates more than 65 buses in annual maximum service, or that operates outside of these regions but in an urbanized area with a population of at least 200,000 and at least 100 buses in annual maximum service. A Small Transit Agency is any other agency that doesn't meet the above criteria.

The SFMTA, as a Large Transit Agency, must comply with the following requirements:

July 1, 2020 – Board of Directors (Board) approved Rollout Plan must be submitted to CARB

January 1, 2023 – 25% of all new bus purchases must be ZE

January 1, 2026 – 50% of all new bus purchases must be ZE

January 1, 2029 – 100% of all new bus purchases must be ZE

January 1, 2040 – The goal for full transition to ZEB fleet, with careful planning that avoids early retirement of conventional ICEBs

March 2021 – **March 2050** – Annual compliance report due to CARB

Due to the impacts of COVID-19, the SFMTA requested and was granted an extension for the submission of the Rollout Plan to March 31, 2021. The purpose of this request was to ensure that critical items such as the SFMTA's direction and decisions on trolley buses, yard rebuilds, stakeholder engagement, and future funding were included in the analysis to define the framework of its ZEB transition more accurately. An updated version was submitted in July 2022, incorporating the most recent procurement and facility upgrade schedules. This current version presents further revisions, including the integration of the paratransit fleet's ZE transition plan, and acknowledges ongoing challenges related to funding availability and facility upgrade timelines faced in the process of transitioning the current fleet to fully ZE.

The SFMTA remains committed to the goal of a full transition to ZE fleet, as outlined in the previous version of the Rollout Plan. However, the timeline of achieving full compliance with the ICT regulation will depend on several factors.

- The bus yard conversion and rebuild projects required for the full transition to a ZE fleet are large, complex, and expensive, and must accommodate evolving technologies and requirements. Additionally, the sequential schedule of the bus yard projects to support the transition to an all zero-emission bus fleet is ambitious.
- The SFMTA is working to secure local, regional, state, and federal funding for its bus yard projects. In addition, where possible, it is incorporating joint development into its rebuild projects to maximize land use and generate revenue. Given the high cost and long-term nature of these projects, they are not fully funded, and funding shortfalls remain an ongoing risk.
- All the SFMTA's revenue sources are growing more slowly than before the pandemic and are not keeping pace with expenditure growth driven by inflation and rising cost of living. Federal, state, and regional relief funds are expected to be fully expended in FY25-26, which contributes to a significant operating deficit starting in FY26-27.

Delays in a bus yard project—whether due to funding shortfalls or other unforeseen factors—could necessitate reevaluating subsequent schedules for both facility projects and associated bus procurements. Factors that could influence these timelines, further detailed in Section 8, include rapid technological advancements and the risk of outdated procurements, limitations in BEB performance and range due to hilly terrain and axle load regulations, challenges in maintaining resiliency and emergency response capabilities, evolving safety and environmental compliance requirements, fluctuating market conditions including supply chain constraints, and potential delays in critical utility upgrades caused by reliance on external providers.

The SFMTA is working to address challenges within its control for a full transition to a ZE fleet. This includes pilot projects, updating its facility planning and advancing its related work to the extent funding is available, and pursuing funding opportunities. <u>As a living document, this Rollout Plan relies on information mainly from 2024 and early 2025 and is subject to change given the challenges described above.</u>

2.1.2 Zero-Emission Bus Technologies

According to the ICT regulation, a ZEB is defined as a bus with zero tailpipe emissions and is either a BEB or a FCEB. The following subsections provide a brief overview of each technology and how they compare to ICEBs. While both BEB and FCEB technologies provide ZE benefits, the feasibility and viability of their application is largely based on an agency's service and operational parameters. The following provides a brief overview of BEB and FCEB technologies. Trolley buses are not part of the ICT regulations, even though CARB considers them to be zero-emission vehicles.

Battery-Electric Buses (BEBs)

BEBs use onboard batteries to store and distribute energy to power an electric motor and other onboard systems. Similar to many other battery-powered products, BEBs must be charged before they can be used.

BEB charging technology exists to charge vehicles at the yard (overnight or midday) or on-route (typically during layovers). A yard charging strategy typically consists of buses with high-capacity (kilowatt-hour or kWh) battery packs that are charged for four to eight hours with “slow” chargers - usually less than 100 kilowatts (kW) – while being stored overnight. An on-route charging strategy typically consists of buses with low-capacity battery packs that are charged with “fast” chargers – usually in excess of 100 kW – during bus layovers (typically 5-20 minutes). BEBs are charged via several dispenser types (conductive and inductive) and orientations (overhead or ground-mounted). The most common dispensers in the U.S. market are plug-in and pantographs, as presented in Figure 2-1.

Figure 2-1. Plug-In and Pantograph Charging

Sources: YorkMix (Left) and ABB (formerly ASEA Brown Boveri) (Right)

In their current state, BEBs cannot meet the ranges that ICEBs can. BEBs with high-capacity battery packs typically offer a range of 125-180 miles, where the exact range is highly dependent on a myriad of factors, including climate, driving behavior, and topography. For this reason, if an agency’s service blocks cannot be completed with BEBs, other capital-intensive strategies may be needed to meet range requirements, including, but not limited to, additional BEBs, on-route charging infrastructure, service changes, and/or a mixed-fleet strategy with the incorporation of FCEBs.

It is important to note that battery technology is advancing rapidly, with developments like solid-state batteries promising to improve range, reduce charge times, and extend lifecycle performance. However, this rapid pace of innovation also creates challenges for agencies planning BEB procurements, as new technologies may render current purchases outdated before the end of their useful lives. Additionally, BEBs remain more expensive than hybrid buses, both in terms of upfront costs and the infrastructure investments required to support them.

Infrastructure upgrades add another layer of complexity. Installing the high-capacity chargers required for BEBs will often necessitate significant utility enhancements, including new transformers, switchgear, and grid improvements. These upgrades depend on coordination with utility providers and may introduce delays, unforeseen costs, and operational risks. Ensuring the safety of this infrastructure is paramount, particularly in addressing risks associated with battery fires through compliance with fire codes and environmental regulations. These considerations underline the necessity of facility conversions and rebuilds to support the transition to BEBs effectively.

Fuel Cell Electric Buses (FCEBs)

FCEBs can typically replace ICEBs at a 1:1 replacement ratio without significant changes to operations and service. A FCEB uses hydrogen and oxygen to produce electricity through an electrochemical reaction to power the propulsion system and auxiliary equipment. This ZE process has only water vapor as a byproduct. The fuel cell is generally used in conjunction with a battery, which supplements the fuel cell's power during peak loads and stores electricity that is recaptured through regenerative braking, allowing for better fuel economy.

The process, operations, and equipment used to refuel hydrogen buses is similar to "lighter-than-air" fuels such as compressed natural gas (CNG). Typically, hydrogen is produced via steam-methane reform (SMR) or electrolysis. SMR, the most common method of producing hydrogen, uses high-pressure steam to produce hydrogen from a methane source, such as natural gas. Electrolysis, on the other hand, uses an electric current to decompose water into hydrogen and oxygen. After the hydrogen is produced, it can be delivered to the site via pipeline or delivered by a truck (as either a gas or liquid). Hydrogen is then stored, compressed, and dispensed to the buses on-site. Depending on space availability and resources, some agencies can produce hydrogen on-site.

Some of the most pressing challenges for FCEB operations is the limited supply network and the amount of energy, space, and high capital costs required to isolate, compress, and store hydrogen. Ensuring compliance with updated safety and environmental regulations, including those governing the handling and storage of hydrogen, adds further complexity to facility planning. Also, if renewable natural gas (RNG) - such as methane capture from organic matter – is not used as an alternative to natural gas via SMR operations, there are some concerns that FCEBs may not be the most sustainable vehicle to achieve greenhouse gas reduction targets due to upstream emissions during hydrogen production.

Moreover, FCEBs currently have higher vehicle capital costs compared to BEBs and hybrid buses. The technology is also not yet available for smaller vehicles, such as cutaways used in paratransit services, further limiting its applicability across diverse fleet needs.

2.1.3 ZEB Suitability for the SFMTA's Service and Operations

The choice between adopting BEBs or FCEBs is contingent on the unique needs and conditions of an agency. Several variables need to be factored into this decision, including costs associated with bus acquisitions and associated infrastructure, spatial requirements, energy/fuel costs, and community acceptance. Based on existing conditions and the stated variables, BEBs appear to be the most suitable technology for the SFMTA to meet the requirements of the ICT regulation. The following provides a brief summary of the main findings of this analysis:

BEBs are more affordable than FCEBs at this time. There are barriers to entry for both BEBs and FCEBs, with both technologies exceeding the cost ICEBs. However, BEBs have achieved better economies of scale and are currently significantly less expensive than FCEBs. On average, the base price of an FCEB is approximately 35% higher than a BEB and more than 80% higher than a hybrid bus. Additionally, the paratransit fleet, which is entirely composed of cutaway-size vehicles, faces significant limitations with fuel cell technology, as options remain in early testing phases and are not yet widely available with proven performance.

The SFMTA's bus facilities are too space-constrained to accommodate FCEB-supporting infrastructure. Infrastructure to support BEBs (charging cabinets, dispensers, and associated utility equipment) can all be contained within the SFMTA's yard (either elevated or ground-mounted). In contrast, the infrastructure required for FCEBs (storage tanks, dispensers, etc.) requires a large footprint due to sizing and the National Fire Protection Association's (NFPA) required buffers. For example, a 15,000-gallon vertical hydrogen storage tank has a footprint of approximately 40 by 50 feet (not including the fueling island). This same tank would need to be located at least 75 feet from all air intakes, 50 feet from liquid or gas lines, and at least 25 feet from public ways, railroads, and property lines due to NFPA requirements. With the SFMTA's yards already being space-constrained in an urban environment, the SFMTA would risk losing a lot of potential bus parking. Nevertheless, should future improvements in hydrogen technology allow for more efficient spatial requirements and prove to be fiscally viable, the SFMTA might reconsider the feasibility of adopting the FCEB technology.

The SFMTA's existing rates for electricity are very competitive. With exceptionally low energy costs, powering BEBs is expected to be significantly less expensive than supplying hydrogen via liquid delivery. Currently, the electricity cost for the SFMTA is $0.08 per kWh. In contrast, hydrogen costs average around $8 per kg and can have wide variability depending on local production supply and distance from the chosen supplier. Assuming an average fuel consumption rate of 11.2 miles per diesel gallon equivalent (MPDGE) for BEBs and 7.4 MPDGE for FCEBs, the fuel costs are approximately $0.24 per mile for BEBs and $1.08 per mile for FCEBs. [4] It is also important to note that actual hydrogen price at the point of dispensing could be much higher than anticipated, due to potential losses during transportation and storage.

Hydrogen and BEB operations in the SF's dense neighborhoods could face challenges related to public acceptance. While BEBs are generally well-received by communities and supported as part of sustainability initiatives by both cities and transit agencies, they are not entirely without concerns. Their near-zero local emissions and quiet operations contribute to their broad appeal, but large-scale charging facilities can raise fire and safety concerns, particularly for indoor facilities in urban areas where space is constrained and safety standards must be rigorously upheld.

Hydrogen storage presents additional complexities. Communities often express heightened caution around the installation of on-site hydrogen storage due to perceived risks of leakage and combustion.

For either hydrogen or BEBs, when planned near urban or residential areas, stakeholder outreach may be needed to garner support. Given that the majority of the SFMTA's yards are in densely populated areas, such outreach efforts may add complexity and potential delays to project implementation.

2.1.4 San Francisco Municipal Transportation Agency

The SFMTA is a department of the City and County of San Francisco. The SFMTA plans and operates bus, rail, historic streetcar, cable car, and paratransit transit service within the City and County of San Francisco. In addition, the SFMTA also manages parking, traffic, bicycling, walking, and taxis in the city. Prior to the COVID-19 pandemic, the SFMTA provided approximately 726,000 weekday and 220 million annual passenger boardings.[5] 71% of these boardings — 520,000 per weekday and over 156 million

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[4] Fuel consumption rates are based on average values in the Department of Energy's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool.
[5] SFMTA Short-Range Transit Plan Fiscal Year 2019 – Fiscal Year 2030, p. 9.

annually — occurred on 76 weekday bus routes. Ridership ranged from 654,300 weekday boardings in FY06 to 726,100 in FY16.[6] As of September 2024, the SFMTA's system-wide ridership remains at approximately 78% of pre-pandemic levels, and the agency is projecting an operating deficit of $239 to $322 million starting in Fiscal Year 26-27 and growing beyond that. Reasons include revenues growing slower than inflation; transit, parking and General Fund revenues are lower than pre-pandemic; and federal, state, and regional temporary relief is set to expire before then.[7]

Service Area

As of 2023, the SFMTA serves approximately 49 square miles within the City and County of San Francisco, reaching a population of 831,703 (Figure 2-2).[8]

Utility Provider

The San Francisco Public Utilities Commission (SFPUC) provides electrical service for the SFMTA service area by way of Pacific Gas & Electric (PG&E) electrical infrastructure. The SFPUC operates Hetch Hetchy Power, a Publicly Owned Utility. Although the SFPUC has served all municipal agencies within the City and County of San Francisco for many decades, it relies upon PG&E's transmission and distribution grid to serve its customers, for which PG&E receives a fee.

This situation, with the lack of designated service territory boundaries between the two utilities, is unlike any other in the country, and greatly limits the SFPUC's visibility into the detailed grid infrastructure and capacities. Despite multiple requests to gather details, PG&E will not provide information on feeder capacities unless the SFPUC submits an application for service through the Wholesale Distribution Tariff (WDT), a process that may cost upwards of $150,000 and require two years or more per service location to perform a System Impact Study to determine the capacity available for new loads.

Under the WDT, each SFPUC customer inter-tie point is viewed by PG&E as a utility-to-utility connection. As such, PG&E applies the rules of the WDT to each SFPUC customer connection. This is significant to the SFMTA in several ways, but particularly in terms of project timelines and budget. Each service upgrade that utilizes the PG&E grid must go through PG&E's review process. The SFPUC therefore has no control over processing delays or resource constraints. Upon completion of the review, any grid or infrastructure upgrades required by PG&E are born solely by the SFPUC customer. Being an SFPUC customer, the SFMTA would not be eligible for any betterment cost sharing, like PG&E retail customers would, regardless of the quantity of PG&E customers that would benefit from the investment. Similarly, the SFMTA is ineligible for PG&E's electric vehicle (EV) Fleet programs, which provide funding for grid infrastructure builds and upgrades that support EV charging.

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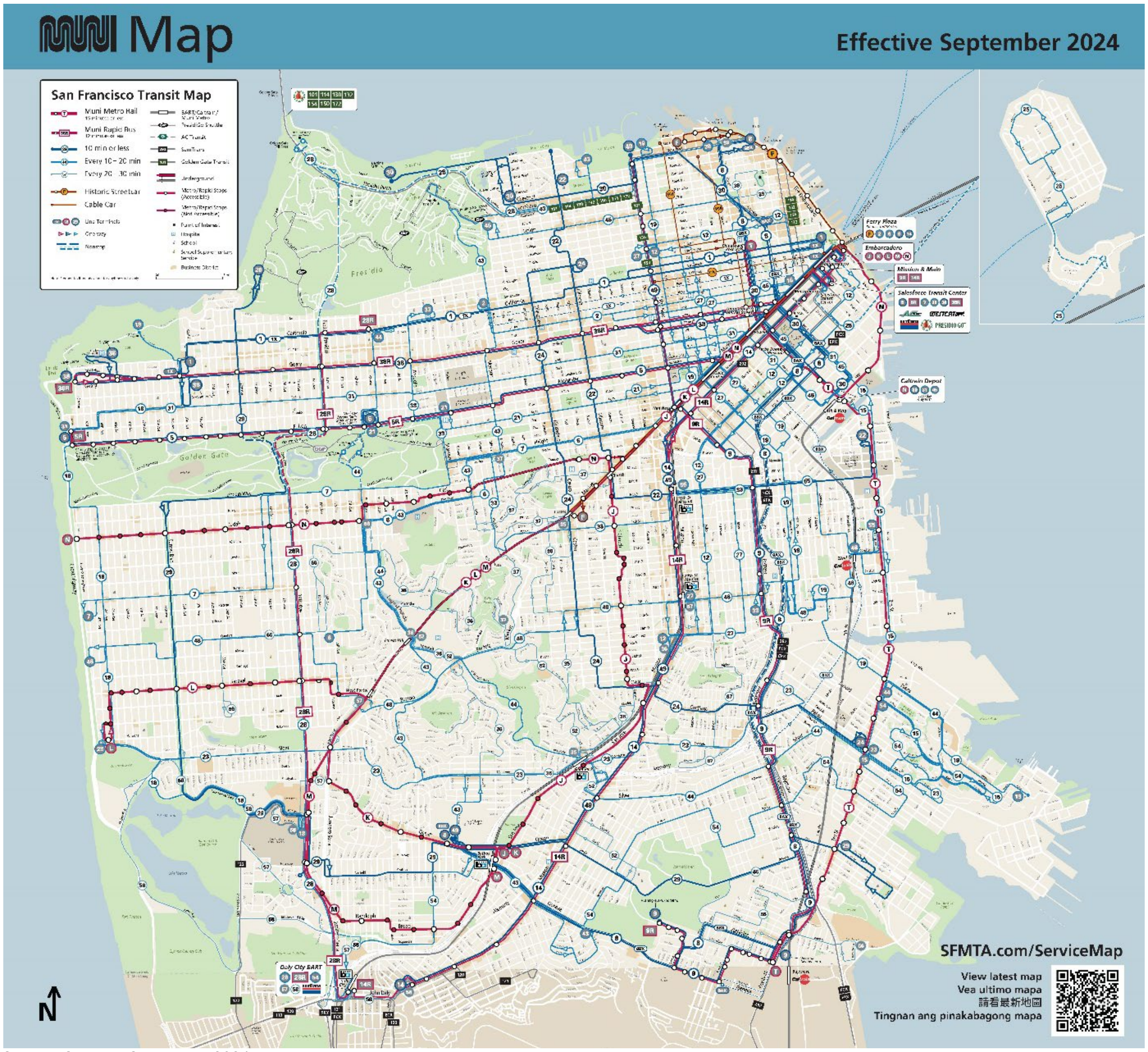
[6] SFMTA Bus Fleet Management Plan 2017-2030, p. 25.
[7] SFMTA Financial Update for the Muni Funding Working Group, September 2024.
[8] NTD 2023 Agency Information

Figure 2-2. SFMTA System Map



Source: SFMTA, September 2024

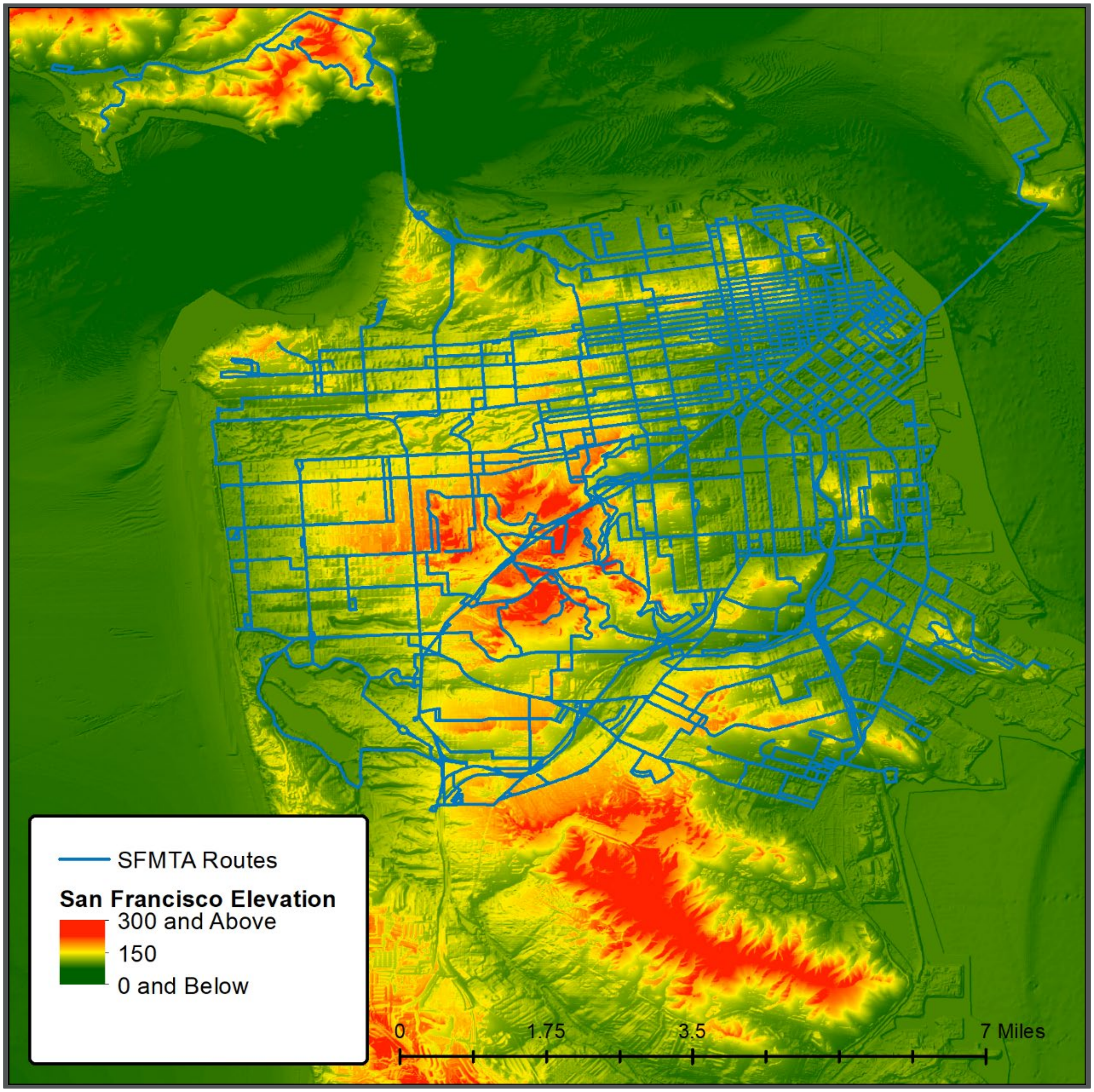
Environmental Factors

San Francisco's Mediterranean climate is characterized by dry summers and wet winters with relatively mild temperatures. Temperature does not vary much throughout the year, with average high temperatures of approximately 70°F during the summer, and average low temperatures of 45°F during the coldest winter days.

Topography is varied, with scores of hills ranging from sea level to over 900 feet in elevation. This varied topography, combined with the effects of cold ocean currents, gives rise to microclimates.

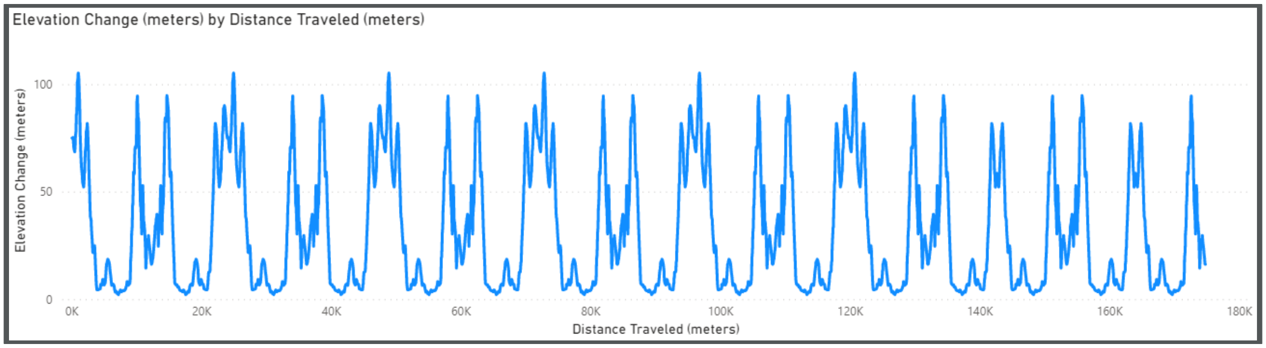
The SFMTA's buses must travel over multiple hills in a day – the steepest grade is 23%. Figure 2-3 shows San Francisco's service and the elevation profile, with much of the service feeding into downtown (which is near sea-level) over numerous hills. An example of the elevation change a transit vehicle may undergo while in-service is shown in Figure 2-4, with the vehicle continuously traveling up and down hills for the entirety of its service. The block gains a total of 3,542 meters or 2.2 miles in a day (the equivalent of over 38 football fields or 11.6 times the height of San Francisco's tallest building, the Salesforce Tower, at 1,070 feet).

Figure 2-3. San Francisco Service and Elevation Profile



Source: WSP, USGS DEM

Figure 2-4. Example of Vehicle Block Elevation Change



Source: WSP, USGS DEM

Schedule and Operations

As of August 2024, the SFMTA directly operates 864 diesel-hybrid, battery-electric, and trolley buses across 58 regular weekday fixed routes, which include supplemental buses for Muni Metro Rail, Owl services, and routes with Rapid or Express services (e.g., Route 14 and Route 14R or Route 1 and Route 1X are distinct routes).[9] These buses are served by six maintenance and storage yards: Flynn, Islais Creek, Kirkland, Potrero, Presidio, and Woods. Additional bus support functions are conducted at 1399 Marin, and the SFMTA is planning bus storage improvements on four undeveloped acres east of the Muni Metro East light rail division. The SFMTA's trolley buses operate exclusively out of Potrero and Presidio yards, both of which are over 100 years old.

The SFMTA's fixed-route bus service is organized into six categories or types of service:

1. **Rapid Bus:** Routes that operate every 10 minutes, or more frequently, all day on weekdays and are the focus of transit-priority measures.
2. **Frequent:** Routes that also operate every 10 minutes, or more frequently, all day on weekdays in major corridors, but make more frequent stops than Rapid Bus routes.
3. **Grid:** Routes that form the framework of "trunk" routes across the city (along with Rapid and Frequent bus routes, and Muni SFMTA), with 12-30 minute headways all day on weekdays.
4. **Connector:** Shorter routes that provide coverage (including neighborhood "circulator" service to hillside neighborhoods) that generally operate every 30 minutes all day on weekdays.
5. **Specialized:** Routes with a focused purpose, including: express routes (primarily peak period-only services for commuters); supplemental service (to middle and high schools); and special event service (i.e., sporting events, concerts, etc.). Frequencies on these routes vary.
6. **Owl:** Some routes operate 24 hours a day, while other overnight routes (operating between 1 and 5 a.m.) are comprised of segments of multiple routes.

Meanwhile, the SFMTA Paratransit provides van and taxi services for individuals unable to independently use public transit due to disabilities or disabling health conditions. As a result of the Americans with Disabilities Act (ADA), the SFMTA – as all public transit agencies - are mandated to offer paratransit services comparable in scope and duration to their regular fixed-route services. This report focuses on the van component of the SFMTA's paratransit service, branded as SF Access Van Service, as the taxi fleets are not owned by the SFMTA. The van service includes both the regular van service and the Group Van service, a door-to-door transportation option pre-arranged specifically for groups of ADA-eligible customers attending designated programs on weekdays. To use the SF Access Van Service, riders must

[9] This was based on September 2024 service.

be registered and pre-qualified. Scheduling for rides, which can be done from one to seven days in advance, is facilitated online or via a call center.

COVID-19-Related Impacts

As a response to the economic and health impacts of COVID-19, the SFMTA has made major interim service changes, including the closure of Muni Metro and prioritization of core bus routes (per the Muni Core Service Plan). The Muni Core Service Plan (April 2020) prioritizes the most-used routes to provide access to San Francisco's medical facilities while also increasing the volume of buses (to promote social distancing) for riders that are most reliant on transit. By September 2020, the COVID-19 situation has resulted in a 71% reduction in bus boardings and a 95% reduction in transit revenue compared to the same time in 2019. Federal relief through the CARES Act provided some assistance to address the SFMTA's funding shortfall.

The effects of COVID-19 have directly impacted the SFMTA's transition to a zero-emission fleet due to increased uncertainty of various important factors: future ridership, changes and adaptations to service planning, continued emergency declarations and operations, general economic health or recession, and capital funding. Starting with the 2022 Muni Service Approved Plan, the SFMTA has gradually restored services, making adjustments as ridership patterns evolve. As of September 2024, ridership remains approximately 78% of pre-pandemic levels, despite ongoing service recovery efforts. The SFMTA remains committed to transitioning the fleet to fully zero-emission, although challenges persist as stated before, including financial constraints and ongoing supply chain issues, particularly with utility equipment.

2.1.5 The SFMTA's Existing ZEB Efforts

The SFMTA is a national leader in confronting climate change and embracing the prospects of a ZE future. The SFMTA has taken multiple steps to not only meet the requirements of CARB's ICT regulation, but also its own ambitious ZE goals, as detailed below.

- The SFMTA currently operates the largest fleet of ZE trolley buses in North America. Trolley buses run on 100% greenhouse gas-free hydropower via an overhead catenary system (OCS). The SFMTA also operates over 600 diesel-hybrid vehicles that run on batteries and renewable diesel.
- In April 2018, in celebration of Earth Day, the then current mayor, Mark Farrell, committed the City of San Francisco to net-zero greenhouse gas emissions by 2050, which would eliminate the city's carbon footprint. The SFMTA is already doing its part and accounts for less than 2% of public transportation emissions (and less than .01% of the city's overall greenhouse gas emissions).
- In partnership with the San Francisco Department of the Environment, the SFPUC, and other city agencies and stakeholders, the SFMTA supported the development of the Electric Mobility Roadmap that lays out a vision for reducing public health and environmental impacts of private transportation. The Roadmap also identifies strategies to help realize an emission-free transportation sector.
- In May 2018, the Board adopted its Zero-Emission Vehicle Policy resolution (ZEV Policy). Under the ZEV Policy, demonstrating the SFMTA's commitment to achieving a 100% zero-emission fleet by 2035.[10] This policy was updated in November 2023 to allow for the acquisition of zero emission vehicles including but not limited to battery electric buses and trolleybuses, and to extend the timeline

[10] Due to the impacts of COVID-19 (reduction in ridership, funding, etc.), the SFMTA is revisiting this policy to align it with the ICT regulation (2040).

for achieving a 100% zero emission fleet to align with the CARB ICT regulation timeline, which is currently 2040.

- In November 2019, the SFMTA procured nine 40-foot BEBs (three each from New Flyer, Proterra, and BYD) as part of a pilot program evaluating the current state of the BEB market. Additionally, the SFMTA procured three 40-ft BEBs from Nova Bus in 2021. These 40-ft buses were used in regular revenue service to analyze performance and to assist in developing a long-term charging strategy. This pilot program included an electrical and facility upgrade at Woods Yard to accommodate BEB charging equipment and infrastructure. A final report detailing the findings of this pilot program has been released.
- In 2018, as part of its Green Zone program, the SFMTA replaced 68 buses with diesel-hybrid buses outfitted with higher capacity batteries and a GPS-enabled switch, which automatically switches the bus to EV mode as it enters geo-fenced areas (Green Zones) throughout the city. In Green Zones, the vehicles operate entirely on battery power, reducing and eliminating SFMTA-generated emissions in some of the city's most environmentally burdened communities.
- In February 2020, the SFMTA awarded a contract to WSP to provide a roadmap for the SFMTA's transition to BEB facilities and transit fleet vehicles. This partnership has produced several deliverables that will guide the SFMTA to meet their electrification goals, including a BEB Facility Implementation Master Plan (Master Plan).
- In March 2024, a Paratransit Electric Vehicle Feasibility Study was completed by WSP for SFMTA. The Study looked at available electrical vehicle market for paratransit services and explored different transition strategies with respect to compliance with ICT and Advanced Clean Fleet (ACF) regulations.
- In 2024, the SFMTA began work on a procurement of 12 40-ft BEBs and 6 60-ft BEBs to expand the SFMTA's ZEB fleet. A facility upgrade at Islais Creek is planned to charge the 60-ft BEBs, while the additional 40-ft BEBs will be charged at Woods once existing charging infrastructure is expanded.
- The SFMTA completed an update to the Facility Framework, which identifies the SFMTA plans for improving its transit facility including to transition to a ZEB fleet.
- The SFMTA is planning a proof of concept to evaluate smart charging and yard management systems. The SFMTA believes that these systems will be necessary for the efficient operation of large-scale BEB fleets.

2.2 Rollout Plan Approach

In accordance with the Rollout Plan Guidance, this document provides an overview of several key components to the SFMTA's ZEB transition, including fleet acquisitions, schedule, training, and funding considerations.

Due to the rapidly evolving nature of ZEB technologies, it is likely that the recommended approaches in this Rollout Plan will be adjusted and changed over time. For that reason, the SFMTA will continue to evaluate technologies and strategies throughout the transition process. Areas that are currently under study will be indicated, where applicable. <u>As a living document, this version of the Rollout Plan relies on information mainly from 2024 and early 2025 and is subject to change.</u> The service-related information in this Rollout Plan is based on September 2024 service and the fleet numbers are based on August 2024.

While ridership has gradually recovered since the COVID-19 pandemic, system-wide ridership remains at approximately 78% of pre-pandemic levels. At the same time, revenue sources, including transit fares, parking, and the General Fund, continue to grow more slowly than inflation, and temporary federal, state, and regional relief funding is set to expire before FY25-26. Despite these financial challenges, the SFMTA remains committed to transitioning to a zero-emission fleet. However, the pace of implementation will depend on several factors, including funding availability, market conditions, and the complexity of infrastructure upgrades required to support the transition. Section 8 further details the various factors and considerations that will impact the transition.

2.3 Rollout Plan Structure

In accordance with CARB's Rollout Plan Guidance, the SFMTA's Rollout Plan includes all required elements. The required elements and corresponding sections are detailed below:

- Transit Agency Information (Section 1: Rollout Plan Summary)
- Rollout Plan General Information (Section 1: Rollout Plan Summary)
- Technology Portfolio (Section 2.1.3: ZEB Suitability for the SFMTA's Service and Operations)
- Current Bus Fleet Composition and Future Bus Purchases (Section 3: Fleet and Acquisitions)
- Facilities and Infrastructure Modifications (Section 4: Facilities and Infrastructure Modifications)
- Providing Service in Disadvantaged Communities (Section 5: Equity Considerations)
- Workforce Training (Section 6: Workforce Training)
- Potential Funding Sources (Section 7: Costs and Funding Opportunities)
- Start-up and Scale-up Challenges (Section 8: Start-up and Scale-up Challenges)

3 Fleet and Acquisitions

The following section provides an overview of the SFMTA's existing fleet, planned ZEB technology, and proposed procurement schedule.

3.1 Existing Fleet

The SFMTA fixed route bus fleet includes diesel-hybrid electric buses (DHEB), BEBs, and electric trolley buses ranging from 32- to 60-feet. As of August 2024, the SFMTA operates a fleet of 864 buses. The fleet is served by six bus maintenance and storage yards, two for trolley buses, two for 60-foot buses, and two for standard (32- and/or 40-foot) buses.

Meanwhile, as of December 2024, the SFMTA's paratransit fleet includes 153 agency-owned vehicles. These vehicles consist of four types: large cutaways, smaller cutaways/passenger vans, minivans, and sedans. Only the large cutaways are subject to the ICT regulation. Additionally, SFMTA also leases vehicles for a nominal fee from group agency partners who originally purchased these vehicles with Federal Transit Administration (FTA) 5310 funds.

Table 3-1 and Table 3-2 provide a detailed overview of the SFMTA's existing bus and paratransit fleet.

Table 3-1. Summary of the SFMTA's Existing Fixed Route Bus Fleet (August 2024)

Manufacturer	Series	Fuel Type	Length	In Service Year	Bus Type	QTY
BYD	5004	BEB	40'	2021	Standard	1
	5005-5006			2023	Standard	2
ENC	8531, 8533-8546, 8551	DHEB	32'	2022	Standard	16
	8548			2023	Standard	1
	8547, 8549-8550, 8552-8553, 8555, 8558			2024	Standard	7
New Flyer	5001	BEB	40'	2021	Standard	1
	5002-5003			2022	Standard	2
	8601-8662, 8701-8704, 8706-8708, 8710, 8712-8720, 8722-8723, 8726, 8728-8734, 8736-8738	DHEB	40'	2013	Standard	92
	8705, 8709, 8711, 8721, 8724-8725, 8727, 8735, 8739-8750			2014	Standard	20
	8800-8854, 8856			2016	Standard	56
	8751-8780, 8855, 8857-8901			2017	Standard	76
	8902-8934, 8936-8941, 8943			2018	Standard	40
	8935, 8942, 8945-8969			2019	Standard	28
	6500-6530, 6532-6539, 6541-6542, 6544, 6546-6548, 6551, 6700		60'	2015*	Articulated	47
	6540, 6543, 6545, 6549-6550, 6552-6554, 6560-6592, 6594-6601, 6605, 6701-6730			2016*	Articulated	79
	6593, 6599, 6602-6604, 6606-6631, 6635, 6638			2017*	Articulated	33

Manufacturer	Series	Fuel Type	Length	In Service Year	Bus Type	QTY
	6632-6634, 6636-6637, 6639-6697			2018	Articulated	64
	6531			2024	Articulated	1
	5701-5774, 5776-5783, 5785-5786	Trolley Bus	40'	2018	Standard	84
	5775, 5784, 5787-5874, 5876-5883			2019	Standard	98
	5875, 5884-5885			2020	Standard	3
	7201-7209, 7211, 7215, 7217		60'	2015	Articulated	12
	7210, 7212-7214, 7216, 7218-7260			2016	Articulated	48
	7261-7266, 7268-7269			2017	Articulated	8
	7267, 7270-7284, 7286-7293			2018	Articulated	24
	7285			2024	Articulated	1
NOVA	5010	BEB	40'	2023	Standard	1
Orion	8501-8502, 8505, 8507-8513, 8617, 8520, 8522, 8526-8528	DHEB	32'	2007	Standard	16
Proterra	5007	BEB	40'	2021	Standard	1
	5008-5009			2022	Standard	2
					Total Buses	864

Source: SFMTA, August 2024
* A total of 23 buses are currently on hold and are located at an offiste vendor.

Table 3-2. SFMTA-Owned Paratransit Fleet (December 2023)

Type	Vehicle Make/Model	Fuel Type	In Service Year	GVWR (lbs)	Quantity
Large Cutaway	Ford E-450, Ram Promaster	Gasoline	2014, 2017, 2022, 2023, 2024	14,500	64
Small Cutaway	Ford Transit 350HD	Gasoline	2019, 2020, 2023, 2024	10,360	64
Minivan	Dodge Caravan Minivan	Gasoline	2017	6,050	19
Sedan	Toyota Prius Prime	Hybrid	2019	3,500	6
				Total Vehicles	132

Source: SFMTA
GVWR = Gross Vehicle Weight Rating

3.1.1 Battery-Electric Bus Technologies

The SFMTA intends to transition its DHEBs to BEBs. The SFMTA's future BEBs are expected to be compatible with the Society of Automotive Engineers' (SAE) J1772 (plug-in) and SAE J3105 (inverted pantograph) charging standards. By supporting both standards, the SFMTA's buses will have the flexibility of charging in multiple yard layouts and bus orientations. The plug-in standard will allow buses to charge while being serviced, and the pantograph standard will allow buses to charge at the vehicle yards and at potential on-route charging locations. The roof-mounted charging rails that are associated with the pantograph standard will allow the SFMTA's BEBs to access "fast" high-power charging (in excess of 150 kW) for a limited duration.

Based on the SFMTA's existing service needs and yard configurations, an inverted pantograph-charging strategy will be implemented to support BEBs at all future BEB facilities. The pantographs will be supported by an overhead frame that covers the surface of the bus parking tracks. The overhead strategy was deemed to be the most suitable due to space constraints at the SFMTA's yards. The overhead frame will also be able to support photovoltaic panels (where applicable) and electrical equipment and components (conduit, etc.). Exceptions to the overhead frame solution could potentially occur in multi-level facilities as they are rebuilt, such as the Presidio Yard. Future design of such facility would likely either include an overhead frame or an equipment mezzanine, but the SFMTA will leave those decisions to the facility design teams. It is important to note that the Potrero Yard will remain as a trolley bus yard and is not initially planned to receive BEBs.

The proposed facility layouts for each yard are based on utilizing a 200-kW direct current (DC) charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers, each capable of charging one bus) or a 360 kW DC charging cabinet in a 1:3 configuration, where one DC charging cabinet energizes two or three separate dispensers/buses, respectively. This charger-to-dispenser ratio maximizes space utility, reduces capital costs, and meets the requirements to charge the fleet during servicing and dwell time on the site while minimizing the peak electrical demand. That said, the SFMTA continues to monitor technological advancements and may explore other strategies that are advantageous to the SFMTA. Figure 3-1 shows an example of a pantograph and charge rails.

Figure 3-1. Inverted Pantograph and Charge Rails

Source: WSP

3.2 Procurement Schedule

In accordance with the ICT regulation, the SFMTA will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. However, given current market conditions and funding limitations, it appears that full compliance with ICT requirements may not be feasible. The procurement of a full ZEV fleet transition cannot occur without facility upgrades. The SFMTA often faces challenges in securing competitive funding for facility upgrades or rebuilds (see section 7.3). Given the current procurement forecast through 2041 (Table 3-3), the SFMTA would need to apply for exemptions from CARB's ICT requirements for several procurements before 2030. Additionally, the SFMTA may require further exemptions for its paratransit vehicles due to the current lack of suitable facility to store, charge and maintain the ZE paratransit vehicles.

Table 3-3. Summary of the SFMTA's Forecast Annual Bus Procurement (Through 2041)

Fleet	Fixed Route Fleet								Paratransit Fleet				
Size	32ft		40ft			60ft			Large Cutaway		Small Cutaway*		Total**
Fuel	DHEB	BEB	DHEB	BEB	TB	DHEB	BEB	TB	Gas	Electric	Gas	Electric	
2024			94							2			96
2025				12			6				16		18
2026				48					22		18		70
2027				56		40			6		6		102
2028						92					20		92
2029			28			23	5		20	2	36		78
2030							40						40
2031		8		51			24	13			16		96
2032		8		40				48		22		5	118
2033		14		19	55			8		6		1	102
2034				2	70			24				20	96
2035				56	28					22		36	106
2036				78			6						84
2037				32			47					16	79
2038				56						22		5	78
2039				56			40			6		1	102
2040				4			92			0		20	96
2041				68			28			22		36	118
2042			94							2			96
2043				12			6				16		18
Notes	"DHEB": Diesel Hybrid Electric Bus, "TB": Trolley Bus, "BEB": Battery Electric Bus												

Source: SFMTA Facility Framework, WSP
*Small Cutaways including cutaways with growth curb weight less than 14,000 pounds and other smaller van type vehicles in the paratransit fleet. They are not within the purview of ICT regulations. Included for reference only.
**Total annual procurement also includes vehicle that are not subject to ICT, such as cutaways and articulated bus purchases before 2026 and small cutaways.
***SFMTA expects that the Notice to Proceed for the buses delivered in the table above would be issued at least 18-24 months in advance.

The SFMTA is working to address challenges within its control for a full transition to a ZE fleet. This includes pilot projects, updating its facility planning and advancing its related work to the extent funding is available, and pursuing funding opportunities.

The current procurement schedule anticipates that the entire fleet will be zero-emission by 2043. In this scenario, early retirement of the DHEB buses is not anticipated. However, if early retirement becomes a risk, one potential strategy is to place the buses on the SFMTA's longest (distance) service blocks. This will ensure that buses meet the FTA 500,000-mile minimal useful life requirement sooner. The achievement of this goal will depend on advancements in technology, availability of funding, ZEB market conditions and vehicle availability, and completion of necessary facility upgrades.

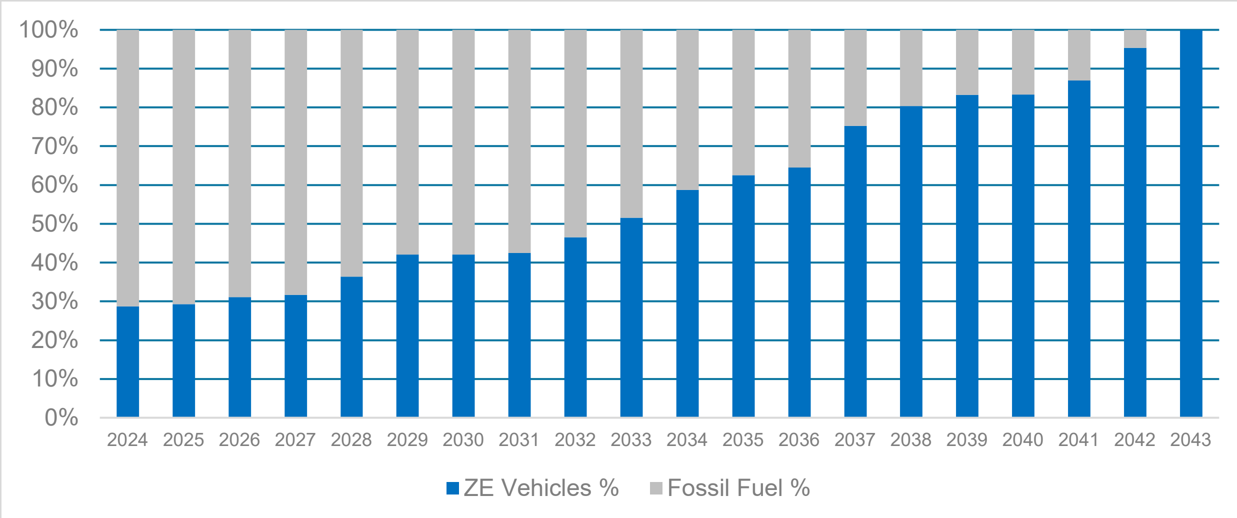
Table 3-4. Summary of the SFMTA's Future Bus Deliveries (Through 2043)*

Fleet Type	Fixed Route Fleet								Paratransit Fleet				Total
Existing Fleet	32ft		40ft			60ft			Large Cutaway		Small Cutaway*		
Procurement Type	DHEB	BEB	DHEB	BEB	TB	DHEB	BEB	TB	Gas	Electric	Gas	Electric	
2024	13			2					1		20		36
2025			47						20	2	34		103
2026			47	12									59
2027							6				18		24
2028				48					22		5		75
2029				56		40			6		1		103
2030						92					20		112
2031			28			23	5		20	2	36		114
2032							40						40
2033		8		51			24	13			16		112
2034		8		40				48		22		5	123
2035		14		19	55			8		6		1	103
2036				2	70			24				20	116
2037				56	28					22		36	142
2038				78			6						84
2039				32			47					16	95
2040				56						22		5	83
2041				56			40			6		1	103
2042				4			92					20	116
2043				68			28			22		36	154
Notes	"DHEB": Diesel Hybrid Electric Bus, "TB": Trolley Bus, "BEB": Battery Electric Bus												

Source: SFMTA Facility Framework, WSP
*Small Cutaways including cutaways with growth curb weight less than 14,000 pounds and other smaller van type vehicles in the paratransit fleet. They are not within the purview of ICT regulations. Included for reference only.
**SFMTA expects that the NTP for the buses delivered in the table above would be issued at least 18-24 months in advance.

Table 3-4 summarizes the SFMTA's anticipated bus deliveries through 2043 and Figure 3-2 presents the percentage of the fleet that are powered by zero-emission technologies or fossil fuels through the same timeframe.

Figure 3-2. Percentage of Zero-Emission and Fossil Fuel Fleet (2024-2043)



Source: SFMTA Facility Framework, WSP

Table 3-5 summarizes the SFMTA's planned fleet totals through 2043. SFMTA also expects some DHEBs to remain in service longer than its typical useful life to align with the timing of the needed facility upgrades and rebuilds, which dictate when SFMTA could receive new ZEBs. Additionally, the SFMTA is considering retaining a sub-fleet of DHEBs for resiliency and emergency response purposes (see Chapter 8).

Table 3-5. Total Fleet Size Each Year

Fleet Type	Fixed Route Fleet								Paratransit Fleet				Total Fleet Size
Existing Fleet	32ft		40ft			60ft			Large Cutaway		Small Cutaway*		
Fuel Type	DHEB	BEB	DHEB	BEB	TB	DHEB	BEB	TB	Gas	Electric	Gas	Electric	
2024	30	0	312	12	185	224	0	93	64	0	89	0	1009
2025	30	0	312	12	185	224	0	93	48	2	90	0	996
2026	30	0	300	24	185	224	0	93	48	2	72	0	978
2027	30	0	294	24	185	224	6	93	48	2	73	0	979
2028	30	0	246	72	185	224	6	93	48	2	78	0	984
2029	30	0	190	128	185	224	6	93	49	2	78	0	985
2030	30	0	190	128	185	224	6	93	48	2	78	0	984
2031	30	0	190	128	185	219	11	93	48	2	80	0	986
2032	30	0	190	128	185	179	51	93	48	2	80	0	986
2033	22	8	174	176	153	155	75	93	48	2	78	0	984
2034	14	16	138	212	153	155	75	93	26	24	73	5	984
2035	0	30	122	228	153	155	75	93	20	30	72	6	984
2036	0	30	122	228	153	155	75	93	20	30	52	26	984
2037	0	30	75	284	153	155	75	93	0	50	16	62	993
2038	0	30	28	350	153	155	75	93	0	50	16	62	1012
2039	0	30	28	382	153	155	122	93	0	50	0	78	1091

Fleet Type	Fixed Route Fleet								Paratransit Fleet				Total Fleet Size
Existing Fleet	32ft		40ft			60ft			Large Cutaway		Small Cutaway*		
Fuel Type	DHEB	BEB	DHEB	BEB	TB	DHEB	BEB	TB	Gas	Electric	Gas	Electric	
2040	0	30	28	390	153	155	122	93	0	50	0	78	1099
2041	0	30	28	390	153	115	162	93	0	50	0	78	1099
2042	0	30	28	394	153	23	254	93	0	50	0	78	1103
2043	0	30	0	462	153	0	277	93	0	50	0	78	1143
Notes	"DHEB": Diesel Hybrid Electric Bus, "TB": Trolley Bus, "BEB": Battery Electric Bus												

Source: WSP
*Small Cutaways including cutaways with growth curb weight less than 14,000 pounds and other smaller van type vehicles in the paratransit fleet. They are not within the purview of ICT regulations. Included for reference only.
**The SFMTA is considering retaining a sub-fleet of DHEBs for resiliency and emergency response purposes. For a more detailed explanation, please refer to Chapter 8.

It should be noted that all BEB procurements are contingent on the availability of funding, availability and lead time of the ZEBs, suitability of the BEBs to meet the SFMTA's range requirements, and the readiness of facilities and utility enhancements. Since vehicle deliveries depend on the completion of facility upgrades, any delays—whether due to funding constraints, utility enhancements, or long equipment lead times—will push back procurement timelines, ultimately affecting the overall transition schedule. Staff is actively analyzing these changes and will update the schedule accordingly.

3.2.1 ZEB Bonus Credits

Based on the ICT regulation, the SFMTA is entitled to 18 bonus credits for their existing trolley buses and will have 12 early purchases available for their 40-ft BEB pilot buses, resulting in 30 available credits for the SFMTA.[11] The SFMTA exercised 23.5 credits in the 2024 procurement cycle for the 94 40-ft DHEBs in lieu of the 25% ICT ZEB purchase requirement.

3.2.2 ZEB Range Requirements and Costs

Approximately 5% of the SFMTA's existing bus blocks travel farther than 160 revenue miles per weekday – a range that exceeds some currently available BEBs' capabilities.[12] If necessary, the SFMTA could consider shortening or modifying blocks over 160 miles where feasible. To further reduce impacts to service, there are several strategies that the SFMTA can consider to meet service (range) requirements, including midday charging, battery/charging management systems, on-route chargers, and additional bus purchases. In addition, with battery technology rapidly evolving, future BEBs may be able to serve all of the SFMTA's service blocks. In such cases, newer BEBs could be strategically deployed on longer routes, with the aim of maintaining a 1:1 replacement ratio wherever possible.

3.2.3 ZEB Conversions

Conventional bus conversions to ZEB technologies are not currently being considered. However, the SFMTA will remain open to conversions if they are deemed financially feasible and align with ZEB adoption goals.

[11] Per the ICT regulation: "Each electric trolley bus placed in service between January 1, 2018, and December 31, 2019, receives one-tenth of a Bonus Credit that will expire by December 31, 2024."
[12] This is based on September 2024 service.

4 Facilities and Infrastructure Modifications

The following sections provide an overview of the existing fleet (by yard), proposed charging strategies, infrastructure, yard improvements, and program schedule. The chapter largely relies on information in the Facilities Framework (2024), which identifies the SFMTA plans for improving its transit facility including to transition to a ZEB fleet. The Facilities Framework includes two scenarios that have the same bus yard capital projects, but different implementation sequences. The Rollout Plan uses Scenario 1 from the Facilities Framework as the SFMTA has not fully vetted Scenario 2 as of December 2024.

4.1 Overview of Existing Facilities

The SFMTA has six yards to store and maintain buses and trolley buses for fixed route services, and a paratransit yard for the paratransit cutaways. Table 4-1 summarizes the number and type of buses that are currently stored at each facility and Figure 4-1 presents the locations of each yard.

Table 4-1. Summary of Existing Yards and Fleets^

Yard*	Address	Total Fleet Size	Large Cutaways	Small Cutaways**	Battery-Electric Buses	Diesel-Hybrid Buses			Trolley Buses	
					40’	32’	40’	60’	40’	60’
Flynn	1940 Harrison St.	119	-	-	-	-	-	119	-	-
Islais Creek	1301 Cesar Chavez St.	105	-	-	-	-	-	105	-	-
Kirkland	2301 Stockton St. and 151 Beach St.	88	-	-	-	-	88	-	-	-
Potrero	2500 Mariposa St.	146	-	-	-	-	-	-	53	93
Presidio	949 Presidio Ave.	132	-	-	-	-	-	-	132	-
Woods	1095 Indiana St.	274	-	-	10	40	224	-	-	-
Paratransit Yard	575 Tunnel Ave. (leased)	132	63	69	-	-	-	-	-	-
	Total	996	63	69	10	40	312	224	185	93

Source: SFMTA Master Fleet Assign Ratio (August 2024), SFMTA Paratransit Vehicle Inventory (December 2023)
^Reflects 2024 use at Yards, not necessarily the Yards’ capacity.
* The SFMTA also leases a space at 290 Industrial Way, Brisbane for maintenance purposes.
**Including minivans and sedans

Figure 4-1. The SFMTA's Bus Yards and Leased Paratransit Yard

Source: WSP

4.2 ZEB Facility and Infrastructure Strategy

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may quickly become outdated or obsolete. However, it is also important to ensure that strategies are future-ready. For this reason, the facility and infrastructure modifications are based on what each yard is planned to accommodate per the latest version of the *SFMTA Facilities Framework* report and resulting *Building Progress* capital program. Since service changes and bus movements may occur multiple times a year, by establishing a full-build scenario, the SFMTA can optimize and tailor strategies based on existing (or anticipated) service.

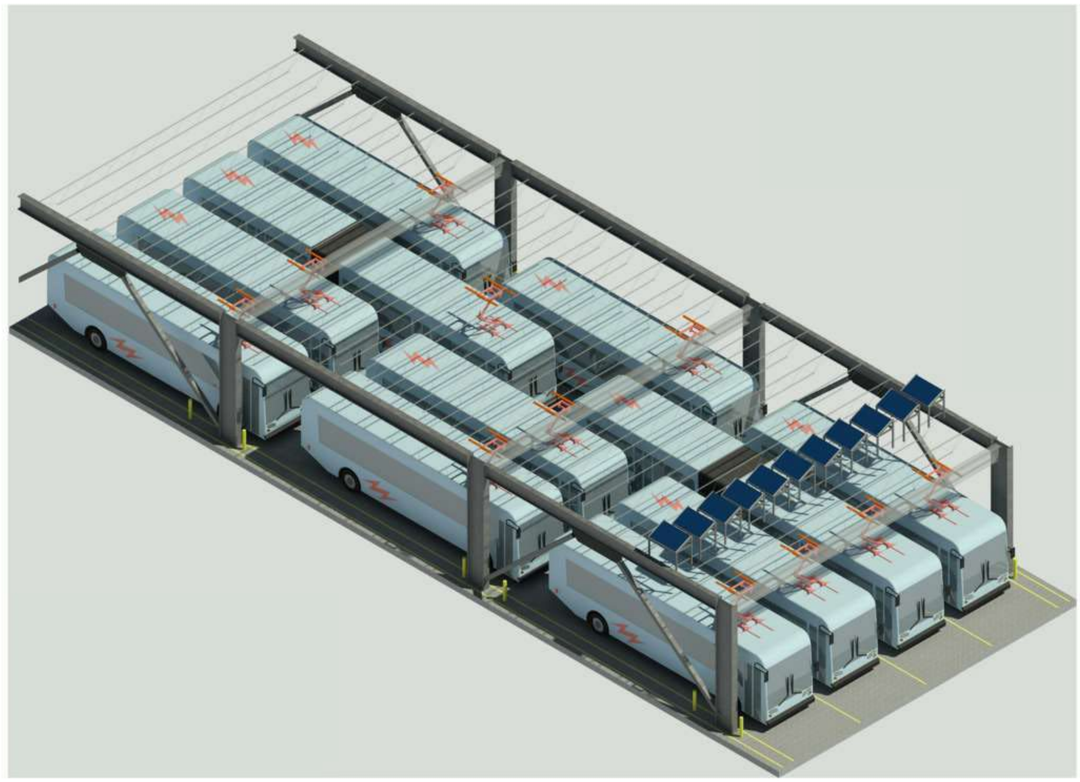
The SFMTA's transition to a zero-emission fleet will require an increase in the electrical supply to each site, enhancements and expansions of electrical equipment, and the installation of gantries, chargers, dispensers, and other components. These modifications must occur at all planned BEB yards. While the SFMTA is not currently actively seeking on-route charging locations, we remain open to the concept, particularly if it is required to meet the service plan.

During preliminary concept discussions, both conductive and inductive charging solutions were considered and analyzed by the SFMTA and the design team. Based on several factors, including the space constraints at each yard and the desire for uniform infrastructure for ongoing maintenance efficiency, the SFMTA committed to an inverted pantograph strategy for all yards that will host BEBs. However, where applicable, such as in maintenance areas, plug-in dispensers may be utilized.

To support the inverted pantographs, a scalable and modular overhead support structure is proposed in open bus yards to retain maximum bus parking capacity while implementing BEB charging. This type of overhead structure can be rapidly modified to meet changes in the SFMTA's fleet mix. The system consists of an overhead structure spanning up to four tracks of bus parking with pantographs mounted at various five-foot intervals as required by the assigned bus fleet. Charger cabinets, switchboards, transformers, and all electrical distribution will be kept above the bus parking area, where possible, to avoid costly trenching and reduce service interruptions during the transition.

Figure 4-2 illustrates inverted pantographs mounted to the modular overhead support structure.

Figure 4-2. Inverted Pantographs and Modular Support Structure



Source: WSP
Note: The frame can also support plug-in dispensers.

The proposed layouts are based on utilizing a 200-kW DC charging cabinet in a 1:2 configuration or a 360 kW DC charging cabinet in a 1:3 configuration, where one DC charging cabinet energizes two or three separate dispensers/buses, respectively. This charger-to-dispenser ratio would meet the requirements to charge the SFMTA's fleet overnight and minimize peak electrical demand.

4.3 ZE Transition

The bus yard conversion and rebuild projects that are needed for the full transition to a ZE fleet are large, complex, and expensive projects that include evolving technology and requirements. In addition, the schedule of sequential bus yard projects to support the transition to an all zero-emission bus fleet is ambitious.

The SFMTA is working to secure local, regional, state, and federal funding for its bus yard projects. In addition, where possible, it is incorporating joint development in its rebuild projects to maximize land use and generate revenue. Given the high cost and long-term nature of projects, the projects are not fully funded, and funding shortfalls are an ongoing risk.

All the SFMTA revenue sources are growing more slowly than before the pandemic and slower than the rate of expenditure growth due to inflation and cost of living increase. Federal, state, and regional relief is expected to be fully expended in FY25-26, which contributes to a large operating deficit starting in FY26-27.

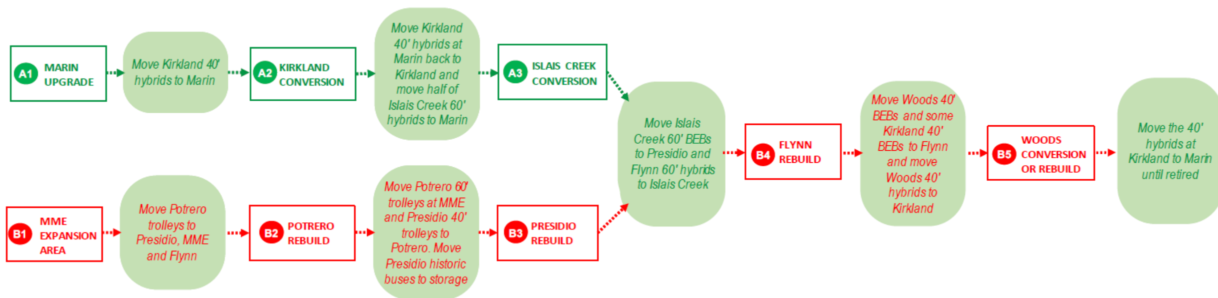
If a bus yard project is delayed—due to funding shortfall, and/or several other factors —the SFMTA will need to evaluate modifying subsequent project schedules and associated bus procurements and deliveries. Section 8 lists and expands on those several other factors which include rapid technological advancements and the risk of outdated procurements, limitations on BEB performance and range, challenges in maintaining resiliency and emergency response capabilities, evolving safety and environmental compliance requirements, fluctuating market conditions, and potential delays in necessary utility upgrades.

Bus Moves

To maintain adequate bus parking, operations, and maintenance, bus yard projects need to occur sequentially. One sequential series includes Marin, Kirkland, and Islais Creek. The other series includes Muni Metro East (MME) storage, Potrero, Presidio, Flynn, and Woods. Under this scenario, both the Islais Creek and Presidio projects must be complete before starting the Flynn project.

Figure 4-3 outlines the planned bus movements between the facilities throughout the facility upgrade process, with detailed explanations provided in the latest SFMTA Facility Framework report. The SFMTA has identified SF Port leased land at 1399 Marin and its MME site as locations for temporary storage and dispatching of buses during construction at other bus yards.

Figure 4-3. Bus Moves Diagram



Source: SFMTA Facility Framework

Following the conversion or rebuild of each yard (except Potrero, which will remain a trolley bus yard), the SFMTA will see a significant increase in available BEB charging positions. As BEB procurements are phased in gradually, this will initially result in more charging positions than BEBs. Consequently, hybrid buses will need to be stored at converted yards that retain fuel stations until they are retired and replaced with BEBs. For example, during specific rebuild projects:

- While Flynn is being rebuilt, the SFMTA will have a surplus of 60-foot BEB charging positions, but a shortfall of 60-foot hybrid bus parking. Therefore, the SFMTA will need to use 60-foot BEB charging positions at Islais Creek to park 60-foot hybrid buses.
- While Woods is being rebuilt, the SFMTA will have a surplus of 40-foot BEB charging positions, but a shortfall of 40-foot hybrid bus parking. Therefore, the SFMTA will need to use 40-foot BEB charging positions at Kirkland to park 40-foot hybrid buses.

Since bus assignments to each yard may shift over time, the SFMTA will need to review bus movements before each yard's construction and, if needed, supplement them with additional crush parking (in maintenance bays, drive aisles or other locations without charging) or temporary reassignments to other yards.

Paratransit Move

The existing Paratransit Yard is a leased facility with limited utility capacity and challenging permits for the installation of additional vehicle chargers. The SFMTA is currently exploring options for a potential future facility to accommodate the paratransit vehicles and necessary chargers, with potential locations including Flynn, Potrero, Presidio, or Woods Yards. Compliance with ICT requirements will depend on the availability and readiness of this facility. The SFMTA may require further exemptions for its paratransit vehicles due to the current lack of suitable facility to store, maintain and charge the ZE vehicles.

4.4 Transition Considerations

There are multiple factors and timetables that must be considered to meet the SFMTA's zero-emission fleet goals in accordance with the ICT regulation. Since BEBs are not operational unless the facilities are in place to energize and maintain them, it is essential to meet facility transition deadlines because it can impact both service and ICT regulation compliance. The following sections provide a brief overview of the various processes and considerations that will impact the transition, while presents the proposed schedule for the SFMTA's zero-emission fleet conversion.

BEB Yard Conversion Projects

For BEB yard conversion projects —such as those planned for Kirkland, Islais Creek, and potentially Woods Yards—the schedule assumes:

- Five years for PG&E application review and electrification concurrent with two years of concept, community outreach, and entitlements and two years of design and procurement.
- Two or three years of on-site construction.

Yard Rebuild Projects

For yard rebuild projects —such as those planned for Flynn, Potrero, Presidio, and potentially Woods Yards—the schedule assumes:

- Two years of concept development, community outreach, and initial entitlement work.
- Five years for PG&E application review and electrification concurrent with five years of design and procurement.
- Three or four years of on-site construction.

BEB Bus Procurements

It is assumed that buses can be procured 18-24 months before the conclusion of the BEB-supporting enhancements or the targeted bus delivery date. Limited Original Equipment Manufacturers (OEMs) and supply chain issues have prolonged the lead time of vehicle delivery. Thus, the SFMTA must strategically align the bus procurement and delivery with the construction of charging equipment at the yard and utility enhancements. The bus procurement plan will also need to align with the yard rebuilt schedule to avoid BEBs arriving before charging infrastructure is ready. It is critical to revisit and update the procurement table regularly to reflect any schedule changes.

Environmental Clearance

All projects will be subject to California Environmental Quality Act (CEQA) review. After several years of work, the SFMTA completed an environmental impact report (EIR) for the Potrero Yard rebuild. The EIR imposes several mitigation measures on the project. Other projects could be subject to similar requirements or a more shorter review due to a CEQA exemption that streamlines zero-emission bus facilities needed for the ICT if particular requirements are met. In addition, the SFMTA may seek federal funding for these projects which would also require National Environmental Policy Act (NEPA) review and potential other federal environmental-related laws.

Yard Management and Operations

The layout and operations of the yard will be different during and after construction. Currently, there are no range issues with the SFMTA's DHEBs and the time it takes to fuel these buses is negligible. However, with the transition from DHEBs to BEBs, more considerations to how buses are parked, operated, and dispatched will be required due to the reduction in range and relatively long charge times. These issues will be even more important during the time(s) that yards are operating mixed fleets (BEB, trolley bus, and DHEB). To mitigate any negative impacts to operations, significant planning and updates to standard operating procedures will be needed to achieve a successful transition.

A critical component of this transition is the implementation of charge management software and BEB yard management systems. Charge management software enables the optimization of charging schedules, helping ensure that buses are fully charged and available when needed. This system integrates with yard management software to provide dispatchers with real-time information on the charge status and range capability of each bus, allowing them to select the most suitable buses to complete specific blocks efficiently. This approach is designed to minimize utility costs, operational downtime, improve efficiency, and ensure the readiness of buses. The SFMTA is currently piloting a concept of charge management and yard management integration with the aim to gather insights on how to integrate these systems into daily BEB fleet operation.

Electricity Needs

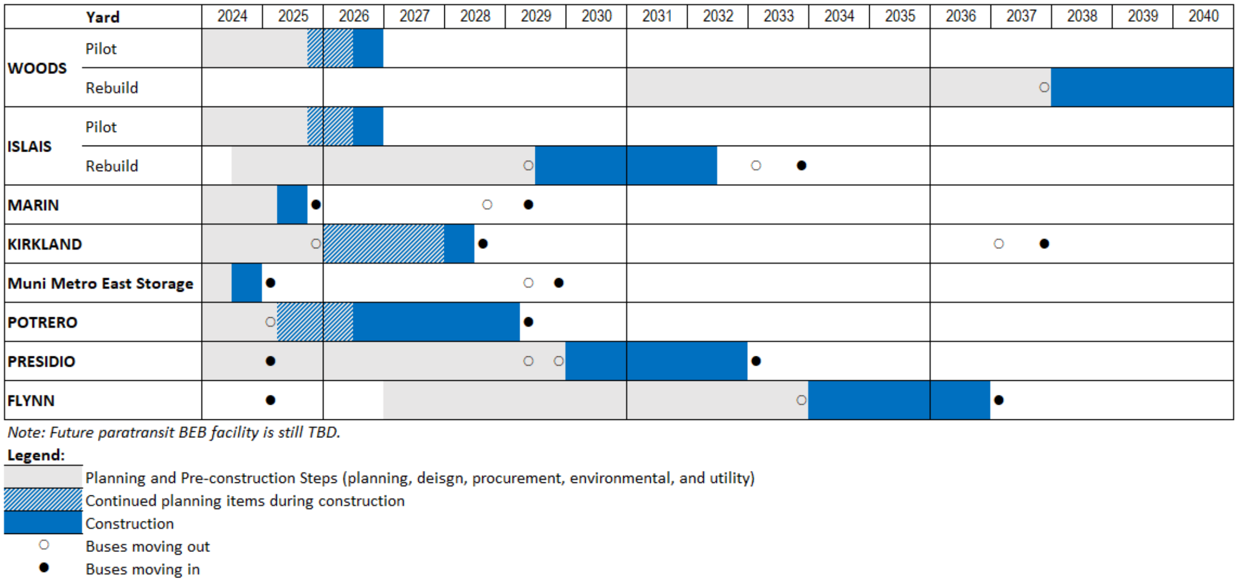
Each yard will need to have sufficient power (utility enhancements) and charging infrastructure in place before buses are delivered. While the utility enhancements can generally be done without impacting normal operations, the installation of the support structure and charging equipment (chargers, switchgear, transformer, etc.) could negatively impact operations. For that reason, the planning of distinct on-site construction stages and program-level phasing is essential.

Schedule

As indicated above, there are multiple prevailing factors that will dictate the SFMTA's transition schedule. illustrates a conceptual schedule. Most projects in this conceptual schedule are unfunded. This schedule largely follows the priorities of the most recent version of the *Facilities Framework* report and uses the utility provider's conservative five-year estimate as the span of time it will take to enhance all facilities. This schedule does not consider the specifics of bus procurement quantities, service planning, or phasing and is highly contingent on the SFMTA's funding and PG&E and SFPUC's ability to meet construction deadlines. These factors and more can impact the conceptual schedule.

The capital investment of BEB conversion is significant, and the SFMTA is committed to fiscally responsible capital projects that meet the larger needs of the SFMTA's service and workforce.

Figure 4-4. Conceptual Schedule



Source: SFMTA Facility Framework, WSP

The schedule is ambitious to support the regulatory required transition to an all zero-emission bus fleet. To provide some contingency the schedule typically includes a year between the on-site construction of sequential projects. However, funding shortfalls, prolonged environmental and/or other regulatory reviews, PG&E capacity and/or timing, construction issues, and/or other issues could delay a project. If a project is delayed the SFMTA will need to evaluate modifying subsequent planned bus procurements and deliveries. If the delay is greater than the scheduled time between the on-site construction of projects the SFMTA will need to modify subsequent project schedules and bus procurements and deliveries.

4.5 Summary of Yard Enhancements

By 2040, assuming the unfunded conceptual schedule is implemented, almost all the SFMTA's yards will be capable of operating a 100% zero-emission fleet. The conceptual schedule shows Woods Rebuild complete in 2041. Assuming this unfunded conceptual schedule, the full ZE transition would occur by 2043.

Table 4-2 summarizes the modifications and schedule of each yard, and the following sections detail the process of each yard's transition from existing conditions to zero-emission vehicle-readiness. The facility narrative is listed in alphabetical order.

Table 4-2. SFMTA ZEB Yard Summary

Yard	Address	Main Functions	Planned Infrastructure	Existing Use (2024)	Designated Charging Positions (2040)^	Upgrades Req'd?	Proposed Full Schedule
Flynn	1940 Harrison St.	Storage/ O&M	Inverted Pantograph	119	250	Yes	2027-2036
Islais Creek	1301 Cesar Chavez St.	Storage/ O&M	Inverted Pantograph	105	75	Yes	Pilot: 2024-2026 Rebuild: 2024-2032
Kirkland	2301 Stockton St. and 151 Beach St.	Storage/ O&M	Inverted Pantograph	88	80	Yes	2022-2028
Potrero*	2500 Mariposa St.	Storage/ O&M	Will be kept as trolley bus yard	146	0 (246 trolley buses)*	Yes	2018-2029
Presidio*	949 Presidio Ave.	Storage/ O&M	Inverted Pantograph	132	215	Yes	2024-2033
Woods	1095 Indiana St.	Storage/ O&M	Inverted Pantograph	264	120 (conversion) or 223 (rebuild)	Yes	Pilot: 2024-2026 Rebuild:2031-2041
Paratransit Yard	575 Tunnel Ave.	Storage/ O&M	The SFMTA is considering options to store, maintain and charge the EV paratransit fleet at Flynn, Potrero, Presidio, or Woods Yards.				

Source: WSP
Note: Flynn, Potrero, and Presidio will be fully rebuilt; the scope of the projects includes more than BEB enhancements. Woods can be converted to a BEB yard or rebuilt with increased capacity.
*Presidio and Potrero Yard are the SFMTA's existing trolley bus years. Without the Potrero Yard rebuild project that expands existing capacity to store and maintain electric trolley buses at the yard, the Presidio Yard BEB project can not move forward because the SFMTA would not have other locations to store and maintain electric trolley buses.
^Crush parking or parking in maintenance basys, drive aisles and other locations without charging could allow for more capacity than that shown in this report.

4.5.1 Flynn Yard

Existing Conditions

Flynn Yard is located at 1940 Harrison Street in the City of San Francisco.

Currently, 119 60-foot diesel-hybrid buses are stored, maintained, fueled, and serviced at Flynn Yard. The yard includes a maintenance area with drive-through bays, transportation area, stand-alone wash canopy, and a stand-alone fuel canopy. These facilities are integrated into the lone, single-story building on the site. A tire shop is located separately from the main facility in a building across Harrison Street. The southeast corner of the block has separate businesses not related to or owned by the SFMTA. Electrical utility service is provided by the SFPUC.

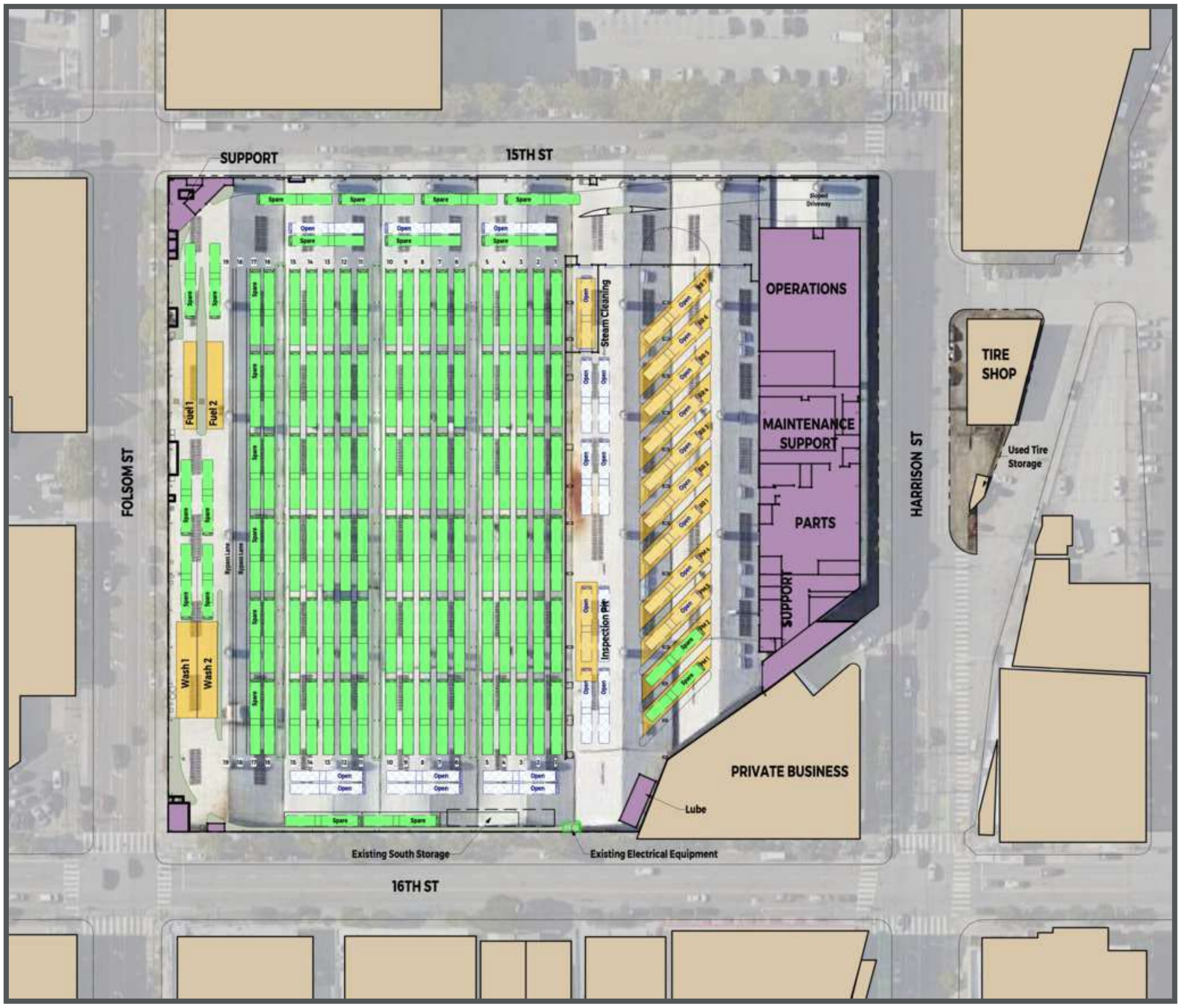
After revenue service, buses enter the yard from Harrison Street and are parked in unassigned, stacked (nose-to-tail) storage tracks in the northern circulation area. Individual buses are then pulled from the storage tracks and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lanes. After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. Non-revenue vehicles (NRVs) are parked in a row of spaces near the transportation area adjacent to the bus circulation's northernmost lane.

An aerial and site plan of Flynn Yard are presented in Figure 4-5 and Figure 4-6, respectively.

Figure 4-5. Flynn Yard - Existing Conditions (Aerial)

Source: SFMTA Facility Framework

Figure 4-6. Flynn Yard - Existing Conditions (Site Plan)



Source: WSP

Planned ZEB Modifications

The building would need significant fire life safety, seismic, and other upgrades if it is converted to a battery electric bus facility. Rebuilding instead of converting the facility is recommended due to the building's age, construction, and condition. Rebuilding Flynn as a multi-level facility will provide a modern, safe, and resilient facility with more capacity. It also will allow the SFMTA to relocate the Kirkland heavy repair and the bus body/paint shop functions, which are currently located at Woods, to Flynn prior to converting or rebuilding Woods as a BEB yard. The project could include joint development and possibly the SFMTA's paratransit BEB facility in addition to the planned bus yard. If the SFMTA could acquire the small adjoining parcel at the corner of Harrison and 16th Streets, it could redevelop the entire block.

Table 4-3 summarizes the ZEB infrastructure planned at Flynn Yard.

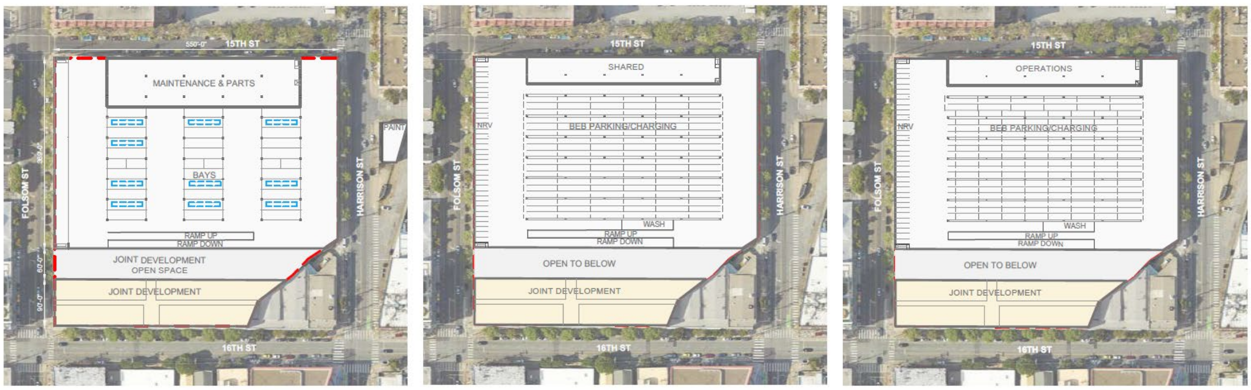
Table 4-3. Flynn Yard ZEB Infrastructure Summary

Primary Charging Strategy	Overhead Inverted Pantograph
No. of Existing Buses (August 2024)	119
No. of Dispensers/Charging Positions (2040)	250

Source: SFMTA Facility Framework

Figure 4-7 provides the test fit diagrams for the Flynn Yard rebuild which includes a three level bus facility and joint development. The bus facility first floor houses bus maintenance, the second floor maintenance, operations, bus parking/charging, and bus washing, and third floor operations, bus parking/charging, and bus washing. A mezzanine over a portion of the first floor could house BEB charging cabinets. A fourth level could be added for the SFMTA's paratransit facility or an additional bus level. The current tire shop at 1941 Harrison could be converted or rebuilt as a bus paint shop.

Figure 4-7. Flynn Yard – Facility Rebuild Concept



First Floor
30 Maintenance Bays
Storage Capacity:
10 crush parking in bays
Paint Booth in former tire shop across street

Second Floor
Storage Capacity:
18 x 8 = 144 40' BEB charging **or**
18 x 6 = 108 60' BEB charging

Third Floor
Storage Capacity:
18 x 8 = 144 40' BEB charging **or**
18 x 6 = 108 60' BEB charging

Source: WSP

4.5.2 Islais Creek Yard

Existing Conditions

Islais Creek Yard is located at 1301 Cesar Chavez Street in the City of San Francisco.

Currently, 105 60-foot diesel-hybrid buses are stored, maintained, fueled, and serviced at Islais Creek Yard. The yard includes the following separate structures and major site areas: a two-story maintenance building, two-story transportation building, and a combined fuel, wash, and tire repair building. Electrical utility service is provided by the SFPUC.

After revenue service, buses enter the yard from Indiana Street and are parked in numbered, stacked (nose-to-tail) storage tracks. Individual buses are then pulled from the storage tracks and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lanes. After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked throughout the site on facility exteriors and the yard perimeter.

Interstate 280 (I-280) traverses over the western side of the site with support columns located in the bus parking yard. Caltrans owns the property under I-280, which the SFMTA leases for bus parking. Due to Caltrans' I-280 maintenance requirements of the support columns and freeway, the SFMTA's ability to construct in this area of the yard may be significantly restricted. Any proposed BEB or other construction under I-280 need to be reviewed and approved by Caltrans.

An aerial and site plan of Islais Creek Yard are presented in Figure 4-8 and Figure 4-9, respectively.

Figure 4-8. Islais Creek Yard - Existing Conditions (Aerial)

Source: SFMTA Facility Framework

Figure 4-9. Islais Creek Yard - Existing Conditions (Site Plan)

Source: WSP

Planned ZEB Modifications

The yard will be used for a 60-foot BEB pilot project and be converted to a BEB yard. The scope of work includes new charging infrastructure and equipment on the SFMTA property. Table 4-4 summarizes the ZEB infrastructure planned at Islais Creek Yard.

Table 4-4. Islais Creek Yard ZEB Infrastructure Summary

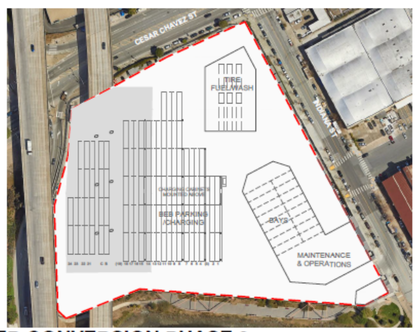
Primary Charging Strategy	Overhead Inverted Pantograph
No. of Existing Buses (August 2024)	105
No. of Dispensers/Charging Positions (2040)	75

Source : WSP

Figure 4-10 provides the test fit diagrams for the Islais Creek Yard facility upgrades. The test fits assume that a gantry structure with BEB charging cabinets and pantographs will be built over bus parking lanes on the SFMTA property but not on the Caltrans property. The diagrams also assume that the light poles under the elevated freeway will be relocated and that BEBs will be crush parked on the Caltrans property and rotated into the bus lanes on the SFMTA property to be charged before returning to service. To avoid unnecessary rework, the SFMTA should develop the BEB pilot project and phased BEB yard conversion project schematic designs together and review these with Caltrans and the SFPUC.

Figure 4-10. Islais Creek Yard – Facility Upgrades Concept

BEB CONVERSION PHASE 1
(lanes 3-15, shown in gray, closed during construction)



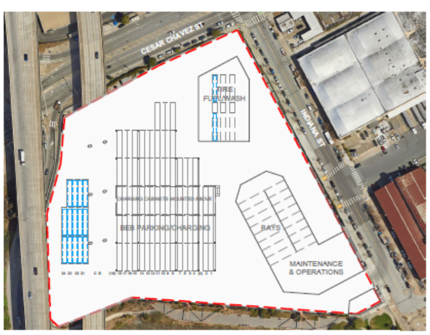
BEB CONVERSION PHASE 2
(lanes 14-24, shown in gray, closed during construction)

Islais Creek Planned Use

During Phase 1 Construction
(lanes 3-15 closed)
2 lanes x 3= 6 60' BEB charging

1 lanes x 2 = 2 60' hybrid parking
4 lanes x 3 = 12 60' hybrid parking
2 lanes x 4 = 8 60' hybrid parking
4 lanes x 5 = 20 60' hybrid parking
42 60' hybrid parking

During Phase 2 Construction
(lanes 14-24 closed)
2 lanes x 3 = 6 60' BEB charging
4 lanes x 4 = 16 60' BEB charging
4 lanes x 6 = 24 60' BEB charging
2 lanes x 5 = 10 60' BEB charging
56 60' BEB charging



FINAL

Final Storage Capacity assumes lanes 3 and 19 used for BEB gantry columns:

2 lanes x 4 = 8 40' BEB charging	or	2 lanes x 3 = 6 60' BEB charging
4 lanes x 6 = 24 40' BEB charging	or	4 lanes x 4 = 16 60' BEB charging
4 lanes x 8 = 32 40' BEB charging	or	4 lanes x 6 = 24 60' BEB charging
7 lanes x 7 = 49 40' BEB charging	or	7 lanes x 5 = 35 60' BEB charging
113 40' BEB charging	or	81 60' charging
21 40' crush	or	16 60' crush

Final
2 lanes x 3 = 6 60' Acceptance

4 lanes x 4 = 16 60' BEB charging
4 lanes x 6 = 24 60' BEB charging
7 lanes x 5 = 35 60' BEB charging
75 60' BEB charging
16 60' crush parking

Source: SFMTA Facility Framework

4.5.3 Kirkland Yard

Existing Conditions

Kirkland Yard is located at 2301 Stockton Street and 151 Beach Street in the City of San Francisco.

Currently, 88 standard diesel-hybrid buses are stored, maintained, fueled, and serviced at Kirkland Yard. The yard includes the following separate structures and major site areas: a maintenance canopy, one-story maintenance support building, one-story transportation building, wash lane (centered in the yard), stand-alone fuel building, and fuel storage yard with support equipment. Electrical utility service is provided by the SFPUC.

After revenue service, buses enter the yard from Stockton Street and are parked in unassigned, stacked (nose-to-tail) storage tracks. Individual buses are then pulled from the storage tracks and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lane, Track 9, if being washed (not all buses are washed due to site restrictions). After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked in a row of spaces along the northern site perimeter, where possible.

An aerial and site plan of Kirkland Yard are presented in Figure 4-11 and Figure 4-12, respectively.

Figure 4-11. Kirkland Yard - Existing Conditions (Aerial)

Source: SFMTA Facility Framework

Figure 4-12. Kirkland Yard - Existing Conditions (Site Plan)

Source: WSP

Planned ZEB Modifications

The Kirkland yard will be converted to a BEB yard. The scope of work includes increasing the existing 11-foot-wide bus parking lanes to industry standard 12-foot-wide lanes and adding storm water collection and management and BEB charging infrastructure and equipment. The existing maintenance and fuel facilities will remain, but the existing operations facilities and bus wash will be replaced in new locations to maximize BEB charging position capacity. The site's small size is a challenge to redeveloping it as a multi-level bus facility because bus circulation ramps and drive aisles required for a multi-level bus facility would use a significant amount of each level. However, a single-level bus facility with joint development above may be possible. The SFMTA may explore joint development opportunities at the site in the future.

Table 4-5 summarizes the ZEB infrastructure planned at Kirkland Yard.

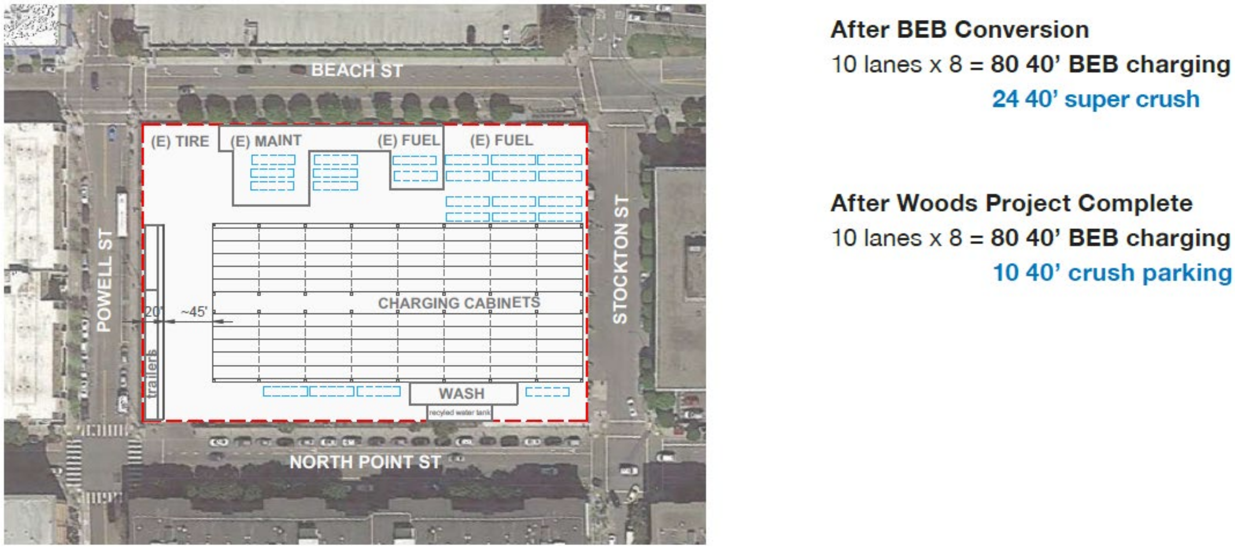
Table 4-5. Kirkland Yard ZEB Infrastructure Summary

Primary Charging Strategy	Overhead Inverted Pantograph
No. of Existing Buses (August 2024)	88
No. of Dispensers/Charging Positions (2040)	80

Source : WSP

Figure 4-13 provides the test fit diagrams for the Kirkland Yard facility upgrades. The location of the operator trailers reduces the drive aisle width to about 45 feet, which is less than 65 feet industry standard for turning. The SFMTA should consider relocating the trailers.

Figure 4-13. Kirkland Yard - Facility Upgrades Concept



Source: SFMTA Facility Framework

4.5.4 Potrero Yard

Existing Conditions

Potrero Yard is located at 2500 Mariposa Street in the City of San Francisco.

Currently, 146 trolley buses (53 40-foot and 93 60-foot) are stored, maintained, fueled, and serviced at Potrero Yard. The yard includes the following separate structures and major site areas: a two-story combined maintenance and transportation building, separate tire shop and body building, wash area, carbon-check area, and two separate bus parking yards. The upper yard and body/tire building are located on the deck above the maintenance building which is accessible from the north via 17th Street. Electrical utility service is provided by the SFPUC.

After revenue service, buses enter the yard from Mariposa Street and are parked in unassigned, stacked (nose-to-tail) storage tracks in front of the carbon check area. Individual buses are then pulled from the storage tracks and taken by nightly service staff to have their carbon checked, fare retrieved, interior cleaned, and fueled before pulling forward to the bus wash area. After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked along the western site perimeter.

In 2022, the SFMTA awarded a pre-development agreement to the Potrero Neighborhood Collective (PNC) to rebuild the yard with more capacity and joint development. The rebuilt yard will be used as a trolley bus yard.

Figure 4-14 presents Potrero Yard under existing conditions.

Figure 4-14. Potrero Yard - Existing Conditions (Aerial)

Source: SFMTA Facility Framework

Planned ZEB Modifications

The Yard will be rebuilt and used as a trolley bus yard. While it is not currently planned to house BEBs or chargers, the Potrero Yard rebuild remains a critical component of the SFMTA's full transition to a zero-emission fleet. Expanding Potrero's capacity to store and maintain electric trolley buses is essential to enabling the Presidio Yard BEB project. Without this expansion, the SFMTA would lack the necessary space to relocate and maintain trolley buses, preventing the Presidio Yard project (and others) from moving forward.

The Potrero Yard rebuild project, which includes joint development and the potential to include the SFMTA's paratransit BEB facility in addition to the planned bus yard, obtained CEQA and special use district approvals in early 2024. The project plan estimates that, once rebuilt, the facility will accommodate 246 trolley buses.

Table 4-6 summarizes the ZEB infrastructure planned at Potrero Yard.

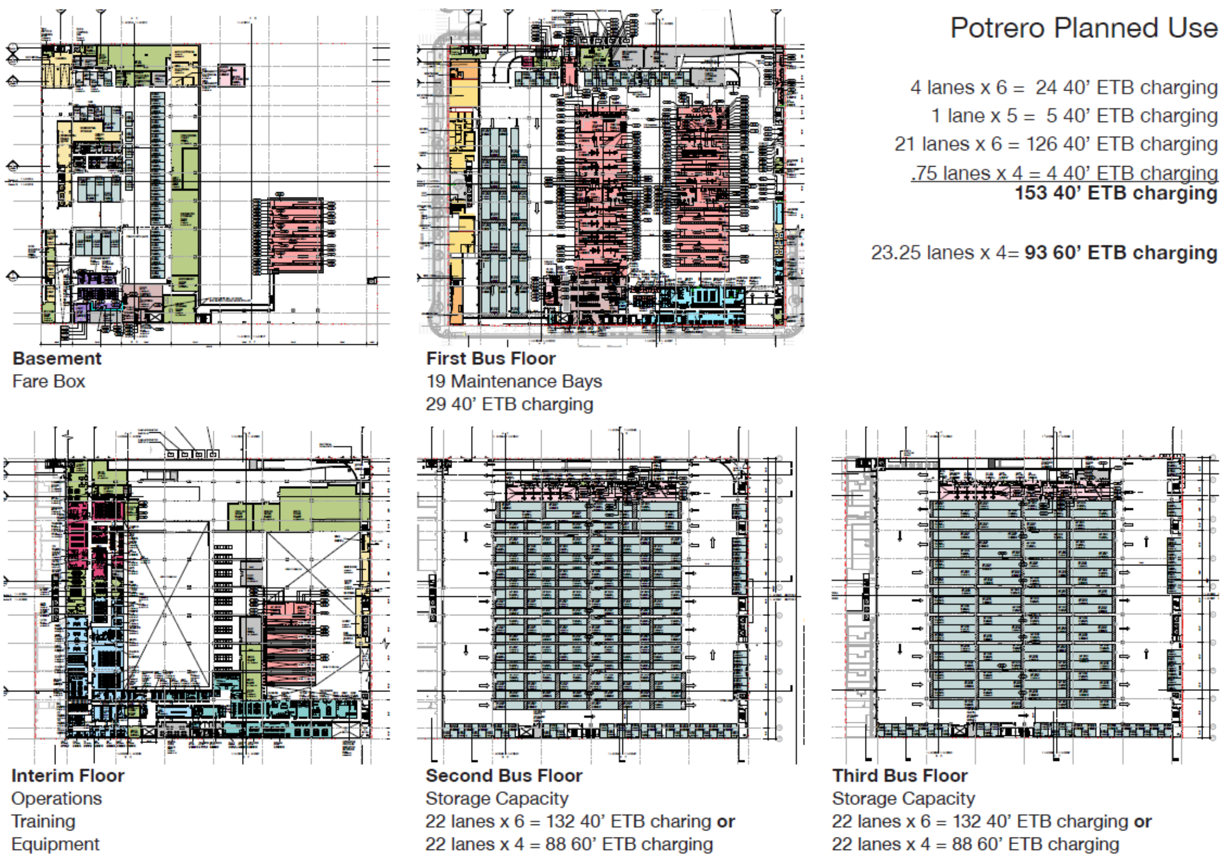
Table 4-6. Potrero Yard ZEB Infrastructure Summary

Primary Charging Strategy	TBD*
No. of Existing Buses (August 2024)	146 of trolley buses
No. of Dispensers/Charging Positions (2040)	TBD*

Source : WSP
* The Potrero Yard will be kept as trolley yard but might have charging positions in the future if chosen to house the paratransit fleet.

Figure 4-15 and Figure 4-16 provide the schematic plans of the Potrero Yard. The plans include a three-level bus facility and joint development. The bus facility basement houses the SFMTA's fare box operations and joint development functions; the first floor houses bus maintenance; the interim floor houses operations, training, and equipment; and the second and third floors house bus parking/charging and bus washing. This layout could allow the yard to be converted to a BEB facility in the future if needed. The design includes joint development along Bryant Street and the potential for joint development or the SFMTA's paratransit facility on top of the bus facility.[13]

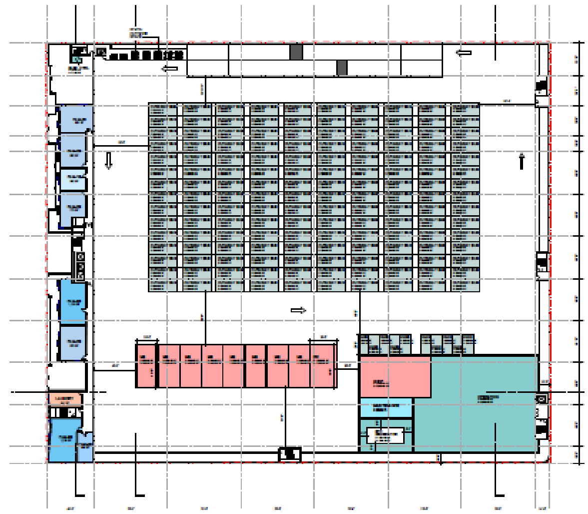
Figure 4-15. Potrero Yard – Modernization Project Schematic Plans (Basement to Third Floor)



[13] The SFMTA Potrero Yard Modernization Project Website

Figure 4-16. Potrero Yard – Modernization Project Schematic Plans (Fourth Floor Options)

Possible Fourth Floor Option
Housing



Possible Fourth Floor Option
Paratransit

Housing: City and County of San Francisco Planning Department, 3 December 2023, Potrero Yard Modernization Project Response to Comments (Case No. 2019-021884ENV), Figure 8.21: Refined Project Proposed Joint Development Floor 7

Paratransit: City and County of San Francisco Planning Department, 3 December 2023, Potrero Yard Modernization Project Response to Comments (Case No. 2019-021884ENV),Figure 8.29: Refined Project Variant Roof Plan.

4.5.5 Presidio Yard

Existing Conditions

Presidio Yard is located at 949 Presidio Avenue in the City of San Francisco.

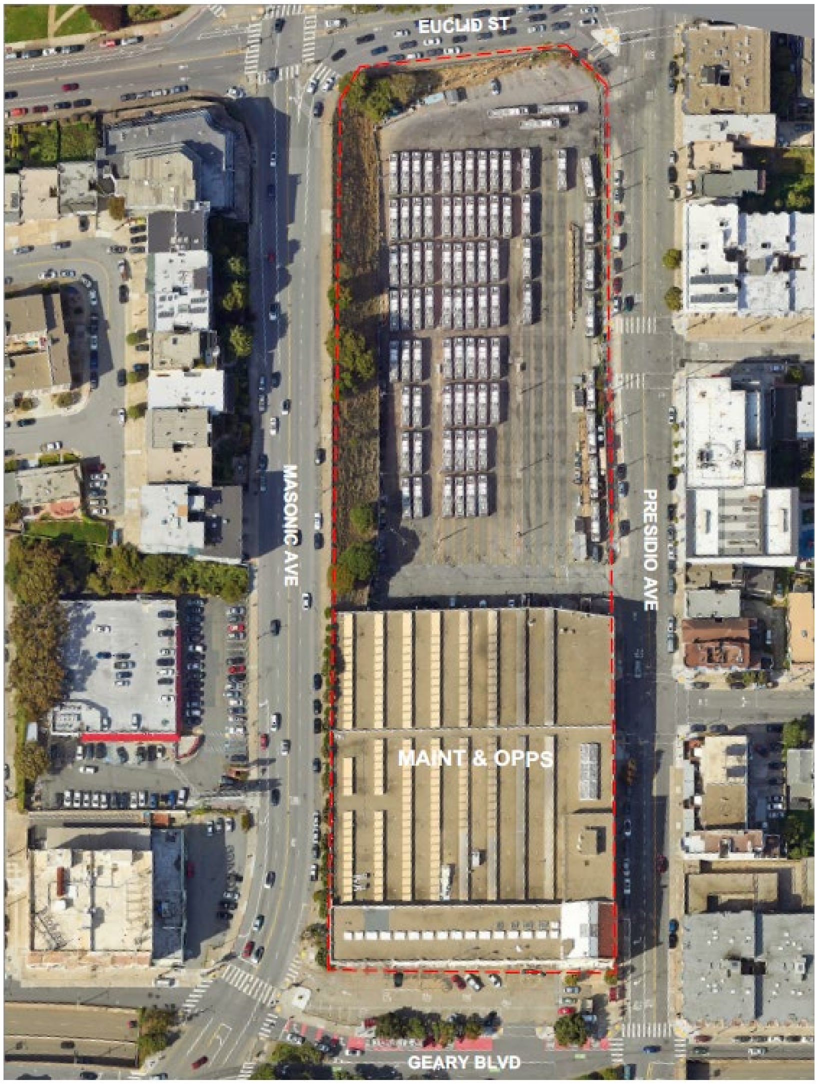
Currently, 132 40-foot trolley buses are stored, maintained, fueled, and serviced at Presidio Yard. The yard includes the following separate structures and major site areas: a two-story combined maintenance and transportation building, wash area, carbon check area, and bus parking yard. Electrical utility service is provided by the SFPUC.

After revenue service, buses enter the yard from Presidio Avenue and are parked in unassigned, stacked (nose-to-tail) storage tracks in front of the carbon check area. Individual buses are then pulled from the storage tracks and taken by nightly service staff to have their carbon checked, fare retrieved, interior cleaned, and fueled before pulling forward to the bus wash area. After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked along the northern site perimeter.

Presidio Yard is over 100 years old and anticipated to be demolished and rebuilt with modern bus facilities. This Yard is expected to be rebuilt as a battery electric bus yard with more capacity.

Figure 4-17 presents Presidio Yard under existing conditions.

Figure 4-17. Presidio Yard - Existing Conditions (Aerial)



Source: SFMTA Facility Framework

Planned ZEB Modifications

Presidio Yard is planned to be fully redeveloped and converted to be a battery electric bus yard with more capacity. The project will include joint development and possibly the SFMTA's paratransit BEB facility in addition to the planned bus yard. Additionally, the SFMTA plans to continue to store its historic buses at Presidio. Most historic buses should be stored in the basement to keep drive aisles clear for turning.

Table 4-7 summarizes the zero-emission vehicle infrastructure planned at Presidio Yard.

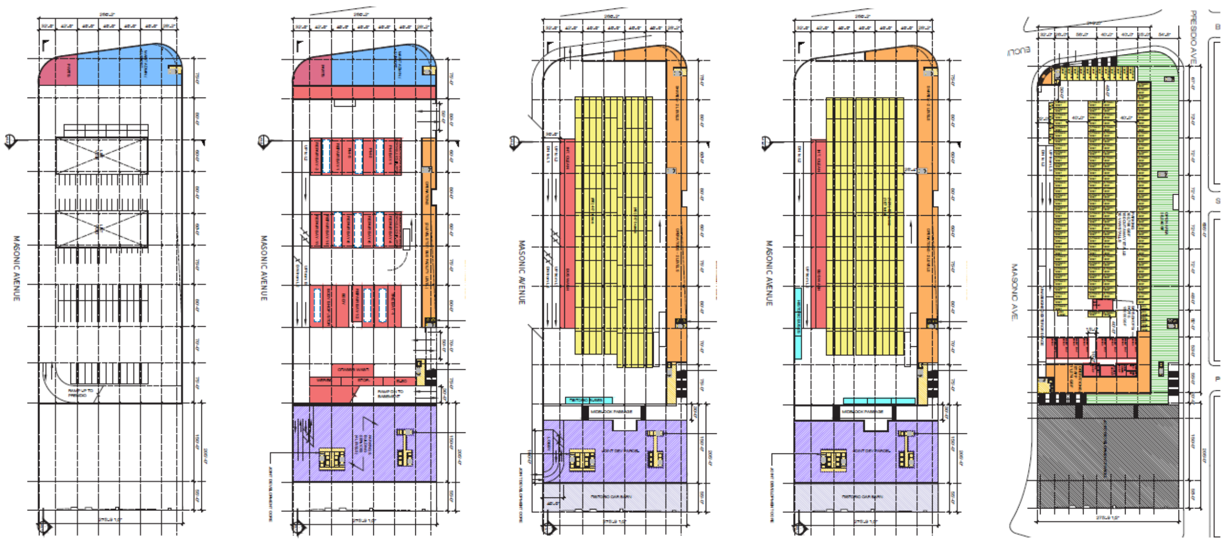
Table 4-7. Presidio Yard ZEB Infrastructure Summary

Primary Charging Strategy	Overhead Inverted Pantograph
No. of Existing Buses (August 2024)	132
No. of Dispensers/Charging Positions (2040)	215

Source : WSP

Figure 4-18 provides the facility rebuild concept for the Presidio Yard. The concept plans include a three-level bus facility and joint development. The bus facility basement houses bus maintenance, stationary engineers, and non-revenue vehicles; the first floor includes bus maintenance; and the second and third floors includes operations, bus parking/charging, and bus washing. The design includes joint development along Geary Boulevard and the potential for a fourth bus floor which could house the SFMTA's paratransit BEB facility as shown, or possibly an additional bus level.

Figure 4-18. Presidio Yard - Facility Rebuild Concept



Source : SFMTA Facility Framework

4.5.6 Woods Yard

Existing Conditions

Woods Yard is located at 1095 Indiana Street in the City of San Francisco.

Currently, 264 (224 40-foot and 40 30-foot) DHEBs are stored, maintained, fueled, and serviced at Woods Yard. Woods has the largest bus capacity in Muni's system and is of strategic importance in the overall Muni service plan. It also has ten 40-foot battery-electric pilot buses that will be expanded.

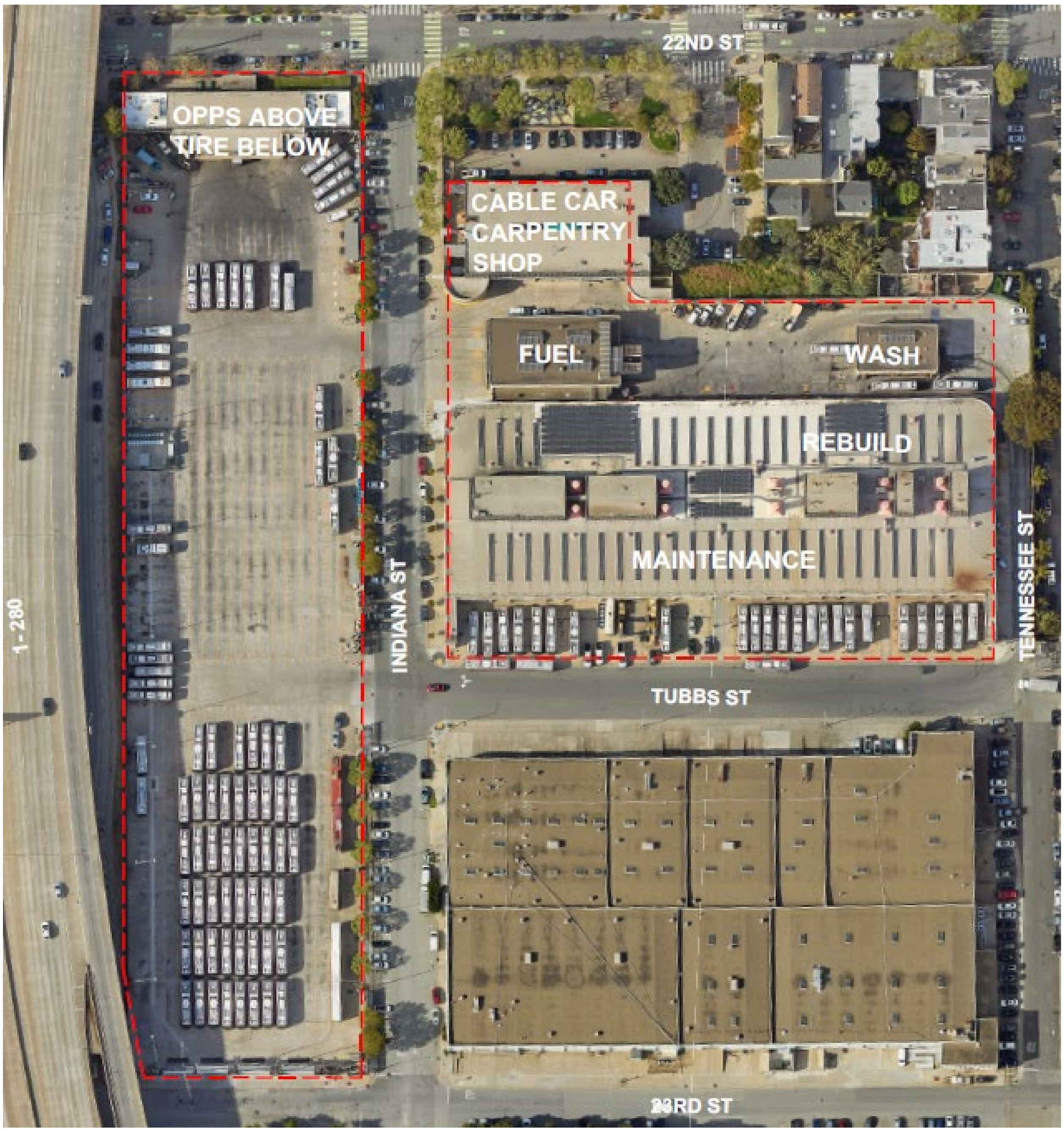
The yard includes the following separate structures and major site areas: a two-story maintenance building, two-story tire shop, stand-alone fuel building, and stand-alone wash building. The site is bisected from north to south by Indiana Street. Electrical utility service is provided by the SFPUC.

After revenue service, buses enter the yard from Indiana Street and are parked in unassigned, stacked (nose-to-tail) storage tracks. Individual buses are then pulled from the storage tracks and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lane. After fuel and wash, buses are re-parked in the storage tracks. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked in a row of spaces along the northern site perimeter, between the fuel and wash areas.

As a result of BEB facility conversion scope and high cost of improvements and electrical upgrade, the SFMTA is analyzing a potential full rebuild and expansion of the Woods Yard. Woods Yard is inefficient in its site design and the maintenance function limits it to only 40-foot buses, which constrains the SFMTA's overall maintenance flexibility. A full rebuild will transform the Yard to a 40 and 60-foot BEB yard with increased capacity and joint development opportunities.

An aerial and site plan of Woods Yard are presented in Figure 4-19 and Figure 4-20, respectively.

Figure 4-19. Woods Yard - Existing Conditions (Aerial)



Source: SFMTA Facility Framework

Figure 4-20. Woods Yard - Existing Conditions (Site Plan)

Source: WSP

Planned ZEB Modifications

Woods could be converted to a battery electric bus yard, or one or both parcels could be rebuilt as a multi-level battery electric bus yard. If rebuilt the project could include joint development and possibly the SFMTA's paratransit BEB facility in addition to the planned bus yard.

Table 4-8 summarizes the ZEB infrastructure planned at Woods Yard.

Table 4-8. Woods Yard ZEB Infrastructure Summary

Primary Charging Strategy	Overhead Inverted Pantograph
No. of Existing Buses (August 2024)	274
No. of Dispensers/Charging Positions (2040)	120 (conversion) or 223 (rebuild)

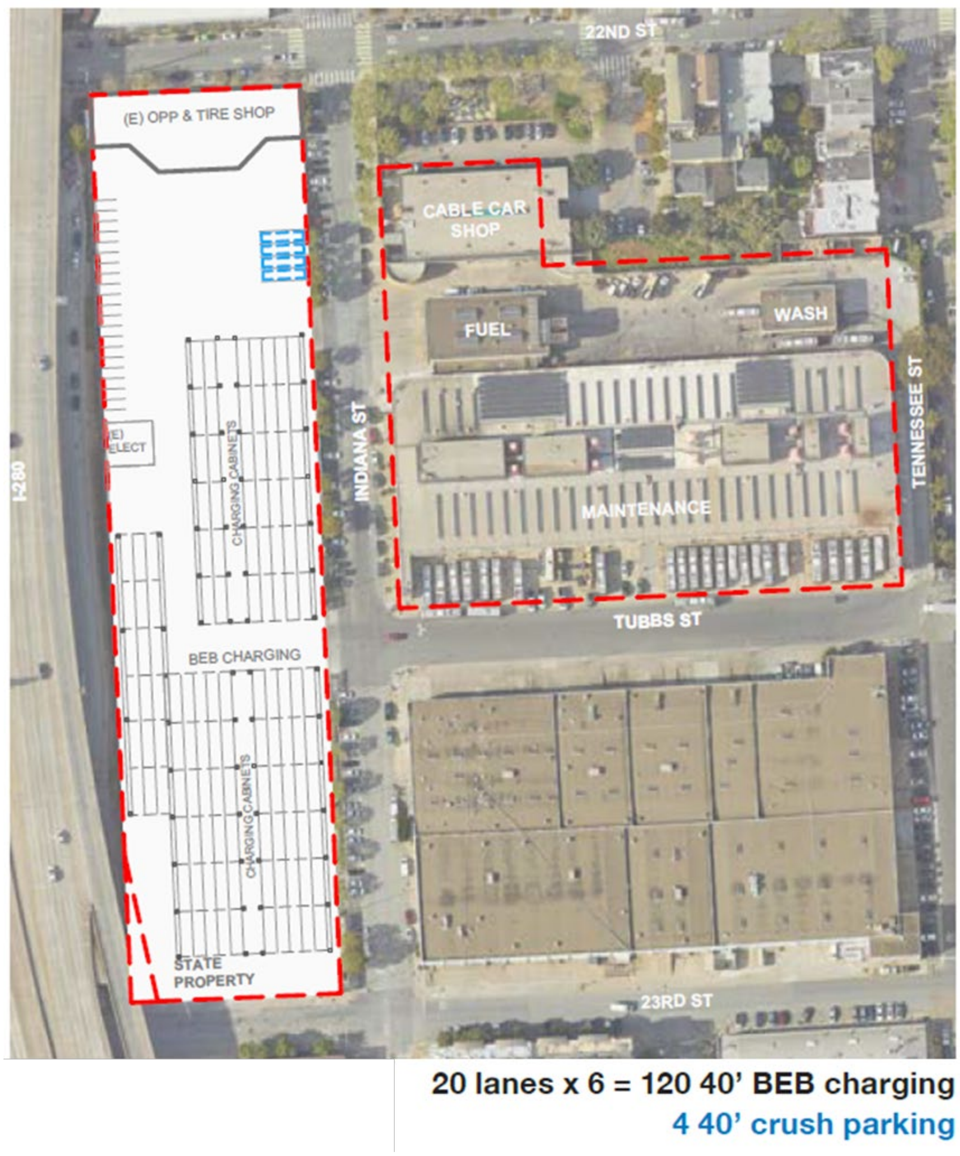
Source : WSP

Figure 4-21 and Figure 4-22 illustrate two potential facility concepts—one for conversion and one for rebuild.

The full set of options includes two design variations for each scenario. One conversion option involves adding gantry-mounted pantographs parallel to the bus lanes, while the other positions pole-mounted pantographs perpendicular to the lanes, allowing for greater parking capacity once the BEB pilot is complete.

For a rebuild, one design places a three-level bus facility on the west parcel and joint development on the east, while the alternative locates the three-level facility and joint development on the east parcel and repurposes the west parcel. In the latter scenario, the west parcel could feature bus parking on the first floor and the SFMTA paratransit facility on the second. For further details, the most recent Facility Framework report provides comprehensive concept designs for all scenarios.

Figure 4-21. Woods Yard – Conversion Concept



Source: SFMTA Facility Framework

Figure 4-22. Woods Yard – Rebuild Concept (West Parcel Rebuild Option)

First Floor	**Second Floor**	**Rebuild Option - Third Floor**
20 Maintenance Bays 8 crush parking in bays	Storage Capacity: 11 lanes x 12 = 132 40' charging positions or 11 lanes x 8 = 88 60' BEB charging positions	Storage Capacity 9 lanes x 13 = 117 40' BEB 2 lanes x 9 = 18 60' BEB positions

Source: SFMTA Facility Framework

5 Equity Considerations

The following section provides an overview of disadvantaged communities within the SFMTA's service area and information on how the SFMTA plans to ensure that zero-emission vehicles are prioritized in these communities.

5.1 Disadvantaged Communities

In 2014, the SFMTA Board of Directors adopted a Muni Service Equity Policy – a commitment to prioritize equity in Muni service planning, to right historic wrongs, better serve marginalized communities, and ensure the most transit-dependent neighborhoods have reliable transit service. The Policy requires the submission of a Service Equity Strategy before the agency's Board approves the SFMTA's budget every two years. The biennial Service Equity Strategy assesses Muni service in neighborhoods identified as Muni Equity Strategy neighborhoods, identify transit related challenges impacting those neighborhoods, and develop strategies to address those challenges. In April 2024, the agency's Board adopted the Muni Equity Strategy for FY 2025 and FY 2026. This edition of the Equity Strategy analyzed service in nine San Francisco neighborhoods (Bayview, Chinatown, Excelsior/Outer Mission, Inner Mission, Oceanview/Ingleside, Tenderloin/SoMa, Treasure Island, Visitacion Valley, and Western Addition) as well as routes across the city that are heavily used by seniors and people with disabilities. The intent is that these neighborhoods see service improvements (or avoid service reductions) equal to or better than the overall system. The FY 2025 & 2026 Equity Strategy also focuses on advancing equity-based service planning in a cost-neutral way.

Additionally, the SFMTA also implemented the "Green Zone" project, initiated in 2019, which utilizes existing technology that permits diesel-hybrid vehicles to run on full electric battery power in select neighborhoods with poor air quality. 68 of these vehicles have larger batteries and a GPS-enabled switch, which will cause the bus to automatically switch to EV mode as it enters geo-fenced areas (Green Zones) throughout the city. The geo-fenced zones were chosen to focus primarily on Muni Equity Strategy neighborhoods, those with high percentages of low-income households and people of color, and where respiratory illnesses occur at a disproportionate rate.

Beyond the agency's initiatives, the SFMTA also considers broader definitions of disadvantaged communities as outlined by state guidelines. Disadvantaged communities (DACs) refer to areas that suffer the most from a combination of economic, health, and environmental burdens. The California Communities Environmental Health Screening Tool (CalEnviroScreen) analyzes environmental, health, and socioeconomic data for each census tract (community) in California. Each tract is assigned a score to gauge a community's pollution burden and socioeconomic vulnerability. A higher score indicates a more disadvantaged community, whereas a lower score indicates fewer disadvantages. The California Environmental Protection Agency (CalEPA) and California's Senate Bill 535, define a "disadvantaged" community as a community (census tract) that is located in the top 25th percentile of U.S. Census tracts identified by the results of (CalEnviroScreen). It is important to note that the neighborhoods identified in the SFMTA's Service Equity Policy align with the DACs designated by the CalEnviroScreen tool.

The replacement of DHEBs with BEBs will yield benefits in the communities they serve, including a slight reduction of noise and harmful pollutants. Most noise and air pollutants in San Francisco are from sources other than DHEBs, including private diesel trucks and private vehicles. Given that DACs are disproportionately exposed to these externalities, they will be considered for prioritization during the initial deployments of BEBs.

5.2 Summary of The San Francisco's DACs

To understand the potential benefits that ZEBs will provide to DACs in the SFMTA's service area, it is necessary to establish if (1) a yard is in a DAC, and (2) if its routes travel within or alongside a DAC boundary. This analysis considers communities as disadvantaged if they are identified as DACs by the California's CalEnviroScreen tool.

As shown in Table 5-1 and Figure 5-1, no bus yard is situated within a DAC. However, all of the SFMTA's six bus yards serve routes that serve DACs. In total, SFMTA serves approximately 200 census tracts, 26 of which (13%) are identified as DACs under state definitions. Among the bus yards, Woods Yard serves the most San Francisco DACs (17), which account for approximately 9% of all communities/census tracts that Woods' routes serve.

As noted above, some routes are operated with buses from more than one yard, so a single DAC could be served by buses from multiple yards. Due to the flexible nature of paratransit services, quantifying the exact amount of DAC coverage for these services is challenging. However, it is important to note that paratransit plays a crucial role in providing accessible transportation to individuals who cannot use public transit due to disabilities or health conditions.

Table 5-1. The SFMTA's Disadvantaged Communities - Yard Summary

Yard	In DAC?	Communities (Census Tracts) Served	DACs Served	Pct. of Tracts Served that are DACs
Flynn	No	85	5	6%
Islais Creek	No	92	7	8%
Kirkland	No	88	6	7%
Potrero	No	84	2	2%
Presidio	No	97	7	7%
Woods	No	182	17	9%
Paratransit Yard	No	N/A	N/A	N/A

Source: CalEnviroScreen 3.0 & 4.0, SFMTA September 2024

Table 5-2 details the number of DAC-serving routes by yard for the fixed route service.

Table 5-2. The SFMTA's Disadvantaged Communities – Weekday Route Summary (As of August 2024)

Yard	No. of DAC-Serving Routes	DAC-Serving Routes
Flynn	5	9R, 14R, 38R
Islais Creek	6	7, 8, 8AX, 8BX, 38, NBUS
Kirkland	5	12, 19
Potrero	7	5, 6, 14, 30
Presidio	7	21, 24, 31, 45
Woods	29	5, 9, 15, 23, 25, 27, 29, 38, 44, 54, 56, 90, 91, 714, LBUS, LOWL, NOWL, TBUS, KBUS

Source: CalEnviroScreen 3.0 & 4.0, SFMTA September 2024

Figure 5-1. The SFMTA's Disadvantaged Communities and Bus Yards

Source: CalEnviroScreen 3.0 & 4.0, SFMTA September 2024

6 Workforce Training

The following section provides an overview of the SFMTA's plan to train personnel on the impending transition.

6.1 Training Requirements

The transition to an all zero-emission fleet will significantly alter SFMTA's service and operations. Converting to BEBs from their existing DHEBs is logistically complicated and will impact all ranks of the organization.

Training for the operation, maintenance, and handling of BEBs will be conducted after bus procurement and in advance of delivery. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. For example, SFMTA has already procured 12 buses for their pilot project (delivered between 2021-2024).[14] Table 6-1 provides an example of training modules that are included with one of their procurements.

It is expected that all relevant personnel will be sufficiently trained before buses arrive. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that SFMTA's staff will be trained well in advance of the commissioning of these additions.

Table 6-1. Zero-Emission Bus Training Modules (Sample)

Module	Hours
General Vehicle Orientation	8
Multiplex System	32
Entrance and Exit Doors	8
Wheelchair Ramp	4
Brake Systems and Axles	16 (8 per axle)
Air System and ABS	8
Front and Rear Suspension, Steering, and Kneeling	8
Body and structure	4
Propulsion & ESS Fam/HV Safety	24
Charging Equipment	4
Electric HVAC, AC Maintenance (Vendor Specific)	24
Propulsion & ESS Troubleshooting	16
Operator Orientation	8
Towing and Recovery	4

Source: SFMTA, 2019

The following provides a list of personnel and positions that will need to be retrained upon adoption of BEBs (this list is not exhaustive):

[14] Nine buses are currently procured with an additional three in negotiations.

- **Bus Operators and Supervisors**
  Bus operators and field supervision will need to be familiarized with the buses, safety, bus operations, and pantograph operations.

- **Facilities Maintenance Staff**
  Maintenance staff will need to be familiarized with scheduled and unscheduled repairs, high-voltage systems, and the specific maintenance and repair of equipment.

- **First Responders**
  Local fire station staff will need to be familiarized with the new buses and supporting facilities.

- **Tow Truck Service Providers**
  Tow truck providers will need to be familiarized with the new buses and proper procedures for towing ZEBs.

- **Mechanics**
  Mechanics will need to be familiarized with the safety-related features and other components of ZEBs.

- **Instructors**
  Maintenance and bus operator instructors will need to understand all aspects of the transition of ZEBs to train others.

- **Utility Service Workers**
  Staff will become familiarized with proper charging protocol and procedures that are ZEB-specific.

- **Management Staff**
  Maintenance and Operations managerial staff will be familiarized with ZEB operations and safety procedures.

7 Costs and Funding Opportunities

The following sections outline preliminary capital cost estimates, previous grant applications, and potential funding sources that the SFMTA may pursue to support its adoption of ZEBs.

7.1 Preliminary Capital Expenditure Costs

The SFMTA must invest significant capital funding into its fleet and facilities over the coming decades, regardless of the bus technology selected for its future fleet. The SFMTA's Facility Framework Report includes planned upgrades and rebuilding of aging facilities and infrastructure to support fleet electrification. Electrification efforts between the fleet and facilities must be aligned. A zero-emission fleet cannot operate without the necessary facility infrastructure. Moreover, installing electrification infrastructure in a facility that requires major renovations or replacement would be counterproductive and may not be feasible due to code requirements.

Table 7-1 presents the estimated capital costs for two scenarios, reflecting infrastructure upgrades and a single round of vehicle procurement. These estimates are intended to highlight the additional capital resources required to implement electrification compared to maintaining DHEB and ICE technologies.

- **"With Electrification"** scenario: the SFMTA converts DHEBs to BEBs , continues operating electric trolley buses, and electrifies facilities as outlined in Section 4.5.

  Because a facility-specific vehicle procurement schedule is not yet available, vehicle costs were estimated based on the final charging capacity in Section 4.5. It is assumed that procurement occurs two years prior to facility readiness. Infrastructure costs were escalated to the midpoint of the construction period.

- **"Without Electrification"** scenario: Follows the same procurement and facility schedule as the "With Electrification" scenario, but the SFMTA continues to procure and operate DHEBs and electric trolley buses and does not install BEB infrastructure.

Overall, electrification is estimated to increase vehicle costs by 26% and infrastructure costs by 34%. The total capital cost of the "With Electrification" scenario is approximately $7 billion, which is $1.7 billion or 31% higher than the $5.3 billion estimated for the "Without Electrification" scenario. See Appendix B for detailed cost breakdowns. Costs may increase further due to delays, significant scope changes, or other challenges identified in Section 8.

Table 7-1. Preliminary Cost Estimates – With and Without Electrification (Year of Expenditure Million $)

Cost Components	Scenario: With Electrification	Scenario: Without Electrification	Cost of Electrification
Vehicles*	$ 2,717	$ 2,148	**$ 569**
Facility Infrastructure**	$ 4,292	$ 3,198	**$ 1,094**
Total	**$ 7,009**	**$ 5,346**	**$ 1,663**

*Vehicle capital costs reflect a single round of vehicle procurement, with the number of vehicles estimated based on each facility's final charging capacity without crush parking.
** Among other exclusions, facility Infrastructure cost estimates exclude potential substantial costs from PG&E, potential new building or fire code requirements or best practices for indoor BEB facilities, and paratransit facility infrastructure.
Source: WSP, M Lee 2025. See Appendix B for more details.

BEBs are about 30% to 40% more expensive than DHEBs on a per vehicle basis. Additionally, the "With Electrification" scenario includes substantial facility infrastructure costs not present in the "Without Electrification" scenario, such as charging equipment, utility upgrades, installation, conduit trenching, and other supporting infrastructure.

The "Without Electrification" scenario still includes significant capital costs, as the SFMTA will require replacement buses and plans to rebuild several yards regardless of fleet type. These rebuilds are included in both scenarios and are intended to address facilities in poor condition, support long-term service reliability, and expand capacity.

The full costs of the "With" and "Without Electrification" scenarios will ultimately be higher than those shown in Table 7-1, as paratransit infrastructure costs are not included. A future yard location for the paratransit fleet has not yet been finalized. Options under consideration include a standalone development or incorporation into existing rebuild projects at Potrero, Presidio, Flynn, or Woods yards. Separately, the estimated vehicle replacement costs to electrify the paratransit fleet is $36 million, which is 53% higher than the $23.5 million estimate under the "Without Electrification" scenario, in which paratransit vehicles would continue operating on gasoline.

Compared to the previous version of the Rollout Plan, the estimated costs have increased significantly. Inflation, especially in construction materials and labor, has driven cost escalation across the board. In addition, the earlier estimates primarily accounted for vehicle and charger costs but did not include construction-related expenses such as site work, utility upgrades, installation, trenching, permitting, and contingency. These items are now integrated into the cost model, providing a more comprehensive capital projection.

While battery technology is becoming more efficient and affordable, the base price of BEBs has increased compared to the previous version of the Rollout Plan. This is due in part to tightening supply in the transit bus market, with only a limited number of Buy America-compliant OEMs producing standard-size BEBs. High demand from agencies across the country has placed pressure on production capacity, contributing to price escalation and longer lead times. Furthermore, trade policies and tariffs on certain vehicle components and raw materials may also drive costs higher in the future.

7.2 Potential Funding Sources

There are a few potential federal, state, local, and project-specific funding and financing sources that may be available to the SFMTA. The SFMTA will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. Table 7-2 identifies potential funding opportunities that the SFMTA may take advantage of in the next 20 years.

Table 7-2. ZEB Funding Opportunities

Type	Agency	Funding Mechanism
Federal	United States Department of Transportation (USDOT)	Rebuilding American Infrastructure with Sustainability and Equity (RAISE) aka Better Uitlizing Investments to Leverage Development (BUILD) Grant Program
	FTA	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant

Type	Agency	Funding Mechanism
		Low- or No-Emission Vehicle Grant
		Metropolitan & Statewide Planning and Non-Metropolitan Transportation Planning
		Urbanized Area Formula Grants
		State of Good Repair Grants
		Flexible Funding Program – Surface Transportation Block Grant Program
	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program
State	CARB	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Sustainable Transportation Equity Project
		Cap-and-Trade Funding
	California Energy Commission (CEC)	EnergIIZE (Transit set-aside)
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	Caltrans	Low Carbon Transit Operations Program (LCTOP)
		Transportation Development Act
		Transit and Intercity Rail Capital Program
		Transportation Development Credits
		New Employment Credit
Local and Project-Specific		Joint Development
		Parking Fees
		Tax Rebates and Reimbursements
		Enhanced Infrastructure Financing Districts
		Opportunity Zones

Source: WSP

7.3 Previous Grant Applications

In recent years, the SFMTA has applied for various competitive grants to support its ZE fleet transition. The SFMTA has been unsuccessful in receiving awards from these grants despite received high ratings.:

- **FY22, F23, and FY24 Kirkland Bus Yard (varying amounts between $60M to $99M)**: The SFMTA has applied for three grants for the Kirkland Bus Yard project design and construction. The SFMTA has been unsuccessful each time.

- **FY22, F23, FY24, FY25 Presidio Bus Yard (varying amounts around $10M)**: the SFMTA has applied for multiple RAISE federal grants to advance the Presidio Bus Yard project during its planning and environmental documentation phase. In early January 2025, the SFMTA was noticed that they were awarded $9.2M from the USDOT to support the project.

- **FY22 and FY23 Islais Creek Bus Yard ($17M and $30M):** The SFMTA applied for two grants for the Islais Creek Bus Yard project and successfully secured $30 million in FY23 through a joint grant between Islais Creek and Woods Bus Yards (see below). This funding will support the installation of EV-ready infrastructure, BEB charging equipment, and the transition of 40- and 60-foot hybrid buses to battery-electric.

- **FY23 Woods Bus Yards ($30.12M)**: The SFMTA was awarded a grant to support the installation of EV-ready infrastructure and BEB charging equipment at both Woods and Islais Creek bus yards, facilitating the transition of 40- and 60-foot hybrid buses to battery-electric. Additionally, the SFMTA pursued $5 million in funding through the California Energy Commission's Innovative Charging Solutions for Medium- and Heavy-Duty Electric Vehicles for BEB Infrastructure at Woods. Although this application was ranked highest in California, the SFMTA ultimately had to withdraw due to conflicts in project timeline requirements.

- **FY24 Potrero Bus Yard ($115.0M):** The SFMTA applied for grant funding to replace an obsolete, century-old bus yard with a four-story trolley bus maintenance and storage facility but was unsuccessful.

8 Start-Up and Scale-Up Challenges

The SFMTA is an industry leader in implementing clean fleets and we share the California Air Resource Board's (CARB) vision to mitigate the impacts of climate change. The transportation sector is San Francisco's largest contributor to the city's overall carbon footprint. As the biggest source of greenhouse gas emissions, it makes up nearly half of all citywide emissions. The pollutants from cars, trucks and other private vehicles account for 66% of transportation emissions, while public transportation accounts for only 2% of transportation emissions.[15] SFMTA's transit fleet accounts for less than 2% of public transportation emissions (and less than .01% of the city's overall greenhouse gas emissions).

Initial analysis identifies significant challenges to further reducing the SFMTA's 2% share of emissions via a full ZE transition by 2040. The timeline in the most recent Facility Framework report projects that the entire fleet will be transitioned to zero-emission by 2043, due to facility upgrades, bus procurement timeline constraints, unpredictable advancements in ZE technology that may affect transit performance and reliability, and substantial capital, operational, and maintenance costs. Additionally, the SFMTA budget remains impacted by a prolonged structural deficit, which the COVID-19 pandemic exacerbated.

While SFMTA remains committed to the goal of a fully zero-emission fleet, as outlined in the previous Rollout Plan, achieving full compliance with this regulation will depend on overcoming several key challenges. Table 8-1 highlights some of these challenges; however, it is not exhaustive. The SFMTA intends to work with CARB to further explore additional risks and complexities associated with the ICT regulation.

Despite these uncertainties, SFMTA continues to take significant steps toward this goal by implementing pilot projects, planning facility upgrades and ZEB procurements, and actively pursuing funding opportunities to support the transition to ZEBs and necessary facility upgrades.

[15] 2022 San Francisco Sector-based Greenhouse Gas Emissions Inventory At-A-Glance, April 2024 (https://www.sfenvironment.org/media/14365)

Table 8-1. ZE Transition Challenges and Considerations

Challenge/Factor	Description	SFMTA's Efforts to Date	Further Uncontrollable Challenges
Uncertain Capital Funding Streams	Transitioning to BEBs requires significant capital investment and long-term funding commitments. While BEBs offer potential lifecycle cost savings, upfront costs are high, and funding sources are uncertain. The SFMTA faces aging, obsolete facilities with substantial deferred maintenance, and its Building Progress Program—intended to address facility renewal—lacks dedicated funding for BEB-related modifications. Without additional funding, the transition remains financially unfeasible.	Pursuing competitive grant opportunities; Exploring joint development and public-private partnerships; Strategically planning facility upgrades in the latest Facility Framework document.	Federal policy uncertainties; Limited availability of grants and funding; Inflation and cost escalation
High Capital and O&M Costs	A full BEB transition requires more vehicles due to range limitations, exceeding a 1:1 replacement ratio. However, the SFMTA's existing facilities are at capacity and cannot accommodate additional buses. Expanding real estate and building new facilities would be costly and complex. Additionally, San Francisco's steep grades necessitate high-performance traction motors and extended warranties, increasing purchase prices and midlife overhaul costs. The limited number of Buy America-compliant OEMs further contributes to market-driven price volatility.	Monitor industry trends to assess fleet needs; Conduct cost estimates for both vehicles and infrastructure upgrades; Pursue grant opportunities; Exploring innovative business models	Market volatility; Inflation; Long lead time
Transition Complexity.	Managing service continuation, compliance to regulations, on-site construction, facility rebuilds, temporary bus relocations, bus procurements, and utility enhancements simultaneously poses a lot of risk to the SFMTA. Delays in one area can create cascading impacts across other components.	Periodical update to the Facility Framework and Rollout Plan	Market volatility; Long lead time; Region grid capacity and upgrade timeline
Strains on Market Supply	Demand for ZEBs is increasing nationwide, making it difficult to secure vehicles. As of 2024, only two Buy America-compliant BEB OEMs exist, further limiting options. If the supply industry cannot keep up and we end up with a less reliable vehicle, this could suppress transit use and not meet program goals. We cannot go electric if vehicles are not reliable.	Assumed long lead-time for BEB procurement; Early engagement with OEMs;	Market volatility
Insufficient BEB Performance and Range.	The SFMTA's analysis currently shows some service blocks that cannot be completed under existing BEB technologies due to the shorter driving range, particularly the hilliest routes. Additionally, California's axle load regulations limit the vehicle	Conducted route modeling simulation during the planning phase; BEB pilot; Monitoring industry trends to reassess vehicle needs	Weather condition, driver behavior, and terrain

Challenge/Factor	Description	SFMTA's Efforts to Date	Further Uncontrollable Challenges
	and battery pack options available for the SFMTA to procure, further restricting achievable range.		
Rapid Technological Advancement	The SFMTA is planning its ZE transition based on current fleet projections, but the rapid evolution of battery and charging technologies presents challenges. The agency must make procurement decisions based on existing technology, risking obsolescence if advancements occur soon after purchases. This uncertainty could impact fleet performance, reliability, and long-term cost-effectiveness.	Monitoring industry trends; Engaging with OEMs and technology providers; BEB pilot before large-scale deployment	Difficulties to determine when exactly new technologies will become available
Resiliency and Emergency Response	The SFMTA is seeking solutions to address resiliency and emergency response within the context of a zero-emission fleet. Service that is dependent on electricity is vulnerable during power outages and emergencies. In addition, the SFMTA provides regional emergency responses and high-capacity evacuation for wildfires, which would be challenging to do with reduced bus ranges offered by zero-emission vehicles.	Acknowledges that the SFMTA will maintain a non-electric fleet component for years to come, which is not compliant with CARB's ICT regulation. Therefore, the SFMTA will need to further explore this concept in the future, which will include revisiting its bus procurement plan and the planning needs of associated facilities.	
Building and Environmental Code Requirements and Compliance	Fire, building, and environmental code updates enhance ZEB safety but may limit facility capacity and increase costs. Compliance with stormwater and sea level rise regulations adds complexity and financial burden. Environmental review mitigations further contribute to project constraints.	Ensuring compliance in all phases of the facility upgrades	Updates to regulations
Dependence on SFPUC and PG&E Enhancements	The SFMTA's ZEB transition requires major electrical infrastructure upgrades, but planning and execution depend on utility providers. PG&E has not provided a clear path for collaboration, despite SFPUC's efforts. Utility enhancements outside the SFMTA's property lines may also require costly upstream grid improvements. Additionally, PG&E may pass millions in upgrade costs per site to the SFMTA. Competing statewide electrification efforts could further delay transit projects as PG&E prioritizes commercial rate-paying customers over wholesale transit customers.	Continuous coordination with both SFPUC and PG&E	The SFPUC is currently undertaking an analysis of their rate structure. The SFMTA currently pays a wholesale distribution rate and receives power to its traction power system and facilities at very favorable rates. The outcome of this study and any resulting rate change impacts the SFMTA's cost to convert from DHEB to BEB.

Challenge/Factor	Description	SFMTA's Efforts to Date	Further Uncontrollable Challenges
Managing Power Demand	The transition to BEBs will require strategies to ensure that the SFMTA can utilize power in the most efficient way. However, managing demand may also come at a hefty capital cost, something that staff is currently analyzing.	Coordinating with utility providers to determine methods to reduce peak demands; Consider charge management software	
Economic Recovery and Revenue Shortfalls	COVID-19 led to a significant decline in ridership and revenue, creating ongoing financial constraints, exacerbating financial challenges that have been faced by the SFMTA. As of September 2024, ridership remains at 78% of pre-pandemic levels, despite ongoing service recovery efforts, resulting in changes to procurement and funding. As we look towards our recovery, we believe our limited resources are best used in retaining and growing our ridership. By prioritizing our commitment to providing reliable, high-frequency buses, we will improve environmental conditions at a lower cost than total fleet conversion. While current CARB fleet conversion goals will help us further reduce, we believe high quality service is the key to even greater emissions reductions.	The SFMTA will continue to analyze trends to determine service changes and plans.	General transit ridership trend and changes in travel patterns

Source: SFMTA, WSP

Appendix B: Preliminary Capital Expenditure Costs Details

The following provides more detailed cost estimates to that included in Section 7.1 Preliminary Capital Expenditure Costs.

Table B- 1: Preliminary Cost Estimates – With Electrification*
(Year of Expenditure (YOE) Million $)

Yard	Vehicles					Facility Infrastructure^				TOTAL
	YOE+	DHEBs/ICEVs	BEBs	Trolleys	Sub-Total	YOE**	Electrification	Other	Sub-Total	
Kirkland	2026	$0	$125	$0	$125	2027	$117	$25	$142	**$267**
Islais Creek	2030	$0	$201	$0	$201	2030	$112	$0	$112	**$313**
Potrero* **	2027	$0	$0	$496	$496	N/A	$0	$560	$560	**$1,056**
Presidio	2033	$0	$504	$0	$504	2033	$211	$844	$1,055	**$1,559**
Flynn	2034	$0	$647	$0	$647	2035	$336	$767	$1,103	**$1,750**
Woods	2039	$0	$708	$0	$708	2039	$318	$1,002	$1,320	**$2,028**
Paratransit	2032	$0	$36	$0	$36	2034	N/A	N/A	N/A	**N/A**
Total		**$0**	**$2,221**	**$496**	**$2,717**		**$1,094**	**$3,198**	**$4,292**	**$7,009**

Source: WSP, M Lee 2025.
*With Electrification scenario: the SFMTA converts DHEBs to BEBs, continues to operate electric trolley buses, and electrifies facilities according to the yard enhancements in section 4.5.
** Infrastructure costs were escalated to the midpoint of the construction period.
*** This is the tentative estimated cost of the fully escalated Design-Build (DB) Potrero scope of work in the context of a Design-Build-Finance-Operate-Maintain (DBFOM) Public-Private Partnership (P3) project delivery methodology. The SFMTA will pay the P3 developer for the DB debt service at different milestones and annually over a period of time following construction, as required through the financing structure and obligations of the DBFOM project agreement.
+ Vehicle costs were estimated based on each facility's final charging capacity outlined in Section 4.5, without crush parking. It is assumed that procurement occurs two years prior to facility readiness.
^ Among other exclusions, facility infrastructure cost estimates exclude potential substantial costs from PG&E, potential new building or fire code requirements or best practices for indoor BEB facilities, and paratransit facility infrastructure.

Table B- 2: Preliminary Cost Estimates – Without Electrification*
(Year of Expenditure (YOE) Million $)

Yard	Vehicles					Facility Infrastructure^				TOTAL
	YOE+	DHEBs/ICEVs	BEBs	Trolleys	Sub-Total	YOE**	Electrification	Other	Sub-Total	
Kirkland	2026	$96	$0	$0	$96	2027	$0	$25	$25	**$121**
Islais Creek	2030	$146	$0	$0	$146	2030	$0	$0	$0	**$146**
Potrero* **	2027	$0	$0	$496	$496	N/A	$0	$560	$560	**$1,056**
Presidio	2033	$378	$0	$0	$378	2033	$0	$844	$844	**$1,222**
Flynn	2034	$482	$0	$0	$482	2035	$0	$767	$767	**$1,249**
Woods	2039	$527	$0	$0	$527	2039	$0	$1,002	$1,002	**$1,529**
Paratransit	2032	$24	$0	$0	$24	2034	N/A	N/A	N/A	**N/A**
Total		**$1,652**	**$0**	**$496**	**$2,148**		**$0**	**$3,198**	**$3,198**	**$5,346**

Source: WSP, M Lee 2025.
*Without Electrification scenario: Follows the same procurement and facility schedule as the "With Electrification" scenario, but the SFMTA continues to procure and operate DHEBs and electric trolley buses and does not install BEB infrastructure.
** Infrastructure costs were escalated to the midpoint of the construction period.
*** This is the tentative estimated cost of the fully escalated Design-Build (DB) Potrero scope of work in the context of a Design-Build-Finance-Operate-Maintain (DBFOM) Public-Private Partnership (P3) project delivery methodology. The SFMTA will pay the P3 developer for the DB debt service at different milestones and annually over a period of time following construction, as required through the financing structure and obligations of the DBFOM project agreement.
+ Vehicle costs are based on the same number of vehicles and procurement timeline as the "With Electrification" scenario to ensure a consistent basis for comparison.
^ Among other exclusions, facility infrastructure cost estimates exclude paratransit facility infrastructure.

Table B- 3: Preliminary Cost Estimates – Cost of Electrification*
(Year of Expenditure (YOE) Million $)

Yard	Vehicles Costs Difference+	Infrastructure Costs Difference**	Total Difference
Kirkland	$29	$117	$146
Islais Creek	$55	$112	$167
Potrero* **	$ -	$ -	$ -
Presidio	$126	$212	$337
Flynn	$165	$336	$501
Woods	$181	$318	$499
Paratransit	$13	$-	$ -
Total	**$569**	**$1,094**	**$1,663**

Source: WSP, M Lee 2025.
*Cost of Electrification represents the difference between the capital costs in the "With Electrification" and "Without Electrification" scenarios, as detailed in Table B- 1 and Table B- 2.
** Infrastructure costs were escalated to the midpoint of the construction period. Among other exclusions, facility infrastructure cost estimates exclude potential substantial costs from PG&E, potential new building or fire code requirements or best practices for indoor BEB facilities, and paratransit facility infrastructure.
*** This is the tentative estimated cost of the fully escalated Design-Build (DB) Potrero scope of work in the context of a Design-Build-Finance-Operate-Maintain (DBFOM) Public-Private Partnership (P3) project delivery methodology. The SFMTA will pay the P3 developer for the DB debt service at different milestones and annually over a period of time following construction, as required through the financing structure and obligations of the DBFOM project agreement.
+Vehicle costs were estimated based on each facility's final charging capacity outlined in Section 4.5, without crush parking. It is assumed that procurement occurs two years prior to facility readiness.