SAN BERNARDINO COUNTY TRANSPORTATION AUTHORITY

FINAL COUNTYWIDE ZEB ROLLOUT PLAN

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

In accordance with the California Air Resource Board's (CARB) Innovative Clean Transportation (ICT) regulation, the following report serves as the San Bernardino Countywide Rollout Plan (Countywide Rollout Plan) to transition agencies within San Bernardino County to 100 percent zero-emission (ZE) fleets by 2040. The Countywide Rollout Plan consists of four transit agencies within San Bernardino County: Morongo Basin Transit Authority (MBTA), Mountain Area Regional Transit Authority (MT), City of Needles (Needles or NAT), and Victor Valley Transit Authority (VVTA).

1.2 BACKGROUND

1.2.1 CALIFORNIA AIR RESOURCE BOARD'S INNOVATIVE CLEAN TRANSPORTATION REGULATION

CARB's ICT regulation requires all public transit agencies in the State of California to transition from conventional buses (compressed natural gas, diesel, etc.) to ZE buses (battery-electric or fuel cell electric) by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be zero-emission buses (ZEBs) based on their fleet size. By 2040, CARB expects all transit agencies in the state to be operating only ZEBs.

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 ("Joint Group"), to submit a ZEB Rollout Plan ("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 (as outlined in the Rollout Plan Guidelines) and must be approved by the transit agency's governing body through the adoption of a resolution, prior to submission to CARB.

In accordance with the ICT regulation, the following report serves as the Countywide Rollout Plan, a plan to transition MBTA, MT, NAT, and VVTA to 100 percent zero-emission fleets by 2040.

Each agencies' respective section in this report covers the following, as required per the ICT regulation:

1. **Introduction** *Details the service area, environmental factors, and schedule and operations.*
2. **Fleet and Acquisitions** *Presents the existing fleet and procurement plan for buses through 2040.*
3. **Facilities and Infrastructure Modifications** *An overview of each yard and the potential ZEB modifications.*
4. **Disadvantaged Communities** *Discusses the disadvantaged communities (DACs) that will be impacted by the ZEB transition.*
5. **Workforce Training** *Provides background on personnel training requirements for ZEB implementation.*
6. **Costs and Funding Opportunities** *Discusses rough order of magnitude costs and potential funding sources.*
7. **Start-Up and Scale-Up Challenges** *Provides an understanding of challenges and issues that the agency will have to mitigate or confront during ZEB adoption*

1.2.2 SAN BERNARDINO COUNTY TRANSIT AGENCIES' ICT FILING REQUIREMENTS

According to the ICT regulation, each agency has different requirements based on its classification as a "Large" or "Small" transit agency.

Large transit agencies under the ICT regulation must comply with the following requirements and deadlines:

— **July 1, 2020 –** Board-approved Rollout Plan must be submitted to CARB

— **January 2023 –** 25 percent of all new bus purchases must be ZE

— **January 2026 –** 50 percent of all new bus purchases must be ZE

— **January 2029 –** 100 percent of all new bus purchases must be ZE

— **January 2040 –** 100 percent of fleet must be ZE

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

Small transit agencies under the ICT regulation must comply with the following requirements and deadlines:

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— **January 2026 –** 25 percent of all new bus purchases must be ZE

— **January 2029 –** 100 percent of all new bus purchases must be ZE

— **January 2040 –** 100 percent of fleet must be ZE

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

There are five bus transit agencies in San Bernardino County but only Omnitrans is considered a large transit agency, therefore, it is the only agency obligated to submit a Rollout Plan by July 1, 2020. For that reason, Omnitrans' Rollout Plan was developed as a stand-alone plan and is appended to the Countywide Rollout Plan (Appendix A).

The four other agencies (hereinafter referred to as "Group" or "Agencies") are considered small transit agencies and have the option to either: 1) file individually at any time between now and 2023, or 2) file as part of a "Joint Group" between now and 2023. At this time, these agencies are still strategizing on how they should approach the filing requirements. The Countywide Rollout Plan, in an effort to provide each agency with flexibility, is written in a way that allows each agency to file individually, or as a Joint Group. It should be noted that although Omnitrans is filing in 2020, they also have the option to join these other agencies as part of a Joint Group at a later date.

Filing as a Joint Group has specific requirements and restrictions that are outlined in the ICT regulation.

1.3 BATTERY-ELECTRIC BUSES AND FUEL CELL ELECTRIC BUSES

According to the ICT regulation, a ZEB is a bus with zero tailpipe emissions and is either a battery-electric bus (BEB) or a fuel cell electric bus (FCEB).

BEBs depend on a system to store and retrieve energy much as cars and trucks need fuel. BEBs have multiple battery packs that power an electric motor, resulting in ZE. BEBs, similar to many other battery-powered products, must be charged for a period of time to be operational. Currently, BEBs can be charged at a bus-base facility, on the route (opportunity charging) and/or via a number of connectors and dispensers.

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. FCEB can replace diesel or compressed natural gas (CNG) fuel buses without significant changes to operations and service and functions as a resilient backup alternative in case of natural disaster. 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.

While both technologies provide ZE benefits, the feasibility and viability of their application is largely based on an agency's service and operational parameters.

1.4 ZERO-EMISSION BUS ADOPTION AND STRATEGIES

The decision on whether to adopt BEBs and/or FCEBs is largely based on availability, applicability, and costs. Due to rapidly changing technologies, it's highly likely that strategies to adopt ZEBs today may need to be adapted and revised to account for advancements and changes in ZEB technology in the future. That said, the plans presented in the Countywide Rollout Plan are subject to alterations and may not necessarily reflect the strategy of each individual agency at the implementation stage. This Countywide Rollout Plan will serve as a guiding document for ZEB implementation, or as a baseline for agencies' subsequent studies and implementation towards ZEB adoption pursuant to the ICT regulation.

The following sections summarize the existing conditions, proposed ZEB technologies, and schedule for MBTA, MT, Needles, and VVTA.

1.4.1 EXISTING CONDITIONS

Public transit within San Bernardino County is largely provided by five local transit operators: MBTA, MT, Needles, Omnitrans, and VVTA. The San Bernardino County Transportation Authority (SBCTA) serves as a funding agency to each of the transit operators. Together, the operators account for approximately 12.4 million annual (unlinked) passenger trips. These agencies, however, have vastly different operations and service conditions. To determine each agency's pathway to 100 percent ZEB adoption, it is pertinent to understand their unique operating conditions and goals. With a comprehensive approach to analyzing the four agencies in the Countywide Rollout Plan, commonalities such as operating conditions, vehicle types, and shared transit centers and stops can be used to ensure comprehensive planning strategies, resulting in potential cost savings, joint agreements, and a more seamless ZEB transition. Table 1-1 summarizes the existing conditions of each agency's facilities and Figure 1-1 presents the locations of each agency's facilities.

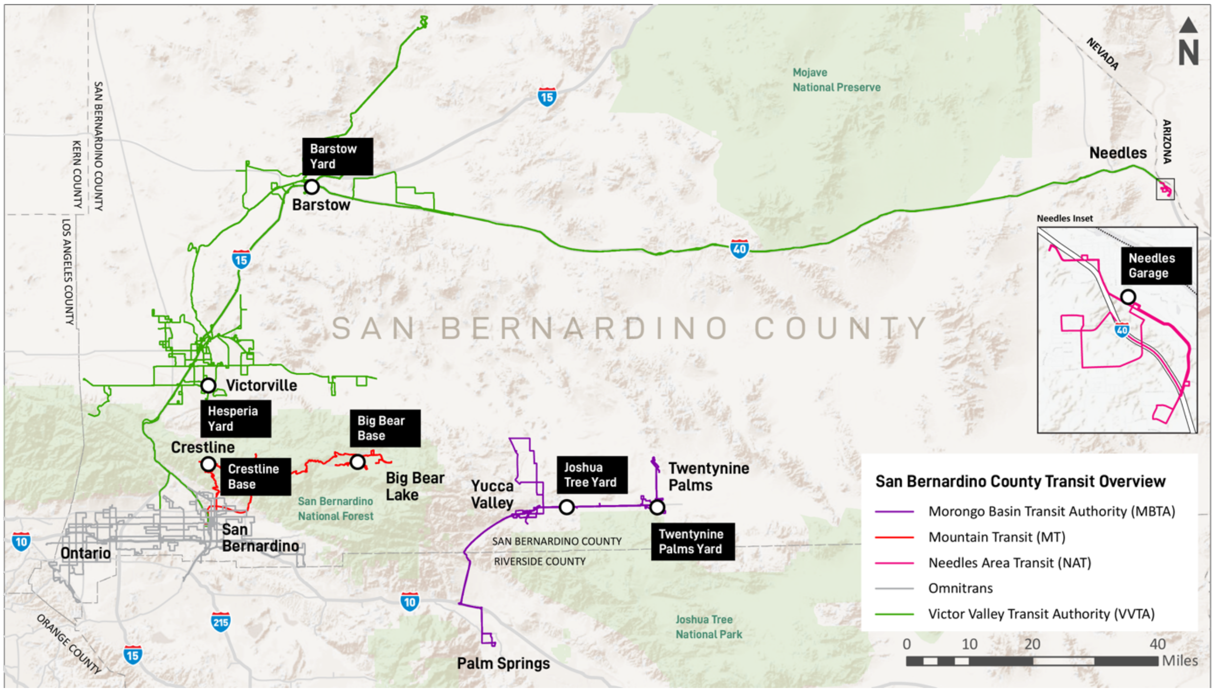
Table 1-1. Existing Conditions Summary

AGENCY	FACILITY	# BUSES	TYPES OF BUSES	FUEL TYPE
MBTA	Joshua Tree	26	Cutaways	CNG
	Twentynine Palms	5		
MT	Crestline	11	Cutaways	Gasoline
	Big Bear Lake	13		Gasoline/Diesel*
NAT	Needles	3	Cutaways	Diesel
VVTA	Hesperia	56	Standard, Cutaway, Coach	CNG; BEB

AGENCY	FACILITY	# BUSES	TYPES OF BUSES	FUEL TYPE
	Barstow	15	Standard, Cutaway	CNG; Gasoline

Source: WSP

Figure 1-1. San Bernardino County Transit Agencies' Facilities



Source: WSP

1.4.2 PROPOSED ZERO-EMISSION BUS STRATEGIES

As mentioned, the decision of whether to commit to either BEBs or FCEBs is largely based on availability, applicability, and costs. Agency input, space availability, and technology applicability was assessed and considered when determining ZEB-based facility improvements. However, since ZEB technologies are constantly evolving, it is recommended that each agency approach the planning and implementation of ZEB technologies in an iterative approach. This will ensure that early adoption or committal to a specific strategy does not result in unintended consequences for an agency.

Table 1-2 summarizes agencies' ZEB facility improvements.

Table 1-2. ZEB Strategies Summary

AGENCY	FACILITY	ZEB STRATEGY	BEB	SERVICE CAPACITY (BUSES)	# OF CHARGERS	CHARGER RATING	FCEB
MBTA	Joshua Tree	BEB	Ground-Mounted; Plug-In	26	13	150 kW	None at this time
	Twentynine Palms			8	4		
MT	Crestline	BEB		12	6	150 kW	

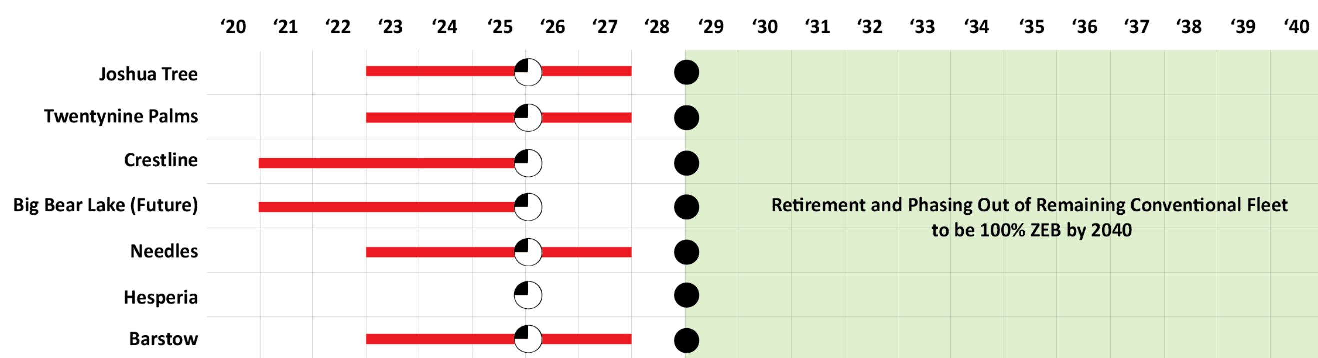
AGENCY	FACILITY	ZEB STRATEGY	BEB	SERVICE CAPACITY (BUSES)	# OF CHARGERS	CHARGER RATING	FCEB
	Big Bear Lake (Future)		Ground-Mounted; Plug-In	18	9		None at this time
NAT	Needles	BEB	Ground-Mounted; Plug-In	4	2	150 kW	None at this time
VVTA	Hesperia	BEB/FCEB	Ground-Mounted; Plug-In	63	7	150 kW	Offsite
	Barstow	BEB/FCEB	Ground-Mounted Plug-In	14	5		Onsite Liquid Storage/Delivery

Source: WSP
Note: Chargers are based on a 1:2 ratio (i.e., one charger for two buses).
-Hesperia Yard will have no improvements. There are currently seven BEBs, remaining buses will be FCEB and for the time being, will be fueled offsite at the Victorville Transit Center.
-Barstow will support five BEBs and the remaining fleet will be replaced with FCEBs that will fuel onsite.
-MT's existing Big Bear Lake site will no longer be used for operations, MT has recently acquired a new parcel ¼-mile from the existing. This new "Big Bear Lake (Future)" will be constructed to accommodate ZEBs.

1.4.3 PHASING AND CONSTRUCTION

The process of implementing ZEBs is broken down into a number of important tasks and phases related to construction of supporting facilities. The assumed approach is a design-bid-build strategy. Multiple requests for proposals (RFPs) need to be developed and put out for bid, with accompanying design and construction activities taking place. Utility upgrades, onsite (phased) construction, and other activities are expected to last approximately five years, for each division. Since ZEBs are not operational unless the facilities are in place, it is pertinent to meet construction deadlines because it has the ability to impact both service and ICT regulation compliance. It is assumed that buses can be procured 18 months before the conclusion of the facilities construction. ICT regulation bus procurement requirements (percentage of new bus acquisitions) are indicated via Harvey Balls in 2023, 2026, and 2029. Figure 1-2 presents the construction schedule for each division and the various milestone purchase requirements pursuant the ICT regulation.

Figure 1-2. Summary of San Bernardino County's Transit Agencies' Construction and Purchase Schedule



Source: WSP
Note: Hesperia Yard currently has infrastructure to support seven BEBs, the remaining buses are expected to be replaced with FCEBs that will be fueled offsite, therefore, no additional ZEB-related enhancements are required at the yard.

1.4.4 START-UP AND SCALE-UP ISSUES

Based on the Rollout Plan, each of operating agencies within San Bernardino County will meet the purchase and reporting requirements pursuant to the ICT regulation. However, it should be noted that the plan assumes a number of factors for this to happen. For instance, it is assumed that despite existing range issues, these will be resolved by the time an agency procures buses (i.e., each existing bus will be replaced at a 1:1 ratio). It is also assumed that funding is in place to construct and implement infrastructure in the allotted time.

After assessing each agency, several common themes that pose challenges to meeting the ICT regulation were identified:

- **Uncertainty of ZEB cutaways.** There is a small market for ZEB cutaways. For the cutaways that do exist, there is uncertainty in their product range and whether they're Altoona-tested. Unfortunately, the cutaway market does not currently offer FCEBs, so some agencies will be forced to adopt BEBs.
- **Operating conditions.** Some agencies' fleets climb altitudes and operate in weather conditions that aren't typical of the region. These conditions have a huge impact on range; meaning, some agencies would have to invest more than other agencies to operate similar bus blocks (in terms of range).
- **Range issues.** Many agencies have many blocks that exceed current BEB *and* FCEB ranges. This means that these agencies will need to consider the following strategies to reduce or avoid service disruptions:
  - **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.
  - **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.
  - **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will need to consider the potential impacts to operator and maintenance costs.
- **Technological adaptation.** With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. Agencies need to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.
- **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. Some agencies are also in remote locations, this can inflate the cost of service, delivery, and warranties. Agencies will need to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.
- **Market Production Factors.** The ICT regulation will put a lot of pressure on original equipment manufacturers (OEMs) to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions; however, it will also make it challenging to meet ZEB goals for agencies if supply of buses cannot meet the demand.

1.4.5 NEXT STEPS

The process to transition to ZEBs should and will be iterative to minimize risk, but also to accommodate new developments in a rapidly evolving market. The transit agencies will use the information outlined in both the Rollout Plan and the Master Plan to identify and further refine the following:

- **BEB and/or FCEB fleet mix at each agency.** Both the Rollout Plan and the Master Plan address each agencies' specific needs and policy choices, as well as making determinations about what is feasible for each. VVTA has made it clear that it is very interested in FCEBs, for example, due to concerns about range and length of its service blocks and its own experience with ZEB implementation to date. The recommendations contained herein address what WSP's team believes is the most feasible and cost-effective means of implementing the mix of ZEB types at each agency. However, all agencies will need to re-address these issues and determine whether these recommendations regarding feasibility based on costs, service requirements, and availability have changed as each agency implements its transition toward ZEBs.
- **Addressing incomplete service blocks.** The WSP team's analysis has revealed that many blocks cannot be completed when considering BEBs and FCEBs; meaning, agencies will need to determine whether they're going to file exemptions, purchase additional buses, restructure service to suit technological limitations, or invest in opportunity charging. These choices are rooted in each agency's own policies and plans outside of ZEB considerations.
- **Costs.** Construction, capital, operating, and maintenance costs vary based on a variety of factors. It will be important to get an understanding of the up-front costs and lifecycle costs and savings of investing in ZEBs. WSP's team has developed such cost estimates and each agency will need to revisit these estimates to determine if pricing has changed and make implementation changes, such as changes in their purchasing schedules, accordingly.
- **Collaboration Opportunities.** Whether purchasing equipment via the California Association for Coordinated Transportation (CalACT) or strategizing on a joint agreement for opportunity charging, agencies can continue to maximize their outcomes by engaging with other regional and local agencies. It important for all agencies to continue to participate in groups such as the Zero Emission Bus Resource Alliance (ZEBRA) working group, California Transit Association (CTA) and the state's chapter of the Association for Commuter Transportation (ACT), the American Public Transportation Association's (APTA) Bus Technology Committee and other industry working groups.
- **Explore pilot projects.** Investing or committing to either FCEBs or BEBs is a difficult decision. Since these technologies are still rapidly evolving, it is pertinent for agencies to understand how they will *actually* operate (outside of modeling or forecasts). Agencies should begin to explore opportunities to partner with OEMs or peer agencies to procure or temporarily use pilot buses to validate assumptions or inform future purchases.
- **ICT regulation compliance and subsequent implementation.** The agencies presented in this Rollout Plan have the option to submit a plan by July 1, 2023. It is recommended that they do so in order to monitor technology trends, market availability of new buses such as cutaways with ZE propulsion expected to come into the bus market, fuel and electricity pricing trends and the impact of contemplated service changes on these agencies' ZEB Rollout Plans. Should the agencies elect to file a Countywide Rollout Plan (as a Joint Group), they need to file their intent with CARB no later than July 1, 2022, which satisfies the one-year notice requirement of the ICT Rule in time for submittal by the July 1, 2023 date for the smaller operators. At that time, it can also notify CARB if Omnitrans will join the Joint Group.

2 INTRODUCTION

In accordance with the California Air Resource Board's (CARB) Innovative Clean Transportation (ICT) regulation, the following report serves as the San Bernardino Countywide Rollout Plan (Countywide Rollout Plan) to transition agencies within San Bernardino County to 100 percent zero-emission (ZE) fleets by 2040. The Countywide Rollout Plan consists of four transit agencies within San Bernardino County: Morongo Basin Transit Authority (MBTA), Mountain Area Regional Transit Authority (MT), City of Needles (Needles or NAT), and Victor Valley Transit Authority (VVTA).

2.1 CALIFORNIA AIR RESOURCE BOARD'S INNOVATIVE CLEAN TRANSPORTATION REGULATION

CARB's ICT regulation requires all public transit agencies in the State of California to transition from conventional buses (compressed natural gas, diesel, etc.) to zero-emission buses (battery-electric or fuel cell electric) by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be zero-emission buses (ZEBs) based on their fleet size. By 2040, CARB expects all transit agencies in the state to be operating only ZEBs.

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According to the ICT regulation, each agency or Joint Group's requirements are based on its classification as either a "Large" transit agency or a "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 it operates outside of these areas, but in an urbanized area with a population of at least 200,000 and has at least 100 buses in annual maximum service. A Small transit agency is an agency that doesn't meet the above criteria.

<u>Large transit agencies under the ICT regulation must comply with the following requirements and deadlines</u>:

— **July 1, 2020 –** Board-approved Rollout Plan must be submitted to CARB

— **January 2023 –** 25 percent of all new bus purchases must be ZE

— **January 2026 –** 50 percent of all new bus purchases must be ZE

— **January 2029 –** 100 percent of all new bus purchases must be ZE

— **January 2040 –** 100 percent of fleet must be ZE

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The four other agencies (hereinafter referred to as "Group" or "Agencies") are considered Small transit agencies and have the option to either: 1) file individually at any time between now and 2023, or 2) file as part of a "Joint Group" between now and 2023. At this time, these agencies are still strategizing on how they should approach the filing requirements. The Countywide Rollout Plan, in an effort to provide each agency with flexibility, is written in a way that allows each agency to file individually, or as a Joint Group. It should be noted that although Omnitrans is filing in 2020, they also have the option to join these other agencies as part of a Joint Group at a later date.

Filing as a Joint Group has specific requirements and restrictions that are outlined in the ICT regulation.

2.2 SAN BERNARDINO COUNTY TRANSIT AGENCIES

As previously mentioned, public transit within San Bernardino County is largely provided by five local transit operators: MBTA, MT, Needles, Omnitrans, and VVTA. Together, they account for approximately 12.4 million annual (unlinked) passenger trips. These agencies, however, have vastly different operations and service conditions. To determine each agency's pathway to 100 percent ZEB adoption, it is pertinent to understand their unique operating conditions and goals. The San Bernardino County Transportation Authority (SBCTA) serves as the county's regional planner, has contracted with WSP to conduct the San Bernardino County Zero Emission Bus Study (Master Plan) and San Bernardino Countywide Rollout Plan to determine the appropriate approach to ZE rollout.

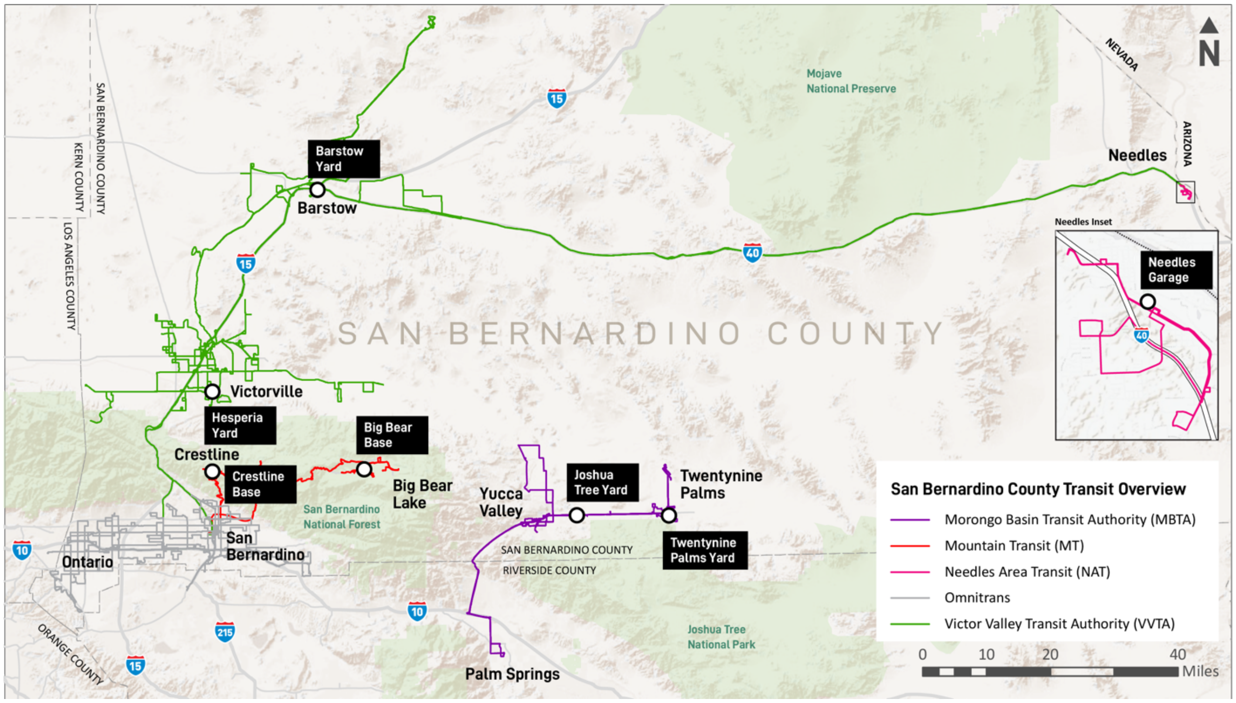
Table 2-1 shows the San Bernardino County agencies and their respective annual operating budgets and passenger trips and Figure 2- presents each agency's service area within San Bernardino County.

Table 2-1. San Bernardino County Transit Agencies' Annual Budgets and Passenger Trips

OPERATOR	ANNUAL OPERATING BUDGET (FY 2019)	ANNUAL UNLINKED PASSENGER TRIPS
MBTA	$3,463,581	258,560
MT	$3,073,781	181,789
NAT	$383,487	27,853
Omnitrans	$91,456,968	10,927,524
VVTA	$26,434,124	1,077,823

Source : WSP

Figure 2-1. San Bernardino County Transit Agencies' Service Areas



Source : WSP

2.3 SAN BERNARDINO COUNTY TRANSPORTATION AUTHORITY'S ZERO-EMISSION BUS EFFORTS

In April 2019, SBCTA issued a Contract Task Order to WSP USA, Inc. to conduct an analysis determine the best path forward for San Bernardino County's transit agencies' ZEB transition pursuant to the ICT regulation.

The goals of the analysis are three-fold for each agency within the Joint Group:

1. **Determine the most cost-effective approach to a 100 percent ZEB fleet**
2. **Determine the capital improvements required to support ZEB fleets**
3. **Provide a financing and purchasing strategy to acquire ZEBs in accordance with the ICT regulation**

The overall results of WSP's analysis will be presented in two documents, the San Bernardino County Zero Emission Bus Study (Master Plan), and the San Bernardino Countywide Rollout Plan (Rollout Plan). The Rollout Plan (said document) serves as the agencies' compliance document per CARB's ICT regulation. The Master Plan is a preliminary planning document for each agency in San Bernardino County.

2.4 ROLLOUT PLAN APPROACH

Pursuant to the ICT regulation, the Rollout Plan identifies a strategy for each agency to procure and operate all ZEBs. Due to the rapidly evolving nature of ZEB technologies, it is possible that the findings and recommended approaches in this report will be outdated when it is time for implementation. For that reason, several generous assumptions were included to account for technological advancements and planning purposes. For example, existing range constraints BEBs are assumed to be resolved by the time an agency is required to transition to ZEBs.

This means that a 1:1 replacement ratio was used to match the existing service requirements. To account for potential fleet increases, facilities are planned and designed for maximum build-out to ensure that enough ZEB infrastructure is in place for fleet expansion. That said, at the end of each agencies' respective chapter, the *Start-Up and Scale-Up Challenges* section will identify the barriers that may prohibit or make these full-buildout scenarios difficult to achieve. These challenges will serve as the springboard for refinements and strategies in the next stages of implementation.

2.5 ROLLOUT PLAN PURPOSE AND STRUCTURE

In accordance with the Rollout Plan Guidance, this document provides an overview of several key components to agencies' ZEB transitions, including, but not limited to, fleet acquisitions, schedule, training, and funding considerations.

Each agencies' section in this Rollout Plan is structured as follows:

1. **Introduction** *Details the service area, environmental factors, and schedule and operations.*
2. **Fleet and Acquisitions** *Presents the existing fleet and procurement plan for buses through 2040.*
3. **Facilities and Infrastructure Modifications** *An overview of each facility and the potential ZEB modifications.*
4. **Disadvantaged Communities** *Discusses the disadvantaged communities (DACs) that will be impacted by the ZEB transition.*
5. **Workforce Training** *Provides background on personnel training requirements for ZEB implementation.*
6. **Costs and Funding** *Opportunities Discusses rough order of magnitude costs and potential funding sources.*
7. **Start-Up and Scale-Up Challenges** *Provides an understanding of challenges and issues that the agency will have to mitigate or confront during ZEB adoption.*

3 MORONGO BASIN TRANSIT AUTHORITY

3.1 INTRODUCTION

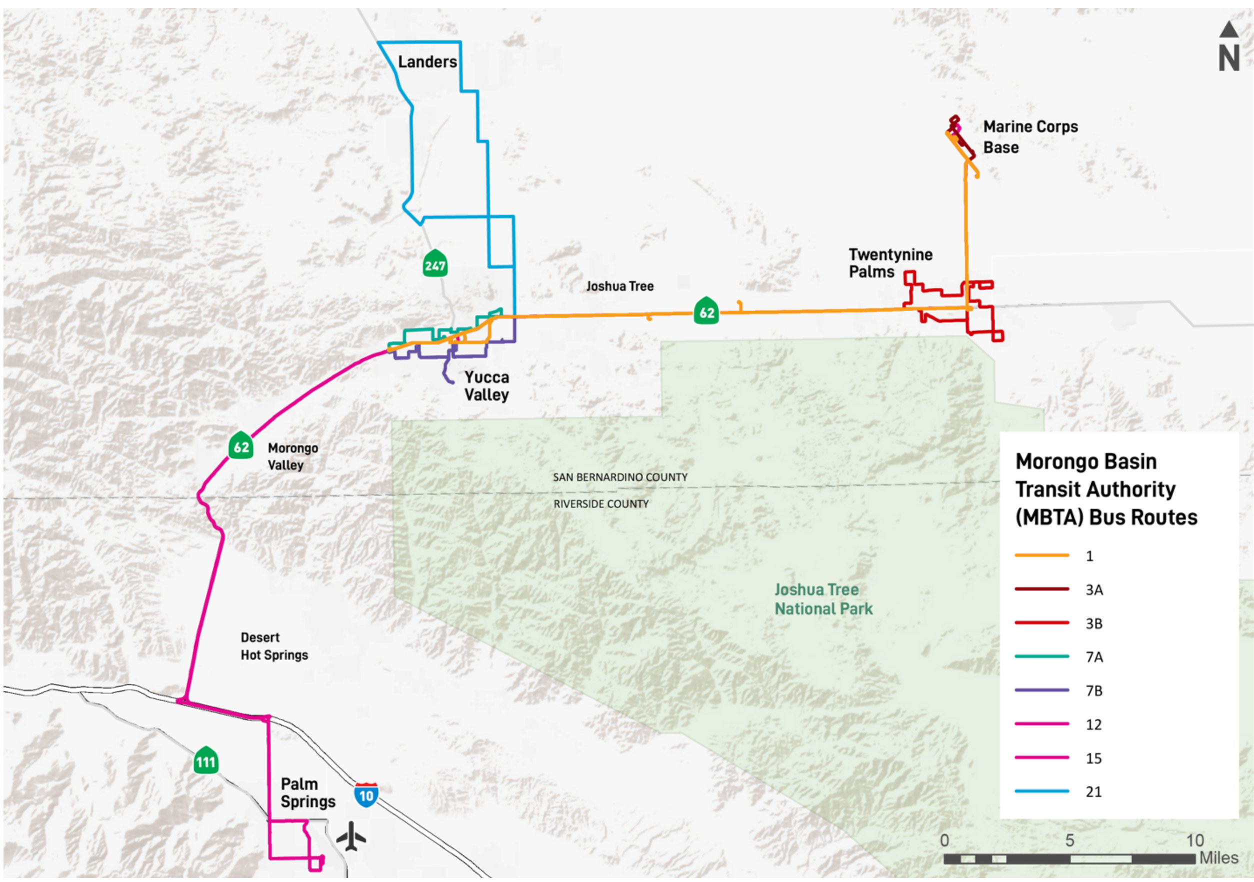
Morongo Basin Transit (MBTA) operates fixed-route transit services with headquarters in the unincorporated community of Joshua Tree. MBTA is a joint powers authority between the Town of Yucca Valley, the City of Twentynine Palms, and San Bernardino County.

3.1.1 SERVICE AREA

MBTA operates services in Yucca Valley, Twentynine Palms, Joshua Tree, and beyond, extending south to Palm Springs in neighboring Riverside County and north to the unincorporated community of Landers. Figure 3-1 shows MBTA's service area.

Much of the Morongo Basin's residential and commercial development is along the State Route 62 corridor between Yucca Valley in the west and Twentynine Palms in the east. This development parallels the northern border of Joshua Tree National Park and is largely the service area for MBTA shuttle routes. Two regional, long-distance routes, 12 and 15, connect the Basin to Palm Springs and Hollywood Burbank (Bob Hope) Airport.

Figure 3-1. MBTA Service Area



Source: WSP

3.1.2 ENVIRONMENTAL FACTORS

MBTA's service area is predominantly in the High Desert Region, with some service extending to Palm Springs in the Low Desert area. The area's summers are hot and dry with relatively cold winters. The average high temperatures in July are over 100 degrees and average low temperatures in December through February are between 35 and 38 degrees. The region typically experiences snowfall in December (1.5-inch average) and January (.5-inch average).

Given the immense shifts in temperature due to the desert climate, power demand for HVAC systems is much more of a factor for MBTA's fleet than a typical BEB serving in a milder climate. Due to the operational range issues of ZEB vehicles, as opposed to conventional diesel or hybrid buses, these temperature variances could likely reduce vehicle range in the summer and winter months.

3.1.3 SCHEDULE AND OPERATIONS

MBTA runs three types of routes: neighborhood shuttles, intercity service, and longer-distance service to Palm Springs. MBTA's eight bus routes include:

- 1 – Intercity service between Yucca Valley and Twentynine Palms Transit Center or Twentynine Palms Marine Corps Base
- 3A – Shuttle service between Twentynine Palms Transit Center and Twentynine Palms Marine Corps Base
- 3B – Neighborhood shuttle around Twentynine Palms
- 7A – Neighborhood shuttle around North Yucca Valley, servicing the Yucca Valley Transit Center and the Walmart Center
- 7B – Neighborhood shuttle around South Yucca Valley, servicing the Yucca Valley Transit Center and Walmart Center
- 12 – Long-distance service between Yucca Valley Transit Center and Palm Springs
- 15 – Long-distance service between Twentynine Palms Marine Corps Base and Palm Springs
- 21 – Shuttle service between Landers and Yucca Valley Transit Center

The majority of MBTA's neighborhood shuttle routes run between 18 and 24 miles in length; Route 21 runs on a 48-mile loop; the intercity route runs between 27 and 43 miles; and the longer-distance routes run between 39 and 79 miles, depending on point of origin relative to Palm Springs.

While most MBTA bus routes have designated fixed stops, in some areas there are no posted bus stops, and passengers may flag the driver to board. Deviations to the fixed route are also available to passengers who are unable to get to regular fixed stops by reserving at least one hour in advance. All routes will deviate up to ¾-mile, except for Route 21, which will deviate up to 1.5 miles. These deviations add slight variability and unpredictability both to the length of runs and blocks, and to the terrain over which the buses operate.

3.2 FLEET AND ACQUISITIONS

The following section provides an overview of MBTA's existing fleet, planned purchases, and description of how MBTA will meet the requirements of the ICT regulation.

3.2.1 EXISTING BUS FLEET

As of July 2019, MBTA directly operates 24 compressed natural gas (CNG)-powered cutaway buses for fixed-route service. These buses range between 25 and 36 feet in length. Table 3-1 presents a summary of MBTA's existing bus fleet.

Table 3-1. Summary of MBTA's Existing Bus Fleet

MANUFACTURER	SERIES	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NUMBER OF BUSES
Ford	550 Goshen	CNG	33'4"	2010	Cutaway	2
	Goshen G	CNG	33'	2011	Cutaway	1
El Dorado	XHF	CNG	33'6"	2007	Cutaway	1
	XHF Class H	CNG	36'	2012	Cutaway	3
	Class E	CNG	27'	2017	Cutaway	1
	Aero Elite Class E	CNG	32'	2017	Cutaway	2
Glaval	Class E	CNG	33'	2016	Cutaway	1
	Entourage – Class E	CNG	33'	2019	Cutaway	4
	Universal – Class E	CNG	26'6"	2011	Cutaway	1
Senator	Startrans II – Class C	CNG	25'	2018	Cutaway	6
	Startrans 550	CNG	32'	2018	Cutaway	1
Chevy	ARBOC	CNG	26'6"	2011	Cutaway	1
					Total Buses	**24**

Source: Morongo Basin Transit Authority, July 2019

3.2.2 ZEB TECHNOLOGY APPLICATION

Past and ongoing ZEB analysis for MBTA's operations has determined that BEB adoption is the ZEB technology that best meets the needs of MBTA for their purchasing and transition requirements pursuant to the ICT regulation. FCEBs, at this time, are not feasible due to no current manufacturers offering a cutaway vehicle.

BATTERY-ELECTRIC BUS

MBTA's future BEBs are expected to have specifications that are compatible with the Society of Automotive Engineers' (SAE) J1772 charging standard (e.g., "plug-in charging") (Figure 3-2). It is recommended that MBTA specify charging ports on the rear of BEBs to allow for their existing site circulation and parking patterns to continue without additional modifications. Battery sizing (kilowatts) will be determined based on service needs requirements and what is available and feasible based on costs and weight. Charger rating (kilowatt-hour) will be based on service needs, battery acceptance, and costs.

Figure 3-2. Ground-Mounted Plug-In Charger

Source: Cultura

FUEL CELL ELECTRIC BUS

Currently, there are no manufacturers in the U.S. market that offer a FCEB cutaway vehicle, deeming hydrogen power infeasible, under existing conditions. While a hydrogen-powered cutaway may be developed in the future, MBTA must plan and design for facilities and buses that are currently on the market to ensure they can comply with CARB's ICT regulation. However, as technology further develops, MBTA will remain open to technologies outside of BEB and will update plans, studies, and strategies, accordingly.

For specific blocks that are not capable of being served efficiently by existing BEB technology, FCEBs could be a viable option, if cutaways are eventually introduced to the market. In that case, it is recommended that FCEBs be fueled at future commercial/public hydrogen fueling stations located in either Twentynine Palms or Palm Springs or a purpose built MBTA containerized hydrogen storage and dispensing unit with pre-compressed hydrogen delivery on site.

3.2.3 EXISTING ZEB PROCUREMENTS AND PROJECTS

MBTA currently has no existing ZEB procurements or projects.

3.2.4 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, MBTA will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus is expected to be purchased in 2027. All new bus purchases are anticipated to be ZEB starting in 2029.

Early retirement should not be an issue pursuant to the ICT regulation based on MBTA's assumed procurement schedule. However, if it becomes one, MBTA will deploy various strategies to ensure that buses fulfill their "useful life". One potential strategy is to place newly acquired buses on MBTA's longest (distance) blocks of service. This will ensure that these buses meet their distance-based useful life requirement more rapidly.

MBTA's existing fleet consists of 24 cutaway buses. Assuming a 1:1 replacement ratio, each existing bus will eventually be replaced with a BEB cutaway bus (of similar size). However, the number of ZEBs required may increase based on service requirements.

Table 3-2 presents a summary of MBTA's anticipated bus procurements through 2040. Years 2026 and 2029 are highlighted because these indicate when MBTA's new purchases should be 25 percent and 100 percent ZEBs, respectively.

Table 3-2. Summary of MBTA's Future Bus Purchases (through 2040)

		ZERO-EMISSION BUSES				CONVENTIONAL (CNG) BUSES			
YEAR	TOTAL BUSES	NUMBER	PCT.	BUS TYPE	FUEL TYPE	NUMBER	PCT.	BUS TYPE	FUEL TYPE
2020	**1**	0	0%	-	-	1	100%	Cutaway	Diesel
2021	**4**	0	0%	-	-	4	100%	Cutaway	Diesel
2022	**3**	0	0%	-	-	3	100%	Cutaway	Diesel
2023	**5**	0	0%	-	-	5	100%	Cutaway	Diesel
2024	**4**	0	0%	-	-	4	100%	Cutaway	Diesel
2025	**6**	0	0%	-	-	6	100%	Cutaway	Diesel
2026	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2027	**2**	1	50%	Cutaway	BEB	1	50%	Cutaway	Diesel
2028	**0**	0	0%	-	-	0	0%	-	-
2029	**3**	3	100%	Cutaway	BEB	0	0%	-	-
2030	**11**	11	100%	Cutaway	BEB	0	0%	-	-
2031	**8**	8	100%	Cutaway	BEB	0	0%	-	-
2032	**0**	0	100%	-	-	0	0%	-	-
2033	**0**	0	100%	-	-	0	0%	-	-
2034	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2035	**6**	6	100%	Cutaway	BEB	0	0%	-	-
2036	**4**	4	100%	Cutaway	BEB	0	0%	-	-
2037	**6**	6	100%	Cutaway	BEB	0	0%	-	-
2038	**4**	4	100%	Cutaway	BEB	0	0%	-	-
2039	**0**	0	100%	-	-	0	0%	-	-
2040	**6**	6	100%	Cutaway	BEB	0	0%	-	-

Source: WSP
Note: All new purchases were assumed to have a useful life of five, seven, and 10 years per FTA Circular 9030.1D, Ch. VI, paragraph 4.a

3.2.5 ZEB RANGE REQUIREMENTS AND COSTS

MBTA operates 14 blocks during weekdays, 11 of which are longer than 100 miles. MBTA's longest block is approximately 230 miles. Depending on operational parameters, including operator behavior, ambient temperature, traffic, and ridership, these ranges may be unattainable or difficult to achieve on certain days. To reduce impacts to service, MBTA will consider many strategies to supplement onboard battery storage, including additional buses, midday charging, battery/charging management systems, and solar and battery storage. In future ZEB applications, MBTA may also consider FCEBs, especially if battery technology doesn't advance as forecasted.

3.2.6 ZEB CONVERSIONS

Conventional bus conversions to ZEB technologies are not currently being considered at this time for MBTA. However, MBTA will remain open to conversions if they are deemed financially feasible and align with goals to ZEB adoption.

3.3 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following sections detail the planned charging strategies, infrastructure, detailed yard improvements, and program schedule.

3.3.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. For that reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each facility. This provides the agency with a ceiling for what can physically be constructed and at what cost. Service changes and bus movements may happen multiple times a year, for some agencies. By establishing a full build scenario, agencies can optimize, and tailor strategies based on existing (or anticipated) service for implementation.

The analysis of FCEBs at each agency is ongoing, however, a hydrogen storage footprint was established at each division where vehicles and space can support it. Further analysis (Master Plan and subsequent studies) will analyze alternatives of hydrogen delivery.

In the case of MBTA, the full build scenario is presented for context. However, refinements and tailored strategies will be developed in the Master Plan and future implementation studies.

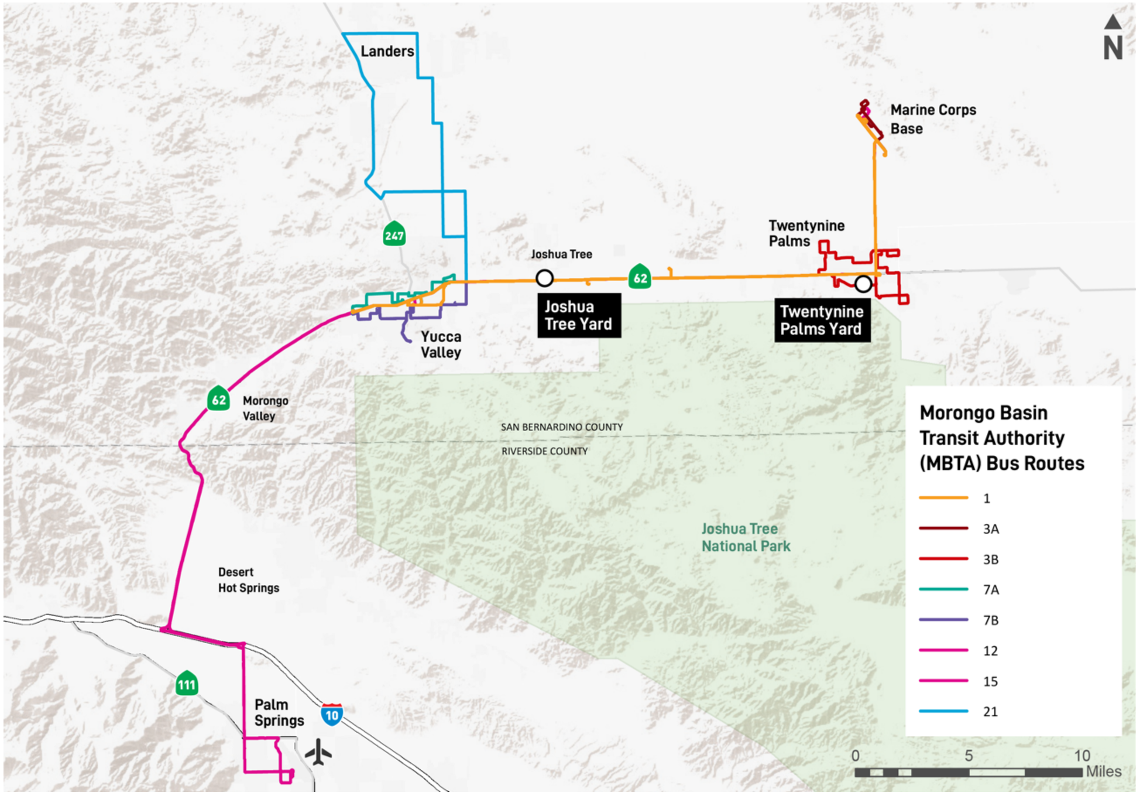
3.3.2 FACILITY MODIFICATIONS

MBTA's transition to ZE technologies, namely, BEB, will require a number of modifications and changes to existing infrastructure and operations. This would include the decommissioning of CNG equipment, enhancements and expansions of electrical equipment, additional electrical capacity, and the installation of BEB chargers, dispensers, and other components. These modifications will occur at MBTA's two yards in Joshua Tree and Twentynine Palms.

Based on MBTA's existing service needs and site configurations, MBTA plans on installing ground-mounted plug-in chargers to support BEBs at both Joshua Tree and Twentynine Palms yards. The proposed full facility layout is based on utilizing a 150-kW DC charging cabinet used in a 1:2 charging ratio (one DC charging cabinet energizes two separate plug-in cord dispensers). This charger to dispenser ratio would meet the requirements to charge MBTA's fleet during the vehicles' servicing and dwell time on the site while minimizing the peak electrical demand. Figure 4-3 illustrates the location of the MBTA's yards.

Table 4-4 summarizes the modifications and schedule of each yard and the following sections detail the process of each yard's transition from existing conditions to BEB-readiness.

Figure 3-3. MBTA's Yard Locations



Source: WSP

Table 3-3. MBTA Yard Summary

GARAGE	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADES REQ'D?	TIMELINE
Joshua Tree	62405 Verbena Rd. Joshua Tree, CA	Fueling, Storage, and Maintenance	Ground-Mounted Plug-In Charging	26 buses	Yes	2023-2028
Twentynine Palms	6994 Bullion Ave. Twentynine Palms, CA	Fueling and Storage	Ground-Mounted Plug-In Charging	8 buses	Yes	2023-2028

Source: WSP

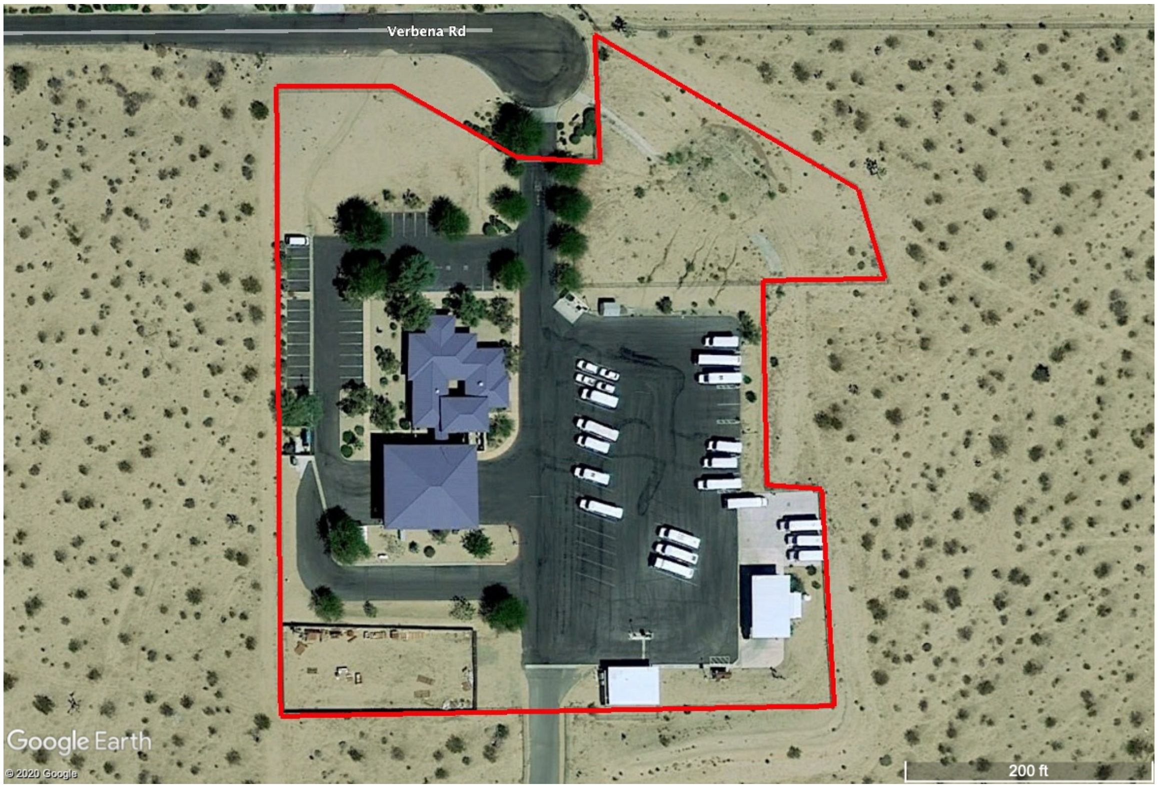
JOSHUA TREE YARD

EXISTING CONDITIONS

Joshua Tree Yard is located at 62405 Verbena Road in the City of Joshua Tree. Electrical service is provided by SCE.

Currently, 26 CNG-powered buses are stored, maintained, fueled, and serviced at the yard. Buses are parked one-deep in angled tracks in the yard or backed in along the eastern fence line. Buses fuel with CNG when they return to the site at the end of daily service via one of two fast-fill CNG positions at the fuel canopy on the southeast corner of the site, or in one of the ten time-fill positions located along the northeastern edge of the parking lot. Washing is handled by service staff in mornings via a pressure wash unit located under a canopy on the southeast boundary of the site.

Figure 3-4. Joshua Tree Yard - Existing Conditions



Source: Google Earth

Figure 3-5. Joshua Tree Yard's Maintenance Facility

Source: WSP

PLANNED ZEB MODIFICATIONS

Based on the recommended ground-mounted DC plug-in charging solution, the Joshua Tree Yard is capable of parking 29 buses with 26 plug-in charging positions in a 1:2 charger to bus dispenser ratio.

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

Table 3-4. Joshua Tree Yard Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY*
MBTA	Joshua Tree	Ground-Mounted; Plug-In	13	26	150 kW	Storage/ Delivery

Source: WSP
Note: At this time, there are no current cutaway FCEBs on the market, however, if one is developed and MBTA determines adoption is feasible, on-site fueling/storage is recommended.

The following BEB equipment and locations are proposed:

— Five charging cabinets with 10 plug-in dispenser-charging positions along the northeastern yard pavement edge in the existing CNG slow-fill area.

— Two charging cabinets with four plug-in dispenser-charging positions along the eastern site pavement edge in the parking space north of the wash canopy.

— Six island-mounted charging cabinets with 12 plug-in dispenser-charging positions in the existing angled yard parking in the center of the yard.

The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

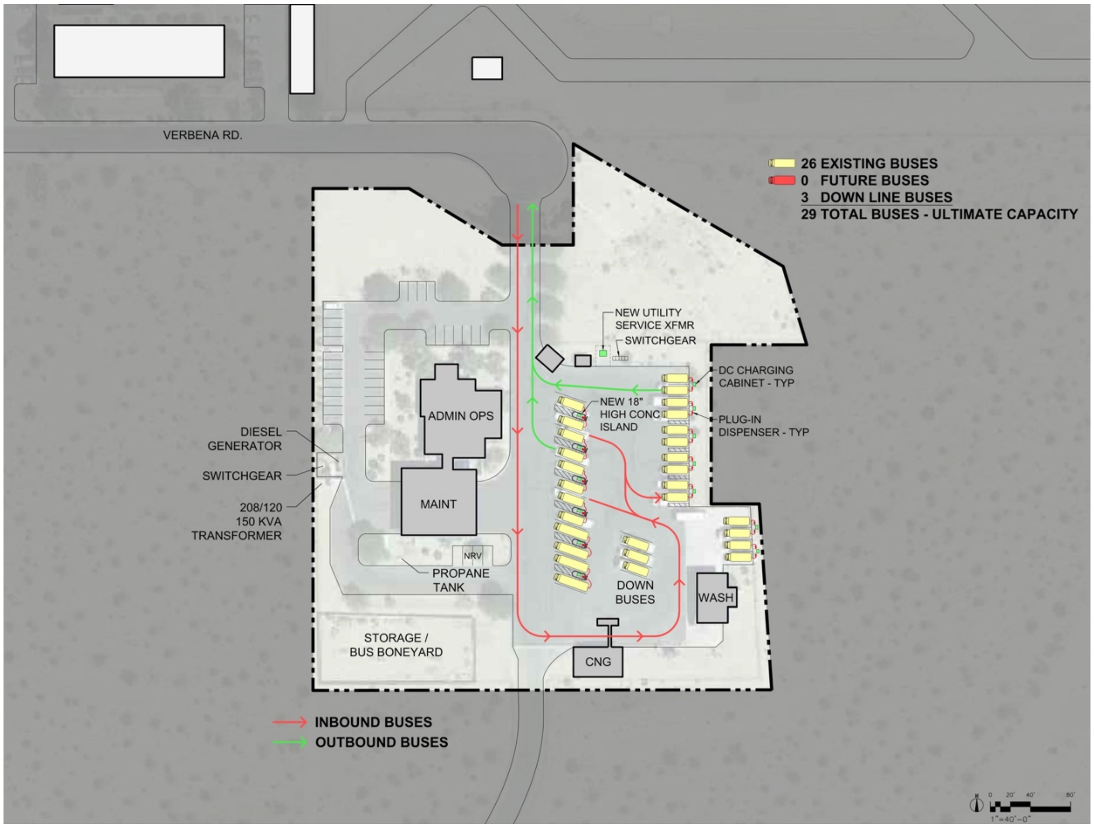
— One medium voltage utility service transformer in a new utility yard in the open space north of the existing parking yard and east of the site entrance.

— One switchgear in a new utility yard in the open space north of the existing parking yard and east of the site entrance.

The primary vehicles used for service out of Joshua Tree are cutaway buses, which are currently not available as FCEBs. For this reason, hydrogen power at Joshua Tree is not recommended. As these technologies become available in the future, Morongo Basin may consider hosting a hydrogen fueling yard located on the southern portion of the site adjacent to the existing CNG yard if commercially available hydrogen fueling stations are not utilized. WSP recommends utilizing a containerized hydrogen solution with hydrogen delivered pre-compressed to meet hydrogen fueling needs as the volume of hydrogen required does not justify the high infrastructure costs associated with on-site generation and/or compression.

Figure 3-6 illustrates the Joshua Tree Yard at full build-out.

Figure 3-6. Joshua Tree Yard – Full ZEB Build-Out



Source: WSP

TWENTYNINE PALMS YARD

EXISTING CONDITIONS

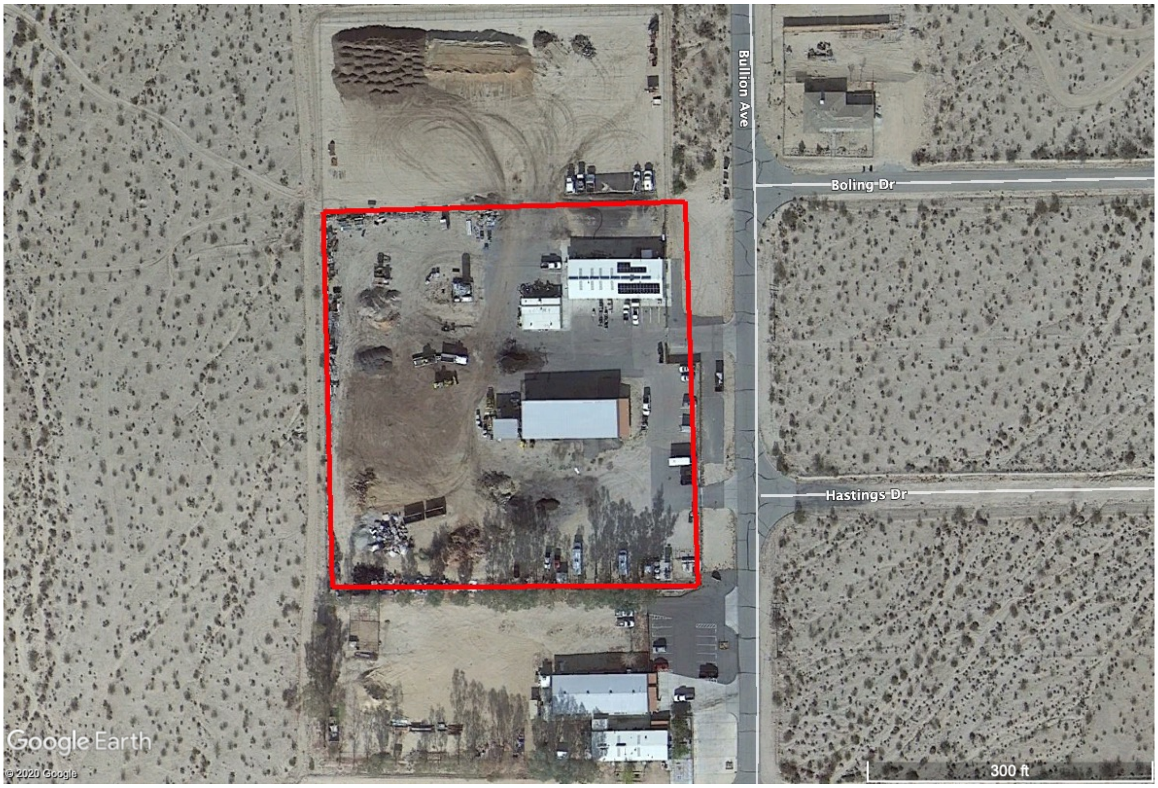
Twentynine Palms Yard is located at 6994 Bullion Avenue in the City of Twentynine Palms. Electrical service is powered by Southern California Edison (SCE).

Currently, eight CNG-powered buses are stored and fueled at the division. The Twentynine Palms Yard site consists of the following separate structures and major site areas: bus parking, a portable restroom for operators, stand-alone fuel island, and an adjacent CNG compressor yard with support equipment. To the north, the rest of the site is used for storage, maintenance, and operations by the public works department.

Buses enter from Bullion Avenue and are backed in along the eastern and southern fence line for nightly parking. Buses fuel with CNG when they return to the site at the end of daily service via either single fast-fill CNG position on the fuel island on the southeast corner of the site or in one of the six time-fill positions located along the southern edge of the parking lot

No maintenance, dispatch, or wash facilities are located on the Twentynine Palms Yard site for MBTA.

Figure 3-7. Twentynine Palms Yard - Existing Conditions



Source: Google Earth

Figure 3-8. Twentynine Palms Yard Bus Parking and CNG Fueling

Source: WSP

PLANNED ZEB MODIFICATIONS

Based on the recommended ground-mounted DC plug-in charging solution, the Twentynine Palms Yard is capable of parking eight buses with eight plug-in charging positions in a 1:2 charger to bus dispenser ratio.

Table 3-5 summarizes the ZEB infrastructure planned at the Twentynine Palms Yard.

Table 3-5. Twentynine Palms Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY*
MBTA	Twentynine Palms	Ground-Mounted; Plug-In	4	8	150 kW	N/A

Source : WSP

The following BEB equipment and locations are proposed:

— Four charging cabinets with eight plug-in dispenser-charging positions along the southern yard pavement edge in the existing CNG slow-fill area.

The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

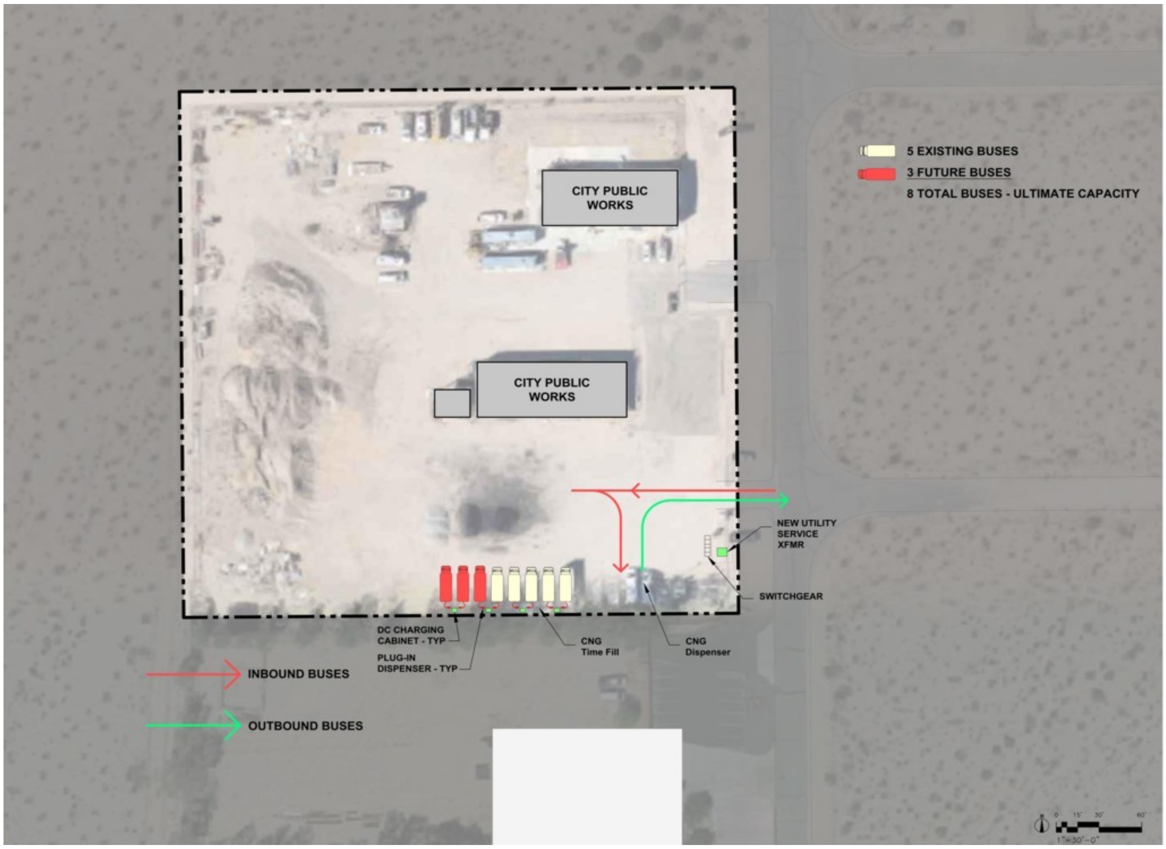
— One medium voltage utility service transformer in the open space north of the existing CNG yard and south of the eastern site entrance.

— One switchgear utility service transformer in a new utility yard in the open space north of the existing CNG yard and south of the eastern site entrance.

Hydrogen fueling is not recommended for this site due to the limited number of vehicles operating from the Twentynine Palms Yard.

Figure 3-9 illustrates the Twentynine Palms Yard at full build-out.

Figure 3-9. Twentynine Palms Yard – Full ZEB Build-Out



Source: WSP

3.3.3 PHASING AND CONSTRUCTION SCHEDULE

Adhering to the construction schedule and milestones will be critical because the facilities' construction must be completed before buses are delivered, otherwise, the buses will not be able to operate. To accomplish this, construction for BEB-supporting infrastructure is expected to be done in phases to minimize disruption of operations. Joshua Tree Yard is expected to be completed in two phases, and Twentynine Palms Yard is expected to be completed in one.

Additional electrical capacity will be required to meet the service needs of buses at both yards. Construction and enhancements to bring this additional electrical capacity is anticipated to take three to five years based on SCE's protocol. This timeframe would include method of service studies, design, and construction. It is recommended that electrical infrastructure such as transformers and switchgears be installed with the initial phase at both Joshua Tree and Twentynine Palms yards to avoid the disruption of ongoing charging operations.

The following provides details on recommended phasing for each yard.

JOSHUA TREE YARD

PHASE 1

The first phase of charger installation the for the Joshua Tree Yard is to install all the in-ground conduit to route electrical service to seven charging cabinets with 14 plug-in dispensers mounted at the edge of the parking spaces on the eastern boundary of the yard. These chargers and dispensers can be installed without any trenching modification to the existing paved parking areas.

PHASE 2

Phase 2 at the Joshua Tree Yard should complete all yard trenching to distribute electrical service to the central yard parking and construct all the islands to house the charging cabinets and dispensers. Charging cabinets and dispensers can then be added to the islands as needed with the phase-in of BEBs.

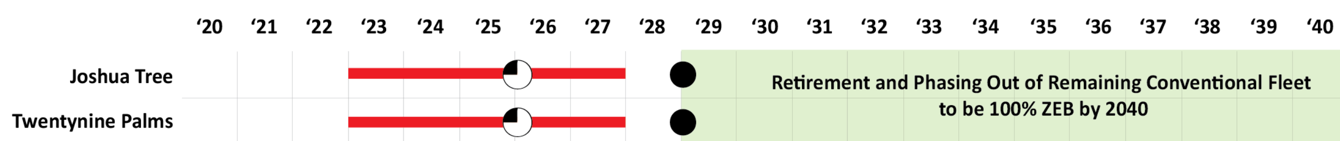
TWENTYNINE PALMS YARD

PHASE 1

Based on the size of the Twentynine Palms Yard site and the lower number of vehicles to be charged, WSP recommends completing the entire BEB charging installation in a single phase at the Twentynine Palms site.

Figure 3-10 presents the proposed construction schedule for MBTA's transition to ZEBs. This schedule incorporates RFP development/award, design, utility construction, and ZEB infrastructure construction. The Harvey Balls indicate the percentage of new buses that need to be ZEB pursuant to the ICT regulation.

Figure 3-10. MBTA Construction Schedule



Source: WSP

3.4 DISADVANTAGED COMMUNITIES

Disadvantaged communities (DACs) refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The California Environmental Protection Agency (CalEPA) and California's Senate Bill 535, define a "disadvantaged" community as a community located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

CalEnviroScreen uses environmental, health, and socioeconomic data to measure 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, as lower score indicates fewer disadvantages.

The replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs.

3.4.1 MBTA'S DISADVANTAGED COMMUNITY ANALYSIS

To understand ZEBs impacts on MBTA's service area, it was pertinent to establish if: 1) its garages are in a DAC; and 2) if its routes traverse DACs.

At this time, neither the Joshua Tree Yard nor Twentynine Palms Yard is in an area considered "disadvantaged". Its routes currently traverse 19 and 25 census tracts, respectively, all of which are not considered disadvantaged by the CalEnviroScreen tool.

Table 3-6 summarizes MBTA's yards and census tracts served in terms of DACs.

Table 3-6. MBTA's Disadvantaged Communities

YARD	IN DAC?	NOX EXEMPT AREA?	COMMUNITIES SERVED	DAC'S SERVED	PCT. OF DACS SERVED
Joshua Tree	No	No	19	0	0%
Twentynine Palms	No	No	25	0	0%

Source : WSP

3.5 WORKFORCE TRAINING

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

3.5.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter MBTA's service and operations. Converting to ZEBs from CNG is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and MBTA. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. MBTA is assumed to procure its first BEBs in 2026 with an expected delivery shortly after. Therefore, it is expected that all personnel will be sufficiently trained before the buses arrive. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that MBTA's staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, MBTA's future procurements/deliveries will require refresher or updated trainings for relevant staff.

Safety training, however, will be provided on an annual or other recurring basis to ensure that staff is knowledgeable and maintains best and safe practices when operating, handling, or servicing BEB-supporting components or infrastructure.

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

— **Bus Operators**
Bus operators will need to be familiarized with the buses, safety, bus operations, and BEB operations.

— **Facilities Maintenance Staff and Maintenance**
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.

— **Body Repairers**
Body repairers at the contracted operator will need to be familiarized with the safety-related features and other components of ZEBs.

— **Instructors**
Maintenance 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**
All Management will be familiarized with ZEB operations and safety procedures.

3.6 COSTS AND FUNDING

The following section identifies preliminary capital costs and potential funding sources that MBTA may pursue in its adoption of ZEBs.

3.6.1 PRELIMINARY COSTS

For MBTA, bus acquisitions are expected to cost between $224K to $905K per bus (depending on length) and plug-in chargers are assumed to cost $71K per charger, with an additional $8K for installation, and labor and permits, per charger. However, operating costs, utility costs, midlife overhauls, training, and soft costs that will all need to be considered in ZEB adoption. The total cost of ownership is further refined and explored in the Master Plan.

3.6.2 POTENTIAL FUNDING SOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at MBTA's disposal. MBTA will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. The following table identifies the many funding opportunities that MBTA may take advantage of in the next 20 years.[1]

Table 3-7. MBTA's ZEB Funding Opportunities

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
	Federal Transportation Administration (FTA)	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		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

1 It should be noted that some of these grants and programs have requirements based on population, service, and fleet size that MBTA may be ineligible for.

TYPE	AGENCY	FUNDING MECHANISM
	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program
	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	California Department of Transportation (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

3.7 START-UP AND SCALE-UP CHALLENGES

To comply with the ICT regulation's purchase and transition requirements, there are a number of challenges and opportunities that MBTA has identified. The following sections briefly describe some of the challenges that MBTA faces for its transition.

— **Uncertainty of ZEB cutaways.** As discussed, there is a small market for ZEB cutaways. For the cutaways that do exist, there is uncertainty in their product range and if they're Altoona-tested. Unfortunately, the cutaway market does not currently offer FCEBs, so MBTA has no other alternative and will need to plan on BEB adoption.

— **Range issues.** MBTA has some blocks that exceed current BEB range. This means that MBTA will need to consider the following strategies to reduce or avoid service disruptions:

  — **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.

  — **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.

  — **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will need to consider the potential impacts to operator and maintenance costs.

— **Technological adaptation.** Currently, MBTA is modeling and planning for a transition based on existing service and ZEB technology. With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. MBTA (and the market) needs to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.

— **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. MBTA will need to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.

— **Market Production Factors.** The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for agencies if supply of buses can meet with demand.

4 MOUNTAIN AREA REGIONAL TRANSIT AUTHORITY

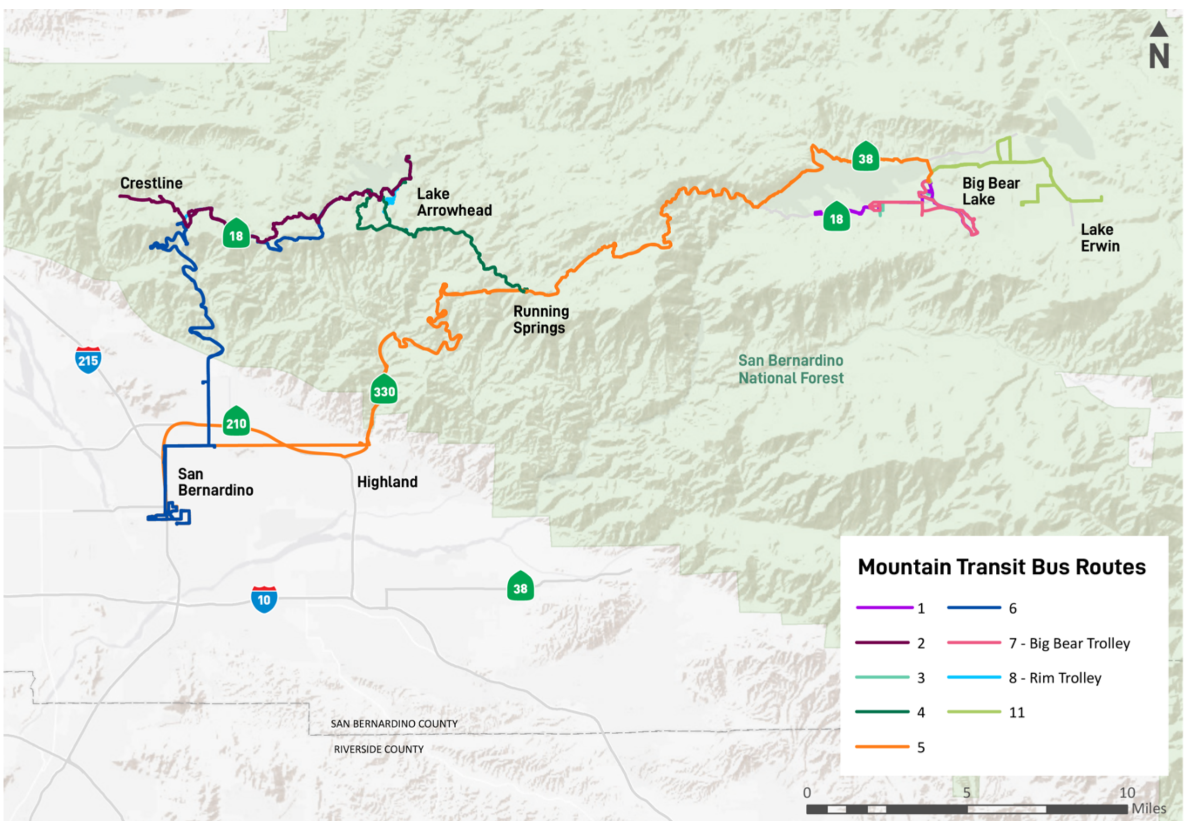
4.1 INTRODUCTION

Mountain Area Regional Transit Authority (MT) was formed as a joint powers authority (JPA) between the City of Big Bear Lake and the County of San Bernardino, providing service between the City of San Bernardino and the San Bernardino mountain communities. MT's ridership peaks between December and March, when tourists are drawn to the robust ski industry in the San Bernardino Mountains during snowy winter months.

4.1.1 SERVICE AREA

MT provides two primary transit services - fixed-route bus service and dial-a-ride. It operates local shuttle services in and between Big Bear Lake, Lake Arrowhead, the surrounding mountain communities, and intercity connection services between these communities and the City of San Bernardino. Through the latter service, MT provides connections to Omnitrans, Metrolink, and private commercial bus service. In addition to its primary destination cities - Big Bear Lake, Crestline, Lake Arrowhead and San Bernardino - MT provides service in the following mountain communities: Big Bear City, Erwin Lake, Highland, Moonridge, and Running Springs. Figure 4-1 shows MT's service area.

Figure 4-1. MT Service Area



Source: WSP

4.1.2 ENVIRONMENTAL FACTORS

MT faces two considerable obstacles in providing its service - weather and terrain. These will undoubtedly also influence MT's electrification process. Because MT operates in both the mountain communities and the City of San Bernardino, its fleet must be able to handle a wide variety of weather conditions. While much of San Bernardino County experiences a hot, arid desert climate, the mountain communities experience significant snowfall during the winter months. Winter average low temperatures in Big Bear Lake are between 21 and 22 degrees, while in the City of San Bernardino average lows in those same months are between 41 and 43. On a given winter day, a bus could begin its service day in the City of San Bernardino with a mid-day high temperature of 68 degrees (average high for January) and conclude its day in Big Bear Lake with a low temperature of 21 degrees (average low for January). The summer months offer a similar juxtaposition, high temperatures in the City of Big Bear Lake average 81 degrees in July, compared with 96 degrees in the City of San Bernardino.

There is also a stark contrast in terrain and elevation between the mountain communities and the City of San Bernardino. Big Bear Lake's elevation is 6,750 while the City of San Bernardino is approximately 1,000 feet, meaning MT must both operate at high altitude *and* climb to that high altitude from the valley floor. Snow typically begins at 5,000 feet but can reach as low as 3,000 feet during storms. To combat these environmental challenges, all MT buses are equipped with auto-chains for their tires and during heavy snow conditions, must put on conventional, heavy duty chains. At the point that chains are to be used for ZEBs, both the auto chains and conventional heavy-duty chains would need to be a consideration when modeling battery consumption and need to be an acceptable after-market equipment use that does not void the manufacturer warranty.

Additionally, many of the roads between the mountain villages - especially in the Rim of the World (RIM is a common term for the Lake Arrowhead and Crestline areas) and even some portions of the roads traveling up the mountain - are very narrow with steep, short grades, and have many curves. These roads present difficulty for buses in all seasons, but especially during the winter months, when snow can lead to slipping and traffic delays. State Routes 18 and 330 provide off-the-mountain (OTM) access to Lake Arrowhead and Big Bear Lake, respectively. Both roads feature grades of up to seven percent, which presents a challenge, snow notwithstanding. The steep grades of the roads that climb the mountain also present an unusual challenge for a transit system. The RIM OTM is a shorter and not as steep grade as the Big Bear OTM; however, the narrow roads do not permit a bus larger than 27.5-feet in length to operate on this route. The Big Bear OTM can handle a larger bus; however, the route length (50 miles one-way) and steeper grades require that these buses utilize a diesel engine. In the past, MT did use gasoline engines for the Big Bear OTM, but the engines frequently broke down and MT had to transition to diesel engines. Electric motors, which have higher torque and better acceleration from low speeds and on hills, should provide benefits to MT in meeting these challenges; however, the terrain, length of the grade climbing thousands of feet, coupled with the low temperatures, will reduce the range of BEBs, reducing the length of blocks that can be completed. In addition, the narrow and mountainous roadways demand service reliability, meaning that greater scrutiny should be observed in calculating the range of vehicles operating on these challenging bus routes. FCEBs can largely meet range concerns, yet the concern lies in the fact that there is no close proximity to hydrogen infrastructure and delivery on the mountain during severe weather.

4.1.3 SCHEDULE AND OPERATIONS

MT operates service on 10 fixed routes. Five routes are local shuttles in the Big Bear Valley, three are local shuttles in the RIM area, and the final two provide intercity OTM service between the two service areas and the City of San Bernardino. Of the ten routes, two are seasonal services in both Big Bear Lake in the winter and a trolley/weekend service in the RIM area from May to November. Odd-numbered routes correspond to Big Bear

Valley service, and even-numbered routes correspond to the RIM/Lake Arrowhead area. All Big Bear routes originate from the Fox Farm Transfer station.

The five local shuttles in Big Bear Lake are:

— 1 – Boulder Bay to Interlaken Center, serving The Village and Bear Mountain
— 3 – Mountain Meadows to Bear Mountain and Interlaken Center
— 11 – Erwin Lake to Interlaken Center, serving Big Bear Lake, Big Bear City, and Sugarloaf
— 7 - Trolley service on weekends, holidays and peak tourist periods from the Village in Big Bear Lake to Snow Summit, year-round
— 9 - Winter service during weekends, holidays and peak tourist periods, from the Backward Look Lot to the two ski resorts

The three local shuttles in the RIM area are:

— 2 – Valley of Enchantment to Lake Arrowhead, serving Crestline
— 4 – Lake Arrowhead to Running Springs
— 8 - Trolley service from Crestline, to Lake Arrowhead to Santa's Village, on weekends, holidays and peak tourist periods, from May to November

The two OTM routes are:

— 5 – Big Bear Valley to San Bernardino, servicing Running Springs
— 6 – Lake Arrowhead to San Bernardino, servicing Crestline

Routes 1, 3 and 11 in Big Bear Lake run daily; OTM service runs one fewer trip on the weekends. For Routes 2 and 4 that service Lake Arrowhead, they operate on full schedule Monday to Friday. On Saturdays, Routes 2 and 4 operate a full schedule, while Route 6 operates a limited schedule. Only Route 2 operates on Sunday and does so on a limited schedule.

As mentioned above, MT operates a weekend, holiday and peak tourist period trolley service in Big Bear Lake and a summer weekend trolley service (mid-May to mid-October) from Lake Arrowhead to Lake Gregory. The Big Bear Trolley runs hourly on Saturdays from 9:30 AM to 9:30 PM and on Sundays from 11:30 AM to 2:30 PM. On holiday weekends MT uses a Saturday schedule on Sunday and a Sunday schedule on Monday. The RIM area trolley runs roughly every hour and 40 minutes from 1:40 PM to 8:40 PM.

4.2 FLEET AND ACQUISITIONS

The following section provides an overview of MT's existing fleet, planned purchases, and description of how MT will meet the requirements of the ICT regulation.

4.2.1 EXISTING BUS FLEET

As of March 2020, MT directly operates 24 gasoline and diesel-powered cutaway buses for fixed-route service. These buses range between 22 and 37-feet in length and are primarily cutaways and vans. Due to the narrow, windy, mountainous roadways, MT cannot operate buses larger than 27.5 feet in the RIM area, and no larger than 37.5 feet in the Big Bear area. Therefore, purchasing vans and cutaways will continue to be their only option for bus procurements. Table 4-1 presents a summary of MT's existing bus fleet.

Table 4-1. Summary of MT's Existing Bus Fleet

MANUFACTURER	SERIES	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NUMBER OF BUSES
Bluebird	Micro Bird E450	Gasoline	25'	2018	Cutaway	1
		Gasoline	27'	2018	Cutaway	1
Braun	Entervan	Gasoline	16.5'	2015	Van	2
Freightliner	Glaval Legacy Cummins ISB	Diesel	37'	2016	Cutaway	2
Ford	Aerolite El Dorado E350	Gasoline	22'	2015	Cutaway	1
	Aeroelite 270-C	Gasoline	27.5'	2015	Cutaway	2
	F550 Class E	Gasoline	27.5'	2016	Cutaway	2
	F550 Trolley	Gasoline	25'	2018	Cutaway	1
	Glaval E450	Gasoline	27.5	2019	Cutaway	4
	Glaval Entourage	Gasoline	32.5'	2016	Cutaway	2
	Glaval F550	Gasoline	32.5'	2015	Cutaway	3
	Norcal Transit Van 350 EL	Gasoline	22'	2019	Van	1
	Supreme F53 Trolley	Gasoline	30'	2016	Cutaway	1
	Transit Van	Gasoline	22'	2017	Van	1
					Total	**24**

Source: Mountain Area Regional Transit Authority, March 2020

4.2.2 ZEB TECHNOLOGY APPLICATION

Past and ongoing ZEB analysis for MT's operations has determined that BEB adoption is the ZEB technology that best meets the needs of MT for their purchasing and transition requirements pursuant to the ICT regulation. FCEBs, at this time, are not feasible due to no current manufacturers offering a cutaway.

BATTERY-ELECTRIC BUS

MT's future BEBs are expected to have specifications that are compatible with the SAE J1772 charging standard (e.g., "plug-in charging") (Figure 4-2). It is recommended that MT specify charging ports on the front and rear of BEBs to allow for their existing site circulation and parking patterns to continue without modifications as both head-in and back-in parking are used in existing MT parking operations. Acquiring buses with the dual port locations will allow for vehicles to operate from all sites with no restrictions based on charger layout.

Figure 4-2. Ground-Mounted Plug-In Charger

Source: Cultura

Any buses which will perform OTM service are recommended to be procured with overhead charging rails (Figure 4-3) to utilize potential opportunity charging that is being considered at the San Bernardino Transit Center (SBTC) for range extending. An alternative "no charging rails" solution would need to identify a non-publicly accessible/isolated layover space for 30+ minute layover space where a BEB could be connected to a plug-in charger. Note that current plug-in chargers are limited to 150-200 kW due to National Electric Code requirements for handheld wiring. Roof-mounted charging rails would allow a MT BEB to access higher power charging (200-600 kW) at the SBTC.

Figure 4-3. Inverted Pantograph and Charge Rails

Source: WSP

FUEL CELL ELECTRIC BUS

Currently, there are no manufacturers in the U.S. market that offer a FCEB cutaway, deeming hydrogen power infeasible, under existing conditions. While a hydrogen-powered cutaway may be developed in the future, MT must plan and design for facilities and buses that are currently on the market to ensure they can comply with CARB's ICT regulation. However, as technology further develops, MT will remain open to technologies outside of BEB and will update plans, studies, and strategies, accordingly.

For specific blocks that are not capable of being served efficiently by existing BEB technology (primarily, the OTM routes), FCEBs could be a viable option, if cutaways are eventually introduced to the market. In that case, it is recommended that hydrogen fuel cell vehicles be utilized and fueled either via future commercial/public hydrogen fueling stations located near the SBTC. As no fueling operations currently exist on MT's sites, and given the makeup of the mountain communities (a small, full-time population base, along with peaks of tourism and few employment centers), MT does not anticipate other employers/fleets building a hydrogen station in the communities, and therefore, it is not recommended to introduce on-site hydrogen fueling.

4.2.3 EXISTING ZEB PROCUREMENTS AND PROJECTS

MT is currently working with Michelle Kirkhoff Consulting, LLC (MKC) in their master planning efforts to adopt ZEBs.

4.2.4 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, MT will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus is expected to be purchased in 2028. All new buses purchases are anticipated to be ZEB starting in 2029.

Early retirement should not be an issue pursuant to the ICT regulation based on MT's assumed procurement schedule. However, if it becomes one, MT will deploy various strategies to ensure that buses fulfill their "useful life". One potential strategy is to place newly acquired buses on MT's longest (distance) blocks of service. This will ensure that these buses meet their distance-based useful life requirement more rapidly.

MT's existing fleet consists of 24 cutaway buses and vans. Assuming a 1:1 replacement ratio, each existing bus will eventually be replaced with an equivalent-length BEB cutaway bus. However, the number of ZEBs required may increase with time based on service requirements.

Table 4-2 presents a summary of MT's anticipated bus procurements through 2040. Years 2026 and 2029 are highlighted because these indicate when MT's new purchases should be 25 percent and 100 percent ZEBs, respectively.

Table 4-2. Summary of MT's Future Bus Purchases (through 2040)

YEAR	TOTAL BUSES	ZERO-EMISSION BUSES				CONVENTIONAL (GASOLINE OR DIESEL) BUSES			
		NUMBER	PCT.	BUS TYPE	FUEL TYPE	NUMBER	PCT.	BUS TYPE	FUEL TYPE
2020	**3**	0	0%	-	-	3	100%	Cutaway	Gasoline
2021	**6**	0	0%	-	-	6	100%	Cutaway	Gasoline
2022	**1**	0	0%	-	-	1	100%	Cutaway	Gasoline
2023	**4**	0	0%	-	-	4	100%	Cutaway	Gasoline
2024	**11**	0	0%	-	-	11	100%	Cutaway	Gasoline/Diesel
2025	**2**	0	0%	-	-	2	100%	Cutaway	Gasoline
2026	**4**	1	25%	Cutaway	BEB	3	75%	Cutaway	Gasoline
2027	**0**	0	0%	-	-	0	0%	-	-
2028	**5**	2	40%	Cutaway	BEB	3	60%	Cutaway	Gasoline
2029	**8**	8	100%	Cutaway	BEB	0	0%	-	-
2030	**5**	5	100%	Cutaway	BEB	0	0%	-	-
2031	**4**	4	100%	Cutaway	BEB	0	0%	-	-
2032	**2**	2	100%	Cutaway	BEB	0	0%	-	-
2033	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2034	**9**	9	100%	Cutaway	BEB	0	0%	-	-
2035	**4**	4	100%	Cutaway	BEB	0	0%	-	-
2036	**7**	7	100%	Cutaway	BEB	0	0%	-	-
2037	**3**	3	100%	Cutaway	BEB	0	0%	-	-
2038	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2039	**7**	7	100%	Cutaway	BEB	0	0%	-	-
2040	**4**	4	100%	Cutaway	BEB	0	0%	-	-

Source: WSP, March 2020
Note: The first replacement for each bus type is based on MT's existing procurement schedule, each subsequent replacement is based on FTA's UBL.

4.2.5 ZEB RANGE REQUIREMENTS AND COSTS

MT operates 11 blocks during weekdays, eight of which are longer than 100 miles. MT's longest blocks are approximately 275 miles. Depending on operational parameters, including operator behavior, ambient temperature, traffic, and ridership, these ranges may be unattainable or difficult to achieve on certain days with ZEB technology. To reduce impacts to service, MT will consider several strategies to supplement onboard battery storage, including additional buses, midday charging, battery/charging management systems, and solar and battery storage. In future ZEB applications, MT may also consider FCEBs, especially if battery technology doesn't advance as forecasted.

4.2.6 ZEB CONVERSIONS

Conventional bus conversions to ZEB technologies are not currently being considered at this time for MT. However, MT will remain open to conversions if they are deemed financially feasible and align with goals to ZEB adoption.

4.3 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following sections detail the planned charging strategies, infrastructure, detailed base improvements, and program schedule.

4.3.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. For that reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each facility. This provides the agency with a ceiling for what can physically be constructed and at what cost. Service changes and bus movements may happen multiple times a year, for some agencies. By establishing a full build scenario, agencies can optimize, and tailor strategies based on existing (or anticipated) service for implementation.

The analysis of FCEBs at each agency is ongoing, however, a hydrogen storage footprint was established at each division where vehicles and space can support it. Further analysis (Master Plan and subsequent studies) will analyze alternatives of hydrogen delivery.

In the case of MT, the full build scenario is presented for context. However, refinements and tailored strategies will be developed in the Master Plan and future implementation studies.

4.3.2 FACILITY MODIFICATIONS

MT's transition to ZE technologies, namely, BEB, will require various modifications and changes to infrastructure and operations. MT is in the process of redeveloping their existing Crestline site and establishing a new replacement site for their Big Bear facility. It is anticipated that both these new facilities will be fully equipped to support a full BEB fleet when they are opened, with all electrical equipment, electrical capacity and BEB chargers, dispensers and other components installed during the initial construction.

At the existing Crestline base, MT intends to demolish all existing structures, and build a new three-bay maintenance facility and small administrative building along the north edge of the property. MT has also acquired a parcel across the street from the Crestline base, the new site will function as temporary bus storage and dispatching/staging while the existing Crestline site is under construction. However, at this time, MT does not intend to use this site for ZE-related bus operations.

MT is in negotiations to purchase a three-acre parcel in Big Bear Lake to construct a new administrative and maintenance facility, bus wash, and customer service center. MT anticipates that the property purchase will be completed by the end of the FY 2019-20. The site is anticipated to be under construction in 2021 with normal operations in 2022. Upon occupying the new facility, MT will cease use or dispose of the existing facility.

Ultimately, MT's two new facilities (remodeled Crestline and new Big Bear Lake facilities) will include enhancements and expansions of electrical equipment, additional electrical capacity, and the installation of BEB chargers, dispensers, and other components to support an all-ZEB fleet.

In the interim, while these facilities are under construction, MT may launch pilot projects at both bases to test and analyze BEBs before full-scale procurements and BEB-infrastructure installations.

Based on MT's existing service needs and site configurations, MT plans on installing ground-mounted plug-in chargers to support BEBs at both bases. The proposed full facility layouts are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging ratio (one DC charging cabinet energizes two separate plug-in cord dispensers/buses). This charger to dispenser ratio would meet the requirements to charge MT's fleet during the vehicles' servicing and dwell time on the site while minimizing the peak electrical demand.

Table 4-3 summarizes the modifications and schedule of each base and the following sections detail the process of each base's transition from existing conditions to BEB-readiness.

Table 4-3. MT's Base Summary

BASE	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADES REQ'D?	TIMELINE
Crestline	621 Forest Shade Rd. Crestline, CA	Storage, and Maintenance	Ground-Mounted, Plug-In Charging	12 buses	Yes	2021-2026
Big Bear Lake (Future)	Big Bear Lake, CA	Storage and Maintenance	Ground-Mounted, Plug-In Charging	18 buses	Yes	2021-2026

Source: WSP

CRESTLINE BASE

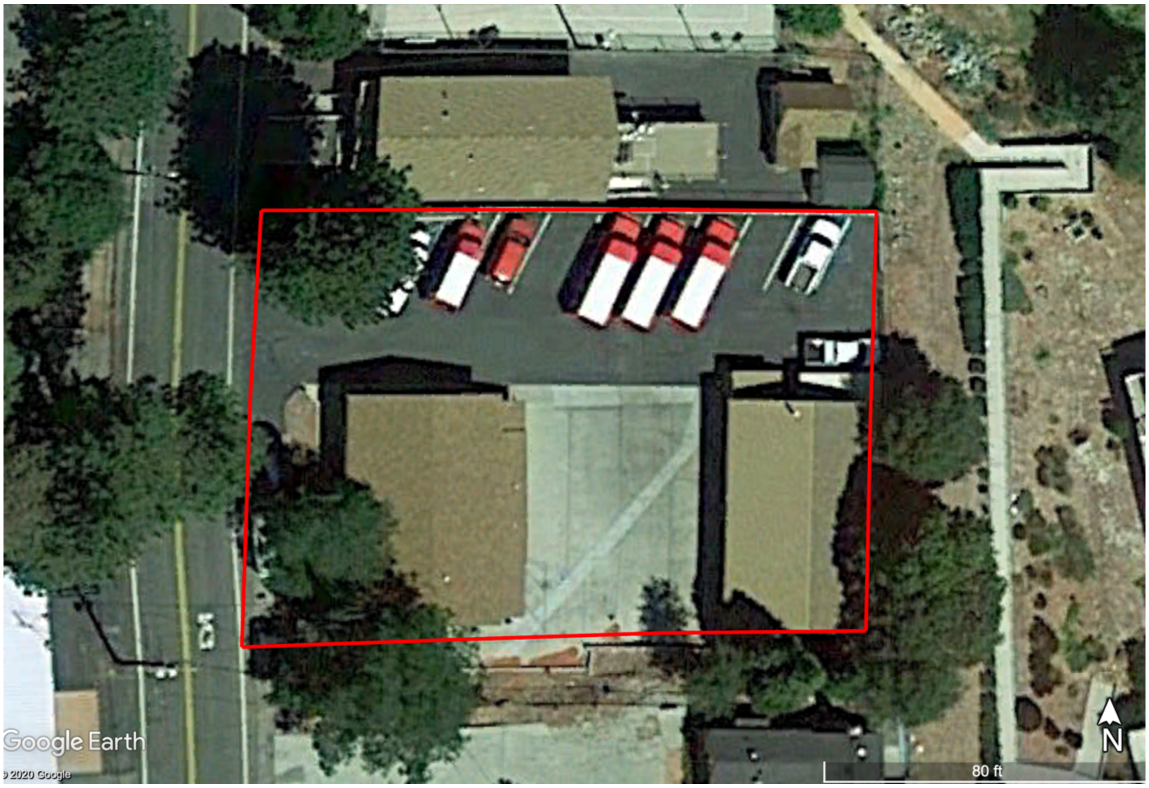
EXISTING CONDITIONS

Crestline Base is located at 621 Forest Shade Road in the Crestline community of San Bernardino County. Electrical service is provided by SCE.

Currently, 11 gasoline-powered buses are stored, maintained, and serviced at the base. The Crestline site consists of the following separate structures and major site areas: bus parking, vehicle maintenance facility, and transportation and administration building. Buses enter from Forest Shade Road and are parked one-deep in angled tracks in the yard along the northern fence line. Buses are pulled nose-first into the spaces and must perform a complex backing procedure to exit the spaces and turn around for pull-out. On pull-out, buses exit the site for service onto Forest Shade Road. Buses are fueled and washed off-site due to no facilities being available on the site. The current base is extremely limited in extra space to install either ground-mounted, overhead electrical charging equipment, or hydrogen storage infrastructure.

As previously mentioned, MT intends to demolish all existing structures, and build a new three-bay maintenance facility and small administrative building along the north edge of the property.

Figure 4-4. Crestline Base - Existing Conditions



Source: Google Earth

Figure 4-5. Crestline Base's Maintenance Facility

Source: WSP

Figure 4-6. Crestline Base's Parking

Source: WSP

PLANNED ZEB MODIFICATIONS

Based on the recommended ground-mounted DC plug-in charging solution, the Crestline Base is capable of parking 12 buses with 12 plug-in charging positions in a 1:2 charger to bus dispenser ratio.

Table 4-4 summarizes the ZEB infrastructure planned at the Crestline Base.

Table 4-4. Crestline Base Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY*
MT	Crestline	Ground-Mounted; Plug-In	6	12	150 kW	N/A

Source: WSP
Note: At this time, there are no current cutaway FCEBs on the market, however, if one is developed and MT determines adoption is feasible, on-site fueling/storage is recommended.

The following BEB equipment and locations are proposed:

— Four charging cabinets in the eastern portion of the yard adjacent to the bus parking with seven plug-in dispenser charging positions along the northern yard wall in the existing parking layout.

— Three charging cabinets along the western property line with five plug-in dispenser charging positions along the western property line. Buses will be connected to the dispenser via a charging point located on the front of the bus.

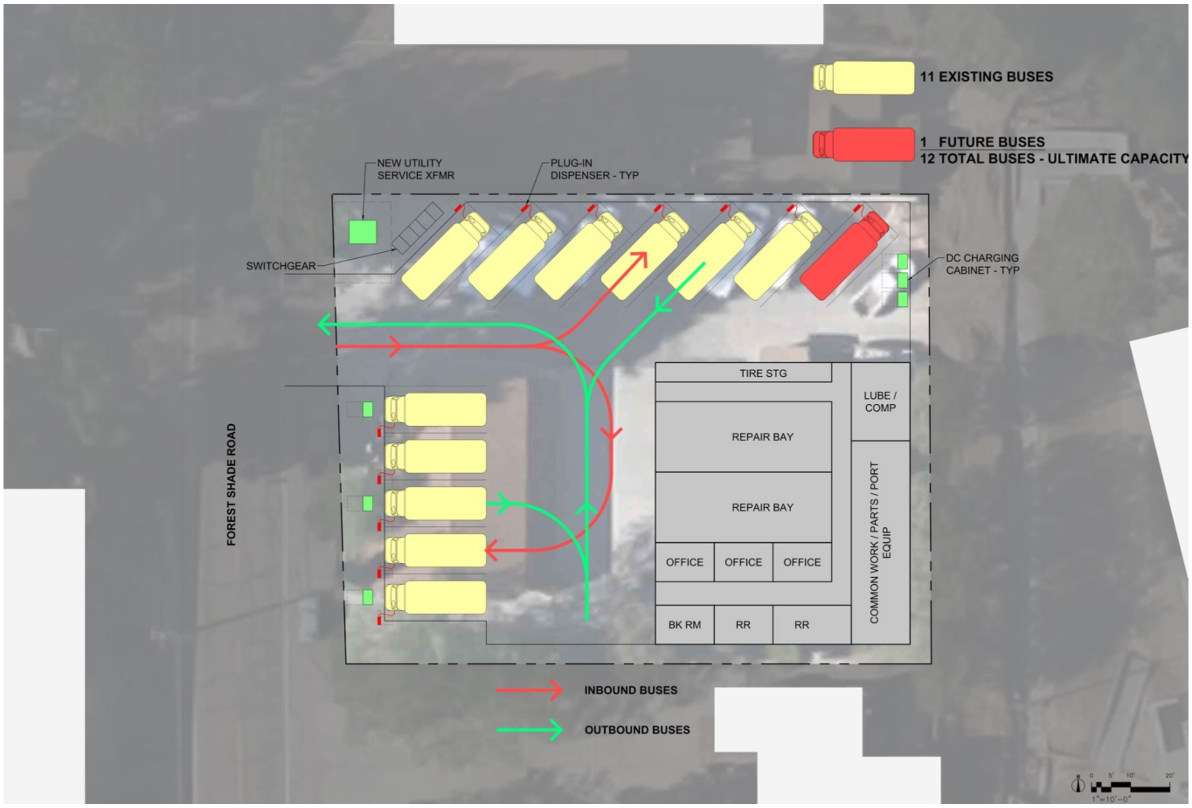
The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

— One medium voltage utility service transformer in a new utility base in the open space west of the existing parking spaces and east of the site entrance.

— One switchgear in a new utility yard in the open space west of the existing parking spaces and east of the site entrance.

Figure 4-7 illustrates the Crestline Base at full build-out.

Figure 4-7. Crestline Base – Full ZEB Build-Out



Source: WSP

BIG BEAR LAKE (FUTURE)

EXISTING CONDITIONS

The Big Bear Lake Base (future) is located approximately ¼-mile north of the existing Big Bear Lake Base. Electrical service will be provided by the Bear Valley Electric Service Utility.

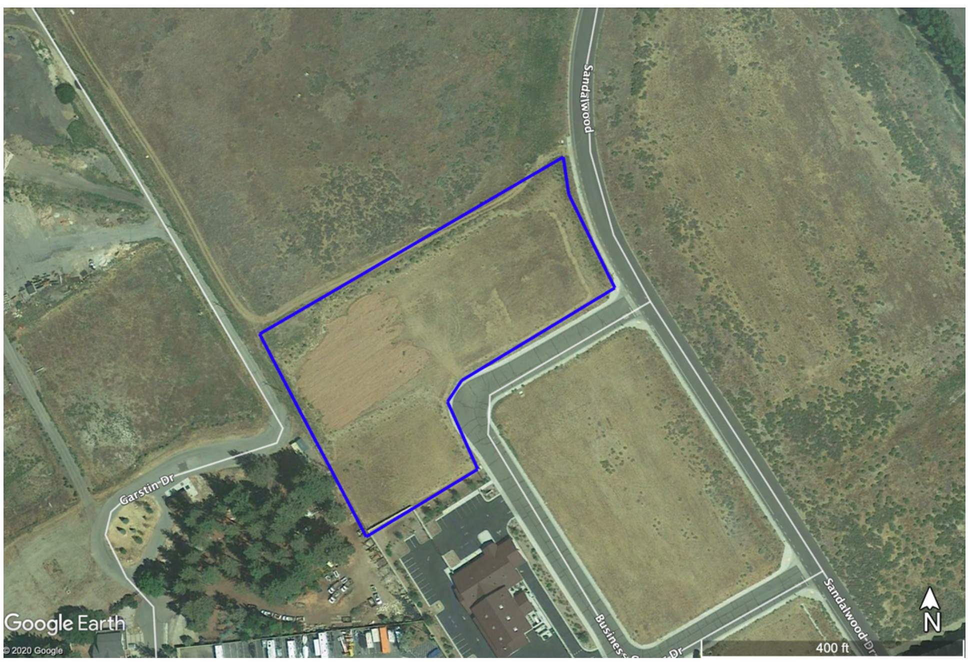
As previously mentioned, MT is in the process of developing a new site to replace the existing Big Bear Lake facility. The planned ZEB modifications shown in this document are based on the concept for the new Big Bear Lake Base (Big Bear Lake Future).

Figure 4-8 and Figure 4-9 present the existing and future Big Bear Lake bases.

Figure 4-8. Existing and Future Big Bear Lake Bases - Existing Conditions

Source: Google Earth

Figure 4-9. Future Big Bear Lake - Existing Conditions



Source: Google Earth

PLANNED ZEB MODIFICATIONS

Based on the recommended ground-mounted DC plug-in charging solution, the Big Bear Lake Base (future) will be capable of parking 18 buses with 18 plug-in charging positions in a 1:2 charger to bus dispenser ratio. Smaller cutaway type vehicles will pull into spaces and charge in the front of the vehicle while larger buses will back into their parking stalls and be charged via a rear plug-in port.

Table 4-5 summarizes the ZEB infrastructure planned at the future Big Bear Lake Base.

Table 4-5. Future Big Bear Lake Base Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY*
MT	Big Bear Lake (Future)	Ground-Mounted; Plug-In	9	18	150 kW	N/A

Source: WSP
Note: At this time, there are no current cutaway FCEBs on the market, however, if one is developed and MT determines adoption is feasible, on-site fueling/storage is recommended.

The following BEB equipment and locations are proposed:

— Nine charging cabinets with 18 plug-in dispenser-charging positions along the western property line.

The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

— One medium voltage utility service transformer in the northwest corner of the site.

— One switchgear located in the northwest corner of the site.

Figure 4-10 illustrates the future Big Bear Lake Base at full build-out.

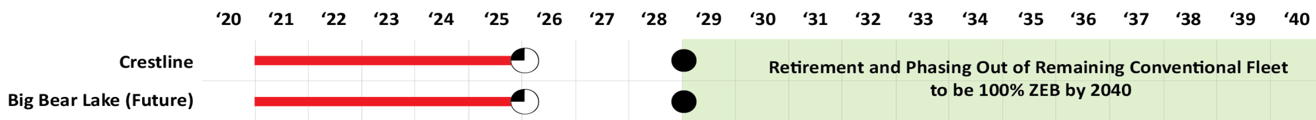
Figure 4-10. Big Bear Lake (Future) Base – Full ZEB Build-Out

Source: WSP

4.3.3 PHASING AND CONSTRUCTION SCHEDULE

Adhering to the construction schedule and milestones will be critical because the facilities' construction must be completed before buses are delivered, otherwise, the buses will not be able to operate. To accomplish this, construction for BEB-supporting infrastructure is expected to be completed during the construction of the two new facilities.

Figure 4-11. MT Construction Schedule



Source : WSP

4.4 DISADVANTAGED COMMUNITIES

Disadvantaged communities (DACs) refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The (CalEPA) and California's Senate Bill 535, define a "disadvantaged" community as a community located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

CalEnviroScreen uses environmental, health, and socioeconomic data to measure 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, as lower score indicates fewer disadvantages.

The replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs.

4.4.1 MT'S DISADVANTAGED COMMUNITY ANALYSIS

To understand ZEBs impacts on MT's service area, it was pertinent to establish if: 1) its yards are in a DAC; and 2) if its routes traverse DACs.

At this time, neither the Crestline nor future Big Bear Lake base is located in areas considered "disadvantaged". However, both bases serve routes that traverse DACs (the future Big Bear Lake Base will serve the same routes that the existing does). Crestline serves 24 communities, 14 of which (58 percent), are considered disadvantaged. Whereas, Big Bear Lake serves 34 communities, 17 of which (50 percent), are considered disadvantaged.

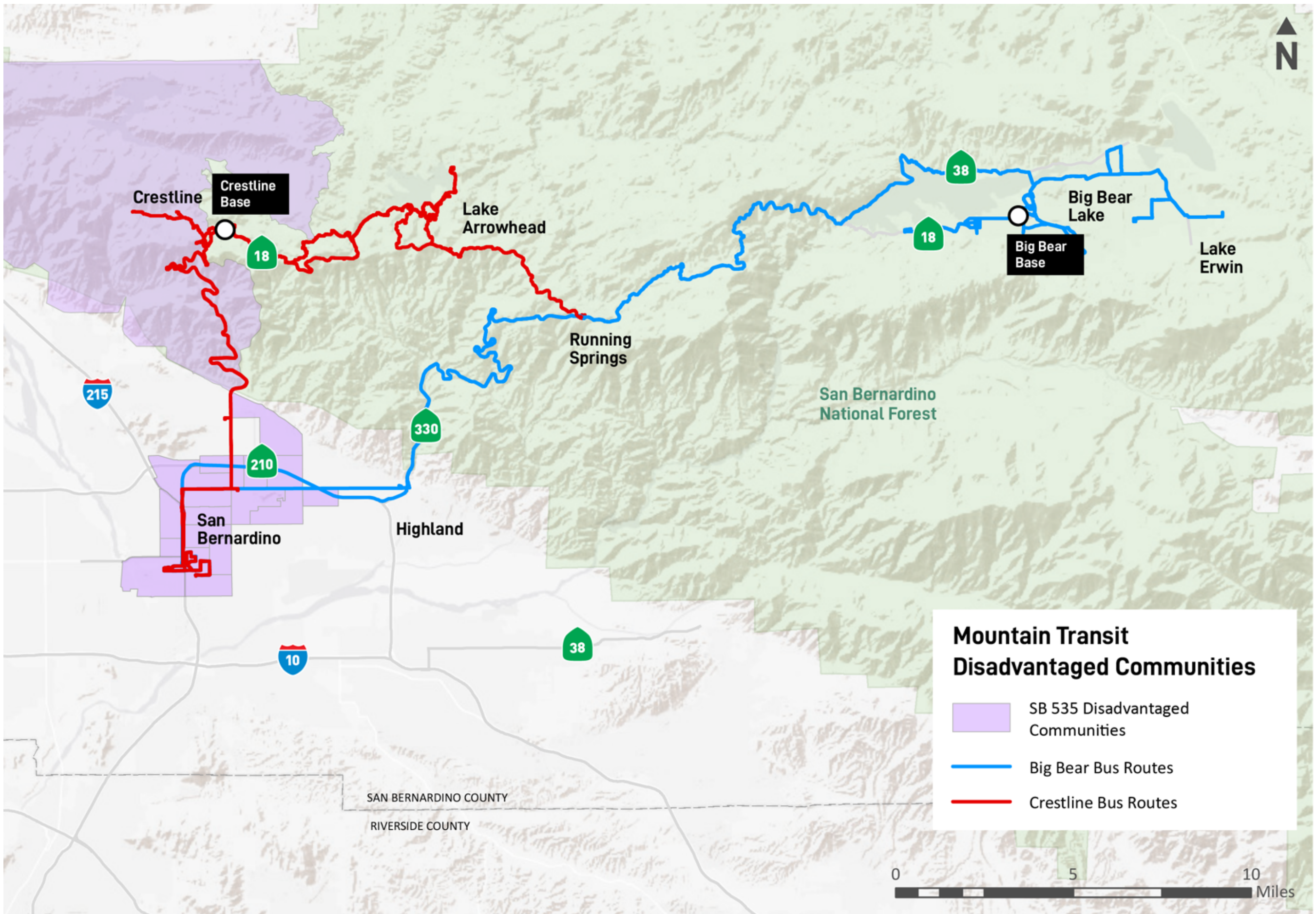
Table 4-6 summarizes MT's bases and census tracts served in terms of DACs. Figure 4-12 illustrates MT's bases and the census tracts that they serve.

Table 4-6. MT's Disadvantaged Communities

BASE	IN DAC?	NOX EXEMPT AREA?	COMMUNITIES SERVED	DAC'S SERVED	PCT. OF DACS SERVED
Crestline	No	No	24	14	58%
Big Bear Lake	No	No	34	17	50%

Source : CalEnviroScreen 3.0

Figure 4-12. MT's Disadvantaged Communities



Source : CalEnviroScreen 3.0

4.5 WORKFORCE TRAINING

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

4.5.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter MT's service and operations. Converting to ZEBs from gasoline and diesel operations is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and MT. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. MT is assumed to procure its first BEBs in 2026 with an expected delivery expected shortly after. Therefore, it is expected that all personnel will be sufficiently trained before the buses arrive. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that MT's staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, MT's future procurements/deliveries will require refresher or updated trainings for relevant staff.

Safety training, however, will be provided on an annual or other recurring basis to ensure that staff is knowledgeable and maintains best and safe practices when operating, handling, or servicing BEB-supporting components or infrastructure.

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

— **Bus Operators**
  Bus operators will need to be familiarized with the buses, safety, bus operations, and BEB operations.

— **Facilities Maintenance Staff and Maintenance**
  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.

— **Body Repairers**
  Body repairers at the contracted operator will need to be familiarized with the safety-related features and other components of ZEBs.

— **Instructors**
  Maintenance 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**
  All Management will be familiarized with ZEB operations and safety procedures.

4.6 COSTS AND FUNDING

The following section identifies preliminary capital costs and potential funding sources that MT may pursue in its adoption of ZEBs.

4.6.1 PRELIMINARY COSTS

For MT, bus acquisitions are expected to cost between $173K to $270K per bus (depending on length) and plug-in chargers are assumed to cost $71K per charger, with an additional $8K for installation, and labor and permits, per charger. However, operating costs, utility costs, midlife overhauls, training, and soft costs that will all need to be considered in ZEB adoption. The total cost of ownership is further refined and explored in the Master Plan.

4.6.2 POTENTIAL FUNDING SOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at MT's disposal. MT will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. The following table identifies the many funding opportunities that MT may take advantage of in the next 20 years.[2]

Table 4-7. MT ZEB Funding Opportunities

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
	Federal Transportation Administration (FTA)	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		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
	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
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		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

2 It should be noted that some of these grants and programs have requirements based on population, service, and fleet size that MT may be ineligible for.

Source : WSP

4.7 START-UP AND SCALE-UP CHALLENGES

To comply with the ICT regulation's purchase and transition requirements, there are various challenges and opportunities that MT has identified. The following sections briefly describe some of the challenges that MT faces for its transition.

— **Uncertainty of ZEB cutaways.** As discussed, there is a small market for ZEB cutaways. For the cutaways that do exist, there is uncertainty in their product range and if they're Altoona-tested. Unfortunately, the cutaway market does not currently offer FCEBs, so MT has no other alternative and will need to plan for BEB adoption.

— **Operating conditions.** MT's fleet currently climbs altitudes and operates in weather conditions that aren't typical of the region. These conditions have a huge impact on range, meaning, MT would have to invest more than other agencies to operate similar bus blocks (in terms of range).

— **Range issues.** MT has some blocks that exceed current BEB range. This means that MT will need to consider the following strategies to reduce or avoid service disruptions:

  — **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.

  — **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.

  — **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will need to consider the potential impacts to operator and maintenance costs.

— **Technological adaptation.** Currently, MT is modeling and planning for a transition based on existing service and ZEB technology. With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. MT (and the market) needs to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.

— **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. MT will need to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service. MT's remote location will likely add additional costs, support for warranties and repairs may be inflated due to reduced access in the mountain communities.

— **Market Production Factors.** The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for agencies if supply of buses can meet with demand.

5 CITY OF NEEDLES

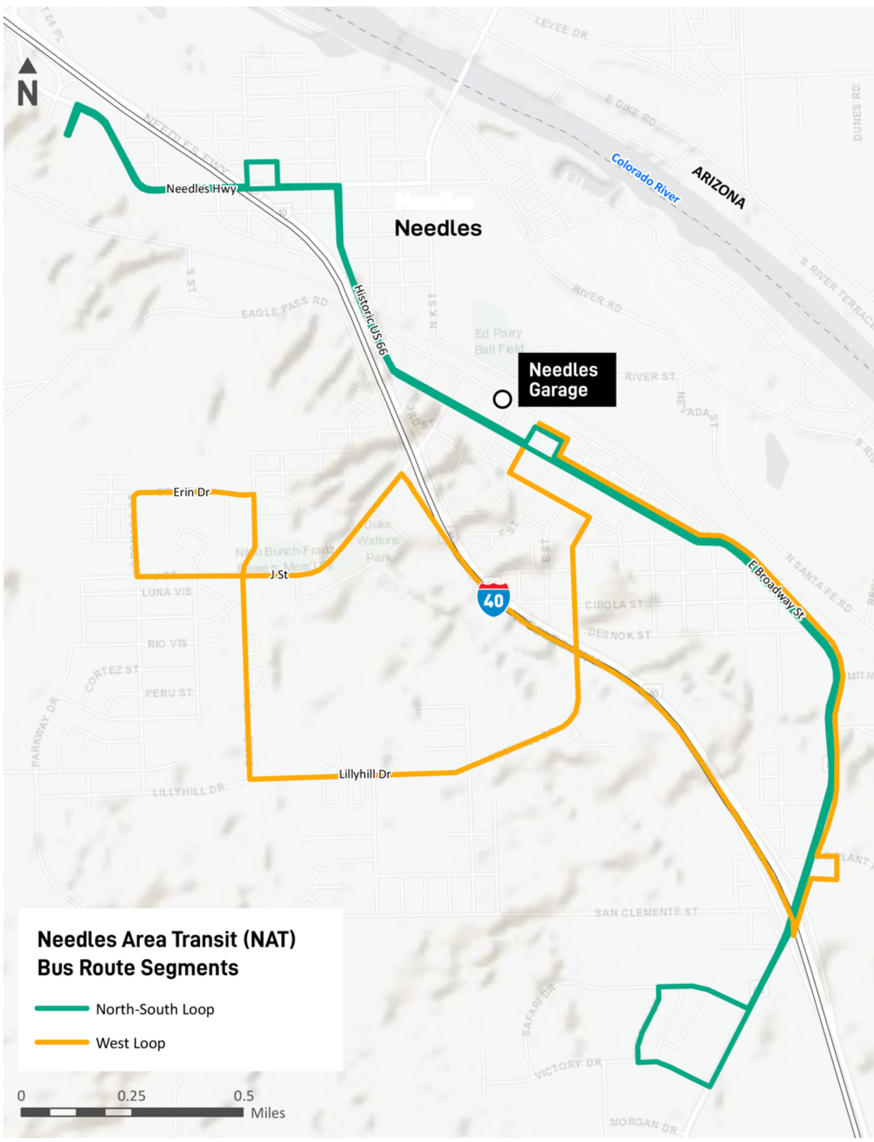
5.1 INTRODUCTION

The City of Needles operates Needles Area Transit (NAT), a service that provides fixed-route transportation within the City of Needles (hereinafter referred to as both Needles and the "city").

5.1.1 SERVICE AREA

NAT serves the City of Needles, which rests along the Colorado River and the Arizona and Nevada borders at the eastern edge of San Bernardino County. Its population according to the 2010 United States Census was 4,984.

Figure 5-1. NAT Service Area



Source: WSP

5.1.2 ENVIRONMENTAL FACTORS

Relative to the other communities that SBCTA-affiliated transit operators serve, the City of Needles is extraordinarily isolated. The nearest city within San Bernardino County is Barstow, over 140 miles away across the Mojave Desert and two mountain ranges; the nearest large city is Las Vegas, Nevada, approximately 110 miles away.

Needles experiences a desert climate, with average high temperatures of 108 degrees in July. Average temperatures are lowest in December and January, 43 and 44 degrees, respectively. The city receives very little precipitation, with annual rainfall amounting to 4.65 inches[3].

5.1.3 SCHEDULE AND OPERATIONS

NAT operates deviated fixed-route service on a single route within the city, which runs weekdays from 7:00 AM to 6:55 PM and Saturdays from 10:00 AM to 4:55 PM. The City of Needles also operates a dial-a-ride service for seniors and disabled passengers, and medical transportation to Mohave Valley/Bullhead City on Tuesdays and Thursdays, and a Shopper Shuttle on Wednesdays to Fort Mohave (with advanced reservation).

The single fixed-route is a combination of two loops, each with a 25-minute duration. The east-west loop begins on the hour and serves several civic destinations and the Colorado River Medical Center. The north-south loop begins on each half-hour and travels along historic Route 66, serving the Needles town center.

5.2 FLEET AND ACQUISITIONS

The following section provides an overview of NAT's existing fleet, planned purchases, and description of how NAT will meet the requirements of the ICT regulation.

5.2.1 EXISTING BUS FLEET

As of October 2019, the City of Needles directly operates three diesel-powered, 25-foot, cutaway buses for fixed-route service. Table 5-1 presents a summary of NAT's fixed-route existing bus fleet.

Table 5-1. Summary of NAT's Existing Bus Fleet

MANUFACTURER	SERIES	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NO. OF BUSES
Glaval Express	4500	Diesel	25'	2018	Cutaway	2
Elkhart Coach	Type C	Diesel	25'	2012	Cutaway	1
					Total Buses	**3**

Source: City of Needles, October 2019

5.2.2 ZEB TECHNOLOGY APPLICATION

Past and ongoing ZEB analysis for NAT's operations has determined that BEB adoption is the ZEB technology that suits the needs of Needles for their purchasing and transition requirements pursuant to the ICT regulation. FCEBs, at this time, are not feasible due to no current manufacturers offering a cutaway.

3 U.S. Climate data; Needles, CA, 2019 https://www.usclimatedata.com/climate/needles/california/united-states/usca0753

BATTERY-ELECTRIC BUS

NAT's future BEBs are expected to have specifications that are compatible with the SAE J1772 charging standard (e.g., "plug-in charging") (Figure 5-2). It is recommended that Needles specify charging ports on the rear of BEBs to allow for their existing site circulation and parking patterns to continue without additional modifications. Battery sizing (kilowatts) will be determined based on service needs requirements and what is available and feasible based on costs and weight. Charger rating (kilowatt-hour) will be based on service needs, battery acceptance, and costs.

Figure 5-2. Ground-Mounted Plug-In Charger

Source: Cultura

FUEL CELL ELECTRIC BUS

Currently, there are no manufacturers in the U.S. market that offer a FCEB cutaway, deeming hydrogen power infeasible, under existing conditions. While a hydrogen-powered cutaway may be developed in the future, Needles must plan and design for facilities and buses that are currently on the market to ensure they can comply with CARB's ICT regulation. However, as technology further develops, the city will remain open to technologies outside of BEB and will update plans, studies, and strategies, accordingly.

For specific blocks that are not capable of being served efficiently by existing BEB technology, FCEBs could be a viable option, if cutaways are eventually introduced to the market. In that case, it is recommended that FCEBs be fueled at future commercial/public hydrogen fueling stations located in the Needles service area. As no fueling operations currently exist at the garage nor does the existing site have enough open area to add a small modular hydrogen fueling system. It is not recommended to introduce on-site hydrogen fueling.

5.2.3 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, the City of Needles will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus is expected to be purchased in 2023. All new buses purchases are anticipated to be ZEB starting in 2028 – one year before the requirement.

Early retirement should not be an issue pursuant to the ICT regulation based on Needles' assumed procurement schedule. However, if it becomes one, the city will deploy several strategies to ensure that buses fulfill their "useful life". One potential strategy is to place newly acquired buses on NAT's longest (distance) blocks of service. This will ensure that these buses meet their distance-based useful life requirement more rapidly.

NAT's existing fleet consists of three 25-foot cutaway buses. Assuming a 1:1 replacement ratio, each existing bus will eventually be replaced with a 25-foot BEB cutaway bus. However, the number of ZEBs required may increase based on service requirements.

Table 5-2 presents a summary of NAT's anticipated bus procurements through 2040. Years 2026 and 2029 are highlighted because these indicate when NAT's new purchases should be 25 percent and 100 percent ZEBs, respectively.

Table 5-2. Summary of NAT's Future Bus Purchases (through 2040)

		ZERO-EMISSION BUSES				CONVENTIONAL (CNG) BUSES			
YEAR	TOTAL BUSES	NUMBER	PCT.	BUS TYPE	FUEL TYPE	NUMBER	PCT.	BUS TYPE	FUEL TYPE
2020	**0**	0	0%	-	-	0	0%	-	-
2021	**0**	0	0%	-	-	0	0%	-	-
2022	**0**	0	0%	-	-	0	0%	-	-
2023	**1**	0	0%	-	-	1	100%	Cutaway	Diesel
2024	**0**	0	0%	-	-	0	0%	-	-
2025	**0**	0	0%	-	-	0	0%	-	-
2026	**0**	0	0%	-	-	0	0%	-	-
2027	**0**	0	0%	-	-	0	0%	-	-
2028	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2029	**0**	0	0%	-	BEB	0	0%	-	-
2030	**0**	0	0%	-	-	0	0%	-	-
2031	**0**	0	0%	-	-	0	0%	-	-
2032	**0**	0	0%	-	-	0	0%	-	-
2033	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2034	**0**	0	0%	-	-	0	0%	-	-
2035	**0**	0	0%	-	-	0	0%	-	-
2036	**0**	0	0%	-	-	0	0%	-	-
2037	**0**	0	0%	-	-	0	0%	-	-
2038	**1**	1	100%	Cutaway	BEB	0	0%	-	-
2039	**0**	0	0%	-	-	0	0%	-	-
2040	**0**	0	0%	-	-	0	0%	-	-

Note: All new purchases were assumed to have a useful life of five years per FTA Circular 9030.1D, Ch. VI, paragraph 4.a. NAT typically has two buses in service with a third classified as a spare. The spare, per this schedule, is kept for 10 years before replacement with the second oldest fleet vehicle. For example, in 2033, NAT will purchase a new BEB. Its 2028 bus will still be used in service and its 2023 bus will be used as a spare (2018 vehicle will be retired).
Source: WSP

5.2.4 ZEB RANGE REQUIREMENTS AND COSTS

NAT operates two blocks. The first block (weekday) is approximately 166 miles with a duration of 10 hours. The second block (Saturday) is approximately 97 miles with a duration of six hours. Depending on operational parameters, including operator behavior, ambient temperature, traffic, and ridership, these ranges may be unattainable or difficult to achieve on certain days. To reduce impacts to service, the city will need to consider a number of strategies to supplement onboard battery storage, including additional buses, mid-day charging, battery/charging management systems, and solar and battery storage. In future ZEB applications, NAT may also consider FCEBs, especially if battery technology doesn't advance as forecasted.

5.2.5 ZEB CONVERSIONS

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

5.3 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following sections detail the planned charging strategies, infrastructure, detailed garage improvements, and program schedule.

5.3.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. For that reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each facility. This is based on the number of existing vehicles plus a predetermined growth factor (or space at the garage). This provides the agency with a ceiling for what can be physically constructed and at what cost. Service changes and bus movements may happen multiple times a year. By establishing a full ZEB build out scenario, agencies can optimize, and tailor strategies based on existing (or anticipated) service for implementation.

The analysis of FCEBs is ongoing, however, a hydrogen storage footprint was established at each division where vehicles and space can support it. Further analysis (Master Plan and subsequent studies) will analyze alternatives of hydrogen delivery.

In the case of Needles, the full ZEB build scenario is presented for context. However, refinements and tailored strategies will be developed in the Master Plan and future implementation studies.

5.3.2 FACILITY MODIFICATIONS

NAT's transition to ZE technologies, namely, BEB, will require a number of modifications and changes to existing infrastructure and operations.

The proposed full facility ZEB layout is based on utilizing a 150-kW DC charging cabinet used in a 1:2 charging ratio (one DC charging cabinet energizes two separate plug-in cord dispensers). This charger to dispenser ratio would meet the requirements to charge NAT's fleet during the vehicles' servicing and dwell time on the site while minimizing the peak electrical demand.

Table 5-3 summarizes the modifications and schedule of the garage and the following sections detail the process of the transition from existing conditions to BEB-readiness.

Table 5-3. Needles Garage Summary

FACILITY	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADES REQ'D?	TIMELINE
NAT	1101 Front St. Needles, CA	Storage	Ground-Mounted Plug-In Charging	4 buses	Yes	2023-2028

Source: WSP
Note: Bus maintenance and fuel is conducted offsite

NEEDLES AREA TRANSIT GARAGE

EXISTING CONDITIONS

The NAT Garage is located at 1101 Front Street in the City of Needles. Electrical service is provided by the Needles Power Utility Authority, a municipal utility.

Currently, three diesel-powered cutaway buses are stored at the garage. Buses enter the driveway for both the garage and parking lot from Front Street and are stored in the three-bay garage for overnight parking. During extreme heat, bus drivers will leave their personal vehicles in the garage during operating hours to shelter vehicles from 120 °F heat. The garage is not equipped with HVAC, only lighting and three garage doors. General maintenance is currently performed off-site with the contract operator in Blythe, California, approximately 96 miles away.

Figure 5-3. NAT Garage - Existing Conditions

Source: Google Earth

Figure 5-4. NAT Garage – Existing Conditions

Source: WSP

PLANNED ZEB MODIFICATIONS

Based on Needles' existing service needs and site configuration, it is recommended that ground-mounted plug-in chargers be installed both internal and external to the NAT garage to support future BEBs.

Based on the recommended ground-mounted DC plug-in charging solution, the NAT garage is capable of parking four buses with two plug-in charging positions in a 1:2 charger to bus dispenser ratio.

Table 5-4 summarizes the ZEB infrastructure planned at NAT's facility.

Table 5-4. NAT ZEB Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY*
Needles	NAT	Ground-Mounted; Plug-In	2	4	150 kW	Off-Site Fueling

Source: WSP
Note: At this time, there are no current cutaway FCEBs on the market, however, if one is developed and Needles determines adoption is feasible, on-site fueling/storage is recommended.

The following BEB equipment and location is proposed:

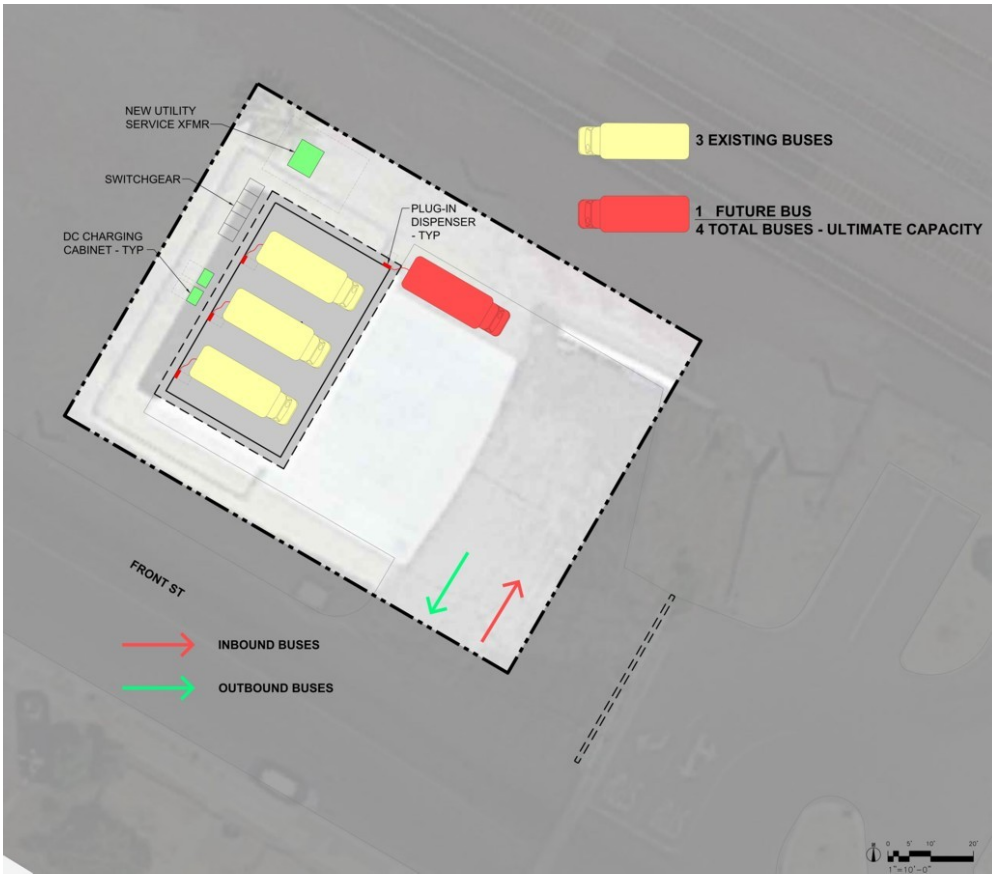
- Two charging cabinets along the western facility exterior and site boundary;
- Three plug-in dispenser-charging positions along the western facility interior wall;
- One plug-in dispenser-charging position on the northeastern existing facility exterior for charging.

The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

- One medium voltage utility service transformer along the northwestern facility exterior and site boundary.
- One switchgear service along the western facility exterior and site boundary.

Figure 5-5 illustrates the NAT Garage at full build-out.

Figure 5-5. NAT Garage – Full ZEB Build-Out



Source: WSP

5.3.3 PHASING AND CONSTRUCTION SCHEDULE

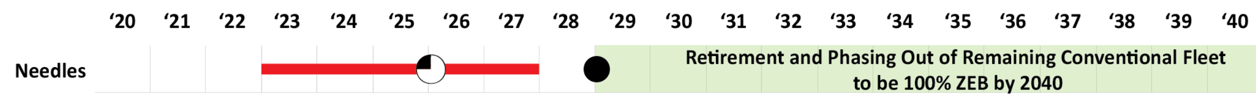
Adhering to the construction schedule and milestones will be critical because the facilities' construction must be completed before buses are delivered, otherwise, the buses will not be able to operate.

Additional electrical capacity will be required to meet the service needs of buses at the NAT garage. Construction and enhancements to bring this additional electrical capacity is anticipated to take three to five years. This timeframe would include method of service studies, design, and construction.

Construction for the NAT garage and its associated BEB charging equipment and support systems is assumed to be completed in one, six-month stage. The plan for the NAT garage is to install all the in-ground conduit to route electrical service to both charging cabinets with four plug-in dispensers mounted at the edge of the parking spaces in the existing building and on its exterior wall. These chargers and dispensers can be installed with aboveground electrical distribution routed along a cable way from the new electrical yard to the western exterior wall to meet the charging cabinets. From the charging cabinets, the electrical distribution can then penetrate the wall to the interior dispensers and route along the interior wall before penetrating the wall to the exterior dispenser.

Figure 5-6 presents the proposed construction schedule for NAT's transition to ZEBs. The Harvey Balls indicate the percentage of new buses that need to be ZEB pursuant to the ICT regulation.

Figure 5-6. Needles Construction Schedule



Source: WSP

5.4 DISADVANTAGED COMMUNITIES

Disadvantaged communities (DACs) refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The CalEPA and California's Senate Bill 535, define a "disadvantaged" community located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

CalEnviroScreen uses environmental, health, and socioeconomic data to measure 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, as lower score indicates fewer disadvantages.

The replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs.

5.4.1 NAT'S DISADVANTAGED COMMUNITY ANALYSIS

To understand ZEBs impacts on NAT's service area, it was pertinent to establish if: 1) its garage is in a DAC; and 2) if its routes traverse DACs.

At this time, the NAT garage is not in an area considered "disadvantaged". Its routes currently traverse two census tracts, both of which are not considered disadvantaged by the CalEnviroScreen tool.

Table 5-5 summarizes NAT's garages and census tracts serves in terms of DACs.

Table 5-5. NAT's Disadvantaged Communities

GARAGE	IN DAC?	NOX EXEMPT AREA?	COMMUNITIES SERVED	DAC'S SERVED	PCT. OF DACS SERVED
Needles Area Transit	No	No	2	0	0%

Source : CalEnviroScreen 3.0

5.5 WORKFORCE TRAINING

The following section provides an overview of Needles' plan and schedule to train personnel on the impending transition.

5.5.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter NAT's service and operations. Converting to ZEBs from diesel is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and NAT. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. NAT is assumed to procure its first BEBs in 2028 with an expected delivery shortly after. Therefore, it is expected that all personnel will be sufficiently trained before the buses arrive. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that NAT's staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, NAT's future procurements/deliveries will require refresher or updated trainings for relevant staff.

Safety training, however, will be provided on an annual or other recurring basis to ensure that staff is knowledgeable and maintains best and safe practices when operating, handling, or servicing BEB-supporting components or infrastructure.

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

— **Bus Operators**
  Bus operators will need to be familiarized with the buses, safety, bus operations, and BEB operations.

— **Facilities Maintenance Staff and Maintenance**
  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.

— **Body Repairers**
  Body repairers at the contracted operator will need to be familiarized with the safety-related features and other components of ZEBs.

— **Instructors**
  Maintenance 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**
  All Management will be familiarized with ZEB operations and safety procedures.

5.6 COSTS AND FUNDING

The following section identifies preliminary capital costs and potential funding sources that Needles may pursue in its adoption of ZEBs.

5.6.1 PRELIMINARY COSTS

For NAT, bus acquisitions are expected to cost between $164K to $298K per bus (depending on length) and plug-in chargers are assumed to cost $71K per charger, with an additional $8K for installation, and labor and permits, per charger. However, operating costs, utility costs, midlife overhauls, training, and soft costs that will all need to be considered in ZEB adoption. The total cost of ownership is further refined and explored in the Master Plan.

5.6.2 POTENTIAL FUNDING SOURCES

There are many potential federal, state, local, and project-specific funding and financing sources at Needles' disposal. Needles will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. The following table identifies the many funding opportunities that Needles may take advantage of in the next 20 years.[4]

Table 5-6. NAT ZEB Funding Opportunities

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
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		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		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
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	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	California Department of Transportation (Caltrans)	Low Carbon Transit Operations Program (LCTOP)
		Transportation Development Act
		Transit and Intercity Rail Capital Program
		Transportation Development Credits

4 It should be noted that some of these grants and programs have requirements based on population, service, and fleet size that NAT may be ineligible for.

TYPE	AGENCY	FUNDING MECHANISM
		New Employment Credit
Local and Project-Specific		Joint Development
		Parking Fees
		Tax Rebates and Reimbursements
		Enhanced Infrastructure Financing Districts
		Opportunity Zones

Source : WSP

5.7 START-UP AND SCALE-UP CHALLENGES

To comply with the ICT regulation's purchase and transition requirements, there are a variety of challenges and opportunities that NAT has identified. The following sections briefly describe some of the challenges that NAT faces for its transition.

- **Uncertainty of ZEB cutaways.** As discussed, there is a small market for ZEB cutaways. For the cutaways that do exist, there is uncertainty in their product range and whether they're Altoona-tested. Unfortunately, the cutaway market does not currently offer FCEBs, so NAT has no other alternative and will need to plan on BEB adoption.
- **Range issues.** NAT has some blocks that exceed current BEB range. This means that NAT will need to consider the following strategies to reduce or avoid service disruptions:
  - **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.
  - **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.
  - **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will need to consider the potential impacts to operator and maintenance costs.
- **Technological adaptation.** Currently, NAT is modeling and planning for a transition based on existing service and ZEB technology. With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. NAT (and the market) needs to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.
- **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. NAT will need to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.
- **Market Production Factors.** The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for agencies if supply of buses can meet with demand.

6 VICTOR VALLEY TRANSIT AUTHORITY

6.1 INTRODUCTION

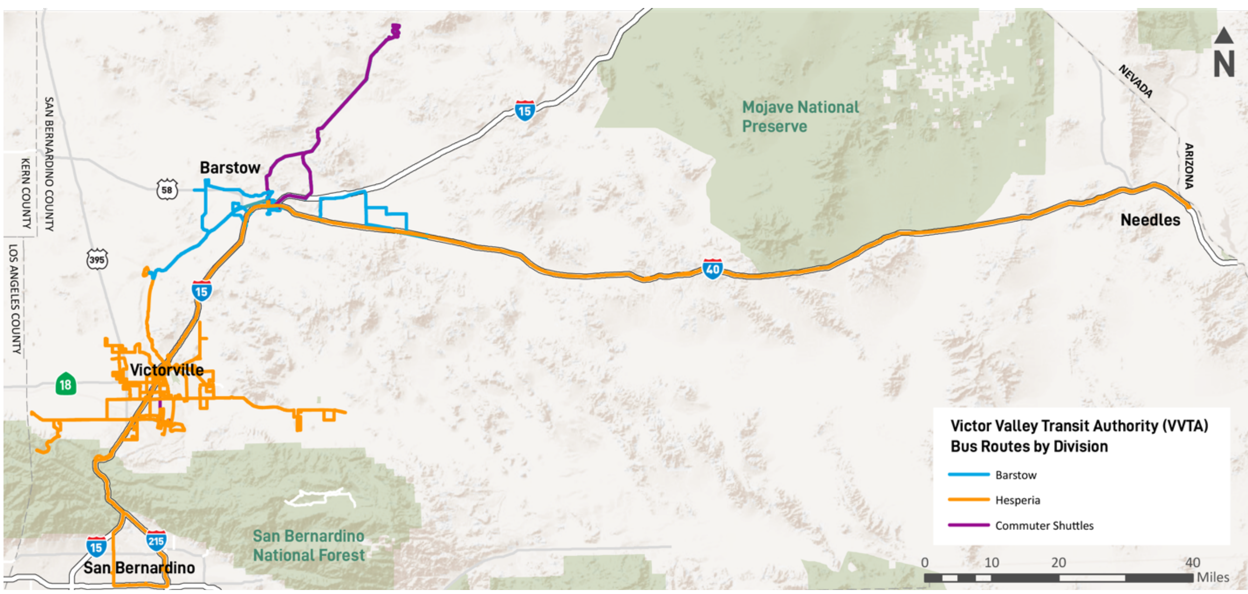
Victor Valley Transit Authority (VVTA) is a joint-powers authority established between San Bernardino County, the Town of Apple Valley, and the cities of Adelanto, Barstow, Hesperia, and Victorville.

6.1.1 SERVICE AREA

VVTA serves the four major cities and their surrounding areas in the high desert area. VVTA also operates transit service to and within the City of Barstow, a relatively isolated city of approximately 22,000, 30 miles northeast of Victorville and halfway between Los Angeles and Las Vegas.

VVTA's service area is large. While its legacy Victor Valley routes all serve cities that share borders, those cities are not densely developed, and the developed portions of the cities are separated, in some cases, by more than 20 miles. Barstow is relatively compact in its development, but it is isolated and smaller than the Victor Valley cities. Additionally, the VVTA operates a limited service route to the City of Needles approximately 175 miles east of Victorville, and a commuter service, NTC Commuter, to Fort Irwin's National Training Center (NTC).

Figure 6-1. VVTA Service Area



Source: WSP

6.1.2 ENVIRONMENTAL FACTORS

VVTA predominantly operates its services in the Mojave Desert, where summer high temperatures often reach 100 degrees while winter low temperatures often drop below freezing. The area experiences very little rainfall and snowfall. The service area itself is largely flat, but it sits in the high desert with elevations of approximately 3,000 feet in Victor Valley and 2,200 feet in Barstow. Elevation changes frequently across the mountainous desert terrain. These elevation changes will reduce the potential range of ZEBs serving these routes.

6.1.3 SCHEDULE AND OPERATIONS

VVTA operates 30 regular routes, eight commuter routes, and one special route across its service area.

VVTA's regular routes are:

— Adelanto: Routes 31, 32, and 33
— Apple Valley: Routes 23, 40, 41, 42, 43, and 47
— Barstow: Routes 1, 2, 3, 6, 28, and 29
— Hesperia/Oak Hills: Routes 24A, 24B, 66, and 68
— Victorville: Routes 15, 21P, 21W, 22, 50, 50X, 51, 52, 53, 54, and 55

All eight commuter routes serve Fort Irwin National Training Center (NTC), a major training area for the United States military in the Mojave Desert approximately 36 miles northeast of Barstow. Not all commuter routes are round-trips - trips inbound to NTC in the AM are designated "A" and return trips in the PM are designated "B." The routes originate from the following locations:

— Victorville: Routes 101A and 101B (Bear Valley Road)
— Hesperia: Routes 102, 103, 105 (L Street) and 107
— Helendale: Route 105
— Barstow: Route 106 (Williams park-and-ride)

Lastly, VVTA offers the intercity Route 200, the "Needles Link." Route 200 operates Friday-only service, a roundtrip of more than 350 miles, the route stops only at Needles G Street, the Barstow Library, the Victorville Transfer Point, and the Victorville Court House. VVTA began offering this service in 2016 to provide alternate transportation to the courts in Barstow and Victorville in the wake of state funding cuts to courts in Needles and Barstow. Needles residents can reserve a seat on Route 200 with curb-to-curb pick-up in advance.

VVTA's longest route is Route 200 to Needles at 513 miles for a round-trip. Even leaving aside this outlier, its other routes generally range from 92 to 352-miles round-trip for the Barstow routes and 84 to 393 miles round-trip in the Hesperia/Victor Valley routes.

6.2 FLEET AND ACQUISITIONS

The following section provides an overview of VVTA's existing fleet, planned purchases, and description of how VVTA will meet the requirements of the ICT regulation.

6.2.1 EXISTING BUS FLEET

VVTA directly operates 71 compressed natural gas (CNG)-powered buses for fixed-route service. Table 6-1 presents a summary of VVTA's existing bus fleet.

Table 6-1. Summary of VVTA's Existing Bus Fleet

MANUFACTURER	SERIES	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NUMBER OF BUSES
New Flyer	Excelsior	BEB	40'	2019	Standard	7
Ford	30-Passenger	CNG	33'	2015	Cutaway	3
Chevy	30-Passenger	CNG	33'	2015	Cutaway	1
Glaval	Entourage	CNG	33'	2012	Cutaway	1
El Dorado National	Aero Elite 320	CNG	32'	2013	Cutaway	2
	Aerolite 320	CNG	32'	2013	Cutaway	3
	Aerolite 320	CNG	32'	2015	Cutaway	1
	Aerotech	Unleaded	24'	2015	Cutaway	3
	Aerotech	Unleaded	24'	2017	Cutaway	1
	XHF	CNG	35'	2016	Standard	2
	XHF	CNG	35'	2018	Standard	2
	Axess	CNG	35'	2016	Standard	3
	Axess	CNG	35'	2018	Standard	2
	Axess	CNG	40'	2014	Standard	9
	Axess	CNG	40'	2015	Standard	1
	Axess	CNG	40'	2019	Standard	12
	40-LFW	CNG	40'	2008	Standard	7
		CNG	40'	2011	Standard	5
		CNG	40'	2014	Standard	1
MCI	D4500	CNG	45'	2015	Coach	5
					Total Buses	**71**

Source: Victor Valley Transit Authority, March 2020

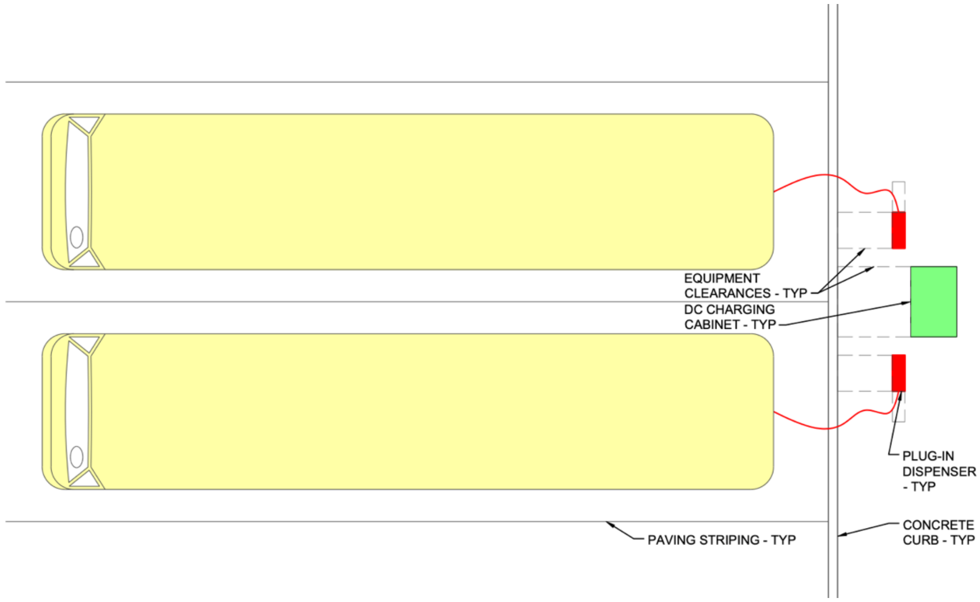
6.2.2 ZEB TECHNOLOGY APPLICATION

Past and ongoing ZEB analysis for VVTA's operations has determined that an adoption of both BEBs and (predominantly) FCEBs is the ZEB technology that best meets the needs of VVTA for their purchasing and transition requirements pursuant to the ICT regulation.

BATTERY-ELECTRIC BUS (BEB)

VVTA's future BEBs are expected to have specifications that are compatible with the Society of Automotive Engineers' (SAE) J1772 charging standard (e.g., "plug-in charging") (Figure 6-2). It is recommended that VVTA specify charging ports on the rear of BEBs to allow for their existing site circulation and parking patterns to continue without additional modifications. Battery sizing (kilowatts) will be determined based on service needs requirements and what is available and feasible based on costs and weight. Charger rating (kilowatt-hour) will be based on service needs, battery acceptance, and costs.

Figure 6-2. Ground-Mounted Plug-In Charger



Source: WSP
Note: This depicts a rear port scenario specification.

FUEL CELL ELECTRIC BUS (FCEB)

The majority of VVTA's service blocks extend beyond the current range capabilities of BEBs, for this reason, it is recommended that BEBs only serve blocks that operate less than 150 miles in a service period. For the remaining service blocks, FCEBs are recommended as the primary ZE technology. Serval methods of hydrogen fuel sourcing are available to VVTA, including delivery and on-site production. A phased investment in hydrogen infrastructure is recommended for VVTA, beginning with on-site liquid hydrogen storage delivered by a local supplier and graduating into on-site production via electrolysis.

6.2.3 EXISTING ZEB PROCUREMENTS AND PROJECTS

In November 2019, VVTA replaced seven of its CNG vehicles were replaced with BEBs (five 35-footers and two 40-footers). These buses are equipped with 466 kWh of battery capacity and are fueled by electrical power via ChargePoint CP-250 chargers (62.5 kW) at the Hesperia Yard.

There is also a new facility under construction in Barstow (expected completion in 2020) which will expand and enhance the existing Barstow site. The Barstow Yard (future) is designed to accept ChargePoint Power Blocks DC charging cabinets of 156+ kW. Although not commercially available at the time of this report, this technology is anticipated to be available in the near future. The charging equipment and electrical infrastructure will be installed in space between the existing CNG fueling site and the new bus parking yard.

It should also be noted that VVTA's newly acquired ZEBs will qualify for ZEB bonus credits as defined in the ICT regulation.

6.2.4 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, VVTA will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus is expected to be purchased in 2028. All new buses purchases are anticipated to be ZEB starting in 2029.

Early retirement should not be an issue pursuant to the ICT regulation based on VVTA's assumed procurement schedule. However, if it becomes one, VVTA will deploy several strategies to ensure that buses fulfill their "useful life". One potential strategy is to place newly acquired ZEBs on shorter (achievable) blocks and gradually move them to longer routes as technology advances and capabilities/limits are determined.

VVTA's existing fleet consists of 71 buses. Assuming a 1:1 replacement ratio, each existing bus will eventually be replaced with an equivalent length FCEB bus. VVTA owns and operates seven BEBs at the Hesperia Yard with plans to acquire an additional five BEBs for the Barstow Yard. The current strategy is to use BEBs to serve blocks with less than 150 miles and utilize FCEBs for longer distance blocks. The number of ZEBs required may increase with time based on service requirements.

Table 6-2 presents a summary of VVTA's anticipated bus procurements through 2040. Years 2026 and 2029 are highlighted because these indicate when VVTA's new purchases should be 25 percent and 100 percent ZEBs, respectively.

Table 6-2. Summary of VVTA's Future Bus Purchases (through 2040)

		ZERO-EMISSION BUSES				CONVENTIONAL (CNG) BUSES			
YEAR	TOTAL BUSES	NUMBER	PCT.	BUS TYPE	FUEL TYPE	NUMBER	PCT.	BUS TYPE	FUEL TYPE
2020	**0**	0	0%	-	-	0	0%	-	-
2021	**5**	5	100%	Standard	BEB	0	0%	-	-
2022	**7**	0	0%	-	-	7	100%	Standard	CNG
2023	**0**	0	0%	-	-	0	0%	-	-
2024	**0**	0	0%	-	-	0	0%	-	-
2025	**5**	0	0%	-	-	5	100%	Standard	CNG
2026	**0**	0	0%	-	-	0	0%	-	-
2027	**0**	0	0%	-	-	0	0%	-	-
2028	**10**	3	30%	Standard	FCEB	7	70%	Standard	CNG
2029	**1**	1	100%	Standard	FCEB	0	0%	-	-
2030	**10**	10	100%	Standard/ Coach	FCEB	0	0%	-	-
2031	**7**	7	100%	Standard	FCEB	0	0%	-	-
2032	**16**	16	100%	Standard	FCEB	0	0%	-	-
2033	**0**	0	0%	-	-	0	0%	-	-
2034	**7**	7	100%	Standard	FCEB	0	0%	-	-
2035	**0**	0	0%	-	-	0	0%	-	-
2036	**0**	0	0%	-	-	0	0%	-	-
2037	**5**	5	100%	Standard	BEB/FCEB	0	0%	-	-
2038	**0**	0	0%	-	-	0	0%	-	-
2039	**0**	0	0%	-	-	0	0%	-	-
2040	**10**	10	100%	Standard	FCEB	0	0%	-	-

Source: WSP
Note: All new purchases were assumed to have a useful life based on VVTA's existing procurement cycle, however, this may vary and be adjusted based on warranties and changes in technology.
-In 2037, VVTA will need to replace their BEBs that were purchased in 2021, based on VVTA's needs, these will be replaced with BEBs or FCEBs
-VVTA's existing fixed-route cutaway fleet is excluded from their planned procurement schedule (pursuant to the ICT regulation) because these vehicles are expected to be replaced with vehicles that have less than a 14,000 GVWR.

6.2.5 ZEB RANGE REQUIREMENTS AND COSTS

VVTA has the longest distance blocks among all five operators, by both average and maximum. VVTA operates 64 weekday blocks, of which, 54 are longer than 100 miles. Its longest two blocks belong to Route 23 (525 miles), which serves Apple Valley. In all, VVTA has five blocks of greater than 400 miles, and all 10 of its longest blocks are greater than 350 miles. Depending on operational parameters, including operator behavior, ambient temperature, traffic, and ridership, these ranges may be unattainable or difficult to achieve on certain days. To reduce impacts to service, VVTA will consider several strategies to extend FCEB range including mid-day refueling and additional fleet vehicle. Full-service scheduling should be conducted in the next phase of ZE planning to determine specific service changes and fleet requirements.

6.2.6 ZEB CONVERSIONS

Conventional bus conversions to ZEB technologies are not currently being considered at this time for VVTA. However, VVTA will remain open to conversions if they are deemed financially feasible and align with goals ZEB adoption.

6.3 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following sections detail the planned charging strategies, infrastructure, detailed base improvements, and program schedule.

6.3.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. For that reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each facility. This provides the agency with a ceiling for what can physically be constructed and at what cost. Service changes and bus movements may happen multiple times a year, for some agencies. By establishing a full-build scenario, agencies can optimize, and tailor strategies based on existing (or anticipated) service for implementation.

A hydrogen storage footprint was established at each division to determine the feasibility of on-site storage at the scale necessary for the planned fleet conversion. This footprint is based on spatial requirements for large-scale liquid hydrogen storage in addition to considerations to national safety codes. Further analysis (Master Plan and subsequent studies) will analyze alternatives of hydrogen delivery.

In the case of VVTA, the full build scenario is presented for context. However, refinements and tailored strategies will be developed in future implementation studies.

6.3.2 FACILITY MODIFICATIONS

VVTA's transition to ZE technologies will require various modifications and changes to existing infrastructure and operations. With plans for a mixed fleet conversion, facility modifications to support both FCEBs and BEBs will be necessary. The incorporation of FCEBs will require investments in storage tanks, hydrogen pumps, vaporizers, and dispensers. Future BEBs at Hesperia Yard may require enhancements and expansions of electrical equipment, additional electrical capacity, and the installation of chargers, dispensers, and other components.

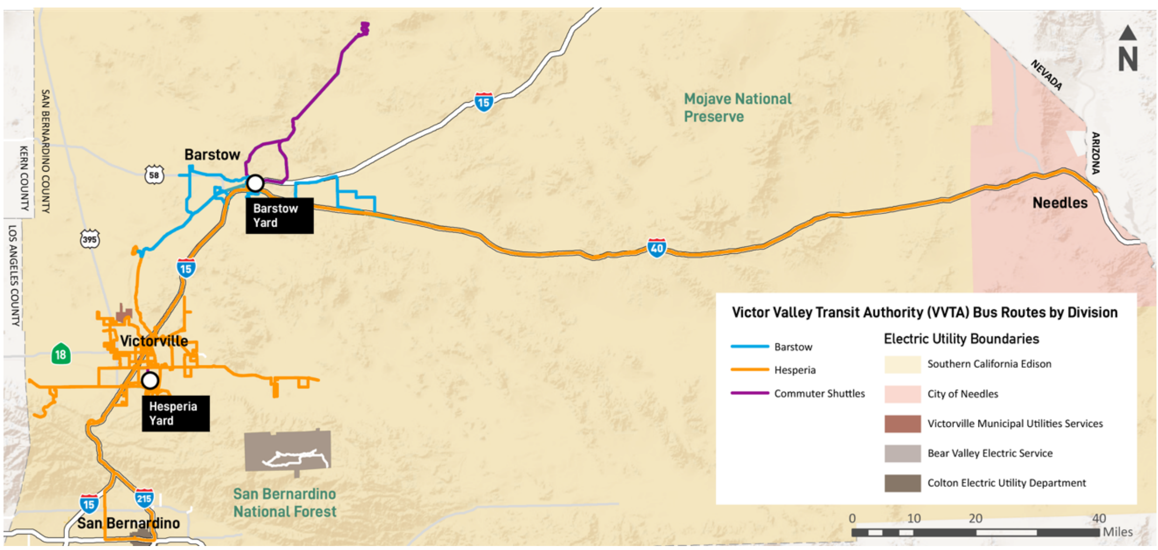
During the transition away from CNG, acute attention to the spatial requirements and safety restrictions of hydrogen equipment will be essential. Currently, safety regulation offsets prohibit the introduction of hydrogen at the Hesperia

Yard. The recommendations for hydrogen infrastructure are provided in the event VVTA identifies a suitable off-site fueling location for the Hesperia Yard. Equipment placement at Hesperia Yard is provided in the sections below, however, as local regulation takes precedence in hydrogen safety compliance, it is recommended that VVTA engage in early and frequent conversations with local fire officials before entering the next phase of planning.

Based on VVTA's existing service needs and site configurations, 15,000-gallon liquid hydrogen storage tanks are recommended to support the full-scale conversion, requiring a minimum footprint of 40-feet by 50-feet plus safety offsets. The complete phasing of hydrogen equipment is outlined below. To support the BEB fleet, VVTA plans to install ground-mounted plug-in chargers at the future Barstow Yard. The proposed facility layout is based on utilizing a 150-kW DC charging cabinet used in a 1:2 charging ratio (one DC charging cabinet energizes two separate plug-in cord dispensers). This charger to dispenser ratio would meet the requirements to charge VVTA's fleet during the vehicles' servicing and dwell time on the site while minimizing the peak electrical demand.

Figure 6-3 illustrates the location of VVTA's yards and Table 6-3 summarizes the modifications and schedule of each base and the following sections detail the process of each base's transition from existing conditions to BEB-readiness.

Figure 6-3. VVTA's Yard Locations



Source: WSP

Table 6-3. VVTA's Yard Summary

YARD	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADES REQ'D?	TIMELINE
Hesperia	171510 Smoke Tree St. Hesperia, CA	Fueling, Storage, and Maintenance	None	N/A	No	N/A
Barstow	2641 W. Main St. Barstow, CA	Fueling and Storage	Plug-In Charging to support 5 buses; On-Site Storage for FCEB	15 buses	Yes	2023-2028

Source: WSP

HESPERIA YARD

EXISTING CONDITIONS

Hesperia Yard is located at 171510 Smoke Tree Street in the City of Hesperia. Electrical service is provided by SCE.

Currently, 49 CNG-powered buses and seven BEBs are stored, maintained, fueled, and serviced at the yard. Hesperia Yard includes the following separate structures and major site areas: a two-story maintenance building, two-story transportation building, stand-alone wash building, stand-alone fuel building, employee parking lots, photovoltaic canopy-coverings in the bus parking and employee parking areas, and a CNG compressor with support equipment. Employee parking is on site in the employee parking lots along Smoke Tree Street.

Buses enter from Smoke Tree Street and park facing south in the yard before undergoing service. Individual buses are then taken by VVTA nightly service staff to the fuel lanes for fare retrieval and fueling before pulling forward to the bus wash lanes. The interiors of the buses are cleaned during the fueling process. After fuel and wash, buses are circulated back into the bus parking tracks and re-parked nose-to-tail in vertical tracks facing north under the bus parking canopy.

Bus parking tracks are located primarily under the photovoltaic solar canopy and are two-deep for 40-foot buses. ChargePoint Express 250 chargers are present in the first three rows along the western edge of the northern bus parking canopy. All bus parking tracks are approximately 12-foot wide and buses are not assigned to specific spaces outside of the BEBs being parked in the charger-equipped rows. The initial BEB transformer and utility equipment is present in the circulation space between the northern site wall and bus parking canopy.

Figure 6-4. Hesperia Yard - Existing Conditions

Source: Google Earth

Figure 6-5. Hesperia Yard's Maintenance Bays

Source: WSP

Figure 6-6. Hesperia Yard's ChargePoint Chargers and BEBs

Source: WSP

PLANNED ZEB MODIFICATIONS

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

Table 6-4. Hesperia Yard Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY
VVTA	Hesperia Yard	-	-	-	-	Off-site liquid storage via delivery

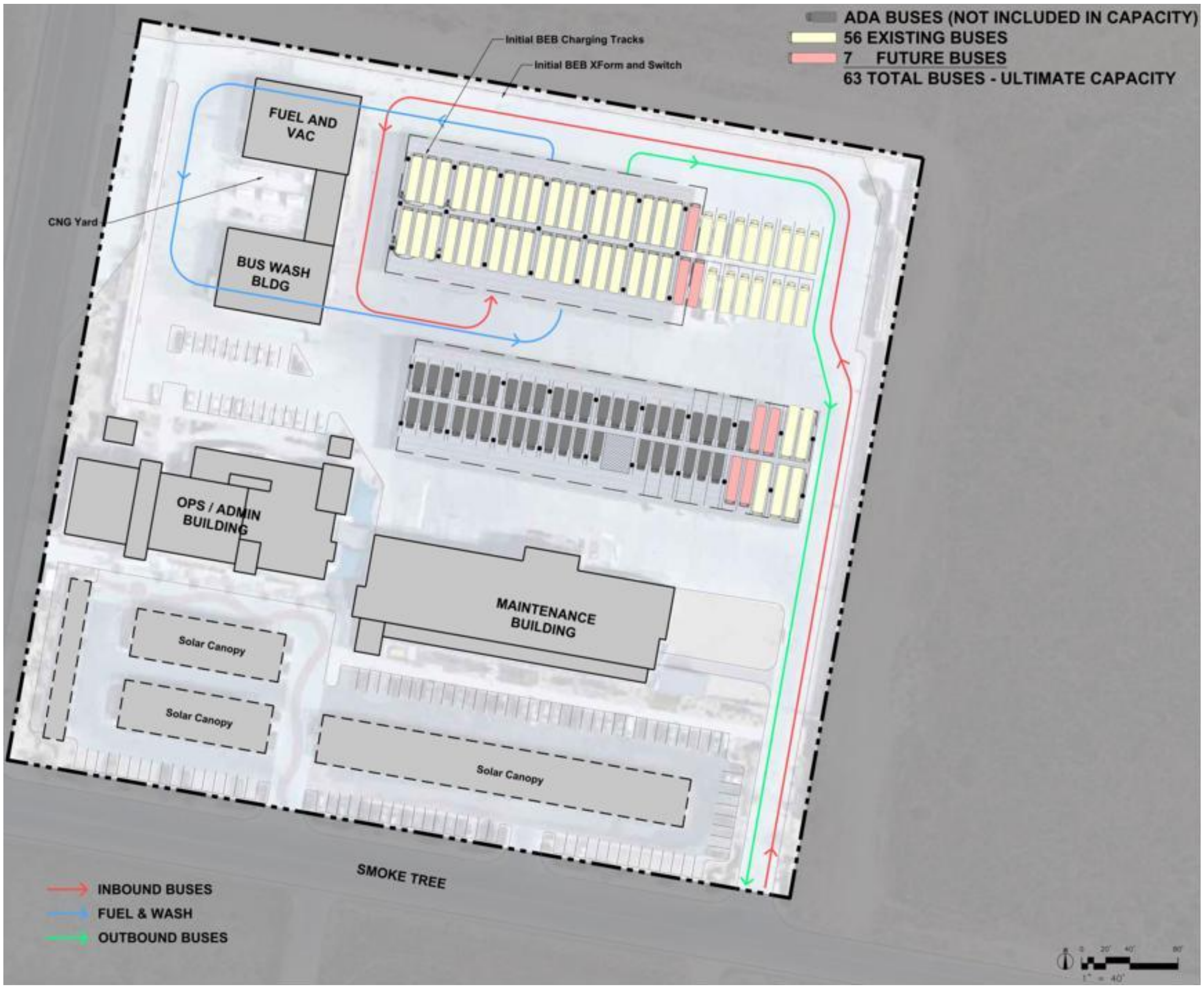
Source: WSP
Note: No additional BEB infrastructure is proposed.

Currently, the site design at Hesperia Yard does not support the spatial requirements for hydrogen infrastructure. According to the NFPA 55 (Table 11.3.2.2), all air intakes (heating, ventilating, or air-conditioning equipment (HVAC), compressors, other) must be located at least 75-feet from liquid hydrogen storage containers. This cannot currently be achieved at the Hesperia site without displacing large amounts of vehicle parking or reconfiguring all the on-site buildings. It is recommended that VVTA identify a nearby site to host hydrogen fueling to avoid significant infrastructural modifications on-site. Under this assumption, the following FCEB equipment is proposed for the off-site fueling location:

- One 15,000-gallon liquid hydrogen storage tank
- One liquid pumping system
- One no-fog vaporization system
- Boil-off gas compressor
- Three hydrogen dispensers located on a dispenser island fueling pad
- Electric capabilities of 480 VAC, 3 phases, 60HZ, 300-350 KW
- H2 & flame detection
- Emergency shut-off buttons
- Additional pump and dispenser for redundancy (optional)

Figure 5-5 illustrates the Hesperia Yard at full build-out.

Figure 6-7. Hesperia Yard – Full ZEB Build-Out



Source: WSP

BARSTOW YARD

EXISTING CONDITIONS

The Barstow Yard is currently in the early stages of construction (unrelated to the ICT regulation) at 2641 W. Main St.in the City of Barstow with an expected completion date in Spring 2020. The site's electrical service is provided by Southern California Edison (SCE).

The Barstow Yard will include the following separate structures and major site areas: a two-story combined maintenance and transportation building, stand-alone wash canopy, the existing CNG fueling site, employee parking lots, photovoltaic canopy-coverings in the bus parking and employee parking areas, and the existing CNG compressor with support equipment. Employee parking is on site in the employee parking lots along Main Street.

Buses will enter from Sandstone Court and park facing southwest, two at a time, before undergoing service. Individual buses will be taken by VVTA nightly service staff to the existing fuel area adjacent to the site for fueling before reentering the site and entering the bus wash lanes. After fuel and wash, buses will be circulated back into the bus parking tracks and re-parked in the parking tracks. The interiors of the buses will be cleaned during the fueling process.

The new maintenance facility will be capable of accommodating FCEBs and BEBs. High-voltage welding outlets can be utilized for mobile plug-in chargers as required to energize buses in maintenance bays. The existing CNG fueling station will remain on the site upon completion of the new yard.

Figure 6-8. Barstow Yard - Existing Conditions

Source: Google Earth

Figure 6-9. Barstow Yard Existing CNG Facilities

Source: WSP

PLANNED ZEB MODIFICATIONS

Table 6-5 summarizes the ZEB infrastructure planned at the Barstow Yard

Table 6-5. Barstow Yard Supporting Infrastructure Summary

AGENCY	FACILITY	CHARGING STRATEGY	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING	FCEB STRATEGY
VVTA	Barstow Yard	Ground-Mounted; Plug-In	3	5	150 kW	On-site liquid storage via delivery

Source: WSP

Based on the planned FCEB fleet at the future Barstow Yard, approximately 400 kg of hydrogen will be required to serve the site. This is a reasonable quantity for on-site production via electrolysis and steam-methane reformation, however, it is recommended that VVTA begin hydrogen phasing with liquid hydrogen delivered to the site by tank truck and stored on-site. Hydrogen fueling is recommended to be located adjacent to the existing CNG and liquefied natural gas (LNG) fueling currently present on the site. The following infrastructural upgrades are recommended at the future Barstow Yard:

- One liquid hydrogen storage tank (tank size may be negotiated with the supplier, VVTA may likely benefit from using a larger storage tank to reduce delivery costs and prevent losses during filling)
- One liquid pumping system
- One no-fog vaporization system
- Two hydrogen dispensers located on a dispenser island fueling pad
- Electric capabilities of 480 VAC, 3 phases, 60HZ, 300-350 KW
- H2 & flame detection
- Emergency shut-off buttons
- *Optional additional pump and dispenser for redundancy
- * Optional fire barrier between CNG and hydrogen storage to reduce footprint

VVTA has plans on procuring an additional five BEBs. If using the recommended ground-mounted DC plug-in charging solution, the Barstow Yard will be capable of parking five buses with five plug-in charging positions in a 1:2 charger to bus dispenser ratio.

The following BEB equipment and locations are suggested:

— Three charging cabinets on the southern side of the southern grouping of bus parking spaces with five plug-in dispenser-charging positions distributed every two tracks in the parking spaces.

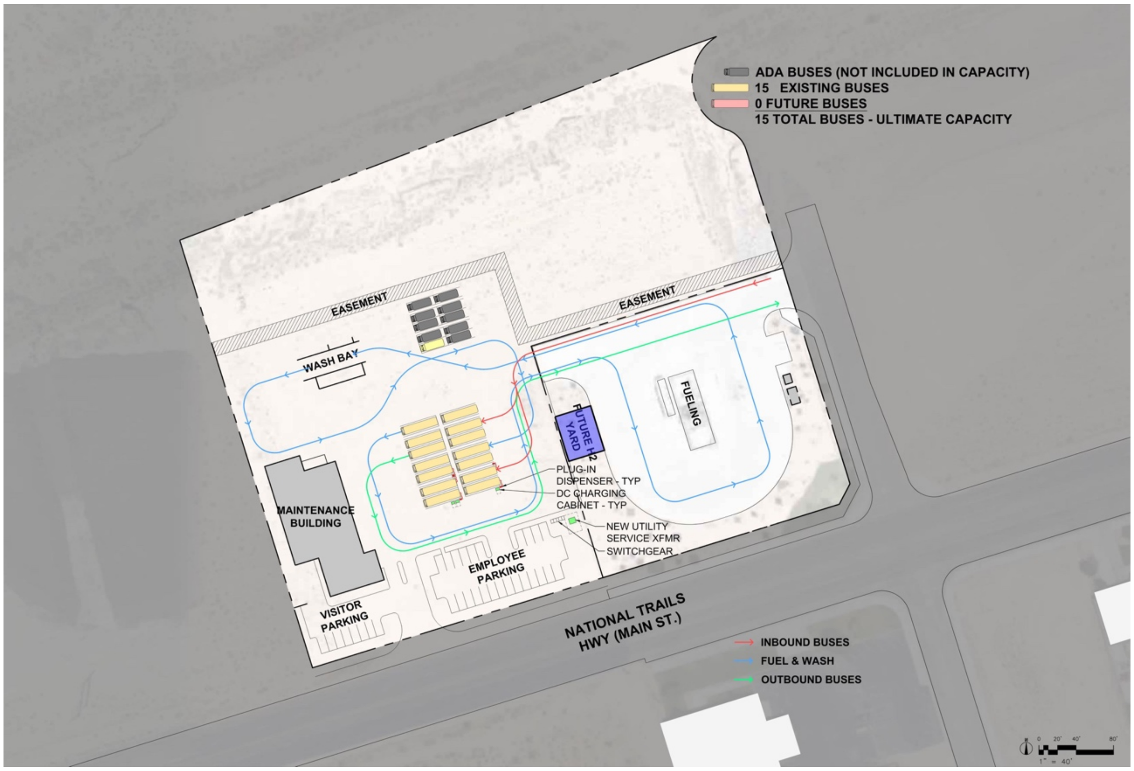
The plug-in charging dispensers and charging cabinets will be served by the following electrical infrastructure:

— One medium voltage utility service transformer in a new utility yard in the open space east of the employee parking lot and west of the CNG fueling circulation area.

— One switchgear in a new utility yard in the open space east of the employee parking lot and west of the CNG fueling circulation area.

Figure 6-10 illustrates the Barstow Yard at full build-out.

Figure 6-10. Barstow Yard – Full ZEB Build-Out



Source: WSP

6.3.3 PHASING AND CONSTRUCTION SCHEDULE

Adhering to the construction schedule and milestones will be critical because the facilities' construction must be completed before buses are delivered, otherwise, the buses will not be able to operate. To accomplish this, construction for FCEB and BEB-supporting infrastructure is expected to be done in phases to minimize disruption of operations. No enhancements are expected at Hesperia Yard since buses are expected to be fueled offsite (not feasible onsite), however, Barstow Yard is anticipated to be constructed in two phases.

Additional electrical capacity may be required to meet the service needs of buses at the future Barstow Yard. Construction and enhancements to bring this additional electrical capacity is anticipated to take three to five years based on electrical utilities' (conservative) protocol. This timeframe would include method of service studies, design, and construction. It is recommended that electrical infrastructure such as transformers and switchgears be installed with the initial phase at Barstow Yard to avoid the disruption of ongoing operations.

The following provides details on recommended phasing for Barstow Yard.

BARSTOW YARD

PHASE 1

WSP recommends completing all infrastructural upgrades (concrete pads, fire barriers, etc.) on the site during the initial construction to avoid having to interrupt services once they begin at the future Barstow Yard. The first step in Phase 1 will include the introduction of BEB infrastructure including three charging cabinets to serve five island-mounted plug-in dispensers in the southern parking spaces.

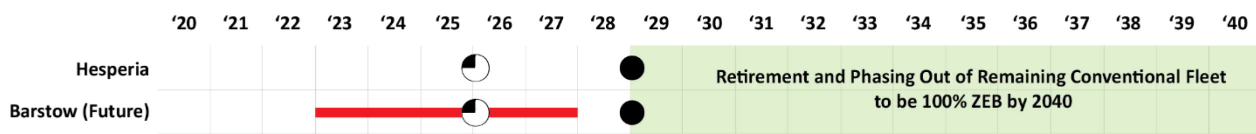
Following BEB upgrades, VVTA may begin the first phase of hydrogen implementation. This will include installation of foundational hydrogen fueling station equipment with a single dispenser and right-sized tank. During the transition from CNG to hydrogen, VVTA may elect to place a fire barrier between the CNG and liquid hydrogen storage to reduce safety offsets from 75 feet to zero feet in accordance with NFPA 55.

PHASE 2

Phase 2 at the future Barstow Yard would include an upgrade of the liquid hydrogen storage tank and an additional dispenser at the fueling yard.

Figure 6-11 presents the proposed construction schedule for VVTA's transition to ZEBs. The Harvey Balls indicate the percentage of new buses that need to be ZEB.

Figure 6-11. VVTA Construction Schedule



Note: WSP

6.4 DISADVANTAGED COMMUNITIES

Disadvantaged communities (DACs) refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The CalEPA and California's Senate Bill 535, define a "disadvantaged" community as a community located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

CalEnviroScreen uses environmental, health, and socioeconomic data to measure 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, as lower score indicates fewer disadvantages.

The replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs.

6.4.1 VVTA'S DISADVANTAGED COMMUNITY ANALYSIS

To understand ZEBs impacts on VVTA's service area, it was pertinent to establish if 1) its garage is in a DAC, and 2) if its routes traverse DACs.

At this time, both the Hesperia Yard and the future Barstow Yard are located in areas considered "disadvantaged". Both yards also serve routes that traverse DACs. Hesperia Yard serves 95 communities, 37 of which (39 percent), are considered disadvantaged. Whereas, Barstow Yard serves 12 communities, five of which (42 percent), are considered disadvantaged.

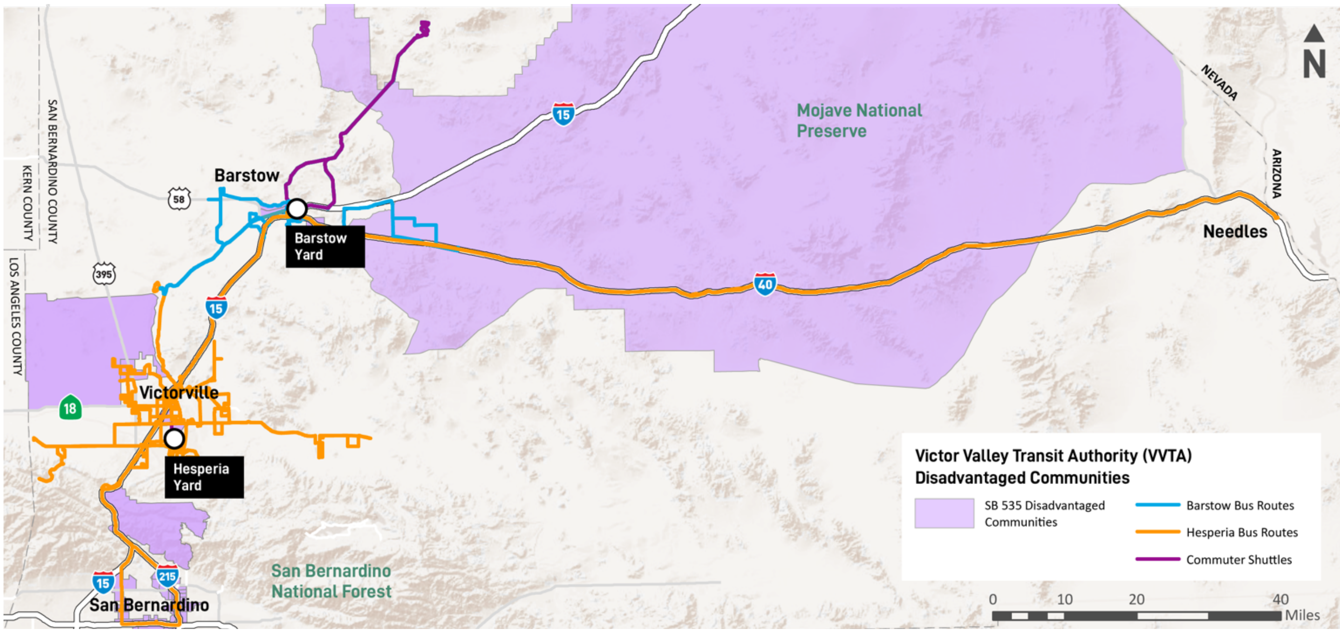
Table 6-6 summarizes VVTA's yards and census tracts served in terms of DACs.

Figure 6-12 illustrates VVTA's yards and the census tracts that they serve.

Table 6-6. VVTA's Disadvantaged Communities

BASE	IN DAC?	NOX EXEMPT AREA?	COMMUNITIES SERVED	DAC'S SERVED	PCT. OF DACS SERVED
Hesperia	Yes	No	95	37	39%
Barstow	Yes	No	12	5	42%

Figure 6-12. VVTA's Disadvantaged Communities



Source: CalEnviroScreen 3.0

6.5 WORKFORCE TRAINING

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

6.5.1 TRAINING REQUIREMENTS

The transition to all ZEBs will significantly alter VVTA's service and operations. Converting to ZEBs from CNG is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and VVTA. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. VVTA currently has seven BEBs in service, therefore, many of its personnel now have experience with working with BEBs. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that VVTA's staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, VVTA's future procurements/deliveries will require refresher or updated trainings for relevant staff.

Safety training, however, will be provided on an annual or other recurring basis to ensure that staff is knowledgeable and maintains best and safe practices when operating, handling, or servicing BEB-supporting components or infrastructure.

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

— **Bus Operators**
  Bus operators will need to be familiarized with the buses, safety, and bus operations.

— **Facilities Maintenance Staff and 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.

— **Body Repairers**
  Body repairers at the contracted operator will need to be familiarized with the safety-related features and other components of ZEBs.

— **Instructors**
  Maintenance instructors will need to understand all aspects of the transition of ZEBs to train others. This training is expected to be provided by OEMs.

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

— **Management Staff**
  All Management will be familiarized with ZEB operations and safety procedures.

— **Surrounding Community**
  Community engagement prior to FCEB implementation may reduce the risk of technology rejection.

6.6 COSTS AND FUNDING

The following section identifies preliminary capital costs and potential funding sources that VVTA may pursue in its adoption of ZEBs.

6.6.1 PRELIMINARY COSTS

For VVTA, BEBs acquisitions are expected to cost approximately $907K per bus (based on VVTA’s existing BEBs) and plug-in chargers are assumed to cost approximately $62K per charger, including warranty software, and support (based on VVTA’s recent acquisitions). An additional $8K is anticipated for installation, and labor and permits, per charger. FCEBs are anticipated to cost between $1M and $1.5M, depending on length. If VVTA opts for liquid storage (delivery), it will cost between $2M and $3M for equipment, depending on size and agreement type. Operating costs, utility costs, midlife overhauls, training, and soft costs that will all need to be considered in ZEB adoption. The total cost of ownership is further refined and explored in the Master Plan.

6.6.2 POTENTIAL FUNDING SOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at VVTA disposal. VVTA will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. The following table identifies the many funding opportunities that VVTA may take advantage of in the next 20 years.[5]

Table 6-7. ZEB Funding Opportunities

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
	Federal Transportation Administration (FTA)	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		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
	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	California Department of Transportation (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

Source: WSP, February 2020

5 It should be noted that some of these grants and programs have requirements based on population, service, and fleet size that VVTA may be ineligible for.

6.7 START-UP AND SCALE-UP CHALLENGES

To comply with the ICT regulation's purchase and transition requirements, there are various challenges and opportunities that VVTA has identified. The following sections briefly describe some of the challenges that VVTA faces for its transition.

— **Range issues.** The majority of VVTA's blocks exceed current BEB range. This means that VVTA will need to consider the following strategies to reduce or avoid service disruptions:

  — **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.

  — **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.

  — **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will to need to consider the potential impacts to operator and maintenance costs.

— **Technological adaptation (FCEB, BEB, or both?).** Currently, VVTA is modeling and planning for a transition to majority FCEBs based on existing service and ZEB technology. With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries, chargers, and advancements in hydrogen production. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. VVTA (and the market) needs to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.

— **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. VVTA will need to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.

— **Market Production Factors.** The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for agencies if supply of buses can meet with demand.

7 NEXT STEPS

As mentioned, the process to transition to ZEBs should and will be iterative to minimize risk, but also to accommodate new developments in a rapidly evolving market. The transit agencies will use the information outlined in both the Rollout Plan and the Master Plan to identify and further refine the following:

— **BEB and/or FCEB fleet mix at each agency.** Both the Rollout Plan and the Master Plan address each agencies' specific needs and policy choices, as well as making determinations about what is feasible for each. VVTA has made it clear that it is very interested in FCEBs, for example, due to concerns about range and length of its service blocks and its own experience with ZEB implementation to date. The recommendations contained herein address what WSP's team believes is the most feasible and cost-effective means of implementing the mix of ZEB types at each agency. However, all agencies will need to re-address these issues and determine whether these recommendations regarding feasibility based on costs, service requirements, and availability have changed as each agency implements its transition toward ZEBs.

— **Addressing incomplete service blocks.** The WSP team's analysis has revealed that many blocks cannot be completed when considering BEBs and FCEBs; meaning, agencies will need to determine whether they're going to file exemptions, purchase additional buses, restructure service to suit technological limitations, or invest in opportunity charging. These choices are rooted in each agency's own policies and plans outside of ZEB considerations.

— **Costs.** Construction, capital, operating, and maintenance costs vary based on a variety of factors. It will be important to get an understanding of the up-front costs and lifecycle costs and savings of investing in ZEBs. WSP's team has developed such cost estimates and each agency will need to revisit these estimates to determine if pricing has changed and make implementation changes, such as changes in their purchasing schedules, accordingly.

— **Collaboration opportunities.** Whether purchasing equipment via CalACT or strategizing on a joint agreement for opportunity charging, agencies can continue to maximize their outcomes by engaging with other regional and local agencies. It important for all agencies to continue to participate in groups such as the Zero Emission Bus Resource Alliance (ZEBRA) working group, California Transit Association (CTA) and the state's chapter of the Association for Commuter Transportation (ACT), the American Public Transportation Association's (APTA) Bus Technology Committee and other industry working groups.

— **Explore pilot projects.** Investing or committing to either FCEBs or BEBs is a difficult decision. Since these technologies are still rapidly evolving, it is pertinent for agencies to understand how they will *actually* operate (outside of modeling or forecasts). Agencies should begin to explore opportunities to partner with OEMs or peer agencies to procure or temporarily use pilot buses to validate assumptions or inform future purchases.

— **ICT regulation compliance and subsequent implementation.** The agencies presented in this Rollout Plan have the option to submit a plan by July 1, 2023. It is recommended that they do so in order to monitor technology trends, market availability of new buses such as cutaways with ZE propulsion expected to come into the bus market, fuel and electricity pricing trends and the impact of contemplated service changes on these agencies' ZEB Rollout Plans. Should the agencies elect to file a Countywide Rollout Plan (as a Joint Group), they need to file their intent with CARB no later than July 1, 2022, which satisfies the one-year notice requirement of the ICT Rule in time for submittal by the July 1, 2023 date for the smaller operators. At that time, it can also notify CARB if Omnitrans will join the Joint Group.

Moreover, as with any major capital plan and infrastructure program, it is important to note that as steps to implement the Rollout Plan and Master Plan, this analysis is only the beginning. Much more will be required as each agency procures buses and engages firms to design and build the needed infrastructure, and to ensure these steps remain the most cost-effective options with respect to their impacts on service operation and maintenance. Finally, while the team listed a variety of funding sources, each agency must tailor its grant funding applications based on its own needs and resources.

While the Rollout Plan and Master Plan documents have such limitations, represent more than a snapshot it time, however. Rather, they are "future-proofed" as much as possible based on the team's knowledge of technology and cost trends to date. Moreover, they are intended to be guides on how best to implement a ZEB transition. It thus remains up to each agency to decide how best to use these recommendations.

APPENDIX A: OMNITRANS ROLLOUT PLAN

OMNITRANS

ZERO-EMISSION BUS ROLLOUT PLAN

WSP USA Inc.

862 E. Hospitality Lane, Suite 350
San Bernardino, CA 92408
wsp.com

April 8, 2020

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1 ROLLOUT PLAN SUMMARY

AGENCY BACKGROUND

Transit Agency's Name	Omnitrans
Mailing Address	1700 W. Fifth Street San Bernardino, CA 92411
Transit Agency's Air District	South Coast Air Quality Management District
Transit Agency's Air Basin	South Coast Air Basin
Total number of buses in Annual Maximum Service[1]	135
Urbanized Area	Riverside – San Bernardino
Population of Urbanized Area[2]	1,932,666
Contact information of general manager, chief operating officer, or equivalent	Erin Rogers General Manager 909.379.7100 Erin.rogers@omnitrans.org
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 approval date	05/06/20
Resolution No.	321-2020
Is copy of Board-approved resolution attached to the Rollout Plan?	Yes (Appendix A)
Contact for Rollout Plan follow-up questions	Connie Raya Director of Maintenance 909.379.7183 Connie.raya@omnitrans.org
Who created the Rollout Plan?	Consultant
Consultant	WSP

[1] The ICT regulation defines "Annual Maximum Service" (13 CCR § 2023(b)(3)) as the number of buses in revenue service that are operated during the peak season of the year, on the week and day that maximum service is provided but excludes demand response buses.
[2] As last published by the Census Bureau before December 31, 2017
[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 EXECUTIVE SUMMARY

2.1 INTRODUCTION

In accordance with the California Air Resource Board's Innovative Clean Transportation regulation, the following report serves as Omnitrans' Rollout Plan to transition its bus fleet to 100 percent zero-emission (ZE) by 2040.

2.2 BACKGROUND

2.2.1 CALIFORNIA AIR RESOURCE BOARD'S INNOVATIVE CLEAN TRANSPORTATION REGULATION

The California Air Resource Board's (CARB) Innovative Clean Transportation (ICT) regulation requires all public transit agencies in the State of California to transition from conventional buses (compressed natural gas, diesel, etc.) to zero-emission buses (battery-electric or fuel cell electric) by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be zero-emission buses (ZEBs) based on their fleet size. By 2040, CARB expects all transit agencies in the state to be operating only ZEBs.

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 ("Joint Group"), to submit a ZEB Rollout Plan ("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 a number of required components (as outlined in the Rollout Plan Guidelines) and must be approved by the transit agency's governing body through the adoption of a resolution, prior to submission to CARB.

Omnitrans must comply with the following requirements under the ICT regulation[4]:

— **July 1, 2020 –** Board-approved Rollout Plan must be submitted to CARB

— **January 1, 2023 –** 25 percent of all new bus purchases must be ZE

— **January 1, 2026 –** 50 percent of all new bus purchases must be ZE

— **January 1, 2029 –** 100 percent of all new bus purchases must be ZE

— **January 1, 2040 –** 100 percent of fleet must be ZE

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

2.2.2 ZERO-EMISSION BUS TECHNOLOGIES

According to the ICT regulation, a ZEB is a bus with zero tailpipe emissions and is either a battery-electric bus (BEB) or a fuel cell electric bus (FCEB).

BEBs depend on a system to store and retrieve energy much as cars and trucks need fuel. BEBs have multiple battery packs that power an electric motor, resulting in ZE. BEBs, similar to many other battery-powered products,

4 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 it operates outside of these areas, but in an urbanized areas with a population of at least 200,000 and has at least 100 buses in annual maximum service. A "Small Transit Agency" is an agency that doesn't meet the above criteria. Each class of transit agency has its own purchase requirements.

must be charged for a period of time to be operational. Currently, BEBs can be charged at the facility, on the route (opportunity charging) and via a number of connectors and dispensers.

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. FCEB can replace diesel or compressed natural gas (CNG) fuel buses without significant changes to operations and service and functions as a resilient backup alternative in case of natural disaster. 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.

While both of these technologies provide ZE benefits, the feasibility and viability of their application is largely based on an agency's service and operational parameters.

2.2.3 OMNITRANS' EXISTING ZERO-EMISSION BUS EFFORTS

Omnitrans is already embracing the prospects of a ZE future and is taking multiple steps to not only meet the requirements of CARB's ICT regulation, but to also provide a cleaner and more sustainable future for the communities that it serves. These efforts include:

- The technical feasibility and viability of Omnitrans adopting and operating an all-ZEB fleet was analyzed in the San Bernardino County Transportation Authority's (SBCTA) *San Bernardino Countywide Zero Emission Bus Study* (herein after referred to as "Master Plan"). The Master Plan serves as a guiding document for the five transit agencies within San Bernardino County (Mountain Area Regional Transit, Morongo Basin Transit Authority, Omnitrans, City of Needles, and Victor Valley Transit Authority) to transition to all-ZEB fleets by 2040. Omnitrans (and other agencies) were instrumental in the Master Plan's development and success. Agencies supported the development of the plan by knowledge sharing, facilitating site visits, and reviewing and providing feedback on the plan and technical documentation.
- In February 2020, Omnitrans purchased four BEBs that are expected to be delivered and operational in 2021.
- Omnitrans is actively engaged with Southern California Edison (SCE) to take advantage of their Charge Ready Program which will provide support on the planning, design, installation, and funding of BEB-supporting infrastructure.
- Omnitrans' future West Valley Connector, a planned bus rapid transit (BRT) project, is currently being developed and Omnitrans, in partnership with SBCTA and WSP, is analyzing the technical feasibility of utilizing ZEBs to serve the line.

2.3 OMNITRANS' PATH TO ZERO-EMISSION BUS ADOPTION

The decision on whether to adopt BEBs and/or FCEBs is largely based on availability, applicability, and costs. Due to rapidly changing technologies, it's highly likely that strategies to adopt ZEBs today may need to be adapted and revised to account for advancements and changes in ZEB technology in the future. The plans presented in the Rollout Plan are subject to alterations and may not necessarily reflect the ultimate implementation strategy of Omnitrans. This Rollout Plan will serve as a guiding document for ZEB implementation, or as a baseline for subsequent studies and implementation towards ZEB adoption pursuant to the ICT regulation.

2.3.1 EXISTING CONDITIONS

Omnitrans is the largest and highest-ridership transit operator in San Bernardino County. Omnitrans served over 11.1 million riders in Fiscal Year 2018-2019, a substantially-higher total than any of the other San Bernardino County transit operators. Omnitrans was established in 1976 through a joint powers agreement, which now includes 15 cities and unincorporated parts of the county.

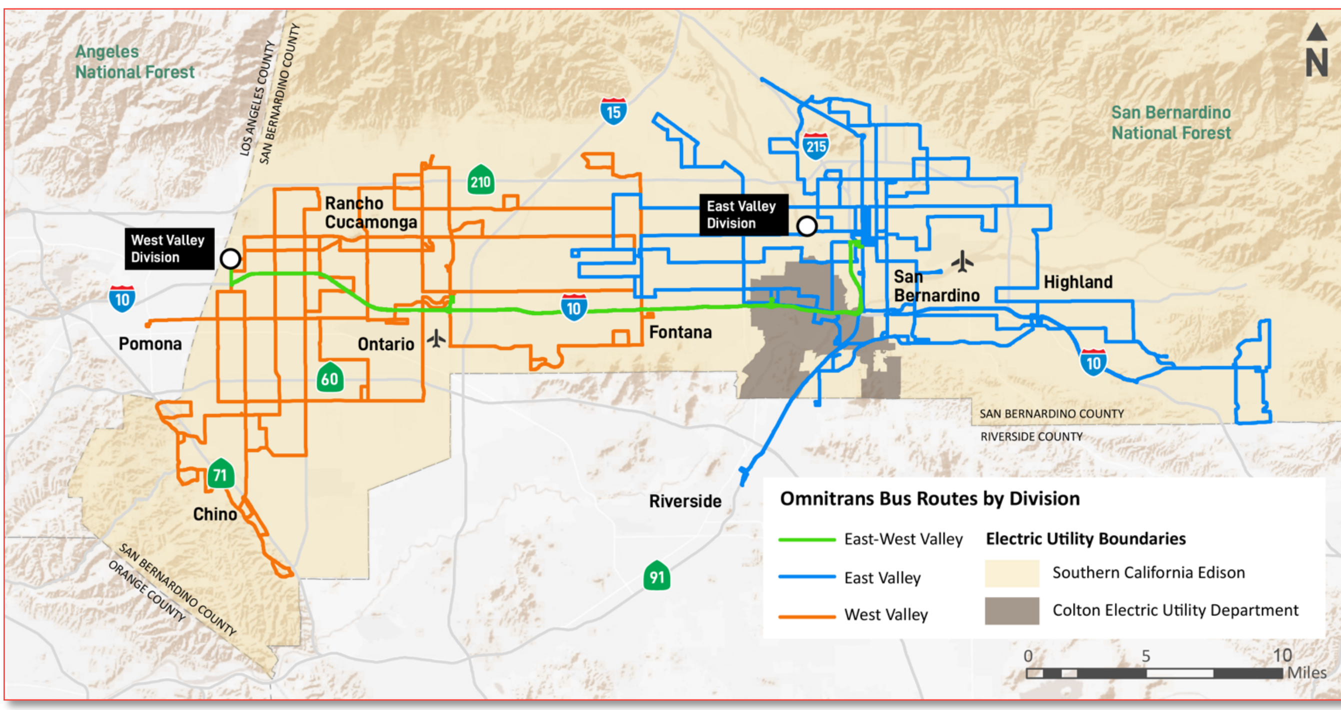
As of April 2020, Omnitrans directly operates 186 CNG-powered buses for fixed-route service. These buses are served by two divisions, the West Valley Division in Montclair, and the East Valley Division in San Bernardino. Table 2-1 summarizes the existing conditions of each division and Figure 2-1 presents the locations and associated routes of each division.

Table 2-1. Existing Conditions Summary

AGENCY	FACILITY	# BUSES	TYPES OF BUSES	FUEL TYPE
Omnitrans	West Valley	71	Standard	CNG
	East Valley	115	Standard; Articulated	CNG

Source: WSP, February 2020

Figure 2-1. Omnitrans Divisions and Routes



Source: WSP, February 2020

2.3.2 *PROPOSED ZERO-EMISSION BUS STRATEGIES*

Previous and current ZEB analyses have determined that at present, BEBs and supporting infrastructure is the ZEB technology that best meets the needs of Omnitrans for its purchasing and transition requirements pursuant to the ICT regulation.

Based on existing service needs and site configurations, overhead (plug-in and/or pantograph) chargers are proposed at both the West Valley and East Valley divisions. The proposed layout are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers/buses). This charger-to-dispenser ratio would meet the requirements to charge Omnitrans' fleet overnight and minimize peak electrical demand.

At this time, the space constraints of the division coupled with the full BEB buildout precludes the feasibility of onsite storage or generation of hydrogen. However, there is a possibility for offsite fueling with the proposed plan. There is also an opportunity to convert to primarily FCEBs, however, Omnitrans recent procurements of BEBs is being used as a baseline for a larger adoption of the technology. That said, Omnitrans remains open to FCEB integration as the technology and market continues to advance. Table 2-2 summarizes the agency's ZEB facility improvements.

Table 2-2. ZEB Strategies Summary

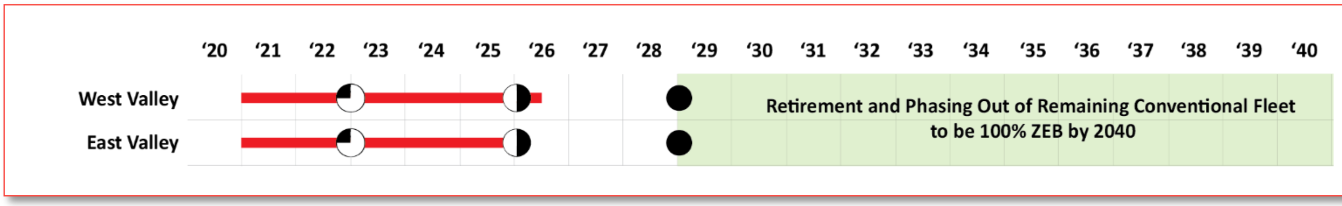
DIVISION	PROPOSED ZEB STRATEGY	BEB	# OF EXISTING BUSES	# OF BUSES SUPPORTED	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING
West Valley	BEB	Overhead-Mounted; Plug-In/Pantograph	71	74	37	74	150 kW
East Valley	BEB	Overhead-Mounted; Plug-In/Pantograph	115	120	60	120	

Source: WSP, February 2020
Note: Chargers are based on a 1:2 ratio (i.e., one charger for two buses).

2.3.3 *PHASING AND CONSTRUCTION*

The process of integrating ZEBs into Omnitrans' fleet is broken down into a number of important tasks and phases related to construction of supporting facilities. The assumed approach is a design-bid-build strategy. Multiple requests for proposals need to be developed and put out for bid, with accompanying design and construction activities taking place. Utility upgrades, onsite (phased) construction, and other activities are expected to last approximately five years, for each division. Since ZEBs are not operational unless the facilities are in place, it is pertinent to meet construction deadlines because it has the ability to impact both service and ICT regulation compliance. It is assumed that buses can be procured 18 months before the conclusion of the facilities' construction. ICT regulation bus procurement requirements (percentage of new bus acquisitions) are indicated via Harvey Balls in 2023, 2026, and 2029. Figure 2-2 presents the construction schedule for each division and the various milestone purchase requirements pursuant the ICT regulation.

Figure 2-2. Summary of Omnitrans' Construction and Purchase Schedule



Source: WSP, February 2020

2.3.4 START-UP AND SCALE-UP ISSUES

Based on the Rollout Plan, Omnitrans will meet the purchase and reporting requirements pursuant to the ICT regulation. However, it should be noted that the plan assumes a number of factors for this to happen. For instance, it is assumed that existing range issues will be resolved by the time Omnitrans procures buses (i.e., each existing bus will be replaced at a 1:1 ratio). It is also assumed that funding is in place to construct and implement infrastructure in the allotted time.

The following briefly describes some of the challenges that Omnitrans must address or overcome in its adoption of an all ZEB fleet:

- **Operating conditions.** Omnitrans operates in extreme temperatures. Hot summer conditions, in particular, require air conditioning that can rapidly deplete batteries, and thus, range.
- **Range issues.** Omnitrans has many blocks that exceed current BEB *and* FCEB ranges. This means that Omnitrans will have to consider the following strategies to reduce or avoid service disruptions:
  - **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.
  - **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs.
  - **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will have to consider the potential impacts to operator and maintenance costs.
- **Technological adaptation.** With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. Omnitrans has to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.
- **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. Omnitrans will have to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.
- **Market Production Factors.** The ICT regulation will put a lot of pressure on original equipment manufacturers (OEMs) to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for Omnitrans if the supply of buses cannot meet demand.

2.3.5 NEXT STEPS

The process to transition to ZEBs should and will be iterative to minimize risk, but also to accommodate new developments in a rapidly evolving market. Omnitrans will use the information outlined in both the Rollout Plan and Master Plan to identify and further refine the following:

— **Determination of the proper mix of BEBs and FCEBs.** Both the Rollout Plan and the Master Plan address and analyze Omnitrans' unique operational conditions to determine paths forward toward 100 percent ZEB adoption. The recommendations contained herein address what the WSP team believes is the most feasible and cost-effective means of implementation. However, Omnitrans will have to re-address these issues and determine whether these recommendations regarding feasibility based on costs, service requirements, and availability have changed as Omnitrans transitions to ZEBs.

— **Address incomplete service blocks.** The WSP team's analysis has revealed that many blocks cannot be completed when considering BEBs and FCEBs, meaning, Omnitrans will have to determine if they're going to file exemptions (under ICT regulation), purchase additional buses, restructure service to suit technological limitations, or invest in opportunity charging. These choices are rooted in Omnitrans' policies and plans outside of ZEB considerations.

— **Costs refinement.** Construction, capital, operating, and maintenance costs vary based on a number of factors. It will be important to get an understanding of the up-front costs and lifecycle costs and savings of investing in ZEBs. The WSP team developed cost estimates (presented in the Master Plan) and Omnitrans will need to revisit these estimates to determine if pricing has changed and make implementation changes, such as changes in their purchasing schedules, accordingly.

— **Explore collaboration opportunities.** Whether purchasing vehicles via CalACT or strategizing on a joint agreement for opportunity charging, Omnitrans can continue to maximize their outcomes by engaging with other regional and local agencies. It is important for Omnitrans to continue to participate in groups such as the Zero-Emission Bus Resource Alliance (ZEBRA) working group, California Transit Association (CTA) and the state's chapter of the Association for Commuter Transportation (ACT), the American Public Transportation Association's (APTA) Bus Technology Committee, and other industry working groups.

— **Engage utilities.** Whether adopting BEBs or FCEBs, there is a good chance that the amount of power at the yard is either insufficient or needs to be adapted to these new technologies. While procuring buses and installing chargers may be relatively straightforward, the process and protocols associated with electrical enhancements on the utility side can be complex. Therefore, it is recommended that Omnitrans continues to engage with SCE to ensure that they can meet critical deadlines.

— **Consider pilot opportunities.** At this time, Omnitrans is able to commit to BEB and/or FCEBs. Since four BEBs are currently on order, it will be easy for Omnitrans to pilot and gauge the performance of a BEB on its routes. However, it may be of interest to engage FCEB OEMs and/or peer agencies that operate FCEBs to collaborate on a pilot project.

3 INTRODUCTION

In accordance with the California Air Resource Board's Innovative Clean Transportation regulation, the following report serves as Omnitrans' Rollout Plan to transition its bus fleet to 100 percent zero-emission (ZE) by 2040.

3.1 BACKGROUND

3.1.1 CALIFORNIA AIR RESOURCE BOARD'S INNOVATIVE CLEAN TRANSPORTATION REGULATION

The California Air Resource Board's (CARB) Innovative Clean Transportation (ICT) regulation requires all public transit agencies in the State of California to transition from conventional buses (compressed natural gas, diesel, etc.) to zero-emission buses (battery-electric or fuel cell electric) by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be zero-emission buses (ZEBs) based on their fleet size. By 2040, CARB expects all transit agencies in the state to be operating only ZEBs.

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 ("Joint Group"), to submit a ZEB Rollout Plan ("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 a number of required components (as outlined in the Rollout Plan Guidelines) 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 or Joint Group's requirements are based on its classification as either a "Large Transit Agency" or a "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 it operates outside of these areas, but in an urbanized area with a population of at least 200,000 and has at least 100 buses in annual maximum service. A Small Transit Agency is an agency that doesn't meet the above criteria.

Omnitrans is categorized as a "Large Transit Agency" under the ICT regulation and must comply with the following requirements[5]:

— **July 1, 2020 –** Board-approved Rollout Plan must be submitted to CARB

— **January 1, 2023 –** 25 percent of all new bus purchases must be ZE

— **January 1, 2026 –** 50 percent of all new bus purchases must be ZE

— **January 1, 2029 –** 100 percent of all new bus purchases must be ZE

— **January 1, 2040 –** 100 percent of fleet must be ZE

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

5 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 it operates outside of these areas, but in an urbanized areas with a population of at least 200,000 and has at least 100 buses in annual maximum service. A "Small Transit Agency" is an agency that doesn't meet the above criteria. Each class of transit agency has its own purchase requirements.

3.1.2 OMNITRANS

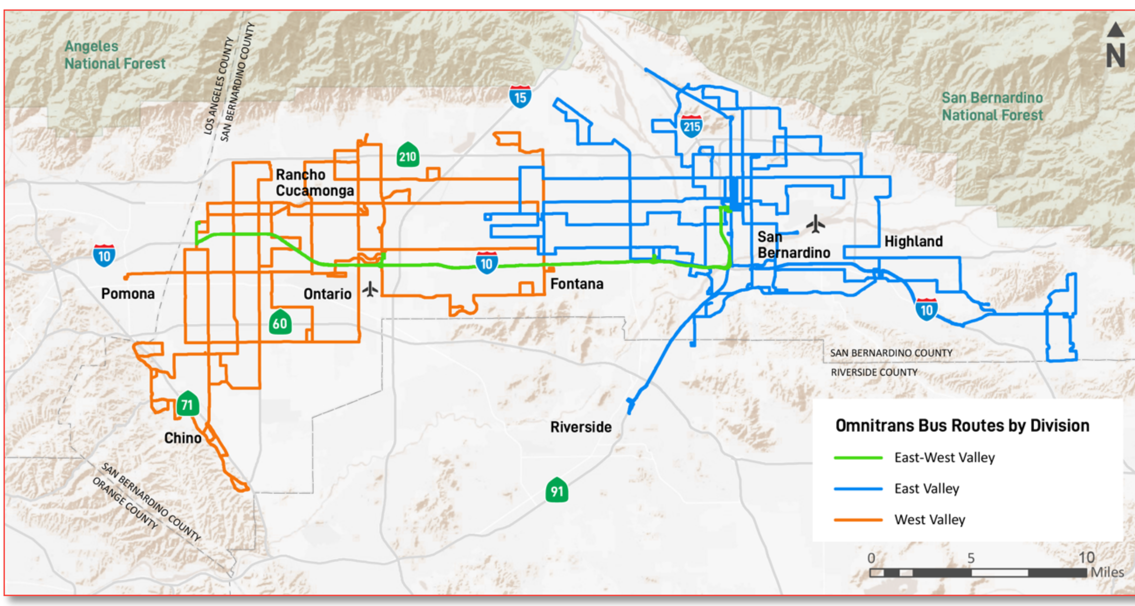
Omnitrans is the largest and highest-ridership transit operator in San Bernardino County. Omnitrans served over 11.1 million riders in Fiscal Year 2018-2019, a substantially-higher total than any of the other San Bernardino County transit operators. Omnitrans was established in 1976 through a joint powers agreement, which now includes 15 cities and unincorporated parts of the county.

SERVICE AREA

Omnitrans serves the urbanized area referred to as the San Bernardino Valley, south of the San Bernardino Mountains, which has a population of approximately 1.7 million and includes the cities of Chino, Chino Hills, Colton, Fontana, Grand Terrace, Highland, Loma Linda, Montclair, Ontario, Redlands, Rialto, San Bernardino, Upland, Rancho Cucamonga, Yucaipa, and portions of unincorporated areas of the County of San Bernardino. The service area includes Ontario and San Bernardino airports, several Metrolink and Amtrak stations, as well as connections to several other regional bus transit authorities: Foothill Transit, Riverside Transit Authority, Mountain Transit (MT), Victor Valley Transit Authority (VVTA), and Pass Transit (Beaumont and Banning); and a connection with Sunline (Palm Springs area) will begin in May 2020.

Omnitrans' service is organized into two divisions: East Valley Division, which serves the cities of Colton, Fontana, Grand Terrace, Highland, Loma Linda, Redlands, Rialto, San Bernardino, Yucaipa and unincorporated areas of the County; and West Valley Division, which serves the cities of Chino, Chino Hills, Fontana, Montclair, Ontario, Rancho Cucamonga, Upland, and unincorporated areas of the County. There are also two smaller division locations that Omnitrans currently uses primarily for paratransit vehicles.

Figure 3-1. Omnitrans Service Area



Source: WSP, February 2020

ENVIRONMENTAL FACTORS

The San Bernardino Valley area is typical of Southern California in terms of environmental conditions. With a hot-summer Mediterranean climate, average high temperatures that peak in August at 96 degrees; December is the coldest average month with a 41-degree average low. During the fall, the region is particularly affected by the Santa Ana winds, bringing higher temperatures and increased risk of wildfires.

SCHEDULE AND OPERATIONS

Omnitrans operates 34 bus routes across four types of service: standard intercity routes, BRT, freeway express, and local shuttles (Table 3-1). Routes in Omnitrans' system connect at several transit centers, which are off-street facilities, and transfer centers, which are on-street stops with multiple routes. The transit centers Omnitrans uses include: Chaffey College Transit Center, Chino Transit Center, Fontana Transit Center (Metrolink), Montclair Transit Center (Metrolink), Pomona Transit Center (South Pomona Metrolink), Riverside Metrolink, San Bernardino Transit Center (Metrolink), and Yucaipa Transit Center. Omnitrans does not own or operate any transit center or transfer center with the exception of the San Bernardino Transit Center.

Table 3-1. Omnitrans Summary of Routes

COMMUNITY	ROUTES
Bloomington	19, 29
Chino	81, 83, 84, 85, 88, OmniGo 365
Chino Hills	88, OmniGo 365
Colton	1, 15, 19, 22, 215, 290
Fontana	10, 14, 15, 19, 20, 29, 61, 66, 67, 82
Grand Terrace	OmniGo 325
Highland	3, 4, 15
Loma Linda	sbX Green Line, 2, 8, 19, OmniGo 325
Mentone	8
Montclair	66, 85, 88, 290
Ontario	61, 80, 81, 82, 83, 86, 290
Pomona	61
Rancho Cucamonga	61, 66, 67, 80, 81, 82, 85
Redlands	8, 15, 19, 208
Rialto	10, 14, 15, 19, 22
San Bernardino	sbX Green Line, 1, 2, 3 & 4, 5, 7, 8, 10, 11, 14, 15, 208, 215, 290
Upland	66, 83, 84, 85
Yucaipa	8, 19, 208, OmniGo 308/309/310

Source: WSP, February 2020

The vast majority of Omnitrans' routes operate daily. Most routes operate with limited service on Saturday, and service is further limited on Sundays. All but two standard routes operate on Saturday; a select few do not operate on Sunday.

All single- and double-digit routes are standard intercity routes. These routes range from seven to 30 thirty miles in route length. The 200-level routes are freeway express routes, serving Interstate 10 and Interstate 215 corridors with limited stops; these routes are also generally longer than the intercity routes. Lastly, the 300-level routes are OmniGo shuttles, which use smaller vehicles to travel short, circular routes in the communities of Yucaipa, Grand Terrace, and Chino Hills.

Omnitrans' only current BRT service is the sbX Green Line, which travels along the E Street Corridor between Cal State University San Bernardino and Loma Linda University and Medical Center. Five of the sbX Green Line's 16 miles are in dedicated bus lanes. Omnitrans has a planned future system of 10 BRT routes; SBCTA is currently leading the final design of the West Valley Connector bus rapid transit line, expected to start operation in 2024, and will provide service in the cities of Montclair, Ontario, Pomona, and Rancho Cucamonga. See Section 3.2.3 for additional details.

3.2 EXISTING ZEB PLANS, PROCUREMENTS, AND PROJECTS

3.2.1 SAN BERNARDINO COUNTY TRANSPORTATION AUTHORITY'S COUNTYWIDE ZERO-EMISSION BUS STUDY

In April 2019, SBCTA issued a contract task order to WSP USA, Inc. to conduct an analysis to determine the best path forward for the City of Needles, MT, Morongo Basin Transit Authority (MBTA), Omnitrans, and VVTA, respective of the ZEB transition pursuant to the ICT regulation.

The goals of the analysis are three-fold for each agency:

1. Determine the most cost-effective approach to a 100 percent ZEB fleet
2. Determine the capital improvements required to support ZEB fleets
3. Provide a financing and purchasing strategy to acquire ZEBs in accordance with the ICT regulation

The overall results of WSP's analysis will be presented in two documents, a Countywide Rollout Plan and the *San Bernardino Countywide Zero Emission Bus Study* (herein after referred to as "Master Plan"), The Rollout Plan serves as each agency in San Bernardino's compliance document per CARB's ICT regulation[6]. The Master Plan is a preliminary planning document that supports each agency in its implementation goals.

The Master Plan is considered a living document and is iterative in nature due to rapid technological development and changes within the ZEB market.

3.2.2 EXISTING ZERO-EMISSION BUS PROCUREMENTS

In February 2020, Omnitrans awarded a purchase order to New Flyer of America, Inc. for the provision of four 40-foot BEBs (expected delivery in 2021). To support these vehicles, Omnitrans is actively engaged with the utility, Southern California Edison (SCE). SCE's Charge Ready Program will provide the agency with support on the planning, design, installation, and funding of BEB-supporting infrastructure at Omnitrans' East Valley and West Valley divisions.

3.2.3 WEST VALLEY CONNECTOR

The West Valley Connector is a BRT project that proposes limited stops, providing speed and quality improvements to the public transit system within the corridor. Among the numerous benefits, BRT provides premium transit with 10-15-minute headways, Transit Signal Priority, dedicated lanes, enhanced stations and integration with other bus routes.

The project seeks to improve mobility in the San Bernardino Valley with an enhanced, state-of-the-art BRT system to address the growing traffic congestion and the projected one million increase in population by 2030. Omnitrans,

6 Omnitrans was analyzed separately since as a "Large Transit Agency" they are required to submit in 2020. The four other agencies included in the Countywide Rollout Plan are not required to submit a Rollout Plan until 2023, therefore, they may opt to file individually (using their respective section in the Countywide Rollout Plan), or receiving individual Board approvals to submit as a "Joint Group".

in partnership with SBCTA and WSP, is currently analyzing the feasibility of utilizing BEBs or FCEBs to serve the West Valley Connector.

3.3 ROLLOUT PLAN APPROACH

Pursuant to the ICT regulation, the Rollout Plan identifies a strategy for Omnitrans to procure and operate all ZEBs by 2040. Due to the rapidly-evolving nature of ZEB technologies, it is possible that the findings and recommended approaches in this report will be outdated when it is time for implementation. For that reason, several generous assumptions were included to account for technological advancements. For example, current BEB technology is not sufficient to meet the range requirements of all of Omnitrans' service blocks. To account for potential future improvements, the Rollout Plan assumes that battery technology will eventually meet the requirements of Omnitrans, therefore, a 1:1 (conventional bus to ZEB) replacement ratio was used to account for future ZEB bus procurements and facility enhancements. This approach ensures that Omnitrans is planning for the future and not conforming to or purchasing infrastructure that will only be compatible with existing technologies. To account for potential fleet increases, facilities are planned and designed for maximum build-out to ensure that enough ZEB infrastructure is in place for fleet expansion.

The *Start-Up and Scale-Up Challenges* section identify the barriers that may prohibit or make these full-buildout scenarios difficult to achieve. These challenges will serve as the springboard for refinements and strategies in the next stages of implementation.

3.4 ROLLOUT PLAN PURPOSE AND STRUCTURE

In accordance with CARB's Rollout Plan Guidance, the Rollout Plan provides an overview of several key components to Omnitrans' ZEB transition, including, but not limited to, fleet acquisitions, facilities and infrastructure enhancements, implementation schedule, personnel training, and funding considerations.

The Rollout Plan is structured as follows:

1. **Introduction** *Details the ICT regulation and provides background on Omnitrans.*
2. **Fleet and Acquisitions** *Presents the existing fleet and procurement plan for buses through 2040.*
3. **Facilities and Infrastructure Modifications** *An overview of each division and the proposed ZEB modifications.*
4. **Disadvantaged Communities** *Discusses the disadvantaged communities (DACs) that will be impacted by the ZEB transition.*
5. **Workforce Training** *Provides background on personnel training requirements for ZEB implementation.*
6. **Costs and Funding Opportunities** *Discusses rough order of magnitude costs and potential funding sources.*
7. **Start-Up and Scale-Up Challenges** *Provides an understanding of challenges and issues that will need to be mitigated or addressed towards ZEB adoption.*

4 FLEET ACQUISITIONS

The following section provides an overview of Omnitrans' existing bus fleet, justification for ZEB technology, and a ZEB procurement schedule through 2040.

4.1 EXISTING BUS FLEET

As of April 2020, Omnitrans directly operates 186 compressed natural gas (CNG)-powered buses for fixed-route service. Table 4-1 presents a summary of Omnitrans' existing bus fleet.

Table 4-1. Summary of Omnitrans' Existing Bus Fleet

MANUFACTURER	SERIES	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NUMBER OF BUSES
New Flyer	C40LF*	CNG	40'	2003	Standard	4
	XN40	CNG	40'	2009	Standard	27
		CNG	40'	2011	Standard	17
		CNG	40'	2012	Standard	20
		CNG	40'	2014	Standard	16
		CNG	40'	2015	Standard	15
		CNG	40'	2016	Standard	13
		CNG	40'	2018	Standard	24
		CNG	40'	2019	Standard	23
	XN60	CNG	60'	2012	Standard	14
		CNG	60'	2018	Standard	1
					Total Buses	**186**

Note: *There are an additional 12 C40LF's that serve as Omnitrans' contingency fleet.
Source: Omnitrans, April 2020

4.2 ZEB TECHNOLOGY APPLICATION

Past and ongoing ZEB analysis for Omnitrans' operations has determined that BEB adoption is the ZEB technology that best meets the needs of Omnitrans for their purchasing and transition requirements pursuant to the ICT regulation. However, Omnitrans remains open to FCEB integration as the technology and market continues to advance. The following provides an overview of overarching specifications for each ZEB type that Omnitrans is considering in their transition.

4.2.1 BATTERY-ELECTRIC BUS

Omnitrans' future BEBs are expected to have specifications that are compatible with the Society of Automotive Engineers' (SAE) J1772 (plug-in) and SAE J3105 (pantograph) charging standards. By supporting both standards, Omnitrans' buses will have flexibility in charging in multiple layouts. The plug-in standard will allow buses to charge at the base (overnight) and while being serviced, and the pantograph standard will allow buses to charge at the base and at potential on-route charging stations. The roof-mounted charging rails that are associated with the pantograph standard will allow a BEB to access high-power charging (200-600 kW) (Figure 4-2).

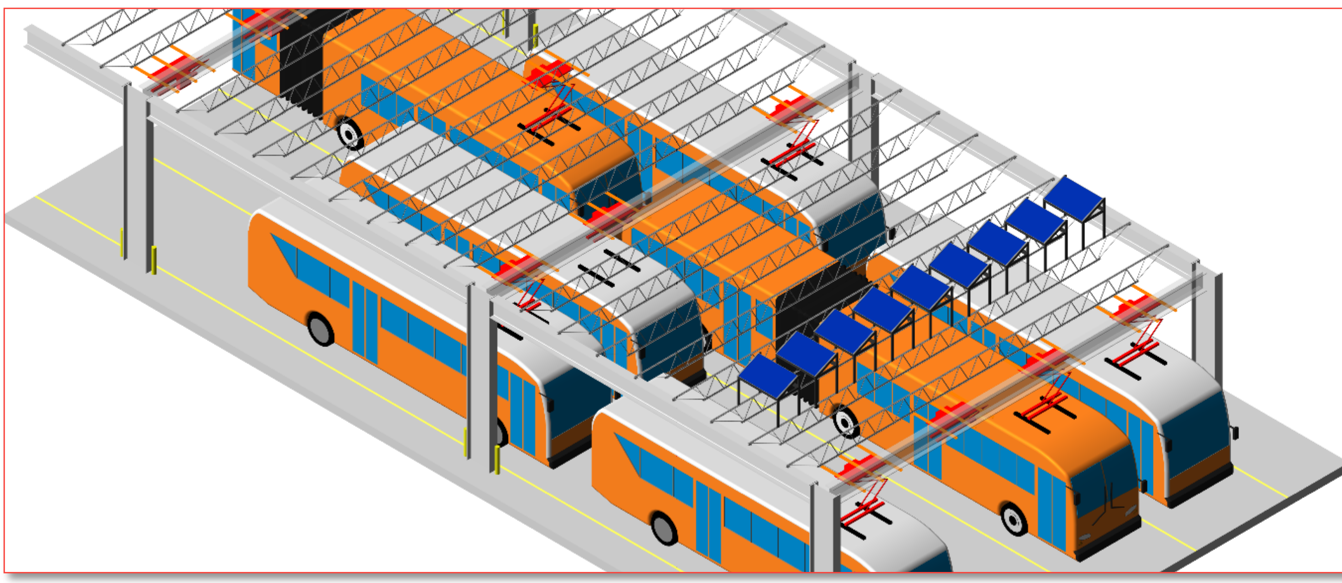
Based on Omnitrans' existing service needs and site configurations, it is recommended that an overhead-mounted (pantograph and/or plug-in) charging strategy be implemented to support BEBs at both West Valley and East Valley divisions. The dispensers will be supported by an overhead frame that will cover the surface of the bus parking tracks. This overhead strategy is due to space constraints at both divisions. The overhead frame can also support photovoltaic panels and electrical equipment and components (conduit, etc.).

The proposed facility layouts for each division are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers/buses). This charger to dispenser ratio maximizes space utility, reduces costs, and meets the requirements to charge the fleet during servicing and dwell time on the site while minimizing the peak electrical demand. However, Omnitrans is currently exploring other strategies that may require less power and space, such as a 1:3 charging orientation.

Inductive (wireless) charging for BEBs is also a future consideration, however, this technology is still very expensive, and has yet to be deployed on a large scale to prove its viability for fleet operations.

Based on current site circulation and configurations, all plug-in ports shall be at the rear of the bus. The following figures illustrated the various BEB connection types that Omnitrans is considering. Figure 4-1 presents a conceptual pantograph charger with supporting frame.

Figure 4-1. Overhead-Mounted Pantograph Charger



Note: The frame can also support plug-in dispensers, however, they will have to be situated above the rear of the bus to be compatible with some OEMs.
Source: WSP, March 2020

Figure 4-2. Inverted Pantograph and Charge Rails

Source: WSP, March 2020

4.2.2 FUEL CELL ELECTRIC BUS

For the specific routes which route-modeling has identified as not capable of being served by existing BEB technology, it is recommended that FCEBs be considered. If FCEBs are integrated into the fleet, they should be fueled at a future commercial or public hydrogen fueling station located in either Ontario or Chino. Based on the recommended BEB strategy, onsite storage or generation is infeasible due to space constraints, however, if plans are revised, onsite solutions may be deemed feasible.

On-site liquid storage (delivered by truck) is a consideration dependent upon space constraints. Alternatively, an on-site electrolyzer that generates hydrogen from water, could be used to eliminate the need to deliver hydrogen to the site. Note that while possible to self- generate, the available space at both Omnitrans' sites do not allow for a large enough electrolyzer to generate more hydrogen than could be used to fill four to six FCEBs, daily (assumption of 37 kilograms per bus at 350 bar).

Even with technical feasibility, there are a number of risks and potential community concerns that would need to be addressed and mitigated with both on-site hydrogen production and/or storage before integration.

4.3 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, Omnitrans will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last CNG bus is expected to be purchased in 2028. All new buses purchases are anticipated to be ZEB starting in 2029, in accordance with the ICT regulation.

Early retirement should not be an issue pursuant to the ICT regulation based on Omnitrans' assumed procurement schedule. However, if it becomes an issue, Omnitrans will deploy a number of strategies to ensure that buses fulfill their "useful life". One potential strategy is to place newly acquired buses on Omnitrans' longest (distance) blocks of service. This will ensure that these buses meet their distance-based useful life requirement more rapidly.

Omnitrans' existing fleet consists of 186 buses. Assuming a 1:1 replacement ratio, each existing bus will eventually be replaced with an equivalent BEB or FCEB. However, the number of ZEBs required may increase with time based on service requirements.

Table 4-2 presents a summary of Omnitrans' anticipated bus procurements through 2040. Years 2023, 2026 and 2029 are highlighted because these indicate when Omnitrans' new purchases should be 25 percent, 50 percent, and 100 percent ZEB, respectively.

Table 4-2. Summary of Omnitrans' Future Bus Purchases (through 2040)

YEAR	TOTAL BUSES	ZERO-EMISSION BUSES				CONVENTIONAL (CNG) BUSES			
		NUMBER	PCT.	BUS TYPE	FUEL TYPE	NUMBER	PCT.	BUS TYPE	FUEL TYPE
2020*	**4**	4	100%	40'	BEB	0	0%	-	-
2021	**0**	0	0%	-	-	0	0%	-	-
2022	**0**	0	0%	-	-	0	0%	-	-
2023	**0**	0	0%	-	-	0	0%	-	-
2024	**0**	0	0%	-	-	0	0%	-	-
2025	**31**	8	26%	40'	BEB	23	74%	40'	CNG
2026	**34**	17	50%	40'/60'	BEB	17	50%	40'/60'	CNG
2027	**0**	0	0%	-	-	0	0%	-	-
2028	**16**	8	50%	40'	BEBs/FCEBs	8	50%	40'	CNG
2029	**15**	15	100%	40'	BEBs/FCEBs	0	0%	-	-
2030	**13**	13	100%	40'	BEBs/FCEBs	0	0%	-	-
2031	**0**	0	0%	-	BEBs/FCEBs	0	0%	-	-
2032	**29**	29	100%	40'/60'	BEBs/FCEBs	0	0%	-	-
2033	**23**	23	100%	40'	BEBs/FCEBs	0	0%	-	-
2034	**0**	0	0%	-	BEBs/FCEBs	0	0%	-	-
2035	**0**	0	0%	-	BEBs/FCEBs	0	0%	-	-
2036	**0**	0	0%	-	BEBs/FCEBs	0	0%	-	-
2037	**8**	8	100%	40'	BEBs/FCEBs	0	0%	-	-
2038	**17**	17	100%	40'/60'	BEBs/FCEBs	0	0%	-	-
2039	**23**	23	100%	40'	BEBs/FCEBs	0	0%	-	-
2040	**33**	33	100%	40'/60'	BEBs/FCEBs	0	0%	-	-

Note: CNG buses assumed to be replaced after 14 years in service and BEBs assumed to be replaced after 12 years in service.
In February 2020, Omnitrans procured their first four BEBs
Source: WSP, February 2020

4.3.1 ZEB RANGE REQUIREMENTS AND COSTS

Omnitrans operates 334 blocks during weekdays, 296 of which are longer than 100 miles. Omnitrans' longest block is approximately 410 miles. Depending on operational parameters, including operator behavior, ambient temperature, traffic, and ridership, these ranges may be unattainable or difficult to achieve on certain days. Based on existing routes, Omnitrans will only be able to support BEB on a 1:1 ration until 2028 (pending advancements in the technology). If vehicle manufacturers cannot meet these range requirements after 2028, Omnitrans will consider a number of strategies to supplement onboard battery storage, including additional buses, midday charging, battery/charging management systems, and solar and battery storage. As mentioned, in future ZEB applications, Omnitrans will also consider FCEBs, especially if battery technology doesn't advance as forecasted.

4.3.2 ZEB CONVERSIONS

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

5 FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following section details the planned charging strategies, infrastructure, detailed division improvements, and construction and phasing schedule.

5.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. However, it is also pertinent to ensure that strategies are future-ready. For this reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each division. This provides Omnitrans with a ceiling for what can physically be constructed and worst-case scenario for electric utility planning. Since service changes and bus movements may occur multiple times a year, by establishing a full-build scenario, Omnitrans can optimize, and tailor strategies based on existing (or anticipated) service.

As previously mentioned, the current path forward for Omnitrans is all BEB, however, the analysis of FCEB feasibility is ongoing. In anticipation of future FCEB integration, a hydrogen storage footprint was established at each division where vehicles and space can support it.

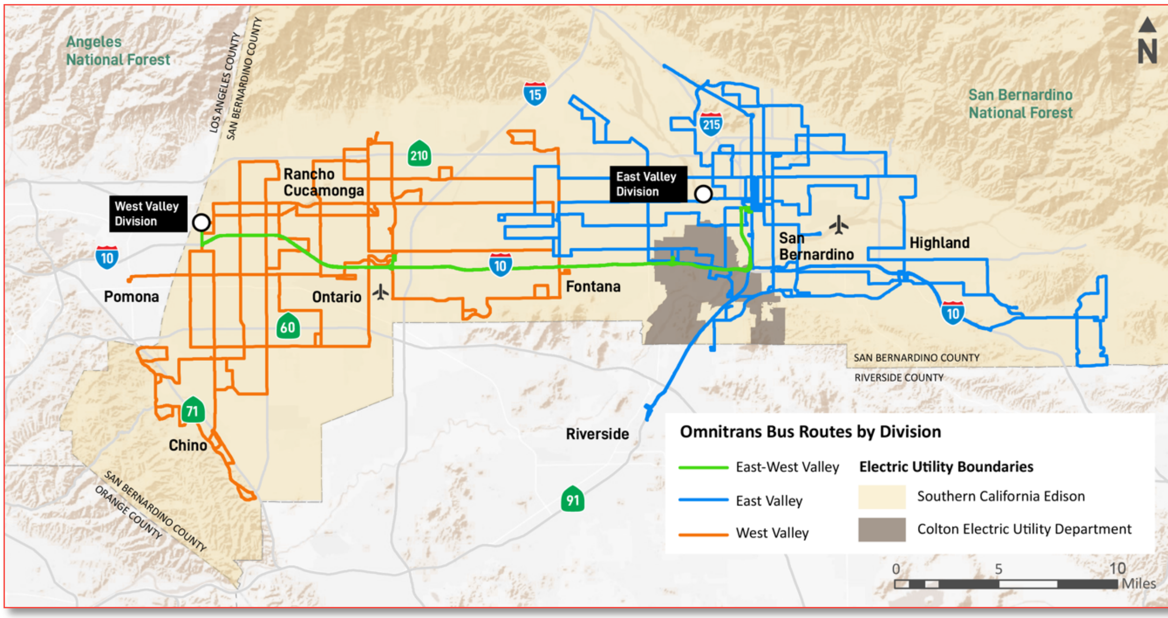
5.2 FACILITY MODIFICATIONS

Omnitrans' transition to ZE technologies will require a number of modifications and changes to existing infrastructure and operations. This will include the enhancements and expansions of electrical equipment, additional electrical capacity, and the installation of BEB chargers, dispensers, and other components. These modifications will occur at Omnitrans' two divisions, the West Valley Division in City of Montclair, and the East Valley Division in the City of San Bernardino. Opportunity for on-route charging is also being considered and being analyzed at potential transit centers and layover locations.

Based on existing service needs and site configurations, overhead (plug-in and/or pantograph) chargers are proposed at both the West Valley and East Valley divisions. The proposed layout are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers/buses). This charger to dispenser ratio would meet the requirements to charge Omnitrans' fleet overnight and minimize peak electrical demand.

Figure 5-1 illustrates the location of Omnitrans' divisions and Table 5-1 summarizes the modifications and schedule of each division.

Figure 5-1. Omnitrans' Base Locations



Source: WSP, February 2020

Table 5-1. Omnitrans' Division Summary

GARAGE	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADES REQ'D?	TIMELINE
West Valley	4748 E. Arrow Hwy. Montclair, CA	Fueling, Storage, and Maintenance	Overhead Pantograph or Plug-In Charging	74 buses	Yes	2021-2026
East Valley	1700 W. 5th St. San Bernardino, CA	Fueling, Storage, and Maintenance	Overhead Pantograph or Plug-In Charging	120 buses	Yes	2021-2026

Source: WSP, February 2020

The following sections detail the process of each division's transition from existing conditions to BEB-readiness.

5.2.1 WEST VALLEY DIVISION

EXISTING CONDITIONS

West Valley Division is located at 4748 E. Arrow Highway in the City of Montclair. The division has an assumed maximum bus capacity of 74 buses with electrical service provided by SCE.[7]

Currently, 71 CNG-powered buses are stored, maintained, fueled, and serviced at the division. The division includes the following separate structures and major site areas: A one-story maintenance building, one-story transportation building, stand-alone wash building, stand-alone fuel building, an employee parking lot on Arrow Highway, and a CNG compressor yard with support equipment.

Buses enter from Arrow Highway and park in the yard before undergoing service. Individual buses are then taken by nightly service staff to the fuel lanes for fare retrieval and fueling before pulling forward to the bus wash lanes.

7 It is assumed that the West Valley Division is supported by a 12 KV line, which can support approximately 8.3 MW of peak power. It is likely that this circuit supports more than West Valley, though. In order to determine the specific amount of power available and the means to get it to the division, a method of service study needs to be conducted by SCE.

After fuel and wash, buses are circulated back into the bus parking tracks, parking in either herringbone or angled configurations. The interiors of the buses are cleaned during the fueling process. Once re-parked after nightly service, buses remain parked in-place until morning pull out unless a maintenance issue has been identified.

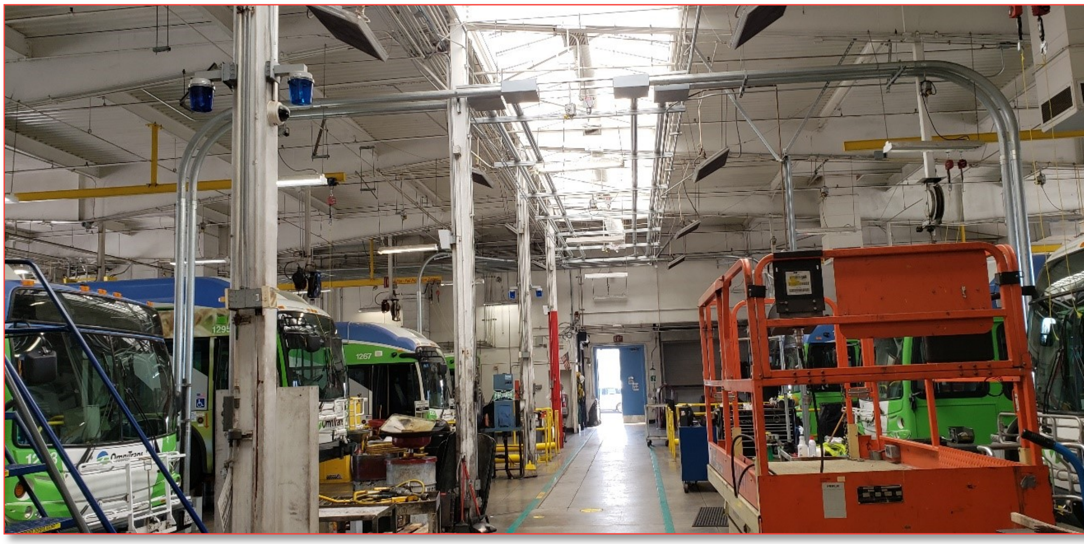
All bus parking tracks are approximately 13-feet wide and buses are assigned to specific spaces. Non-revenue vehicles (NRVs) are parked in a row of spaces along the western edge of the bus parking spaces. Additionally, battery electric NRV's are parked and charge along the eastern wall of the maintenance facility.

According to Omnitrans, a new overhead transformer and a 600-amp service meter along with two power cabinets and four depot charge boxes will be installed in the north west corner of the yard for the first four BEBs (expected delivery in 2021). This is part of the SCE Charge-Ready Transport program.

Figure 5-2. West Valley Division - Existing Conditions

Source: Google Earth, February 2020

Figure 5-3. West Valley Division's Maintenance Bays



Source: WSP, February 2020

PLANNED ZEB MODIFICATIONS

It is recommended that the West Valley division adopt an overhead platform-mounted retractor cord DC plug-in or overhead pantograph charging solution. With this approach, the West Valley division is capable of parking 74 buses (max capacity of the division) with 74 charging positions in a 1:2 charger to bus dispenser ratio. Ground-mounted charging cabinets and dispensers are not recommended for West Valley as they would create a significant reduction in bus parking capacity due to parking losses to accommodate ground-mounted charging equipment.

Table 5-2 summarizes the ZEB infrastructure planned at the West Valley division.

Table 5-2. West Valley Division Supporting Infrastructure Summary

DIVISION	CHARGING STRATEGY	# OF EXISTING BUSES	# OF BUSES SUPPORTED	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING
West Valley	Overhead Plug-in or Pantograph	71	74	37	74	150 kW

Source : WSP, February 2020

The following BEB equipment and locations are proposed:

— 37 ground-mounted DC charging cabinets located at both ends of the proposed overhead support structures. Distribution to 74 retractor cord plug-in dispenser (or pantograph) charging positions mounted from overhead support structures in a new 45-degree track parking layout.

— Dispensers are located for connecting to the rear of the bus to reduce the length of support structure at the rear of the parking tracks in order to maintain bus turning clearances.

— The overhead support structure columns are to be placed every three to four tracks. These columns will also provide the mounting space for retractor cord controls to be installed to control each overhead dispenser's charging cable position for a plug-in option, or to support overhead mounted pantographs.

The plug-in charging dispensers (or pantographs) and charging cabinets will be served by the following electrical infrastructure:

- Three medium voltage utility service transformers in a new utility yard in the open space south of the existing parking yard and east of the site entrance.
- Three sets of switchgear will be located near the proposed overhead support structures to reduce long-distance medium voltage conduit runs.

If FCEBs are to be integrated in the future (using the proposed configuration), it is recommended that offsite commercially available hydrogen fueling stations be utilized. Required clearances around liquid hydrogen storage exceed what the current site configuration is able to accommodate, making onsite hydrogen fueling infeasible at this time.

Figure 5-4 illustrates the West Valley Division at full build-out.

Figure 5-4. West Valley Division – Full ZEB Build-Out

Source: WSP, March 2020

PHASING AND CONSTRUCTION STRATEGY

The process of integrating ZEBs into Omnitrans' fleet is broken down into a number of important tasks and phases related to construction of supporting facilities. The assumed approach is a design-bid-build strategy. Multiple requests for proposals (RFPs) need to be developed and put out for bid, with accompanying design and construction activities taking place. Utility upgrades, onsite (phased) construction, and other activities are expected to last approximately five years, for each division. This five years is a conservative estimate based on the amount of time it will take the utility to provide upgraded electrical equipment *outside* of the division. The onsite upgrades and construction of BEB supporting infrastructure can be done concurrently.

To minimize or avoid operational or service impacts, it is recommended that onsite construction be implemented in phases. This method essentially segments the yard and ensures that construction continues without completely shutting down the division.

Since ZEBs are not operational unless the facilities are in place, it is pertinent to meet construction deadlines because it has the ability to impact both service and ICT regulation compliance. It is assumed that buses can be procured 18 months before the conclusion of the facilities construction.

The following provides details on recommended phasing for the West Valley division.

PHASE 1

The recommended first phase of charger installation the for the West Valley Division is to install all of the in-ground conduit to route electrical service from the new electrical yard to seven charging cabinets with 14 overhead plug-in (or pantograph) dispensers mounted to the new overhead support structure on the eastern boundary of the yard.

PHASE 2

Phase 2 at West Valley will consist of yard trenching to distribute electrical service to the northern yard parking area and construct the overhead support structure over 30 bus positions and dispensers for an additional 20 charging positions.

PHASE 3

Phase 3 at West Valley will complete yard trenching to distribute to electrical service to the southern yard parking grouping and the remainder of the overhead support structure and remaining dispensers.

5.2.2 EAST VALLEY DIVISION

EXISTING CONDITIONS

East Valley Division is located at 1700 West 5th Street in the City of San Bernardino. The division has an assumed maximum bus capacity of 120 buses with electrical service provided by SCE.[8]

Currently, 115 CNG-powered buses are stored, fueled, and serviced at the division. The East Valley facility includes the following separate structures and major site areas: A two-story maintenance building, two-story transportation building, stand-alone wash building, stand-alone fuel building, an employee parking lot, and a CNG compressor yard with support equipment. Employee parking is on site in the employee parking lot along 5th Street or the satellite employee parking, which is off Medical Center Drive.

Buses enter from Medical Center Drive and park facing west in the yard before undergoing service. Individual buses are then taken by Omnitrans nightly service staff to the fuel lanes for fare retrieval and fueling before pulling forward to the bus wash lanes. After fuel and wash, buses are circulated back into the bus parking tracks and re-parked facing

8 It is assumed that the West Valley Division is supported by a 12 KV line, which can support approximately 8.3 MW of peak power. It is likely that this circuit supports more than West Valley, though. In order to determine the specific amount of power available and the means to get it to the division, a method of service study needs to be conducted by SCE.

east in nose-to-tail tracks. The interiors of the buses are cleaned during the fueling process. Once re-parked after nightly service, buses remain parked in-place until morning pull out unless a maintenance issue has been identified.

All bus parking tracks are approximately 13-foot wide and buses are not assigned to specific spaces. NRV vehicles are parked in a row of spaces along the southern edge of the maintenance building and the southern fence in the bus circulation area south from the maintenance building. Additionally, battery electric NRV's are parked and charge along the southern fence in this area.

A new transformer and a 600-amp service meter along with two power cabinets and five depot charge boxes will be installed along the east side of the property along Medical Center Drive for the first four BEBs. This is part of the SCE Charge-Ready Transport Program.

Figure 5-5. East Valley Division - Existing Conditions

Source: Google Earth, February 2020

Figure 5-6. East Valley Division's Maintenance Bays

Source: WSP, February 2020

PLANNED ZEB MODIFICATIONS

It is recommended that the East Valley division adopt an overhead platform-mounted retractor cord DC plug-in or overhead pantograph charging solution. With this approach, the West Valley division is capable of parking 120 buses (max capacity of the division) with 120 charging positions in a 1:2 charger to bus dispenser ratio. Ground-mounted charging cabinets and dispensers are not recommended for East Valley as they would create a significant reduction in bus parking capacity due to parking losses to accommodate ground-mounted charging equipment.

Table 5-3 summarizes the ZEB infrastructure planned at the East Valley division.

Table 5-3. East Valley Division Supporting Infrastructure Summary

DIVISION	CHARGING STRATEGY	# OF EXISTING BUSES	# OF BUSES SUPPORTED	# OF CHARGERS	# OF DISPENSERS	CHARGER RATING
East Valley	Overhead Plug-in or Pantograph	115	120	60	120	150 kW

Source : WSP, February 2020

The following BEB equipment and locations are proposed:

- 60 ground-mounted charging cabinets located in a centralized island in the middle of the parking racks. Distribution to 120 retractor cord plug-in dispenser or overhead pantograph charging positions mounted from an overhead support structure in the existing track parking.
- Dispensers are located for connecting to the rear of the bus to reduce the length of support structure at the rear of the parking tracks in order to maintain bus turning clearances. Additionally, the eastern-most front row of tracks will have the dispensers staggered back slightly to allow for less support structure and easier maneuvers out of the track parking area.
- Overhead support structure columns will be placed every four tracks. These columns will also provide the mounting space for retractor cord controls to be installed to control each overhead dispenser's charging cable position.

The plug-in (or pantograph) charging dispensers and charging cabinets will be served by the following electrical infrastructure:

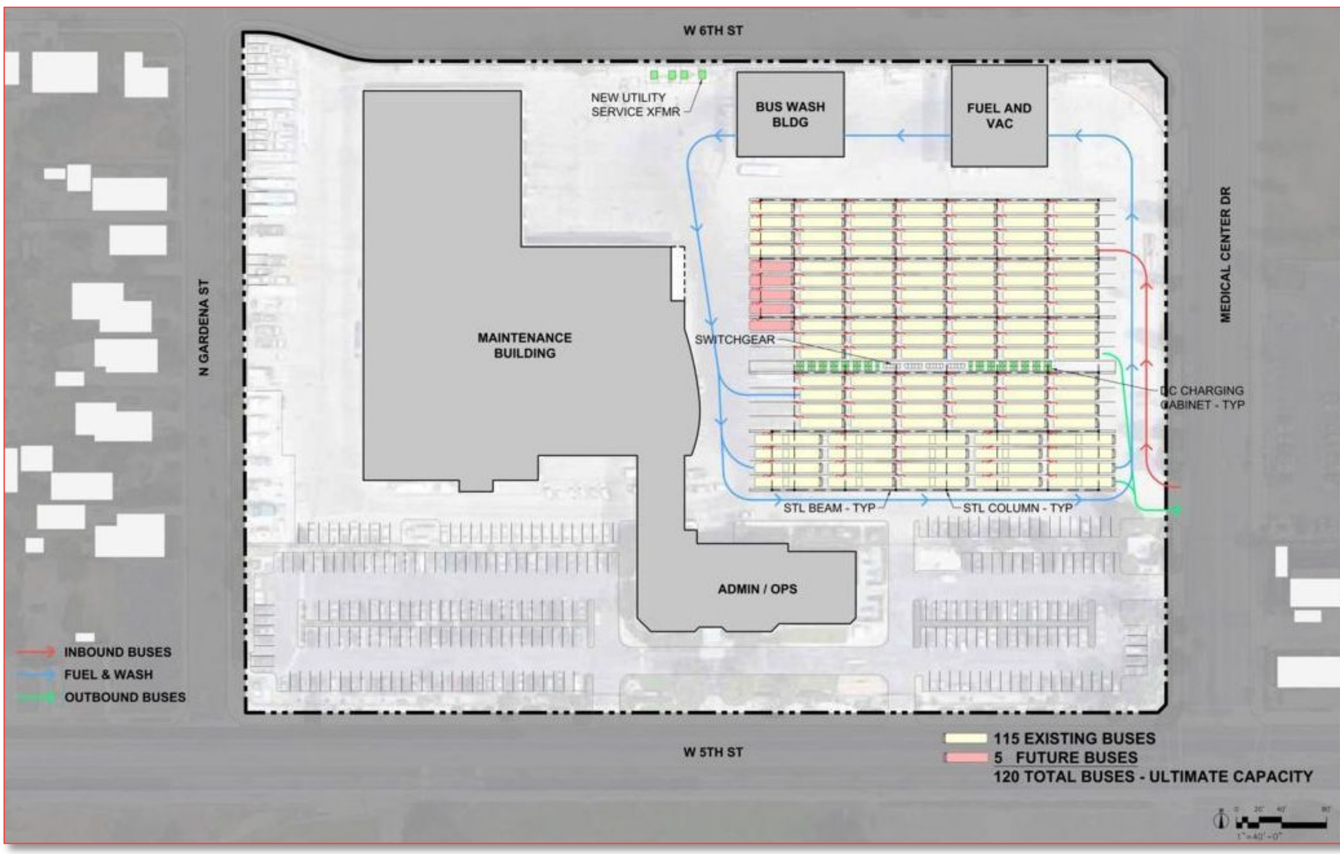
— Four medium voltage utility service transformers in a new utility yard in the open space along the northern site wall and west of the existing bus wash.

— Four sets of switchgear in a central utility yard in the open space at a central island in the parking tracks.

If FCEBs are to be integrated in the future (using the proposed configuration), it is recommended that offsite commercially available hydrogen fueling stations be utilized. Required clearances around liquid hydrogen storage exceed what the current site configuration is able to accommodate, making onsite hydrogen fueling infeasible at this time.

Figure 5-7 illustrates the East Valley Division at full build-out.

Figure 5-7. East Valley Division – Full ZEB Build-Out



Source: WSP, February 2020

PHASING AND CONSTRUCTION STRATEGY

The process of integrating ZEBs into Omnitrans' fleet is broken down into a number of important tasks and phases related to construction of supporting facilities. The assumed approach is a design-bid-build strategy. Multiple RFPs need to be developed and put out for bid, with accompanying design and construction activities taking place. Utility upgrades, onsite (phased) construction, and other activities are expected to last approximately five years, for each division. This five years is a conservative estimate based on the amount of time it will take the utility to provide upgraded electrical equipment *outside* of the division. The onsite upgrades and construction of BEB supporting infrastructure can be done concurrently.

To minimize or avoid operational or service impacts, it is recommended that onsite construction be implemented in phases. This method essentially segments the yard and ensures that construction continues without completely shutting down the division.

Since ZEBs are not operational unless the facilities are in place, it is pertinent to meet construction deadlines because it has the ability to impact both service and ICT regulation compliance. It is assumed that buses can be procured 18 months before the conclusion of the facilities construction.

The following provides details on recommended phasing for the East Valley division.

PHASE 1

The first phase of construction will include the installation of all in-ground conduit to route electrical service from the new electrical service yard to the proposed overhead structure and charging cabinet island. A portion of the support structure should be installed over the northern half of the exiting parking tracks and the charging cabinet platform should be installed on the southern central edge of the new support structure to support the initial 30 charging cabinets. The conduit routing power from the electrical yard to the support structure should be sized for the ultimate distribution demand to meet the needs of the subsequent phase without further trenching. 60 overhead retractor cable plug-in (or pantograph) charging dispensers will be hung from the new support structure to serve each of the covered parking spaces and controls for the retractor cable (plug-in charging) in each spot will be located on the nearest support structure column.

PHASE 2

Phase 2 at East Valley will consist of construction of the southern half of the support structure and charging cabinet in a mirrored design of the northern portion completed in Phase 1. The additional transformer and switchgear will be installed on the pads and conduit constructed in the electrical yard during Phase 1 and routed via the overhead support structure, so that no new trenching will be required. The new support structure housing an additional 60 retractor cable plug-in (or pantograph) charging dispensers and overhead platform with 30 additional charging cabinets will be installed to provide the entire yard with charging capabilities.

6 DISADVANTAGED COMMUNITIES

DACs refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The CalEPA and California's Senate Bill 535, define a "disadvantaged" community as a community that is located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

CalEnviroScreen uses environmental, health, and socioeconomic data to measure 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 replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs.

6.1 OMNITRANS' DISADVANTAGED COMMUNITY ANALYSIS

To understand ZEBs impacts on Omnitrans' service area, it was pertinent to establish if (1) its garage is in a DAC; and (2) if its routes traverse DACs.

At this time, both the West Valley and the East Valley divisions are located in DACs. Both yards also serve routes that traverse DACs. The West Valley division serves 129 Census tracts, 78 of which (60 percent), are considered disadvantaged. Whereas, the East Valley division serves 163 Census tracts, 103 of which (63 percent), are considered disadvantaged.

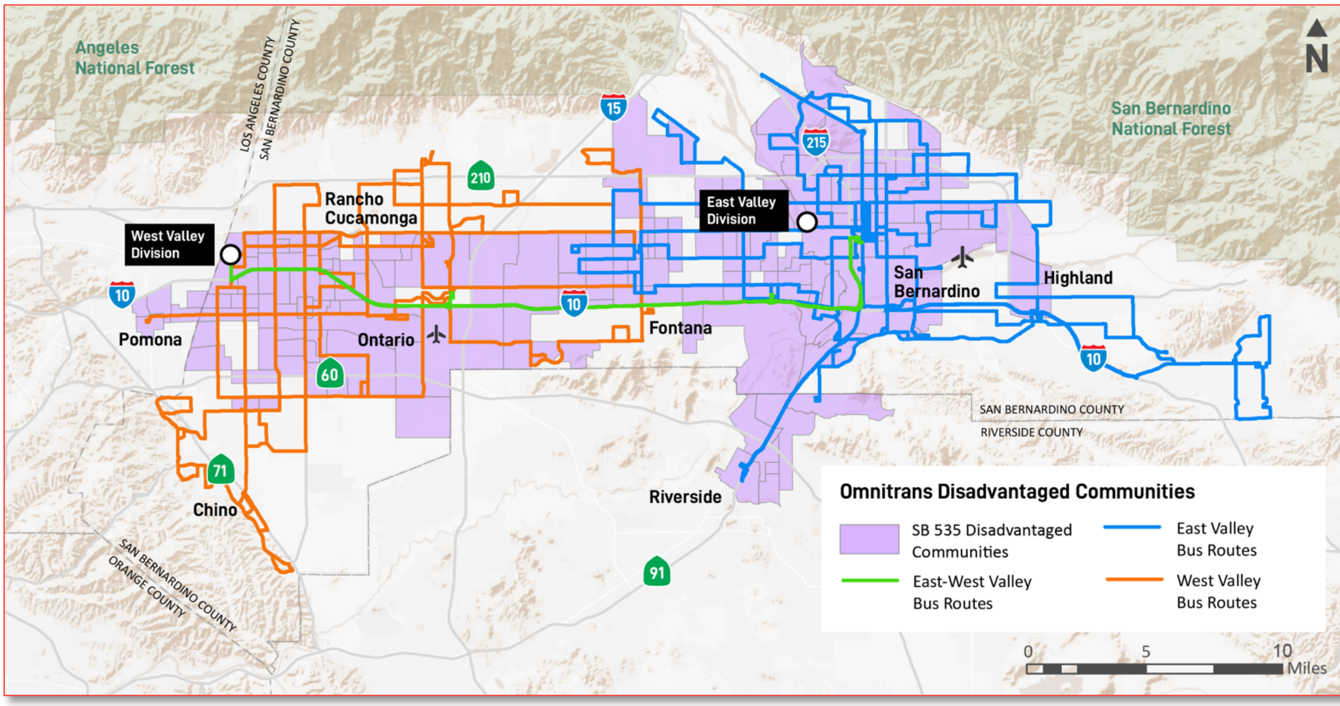
Table 6-1 summarizes Omnitrans' divisions and census tracts served in terms of DACs. Figure 6-1 illustrates Omnitrans' divisions and the Census tracts that they serve.

Table 6-1. Omnitrans' Disadvantaged Communities

DIVISION	IN DAC?	NOx EXEMPT AREA?	COMMUNITIES SERVED	DACs SERVED	PCT. OF DACs SERVED
West Valley	Yes	No	129	78	60%
East Valley	Yes	No	163	103	63%

Source : CalEnviroScreen 3.0, February 2020

Figure 6-1. Omnitrans' Disadvantaged Communities



Source : CalEnviroScreen 3.0, February 2020

7 WORKFORCE TRAINING

The following section provides an overview of Omnitrans' plan and schedule to train personnel on the impending transition.

7.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter Omnitrans' service and operations. Converting to ZEBs from CNG is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and Omnitrans. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. Omnitrans procured its first BEBs in 2020 with an expected 2021 delivery. Therefore, it is expected that all personnel will be sufficiently trained before the buses arrive. Training conditions and schedules will be included in procurement documents, as they are with all existing procurements. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that Omnitrans' staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, Omnitrans' future procurements/deliveries will require refresher or updated trainings for relevant staff.

Safety training, however, will be provided on an annual or other recurring basis to ensure that staff is knowledgeable and maintains best and safe practices when operating, handling, or servicing BEB-supporting components or infrastructure.

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

— **Bus Operators**
Bus operators will need to be familiarized with the buses, safety, bus operations, and pantograph operations.

— **Facilities Maintenance Staff and Maintenance**
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.

— **Body Repairers**
Body repairers at the contracted operator will need to be familiarized with the safety-related features and other components of ZEBs.

— **Instructors**
Maintenance 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**
All Management will be familiarized with ZEB operations and safety procedures.

8 COSTS AND FUNDING OPPORTUNITIES

The following section identifies preliminary capital costs and potential funding sources that Omnitrans may pursue in its adoption of ZEBs.

8.1 PRELIMINARY CAPITAL COSTS

As expected, the cost of ZEB adoption is going to be very expensive. It is assumed that a full transition for just BEBs and supporting charging infrastructure (based on existing conditions) will cost approximately $223.1 million (in 2020 dollars). This assumes approximately $100K and $50k for charging equipment (DC cabinets and dispensers) and support equipment (conduit, trenching, cabling, etc.), respectively, per bus. This also includes an assumed cost of $1M per bus, however, this will vary depending on length, customizations, etc.[9] This rough order of magnitude (ROM) cost does not factor in operating costs, utility costs, midlife overhauls, training, and soft costs that will all need to be considered in ZEB adoption. The total cost of ownership is further refined and explored in the Master Plan.

8.2 POTENTIAL FUNDING SOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at Omnitrans' disposal. Omnitrans will monitor funding cycles and pursue opportunities that yield the most benefits for the agency pursuant to the ICT regulation. The following table identifies the many funding opportunities that Omnitrans may take advantage of in the next 20 years.

Table 8-1. ZEB Funding Opportunities

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
	Federal Transportation Administration (FTA)	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		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
	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements

9 Charging equipment and support equipment assumptions were based on peer agency inputs that were then condensed to a "per bus" cost. The average cost of a bus ($1M) was based on Omnitrans' recent BEB procurements and multiplied by the future potential buildout of both the West and East Valley Divisions (194 total buses).

TYPE	AGENCY	FUNDING MECHANISM
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	California Department of Transportation (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, February 2020

9 START-UP AND SCALE-UP CHALLENGES

To comply with the ICT regulation's purchase and transition requirements, there are a number of challenges and opportunities that Omnitrans has identified. The following sections briefly describe some of the challenges that Omnitrans faces for its transition.

- **Range issues.** Omnitrans has some blocks that exceed current BEB range. This means that Omnitrans will have to consider the following strategies to reduce or avoid service disruptions:
  - **Buy more buses.** This can assist with service requirements; however, more buses will require more chargers, more space at the division, and potentially higher utility costs.
  - **Opportunity charging.** This strategy could potentially reduce the costs (per bus) due to a smaller battery requirement, however, it would result in more capital infrastructure and utility costs. It can also be difficult in acquiring permission to install chargers on rights-of-way that Omnitrans doesn't own.
  - **Service changes.** This would require the manipulation of block structure. While the riders may not notice the change, the agency will have to consider the potential impacts to operator and maintenance costs.
- **Technological adaptation (FCEB, BEB, or both?).** Currently, Omnitrans is modeling and planning for a transition based on existing service and ZEB technology. With the 2040 deadline looming, it is difficult to anticipate future technological enhancements and changes, such as improved batteries and chargers. Slight changes in these technologies could improve bus ranges, in turn, reducing costs. Omnitrans (and the market) has to be aware of these changes as it would be counterproductive to invest in technologies that will soon be outdated.
- **Costs.** Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. Omnitrans will have to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service.
- **Market Production Factors.** The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, however, it will also make it challenging to meet ZEB goals for agencies if supply of buses cannot meet demand.

10 NEXT STEPS

As mentioned, the process to transition to ZEBs should and will be iterative to minimize risk, but also to accommodate new developments in a rapidly evolving market. Omnitrans will use the information outlined in both the Rollout Plan and the Master Plan to refine and determine the following:

— **Determination of the proper mix of BEBs and FCEBs.** Both the Rollout Plan and Master Plan address and analyze Omnitrans' unique operational conditions to determine paths forward toward 100 percent ZEB adoption. The recommendations contained herein address what WSP's team believes is the most feasible and cost-effective means of implementation. However, Omnitrans will have to re-address these issues and determine whether these recommendations regarding feasibility based on costs, service requirements, and availability have changed as Omnitrans transitions to ZEBs.

— **Address incomplete service blocks.** The WSP team's analysis has revealed that many blocks cannot be completed when considering BEBs and FCEBs, meaning, Omnitrans will have to determine if they're going to file exemptions (under ICT regulation), purchase additional buses, restructure service to suit technological limitations, or invest in opportunity charging. These choices are rooted in Omnitrans' policies and plans outside of ZEB considerations.

— **Costs refinement.** Construction, capital, operating, and maintenance costs vary based on a number of factors. It will be important to get an understanding of the up-front costs and lifecycle costs and savings of investing in ZEBs. The WSP team has developing cost estimates in the Master Plan and Omnitrans will need to revisit these estimates to determine if pricing has changed and make implementation changes, such as changes in their purchasing schedules, accordingly.

— **Explore collaboration opportunities.** Whether purchasing things via CalACT or strategizing on a joint agreement for opportunity charging, Omnitrans can continue to maximize their outcomes by engaging with other regional and local agencies. It important for Omnitrans to continue to participate in groups such as the ZEBRA working group, CTA and the state's chapter of the ACT, APTA's Bus Technology Committee, and other industry working groups.

— **Engage utilities.** Whether adopting BEBs or FCEBs, there is a good chance that the amount of power at the yard is either insufficient or needs to be adapted to these new technologies. While procuring buses and installing chargers may be relatively straightforward, the process and protocols associated with electrical enhancements on the utility side can be complex. Therefore, it is recommended that Omnitrans continues to engage with SCE to ensure that they can meet critical deadlines.

— **Consider pilot opportunities.** At this time, Omnitrans is able to commit to BEB and/or FCEBs. Since four BEBs are currently on order, it will be easy for Omnitrans to pilot and gauge the performance of a BEB on its routes. However, it may be of interest to engage FCEB OEMs and/or peer agencies that operate FCEBs to collaborate on a pilot project.

Moreover, this analysis is only the beginning. Much more will be required as Omnitrans procures buses and engages firms to design and build the needed infrastructure, and to ensure these steps remain the most cost-effective options with respect to their impacts on service operation and maintenance. Finally, while a variety of funding sources have been identified, Omnitrans must tailor its grant funding applications based on its needs and resources.

While the Rollout Plan and the Master Plan have limitations, they both are "future-proofed" as much as possible based on the team's knowledge of technology and cost trends to date. Moreover, both plans intend to be a guide on how best to implement a ZEB transition. Thus, it remains up to Omnitrans to decide how best to use these recommendations.