



CLEAN CORRIDORS

2020 UPDATE

AC TRANSIT



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BACKGROUND

In 2015, the California Air Resources Board (CARB) began public vetting of a potential new rule, the Advanced Clean Transit regulation, which mandates public transit fleets be entirely emissions-free by 2040. In December 2018 CARB formally adopted the new rule. This means transit agencies must begin incorporating zero-emission buses (ZEBs) into their fleets as they purchase new vehicles with a requirement for a fully zero-emission fleet by 2040. For the purposes of AC Transit's heavy-duty coaches, this will mean all vehicle purchases after 2029 have to be zero-emission. To ease the transition for transit agencies, CARB has included incentives within the program for those who are early adopters, with credits for buses already in the fleet counting towards the respective agency's minimum ZEB fleet composition figure.

The term "zero-emission" is used in the plan and throughout the Bay Area to refer to tail-pipe emissions. Clearly there are emissions from all types of fueling technology, including associated with procurement, delivery, assembly, maintenance, and decommissioning; however, it is also evident that hydrogen fuel-cell and battery-electric buses have significantly lower overall emissions than diesel buses. The District realizes the benefits of moving toward a "zero-emission" fleet, while acknowledging the more appropriate name may be "low-emission." For the purposes of this plan, the term zero-emission will be used.

The District is in the enviable position of having over 16 years of experience with ZEBs starting with its initial three-bus fuel-cell electric bus (FCEB) fleet in the early 2000s. The current fleet of 13 hydrogen FCEBs operated out of garages in Emeryville and East Oakland are one of the longest running ZEB fleets in the country. However, with a need to transition to a 100-percent ZEB fleet by 2040, the District should begin planning where to prioritize future ZEBs to ensure they are distributed equitably around the service area as well as contribute to meeting regional and state-wide emissions-reductions goals.

CLEAN CORRIDORS PLAN – 2017

The original Clean Corridors Plan identified a series of corridors and communities to be prioritized for ZEBs as the District procures more ZEBs with a plan of 25 percent of the fleet being zero-emission by 2032. The overall goal of the plan is to have vehicles used on all lines serving these corridors and communities be completely zero-emission (whether battery-electric bus or hydrogen fuel-cell electric bus).

The California Legislature passed AB 32 – the California Global Warming Solutions Act of 2006 – which is commonly referred to as the Cap & Trade Program. This program is designed to create a market for trading emissions credits and the proceeds from sales in the marketplace are used to reduce greenhouse gas (GHG) emissions that cause climate change. In 2017, the state reaffirmed its commitment to the Cap & Trade program when the legislature passed AB 398, extending the program to 2030. Investments from Cap & Trade are also specifically targeted for disadvantaged communities, with legislation from 2012 (SB 535) and 2016 (AB 1550) requiring 25 percent of the proceeds from Cap & Trade funds go to projects that provide a benefit to disadvantaged communities and gave the California Environmental Protection Agency (CalEPA) responsibility for identifying those communities.

The focus on investments in disadvantaged communities is aimed at improving public health, quality of life and economic opportunity in California's most burdened communities and at the same time reducing pollution that causes climate change. The Clean Corridors Plan used the terminology Disadvantaged Communities (DACs) to refer to the communities designated by the CalEPA with their CalEnviroScreen tool.

The methodology for identifying and prioritizing the corridors and communities in that plan was as follows:

- 1) Evaluate existing conditions.
- 2) Review areas identified as DACs in our service area.
- 3) Rank lines based on ridership and productivity to ensure maximum impact of the ZEB fleet.
- 4) Consider constraints such as capacity/capability of divisions to accommodate ZEB growth.
- 5) Scope out the number of vehicles and supporting infrastructure required to convert entire corridors/communities into Clean Corridors.
- 6) Forecast operating and capital costs associated with conversion to Clean Corridors.

The original Clean Corridors Plan identified four corridors for prioritization for ZEB deployment:

- San Pablo Avenue
- West Oakland
- Macarthur-Grand
- Richmond

Taken together, lines in these corridors carry 23 percent of the District's average weekday ridership and serve a population of more than 600,000 residents within one-quarter mile of their stops. The lines require 120 buses to operate in peak service, with another 24 spares to support operations and facilitate preventative maintenance. Each of the four Clean Corridors has a different mix of communities, line types, and bus types. The corridors also overlap geographically. Line NL serves both the Macarthur-Grand and West Oakland corridors. The San Pablo Corridor serves San Pablo Avenue, West Oakland, and Richmond.

The plan estimated that procuring the buses and charging/fueling infrastructure for Clean Corridors in these four areas was \$213.3 million. This represents capital costs of approximately \$100 million above the cost of replacing the same buses with diesel coaches.

PROGRESS SINCE CLEAN CORRIDORS ADOPTION

Following the adoption of the Clean Corridors Plan in Fall 2017, the District has been taking substantial steps towards implementing the Plan and moving the fleet towards a zero-emission future. The District submitted an application to the State of California's Transit Intercity Rail Cooperative Program (TIRCP) for funding of buses for the Macarthur-Grand Clean Corridor in 2018. The State awarded the District \$15 million dollars in TIRCP funding later that year and linked it with a separate \$15 million grant from the Senate Bill 1 Local Partnership Program for hybrid vehicles. The combined \$30 million in funding will be

used with another \$38 million in other federal, state, and local funding to procure the 40 ZEBs necessary to operate the Macarthur-Grand service along with another five buses to operate a service linking the Emeryville Amtrak Station with San Francisco.

To ensure a successful transition to a zero-emission future, the District has also undertaken a number of other studies, including the development of a Zero Emission Bus Study and the Facilities Utilization Plan, which will guide the location of the District's operating facilities moving forward, including any considerations about what those facilities will need to support a zero-emission fleet. In addition, the District is working on a New Emissions Fleet Transition Plan to analyze how to ensure facilities will have the proper power infrastructure to support a fully zero-emission fleet.

CLEAN CORRIDORS PLAN – 2020

The new Innovative Clean Transit Rule adopted by CARB in 2018 will require a 100-percent zero-emission fleet by 2040, meaning the schedule identified in the original Clean Corridors Plan will need to be accelerated. AC Transit will need to have 25 percent of its bus purchases – including accrued bonus points from the District's fuel-cell fleet – be zero-emission as early as 2023, though if agencies in the state meet fleet requirements that date could be pushed back as far as 2025. The next key milestone is 50 percent of new bus purchases must be zero-emission by 2026 and 100 percent by 2029. It is critical to note that cutaways and articulated buses are exempt from these calculations until FTA-required testing is completed and viable zero-emission versions of those bus types are available commercially.

Recent experiences with battery-electric buses (BEBs) at other agencies and through the District's own studies have revealed limited daily range for those buses available today. Some transit agencies have responded by splitting long vehicle assignments into short, more manageable blocks. However, AC Transit is already at or near the capacity of its divisions and cannot add more vehicles. This update to Clean Corridors will continue to use the criteria for equity and ridership to prioritize lines and corridors for implementation but will also identify those lines or corridors with shorter blocks available for the first round of BEBs. Doing so will ensure this new fleet type can be incorporated into AC Transit operations without complicated vehicle swaps and service interruptions. This document also represents a shift from the initial Clean Corridors Plan – while that plan prioritized four corridors, this plan exists in a regulatory environment where all lines will be zero-emission by 2040 and thus arranges the lines in phases for implementation.

EVALUATION

This section evaluates existing AC Transit lines to determine the most appropriate lines to prioritize for assignment of future zero-emission buses. The chapter consists of the following elements:

- 1) Baseline description of existing and procured ZEB fleet.
- 2) Discussion of existing division and infrastructure capacity.
- 3) Planned future expansion of the zero-emission fleet.
- 4) The evaluation of lines and corridors for priority ZEB assignment.

EXISTING ZERO-EMISSION FLEET

The District currently has thirteen 40-foot hydrogen fuel-cell electric buses (FCEBs), which represents the largest and longest-running fuel-cell transit fleet in the nation. The District has begun procurement of 10 additional 40-foot FCEBs as well as a demonstration project of one 60-foot FCEB. This will bring the District's FCEB fleet to 24 buses, which will be the maximum number of buses existing hydrogen fueling infrastructure at Divisions 2 and 4 can accommodate. The District has also received funding to assist with the purchase of five 40-foot battery-electric buses (BEBs) that will be deployed from Division 4 on various routes including Line 73 in East Oakland, operating along 73rd and Hegenberger between Eastmont Transit Center and the Oakland International Airport. The current and planned fleet is depicted in Exhibit 1 below. By early 2020, the District plans to have 29 zero-emission buses in its fleet. Thirteen VanHool FCEBs are expected to be retired within the next several years.

DIVISION CAPACITY

The District is nearing completion of an expansion of the hydrogen dispensing capacity at Division 2. With the project, the total fueling capacity is conservatively estimated at 41 FCEBs. The hydrogen fueling infrastructure upgrade at Division 2 will allow for faster and more efficient fueling operations as well as move hydrogen fueling to the existing (diesel) fueling island. This will improve operational efficiency of fueling and servicing FCEBs. After the project goes into operation, staff will examine actual fueling capacity of FCEBs.

Exhibit 1 – Fuel-cell Electric Bus Maintenance and Fueling Capacity

Division	Maintenance Capacity	Fueling Capacity
Division 2	30 buses	30 buses
Division 4	20 buses	11 buses
Total	50 buses	41 buses

Note: Division 2 capacity includes the expansion project, which will be completed in January 2020.

Source: Preliminary Engineering Design for 45 Zero Emission Buses (October 2019)

Expansion of the hydrogen FCEB fleet beyond the existing FCEBs and planned purchase may require significant upgrade of existing fueling stations or construction of another hydrogen fuel station at another division, as well as increasing FCEB maintenance capacity to accommodate growth.

The District has installed depot charging stations at Division 4 to support the five BEBs going into revenue service in 2020. The District is also in discussions with Pacific Gas & Electric (PG&E) regarding any infrastructure changes necessary to accommodate charging systems for the BEBs. Discussions include potential scalability of the BEB charging infrastructure from the initial five bus capacity up to 50 BEBs.

PLANNED EXPANSION

There are a number of current plans in place for additional ZEBs for the District across the next several years. The first is the procurement of 45 ZEBs using funding from various grants, including the TIRCP and SB 1 grants, which were awarded in 2018. This funding was secured in part due to the vision outlined in

the original Clean Corridors Plan and features the complete implementation of the Macarthur-Grand Corridor plan along with five additional expansion buses for a Transbay link between the Emeryville Amtrak Station and Salesforce Transit Center in San Francisco. These buses should begin entering service as early as late 2021.

DISADVANTAGED COMMUNITIES

Richmond
 San Pablo
 West Berkeley
 West Oakland
 North Oakland
 East Oakland
 International Boulevard/East 14th
 Oakland International Airport
 Ashland (San Leandro)
 Russell City (Hayward)
 Union City

The second planned expansion of ZEBs is through the state's Affordable Housing and Sustainable Communities (AHSC) program. This program allows for developers of affordable housing to secure funding from the State's Cap & Trade program for their residential developments as well as for transit agencies to receive funding for new buses if transit service is being improved in proximity to those proposed affordable developments. The District has been

awarded funding for five buses through the AHSC program and will be purchasing four ZEBs as part of the grant awards to various developments.

Finally, there is a Memorandum of Understanding with the Treasure Island Mobility Management Agency (TIMMA) for the procurement and operations of as many as 11 buses for operation between downtown Oakland and Treasure Island. The initial service plan calls for five 40-foot buses and as development increases over a decade-long period, more and larger buses will be procured until final build-out service levels are achieved and the island has its forecast population of 20,000 residents. One of the affordable developments on Treasure Island was awarded an AHSC grant in the 2019 round that includes funding for four 40-foot ZEBs.

CLEAN CORRIDORS EVALUATION

There are four primary criteria used in this plan to evaluate AC Transit lines and prioritize their transition to zero-emission coaches:

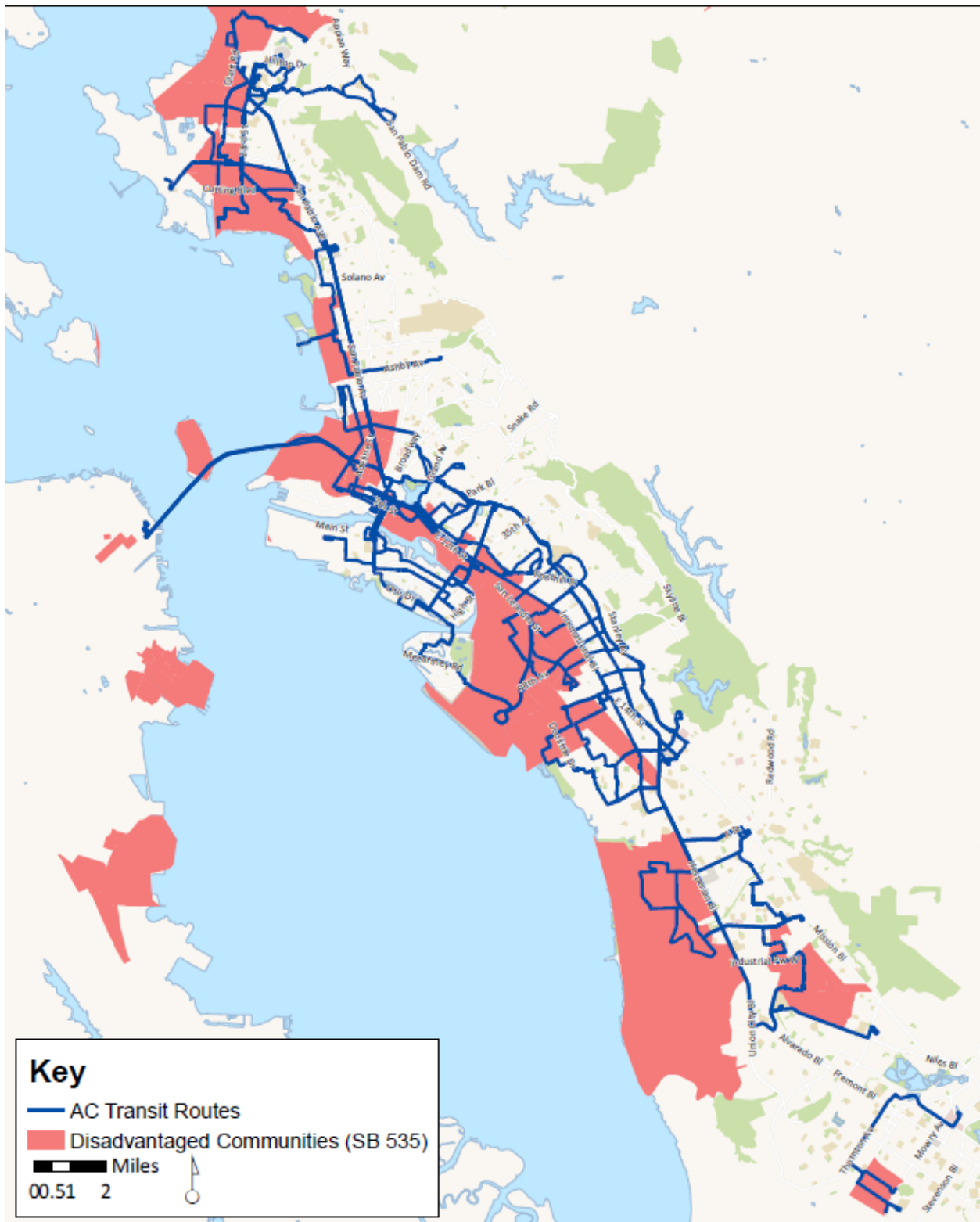
- 1) Inclusion in the list of DACs,
- 2) Division Infrastructure,
- 3) Appropriate Block length (i.e., daily service mileage), and
- 4) Service Frequency and Ridership.

Disadvantaged Communities

These communities stretch from the northern-most point of the District in Contra Costa County to nearly the southern-most part of Alameda County and touch all operating divisions (Richmond, Emeryville, East Oakland, and Hayward). The level of service offered in each of the SB 535 Disadvantaged Communities (DACs) varies considerably. North/West Oakland has the highest level of service with multiple lines offering service every 15 minutes or better and strong service levels at night and on the weekend. Ashland and Russell City have lower levels of service and many areas not served by AC Transit at all.

This criterion represents the “first cut” to determine which lines should be prioritized for future zero-emission buses. From an equity standpoint, the Clean Corridor Plan establishes as its foundation that all initial zero-emission buses should be focused on serving areas identified as DACs. The map in Exhibit 2 illustrates the DACs within the District as well as the AC Transit bus lines serving those communities.

Exhibit 2 – AC Transit Lines Serving SB 535 Disadvantaged Communities



Division Infrastructure

Divisions 2 and 4 currently have a combined fueling capacity of 41 FCEBs with an additional five BEBs for Division 4. The District is currently working with PG&E on electrical infrastructure requirements to support a significant expansion of BEBs at Division 4.

Divisions 2 is the next logical location after Division 4 for ZEBs as it is already home to a FCEB fleet. However, the District's Facilities Utilization Plan calls for building a new facility to replace Divisions 2 and 3, expanding Division 4 to allow Divisions 2 and 4 to merge, or some combination of the two. As the District continues to make decisions about the future of its facilities, no plans exist for adding electric charging infrastructure to Division 2. At this time, any ZEBs operating out of Emeryville will need to be FCEBs. Staff will re-evaluate ZEB expansion at D2 in coordination with the District's implementation of the Facility Utilization Plan.

Division 3 in Richmond is the District's smallest operating division but is in a DAC. Its small size would allow the District to convert a significant portion of the division's fleet to zero-emission just by converting the local Richmond lines – 70, 71, 74, 76 – to zero-emission along with the San Pablo Corridor lines.

Division 6 would be the lowest priority in the near-term given it has few lines serving DACs and many of the lines operating out of Division 6 have low ridership, meaning the benefits of zero-emission buses would be felt by fewer customers. As it does convert to zero-emission, priority should be placed on lines 10, 97, and 99.

Block Length

Since the adoption of the initial Clean Corridors Plan in 2017, the District has been refining plans for converting the fleet to 100-percent zero emission. In discussing the performance of BEBs already in use by peer operators, it has become clear that the daily range of these vehicles is more limited than a traditional diesel bus or a FCEB. This has been a common theme for the first BEBs that have begun service but improvements in battery technology are expected to result in much longer ranges in the future. This update of the Clean Corridors Plan serves as an opportunity to identify the lines where it makes most sense to deploy the first round of BEBs as they arrive over the next few years.

All AC Transit lines are dedicated to specific garages, so the following analysis is broken down by division. Each block at each division was analyzed for length and primary line (Owl, BART Early Bird, Supplementary,

and 300-series lines were excluded from this analysis as they are typically interlined or exist as very small pieces that are later grouped in longer blocks). The blocks were then split into groups:

AC TRANSIT DIVISIONS

Division 2 – Emeryville

Division 3 – Richmond

Division 4 – East Oakland

Division 6 – Hayward

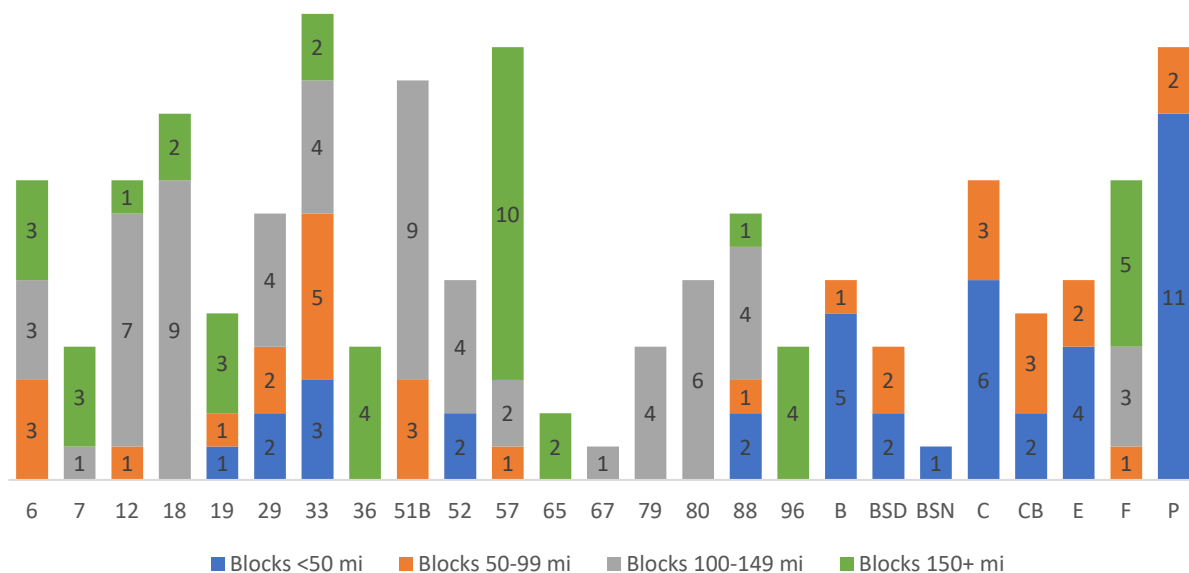
- Under 50 miles,
- 50 to 99 miles,
- 100 to 149 miles, and
- Over 150 miles.

These groupings were next organized by line and combined into the exhibits below. Each exhibit details the local and Transbay lines and how many total blocks are assigned to each line, with color-coding for the number of each length of block assigned to each line. This analysis is intended to provide insight into which lines at each division are candidates for zero-emission buses given daily range is a potential constraint.

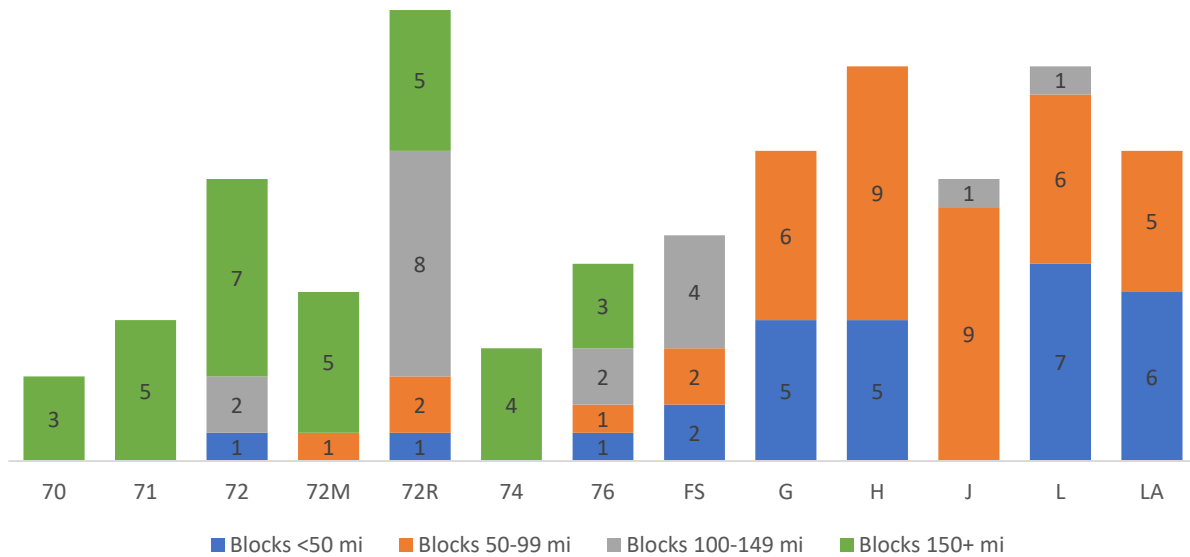
Exhibit 3 details the block lengths for Division 2 in Emeryville. Some lines have a high percentage of blocks greater than 150 miles. These include Lines 7, 19, 36, 57, 65, 96, and F. There are a handful of lines with a few long blocks – 6, 12, 18, 33, and 88. A significant number of lines have no blocks longer than 150 miles, including Lines 29, 51B, 52, 67, 79, 80, and all Transbay lines but Line F.

Taken together, these results mean Division 2 is a great candidate for BEBs based on the length of the blocks and the number of lines which could be operated without compromising on range and splitting blocks, thus adding buses to the fleet.

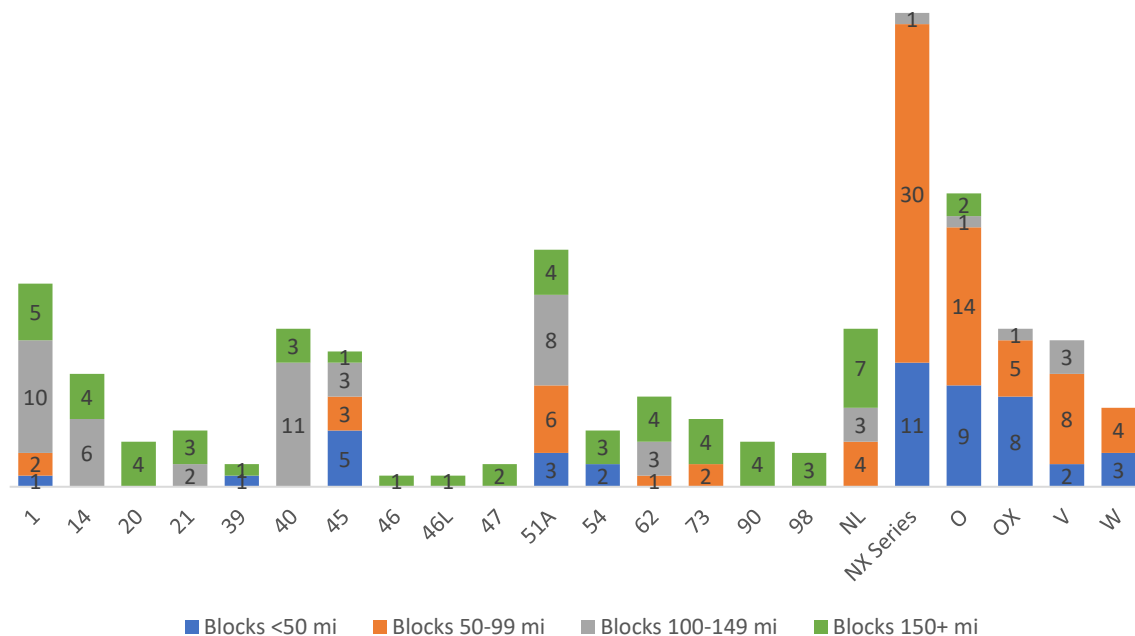
Exhibit 3 – Division 2 Block Lengths by Route



Based on the nature of the routes at Division 3 in Richmond and the location of the division in the District, the service is less conducive to a conversion to 100 percent zero-emission vehicles until such time as BEBs have a reliable range of more than 200 miles a day. It has no fuel-cell fueling infrastructure and many of its core lines are composed entirely of long blocks or have a high percentage of long blocks.

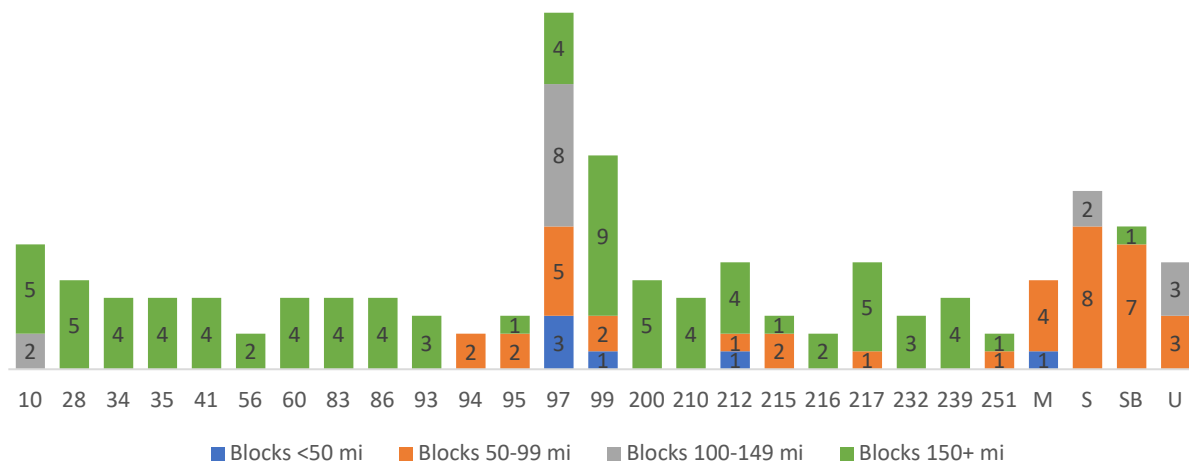
Exhibit 4 – Division 3 Block Lengths by Line

As illustrated in Exhibit 5, Division 4 has a mix of lines that would make the transition to zero-emission easy in the short-term, assuming the first round of BEBs will have a range below 150 miles a day. Many of the most important trunk lines in the system either have very few long blocks or none at all. These include Lines 14, 40, 45, 51A, O, and the NX series of Transbay lines.

Exhibit 5 – Division 4 Block Lengths by Line

Division 6 has a unique mix of lower-frequency lines that do not have distinct peaks in their headways, resulting in a significant number of lines composed entirely of long blocks, making it a poor destination for the initial round of BEBs. The only major exception is Line 97, which would lend itself well to a transition to zero-emission buses.

Exhibit 6 – Division 6 Block Lengths by Line



Following the evaluation of these lines solely on the number and length of their blocks, the lines were ranked by a number of key factors:

- 1) Whether the lines were part of a Disadvantaged Community as identified early in this document.
- 2) Number of blocks under 150 miles per day.
- 3) Average weekday ridership.

For the first factor, the groups were arranged alphabetically, with no preference for one group over another. When reading the chart, the fact that lines in Hayward come before lines in West Oakland does not mean the District will prioritize Hayward over West Oakland. Rather, the factors for number of blocks and ridership rank the lines within the groups for prioritization. It is also critical to note that many groups have lines split across multiple divisions. In addition, many lines cross into multiple groups – Line 72R could be included in Richmond, San Pablo Avenue, North Oakland, West Oakland, or Downtown Oakland – so transitioning to ZEBs on these lines will ultimately benefit numerous communities.

Exhibit 7 features the line ranking for Division 2. Looking at the chart, a number of lines stand out as viable candidates for the initial phase of BEBs. In Downtown Oakland, Line 33 carries more than 3,000 passengers each day and has 12 blocks of fewer than 150 miles. In North Oakland, Lines 12, 18, and 6 all have high numbers of shorter blocks and carry large numbers of passengers (more than 13,000 each day). In West Berkeley, Lines 51B, 52, and 80 would all be candidates for prioritization of zero-emission buses and

combine to carry approximately 13,000 riders each weekday. In West Oakland – one of the original Clean Corridors – Lines 29 and 88 have 15 blocks under 150 miles a day and combine to carry about 3,800 riders each weekday.

Exhibit 7 – Division 2 Zero-emissions Line Rankings

Division 2 Zero-emissions Index							
Route	Blocks <150 mi	Blocks 150+ mi	Total Blocks	Bus Type	Disadvantaged	Group	Weekday Ridership
33	12	2	14	40	Y	Downtown Oakland	3,298
96	0	4	4	40	Y	Downtown Oakland	1,408
19	2	3	5	40	Y	Fruitvale	781
57	3	10	13	40/60	Y	Macarthur-Grand	6,235
18	9	2	11	40	Y	North Oakland	4,382
12	8	1	9	40	Y	North Oakland	2,969
6	6	3	9	40	y	North Oakland	5,931
51B	12	0	12	40	Y	West Berkeley	9,440
C	9	0	9	45	Y	West Berkeley	414
52	6	0	6	60	Y	West Berkeley	2,742
80	6	0	6	40	Y	West Berkeley	895
F	4	5	9	40	Y	West Berkeley	2,038
29	8	0	8	40	Y	West Oakland	1,347
88	7	1	8	40	Y	West Oakland	2,450
36	0	4	4	40	Y	West Oakland	1,656
P	13	0	13	45	N		961
E	6	0	6	45	N		389
B	6	0	6	45	N		297
CB	5	0	5	45	N		296
79	4	0	4	40	N		1,802
BSD	4	0	4	40	Y		1,763
7	1	3	4	30	N		763
67	1	0	1	30	N		442
BSN	1	0	1	40	Y		194
65	0	2	2	30	N		632
Total	133	40	173				53,525

As noted in the previous section, there are few local lines operating out of Division 3 that are candidates for prioritization of zero-emission buses as many lines are reliant upon long blocks, with the exception of Line 72R. The Transbay lines out of Division 3 are viable zero-emission candidates but some would require a zero-emission double-decker bus to be available.

Exhibit 8 – Division 3 Zero-emissions Line Rankings

Division 3 Zero-emissions Index							
Route	Blocks <150 mi	Blocks 150+ mi	Total Blocks	Bus Type	Disadvantaged	Group	Weekday Ridership
L	14	0	14	Double	Y	Richmond	702
LA	11	0	11	Double	Y	Richmond	492
76	4	3	7	40	Y	Richmond	2,556
71	0	5	5	40	Y	Richmond	1,431
74	0	4	4	40	Y	Richmond	1,333
70	0	3	3	40	Y	Richmond	886
72R	11	5	16	40	Y	San Pablo	5,490
72	3	7	10	40	Y	San Pablo	3,735
72M	1	5	6	40	Y	San Pablo	3,449
J	10	0	10	Double	Y	West Berkeley	1,029
H	14	0	14	45	N		635
G	11	0	11	45	N		495
FS	8	0	8	Double	N		542
Total	87	32	119				22,775

There are numerous opportunities for ZEB prioritization at Division 4, the largest garage in the District. While Line 1 looks like a viable candidate, it will not be in the initial round of ZEB procurement given it will be replaced by the BRT special five-door vehicles that have already been procured as diesel hybrids. Line 40 along Foothill Boulevard stands out as a high-priority candidate for ZEBs given its high ridership (9,000 average weekday riders) and significant number of shorter blocks (11). Within the Coliseum grouping, Line 45 stands out as a good candidate for prioritization. In the Fruitvale grouping, Lines O and 51A account for 41 short blocks and 11,000 riders. For Macarthur-Grand, the entire NX series, as well as half of NL blocks can be converted to zero-emission and would account for approximately 49 blocks and 3,000 riders each day.

Exhibit 9 – Division 4 Zero-emissions Line Rankings

Division 4 Zero-emissions Index							
Route	Blocks <150 mi	Blocks 150+ mi	Total Blocks	Bus Type	Disadvantaged	Group	Weekday Ridership
45	11	1	12	40	Y	Coliseum	1,894
73	2	4	6	40	Y	Coliseum	2,709
98	0	3	3	40	Y	Coliseum	1,730
90	0	4	4	40	Y	Coliseum	963
46	0	1	1	40	Y	Coliseum	283
46L	0	1	1	40	Y	Coliseum	179
40	11	3	14	60	Y	Foothill	8,951
O	24	2	26	45/60	Y	Fruitvale	1,956
51A	17	4	21	40	Y	Fruitvale	9,170
54	2	3	5	40	Y	Fruitvale	2,113
21	2	3	5	40	Y	Fruitvale	1,714
39	1	1	2	40	Y	Fruitvale	505
20	0	4	4	40	Y	Fruitvale	2,656
47	0	2	2	40	Y	Fruitvale	117
1	13	5	18	BRT	Y	International	11,469
NX Series	42	0	42	45	Y	Macarthur-Grand	1,594
NL	7	7	14	40/60	Y	Macarthur-Grand	3,213
14	6	4	10	40	Y	West Oakland	4,675
62	4	4	8	40	Y	West Oakland	3,375
OX	14	0	14	45	N		596
V	13	0	13	45	N		814
W	7	0	7	45	N		571
Total	176	56	232				61,247

As noted previously, Division 6 has fewer opportunities for zero-emission prioritization as ridership is lower in the central and southern portions of Alameda County. In addition, there are few lines with significant numbers of short blocks, making the range limitation of the initial BEBs a significant issue. Aside from the Transbay lines, the line best-suited for zero-emission conversion is Line 97 given its high ridership and high number of short blocks.

Exhibit 10 – Division 6 Zero-emissions Line Rankings

Division 6 Zero-emissions Index							
Route	Blocks <150 mi	Blocks 150+ mi	Total Blocks	Bus Type	Disadvantaged	Group	Weekday Ridership
SB	7	1	8	45	Y	Fremont	429
232	0	3	3	40	Y	Fremont	410
251	5	0	5	40	N	Fremont	199
212	2	4	6	40	N	Fremont	771
200	0	5	5	40	N	Fremont	1,318
216	0	2	2	40	N	Fremont	313
97	16	4	20	60	Y	Hayward	4,093
S	10	0	10	45	Y	Hayward	194
M	5	0	5	45	Y	Hayward	238
60	0	4	4	40	Y	Hayward	1,263
86	0	4	4	40	Y	Hayward	1,111
83	0	4	4	40	Y	Hayward	969
41	0	4	4	40	Y	Hayward	540
56	0	2	2	40	Y	Hayward	451
U	6	0	6	45	Y		361
239	0	4	4	40	Y		640
99	3	9	12	60	Y		2,739
10	2	5	7	40	Y		3,322
28	0	5	5	40	Y		978
35	0	4	4	40	Y		885
34	0	4	4	40	Y		844
95	2	1	3	40	N		352
215	2	1	3	40	N		186
94	2	0	2	40	N		146
217	1	5	6	40	N		1,323
210	0	4	4	40	N		1,390
93	0	3	3	40	N		616
Total	74	83	157				26,081

Service Frequency and Ridership

The District operates 70 regular local and Transbay lines that also serve significant portions of the DACs identified in the map in Exhibit 2. The next step in the evaluation of which lines to prioritize for the operation of ZEBs is to rank the lines serving those communities by frequency and ridership. The purpose of using ridership is to ensure the new ZEBs benefit the greatest number of customers as they're rolled out, keeping in mind that ultimately all AC Transit vehicles will be zero-emissions by 2040. Frequency ensures that routes with the most buses are prioritized in order to maximize the benefit on ZEBs on the environment in the DACs.

Exhibit 11 illustrates those lines serving the DACs as well as their passengers/service hour (productivity), average daily ridership, and the number of buses in each direction during peak hours. The lines are in numerical order.

The highest-ridership line – Line 1 – is slated for replacement by AC Transit's first bus rapid transit line in 2020 and the District has taken delivery of purpose-built, five-door articulated buses for that line. All 27 of these vehicles are diesel-hybrid coaches.

To provide more clarity regarding which corridors or communities to prioritize as the first lines for ZEB deployment, the lines were then grouped by area. Some common themes emerged from these groupings:

- Many of the lines in East Oakland operate along single corridors – lines 20, 21, 39, 40, 46, 46L, 54, 73, 90, 98, etc. – but also operate out of either Fruitvale BART or Coliseum BART and are combined into groupings as a result.
- Some lines had lower ridership but were in key areas such as Richmond or West Oakland where they could be coupled with other lines to form a cohesive community of clean buses, including lines 29 and 36 in West Oakland and lines 71 and 74 in Richmond.
- Lines in Hayward and Fremont had low ridership on their own but could be combined into large groupings that carry significant numbers of riders.
- Taken together, the lines comprise 140,000 weekday riders across 370 peak buses, making up 78 percent of District ridership and 70 percent of the peak fleet pull-out.

Exhibit 11 – Lines Serving SB 535 Disadvantaged Communities

Route	Route Type	Division	Estimated Avg Daily Pass	Pass per Rev Hour	Area	Buses/Hour/Direction	Peak Vehicles
1	Trunk	D4	11,469	43.1	International	8	18
6	Trunk	D2	5,931	38.3	North Oakland	6	11
12	Trunk	D2	2,969	21.3	North Oakland	3	9
14	Urban Crosstown	D4	4,675	31.9	West Oakland	4	10
18	Trunk	D2	4,382	28.1	North Oakland	4	10
19	Urban Crosstown	D2	781	14.1	Fruitvale	3	4
20	Major Corridor	D4	2,656	33.3	Fruitvale	2	4
21	Urban Crosstown	D4	1,714	25.1	Fruitvale	2	5
29	Urban Crosstown	D2	1,347	16.6	West Oakland	3	6
33	Trunk	D2	3,298	26.2	Downtown Oakland	4	11
36	Urban Crosstown	D2	1,656	22.7	West Oakland	2	4
39	Urban Crosstown	D4	505	35.5	Fruitvale	1	1
40	Trunk	D4	8,951	44.2	Foothill	5	13
41	Trunk	D6	540	11.4	Hayward	1	1
45	Urban Crosstown	D4	1,894	21.7	Coliseum	2	6
46	Urban Crosstown	D4	283	20.1	Coliseum	1	1
47	Urban Crosstown	D4	117	13.1	Fruitvale	1	1
52	Urban Crosstown	D2	2,742	37.4	West Berkeley	4	5
54	Urban Crosstown	D4	2,113	44.7	Fruitvale	6	3
56	Suburban Crosstown	D6	451	8.8	Hayward	1	5
57	Trunk	D2	6,235	30.3	Macarthur-Grand	4	4
60	Suburban Crosstown	D6	1,263	18.0	Hayward	3	4
62	Urban Crosstown	D4	3,375	28.5	West Oakland	4	8
70	Urban Crosstown	D3	886	20.6	Richmond	2	3
71	Urban Crosstown	D3	1,431	20.1	Richmond	2	5
72	Trunk	D3	3,735	27.4	San Pablo Avenue	2	8
73	Major Corridor	D4	2,709	37.8	Coliseum	4	4
74	Urban Crosstown	D3	1,333	20.2	Richmond	2	4
76	Urban Crosstown	D3	2,556	32.0	Richmond	2	6
80	Trunk	D2	895	9.5	West Berkeley	2	6
83	Suburban Crosstown	D6	969	15.0	Hayward	2	4
86	Suburban Crosstown	D6	1,111	14.5	Hayward	2	4
88	Major Corridor	D2	2,450	25.6	West Oakland	4	7
90	Trunk	D4	963	20.5	Coliseum	3	0
96	Urban Crosstown	D2	1,408	21.7	Downtown Oakland	2	4
97	Major Corridor	D6	4,093	27.6	Hayward	4	13
98	Trunk	D4	1,730	23.9	Coliseum	3	7
200	Suburban Crosstown	D6	1,318	14.6	Fremont	2	5
212	Very Low Density	D6	771	10.6	Fremont	2	4
216	Very Low Density	D6	313	11.0	Fremont	1	2
232	Very Low Density	D6	410	12.4	Fremont	1	4
251	Very Low Density	D6	199	11.8	Fremont	1	2

Exhibit 11 – Lines Serving SB 535 Disadvantaged Communities (cont.)

Route	Route Type	Division	Estimated Avg Daily Pass	Pass per Rev Hour	Area	Buses/Hour/Direction	Peak Vehicles
46L	Urban Crosstown	D4	179	13.0	Coliseum	1	1
51A	Trunk	D4	9,170	45.0	Fruitvale	6	13
51B	Trunk	D2	9,440	60.6	West Berkeley	6	10
72M	Trunk	D3	3,449	28.3	San Pablo Avenue	2	8
72R	Rapid	D3	5,490	30.7	San Pablo Avenue	5	15
BSD	Shuttle	D2	1,763	54.2	Downtown Oakland	5	3
BSN	Shuttle	D2	194	19.8	Downtown Oakland	2	0
C	Transbay	D2	414	31.8	West Berkeley	2	5
F	Transbay	D2	2,038	20.5	West Berkeley	2	6
J	Transbay	D3	1,029	56.1	West Berkeley	4	6
L	Transbay	D3	702	25.0	Richmond	6	8
LA	Transbay	D3	492	17.5	Richmond	6	5
M	Transbay	D6	238	12.1	Hayward	1	3
NL	Transbay	D4	3,213	24.9	Macarthur-Grand	4	10
NX	Transbay	D4	347	37.4	Macarthur-Grand	3	3
NX1	Transbay	D4	188	28.9	Macarthur-Grand	3	3
NX2	Transbay	D4	269	25.4	Macarthur-Grand	3	3
NX3	Transbay	D4	360	23.8	Macarthur-Grand	3	4
NX4	Transbay	D4	399	21.4	Macarthur-Grand	5	6
NXC	Transbay	D4	31	11.2	Macarthur-Grand	1	1
O	Transbay	D4	1,956	26.8	Fruitvale	6	10
S	Transbay	D6	194	12.8	Hayward	2	4
SB	Transbay	D6	429	18.3	Fremont	4	7
Z	Transbay	D3	57	14.8	West Berkeley	1	0

The first Clean Corridors Plan identified four major corridors or communities for prioritization for zero-emission infrastructure:

- San Pablo Avenue
- West Oakland
- Macarthur-Grand
- Richmond

The new CARB requirement for all buses to be zero-emission by 2040 has resulted in a tweaked methodology for this update of the Clean Corridors Plan. This brings the number of lines to 70 (from 39) and also yields new groupings, some of which have higher ridership than those in the initial plan, which was much more focused on only routes that existed entirely within DACs. Many of these new routes serve DACs with part of their alignment.

Exhibit 12 groups the lines into their respective corridors or communities and approaches the ranking differently. In this case, the methodology focuses on frequency as illustrated by the number of buses per hour, per direction. To provide context, a line like Line 97 which operates every 15 minutes has four buses running per hour per direction. Frequency provides a good indication of the impact to the surrounding community from switching from diesel buses to zero-emission buses. The more buses running in a community or along a corridor, the greater the impact of switching to zero-emissions

With this update, the number of peak vehicles per hour per direction is a key factor in helping to determine the relative impact of converting a line or service area into a purely zero-emission Clean Corridor. To do this, the average weekday ridership is divided by the number of peak vehicles per direction per hour. Doing so allows the District to prioritize lines where the greatest number of buses running along a corridor can be converted to zero-emission.

Exhibit 12 – Clean Corridor Line Groupings

Area	Lines	Division(s)	Weekday Ridership	Peak Vehicles	Buses/Hour/Direction	Riders per Vehicle
Fruitvale	19, 20, 21, 39, 47, 51A, 54, O	D2, D4	19,012	41	27	704
Macarthur-Grand	57, NL, NXs	D2, D4	11,042	34	26	425
West Berkeley	51B, 52, 80, C, F, J, Z	D2, D3	16,615	38	21	791
Richmond	70, 71, 74, 76, L, LA	D3	7,400	31	20	370
West Oakland	14, 29, 36, 62, 88	D2, D4	13,503	35	17	794
Hayward	41, 56, 60, 83, 86, 97, M, S	D6	8,859	38	16	554
Coliseum	45, 46, 46L, 73, 90, 98	D4	7,758	19	14	554
North Oakland	6, 12, 18	D2	13,282	30	13	1,022
Downtown Oakland	33, 96, BS	D2, D4	6,663	18	13	513
Fremont	200, 212, 216, 232, 251, SB	D6	3,440	24	11	313
San Pablo Avenue	72, 72M, 72R	D3	12,674	31	9	1,408
International	1	D4	11,469	18	8	1,434
Foothill	40	D4	8,951	13	5	1,790

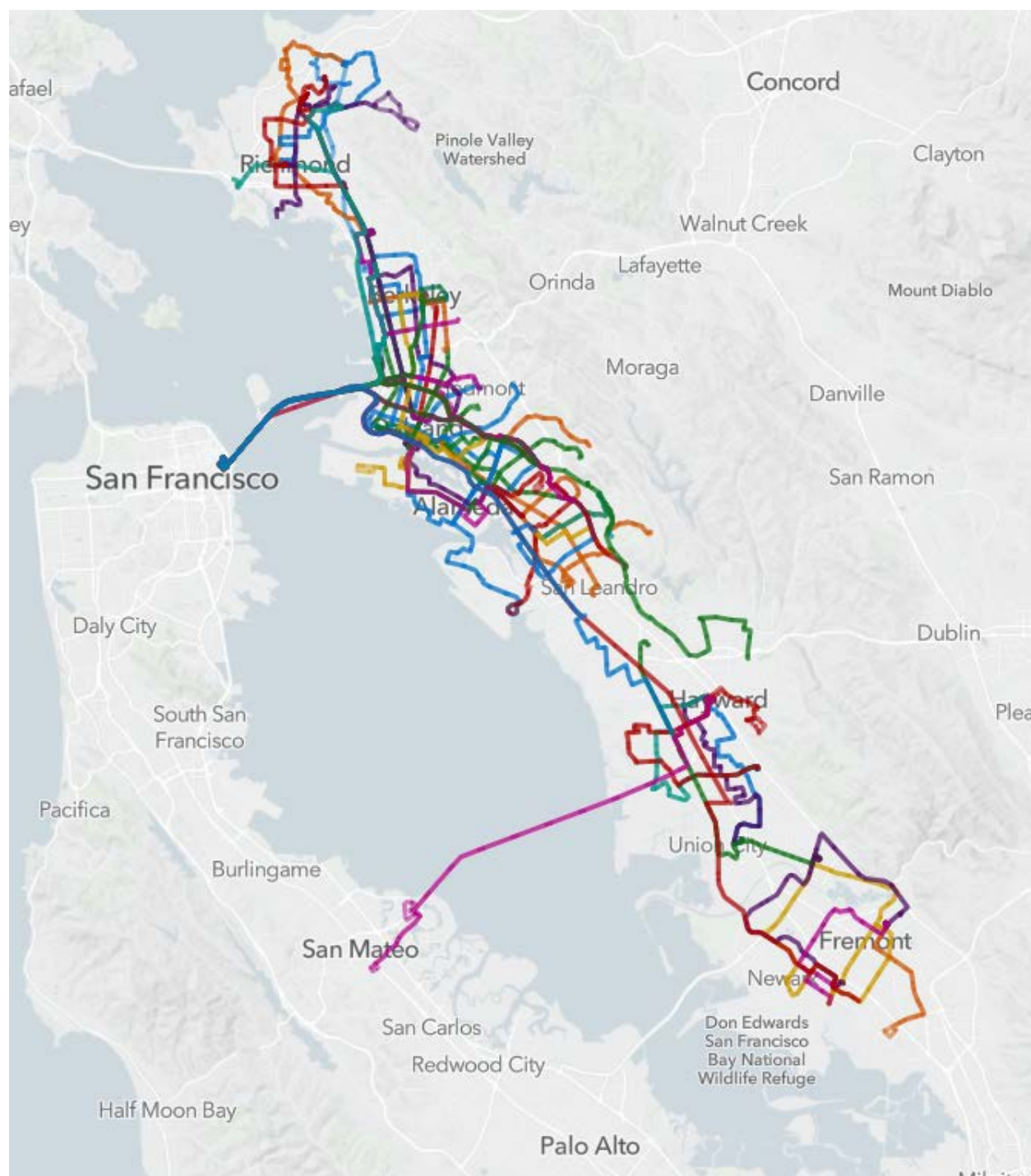
CLEAN CORRIDORS

Based on the analysis in the previous section, several key corridors and communities in the service area have been identified as the next to prioritize for zero-emission conversion, keeping in mind the entire fleet will be zero-emission by 2040 at the latest. The corridors are prioritized by division, given Division 4 will be the first to have extensive battery-electric charging infrastructure. Expansion of ZEBs at Division 2 will be reassessed as the District decides how the vision outlined in the Facilities Utilization Plan will be implemented. As Division 2 is recommended to be replaced, a major investment in zero-emission infrastructure beyond the recent hydrogen fueling upgrades is not programmed. The Clean Corridors are grouped (alphabetically) as the following:

- Coliseum
- Downtown Oakland
- Foothill
- Fremont
- Fruitvale
- Hayward
- International
- Macarthur-Grand
- North Oakland
- Richmond
- San Pablo
- West Berkeley
- West Oakland

These Clean Corridors cover the majority of the service area, from Richmond to Fremont. Taken together, lines in these corridors carry 78 percent of the District's average weekday ridership and serve more than 1,120,000 residents and 400,000 jobs within one-quarter mile of their stops. The Clean Corridor lines require 371 buses to operate in peak service, with another 93 spares to support operations and facilitate preventative maintenance. Exhibit 13 illustrates the Clean Corridors network coverage.

Exhibit 13 – Clean Corridor Lines



Each of the Clean Corridors has a different mix of communities, line types, and bus types. The corridors also overlap in many ways. Line NL serves both the Macarthur-Grand and West Oakland corridors. The San Pablo Corridor serves San Pablo Avenue, West Oakland, and Richmond. Each Clean Corridor is discussed in more detail below. For cost purposes, this report assumes the highest list price for zero-emission vehicles depending on bus size. The costs, shown in Exhibit 14, were taken from the District's

Zero Emission Bus Study from February 2019 and reflect the base price of the vehicles, without any additional options or systems (TSP, Farebox, etc.). The report also estimates an incremental cost of \$496,000 for charging/fueling infrastructure for each bus, this is the same figure used in the previous Clean Corridors Plan. For Transbay bus costs, this report assumes all vehicles on peak-only Transbay lines will use 45' coaches as firm figures for zero-emission double-decker coaches are not available at this time. The overall cost assumptions are based on the District's past experience with procuring ZEBs and supporting infrastructure and do not reflect maintenance or operations costs. As the District procures more ZEBs and the technology matures, these costs are likely to come down. For the purposes of this report, the estimates are conservative and grants are likely to cover significant portions of future ZEB and infrastructure procurements.

Exhibit 14 – Estimated Costs by Fuel and Fleet Type

Length	Diesel	Hybrid	Gasoline	Electric	Hydrogen
26'			\$ 110,000	\$ 350,000	\$ 500,000
30'	\$ 365,000			\$ 625,000	\$ 900,000
40'	\$ 500,000	\$ 775,000		\$ 900,000	\$ 1,300,000
45'	\$ 660,000			\$ 1,000,000	\$ 1,450,000
60'	\$ 650,000			\$ 1,300,000	\$ 1,550,000

Source: AC Transit Zero Emissions Bus Study Table 17

Many of the corridors and communities have lines housed in different garages. It is critical to note Division 4 will likely be the first division to be converted to BEB and capacity for hydrogen fueling will max out at 41 vehicles between Divisions 2 and 4, so the scale of the infrastructure will play a critical role in the order in which the corridors are converted to zero-emission.

Coliseum

The Coliseum area has service focused around Coliseum BART in East Oakland, with lines providing cross-town connections along major numbered streets and connecting with major north-south corridors (International, Foothill, Macarthur). The lines serving Coliseum – 45, 46, 46L, 73, 90, and 98 – carry 7,700 riders each weekday and serve Seminary, 81st, 82nd, 85th, 90th, 98th, and 105th. These routes are some of the District's highest frequency cross-town routes.

The total cost of converting these lines to zero-emission is estimated to be \$46,696,000, including infrastructure. All lines operate using 40' coaches out of Division 4 in East Oakland.

Exhibit 15 – Coliseum Corridor Map

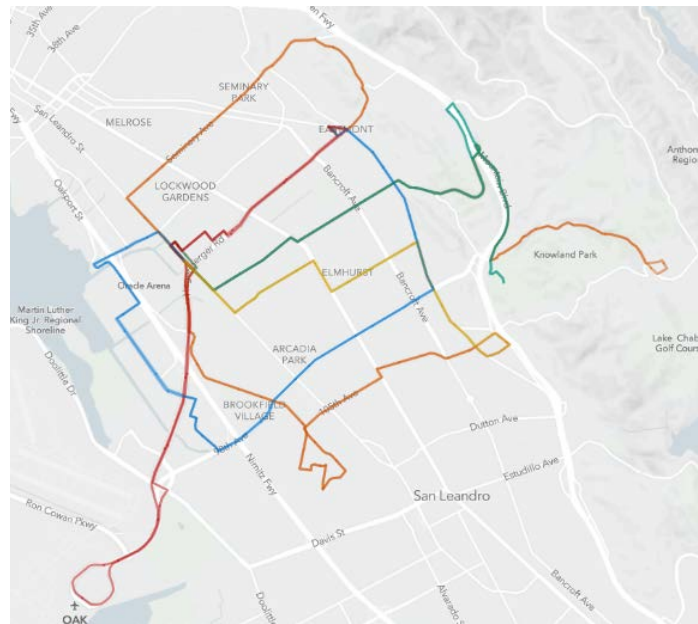


Exhibit 16 – Coliseum Corridor Fleet and Costs

Coliseum Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
45	4	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
46	4	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
46L	4	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
73	4	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
90/98	4	40'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
Total			19	4	26	\$ 33,800,000	\$ 12,896,000	\$ 46,696,000

Downtown Oakland

While many AC Transit lines serve downtown Oakland – it is the core of the network – most other lines in this document are included within other DACs, leaving Lines 33, 96, and the Broadway Shuttle within the downtown Oakland Corridor. These three lines carry a combined 6,600 riders each weekday and also provide service up Park Boulevard, Oakland Avenue, into Chinatown, and Alameda Point. Lines 33 and 96 are relatively frequent crosstown routes with 17- and 20-minute frequencies respectively.

The total cost of converting these lines to zero-emission is estimated to be \$41,308,000, including infrastructure. All lines operate out of Division 2 in Emeryville and are assigned or can accommodate 40' coaches.

Exhibit 17 – Downtown Oakland Corridor

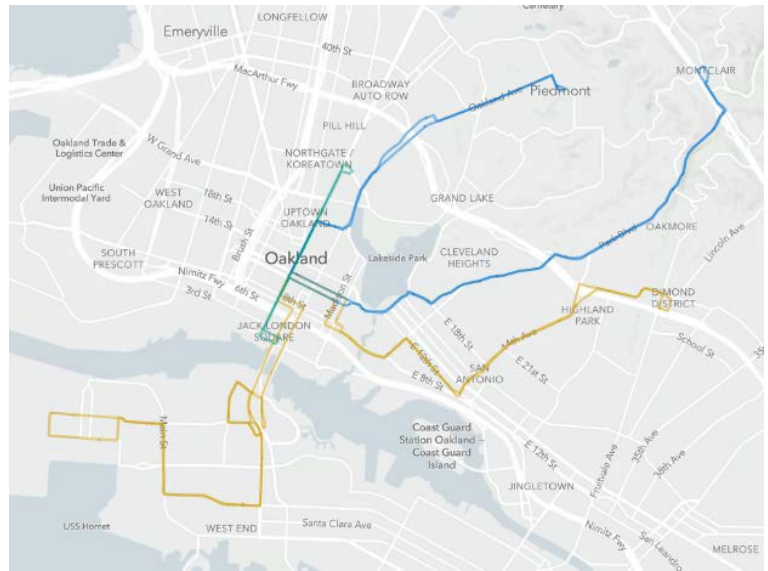


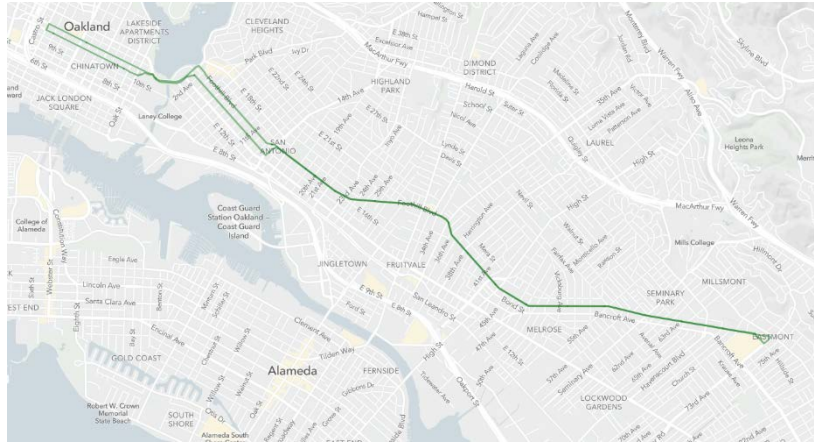
Exhibit 18 – Downtown Oakland Corridor Fleet and Costs

Downtown Oakland Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
33	2	40'	11	3	14	\$ 18,200,000	\$ 6,944,000	\$ 25,144,000
96	2	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
Broadway Shuttle	2	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
Total			18	4	23	\$ 29,900,000	\$ 11,408,000	\$ 41,308,000

Foothill

The Foothill Clean Corridor consists of a single line – Line 40 – and carries nearly 9,000 riders each weekday on its alignment between downtown Oakland and Bay Fair BART. It is a major north-south corridor operating at every 10 minutes and is the fourth-highest ridership line in the system (behind Lines 1, 51A, and 51B). The line serves the heart of East Oakland and provides connections with all other lines serving East Oakland.

Exhibit 19 – Foothill Corridor Map



The total cost of converting Line 40 to zero-emission is estimated to be \$32,736,000, including infrastructure. Line 40 is assigned 60' articulated coaches and operates out of Division 4 in East Oakland.

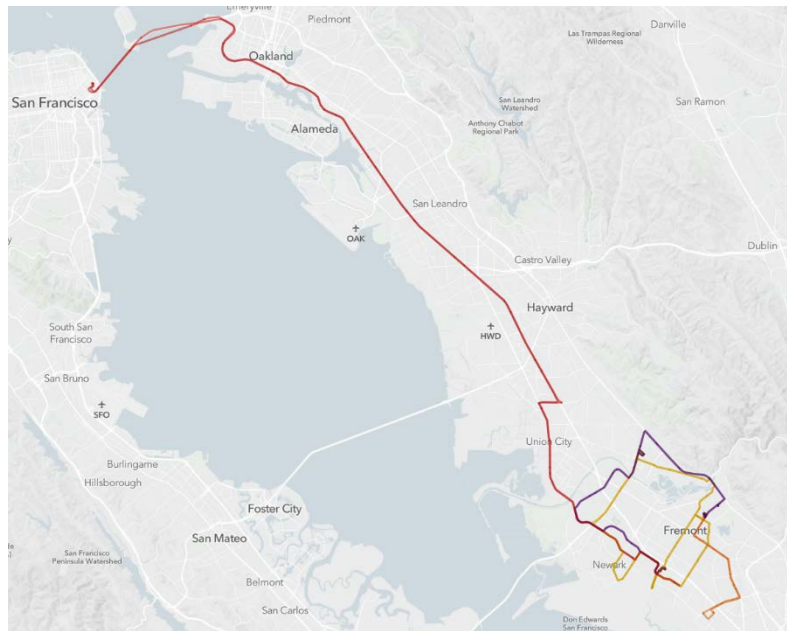
Exhibit 20 – Foothill Corridor Fleet and Costs

Foothill Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
40	4	60'	13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000
Total			13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000

Fremont

Fremont is the fourth-largest city in the Bay Area, behind San Jose, San Francisco, and Oakland. It is undergoing rapid growth and the City is focusing on increasing density near BART and along major transit corridors. The lines serving DACs in Fremont and Newark – 200, 212, 216, 232, 251, and SB -- are generally low-frequency but the District is developing a plan to restructure service or make improvements to frequency along major corridors. Together, the lines serving DACs in Fremont carry 3,440 riders each weekday.

Exhibit 21 – Fremont Corridor Map



The total cost of converting these lines to zero-emission is estimated to be \$55,230,000, including infrastructure. All lines operate out of Division 6 in Hayward and line SB is assigned 45' over-the-road coaches.

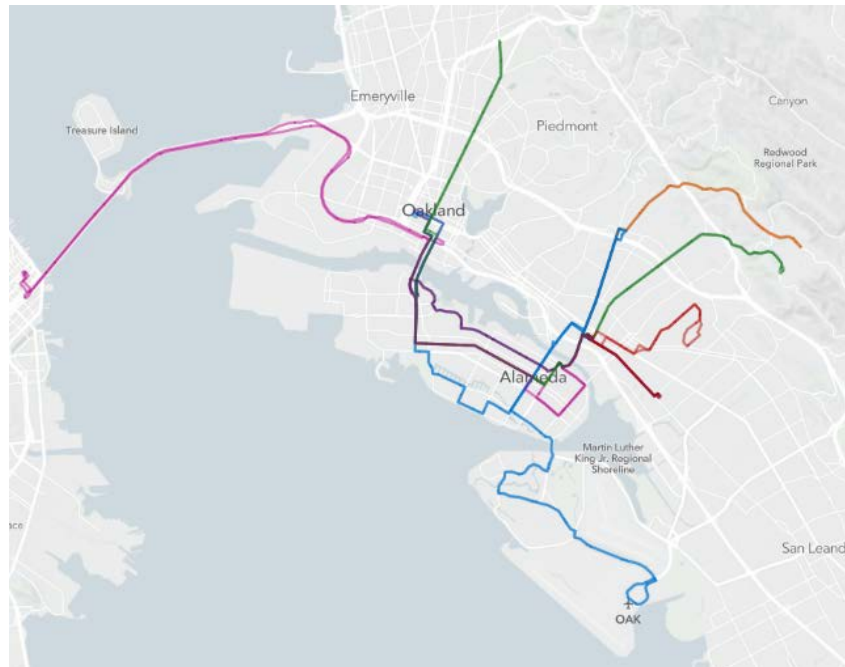
Exhibit 22 – Fremont Corridor Fleet and Costs

Fremont Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
200	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
212	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
216	6	40'	2	1	3	\$ 3,900,000	\$ 1,488,000	\$ 5,388,000
232	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
251	6	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
SB	6	45'	7	2	9	\$ 13,050,000	\$ 4,464,000	\$ 17,514,000
Total			23	7	30	\$ 39,000,000	\$ 14,880,000	\$ 55,230,000

Fruitvale

Fruitvale is a vibrant cultural district and a major node for AC Transit. The lines serving Fruitvale – 19, 20, 21, 39, 47, 51A, 54, O – also serve other parts of East Oakland, Alameda, and downtown Oakland. In addition to these lines, Lines 1 (BRT), 14, 40, and 62 serve Fruitvale and are captured in other Clean Corridors. These lines carry 19,000 riders each weekday and require 41 peak vehicles to operate due to the high-frequency of service.

Exhibit 23 – Fruitvale Corridor Map



The total cost of converting these lines to zero-emission is estimated to be \$93,392,000, including infrastructure. Line 19 operates out of Division 2 in Emeryville and all other lines operate out of Division 4 in East Oakland. All lines are assigned 40' coaches, with the exception of Line O, which can accommodate 45' over-the-road coaches or 60' articulated coaches.

Exhibit 24 – Fruitvale Corridor Fleet and Costs

Fruitvale Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
19	2	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
20	4	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
21	4	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
39	4	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
47	4	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
51A	4	40'	13	3	16	\$ 20,800,000	\$ 7,936,000	\$ 28,736,000
54	4	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
O	4	45'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
Total			41	11	52	\$ 67,600,000	\$ 25,792,000	\$ 93,392,000

Hayward

Hayward is in west-central Alameda County and recently underwent significant service changes as part of AC Go aimed at breaking up loops, increasing frequency and span, and adding weekend service to make transit a more attractive option. The lines serving Hayward – 41, 56, 60, 86, 97, M, and S – also serve San Leandro and unincorporated portions of Alameda County. Together, these lines carry 8,859 riders each weekday and are less frequent than similar routes to the north

The total cost of converting these lines to zero-emission is estimated to be \$86,208,000, including infrastructure.

Line 97 is assigned 60' articulated coaches, Lines S and M are assigned 45-foot over-the-road coaches and all other lines are assigned 40' coaches. All lines operate out of Division 6 in Hayward.

Exhibit 25 – Hayward Corridor Map

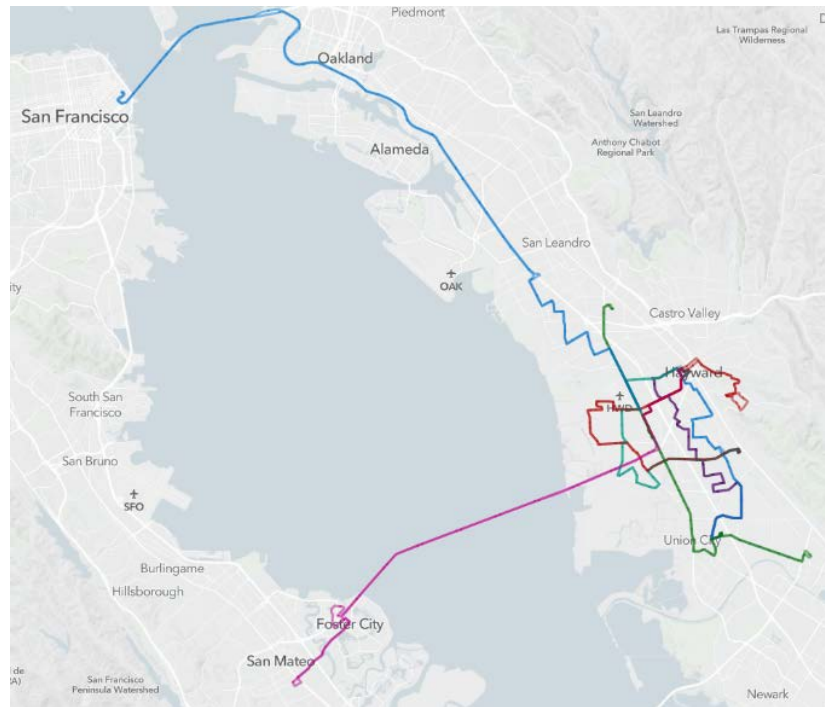


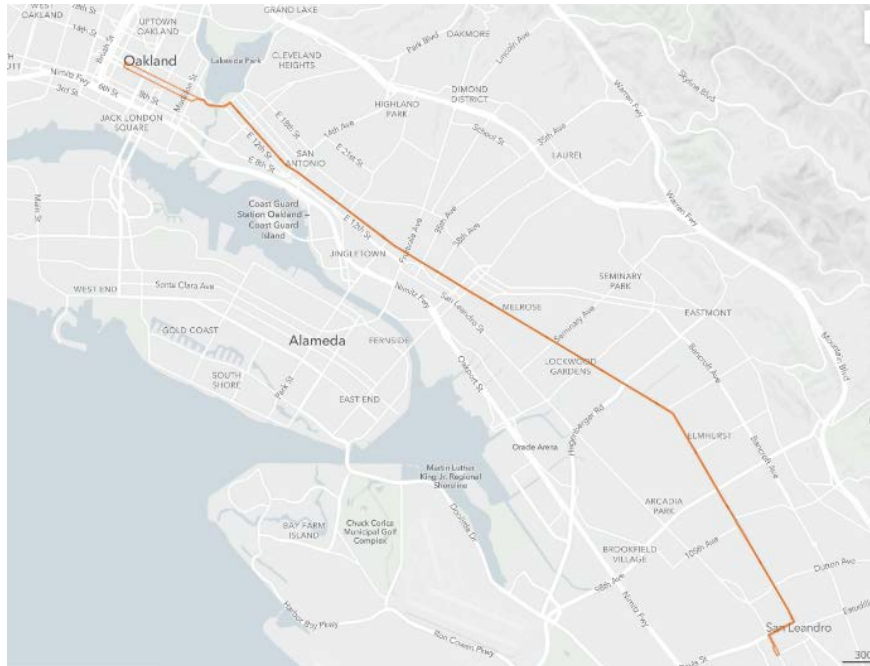
Exhibit 26 – Hayward Corridor Fleet and Costs

Hayward Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
41	6	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
56	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
60	6	60'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
83	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
86	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
97	6	60'	13	3	16	\$ 20,800,000	\$ 7,936,000	\$ 28,736,000
M	6	45'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
S	6	45'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
Total			38	10	48	\$ 62,400,000	\$ 23,808,000	\$ 86,208,000

International

The international/East 14th Corridor is served by the highest-ridership line in the system – Line 1 – carrying 11,500 riders each weekday and operating at a 10-minute frequency. This corridor will be converted into BRT, in FY 2019/20. The BRT line, named Tempo, will include longer stop spacing, level-boarding, all-door boarding, off-board fare payment, dedicated transit lanes, and new transit signal priority from San Leandro BART to uptown Oakland. The corridor will

Exhibit 27 – International Corridor Map



have a combination of center-running lanes and side-running lanes, meaning the new vehicles procured for Tempo have doors on both sides of the coach, making them unique in the system. Given they are brand new, the hybrid coaches used to start the service will not be replaced for another twelve years.

The total cost of converting Line 1 to zero-emission is estimated to be \$45,012,000, including infrastructure. As previously mentioned, this line will be converted into a BRT service with a dedicated sub-fleet of 60-foot articulated coaches with doors on both sides of the vehicle and will operate out of Division 4 in East Oakland.

Exhibit 28 – International Corridor Fleet and Costs

International Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
1	4	60'	18	4	22	\$ 34,100,000	\$ 10,912,000	\$ 45,012,000
Total			18	4	22	\$ 34,100,000	\$ 10,912,000	\$ 45,012,000

Macarthur-Grand Corridor

The Macarthur-Grand Corridor stretches from the Foothill Square Shopping Center near Macarthur and 106th through downtown Oakland and into Emeryville and San Francisco. The corridor crosses through a variety of different neighborhoods including West Oakland, the Diamond District, Grand Lake, and the Laurel District. It is served by Lines 57, NL, and six NX lines, carrying more than 11,000 customers on a typical weekday.

The corridor requires 33 peak buses and as many as seven spares to operate due to the high frequency of Line 57 and the combined frequency of the express buses.

The total cost of converting these lines to zero-emission is estimated to be \$83,886,000, including infrastructure. This effort received grant funding from the TIRCP and the SB1 Local Partnership Program and will be completely converted by 2022.

Exhibit 29 – Macarthur-Grand Corridor

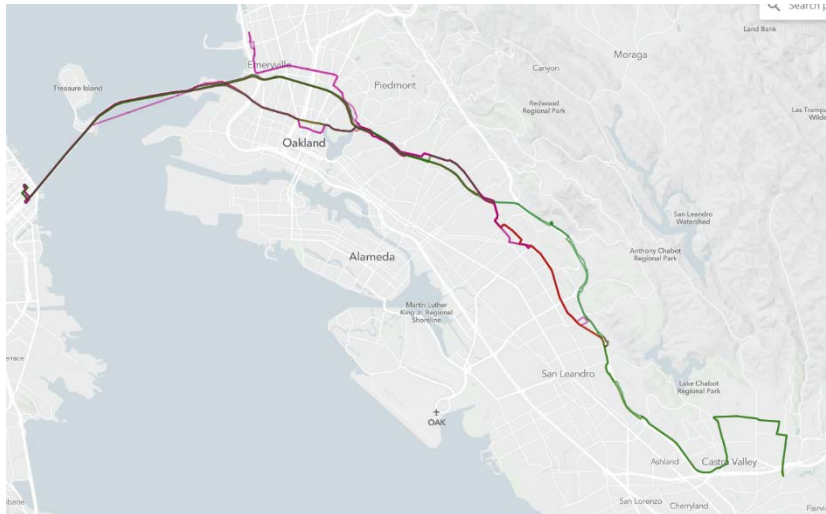


Exhibit 30 – Macarthur-Grand Corridor Fleet and Costs

Macarthur-Grand Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
57	2	60'	13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000
NL	4	60'	14	3	17	\$ 26,350,000	\$ 8,432,000	\$ 34,782,000
NX Series	4	45'	6	2	8	\$ 12,400,000	\$ 3,968,000	\$ 16,368,000
Total			33	8	41	\$ 63,550,000	\$ 20,336,000	\$ 83,886,000

North Oakland

The North Oakland Corridor has three high-ridership lines – 6, 12, and 18 – which carry more than 13,000 riders each weekday. It covers a mix of neighborhoods in Oakland and Berkeley that range from wealthy – Rockridge and Temescal – to transitioning – Bushrod, Longfellow. These lines primarily connect downtown Oakland with downtown Berkeley via major corridors such as Telegraph, Martin Luther King, and Shattuck; all of which have frequencies equivalent to a major transit corridor

The total cost of converting these lines to zero-emission is estimated to be \$66,452,000, including infrastructure. All lines are assigned 40-foot coaches and operate out of Division 2 in Emeryville.

Exhibit 31 – North Oakland Corridor Map

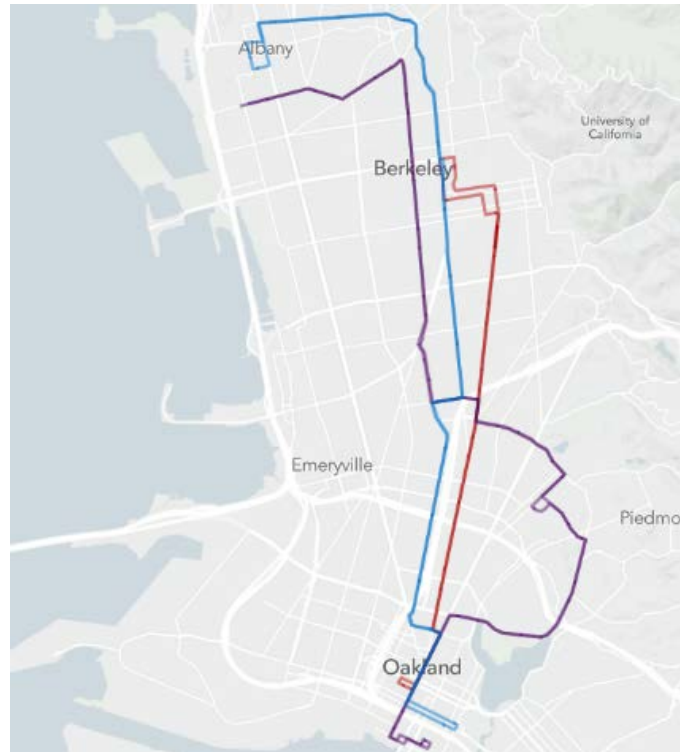


Exhibit 32 – North Oakland Corridor Fleet and Costs

North Oakland Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
6	2	40'	11	3	14	\$ 18,200,000	\$ 6,944,000	\$ 25,144,000
12	2	40'	9	2	11	\$ 14,300,000	\$ 5,456,000	\$ 19,756,000
18	2	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
Total			30	7	37	\$ 48,100,000	\$ 18,352,000	\$ 66,452,000

Richmond

Similar to West Oakland, Richmond is hemmed in by two freeways and is home to some heavy industrial sites, including the Chevron oil refinery. The area is served by six lines not covered by other Clean Corridors: 70, 71, 74, 76, L, and LA. Together, these buses carry more than 6,500 customers on a typical weekday and require 18 peak buses and four spares to operate. These routes operate at a 30-minute frequency with higher frequency on the Transbay routes.

The total cost of converting these lines to zero-emission is estimated to be \$70,044,000, including infrastructure. All six lines operate out of Division 3. The Richmond facility does not currently have any electric charging stations or hydrogen fueling infrastructure in place. As such, any conversion of the fleet at Division 3 from diesel to zero-emission will require either new electric charging infrastructure or a new fueling hydrogen station altogether, as well as providing for maintenance accommodations for FCEBs.

Exhibit 33 – Richmond Corridor Map

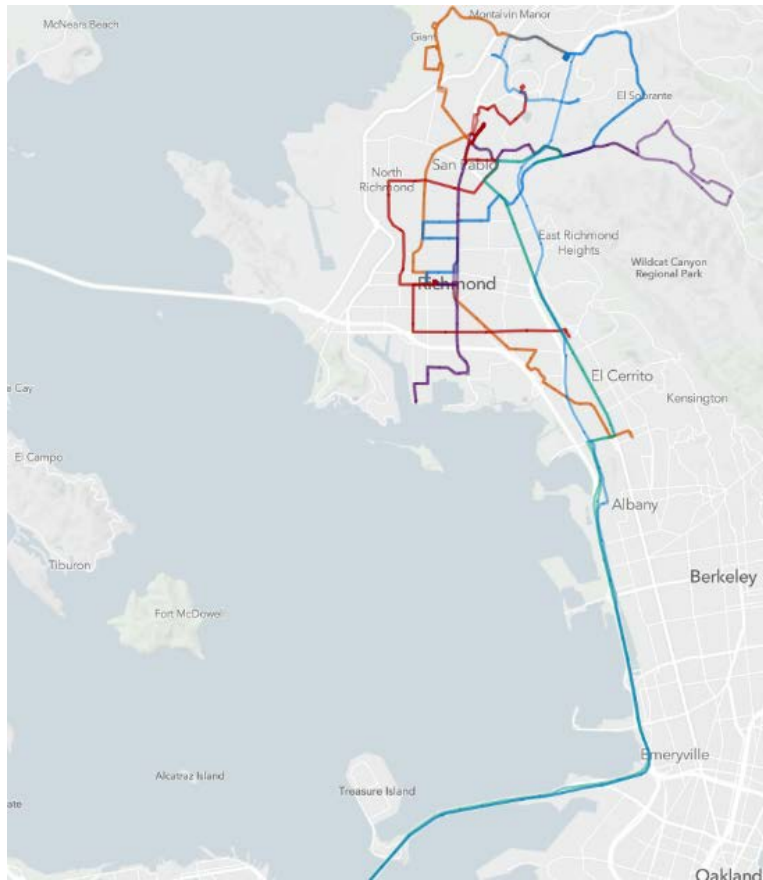


Exhibit 34 – Richmond Corridor Fleet and Costs

Richmond Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
70	3	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
71	3	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
74	3	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
76	3	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
L	3	45'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
LA	3	45'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
Total			31	8	39	\$ 50,700,000	\$ 19,344,000	\$ 70,044,000

San Pablo Avenue

The San Pablo Avenue Corridor is the longest of the four, with three lines serving Oakland, Emeryville, Berkeley, Albany, El Cerrito, Richmond, and San Pablo. Lines 72, 72M, and 72R carry nearly 14,000 riders on a typical weekday and have a combined headway of about 6.5 minutes through the core of the corridor (Jack London Square to Macdonald Avenue in Richmond). Together, the lines require 33 peak buses and seven spares to operate each weekday. Operating these lines exclusively with zero-emission vehicles would benefit more than 150,000 residents living within a quarter mile of the bus stops they serve.

The total cost of converting these lines to zero-emission is estimated to be \$73,636,000, including infrastructure. All of these lines operate out of Division 3 in Richmond, which has neither hydrogen fueling or electric charging infrastructure in place. Any zero-emission buses at Division 3 will require either new electric charging infrastructure or a new hydrogen fueling station altogether, as well as providing for maintenance accommodations for FCEBs.

Exhibit 35 – San Pablo Avenue Corridor

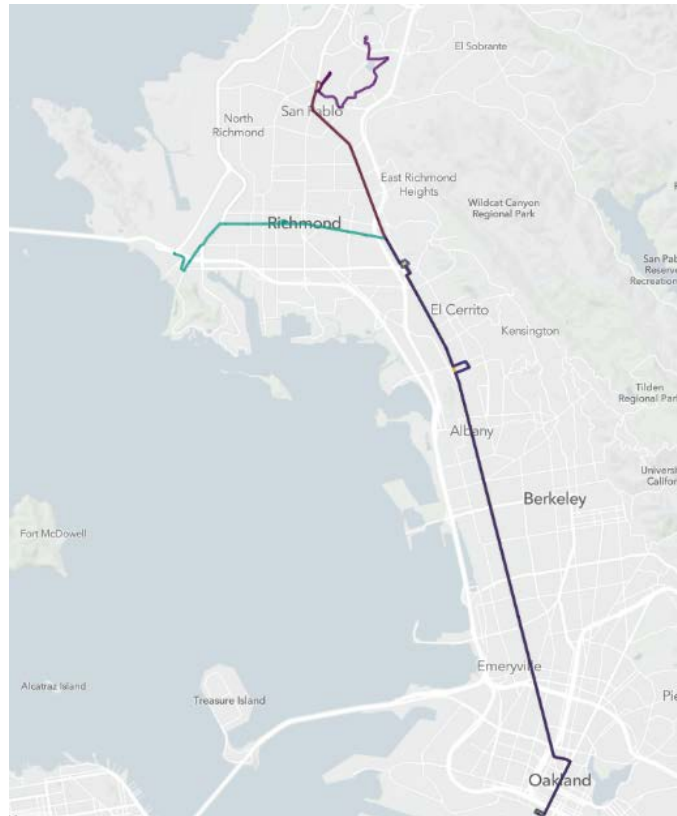
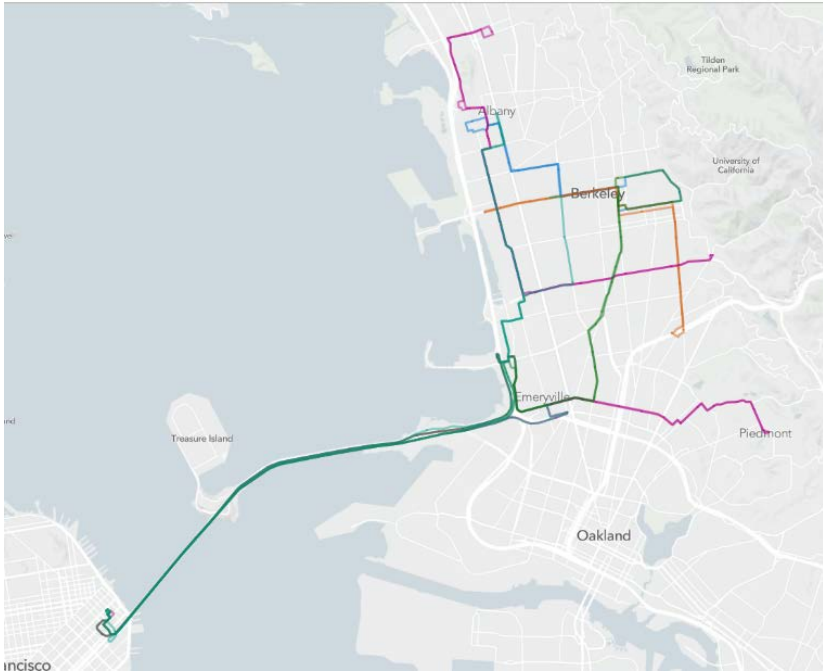


Exhibit 36 – San Pablo Avenue Corridor Fleet and Costs

San Pablo Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
72/M	3	40'	17	4	21	\$ 27,300,000	\$ 10,416,000	\$ 37,716,000
72R	3	40'	16	4	20	\$ 26,000,000	\$ 9,920,000	\$ 35,920,000
Total			33	8	41	\$ 53,300,000	\$ 20,336,000	\$ 73,636,000

West Berkeley

The West Berkeley Clean Corridor is a combination of residential, commercial and light industrial, covering an area from Emeryville up to Albany and includes lines 51B, 52, 80, C, F, and J which carry a combined 16,600 riders each weekday. It is also served by lines serving the West Oakland Corridor as well as the San Pablo Corridor. Frequency of routes range from very frequent (every 10 minutes on the 51B) to basic coverage (every 30 minutes on Line 80)



The total cost of converting these lines to zero-emission is estimated to be \$86,208,000, including infrastructure. Line 52 uses 60' Articulated Coaches while Lines C, J, and Z use 45' over-the-road coaches and the remainder use 40' coaches. Line J and Z operate out of Division 3 in Richmond and all others operate out of Division 2 in Emeryville.

Exhibit 38 – West Berkeley Corridor Fleet and Costs

West Berkeley Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
51B	2	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
52	2	60'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
80	2	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
C	2	45'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
F	2	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
J/Z	3	45'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
Total			38	10	48	\$ 62,400,000	\$ 23,808,000	\$ 86,208,000

West Oakland

Surrounded by freeways and connections to the Bay Bridge and in close proximity to the Port of Oakland, West Oakland has long been subject to the externalities of projects that benefit other communities. The area is served by five lines not covered by other Clean Corridors: 14, 29, 36, 62, and 88. Together, these lines carry more than 12,500 customers on a typical weekday and require 36 peak buses and seven spares to operate due to high frequency on these crosstown routes

The total cost of converting these lines to zero-emission is estimated to be \$80,820,000, including infrastructure. Lines 29, 36, and 88 operate out of Division 2 in Emeryville and lines 14 and 62 operate out of Division 4 in East Oakland.

Exhibit 39 – West Oakland Corridor Map

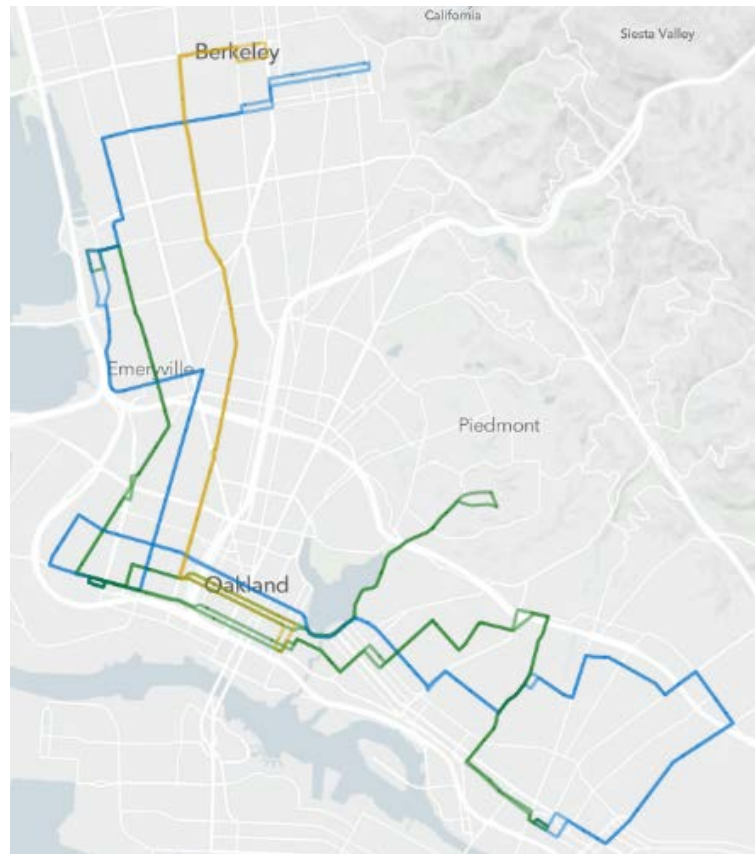


Exhibit 40 – West Oakland Corridor Fleet and Costs

West Oakland Clean Corridor								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
14	4	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
29	2	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
36	2	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
62	4	40'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
88	2	40'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
Total			36	9	45	\$ 58,500,000	\$ 22,320,000	\$ 80,820,000

Non-DAC Service

The remainder of the District's buses are either serving areas outside of DACs as defined by the State of California or are complementary service and will be converted to zero-emission prior to the 2040 CARB deadline.

Exhibit 41 – Non-DAC Fleet and Costs

Non-DAC Lines								
Lines	Division	Type	Fleet			Costs		
			Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
7	2	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
10	6	40'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
28	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
34	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
35	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
65/67	2	30'	2	1	3	\$ 2,700,000	\$ 1,488,000	\$ 4,188,000
79	2	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
93	6	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
94	6	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
95	6	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
99	6	60'	9	2	11	\$ 14,300,000	\$ 5,456,000	\$ 19,756,000
200	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
210	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
212	6	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
215	6	40'	2	1	3	\$ 3,900,000	\$ 1,488,000	\$ 5,388,000
216	6	40'	2	1	3	\$ 3,900,000	\$ 1,488,000	\$ 5,388,000
217	6	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
239	6	40'	4	1	5	\$ 4,500,000	\$ 7,250,000	\$ 11,750,000
251	6	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
B	2	45'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
CB	2	45'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
E	2	45'	2	1	3	\$ 3,900,000	\$ 1,488,000	\$ 5,388,000
FS	3	45'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
G	3	45'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
H	3	45'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
OX	4	45'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
P	2	45'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
U	6	45'	4	1	5	\$ 7,250,000	\$ 7,250,000	\$ 14,500,000
V	4	45'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
W	4	45'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
Total			122	35	157	\$ 204,100,000	\$ 77,872,000	\$ 289,062,000

DIVISIONS

Among the District's four current operating divisions, two – Division 2 in Emeryville and Division 4 in Oakland – are equipped with hydrogen fueling infrastructure. Division 4 will also soon have electric charging infrastructure for five buses as the District is in discussions with PG&E regarding upgrading its infrastructure for as many as fifty BEBs by 2021.

Given Division 4 is already accustomed to operating hydrogen FCEBs and will soon have capacity for BEBs, it should be prioritized as the first division to support the Clean Corridors Plan. This will facilitate some or all of the Macarthur-Grand Corridor (40 coaches plus five expansion coaches for Emeryville Amtrak service), 52 coaches in the Fruitvale Corridor, 22 buses from the West Oakland Corridor, 16 buses for the Foothill Corridor, and 26 buses from the Coliseum Corridor. When combined with the 27 buses to be used for BRT and replaced in 2032, Division 4 will feature 158 zero-emission buses by 2032. The District's Zero Emission Bus Study and Facilities Master Plan also prioritize Division 4 as the first facility to be converted to facilitate zero-emission fielding/charging. The facility must be able to scale its zero-emission capacity up to at least 133 buses in the coming years to prioritize Clean Corridors and ultimately 200 buses or more to meet the Innovative Clean Transit Rule. The Facilities Utilization Plan recommends expanding Division 4 to a 250-300-bus facility (from its current 200-bus capacity) by 2028 and potentially to a 500-bus facility by 2031.

Exhibit 42 – Division 4 Summary

Division 4 Clean Corridor Summary								
Corridor	Fleet					Costs		
	Lines	Type	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
Coliseum	45	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
	46	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	46L	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	73	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	90/98	40'	7	2	9	\$ 11,700,000	\$ 4,464,000	\$ 16,164,000
Foothill	40	60'	13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000
Fruitvale	20	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	21	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	39	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	47	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	51A	40'	13	3	16	\$ 20,800,000	\$ 7,936,000	\$ 28,736,000
	54	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
	O	45'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
International	1	60'	18	4	22	\$ 34,100,000	\$ 10,912,000	\$ 45,012,000
Macarthur-Grand	NL	60'	14	3	17	\$ 26,350,000	\$ 8,432,000	\$ 34,782,000
	NX Series	45'	6	2	8	\$ 12,400,000	\$ 3,968,000	\$ 16,368,000
West Oakland	14	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
	62	40'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
Total			125	33	158	\$ 221,150,000	\$ 78,368,000	\$ 299,518,000

Division 2 should be prioritized as the second operating division for facilitating the Clean Corridors Plan as it already has hydrogen fueling infrastructure and supports the Downtown Oakland, North Oakland, and West Berkeley Corridors as well as parts of the Fruitvale and West Oakland Corridors. It will also be the

most likely division to support future service to Treasure Island, which is planned to be a completely zero-emission service. The Clean Corridors lines comprise 144 buses which can be converted to zero-emission. This would benefit more than 50,000 daily customers (more than 20 percent of the District total) and about 366,000 residents living within a quarter-mile of the lines. The Facilities Utilization Plan calls for replacement of Division 2 by 2027 with a new 300-bus facility in the north-central portion of the service area with the possible inclusion of the Training and Education Center (TEC).

Exhibit 43 – Division 2 Summary

Division 2 Clean Corridor Summary								
Corridor	Fleet					Costs		
	Lines	Type	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
Downtown Oakland	33	40'	11	3	14	\$ 18,200,000	\$ 6,944,000	\$ 25,144,000
	96	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	Broadway Shuttle	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
Fruitvale	19	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
Macarthur-Grand	57	60'	13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000
North Oakland	6	40'	11	3	14	\$ 18,200,000	\$ 6,944,000	\$ 25,144,000
	12	40'	9	2	11	\$ 14,300,000	\$ 5,456,000	\$ 19,756,000
	18	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
West Berkeley	51B	40'	10	2	12	\$ 15,600,000	\$ 5,952,000	\$ 21,552,000
	52	60'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	80	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
	C	45'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	F	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
West Oakland	29	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
	36	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	88	40'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
Total			115	29	144	\$ 191,200,000	\$ 71,424,000	\$ 262,624,000

Division 3 serves the Richmond and San Pablo Clean Corridors as well as Lines J and Z in the West Berkeley Corridor and it or its replacement should be the third division prioritized for the program given converting the facility to zero-emission would benefit more than 20,000 daily customers and 200,000 residents within a quarter mile of their bus stops. The priority order for Divisions 2 and 3 depends in large part on how the District implements the Facilities Utilization Plan as they could be replaced individually or combined into a single, larger division depending upon the availability of parcels and other factors.

Exhibit 44 – Division 3 Summary

Division 3 Clean Corridor Summary								
Corridor	Fleet					Costs		
	Lines	Type	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
Richmond	70	40'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
	71	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	74	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	76	40'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
	L	45'	8	2	10	\$ 13,000,000	\$ 4,960,000	\$ 17,960,000
	LA	45'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
San Pablo	72/M	40'	17	4	21	\$ 27,300,000	\$ 10,416,000	\$ 37,716,000
	72R	40'	16	4	20	\$ 26,000,000	\$ 9,920,000	\$ 35,920,000
West Berkeley	J/Z	45'	6	2	8	\$ 10,400,000	\$ 3,968,000	\$ 14,368,000
Total			70	18	88	\$ 114,400,000	\$ 43,648,000	\$ 158,048,000

Division 6 should be the final operating division given it does not currently have any zero-emission infrastructure and has few high-ridership lines serving DACs and the resources spent on zero-emission buses would benefit a greater number of customers and residents on lines elsewhere in the District. The Facilities Utilization Plan calls for the replacement of Division 6 as soon as 2032 and it may include a relocation of the Central Maintenance Facility from East Oakland to Hayward.

Exhibit 45 – Division 6 Summary

Division 6 Clean Corridor Summary								
Corridor	Fleet					Costs		
	Lines	Type	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
Fremont	200	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	212	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	216	40'	2	1	3	\$ 3,900,000	\$ 1,488,000	\$ 5,388,000
	232	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	251	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	SB	45'	7	2	9	\$ 13,050,000	\$ 4,464,000	\$ 17,514,000
	41	40'	1	1	2	\$ 2,600,000	\$ 992,000	\$ 3,592,000
	56	40'	5	1	6	\$ 7,800,000	\$ 2,976,000	\$ 10,776,000
	60	60'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	83	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	86	40'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
	97	60'	13	3	16	\$ 20,800,000	\$ 7,936,000	\$ 28,736,000
	M	45'	3	1	4	\$ 5,200,000	\$ 1,984,000	\$ 7,184,000
	S	45'	4	1	5	\$ 6,500,000	\$ 2,480,000	\$ 8,980,000
Total			61	17	78	\$ 102,750,000	\$ 38,688,000	\$ 141,438,000

CAPITAL COST AND BENEFITS

This section analyzes the capital outlays necessary to implement the recommendations in the previous section as well as some of the benefits associated with implementing the plan. Note that many of the costs projected below are based on assumptions and require further research and industry experience. In addition, the infrastructure and operational implications of scaling up ZEB fleets are still being determined. Only a handful of transit agencies have as of yet converted more than a small portion of their fleet to ZEBs.

Exhibit 46 below details the cost of replacing each vehicle in each of the Clean Corridors with battery-electric or hydrogen fuel-cell electric buses from a capital perspective. The numbers are then combined into a total for the entire program. Altogether, procuring the buses and charging/fueling infrastructure for Clean Corridors is estimated to be \$1.151 billion. This represents capital costs of approximately \$805 million above the cost of replacing the same buses with diesel coaches in 2019 dollars. These costs are based on the District's past experience with procuring ZEBs and supporting infrastructure. As the District procures more ZEBs and the technology matures, these costs are likely to come down. For the purposes of this report, the estimates are conservative and grants are likely to cover significant portions of future ZEB and infrastructure procurements.

Exhibit 46 – Clean Corridor Program Capital Costs

Clean Corridor Comparison									
Clean Corridor	Division	Fleet			Costs				
		Peak Buses	Spares	Total	Vehicle	Infrastructure	Total	Diesel	Difference
Coliseum	4	19	4	26	\$ 33,800,000	\$ 12,896,000	\$ 46,696,000	\$ 13,000,000	\$ 33,696,000
Downtown Oakland	2	18	4	23	\$ 29,900,000	\$ 11,408,000	\$ 41,308,000	\$ 11,500,000	\$ 29,808,000
Foothill	4	13	3	16	\$ 24,800,000	\$ 7,936,000	\$ 32,736,000	\$ 10,400,000	\$ 22,336,000
Fremont	6	23	7	30	\$ 39,000,000	\$ 14,880,000	\$ 55,230,000	\$ 16,440,000	\$ 38,790,000
Fruitvale	2/4	41	11	52	\$ 67,600,000	\$ 25,792,000	\$ 93,392,000	\$ 27,920,000	\$ 65,472,000
Hayward	6	38	10	48	\$ 62,400,000	\$ 23,808,000	\$ 86,208,000	\$ 27,840,000	\$ 58,368,000
International	4	18	4	22	\$ 34,100,000	\$ 10,912,000	\$ 45,012,000	\$ 14,300,000	\$ 30,712,000
Macarthur-Grand	4	33	8	41	\$ 63,550,000	\$ 20,336,000	\$ 83,886,000	\$ 26,730,000	\$ 57,156,000
North Oakland	2	30	7	37	\$ 48,100,000	\$ 18,352,000	\$ 66,452,000	\$ 18,500,000	\$ 47,952,000
Richmond	3	31	8	39	\$ 50,700,000	\$ 19,344,000	\$ 70,044,000	\$ 22,060,000	\$ 47,984,000
San Pablo	3	33	8	41	\$ 53,300,000	\$ 20,336,000	\$ 73,636,000	\$ 20,500,000	\$ 53,136,000
West Berkeley	2/3	38	10	48	\$ 62,400,000	\$ 23,808,000	\$ 86,208,000	\$ 27,140,000	\$ 59,068,000
West Oakland	2/4	36	9	45	\$ 58,500,000	\$ 22,320,000	\$ 80,820,000	\$ 22,500,000	\$ 58,320,000
Non DAC Lines	All	122	35	157	\$ 204,100,000	\$ 77,872,000	\$ 289,062,000	\$ 86,315,000	\$ 202,747,000
Total		493	128	625	\$ 832,250,000	\$ 310,000,000	\$ 1,150,690,000	\$ 345,145,000	\$ 805,545,000

While there are additional costs associated with procuring ZEBs for use along these corridors, the benefits are substantial. First, California transit fleets are required to be 100 percent zero-emission by 2040 so the added cost over diesel is moot as all buses will required by law to be ZEBs. Second, eliminating tail-pipe emissions from the lines serving these communities will lead to improvements in air quality for local residents. Third, implementing this plan demonstrates the District's continued commitment to being at the forefront of transit technology deployment as well as its commitment to improving environmental

quality for our customers, communities, and employees. Finally, it is a great opportunity to attract new customers, especially those who consider sustainability a core tenet of their decision-making process.

IMPLEMENTATION

This section details some of the specific challenges related to implementing the recommendations in the Clean Corridors Plan, as well as a schedule and the short-term next steps.

CHALLENGES

The following issues may be challenges associated with implementing the Clean Corridors Plan as presented in this document.

Funding

Given the additional cost of replacing nearly the entire fleet of diesel, hybrid, and older FCEB buses with new zero-emission buses, funding plays a critical role in ensuring the District can successfully implement the Clean Corridors Plan. Through the existing Metropolitan Transportation Commission's Transit Capital Priorities (TCP) Program, the District is eligible to receive Federal Transit Administration (FTA) funds for up to 80% of the cost of a bus replacement, with the District responsible for the remaining 20% local matching funds. The TCP policy currently allows an agency to request funding for up to the cost of a hybrid diesel-electric bus when purchasing a zero-emission bus. To purchase a ZEB the District must find funding for the "increment" of the ZEB above a hybrid bus which is \$300,000 to \$400,000, as mentioned above. The following are some of the key grant programs that can fund all or part of a ZEB purchase:

- 1) Federal Transit Administration (FTA) Grants
 - a) FTA Section 5339 Bus and Bus Facilities Infrastructure Investment Program is a discretionary program the District can apply for to supplement local funds for the purchase and replacement of transit vehicles, regardless of power source.
 - b) FTA Section 5339 Low or No Emission Competitive Program provides grants on a competitive basis to supplement local dollars for the replacement of Hybrid and zero-emission vehicles. As much as \$55 million is available each year through FY 2020. AC Transit is currently using this source to fund a portion of the cost of the first five BEBs.
- 2) State Funding: The most prominent state programs for funding zero-emission transit service comes from the Cap and Trade Program. Proceeds from California's Cap and Trade program are channeled to fund four programs:
 - a) Low Carbon Transit Operations Program (LCTOP): The District receives LCTOP funds annually through a formula to support capital projects that reduce GHG emissions and increase ridership.
 - b) Transit and Intercity Rail Capital Program (TIRCP): This is a large-scale competitive grant program for investments that reduce GHG emissions and increase ridership.
 - c) Affordable Housing and Sustainable Communities Program (AHSC): The California Strategic Growth Council offers grants through the Affordable Housing and Sustainable Communities (AHSC) Program to support – among other things -- projects that improve

transit service and amenities or improve the environmental sustainability of transit service in communities identified as SB 535 Disadvantaged Communities. The project seeks to reduce GHG emissions, vehicle-miles traveled, and use of single-occupancy vehicles. The District has successfully partnered with multiple housing developments to win funding for zero-emission buses to support service expansion.

- d) Low Carbon Transportation Investments and Air Quality Improvement Program (AQIP) are CARB funding programs with components designed to incentivize the transition to zero-emission fleets. This program funded the purchase of ten FCBEs delivered to the District in 2019 as well as upgrades to the hydrogen fueling facility at Division 2. One continuing program under AQIP is the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), which provides vouchers for transit agencies to purchase hybrid and zero-emission buses on a first-come, first-served basis. New Flyer, the manufacturer of the five BEBs, applied for and received this funding on behalf of the District to facilitate purchase of those buses.
- 3) Bay Area Air Quality Management District (BAAQMD)
 - a) Regionally, the Transportation Fund for Clean Air Program (TFCA) provides significant funding for emissions-reducing projects. The BAAQMD provides TFCA funding through the Heavy-Duty Zero-Emission Vehicle (ZEV) Program which will partially fund the purchase ten hydrogen fuel cell buses in 2019. BAAQMD also has funding programs that support construction of new hydrogen fueling stations and electrical charging stations.

Division Infrastructure

There is current capacity for 24 hydrogen FCEBs between Divisions 2 and 4 and the District is working on a project which would expand system-wide fuel-cell fueling capacity to 42 buses. When the five new BEBs are added to revenue service fleet in 2020, the District will have capacity for those five buses and the District is working to significantly scale up charging capacity at Division 4. The District needs to increase charging and hydrogen fueling and maintenance capacity at divisions in a strategic manner alongside any planned increases in ZEBs. Rolling out any new hydrogen fueling will require expanding or building new fueling infrastructure while introducing or increasing BEBs to a division will require coordinating with PG&E to assess the electrical transmission capacity at each division before committing to procuring the vehicles and their requisite charging infrastructure. The District's Facility Utilization Plan includes specific recommendations for how to lay out the operating divisions to accommodate changes in fleet composition as well as improvements to the Training and Education Center (TEC) and Central Maintenance Facility (CMF). Further, the Zero Emission Bus (ZEB) Analysis identifies – on a lifecycle basis – the economic costs, performance issues, risks, and recommended timeline associated with transition to a zero-emission transit bus fleet.

Division Capacity

The District currently has capacity for about 640 buses among its four operating divisions, based on maintenance capacity available. While this plan doesn't explicitly call for fleet expansion, the transition to zero-emission technology will necessitate a period from 2019 – when BEBs enter the fleet – to 2040 – when the entire fleet is zero-emission. The AC Transit operating divisions are already at or above capacity. The need to have hydrogen fuel-cell, diesel, and electric charging infrastructure would place additional stress on operating divisions with respect to space constraints; the divisions need to be replaced and/or expanded for additional maintenance capacity.

Compounding this issue is the number of sub-fleets operated by the District. Looking to 2020, the fleet will be composed of 13 different sub-fleets based on power source, branding, service type, size, and number of doors. The breakdown of the District's fleet types is illustrated in Exhibit 47 below. Once the BEBs enter the fleet, there will be four different 40-foot buses. Once the 60-foot hydrogen FCEB and the 27 BRT buses (which don't have fareboxes but do have five doors) enter the fleet, there will be three different articulated sub-fleets. There are already two different sub-fleets for the 30-foot buses and the double-decker buses added a third Transbay sub-fleet when they arrived in Fall 2018.

Exhibit 47 – AC Transit Sub-Fleets in 2019-2020

Bus Type	Sub-Type	Length	Power Source	Quantity	Limitations
Standard	Diesel	40'	Diesel	281	None
	Hydrogen Fuel-Cell*	40'	Fuel Cell	23	None
	Hybrid	40'	Hybrid	25	None
	Battery-Electric**	40'	Battery-Electric	5	Grant indicates they will be used in East Oakland
Articulated	Diesel	60'	Diesel	79	Limited to handful of lines and supplementary trips
	Hydrogen Fuel-Cell***	60'	Fuel Cell	1	Limited to handful of lines and supplementary trips
	BRT	60'	Diesel	27	No farebox and doors on both sides, must be used on BRT
Short	Standard	30'	Diesel	86	Can't be used on high-ridership lines
	Broadway Shuttle	30'	Diesel	4	Must be used on Broadway Shuttle
Transbay	MCI	45'	Diesel	36	Must be used on Transbay
	Gillig	40'	Diesel	54	Can be deployed anywhere, should be reserved for Transbay
	Double-Decker	42'	Diesel	15	Must be used on Transbay
Cutaway		26'	Diesel	10	Only used on FLEX and low-ridership lines
Total				646	

*Expand to 23 in 2020

**Enter Fleet in 2020

*** Enters Fleet in 2020

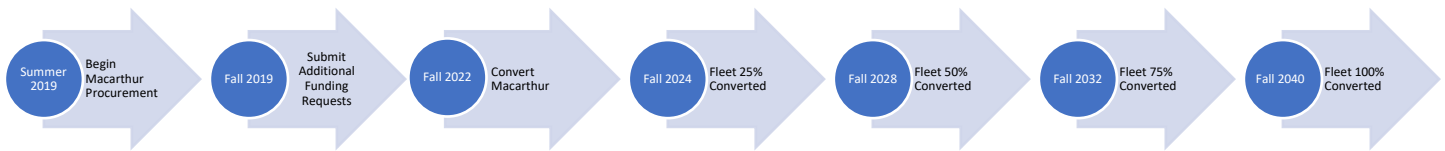
While the large number of sub-fleets allows AC Transit to tailor vehicle type for specific lines or communities, it also means the divisions must know how to maintain, fuel, and assign the different fleets effectively. This also impacts the spare ratios for each sub-fleet, limiting availability of buses designated for maintenance programs. Decisions must be made about which vehicles should be prioritized for specific lines and accommodating the additional space for separate fueling and charging infrastructure. The District is evaluating other striping layouts to expand division parking capacity and accommodate in-stall battery-electric charging based on the results of the Facilities Utilization Plan.

Vehicle Assignment Flexibility

Implementing the Clean Corridors Plan will mean prioritizing the lines in the plan for primary assignment of the new zero-emission buses. However, AC Transit operates in a dynamic environment and sometimes ideal bus assignment isn't feasible given conditions in the field or maintenance schedules. The Plan calls for sufficient spares to ensure the Clean Corridors lines always have ZEBs available, but should that fail due to forces beyond the control of the operations and maintenance staff, the lines should be prioritized for assignment of the District's existing hydrogen FCEBs or diesel-hybrid buses.

SCHEDULE

The following is a proposed schedule of implementation of the four corridors identified in the Clean Corridors Plan.



Staff will evaluate the appropriate order for implementation of the corridors based on the findings from the Facilities Utilization Plan and Zero Emission Bus Analysis as well as discussions with PG&E and other critical stakeholders. The Clean Corridors Plan will be revised as progress on service expansion or facilities decisions are made. As each corridor is implemented, staff will update the plan with new corridors for prioritization with the goal of a complete zero-emission bus fleet by 2040.