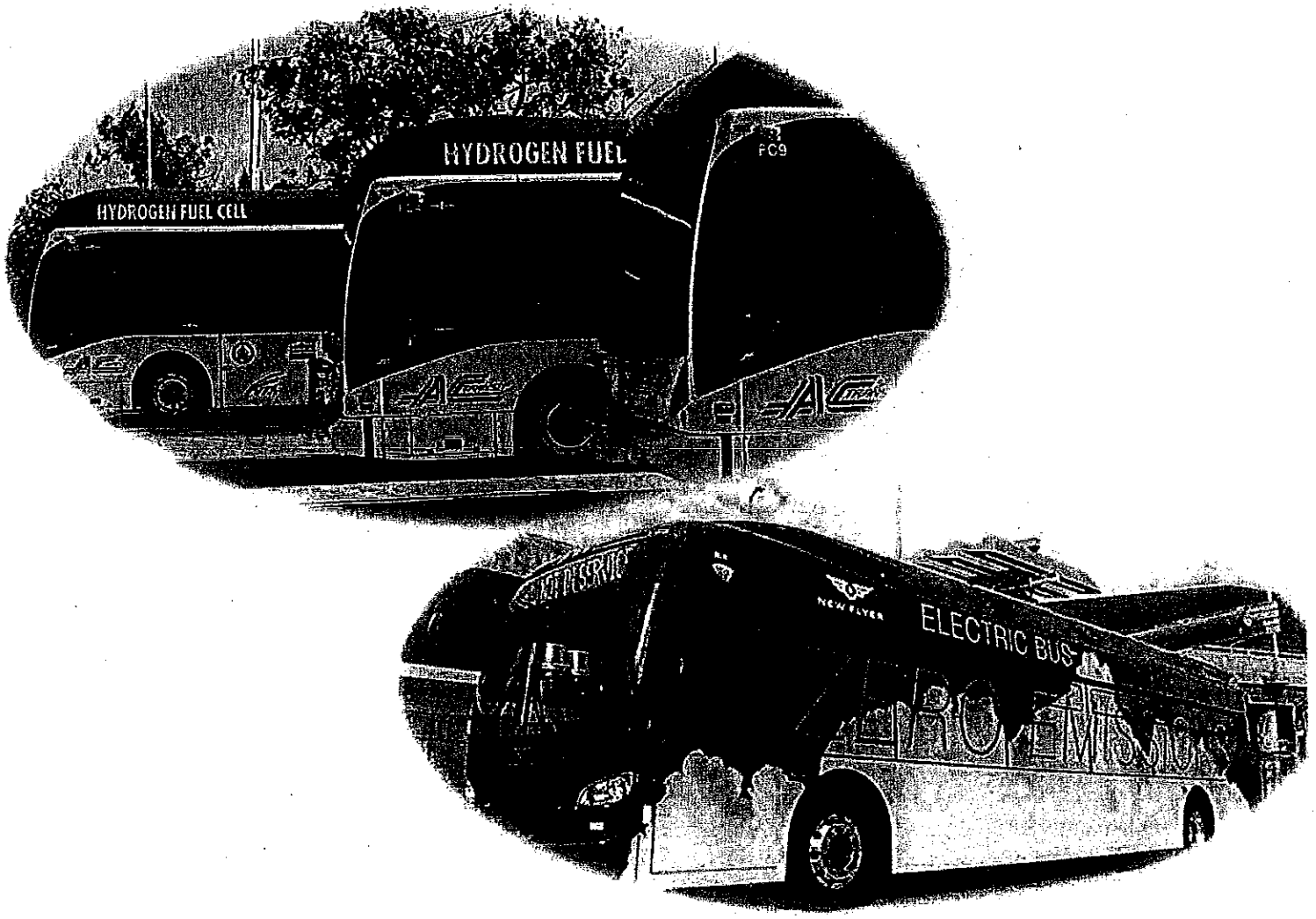
Chris Peeples
SR 17-325
Attachment 1 17-12-4



CLEAN CORRIDORS PLAN

AC TRANSIT

Service Planning Department

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INTRODUCTION

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. It may also require transit agencies to begin incorporating zero-emissions buses (ZEBs) into their fleets in 2018. This new regulation may require that the Alameda-Contra Costa Transit District (District) transition to a fully zero-emission fleet by 2040, which would mean all vehicle purchases after 2027 would have to be zero-emission. And beyond CARB regulations, several major auto manufacturers have discussed their plans to phase out fossil fuel powered vehicles over a similar time frame.

The term "zero-emissions" is used in the plan and throughout the Bay Area to connote tail-pipe emissions. Clearly, there are emissions into the atmosphere from any type of fueling technology. However, it is also evident that Hydrogen fuel-cell and electric battery powered buses have significantly lower overall emissions than diesel buses, especially given the District's Bloombox technology and California's increasingly clean energy portfolio. Electric buses, due to the high levels of energy needed to produce and dispose of batteries, need to be used for their projected life (beyond 10 years) in order to fully recover life-cycle emissions. There are also emissions associated with procurement, delivery, assembly, maintenance, and decommissioning that are not addressed in this plan. Notwithstanding the above, the District realizes the benefits of moving toward a "zero-emissions" fleet and supports a move in that direction, while acknowledging the more appropriate name may be low emissions. For the purposes of this plan, the term zero-emissions will be used and is duly qualified.

The District is in the enviable position of having over 16 years of experience with zero-emission buses starting with its initial three-bus fuel cell electric bus (FCEB) fleet in the early 2000s. The current fleet of 13 hydrogen fuel-cell electric buses operated out of garages in Emeryville and East Oakland are one of the longest running zero-emission bus fleets in the country. However, with a need to transition to a 100-percent zero-emission bus 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.

The corridors and communities identified in this plan reflect those areas that will be prioritized for zero-emissions buses as the District procures more ZEBs. The overall goal of the plan is to have vehicles used on all lines serving these corridors and communities be completely zero-emissions (whether battery-electric bus or hydrogen fuel-cell electric bus) by 2032.

The California Legislature passed AB 32 – the California Global Warming Solutions Act of 2006 – which is commonly referred to as the Cap and 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 emissions that cause climate change. In 2017 the state reaffirmed its commitment to the Cap and Trade program when the legislature passed AB 398 with a two-thirds margin, extending the program to 2030. Investments from Cap and Trade are also specifically targeted at disadvantaged

communities, with legislation from 2012 (SB 535) and 2016 (AB 1550) requiring 25 percent of the proceeds from Cap and Trade funds go to projects that provide a benefit to disadvantaged communities and gave CalEPA responsibility for identifying those communities.

The focus on investments in disadvantaged communities are aimed at improving public health, quality of life and economic opportunity in California's most burdened communities at the same time reducing pollution that causes climate change. The Clean Corridors Plan will use 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 this plan is 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 zero-emission bus 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 following chapters detail the evaluation process, recommendations, the operating and capital costs, and the implementation plan. The District's vision is to review and refresh this document as conditions, funding sources, or priorities change.

EVALUATION

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

1) Baseline description of existing and procured zero-emissions bus 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 13 40-foot hydrogen fuel-cell electric buses, which represents the largest and longest-running fuel-cell transit fleet in the nation. The District has begun procurement of 10 additional 40-foot fuel-cell electric buses as well as a demonstration project of one 60-foot fuel-cell electric bus. This will bring the District's fuel-cell electric bus 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 that will likely 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 the end of 2019, the District plans to have 29 zero-emission buses in its fleet.

DIVISION CAPACITY

At present, the District has capacity for 12 hydrogen fuel-cell electric buses at each of two divisions – 2 and 4. There is no current infrastructure in place to allow for the charging of battery-electric buses. Planned expansions will mean an additional 11 hydrogen fuel-cell electric buses will join the fleet across the next several years, bringing the District to its full capacity of 24 buses. Along with the 10 hydrogen fuel-cell electric bus purchase, the District will be upgrading the hydrogen fueling infrastructure at Division 2 to allow for faster and more efficient fueling operations, but not increasing capacity. The District will also install five depot charging stations at division 4 to support the five battery-electric buses coming in 2019.

Expansion of the hydrogen fuel-cell electric bus fleet beyond the planned 24 buses will require significant upgrade of existing fueling stations or construction of another hydrogen fuel station at another division to accommodate growth. The District is also in discussions with Pacific Gas & Electric (PG&E) regarding any infrastructure changes necessary to accommodate charging systems for the battery-electric buses. Discussions include potential scalability of the battery electric bus charging infrastructure from the initial five bus capacity up to fifty battery electric buses. Given the significant up-front cost associated with improving the transmission infrastructure for the battery electric bus charging system there may be a requirement to provide PG&E a detailed phased growth of the battery electric bus fleet to avoid incurring cost of the unused infrastructure capacity installed by PG&E.

PLANNED EXPANSION

The only current plan in place for additional zero-emission buses 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 three 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.

CLEAN CORRIDORS EVALUATION

There are three primary criteria used in this plan to evaluate which lines would be included in the initial list of Clean Corridors Plan communities:

1) Inclusion in the list of DACs.
2) Ridership.
3) Division Infrastructure.

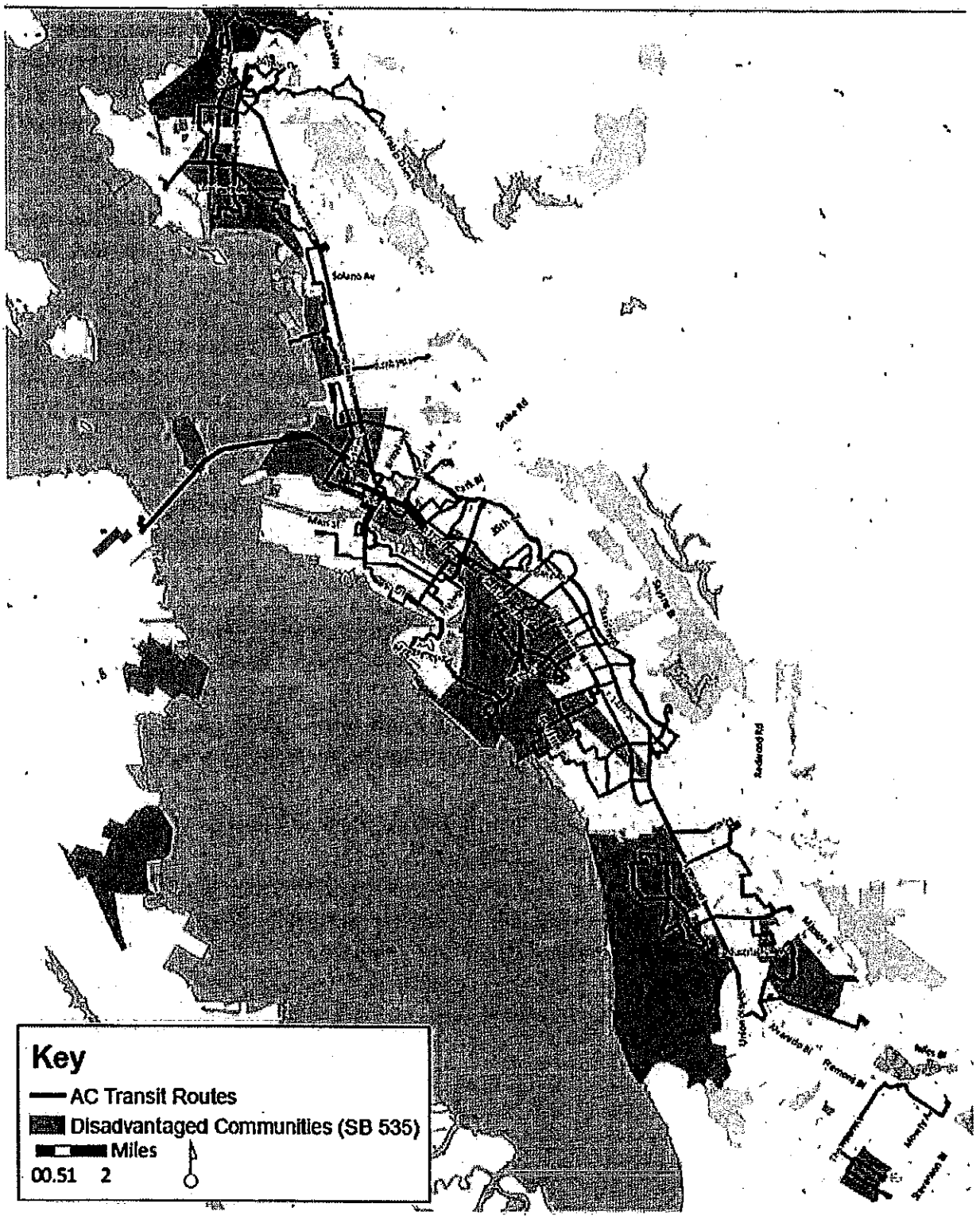
Disadvantaged Communities

These communities stretch from the northern-most point of the District 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 Disadvantaged Communities 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.

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

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

Exhibit 1 – AC Transit Lines Serving SB 535 Disadvantaged Communities



Ridership

The District operates 39 regular local and select Transbay lines that also serve significant portions of the DACs identified in the map in Exhibit 1. 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 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 may well be zero-emissions by 2040.

Exhibit 2 illustrates those lines serving the DACs as well as their termini, passengers/service hour (productivity), and average daily ridership. The lines are ranked by average passengers/service hour ridership.

The highest-ridership line – Line 1 – is slated for replacement by AC Transit's first bus rapid transit line in 2019 and the District is taking delivery of purpose-built, five-door articulated buses for that line. All 27 of these vehicles will be diesel-hybrid coaches. A common theme emerges with the first half of the list as the lines are primarily along major corridors, in Richmond, or in east or west Oakland.

There are a handful of lines from Division 6 – 10, 83, 86, and 97. These lines serve Hesperian, East 14th, or the industrial area in west Hayward (Russell City) where Division 6 and the Training and Education Center are located.

To provide more clarity regarding which corridors or communities to designate "Clean Corridors" for the purposes of this plan, the lines were then assigned to areas. Some common themes emerged from these groupings:

- Many of the lines in East Oakland operate along single corridors – lines 40, 54, 73, 90, 98, etc. – and are spaced some distance apart, minimizing the impact of assigning large numbers of zero-emissions buses.
- Some lines, while touching DACs, spent much of their alignment well outside of those communities, including lines 18, 19, 20, 46, 46L, 47, 96, and O.
- 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.
- Some lines were so unproductive on their own, coupled with not having many other nearby lines to join them with, that they did not make sense for ZEB prioritization, including lines 80, 81, and 251.

Exhibit 2 – Lines Serving SB 535 Disadvantaged Communities

Line	Type	Division	Weekday Ridership	Passengers/ Hour	Terminal A	Terminal B	Area
1	Trunk	D6	12,856	48.5	San Leandro BART	Jefferson/11th	International
40	Trunk	D4	8,978	44.3	Bay Fair BART	Jefferson/11th	Foothill Blvd.
54	Urban Crosstown	D4	2,022	42.8	Fruitvale BART	Merritt College	35th
73	Major Corridor	D4	2,817	40.3	Eastmont Transit Center	Oakland Airport	73rd/Hegenberger
20	Major Corridor	D4	2,875	36.0	Fruitvale/Macarthur	MLK/11th	Shoreline
72R	Rapid	D2	5,981	33.4	2nd/Clay	Contra Costa College	San Pablo
76	Urban Crosstown	D3	2,651	32.8	El Cerrito Del Norte	Hilltop Mall	Richmond
72M	Trunk	D2	3,830	31.4	2nd/Clay	Point Richmond	San Pablo
14	Urban Crosstown	D4	4,594	31.3	Fruitvale BART	West Oakland BART	West Oakland
57	Trunk	D4	6,472	31.0	Eastmont Transit Center	Emeryville Public Market	Macarthur/Grand
72	Trunk	D2	4,110	30.5	2nd/Clay	Hilltop Mall	San Pablo Ave
62	Urban Crosstown	D4	3,314	28.0	Fruitvale BART	West Oakland BART	West Oakland
97	Major Corridor	D6	4,155	27.9	Bay Fair BART	Union City BART	Hesperian
18	Trunk	D2	4,484	27.3	Lake Merritt BART	Harrison/5th	MLK
O	Transbay	D4	1,841	26.3	Fruitvale BART	San Francisco Transbay	Alameda/Transbay
88	Major Corridor	D2	2,551	25.7	Lake Merritt BART	Downtown Berkeley	West Oakland
21	Urban Crosstown	D4	1,742	25.5	Fruitvale/Macarthur	Oakland Airport	Fruitvale/Airport
NL	Transbay	D4	3,242	25.1	Eastmont Transit Center	San Francisco Transbay	Macarthur/Grand
70	Urban Crosstown	D3	1,059	24.6	Richmond BART	Richmond Parkway	Richmond
10	Major Corridor	D6	2,954	24.5	San Leandro BART	Hayward BART	East 14th
45	Urban Crosstown	D4	2,009	22.8	Eastmont Transit Center	Foothill Square	Seminary
74	Urban Crosstown	D3	1,369	22.0	Harbor Way South	Ford Point	Richmond
98	Trunk	D4	1,532	21.1	Coliseum BART	Eastmont Transit Center	98th
71	Urban Crosstown	D3	1,467	20.6	El Cerrito Plaza BART	Richmond Parkway	Richmond
46	Urban Crosstown	D4	282	20.0	Coliseum BART	Oakland Zoo	82nd
90	Trunk	D4	887	18.9	Coliseum BART	Foothill Square	90th
86	Suburban Crosstown	D6	696	17.8	Hayward BART	Division 6	Russell City
96	Urban Crosstown	D2	1,112	17.1	Fruitvale/Macarthur	Alameda Point	Alameda
85	Suburban Crosstown	D6	845	16.0	San Leandro BART	Union Landing	Central County
89	Suburban Crosstown	D6	1,198	15.7	San Leandro BART	San Leandro BART	San Leandro
83	Suburban Crosstown	D6	473	15.4	Hayward BART	South Hayward BART	Russell City
29	Urban Crosstown	D2	1,122	14.0	Lakeshore/Walavista	Emeryville Public Market	West Oakland
36	Urban Crosstown	D2	1,007	13.8	Bancroft/Piedmont	West Oakland BART	West Oakland
251	Very Low Density	D6	211	13.6	Fremont BART	Ohlone College, Newark	Fremont
47	Urban Crosstown	D4	98	12.6	Fruitvale BART	Maxwell Park	50th/Monticello
19	Urban Crosstown	D2	637	11.5	Fruitvale BART	Jefferson/11th	Alameda
46L	Urban Crosstown	D4	154	11.2	Coliseum BART	Grass Valley	82nd
81	Urban Crosstown	D2	424	6.2	Russell/Claremont	Berkeley Marina	Ashby
80	Urban Crosstown	D2	473	5.6	Russell/Claremont	El Cerrito Plaza BART	Ashby
NX	Transbay	D4	314	33.8	Macarthur/Seminary	San Francisco Transbay	Macarthur/Grand
NX1	Transbay	D4	204	30.1	Macarthur/Fruitvale	San Francisco Transbay	Macarthur/Grand
NX2	Transbay	D4	262	26.1	Macarthur/High	San Francisco Transbay	Macarthur/Grand
NX3	Transbay	D4	333	22.2	Marlow/Foothill	San Francisco Transbay	Macarthur/Grand
NX4	Transbay	D4	362	18.2	Center/Grove	San Francisco Transbay	Macarthur/Grand
NXC	Transbay	D4	32	11.4	Center/Grove	San Francisco Transbay	Macarthur/Grand

Lines operated out of Division 6 as well as Line 1 were removed from the list and the lines were then combined into groupings to rank them based on the combined ridership of those lines serving each corridor/community.

When combined, the ridership for four key areas rose to the top of the evaluation:

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

The list also gives the District insight regarding future Clean Corridors communities, including the Martin Luther King corridor and many areas in East Oakland.

Exhibit 3 – Ridership by Area

Area	Lines	Daily Riders
San Pablo	3	13,921
West Oakland	5	12,588
Macarthur/Grand	8	11,221
Richmond	4	6,546
MLK	1	4,484
Shoreline	1	2,875
73rd/Hegenberger	1	2,817
35th	1	2,022
Seminary	1	2,009
Alameda/Transbay	1	1,841
Alameda	2	1,749
Fruitvale/Airport	1	1,742
98th	1	1,532
Ashby	2	897
90th	1	887
82nd	2	436
50th/Monticello	1	98

Division Infrastructure

Divisions 2 and 4 currently have a combined capacity of 24 hydrogen fuel-cell buses with an additional five battery-electric buses likely planned for Division 4. The District is currently working with PG&E on electrical infrastructure requirements to support as many as fifty battery electric buses at Division 4. As part of any agreement for PG&E to improve the electrical infrastructure at Division 4, the District would need to prove it will have enough electric buses to utilize that infrastructure or possibly incur cost from PG&E for the expanded charging infrastructure capacity not being used.

AC TRANSIT DIVISIONS
Division 2 – Emeryville
Division 3 – Richmond
Division 4 – East Oakland
Division 6 – Hayward

Division 2 is the next logical location for zero-emissions buses as it is already home to a hydrogen fuel-cell electric bus fleet. In addition, the District has discussed electrical charging infrastructure with PG&E and due to existing infrastructure in the area, there should not be any issues with expanding battery-electric capacity at the Emeryville division.

Division 3 in Richmond is the District's smallest operating division but is in a DAC and its small size would allow the District to convert a significant portion of the fleet there to zero-emissions just by converting the local Richmond lines – 70, 71, 74, 76 – to zero-emissions.

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-emissions buses would be felt by fewer customers. As it does convert to zero-emissions, priority should be placed on lines 10, 83, 86, and 97.

RECOMMENDATIONS

This section details the recommendations for which lines and divisions should be prioritized for future zero-emissions buses as the District plans for a 100-percent ZEB fleet by 2040.

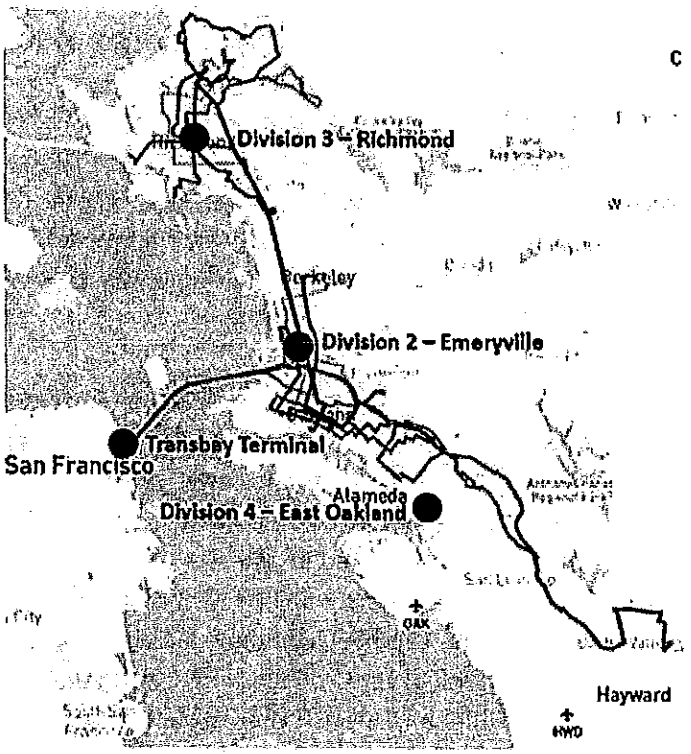
LINES

The Evaluation section revealed four corridors or communities which should be prioritized as Clean Corridors based on a combination of three factors:

- Inclusion in the list of SB 535 Disadvantaged Communities.
- Ridership.
- Division Infrastructure.

These four Clean Corridors include San Pablo Avenue, West Oakland, Grand/Macarthur, and Richmond. Taken together, these lines constitute 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. Exhibit 4 illustrates the Clean Corridors network coverage.

Exhibit 4 – Clean Corridors Map



Each of the four 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 Grand/Macarthur 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 a cost of $985,000 for a 40-foot zero-emissions bus. The report also estimates an incremental cost of $496,000 for charging/fueling infrastructure for each bus. These cost assumptions 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.

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-emissions 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-emissions is estimated to be $58,647,600, including infrastructure. All of these lines operate out of Division 2 in Emeryville, which already has hydrogen fueling infrastructure in place. However, the hydrogen infrastructure will be at maximum capacity with the fuel cell fleet additions already in process. Any expansion of zero-emissions fleet at Division 2 will require either new electric charging infrastructure, the expansion of the existing hydrogen fueling station, or a new fueling station altogether.

Exhibit 5 – San Pablo Avenue Corridor Map

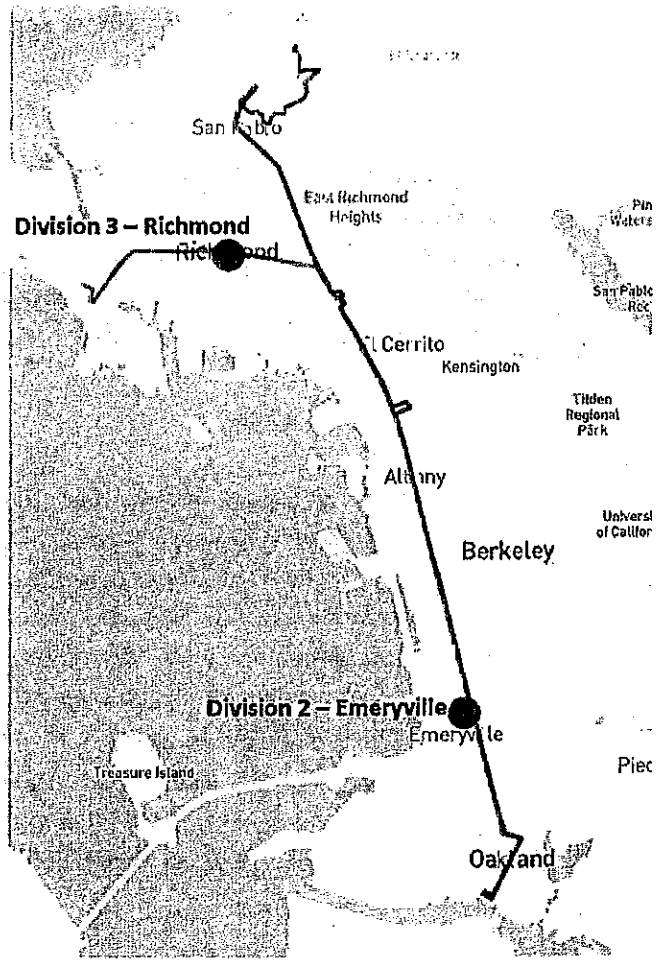


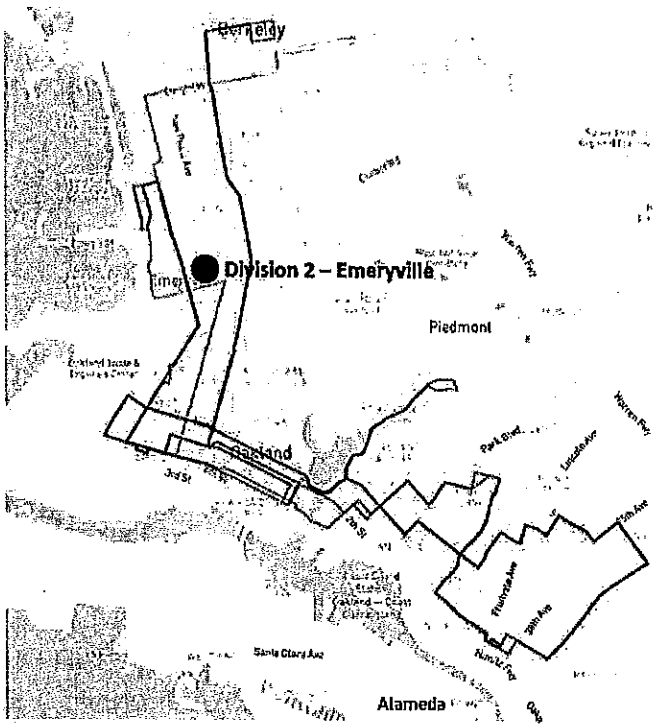
Exhibit 6 – San Pablo Avenue Corridor Fleet and Costs

San Pablo Clean Corridor							
		Fleet			Costs		
Lines	Division	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
72/M	2	17	3.4	20.4	$20,094,000	$ 10,118,400	$30,212,400
72R	2	16	3.2	19.2	$18,912,000	$ 9,523,200	$28,435,200
Total		33	6.6	39.6	$39,006,000	$ 19,641,600	$58,647,600

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.

Exhibit 7 – West Oakland Corridor Map



The total cost of converting these lines to zero-emissions is estimated to be $63,979,200, 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. Both facilities already have hydrogen fueling infrastructure in place. However, the hydrogen infrastructure will be at maximum capacity with the fuel cell fleet additions already in process. Any expansion of zero-emissions fleet at either facility will require either new electric charging infrastructure, the expansion of the existing hydrogen fueling station, or a new fueling station altogether.

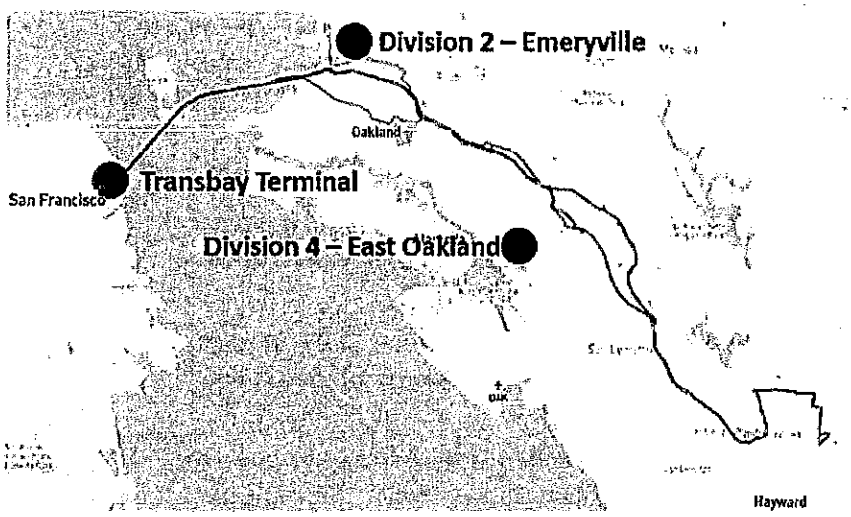
Exhibit 8 – West Oakland Corridor Fleet and Costs

West Oakland Clean Corridor							
Fleet					Costs		
Lines	Division	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
14	4	10	2.0	12.0	$11,820,000	$ 5,952,000	$17,772,000
29	2	6	1.2	7.2	$ 7,092,000	$ 3,571,200	$10,663,200
36	2	4	0.8	4.8	$ 4,728,000	$ 2,380,800	$ 7,108,800
62	4	8	1.6	9.6	$ 9,456,000	$ 4,761,600	$14,217,600
88	2	8	1.6	9.6	$ 9,456,000	$ 4,761,600	$14,217,600
Total		36	7.2	43.2	$42,552,000	$ 21,427,200	$63,979,200

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 and require 33 peak buses and as many as seven spares to operate.

Exhibit 9 – Macarthur-Grand Corridor Map



The total cost of converting these lines to zero-emissions is estimated to be $58,647,600, including infrastructure. All lines operate out of Division 4 in East Oakland, which already has hydrogen fueling infrastructure in place. However, the hydrogen infrastructure will be at maximum capacity with the fuel cell fleet additions already in process. Any expansion of zero-emissions fleet at the facility will require either new electric charging infrastructure, the expansion of the existing hydrogen fueling station, or a new fueling station altogether.

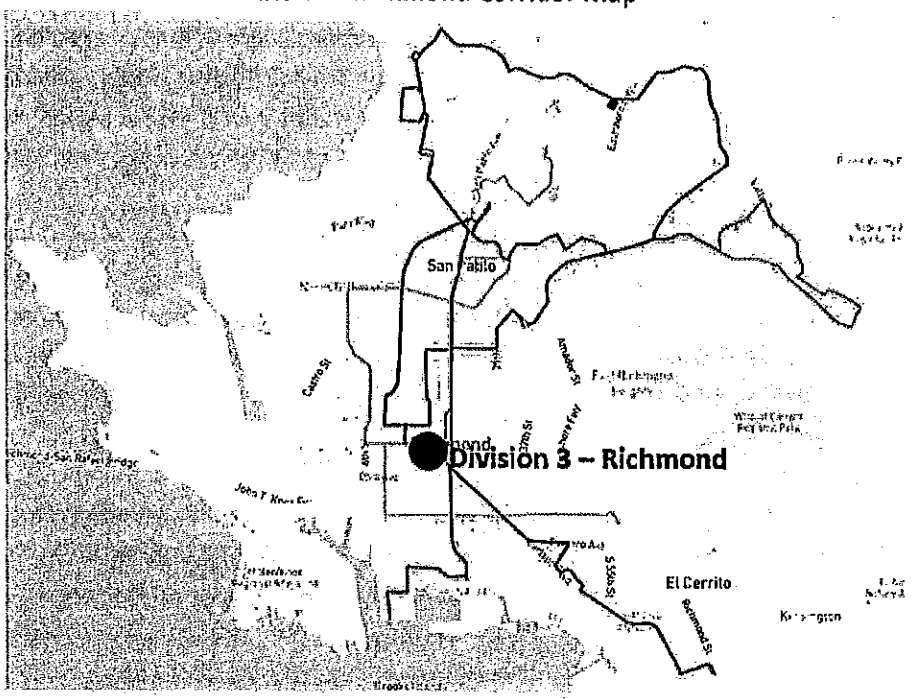
Exhibit 10 – Macarthur-Grand Corridor Fleet and Costs

Macarthur Grand Clean Corridor							
		Fleet			Costs		
Lines	Division	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
57	4	13	2.6	15.6	$15,366,000	$ 7,737,600	$23,103,600
NL	4	14	2.8	16.8	$16,548,000	$ 8,332,800	$24,880,800
NX Series	4	6	1.2	7.2	$ 7,092,000	$ 3,571,200	$10,663,200
Total		33	6.6	39.6	$39,006,000	$ 19,641,600	$58,647,600

Richmond

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

Exhibit 11 – Richmond Corridor Map



The total cost of converting these lines to zero-emissions is estimated to be $31,989,600, including infrastructure. All four lines operate out of Division 3 in Richmond on weekdays and Division 2 on weekends. 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-emissions fleet at the facility will require either new electric charging infrastructure, the expansion of the existing hydrogen fueling station, or a new fueling station altogether.

Exhibit 12 – Richmond Corridor Fleet and Costs

Richmond Clean Corridor							
Fleet					Costs		
Lines	Division	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
70	3	3	1	4	$ 3,546,000	$ 1,785,600	$ 5,331,600
71	3	5	1	6	$ 5,910,000	$ 2,976,000	$ 8,886,000
74	3	4	1	5	$ 4,728,000	$ 2,380,800	$ 7,108,800
76	3	6	1	7	$ 7,092,000	$ 3,571,200	$ 10,663,200
Total		18	4	22	$ 21,276,000	$ 10,713,600	$ 31,989,600

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 may 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 battery-electric buses in the next several years.

Given that Division 4 is already accustomed to operating hydrogen fuel-cell electric buses and will soon have capacity for battery-electric buses, it should be prioritized as the first division to support the Clean Corridors Plan. This will facilitate the Macarthur-Grand Corridor (40 coaches) and Lines 14 and 62 from the West Oakland Corridor (22 coaches). Since PG&E is planning to expand distribution capacity near Division 4 for the District to only handle up to fifty battery-electric buses, the District can follow one of four paths:

1) Discuss increasing the capacity for Division for to handle 60 buses with PG&E.
2) Only partially implement the two corridors, leaving 16 of the 71 Clean Corridors buses as diesel. This can be accomplished by using the diesel or diesel hybrid buses as spares.
3) Utilize a mix of hydrogen fuel-cell electric and battery-electric buses for some of the Clean Corridors buses. This will require expanding, re-building, or constructing a new hydrogen fueling station.
4) Dedicate existing hydrogen fuel-cell electric buses to Clean Corridors lines to make up the gap.

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 San Pablo 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. Together with Division 4, the District can convert all lines to zero-emissions lines except for 70, 71, 74, and 76. This would benefit 36,223 daily customers (20 percent of the District total) and about 500,000 residents living within a quarter-mile of the lines.

Division 3 serves the Richmond Clean Corridor and should be the third division prioritized for the program given converting the local Richmond 70-series lines into zero-emissions lines would benefit about 6,500 daily customers and 150,000 residents within a quarter mile of their bus stops.

Division 6 should be the final operating division given it does not currently have any zero-emissions infrastructure and has few high-ridership lines serving DACs and the resources spent on zero-emissions buses would benefit a greater number of customers and residents on lines elsewhere in the District.

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. A caution that many of the costs projected below are based on assumptions and require further research and industry experience. Even the District's considerable experience with fuel cell buses is only reaching the mid-life stage of the bus. In addition, the infrastructure and operational implications of scaling up ZEB fleets are still being determined. No transit agency has as of yet converted more than a small portion of their fleet to ZEBs.

Exhibit 13 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 in these four areas is estimated to be $213.3 million. This represents capital costs of approximately $100 million above the cost of replacing the same buses with diesel coaches. 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. The District's Zero Emissions Bus Study will evaluate the specific costs to the District for Batter-electric and Hydrogen fuel-cell vehicles next year and this report will be adjusted to reflect those new numbers.

Exhibit 13 – Clean Corridor Program Capital Costs

Clean Corridor Comparison							
	Fleet				Costs		
Clean Corridor	Division	Peak Buses	Spares	Total	Vehicle	Infrastructure	Total
Richmond	3	18	4	22	$ 21,276,000	$ 10,713,600	$ 31,989,600
San Pablo	2	33	7	40	$ 39,006,000	$ 19,641,600	$ 58,647,600
Macarthur-Grand	4	33	7	40	$ 39,006,000	$ 19,641,600	$ 58,647,600
West Oakland	2/4	36	7	43	$ 42,552,000	$ 21,427,200	$ 63,979,200
Total		120	24	144	$ 141,840,000	$ 71,424,000	$ 213,264,000

While there are additional costs associated with procuring ZEBs for use along these corridors, the benefits are substantial. First, California transit fleets may be required to be 100-percent zero emissions by 2040 so the added cost over diesel is moot as all buses will need to be ZEBs regardless. 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 137 diesel buses with zero-emissions buses, funding plays a critical role in ensuring the District can successful 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 70% of the cost of a bus replacement, with the District responsible for the remaining 30% local matching funds. The TCP policy 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 the $300,000 to $400,000 mentioned earlier. 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-emissions 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 five future battery-electric buses.
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 greenhouse-gas emissions, vehicle-miles traveled, and use of single-occupancy vehicles. The District successfully partnered with four housing developments to win funding for four hybrid diesel-electric buses to support AC Go 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-emissions fleets. 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 electric buses, 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-Emissions Vehicle (ZEV) Program which will partially fund the purchase ten hydrogen fuel cell buses in 2018. 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 fuel-cell electric buses between Divisions 2 and 4. When the five new battery-electric buses are added to the fleet in 2019, the District will have capacity for those five buses, and PG&E is exploring the possibility to scale up to have power available for charging up to 45 more battery-electric buses at Division 4. The District needs to increase charging and hydrogen fueling capacity at divisions in a strategic manner alongside any planned increases in zero-emissions buses. Rolling out any new hydrogen fueling will require expanding or building new fueling infrastructure while introducing or increasing battery-electric buses 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 will include specific recommendations for how to lay out the operating divisions to accommodate changes in fleet composition. Further, the Zero Emission Bus (ZEB) Analysis will identify – 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 680 buses among its four operating divisions, depending upon striping configurations. While this plan doesn't explicitly call for fleet expansion, the transition to zero-emissions technology will necessitate a period from 2019 – when battery-electric buses enter to fleet – to 2040 – when the entire fleet is zero-emissions – when we have three different power sources. The need to have hydrogen fuel-cell, diesel, and electric charging infrastructure could place stress on operating divisions with respect to space constraints. Compounding this issue is the number of sub-fleets operated by the District. Looking to 2018, 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 14 below. Once the battery-electric buses enter the fleet, there will be four different 40' buses. Once the 60' hydrogen fuel-cell electric bus 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' buses and the double-decker buses will add a third Transbay sub-fleet when they arrive in spring 2018.

Exhibit 14 – AC Transit Sub-Fleets in 2018

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 2019
**Enter Fleet in 2019
*** Enters Fleet in 2019

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 separate fueling and charging infrastructure takes up additional space. The District will evaluate other striping layouts to expand Division capacity and accommodate in-stall battery-electric charging in parking stalls/lanes.

Vehicle Assignment Flexibility

Implementing the Clean Corridors Plan will mean prioritizing the lines in the plan as the primary assignment of the new zero-emissions 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 zero-emissions buses 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 fuel-cell electric buses 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 the specific corridors are prioritized. As each corridor is implemented, staff will update the plan with new corridors for prioritization with the goal of a complete zero-emissions bus fleet by 2040.