Appendix A

Community Engagement and Participation

Climate Change Survey

VTA is seeking your input to inform the development of a Climate Action and Adaptation Plan (CAAP). Please answer the following questions. This survey will close on June 3, 2022. Results will be shared on the project website.

¿Puede leer este documento? Si no, podemos ayudarle a leerlo. Si desea recibir asistencia, llame al Departamento de Relaciones con la Comunidad de VTA al (408) 321-7575.

이 문서를 읽을 수 있습니까? 읽지 못하신다면 저희가 도와 드릴 수 있습니다. 무료 도움이 필요하시다면, VTA 커뮤니티 관계 부서에 (408) 321-7575로 연락주시기 바랍니다.

Kaya mo bang basahin ang dokumentong ito? Kung hindi, matutulungan ka naming basahin ito. Para makatanggap ng libreng tulong, mangyaring tumawag sa Community Relations Department ng VTA sa (408) 321-7575.

您是否能閱讀本文件？若否，我們能協助您閱讀 。欲取得免費協助，請聯絡 VTA 社區關係部專線 (408) 321-7575 。

Bạn có thể đọc tài liệu này không? Nếu không, chúng tôi có thể giúp bạn đọc tài liệu này. Để được trợ giúp miễn phí, vui lòng gọi Bộ Phận Quan hệ Cộng đ ồng của VTA theo số (408) 321-7575.

Next

Climate Change Survey

! This question requires an answer.

* 1. **How much do you agree or disagree with the following statement: “Climate change will affect me personally during my lifetime”?**

◯ Strongly agree

◯ Somewhat agree

◯ Somewhat disagree

◯ Strongly disagree

! This question requires an answer.

* 2. **Please rate your level of concern with the following climate impacts:**

	Extremely concerned	Moderately concerned	Somewhat concerned	Slightly concerned	Not concerned at all
Sea level rise, coastal flooding, and coastal erosion	◯	◯	◯	◯	◯

	Extremely concerned	Moderately concerned	Somewhat concerned	Slightly concerned	Not concerned at all
Higher risk of wildfire	○	○	○	○	○
Extreme heat events and higher temperatures	○	○	○	○	○
Extreme rain events and local flooding of creeks and rivers	○	○	○	○	○
Drought and water scarcity	○	○	○	○	○
Loss of habitat and biodiversity	○	○	○	○	○
Effects on public infrastructure such as transportation and communication systems	○	○	○	○	○
Effects on public health such as lower air quality	○	○	○	○	○
Other	○	○	○	○	○

If Other, please specify:

Climate Change Survey

* 3. **What zip code do you live in?**

4. **What is your primary mode of transportation? Please select the mode that you take most often in a one-week period.**

- ◯ Car (driving alone)
- ◯ Carpool or vanpool
- ◯ Public transportation (bus, train)
- ◯ Shuttle or ridesharing service
- ◯ Bicycle or micro-mobility device (e-scooter)
- ◯ Walking
- ◯ Other

Prev Next

Climate Change Survey

5. **If you drive alone, would you be willing to try different transportation options, such as public transit or bicycling if financial incentives or benefits (rewards, discounted transit passes, etc.) were provided?**

◯ Yes

◯ No

6. **What kind of vehicle do you primarily drive?**

◯ Electric or zero-emission

◯ Hybrid

◯ Conventional gas or diesel

◯ Not applicable

Prev Next

Climate Change Survey

7. **VTA's Climate Action and Adaptation Plan (CAAP) will focus on the following four main objectives. Please rank these objectives in order of importance to you. (1 = highest priority, 4 = lowest priority)**

☐ Quantify VTA and countywide transportation related greenhouse gas emissions.

☐ Identify measures to reduce VTA's contribution to climate change by reducing greenhouse gas emissions from its own operations.

☐ Identify actions VTA can take in partnership with agencies and the community to reduce greenhouse gas emissions by reducing the amount of driving.

☐ Conduct a vulnerability assessment that identifies the risks to transportation assets (such as roads, bridges, rail infrastructure, etc.) from climate change impacts and actions that can be taken to protect these assets for the public good.

* 8. **Are you interested in being involved in the development of the CAAP?**

development of the CAAP?

◯ Yes

◯ No

Prev Next

Climate Change Survey

9. **What is your age group?**

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+

10. **With which ethnic/racial category do you most identify?**

- ◯ White or Caucasian
- ◯ Hispanic/Latino
- ◯ Black/African American
- ◯ American Indian and Alaska Native

◯ Asian/Asian American

◯ Native Hawaiian or Pacific Islander

◯ Two or more races

◯ Other

11. **What is your household income?**

◯ Less than $25,000

◯ $25,000 to $49,999

◯ $50,000 to $74,999

◯ $75,000 to $99,999

◯ $100,000 to $149,999

◯ $150,000 to $199,999

◯ $200,000 or more

Your survey is now complete.
Please make sure to click the "Done" button below.

Thank you for your participation!

Prev Done

Virtual Workshop

CAAP
CLIMATE ACTION & ADAPTATION PLAN

October 25, 2022
6:00 – 7:30 pm

Santa Clara Valley Transportation Authority

1

1

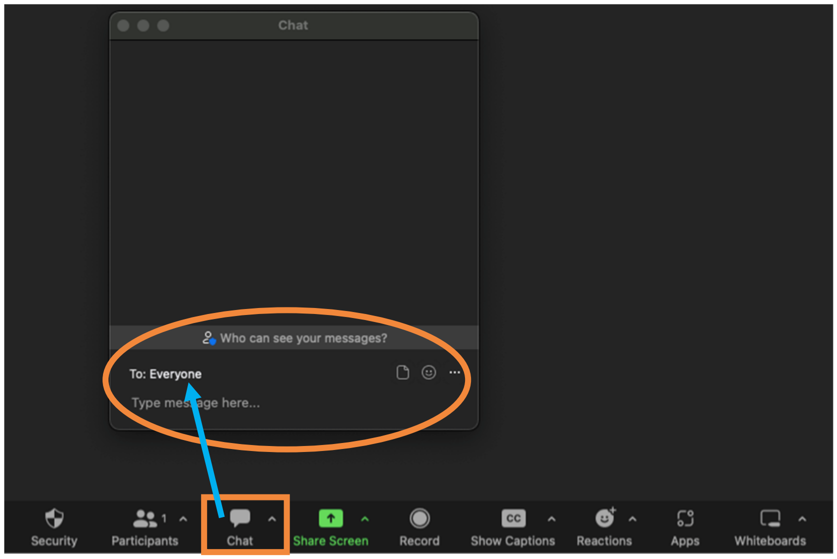
Virtual Meeting Agreements and Etiquette

- Treat everyone with kindness, respect, and consideration.
- Participate! Share your ideas and opinions.
- Everyone's input matters.
- Stay on track.
- Type questions in the chat.
- Mute your audio when you are not speaking.
- This event is being recorded and will be posted on *vta.org*.
- VTA will not tolerate demeaning, discriminatory or harassing behavior and speech. VTA staff will remove participants who refuse to adhere to this code of conduct.

2

2

How to Use the Chat Function



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3

Agenda

- Introductions
- Background Information
- Group Exercises
- Report Back and Questions
- Wrap-up

4

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Who are we?

Deanna Bolio, Community Outreach Supervisor

Patty Boonlue, Environmental Planner

Lani Lee Ho, Senior Environmental Planner

John Sighamony, Senior Transportation Planner

Rob Swierk, Principal Transportation Planner

Vishal Ream-Rao, Climate Change Planning Coordinator

Breann Boyle, Sustainability Analyst

Monica Mallon, Silicon Valley Youth Climate Action

5

5

Who are you?

- Help us get to know you by answering the questions in the Zoom poll window.
- Responses are anonymous.
- Participation is optional.

6

6

Why are we here today?

- The purpose of this meeting is to find out what is important to you.
- Your input will help shape the development of the CAAP.

7

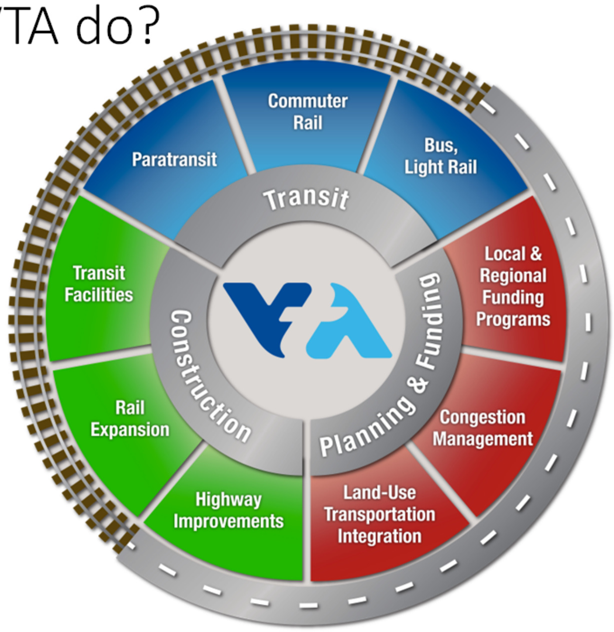
Caltrans SB1 Sustainable Transportation Planning Grant Program

- VTA was awarded funding in 2021 to develop this Climate Action & Adaptation Plan.
- How does grant funding relate back to broader State climate goals?

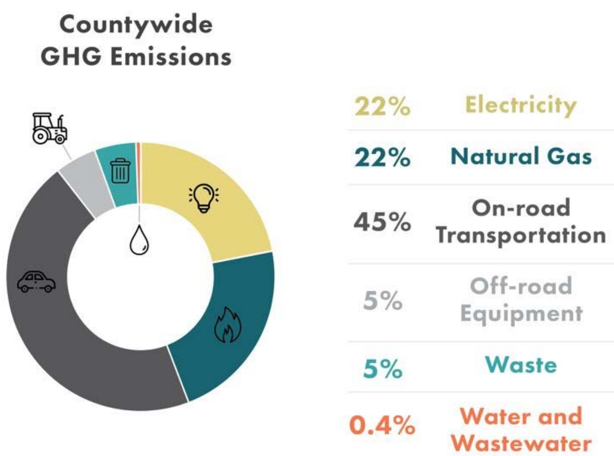
8

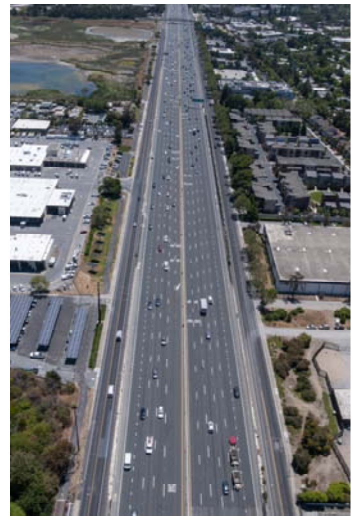
Background Information

What does VTA do?



Greenhouse Gas Emissions from Transportation





Source: County of Santa Clara, Office of Sustainability

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Vulnerability of Transportation Infrastructure

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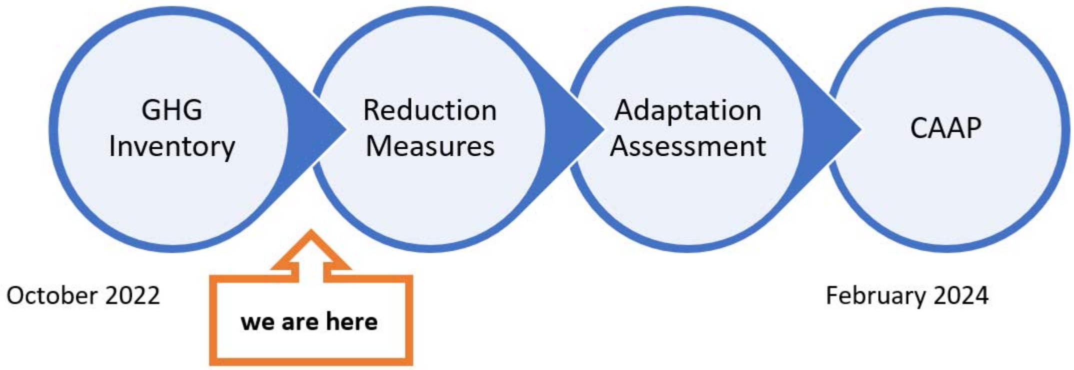
Overview of VTA's CAAP



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Group Exercises

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Mural Exercise

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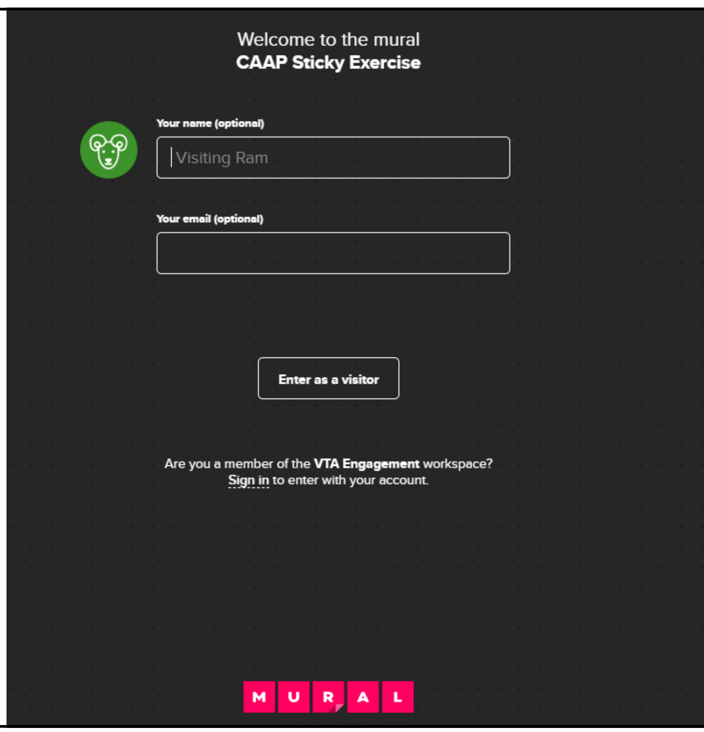

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Breakout Groups

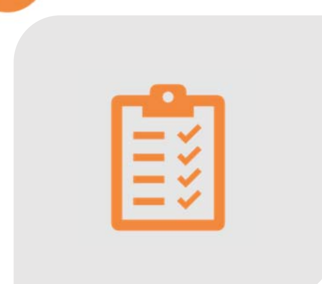
Next Steps

1

www.vta.org/climateplan

Project website – Sign up for the Mailing List!

2

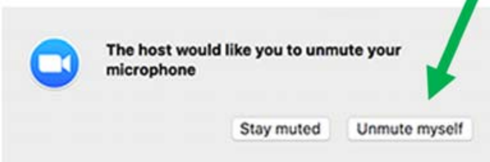


Survey Link in Chat Box

Take a quick post-meeting survey!

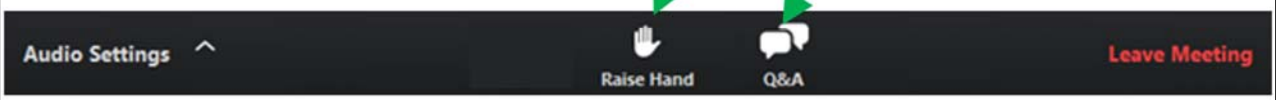
How you can participate

Unmute/Mute: If the host gives you permission, you will receive this notification - **click "unmute myself"** so everyone can hear you



Raise Hand: Raise your hand to indicate that you want to ask a question.

Question & Answer: Open the Q&A panel to ask questions.



This event is being recorded by VTA for posting on vta.org.

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Breakout Groups Discussion

What is your vision for VTA's Climate Action and Adaptation Plan?

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20

Report Back and Questions

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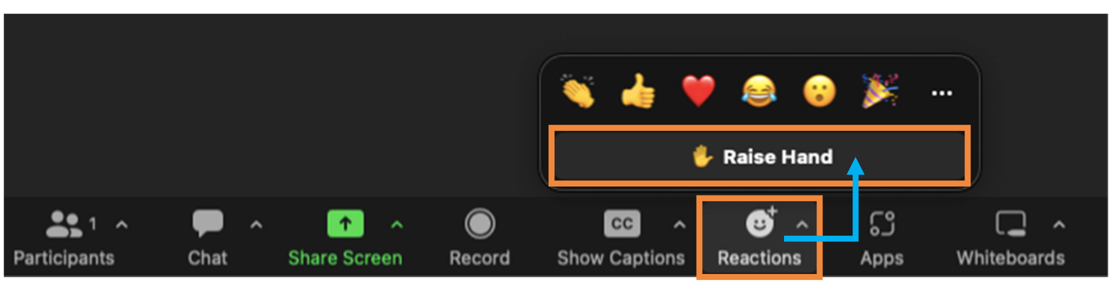
Questions?

- Share input from your breakout room or ask a question for one of the presenters



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Wrap-Up

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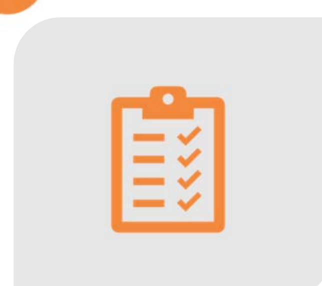
Next Steps

1

www.vta.org/climateplan

Project website – Sign up for the Mailing List!

2



Survey Link in Chat Box

Take a quick post-meeting survey!

24

24

Thank You!

Contact info – community.outreach@vta.org

CAAP
CLIMATE ACTION & ADAPTATION PLAN

Santa Clara Valley Transportation Authority

Climate action refers to actions taken to reduce the emissions of greenhouse gases (GHG). Transportation is the largest source of GHG emissions in Santa Clara County.

What actions should VTA take to reduce emissions related to transportation use?

- Eliminate fares
- More frequent transit service- make it more convenient than driving!
- build density, reduce sprawl
- Provide transit or access to parks/open spaces
- Work with cities to support their CAP
- Collaborate with other public agencies: program to visit parks on weekends, etc.
- Build stronger connectivity to additional/other transit
- Safe, comfortable, convenient, connected bicycle network
- VTA bike maps everywhere there are bus schedules
- Comfortable and safer transit facilities (bus stops, transit centers)
- Build transit access along major arterial roadways
- Work with cities to improve land use near LRT/ BART stations
- Require stricter TDM from developments
- Partner with the County to implement its CCAP
- eliminate or reduce parking in urban core
- Outreach campaign to encourage public transit
- MULTIMODAL LAND USE
- More service
- Support non-vehicle options for access to work and to parks and open space
- Expand light rail routes
- Make transit fast, frequent, and convenient enough to inspire people to get out of their Teslas
- Taking advantage of funding available through cap and trade for ZEV buses
- Funding to build Complete Streets
- engage in integrated land use planning
- Add more bike lanes that are protected from vehicles
- Better Land Uses that support Transit
- Partner with cities for local programs to avoid duplicate shuttles
- BRT
- Less highway/lane expansion
- Connec bicycle network to cross-jurisdiction bicycle superhighways and other e-bike networks
- Improve transit options in underserved communities
- Improved wayfinding and last mile transit
- More frequent bus stops
- focus on transit oriented development
- Improve ped. access More bike racks Cleaner buses Safer stops
- Convert the bus fleet to electric
- Catenary buses
- Electric charging infrastructure for electric vehicles, scooters, and e-bikes
- More frequent service, esp. in more dense areas
- Bus Rapid Transit
- More access in more areas to avoid private vehicles
- Secure, convenient bike parking and public e-bike charging
- Work with cities to remove car lanes for bus lanes/emergency vehicles!
- Converting BRT routes to trolleybus + BEV? (Santa Clara St/ Alum Rock)
- Invest in Active Transportation
- 15 minute communities
- more transit access / electric shuttles from underserved communities to parks and open space areas
- Ask the community about safety concerns
- Parking cash-out for area companies
- Greenways connecting transit, especially in underserved areas
- New Light Rail rolling stock that are more energy efficient and faster to make it more appealing to car drivers
- Decreased overlap of bus stop to allow for faster service and greater VMT, more people served vs miles driven
- Work on funding strategies to make lightrail more attractive to more users (lower cost to users)
- Greater emphasis on light rail to bus transfers as well as bus frequency to attract car drivers
- Abolishment of 60 minute frequency buses

Climate change impacts, like wildfire, heat waves, and flooding, are expected to get worse over time. *Climate adaptation* refers to preparing transportation infrastructure and facilities for the future.

What can VTA do to prepare for climate change impacts in our community?

Marketed safety procedures so that people can feel safe on public transit even in an emergency

Work with partners through the County Climate Collaborative

Operator training for heat exhaustion

Prioritize vulnerable populations in resource planning

Emergency Preparedness notifications for all communities and how to utilize transit during certain events

Plan for effects of sea level rise, for instance on North Yard

Rainwater basins in parking areas, streetside

Consider short- and long-term solutions for transit access during specific climate action events

More seating at bus stops

Better shelters at bus/LRT stops

Transit take-one maps that can be folded into fans

More Bus Shelters since too hot

Trees for cooler transit stops and sidewalks

Collaborate with the water district on adaptation projects in Alviso

Have alternate routes for high heat that reduce outdoor wait times

Better air conditioning on transit

Actively fund less expansion

Work with CCAs to identify priority areas for microgrid capacity and battery storage

More greenspace in transit areas

Work with cities to plant trees around bus shelters- typically their ROW

Increase shelter at bus stops and train stations

Provide shaded structures at transit stops

Figure out a solution to overheated track

improve community engagement techniques (language, format i.e. print, media, social media)

Require cities to plant more trees on main walking streets!

Access to water at bus stops, especially in rural areas without services

Utility hardening

Using sea level rise data to anticipate future infrastructure improvements

Partner with other agencies to create greenspace and green infrastructure in cities and adjacent to cities

Collaborate on Emergency Action Plans (due to climate emergencies) with other agencies

Increase frequency of service

Environmental protection adjacent to facilities

Support more biking and walking

Backup (bus?) plans if LR rails warp

avoid development in vulnerable areas

Anticipate rider/ community needs to access cooling, filtered air (including on transit vehicles)

Remove car lanes to add stormwater drainage gardens

Plant native plants wherever greenspace is!!!!!!

Aggressive CAP with bold goals and measures

Partner with Valley Water to better understand flood risks near facilities

ensure infrastructure is up to date, prepared for climate emergencies. Pay now so you don't later

Be committed to funding zero emission fleet

include climate change into design standards

Agency Emergency plan that includes climate change impacts (high heat, loss of electrcity, flooding)

Partner with Valley Water on Clearing culverts to reduce flooding and provide wildlife movement

along transportation corridors integrate wildlife crossings

Work with cities to add parks near transit

big trees in communities!

More drinking fountains

Maintaining drainage

Ensure light rail routes are not vulnerable to sea level rise

Assist with local jurisdictions with wildfire evacuation plans

Encourage cities to use porous asphalt for stormwater drainage!

Backup supplies of coolant and equipment

Assess wildlife risks near facilities

Allow water on transit

Replant trees along VTA LRT Blue lines along highway median route

Increase viability of bicycle storage/parking/ bikeshare near major transit stops

Alternative travel mode friendly VTA LRT rolling stock

Overhaul of all bus stops that include vegetation and trees

A second VTA LRT rail yard, wasn't this supposed to be done years ago?

Widespread adaptation of, at minimum, hybrid transit vehicles earlier than expected

Santa Clara County Climate Collaborative

OVERVIEW

The Collaborative is a cross-sector network and community of practice for public agencies, academia, nonprofit and community-based organizations, and business and community leaders to advance regional solutions to climate change through resource and expertise sharing, joint-funding opportunities, and partnership development. This is an informal collaboration and not a separate body, organization, or entity.

Vision For a Resilient Santa Clara County

We envision a Santa Clara County where diverse stakeholders come together to partner on and coordinate regional strategies to combat climate change and protect people and the natural environment, while advancing strategies to eliminate inequities and improve quality of life for all.

Collaborative Goals

Goal 1: Sustain a diverse impact network of staff from Santa Clara County public agencies and organizations to advance regional climate projects, programs and policies.

Goal 2: Develop and formalize partnerships to coordinate and fund programs and projects that enhance the county's ability to mitigate and adapt to climate change.

Goal 3: Empower communities through inclusive decision-making processes that provide culturally responsive engagement and capacity building to support the integration of equity and climate justice in the Collaborative.

Goal 4: Prioritize natural and nature-based climate solutions to promote regional resilience.

Joining The Collaborative

The Collaborative welcomes representatives from the following organizations based in Santa Clara County to serve as core participants:

- **Local and Regional Public Agencies** - staff of local jurisdictions, special districts, metropolitan planning organizations.
- **Non-profit Organizations** - staff of not-for-profit faith-based organizations, community-based organizations, social advocacy groups, or foundations.
- **Tribes** - tribal communities or native-led organizations.
- **Academic Institutions** - staff of academic or research institutions.
- **For-profit organizations** – private businesses and firms, based in Santa Clara County.

All organizations will sign a Participant Commitment Letter to join the Collaborative to demonstrate their commitment to working jointly with other organizations to advance the Collaborative vision and goals by dedicating staff time, sharing information, and coordinating efforts. This is an informal collaboration, and participation in the collaborative does not create a separate body, organization, or entity. Visit https://www.climatecollaborativescc.org to learn more and join.

For profit organizations will be required to sign an Affiliate Commitment letter that specifies the terms and expectations of their participation in the Collaborative. For profit organizations can attend Collaborative meetings and participate through working groups of the Collaborative as invited but are not eligible to become core participants of the collaborative (cannot be appointed to leadership position or serve as working group chair).

Collaborative Structure

The establishment of the Collaborative, including decisions pertaining to the operational, strategic direction, and financial sustainability of the Collaborative will be guided by an appointed Leadership Advisory Team (LAT). The LAT will be appointed by the County of Santa Clara Office of Sustainability, and will be composed of 9-11 representatives, with equal representation from both the non-profit and public sector. The LAT will meet at least four times per year.

Working groups: The LAT, in coordination with County Staff, is responsible for the approval of working groups that advance specific projects or initiatives of the Collaborative. Working groups may address topics including, but not limited to: Flooding and Sea level Rise, Heat and Air Quality, Transportation, Forestry and Equity and Environmental Justice. Working groups, as needed can establish a governance framework related to roles/responsibilities, operations, and decision-making.

Collaborative Initiatives Through December 2024

- Santa Clara County Resiliency Strategy for Flooding and Sea Level Rise
- Heat and Air Quality Resiliency (HAQR)
- Santa Clara County Urban Forestry Alliance (SCVUFA)
- Collaborative Strategic Plan and Capacity Building

Fiscal Sponsorship and Staffing Support

The County of Santa Clara Office of Sustainability provides fiscal and administrative support and day to-day oversight of Collaborative operations, including the Leadership Advisory Team, Collaborative meetings and working groups. Because the Collaborative is administered by the County, the Collaborative must comply with the County rules and regulations governing procurement, grants, contracting, lobbying, donations, etc.

Consultation and Implementation Advisors

The County of Santa Clara Office of Sustainability will seek administrative, operational, and strategic planning support from the following consultation and implementation advisors:

- Farallon Strategies, Planning and Administrative Support Partner
- Coastal Quest, Funding and Implementation Partner
- Climate Resilient Community, Equity Integration Partner

Climate Change Workshop at De Anza College

Thursday, October 26, 2023
3 pm – 4:30 pm

In collaboration with Students for Equity and Environment at De Anza (SEED)

Santa Clara Valley Transportation Authority
Solutions that move you

CAAP
CLIMATE ACTION & ADAPTATION PLAN

1

MEETING ETIQUETTE

- Treat everyone with kindness, respect, and consideration.
- Participate! Share your ideas and opinions.
- Everyone's input matters.
- Make space for everyone to contribute.
- Seek to listen & understand.
- Uplift quieter voices.
- Respect differing viewpoints.

VTA will not tolerate demeaning, discriminatory or harassing behavior and speech. VTA staff will remove participants who refuse to adhere to this code of conduct.

Solutions that move you

2

TODAY'S *AGENDA*

- Welcome
- VTA's Role in Santa Clara County
- VTA's Climate Action and Adaptation Plan
- Related and Connected Programs
- Small Group Discussion
- Thank You

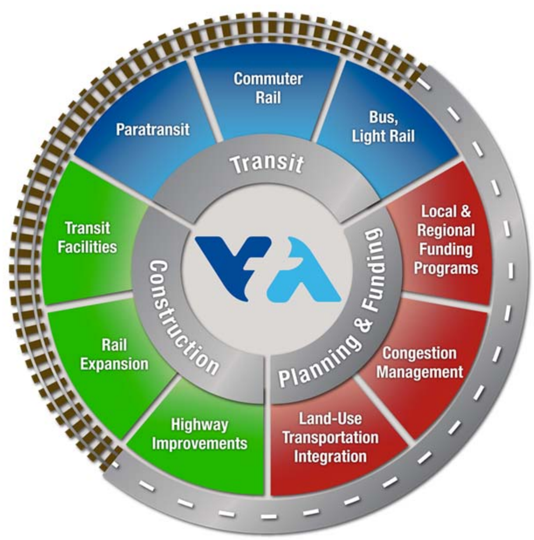
Solutions that move you

3

VTA's Role in Santa Clara County

VTA is more than buses and light rail. As the County Transportation Agency, we also:

- Act as a funding conduit for local cities and other agencies
- Design and build transit facilities, highway improvements, and expand rail service
- Plan for congestion management and land-use
- Design, build and own BART to Silicon Valley infrastructure in Santa Clara County



Solutions that move you

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4

Climate Action and Adaptation Plan

Lani Lee Ho and Patty Boonlue

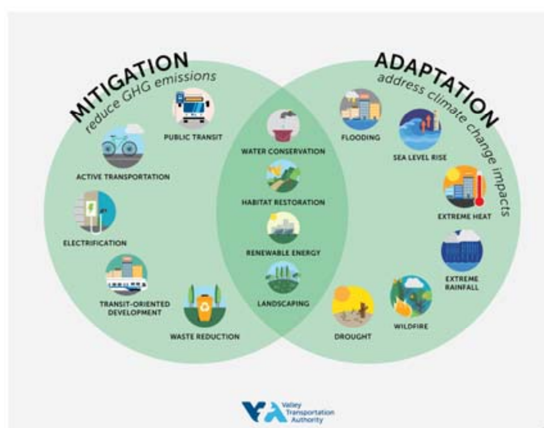
Santa Clara Valley Transportation Authority

Solutions that move you

5

CAAP Background and Purpose

- Recognizing the climate crisis for what it is, VTA formally declared a climate emergency and resolved to prepare a climate action plan to guide its response to climate change.
- The Climate Action and Adaptation Plan includes actions to (1) reduce GHG emissions and (2) prepare for more frequent and severe climate hazards.
- Actions to reduce GHG emissions are focused on the major sources of emissions generated in Santa Clara County.



Solutions that move you

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CAAP Focuses on 4 Major Sources of GHG Emissions

TRANSPORTATION AND LAND USE

--

Mode shift, sustainable land use planning and development

BUILDINGS AND FACILITIES

--

Reduce energy use and decarbonize

FLEET AND EMPLOYEE COMMUTE

--

Zero emission buses, cars, trucks, and less driving to work

MATERIALS AND WASTE

--

Reduce, reuse, recycle

Solutions that move you

7

7

TELL US WHAT YOU THINK

- Submit comments online at: https://www.vta.org/caapform
- Send us an email at: community.outreach@vta.org
- Deadline to receive comments: November 17

Measure	Action
	Strategy GHG-TL-3: Fast, Frequent, and Reliable Public Transportation for All
GHG-TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.	GHG-TL-3.1.1: Implement VTA's annual transit service plans based on the Visionary Transit Network's transit vision and recommended service enhancements. GHG-TL-3.1.2: Pursue new funding streams to support increased service, stops, reliability, extended hours, and capital projects identified in the Visionary Transit Network. GHG-TL-3.1.3: Implement service changes pursuant to available funding, in accordance with adopted service plans, and in compliance with VTA's service equity policies.
GHG-TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.	GHG-TL-3.2.1: Collaborate with member agencies and other relevant partners to make transit faster and more reliable with solutions like transit signal priority and transit-only lanes. GHG-TL-3.2.2: Implement transit signal priority, dedicated lanes, and other improvements in collaboration with member agencies. GHG-TL-3.2.3: Support member agencies through collaborative grant writing and project management of transit priority improvements.
	Strategy GHG-TL-4: Sustainable Land Use Planning and Development
GHG-TL-4.1: Collaborate with member agencies in advanced planning efforts to increase residential and employment densities and expand mixed-use development potential near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).	GHG-TL-4.1.1: Continue coordinating and collaborating with member agencies on advanced planning efforts through the LUTI Development Review Program and regularly scheduled coordination meetings, including on General Plan updates, station area plans, neighborhood/corridor plans, housing elements, zoning code updates, or other area-wide planning efforts, to ensure that densities, floor-area ratios, and land use designations are transit-supportive and aligned with existing system and planned transit investments. GHG-TL-4.1.2: Support member agencies through collaborative grant writing and project management of land use plans surrounding transit stations and priority corridors. GHG-TL-4.1.3: Promote and provide local support/technical assistance for using VTA's Community Design and Transportation (CDT) Manual and other resources.
GHG-TL-4.2: Increase development around transit stations and along transit corridors to facilitate multi-modal, carbon-neutral neighborhoods that are sustainable and resilient.	GHG-TL-4.2.1: Collaborate with member agencies to increase and facilitate (1) commercial and mixed-use development in or near job centers and (2) residential, commercial, and mixed use near rail stations, along Frequent Network bus routes, and in PDAs. GHG-TL 4.2.2: Continue to seek funding through the Strategic Growth Council's Affordable Housing and Sustainable Communities Program (AHSC) to reduce GHG's and produce affordable, equitable, and dense housing near VTA transit facilities.
GHG-TL-4.3: Strategically repurpose underutilized parking lots or other vacant lots at or near VTA transit stations and major transit stops into lively mixed-use, transit-oriented communities with activated ground floor uses that increase transit ridership, help provide revenue for transit capital investments and operations, and reduce VMT.	GHG-TL-4.3.1: Continue to implement VTA's TOC policy and TOD Development Programs. GHG-TL-4.3.2: Catalyze equitable and inclusive TOCs with thorough public engagement, resulting in thoughtful placemaking and place-keeping. GHG-TL-4.3.3: Focus on priority joint development parcels first and parcels that have the potential for achieving the highest VMT reductions and ridership improvements.
GHG-TL-4.4: Provide people of all generations and backgrounds with affordable housing and access to the necessities of daily life available within a short walk, bicycle ride, or transit trip.	GHG-TL-4.4.1: Continue to work through VTA's TOD program with local jurisdictions and the development community to produce mixed-use, mixed-income, and 100% affordable housing projects, consistent with VTA's Affordable Housing Goals identified in the TOC Policy. GHG-TL-4.4.2: Implement VTA-funded TOC Playbook strategies in Downtown San Jose, 28th Street/Little Portugal Station, and Santa Clara Station, in partnership with the cities of San Jose and Santa Clara and surrounding communities.

8

SAVE THE DATE: ***TUESDAY, NOVEMBER 7, 12-1 PM***

You're invited to a virtual lunch-time talk about climate change adaptation in Santa Clara County!

eventbrite

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Valley Transportation Plan 2050

Santa Clara Valley Transportation Authority

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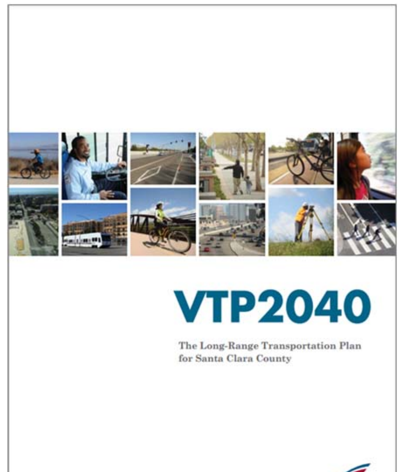
What Is The Valley Transportation Plan 2050?

Valley Transportation Plan 2050 (VTP) is our Agency's long-term plan for transportation and land use.

We are doing this update because we need to:

- Set a transportation vision for Santa Clara County for the next 25 years.
- Identify transportation projects and programs for that period
- Align our strategies with Regional/State goals
- Have a stronger connection with the Regional Long Range Transportation Plan, Plan Bay Area



Previous VTP in 2014

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Timeline

FALL 2022 – SPRING 2023	SUMMER 2023 - WINTER 2023	SPRING 2024	SUMMER 2024
Visioning & Community Engagement	**Project List Development**	**VTP Document Development**	**VTA Board Adoption**

Engagement and Goal Setting:
- *Reaching out to the Public*
  - *Community-based organizations (leaders & members)*
  - *City staff*
  - *Elected officials*
- *Identify Vision for the Plan*
- *Develop and Finalize Goals*

Projects:
- *Develop Project Development Process*
- *Propose Scoring Criteria*
- *Develop Engagement Strategy for Project Development*
- *Public Outreach for Projects*

VTP 2050 Document:
- *Write Plan Chapters*
- *Do Final Round of Public Outreach*

Board considers Final Document Adoption

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VTP 2050 Goals

- IMPLEMENT FASTER, MORE FREQUENT, SAFE, AND CONVENIENT *TRANSIT*
- PRIORITIZE *ACTIVE TRANSPORTATION* TO ENCOURAGE HEALTHIER MULTIMODAL OPTIONS
- ENCOURAGE *LAND USES* THAT CREATE COMPLETE AND CONVENIENT PLACES
- ADDRESS THE CLIMATE EMERGENCY BY REDUCING *TRANSPORTATION EMISSIONS*
- SUPPORT *EQUITY* IN TRANSPORTATION
- PURSUE SAFE AND RELIABLE TRAVEL ON *HIGHWAYS AND EXPRESSWAYS*

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Transit-Oriented Communities (TOC) & Development (TOD)

Christina Gotuaco
Sr. TOD Project Manager

Santa Clara Valley Transportation Authority
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WHAT ARE “TRANSIT-ORIENTED COMMUNITIES” (TOC)?

- **Mix of housing, businesses, & services**
- **Inclusive communities serving all income levels**
- **Near current and future transit stations**

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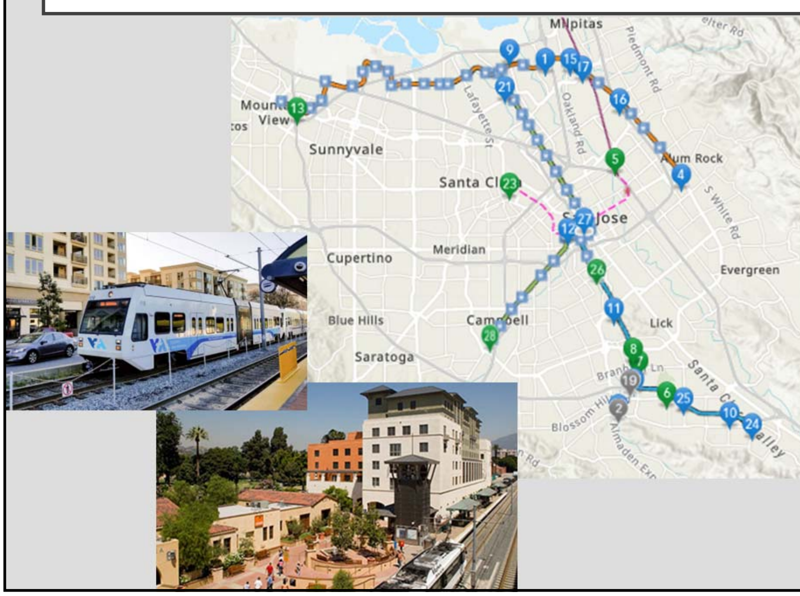
CURRENT STATIONS: TRANSIT-ORIENTED DEVELOPMENT



VTA's TOD Program & TOC Policy

Affordable Housing Policy

- 25% or more of units in each development
- 40% or more of units across overall VTA sites

Additional Goals

- More family-sized units
- Partnerships for deeper affordability

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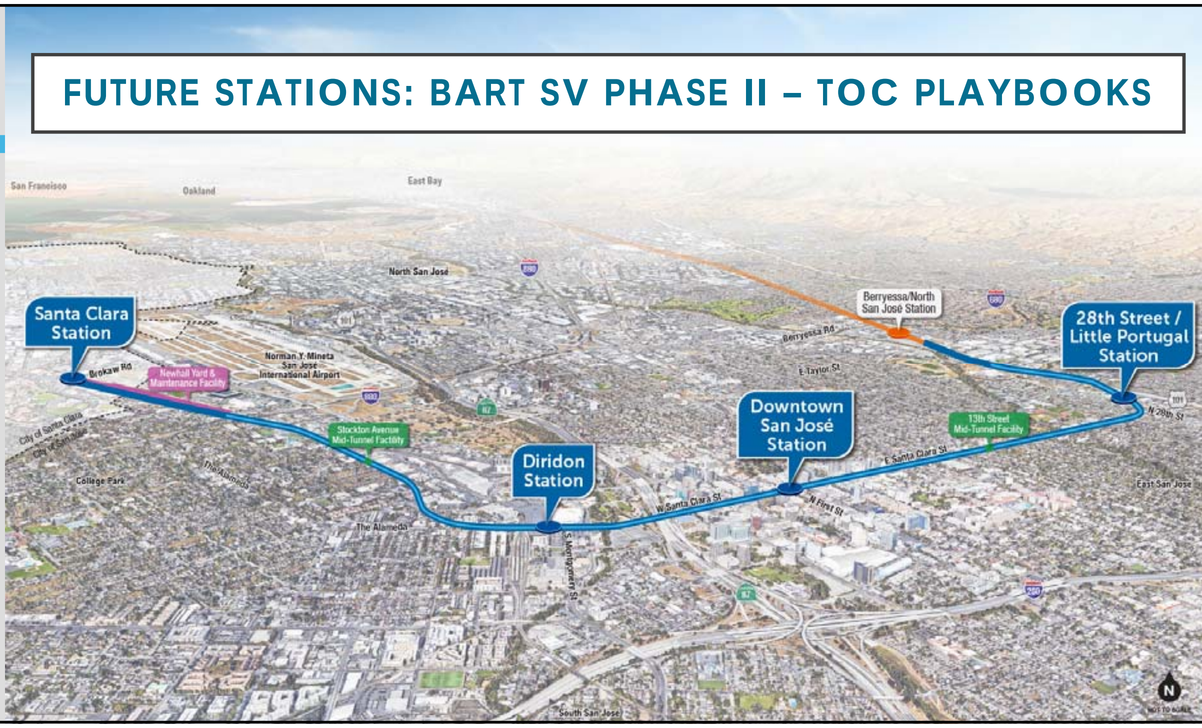
FUTURE STATIONS: BART SV PHASE II – TOC PLAYBOOKS



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ELEMENTS OF A TOC

Valley Transportation Authority

Easy Access to Everyday Needs

TOCs offer what you need to work, live, play, and run your daily errands without needing to drive.

Housing Choices for Everyone

TOCs offer a range of housing choices for people at all income levels.

Safe Spaces for all People

TOCs support vibrant public spaces that support and help build diverse communities.

Local Businesses and Services

Walkable, transit oriented neighborhoods support local retail, services, restaurants and other businesses.

Community-Supporting

TOCs strengthen neighborhoods by adding needed services and being designed for community.

Active Street Life

TOCs prioritize activity at the street level like shops and places to eat and recreate.

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Reducing Driving from Development Projects:
Equitable VMT Mitigation

Rob Swierk
robert.swierk@vta.org

Santa Clara Valley Transportation Authority
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What Is This Project About?

20

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Why Is This Important? How Does Equity Tie In?

- The amount of driving, or Vehicle Miles Traveled (VMT), is tied to Greenhouse Gas emissions, local air quality, noise, health, street safety and more
- So reducing VMT improves quality of life and the environment
- We're taking an equity-focused approach – both in the project process, and in the outcomes

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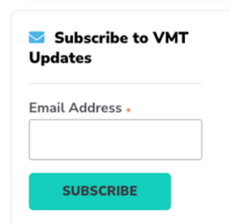
How To Learn More & Get Involved



- Project intro and explainer videos and more at www.vta.org/EquitableVMT - sign up for updates!
- Community Survey at www.vta.org/vmtsurvey
- Tabling / pop-up events
  - Gilroy La Ofrenda Festival 10/28
  - De Anza Flea Market 12/2
- Project continues through Fall 2024

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Homestead Road Safe Routes to School Project

Lauren Ledbetter

Santa Clara Valley Transportation Authority

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Countywide Context

Countywide Bicycle Plan

Bicycle Superhighway Network

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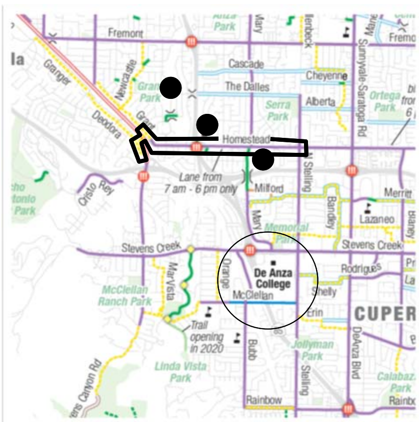
Project Area and Issues

Los Altos, Sunnyvale, Cupertino, County



TRAIL ENDS ABRUPTLY

MIDDLE SCHOOL STUDENTS BIKE THE WRONG WAY

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Project Improvements

- Extend two-way bike path
- Convert bike lanes into protected bike lanes
- Modify freeway ramp entrance
- Add traffic signal for pedestrians/bicyclists
- Fill in sidewalk gaps
- Narrow turning radii

- Outreach November 2023 through April 2024

Phase	Est. Date	Status
Preliminary Design	June 2024	Funded In progress
Environmental Clearance	Oct 2024	Funded In progress
Final Design Complete	June 2025	Not Funded
Advertise	Oct 2025	Not funded
Construction Begin	Feb 2026	Not Funded
Construction End	Aug 2027	Not funded

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Stevens Creek Corridor Vision Study

Santa Clara Valley Transportation Authority

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What is It?

- The study is a multi-jurisdictional two-year effort to create a shared vision for the future of the Stevens Creek Corridor.
- The study will gather input from community members on challenges and opportunities they see on the corridor.
- This will include recommendations on how to direct transportation investment from the cities of San José, Santa Clara, Cupertino, the county and VTA.

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Schedule

	Vision Statement		Implementation Plan	
Activities	Phase 1 Needs	Phase 2 Vision Development	Phase 3 Alternatives	Phase 4 Vision Implementation Plan
	Fall 2023	Winter 2023	Spring 2024	Fall 2024
Engagement Events	Interviews Focus Groups Pop-ups	Focus Groups Pop-ups	Focus Groups Pop-ups	
Virtual Community Workshops	Needs	Vision Statement	Alternatives	Final Vision Implementation Plan
Steering Committee	Engagement Planning Needs Review	Draft Final	Initial Preferred	Approve
Council and Commission Meetings				

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Small Group Discussion

<u>Schedule:</u>

Round 1 ~3:30 – 3:50

***rotate ***

Round 2 ~3:50 – 4:10

Report Back ~4:10 – 4:20

Closing & Clean up ~4:20 – 4:30

Santa Clara Valley Transportation Authority

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Engage with

Visit Community Outreach and Public Engagement's page to learn more about VTA's upcoming events and activities.

vta.org/COPE

SCAN ME

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1

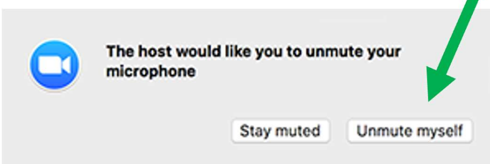
Virtual Meeting Agreements and Etiquette

- Treat everyone with kindness, respect, and consideration.
- Participate! Share your ideas and opinions.
- Everyone's input matters, respect differing viewpoints
- Make space for everyone to contribute
- Seek to listen and understand
- This event is being recorded and will be posted on *vta.org*.
- VTA will not tolerate demeaning, discriminatory or harassing behavior and speech. VTA staff will remove participants who refuse to adhere to this code of conduct.

2

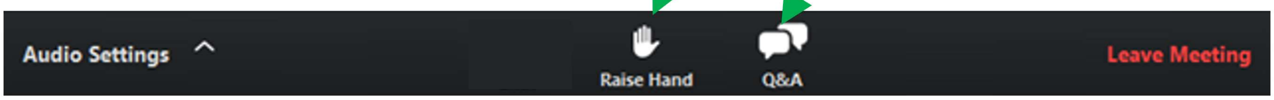
How you can participate

Unmute/Mute: If the host gives you permission, you will receive this notification - **click "unmute myself"** so everyone can hear you



Raise Hand: Raise your hand to indicate that you want to ask a question.

Question & Answer: Open the Q&A panel to ask questions.



This event is being recorded by VTA for posting on vta.org.

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Agenda

- Welcome and Introductions
- Panel presentations
- Question and Answer Session

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Introductions

Moderator

Breann Boyle
Senior Sustainability Analyst, Office of Sustainability at County of Santa Clara

Panelist

Lani Lee Ho
Senior Environmental Planner

Staff:
- Patty Boonlue, Environmental Planner
- Menominee Boyd, Public Communication Specialist

Panelist

Brian Mendenhall
Senior Water Resources Specialist

5

County of Santa Clara Climate Roadmap 2035

www.climatenetworkscc.org

Climate Organizations Directory

Browse a directory of organizations working on climate action and adaptation, and filter by location and/or sector.

Filter by Sectors

Sector

Filter by Locations

Location

Filter by Organization Name Keyword

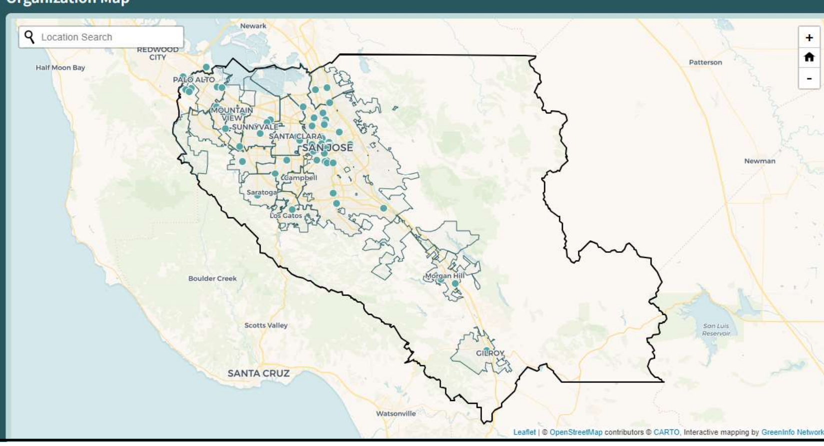
Search for an organization by name

Search

Download All Organization Data

Download Filtered Organization Data

Organization Map



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The Climate Crisis in SCC

Increase by up to 13 heat days and 55 warm nights

Extreme Heat *by mid-century*

Extreme wet and dry periods, up to 30% increase in storm events

Precipitation

+ 1-2 feet leading to increased coastal flooding

Sea Level Rise *by mid-century*

Increasing frequency, duration, and extent

Wildfire

Source: Climate Change Projections for Santa Clara County, Silicon Valley 2.0 Climate Change Preparedness Decision Support Tool

In Santa Clara County:

2-3x The average high-income neighborhood has 2-3x more tree canopy than low-income neighborhoods

15% Of the socially vulnerable residents are exposed to the 100-year floodplain compared to 9% countywide residents

7

7

Wildfire in SCC

2020 SCU Lightning Complex Impacts:

165,000 acres Area burned in Santa Clara County alone

>$77 million Total amount CAL FIRE spent in suppression and repair costs

$4 million Total amount County incurred in damage repair costs

3

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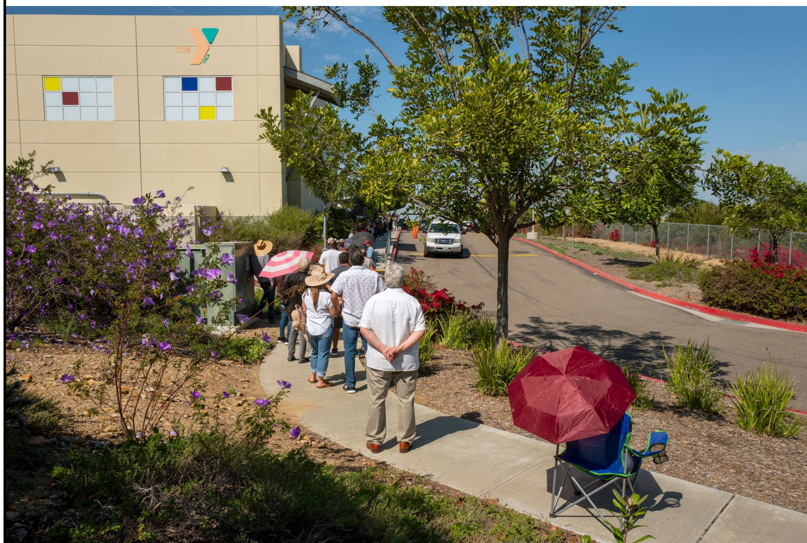
Extreme Heat in SCC



August-September 2022 Heat Wave Impacts:

16 fatalities	Potentially related deaths under investigation
109 degrees	San Jose set a record high, beating the old record of 108 degrees set in 2017
9 days	Maximum temperature of 90 degrees or higher during the heat wave

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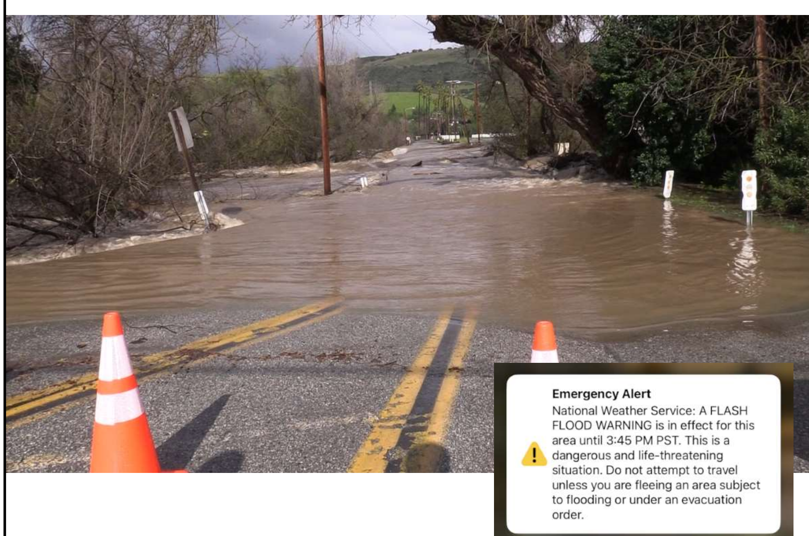
Flooding in SCC



2022-23 Atmospheric River Impacts:

21.48 inches	Amount of rainfall in Los Gatos in Jan 2023, which is 300% more than the average amount in January
$15.4 million	Damages to County roads from winter 22-23 atmospheric river events

10

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Planning for Climate Change at VTA

Lani Lee Ho
Senior Environmental Planner
lani.ho@vta.org

Santa Clara Valley Transportation Authority
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VTA'S BOARD OF DIRECTORS DECLARED A CLIMATE EMERGENCY

WHEREAS, a number of local jurisdictions and governments in the United States, and across the world, have already declared a climate emergency, and a number of State and local governments are considering declaring a climate emergency in response to the massive challenges posed by the climate crisis;

NOW, THEREFORE, BE IT RESOLVED by the Santa Clara Valley Transportation Authority Board of Directors that:

1. Global climate change caused by human activities has resulted in a climate emergency which demands mobilization at a massive scale to halt, reverse, mitigate, and prepare for the consequences of the climate emergency and to restore the climate for future generations.
2. VTA staff will evaluate administrative procedures to incorporate the consideration of climate change impacts for all relevant proposed policies, programs, or actions approved by the Board of Directors.
3. VTA will identify specific metrics, including objectives and targets, to prioritize opportunities to reduce greenhouse gas emissions and develop a Climate Action Plan to guide its climate emergency response.
4. VTA will support legislative efforts to avert climate change by federal, state, regional, and local entities, and join with stakeholders to reduce greenhouse gas emissions in the transportation sector.

PASSED AND ADOPTED by the Santa Clara Valley Transportation Authority Board of

CAAP
CLIMATE ACTION & ADAPTATION PLAN

Excerpt from resolution adopted on 2/6/2020

12

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CAAP OBJECTIVES

Identify measures to reduce GHG emissions

Conduct Vulnerability Assessment of transportation assets

Quantify GHG emissions generated from transportation use in the county

Focus of today's presentation

CLIMATE ACTION & ADAPTATION PLAN

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ADAPTATION PLANNING PROCESS

Adaptation: An action or set of actions that reduce physical climate risk. In the context of this CAAP, climate change adaptation refers to building resilience of VTA's assets and operations in response to the current or expected effects of climate change.

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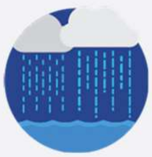
CLIMATE HAZARDS EVALUATED


Permanent Coastal Inundation


Temporary Urban/Inland Flooding


Temporary Coastal Flooding


Wildfire


Extreme Heat


Drought

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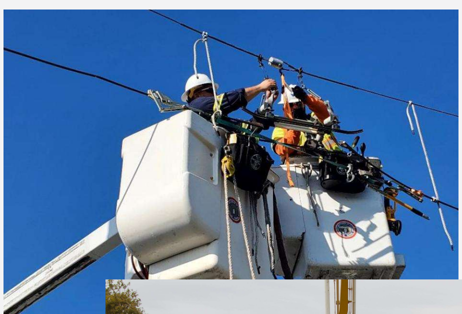
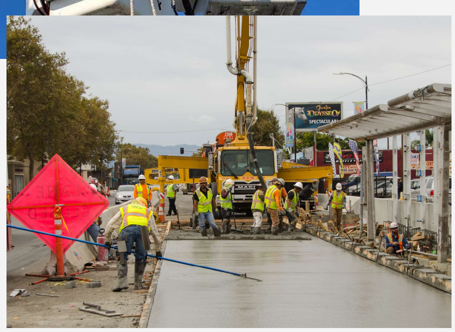
EXTREME HEAT IMPACTS ALL OF US:
TRANSIT USERS, BICYCLISTS, PEDESTRIANS, & OUTDOOR WORKERS





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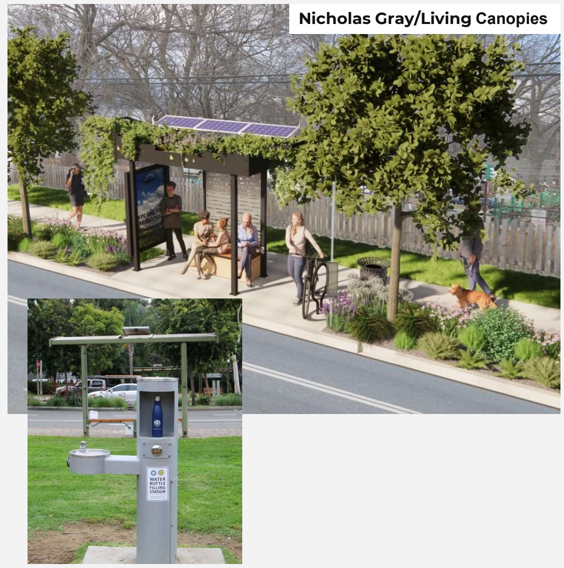
ADAPTATION ACTIONS

Extreme Heat

- **AD-F-1.1:** Install cooling amenities in areas where they do not yet exist and where feasible, such as: hydration stations on station platforms and in maintenance areas to ensure riders and VTA staff have access to drinking water; additional seating under pre-existing shade platforms; additional shaded areas at park-and-ride lots, bike racks, and platforms; air conditioning in indoor waiting areas; and misters in outdoor waiting areas.
- **AD-F-6.1:** Shift outdoor physical labor hours to earlier in the morning during extreme heat events, and allow for flexible hours and remote work, in general (where possible), to ensure safety during other climate hazard events.
- **AD-F-6.5:** Develop and share emergency preparedness tips and safety communications with employees.



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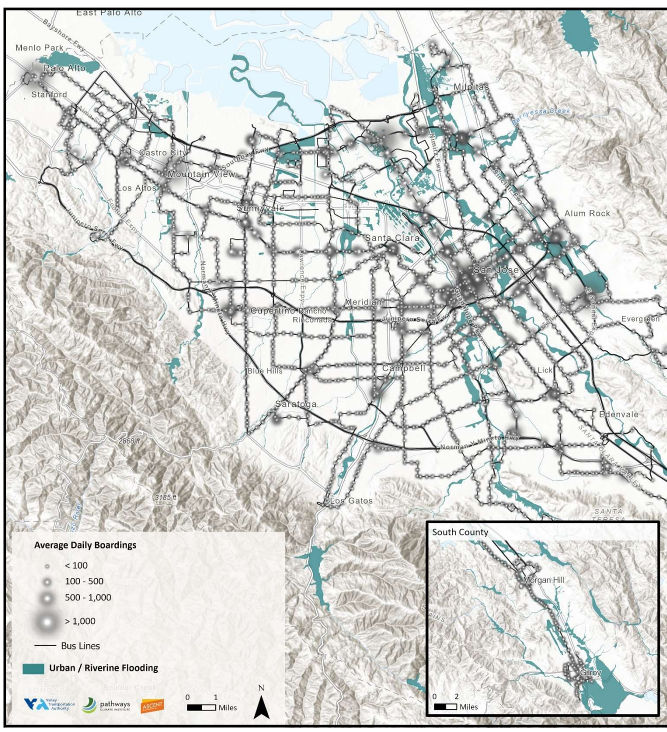

BUS ROUTES EXPOSURE & ADAPTATION ACTIONS

Temporary Urban/Inland Flooding

- **AD-CC-3.1:** Identify alternative transit routes and modes of transportation and develop protocols for service disruptions or temporary closures during climate hazard events, ensuring effective communication with riders and VTA staff.
- **AD-F-3.1:** Prioritize nature-based solutions to address flooding. This may include coordination with other agencies to restore wetland and riparian habitats on floodplains to further slowdown the flow of floodwaters and hold soil in place.
- **AD-F-3.5:** Install permeable pavement to minimize flood risk in park-and-ride lots that are exposed to temporary flooding
- **AD-F-3.7:** Procure additional and appropriate temporary flood protection barriers to be better prepared during a temporary flood event.

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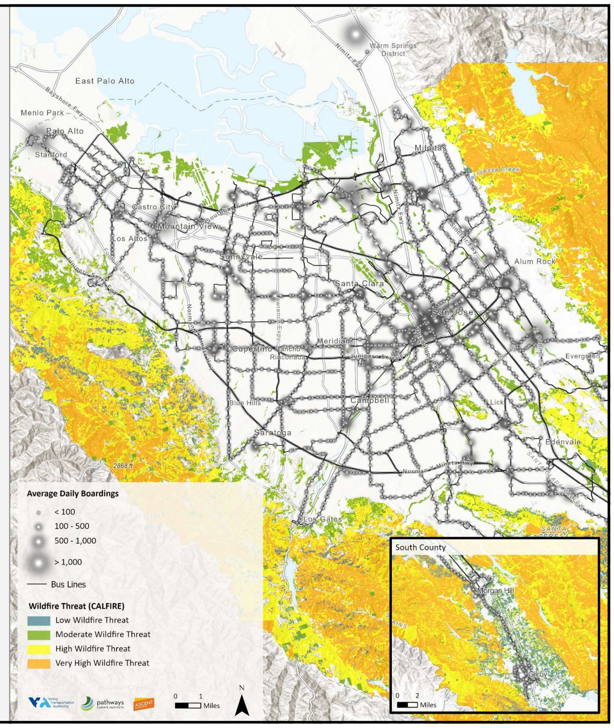
BUS ROUTES EXPOSURE & ADAPTATION ACTIONS

Wildfire Threat

- **AD-F-5.3:** For VTA assets that are in higher wildfire risk areas, manage adjacent trees and vegetation in a way that minimizes risk of wildfire ignition and spread. This may include removing and/or replacing trees with other forms of vegetation or hardening features (e.g., fire-resistant materials) that would reduce risk and ensure adequate defensible space.
- **AD-F-6.2:** Conduct safety audits and inspections across VTA's transportation system (e.g., facilities, buses) to identify and address potential safety risks to riders and VTA staff that would be caused or exacerbated by climate hazards.
- **AD-F-6.4:** Ensure indoor facilities, buses, and trains are equipped with air filtration systems to protect public health from wildfire smoke and the harmful effects of particulate matter pollution.



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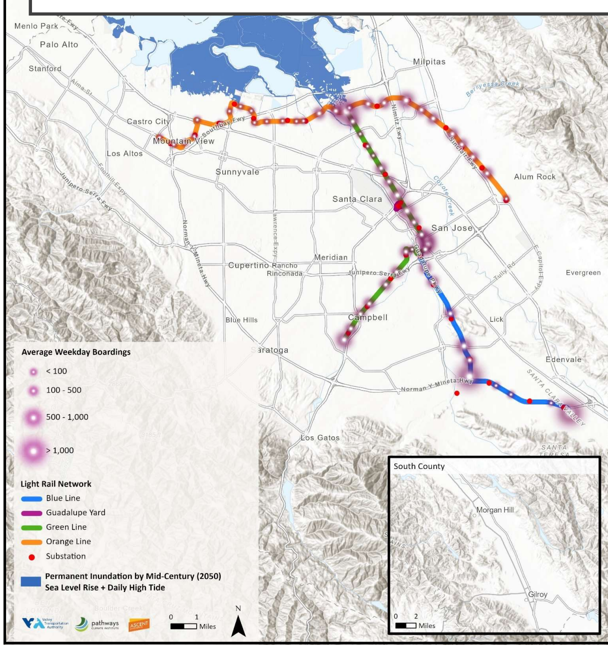
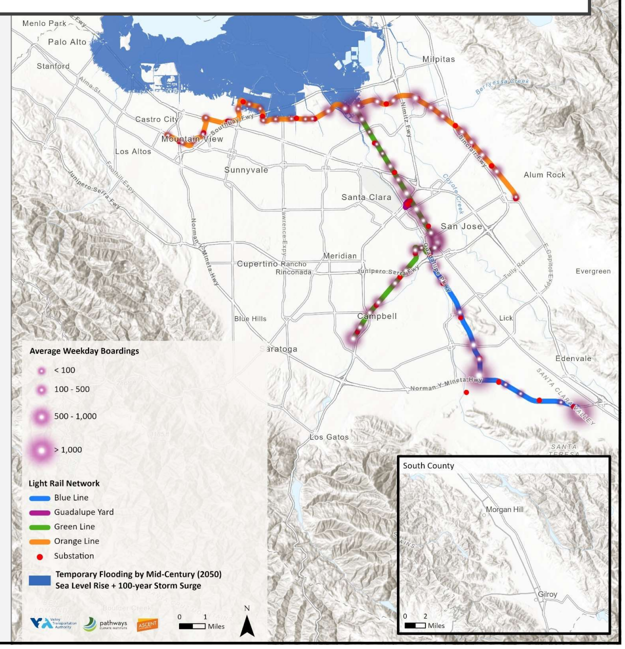
LIGHT RAIL EXPOSURE TO SEA LEVEL RISE & STORM SURGE





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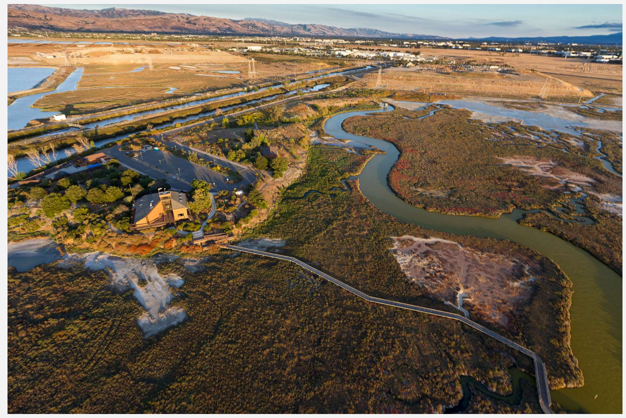
ADAPTATION ACTIONS FOR LIGHT RAIL

Permanent Coastal Inundation/Temporary Coastal Flooding

- **AD-CC-4.2:** Coordinate with VTA member agencies to explore the establishment of a countywide Climate Resilience District to fund or finance climate adaptation projects and programs, in line with SB 852.
- **AD-F-3.8:** Collaborate with partnering organizations to encourage and expedite shoreline protection and restoration projects to reduce the overall vulnerability of VTA's transportation system to the effects of permanent inundation and coastal flooding.
- **AD-F-3.9:** Incorporate future sea-level rise, permanent inundation, and precipitation projections into long-term infrastructure planning processes, influencing decisions on expansion, relocation, or retrofitting of assets.



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WE WANT TO HEAR FROM YOU!

- The Draft CAAP is available for review.
- Comments are requested **by November 17, 2023.**
  - Submit comments online at: https://www.vta.org/caapform OR
  - Email comments to: community.outreach@vta.org

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Climate Adaptation

Implementing Valley Water's Climate Change Action Plan
November 16, 2023

Valley Water

23

Climate Action Goals

GOAL 1-3	Climate Mitigation
GOAL 4	Water Supply Adaptation
GOAL 5	Flood Protection Adaptation
GOAL 6	Ecosystem Adaptation
GOAL 7	Emergency Preparedness

Valley Water

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Water Supply Adaptation

Strategy
S4.1 Diversify local water supplies
S4.2 Improve demand management and increase water conservation
S4.3 Increase reliability of imported water.
S4.4 Support efforts to maintain and enhance source water quality.
S4.5 Implement source water improvement and water treatment actions.
S4.6 Increase flexibility and resilience of water utility operations and assets.
S4.7 Support ecological water supply management objectives.

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Flood Risk Adaptation

Strategy
S5.1 Minimize riverine flooding risks.
S5.2 Minimize flood risk in coastal areas.
S5.3 Improve flood preparedness
S5.4 Increase the flexibility and resilience of flood protection operations and assets.
S5.5 Expand the use of flood forecasting and modeling tools to maximize protection from flood risks.

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Ecosystem Stewardship Adaptation

Strategy
S6.1 Protect and enhance ecosystems to improve climate change resilience and wildlife habitat.
S6.2 Develop and expand programs and plans that support more climate-resilient ecosystems.
S6.3 Expand the availability of data on regional ecosystems in order to avoid detrimental climate change-related ecosystem impacts.

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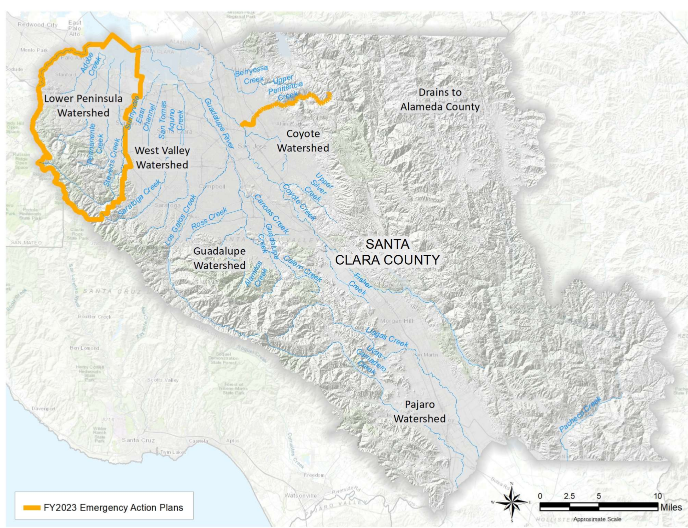
Adaptation for Emergency Preparedness

Strategy
S7.1 Maximize Valley Water's emergency preparedness for climate related impacts (e.g.: from flooding, extreme heat events, fire, severe storms).

21 Emergency Action Plans

Valley Water



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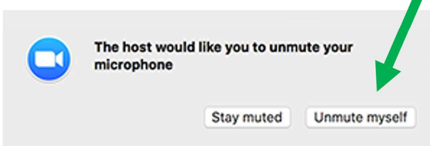
Q&A Session

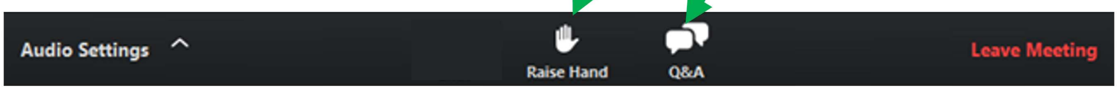
How you can participate

Unmute/Mute: If the host gives you permission, you will receive this notification - **click "unmute myself"** so everyone can hear you



Raise Hand: Raise your hand in the webinar to indicate that you want to make a comment.

Question & Answer: Open the Q&A panel to ask questions.



This event is being recorded by VTA for posting on vta.org.

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Closing Remarks

- VTA is taking comments on the Draft CAAP. Submit comments online at www.vta.org/caapform or send an email to community.outreach@vta.org by 11/17/23.
- More information on how to engage with the County's Office of Sustainability and Valley Water is posted in the chat.
- Thank you!

Scan me

for the CAAP

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WE SUPPORT CLIMATE ACTION

One Planet, One Future

Valley Transportation Authority

vta.org/climateplan

Word Scramble

Unscamble the letters to reveal climate change hazards

HUORGTD

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TXMEERE FRIALNAL

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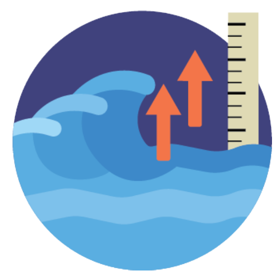

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Valley Transportation Authority

CAAP CLIMATE ACTION & ADAPTATION PLAN

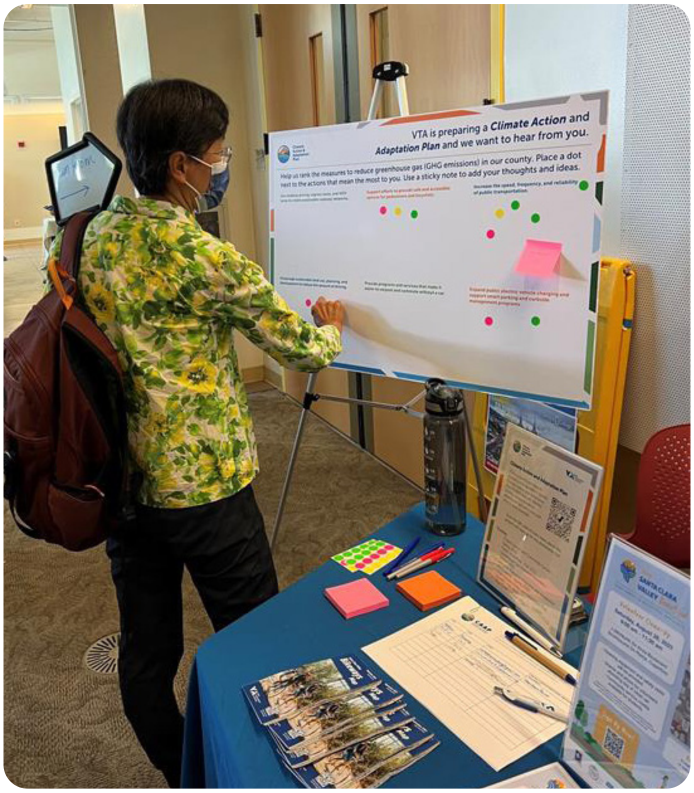
Valley Transportation Authority

CAAP
CLIMATE ACTION & ADAPTATION PLAN

Climate Action & Adaption Plan **FACTSHEET**

Purpose

The purpose of this Climate Action and Adaptation Plan (CAAP) is to provide a comprehensive plan for VTA to address climate change. It includes actionable strategies VTA will implement to both reduce greenhouse gas (GHG) emissions and address climate change impacts by adapting to and building resilience of VTA's assets and operations. This work is funded by a Sustainable Transportation Planning Grant provided by the State of California Department of Transportation (Caltrans).



Objectives

The primary objectives for the CAAP are to:

- Quantify GHG emissions from VTA operations and countywide transportation.
- Identify strategies and actions to reduce VTA's contribution to climate change by reducing GHG emissions from its operations, as well as actions VTA can take in partnership with agencies and the community to reduce vehicle miles traveled (VMT) and associated GHG emissions.
- Conduct a vulnerability assessment that identifies the risks to VTA's transportation assets and operations from climate change impacts and identify adaptation strategies and actions VTA can take to protect its assets and improve overall resilience to address growing climate risk and uncertainty.

Contact Us

If you are interested in providing input or getting involved, please contact VTA's Community Outreach at community.outreach@vta.org and (408) 321-7575, (408) 321-2330 TTY.

2309-2757

Valley Transportation Authority

CAAP CLIMATE ACTION & ADAPTATION PLAN

Climate Action & Adaption Plan **FACTSHEET**

Propósito

El propósito de este Plan de Acción y Adaptación Climática (CAAP, por sus siglas en inglés) es proporcionar un plan integral para que VTA aborde el cambio climático. Incluye estrategias prácticas que VTA implementará para reducir las emisiones de gases de efecto invernadero (GEI) y abordar los impactos del cambio climático mediante la adaptación y el aumento de la resiliencia de los activos y operaciones de VTA. Este trabajo está financiado por una subvención para la planificación del transporte sostenible proporcionada por el Departamento de Transporte del Estado de California (Caltrans).

2309-2757

Objetivos

Los objetivos principales del CAAP son:

- Cuantificar las emisiones de GEI de las operaciones de VTA y el transporte en todo el condado.
- Identificar estrategias y acciones para reducir la contribución de VTA al cambio climático mediante la reducción de las emisiones de GEI de sus operaciones, así como las acciones que VTA puede tomar en colaboración con las agencias y la comunidad para reducir las millas recorridas por vehículos (VMT, por sus siglas en inglés) y las emisiones de GEI asociadas.
- Realizar una evaluación de vulnerabilidad que identifique los riesgos para los activos y operaciones de transporte de VTA derivados de los impactos del cambio climático e identificar las estrategias y acciones de adaptación que VTA puede tomar para proteger sus activos y mejorar la resiliencia general para abordar el creciente riesgo climático y la incertidumbre.

Contáctenos

Si le interesa compartir sus comentarios o participar, comuníquese con el Programa de extensión a la comunidad de VTA llamando al (408) 321-7575, (TTY) personas con discapacidades auditivas llamar al (408) 321-2330.

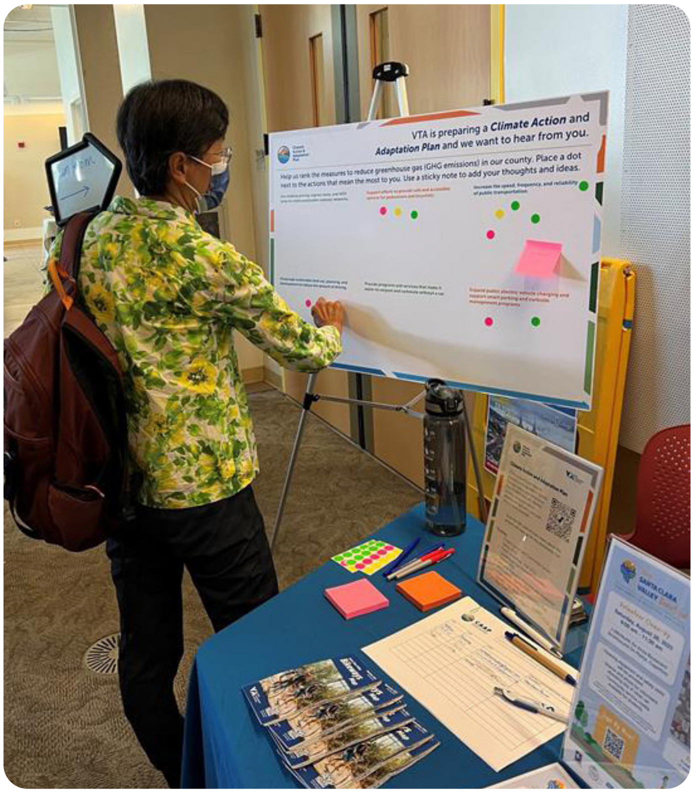
Valley Transportation Authority

CAAP
CLIMATE ACTION & ADAPTATION PLAN

Climate Action & Adaption Plan **FACTSHEET**

Mục Đích

Mục đích của Kế Hoạch Hành Động và Thích Ứng Khí Hậu (CAAP) này là cung cấp một kế hoạch toàn diện cho VTA để giải quyết tình trạng biến đổi khí hậu. Nó bao gồm các chiến lược có thể hành động mà VTA sẽ thực hiện để vừa giảm phát thải khí nhà kính (GHG) vừa giải quyết các tác động của tình trạng biến đổi khí hậu bằng cách thích ứng và xây dựng khả năng phục hồi của các tài sản và hoạt động của VTA. Công việc này được tài trợ bởi Tài Trợ Quy Hoạch Giao Thông Bền Vững do Bộ Giao Thông Tiểu Bang California (Caltrans) cung cấp.



2309-2757

Mục Tiêu

Các mục tiêu chính của CAAP là:

- Định lượng phát thải khí nhà kính từ các hoạt động VTA và giao thông trên toàn quận.
- Xác định các chiến lược và hành động để giảm sự đóng góp của VTA đối với tình trạng biến đổi khí hậu bằng cách giảm phát thải khí nhà kính từ các hoạt động của mình, cũng như các hành động mà VTA có thể hợp tác với các cơ quan và cộng đồng để giảm số dặm xe đi (VMT) và phát thải GHG liên quan.
- Tiến hành đánh giá tính dễ bị tổn thương mà xác định các rủi ro đối với tài sản và hoạt động giao thông của VTA do tác động của tình trạng biến đổi khí hậu và xác định các chiến lược và hành động thích ứng mà VTA có thể thực hiện để bảo vệ tài sản của mình và cải thiện khả năng phục hồi tổng thể để giải quyết rủi ro và sự không chắc chắn về khí hậu ngày càng tăng.

Liên Hệ với Chúng Tôi

Nếu quý vị muốn đóng góp ý kiến hoặc tham gia, vui lòng liên hệ với ban Tiếp Cận Cộng Đồng của VTA (VTA Community Outreach) theo số (408) 321-7575, (TTY) cho người khiếm thính (408) 321-2330.

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VTA
8,224 followers
7mo •

At VTA, every day is Earth Day! To officially celebrate Earth month, our team is out and about, talking to the community about sustainability, reducing greenhouse gases, and doing our part to help the environment. Come meet our staff at an Earth Day celebration!

📍 April 19, 2023 - Mission College Eco Fair - https://bit.ly/3oqsisr

📍 April 20, 2023 - West Valley College - Earth Stewardship Symposium - https://bit.ly/3At2yi1

And what better way to celebrate Earth Day than by 🚶🛴or 🚲 through #VivaCalleSJ on Sunday, April 23. Hope to see you there!

#EarthDay #cleanair #enviornment #busrides #publictransportation #VTAcares

40

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VTA took part in the 2023 Silicon Valley Youth Climate Action Annual Leadership Summit at De Anza College and had a great time. We spoke to students about various VTA initiatives, including the Climate Action & Adaptation Plan, Valley Transportation Plan 2050, Equitable Vehicle Miles Traveled (VMT) Mitigation Program, and the Guaranteed Ride Home (GRH) Program. It was a pleasure to see so many people passionate about making a difference! #publictransit #futureleaders #environment #sustainability

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VTA's Draft Climate Action and Adaptation Plan is now available for public review and public comment. Read about the purpose of VTA's Climate Action and Adaptation Plan (CAAP) and how to submit your comment before Friday, November 17, 2023: https://lnkd.in/gd4DhncQ

#climatechange #VTA #publictransit #community #enviornment

CAAP
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Comments Requested on VTA's Climate Action and Adaptation Plan
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Santa Clara Valley Transportation Authority
October 17 at 4:12 PM ·

VTA's Draft Climate Action and Adaptation Plan (CAAP) is now available for public review and comment. Read about the purpose of VTA's CAAP and how to submit your comment before Friday, November 17: https://www.vta.org/.../comments-requested-vtas-climate...
#climatechange #VTA #publictransit #community #enviornment

VTA.ORG
Comments Requested on VTA's Climate Action and Adaptation Plan

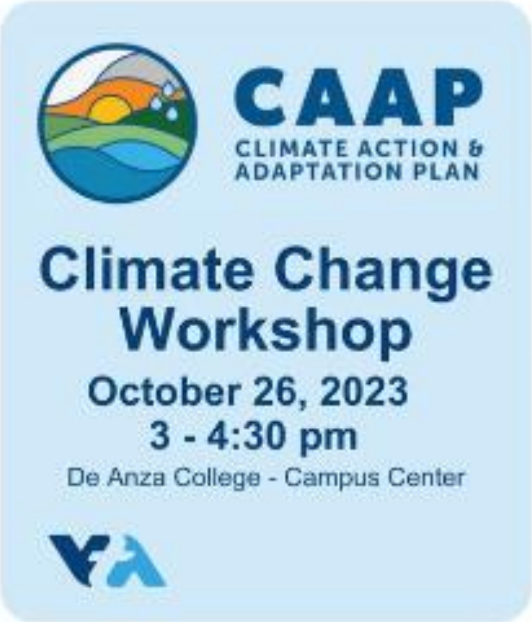
7

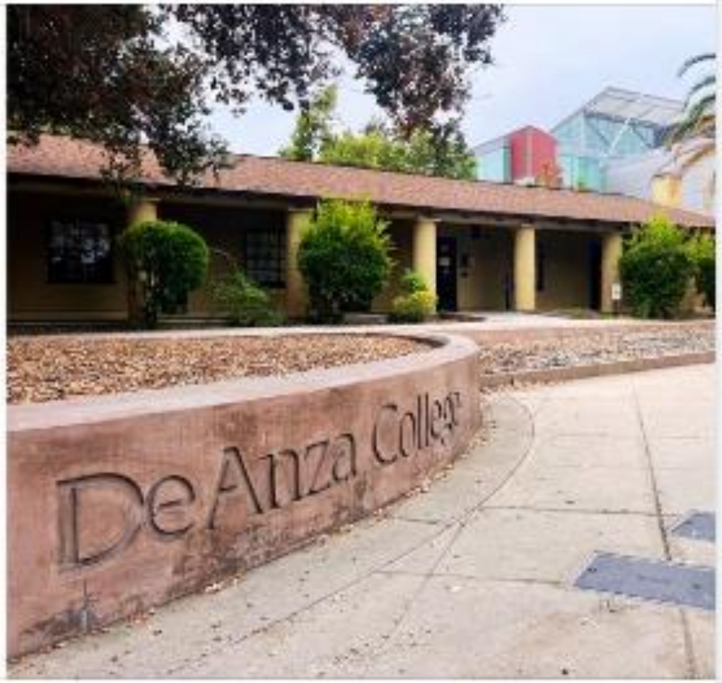
Santa Clara Valley Transportation Authority
October 25 at 8:00 AM ·

Join VTA for an interactive workshop centered on the Climate Action and Adaptation Plan (CAAP) 🌿💧 that will feature mini-presentations followed by a smaller group dialogue.

Also, the Draft CAAP is available for public comment.

More information: http://vta.org/climateplan





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First stop: Climate Action and Adaptation Plan (CAAP) 🌿💧

The Draft CAAP is available for public comment: vta.org/climateplan

10:20 AM · Oct 21, 2023 · **531** Views

1 5

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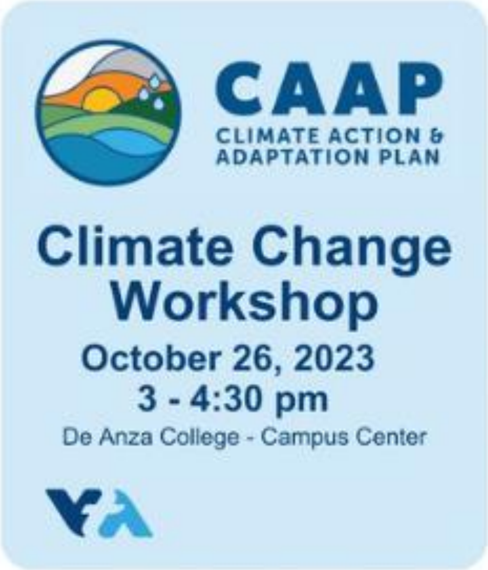
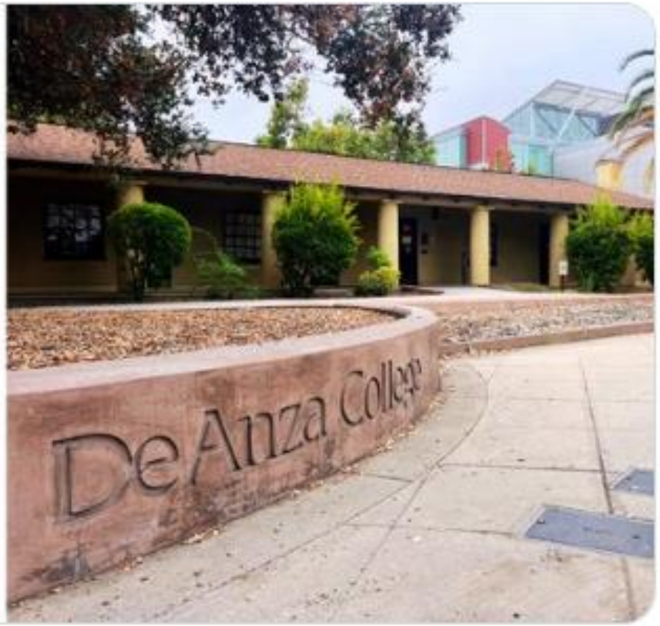
Join VTA for an interactive workshop centered on the Climate Action and Adaptation Plan (CAAP) 🌿💧 that will feature mini-presentations followed by a smaller group dialogue.

Also, the Draft CAAP is available for public comment.

More information: vta.org/climateplan





8:00 AM · Oct 25, 2023 · **1,010** Views

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🌿💧Read about the purpose of VTA's Climate Action and Adaptation Plan (CAAP) and how to submit your comment by Friday, November 17: bit.ly/47aMuzw

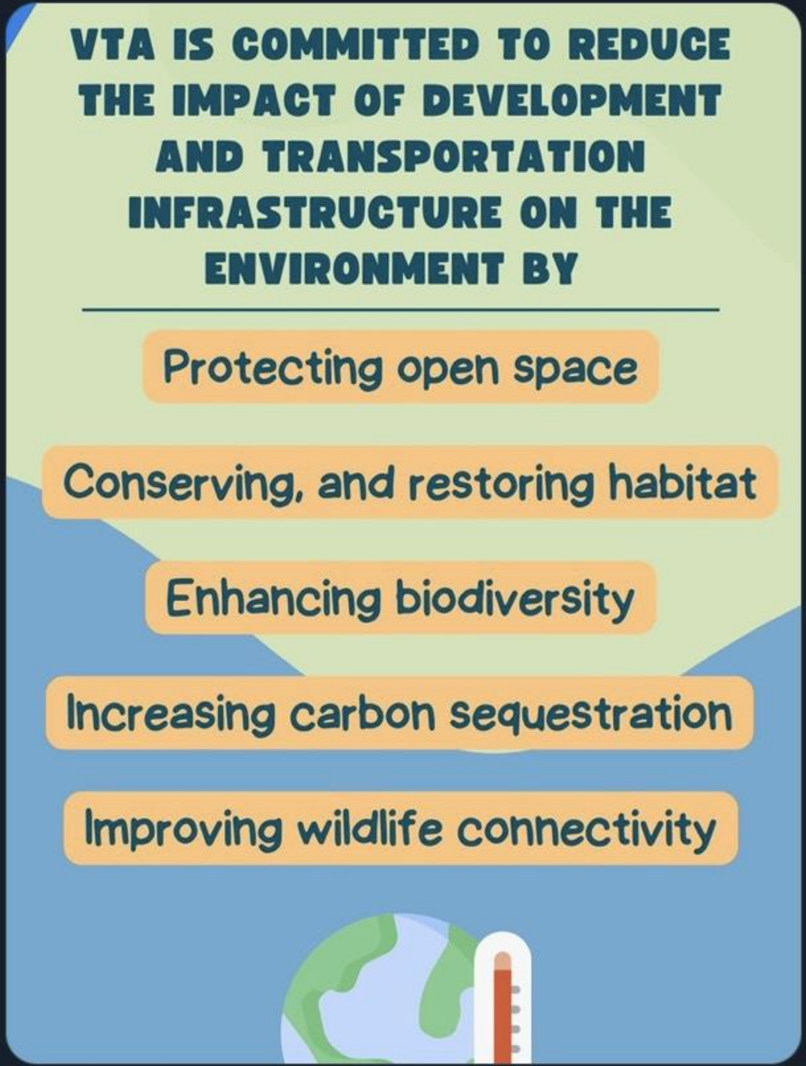
☀️You can also join the upcoming webinar next week to learn more: bit.ly/3MwiIOf

12:00 PM · Nov 2, 2023 · **243** Views

1 3

VTA @VTA · 11/14/23

Have other ideas to respond to the #climate crisis? Check out the #VTA Draft Climate Action and Adaptation Plan to provide input by 11/17/23: vta.org/climateplan



2 4 951

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#NationalRecyclingDay: Recycling is good for the environment, but buying less & reducing waste is even better. VTA's CAAP proposes actions to reduce construction & demolition waste in VTA projects to reduce GHG emissions. bit.ly/49su4wj

*Public comments are due 11/17.

11:00 AM · 11/15/23 from Earth · **502** Views

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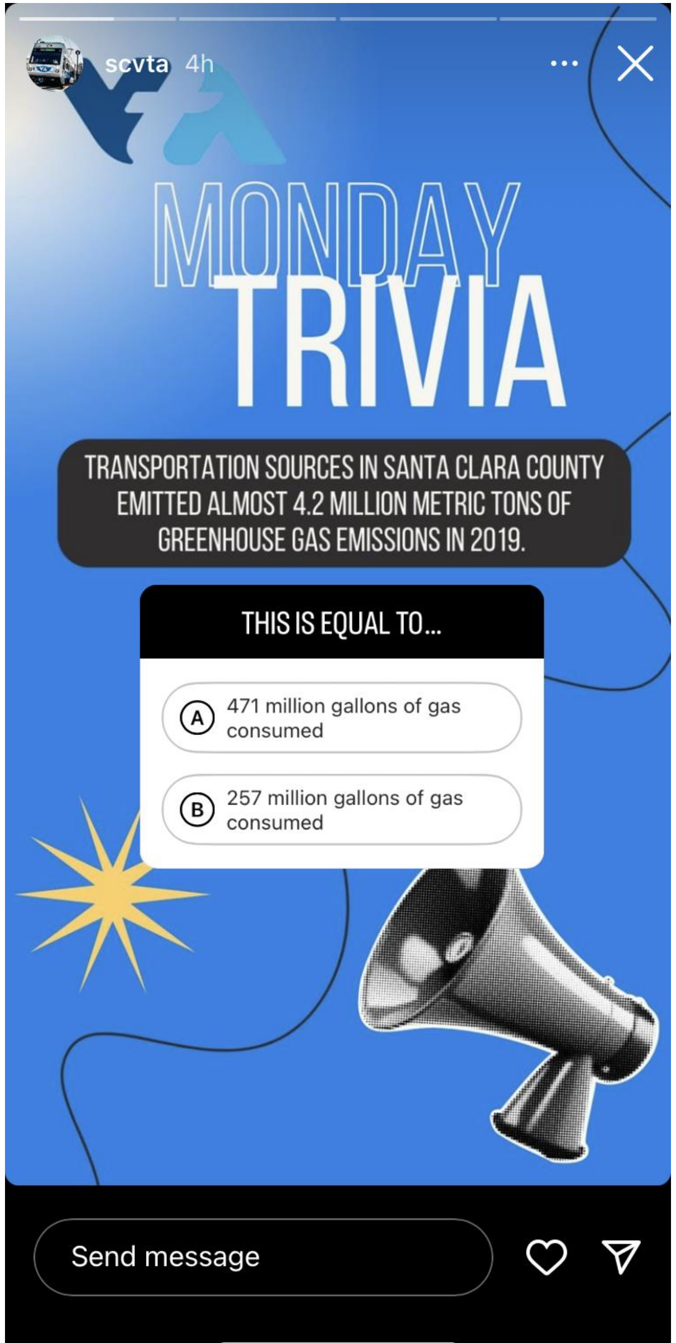

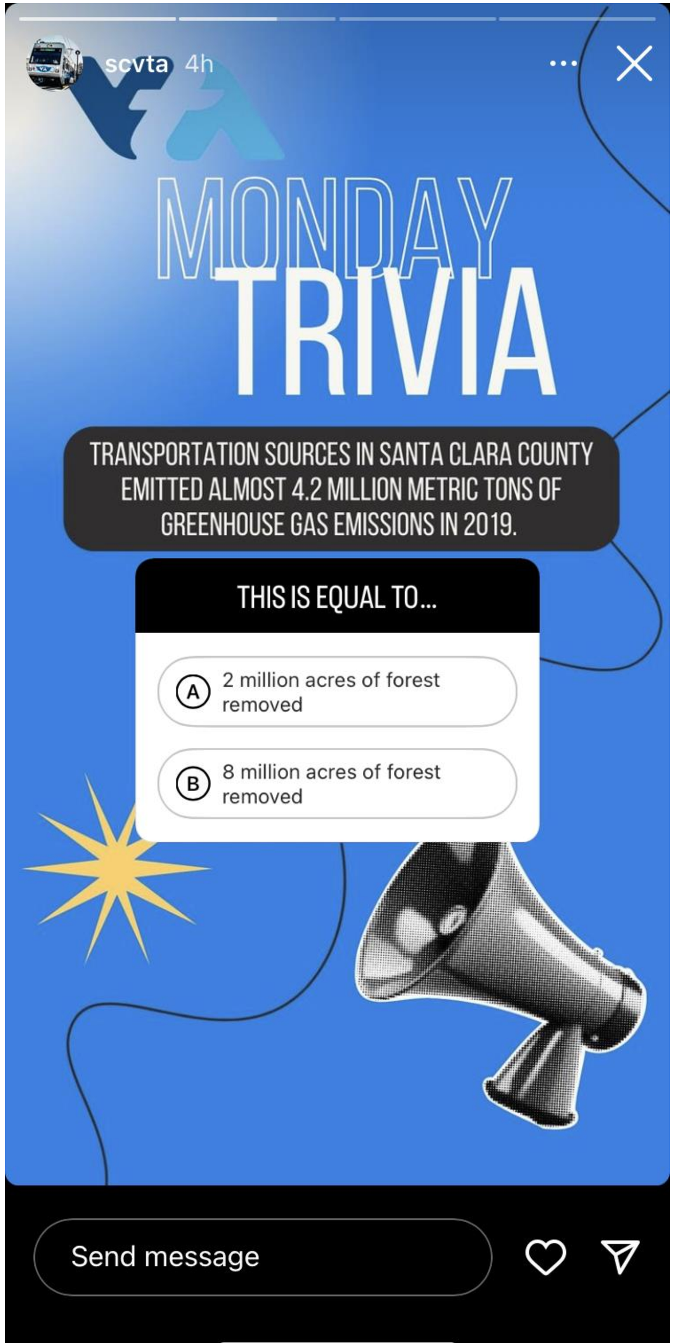

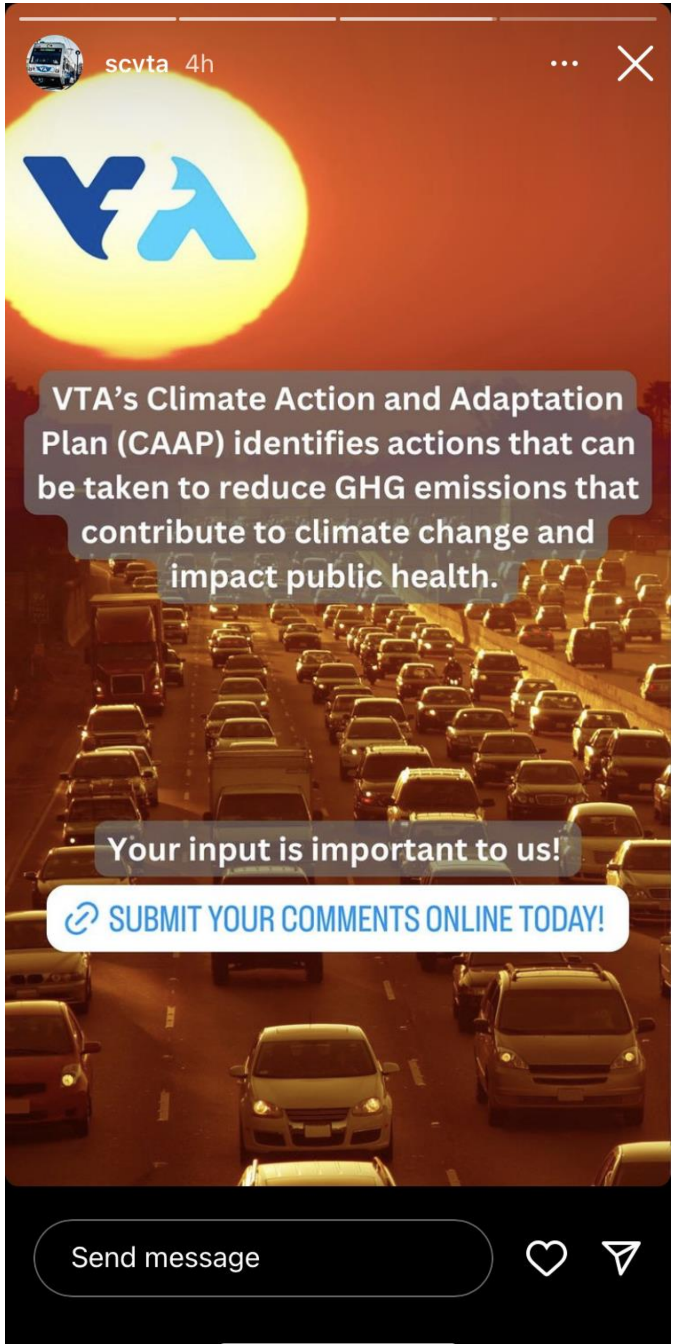

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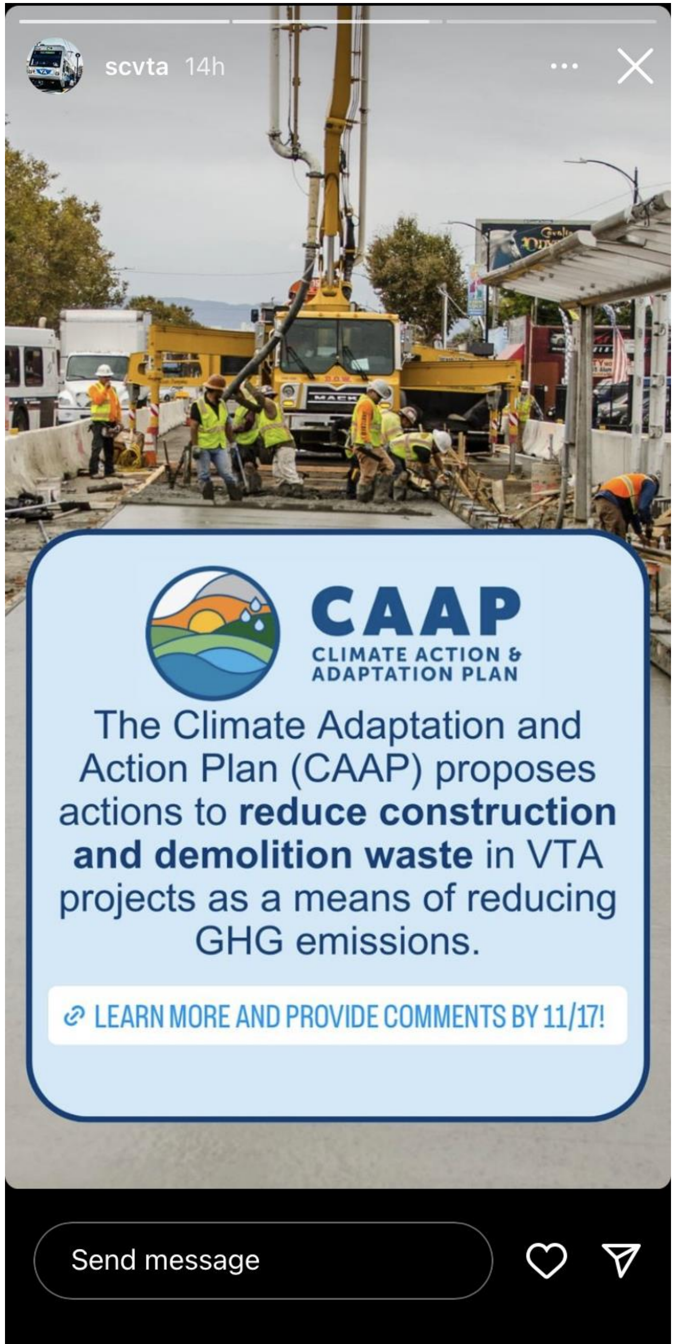

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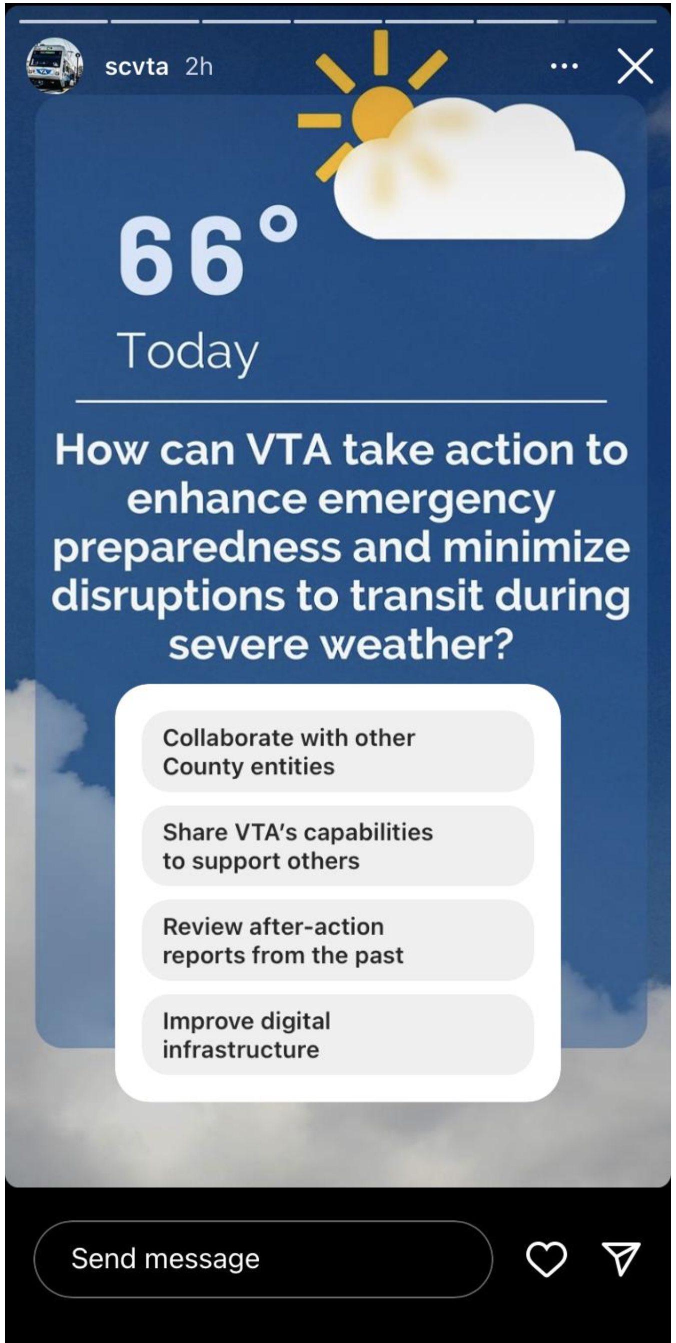

E-mails to Distribution List

From: VTA Community Outreach <community.outreach@vta.org>
Sent: Monday, October 16, 2023 12:14 PM
Subject: [EXTERNAL] VTA's Draft Climate Action and Adaptation Plan Available for Public Review

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Valley Transportation Authority
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CAAP
CLIMATE ACTION & ADAPTATION PLAN

VTA's Draft Climate Action and Adaptation Plan Now Available

VTA's Draft Climate Action and Adaptation Plan is now available for public review and comment. The purpose of VTA's Climate Action and Adaptation Plan (CAAP) is to reduce greenhouse gas emissions (GHG) associated with transportation use and operations and prepare for climate change impacts that are already occurring and projected to get worse over time.

This CAAP represents VTA's first comprehensive look at the climate crisis, and Santa Clara County's first look at climate change through the transportation

lens, specifically. Work on the CAAP started in 2022 with a community survey and public workshop, followed by data collection and analysis which included quantifying GHG emissions and conducting a vulnerability assessment of VTA's transportation assets and operations. This information was used to develop two lists of proposed strategies, measures, and actions: one that addresses reducing GHG emissions, and another that addresses preparing for sea level rise, flooding, wildfire, extreme heat, and drought. The Draft CAAP includes all this information and more!

We want to hear from you! Now is the time to provide input. Please email your comments to community.outreach@vta.org by Friday, November 17, 2023.

The CAAP will be revised based on input received and is targeted to be complete by March 2024. For more information, check out the project website at vta.org/climateplan.

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E-mails to Distribution List

From: VTA Community Outreach <community.outreach@vta.org>
Sent: Monday, October 23, 2023 3:44 PM
Subject: [EXTERNAL] Join VTA at Upcoming Events for Draft Climate Action and Adaptation Plan

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CAAP
CLIMATE ACTION & ADAPTATION PLAN

Engage with VTA's Draft Climate Action and Adaptation Plan

As Santa Clara County's congestion management agency and provider of bus, light rail, and paratransit services, VTA understands the urgent need to reduce greenhouse gas (GHG) emissions now, while simultaneously taking steps to adapt, and prepare for more frequent and intense flooding, extreme heat, sea level rise, wildfire, and drought. That's why VTA drafted a Climate Action and Adaptation Plan (CAAP) that addresses both GHG reduction and climate change adaptation.

1

VTA's Draft CAAP is now available for public review and comment.
Please **submit your comments online** or by email to **community.outreach@vta.org**.
Comments must be received by Friday, November 17, 2023.

Upcoming Events:

Join VTA and Students for Equity and Environment at De Anza to learn more about the CAAP and related projects that seek to reduce GHG emissions on **Thursday, October 26** from 3:00 to 4:30 PM. This event will be held at De Anza College, Campus Center Upper Level Conference Room A, 21250 Stevens Creek Blvd. in Cupertino, and is accessible by Bus Routes 23, 25, 51, and 55. RSVP on Eventbrite.

You are also invited to a virtual lunch-time talk about climate change adaptation on **Tuesday, November 7** from 12:00 to 1:00 pm on Zoom. This event will include presentations from VTA and Valley Water. Register on Eventbrite.

For more information, check out the project website at http://www.vta.org/climateplan.

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Our mailing address is:

2

E-mails to Distribution List

From: VTA Community Outreach <community.outreach@vta.org>
Sent: Monday, November 6, 2023 9:45 AM
Subject: [EXTERNAL] TOMORROW! Virtual Lunch and Learn: Adapting to Climate Change in Santa Clara County

Follow Up Flag: Follow up
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CAAP
CLIMATE ACTION & ADAPTATION PLAN

Virtual Lunch and Learn: Adapting to Climate Change in Santa Clara County

VTA's Draft Climate Action and Adaptation Plan (CAAP) is available for public review and comment through November 17, 2023. The purpose of VTA's CAAP is to identify actions VTA can take to reduce greenhouse gas emissions (GHG) associated with transportation use and operations and prepare for the impacts

of climate change. We want to hear from you! Please **submit your comments online** or email **community.outreach@vta.org**.

To learn more about the Draft CAAP, join us for a virtual lunchtime talk on Tuesday, November 7, from 12 to 1 pm. This event will be moderated by Breann Boyle, Senior Sustainability Analyst at the County of Santa Clara's Office of Sustainability. Panelists include Lani Lee Ho, Senior Environmental Planner at Santa Clara Valley Transportation Authority (VTA), and Brian Mendenhall, Senior Water Resources Specialist at Santa Clara Valley Water District. Register here.

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Appendix B

Greenhouse Gas Emissions Inventory and Forecasts

Memo

455 Capitol Mall, Suite 300
Sacramento, CA 95814
916.444.7301

Date: August 2023

To: Lani Lee Ho, Santa Clara Valley Transportation Authority

From: Brenda Hom, Fred Hochberg, Lisa Fenton, and Honey Walters

Subject: GHG Emissions Inventory and Forecast for Countywide Transportation and VTA Transit Operations (Revised Final)

---

1 INTRODUCTION

1.1 PROJECT OVERVIEW

The Santa Clara Valley Transportation Authority (VTA) is working with Ascent to prepare a climate action and adaptation plan (CAAP) that identifies specific actions VTA can take to minimize contributions to climate change, as well as adapt and build resilience to long-term climate impacts. The first objective of this project is to quantify greenhouse (GHG) emissions from countywide transportation and VTA's transit operations. For the purposes of this assessment, "countywide transportation" emissions are limited to surface transportation modes (i.e., rail and on-road transportation). The second objective of this project is to identify actions VTA can take to reduce its operational emissions, as well as actions it can take in partnership with other agencies and the community to reduce communitywide vehicle miles traveled (VMT). The final objective is to conduct a vulnerability assessment that identifies the risks that climate change impacts pose to transportation assets and actions that can be taken to protect these assets for the public good.

1.2 PURPOSE AND DESCRIPTION

This memorandum meets the first objective of the project and presents the estimated GHG emissions generated by countywide transportation in Santa Clara County and VTA's own transit operations. The countywide transportation inventory quantifies emissions from all surface transportation use in Santa Clara County and the transit operations inventory quantifies emissions from VTA's operational activity across five activity sectors: buildings and facilities, revenue and non-revenue fleet, employee commute, water, and waste. This memorandum presents the data, methods, and resulting estimates for each inventory. It also presents emissions forecasts for 2030, 2035, 2040, 2045, and 2050.

In addition to establishing a foundation for the CAAP, the transit operations inventory also provides an update on the progress VTA has made towards the emissions reduction targets set in their sustainability goals.

1.3 DATA QUALITY AND ACCURACY

When preparing a GHG emissions inventory, the goal is to use the best available data and methodologies to develop the most accurate picture of a community's emissions. However, some degree of inaccuracy is inherent to all inventories. As described by the Community Protocol, "While no community inventory is fully comprehensive (some emissions cannot be estimated due to a lack of valid methods, a lack of emissions data, or for other reasons), community inventories often aim to provide as complete a picture of GHG emissions associated with a community as is feasible" (ICLEI 2019:12). The accuracy of a countywide GHG emissions inventory is primarily dependent on activity data (e.g., VMT) and emissions factors (e.g., grams of carbon dioxide [CO_2] per VMT). Development of this GHG emissions inventory was a robust and comprehensive process rooted in industry standards and best practices, and it included extensive research and consultation with VTA and County staff as well as regional and State agencies to ensure data were as accurate as feasible.

1.4 ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of five parts:

- Introduction
  - Project Overview
  - Purpose and Description
  - Data Quality and Accuracy
  - Organization of this Memorandum
  - Summary of Results
- GHG Emissions Inventory and Forecast for Countywide Transportation
  - Background
  - Inventory Overview
  - Data, Methods, and Assumptions
  - Inventory Results for Countywide Transportation
  - Forecast for Countywide Transportation
- GHG Emissions Inventory and Forecast for Transit Operations
  - Background
  - Inventory Purpose and Overview
  - Inventory Results for Transit Operations
  - Forecast for Transit Operations
- References
  - Attachment 1 – VMT Process Technical Memo
  - Attachment 2 – Communitywide Transportation Calculations

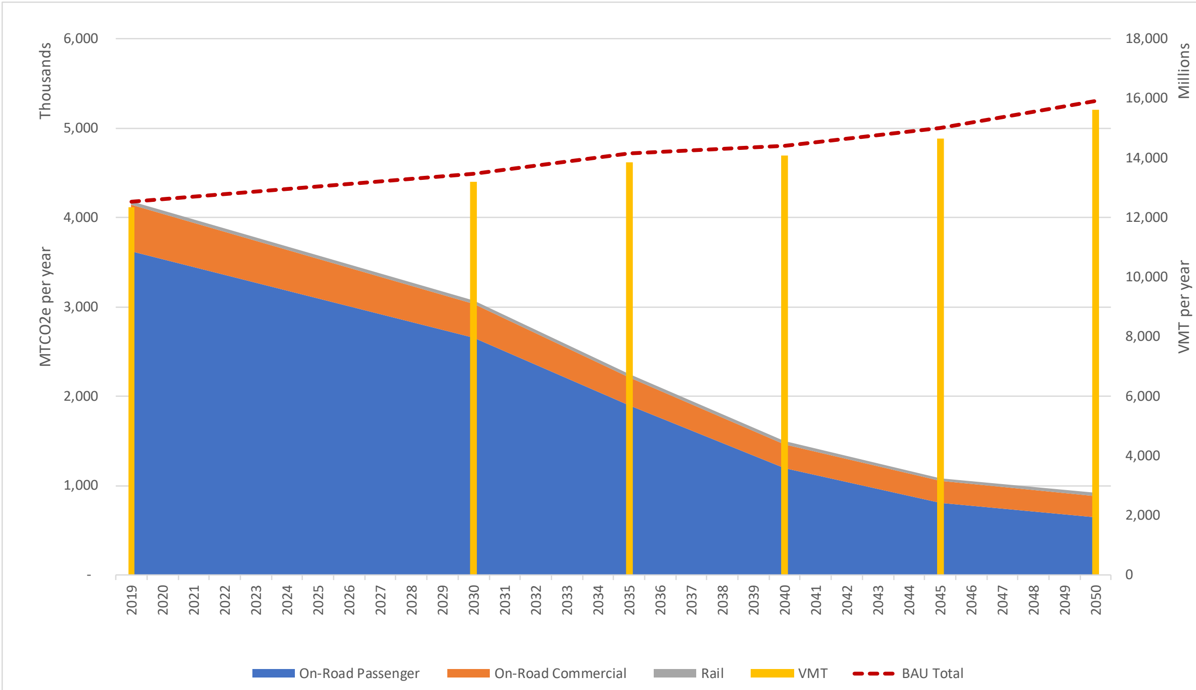
1.5 SUMMARY OF RESULTS

1.5.1 Countywide Transportation

Based on the modeling conducted, Santa Clara County's surface transportation sector, representing on-road and rail transportation modes, emitted 4.2 million metric tons of carbon dioxide equivalent ($MTCO_2e$) in calendar year 2019 countywide. Ninety-nine percent of these emissions are associated with on-road vehicles. For on-road modes, modeling was based on VMT data provided by the Metropolitan Transportation Commission (MTC) and processed by VTA and county-specific vehicle emission factors, available from the California Air Resources Board's (CARB) 2021 EMissions FACtor (EMFAC2021) model. For rail modes, emissions were estimated based on available emissions data from each rail provider and scaled to the county based on relative train miles in the county, accounting for any plans for conversion to renewable fuels or electrification. Based on the modeling conducted and regulatory trends toward lower emissions, the County's transportation emissions are anticipated to decline by up to 78 percent from 2019 levels by 2050. Most of these reductions are due to advances in vehicle technology policies (e.g., zero emission vehicle mandates under the Advanced Clean Cars II Regulations) and forecasted reductions in VMT as estimated by MTC (e.g., with implementation of Senate Bill [SB] 743 and a focus of growth in Priority Development Areas and multi-modal transportation programs and infrastructure in alignment with long-term regional planning to reduce driving).

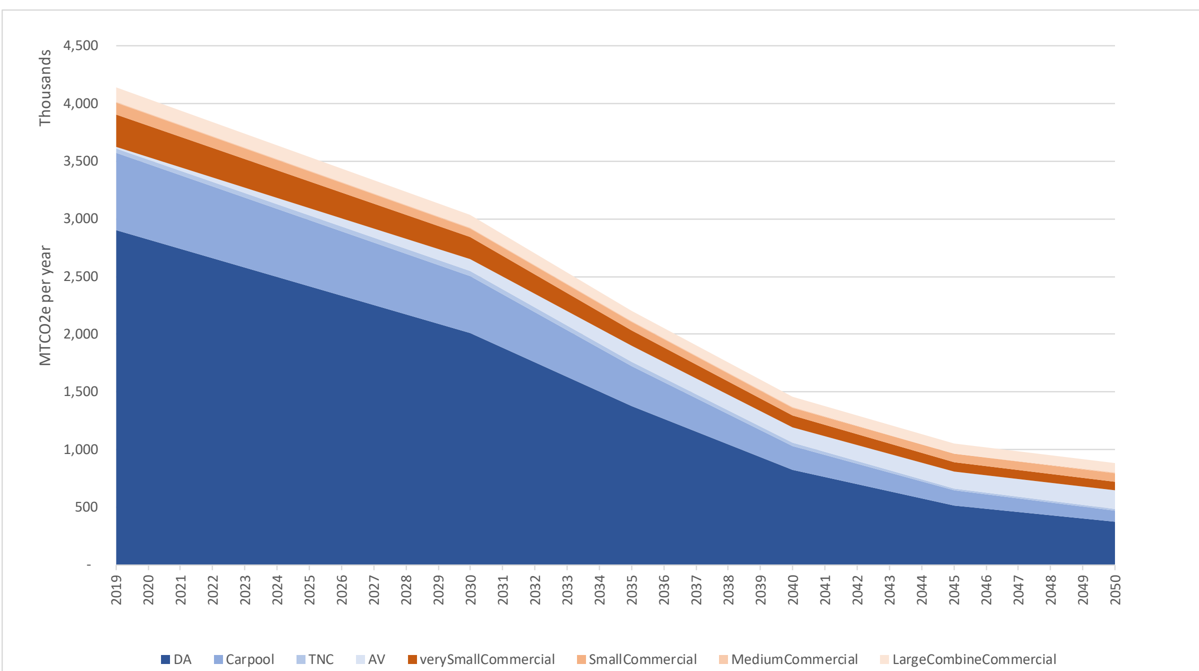
Based on the results the countywide transportation emissions inventory, Figure 1 presents two forecast scenarios that estimate future GHG emissions from transportation in the county: a Business-As-Usual (BAU) scenario, shown as the red dotted line, and a legislative-adjusted BAU forecast, shown as the stacked area in blue, orange, and gray, representing on-road passenger, on-road commercial, and rail emissions, respectively. The BAU forecast illustrates how transportation emissions would increase due to population and economic growth without additional legislative regulations that reduce emissions. The legislative-adjusted BAU scenario accounts for emissions reductions from laws and regulations enacted by regional, State, and federal agencies as well as rail provider sustainability plans; it does not reflect local actions to reduce GHG emissions. Examples of local actions to reduce emissions include adoption of reach codes for energy efficiency and city ordinances to ban natural gas in new construction. GHG emissions forecasts provide insights to the scale of additional regional and local reductions needed to achieve GHG emissions reduction targets. Additionally, Figure 1 also presents the VMT estimates upon which these emission forecast scenarios were developed, shown as the yellow bars. The trends in the BAU forecasts are inherently proportional to the BAU forecasts because no additional reductions to emissions rates are assumed.

The legislative-adjusted BAU forecast for on-road transportation is comprised of emissions from eight different vehicle groups, representing two vehicle categories and various classes and modes. These groupings were based on the available modeling data provided by MTC. Passenger vehicle emissions are split into four modes: drive alone (DA); autonomous vehicle (AV); carpool; transportation network company (TNC) (e.g., ride hailing operations like Uber and Lyft). Commercial vehicle emissions are split into four vehicle classes: large, medium, small, and very small. Table 4 in Section 2.2.3 describes the definition of these vehicle groups in more detail. The breakdown of emissions by vehicle category is shown in Figure 2. For rail modes, rail emissions include those from VTA, Caltrain, Amtrak, and Union Pacific Railroad (UP). Emissions from Altamont Corridor Express (ACE) were excluded due to lack of available data and Bay Area Rapid Transit (BART) emissions were excluded because activity in the county did not begin until 2020. The legislative-adjusted BAU forecast emissions were based on a combination of activity forecasts from the 2018 State Rail Plan, individual rail provider forecasts and long range plans, sustainability plans (e.g., electrification of Caltrain), and accounting of carbon neutral electricity emission factors by 2045 under SB 100.



Source: Compiled by Ascent Environmental in 2022.

Figure 1 Santa Clara County Transportation GHG Emissions (2019-2050) – Legislative Adjusted BAU Forecast



Notes: DA = drive alone, AV = autonomous vehicle, TNC = transportation network company, VMT = vehicle miles traveled, $MTCO_2e$ = metric tons of carbon dioxide equivalent. All values shown in chart are presented in $MTCO_2e$ except for VMT, which is presented in miles per year.

Source: Compiled by Ascent Environmental in 2022.

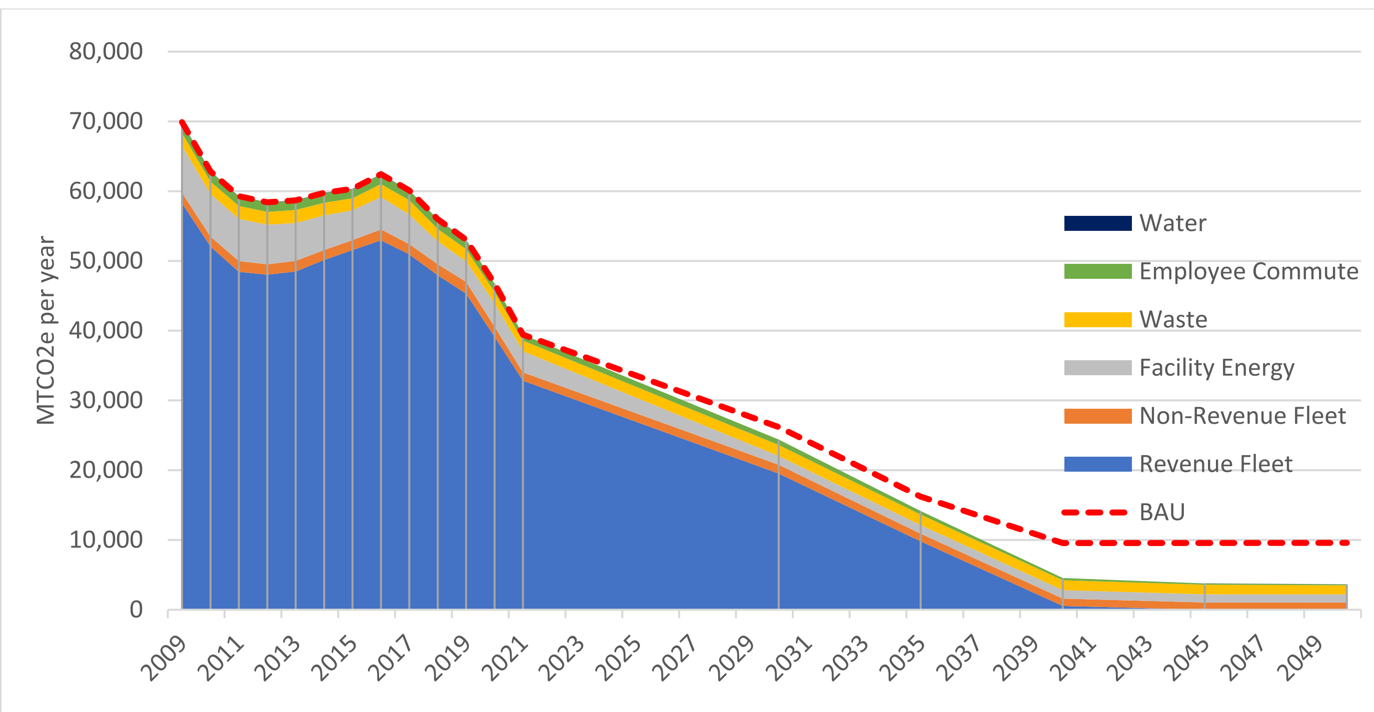
Figure 2 Santa Clara County On-Road Transportation GHG Emissions by Vehicle Group (2019-2050) – Legislative Adjusted BAU Forecast

1.5.2 Transit Operations – 2021 Inventory Update and Forecast

Based on the modeling conducted from data provided by VTA from 2009 through 2021, VTA's transit operations generated 39,431 $MTCO_2e$ per year in 2021, which is 44 percent below 2009 levels. From 2021, transit operation emissions would continue to decline by another 91 percent by 2050. These changes are largely due to VTA's Zero Emissions Bus Program, as well as additional legislative reductions, such as Advanced Clean Cars 2 and utility-scale carbon neutrality targets by 2045.

Similar to Figure 1, Figure 3 presents two trend scenarios: a BAU forecast, shown as the red dotted line, and a legislative-adjusted BAU forecast, shown in the colored stacked area. However, specific to the transit operations emissions, historical emissions are presented alongside forecasts in this chart. Emissions between 2009 and 2021 are the same in both scenarios based on existing activity data available from VTA. These emissions are broken out into six main categories: revenue fleet, non-revenue fleet, facility energy, waste, employee commute, and water. These emissions categories are consistent with those used in VTA's past sustainability reports and recommended by the American Public Transportation Association (APTA) for annual reporting on sustainability commitments. Fleet-related emissions result from the combustion of diesel, natural gas, gasoline, and electricity used in buses, maintenance and administrative vehicles, paratransit, and other related fleet vehicles. Facility energy-related emissions are generated from on-site natural gas and propane combustion and indirectly at power plants or other sources that supply electricity to VTA facilities. Waste-related emissions result from the anaerobic decay of organic material disposed at landfills, generating methane. Employee commute activities also generate emissions from fuel combustion in vehicle trips. Water consumption generates emissions indirectly through the conveyance, treatment, and distribution of water.

As shown in Figure 3, emissions are projected to decrease over the time horizon of the analysis. Bus emissions, which account for over 75 percent of fleet emissions in FY 2021, are anticipated to continue to decline through 2050 due to the Zero Emissions Bus Program. Additional details can be found under Section 3.



Source: Compiled by Ascent Environmental in 2023.

Figure 3 VTA Transit Operations GHG Emissions (2009-2050)

2 GHG EMISSIONS INVENTORY AND FORECAST FOR COUNTYWIDE TRANSPORTATION

This section presents the GHG emissions inventory and forecast for the countywide transportation sector, assuming an updated baseline year of calendar year 2019 forecasted through 2050. Section 2.1 presents a background discussion of previous county transportation emissions estimates to provide context for the current baseline update and for comparison to the previous methods used and the emissions estimates. Sections 2.2 and 2.3 present the foundational protocols and boundaries of this analysis as well as the data, methods, and assumptions used. Sections 2.4 and 2.5 present the resulting inventory and forecasted emissions estimates for the county's transportation sector.

2.1 BACKGROUND

2.1.1 Previous County Transportation Emissions Quantification

In 2021, the County of Santa Clara completed a communitywide GHG inventory and forecast. The report includes an emissions inventory for 2017 from activities within the unincorporated area of the County as well as the incorporated jurisdictions within the County. The inventory and forecast serve as part of the preparation for the County's forthcoming Climate Roadmap 2030, the County's first climate action plan, which will outline actions the County can take to reduce GHG emissions. According to the County's report, on-road transportation emissions from 2017 totaled approximately 4,853,000 $MTCO_2e$ for the County as a whole and 41,500 $MTCO_2e$ for the unincorporated areas of the County (County of Santa Clara 2021). Emissions from the on-road transportation sector accounted for 45 percent of countywide GHG emissions. The County's report accounted for rail emissions through CARB's OFFROAD2017 model and did not consider actual rail activity or emissions.

Although the County's 2017 inventory provided a countywide emissions estimate, it aggregated the on-road transportation emissions from each of the incorporated jurisdictions. To provide context of the contributions of each of the 15 incorporated jurisdictions and the unincorporated area, Table 1 compares the most recent on-road transportation emissions reported for ten incorporated jurisdictions within the County that have also independently calculated on-road transportation emissions as part of their climate action and sustainability plans for other years within the last decade. (The City of Santa Clara and the Town of Los Altos Hills also developed climate action plans but did not specify exact emissions resulting from on-road transportation. The cities of Campbell, Gilroy, and Monte Sereno have not developed climate action plans for their jurisdictions.) Table 1 presents the reported on-road transportation emissions estimates from each jurisdiction as well as the respective data sources and methods used.

Table 1 Recent On-Road Transportation Emissions Estimates for Jurisdictions throughout Santa Clara County

Jurisdiction	Year	Population[13]	$MTCO_2e$/year	$MTCO_2e$/capita	Data Source	Method
County of Santa Clara[1]	2017	88,545	41,464	0.468	VMT: SVCE EF: EMFAC2017	RTAC
City of San Jose[2]	2019	1,793,112	2,463,770	1.374	VMT: Google EIE EF: EMFAC2017	RTAC[12]
City of Mountain View[3]	2012	74,447	478,986	6.434	VMT: Not specified EF: Not specified	Not specified
City of Sunnyvale[4]	2016	149,596	387,200	2.588	VMT: Not specified EF: Not specified	Not specified
City of Palo Alto[5]	2019	66,573	293,413	4.407	VMT: Fehr & Peers EF: Not specified	RTAC

Jurisdiction	Year	Population[13]	$MTCO_2e$/year	$MTCO_2e$/capita	Data Source	Method
City of Milpitas[6]	2019	79,517	259,627	3.265	VMT: MTC EF: EMFAC2021	RTAC
Town of Los Gatos[7]	2008	28,878	248,150	8.593	VMT: Fehr & Peers EF: EMFAC2011	Not specified
City of Cupertino[8]	2018	60,614	206,634	3.409	VMT: MTC EF: EMFAC2021	RTAC
City of Saratoga[9]	2017	31,013	56,847	1.833	VMT: MTC EF: EMFAC2017	RTAC
City of Morgan Hill[10]	2020	44,789	58,757	1.312	VMT: Not specified EF: Not specified	Not specified
City of Los Altos[11]	2018	30,588	56,555	1.849	VMT: SVCE EF: Not specified	RTAC

Notes: EF = emissions factor; EIE = Environmental Insights Explorer; RTAC = Regional Targets Advisory Committee; VMT = vehicle miles traveled, $MTCO_2e$ = metric tons of carbon dioxide equivalent; SVCE – Silicon Valley Clean Energy; EMFAC = California Air Resources Board's EMissions FACtor model.

1 County of Santa Clara 2021
2 City of San Jose 2021
3 City of Mountain View 2015
4 City of Sunnyvale 2019
5 City of Palo Alto 2020
6 City of Milpitas 2022
7 Town of Los Gatos 2012
8 City of Cupertino 2022
9 City of Saratoga 2020
10 City of Morgan Hill 2021
11 City of Los Altos 2022
12 2019 emissions were calculated by adding up 100% of EIE in-boundary emissions for the automobile category and 50% of inbound and outbound automobile emissions
13 County of Santa Clara and census.gov

Source: Data compiled by Ascent Environmental in 2023.

With respect to the County's countywide GHG estimates specifically, the 2017 inventory was completed using the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions Version 1.2 (ICLEI CP) and focused on CO_2, methane (CH_4), and nitrous oxide (N_2O) emissions—the three GHGs most relevant to operations in the County. For the on-road transportation sector, GHG emissions from the operation of passenger and commercial vehicles were assessed based on VMT. According to the County, the 2017 VMT data were provided by Silicon Valley Clean Energy (SVCE) for the unincorporated County and the incorporated jurisdictions within SVCE's service area, including Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, and Sunnyvale. The VMT provided by SVCE was based on aggregated data queried from MTC. (Although Los Altos Hills and Los Gatos are considered towns, for the purposes of this discussion all incorporated jurisdictions are referred to as "cities".) Transportation data for the cities outside of SVCE's territory—Palo Alto, San Jose, and Santa Clara—were sourced from each of the city's travel demand models. Data for 2017 were not available for the City of Santa Clara, so 2016 data was used as a proxy. To calculate emissions, VMT data was multiplied by the emissions factor for mileage (g CO_2e/mile). VMT data was aggregated for all the incorporated areas of the County and the unincorporated area was presented separately. VMT data for both the incorporated and unincorporated areas were disaggregated by vehicle type using the output of CARB's EMFAC2017. (County of Santa Clara 2021).

2.1.2 Regional Transportation Planning

In 2021, the Bay Area adopted a long-range regional plan—Plan Bay Area 2050—that provides a roadmap and shared vision for the nine counties within the San Francisco Bay Area. One of the key focus areas of the plan is transportation. Plan Bay Area 2050 aims to build a well-connected transportation network, reduce transportation-related GHG emissions, and advance transportation equity through three key regional transportation strategies: *Maintain and Optimize the Existing Transportation System, Create Healthy and Safe Streets, and Build a Next-Generation Transit Network* (MTC & ABAG 2021a). VTA plays a key role in supporting these strategies due to its wide-ranging authority and influence over transportation in Santa Clara County. VTA provides bus, light rail, and paratransit services and is responsible for transit development and operations, congestion management, funding, highway design and construction, real estate and transit-oriented development, and bicycle and pedestrian planning (VTA 2017). VTA strives to provide sustainable, accessible, community-focused transportation options that are innovative, environmentally responsible, and promote the vitality of the region (VTA 2019).

2.2 INVENTORY OVERVIEW

2.2.1 Protocols and Methodologies

ON-ROAD TRANSPORTATION

This inventory follows the International Council for Local Environmental Initiatives (ICLEI) methodologies for quantifying on-road transportation emissions, specifically, the *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* Version 1.2 (Community Protocol). The Community Protocol was selected because it is the industry standard for local governments and agencies developing GHG emissions inventories and offers accuracy and consistency in reporting.

Following the recommended guidance from the Community Protocol, the RTAC origin-destination method was used to calculate VMT within the county. The RTAC method includes VMT estimates associated with trips that begin and/or end in the county. VMT estimates include 100 percent of vehicle trips that both originate from and end in the county (i.e., fully internal trips) and 50 percent of trips that either end in or depart from the county (i.e., internal-external or external-internal trips). Vehicle trips that are simply passing through the County boundaries without stopping (i.e., external-external, or "pass-through," trips) are not included. Table 2 provides a summary of what is included and excluded in the RTAC method.

Table 2 RTAC Method Summary

On-Road Transportation	Included	Excluded	Protocol(s)
On-Road Transportation	Emissions from 100 percent of trips within the County (internal-internal) and 50 percent of trips starting or ending outside the County (internal-external and external-internal)	Emissions from 100 percent of pass-through trips starting and ending outside the County (external-external)	ICLEI/RTAC

Notes: ICLEI = ICLEI – Local Governments for Sustainability; RTAC = Regional Targets Advisory Committee.

Source: Compiled by Ascent Environmental in 2022.

RAIL TRANSPORTATION

Unlike on-road transportation, ICLEI recommends that passenger and freight rail emissions be based on the activity generated within the boundary of the jurisdiction, measured in train miles, rather than by using the origin and destination method (ICLEI 2019: Appendix D). Train miles (i.e., the number of miles travelled per locomotive) can be calculated using the product of total track miles within the county and number of annual trains passing through the county. ICLEI then recommends multiplying the train miles by the respective fuel mileage of each vehicle type (e.g., gallons of diesel per train mile), then by the GHG emission factors per unit of fuel. However, apart from VTA's own light rail activity, fuel mileage data was not readily available from most of the rail providers operating in the county. As an alternative, total locomotive GHG emissions for non-VTA rail providers were scaled to the county based on their relative train miles in the county. Although recommended by ICLEI, this method does not consider the variability in efficiencies between different train trips, which may carry heavy or lighter loads. These variabilities, however, are inconsequential when considering that total rail emissions are a very small percentage of total transportation emissions.

2.2.2 Boundaries

This inventory quantifies GHG emissions from surface transportation in the County, which includes on-road and rail transportation-related emissions generated by the unincorporated areas of the County and the 15 incorporated jurisdictions within the County, for 2019. This 2019 baseline year is then used to estimate future emissions under BAU and legislative-adjusted BAU scenarios for the years 2030, 2035, 2040, 2045 and 2050. These years are based on baseline and forecast years included in MTC's transportation model and GHG reduction target years included in the State's climate policies (e.g., SB 32, SB 100, Assembly Bill [AB] 1279).

With respect to on-road transportation emissions, this inventory is primarily based on the RTAC method for attributing vehicle emissions to a certain jurisdiction. This method is the same method recommended by RTAC to Metropolitan Planning Organizations, like MTC, to calculate VMT per the SB 375 GHG emission reduction target setting process developed in 2010 (CARB 2019: 42). Under this method, only on-road vehicle activity generated by the targeted jurisdiction is included in the jurisdiction's inventory, thereby excluding any trips solely passing through the jurisdiction.

With respect to rail emissions, this inventory includes those from VTA, Caltrain, Amtrak, and UP for activity occurring within the boundary of the county, per ICLEI recommendations. ACE and BART emissions were excluded from the 2019 communitywide transportation inventory because data was not readily available from ACE, and BART did not begin operations in the county until 2020. The Milpitas and Berryessa BART stations began operations in July 2020.

2.2.3 Data, Methods, and Assumptions

OVERVIEW OF ACTIVITY DATA, YEARS, AND EMISSIONS FACTORS

For on-road transportation, the basic calculation for estimating GHG emissions involves two primary inputs: activity data and emissions factors (Table 3). Activity data refers to the relevant measurement of a community's activity resulting in emissions, and emissions factors represent the amount of a GHG emitted on a per unit of activity basis. Emissions factors are applied to activity data (i.e., the two values are multiplied together) to estimate GHG emissions. However, for rail activity, these emission factors were not readily available. Thus, a scaling approach was used to estimate county-level emissions from systemwide rail operations, described further below.

Table 3 Summary of Data Inputs

On-Road Transportation	Input Type	Description and Data Sources
On-Road Transportation	Activity data	VMT data provided by VTA, based on MTC's travel demand model under Plan Bay Area 2050.
	Emissions factor	County of Santa Clara specific emissions factors from CARB
Rail Transportation	Passenger Rail Emissions	Except for emissions from VTA's light rail system, total emissions for each rail service provider were scaled to the county based on the relative number of train miles in the county. VTA emissions were taken from the transit emissions inventory directly.
	Freight Rail Emissions	Total emissions for UP scaled to the county based on the relative track miles in the county compared to systemwide.

Notes: CARB = California Air Resources Board; VMT = vehicle miles traveled, MTC = Metropolitan Transportation Commission; VTA = Valley Transportation Authority; UP = Union Pacific

Source: Compiled by Ascent Environmental in 2022.

ON-ROAD TRANSPORTATION

To prepare for the CAAP, VTA worked with MTC to provide trip-based VMT for the entire County. Daily VMT was provided for 2015, 2035, and 2050 for passenger trips and commercial trips. Passenger VMT was provided by mode and aggregated into the following groups: DA, Carpool, TNC, and AV. According to MTC, AV activity is assumed to represent those generated by autonomous vehicles (e.g., vehicles that are driven without a physical driver on-board) operated by households. TNCs represent light duty ride hailing modes, similar to taxis, Uber, and Lyft. MTC assumes that TNCs are all autonomous after 2035 (Leung, pers. comm., 2022). Commercial VMT was provided by vehicle category and included Very Small, Small, Medium, and Large commercial vehicles. A description for each vehicle group can be found in Table 4 and a detailed methodology for how VMT was calculated can be found in Attachment 1 (Section 5).

MTC VMT data were based on modeling representative of the MPO's latest regional transportation plan: Plan Bay Area 2050. Plan Bay Area 2050 accounted for short-term COVID impacts, but only did so for its economic assessments, similar to the impact of a recession, and did not account for these impacts with respect to travel behavior, which would impact VMT estimates. Although MTC does not account for COVID impacts in its VMT estimates (e.g., increased percentage of workers working from home), MTC assumes a normal growth pattern beyond 2030. Thus, COVID impacts are not anticipated to have a significant effect on VMT forecasts after 2030.

Consistent with the methodology used in the Plan Bay Area 2050 Environmental Impact Report, an average annualization factor of 300 days per year was applied to daily VMT to get annual VMT (MTC & ABAG 2021b). This factor accounts for lighter traffic levels on weekends compared to weekdays.

Table 4 Vehicle Group Descriptions

Vehicle Groups	Description
Passenger – Drive Alone (DA)	Trips taken by single-occupant vehicles
Passenger - Carpool	Trips taken with two or more occupants in a vehicle
Passenger – Transportation Network Company (TNC)	Trips taken by Transportation Network Companies (e.g., Uber and Lyft); includes customer and deadhead VMT
Passenger – Autonomous Vehicle (AV)	Trips taken by a driverless vehicle; includes customer and deadhead VMT
Commercial – Very Small[1]	Two-axle, four-tire vehicles
Commercial – Small[1]	Two-axle, six-tire vehicles
Commercial – Medium[1]	Three-axle vehicles
Commercial – Large[1]	Four-or-more-axle vehicles

Note: Deadhead VMT refers to VMT from trips without a customer, taken in anticipation of the next customer trip.

[1] Bay Area Metro

Source: Bay Area Metro 2017, Leung, pers. comm., 2022; and Ascent Environmental 2022.

For the purposes of the CAAP, annual VMT estimates for each vehicle group, except for AVs, were linearly interpolated for 2019 using the RTAC origin-destination method established through SB 375 and CARB recommendations. AV VMT for 2019 were calculated based on a best fit logarithmic growth curve that aligns with MTC's VMT estimates for AVs in 2015, 2035, and 2050, to reflect AV's current early stages of research and adoption. These VMT estimates are associated with trips that begin and/or end in the County and exclude wholly pass-through trips, as explained in Section 2.1.1.

Emissions rates for countywide VMT were derived from EMFAC2021, CARB's statewide mobile source emissions inventory model. The eight vehicle groups provided by VTA were assigned an appropriate EMFAC2021 vehicle category, as shown in Table 5. EMFAC2021 was then used to generate emission rates specific to the County for the calendar year 2019 for all vehicle groups using aggregated model years, speeds, and fuel types. The countywide $MTCO_2e$ per mile emissions factor was calculated based on the distribution of VMT for each vehicle group and its emissions factor based on the assigned EMFAC vehicle categories.

Table 5 EMFAC2021 Vehicle Category Assignment

Vehicle Groups	EMFAC2021 Vehicle Category
Passenger - DA	LDA, LDT1, LDT2, MH, and MCY
Passenger - Carpool	LDA, LDT1, and LDT2
Passenger - TNC	LDA, LDT1, and LDT2
Passenger - AV	LDA, LDT1, and LDT2
Commercial – Very Small	LDA, LDT1, LDT2, and MDV
Commercial - Small	MDV
Commercial - Medium	LHD1, LHD2, and MDV
Commercial - Large	T6 CAIRP Heavy, T6 CAIRP Small, T6 Instate Heavy, T6 /instate Small, T6 OOS Heavy, T6 OOS Small, T6 Public, T6 Utility, T6TS, T7 CAIRP, T7 NNOOS, T7 NOOS, T7 Other Port, T7 POAK, T7 POLA, T7 Public, T7 Single, T7 SWCV, T7 Tractor, T7 Utility, T7IS, Motor Coach, OBUS, PTO, SBUS, and UBUS

Notes: DA = Drive Alone; TNC = Transportation Network Company; AV = Autonomous Vehicles; GVWR = Gross Vehicle Weight Rating; LDA = Passenger Cars; LDT1 = Light-Duty Trucks (GVWR* <= 3750 lbs.); LDT2 = Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs.); MDV = Medium-Duty Trucks (GVWR 5751-8500 lbs.); MH = Motor Homes; MCY = Motorcycles; T6 CAIRP Heavy = Medium-Heavy Duty CA International Registration Plan Truck (GVWR 26001- 33000 lbs.); T6 CAIRP Small = Medium-Heavy Duty CA International Registration Plan Truck (GVWR 14001- 26000 lbs.); T6 Instate Heavy = Medium-Heavy Duty Tractor, Delivery or Other Truck (GVWR 26001-33000 lbs.); T6 Instate Small = Medium-Heavy Duty Tractor, Delivery or Other Truck (GVWR 14001-26000 lbs.); T6 OOS Heavy = Medium-Heavy Duty Out-of-state Truck (GVWR 26001-33000 lbs.); T6 OOS Small = Medium-Heavy Duty Out-of-state Truck (GVWR 14001-26000 lbs.); T6 Public = Medium-Heavy Duty Public Fleet Truck (GVWR 14001-33000 lbs.); T6 Utility = Medium-Heavy Duty Utility Fleet Truck (GVWR 16001-33000 lbs.); T6TS = Medium-Heavy Duty Truck; T7 CAIRP = Heavy-Heavy Duty CA International Registration Plan Truck (GVWR 33001 lbs. and over); T7 NNOOS = Heavy-Heavy Duty Non-Neighboring Out-of-state Truck (GVWR 33001 lbs. and over); T7 NOOS = Heavy-Heavy Duty Neighboring Out-of-state Truck (GVWR 33001 lbs. and over); T7 Other Port = Heavy-Heavy Duty Drayage Truck at Other Facilities (GVWR 33001 lbs. and over); T7 POAK = Heavy-Heavy Duty Drayage Truck in Bay Area (GVWR 33001 lbs. and over); T7 POLA = Heavy-Heavy Duty Drayage Truck near South Coast (GVWR 33001 lbs. and over); T7 Public = Heavy-Heavy Duty Public Fleet Truck (GVWR 33001 lbs. and over); T7 Single = Heavy-Heavy Duty Single Unit Concrete/Transit Mix, Dump or Other Truck (GVWR 33001 lbs. and over); T7 SWCV = Heavy-Heavy Duty Solid Waste Collection Truck (GVWR 33001 lbs. and over); T7 Tractor = Heavy-Heavy Duty Tractor Truck (GVWR 33001 lbs. and over); T7 Utility = Heavy-Heavy Duty Utility Fleet Truck (GVWR 33001 lbs. and over); T7IS = Heavy-Heavy Duty Truck; OBUS = Other Buses; PTO = Power Take Off; SBUS = School Buses; and UBUS = Urban Buses.

Source: CARB 2021 and Ascent Environmental 2022.

RAIL TRANSPORTATION

Emissions from rail transportation in 2019 are represented by activity from four rail providers: VTA, Caltrain, Amtrak, and UP. Passenger rail activity in the county in 2019 was comprised of VTA, Caltrain, Amtrak, and ACE trains. As mentioned, ACE and BART emissions are excluded for 2019 as ACE data was not readily available and BART did not begin operations in the county until 2020. Freight rail activity in the county was comprised of UP trains.

VTA Light Rail

Emissions generated from VTA's light rail activity in 2019 were calculated as part of VTA's transit operations GHG inventory and described under Section 3.

Caltrain

Although Caltrain has a plan to electrify its locomotive fleet, in 2019, Caltrain locomotives were still powered by diesel. According to Caltrain's 2021 Sustainability Report, Caltrain operations generated 43,253 $MTCO_2e$ in 2019, 97 percent of which was associated with diesel use in their revenue fleet operations (Caltrain 2022). Thus, it is assumed that Caltrain's locomotives generated 41,955 $MTCO_2e$ in 2019. To scale these emissions to the county level, the total train miles were calculated by using Caltrain's weekly schedule and noting the number of northbound and southbound trains within certain segments between county stations (from Palo Alto through Gilroy) and multiplying those trains by the track miles between each segment in the county. These calculations are shown in Attachment 2. Based on these calculations; it was estimated that county accounted for 27 percent of train miles across the Caltrain system. This percentage was applied to the 41,955 $MTCO_2e$ to estimate 17,600 $MTCO_2e$ associated with Caltrain locomotive activity in the county in 2019.

Amtrak

According to Amtrak's FY2021 Sustainability Report, Amtrak's Scope 1 emissions accounted for 686,984 $MTCO_2e$ in FY2019 across its operations throughout the country. For the purposes of the communitywide inventory, FY2019 emissions are used in place of calendar year 2019 emissions. For Amtrak, Scope 1 emissions primarily refer to diesel combustion emissions in locomotives. Across the country, Amtrak operated a total of 30 million train miles in 2019, according to the Federal Railway Administration (FRA) (FRA 2023a,b). Approximately, 6 million train miles are associated with electrified rail lines in the Northeast Corridor. In county, Amtrak operates two main lines: the Capitol Corridor and Coast Starlight, both of which are currently diesel-powered only. The Capitol Corridor operates about 11 track miles within the county and Coast Starlight operates approximately 49 miles within the county. According to the train schedules for both lines, a total of 5,306 Amtrak trains pass through the county each year. Based on these assumptions, Amtrak operations in the county account for 35,770 train miles per year, or 0.4 percent of Amtrak's systemwide non-electrified operations in 2019. This percentage was applied to the 686,984 $MTCO_2e$ to estimate 2,400 $MTCO_2e$ associated with Amtrak locomotive activity in the county in 2019.

Union Pacific

Freight railroad activity in the county is provided by UP. According to UP's 2020 Carbon Disclosure Project (CDP) Climate Report, UP's locomotive emissions accounted for 9.7 million $MTCO_2e$ in 2019 across its operations throughout the country (UP 2019). Systemwide, UP operated a total of 270 million train miles in 2019 (UP 2019). In the county, UP operates 108 miles of freight railway. According to FRA's railroad crossing reports, 12 trains traveled through the county daily in 2019, for a total of 4,380 trains per year (FRA 2023a,b). Based on these assumptions, UP operations in the county account for 473,040 train miles per year, or 0.18 percent of UP's systemwide operations in 2019. This percentage was applied to the total emissions per year to estimate 17,000 $MTCO_2e$ associated with UP locomotive activity in the county in 2019.

A summary of assumptions used to calculate emissions from Caltrain, Amtrak, and UP operations in the county is presented in Table 6. The methods used for Caltrain, Amtrak, and UP have the disadvantage of being based on consolidated GHGs under a CO_2 equivalent. Individual GHG pollutant emissions were not available from these providers, thus any differences in Global Warming Potential (GWP) assumptions are not accounted for in the resulting emissions scaled to the county level. VTA light rail emissions are quantified separately, as presented in Section 3.

Table 6 2019 Rail Emissions Calculations for Caltrain, Amtrak, and Union Pacific

	Caltrain[1]	*Amtrak Capitol Corridor*[2]	*Amtrak Coast Starlight*[2]	Total Amtrak	Union Pacific[3]
Total Locomotive Emissions ($MTCO_2e$)	41,955	*686,984*	*686,984*	686,984	9,683,378
Total Train Miles per year	1,435,824	*30,122,522*	*30,122,522*	30,122,522	269,909,640
Track Miles in Santa Clara County	46	*11*	*49*	60	108
Annual trains through Santa Clara County	13,356	*4,576*	*730*	5,306	4,380
Train Miles in Santa Clara County	618,384	*50,336*	*35,770*	86,106	473,040
Percent Train Miles in Santa Clara County	43%	*0.21%*	*0.15%*	0.35%	0.18%
Train Emissions in Santa Clara County ($MTCO_2e$)	17,600	1,400	1,000	2,400	17,000

Note: $MTCO_2e$ = metric tons of carbon dioxide equivalent. Totals may not sum due to rounding. See Attachment 2 for detailed calculations.

1 Locomotive emissions taken from Caltrain's 2021 Sustainability Report Update (Caltrain 2022). See Attachment 2 for sources used to calculate train miles per year by location.

2 Scope 1 emissions from Amtrak's FY2021 Sustainability Report assumed for total locomotive emissions (Amtrak 2022). Total train miles from Federal Railroad Administration and adjusted for electrified train miles in the Northeast Corridor based on train schedules and a total alignment

of 457 miles in that corridor (FRA 2023a,b). County-level train miles and annual trains based on mileage of Capitol Corridor and Coast Starlight tracks in Santa Clara County and the respective train schedules through the county.

[3] Locomotive emissions taken from Union Pacific's 2020 Carbon Disclosure Project Climate Report (CDP 2020). Total train miles from UP (UP 2019). Santa Clara county train miles based UP track length in the county and 12 daily trains, per FRA crossing reports (FRA 2023a,b).

Source: Compiled by Ascent Environmental in 2023.

2.2.4 Global Warming Potentials

GHG emissions other than CO_2 generally have a stronger insulating effect and thus, a greater ability to warm the Earth's atmosphere through the greenhouse effect. This effect is measured in terms of a pollutant's GWP. CO_2 has a GWP factor of one while all other GHGs have GWP factors measured in multiples of one relative to the GWP of CO_2. This conversion of non-CO_2 gases to one unit enables the reporting of all emissions in terms of carbon dioxide equivalent (CO_2e), which allows for the consideration of all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to climate change. The standard unit for reporting emissions is metric tons of carbon dioxide equivalent ($MTCO_2e$).

Consistent with the best available science, these inventories use GWP factors published in the Sixth Assessment Report from IPCC, where CH_4 and N_2O have GWP factors of 27.9 and 273, respectively (IPCC 2021). These values represent the GWP of GHG on a 100-year time horizon. This means that CH_4 is approximately 28 times stronger than CO_2 and N_2O is 273 times stronger than CO_2 in their potential to warm Earth's atmosphere over the course of 100 years. The use of 100-year GWP values is consistent with CARB methods and reflects the long-term planning horizon of the CAP.

2.3 COUNTYWIDE TRANSPORTATION GHG EMISSIONS INVENTORY RESULTS FOR 2019

2.3.1 Summary of Results

Based on modeling conducted, transportation in the County in 2019 emitted approximately 4.2 million $MTCO_2e$ in 2019. Approximately 99 percent of these emissions were from on-road transportation, while the remaining one percent was attributable to rail activity in the county. Annual VMT and GHG emissions from on-road and rail transportation are shown by source in Table 7.

Table 7 2019 On-Road Transportation VMT and GHG Emissions by Vehicle Group

On-Road Transportation Source	Annual VMT	Percent VMT	GHG Emissions ($MTCO_2e$)	Percent Emissions
Passenger - DA	8,991,351,330	73%	2,905,000	69%
Passenger - Carpool	2,075,863,530	17%	669,000	16%
Passenger - TNC	104,907,270	<1%	34,000	0.4%
Passenger - AV	53,628,058	1%	17,000	1%
Commercial – Very Small	817,666,890	7%	279,000	7%
Commercial - Small	219,336,690	2%	104,000	2%
Commercial - Medium	14,299,110	<1%	8,000	0.2%
Commercial - Large	75,046,320	1%	128,000	3%
On-Road Transportation Total	**12,352,099,198**	**100%**	**4,143,000**	**99%**
Rail - Freight	NA	NA	17,000	0.4%
Rail - Passenger	NA	NA	22,000	0.5%

On-Road Transportation Source	Annual VMT	Percent VMT	GHG Emissions ($MTCO_2e$)	Percent Emissions
Rail Total	NA	NA	39,000	1%
Total	**12,352,099,198**	**100%**	**4,182,000**	**100%**

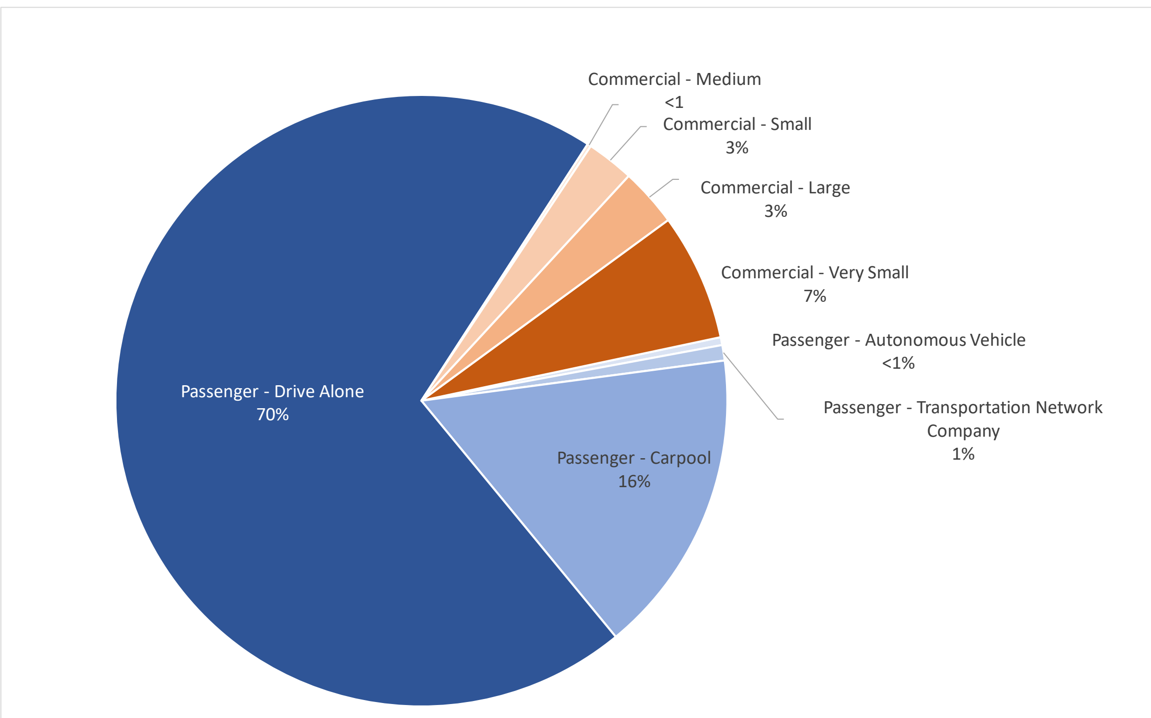
Notes: Except for AVs, VMT for 2019 were linearly interpolated from VMT data provided through MTC for 2015 and 2035. AV VMT is estimated based on a logarithmic growth curve based on VMT data provided through MTC for 2015, 2035, and 2050. GHG = greenhouse gas emissions; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled; DA = Drive Alone; TNC = Transportation Network Company; AV = Autonomous Vehicles. Totals may not sum due to rounding. Emissions results shown are rounded to account for variability with actual emissions.

Source: VTA and Ascent Environmental 2022.

ON-ROAD TRANSPORTATION

In 2019, passenger trips generated 11 billion VMT and resulted in 3.6 million $MTCO_2e$, approximately 86 percent of total on-road transportation emissions. Drive Alone trips produced the largest source of passenger emissions with 2.9 million $MTCO_2e$, followed by Carpool trips with 669,000 $MTCO_2e$, TNC trips with 34,000 $MTCO_2e$, and AV trips with 17,000 $MTCO_2e$.

Commercial trips accounted for 1 billion VMT in 2019 and resulted in 519,000 $MTCO_2e$, approximately 12 percent of total on-road emissions for the year. The largest source of commercial emissions came from Very Small commercial vehicles with 279,000 $MTCO_2e$, followed by Large commercial vehicles with 128,000 $MTCO_2e$, Small commercial vehicles with 104,000 $MTCO_2e$, and Medium commercial vehicles with 8,000 $MTCO_2e$. Overall, the largest source of on-road emissions from all vehicle groups in 2019 was from Drive Alone passenger trips, which accounted for 70 percent of total on-road emissions. Annual emissions in percentage by vehicle group are shown in Figure 4.



Source: Compiled by Ascent Environmental in 2022.

Figure 4 2019 Passenger and Commercial Transportation Emissions – by Vehicle Group

RAIL TRANSPORTATION

Rail transportation accounted for one percent of total transportation emissions in 2019. A total of 2.8 million train miles operated in the county generated 38,800 $MTCO_2e$ in 2019. Passenger rail (e.g., VTA, Caltrain, and Amtrak) accounted for 56 percent of total rail emissions, while freight rail accounted for the remaining 44 percent of total rail emissions. With respect to total countywide transportation emissions, passenger rail accounted for 0.5 percent of total communitywide transportation emissions and freight rail accounted for 0.4 percent of total emissions. A summary of the data used to estimate rail emissions in 2019 is shown in Table 8 below.

Table 8 2019 Rail Emissions Assumptions and Calculations

Rail Provider	Mode Type	System Wide Locomotive Emissions ($MTCO_2e$/year)	Annual Train Miles in Santa Clara County	Percent of Train Vehicle Miles in Santa Clara County	Santa Clara County Locomotive Emissions ($MTCO_2e$)	Percent of Total Rail Emissions
VTA	Passenger	1,330	2,284,831	100%	1,300	3%
Caltrain	Passenger	41,955	13,356	43%	18,100	47%
Amtrak	Passenger	686,984	86,106	0.35%	2,400	6%
Union Pacific	Freight	9,683,378	473,040	0.18%	17,000	44%
				Total	38,800	100%

Notes: VTA = Valley Transportation Authority; $MTCO_2e$ = metric tons of carbon dioxide equivalent. Altamont Corridor Express emissions excluded due to lack of data. Totals may not sum due to rounding. Emissions results shown are rounded to account for variability with actual emissions. See Table 6 for data sources and calculation assumptions.

Source: Compiled by Ascent Environmental in 2023.

2.4 COUNTYWIDE TRANSPORTATION GHG EMISSIONS FORECASTS

2.4.1 Overview

Using the results of the 2019 countywide transportation emissions inventory, two forecast scenarios are provided to estimate future GHG levels from transportation in the county. The first scenario, Business-As-Usual (BAU), is based on a continuation of current trends in activity and does not account for GHG emissions reductions resulting from laws and regulations adopted by local, regional, State, or federal agencies; it illustrates how much emissions would increase due to population and economic growth if no actions to reduce emissions were taken. The second scenario, a legislative-adjusted BAU scenario, shows emissions reductions from laws and regulations enacted by regional, State, and federal agencies; it does not reflect local actions to reduce GHG emissions. GHG emissions forecasts provide insights to the scale of regional and local reductions needed to achieve GHG emissions reduction targets.

2.4.2 VMT Projections

Annual VMT projections were provided by MTC and processed by VTA for 2035 and 2050 for each of the same passenger and commercial vehicle groups that were provided for the 2019 inventory. Passenger VMT included projections for DA, Carpool, TNC, and AV. Commercial VMT included projections for Very Small, Small, Medium, and Large commercial vehicles. Annual VMT projections for all groups, except for AVs, were interpolated for 2030, 2040, and 2045 using the data from 2035 and 2050. As with the 2019 estimates, AV forecasts were based on a best fit growth curve using MTC's 2015, 2035, and 2050 data. Consistent with the 2019 inventory, the RTAC origin-destination method was used in all VMT projections. Total VMT is projected to increase each year, as shown in Table 9. Compared to 2019, VMT is projected to increase 7 percent by 2030, 12 percent by 2035, 14 percent by 2040, and 19 percent by 2045. By 2050, annual VMT is projected to be 15.6 billion, a 26 percent increase from 2019. These growth forecasts reflect MTC's travel modeling under Plan Bay Area 2050 which accounts for increases in population, economic activity and transportation costs, transportation infrastructure and program investments (e.g., roadway and transit networks), changes in land use, job-housing balance, and other variables (MTC & ABAG 2021c).

Table 9 County of Santa Clara 2019 and Projected VMT (million vehicle miles per year)

On-Road Transportation Source	2015	2019	2030	2035	2040	2045	2050
Passenger - DA	8,927	8,991	9,168	9,248	8,887	8,526	8,165
Passenger - Carpool	2,008	2,076	2,261	2,345	2,267	2,189	2,111
Passenger - TNC	65	105	215	264	295	326	357
Passenger - AV	0	54	477	934	1,521	2,469	3,788
Commercial – Very Small	829	818	787	773	800	826	853
Commercial - Small	222	219	212	209	216	224	231
Commercial - Medium	14	14	15	15	15	16	16
Commercial - Large	74	75	78	79	82	86	89
Total	12,140	12,352	13,212	13,868	14,084	14,662	15,610
Percent change from 2019	*-1.7%*	*N/A*	7%	12%	14%	19%	26%

Notes: VMT for 2019, 2030, 2040, and 2045 was interpolated from VMT data provided by VTA for 2015, 2035, and 2050. VMT = vehicle miles traveled; DA = Drive Alone; TNC = Transportation Network Company; AV = Autonomous Vehicles.

Source: VTA and Ascent Environmental 2022.

2.4.3 Rail Activity Projections Forecasts

VTA Light Rail

VTA estimates future light rail activity to increase by at least 26 percent from 2019 levels by 2030 and stay constant from 2030 through 2050. VTA light rail activity projections are discussed in further detail under Section 3.4.

Caltrain

Caltrain activity projections are based on Caltrain's 2040 Long Range Service Plan (Caltrain 2019). Under this plan, service across the peninsula would increase by 182 percent, or nearly three times, between 2019 and 2040. It is assumed that after 2040, service would then remain constant.

Amtrak

Amtrak does not have long term activity projections for either Capitol Corridor or Coast Starlight. In absence of these plans, Amtrak activity in California, and in the county, is assumed to be proportional to the State's overall plan for passenger rail under the 2018 State Rail Plan. The 2018 State Rail Plan estimates that passenger rail trips in the state will increase by 11 times from 2018 to 2040, from 115,000 to 1.3 million trips per day (California Department of Transportation 2018:213). Amtrak activity in the county is expected to increase proportionally to this and remain constant after 2040.

BART

BART began operations in the county in 2020. However, according to their 2021 Sustainability Report, starting in 2021, 100 percent of BART's electricity is purchased from GHG-free sources (BART 2021). This commitment is assumed to continue in perpetuity. Given that BART's trains are all electrified, this means that regardless of increases in activity in the future, GHG emissions from BART traction power will continue to be zero.

Union Pacific

Like Amtrak, UP does not have long term activity projections for its operations in California. In absence of these plans, UP activity in California, and in the county, is assumed to be proportional to the State's overall plan for freight rail under the 2018 State Rail Plan. The 2018 State Rail Plan estimates that freight rail volumes in the state will nearly double from 2013 to 2040, from 161 to 319 million tons (California Department of Transportation 2018:170). UP activity in the county is expected to increase proportionally to this and remain constant after 2040.

2.4.4 BAU Emissions Forecasts

The following BAU GHG emissions forecasts provide an assessment of how emissions generated by surface transportation use will change over time without further local, State, or federal action. If no action is taken, emissions are projected to increase each forecast year, as shown in Table 10. Compared to 2019 levels, emissions are projected to increase by 7 percent by 2030, 13 percent by 2035, 15 percent by 2040, and 20 percent by 2045. Under a BAU scenario, emissions are projected to reach 5,313,000 $MTCO_2e$ by 2050, an increase of 27 percent from 2019 levels.

Table 10 County of Santa Clara Transportation GHG Inventory 2019 and BAU Forecasts 2030 through 2050 ($MTCO_2e$)

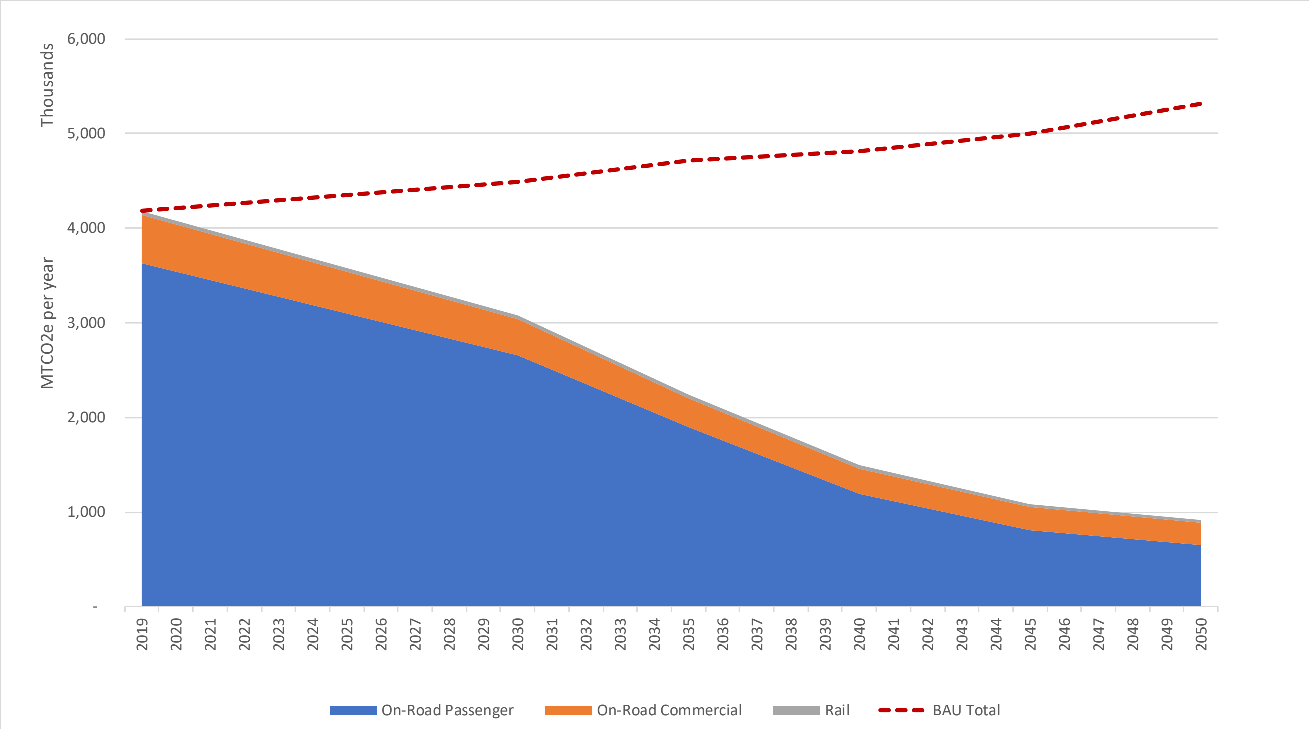
On-Road Transportation Source	2019	2030	2035	2040	2045	2050
Passenger - DA	2,905,000	2,962,000	2,988,000	2,871,000	2,754,000	2,638,000
Passenger - Carpool	669,000	729,000	756,000	730,000	705,000	680,000
Passenger - TNC	34,000	69,000	85,000	95,000	105,000	115,000
Passenger - AV	17,000	154,000	301,000	490,000	796,000	1,220,000
Commercial – Very Small	279,000	268,000	263,000	272,000	282,000	291,000
Commercial - Small	104,000	101,000	99,000	103,000	106,000	110,000
Commercial - Medium	8,000	8,000	8,000	8,000	9,000	9,000
Commercial - Large	128,000	132,000	134,000	140,000	146,000	151,000
Total On-Road Transportation	**4,143,000**	**4,423,000**	**4,635,000**	**4,710,000**	**4,903,000**	**5,214,000**
Rail - Freight	17,000	23,000	25,000	28,000	28,000	28,000
Rail - Passenger	22,000	47,000	59,000	71,000	71,000	71,000
Total Rail	39,000	70,000	84,000	98,000	98,000	98,000
Total	**4,182,000**	**4,492,000**	**4,719,000**	**4,809,000**	**5,001,000**	**5,313,000**
Percent change from 2019	*N/A*	*7%*	*13%*	*15%*	*20%*	*27%*

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; DA = Drive Alone; TNC = Transportation Network Company; AV = Autonomous Vehicles. Totals may not sum due to rounding. Emissions results shown are rounded to account for variability with actual emissions.

Source: Ascent Environmental 2022.

2.4.5 Legislative-Adjusted BAU Emissions Forecasts

With legislative adjustments, countywide transportation emissions would decrease by 78 percent from 2019 through 2050. Reductions in on-road transportation emissions from passenger vehicles contribute to a large part of this reduction, as shown in Figure 5. A detailed breakdown of the legislative adjusted BAU emissions forecasts is presented in Table 11.



Source: Ascent Environmental 2022.

Figure 5 Santa Clara County Transportation GHG BAU Emissions and Legislative-Adjusted Forecast Emissions (2019-2050)

Table 11 County of Santa Clara Transportation GHG Inventory 2019 and Legislative-Adjusted BAU Forecasts 2030 through 2050 ($MTCO_2e$)

On-Road Transportation Source	2019	2030	2035	2040	2045	2050
Passenger - DA	2,905,000	2,010,000	1,377,000	823,000	517,000	374,000
Passenger - Carpool	669,000	493,000	346,000	206,000	129,000	93,000
Passenger - TNC	34,000	47,000	39,000	27,000	19,000	16,000
Passenger - AV	17,000	104,000	138,000	138,000	145,000	167,000
Commercial – Very Small	279,000	188,000	135,000	100,000	80,000	72,000
Commercial - Small	104,000	77,000	71,000	70,000	71,000	73,000
Commercial - Medium	8,000	6,000	6,000	5,000	5,000	5,000
Commercial - Large	128,000	110,000	94,000	87,000	84,000	84,000
Total On-Road	4,143,000	3,036,000	2,205,000	1,457,000	1,051,000	883,000
Rail - Freight	17,000	23,000	25,000	28,000	28,000	28,000
Rail - Passenger	22,000	18,000	17,000	16,000	8,000	8,000
Total Rail	39,000	41,000	42,000	43,000	36,000	36,000
Total	4,182,000	3,077,000	2,247,000	1,501,000	1,087,000	919,000
Percent change from 2019	*N/A*	*-26%*	*-46%*	*-64%*	*-74%*	*-78%*

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent. DA = Drive Alone; TNC = Transportation Network Company; AV = Autonomous Vehicles. Totals may not sum due to rounding. Emissions results shown are rounded to account for variability with actual emissions.

Source: Compiled by Ascent Environmental in 2023.

ON-ROAD TRANSPORTATION

In addition to accounting for countywide growth under a BAU scenario, a legislative-adjusted BAU forecast was prepared, which includes adopted legislative and regulatory actions at the local, State, and federal levels that would affect emissions without any additional action. These include regulatory requirements to increase the percentage of zero-emission vehicles in new vehicle sales and improve vehicle fuel efficiency standards. It is important to note that the legislative-adjusted BAU emissions forecasts only include emissions reductions associated with implementation of federal, State, and local legislation and regulations that are adopted and do not include goals established by executive orders or targets established by federal or State agencies. There are several legislative actions (e.g., Advanced Clean Fleet) currently in draft form that could result in further reductions for future inventory updates once adopted. In addition, local VMT reductions associated with Senate Bill (SB) 743 are already accounted for in the MTC data and thus are not included in Table 12. The GHG emissions forecasts are aligned with various legislative actions, as shown in Table 12.

Table 12 Legislative Reductions Summary for Communitywide Transportation Emissions Forecasts

Source	Legislative Reduction	Description
State	Advanced Clean Car I Regulations	Establishes GHG emission reduction standards for model years 2017-2025 that are more stringent than federal CAFE standards.
State	Advanced Clean Car Standards II Regulations	Establishes a target for all new passenger cars, trucks, and SUVs sold in California to be 100 percent zero-emission vehicles by 2035.
State	Truck and Bus Regulation	Requires diesel trucks and buses that operate in California to be upgraded to reduce GHG emissions by 2035.
State	Innovative Clean Transit Rule	Requires 100 percent of new purchases by transit agencies to be zero emissions starting in 2029 and achieving full transition to ZEBs by 2040.
Federal	Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles	Establishes fuel efficiency standards for medium- and heavy-duty engines and vehicles.

Notes: CAFE = Corporate Average Fuel Economy; GHG = greenhouse gas; SB = Senate Bill; SUV = sport utility vehicle; ZEB = zero-emission bus

Source: Ascent Environmental in 2022.

With respect to the legislative adjustments included in this forecast, State and federal laws and regulations incorporated in the on-road transportation sector include the ACC Regulatory Program (ACC I and II) and fuel efficiency standards for medium- and heavy-duty vehicles. All of these policies, with the exception of Advanced Clean Cars II, are included in EMFAC2021's emissions factor estimates and forecast. Advanced Clean Cars II was included in an off-model adjustment and accelerates the State's climate goals by requiring that all new light duty vehicle sales be zero emissions by model year 2035, with increased intermediate targets starting for model year 2026. The Low Carbon Fuel Standard was excluded in EMFAC2021 forecasts because the emissions benefits originate from upstream fuel production and do not directly reduce vehicle tailpipe emissions that affect the county's GHG emissions forecasts. Table 13 summarizes the scaling factors and legislative reductions used to forecast on-road transportation emissions.

Table 13 On-Road Transportation Emissions Forecast Methods

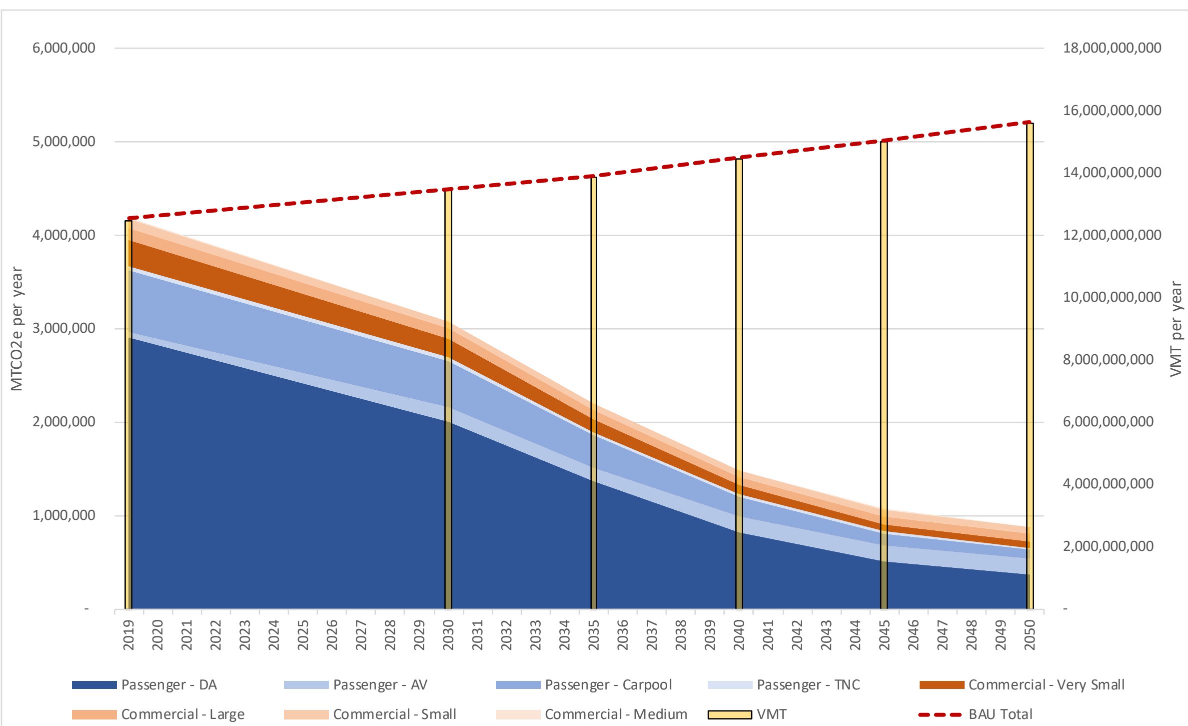
Forecast Methods	
Growth Factor	Applied Legislative Reductions
Scaled by VMT estimates provided by VTA and MTC.	EMFAC2021 forecasts vehicle fleet distributions by vehicle type and the emissions factors anticipated for each vehicle category based on both vehicle emissions testing and approved legislative reductions. EMFAC2021's forecasts incorporate the effects of the ACC I Standards, federal CAFE standards, and fuel efficiency standards for medium- and heavy-duty vehicles, as well as truck and bus regulations. Legislative actions that are anticipated to impact the number of electric vehicles in the future are incorporated into the emissions factors obtained from EMFAC2021. Per ACC II, additional adjustments were made to the EMFAC2021 emission factors to account for accelerated proportion of new light duty vehicles that are zero emissions starting in model year 2026 and fully transitioning by model year 2035.

Notes: ACC = Advanced Clean Cars; CAFE = Corporate Average Fuel Economy; EMFAC2021 = California Air Resources Board's EMisson FACtor 2021 model; VMT = vehicle miles traveled; MTC = Metropolitan Transportation Commission.
Source: Ascent Environmental 2022.

Table 11 and Figure 6 show the 2019 inventory and legislative-adjusted BAU forecasted emissions from on-road transportation for 2030, 2035, 2040, 2045, and 2050. When compared to the 2019 baseline year, the County's legislative-adjusted BAU emissions are anticipated to decrease for each of the forecast years. In 2030, emissions are projected to decrease 27 percent from the baseline year, producing 3,036,000 $MTCO_2e$. In 2035, emissions are projected to decrease 47 percent, producing 2,205,000 $MTCO_2e$. In 2040, emissions are anticipated to decrease approximately 65 percent, producing 1,457,000 $MTCO_2e$. In 2045, emissions are projected to decrease 74 percent, producing 1,051,000 $MTCO_2e$. Projections show a 78 percent decrease for 2050, with emissions estimated to be 883,000 $MTCO_2e$.

Based on the results the countywide transportation emissions inventory, Figure 6 presents two forecast scenarios that estimate future GHG emissions from transportation in the county: a Business-As-Usual (BAU) scenario, shown as the red dotted line, and a legislative-adjusted BAU forecast, shown as the stacked area in blue and orange. The BAU forecast illustrates how transportation emissions would increase due to population and economic growth without additional legislative regulations that reduce emissions. The legislative-adjusted BAU scenario accounts for emissions reductions from laws and regulations enacted by regional, State, and federal agencies; it does not reflect local actions to reduce GHG emissions. GHG emissions forecasts provide insights to the scale of additional regional and local reductions needed to achieve GHG emissions reduction targets. Additionally, Figure 6 also presents the VMT estimates upon which these emission forecast scenarios were developed, shown as the yellow bars. The trends in the BAU forecasts are inherently proportional to the BAU forecasts because no additional reductions to emissions rates are assumed.

The legislative-adjusted BAU forecast is comprised of emissions from eight different vehicle groups, represented by two vehicle categories (passenger and commercial) and various classes and modes. These groupings were based on the available modeling data provided by MTC. Passenger vehicle emissions are split into four modes: drive alone (DA); autonomous vehicle (AV); carpool; transportation network company (TNC) (e.g., ride hailing operations like Uber and Lyft). Commercial vehicle emissions are split into four vehicle classes: large, medium, small, and very small. Table 4 in Section 2.2.3 describes the definition of these vehicle groups in more detail.



Source: Ascent Environmental 2022.

Figure 6 Santa Clara County On-Road Transportation GHG BAU Emissions, Legislative-Adjusted Forecast Emissions, and VMT (2019-2050)

RAIL TRANSPORTATION

Rail emissions, accounting for legislative reductions, are expected to decline by a modest seven percent by 2050 from 2019 levels. The applied legislative reductions are discussed below for each rail operator.

VTA Light Rail

VTA's future light rail emissions under the legislative adjusted BAU forecast account for the increase of procurement of electricity from GHG-free sources, as all VTA light rail operations are electric. These emissions projections are discussed in further detail under Section 3.4.3.

Caltrain

Caltrain plans to electrify its entire passenger rail line by 2025 projections per Caltrain's Electrification project timeline (Caltrain 2023). According to the Environmental Impact Report for the electrification project, by 2040 emissions from Caltrain's locomotives would be 72 percent lower than the no project alternative (Caltrain 2014: Table 3.7-4). In 2040, locomotive emissions would be represented by both electric and diesel emissions, as Caltrain will continue to use diesel for railyard operations. However, by 2045, all electricity-related emissions are assumed to be zero pursuant to the carbon neutrality target for electric utilities under SB100. Thus, by 2045, it is estimated that Caltrain electrification will result in a 97 percent reduction relative to a no project condition, or a BAU. These calculations are shown in Attachment 2. These percentage reductions are applied to the forecasted BAU emissions to estimate legislative adjusted forecasts from Caltrain rail emissions in the county.

Amtrak

Amtrak plans to use 100 percent renewable diesel on its Capitol Corridor line by 2030 (Amtrak 2022). However, Amtrak does not have similar plans for Coast Starlight. Based on this information, Capitol Corridor GHG emissions are expected to be zero starting in 2030, due to renewable diesel's biogenic sources. This means that the forecasted emissions from Amtrak operations in the county starting in 2030 will only be representative of activity of the Coast Starlight line, which is assumed to continue to operate on traditional petroleum-based diesel. No legislative adjustments would be made to emissions forecasts for the Coast Starlight line, which is scaled by the passenger rail forecasts under the 2018 State Rail Plan.

BART

BART began operations in the county in 2020. However, according to their 2021 Sustainability Report, starting in 2021, 100 percent of BART's electricity is purchased from GHG-free sources (BART 2021). This commitment is assumed to continue in perpetuity. Given that BART's trains operating in the county are all electrified, this means that regardless of increases in activity in the future, GHG emissions from BART traction power in the county will continue to be zero.

Union Pacific

UP has not identified any concrete plans to convert to using renewable fuels or electrification of their lines within the county or elsewhere throughout its system in the future. As such, no legislative adjustments are made to emissions forecasts for UP operations in the county.

3 GHG EMISSIONS INVENTORY AND FORECAST FOR TRANSIT OPERATIONS

This section presents an updated inventory and forecast for GHG emissions from VTA's transit operations, drawing from historical data available from fiscal years (FY) 2009 through 2021 and forecasting these emissions through 2050. VTA's fiscal year is the 12-month accounting period that starts on July 1 and ends on June 30. Fiscal year is often abbreviated FY, and the year referenced is the end of that period. For example, FY 2021 covers from July 1, 2020 to June 30, 2021. The countywide transportation emissions estimates in the previous section inherently includes emissions from the fleet and employee commute portion of the transit operations inventory, but transit operations emissions also include emissions from building energy use, waste generation, and water consumption. A background discussion (Section 3.1) of VTA's previous sustainability efforts and emissions tool development explains the approach to this update to VTA's transit operations emissions inventory and forecasts. Section 3.2 presents the purpose behind the inventory and an explanation of the methodology used for the inventory. Section 3.3 presents the results of the transit operations emissions inventory update. Section 3.4 presents the transit operations emissions forecast, including a discussion of the forecast methodology by emissions sector (e.g., fleet, building energy).

3.1 BACKGROUND

Ascent previously worked with VTA to create sustainability trends and targets for the development of VTA's Sustainability Plan (Plan), which was approved in 2020. As part of the Plan's development, Ascent prepared a Sustainability Inventory, Goals, and Targets Tool (Tool) to track VTA's sustainability metrics, starting from FY 2009, and to develop sustainability targets based on those metrics and other influencing factors. The Tool tracks five main sustainability metrics (energy use, GHG emissions, criteria air pollutant emissions, water use, and waste disposal tonnage) across six activity sectors (i.e., buildings and facilities, revenue and non-revenue fleet, employee commute, displaced and avoided trips, water, and waste). The Plan showed results through FY 2019.

The Tool developed for the Plan was designed to produce results showing trends in resource consumption and emissions since FY 2009. These results can be used to identify where progress on achieving sustainability goals has occurred to date and areas where additional progress could be made. Progress is determined by reductions in GHGs, criteria air pollutants, resource consumption (e.g., water and energy), and by increases in activities associated with enhanced sustainability (e.g., recycling and waste diversion). The tool allows for a more comprehensive analysis by compiling data for multiple years rather than a single year (VTA 2017). The Tool also offers the flexibility to track progress in future years as additional data become available. The ability to accurately track future progress allows VTA to establish and work toward quantitative targets for future years that are aligned with internal agency objectives, goals set by municipal and state agencies, and targets from non-profit organizations such as the Sustainability Commitment Guidelines from the American Public Transportation Association (APTA).

3.2 INVENTORY PURPOSE AND OVERVIEW

This inventory updates and quantifies GHG emissions from VTA's transit operations in FY 2020 and FY 2021. Ascent used the existing Tool—described in Section 3.1—to update the inventory through FY 2021. While the Tool was previously used to track five sustainability metrics (energy use, GHG emissions, criteria air pollutant emissions, water use, and waste disposal tonnage), the purpose of this inventory is to prepare for VTA's CAAP and is therefore solely focused on tracking GHG emissions. GHG emissions are assessed across the five activity sectors highlighted in the Tool (i.e., buildings and facilities, revenue and non-revenue fleet, employee commute, water, and waste). Avoided emissions from displaced and avoided trips, which were included in the Tool, were not included in this inventory because that sector was originally required to meet APTA's sustainability metrics and is calculated using APTA mode shift assumptions. Displaced and avoided trips were also excluded because these offsets are outside of VTA's direct jurisdiction. Short-term GHG emissions that result from material processing and transportation, on-site construction equipment, and traffic delays due to construction of projects, are also excluded. These construction-related GHG emissions are based on project-specific information (e.g., equipment needs, construction phasing, duration, frequency) and are evaluated as part of the environmental review process for that project.

A detailed methodology can be found in the VTA Sustainability Plan Technical Memorandum prepared by Ascent in 2020. Only updates to any methodologies or emissions factors relevant for the inventory are highlighted in this memorandum. All other assumptions can be found in the 2020 VTA Sustainability Plan Technical Memorandum. Herein going forward to be consistent with the previous inventory conducted, all reference to years are assumed to be in fiscal years.

3.3 TRANSIT OPERATIONS GHG EMISSIONS INVENTORY UPDATES

3.3.1 GHG Emissions Inventory Updates

Table 14 details emissions by year and sector. Based on the modeling conducted, VTA's transit operations generated approximately 39,431 $MTCO_2e$ in FY 2021. Overall, emissions decreased by 44 percent compared to the 2009 baseline year. This decline in emissions is largely attributed to the significant declines in ridership VTA experienced in FY 2021 due to the Novel Coronavirus 2019 (COVID-19) pandemic which started in March 2020 with a shelter-in-place order issued for Santa Clara County. For FY 2021, overall ridership was down by 58 percent compared to the prior fiscal year. Limited vehicle capacity seating was imposed, and service adjustments were implemented to address passenger pass-ups in accordance with social distancing guidelines. No special event service was provided this year because large gatherings were not permitted. School service was reduced as most schools adopted distance learning programs. Commute trips decreased as most offices and businesses allowed employees to work from home and online shopping was substituted for in-person trips. At the time of this writing, efforts to restore transit to pre-pandemic levels are underway and bus ridership is nearing 80 percent of what it was before COVID-19.

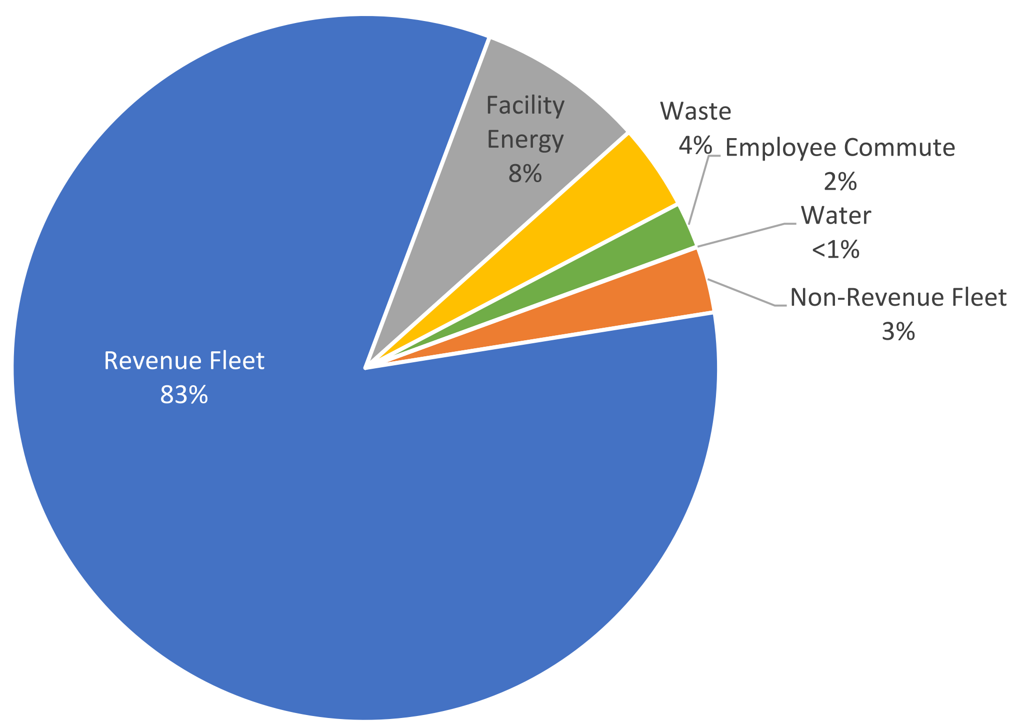
Table 14 VTA's Transit Operations Emissions by Fiscal Year and Sector

Fiscal Year	Fleet ($MTCO_2e$)	Building Energy ($MTCO_2e$)	Waste ($MTCO_2e$)	Employee Commute ($MTCO_2e$)	Water ($MTCO_2e$)	Total ($MTCO_2e$)	Percent Change from FY 2009
2009	59,747	6,777	1,803	1,507	61	69,895	n/a
2010	53,486	6,115	1,754	1,442	39	62,835	-10%
2011	49,962	6,060	1,851	1,378	28	59,278	-15%
2012	49,517	5,692	1,817	1,366	27	58,418	-16%
2013	49,999	5,424	1,875	1,344	32	58,675	-16%
2014	51,557	4,976	1,806	1,368	43	59,750	-15%
2015	52,975	4,280	1,724	1,313	38	60,330	-14%
2016	54,508	4,652	1,853	1,416	20	62,449	-11%
2017	52,405	4,249	2,048	1,380	13	60,095	-14%
2018	49,503	3,280	1,793	1,385	13	55,974	-20%
2019	46,999	2,962	1,726	1,341	8	53,036	-24%
2020	40,559	3,381	1,586	1,215	5	46,746	-33%
2021	34,019	3,024	1,548	832	8	39,431	-44%

Note: $MTCO_2e$ = metric tons of carbon dioxide equivalent; FY = fiscal year. Totals may not sum total due to rounding.

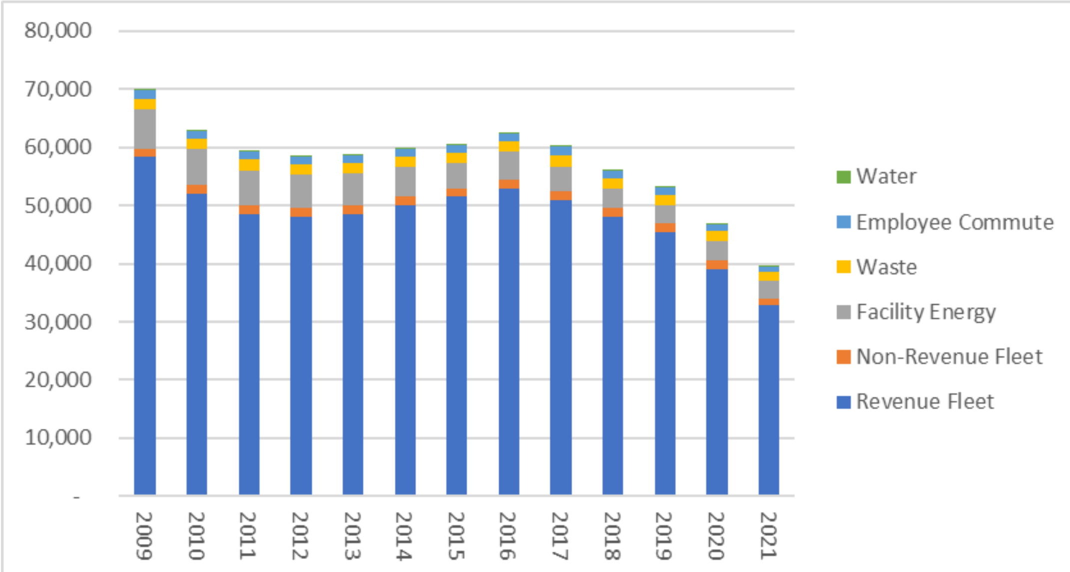
Source: Ascent Environmental in 2022.

As shown in Table 14 and Figure 7 and 8, the top emitting sector in 2021 was revenue and non-revenue fleet, which has been the top emitting sector since the 2009 baseline year. Revenue and non-revenue fleet produced 34,019 $MTCO_2e$ and accounted for 86 percent of VTA's transit operations emissions in 2021. The second most emitting sector was building energy, which produced 3,024 $MTCO_2e$ and accounted for 8 percent of emissions. This sector was followed by waste which produced 1,548 $MTCO_2e$ and accounted for 4 percent, employee commute which produced 830 $MTCO_2e$ and accounted for 2 percent, and water which produced 8 $MTCO_2e$ and accounted for less than 1 percent of total emissions.



Source: Ascent Environmental 2023.

Figure 7 FY 2021 Transit Operations Percent Emissions by Sector



Source: Ascent Environmental 2022.

Figure 8 FY 2009 to FY 2021 GHG Emissions from Transit Operations by Sector

3.3.2 Methodology Updates by Sector

REVENUE AND NON-REVENUE FLEET

For revenue and non-revenue fleet, GHG emissions were estimated by multiplying the fleet activity, such as vehicle mileage or fuel use, with fuel- and vehicle-specific emission factors. The revenue fleet refers to vehicles used for revenue generating transit service. The non-revenue fleet refers to vehicles provided by VTA for employees to perform VTA business. For electric fleet (e.g., light rail, electric buses, electric non-revenue cars), the electricity used by the fleet was multiplied by utility-specific electricity emission factors for 2020, which varied depending on where the vehicles were being charged or powered. These factors are the same electricity-related emission factors used to calculate GHG emissions from electricity consumption in buildings and facilities, as shown in Table 13.

For light-duty vehicles, off-model adjustments were made to account for the increasing penetration of electric cars under ACC2.

Additionally, for Santa Clara County, EMFAC assumes that buses older than 14 years are decommissioned and no longer report emission factors for those buses; however, VTA did operate a few buses older than 14 years in limited capacity in FY 2021. Thus, to determine emissions factors for the decommissioned buses, statewide average emission factors for older bus model years were queried from EMFAC or were assumed to be equal to the emission factor in the latest year in which the older model year bus was operating.

BUILDING AND FACILITIES

Utility-specific emissions factors for electricity generation from buildings and facilities were updated to include emissions factors for 2020 and 2021. Table 15 shows a summary of the utilities serving VTA and the associated emissions factors. Utility-specific emissions factors, given in lb CO_2e/MWh, are publicly available from the CEC's utility Power Content Labels (PCL) for 2020. This data was then extrapolated to get 2021 emissions factors. As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

Table 15 2020 Electricity GHG Emissions Factors by Utility

Utility	2020 Percent GHG-Free	2020 lb CO_2e/MWh	2021 Percent GHG-Free	2021 lb CO_2e/MWh
PG&E	84%	160	88%	121
SVP	75%	542	76%	520
SVCE[1] GreenStart	98%	7	98%	7
SVCE[1] GreenPrime	100%	0	100%	0
SJCE[1] GreenSource	89%	190	90%	171
CPAU	100%	0	100%	0

Notes: GHG = greenhouse gas; CO_2e = carbon dioxide equivalents, lb = pound, MWh = megawatt-hour, CPAU = City of Palo Alto Utilities, PG&E = Pacific Gas and Electric, SJCE = San Jose Clean Energy, SVCE = Silicon Valley Clean Energy, SVP = Silicon Valley Power. GreenPrime is a 100-percent renewable option.

[1] Community Choice Aggregator

Source: Compiled by Ascent Environmental in 2022 using emission factors from each utility's Power Content Labels, CEC 2021

There were no changes to methodology for natural gas and propane emissions, as these emissions factors are not specific to utility and do not change from year to year. These emission factors can be found in the 2020 VTA Sustainability Plan Technical Memorandum.

WASTE

No methodological changes were made. Please refer to the 2020 VTA Sustainability Plan Technical Memorandum for the description of the original methodology and assumptions for the waste sector.

EMPLOYEE COMMUTE

Like the methodology used for revenue and non-revenue fleet, GHG emissions from employee commute were calculated using vehicle emission factors from EMFAC2021 and adjusted off-model for additional reductions expected under ACC2. For all VTA facilities, employee commute VMT data were based off survey results from FY 2015 and scaled to FY 2020 and FY 2021 based on the VTA's employee population in FY 2021 in comparison to FY 2015. The employee commute survey conducted in 2015 found that 70 percent of respondents drove alone, 15 percent take transit, 6.6 percent carpool, and 2.4 percent bike to work. On June 30, 2021, the employee population was 2,078. For the River Oaks facility, it was assumed that for two months in FY 2020 and all of FY 2021, 100 percent of the 444 employees at that facility worked from home in accordance with COVID-19 directives. Note that discrepancies between estimated employee commute emissions and actual emissions are overshadowed by other emissions sectors. Employee commute accounts for less than four percent of total transit emissions in FY 2021 as shown in Table 18.

To calculate emissions, the annual employee commute VMT was multiplied by the per-mile emissions factors for an average light-duty gasoline passenger vehicle in Santa Clara County, available from EMFAC2021. See Table 16 for a summary of the GHG emission factors for 2020 and 2021. As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

Table 16 2020 and 2021 Light-Duty Gasoline Vehicle GHG Emission Factors

Year	g CO_2e/mi
2020	334.77
2021	328.09

Notes: GHG = greenhouse gas; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalents; mi = mile. Emission factors are based on an average light-duty gasoline vehicle in Santa Clara County, across all vehicle speeds. EMFAC vehicle categories include LDA, LDT1, and LDT2.

WATER

To quantify emissions from the use of water, PG&E electricity emission factors for 2020 and 2021, shown in Table 13, were applied to the annual electricity demand for water. For consistency with the previous inventory, it was assumed that the upstream pumping and treatment electricity demand would continue to be supplied by PG&E.

The prior analysis did not account for emissions differences in potable versus non-potable water and had only accounted for treatment and distribution energy for both water types. This analysis corrects this for all years since FY 2009. Non-potable water-related energy intensity only includes energy used for treatment and distribution, while potable water includes energy use from conveyance, treatment, distribution, and wastewater treatment. The correction resulted in an increase in water-related emissions. The applied energy intensity factors are summarized in Table 17.

Table 17 Water Energy Action Energy Intensity Factors

Water Energy Action	Energy Intensity Factor	Units	Accounted for Potable Water	Accounted for Non-Potable Water
Conveyance Energy	150	kWh/MG	Yes	No
Treatment Energy	100	kWh/MG	Yes	Yes
Distribution Energy	1200	kWh/MG	Yes	Yes
Wastewater Treatment	2500	kWh/MG	Yes	No

Notes: kWh = kilowatt hour; MG = million gallons.

Source: CEC 2005.

3.4 TRANSIT OPERATIONS GHG EMISSIONS FORECASTS

3.4.1 Overview

Using the results of the FY 2021 VTA transit operations inventory, two forecast scenarios are provided that estimate future GHG levels from transit operations for FY 2030, FY 2035, FY 2040, FY 2045, and FY 2050. The first scenario, Business-As-Usual (BAU), is based on a continuation of current trends in activity and does not account for future (post-2021) GHG emissions reductions resulting from laws and regulations adopted by local, regional, State, or federal agencies; it illustrates how much emissions would increase due to population and economic growth if no actions to reduce emissions were taken. The second scenario, a legislative-adjusted BAU scenario, shows emissions reductions from laws and regulations enacted by regional, State, and federal agencies; it does not reflect local actions to reduce GHG emissions. GHG emissions forecasts provide insights to the scale of regional and local reductions needed to achieve GHG emissions reduction targets.

3.4.2 BAU Emissions Forecasts

The following BAU GHG emissions forecasts provide an assessment of how emissions generated by VTA's transit operations will change over time without further local, State, or federal action. If no action is taken, emissions are projected to decrease each forecast year, except for in 2045 and 2050, as shown in Table 18 and Figure 9. This slight increase in 2045 is due to the balance in forecasts for revenue and non-revenue fleet. Bus emissions, which account for over 75 percent of fleet emissions in FY 2021, are anticipated to continue to decline through 2050 due to the Zero Emissions Bus Program. Subsequent increases in BAU emissions from other fleet activity, due to anticipated fleet wide growth, would begin to dominate fleet emissions after 2040. Compared to FY 2021 levels, total emissions are projected to decrease by 34 percent by FY 2030, 59 percent by FY 2035, 76 percent by FY 2040, and 76 percent by FY 2045. Under a BAU scenario, emissions are projected to be 9,598 $MTCO_2e$ by FY 2050, a decrease of 76 percent from FY 2021 levels.

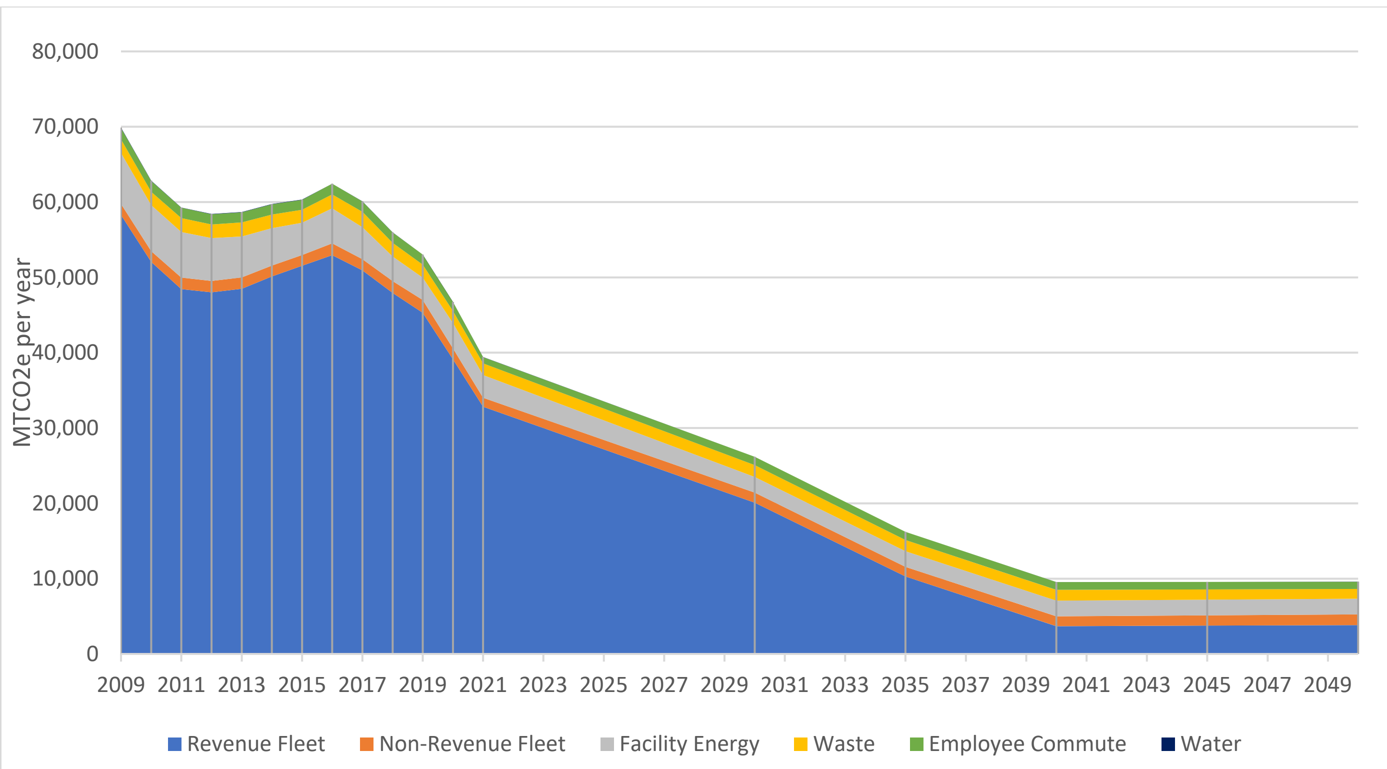
Table 18 VTA Transit Operations GHG Inventory and BAU Forecasts ($MTCO_2e$)

Fiscal Year	Revenue Fleet ($MTCO_2e$)	Non-Revenue Fleet ($MTCO_2e$)	Building Energy ($MTCO_2e$)	Waste ($MTCO_2e$)	Employee Commute ($MTCO_2e$)	Water ($MTCO_2e$)	Total ($MTCO_2e$)	Percent Change from FY 2021
2021	32,820	1,198	3,024	1,548	832	8	39,431	NA
2030	20,071	1,358	2,064	1,573	1,107	5	26,178	-34%
2035	10,283	1,285	2,067	1,504	1,072	5	16,216	-59%
2040	3,691	1,318	2,070	1,434	1,038	5	9,555	-76%
2045	3,766	1,365	2,073	1,364	1,003	4	9,575	-76%
2050	3,840	1,415	2,076	1,294	969	4	9,598	-76%

Note: $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable; GHG = greenhouse gas; BAU = business-as-usual; FY = fiscal year. Totals may not sum due to rounding.

Source: Ascent Environmental in 2022.

The large reduction in total emissions from FY 2030 to FY 2035, under this BAU scenario, is largely due to the reduction in emissions from revenue fleet, specifically buses. Under the Zero Emissions Bus Program, which targets a complete conversion of the bus fleet to zero emissions by FY 2040, the diesel bus population will dramatically decline by 61 percent from FY 2030 to FY 2035 to make way for electric buses, while total bus fleet activity remains constant. These and other forecast assumptions are discussed in Section 3.4.4.



Note: Forecasts modeled for years FY 2030, FY 2035, FY 2040, FY 2045, and FY 2050. FY = fiscal year

Source: Ascent Environmental 2023.

Figure 9 FY 2030 to FY 2050 GHG Emissions BAU Forecasts from Transit Operations by Sector

3.4.3 Legislative-Adjusted BAU Emissions Forecasts

In addition to accounting for countywide growth under a BAU scenario, a legislative-adjusted BAU forecast was prepared, which includes adopted legislative and regulatory actions at the local, State, federal levels that would affect emissions without any additional action. These include regulatory requirements to increase the percentage of zero-emission vehicles in new vehicle sales and improve vehicle fuel efficiency standards. It is important to note that the legislative-adjusted BAU emissions forecasts only include emissions reductions associated with implementation of adopted federal, State, and local legislation and regulations and do not include goals established by executive orders or targets established by federal or State agencies. The GHG emissions forecasts are aligned with various legislative actions, as shown in Table 19. There are several legislative actions (e.g., Advanced Clean Fleet) currently in draft form that could result in further reductions for future inventory updates once adopted.

Table 19 Legislative Reductions Summary for Transit Operations Emissions Forecasts

Source	Legislative Reduction	Description	Sectors Applied
State	Renewable Energy and Zero-Carbon Electricity Requirements (SB 1020 and SB 100)	Requires California energy utilities to procure 60 percent of electricity from eligible renewable and zero-carbon sources by 2030, 90 percent by 2035, 95 percent by 2040, and 100 percent by 2045.	Building Energy
State	Advanced Clean Car I Regulations	Establishes GHG emission reduction standards for model years 2017 through 2025 that are more stringent than federal CAFE standards.	Revenue and Non-Revenue Fleet
State	Advanced Clean Cars II Regulations	Establishes a target for all new passenger cars, trucks, and SUVs sold in California to be 100 percent zero-emission vehicles by 2035.	Revenue and Non-Revenue Fleet
State	Truck and Bus Regulation	Requires diesel trucks and buses that operate in California to be upgraded to reduce GHG emissions by 2035.	Revenue Fleet
State	Innovative Clean Transit Rule	Requires 100 percent of new purchases by transit agencies to be zero emissions starting in 2029 and achieving full transition to ZEBs by 2040.	Revenue Fleet
Federal	Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles	Establishes fuel efficiency standards for medium- and heavy-duty engines and vehicles.	Revenue and Non-Revenue Fleet

Notes: CAFE = Corporate Average Fuel Economy; CEC = California Energy Commission; EPA = U.S. Environmental Protection Agency; GHG = greenhouse gas; SUV = sports utility vehicle; SB = Senate Bill.

Source: Table compiled by Ascent Environmental in 2022.

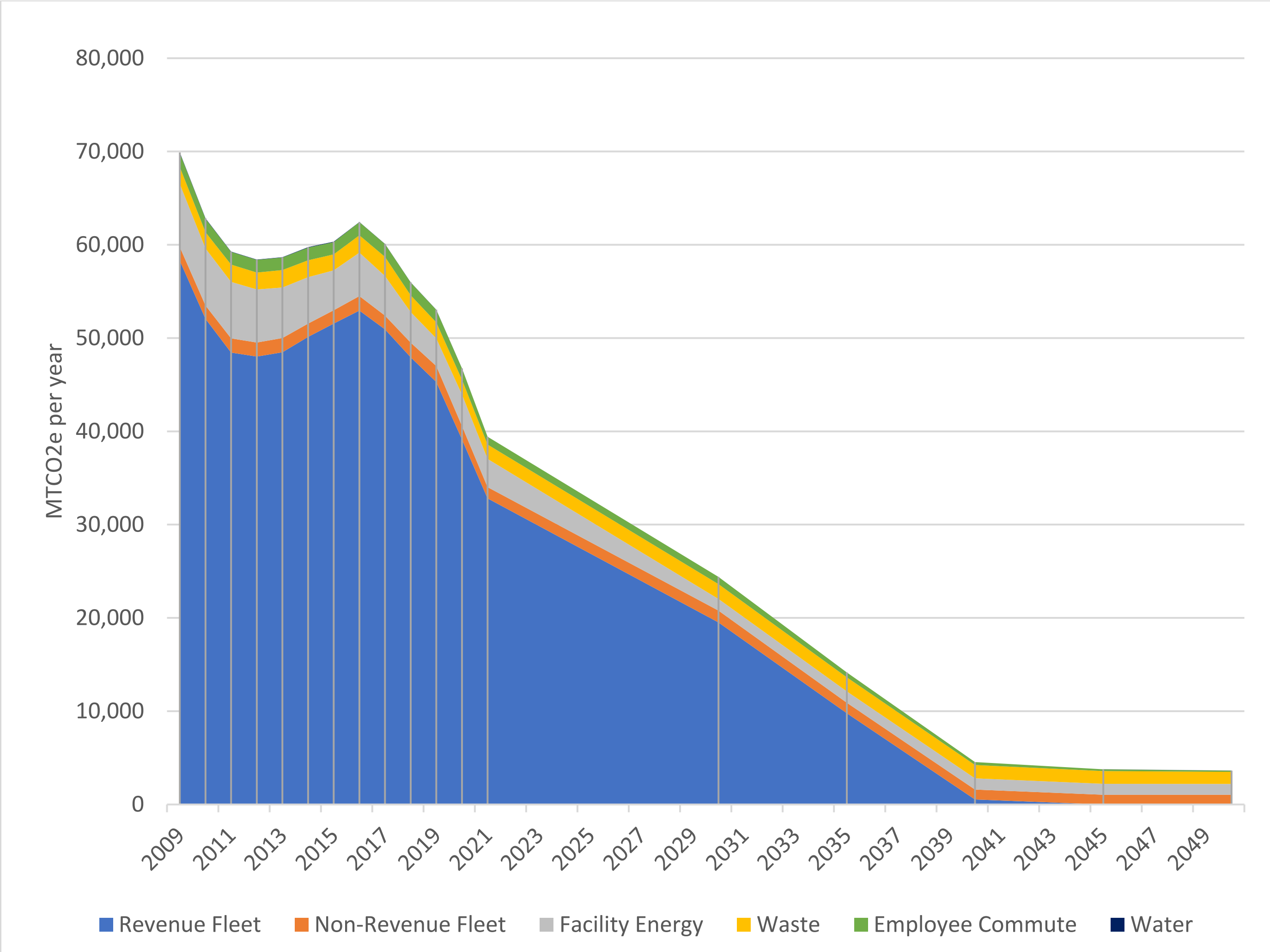
In the legislative-adjusted BAU forecast, emissions are projected to decrease each forecast year, though steadying by 2045, as shown in Table 20 and Figure 10. Compared to FY 2021 levels, emissions are projected to decrease 38 percent by FY 2030, 64 percent by FY 2035, 88 percent by FY 2040, and 90 percent by FY 2045. Under a legislative-adjusted BAU scenario, emissions are projected to be 3,629 $MTCO_2e$ in FY 2050, a decrease of 91 percent from FY 2021 levels.

Table 20 VTA Transit Operations GHG Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Fiscal Year	Revenue Fleet ($MTCO_2e$)	Non-Revenue Fleet ($MTCO_2e$)	Building Energy ($MTCO_2e$)	Waste ($MTCO_2e$)	Employee Commute ($MTCO_2e$)	Water ($MTCO_2e$)	Total ($MTCO_2e$)	Percent Change from FY 2021
2021	32,820	1,198	3,024	1,548	832	8	39,431	NA
2030	19,506	1,273	1,261	1,573	779	3	24,396	-38%
2035	9,786	1,115	1,231	1,504	516	2	14,154	-64%
2040	541	1,058	1,201	1,434	311	1	4,546	-88%
2045	0	1,038	1,170	1,364	191	0	3,763	-90%
2050	0	1,041	1,161	1,294	133	0	3,629	-91%

Note: $MTCO_2e$ = metric tons of carbon dioxide equivalent; GHG = greenhouse gas; BAU = business-as-usual; NA = not applicable; FY = fiscal year. Totals may not sum due to rounding.

Source: Ascent Environmental 2023.



Note: Forecasts modeled for years FY 2030, FY 2035, FY 2040, FY 2045, and FY 2050.

Source: Ascent Environmental 2023.

Figure 10 FY 2030 to FY 2050 GHG Emissions Legislative-Adjusted Forecasts from Transit Operations by Sector

3.4.4 Forecast Methodology

To forecast emissions from each of VTA's GHG emissions sectors a two-phased approach was used. First, activity levels (e.g., VMT, energy consumption) were forecasted based on projected activity levels, and where activity projections were not available, historical trends were used to extrapolate activity levels into the future. Second, future emission factors were applied as available (e.g., vehicle emission factors from EMFAC2021, electricity emission factors as estimated for the various electric utilities serving VTA operations). Some emission factors are assumed to stay constant (e.g., waste, natural gas, propane). For the BAU forecasts, for all emissions sectors, emission factors were assumed not to change from those assumed in the FY 2021 inventory. For the legislative-adjusted forecasts, emission factors were assumed to reflect anticipated changes in future regulations (e.g., ACC2, SB 100). These especially effect on-road vehicle and electricity-related emission factors, which affect both facility energy-related emissions and indirect emissions from water delivery and treatment. Activity levels were multiplied by their respective emission factors to forecast emissions.

REVENUE FLEET

VTA's revenue fleet consists of its bus fleet, light rail, and paratransit fleet. VMT projections for the bus fleet and light rail operations were provided by VTA's service planning department. Paratransit fleet activity was forecasted based on historical trends in paratransit activity.

Bus Fleet Forecasts

Activity

To forecast bus fleet emissions, bus VMT projections by fuel type were provided by VTA's service planning manager that reflect VTA's plan to achieve its Zero Emissions Bus goal by FY 2040, as mandated under the California Air Resources Board's Innovative Clean Transit Regulation. As shown in Table 21, VTA's bus fleet is anticipated to gradually transition away from diesel to battery-electric buses by FY 2040. Table 21 shows the anticipated change in annual bus VMT by bus length and fuel type in FY 2030, FY 2035, and FY 2040. After FY 2040, it is assumed that bus VMT will remain constant.

Table 21 VTA's Zero 2040 Fleet Composition and Service Level VMT Projections

Bus Type by Vehicle Miles Traveled	FY 2030	FY 2035	FY 2040
40-Foot Hybrid Diesel Bus	12,000,118	5,156,156	0
60-Foot Hybrid Diesel Bus	1,298,313	0	0
40-Foot Battery-Electric Bus	3,950,580	10,794,542	15,950,698
60-Foot Battery-Electric Bus	1,298,313	2,596,625	2,596,625
Total	**18,547,323**	**18,547,323**	**18,547,323**

Notes: FY = fiscal year, VMT = Vehicle Miles Traveled

Source: Tyree, pers. comm., 2022.

Emission Factors

For diesel buses, future GHG emission factors through FY 2050 were obtained from EMFAC2021, which was run for Santa Clara County for the UBUS, or urban bus, vehicle category. These emission factors varied by calendar year and vehicle model year. For forecasting purposes, only average bus model years for each calendar year were used. To estimate the average model year for diesel buses, it was assumed that the average age of VTA's bus fleet by vehicle length would not change. Between FY 2009 and FY 2021, the average age of 40-foot and 60-foot buses at VTA has been approximately 9 years. This average age was assumed to continue through FY 2050 and was used to estimate the relative model years to be queried from EMFAC. The resulting average bus emission factors from EMFAC are anticipated to decrease by 36 percent from FY 2021 to FY 2030, as shown in Table 22. After FY 2035, VTA would no longer use diesel buses, as shown in Table 21 above. These emission factors were then multiplied by the forecasted diesel bus VMT shown in Table 21 to forecast emissions. As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

Table 22 Forecasted Diesel Bus Emission Factors

Year	Average Model Year	Average Emissions Factors (g CO_2e/mi)
2021	2011	1,972
2030	2021	1,253
2035	2026	1,311

Notes: Emission factors represent diesel UBUS vehicles in Santa Clara County, as estimated in EMFAC2021. After 2030, diesel buses would no longer be used. $MTCO_2e$ = metric tons of carbon dioxide equivalent; g = gram; mi =miles.

Source: Ascent Environmental in 2022.

For electric buses, future legislative-adjusted GHG emission factors were derived from forecasted PG&E emission factors for each milestone year, based on historical purchase trends (FY 2030, FY 2035, FY 2040, FY 2045, and FY 2050). In FY 2021, all electric buses used electricity purchased from PG&E. This purchase arrangement was assumed to continue. PG&E's CO_2 emissions factor for each forecast year was calculated by interpolating 2020 emission factors (160.05 pounds [lb] of CO_2/megawatt-hour [MWh]) available from PG&E's Power Content Label, available from the California Energy Commission (CEC), and a zero emissions factor for 2045 (CEC 2021). This latter assumption assumes that PG&E would achieve carbon neutrality (i.e., 100 percent GHG-free electricity) by 2045, per SB 100. CH_4 and N_2O emission factors were calculated in a similar way. However, because these factors were not available for PG&E, 2020 California-specific electricity emissions factors for CH_4 and N_2O were obtained from the U.S. Environmental Protection Agency's (EPA's) Emissions & Generation Resource Integrated Database for the CAMX region (eGRID) (EPA 2021). Thus, the future CH_4 and N_2O emission factors were also interpolated between eGRID factors for 2020 and a zero emissions factor for 2045. In FY 2050, PG&E emissions factors are assumed to be 100 percent GHG-free, continuing the 2045 carbon neutrality mandate under SB100. PG&E's forecasted emissions factors are shown in Table 28.

These emission factors were then multiplied by the average fuel economy for each electric bus category (kWh/mi) then by the forecasted electric bus miles shown in Table 19 above. The 40-foot and 60-foot buses were assumed to have the same fuel economy as a Proterra 40' bus (e.g., ZX5+) and a BYD K11M 60' transit bus, respectively. The Proterra ZX5+ bus has an average fuel economy of 2.2 kWh per mile; the BYD K11M 60' transit bus has an average fuel economy of 3.0 kWh per mile, according to each manufacturer's specifications (Proterra 2022, BYD 2022).

Light Rail

Activity

Light rail forecasts were based on light rail service level projections of train car-miles through FY 2045, as provided by VTA's service planning manager. These growth projections were used to scale light rail electricity use from FY 2021 levels. This approach assumes light rail train efficiency would likely remain unchanged from FY 2021 through FY 2050, which has been confirmed by VTA's light rail department (Kim, pers. comm., 2023). However, VTA's light rail service projections for boardings and car-miles were only available starting in FY 2022. The inventory also did not estimate train car-miles. Instead, VTA's FY 2021 train car-miles were separately obtained from the National Transit Database (NTD) (NTD FY 2022). As shown in Table 23, VTA's light rail service levels are anticipated to increase by 26 percent from FY 2021 to FY 2030, accounting for the opening of the Eastridge to BART Regional Connector slated for FY 2027 and remain constant through FY 2045. After FY 2045, it is assumed that light rail activity will remain constant. It was assumed that light rail electricity use would also increase by the same rate from FY 2021.

Table 23 VTA's Light Rail Service Level Projections and Estimated Electricity Forecasts

	FY 2021	FY 2030	FY 2035	FY 2040	FY 2045
Annual Total Car-Miles	3,037,317[1]	3,818,726	3,818,726	3,818,726	3,818,726
% Change in Car-Miles from FY 2021	NA	26%	26%	26%	26%
Light Rail Electricity Use (kWh/year)	20,625,365[2]	25,931,640	25,931,640	25,931,640	25,931,640

Notes: NTD = National Transit Database; NA = not applicable; kWh = kilowatt-hour; FY = fiscal year

[1] From NTD 2022 data

[2] From VTA's 2021 GHG Inventory

Source: Tyree, pers. comm., 2022, NTD 2022.

Emission Factors

Future legislative-adjusted GHG electricity emission factors were based on forecasted utility emission factors (SJCE GreenSource, SVCE GreenStart, and SVP) for each milestone year (FY 2030, FY 2035, FY 2040, FY 2045, and FY 2050). In FY 2021, VTA procured 78 percent, 18 percent, and four percent of total light rail electricity demand from SJCE GreenSource, SVCE GreenStart, and SVP, respectively. This utility distribution was assumed to remain constant into the future. The forecasted emission factors for each utility are shown in Table 28.

Paratransit

Activity

VTA's paratransit activity has been characterized by a variety of vehicle types, makes, and models from light duty auto to small buses. By 2021, passenger cars and light-duty trucks with an equivalent test weight between 3,751 and 5,750 pounds (EMFAC types LDA and LDT2, respectively) were retired from the fleet. They were replaced by light-heavy-duty trucks with a gross vehicle weight between 10,001 and 14,000 pounds and light-duty trucks with an equivalent test weight of under 3,750 pounds (EMFAC types LHDT2 and LDT1, respectively). It was assumed that future VMT for the LHDT2 and LDT1 vehicles grew at a rate of 0.75 percent per year, which was the historical rate of population growth in Santa Clara county from 2009 to 2019 (2009 was chosen because it was the first year of the inventory; 2019 was chosen because it was the last year before COVID-19). Table 24 below shows both historical and future VMT for the paratransit fleet.

Table 24 VTA Paratransit Activity Historical Data and Projections (VMT per year)

Vehicle Category	FY 2009	FY 2021	FY 2030	FY 2035	FY 2040	FY 2045	FY 2050
LDA	3,678,018	0	0	0	0	0	0
LDT2	4,392,906	0	0	0	0	0	0
LDT1	838,722	1,678,020	2,704,473	2,798,720	2,892,966	2,987,213	3,081,460
LHDT2	505,539	1,039,106	1,664,278	1,722,276	1,780,273	1,838,271	1,896,268

Notes: All vehicles assumed to be gasoline powered. LDA = Passenger Cars; LDT2 = Light-Duty Trucks (Gross Vehicle Weight <= 6,000 lbs and Equivalent Test Weight between 3,751 and 5,750 lbs); LDT1 = Light-Duty Trucks (Gross Vehicle Weight <= 6000 lbs and Equivalent Test Weight <=3,750 lbs); LHDT2 = Light Heavy Duty Trucks with a gross vehicle weight between 10,001 and 14,000 lbs; VMT = vehicles miles travelled.; FY = fiscal year

Source: Ascent Environmental in 2023.

Emissions Factors

For the forecasted paratransit vehicles, future GHG emission factors through FY 2050 were obtained from EMFAC2021. These emission factors varied by calendar year and vehicle model year. For forecasting purposes, only average vehicle model years were used. The average model years for LDT1 in the future were calculated based on historical average LDT1 vehicle age from FY 2009 to FY 2021. The average age of LDT1 paratransit vehicles was assumed to be 8 years, based on the current average of the paratransit fleet in 2023 (Tran, pers. comm., 2023). Refer to Table 25 for the forecasted paratransit emission factor by forecast year.

For the legislative adjusted forecast, all paratransit vehicles were assumed to be gasoline vehicles from through FY 2035. Depending on the final types of vehicles purchased, the paratransit fleet may be subject to CARB's proposed Advanced Clean Fleets Regulation (ACFR), which would require medium- and heavy- duty fleets to be zero emissions by 2045. However, VTA's paratransit division is requesting a five year exemption from this regulation or until battery technology and charging infrastructure is improved. As such, ACFR is not considered in the forecasts for paratransit (Tran, pers. Comm., 2023). Even so, under ACC2, 100 percent of all new light duty vehicles sold by 2035 are required to be zero emission vehicles, with 82 percent required to be ZEVs by MY 2032. Starting in FY 2040, the paratransit fleet would be newer than the 2032 model year, based on the average fleet age. Thus, from FY 2040 onward, the paratransit fleet is assumed to only operate electric vehicles. As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

These emission factors were then multiplied by the VMT shown in Table 24 to forecast emissions.

Table 25 Legislative-Adjusted Forecasted Paratransit Model Years Emission Factors

Vehicle Type	Fiscal Year	Average Model Year	Average Emissions Factors (g CO_2e/mi)
LDT1	2030	2022	295
LDT1	2035	2027	263
LDT1	2040	2032	0
LDT1	2045	2037	0
LDT1	2050	2042	0
LHDT2	2030	2022	870
LHDT2	2035	2027	848
LHDT2	2040	2032	0
LHDT2	2045	2037	0
LHDT2	2050	2042	0

Notes: Emission factors represent gasoline LDT1 and LHDT2 vehicles in Santa Clara County, as estimated in EMFAC2021. CO_2e = metric tons of carbon dioxide equivalent; g = grams; mi =miles; LDT1 = Light-Duty Trucks (Gross Vehicle Weight <= 6000 lbs and Equivalent Test Weight <=3,750 lbs); LHDT2 = Light Heavy Duty Trucks with a gross vehicle weight between 10,001 and 14,000 lbs.

Source: Ascent Environmental in 2023.

NON-REVENUE FLEET

Activity

Like paratransit, VTA's non-revenue fleet has been characterized by a variety of vehicle types, makes, models, and fuel types from light duty auto to heavy duty trucks serving a variety of functions at VTA, accounting for eight different vehicle categories. Two of these vehicle categories (heavy heavy-duty truck and medium duty vehicles, represented by the HHDT and MDV EMFAC categories) were removed from the forecast because their activity diminished between FY 2009 and FY 2021 to insignificant levels. The activity in remaining vehicle categories, except for light duty auto, were individually forecasted through FY 2050 based on historical trends in each category's respective non-revenue VMT.

Forecasts for light duty auto activity were first forecasted on a total VMT basis, using the historical trends in VTA's non-revenue light duty VMT across all fuel types. Between FY 2009 and FY 2021, total non-revenue light duty VMT increased by an average of seven percent annually. This was directly applied to all forecast years, assuming the distribution of light duty vehicle fuel types would remain the same as in FY 2021.

For the legislative-adjusted BAU forecasts, the distribution of forecasted light duty VMT across fuel types is expected to change over time in consideration of the trends toward increased ZEVs under the ACC2. Based on off-model ACC2 adjustments to CARB's EMFAC2021 model, it is anticipated that by 2050, electric VMT will account for 73 percent of light duty VMT, with the remainder from gasoline and hydrogen. The resulting assumed changes in proportions are shown in Table 26. Table 27 shows the VMT forecast assumptions by vehicle category.

Table 26 Forecasted Legislative-Adjusted Non-Revenue Light Duty Fleet Activity Proportions by Fuel Type (VMT/year)

EMFAC Vehicle Category	Fuel Type	FY 2021[1]	FY 2030[2]	FY 2035[2]	FY 2040[2]	FY 2045[2]	FY 2050[2]
LDA	Gasoline	92%	66%	40%	19%	7%	2%
LDA	Electric	1%	25%	45%	61%	70%	73%
LDA	Hydrogen	6%	9%	15%	20%	23%	24%

Notes: LDA = Light Duty Auto Passenger Cars

[1] Based on existing proportion of non-revenue light duty VMT by fuel type. This distribution is assumed to be constant for all forecast years under the BAU forecast.

[2] For gasoline and electric fuel types, changes in proportion of VMT are based on the average proportion of gasoline and electric vehicles in the countywide fleet of light duty vehicles, as expected in EMFAC 2021 and adjusted for the Advanced Clean Cars 2 rule. For hydrogen vehicles, EMFAC 2021 does not provide estimates for this fuel type, so hydrogen VMT were assumed to account for the remaining proportion (e.g., 100% - percent gasoline VMT – percent electric VMT).

Source: CARB 2021 and Ascent Environmental in 2022.

Table 27 VTA Non-Revenue Fleet Activity Projections (VMT/year)

EMFAC Vehicle Category	Fuel Type	FY 2021	FY 2030	FY 2035	FY 2040	FY 2045	FY 2050
All Forecast Scenarios							
LDT1	Gasoline	267,636	433,263	487,471	541,680	595,889	650,098
LDT2	Gasoline	238,868	197,093	173,853	150,614	127,374	104,135
LHDT1	Gasoline	185,481	239,871	247,941	256,011	264,081	272,151
LHDT1	Diesel	65,858	0	0	0	0	0
LHDT2	Gasoline	32,833	0	0	0	0	0
LHDT2	Diesel	397,833	521,959	492,757	463,556	434,355	405,154
MHDT	Gasoline	71,351	95,590	112,859	130,129	147,398	164,667
MHDT	Diesel	35,862	61,263	63,554	65,845	68,136	70,428
MDV	Gasoline	6,076	0	0	0	0	0
HHDT	Diesel	2,835	0	0	0	0	0
BAU Forecast Scenario							
LDA	Gasoline	637,300	1,169,142	1,295,143	1,421,144	1,547,147	1,673,148
LDA	Electric	9,989	18,325	20,300	22,275	24,250	26,225
LDA	Hydrogen	43,583	79,954	88,571	97,188	105,805	114,421
Legislative-Adjusted BAU Forecast Scenario							
LDA	Gasoline	637,300	840,748	555,917	290,022	125,164	44,660
LDA	Electric	9,989	316,950	634,578	938,385	1,166,387	1,330,512
LDA	Hydrogen	43,583	109,723	213,519	312,199	385,650	438,622

Duty Trucks (GVWR 10001-14000 lbs.); LHDT1 = Light-Heavy-Duty Trucks (GVWR 8501- 10000 lbs.); LHDT2 = Light-Heavy-Duty Trucks (GVWR 10001- 14000 lbs.); MHDT = Medium-Heavy Duty Public Fleet Truck (GVWR 14001-16000 lbs.); VMT = vehicle miles travelled.

Source: CARB 2021 and Ascent Environmental in 2022.

Emissions Factors

For the forecasted non-revenue fleet, future GHG emission factors through FY 2050 were obtained from EMFAC2021, which was run for Santa Clara County for the six vehicle categories shown in Table 26 above. These emission factors varied by calendar year and vehicle model year. For forecasting purposes, only average vehicle model years were used. The average model years in the future were calculated based on historical average vehicle age each vehicle category from FY 2009 to FY 2021. For the legislative-adjusted forecast, any light duty non-revenue vehicles with model years newer than 2035 were assumed to be electric. Under ACC2, 100 percent of new vehicles sold by 2035 are required to be zero emission vehicles. The assumed model years and emission factors are shown in Table 28.

These emission factors were then multiplied by the VMT shown in Table 27 to forecast emissions.

Table 28 Forecasted Non-Revenue Model Years

Vehicle Category	Fuel Type	FY 2030	FY 2035	FY 2040	FY 2045	FY 2050
Average Model Years						
LDA	Gasoline	2022	2027	2032	2037	2042
LDA	Hydrogen	2022	2027	2032	2037	2042
LDT1	Gasoline	2018	2023	2028	2033	2038
LDT2	Gasoline	2019	2024	2029	2034	2039
LHDT1	Gasoline	2018	2023	2028	2033	2038
LHDT2	Diesel	2020	2025	2030	2035	2040
MHDT	Diesel	2022	2027	2032	2037	2042
MHDT	Gasoline	2022	2027	2032	2037	2042
Legislative-Adjusted Average Emission Factors (g CO_2e/mi)[1]						
LDA	Gasoline	257	229	229	230	230
LDA	Hydrogen	0	0	0	0	0
LDT1	Gasoline	330	287	265	265	265
LDT2	Gasoline	339	290	276	276	276
LHDT1	Gasoline	867	755	756	756	756
LHDT2	Diesel	788	730	730	730	731
MHDT	Diesel	1,175	1,121	1,098	1,080	1,080
MHDT	Gasoline	1,630	1,582	1,554	1,534	1,532

Notes: Emission factors represent gasoline LDA and LDT1 vehicles in Santa Clara County, as estimated in EMFAC2021. LDA = Passenger Cars; LDT1 = Light-Duty Trucks (GVWR* <= 3750 lbs.); LDT2 = Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs.); LHDT1 = Light-Heavy-Duty Trucks (GVWR 8501- 10000 lbs.); LHDT2 = Light-Heavy-Duty Trucks (GVWR 10001- 14000 lbs.); MHDT = Medium-Heavy Duty Public Fleet Truck (GVWR 14001-16000 lbs.); CO_2e = metric tons of carbon dioxide equivalent; g = grams; mi =miles; FY = fiscal year

Source: CARB 2021 and Ascent Environmental in 2022.

BUILDING AND FACILITIES

Electricity

Activity

VTA facilities include buildings (e.g., maintenance facilities, office buildings) and transit amenities (e.g., bus stops, transit stations), which are located throughout Santa Clara County across multiple utility/CCA service areas. To forecast the future electricity use at VTA facilities, the following assumptions were made regarding the distribution of electricity use amongst utilities. Per discussions with VTA's Environmental Program staff, future distribution of electricity consumption by utility is expected to reflect FY 2021 conditions, except for consumption from PG&E. By calendar year 2021, which starts in the second half of FY 2021, VTA no longer purchased electricity from PG&E and the remainder was purchased from SJCE GreenSource. This is assumed to continue into all future years. The proportion of electricity purchases between CPAU, SVCE GreenPrime, SVCE GreenStart, SVP are assumed to remain constant, at one, six, 16, and three percent of VTA's total facility-level electricity consumption, respectively, from FY 2030 through FY 2050. The remainder are assumed to be purchased from SJCE GreenSource, at 74 percent of total future electricity consumption. The resulting forecasted trends in electricity use by utility are shown in Table 29.

Table 29 Historical and Forecasted Distribution of Electricity Consumption by Utility

Fiscal Year	PG&E	CPAU	SJCE GreenSource	SVCE GreenPrime	SVCE GreenStart	SVP
2009	98.46%	0.65%	0.00%	0.00%	0.00%	0.89%
2010	98.48%	0.58%	0.00%	0.00%	0.00%	0.94%
2011	98.37%	0.62%	0.00%	0.00%	0.00%	1.01%
2012	98.69%	0.35%	0.00%	0.00%	0.00%	0.96%
2013	98.69%	0.27%	0.00%	0.00%	0.00%	1.05%
2014	98.67%	0.22%	0.00%	0.00%	0.00%	1.11%
2015	98.25%	0.37%	0.00%	0.00%	0.00%	1.38%
2016	98.19%	0.40%	0.00%	0.00%	0.00%	1.41%
2017	96.65%	0.45%	0.00%	1.57%	0.00%	1.33%
2018	86.56%	0.40%	0.00%	6.55%	5.02%	1.47%
2019	61.93%	0.41%	14.16%	6.31%	15.77%	1.43%
2020	25.76%	3.23%	43.40%	6.05%	15.67%	5.89%
2021	15.40%	0.45%	60.31%	6.37%	15.79%	1.69%
Forecasted Distribution						
2030	0%	1%	74%	6.0%	16.0%	3%
2035	0%	1%	74%	6.0%	16.0%	3%
2040	0%	1%	74%	6.0%	16.0%	3%
2045	0%	1%	74%	6.0%	16.0%	3%
2050	0%	1%	74%	6.0%	16.0%	3%

Notes: PG&E = Pacific Gas and Electric; CPAU = City of Palo Alto Utilities; SJCE = San Jose Clean Energy; SVCE = Silicon Valley Clean Energy; SVP = Silicon Valley Power.

Source: Ascent Environmental in 2022.

The distribution of utilities shown in Table 29 were applied to the overall forecast in total facility electricity use at VTA facilities. That is, VTA's historical total facility electricity use from FY 2009 to FY2021 was extrapolated to the future milestone years (FY 2030 through FY 2050), then the forecasted total usage was broken down to each utility based on usage trends across utilities from FY 2009, as shown in the first part of Table 29. Details on future facility expansions or construction (e.g., new building square footage, construction timelines) were not readily available. As such, the historical trend in agency-wide electricity use was used to extrapolate future electricity demand. Between FY 2009 and FY 2021, the average electricity use has increased by about 0.3 percent per year. Continuing this trend, it is anticipated that VTA's electricity use will increase from 12,422 MWh per year to 14,065 MWh per year by 2050, further shown in Table 30. Although legislative adjustments, such as new building energy efficiency standards could apply to new facilities constructed by VTA, without known concrete expansion or construction plans, it was conservatively assumed that the additional electricity usage would be used in existing facilities. Even with this conservative assumption, facility energy use is expected to make up no more than 25 percent of VTA's emissions by FY 2050, as shown in Table 20 and Figure 10.

Table 30 Forecasted VTA Electricity Use by Utility (MWh/year)

Fiscal Year	PG&E	CPAU	SJCE GreenSource	SVCE GreenPrime	SVCE GreenStart	SVP	Total
2009	84	12,695	0	0	0	115	12,893
2010	71	12,127	0	0	0	116	12,314
2011	76	12,173	0	0	0	125	12,375

Fiscal Year	PG&E	CPAU	SJCE GreenSource	SVCE GreenPrime	SVCE GreenStart	SVP	Total
2012	48	13,308	0	0	0	129	13,484
2013	33	12,196	0	0	0	129	12,358
2014	27	12,317	0	0	0	139	12,483
2015	47	12,357	0	0	0	173	12,577
2016	50	12,194	0	0	0	175	12,418
2017	54	11,712	0	190	0	161	12,118
2018	52	11,153	0	844	646	189	12,884
2019	55	8,337	1,907	849	2,123	192	13,462
2020	448	3,569	6,012	839	2,171	816	13,855
2021	56	1,913	7,492	791	1,962	209	12,422
Forecasted Distribution							
2030	0	133	9,849	799	2,129	399	13,309
2035	0	135	9,988	810	2,160	405	13,498
2040	0	137	10,128	821	2,190	411	13,687
2045	0	139	10,268	833	2,220	416	13,876
2050	0	141	10,408	844	2,250	422	14,065

Notes: MWh = megawatt-hours, CPAU = City of Palo Alto Utilities, PG&E = Pacific Gas and Electric, SJCE = San Jose Clean Energy, SVCE = Silicon Valley Clean Energy, SVP = Silicon Valley Power. GreenPrime is a 100-percent renewable option.

Source: Ascent Environmental in 2022.

Emission Factors

To calculate future electricity emissions for buildings and facilities, estimated future emissions factors were multiplied by estimated future electricity use for each utility. Future emissions factors for each utility were extrapolated from FY FY2021 data (refer to Table 31). As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

Table 31 Electricity Emission Factors (lb CO_2e/MWh)

Year	PG&E	CPAU	SJCE GreenSource	SVCE GreenPrime	SVCE GreenStart	SVP
2021	121.4	0.0	171	0.0	6.7	520.3
2030	75.9	0.0	0	0.0	4.2	325.2
2035	50.6	0.0	0	0.0	2.8	216.8
2040	25.3	0.0	0	0.0	1.4	108.4
2045	0.0	0.0	0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0

Notes: CO_2e = carbon dioxide equivalents, lb = pound, MWh = megawatt-hour, CPAU = City of Palo Alto Utilities, PG&E = Pacific Gas and Electric, SJCE = San Jose Clean Energy, SVCE = Silicon Valley Clean Energy, SVP = Silicon Valley Power. GreenPrime is a 100-percent renewable option.

Source: Ascent Environmental in 2022.

Natural Gas and Propane

Activity

In addition to electricity use, VTA facilities also consume natural gas and propane. Unlike electricity, the emission factors for natural gas and propane do not vary by source; thus, the evaluation of utilities is irrelevant to forecasting VTA natural gas and propane demand. Between FY 2032 and 2050, VTA's administrative building and four maintenance facilities are anticipated to be retrofitted, constructed, or moved to new locations to coincide with the opening of BART in Downtown San Jose and support the full transition to a ZEB fleet. However, there are currently no detailed plan information or budgetary commitments in place to support any assumptions regarding the size or scale of these buildings and facilities. Thus, the historical trend in agency-wide gas use was used to extrapolate future gas demand.

Between FY 2009 and FY 2021, the average annual natural gas and propane consumption has decreased on average by about 0.2 percent per year and 3.7 percent per year, respectively. Continuing this trend, it is anticipated that VTA's natural gas use would decrease from 166,062 therms per year by 20 percent to 134,323 therms per year by FY 2050. However, propane use is assumed to remain constant at around FY 2018 to 2021 average levels. This assumption represents recent usage levels, as there are no plans to convert the specific end uses that currently require propane (e.g., remote generators or heaters) to other fuel types. These forecasted trends in both natural gas and propane usage are shown in Table 32.

Table 32 Forecasted VTA Natural Gas and Propane Use by Utility

Fiscal Year	Natural Gas Use (therms/year)	Propane Use (gal/year)
2009	152,339	109,858
2010	167,749	107,753
2011	164,411	128,853
2012	149,909	122,674
2013	136,841	133,453
2014	130,380	113,503
2015	111,484	86,848
2016	136,820	111,727
2017	148,488	112,279
2018	141,842	79,387
2019	139,137	80,161
2020	157,827	88,716
2021	166,062	69,754
Forecasts		
2030	141,228	80,000
2035	139,502	80,000
2040	137,776	80,000
2045	136,049	80,000
2050	134,323	80,000

Notes: gal = gallons

Source: Ascent Environmental in 2022.

Emission Factors

To calculate emissions from natural gas and propane use, the same emission factors used in quantifying the inventory were used to calculate emissions from forecasted natural gas and propane use. Please refer to the 2020 VTA Sustainability Plan Technical Memorandum for the description of the original emission factors used to quantify emissions from natural gas and propane usage.

WASTE

Activity

Emissions from the waste sector are attributable to landfilled waste. Recycled and composted waste were not assumed to result in emissions, consistent with the assumptions used in quantifying the FY 2021 inventory. Absent major known changes in plans to VTA's operations, landfilled waste tonnages were forecast using historical trends. Between FY 2009 and FY 2021, VTA's landfilled waste generation declined by 0.8 percent per year on average. Extrapolating this trend into the future, VTA's landfilled waste generation would decline by 16 percent from 1,032 tons per year in FY 2021 to 863 tons per year in FY 2050. These trends and forecasts are shown in Table 33.

Table 33 Forecasted VTA Landfilled Waste Generation

Fiscal Year	Landfilled Waste Generation (tons/year)
2009	1,202
2010	1,169
2011	1,234
2012	1,211
2013	1,250
2014	1,204
2015	1,150
2016	1,235
2017	1,365
2018	1,195
2019	1,151
2020	1,058
2021	1,032
Forecasts	
2030	1,049
2035	1,002
2040	956
2045	909
2050	863

Source: Ascent Environmental in 2022.

Emission Factors

To calculate emissions from waste generation, the same emission factors used in quantifying the inventory were used to calculate emissions from forecasted waste generation. Please refer to the 2020 VTA Sustainability Plan Technical Memorandum for the description of the original emission factors used to quantify emissions from waste.

EMPLOYEE COMMUTE

Activity

Fundamentally, employee commute activity is affected by changes in employee numbers and commute behavior. According to VTA's most recent employee commute survey, conducted in November-December 2015, most (70%) employees drive alone to work. Due to VTA's work-from-home COVID-19 policies in FY 2020 and FY 2021, employee commute activity substantially declined in those years compared to years prior. Between FY 2020 and FY 2021, employee commute activity declined by 30 percent, whereas between FY 2009 and FY 2019, employee commute activity generally remained constant. According to discussions with VTA, these depressed employee commute trends have persisted in FY 2022, particularly for those working in offices. It is likely that during the pandemic, more employees that may have formerly commuted by transit or carpool drove alone when commuting to their work location. For forecasting purposes, it was assumed that employee commute would continue to remain suppressed at similar levels to FY 2020 and FY 2021 for the next few years, consistent with trends assumed in MTC's PBA FY 2050 regional VMT forecasts, and then return to pre-COVID levels by FY 2030. However, to balance the recent work-from-home trends, the anticipated return to pre-COVID levels, and potential growth in VTA employee population, it was assumed that employee commute activity would remain at a constant level, representing the FY 2009-FY 2021 average, through FY 2050. As a result, employee commute VMT was assumed to be 3,688,803 VMT per year from FY 2030 through FY 2050. The historical trends and forecasts are shown in Table 34.

Table 34 Forecasted VTA Employee Commute Activity

Fiscal Year	Employee Commute VMT
2009	3,779,745
2010	3,705,668
2011	3,588,228
2012	3,599,069
2013	3,618,943
2014	3,754,450
2015	3,658,692
2016	4,041,725
2017	3,994,750
2018	4,067,020
2019	3,980,296
2020	3,628,510
2021	2,537,340
Forecasts	
2030	3,688,803
2035	3,688,803
2040	3,688,803
2045	3,688,803
2050	3,688,803

Source: Ascent Environmental in 2022.

Emissions Factors

For the forecasted emissions from employee commute, future GHG emission factors through FY 2050 were obtained from EMFAC2021, which was run for Santa Clara County for the three vehicle categories (LDA, LDT1, and LDT2). EMFAC2021 outputs were also adjusted to account for ACC2, which accelerates future penetration of ZEVs into the overall passenger vehicle market. Apart from the use of EMFAC2021, ACC2, and querying the emission factors for future years, the remaining methodology remains the same as in the inventory. Please refer to the 2020 VTA Sustainability Plan Technical Memorandum for the description of the original methods used to quantify emission factors used for the employee commute sector. The resulting emission factors are shown in Table 35. As these emissions factors are presented by calendar year, for modeling purposes, it was assumed that the emission factors for the same years were applied to fiscal years directly (e.g., CY 2020 emission factor used for FY 2020).

Table 35 Forecasted Employee Commute Emission Factors (g CO_2e/mi)

Vehicle Category	Fuel Type	FY 2030	FY 2035	FY 2040	FY 2045	FY 2050
LDA, LDT1, LDT2 Average	Gasoline	231	158	98	63	45

Note: CO_2e = carbon dioxide equivalents, g = gram, mi = mile, LDA = Passenger Cars; LDT1 = Light-Duty Trucks (GVWR* <= 3750 lbs.); LDT2 = Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs.); FY = fiscal year

Source: Ascent Environmental in 2022.

WATER

Activity

Total water use forecasts were extrapolated linearly from historical trends in water consumption at VTA facilities. The distribution between non-potable and potable water use trends were evaluated separately. Between FY 2009 and FY 2021, VTA's overall water use has declined by 1.2 percent per year on average. At the same time, the percentage of potable water use has also decreased from 95 percent to 67 percent of total water consumption from FY 2009 to FY 2021, an average of a three percent annual reduction, while the percentage of non-potable use has also increased in proportion. These trends were applied to future total water forecasts, as shown in Table 36.

Table 36 Forecasted Water Use Activity by Source (gallons per year)

Fiscal Year	Potable	Non-Potable	Total
2009	54,321,484	2,883,910	57,205,394
2010	40,534,621	1,838,160	42,372,780
2011	36,246,886	2,337,373	38,584,259
2012	35,320,853	2,519,545	37,840,398
2013	39,695,829	3,401,841	43,097,670
2014	54,660,071	2,078,491	56,738,561
2015	48,139,825	4,737,427	52,877,252
2016	28,416,053	6,347,731	34,763,784
2017	25,534,268	7,836,806	33,371,075
2018	31,772,297	9,010,187	40,782,484
2019	32,691,249	15,691,916	48,383,165
2020	31,064,707	11,629,105	42,693,812
2021	26,347,823	12,745,214	39,093,036
Forecasts			
2030	19,339,261	16,057,032	35,396,293

Fiscal Year	Potable	Non-Potable	Total
2035	19,581,593	13,054,396	32,635,989
2040	17,925,411	11,950,274	29,875,685
2045	16,269,228	10,846,152	27,115,381
2050	14,613,046	9,742,031	24,355,076

Source: Ascent Environmental in 2022.

Emissions Factors

Emissions resulting from water use were based on water energy intensity factors assumed in the inventory and future estimated PG&E emission factors are shown in Table 31.

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ATTACHMENT 1
VMT PROCESS TECHNICAL MEMO

The following is the VMT processing technical memo prepared by MTC.

1 OD TRIP MATRIX AVAILABILITY

Since the project team decided that the VMT by speed bins are not needed, MTC recommended that we use the OD trip matrix to estimate the VMT, instead of using individual and joint residence micro trip table previously.

Through the BOX, MTC provided 20 trip matrix for each year, separated by four categories as below:

- household travel demand (main/trips@token_period@.tpp)
- external travel demand for the 9-county region (nonres/tripsIx@token_period@.tpp)
- commercial travel demand (nonres/tripsTrk@token_period@.tpp)
- air passenger travel demand (nonres/tripsAirPax@token_period@.tpp)

Specifically, the matrix for year 2050 are listed below in Figure1-1 and Figure1-2:

› Base › Year2050 › main

Name	Date modified	Type	Size
tripsAM.tpp	8/31/2022 11:35 AM	TPP File	5,906 KB
tripsEV.tpp	8/31/2022 11:34 AM	TPP File	4,629 KB
tripsMD.tpp	8/31/2022 11:34 AM	TPP File	4,729 KB
tripsPM.tpp	8/31/2022 11:24 AM	TPP File	5,631 KB
tripsEA.tpp	8/31/2022 11:22 AM	TPP File	1,687 KB

Figure 1-1 Files of Trip Matrix of Main Residence Model

› Base › Year2050 › nonres

Name	Date modified	Type	Size
tripsAirPaxAM.tpp	8/31/2022 11:39 AM	TPP File	277 KB
tripsAirPaxEA.tpp	8/31/2022 11:38 AM	TPP File	249 KB
tripsAirPaxEV.tpp	8/31/2022 11:38 AM	TPP File	284 KB
tripsAirPaxMD.tpp	8/31/2022 11:38 AM	TPP File	291 KB
tripsAirPaxPM.tpp	8/31/2022 11:38 AM	TPP File	280 KB
tripsIXAM.tpp	8/31/2022 11:39 AM	TPP File	404 KB
tripsIXEA.tpp	8/31/2022 11:39 AM	TPP File	297 KB
tripsIXEV.tpp	8/31/2022 11:39 AM	TPP File	412 KB
tripsIXMD.tpp	8/31/2022 11:39 AM	TPP File	422 KB
tripsIXPM.tpp	8/31/2022 11:39 AM	TPP File	406 KB
tripstrkAM.tpp	8/31/2022 11:37 AM	TPP File	4,516 KB
tripstrkEA.tpp	8/31/2022 11:37 AM	TPP File	4,289 KB
tripstrkEV.tpp	8/31/2022 11:37 AM	TPP File	4,814 KB
tripstrkMD.tpp	8/31/2022 11:37 AM	TPP File	7,504 KB
tripstrkPM.tpp	8/31/2022 11:37 AM	TPP File	5,809 KB

Figure 1-2 Files of Trip Matrix of Non-residence Modes

2 SKIM MATRIX AVAILABILITY

Also, MTC provided 5 files of skims matrix for each TOD (time of day), for each year. The skims files for year 2050 are listed below.

› Base › Year2050 › skims

Name	Date modified	Type	Size
HWYSKMAM.tpp	9/12/2022 2:18 PM	TPP File	74,262 KB
HWYSKMEA.tpp	9/12/2022 2:17 PM	TPP File	74,099 KB
HWYSKMEV.tpp	9/12/2022 2:18 PM	TPP File	74,217 KB
HWYSKMMD.tpp	9/12/2022 2:17 PM	TPP File	74,640 KB
HWYSKMPM.tpp	9/12/2022 2:17 PM	TPP File	74,637 KB

Specifically, each skim file contains 21 tables that include distances, times, tolls and others by mode. Of the 21 tables, six tables are distance related, which are used to calculate the VMT by mode. They are listed below.

skim_table_num	skim_table_name
2	DISTDA
5	TOLLDISTDA
9	DISTS2
12	TOLLDISTS2
16	DISTS3
19	TOLLDISTS3

Figure 2-1 List of Tables of Distance Skims

3 CLARIFICATION ON TRIP MATRIX: PERSON TRIPS VS VEHICLE TRIPS

As MTC instructed, of all OD trip matrix tables, only the main model provides person trips, while the rest of model presents vehicle trips. See the details below.

- household travel demand (main/trips@token_period@.tpp): **person** trips
- external travel demand (nonres/tripsIx@token_period@.tpp): **vehicle** trips
- commercial travel demand (nonres/tripsTrk@token_period@.tpp): **vehicle** trips
- air passenger travel demand (nonres/tripsAirPax@token_period@.tpp)L: **vehicle** trips

4 MAIN MODEL – MODES OF TRIPS, MATCHED SKIMS, AND OCCUPANCY ASSUMPTION

The modes availability in each OD trip matrix varies depending on the type of model, and different skims are matched accordingly. The details are listed in Figure 4-1 below.

The main model is the only one displaying in person trips, which needs to be converted into vehicle trips before multiplying with skims. The Occupancy assumption are listed in the same figure. Specifically, the 3.25 persons/vehicle for sr3 and s3_av is suggested by MTC. The 3.83 persons/vehicle for s3_tnc is the weighted average from MTC Model Calibration and Validation Report.

Moreover, through discussions with MTC, please note the important clarifications:

- The DA, SR2, SR3 modes (modes 1-6) in the trip tables are trips made in human-driven vehicles.
- The "AV modes" refer to household owned AVs.
- Trips included in the TNC modes are mutually exclusive from those counted in the household-owned AV modes.

With this clarification, we can simply sum up VMT of each mode in the main model and are sure we're not double-counting trips/VMT.

In addition, as MTC suggested, we applied the TOLLDISTS2 skim for 'da_tnc' mode due to considering the additional TNC driver in the vehicle; similarly, we applied the TOLLDISTS3 skim for s2_tnc and s3_tnc due to considering the TNC driver in the vehicle.

table_number	mode_name	skims_matched	Occupancy(person/vehicle)
1	da	DISTDA	1
2	datoll	TOLLDISTDA	1
3	sr2	DISTS2	2
4	sr2toll	TOLLDISTS2	2
5	sr3	DISTS3	3.25
6	sr3toll	TOLLDISTS3	3.25
7	walk	not used	
8	bike	not used	
9	walk_loc_walk	not used	
10	walk_lrf_walk	not used	
11	walk_exp_walk	not used	
12	walk_hvy_walk	not used	
13	walk_com_walk	not used	
14	drv_loc_walk	not used	
15	drv_lrf_walk	not used	
16	drv_exp_walk	not used	
17	drv_hvy_walk	not used	
18	drv_com_walk	not used	
19	walk_loc_drv	not used	
20	walk_lrf_drv	not used	
21	walk_exp_drv	not used	
22	walk_hvy_drv	not used	
23	walk_com_drv	not used	
24	da_tnc	TOLLDISTS2	1
25	s2_tnc	TOLLDISTS3	2
26	s3_tnc	TOLLDISTS3	3.83
27	da_av	DISTDA	1
28	s2_av	DISTS2	2
29	s3_av	DISTS3	3.25

Figure 4-1 List of Trip Modes, Skims, and Occupancy of Main Model

5 AIRPORT MODEL: MODES OF TRIPS AND MATCHED SKIMS

In the airport model, there are only six modes available. The trip modes and the matched skims are displayed in Figure5-1.

Please note that mode choice of air passengers is conducted in the air passenger model separately, which is different from the mode choice in the main model. In another words, TM 1.5 does not assume any usage of TNC or household AVs for airport passengers.

table_number	mode_name	skims_matched
1	da	DISTDA
2	sr2	DISTS2
3	sr3	DISTS3
4	datoll	TOLLDISTDA
5	sr2toll	TOLLDISTS2
6	sr3toll	TOLLDISTS3

Figure 5-1 List of Trip Modes and Skims Matched for Airport Model

6 EXTERNAL MODEL: MODES OF TRIPS AND MATCHED SKIMS

In the external model, there are only six modes available. The trip modes and the matched skims are displayed in Figure 6-1.

table_number	mode_name	skims_matched
1	da	DISTDA
2	sr2	DISTS2
3	sr3	DISTS3
4	datoll	TOLLDISTDA
5	sr2toll	TOLLDISTS2
6	sr3toll	TOLLDISTS3

Figure 6-1 List of Trip Modes and Skims Matched for External Model

7 COMMERCIAL MODEL: MODES OF TRIPS AND MATCHED SKIMS

In truck model, there are eight modes available. The trip modes and the matched skims are displayed in Figure 7-1.

tab_number	tab_name	notes	skimsUsed
1	vsTruck	verySmallTruck	DISTDA
2	sTruck	smallTruck	DISTDA
3	mTruck	mediumTruck	DISTDA
4	cTruck	CombinedTruck	DISTDA
5	vsTollTruck	verySmallTruckToll	TOLLDISTDA
6	sTollTruck	smallTruckToll	TOLLDISTDA
7	mTollTruck	mediumTruckToll	TOLLDISTDA
8	cTollTruck	CombinedTruckToll	TOLLDISTDA

Figure 7-1 List of Trip Modes and Skims Matched for Commercial Model

8 TRIP-BASED VMT VS. LINK-BASED VMT

The link-based VMT is not required by the project. However, we still calculated it for purpose to verify with the trip-based result.

As displayed in figure 8-1 below, at the whole regional level, the total of trip-based VMT is close to the link-based VMT within 3% range.

Year	linkBasedVmt	tripBasedVmt	gaps
2015	140,389,348	142,469,457	1.5%
2035	156,470,654	159,904,897	2.2%
2050	173,949,337	179,380,232	3.1%

Figure 8-1 Compare trip-based VMT with link-based VMT, at regional level

ATTACHMENT 2
COMMUNITYWIDE TRANSPORTATION CALCULATIONS

This attachment will be provided online.

Appendix C

Greenhouse Gas Reduction Measures Analysis

Memo

455 Capitol Mall, Suite 300
Sacramento, CA 95814
916.444.7301

Date: August 2023

To: Lani Lee Ho, Santa Clara Valley Transportation Authority

From: Erik de Kok, John Steponick, and Honey Walters

Subject: VTA CAAP – Revised Final Greenhouse Gas Reduction Memorandum

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1 INTRODUCTION

This technical memorandum (Memo) was prepared for the forthcoming Santa Clara Valley Transportation Authority (VTA) Climate Action and Adaptation Plan (CAAP). The goals of the CAAP are as follows: (1) to minimize VTA's contributions to climate change by reducing greenhouse gas (GHG) emissions; and (2) to build adaptive capacity and resilience to climate impacts. The purpose of this Memo is related to the first goal. A separate memo will be prepared to address the second goal.

This Memo outlines a series of draft GHG reduction strategies, along with more detailed measures and specific implementing actions under each measure, that were developed for VTA's consideration. These strategies are intended to reduce countywide GHG emissions from both the countywide surface transportation system and from VTA's own operations.

The main sections of this Memo, following this introductory section, include:

- Section 2, Methodology, describes the methods used and overall framework for developing and analyzing potential GHG reduction strategies, measures, and implementing actions, including the creation of prioritization criteria.
- Section 3, Analysis of Draft GHG Reduction Strategies, Measures, and Implementing Actions, includes a detailed description of all strategies, measures, and implementing actions, along with discussion of results from analyzing and scoring the proposed measures.
- Section 4, Quantitative GHG Analysis, includes a description of GHG quantification results from the subset of GHG reduction measures that were determined to be quantifiable, and an analysis of how the estimated GHG reductions compare to VTA's GHG emissions inventory, forecasts, and adopted targets for reducing GHG emissions in VTA's Sustainability Plan 2020.
- Section 5, Recommendations, includes recommendations for which measures should be prioritized for inclusion in the CAAP, and which should be removed from further consideration.

2 METHODOLOGY

Ascent developed a framework for identifying, analyzing, and prioritizing potential GHG reduction strategies. The framework is described in more detail below under Section 2.1.

Section 2.2 outlines the multi-step process used to refine preliminary GHG reduction strategies, including criteria that were used to evaluate and inform prioritization of the draft strategies. The steps described in Section 2.2 represent an iterative process whereby strategies were vetted and refined in collaboration with VTA staff.

2.1 GHG REDUCTION FRAMEWORK

The structure and approach for identifying actionable strategies that can be included in the CAAP is based on a framework that consists of a series of nested categories including **focus areas, strategies, measures, and implementing actions**. Each of these are defined and explained below.

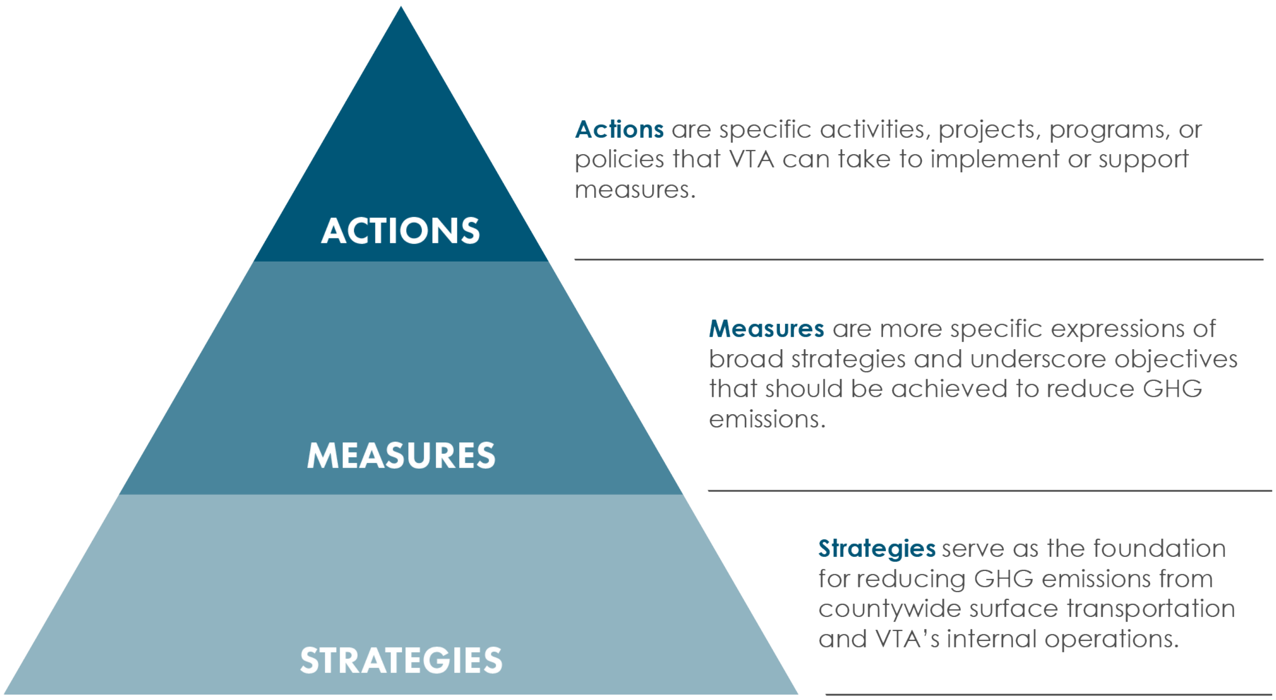
Focus Areas

Mitigating climate change means reducing the amount of GHGs in the atmosphere. The major sources of GHG emissions, according to VTA's updated GHG emissions inventory, are passenger trips, buildings, fleet operations, and decomposition of waste. Taking this into consideration, Ascent first identified four broad **focus areas** that represent the major sectors where GHG reduction potential would be the greatest. The focus areas are the broadest category in the framework and are defined as follows:

- **Transportation and Land Use:** This focus area addresses the Countywide Transportation section of the updated GHG emissions inventory and forecast. While Countywide Transportation refers to GHG emissions generated by the transportation system countywide, these corresponding strategies, measures, and implementing actions primarily address the reduction of vehicle trips and vehicle miles traveled (VMT) on the roadway network and associated GHG reductions, with some emphasis also on supporting the transition to zero-emission vehicles by countywide transportation system users.
- **Building and Facilities:** This focus area addresses the Buildings and Facilities sector of the VTA Transit Operations section of the updated GHG emissions inventory and forecast. This focus area addresses emissions from energy used in all buildings and other energy-consuming facilities in VTA's internal operations, and its strategies and measures are focused on energy efficiency, energy conservation, renewable energy, and decarbonization.
- **Fleet and Employee Commute:** This focus area addresses both the Revenue and Non-Revenue Fleet sector and the Employee Commute sector of the VTA Transit Operations section of the GHG emissions inventory and forecast. This focus area addresses emissions from revenue-generated vehicles (e.g., VTA buses), non-revenue vehicles (e.g., VTA-owned cars or trucks operated by VTA employees on the job), and private vehicles operated by VTA employees in their commute to/from their workplace, through a combination of zero-emission vehicle and transportation demand management strategies.
- **Materials and Waste:** This focus area addresses the Waste sector of the section of the updated GHG emissions inventory and forecast. This focus area addresses emissions from all waste generated by VTA operations through a combination of waste management, reduction, and recycling measures.

GHG Reduction Strategies, Measures, and Implementing Actions

Strategies under each focus area serve as the foundation for reducing GHG emissions—they are purposefully broad and overarching and tend to be expressions of goals or desired outcomes. Each strategy contains a series of **measures**, which are more specific and tactical areas of action that include commitments and more specific and measurable objectives that can be achieved to reduce GHG emissions. Lastly, **implementing actions** are the specific activities, projects, programs, or other steps that VTA can enact to implement the measures and achieve the objectives described under each measure. Some measures can be quantified in terms of their GHG reduction potential, depending on the level of detail included in each measure and associated implementing actions. The hierarchy of strategies, measures, and implementing actions serves as VTA's framework for reducing GHG emissions and is visualized in **Figure 1** below.



Source: Ascent 2023.

Figure 1 Hierarchy of Strategies, Measures, and Implementing Actions

2.2 STRATEGY AND PRIORITIZATION CRITERIA DEVELOPMENT

Preliminary Draft Strategies and Measures

To help inform the strategy development process, Ascent and VTA staff first reviewed background information and materials, including existing local, regional, and statewide plans, and other documents that address GHG reduction strategies or related policies. Upon completing this review and following completion of the GHG emissions inventory updates and forecast (see memo to VTA dated February 27, 2023: "GHG Emissions Inventory and Forecast for Countywide Transportation and VTA Transit Operations"), a preliminary set of 51 GHG reduction measures were developed and included into an Excel-based matrix known as the "GHG Reduction Workbook."

The GHG Reduction Workbook was organized into four separate worksheets which align with the four focus areas identified in Section 2.1. After obtaining VTA staff feedback on the first preliminary draft GHG Workbook, a second preliminary draft of the GHG Reduction Workbook was prepared to incorporate VTA staff feedback by revising, consolidating, removing, or adding strategies and measures. Additionally, specific implementing actions were also drafted and added to the second preliminary draft GHG Reduction Workbook under each measure. Further revisions were made in response to additional VTA comments, and the draft strategies, measures, and implementing actions, are analyzed and discussed in detail in Section 3 of this memo.

Prioritization Criteria

Prioritization criteria were developed to inform staff of the relative potential for each measure to contribute to achieving GHG emission reduction goals, as well as other consideration including cost effectiveness, degree of jurisdictional control, implementation timing, and co-benefits related to environmental, equity, public health, quality of life, and engagement goals.

The full set of prioritization criteria are presented and defined in detail below in Table 1. Further details on scoring results for all measures relative to the prioritization criteria and rationale for the scoring results can be found in Section 3. Abbreviated scoring results are also included in the attached GHG Reduction Workbook in Excel format.

Table 1 Prioritization Criteria and Scoring Rubric

Prioritization Criteria	Description	Scoring Rubric
GHG Reduction Potential	GHG Reduction Potential represents a qualitative assessment of the potential scale of GHG emissions that will be reduced or avoided if a measure is implemented. This is determined based on the scale of applicable GHG emissions in the updated inventory and forecast relative to scale of reductions that would typically be achieved by the measure as defined. Where applicable, the relative scale of GHG Mitigation Potential may be informed by the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*, published by the California Air Pollution Control Officers Association (CAPCOA, 2021) and the memo to VTA dated February 27, 2023: "GHG Emissions Inventory and Forecast for Countywide Transportation and VTA Transit Operations." Note that only some of the GHG reduction measures have been quantified, and quantification details are reported in more detail under Section 4 of this memo where applicable, along with a summary of methods and assumptions used to quantify GHG reductions.	▸ Low = The measure has a low (between 0%-2%) GHG reduction potential. ▸ Medium = The measure has a medium (between 3%-5%) GHG reduction potential. ▸ High = The measure has a high (over 5%) GHG reduction potential.
Cost Effectiveness	Cost Effectiveness represents a broad qualitative assessment of the potential costs to implement a measure relative to GHG reduction potential. Full quantitative estimates of implementation costs are not included in the scope of this analysis, but rather order-of-magnitude conceptual costs relative to GHG reduction potentials are qualitatively described.	▸ Low (Costs Outweigh Benefits) = Conceptual implementation costs are high relative to GHG reduction potential. ▸ Medium (Benefits Match Costs) = Conceptual implementation costs are moderate relative to GHG reduction potential. ▸ High (Benefits Outweigh Costs) = Conceptual implementation costs are low relative to GHG reduction potential.

Prioritization Criteria	Description	Scoring Rubric
Jurisdictional Control	Jurisdictional Control represents the degree of control that VTA has in ensuring specific implementing actions are taken such that the GHG reduction measure can be fully achieved. VTA's jurisdictional control varies, depending on the focus area and associated GHG emissions sectors addressed as well as the unique characteristics of each measure and its associated implementing actions.	▸ Low = VTA is the "influencer" – This means VTA does not have any direct control over measure implementation, but VTA may have the ability to partner, coordinate with, or influence actions of others. ▸ Medium = VTA is the "regulator" or "initiator" – This means that VTA may have some degree of jurisdictional control, either directly or indirectly, but is not solely responsible for taking all actions required to achieve the full potential of the measure. For example, VTA may act as a regulator or initiator for some measures and their implementing actions, but the broader community or other agencies may also need to respond with some degree of action. ▸ High = VTA is the "actor" – This means that VTA has sole authority and full jurisdictional control over the measure and is likely to be the sole actor. This primarily applies to strategies and measures focused on VTA's internal operations (e.g., buildings and facilities, revenue, and non-revenue fleet).
Implementation Timeframe	For each measure, the Implementation Timeframe is conceptually estimated in terms of how long it will take to fully implement the measure and achieve GHG reductions. The Implementation Timeframe considers various assumptions either implicit in the measure itself as defined, or as outlined in the implementing actions such as the status of technology availability, whether or not a study/program/policy needs to be created or updated, or funding and staffing needs.	▸ Long-Term (6+ Years) = Measure could be operational after 6+ years. ▸ Mid-Term (3-5 Years) = Measure could be operational in the next 3 to 5 years. ▸ Near-Term (1-2 Years) = Measure could be operational in the next 1 to 2 years.
Co-Benefits	Each measure was assessed for its potential to result in positive outcomes for the following co-benefit categories, using a simple "Yes/No" score: Environmental Quality, Racial and Social Equity, Public Health, Quality of Life, and Community Engagement. See the GHG Reduction Workbook for co-benefit scoring results.	Each measure was assessed for its potential to result in positive outcomes for the following co-benefit categories, using a simple "Yes/No" score: Environmental Quality, Racial and Social Equity, Public Health, Quality of Life, and Community Engagement. See the GHG Reduction Workbook for co-benefit scoring results.

Source: Ascent 2023.

3 ANALYSIS OF DRAFT GHG REDUCTION STRATEGIES, MEASURES, AND IMPLEMENTING ACTIONS

The draft GHG reduction strategies, measures, and implementing actions, along with results of the qualitative analysis of the GHG reduction potential and other criteria outlined in Section 2, are presented in this section. The results of the quantitative GHG reduction analysis for certain measures are discussed in further detail under Section 4 (Quantitative GHG Analysis). The GHG Reduction Workbook in Excel format, which includes all draft strategies and measure and prioritization scoring results, is attached separately.

A summary of all 39 draft GHG reduction strategies and measures is shown in Table 2 below, organized according to the four focus areas previously described (i.e., Transportation and Land Use, Buildings and Facilities, Fleet and

Employee Commute, Materials and Waste). Each of the four focus areas, along with their respective strategies, measures, and implementing actions, are discussed in further detail in **Sections 3.1 through 3.4**, including analysis results of each measure using the prioritization criteria defined in **Table 1**.

The prioritization criteria scoring results in Section 3.1 through 3.4 also include rationale statements that explains why specific scores were assigned across most of the criteria. Please note, however, that this memo does not include a detailed measure-by-measure series of rationale statements for each of the co-benefit categories. Co-benefit scoring can be found in the separate GHG Reduction Workbook file attached to this memo in Excel format, which allows for a quick visual scan of potential co-benefits achieved. Many measures were determined to achieve multiple co-benefits across most of the co-benefit categories, given the primary focus of all measures on improving the sustainability and overall performance of both countywide transportation and VTA operations.

Table 2 GHG Reduction Strategies and Measures Summary

Focus Area	Strategy	Measure
Transportation and Land Use (TL)	TL-1: Sustainable Roadway Networks and Pricing	TL-1.1: Assist VTA member agencies in implementing SB 743 and mitigating VMT from new land development projects and transportation projects.
		TL-1.2: Continue to build out the countywide Express Lane network to use roadway pricing as a tool to provide reliable travel options and generate a revenue stream for projects that improve the operations of HOV lanes and transit.
		TL-1.3: Maximize the efficacy and performance of HOV lanes by converting to HOT lanes and using occupancy requirements, improved enforcement, and establish an infrastructure that will increase the ability to create dedicated lanes for transit and emerging technologies.
	TL-2: Safe and Accessible Active Transportation for All	TL-2.1: Increase bicycle and pedestrian infrastructure and improve the safety of existing facilities, prioritizing investments in disadvantaged communities.
		TL-2.2: Encourage and support efforts to plan and build walkable and bikeable communities, accessible to people of all income levels and races.
		TL-2.3: Support local, county, state, and federal efforts to promote use of electric bicycles as an alternative to driving.
		TL-2.4: Support education and encouragement programs that promote replacing polluting travel with low-emission travel.
	TL-3: Fast, Frequent, and Reliable Public Transportation for All	TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.
		TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.
	TL-4: Sustainable Land Use, Planning, and Development	TL-4.1: Collaborate with member agencies in advanced planning efforts to increase residential and employment densities and expand mixed-use development potential near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).
		TL-4.2: Increase development around transit stations and along transit corridors to facilitate multi-modal, carbon-neutral neighborhoods that are sustainable and resilient.
		TL-4.3: Strategically repurpose underutilized parking lots or other vacant lots at or near VTA transit stations and major transit stops into lively mixed-use, transit-oriented communities with activated ground floor uses that increase transit ridership, help provide revenue for transit capital investments and operations, and reduce VMT.
		TL-4.4: Provide people of all generations and backgrounds with affordable housing and access to the necessities of daily life available within a short walk, bicycle ride, or transit trip.

Focus Area	Strategy	Measure
		TL-4.5: Work with member agencies and other partners to focus development where it already exists (i.e., promote infill development) and reduce the impact of development and transportation infrastructure on the environment by protecting open space, conserving and restoring habitat, enhancing biodiversity, increasing carbon sequestration, and improving wildlife connectivity.
	TL-5: Smart Parking and Curbside Management	TL-5.1: Support local efforts to reduce or eliminate minimum parking standards and institute parking maximums, require "unbundling" of parking costs from commercial leasing or residential rental rates, support shared parking, and introduce demand-based parking pricing in public on- and off-street parking facilities.
		TL-5.2: Provide EV charging infrastructure at VTA parking facilities open to the public.
	TL-6: Smart Mobility and Transportation Demand Management (TDM)	TL-6.1: Increase participation in smart commute and mobility options throughout the county including bicycle sharing, ridesharing, car-sharing, mobility-as-a-service, guaranteed ride home programs, carpools, vanpools, and other emerging options.
		TL-6.2: Channel the deployment of autonomous vehicles, ride-hailing services, and other new mobility options toward high passenger-occupancy and low VMT-impact service models that complement transit.
		TL-6.3: Expand TDM programs and services in partnership with member agencies, employers, schools, and residential communities.
Buildings and Facilities (BF)	BF-1: Clean and Renewable Energy	BF-1.1: Decarbonize existing VTA buildings by phasing out fossil fuel usage and electrifying water heating and space heating or using renewable fuels such as renewable natural gas (RNG) where appropriate.
		BF-1.2: Increase renewable energy, battery storage, and microgrid installations in existing VTA buildings, and/or procure 100% renewable options through local community choice energy (CCE) providers, where applicable.
		BF-1.3: Require all new VTA buildings to be 100% electric and include on-site renewable energy systems with battery storage and microgrids and achieve net-zero standards where feasible.
		BF-1.4: Increase use of electricity and alternative fuels in construction equipment on VTA projects.
	BF-2: Energy Efficiency and Reliability	BF-2.1: Upgrade outdoor lighting at VTA buildings, and at park-and-ride lots and stations, to LEDs or other high-efficiency lighting.
		BF-2.2: Reduce energy use in VTA buildings through conservation best practices consistent with LEED®, ENERGY STAR®, or other standards.
		BF-2.3: Update VTA's building and construction policies, specifications, and practices to increase energy efficiency, and complete energy audits of existing buildings.
		BF-2.4: Consider installing microgrids with battery storage to power critical assets during power outages and provide ancillary services to the grid.
Fleet and Employee Commute (FE)	FE-1: Zero-Emission Vehicles	FE-1.1: Accelerate zero-emission bus (ZEB) and paratransit zero-emission vehicles (ZEV) replacements to ramp up and reduce GHG emissions faster, relative to existing regulations and expected phase-out timelines.
		FE-1.2: Replace VTA diesel trucks and other non-revenue VTA vehicles with ZEVs.
		FE-1.3: Expand electric vehicle (EV) and electric bicycle charging infrastructure at VTA buildings to support VTA fleet EVs and employee bicycles.

Focus Area	Strategy	Measure
	FE-2: Zero-Emission Equipment	FE-2.1: Use cleaner fuel, such as renewable diesel, for off-road equipment and construction equipment where feasible.
		FE-2.2: Require ZEV or low-emission vehicle (LEV) equipment in VTA projects.
	FE-3: Operational Efficiency	FE-3.1: Maximize the operational efficiency of VTA vehicles, including reducing vehicle idling.
	FE-4: Employee Commute	FE-4.1: Monitor employee commute patterns to understand employee behaviors, needs, and overall contributions to VTA's operational GHG inventory.
		FE-4.2: Encourage and enable VTA employees to use transit, carpool, bike, and telecommute to work to reduce single-occupancy vehicle commute trips and VMT.
Materials and Waste (MW)	MW-1: Waste Management, Reduction, and Recycling	MW-1.1: Require procurement and operational practices that avoid generation of waste (e.g., reusable materials, reduced packaging, and compostable products).
		MW-1.2: Increase recycling and organic waste diversion at all facilities.
		MW-1.3: Require food waste composting and composting of biomass generated from landscape maintenance.
		MW-1.4: Reduce the generation of construction and demolition (C&D) waste in VTA projects, and increase sustainable materials use and recovery.

Source: Ascent 2023.

3.1 TRANSPORTATION AND LAND USE (TL)

The Transportation and Land Use (TL) focus area provides VTA a significant opportunity to reduce GHG emissions associated with the countywide transportation system. The strategies, measures, and implementing actions under this focus area address the overall efficiency of the transportation system itself, the behaviors and potential choices made by those who use it, as well as current and future land use plans, land development projects, and community design approaches in both cities and unincorporated county areas that relate to transportation activity.

Reducing vehicle miles traveled (VMT) is a key objective and metric associated with TL focus area strategies and measures. As noted in VTA's updated GHG emissions inventory and forecast, countywide VMT is projected to increase over time unless specific actions are taken. While accelerating the transition to zero-emission vehicles in light duty vehicles and supporting infrastructure are critically important policies, focusing on ZEVs alone is not enough to solve the climate crisis. As noted in the California Air Resources Board (CARB) 2022 Scoping Plan, per capita VMT must be reduced statewide by 25 percent by 2030 and 30 percent by 2045. CARB notes that "approximately 30 percent of light duty vehicles on the road in 2045 will still burn fossil fuels even with all new car sales being ZEVs by 2035" (2022: 4). Thus, countywide VMT reductions are essential to achieving both local and statewide GHG reduction goals.

Avoiding or reducing vehicle trips and VMT is also essential to reducing harmful air pollution generated from fossil fuel combustion and braking and tire wear across all vehicle types, which impacts public health. Reducing vehicle trips and VMT by expanding transportation choices and more sustainable land use patterns also helps to reduce automobile dependency and long commutes associated with urban sprawl and improves overall quality of life.

Finally, investing in a sustainable transportation system and promoting sustainable land use patterns and development decisions also help to advance housing and climate equity, as critically needed affordable housing and supporting transit and infrastructure will meet the needs of vulnerable and historically marginalized members of the community.

Strategy TL-1: Sustainable Roadway Networks and Pricing

Measures under this strategy are focused on improving the sustainability and efficiency of the existing roadway network through pricing, mitigation of transportation impacts from land use projects, and monitoring and enforcement mechanisms. Some of the measures under this strategy are also closely related and/or may depend on or support implementation of measures under other strategies in the TL focus area, and those relationships are noted where applicable.

Measure TL-1.1: Assist VTA member agencies in implementing SB 743 and mitigating VMT from new land development projects and transportation projects.

Senate Bill (SB) 743 required that all transportation impact analysis for projects that are subject to environmental review under the California Environmental Quality Act (CEQA) use VMT as the metric for assessing transportation impacts and mitigation, effective July 1, 2020. VTA is already assessing VMT impacts during review of VTA's proposed projects that require environmental review under CEQA, and as a countywide transportation agency VTA has been supporting efforts to implement SB 743 associated with land use and land development projects by its member agencies (i.e., 15 cities and the County of Santa Clara). However, VTA can extend these efforts, especially in developing opportunities for countywide or regional VMT mitigation approaches. VTA recently began the "Equitable VMT Mitigation Program for Santa Clara County" study funded by Caltrans that will evaluate the feasibility of a countywide VMT exchange, VMT mitigation bank, or similar program that works across jurisdictional boundaries and enhances equity. The study is expected to be completed in late 2024. Based on the results of the study, VTA will evaluate and determine the best approach to implementing such a potential program, in coordination with its member agencies.

Implementing Actions

- Evaluate the feasibility of a countywide VMT exchange, VMT mitigation bank, or similar program that helps mitigate transportation impacts from land use projects in a way that reduces VMT and GHG emissions, works across jurisdictional boundaries, and enhances equity.
- If determined to be feasible, work with VTA's member agencies to implement a countywide VMT mitigation program.

Table 3 Measure TL-1.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure are not quantifiable at this time as no specific program has been proposed and will require the completion of a feasibility study. However, the GHG reduction potential is estimated to be medium because mitigation requirements for new development would ensure that VMT-reducing measures are implemented, leading to associated reductions in GHG emissions.
Cost Effectiveness	Medium	A countywide VMT exchange, VMT mitigation bank, or similar program could help to reduce the overall costs of VMT mitigation (and associated GHG reductions) by scaling up and/or aggregating VMT reductions and providing a framework for cost-sharing. For more information, see "Implementing SB 743: Design Considerations for Vehicle Miles Traveled Mitigation Bank and Exchange Programs," UC Berkeley, August 2022 (Implementing-SB-743-August-2022.pdf (berkeley.edu)) .
Jurisdictional Control	Medium	VTA is leading the feasibility study and would have significant influence over implementation of this measure if a countywide program is determined to be feasible. However ultimately CEQA review and any associated mitigation requirements and enforcement are within the jurisdiction of the lead agency with authority to approve or carry out a specific project, and development of a countywide program would require buy-in from all or many of VTA's member agencies.
Implementation Timeframe	Mid-Term	Completion of the feasibility study is targeted for late 2024. The timing for potential development and launch of a program is currently unknown because the feasibility study has not been completed yet.

Source: Ascent 2023.

Measure TL-1.2: Continue to build out the countywide Express Lane network to use roadway pricing as a tool to provide reliable travel options and generate a revenue stream for projects that improve the operations of HOV lanes and transit.

VTA is already using dynamic roadway pricing on existing Express Lanes to manage demand, as it helps to regulate the number of users in specific lanes on certain freeway segments. While dynamic pricing helps to improve travel reliability, it can also encourage more carpooling and transit ridership. Expanding the Express Lane network may also have the potential to generate additional revenue to support transit enhancements or other measures that reduce VMT and GHG emissions, and thus this measure could be "bundled" with other measures under other strategies.

Implementing Actions

- Develop and implement an Express Lanes Strategic Plan to explore options that will achieve VTA's goals for reducing VMT and GHG emissions while also managing travel demand and improving reliability.
- Collaborate with regional partners to explore region-wide Bay Area tolling and the future of Express Lanes and dynamic pricing in Santa Clara County relative to potential shifts in regional policy.

Table 4 Measure TL-1.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	Pricing strategies can help to both reduce Single-Occupant Vehicle demand and improve travel reliability; however potential reductions in vehicle trips or VMT are uncertain. GHG reduction potential for this measure will vary considerably depending on the timing and scale of implementation, along with how this measure is implemented in combination with other strategies and measures related to improving or expanding active transportation, transit, and other modes.
Cost Effectiveness	Medium	For similar reasons noted above under GHG Reduction Potential, cost effectiveness is difficult to assess given uncertainties about implementing actions and timing. Some costs could be incurred to expand infrastructure for dynamic pricing on express lanes, but the scale on investments relative to GHG reductions is unknown at this time.
Jurisdictional Control	Medium	VTA has jurisdictional control over dynamic pricing of authorized express lanes in Santa Clara County. New authorization is required to expand the Express Lanes program to other freeway segments. The effectiveness of this measure also depends on actions by the community and behavioral response.
Implementation Timeframe	Mid-Term	Timeframe is dependent on availability of funding. A dedicated amount of funding for the Silicon Valley Express Lanes Program or successfully securing grant funds can accelerate the delivery of the entire Express Lanes Program. Funding projects through financing will extend the implementation timeframe for the delivery of the Express Lanes network. Additional information regarding implementing actions is required.

Source: Ascent 2023.

Measure TL-1.3: Maximize the efficacy and performance of HOV lanes by converting to HOT lanes and using occupancy requirements, improved enforcement, and establish an infrastructure that will increase the ability to create dedicated lanes for transit and emerging technologies.

VTA staff noted in preliminary review of the draft measures that HOV lanes are most effective when they carry larger numbers of carpools and vanpools, as well as transit buses, to achieve increased person throughout. High functioning HOV lanes with enhanced enforcement can reduce travel times and can make transit faster/more attractive.

Implementing Actions

- Conduct a feasibility study to explore options and potential costs for improving HOV performance. Following completion of study, develop and implement recommendations.

Table 5 Measure TL-1.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low-Medium	The scale of GHG reductions is difficult to quantify at this stage. Completion of a feasibility study will identify what specific actions would need to be taken. The effectiveness of this measure may also depend on how this measure is implemented in combination with other measures that are focused on improving transit service or carpooling options.
Cost Effectiveness	Medium	For similar reasons noted above under GHG Reduction Potential, cost effectiveness is difficult to assess given uncertainties about implementation actions and timing. Costs would be incurred to adjust HOV lane operations and increase enforcement, but the specific options and their associated costs and scale on investments relative to GHG reductions is unknown at this time.
Jurisdictional Control	Medium	VTA has some degree of jurisdictional control HOV lanes and their operations and enforcement, however the effectiveness of this measure also depends on actions by the community and behavioral response.
Implementation Timeframe	Mid-Term	Completion of the feasibility study could be expected in the near term. Specific modifications to HOV lanes and enforcement pursuant to study findings could be completed mid-term.

Source: Ascent 2023.

Strategy TL-2: Safe and Accessible Active Transportation for All

VTA can work with local and regional agencies to increase or improve pedestrian and bicycling infrastructure by filling gaps, improving connectivity to transit, addressing safety issues such as improving crossings or removing other types of barriers, building new infrastructure, and upgrading existing transportation infrastructure to more comfortable, lower-stress designs. VTA can also support operational improvements to increase safety and/or reduce delay for pedestrians and bicyclists and improve maintenance of existing infrastructure. VTA can also prioritize support for bicycle and pedestrian projects that have the highest potential to result in GHG emissions reductions.

Measure TL-2.1: Increase bicycle and pedestrian infrastructure and improve the safety of existing facilities, prioritizing investments for disadvantaged communities.[1]

Implementing Actions

- Conduct a study to identify under-served areas and develop a program to prioritize active transportation investments for disadvantaged communities, in partnership with member agencies. For example, there could be opportunities to align with SB 1000 requirements to address active transportation for disadvantaged communities in environmental justice elements in local general plan updates.
- Advocate for adequate funding for bicycle and pedestrian capital projects and maintenance from existing funding sources and identify new funding streams where necessary.

Table 6 Measure TL-2.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low-Medium	Improving bicycle and pedestrian infrastructure can help to reduce vehicle trips and VMT. The scale of VMT and associated GHG reductions is dependent on the scale of improvements. Low to medium GHG reductions could be expected depending on outcomes of studies and/or local planning and capital investments. The effectiveness of this measure may also depend on how this measure is implemented in combination with other measures under the Sustainability Roadways and Pricing strategy (TL-1).
Cost Effectiveness	Medium	Costs would be incurred to expand or improve bicycle and pedestrian infrastructure, however specific improvements and their associated costs and the scale on investments relative to GHG reductions is unknown at this time.
Jurisdictional Control	Medium	VTA has some degree of jurisdictional control over local revenues. VTA can also be an influencer by working collaboratively with local cities and the County on local public works projects on roadways and rights-of-way when mutual goals present themselves. VTA also has some degree of influence when advocating for or pursuing funding from regional, state, and federal funding sources. When multi-jurisdictional projects cross member agency boundaries, VTA is well suited to lead project delivery.
Implementation Timeframe	Mid-Term	Completion of a feasibility study could be expected in the near term. Specific improvements could be completed in the near, mid-, or even long-term, depending on the scope and scale of improvements defined and study recommendations.

Source: Ascent 2023.

Measure TL-2.2: Encourage and support efforts to plan and build walkable and bikeable communities, accessible to people of all income levels and races.

Implementing Actions

- Collaborate with planners and public works officials from member agencies by participating in development project reviews, community planning, or corridor planning efforts, to ensure pedestrian/bicycle infrastructure and connectivity to transit are included in projects and area-wide plans.
- Promote and provide local support/technical assistance for using VTA's Community Design and Transportation Manual, Bicycle Technical Guidelines, and Pedestrian Access to Transit Plan.
- Support collaborative funding opportunities for shared investments between VTA and partner agencies.

[1] The term "disadvantaged communities" is defined by State law as areas that can include either of the following: (a) areas that are disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation, or (b) areas with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment (CA Health and Safety Code, Section 39711). The California Environmental Protection Agency (CalEPA) identifies these areas in further detail using the CalEnviroScreen tool. SB 535 (2012) requires that at least 25% of California Climate Investments be targeted specifically in disadvantaged communities. For more information, see https://oehha.ca.gov/calenviroscreen/sb535.

Table 7 Measure TL-2.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are difficult to quantify for this measure. VTA would be acting in a coordinating or supporting role. Potential is considered low.
Cost Effectiveness	Low	Implementing costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Low	VTA does not have jurisdiction over local planning or project approvals, however VTA can influence local planning and public works project decision-making by coordinating and collaborating with local agencies to promote effective use of VTA's guidance.
Implementation Timeframe	Variable	The timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies which spans all timeframes. The timeframe for retrofitting neighborhoods, new development construction, or public improvement construction may also vary considerably depending on the scope or scale of proposed plans or projects.

Source: Ascent 2023.

Measure TL-2.3: Support local, county, state, and federal efforts to promote the use of electric bicycles as an alternative to driving.

Implementing Actions

- Implementing actions from Measures TL-2.1 and TL-2.2 may also apply to this measure.
- Seek funding through programs such as Metropolitan Transportation Commission's (MTC's) Bike Share Capital Program and California's Active Transportation Program, among others, which support electric bicycle and bicycle sharing projects.
- Work to expand access and incentivize the use of electric bicycles and bicycle sharing in Santa Clara County by emulating current programs across the Bay Area, such as the "Richmond-San Rafael E-bike Commuter Program," collaborating with relevant partners, as needed.

Table 8 Measure TL-2.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. Reduction potential is estimated to be low as VTA would be acting in a coordinating or supporting role, and the scope and scale of electric bicycle usage is undefined at this time.
Cost Effectiveness	Medium	Implementing costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Low	VTA would act in an influencing role under this measure by supporting existing efforts.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with other agencies noted.

Source: Ascent 2023.

Measure TL-2.4: Support education and encouragement programs that promote replacing polluting travel with low-emission travel.

Implementing Actions

- Support local and countywide Safe Routes to Schools efforts by providing funding and facilitating information-sharing.
- Support local and countywide events that promote walking and biking, such as Viva CalleSJ and Bike to Wherever Days, by providing funding, cross-promoting, and facilitating information-sharing.

Table 9 Measure TL-2.4 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. Reduction potential is estimated to be low as this measure involves VTA acting in a coordinating or supporting role.
Cost Effectiveness	Medium	Implementing costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Low	VTA would act in an influencing role under this measure by supporting existing efforts.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with other agencies noted.

Source: Ascent 2023.

Strategy TL-3: Fast, Frequent, Reliable, and Equitable Public Transportation

In 2022, VTA kicked off a planning initiative known as "Visionary Network: A Blueprint for Aspirational Transit Service in Santa Clara County." Visionary Network will "define how transit service in Santa Clara County should look over the next 30 years, including street corridors it should serve in the future, how often buses and trains should arrive, how early and late-night service should run, and what bus stops and stations should look like and provide. By the end of the process, it should reflect a shared vision between VTA, each of the 15 member agency cities, and all residents of the county." (VTA 2022a).

Measure TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.

Improving VTA transit service frequency, hours, and facilities will help to increase transit ridership, which is associated with reducing VMT and associated GHG emissions.

Implementing Actions

- Implement VTA's annual transit service plans based on the Visionary Network's transit vision and recommended service enhancements.
- Pursue new funding streams to support increased service, stops, reliability, extended hours, and capital projects identified in the Visionary Network.
- Implement service changes pursuant to available funding, in accordance with adopted service plans, and in compliance with VTA's service equity policies.

Table 10 Measure TL-3.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium-High	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA GHG Handbook. Applicable measures may include T-25: Extend Transit Network Coverage or Hours, and T-26: Increase Transit Service Frequency. GHG reduction potential could range from medium to high, depending on the scope/scale of improvements identified and funded for implementation. T-25 GHG Mitigation Potential is up to 4.6%, while T-26 is up to 11.3% of GHG emissions from vehicle travel in the community.
Cost Effectiveness	Medium	Increases in capital and operational costs for expanding or improving transit service frequency, hours, and facilities, could be substantial but would be expected to result in medium to high GHG reductions over time.
Jurisdictional Control	Medium	VTA has direct operational control over transit services, hours, and facilities. However, VTA's ability to make service changes or improve the quality of facilities are subject to funding availability.
Implementation Timeframe	Mid- to Long-Term	Specific improvements could be completed in the near, mid-, or even long-term, depending on the specific scope and scale of improvements that need to be defined and their associated costs and available funding sources. However given current challenges associated with impacts of the COVID-19 pandemic and lack of available funding, mid- to long-term implementation may be a more reasonable assumption.

Source: Ascent 2023.

Measure TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.

Implementing Actions

- Collaborate with member agencies and other relevant partners to make transit faster and more reliable with solutions like transit signal priority (TSP) and transit-only lanes.
- Implement TSP, dedicated lanes, and other improvements in collaboration with member agencies.
- Support member agencies through collaborative grant writing and project management of transit priority improvements.

Table 11 Measure TL-3.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions for this measure may be quantifiable using one or more methods outlined in the CAPCOA GHG Handbook. Applicable CAPCOA Measures may include T-27: Implement Transit-Supportive Roadway Treatments. GHG reduction potential would likely be low, based on GHG Mitigation Potential ranking for T-27 of up to 0.6% of GHG emissions from vehicle travel in the community.
Cost Effectiveness	Low	Expansion of infrastructure to support TSP, dedicated bus lanes, or expand bus service would require a modest degree of capital and operational spending across local agencies in the county. Given that the estimated GHG reduction potential for this measure is low, cost effectiveness would appear to be low.
Jurisdictional Control	Medium	VTA has jurisdictional control over operations of Rapid bus service, however the installation of TSP and dedicated bus lanes requires coordination with member agencies with jurisdiction over roadways, signals, and other supporting infrastructure.
Implementation Timeframe	Mid- to Long-Term	Specific improvements could be completed in the near, mid-, or even long-term, depending on the specific scope and scale of improvements that need to be defined and their associated costs and available funding sources. However, given current challenges associated with the impacts of the COVID-19 pandemic and lack of available funding, mid- to long-term implementation may be a more reasonable assumption.

Source: Ascent 2023.

Strategy TL-4: Sustainable Land Use, Planning, and Development

Sustainable land use, planning, and development are critical and complementary to transportation-system focused measures to reduce VMT and associated GHG emissions. VTA's guiding principles for integrating land use and transportation reflect the values of equity, partnership, sustainability, and resilience (VTA 2023a).

- Equity: An outcome and process that enables just and fair access to opportunities so that all can participate and thrive.
- Partnership: an ongoing process to build shared understanding and common ground with local jurisdictions, community, developers, and other institutions to achieve meaningful results.
- Sustainability: integrating social, cultural, economic, and environmental conditions to reduce impacts on future generations.
- Resilience: ability to account for vulnerabilities (e.g., existing inequities) and withstand the impacts of varying types of adversity (e.g., economic or climate related changes).

The guiding principles overlap and are strengthened when implemented together. The principles represent how VTA will work closely with local jurisdictions on land use planning efforts (e.g., land development projects and long-range plans) at the earliest planning stages. They can also provide a framework to expand mobility options in sustainable locations (e.g., promoting growth near VTA's Frequent Network), and to preserve and enhance VTA operations and the quality of service VTA provides. The principles form the foundation of a transparent, comprehensive, and streamlined process for VTA, including VTA internal procedures, development review process, and other tools to facilitate well-integrated and structurally safe development adjacent to transit facilities, and ensure early and ongoing coordination. Successful implementation of these principles will create high-quality, equitably built environments that enable multimodal access, support fast and efficient transit operations, and create transit ridership.

Measure TL-4.1: Collaborate with member agencies in advanced planning efforts to increase residential and employment densities and expand mixed-use development potential near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).

VTA's Land Use and Transportation (LUTI) program seeks to strengthen coordination of land use and transportation strategies with local jurisdictions and the development community by promoting equitable and sustainable development and expanding mobility options. As part of the LUTI Program, VTA manages a Development Review Program to engage in local near-term land development projects and long-range land use and transportation policies (e.g., General Plans or Specific Plans) to encourage a multimodal/transit-integrative planning approach (VTA 2023a).

<u>Implementing Actions</u>

- Continue coordinating and collaborating with member agencies on advanced planning efforts through the LUTI Development Review Program and regularly scheduled collaboration meetings, including on General Plan updates, station area plans, neighborhood/corridor plans, zoning code updates, or other area-wide planning efforts, to ensure that densities, floor-area ratios, and land use designations are transit-supportive and aligned with existing system and planned transit investments.
- Support member agencies through collaborative grant writing and project management of land use plans surrounding transit stations and priority corridors.
- Promote and provide local support/technical assistance for using VTA's Community Design and Transportation (CDT) Manual and other resources.

Table 12 Measure TL-4.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. GHG Reduction Potential is also considered low as VTA only plays a coordinating or supporting role.
Cost Effectiveness	Medium	Implementation costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Low	VTA does not have jurisdiction over local city and county land use planning, however VTA can influence local planning and project-level decision-making by coordinating and collaborating with local agencies during preparation or updates to land use plans and by promoting effective use of VTA's guidance.
Implementation Timeframe	Variable	The timeframe for this measure is somewhat variable, based on ongoing coordination and collaboration with local agencies which spans all timeframes.

Source: Ascent 2023.

Measure TL-4.2: Increase development around transit stations and along transit corridors to facilitate multi-modal, carbon-neutral neighborhoods that are sustainable and resilient.

Implementing Actions

- Collaborate with member agencies to increase and facilitate (1) commercial and mixed-use development in or near job centers and (2) residential, commercial, and mixed use near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).

Table 13 Measure TL-4.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. GHG Reduction Potential is considered low as this measure involves VTA acting in a coordinating or supporting role, and the scope and scale of job density increases is undefined currently.
Cost Effectiveness	Medium	Implementation costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Low	VTA does not have jurisdiction over local city and county land use planning, however VTA can influence local planning and project-level decision-making by coordinating and collaborating with local agencies during preparation or updates to land use plans and by promoting effective use of VTA's guidance.
Implementation Timeframe	Variable	The timeframe for this measure is somewhat variable, based on ongoing coordination and collaboration with local agencies which spans all timeframes.

Source: Ascent 2023.

Measure TL-4.3: Strategically repurpose underutilized parking lots or other vacant lots at or near VTA transit stations and major transit stops into lively mixed-use, transit-oriented communities with activated ground floor uses that increase transit ridership, help provide revenue for transit capital investments and operations, and reduce VMT.

Transit-oriented development (TOD) refers to projects built in compact, walkable areas that have easy access to public transit, ideally in a location with a mix of uses, including housing, retail offices, and community facilities. TODs are generally described as places within a 10-minute walk (0.5 mile) of a high-frequency rail transit station (either rail, or bus with headways less than 15 minutes) (CAPCOA 2021: Appendix A).

Implementing Actions

- Continue to implement VTA's Transit-Oriented Communities (TOC) policy and TOD Development Programs.
- Catalyze equitable and inclusive TOCs with thorough public engagement, resulting in thoughtful placemaking and place-keeping.
- Focus on priority joint development parcels first and parcels that have the potential for achieving the highest VMT reductions and ridership improvements.

Table 14 Measure TL-4.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA GHG Handbook. Applicable measures may include T-3: Provide Transit-Oriented Development; however, the cited reduction potential of up to ~30% is local (not regional as would be the case for VTA) so this measure is considered medium.
Cost Effectiveness	Medium	Implementation costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Medium	VTA has jurisdictional control over VTA-owned sites and has discretion over decisions to approve ground leases or disposition of land for development projects, however VTA does not have direct control of lands in TOD areas that are not owned by VTA. VTA staff working through the TOD Program have influence and can partner with local agencies and the development community to facilitate TOD project development.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies and the development communities to plan and build TOD projects.

Source: Ascent 2023.

Measure TL-4.4: Provide people of all generations and backgrounds with affordable housing and access to the necessities of daily life available within a short walk, bicycle ride, or transit trip.

As noted in VTA's 2022 Affordable Housing Report, VTA increased its Affordable Housing Policy goals in June 2022 to ensure that 40% of its residential TOD development portfolio will be developed as affordable units. The Board also increased its affordable set-aside in market-rate projects to 25%. All of VTA's affordable units must serve households earning 60% of Santa Clara County's Area Median Income (AMI) or below, and half of VTA's affordable units must serve households earning 50% of AMI or below. To achieve these goals, the VTA TOD program is working with Santa Clara County, local jurisdictions, and the development community to produce mixed-income and 100% affordable housing projects throughout VTA's service area. VTA's recently updated projections indicate that its active current pipeline and future development sites will create approximately 2,600 affordable units (VTA 2023b).

Implementing Actions

- Continue to work through VTA's TOD program with local jurisdictions and the development community to produce mixed-use, mixed-income, and 100% affordable housing projects, consistent with VTA's Affordable Housing Goals.
- Implement FTA-funded TOC Playbook implementation activities in Downtown San Jose, 28th Street/Little Portugal Station, and Santa Clara Station, in partnership with the cities of San Jose and Santa Clara and surrounding communities.

Table 15 Measure TL-4.4 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures outlined in the CAPCOA GHG Handbook. Applicable measures may include T-4: Integrate Affordable and Below Market Rate Housing; however, the cited reduction potential of up to ~30% is local (not regional as would be the case for VTA) so this measure is considered medium.
Cost Effectiveness	Medium	Implementation costs associated with this measure are assumed to be relatively low given that VTA staff already coordinate and collaborate with local agencies. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Medium	VTA has jurisdictional control over VTA-owned sites and has discretion over decisions to approve ground leases or disposition of land for housing projects, however VTA does not have direct control lands in TOD areas that are not owned by VTA. VTA staff working through the TOD Program have influence and can partner with local agencies and the development community to facilitate housing development.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies and the development communities to plan and build TOD projects.

Source: Ascent 2023.

Measure TL-4.5: Work with member agencies and other partners to focus development where it already exists (i.e., promote infill development) and reduce the impact of development and transportation infrastructure on the environment by protecting open space, conserving and restoring habitat, enhancing biodiversity, increasing carbon sequestration, and improving wildlife connectivity.

Implementing Actions

- Explore opportunities for VTA to support local and regional efforts to protect and enhance natural and working lands. Partnering agencies could include Santa Clara Valley Open Space Authority, Santa Clara Valley Habitat Plan, City of San Jose, Santa Clara Valley Land Trust, Peninsula Open Space Trust, Mid-Pen Open Space District, the Metropolitan Transportation Commission / Association of Bay Area Governments (MTC/ABAG), or others.
- Collaborate with regional stakeholders to explore the potential for creating a transfer of development rights (TDR)[2] program to (1) prioritize compact development in closer proximity to transit corridors, and (2) avoid conversion of open space to low-density development, especially areas identified as high priority for conservation. A TDR program could potentially identify TOD/TOC areas in VTA's network as receiving areas for TDRs.
- Explore VTA opportunities to partner with existing community organizations in providing transportation services that increase equitable access to local open space to support recreational and educational opportunities, with a priority emphasis on increasing open space access in historically marginalized and disadvantaged communities.

[2] For more information on TDR and examples used in other regions in CA and elsewhere, see Smart Climate Action through Transfer of Development Rights.

Table 16 Measure TL-4.5 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The scale of GHG reductions is difficult to quantify at this stage. VTA would be acting in an exploratory role, and further study would be necessary to identify what specific actions would need to be taken. Potential is considered low.
Cost Effectiveness	N/A	Cost effectiveness is unknown at this stage.
Jurisdictional Control	Low	VTA does not have jurisdiction over lands it does not own, however it can act as an influencer in its role as a coordinating entity in collaboration with other agencies in the county and the region on broader growth management and conservation issues.
Implementation Timeframe	Mid-Term	Initiation of coordination and collaboration efforts could occur in the near term, however initiation and completion of any exploratory studies noted in the implementing actions, and implementation of recommendations pursuant to studies may take several years.

Source: Ascent 2023.

Strategy TL-5: Parking Management and Pricing

Measure TL-5.1: Support local efforts to reduce or eliminate minimum parking standards and institute parking maximums, require "unbundling" of parking costs from commercial leasing or residential rental rates, support shared parking, and introduce demand-based parking pricing in public on- and off-street parking facilities.

<u>Implementing Actions</u>

- Develop and implement demand-based pricing policies at existing VTA-owned off-street parking lots or garages.
- Promote and provide local support/technical assistance for using VTA's CDT Manual, which includes guidance for "Rethinking Parking Requirements" and "Parking Management."

Table 17 Measure TL-5.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The scale of GHG reductions of this measure is difficult to quantify at this stage. VTA would be acting in a promotional role; however, VTA's implementing demand-based pricing policies would reduce GHG emissions (CAPCOA T-12: Price Workplace Parking). However, CAPCOA's cited reduction potential of up to ~20% is local (not regional as would be the case for VTA) so this measure is considered low in combination with VTA's support role.
Cost Effectiveness	Medium	Implementation costs are assumed to be moderate. While VTA staff already coordinate and collaborate with local agencies, establishing and implementing a new demand-based pricing policy would create a new program and additional workload. The scale of these costs relative to GHG reductions is unknown, however, as GHG reduction potential is not estimated.
Jurisdictional Control	Medium	VTA has direct control over parking lots and garages owned by VTA. VTA can coordinate and support local agency efforts to address parking standards and pricing.
Implementation Timeframe	Variable	The timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies.

Source: Ascent 2023.

Measure TL-5.2: Provide EV charging infrastructure at VTA parking facilities open to the public.

Implementing Actions

- Identify existing VTA facilities where additional publicly accessible EV charging stations, charging infrastructure, and solar canopies with EV charging could be installed. Develop an implementation plan and policy that identifies funding and/or agreements with vendors for installation and maintenance.

Table 18 Measure TL-5.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA GHG Handbook (e.g., CAPCOA T-14: Provide Electric Vehicle Charging Infrastructure - Expanding EV charging infrastructure supports increased consumer adoption of all types of EVs, However, the cited reduction potential of up to ~12% is local (not regional as would be the case for VTA) so this measure is considered low.
Cost Effectiveness	Medium	Potential implementation costs will vary depending on the results of studies and scale of EV charging installations in existing parking facilities.
Jurisdictional Control	High	VTA has direct control over its parking facilities
Implementation Timeframe	Near-Term	Given that VTA has direct control over and has already been installing EV charging in its parking facilities, increased/expanded installations could be accelerated assuming reasonable costs and funding availability and/or agreements with vendors can be negotiated in a timely manner.

Source: Ascent 2023.

Strategy TL-6: Smart Mobility and Transportation Demand Management (TDM)

Measures under this strategy address smarter and more effective use of the existing transportation system through TDM, along with guiding a range of new or emerging smart mobility solutions in ways that are consistent with VTA's sustainability and climate goals. VTA has an opportunity to support proven strategies for TDM across the countywide transportation system that reduce vehicle trips and VMT, while also ensuring that new and emerging mobility solutions are integrated with public transit services and will not adversely impact VTA ridership or increase VMT.

TDM measures can also be applied to VTA employee commuting and internal operations, which are addressed more specifically under the Fleet and Employee Commute (FE) focus area later in this memo.

Measure TL-6.1: Increase participation in smart commute and mobility options throughout the county including bicycle sharing, ridesharing, car-sharing, mobility-as-a-service, guaranteed ride home programs, carpools, vanpools, and other emerging options.

Implementing Actions

- Expand VTA's guaranteed ride home program to ease commuter anxiety and encourage transit use.
- Launch and expand a countywide web-based incentive platform that offers rewards and discounts to encourage use of alternative modes of travel other than solo driving.
- Increase marketing activities for all smart commute and mobility options.

Table 19 Measure TL-6.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-5: Implement Commute Trip Reduction Program (Voluntary), T-6: Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring), T-7: Implement Commute Trip Reduction Marketing, T-8: Provide Ridesharing Program, T-9: Implement Subsidized or Discounted Transit Program, T-10: Provide End-of-Trip Bicycle Facilities). The maximum cited reduction potential of up to ~30% is mostly local (not regional as would be the case for VTA) so this measure is considered medium.
Cost Effectiveness	Medium	VTA would likely play a supporting role and costs could be low to modest, depending on VTA's specific role in relationship to existing programs or services.
Jurisdictional Control	Medium	VTA may have some degree of control over local trip reduction actions where transit services or on-road systems under VTA's authority are integrated with local programs. VTA can also influence local programs through collaborative efforts where VTA plays a supportive or coordinating role.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies.

Source: Ascent 2023.

Measure TL-6.2: Channel the deployment of autonomous vehicles, ride-hailing services, and other new mobility options toward high passenger-occupancy and low VMT-impact service models that complement transit.

Autonomous vehicles (AVs), ride-hailing services (also sometimes referred to as "transportation network companies," or TNCs), and other new mobility options could increase VMT and GHG emissions unless specific actions are taken to ensure that public health, safety, and environmental goals are achieved (OPR 2018).

Implementing Actions

- Explore partnering with local AV startups to develop a pilot program that integrates AV deployment with measures designed to further local sustainability and climate goals in the county.
- Encourage ride-hailing services like Uber/Lyft to focus on high passenger-occupancy rides and improve access to or complement transit usage.

Table 20 Measure TL-6.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. GHG Reduction Potential is also considered low as VTA only plays an exploratory or supporting role.
Cost Effectiveness	N/A	Cost effectiveness is unknown at this stage.
Jurisdictional Control	Medium	VTA's jurisdictional control over VTA transit services and express lanes on the roadway system could play a role in how this measure is implemented. VTA can also play an influencing role by coordinating and collaborating with the private sector and regional, state, or federal agencies in how AVs, TNCs, and emerging technologies and systems that may deployed in the future will be deployed and regulated.
Implementation Timeframe	Mid- to Long-Term	While ride-sharing companies are already operating, AV systems are not yet broadly deployed but would be expected over the long term. Measure implementation could begin in the near- to mid-term on partnership formation or pilot program development, but realistically, AV deployment will likely extend into the long-term timeframe.

Source: Ascent 2023.

Measure TL-6.3: Expand TDM programs and services in partnership with member agencies, employers, schools, and residential communities.

VTA's CDT Manual includes a section entitled "Transportation Demand Management." Topics and possible actions in the CDT Manual include:

- Changing the cost of commuting.
- Helping communities leave their cars at home.
- TDM and the development process.
- Formation of Transportation Management Associations (TMAs).
- Sustainable mode education, infrastructure, and accessibility.
- Transit and TOD.

<u>Implementing Actions</u>

- Coordinate and collaborate with member agencies to implement TDM recommendations consistent with VTA's CDT Manual and other best practices guidance.
- Coordinate and collaborate with member agencies, employers, and existing transportation management associations (TMAs) to increase options and identify opportunities for VTA to support connectivity across modes and services. Establish performance metrics and targets to measure the success of VTA's TDM strategies to decrease single-occupant vehicle (SOV) commuting.
- Consider forming a countywide TMA or joining existing local transportation management associations (TMAs). VTA is actively exploring its role in countywide TDM efforts similar to other countywide transportation authorities in the region.

Table 21 Measure TL-6.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-5: Implement Commute Trip Reduction Program (Voluntary), T-6: Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring), T-7: Implement Commute Trip Reduction Marketing, T-8: Provide Ridesharing Program, T-9: Implement Subsidized or Discounted Transit Program, T-10: Provide End-of-Trip Bicycle Facilities). The maximum cited reduction potential of up to ~30% is mostly local (not regional as would be the case for VTA) and VTA would be serving a coordination role, so this measure is considered medium.
Cost Effectiveness	Medium	VTA would likely play a supporting role and costs could be low to modest, depending on VTA's specific role in relationship to existing or new programs or services.
Jurisdictional Control	Medium	VTA may have some degree of control over local trip reduction actions where transit services or on-road systems under VTA's authority are integrated with local programs. VTA can also influence local programs through collaborative efforts where VTA plays a supportive or coordinating role.
Implementation Timeframe	Variable	Timeframe for this measure is variable, based on ongoing coordination and collaboration with local agencies.

Source: Ascent 2023.

3.2 BUILDINGS AND FACILITIES (BF)

The Buildings and Facilities (BF) focus area strategies, measures, and implementing actions are centered on reducing energy usage and decarbonizing the energy used in all structures across VTA's internal operations. In general, VTA facilities include buildings (e.g., maintenance facilities, office buildings) and transit facilities (e.g., bus stops, transit stations), which are located throughout Santa Clara County. The two primary strategies under this focus area include **BF-1: Clean and Renewable Energy**, and **BF-2: Energy Efficiency and Reliability**.

Strategies and measures under this focus area, particularly Strategy BF-2, align with and support VTA's Sustainability Plan 2020 targets to reduce building energy consumption by 15% by FY 2025 and 40% by FY 2040, in addition to GHG emissions targets (VTA 2020: 5). Currently, VTA is not on-track to meet these targets. Building energy consumption has only decreased by approximately 6% since the established baseline of FY 2009 and has been flagged by VTA staff as an area needing improvement.

Strategy BF-1: Clean and Renewable Energy

This strategy is focused on facilitating VTA's transition to clean and renewable energy in its buildings and facilities. It includes the decarbonization of existing buildings, continuing expanding renewable energy and battery storage across existing buildings and facilities, and ensuring that future new buildings are carbon-free and incorporate renewable energy to the maximum extent possible.

Measure BF-1.1: Decarbonize existing VTA buildings by phasing out fossil fuel usage and electrifying water heating and space heating or using renewable fuels such as renewable natural gas (RNG), where appropriate.

Implementing Actions

- Conduct studies and develop a comprehensive building retrofit program/plan that identifies energy efficiency measures, electrification opportunities, and facility-specific decarbonization, renewable energy, and energy storage solutions. For example, converting Cerone Division from propane to electric sources of heating and replacing the natural gas radiant heaters in maintenance bays with electric heaters.
- Identify funding needs and sources to fund or finance retrofits, along with potential incentives from energy utilities or other sources.

Table 22 Measure BF-1.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	The scale of GHG reductions is difficult to quantify at this stage. Completion of studies will identify what specific actions would need to be taken. The GHG reduction potential for this measure is medium, based on the scale of reduction potential and overall magnitude of GHG emissions in the Energy sector of VTA's GHG inventory.
Cost Effectiveness	Medium	Specific costs are unknown currently, but the general range of costs to implement efficiency, electrification, or other decarbonization-focused building retrofits vary considerably across equipment, lighting, appliance, or HVAC replacements/upgrades. Costs for such measures can also be offset by energy savings and/or fuel switching.
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Mid	Implementation timeframes may vary, based on when studies are completed, and programs/plans are put in place and funded. While studies could begin in the near-term, retrofits may take more time to complete and could be phased in or coordinated with expected lifecycle of equipment and replacement schedules.

Source: Ascent 2023.

Measure BF-1.2: Increase renewable energy, battery storage, and microgrid installations in existing VTA buildings, and/or procure 100% renewable options through local community choice energy (CCE) providers, where applicable.

Implementing Actions

- Actions from Measure BF-1.1 may also apply to this measure.

Table 23 Measure BF-1.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	The scale of GHG reductions is difficult to quantify at this stage. The GHG reduction potential for this measure is medium, based on the scale of reduction potential and overall magnitude of GHG emissions in the Energy sector of VTA's GHG inventory.
Cost Effectiveness	Medium/High	Specific costs are unknown at this time, but the general range of costs to implement renewable energy will vary considerably depending on which approach (e.g., on-site installation vs. procuring renewable options from CCE providers) or technology is used. Procuring 100% renewable energy from a CCE may be considered a more cost-effective option. Currently, procuring 100% renewable energy from the two Santa Clara Valley CCEs (Silicon Valley Clean Energy and San Jose Clean Energy), which in 2030 are anticipated to serve 96% of VTA fleet electric load, has similar costs to procuring the default energy mix from PG&E,[3] making the incremental shift to an 100% relatively inexpensive. However, these rates will change depending on weather, utility hedging strategies, and the cost impact of future energy procurement.
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Mid-Term	Implementation timeframe may extend into mid-term, based studies to be completed, and time to get programs/plans in place and funded.

Source: Ascent 2023.

Measure BF-1.3: Require all new VTA buildings to be 100% electric and include on-site renewable energy systems with battery storage and microgrids and achieve net-zero standards where feasible.

Implementing Actions

- Update VTA's Green Building Policy (adopted in 2018) to require 100% electric for all new construction. This may require VTA facility staff to identify specific standards or specifications per building codes, including reach codes, and/or rating systems, to achieve these outcomes.[4] For example, the new Cerone OCC Building is an opportunity to build a 100% electric and/or net-zero building.
- Implement the amended policy in all new building design and construction projects moving forward, and evaluate space requirements, costs, financial incentives, and efficiencies for each potential technology used on a project-by-project basis.

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[3] See Joint Rate Comparisons for Silicon Valley Clean Energy (SVCE) and San Jose Clean Energy (SJCE) , available respectively at https://www.pge.com/pge_global/common/pdfs/customer-service/other-services/alternative-energy-providers/community-choice-aggregation/svce_rateclasscomparison.pdf and https://www.pge.com/pge_global/common/pdfs/customer-service/other-services/alternative-energy-providers/community-choice-aggregation/sjce_rateclasscomparison.pdf. For SVCE, the GreenPrime product is 100% renewable (see: https://svcleanenergy.org/greenprime/), and for its B-19 S (Business Medium-High Use) customers, the GreenPrime rate is currently less than 1 percent above the PG&E rate. For SJCE, the TotalGreen product is 100 percent renewable, and for its B-19 S customers, the rate is less than one tenth of 1 percent above PG&E.

[4] See the Building Decarbonization Coalition's 2022 Reach Code Implementation Resources page for examples: https://buildingdecarb.org/resource/2022-reach-code-implementation-resources.

Table 24 Measure BF-1.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The GHG reduction potential for this measure is low, based on the scale of reduction potential being limited to avoiding new emissions from new VTA buildings and the overall magnitude of GHG emissions in the Energy sector of VTA's operational inventory.
Cost Effectiveness	Medium	Specific costs are unknown at this time, but the general range of costs to implement all-electric development will vary considerably depending on which codes, construction methods, or technologies are used in the design and construction of new buildings. All-electric buildings may have similar or even lower up-front costs than a mixed-fuel building in some cases, particularly when considering the avoided costs of natural gas infrastructure. Additionally, switching to high-efficiency electric for various end uses may result in substantial cost savings over the life cycle of improvements as natural gas prices have been increasing.
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Mid-Term	While updates to VTA's policy could be achieved in the near term, full implementation timeframes depend on when new building projects are funded, designed, and constructed.

Source: Ascent 2023.

Measure BF-1.4: Increase use of electricity and alternative fuels in construction equipment on VTA projects.

The Bay Area Air Quality Management District (BAAQMD) provides funding to equipment owners to help offset costs of converting off-road equipment to ZEV or alternative fuels.[5] Additionally, several air districts now include guidance for use of electric and alternative fuels in construction equipment in mitigation measures.[6] CARB is also working on the Zero-Emission Forklifts program and forthcoming regulations.[7]

Implementing Actions

- Develop and adopt specifications for electric and alternative fuel equipment that must be used in VTA construction projects. Specifications may also be identified in air quality or GHG mitigation measures that are required per CEQA documents prepared for projects in which VTA is designated as the CEQA lead agency.

Table 26 Measure BF-1.5 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The GHG reduction potential for this measure is limited to avoiding future emissions associated with the construction equipment used in new VTA buildings. Construction emissions are also finite and low compared to operational emissions and thus, the GHG reduction potential from avoided emissions is considered low.
Cost Effectiveness	Medium	Specific costs are unknown at this time, as the range of costs to implement use of low or zero emission equipment in new construction projects varies considerably and depends on which approach or technology is used and to which class of equipment that standards and specifications would apply. Capital costs to purchase cleaner fuel vehicles may be high, although as ZEV options increase in the marketplace, they will likely decline over time. Fueling infrastructure may be required, which will add to the upfront cost of transitioning to cleaner fuel vehicles. However, fuel costs and savings compared to gasoline and diesel will vary depending on the type of fuel and market conditions. It is feasible to expect reduced fuel costs from cleaner fuels with an increased market and overall fuel cost savings over the life of the vehicle fleet. (CAPCOA T-30: Use Cleaner Fuel Vehicles)
Jurisdictional Control	High	VTA has direct control over specifications and standards that are required in VTA construction projects
Implementation Timeframe	Near	Updates to VTA's policies and specifications for construction equipment could be completed in the near term.

Source: Ascent 2023.

[5] See https://www.baaqmd.gov/funding-and-incentives/businesses-and-fleets/off-road-vehicles
[6] See https://www.airquality.org/LandUseTransportation/Documents/Ch6ConstructionMitMeasuresFINAL5-2016.pdf
[7] See Zero-Emission Forklifts | California Air Resources Board

Strategy BF-2: Energy Efficiency and Reliability

Measure BF-2.1: Upgrade outdoor lighting at VTA buildings, and at park-and-ride lots and stations, to LEDs or other high-efficiency lighting.

Implementing Actions

- Conduct a study and develop a comprehensive plan that (1) identifies and prioritizes buildings and parking lots in need of more efficient replacement outdoor lighting, such as LEDs or other more efficient technologies; and (2) secure/allocate funding and labor to replace lighting.

Table 27 Measure BF-2.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The scale of GHG reductions is difficult to quantify at this stage. Completion of a study will identify what specific actions would need to be taken. The GHG reduction potential for this measure is low based on the scale of reduction potential and overall magnitude of GHG emissions in the Energy sector of VTA's GHG inventory.
Cost Effectiveness	High	High-efficiency lighting upgrades are generally cost effective. More energy-efficient lighting options may have greater upfront installation costs. However, the replacement of less efficient lighting with more efficient bulbs reduces energy consumption and thereby reduces energy costs over time which may result in net cost savings over the lifespan of the investment. Additionally, the rated life of more efficient bulbs is typically longer than less efficient ones, which reduces the frequency of replacement costs (Source: CAPCOA Handbook, Measure E-7: Higher Efficacy Public Street and Area Lighting).
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Mid	Implementation timeframes may vary, based on when studies are completed and projects are identified, funded, and constructed.

Source: Ascent 2023.

Measure BF-2.2: Reduce energy use in VTA buildings through conservation best practices consistent with LEED®, ENERGY STAR®, or other standards.

Implementing Actions

- Conduct a study and prioritize projects to retrofit buildings with energy-saving features such as dimmer switches or timers, replace older inefficient plug-load appliances with higher-efficiency ENERGY STAR® rated appliances, or implement conservation best practices through occupant behavioral changes (e.g., turning off lights in an empty room, unplugging appliances when not needed). Identify actions that could be taken in both LEED® and non-LEED® certified buildings.
- Identify and secure funding sources needed to complete retrofits.

Table 28 Measure BF-2.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The GHG reduction potential for this measure is low, based on the scale of reduction potential and overall magnitude of GHG emissions in the Energy sector of VTA's GHG inventory. Conservation-based approaches to reducing energy usage can be helpful as part of an overall energy efficiency and conservation program for an agency's operations; however, conservation-based reductions are typically much lower than reductions from efficiency upgrades in building heating and cooling, water heating, and lighting.
Cost Effectiveness	High	Conservation best practices typically include low-cost actions and can be cost-effective relative to energy savings achieved.

Prioritization Criteria	Score	Rationale
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Mid	Implementation timeframes may vary, based on when studies are completed and projects are identified, funded, and constructed.

Source: Ascent 2023.

Measure BF-2.3: Update VTA's building and construction policies, specifications, and practices to increase energy efficiency, and complete energy audits of existing buildings.

Implementing Actions

- Update VTA's Green Building Policy (adopted in 2018) to increase energy efficiency in all existing and new buildings. This update may be coordinated or included with the implementation action under Measure BF-1.3.
- Conduct an energy audit of existing buildings to identify cost effective energy efficiency improvements and identify funding sources to complete appropriate energy efficiency upgrades.
  - The River Oaks Administrative Offices used over 3 million kWh of electricity in FY22. Of VTA's five major divisions, it has the highest usage of grid electricity (the Light Rail Division has the highest). Despite past efforts to update the building management system, energy usage continues to be high. In an effort to increase energy efficiency, a more rigorous effort to improve the HVAC system and lighting controls should be undertaken.

Table 29 Measure BF-2.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	The GHG reduction potential for this measure is medium, based on the scale of reduction potential and overall magnitude of GHG emissions in the Energy sector of VTA's GHG inventory.
Cost Effectiveness	High	Specific costs are unknown at this time, but the general range of costs to increase energy efficiency will vary considerably depending on which codes, construction methods, or technologies are used in the design and construction of new buildings or retrofits to existing buildings. Energy audits generally recommend upgrades that appear to be the most cost effective in terms of achieving energy and cost savings relative to project costs.
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Near Mid	Updating VTA's policy could be completed in the near term, while completing energy audits and identifying and completing energy efficiency retrofits in existing buildings could be a near-mid term program.

Source: Ascent 2023.

Measure BF-2.4: Consider installing microgrids with battery storage to power critical assets during power outages and provide ancillary services to the grid.

Implementing Actions

- Conduct a feasibility study to determine where and how microgrids or battery storage could be implemented at VTA facilities with existing solar generation. Based on findings, develop recommendations and secure funding based on prioritized project opportunities.

Table 30 Measure BF-2.4 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	Microgrids are generally focused on providing energy reliability and operational resilience. They can help to reduce GHG emission when appropriately designed with on-site renewables combined with battery storage. The extent to which microgrids can be deployed in VTA operations, however, is unknown and results of feasibility study may help to determine the scale of GHG reduction potential that could be expected. See CAPCOA E-23: Use Microgrids and Energy Storage (non-quantified measure).
Cost Effectiveness	Low	Cost effectiveness is currently unknown. Feasibility study findings may provide more information once completed.
Jurisdictional Control	High	VTA-owned buildings and facilities are under the direct jurisdictional control of VTA.
Implementation Timeframe	Long-Term	Completion of a feasibility study could be completed in the near-term, with recommendation implemented thereafter in the mid- to long-term, depending on study findings and recommendations.

Source: Ascent 2023.

3.3 FLEET AND EMPLOYEE COMMUTE (FE)

The Fleet and Employee Commute (FE) focus area includes strategies, measures, and implementing actions that reduce emissions in both the Revenue and Non-Revenue Fleet and the Employee Commute sectors in VTA's updated Transit Operations GHG emissions inventory and forecast. The four strategies under this focus area include: **FE-1 Zero-Emission Vehicles, FE-2 Zero-Emission Equipment, FE-3 Operational Efficiency, and FE-4 Employee Commute**.

Strategies and measures under this focus area are also intended to align with and support VTA's Sustainability Plan 2020 targets to reduce revenue fleet energy consumption, in addition to the plan's GHG emissions targets.

Strategy FE-1: Zero-Emission Vehicles

Measure FE-1.1: Accelerate zero-emission bus (ZEB) and paratransit zero-emission vehicles (ZEV) replacements to ramp up and reduce GHG emissions faster, relative to existing regulations and expected phase-out timelines.

Several laws and regulations are now mandating that both transit agency revenue fleets and other classes of privately-owned vehicles begin transitioning to zero-emission vehicles by specific target years.[8]

VTA is actively working to transition affected revenue and non-revenue vehicles to zero-emission technology as quickly as possible, but VTA may also consider accelerating transition of affected vehicles ahead of expected phase-out timelines in existing regulations. These efforts, along with any accelerated efforts, will require a substantial commitment to increase funding for purchases and operations and maintenance and sufficient staffing resources.

<u>Implementing Actions</u>

- Allocate sufficient VTA staff and funding resources to successfully support the ZEB transition pursuant to existing regulatory requirements.
- Identify potentially feasible pathways to accelerating ZEB and paratransit ZEV replacements, including timelines/phasing strategies resource needs.
- Champion efforts to get more funding to accelerate ZEB and paratransit ZEV replacements.

[8] See VTA Transit Operations GHG Emissions Inventory and Forecast memo, Table 19, page 29 for a list of legislative reductions and associated regulations.

Table 31 Measure FE-1.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	High	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-30: Use Cleaner Vehicles). The GHG reduction potential for this measure is high, based on the scale of reduction potential and overall magnitude of GHG emissions in VTA's GHG inventory.
Cost Effectiveness	Medium	Replacing existing internal combustion vehicles with ZEVs would have a substantial cost based on current costs of ZEVs in these vehicle classes. An accelerated replacement program could be designed to align as closely as possible with lifecycle replacements that already would have occurred, such that incremental costs of replacement would be minimized, particularly as zero-emission technologies are deployed and more widely adopted over the next 10 years which may reduce ZEV costs.
Jurisdictional Control	High	VTA-owned revenue and non-revenue vehicles and specific replacement decisions are under the direct operational control of VTA.
Implementation Timeframe	Variable	Timeframe for this measure is variable, given VTA's ongoing efforts combined with future actions to identify potential ZEV acceleration pathways and funding resources.

Source: Ascent 2023.

Measure FE-1.2: Replace VTA diesel trucks and other non-revenue VTA vehicles with ZEVs.

Implementing Actions

- Develop and implement a ZEV replacement plan to replace non-revenue internal combustion engine (ICE) vehicles with ZEVs as opportunities arise and take advantage of funding opportunities and/or rebates to minimize cost to VTA.

Table 32 Measure FE-1.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-30: Use Cleaner Vehicles). The GHG reduction potential for this measure is medium, based on the scale of reduction potential and overall magnitude of GHG emissions in VTA's GHG inventory.
Cost Effectiveness	Medium	Replacing existing non-revenue fleet vehicles with ZEVs would have a substantial cost based on current costs of ZEVs in these vehicle classes. VTA can align ZEV replacements to match up as closely as possible with lifecycle replacements that already would have occurred, such that incremental costs of replacement could be minimized, particularly as zero-emission technologies are deployed and more widely adopted over the next 10 years which may reduce ZEV costs.
Jurisdictional Control	High	VTA-owned non-revenue vehicles and specific replacement decisions are under the direct operational control of VTA.
Implementation Timeframe	Variable	Implementation for this measure is variable, given VTA's ongoing efforts combined with future actions to identify potential ZEV acceleration pathways and funding resources.

Source: Ascent 2023.

Measure FE-1.3: Expand electric vehicle (EV) and electric bicycle charging infrastructure at VTA buildings to support VTA fleet EVs and employee bicycles.

This measure promotes expansion of EV charging infrastructure to support EVs in VTA's fleet which can apply to both revenue and non-revenue vehicles. Implementation of this measure will also need to be coordinated with the two previous ZEV measures under this strategy.

Measure TL-5.2 under the Smart Parking and Curbside Management Strategy above is similar, however Measure TL-5.2 is focused on public-facing EV charging infrastructure to support community members who use VTA's publicly accessible parking facilities at transit stations or other locations. There could be some overlap between the two measures, depending on configuration of VTA parking facilities at VTA's office buildings, the degree of public access to EV chargers at existing VTA buildings, and VTA's approach to deploying EV charging infrastructure in partnership with existing vendors.

Implementing Actions

- Identify existing facilities where additional EV charging stations could be installed and develop an implementation plan including securing funding and/or any agreements with vendors for installation and maintenance.

Table 33 Measure FE-1.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-14: Provide Electric Vehicle Charging Infrastructure). The GHG reduction potential for this measure is high, based on the scale of reduction potential and overall magnitude of GHG emissions in VTA's GHG inventory. Because this measure is focused on supporting the transition of VTA's revenue and non-revenue fleet, reductions are considered medium.
Cost Effectiveness	Medium	Potential implementation costs and cost effectiveness relative to GHG reductions achieved will vary depending on results of studies and scale of EV charging installations at existing facilities.
Jurisdictional Control	High	VTA has direct control over its buildings and facilities.
Implementation Timeframe	Variable	The timeframe for this measure will vary, depending on the pace and scale of ZEV replacements determined under other measures, different types of charging that may be needed to support light, medium, or heavy-duty vehicles, and potential variation in charging operations to support effective use of ZEVs across revenue vs. non-revenue fleet vehicles.

Source: Ascent 2023.

Strategy FE-2: Use Cleaner-Fuel for Off-Road and Construction Equipment

Measure FE-2.1: Use cleaner fuel, such as renewable diesel, for off-road equipment and construction equipment where feasible.

Implementing Actions

- Explore and implement appropriate solutions to procure renewable diesel for use in VTA off-road equipment.
- Update VTA's construction policies, specifications, and practices to require or encourage equipment that produces zero- or low-emissions where feasible.

Table 34 Measure FE-2.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., C-1-B: Use Cleaner-Fuel Equipment). The GHG reduction potential for this measure is low, based on the scale of reduction potential and overall magnitude of GHG emissions in VTA's GHG inventory.
Cost Effectiveness	High	Renewable diesel is generally similar in cost to regular non-renewable diesel
Jurisdictional Control	High	VTA has direct control over VTA-owned equipment
Implementation Timeframe	Near	Renewable diesel purchasing may be feasible to accomplish in the near term. Renewable diesel is typically readily available in California.

Source: Ascent 2023.

Measure FE-2.2: Require ZEV or low-emission vehicle (LEV) equipment in VTA projects.

Implementing Actions

- Update VTA's construction policies, specifications, and practices to require the use of zero-emissions or low-emissions equipment in VTA projects where feasible.

Table 35 Measure FE-2.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., C-1-B: Use Cleaner-Fuel Equipment). The GHG reduction potential for this measure is low, based on the scale of reduction potential and overall magnitude of GHG emissions in VTA's GHG inventory.
Cost Effectiveness	High	Equipment powered by cleaner-fuels tend to be more expensive to purchase and install than less clean models. These costs may be offset by savings in fuel use and maintenance.
Jurisdictional Control	High	VTA has direct control over specifications required for VTA construction projects.
Implementation Timeframe	Near	Updating VTA's policies, standard specifications, and practices could be completed in the near term.

Source: Ascent 2023.

Strategy FE-3: Operational Efficiency

Measure FE-3.1: Maximize the operational efficiency of VTA vehicles, including reducing vehicle idling.

This is a near- to mid-term measure designed to reduce GHG emissions from idling, especially in heavy-duty on-road vehicles or off-road equipment which may take longer to transition to ZEV technology.

Implementing Actions

- Consider deploying software on VTA fleet vehicles to monitor vehicle trips, VMT, and idling via engine analytics.
- Train VTA staff to operate diesel trucks, heavy-duty vehicles, and off-road equipment more efficiently and enforce current "no-idling" policies.

Table 36 Measure FE-3.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure because data on the VTA fleet's idling time is not available.
Cost Effectiveness	Low-Medium	Costs associated with this measure vary. Software deployment costs could be considerable; however, education and training costs would be minimal. Restricting vehicle idling time beyond regulation will reduce fuel consumption, leading to long-term net cost savings.
Jurisdictional Control	High	VTA has direct control over vehicles and driver/operator training and performance.
Implementation Timeframe	Near-Mid	Training could begin in the near term. If determined to be feasible and funded, deploying software and monitoring systems could be deployed in the near- to mid-term.

Source: Ascent 2023.

Strategy FE-4: Employee Commute

Measure FE-4.1: Monitor employee commute patterns to understand employee behaviors, needs, and overall contributions to VTA's operational GHG inventory.

Implementing Actions

- Conduct a new employee commute survey, annually or at least every five years, to understand commute patterns and quantify associated trips and VMT. Incorporate findings into future GHG inventory updates.

Table 37 Measure FE-4.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions are not quantifiable for this measure. GHG Reduction Potential is also considered low as VTA would be conducting a study. Monitoring activities alone do not reduce GHG emissions, however monitoring activities are complementary to other measures and implementing actions under this strategy.
Cost Effectiveness	Medium	Costs of updating VTA's employee commute survey are relatively low.
Jurisdictional Control	Medium	VTA can conduct employee surveys, however employee engagement and responses may be required.
Implementation Timeframe	Variable	This is an ongoing measure, as the survey will be updated every five years.

Source: Ascent 2023.

Measure FE-4.2: Encourage and enable VTA employees to use transit, carpool, bike, and telecommute to work to reduce single-occupancy vehicle commute trips and VMT.

VTA has an opportunity to develop a more comprehensive policy to support "active transportation" among employees and to adopt a more comprehensive TDM program to help reduce commute trips and VMT. Additionally, VTA is planning to launch a new Guaranteed Ride Home (GRH) program in June 2023, and VTA implemented a vanpool subsidy program (expanding on a regional program) in 2021; both of these programs will be available to VTA employees and the general public.

Implementing Actions

- Develop and adopt an official VTA policy that supports an active workplace culture that makes it easier to walk, bike, share rides, or take transit, and provide training to ensure managers fully and consistently integrate mobility programs and policies into their departments.

- In coordination with implementation of Measure TL-6 (Smart Mobility and TDM), develop and launch a comprehensive TDM program for VTA employees and/or align VTA's efforts with existing local TMAs.
- Encourage and increase employee bicycle use, promote safe riding, and incentivize bicycle commuting.
- Review VTA facilities to identify opportunities to increase amenities that encourage bicycling, such as bicycle parking/storage, shelters, end-of-trip facilities (e.g., repair stands, bicycle wash stations, showers, locker rooms), and electric bicycle charging infrastructure. Identify funding necessary to expand amenities as needed.
- Improve support for teleworking for applicable employees by expanding technology and remote access to information and services.

Table 38 Measure FE-4.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Medium	GHG reductions for this measure may be quantifiable using one or more methods outlined in the applicable GHG reduction measures in the CAPCOA (e.g., T-5: Implement Commute Trip Reduction Program (Voluntary), T-6: Implement Commute Trip Reduction Program (Mandatory Implementation and Monitoring), T-7: Implement Commute Trip Reduction Marketing, T-8: Provide Ridesharing Program, T-9: Implement Subsidized or Discounted Transit Program, T-10: Provide End-of-Trip Bicycle Facilities). The maximum cited reduction potential of up to ~30% is mostly local (not regional as would be the case for VTA) so this measure is considered medium.
Cost Effectiveness	Medium	Potential costs to change internal policies and implement employee-facing programs are low to modest and will depend on the scope and scale of programs and specific services offered. Cost effectiveness may be medium, depending on projected employee participation and actual trip or VMT reductions resulting from new programs or services.
Jurisdictional Control	Medium	VTA has control over employee-facing incentive programs and improving on-site amenities, however successful TDM depends on employee participation and choices made on how to commute to work. VTA can also influence changes in employee commuting by participating in or joining local programs or TMAs and promoting local programs for VTA employees.
Implementation Timeframe	Variable	Timeframe for implementation may include a near-term action (e.g., adopting/updating VTA policy), and near- to mid-term actions to develop and launch new programs and upgrade VTA facilities as needed.

Source: Ascent 2023.

3.4 MATERIALS AND WASTE (MW)

The Materials and Waste (MW) focus area includes strategies, measures, and implementing actions that reduce GHG emissions associated with solid waste generated by VTA's operations and disposed in landfills. The primary strategy under this focus area is **MW-1: Waste Management, Reduction, and Recycling.**

The strategy and measures under this sector are aligned with and supportive of VTA's Sustainability Plan 2020 targets for increasing waste diversion to 50% by FY 2025 and 80% by FY 2040 (VTA 2020: 5), implying landfill rates of 50% by FY 2025 and 20% by FY 2040. Currently, VTA is not on track to meet these targets and has recognized, in annual sustainability reports, that it needs to step up efforts to increase waste diversion which has remained stagnant at approximately 30% for several years.

Strategy MW-1: Waste Management, Reduction, and Recycling

Measure MW-1.1: Require procurement and operational practices that avoid generation of waste (e.g., reusable materials, reduced packaging, and compostable products).

Implementing Actions

- Review procurement policies and procedures; update as needed. For example, StopWaste developed a Sustainable Procurement Policy template that provides a framework and core strategies for waste reduction and avoiding waste generation that can be used by government agencies (StopWaste 2022). CalRecycle also provides State guidance for Environmentally Preferable Purchasing (EPP) and includes guidance on tools, resources, and a range of possible standards or guidelines to use for becoming a "Zero Waste Community" (CalRecycle 2023a, 2023b).
- Develop training for VTA staff on sustainable purchasing, procurement, and operations to maximize avoidance of waste generation.
- Conduct periodic waste audits to measure the success of existing efforts and inform potential changes to policies or procedures, as necessary.

Table 39 Measure MW-1.1 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	The scale of GHG reductions associated with changes in procurement and operations would likely be low, based on the overall lower magnitude of waste sector emissions compared to other sectors and uncertainties in terms of policy and procedural changes.
Cost Effectiveness	Medium	Costs for implementing changes in procurement and operations to avoid waste are expected to relatively low, and when compared to GHG reduction potential a modest degree of cost effectiveness.
Jurisdictional Control	High	VTA has direct control over its procurement and operational policies and procedures.
Implementation Timeframe	Near	Changes in VTA operating policies and procedures could be implemented in the near-term.

Source: Ascent 2023.

Measure MW-1.2: Increase recycling and organic waste diversion at all facilities.

Implementing Actions

- Inventory facilities and identify needs for additional bins to ensure adequate recycling and food waste bins are available in all VTA buildings, including proper signage to inform and educate staff and the public on placing waste in the proper bins for waste, recycling, and food waste/compostable waste disposal.
- Identify potential costs and funding sources to implement, as needed.

Table 40 Measure MW-1.2 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	Each ton of waste diverted from landfills to recycling or composting reduces methane emissions. If the VTA Sustainability Plan 2020 waste diversion targets were achieved for 2040, this would result in an overall reduction of approximately 916 MT CO_2e relative to projected levels in that year. In percentage terms, this 916 $MTCO_2e$ represents about 2 percent of VTA"s total 2021 operational emissions (39,431 MT CO_2e).
Cost Effectiveness	Medium	Costs for implementing changes to increase recycling and organic waste diversion are relatively low, compared to GHG reduction potential.
Jurisdictional Control	Medium	VTA has control over its facilities and placement of bins and signage, however the success of this measure also depends on employee participation and action to increase recycling and proper food waste disposal.
Implementation Timeframe	Near	Completion of an inventory could be completed in the near-term, along with deployment of bins, signage, and training.

Source: Ascent 2023.

Measure MW-1.3: Require food waste composting and composting of biomass generated from landscape maintenance.

Implementing Actions

- Develop and implement a program/plan to provide composting at appropriate site(s) at VTA facilities, and/or identify external contracting opportunities to ensure that compostable materials are diverted to an existing composting facility.
- Identify potential costs and funding sources to implement, as needed.

Table 41 Measure MW-1.3 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	GHG reductions would likely be relatively low compared to current conditions and overall scale of the waste sector of VTA's inventory.
Cost Effectiveness	Medium	Costs for implementing changes to increase recycling and organic waste diversion are relatively modest, compared to GHG reduction potential.
Jurisdictional Control	Medium	VTA has control over its facilities, however reliance on external contractors could affect VTA's control over waste management and diversion outcomes.
Implementation Timeframe	Mid	Program development and identification of on-site vs. off-site options may take several years to fully implement.

Source: Ascent 2023.

Measure MW-1.4: Reduce the generation of construction and demolition (C&D) waste in VTA projects, and increase sustainable materials use and recovery.

Implementing Actions

- Coordinate with permitting agencies and design professionals to determine sustainable materials, C&D diversion requirements, etc., to meet existing codes (e.g., CALGreen), and/or achieve green ratings (e.g., LEED®, Envision) consistent with VTA's Green Buildings Policy.
- Update VTA specifications and Green Buildings Policy to increase the use of recycled materials and the diversion of C&D waste from disposal to recycling and reuse.

Table 42 Measure MW-1.4 Prioritization Scoring and Rationale

Prioritization Criteria	Score	Rationale
GHG Reduction Potential	Low	C&D waste from construction is not included in VTA's emissions inventory. However, GHG reduction potential is expected to relatively low in consideration of limited construction activities.
Cost Effectiveness	Medium	Potential costs would likely be low to moderate to include C&D diversion and reuse in project specifications.
Jurisdictional Control	Medium	VTA has control over specifications for new construction, however full implementation ultimately requires contractor actions to fulfill diversion requirements for C&D waste generated.
Implementation Timeframe	Variable	Implementation of this measure spans all timeframes. Coordination could begin in the near-term to define specific standards or codes that apply, however full implementation would occur during future construction projects across near/mid/long term.

Source: Ascent 2023.

4 QUANTITATIVE GHG ANALYSIS

This section describes the results of GHG emissions reduction quantification for all GHG reduction measures that were determined to be quantifiable (Section 4.1). It also contains an analysis of total estimated GHG reductions from the draft measures relative to VTA's updated baseline and forecasts emissions and VTA's GHG reduction targets in the VTA Sustainability Plan 2020 (Section 4.2).

4.1 QUANTIFICATION OF GHG REDUCTION MEASURES

To create a list of quantifiable measures, the following steps were performed. First, any measures that were deemed unquantifiable (per the "GHG Reduction Potential" table entries in Section 3) were removed from the list. Second, measures for which no activity data were available were removed from the list—for example, no data on future VTA construction projects was included in the inventory or forecast, so measures such as Measure BF-1.5 ("Increase use of electricity and alternative fuels in construction equipment on VTA projects") were removed from consideration. Third, measures only pertaining to GHG reductions for a specific project or site were removed from the list, as specific site-level analysis is not in the scope of this memo. The remaining measures were included in the analysis.

Table 43 below shows the GHG reduction quantification results for these eight remaining measures. A positive number represents a reduction in emissions, and a negative number represents an increase (only one measure, TL-3.1, results in an increase in emissions in VTA Operations, due to additional VMT generated by increasing the frequency of transit services). Results were calculated separately for 1) VTA operations only, including its transit fleet, waste, employee commute, and building emissions and 2) the entire Santa Clara County on-road transportation and rail transportation sectors, which together comprise the countywide transportation inventory (VTA 2023c: 9). As a shorthand, the table and the proceeding text in Section 4 uses "VTA Operations" and "Countywide Transportation" for items 1) and 2) above, respectively.

For Measures TL-3.1, FE-1.2, and FE-4.2, the methods used to quantify GHG emissions are based on those used in the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity: Designed for Local Governments, Communities, and Project Developers*. This document was prepared under the direction of the California Air Pollution Control Officers Association (CAPCOA), and will be referred to in the proceeding text using "CAPCOA" as a shorthand. It describes methods for quantifying emissions reductions from the implementation of mitigation measures, and thus can be used to create climate action plans, master plans, and general plans. Other GHG reduction measures were quantified using techniques developed by Ascent, which are described in detail below.

Table 43 VTA and Countywide Transportation Emissions Reductions, $MTCO_2e$ / Year

Measure	VTA Operations 2030	VTA Operations 2040	VTA Operations 2045	VTA Operations 2050	Countywide Transportation 2030	Countywide Transportation 2040	Countywide Transportation 2045	Countywide Transportation 2050
TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.	-4,573	-381	0	0	7,420	12,305	12,168	13,240
TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.	942	6	0	0	942	6	0	0
BF-1.1: Decarbonize existing VTA buildings by phasing out fossil fuel usage and electrifying water heating and space heating or using renewable fuels such as renewable natural gas (RNG) where appropriate.	68	295	463	675				
BF-1.2: Increase renewable energy, battery storage, and microgrid installations in existing VTA buildings, and/or procure 100% renewable options through local community choice energy (CCE) providers, where applicable.	63	22	0	0				
FE-1.1: Accelerate zero-emission bus (ZEB) and paratransit zero-emission vehicles (ZEV) replacements to ramp up and reduce GHG emissions faster, relative to existing regulations and expected phase-out timelines.	5,543	0	0	0	5,543	0	0	0
FE-1.2: Replace VTA diesel trucks and other non-revenue VTA vehicles with ZEVs.	394	692	859	1,041	394	692	859	1,041
FE-4.2: Encourage and enable VTA employees to use transit, carpool, bike, and telecommute to work to reduce single-occupancy vehicle commute trips and VMT.	32	14	9	7	32	14	9	7
MW-1.2: Increase recycling and organic waste diversion at all facilities.	570	916	1,101	1,294				
Total reductions	**3,039**	**1,564**	**2,432**	**3,017**	**14,331**	**13,017**	**13,036**	**14,288**

Notes: $MTCO_2e$ = metric tons of carbon dioxide equivalent; RNG = renewable natural gas; VMT = vehicle miles traveled; VTA = Santa Clara Valley Transit Authority; ZEB = zero-emission bus; ZEV = zero-emission vehicle.

Source: Ascent 2023.

Key assumptions and notes that help to explain the quantification methods used and results for each quantified measure are discussed below (see Attachment 2: Measures Quantification Workbook for further detail):

- Measures related to building electrification and municipal waste (i.e., BF-1.1, BF-1.2, MW-1.2) were only counted as reducing VTA's GHG emissions, as these items do not affect the County's transportation emissions. Other measures reduce GHG in both VTA operations and the County's transportation sector because they reduce tailpipe emissions in the VTA fleet, which is a subset of the vehicles in the County.
- For the Visionary Network, an implementation start date of 2025 was assumed, with full implementation of the Visionary Network goals by 2040. 2040 was chosen to match VTA's target year in the Sustainability Plan (VTA 2020: 4).
- TL-3.1 was calculated as the sum of two measures from CAPCOA: "T-25. Extend Transit Network Coverage or Hours" and "T-26. Increase Transit Service Frequency" (2021: 178-187).
  - For T-25, it was assumed that transit service hours (or "span" of service) would increase by 5, 16, 21, and 27 percent in 2030, 2040, 2045, and 2050, respectively. These values were linearly interpolated based on the Visionary Network goal of 16 percent by 2040 (VTA 2023e), which implies an approximately 1 percent increase per year. These percentages were applied to the following values from CAPCOA: transit mode share, elasticity of transit demand, statewide mode shift factor, and a ratio of vehicle trip reduction to VMT. The result was a percentage reduction in GHG emissions from community VMT, which was then applied to communitywide on-road vehicle emissions for passenger cars only. Commercial vehicles were excluded from the calculation, as increasing transit hours would not displace commercial activities such as moving freight.
  - For T-26, it was assumed that transit frequency would increase by 18, 54, 72, and 91 percent in 2030, 2040, 2045, and 2050, respectively. These percentages were linearly interpolated based on VTA Visionary Network modeling data (VTA 2023d), which shows an approximately 4 percent increase in frequency each year from 2025 to 2040. These percentages were applied to the following values from CAPCOA: transit mode share, vehicle mode share, statewide mode shift factor, and elasticity of transit ridership with respect to frequency of service.
  - These reductions were then offset by the increased emissions from additional transit VMT that would be required to implement increased hours and frequency.
- TL-3.2 was calculated assuming a 20 percent increase in bus speed by 2040, per the Visionary Network plan (20 percent represents the middle of the range of the plan's possible increases of 10 to 30 percent; see VTA 2023f). A current average bus speed of 11.6 miles per hour was assumed (VTA 2022b). These increases in bus speed result in increased fuel efficiency (and therefore less fuel consumption and lower emissions). To quantify this reduction in fuel consumption, data on the relationship between bus speed and fuel consumption from the California Air Resources Board's EMisson FACtor 2021 Model (EMFAC) was used (CARB 2023).
- BF-1.1 reductions were calculated using the following steps. First, it was assumed that VTA's entire building stock can be retrofitted to use electricity instead of natural gas at the heating source, and that VTA would begin electrification efforts on July 1st, 2026. Second, the following assumptions were made for the percent of building stock that can be electrified: 6 percent by 2030, 25 percent by 2040, 40 percent by 2045, and 58 percent by 2050 (based on Mozingo: 297, prorated for July 1st, 2026 start date). Third, it was assumed that if a building was electrified, the energy required to provide a given amount of heat would only be 78 percent of the energy from natural gas, based on the Annual Fuel Utilization Efficiencies (AFUE) of both fuels (ESC n.d.). Fourth, emissions factors from electricity were applied to the electrified buildings, and subtracted from the reductions from removing the gas heat.
- BF-1.2 reductions were considered to be equal to current legislative-adjusted BAU electric emissions from buildings since these emissions would fall to zero. Note that this measure was evaluated separately from BF-1.1, so the effects of additional electrification are not included.
- FE-1.1 reductions were calculated assuming that 100 percent of paratransit and bus VMT could be electrified by 2040, a target date in keeping with the goal in the Sustainability Report. A linear increase in electric VMT was

calculated to reach this 100 percent target, equating to approximately 5 percent of 2021 values per year. Assuming this rate of electrification, paratransit and bus VMT would be approximately 47 percent electrified by 2030, representing an increase from the current legislative-adjusted electrification forecast of 23 percent. This increase in electrification results in a reduction in emissions factor of approximately 242 grams of CO2e per VMT, as shown in Table 44 below. This reduction in emissions factor was applied to total bus VMT to calculate total emissions reductions. Only 2030 is shown in Table 44 because in all scenarios, the bus and paratransit fleet is fully electric already by 2040, so there is no effect in 2040 and 2045.

Table 44 Bus and Paratransit fleet emissions factors in 2030, grams CO2e/VMT

Current legislative-adjusted scenario (23 percent of VMT electrified)	844
Accelerated (47 percent of VMT electrified)	602
Reduction in emissions factor	242

- FE-1.2 was calculated using Formula A1 from CAPCOA measure "T-30. Use Cleaner Fuel Vehicles" (CAPCOA 2021: 203-209). This formula uses existing emissions factors for conventional vehicles, battery efficiencies (in kWh per mile) derived from EMFAC, and the carbon intensity of electricity. 2050, the latest year in the forecast horizon, was chosen as the target year for full electrification because electrification of these vehicles (many of which are heavy-duty trucks) will likely take longer than passenger car and light-duty vehicles, due to the lack of commercially available heavy-duty electric vehicles. To calculate electrification targets for earlier years, linear interpolation was used. This resulted in percentages of 31, 66, and 83, and 100 percent of the non-revenue fleet being converted to electric by 2030, 2040, 2045, and 2050 respectively.
- FE-4.2 used CAPCOA measure "T-5. Implement Commute Trip Reduction Program (Voluntary)" to calculate emissions reductions (CAPCOA 2021: 83-85). There was no data available on which of VTA's employees would be eligible for transit, carpool, bike to work, or telecommute (some employees may not be eligible due to job duties or work schedule). Therefore, as an upper bound estimate, it was assumed that 100 percent of employees were eligible for transit, carpool, biking to work, or telecommute.
- MW-1.2 assumed landfill rates of 40 percent, 20 percent, 10 percent, and zero percent in 2030, 2040, 2045, and 2050 respectively. These percentages were linearly interpolated based on the Sustainability Plan landfill rate targets of 50 percent by 2025 and 20 percent by 2040. The percentages were applied to a forecast of VTA waste tonnage per year based on a linear regression of historical data. The result was compared to the waste tonnage based on current legislative-adjusted forecast landfill rates (63, 55, 52, and 48 percent for 2030, 2040, 2045, and 2050, respectively) to obtain a reduction quantity.

In summary, the implementation of all quantifiable measures would result in a GHG emission savings of 3,017 MT CO2e by 2050 for VTA operations only, and 14,288 for countywide transportation. This is equivalent to removing approximately 729 and 3,451 gasoline-powered passenger cars from the road for a year, respectively.

4.2 ANALYSIS OF ESTIMATED GHG REDUCTIONS RELATIVE TO BASELINE, FORECASTS, AND ADOPTED TARGETS

VTA OPERATIONS

VTA's Sustainability Plan 2020 established a GHG emissions reduction target of 90 percent below a 2009 baseline by 2040 (i.e., 2040 emissions should be 10 percent of 2009 levels) for VTA operations. Without implementing the measures described above, VTA is projected to reduce emissions by approximately 93 percent by 2040, and 95 percent by 2050. This is due largely to VTA's Zero Emission Bus Program, and additional legislative reductions described in the VTA Transit Operations GHG Emissions Inventory and Forecast memo. If the proposed measures are implemented, VTA is projected to reduce emissions by approximately 96 percent by 2040 and 99 percent by 2050. Both of these reduction percentages exceed the 2040 target of 90 percent reduction in the Sustainability Plan and the statewide goal of reducing GHG emissions 85% by 2045 under Assembly Bill 1279 (2022).[9] By focusing on GHG reductions across all sectors in VTA's operational inventory, VTA is providing substantial contributions on the path to carbon neutrality.

Table 45 Comparison of VTA Operations GHG Reductions to 2009 Baseline, 2040 Target, and Legislative-adjusted BAU Forecast

Scenario	Quantity	Units
2009 Baseline Emissions for VTA transit operations	69,895	MT CO_2e
2040 Target emissions level (90% reduction below 2009)	6,989	MT CO_2e
Legislative-adjusted BAU forecast emissions without measure implementation in 2040	4,546	MT CO_2e
Legislative-adjusted BAU forecast emissions with measure implementation in 2040	2,982	MT CO_2e
Emissions reductions without measure implementation in 2040	93%	Percent
Emissions reductions with measure implementation in 2040	96%	Percent
Legislative-adjusted BAU forecast emissions without measure implementation in 2050	3,629	MT CO_2e
Legislative-adjusted BAU forecast emissions with measure implementation in 2050	613	MT CO_2e
Emissions reductions without measure implementation in 2050	95%	Percent
Emissions reductions with measure implementation in 2050	99%	Percent

COUNTYWIDE TRANSPORTATION

VTA does not have established GHG reduction targets for countywide transportation emissions. Table 46 below summarizes the total GHG reductions from quantified GHG reduction measures that are applicable to countywide transportation and compares these reductions to total forecasted emissions in the forecast years. These reductions represent between 0.54 percent and 2.2 percent, depending on the year, of total County passenger vehicle transportation emissions (defined as the sum of emissions from drive-alone trips, carpool, autonomous vehicle, and transportation network company VMT) in each of the forecast years, as shown in the table below.

Table 46 Countywide Transportation GHG Reductions from Measure Implementation (MT CO_2e)

	2030	2040	2045	2050
GHG Reductions from quantified measures applicable to Countywide Transportation	14,331	13,017	13,036	14,288
Total legislative-adjusted countywide transportation emissions forecasts for passenger vehicles	2,654,587	1,194,896	810,104	649,078
Reductions as percent of total forecast emissions	0.54%	1.09%	1.61%	2.20%

GHG quantification and reduction values discussed in Sections 4.1 and 4.2 were adjusted following VTA's review of the revised draft GHG Memo to reflect changes in measure quantification methods, adjustments to assumptions or calculations. Final quantification will also need to consider and incorporate staff's final comments and direction on which measures should be included or not included in the CAAP in the next section.

[9] AB 1279 (2022) and the 2022 Climate Change Scoping Plan established a statewide 85% GHG emissions reduction target by 2045, as well as a net-zero GHG target in 2045 assuming that any remaining emissions would be offset by carbon capture, utilization, and storage projects and associated regulations; natural sequestration; or a combination thereof.

5 RECOMMENDATIONS

This section provides recommendations to VTA staff regarding GHG reduction measures that should be prioritized for inclusion in the CAAP, along with a brief discussion of why certain measures should not be included.

5.1 RECOMMENDED GHG REDUCTION MEASURES

After reviewing the results of the draft GHG reduction measures analysis in Section 3 (including staff's comments on the first draft of this Memo), along with the quantification results in Section 4, Ascent recommends that 33 out of the 39 measures analyzed in Section 3 be prioritized in the CAAP. This includes seven out of the eight quantified measures discussed in Section 4. The full proposed list of measures for inclusion in the CAAP is shown in Table 47 below, followed by a brief explanation of why these measures should be included.

Table 47 Proposed GHG Reduction Measures for the CAAP

Focus Area	Strategy	Measure
Transportation and Land Use (TL)	TL-1: Sustainable Roadway Networks and Pricing	TL-1.1: Assist VTA member agencies in implementing SB 743 and mitigating VMT from new land development projects and transportation projects.
		TL-1.2: Continue to build out the countywide Express Lane network to use roadway pricing as a tool to provide reliable travel options and generate a revenue stream for projects that improve the operations of HOV lanes and transit.
	TL-2: Safe and Accessible Active Transportation for All	TL-2.1: Increase bicycle and pedestrian infrastructure and improve the safety of existing facilities, prioritizing investments in disadvantaged communities.
		TL-2.2: Encourage and support efforts to plan and build walkable and bikeable communities, accessible to people of all income levels and races.
		TL-2.3: Support local, county, state, and federal efforts to promote use of electric bicycles as an alternative to driving.
		TL-2.4: Support education and encouragement programs that promote replacing polluting travel with low-emission travel.
	TL-3: Fast, Frequent, and Reliable Public Transportation for All	TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.
		TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.
	TL-4: Sustainable Land Use, Planning, and Development	TL-4.1: Collaborate with member agencies in advanced planning efforts to increase residential and employment densities and expand mixed-use development potential near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).
		TL-4.2: Increase development around transit stations and along transit corridors to facilitate multi-modal, carbon-neutral neighborhoods that are sustainable and resilient.
		TL-4.3: Strategically repurpose underutilized parking lots or other vacant lots at or near VTA transit stations and major transit stops into lively mixed-use, transit-oriented communities with activated ground floor uses that increase transit ridership, help provide revenue for transit capital investments and operations, and reduce VMT.
		TL-4.4: Provide people of all generations and backgrounds with affordable housing and access to the necessities of daily life available within a short walk, bicycle ride, or transit trip.

Focus Area	Strategy	Measure
		TL-4.5: Work with member agencies and other partners to focus development where it already exists (i.e., promote infill development) and reduce the impact of development and transportation infrastructure on the environment by protecting open space, conserving and restoring habitat, enhancing biodiversity, increasing carbon sequestration, and improving wildlife connectivity.
	TL-5: Smart Parking and Curbside Management	TL-5.1: Support local efforts to reduce or eliminate minimum parking standards and institute parking maximums, require "unbundling" of parking costs from commercial leasing or residential rental rates, support shared parking, and introduce demand-based parking pricing in public on- and off-street parking facilities.
		TL-5.2: Provide EV charging infrastructure at VTA parking facilities open to the public.
	TL-6: Smart Mobility and Transportation Demand Management (TDM)	TL-6.1: Increase participation in smart commute and mobility options throughout the county including bicycle sharing, ridesharing, car-sharing, mobility-as-a-service, guaranteed ride home programs, carpools, vanpools, and other emerging options.
		TL-6.3: Expand TDM programs and services in partnership with member agencies, employers, schools, and residential communities.
Buildings and Facilities (BF)	BF-1: Clean and Renewable Energy	BF-1.1: Decarbonize existing VTA buildings by phasing out fossil fuel usage and electrifying water heating and space heating or using renewable fuels such as renewable natural gas (RNG) where appropriate.
		BF-1.2: Increase renewable energy, battery storage, and microgrid installations in existing VTA buildings, and/or procure 100% renewable options through local community choice energy (CCE) providers, where applicable.
		BF-1.3: Require all new VTA buildings to be 100% electric and include on-site renewable energy systems with battery storage and microgrids and achieve net-zero standards where feasible.
		BF-1.4: Increase use of electricity and alternative fuels in construction equipment on VTA projects.
	BF-2: Energy Efficiency and Reliability	BF-2.1: Upgrade outdoor lighting at VTA buildings, and at park-and-ride lots and stations to LEDs or other high-efficiency lighting.
		BF-2.2: Reduce energy use in VTA buildings through conservation best practices consistent with LEED®, ENERGY STAR®, or other standards.
Fleet and Employee Commute (FE)	FE-1: Zero-Emission Vehicles	FE-1.2: Replace VTA diesel trucks and other non-revenue VTA vehicles to ZEVs.
		FE-1.3: Expand electric vehicle (EV) and electric bicycle charging infrastructure at VTA buildings to support VTA fleet EVs and employee bicycles.
	FE-2: Zero-Emission Equipment	FE-2.1: Use cleaner fuel, such as renewable diesel, for off-road equipment and construction equipment where feasible.
		FE-2.2: Require ZEV or low-emission vehicle (LEV) equipment in VTA projects.
	FE-3: Operational Efficiency	FE-3.1: Maximize the operational efficiency of VTA vehicles, including reducing vehicle idling.
	FE-4: Employee Commute	FE-4.1: Monitor employee commute patterns to understand employee behaviors, needs, and overall contributions to VTA's operational GHG inventory.
		FE-4.2: Encourage and enable VTA employees to use transit, carpool, bike, and telecommute to work to reduce single-occupancy vehicle commute trips and VMT.

Focus Area	Strategy	Measure
Materials and Waste (MW)	MW-1: Waste Management, Reduction, and Recycling	MW-1.1: Require procurement and operational practices that avoid generation of waste (e.g., reusable materials, reduced packaging, and compostable products).
		MW-1.2: Increase recycling and organic waste diversion at all facilities.
		MW-1.4: Reduce the generation of construction and demolition (C&D) waste in VTA projects, and increase sustainable materials use and recovery.

Source: Ascent 2023.

We recommend that seven out of the eight quantifiable measures identified under Section 4 be included in the CAAP (see discussion further below under subsection 5.2 regarding removal of FE-1.1). It is important to include as many quantifiable measures as possible in the CAAP, and of those that are quantifiable and recommended, they appear to be feasible and are generally aligned with VTA's sustainability goals.

Many of the recommended measures are difficult to quantify at the plan level because quantification is not possible without project-specific details, however several of them are still considered to have at least medium GHG reduction potential and thus should still be included.

While some of the recommended GHG reduction measures were found to have low GHG reduction on their own individually, they may still have considerable GHG reduction potential as a group within a particular strategy or group of strategies. For example, regarding the suite of measures identified under Strategy TL-4: Sustainable Land Use, Planning, and Development; Strategy TL-5: Parking Management and Pricing; and, Strategy TL-6: Smart Mobility and TDM, VTA has an ongoing opportunity to support and collaborate in planning, development review, and community design-focused activities of member agencies who may have a higher degree of jurisdictional control over local land use or right of way improvements under these strategies.

Finally, many of the recommended measures achieve several co-benefits, including addressing the needs of disadvantaged communities, or protecting the environment and public health.

5.2 GHG MEASURES RECOMMENDED FOR REMOVAL

We recommend that the following six measures not be considered further for inclusion in the CAAP. Specific reasons are included under each measure.

- TL-1.3 (Enhance the efficacy and performance of HOV lanes)
  - This measure will not be included in the CAAP following discussions with VTA staff. VTA has no jurisdiction and limited influence over HOV lanes, which are under the jurisdiction of Caltrans and enforced by the California Highway Patrol.
  - Measure TL-1.2 is a priority for VTA at this time, given that federal and state agencies are actively supporting local efforts to transition HOV lanes to Express Lanes.
- TL-6.2 (Channel the deployment of autonomous vehicles, ride-hailing services, and other new mobility options…)
  - VTA's jurisdictional control over AV's and other privately operated services is low and the implementation timeframe and approach are unclear.
  - Staff comments on this measure expressed concern regarding VTA's lack of authority or ability to form partnerships with these private companies, largely due to their track record of very limited cooperation with public agencies around the United States. Staff comments also indicated that without a clear sense of how

this measure would be implemented in practice and given the lack of helpful precedents or examples, it may not be worth exploring or developing further.

- BF-2.3 (Update VTA's policies…to increase energy efficiency and complete energy audits of existing buildings)
  - Staff comments indicated that this measure overlaps with Measure BF-1.1 (Decarbonize existing buildings) as both include implementing actions that relate to energy efficiency. Rather than combine measures together, we recommend removing BF-2.3 altogether if VTA staff agrees that the implementation actions for BF-1.1 would include audits of existing facilities that could address both energy efficiency and decarbonization approaches when considering a holistic, comprehensive approach to energy in existing VTA buildings.
- BF-2.4 (Microgrids)
  - Edits to BF-1.2 and BF-1.3 include references to microgrids as part of increasing renewable energy, battery storage, and microgrids in existing or new buildings. Thus, a separate measure for microgrids is not included for GHG reduction purposes.
- FE-1.1 (Accelerate zero-emission bus (ZEB) and paratransit zero-emission vehicles (ZEV) replacements…)
  - Staff comments indicated that the ZEB transition is already occurring at a measured pace that balances cost, risk, and potential disruptions to VTA's ability to provide service; and that accelerating the transition could result in serious costs from making wrong decisions that could harm VTA's ability to provide reliable service to the public.
  - As noted in the VTA inventory and forecast, existing laws and regulations are either in place or are reasonably foreseeable and would result in substantial reduction and eventual elimination of revenue and non-revenue GHG emissions over the long-term, regardless of whether VTA accelerates ZEB and paratransit replacements. Thus, achievement of VTA's longer-term 2040 target would not be impeded by eliminating this measure.
- MW-1.3 (Require food waste composting and composting of biomass generated from landscape maintenance)
  - Staff commented that the State already requires composting of organics via SB 1383, and that therefore, MW-1.3 is not needed.
  - Staff also pointed out that MW-1.2 addresses recycling and organic waste diversion more broadly and could overlap with the intent of this measure.

5.3 NEXT STEPS

In conclusion, the menu of strategies, measures, and implementing actions identified in this section represent the most effective way to reduce GHG emissions based on the prioritization criteria. They will be included in the draft CAAP for consideration by stakeholders and the public. Refinements will continue to be made based on the input received during the CAAP review process.

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ATTACHMENT 1 – GHG REDUCTION MEASURES WORKBOOK

A copy of the draft GHG Reduction Measures Workbook file in Excel format will be transmitted with this memo. While not embedded in this Word document directly, the separate Excel file is considered an attachment to and supportive of the information contained in this memo. Please see the main body of the memo for an explanation of the GHG Reduction Measures Workbook and its purpose and contents.

ATTACHMENT 2 – MEASURES QUANTIFICATION WORKBOOK

A copy of the draft Measures Quantification Workbook file in Excel format will be transmitted with this memo. While not embedded in this Word document directly, the separate Excel file is considered an attachment to and supportive of the information contained in this memo. Please see the main body of the memo for an explanation of the Measures Quantification Workbook and its purpose and contents.

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Appendix D

Climate Vulnerability Assessment and Adaptation Analysis

Memo

Date: August 25, 2023

To: Lani Lee Ho, Santa Clara Valley Transportation Authority

From: Michael Mak, P.E., Sierra Ramer, Katie Riles, Hilary Papendick, Kris May, P.E., Ph.D. (Pathways Climate Institute); and Erik de Kok, John Steponick, Honey Walters (Ascent)

Subject: VTA CAAP – Final Adaptation and Resiliency Memorandum

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1 INTRODUCTION

The Santa Clara Valley Transportation Authority (VTA) provides sustainable, accessible, community-focused transportation options to get residents to where they need to go in Santa Clara County (e.g., bus, light rail, and paratransit services). In addition, VTA provides congestion management, bicycle and pedestrian planning, funding for regional transit, highway design and construction, and supports transit-oriented development (Valley Transportation Authority 2023a; 2016). Climate change has already affected VTA's infrastructure and operations and will continue to do so in the future. These impacts are anticipated to worsen if no action is taken to adequately prepare and address vulnerabilities. Using funding from a Caltrans Sustainable Transportation Planning Grant, VTA is taking steps to address climate change by completing a transportation-specific Climate Action and Adaptation Plan (CAAP) that will identify specific actions to minimize contributions to climate change, as well as to adapt and build resilience to long-term climate impacts (Valley Transportation Authority 2023b).

1.1 CLIMATE ACTION AND ADAPTATION PLAN OBJECTIVES

The objectives of the CAAP are to:

1. Quantify VTA and countywide transportation-related greenhouse gas (GHG) emissions.
2. Identify measures to reduce VTA's contribution to climate change by reducing GHG emissions from its operations. Identify actions VTA can take in partnership with agencies and the community to reduce vehicle miles traveled (VMT).
3. Conduct a vulnerability assessment that identifies the risks to transportation assets from climate change impacts and actions that can be taken to protect these assets for the public good.

This memorandum supports the third CAAP objective, provides the results of a detailed climate vulnerability assessment, and recommends relevant adaptation strategies to address the vulnerabilities. The objectives include:

1. Identify climate change threats that may impact VTA's infrastructure and operations.
2. Assess the vulnerability of VTA's infrastructure and operations.
3. Identify and prioritize adaptation strategies and actions to improve VTA's resilience.

1.2 DOCUMENT ORGANIZATION

This memorandum includes the following sections:

Section 1. Introduction

- Climate Action and Adaptation Plan Objectives
- Document Organization
- Memo Summary

Section 2. Glossary of Terms

Section 3. Adaptation Planning Process (Overview)

- Overview of Process

Section 4. Climate Impacts and Trends

- Past Impacts
- Climate Hazards
- Future Trends

Section 5. Assets and Data Sources

- Physical Assets
- Operations Assets
- Data Sources and Scenarios

Section 6. Vulnerability and Consequence Assessment - Approach

- Vulnerability
- Consequences
- Validation Workshop

Section 7. Exposure and Vulnerability Findings

- Summary of Assets Exposed
- Summary of Vulnerability Scores
- Asset Vulnerability Profiles
- Cascading Impacts

Section 8. Adaptation Strategies

- Framework
- Evaluation Criteria
- Strategies and Potential Actions

Section 9. Next Steps

- Data Gaps
- Caveats and Uncertainties

Section 10. References

Attachments

- Attachment 1 - Climate Science and Scenarios Selection
- Attachment 2 – VTA Vulnerability and Consequences Workshop (5.12.23) Summary
- Attachment 3 – Vulnerability Profile – Facilities
- Attachment 4 – Vulnerability Profile – Light Rail and Substations
- Attachment 5 – Vulnerability Profile – Bus and Paratransit
- Attachment 6 – Vulnerability Profile – Operations
- Attachment 7 – Asset Vulnerability Ratings (Excel)
- Attachment 8 – Adaptation Strategies Workbook (Excel)

1.3 MEMO SUMMARY

This memo includes the results of a climate vulnerability assessment that evaluated how climate hazards including sea-level rise, inland flooding, wildfire, extreme heat, and drought could affect VTA facilities, light rail, bus routes and stops, popular paratransit destinations, and operations based on current and future conditions. The memo also includes proposed strategies and actions VTA can take to adapt to climate change and increase the resilience of VTA's assets and operations.

VTA assets and operations are highly vulnerable to climate impacts, with the highest overall vulnerability to flooding and extreme heat in terms of consequences and number of assets affected. In addition, a key vulnerability is that many VTA assets depend on electricity, and the power grid is vulnerable to extreme heat, flooding, and wildfire. With a loss of electricity, VTA could experience cascading impacts, where an impact to one part of VTA's system causes a ripple effect throughout the entire VTA network and connected community services. VTA provides aid to surrounding communities and impacts from climate change could affect VTA's ability to provide these services.

- Extreme Heat: The rise in temperature and frequency of extreme heat events will have significant consequences for multiple aspects of VTA's assets and operations, including buckling of light rail tracks, slowed service speeds, overheating of substations, signal houses, and IT equipment, and unsafe conditions for workers and riders. In addition, heat can lead to power outages, which can make it difficult for battery electric buses to charge and have cascading impacts throughout VTA's service area, as light rail, transit centers, and other facilities depend on electricity but not all aspects of VTA operations have backup power sources.
- Flooding: For sea-level rise, the assessment evaluated permanent coastal inundation due to permanent sea-level rise and temporary coastal flooding from sea-level rise coupled with a 1%-annual-chance (100-year) storm surge, focusing on the 2050 time horizon but also up to the year 2100 to account for lower asset vulnerability. The assessment also evaluated assets that are exposed to creek and riverine flooding from a 100-year and 500-year storm event. Flooding could lead to asset damage, loss of access to facilities and routes, transit delays and loss of service, and the need to relocate structures if they are permanently inundated. Flooding could also submerge substations, which could lead to a loss of power and cause cascading impacts.
- Drought: Warmer temperatures, variable snowpack and precipitation, and earlier snowmelt caused by climate change, make for longer and more intense dry seasons. Drought could lead to water shortages, which could make it difficult to properly clean and maintain buses, and could increase dust and debris, leading to service disruptions, and increased costs or fines with water use. Moisture loss from soils and vegetation contribute to drier conditions and may lead to increased plant mortality and increased wildfire risk. It could also lead to soil subsidence, which could damage tracks, facilities, and roads.
- Wildfire: The majority of bus routes are vulnerable to wildfire, with almost 70% of routes (45 of 67) having at least one segment at risk to wildfire. Wildfire could damage VTA assets if burned or ash fell on equipment. Wildfire smoke could cause health impacts to VTA workers and riders.

Additional findings from the vulnerability assessment for specific VTA assets and operations are presented in Section 7.

There are several next steps that VTA can take to reduce vulnerabilities to current and future climate hazards. A key next step could be to develop adaptation plans for key facilities and operations that outline strategies VTA could take over time, as climate conditions change, known as adaptation pathways. Some of these actions include elevating substations and providing backup power to critical parts of VTA's service network. Community engagement and a focus on disadvantaged and vulnerable communities is also an important component of next steps. A detailed list of proposed adaptation strategies and actions is included in Section 8 (Adaptation Strategies).

2 GLOSSARY OF TERMS

The following terms are used throughout this memorandum.

- **Adaptation:** The modifications made to adjust to the effects of actual or expected climate changes to mitigate harm on the VTA system.
- **Adaptive Capacity:** The inherent ability of an asset, system, or group of people (here: VTA system) to adjust to an impact without the need for significant intervention or modification — and/or existing flexibility or redundancy within a system — that allows for continued functionality when a system is under stress. Also, the existing/inherent ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequence. (An element of Vulnerability.)[1]
- **Asset:** Specific physical infrastructure managed by VTA.
- **Cascading Impacts**: sequence of secondary events in natural and human systems caused by extreme climate events that result in physical, natural, social, or economic disruption, whereby the resulting impact is significantly larger than the initial impact.[2]
- **Climate Projection:** The simulated response of the climate system to a global GHG emissions scenario, developed using climate models.[3]
- **Consequence:** The results or effects of climate change impacts on society, equity, the economy, or the built and natural environment including: 1) system failures, 2) damage to the environment, 3) reduced or disrupted service to customers, and 4) long-term financial impacts, such as increasing repair/replacement costs.
- **Cooling Degree Days:** Degree Days measure the difference between the mean daily temperature and 65 degrees Fahrenheit (F). Cooling Degree Days are the difference between a mean temperature that is above 65 degrees. For example, a mean temperature of 80 degrees has 15 cooling Degree Days.[4]
- **Daily High Tides:** Represented by the Mean Higher High Water tidal datum, which is the average height of the higher high tides of each day during the current National Tidal Datum Epoch, which is a specific 19-year period (1983 to 2001) adopted by NOAA to perform tidal computations.
- **Disruption:** An interruption or barrier to providing ongoing services to VTA customers.
- **Mid-Century:** Mid-century (i.e., 2035–2064). Climate projections for each of the 30 years in a time horizon are averaged to account for natural climate variability across shorter time periods. See Attachment 1, *Climate Science Methodology*, for additional information.
- **Exposure:** The presence of people, assets, systems, or resources in areas that are subject to a hazard. (An element of Vulnerability.)[5,6]
- **Global Climate Model (GCM):** A numerical representation of the climate system, applied as a research tool to study and simulate the climate and future projections.[7]

[1] IPCC's Climate Change 2014 Synthesis Report (IPCC 2014).
[2] IPCC's Climate Change 2022 Synthesis Report (IPCC 2023)
[3] IPCC's Climate Change 2014 Synthesis Report (IPCC 2014).
[4] National weather Service: https://www.weather.gov/key/climate_heat_cool (2023)
[5] IPCC's Climate Change 2014 Synthesis Report (IPCC 2014).
[6] California Adaptation Planning Process (California Governor's Office of Emergency Services 2020).
[7] IPCC's Climate Change 2014 Synthesis Report (IPCC 2014).

- **Hazard:**
  - **Climate Hazard:** A climate change variable which may negatively impact any asset, such as sea-level rise, large storm surge events, temperature extremes, or watershed flooding.
  - **Operational Hazard:** The implications of climate stressors on operations and associated services required for system performance.
- **Infrastructure:** The basic systems and services, such as transportation and power supplies, that a country or organization uses in order to work effectively.[8]
- **Lifelines:** Systems or networks that provide for the circulation of people, goods, services, and information that are vital for the health, safety, comfort, and economic activity of a community.[9]
- **Permanent Inundation:** Occurs when an area is regularly covered by daily tidal fluctuations, due to sea-level rise. As sea level rises, additional areas will potentially be subjected to permanent inundation.
- **Potential Impact:** The possible consequences or outcomes of risks because of vulnerability, driven primarily by exposure and sensitivity and mitigated by adaptive capacity.[10]
- **Operations:** The actions, techniques, and processes undertaken by VTA and required to provide services.
- **Representative Concentration Pathway (RCP):** A scenario that represents time-dependent projections of global greenhouse gas concentrations. The pathways (e.g., RCPs 4.5 and 8.5) represent the trajectories of different climate futures, depending on the volume of future global GHG emissions.[11]
- **Risk:** The potential damage or disruption to VTA's system resulting from climate hazards.[12]
- **Sensitivity:** The level to which an asset, system, or group of people would be affected by changing climate conditions; the degree to which a system is affected, either adversely or beneficially, by a hazard. Sensitivity scores are reflective of VTA's current system. (An element of Vulnerability.)[13]
- **Social Vulnerability Index:** an index that indicates the relative overall social vulnerability of communities (at a census tract level) based on social factors.
- **Storm Surge:** an abnormal rise of water generated by high winds and low atmospheric pressure in the presence of a storm that is over and above the predicted astronomical tide. The magnitude of a storm surge and the height of an astronomical tide are additive: when the sum of the two is unusually large, an extreme tide occurs.
- **Temporary Flooding:** occurs when an area is exposed to episodic, short duration, extreme tide events of greater magnitude than normal tide levels. Inland areas may be temporarily flooded during an extreme tidal event, while maintaining at least a portion of their functionality once the floodwaters recede.
- **Urban/Riverine Flooding:** landward flooding in urban areas when creeks and rivers are overtopped during rainfall driven storm events.
- **Vulnerability:** The degree to which natural, built, and human systems are susceptible to adverse effects of climate change. For buildings and other structures, vulnerability means susceptibility to damage given the inherent characteristics of a particular structure. Its broader meaning is the level of exposure of human life and property to damage from natural and human-made hazards. Vulnerability can increase because of physical (built and environmental), social, political, and/or economic factor(s). Vulnerability is composed of the following elements: Exposure, Sensitivity, and Adaptive Capacity.

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[8] Cambridge Dictionary: https://dictionary.cambridge.org/us/dictionary/english/infrastructure (2023).
[9] This definition is from Platt's 1991 article on Lifelines (Platt 1991).
[10] IPCC's *Climate Change 2014 Synthesis Report* (IPCC 2014).
[11] IPCC's *Climate Change 2014 Synthesis Report* (IPCC 2014).
[12] IPCC's *Climate Change 2014 Synthesis Report* (IPCC 2014).
[13] California Adaptation Planning Process (California Governor's Office of Emergency Services 2020).

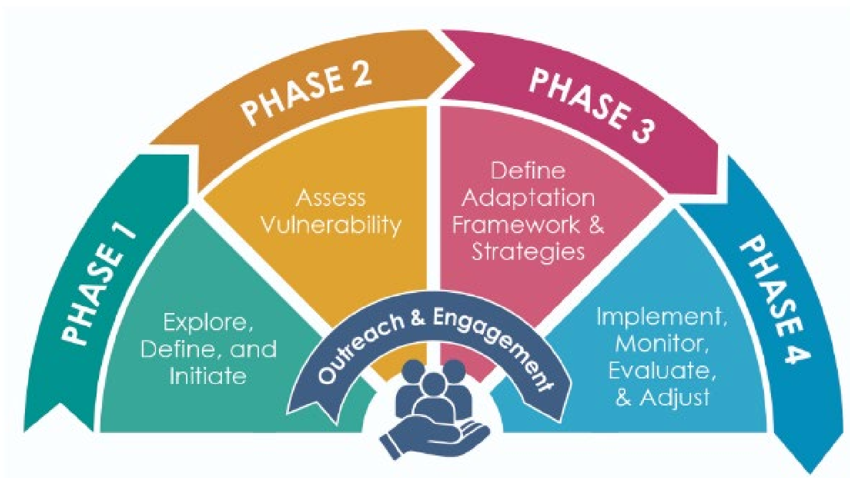
3 ADAPTATION PLANNING PROCESS (OVERVIEW)

The consultant team followed the adaptation planning process outlined in the California Adaptation Planning Guide (APG) in the preparation of the vulnerability assessment and adaptation strategies described in this memo. The APG, developed by the California Office of Emergency Services and updated in 2020, is a guidance document designed to support local, regional, and tribal governments in California (California Governor's Office of Emergency Services 2020). The APG is known as the state's best comprehensive guidance for assessing climate vulnerability on the local level.

This memorandum also builds off existing climate adaptation efforts already completed by Santa Clara County and others, including Silicon Valley 2.0, Santa Clara County Climate Collaborative, and the City of Palo Alto's Sea-Level Rise Vulnerability Assessment (Santa Clara County 2023b; 2015; 2023a; AECOM and Pathways Climate Institute 2022). It also builds on regional efforts such as the SamTrans Adaptation and Resilience Plan (WSP 2021) and the San Francisco Bay Conservation and Development Commission's (BCDC) Adaptation to Rising Tides program (BCDC 2023). The consultant team strengthened the vulnerability assessment by including a qualitative consequence assessment, highlighting key consequences for operations and asset classes. Using these existing efforts as a foundation, this memorandum provides a more detailed analysis of the vulnerability of VTA's assets and operations to climate impacts.

3.1 OVERVIEW OF PROCESS

The APG provides a four-step process for planning and adapting to climate change impacts (see Figure 1). The results of the vulnerability assessment and proposed adaptation strategies are aligned with Phases 1 through 3, and the memo provides recommendations on the next steps for initiating Phase 4.



Source: California Governor's Office of Emergency Services 2020.

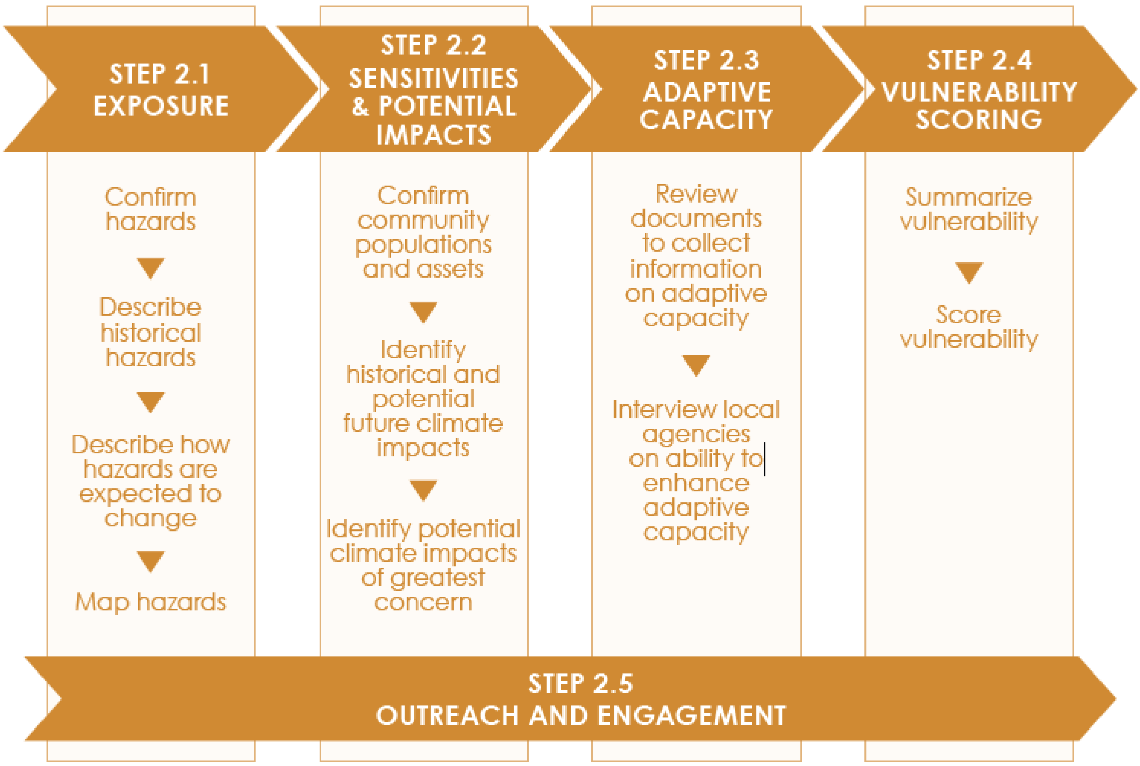
Figure 1 California Adaptation Planning Process

3.1.1 Phase 1. Explore, Define, and Initiate

The first step in Phase 1 includes the initial actions needed to establish the project outcomes, scope, partners, resources, and the community engagement approach needed to complete the project. The steps in the APG include developing the scope of the process and the outcome for the effort and assembling the project team and the resources needed for a successful project. This phase also includes identifying the relevant climate impacts and preparing an equitable outreach and engagement approach. VTA has already initiated these efforts by scoping the CAAP project, securing funding, and initiating engagement and outreach activities with internal and external stakeholders.

3.1.2 Phase 2. Assess Vulnerability

This Phase includes development of the vulnerability assessment. There are four main components: evaluating exposure, sensitivity and potential impacts, adaptive capacity, and completing vulnerability scoring, as shown in Figure 2. Sections 4 through 7 of this memo are aligned with Phase 2.



Source: California Governor's Office of Emergency Services 2020.

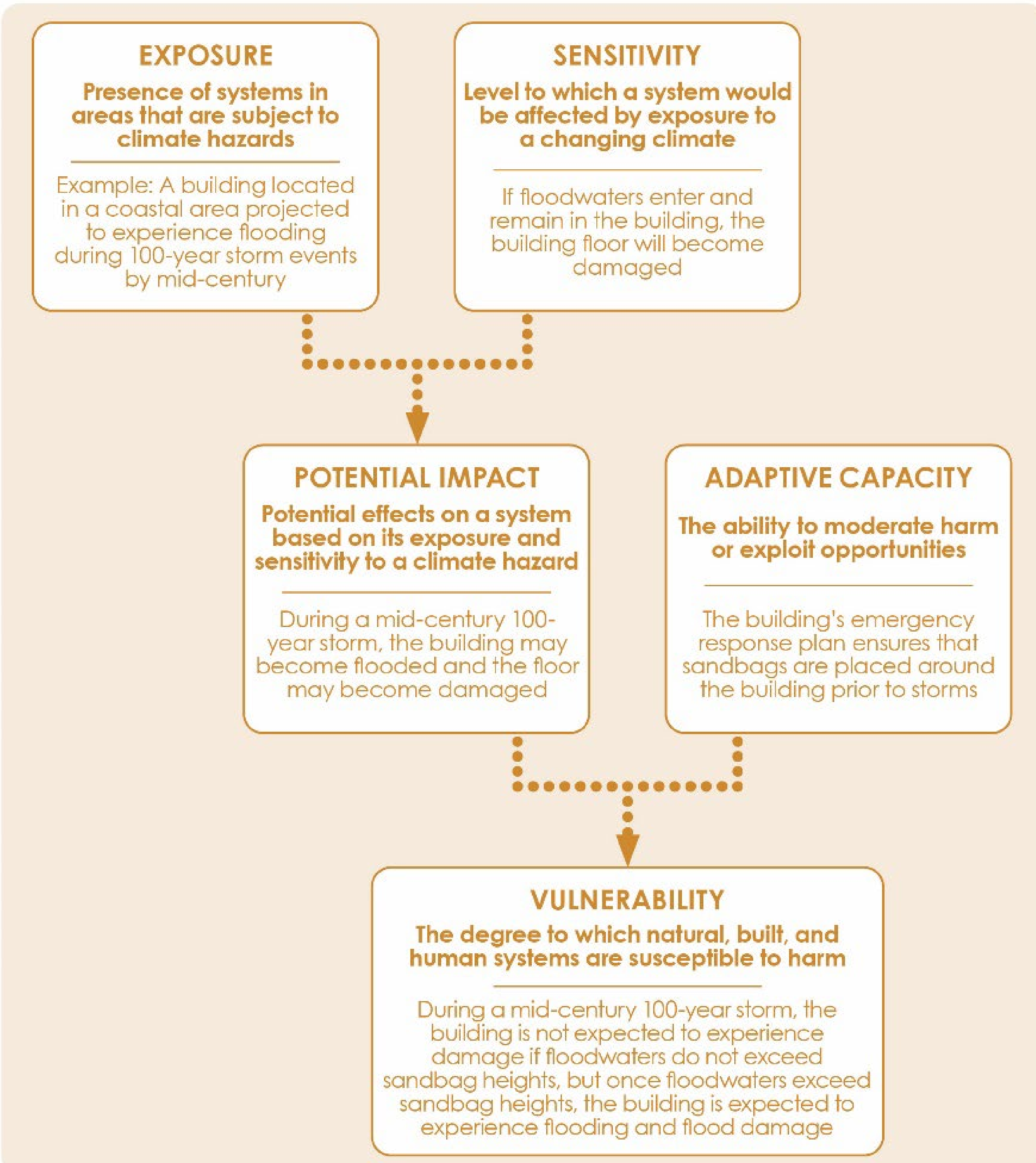
Figure 2 Steps in Phase 2 Assess Vulnerability

Exposure: As shown in Figure 3, exposure is the "presence of systems in areas that are subject to climate hazards." The purpose of evaluating exposure is to narrow down which assets or populations have the potential to be affected by climate change. If an asset is not in an area anticipated to be affected by climate change, then it is not vulnerable to climate impacts and it does not need to be included in the vulnerability assessment. For example, if a VTA asset is in an area that is known to flood regularly during winter storms, it is exposed to flooding. If a VTA asset is in an area that is projected to be permanently inundated in the future with sea-level rise, it will be exposed to sea-level rise in the future if no actions are taken.

Sensitivity: The next step is to assess sensitivity and potential impacts. Sensitivity is the "level to which a system would be affected by exposure to a changing climate" (California Governor's Office of Emergency Services 2020). The purpose of evaluating sensitivity is to understand which assets and community populations are likely to be affected by climate impacts, and to understand which climate impacts are of greatest concern for an asset or community.

Adaptive Capacity: The next step is to evaluate adaptive capacity. The goal of evaluating adaptive capacity is to assess an asset or community's "current ability to cope with climate impacts" (California Governor's Office of Emergency Services 2020).

Vulnerability Scoring: Vulnerability is the "degree to which a natural, built, and human systems are susceptible to harm" (California Governor's Office of Emergency Services 2020). This step involves assigning a score to each asset or population. The goal of systematic scoring is to identify priority climate vulnerabilities. The vulnerability scores are calculated based on adding the exposure and sensitivity scores and subtract adaptive capacity.



Source: California Governor's Office of Emergency Services 2020.

Figure 3 Assessing Vulnerability to Climate Hazards

3.1.3 Phase 3. Define Adaptation Framework and Strategies

In Phase 3, the project team takes the vulnerability assessment results and uses them to inform the development of an Adaptation Framework and Strategies. During this Phase, the project team develops strategies within the policy framework of the planning effort, for example, as measures of a Climate Action and Adaptation Plan, or as policies in a General Plan. Strategies include the action, who is responsible, how it will be achieved, how it will be assessed, and what is needed to accomplish it. Finally, the project team works to prioritize adaptation strategies. Strategies can be evaluated based on whether they address assets with the highest vulnerability, cost, staffing availability for implementation, funding availability, co-benefits, equity, amount of time to implement, or effectiveness, among other factors. Community engagement is a vital part of developing and refining adaptation strategies, and can occur throughout this phase, depending on the needs of the project. According to the APG, strategies broadly refer to a policy, program, project, measure, or action meant to respond to climate impacts. Section 8 (Adaptation Strategies) describes the adaptation strategy framework and specific strategies and actions recommended for VTA assets and operations that should be included in the CAAP.

3.1.4 Phase 4. Implement, Monitor, Evaluate, and Adjust

Phase 4 is outside of the scope of this memo and will take place after VTA completes the CAAP. Community engagement and coordination with key stakeholders and community members is key for successful implementation. It is important to continue engagement efforts through implementation, to be transparent about progress and monitoring results, and to engage community partners in decisions around changes in adaptation strategies. Section 9 (Next Steps) in this memo outlines the recommended next steps that VTA can take following adoption of the CAAP.

Phase 4 includes developing an implementation program that outlines what department, staff, or organizations will take the lead on different actions, what steps are needed to implement strategies, and which actions should be completed first, or prioritized over other actions. Funding is a critical component to successful implementation. Agencies can prioritize strategies for funding based on their ability to have the most impact on increasing resilience to climate hazards. Adaptation planning staff can then evaluate the effectiveness of strategies and adjust as needed. Since climate impacts are changing and increasing over time, strategies may lose effectiveness as conditions change. If strategies lose effectiveness, the APG recommends reassessing vulnerability to understand how the community has changed and how to adjust strategies. In addition, communities should regularly evaluate the monitoring data and indicators and adjust as needed. Adaptation planners can set specific thresholds or triggers, such that when they occur or are exceeded, it is time to shift to a longer-term strategy (California Governor’s Office of Emergency Services 2020).

4 CLIMATE IMPACTS AND TRENDS

This section presents a summary of the climate extremes that have impacted VTA assets and operations in the past and are expected to impact the system in the future. With climate change, past and current climate events are expected to increase acute and chronic stressors on the VTA system. First, the memorandum provides a summary of significant past climate events that impacted VTA assets and operations, followed by a summary of the climate indicators the project team evaluated to support the vulnerability and adaptation assessment and the expected trends in a warming climate.

4.1 PAST IMPACTS

The climate of Santa Clara County is generally Mediterranean in character, with cool winters and warm, dry summers. However, the impacts of climate change have been rapidly getting worse. This section briefly highlights past climate events that had significant impacts to VTA assets and operations. One of the most severe impacts to VTA operations occurred during a strong El Niño winter of 1998, where multiple storm events delivered over 9 inches of rainfall between February 1 and February 3, 1998, and upper watersheds in Santa Clara County received up to 7 inches of rainfall on February 5, resulting in significant and damaging flooding over several days (Santa Clara Valley Water District 1999). Many creeks in Santa Clara County exceeded capacity, including Sunnyvale East Channel, Calabazas Creek, Guadalupe River, and Coyote Creek, which flooded inland urban areas. Flooding in low-lying areas were exacerbated by extreme tide conditions in the San Francisco Bay. VTA staff working in the River Oaks Administration Building during this time recall wading through the parking lot to evacuate the site because the water levels had reached the doors of the main offices (Cuff, pers. comm., 2023).

While drought and wildfire are not new problems for California, several of the largest wildfires ever recorded in the state occurred in 2020 and 2021 and resulted in dangerous air quality conditions that impacted VTA's ridership and operations. The Santa Clara (SCU) and Santa Cruz (CZU) lightning complex fires, for example, consisted of simultaneous fires in multiple counties, including Santa Clara County, that resulted in the loss of life, property, and habitat, and severe wildfire smoke for several weeks in 2020.

The governor declared a drought state of emergency in October 2021. Extreme drought conditions continued through 2022. In September 2022, VTA faced an uninterrupted 10-day stretch of triple-digit heat. A few months later, between December 26, 2022, and January 17, 2023, California was hit by severe storms that caused widespread flooding and successive days of high winds and heavy rains. These conditions created a situation where California was in a drought and experiencing flood emergencies at the same time. The flooding caused the closure of several highways, roads, bridges, and trails which impacted employee commutes and caused delays in VTA service due to power outages, mudslides, and fallen trees.

4.2 CLIMATE HAZARDS

VTA assets and operations will be affected by short-term acute physical impacts (e.g., wildfire), or longer-term chronic impacts (e.g., increases in annual average temperature). Both impacts can also occur over various geographic scales, including site-specific (flooding at a facility) or broader (higher temperatures across the hydrologic region). Climate hazards that could have the greatest impact on VTA's assets and operations include extreme heat, wildfire, drought, extreme rain, and urban/inland flooding, temporary coastal flooding, and permanent coastal flooding. This section highlights why evaluating vulnerabilities to these hazards is important to support VTA's long-term climate resilience. Evaluating changes in climate stressors provides valuable information to understand current and upcoming vulnerabilities across VTA's physical assets, operations, and ridership forecast.

- Extreme Heat – increasing temperatures will lead to both acute and chronic stressors on VTA assets and operations, with potential for widespread impacts to reliability of the VTA system. VTA's Heat Illness Prevention Plan, guided by California Division of Occupational Safety and Health (Cal/OSHA) standards, documents temperature thresholds significant to VTA employees (Santa Clara Valley Transportation Agency 2021). This includes various responses when the temperatures exceed 85 or 95 degrees or when the Heat Index (which accounts for humidity) exceeds 80 or 90 degrees. Responses may include mandatory water breaks, shade requirements, or increased staff monitoring activities. Certain temperature exceedances have also been found to be linked to declines in ridership (WSP 2021). This can lead to revenue loss or shifting ridership patterns (e.g., increased load during evening hours). Chronic heat stress can also degrade mechanical and electrical equipment over time, resulting in performance loss and increased replacement cycles with additional degree days of energy consumption (Water Utility Climate Alliance, Association of Metropolitan Water Agencies 2020).Degree Days measure the difference between the mean daily temperature and 65 degrees Fahrenheit (F). Cooling Degree Days are the difference between a mean temperature that is above 65 degrees. For example, a mean temperature of 80 degrees has 15 cooling Degree Days.

- Wildfire – uncontrolled wildfire burning vegetated areas poses direct threats to physical assets and creates hazardous air quality for staff and riders. More extreme temperatures and drought conditions increase the potential for wildfire across the VTA service area. Vulnerability to flooding also increases when wildfire damages vegetated watersheds across Santa Clara County. Extreme rainfall on burned areas cannot easily infiltrate into the soil, resulting in excessive amounts of stormwater runoff that occurs more quickly than before. Evaluating changes in potential wildfire threats due to climate change provides insight for adaptation planning for both VTA facilities and operations.
- Drought – meteorological drought conditions occur when there is prolonged dry weather from abnormally low precipitation, coupled with an imbalance with evaporation (which increases with temperature). While drought may have minimal direct effects on assets and infrastructure, many indirect effects have been observed, including damage to infrastructure from subsidence linked to groundwater depletion, damage to property from dried vegetation, increased wildfire potential, and fines from exceedances of water use during restrictions.
- Extreme Rain and Urban/Inland Flooding – flooding affecting VTA assets and operations occurs during extreme rain events, most commonly from atmospheric rivers, extratropical cyclones, or when they occur together. Atmospheric rivers carry significant moisture from the tropics and often release heavy rains when they make landfall. Extratropical cyclones that originate from northern regions of the Pacific Ocean also bring heavy rainfall, and when they collide with atmospheric rivers the storms can intensify, potentially releasing more intense rainfall. In a warming climate, these storms have the capacity to release more water from the atmosphere and with higher intensity (Patricola et al. 2022; Mak et al. 2023). Extreme rain can lead to flooding on city streets by overwhelming the storm drain system and river channels. Assets can be damaged during flood events, and access may be limited until floodwaters recede. The reliability of VTA operations is often impacted during flood events, and even in the absence of flooding, heavy rains can impede transit operations, especially during strong winds. Impacts from extreme rain will worsen with climate change, and understanding the potential increase in heavy rainfall will be critical in building flood resilience across the VTA system.
- Coastal Flooding (Temporary Flooding from Extreme Tides and Sea-Level Rise) – past extreme coastal storm events have already resulted in flooding of low-lying shoreline adjacent areas in Santa Clara County. Coastal flooding occurs during instances of extreme tides (storm surge), which can be worsened during El Niño winters where Bay tides are elevated for longer periods of time. If these coastal storms occurred again with sea-level rise, landward areas (and new areas) will be more frequently flooded. Without major shoreline adaptation or localized flood protection, these areas and assets may experience repetitive damage. Operations and ridership may also be severely affected until floodwaters recede. Impacts on operations may linger until repairs to facilities are completed.
- Coastal Flooding (Permanent Inundation from Sea-Level Rise) – under normal day-to-day tide conditions, sea-level rise will permanently inundate low-lying areas. The lowest-lying shoreline areas experience tidal flooding today during King Tides (the highest astronomical tides occurring each year), and as Bay water levels permanently increase with sea-level rise, flooding that only occurs a few times per year will occur more frequently. Eventually additional landward areas and assets will be impacted by permanent inundation. Without major shoreline adaptation, these areas and assets could be permanently lost. Assets would require relocation and operations would require adjustments to maintain service.

4.3 FUTURE TRENDS

The goal of the future trends assessment is to quantify the future change in climate hazards described in Section 4.2, where possible. The study team relied on the best available climate science to support the vulnerability assessment of VTA's infrastructure and operations within the mid-century timeframe, which is the general planning horizon for the CAAP. Climate change projection data comes from downscaled Global Climate Models (GCMs) and other climate hazard datasets available in the public domain (see Section 5 for data sources). The project team identified climate indicators to evaluate using climate change projection data based on climate stressors known to affect VTA's assets and operations, or stressors that could become severe enough in the future to cause disruption. Table 1 below summarizes the climate indicators evaluated in this assessment. Table 2 summarizes the expected change in the climate variables by the mid-century (2035 through 2064) time horizon, under the Representative Concentration Pathway (RCP) 8.5 scenario. The climate region used for the evaluation is the USGS Hydrologic Unit Code 8 (HUC8), which includes Santa Clara County.

See Section 3.3 for details on the data sources and Attachment 1 for detailed methodology.

Table 1 Climate Change Indicators

	Climate Change Indicator	Stressor
Extreme Rain	Avg. annual change in days exceeding the 99th Percentile	Change in single-day extreme rain events; potential increase in the frequency of extreme flooding
	Avg. annual change in max 3-day total	Change longer storm events (e.g., atmospheric rivers); potential increase in rainfall during storm events
Extreme Heat	Avg. annual daily maximum temperature	Change in avg. annual maximum temperature; measuring an increase in extreme daytime temperature
	Avg. annual daily minimum temperature	Change in avg. annual minimum temperature; measuring an increase in extreme nighttime temperature
	Avg. annual days max temp above 85 deg	Change in avg. annual days where the maximum temperature exceeds the threshold; informing potential decline in ridership[1]
	Avg. annual days max temp above 95 deg	Change in avg. annual days where the maximum temperature exceeds the threshold; relating to an increase in staff water breaks[2]
	Avg. annual days max temp above 104 deg	Change in avg. annual days where the maximum temperature exceeds the threshold; relating to potential degradation to mechanical equipment[3]
	Avg. annual days heat index above 80 deg	Change in avg. annual days where heat index exceeds threshold; resulting in shade required for staff and riders[2]
	Avg. annual days heat index above 90 deg	Change in avg. annual days where heat index exceeds threshold; related to increased heat illness in direct sun, risk of sunstroke, heat cramps, or heat exhaustion[2]
	Avg. annual number heat waves	Change in avg. number of heat waves per year
	Avg. annual max length of heat waves	Change in avg. heat wave duration
	Avg. annual cooling degree days	Change in avg. annual cooling days required; increase in energy demand
Wildfire	Avg annual area burned	Change in avg. annual area burned by wildfire
Drought	Avg. annual duration	Change in drought duration
	Avg. annual intensity	Change in drought intensity
	Avg. annual frequency	Change in drought frequency
Sea-Level Rise	Sea-level rise	Change in sea level coupled with daily high tides and storm surge; increased frequency of coastal flooding and increased area of flooding
Urban/Riverine Flooding	Urban/riverine floodplain	Not Evaluated

Notes: Avg. = average.

[1] WSP 2021

[2] Santa Clara Valley Transportation Agency 2021

[3] Water Utility Climate Alliance, Association of Metropolitan Water Agencies 2020

Table 2 Summary of Climate Variables by Mid-Century for Santa Clara County

	Variable	Historical Observed Value[1] (1950-2005)	Increase by Mid-Century (2035-2064)	Increase by Mid-Century (2035-2064)
Extreme Rain	Avg. annual days exceeding 99th percentile	2 days	+23%	2.5 days
	Avg. annual max 3-day total	~5 inches	+11%	~5.5 inches
Extreme Heat	Avg. annual maximum temperature	69 °F	+6%	73 °F
	Avg. annual minimum temperature	47 °F	+8%	51 °F
	Avg. annual days max temp above 85 °F	20 days	+91%	39 days
	Avg. annual days max temp above 95 °F	2 days	+219%	7 days
	Avg. annual days max temp above 104 °F	~1 (0.1) days	+658%	~1 (0.8) days
	Avg. annual days heat index above 80 °F	33 days	+71%	57 days
	Avg. annual days heat index above 90 °F	5 days	+173%	14 days
	Avg. annual number heat waves	~1 (0.13)	+423%	~1 (0.7)
	Avg. annual max length of heat waves (days)	~1 (0.4) day	+328%	2 days
	Avg. annual cooling degree days	304 days	+82%	554 days
Wildfire	Avg annual area burned	21 hectares[2]	+14%	24 hectares
Drought	Epoch avg. drought duration (months)	15 months[2]	+15%	17 months
	Epoch avg. intensity (Standardized Precipitation Evapotranspiration Index, or SPEI)	0.89 (SPEI)[2]	+77%	1.6 SPEI
	Epoch avg. drought frequency	3.6 years[2]	-19%	2.9 years
Coastal Flooding (Sea-Level Rise)	Sea-Level Rise (inches)	4.2 inches	+23 inches	-
Urban/Riverine Flooding	Urban/riverine floodplain	NA	NA	NA

Notes: °F = degrees Fahrenheit; % = percent; Avg. = average.

1 historical value based on LIVNEH observed climate dataset

2 historical value based on LOCA modeled climate dataset

4.3.1 Extreme Rain

Climate projections show an increase in the average annual number of days with extreme rainfall mid-century. The average annual number of days where rainfall exceeds the 99th percentile (of historical rainfall) is expected to increase from the observed historical average by 23%, to 2.5 days. The amount of rainfall during extreme storm events is also expected to increase by mid-century. The average annual maximum 3-day rainfall total is expected to increase from the observed historical average by 11%, to approximately 5.5 inches. The increase in extreme rainfall in both frequency and magnitude can result in increased street flooding from stormwater runoff and increased river flows which can also result in urban flooding. Even in the absence of flooding, heavy rains disrupt VTA operations.

4.3.2 Extreme Heat

The best available science on climate trends projects an average increase in the daily temperature from the observed historical average by 6% from 69 degrees to 73 degrees F (by 2050). The average increase in daily minimum temperature is expected to increase by 8%, from 47 degrees F to 51 degrees F (by 2050). The average increase in daily minimum and maximum temperature is relatively low compared to changes in extreme heat events.

Extreme heat events where the maximum daily temperature exceeds a temperature threshold or exceeds a temperature threshold for several days (heat waves) are expected to increase significantly. The average annual days where the maximum daily temperature exceeds 85, 95, and 104 degrees F is expected to increase from the observed historical average by +91% (approx. +20 days/year), +219% (approx. +2 days/year), and +658% (approx. +1 day/year), respectively. Temperatures exceeding 85 degrees is associated with loss in ridership (WSP 2021), temperatures at or exceeding 95 degrees F is associated with an increase in required staff water breaks (2021 VTA Heat Illness Prevention Procedures), and temperature exceeding 104 degrees F is associated with increased degradation of mechanical equipment (Water Utility Climate Alliance, Association of Metropolitan Water Agencies 2020). Higher temperatures (108 degrees) may also impact roadways with tar softening (AECOM 2015), but was not evaluated in this assessment (temperatures exceeding 104 degrees F, which was evaluated in this assessment can be used as a proxy).

Days where the heat index exceeds 80 degrees and 90 degrees are expected to increase from the observed historical average by +71% (approx. +33 days/year), and +173% (approx. +5 days/year), respectively. A heat index exceeding 80 degrees can increase the potential of heat related illness for employees working outdoors and require enhanced safety protocols in relation to CalOSHA/OSHA, and the heat index exceeding 90 degrees can result in heat illness for employees working in the shade (2021 VTA Heat Illness Prevention Procedures). The average annual number of cooling degree days[14] is expected to increase by +82%, from 309 to 561 days, resulting in increasing energy consumption in an increasingly warming climate.

4.3.3 Wildfire

Wildfire risk is expected to increase by the mid-century time horizon. The average annual area burned where vegetation currently exists within the region is expected to increase from the historical average by +14%. This increase in wildfire potential can lead to direct physical impact to assets and indirect impacts such as poor air quality for staff and riders. When air quality is forecasted to be unhealthy, Spare the Air Alerts are issued by the Bay Area Air Quality Management District to inform residents about air quality in the Bay Area and encourage residents to stay indoors.

4.3.4 Drought

By mid-century, the climate region will experience an increase in drought duration and intensity. Drought frequency may decline towards the mid-century, which may be attributed to increasing average drought duration. There may be less drought events due to the increasing length of drought events, but when drought occurs, conditions will be more severe. This can lead to increased wildfire risk, infrastructure damage from climate whiplash (extreme drought years to above-average wet years), and water restrictions.

4.3.5 Coastal Flooding (Sea-Level Rise)

The current best available science on sea-level rise projections for the San Francisco Bay is the State of California Sea-Level Rise Guidance, adopted in 2018 by the California Ocean Protection Council (OPC) (CCC 2018, OPC and CNRA

[14] Degree Days measure the difference between the mean daily temperature and 65 degrees Fahrenheit (F). Cooling Degree Days are the difference between a mean temperature that is above 65 degrees. For example, a mean temperature of 80 degrees has 15 cooling Degree Days

2018). The Guidance provides a range of sea-level rise projections for different type periods. According to the Guidance, sea levels could rise by 23 inches by 2050, and 83 inches by 2100 in the San Francisco Bay under the "1-in-200" chance sea level projection. Sea-level rise can result in overtopping of Bay water over the shoreline, leading to permanent inundation of coastal areas from daily high tides (in the absence of storm events), and additional areas that could be temporarily flooded during storm events. Temporary coastal flooding includes flooding due to episodic, short-duration extreme tide events, such as during storm surge or El Niño events. Extreme storm surge events, such as the 1%-annual-chance (100-year) storm surge, results in water levels approximately 47 inches above average daily tides (BCDC, MTC, and BATA 2019) and can temporarily overtop shoreline flood defense structures and flood landward low-lying areas for a few hours or days.

4.3.6 Urban and Riverine Flooding

The vulnerability assessment did not directly evaluate inland temporary flooding from increased riverine flows and stormwater runoff because future projections are not readily available. However, studies project that these climate hazards will increase because of increases in extreme rainfall.

4.3.7 Other Hazards

Rising groundwater and land subsidence are two additional hazards that could cause significant impacts to VTA assets and operations and could compound current and future flood risks. This assessment does not include an evaluation of impacts from shallow and emergency groundwater or land subsidence. These hazards are described in more detail below.

Rising Groundwater: In nearshore coastal areas, where shallow aquifers are unconfined, the groundwater table will rise as sea levels rise. This slow but chronic threat can flood urban areas from below, damaging buried infrastructure and roadway subgrades, flooding below-grade structures, and emerging aboveground as an urban flood hazard, even before coastal flood waters overtop the shoreline due to sea-level rise. Emergent groundwater effects are particularly relevant in coastal areas with shallow groundwater and assets in low-lying elevations and should be considered in subsequent assessments and adaptation planning phases.

Land Subsidence: Land subsidence may also damage critical VTA assets by shifting ground elevations, and damaging facilities, and roadways. Shifting land elevations may also exacerbate the effects of sea-level rise. Historically Santa Clara County has experienced significant land subsidence due to excessive groundwater pump activities. Land subsidence should also be considered in subsequent assessment and adaptation planning phases.

5 ASSETS AND DATA SOURCES

The following summarizes physical assets and operations evaluated in the climate vulnerability assessment. Because of the large volume of VTA assets and level of effort to include all asset types, this assessment is narrowed to the most critical of VTA's operations and services based on staff feedback. See Attachment 7 for the full list of vulnerable assets.

5.1 PHYSICAL ASSETS

The following types of physical assets were included: bus routes and popular paratransit destinations, light rail guideways and routes, facilities, and regional transit. Although this assessment primarily focused on assets owned by VTA, in some instances, assets owned or managed by other jurisdictions, such as BART and Caltrain, were also included because the resilience of the larger transit network in Santa Clara County is essential for VTA service. Other assets used but not maintained by VTA, such as traffic signals, are acknowledged but not included in this analysis. Table 3 presents the physical assets evaluated in the vulnerability assessment.

Table 3 VTA System - Physical Assets

Asset Classes	Assets
BUS AND PARATRANSIT ROUTES	Bus Routes
	Bus Stops
	Paratransit Destinations
	Streets
LIGHT RAIL GUIDEWAY AND ROUTES	Light Rail Routes
	Grade Crossings
	Service Grade Crossings
	Frogs
	Utility Poles
	Traction Poles
	Turnouts
FACILITIES	Stations
	Station Platforms
	Station Shelters
	Park and Ride Lots
	Transit Centers
	Substations
	Administration and Operation Buildings
REGIONAL TRANSIT	BART Stations
	BART Lines
	Bike Routes
	Express Lanes
OTHER SITES	Transit-Oriented Development
	VTA-Owned Parcels

5.2 OPERATIONS ASSETS

The consultant team assessed the vulnerability of the following types of operations: service and ridership, maintenance, and rider and workforce safety. Service and ridership refer to the level of transit service VTA provides and the number of passengers that ride the system. Maintenance refers to the routine maintenance and repair of VTA facilities, vehicles, and supporting infrastructure. Rider and workforce safety refers to the safety of passengers and VTA employees. These operations were evaluated as part of this assessment because of their significance in ensuring operational efficiency and providing a safe and reliable transportation experience for the community. The operations evaluated in the vulnerability assessment are presented in Table 4.

Table 4 Operations Included in Climate Trends Analysis

Operations	Service and Ridership
	Maintenance
	Rider and Workforce Safety

5.3 DATA SOURCES AND SCENARIOS

5.3.1 Physical Asset Data

The VTA GIS asset management team provided the physical asset data listed in Table 3 in a GIS format, as polylines (e.g., light rail routes), polygons (e.g., station platforms), and points (e.g., bus stops). The climate exposure analysis of each asset used the GIS datasets as-is, without modifications to asset locations or attributes, except for the following:

- Initial analysis of the GIS data showed that stations as point data did not adequately capture the representative footprint for each station (including relevant station components) when overlaid with climate hazards. After VTA's initial review of the station footprints using aerial imagery, a 0.25 mile buffer distance around the station platform was selected to effectively represent the station area. Station buffers were used to represent station footprints in this analysis.
- Paratransit addresses were taken from the most frequently visited origins and destinations, with the consultant team geocoding an Excel file of addresses into locational data points.

Using the GIS data as-is also included the following assumptions:

- The Bicycle Superhighway Priority Network was evaluated as bike routes in this analysis although it is assuming the implementation and construction of the superhighway. Currently, VTA publishes the Countywide Bicycle Plan which guides bicycle projects in Santa Clara County over the next 25 years and includes the Bicycle Superhighway Implementation Plan.
- Another assumption was made for the Express Lanes network, the VTA operated express lanes in the County, using built SR 237 and US 101 Express Lanes as a proctor for the future location of assets.

5.3.2 Climate Hazard Data

The vulnerability assessment leveraged publicly available climate hazards datasets across various time conditions (historical and/or future) and geographic scales. Best professional judgment based on experience using climate data in other regions of the Bay Area and greater California was used to identify the climate datasets to support the climate vulnerability assessment and CAAP, including selecting the appropriate time horizons, climate scenarios, and geographic region of analysis. Additional detail on the methods used to translate this information for use in the climate vulnerability assessment is presented in Section 6, and Attachment 1.

5.3.3 GIS Hazards Data

The vulnerability assessment considered four climate-change related hazards, including 1. permanent coastal inundation from daily high tides with sea-level rise, 2. temporary coastal flooding from storm surge and sea-level rise, 3. temporary urban flooding (from riverine sources), and 4. wildfire potential.

The project team obtained GIS based datasets containing the spatially varying hazards from publicly available sources. While these datasets have resolutions to identify impacts to individual assets, some do not have consistent future time horizons or RCP scenarios (or any future projections at all). The range of data sources to support overall vulnerability assessment for VTA assets is presented below.

COASTAL FLOODING (SAN FRANCISCO BAY)

Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea-Level Rise and Shoreline Analysis - coastal inundation mapping for the nine counties in the San Francisco Bay developed for the Adapting to Rising Tides, Bay Area Sea Level Rise Analysis and Mapping Project (BCDC, MTC, and BATA 2019). The coastal mapping is based on hydrodynamic modeling output developed for the Federal Emergency Management Agency (FEMA) San Francisco Bay Area Coastal Study. It does not consider future shoreline change conditions. The available mapping at a 1-meter grid resolution captures permanent and temporary flooding impacts from sea-level rise scenarios from 0 to 66 inches, and sea-level rise coupled with storm surge up to a 1%-annual-chance (100-year) storm event.

The scenarios selected for the exposure assessment are intended to align as best possible with the sea-level rise estimates for the OPC 1:200 scenario for San Francisco (closest location to the South San Francisco Bay), for both sea-level rise only and sea-level rise coupled with a 100-year storm surge event. The BATA Sea-Level Rise and Mapping Report provides an approximation of the 100-year storm surge event (BCDC, MTC, and BATA 2019). Best judgment (based on the study team's firsthand experience in developing the ART scenarios with BCDC) was applied to crosswalk the future change layers to the appropriate time horizons. For example, the 2050 sea-level rise projection for San Francisco under the OPC 1:200 Chance scenario is 23 inches, and the closest matching inundation layer from the BATA GIS dataset is a layer representing sea-level rise of 24 inches. This closely matches the permanent sea-level rise by the 2050 time horizon. For temporary flooding from the 100-year coastal storm surge by 2050, this requires a GIS layer corresponding to 24 inches of permanent sea-level rise plus an additional 47 inches of temporary storm surge above average daily high tides (in total this is 71 inches above average daily high tides). The best matching GIS layer from the BATA seal-level rise (SLR) dataset is 66 inches above average daily high tides.

TEMPORARY URBAN FLOODING (INLAND AND RIVERINE)

Source: FEMA National Flood Hazard Layer - current effective FEMA Special Flood Hazard Areas (SFHAs) for California are available through FEMA's National Flood Hazard Layer Viewer[15]. This depicts floodplain areas that could be inundated by the 1-percent-annual-chance (100-year) and 0.2-percent-annual-chance flood (500-year), from riverine, urban, and coastal flood sources. It does not consider climate change across future time horizons; however, the 500-year flood extent (where available) can be used as a proxy for potential increases in the 100-year flood event.

The FEMA SHFA GIS was modified to remove any coastal flooding, which otherwise overlaps or conflicts with the coastal flood layers from the ART GIS layers that represent coastal flooding for current conditions and with sea-level rise.

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[15] https://www.fema.gov/flood-maps/national-flood-hazard-layer

WILDFIRE

Source: California Department of Forestry and Fire Protection (CALFIRE) Wildfire Threat Class mapping - considering potential fire frequency and fire behavior binned into five threat classes (Low, Moderate, High, Very High, and Extreme). The CALFIRE Wildfire Threat Class mapping used for the asset exposure assessment includes portions of Local Responsibility Areas (in addition to State Responsibility Areas), meaning wildfire risk coverage is available within district service boundaries. This dataset does not consider climate change projections.

5.3.4 Downscaled Climate Projections

The vulnerability assessment of VTA's operations used statistically downscaled historical and future Global Climate Model (GCM) projections for rainfall, temperature, humidity, evapotranspiration, and wildfire. Statistical downscaling is a process used to translate climate data output from large-scale Global Climate Models to smaller spatial scales. This process allows the data to be more useful for local and regional analysis (USGS 2021). The study team leveraged the downscaled climate projections described below to evaluate changes in extreme rainfall, extreme heat, drought, and wildfire events. Attachment 1 provides an additional summary of the GCM and RCP scenario selection for the climate projections.

RAINFALL AND TEMPERATURE

Source: Localized Constructed Analogs (LOCA) downscaled CMIP5 projections - a key dataset used for the Fourth National Climate Change Assessment and includes daily precipitation and temperature variables downscaled to a ~6km grid resolution from 1950 to 2100 (Pierce, Cayan, and Thrasher 2014). The LOCA dataset was developed by the Scripps Institute of Oceanography using a downscaling methodology designed to better represent local scale changes in climate variables (compared to other downscaling techniques) and can be considered the best available science, especially in California where it is the key dataset supporting publicly available climate projection summaries published by Cal-Adapt. The climate projections are available for several with Representative Concentration Pathways (RCP) scenarios, including RCP 8.5 used for this climate vulnerability assessment (see Attachment 1 for additional detail on methodology).

Source: Livneh observed hydrometeorological dataset - historical observed gridded (~6km) daily rainfall data, and maximum and minimum daily temperature data used for training and correction of the LOCA downscaled projections (Livneh et al. 2015).

HUMIDITY AND EVAPOTRANSPIRATION

Source: LOCA forced Variable Infiltration Capacity (VIC) land surface model output (LOCA-VIC) - includes future projections of humidity and evapotranspiration from 1950 to 2100. The VIC model is forced using meteorological data from the LOCA dataset (supplemented with wind speeds from an observational reanalysis). Climate projections are available for several RCP scenarios, including the RCP 8.5 used for this climate vulnerability assessment (see Attachment 1 for additional detail on methodology).

WILDFIRE

Source: UC Merced wildfire projections - wildfire scenario projections from 1950 to 2100 produced for the Fourth National Climate Change Assessment are derived from a statistical model (land cover, population, and fire history) coupled with the LOCA meteorological projections to estimate the annual or monthly average annual area burned within a grid cell. Areas outside state and federal protection are not included in the wildfire scenarios. The wildfire projections are available for several RCP scenarios, including RCP 8.5 used for this climate vulnerability assessment (see Attachment 1 for additional detail on methodology).

6 VULNERABILITY AND CONSEQUENCE ASSESSMENT – APPROACH

6.1 VULNERABILITY

As part of the vulnerability assessment, the consultant team collected data on VTA assets, operations, and local climate impacts and gathered firsthand information on experiences with flooding, heat, and other climate hazards from VTA staff through a survey and workshop. Exposure, sensitivity, and adaptive capacity were evaluated for each physical asset using methods found in the APG referred to in Section 3.

The vulnerability assessment leverages publicly available climate hazards datasets various time conditions (historical and/or future) and geographic scales (see Section 5). Best professional judgment based on experience using climate data in other regions of the Bay Area and greater California was used to align this information to best support the climate vulnerability assessment and CAAP, including selecting the appropriate time horizons, climate scenarios, and geographic region of analysis for the exposure analysis.

Section 6.1.1 to Section 6.1.3 summarizes the approach to evaluating exposure, sensitivity, and adaptive capacity for VTA assets and operations. Section 6.2 summarizes the approach to identify the consequences that assets and operations could experience from climate hazard exposure.

6.1.1 Assets

Evaluating vulnerability for VTA assets entailed assessing the exposure of each individual asset to each type of climate hazard, then analyzing the sensitivity and adaptive capacity of each asset class. The physical assets and asset classes included in this assessment are shown in Table 5. Asset exposure was assessed for permanent coastal inundation, temporary coastal flooding, and wildfire using a spatial GIS analysis.

The team overlayed the climate hazards GIS layers with the GIS layers of the individual physical assets to determine the degree of exposure. To identify key parts of an asset's sensitivity and adaptive capacity to each hazard, the team utilized a survey and workshop with VTA staff to justify ratings, identify additional consequences, and incorporate field knowledge. The findings from this outreach were integrated into the sensitivity and adaptive capacity scores and statements for each asset class.

6.1.2 Operations

To evaluate vulnerability for VTA's operations, the team conducted a climate exposure assessment for the hydroclimate region covering VTA's service area. The degree of potential future change in the climate indicators (presented in Section 3.3) was evaluated by comparing GCM projections between the historical (1950-2005) and mid-century (2035-2064) time horizons for each climate indicator. The expected rates of change across the historical and future time horizons are listed in Table 2 and informed the assignment of a low, moderate, or high exposure score for each climate indicator in the context of how VTA operations could be affected (see Section 6.1.3 below for detail on the exposure scoring methods and Attachment 1 for additional information on the operations exposure scores). The scores for sensitivity and adaptive capacity relied on the same methods as the physical assets.

6.1.3 Ratings

The team rated VTA assets and operations to each of the components of vulnerability (described in Section 4.1). This includes exposure, sensitivity, and adaptive capacity to climate stressors that could affect the assets and the anticipated ability to cope with projected changes. The following summarizes the approach for assigning exposure, sensitivity, and adaptive capacity scores to each asset and operation described in Section 5.1.

Exposure – an exposure rating qualifies the degree of exposure to permanent coastal inundation, temporary coastal flooding, temporary urban/inland flooding, and wildfire.

ASSET EXPOSURE RATINGS

- **Permanent coastal inundation** – a low exposure rating is assigned if an asset is within a permanently inundated area by daily high tides after 2050, a moderate rating is assigned is if an asset is within a permanently inundated area between 2030 to 2050, and high rating is assigned if an asset is within a permanently inundated area by 2030. The OPC 1:200 scenario projects 10 inches of permanent sea-level rise by 2030, 23 inches of sea-level rise by 2050, and 83 inches of sea-level rise by 2100.
- **Temporary coastal flooding** – a low exposure rating is assigned if an asset is within an area temporarily flooded by a 100-year storm surge coupled with sea-level rise after 2050, a moderate rating is assigned is if an asset is within a temporarily flooded area between 2030 to 2050, and high rating is assigned if an asset is within a temporarily flooded area by 2030 (100-year storm surge with 23 inches of projected sea-level rise).
- **Temporary urban/inland flooding** – a moderate rating is assigned if an asset is located in a 0.2% annual-chance (500-year) FEMA SFHA; a high exposure rating is assigned if an asset is located within the FEMA 1%-annual-chance (100-year) Special Flood Hazard Area (SFHA).
- **Wildfire** – a low exposure rating is assigned if an asset is in a low wildfire risk area (based on the CALFIRE wildfire threat area), and a moderate exposure rating is assigned if an asset is in a moderate CALFIRE wildfire threat area, and a high exposure rating is assigned if an asset is in a high, very high, or extreme CALFIRE wildfire threat area.

  Table 5 shows the asset exposure scoring guide and time horizons used for each climate hazard.

Table 5 Asset Exposure Scoring.

Exposure Rating	Permanent Coastal Inundation (SLR)	Temporary Coastal Flooding (SLR + 100-year Storm Surge)	Temporary Urban/Inland Flooding	Wildfire
NA	>2100	>2100	-	None
Low (1)	>2050	>2050	-	Low
Moderate (2)	2030 to 2050	2030 to 2050	500-year FEMA Special Flood Hazard Area	Moderate
High (3)	now to 2030	now to 2030	100-year FEMA Special Flood Hazard Area	High/Very High/Extreme

Note: FEMA = Federal Emergency Management Agency; SLR = sea level rise.

OPERATIONS EXPOSURE RATINGS

The exposure ratings for VTA operations are assigned based on the rate of change in climate indicators by the mid-century time horizon (2035-2065), presented in Table 2 and with additional detail in Attachment 1. The low exposure rating was assigned if the percent change of the climate indicator value between the historical period (1950-2005) and the mid-century period (2035-2065) is less than +10%, a moderate rating was assigned if the percent change by mid-century is between +10 and +20%, and a high rating was assigned if the percent change by mid-century is greater than +20%.

For more detailed methodology for the asset or operation exposure assessments, refer to Attachment 1.

Sensitivity - describes the degree to which VTA's assets and operations are affected by the climate hazards considered in this assessment. The sensitivity evaluation aims to identify potential impacts to asset classes and operations that could be exposed to these hazards. Sensitivity scores were assigned to each asset class and are informed by key drivers, existing conditions as described by VTA staff, and incorporates condition ratings provided in VTA's 2017 Transit Asset Management Plan. The consultant team identified these key drivers to determine the sensitivity score by asking the following questions:

1. Does the current condition cause the hazard to have a greater impact on the asset?
2. Can the asset function or operation happen during the hazard?

The answers to these questions and the definitions in Table 6 helped inform and justify each score.

Table 6 Sensitivity Scoring Definitions.

LOW **(1)** Minimal to no impact to asset/operation or minimal or no additional services required to maintain performance of asset/operation	MODERATE **(2)** Moderate lapse in performance of asset/operation	HIGH **(3)** Major lapse in performance of asset/operation or cannot achieve key performance milestone

Adaptive Capacity – considers the ability of VTA's assets to adjust to or minimize potential damages caused by climate hazards. Discussions and responses in the data discovery survey and workshop helped inform adaptive capacity scores. The consultant team identified these key drivers to determine the adaptive capacity score by asking the following questions:

1. Is there an alternative for this asset if it stops functioning?
2. Can the asset or operation recover quickly once the hazard event ends?

The answers to these questions and the definitions in Table 7 helped inform and justify each score.

Table 7 Adaptive Capacity Scoring Definitions.

LOW **(3)** Inherent ability to adjust is insufficient to mitigate potential impacts	MODERATE **(2)** Inherent ability to adjust will mitigate some potential impacts, but not all	HIGH **(1)** Inherent ability to adjust is sufficient to mitigate potential impacts

The consultant team followed the APG method of scoring vulnerability by averaging the exposure and sensitivity scores to obtain a potential impacts score, then comparing the potential impacts score to the adaptive capacity score to assign an overall vulnerability score (see Table 8). The overall scores helped the team determine which assets and operations had the highest vulnerabilities to the climate hazards included in this assessment.

Table 8 Vulnerability Scoring Matrix

		Adaptive Capacity		
Potential impacts (average of exposure and sensitivity)	High	3	4	5
	Moderate	2	3	4
	Low	1	2	3
		High	Moderate	Low

Source: California Adaptation Planning Guide (California Governor's Office of Emergency Services 2020).

6.2 CONSEQUENCES

The consultant team developed consequence statements based on research, survey results, and discussions at the workshop with VTA staff (see Section 6.3 and Attachment 2 for further details on the workshop). The consequence statements were assigned consequence sectors, presented in Table 9.

Table 9 Consequence Sectors

Consequence Sectors		
Primary Consequence	Physical	Direct impact or damage to infrastructure
		Functional or operational loss of service
Secondary Consequences	Fiscal	Reduced revenue due to loss of service and ridership
		Increased costs for damage or failure
	Local & Regional Economy	Loss of productivity
	Environment	Environmental degradation
		Ecosystem services impacts
	Social	Social disruption/ mobility disruption
		Equity impacts
		Public health and safety impacts

6.3 VALIDATION WORKSHOP

For this project, the consultant team summarized vulnerability and consequence statements and presented them to VTA staff at a virtual workshop on May 12, 2023. A total of 23 staff members attended. Attachment 2 includes a list of the attendees. The workshop focused on three asset groupings (Facilities, Light Rail, and Bus/Paratransit) and three operations groupings (Service and Ridership, Maintenance, and Rider and Workforce Safety). The team provided an overview of the vulnerability and adaptation assessment goals within three virtual breakout rooms, and VTA staff helped refine and validate the statements and provided initial suggestions for adaptation strategies. Section 8 presents a matrix of recommended adaptation strategies and actions based on research and input from VTA staff. These strategies will then be further refined and prioritized through community engagement as a part of the CAAP outreach process. Please see Attachment 2 for a summary of the VTA vulnerability and consequences workshop.

7 EXPOSURE AND VULNERABILITY FINDINGS

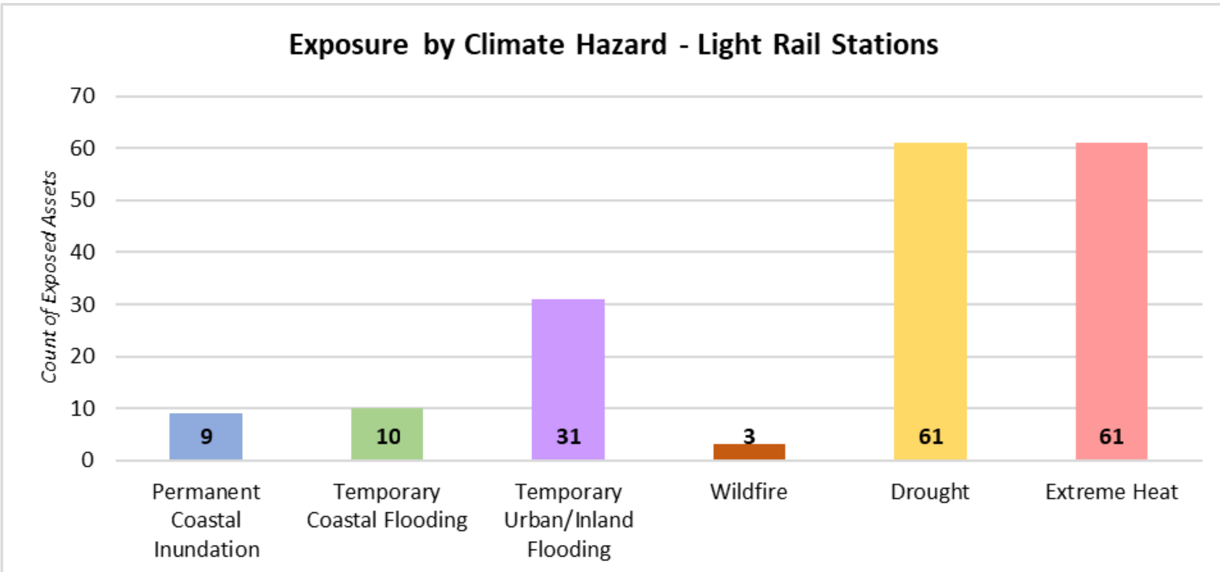
Section 7 presents a summary of the exposure and vulnerability ratings of VTA assets to permanent coastal inundation (i.e., SLR), temporary coastal flooding (i.e., storm surge), urban/inland flooding, wildfire, drought, and extreme heat. The section also presents climate hazards with the Social Vulnerability Index (SVI) for Santa Clara County at the census tract level to show vulnerable populations that may rely on VTA's services. Additionally, VTA asset vulnerability to climate hazards are summarized within four asset profiles: Facilities, Light Rail, Bus and Paratransit, and Operations. Section 7.3 discusses these asset vulnerability profiles in more detail.

7.1 SUMMARY OF ASSET EXPOSURE

As described in Section 3, exposure is the "presence of systems in areas that are subject to climate hazards." The purpose of evaluating exposure is to narrow down which assets or populations have the potential to be affected by climate change. If an asset is not in an area anticipated to be affected by climate change, then it is not vulnerable to climate impacts and it does not need to be included in the vulnerability assessment.

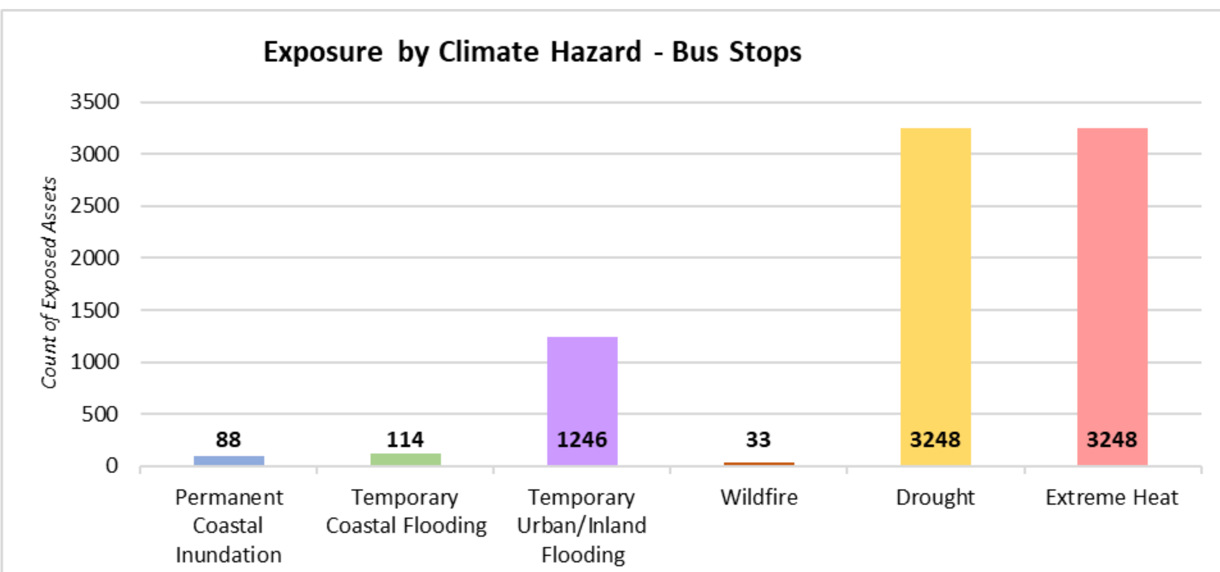
For coastal flooding (both permanent inundation and temporary flooding), the number of assets potentially exposed by the mid-century time horizon is presented. Findings for temporary urban/inland flooding and wildfire threat are based on current climate conditions. For the purposes of this exposure assessment, all assets in VTA's service area are exposed to drought and extreme heat to the same degree (i.e., drought and extreme heat conditions are uniform across the VTA service area).

Figures 4 through Figure 7 present the summary of the climate exposure assessment for the VTA asset types that are affected.



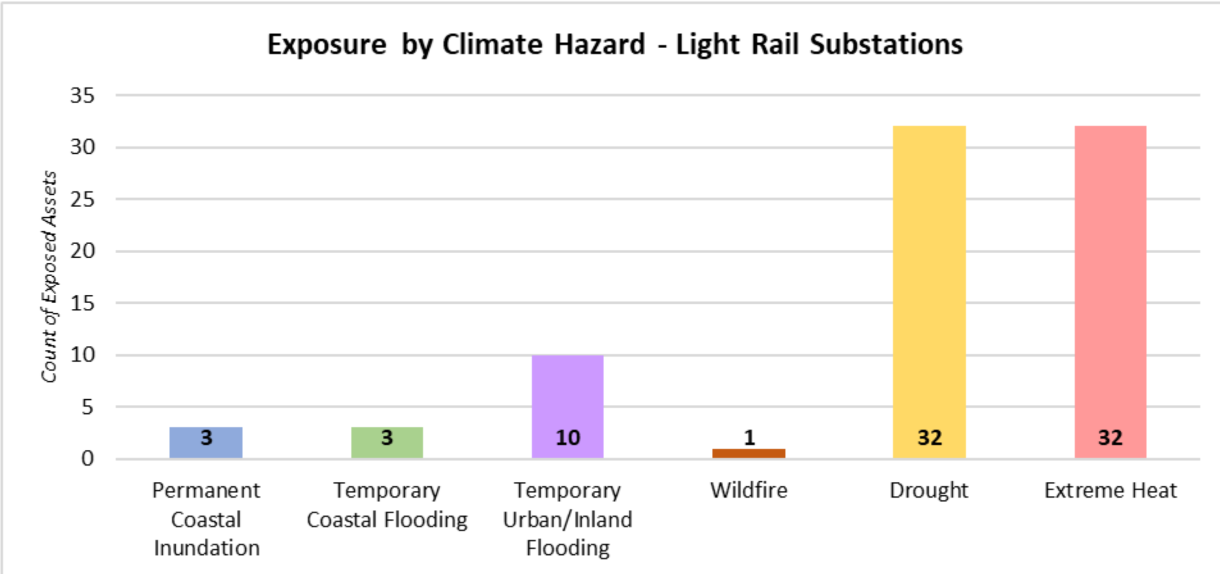
Notes: Drought and Extreme Heat are applied uniformly over the VTA service region; therefore, all assets are exposed to the same degree.

Figure 4 Exposure Summary for VTA Light Rail Stations



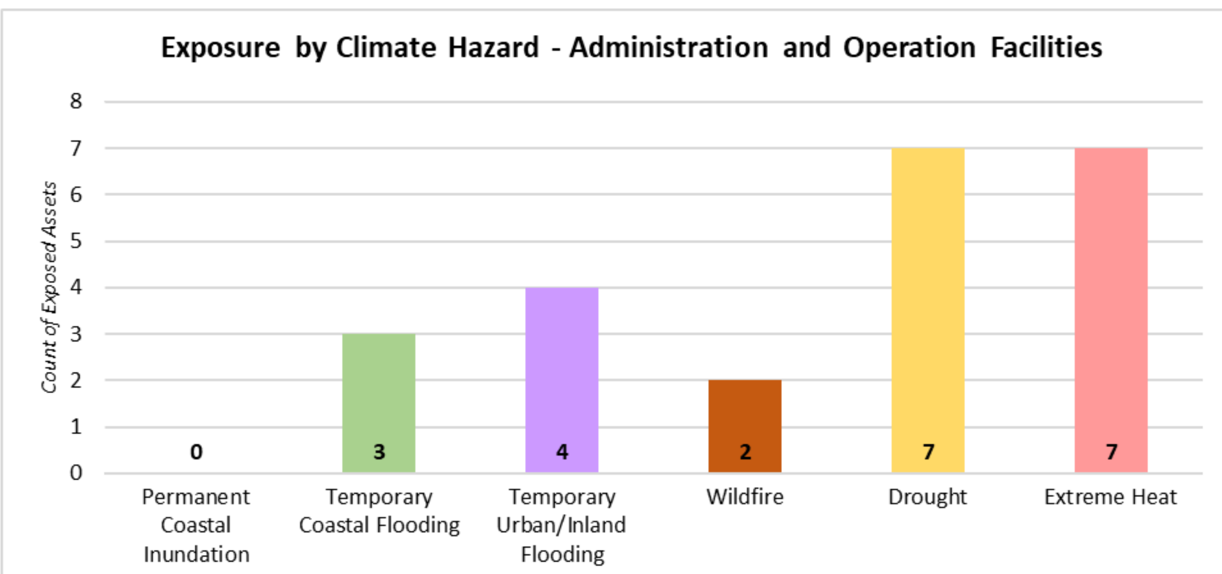
Note: Drought and Extreme Heat are applied uniformly over the VTA service region, therefore all assets are exposed to the same degree.

Figure 5 Exposure Summary for Bus Stops



Note: Drought and Extreme Heat are applied uniformly over the VTA service region, therefore all assets are exposed to the same degree; Although VTA owns a total of 34 light rail substations, two substations are located at the Guadalupe Light Rail Division, which are accounted for under the exposure to Administration and Operations Facilities. To avoid duplication, the light rail substations are shown as 32 in this graph.

Figure 6 Exposure Summary for Light Rail Substations



Note: Drought and Extreme Heat are applied uniformly over the VTA service region, therefore all assets are exposed to the same degree.

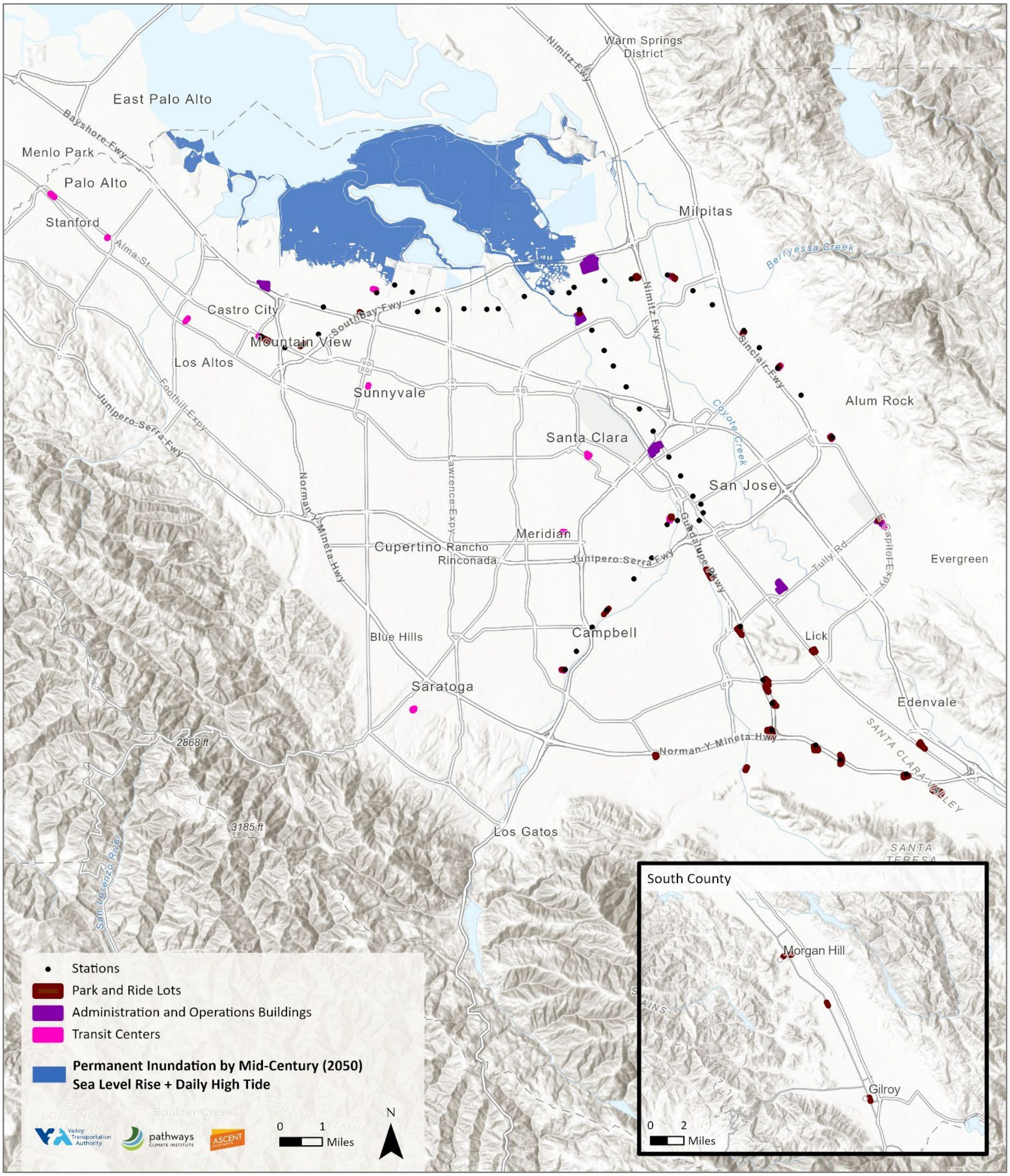
Figure 7 Exposure Summary for Administration and Operations Buildings and Facilities

Figure 8 through Figure 23 present maps of the climate hazards and the locations of several VTA asset types. Facilities exposed to permanent coastal inundation and temporary coastal flooding are shown in Figures 8 and 9. Facilities exposed to temporary urban/inland flooding and wildfire threat are shown in Figures 10 and 11. These facilities include stations, park and ride lots, administration and operation buildings, and transit centers owned and maintained by VTA.

Figures 12 through 15 show the light rail system, substations, the Guadalupe Light Rail Yard, and the average weekday boardings associated with stations along those lines. The exposure of the light rail system to permanent coastal inundation and temporary coastal flooding are shown in Figures 12 and 13. The light rail system exposed to temporary urban/inland flooding and wildfire threat are shown in Figures 14 and 15. The light rail system is comprised of three lines Green, Orange, and Blue.

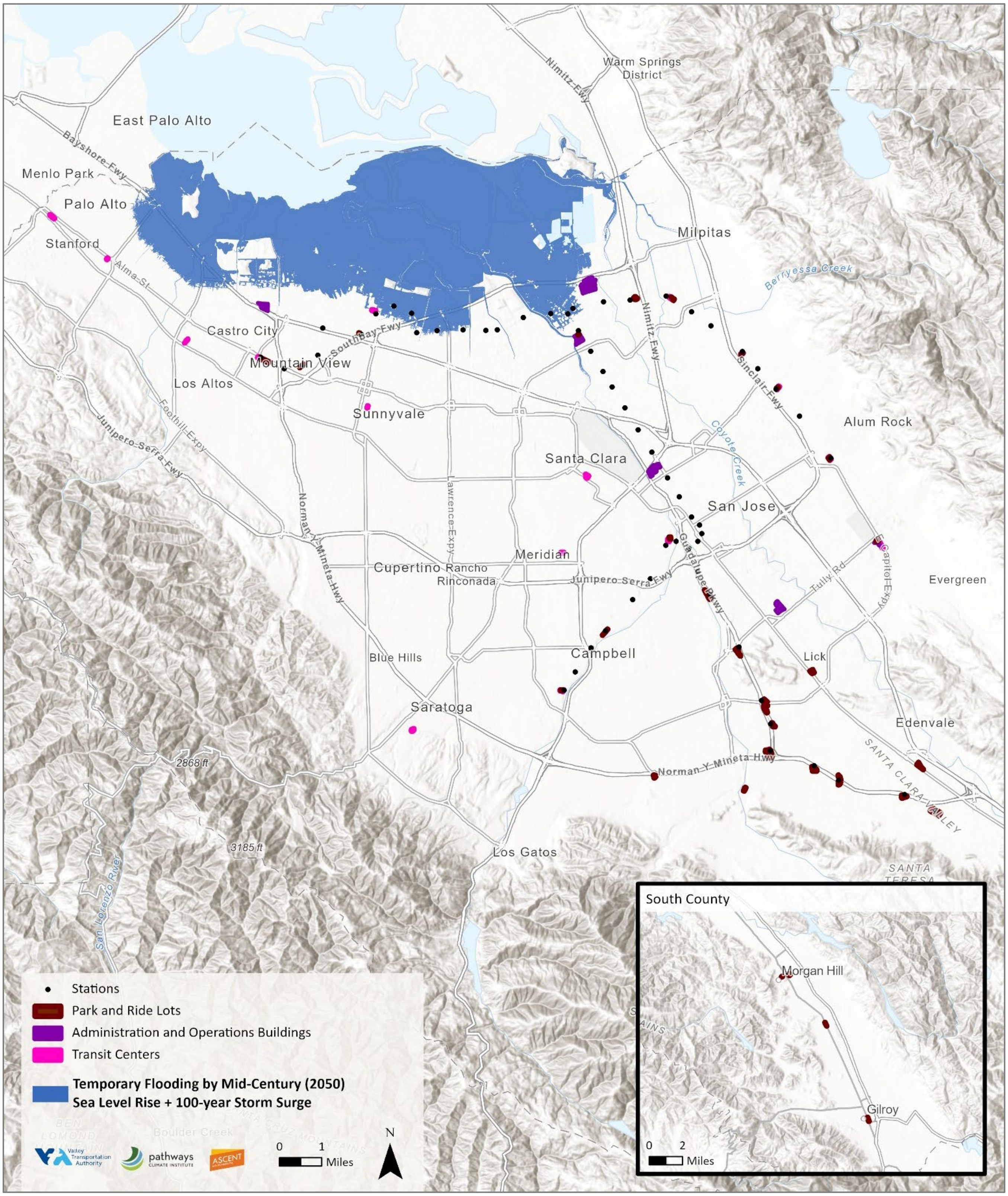
Figures 16 through 19 show bus routes currently operated by VTA, as of July 2023, along with the average daily boardings at the stations that serve these routes. Bus routes exposed to permanent coastal inundation and temporary coastal flooding are shown in Figures 16 and 17. Bus routes exposed to temporary urban/inland flooding and wildfire threat are shown in Figures 18 and 19.

Figures 20 through 23 relate to VTA's ACCESS Paratransit service. Paratransit service is provided to eligible individuals with disabilities and operates within the same service area and service times as VTA bus and light rail service. The paratransit service area is within ¾ mile of an existing VTA bus routes and light rail stations. This door-to-door service picks up the customer at their door during a scheduled appointment time and drops them off at their preferred destination. The popular paratransit destinations exposed to permanent coastal inundation and temporary coastal flooding are shown in Figures 20 and 21. The popular paratransit destinations exposed to temporary urban/inland flooding and wildfire threat are shown in Figures 22 and 23.



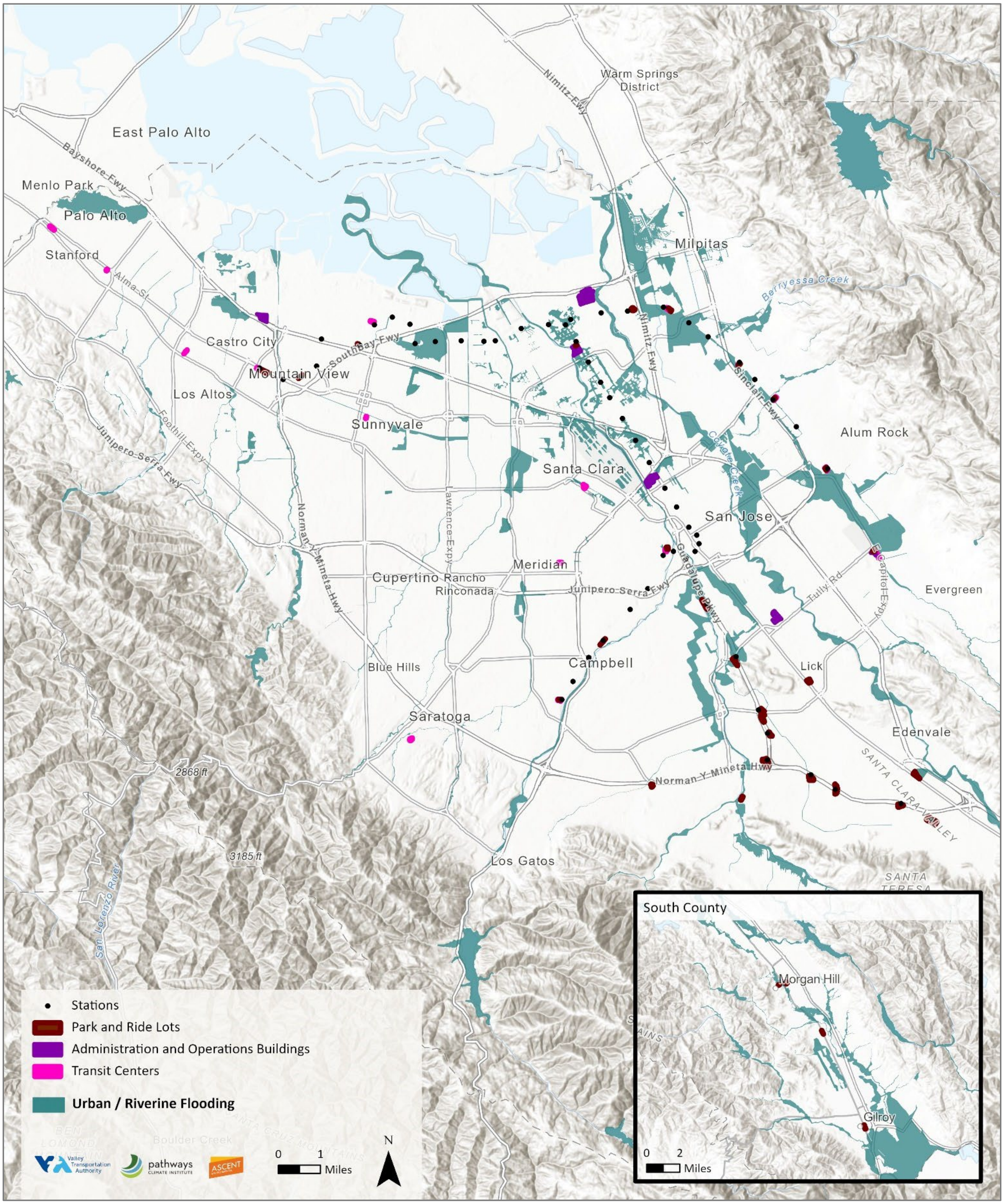
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 8 Facilities Exposure – Permanent Coastal Inundation by Mid-Century (Sea-Level Rise + Daily High Tides)



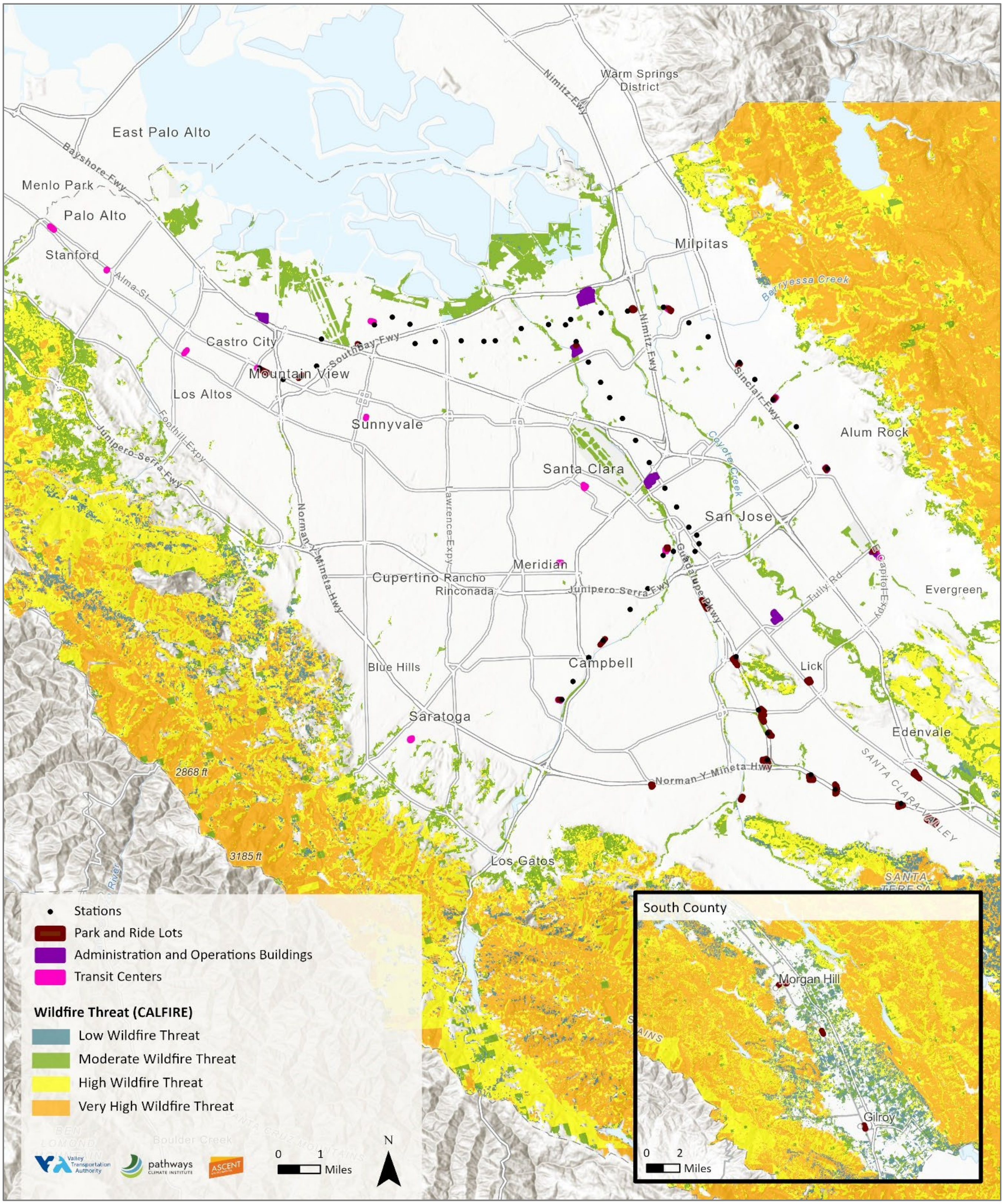
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 9 Facilities Exposure – Temporary Coastal Flooding by Mid-Century (Sea-Level Rise + 100yr Storm Surge)



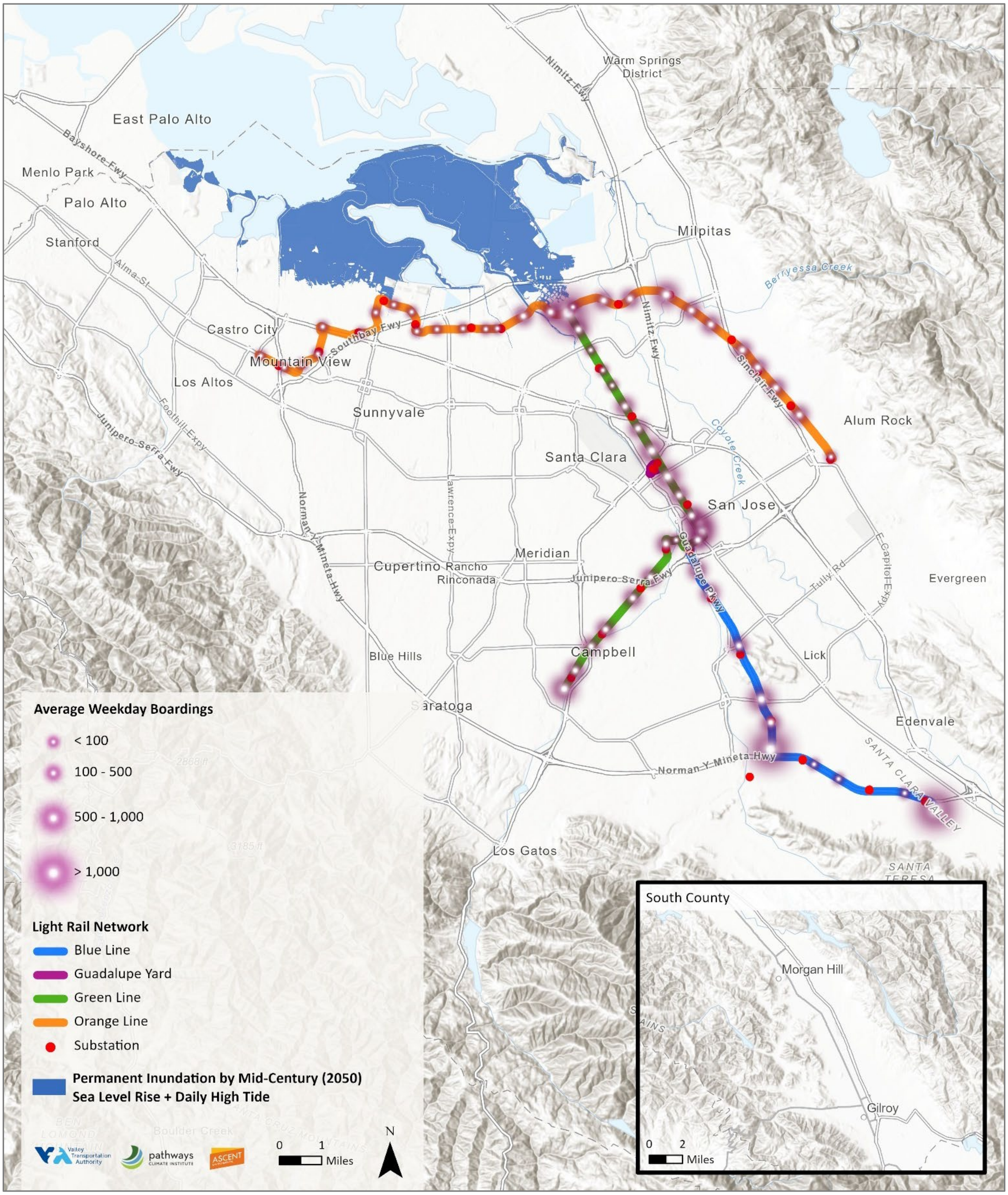
Source: FEMA National Flood Hazard Layer

Figure 10 Facilities Exposure – Temporary Urban/Inland Flooding



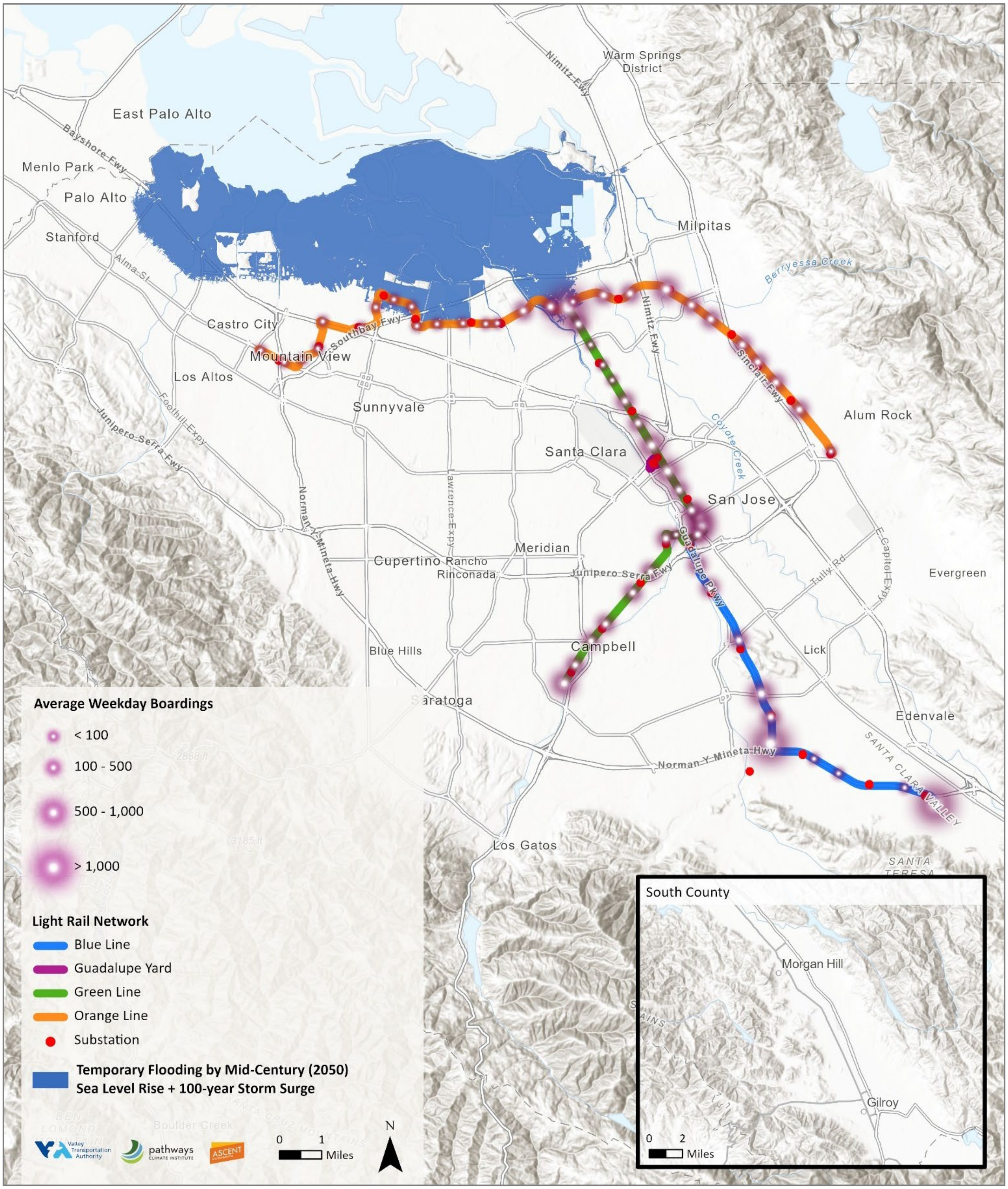
Source: CALFIRE Wildfire Threat Class

Figure 11 Facilities Exposure – Wildfire Threat



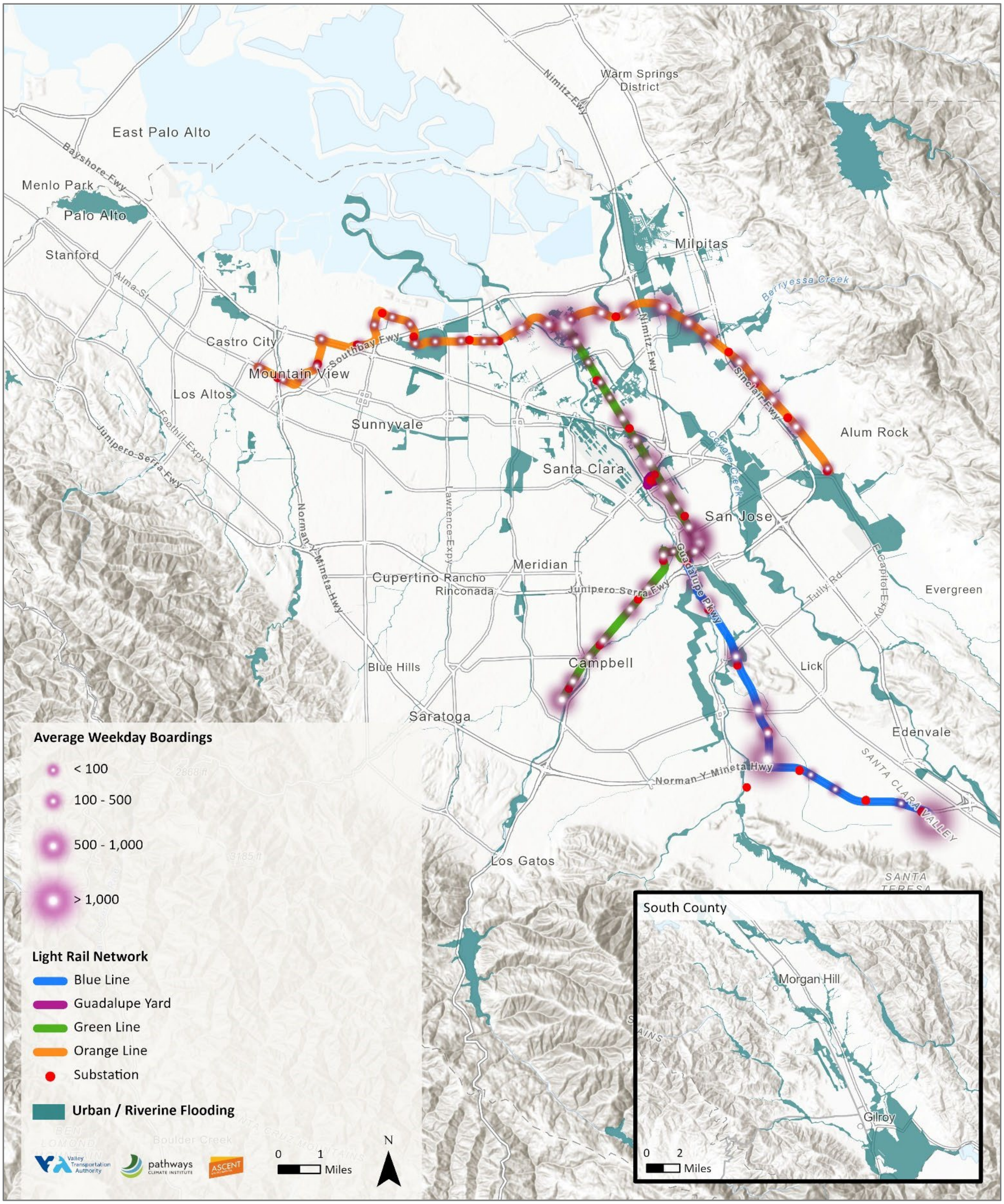
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 12 Light Rail Exposure – Permanent Coastal Inundation by Mid-Century (Sea-Level Rise + Daily High Tides)



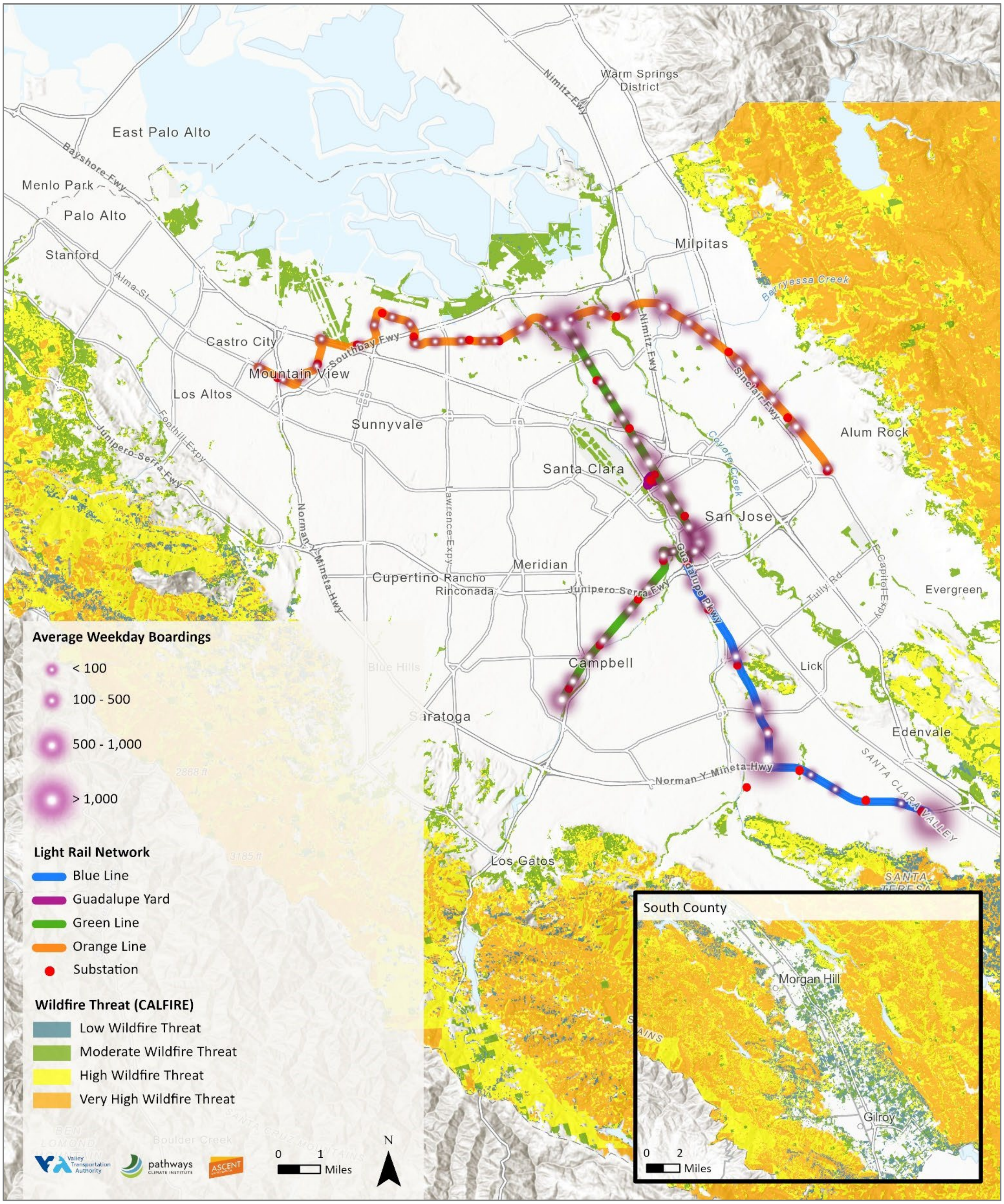
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 13 Light Rail Exposure – Temporary Coastal Flooding by Mid-Century (Sea-Level Rise + 100yr Storm Surge)



Source: FEMA National Flood Hazard Layer

Figure 14 Light Rail Exposure – Temporary Urban/Inland Flooding



Source: CALFIRE Wildfire Threat Class

Figure 15 Light Rail Exposure – Wildfire Threat

Note: SLR = sea level rise.

Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

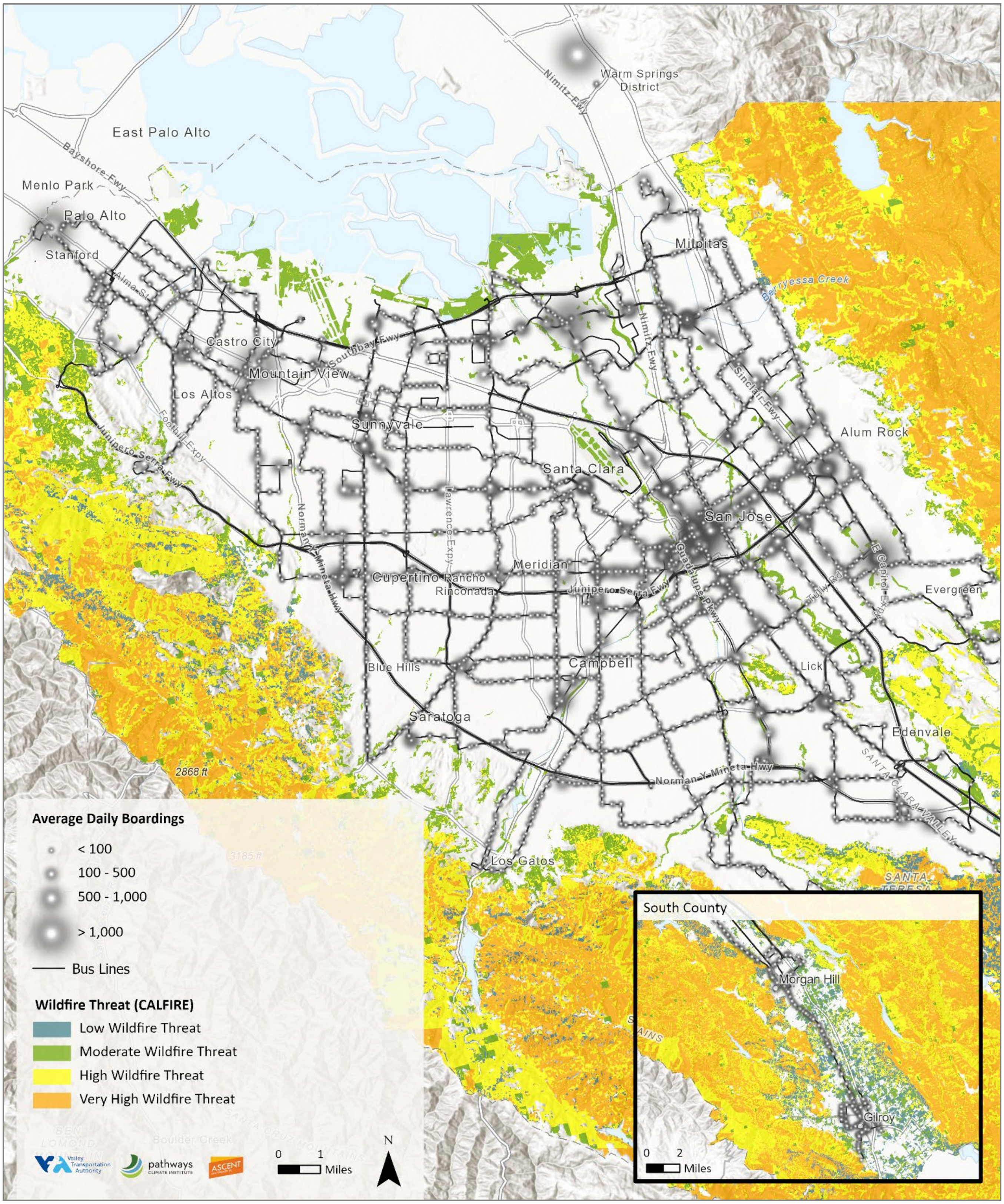
Figure 16 Bus Transit Exposure – Permanent Coastal Inundation by Mid-Century (Sea-Level Rise + Daily High Tides)

Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 17 Bus Transit Exposure – Temporary Coastal Flooding by Mid-Century (Sea-Level Rise + 100yr Storm Surge)

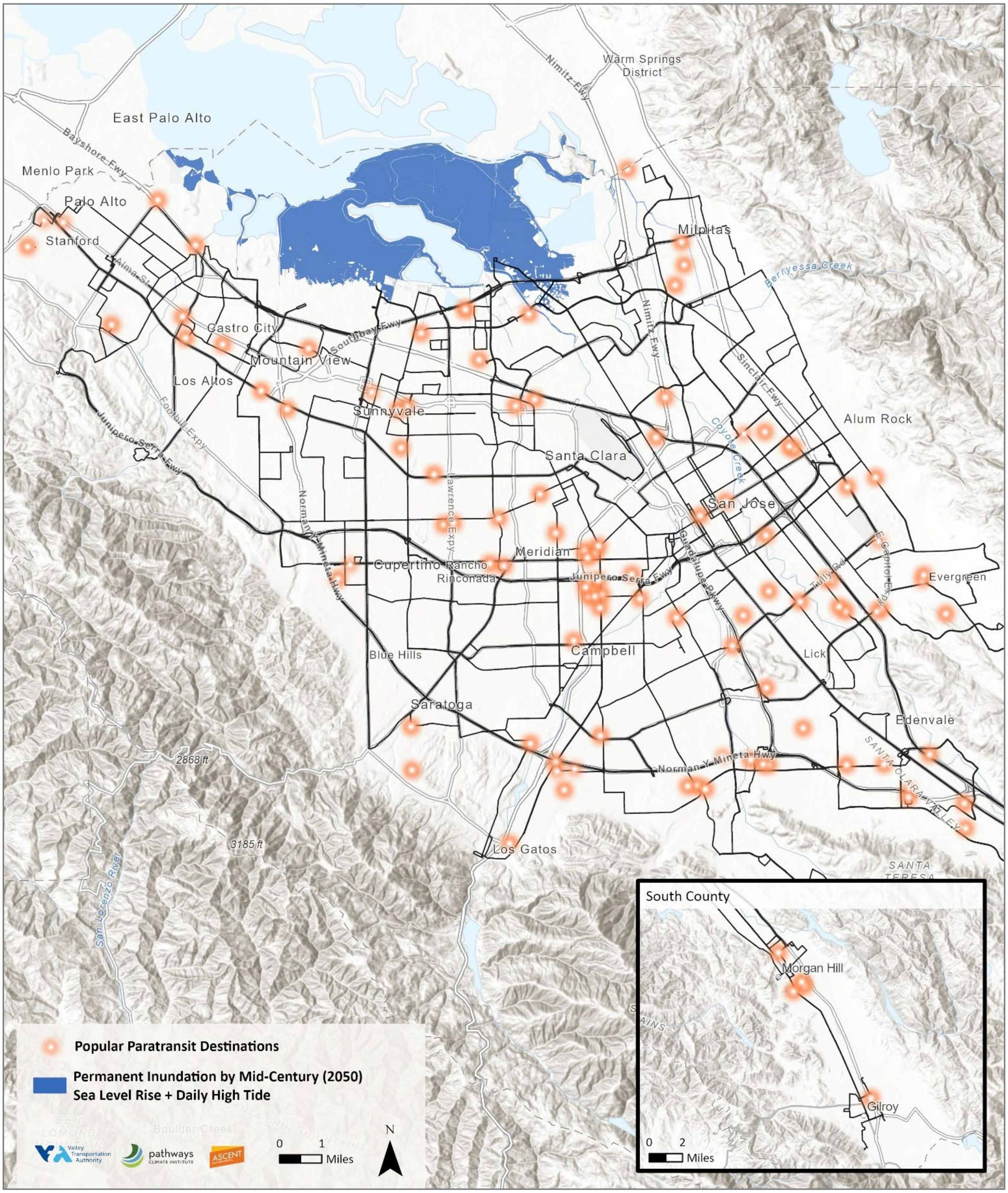
Source: FEMA National Flood Hazard Layer

Figure 18 Bus Transit Exposure – Temporary Urban/Inland Flooding



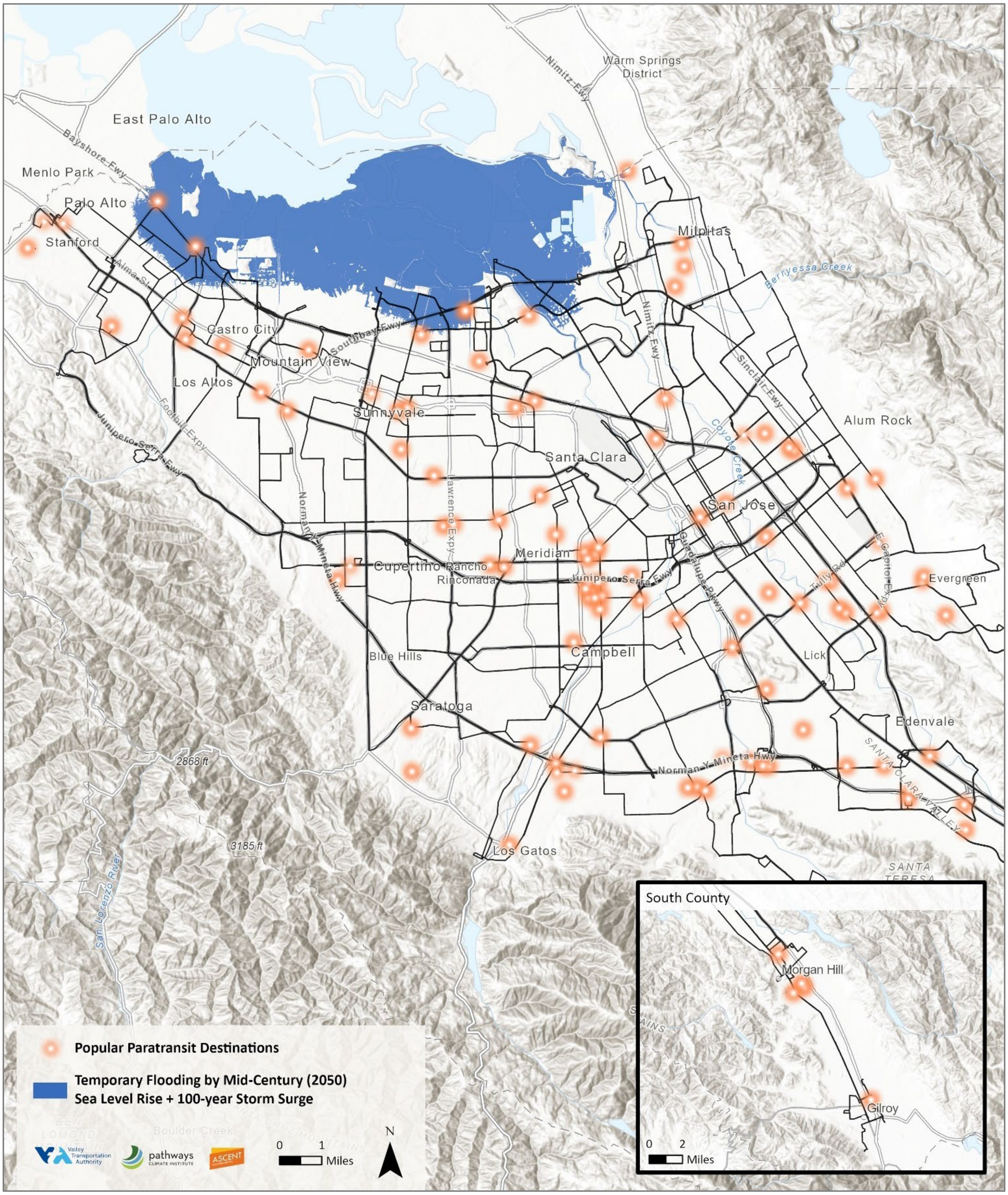
Source: CALFIRE Wildfire Threat Class

Figure 19 Bus Transit Exposure – Wildfire Threat



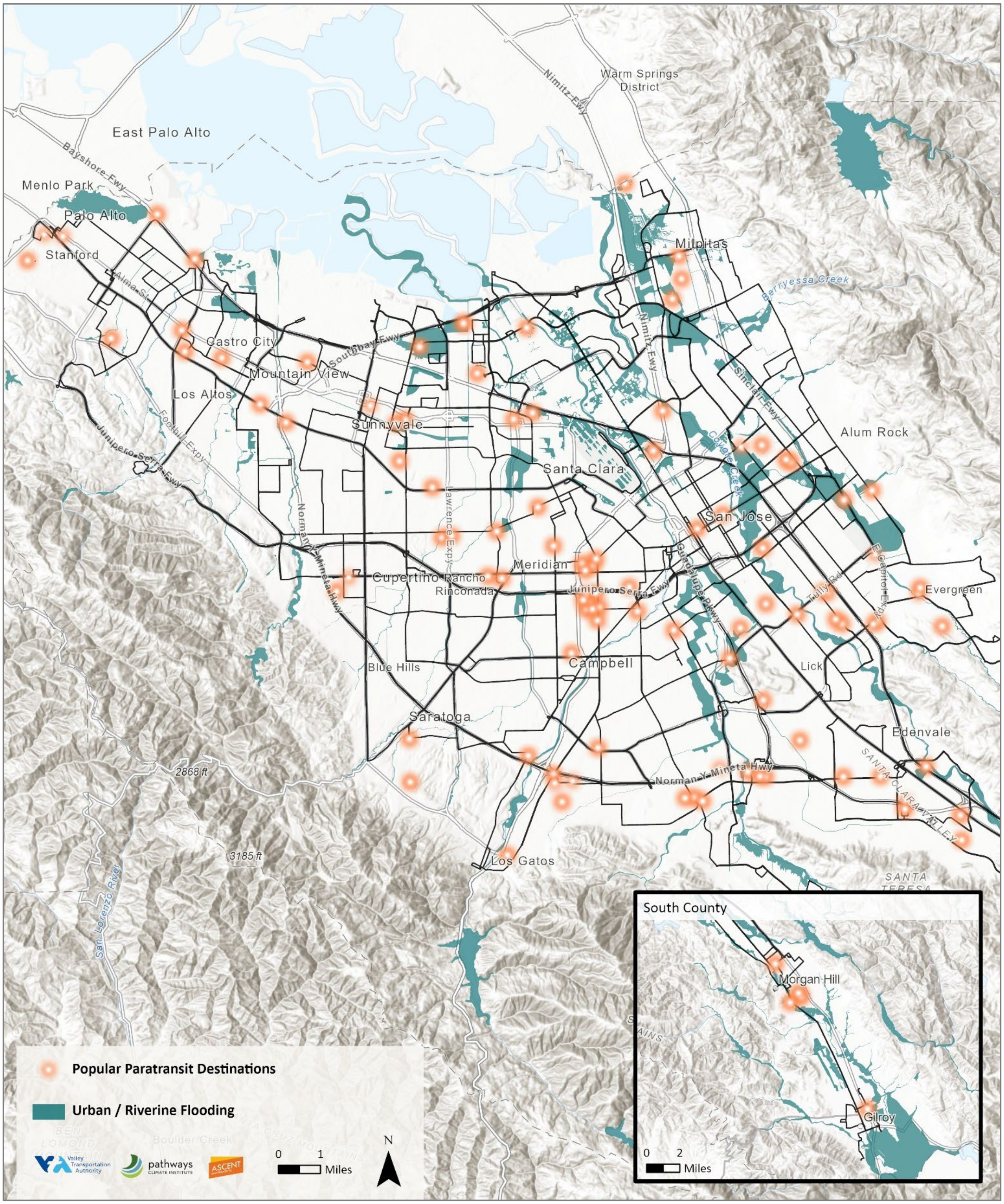
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 20 Paratransit Exposure – Permanent Coastal Inundation by Mid-Century (Sea-Level Rise + Daily High Tides)



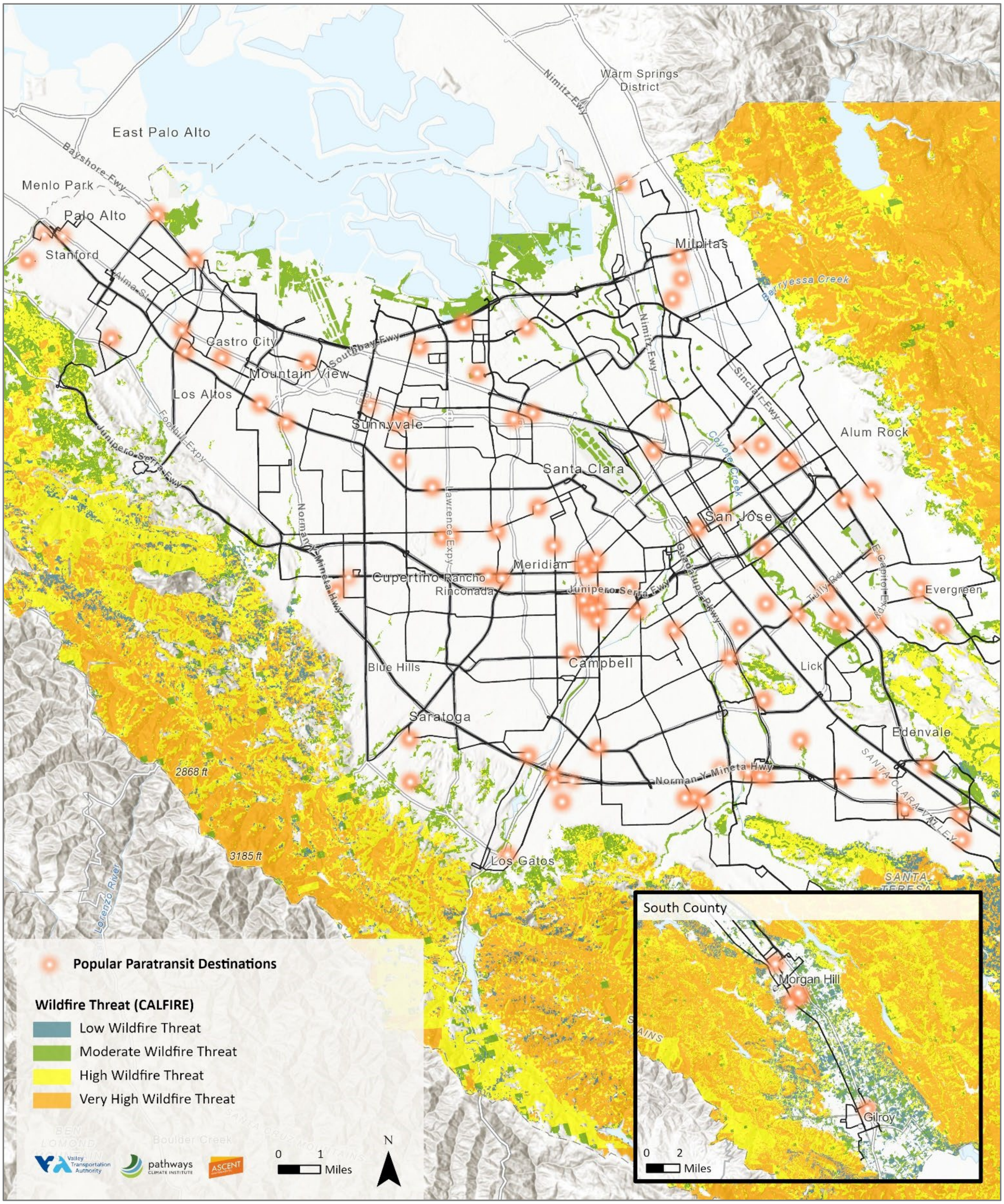
Note: SLR = sea level rise.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 21 Paratransit Exposure – Temporary Coastal Flooding by Mid-Century (Sea-Level Rise + 100yr Storm Surge)



Source: FEMA National Flood Hazard Layer

Figure 22 Paratransit Exposure – Temporary Urban/Inland Flooding



Source: CALFIRE Wildfire Threat Class

Figure 23 Paratransit Exposure – Wildfire Threat

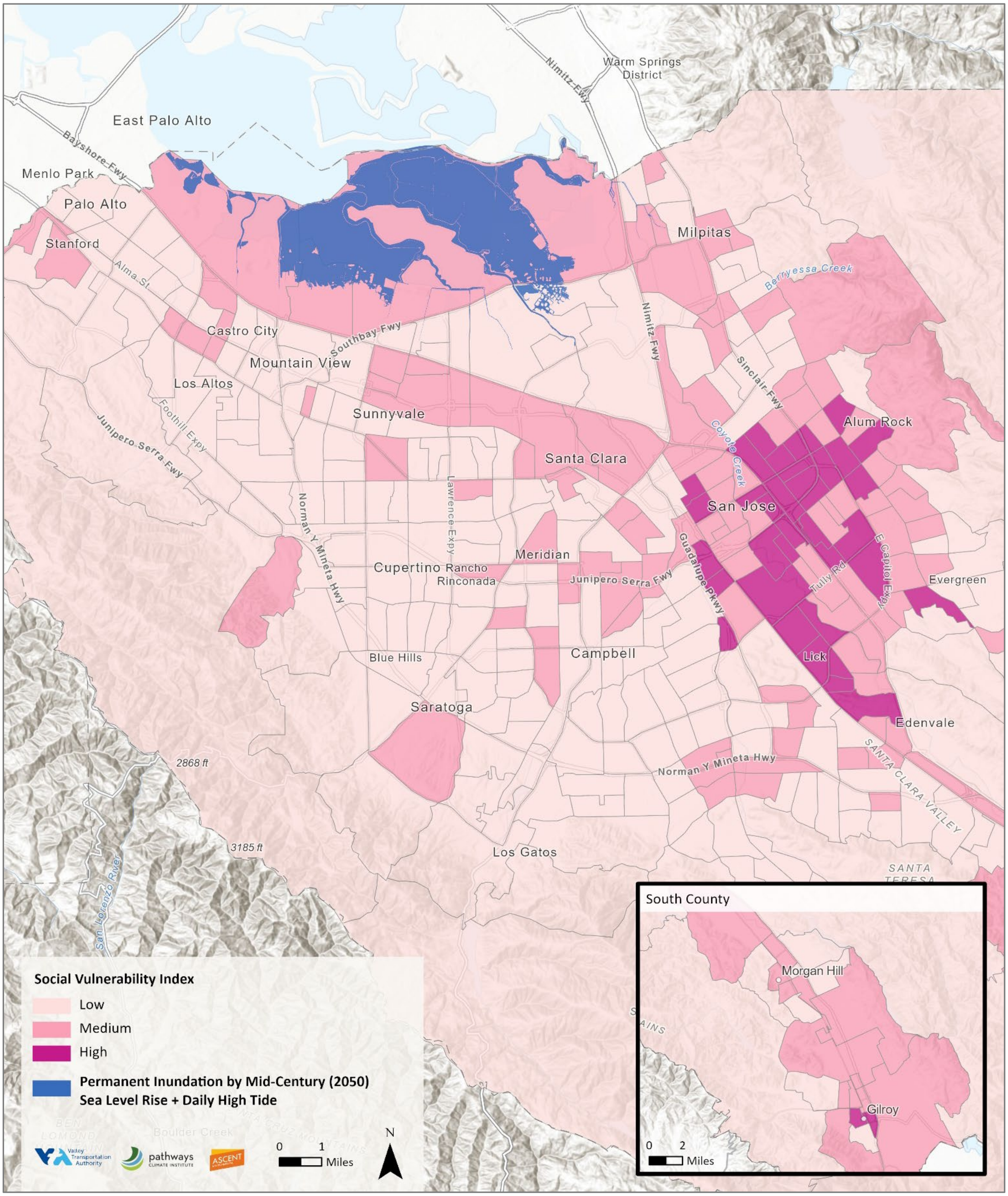
7.1.1 Social Vulnerability Index (SVI)

Figure 24 to Figure 27 shows the climate hazards with the Social Vulnerability Index (SVI) for Santa Clara County, created for Silicon Valley 2.0 and compiled data at the census tract level from the U.S. Census Bureau American Community Survey (ACS), CalEnviroScreen 4.0, USDA Flood Access Research Atlas, Department of Public Health, and County Homeless Census and Survey Reports (AECOM 2015)[16]. The SVI shows where vulnerable populations reside in the County and indicates areas where reliability of VTA assets and operations may be critical to vulnerable populations that rely on public transit. Vulnerable populations include, but are not limited to, persons with disabilities, lack of higher education, health dispositions such as asthma and cardiovascular disease, and households with low income or with limited English proficiencies.

The SVI overlay shows there are vulnerable populations that may rely on VTA transit for mobility across local communities or beyond. The greatest overlap of climate hazards with communities receiving a high SVI score occurs in the City of San Jose around the Downtown and Fairgrounds area, in the Alum Rock neighborhood and in the southern part of the city in areas along the Guadalupe River, Coyote Creek, and Interstate 680.These areas are within temporary urban/inland flood and wildfire hazard areas. Communities in the City of Milpitas and the City of Santa Clara have medium SVI scores and are also within larger temporary urban/inland flood hazard areas. The Alviso neighborhood in the City of San Jose located north of State Route 237 adjacent to the San Francisco Bay also have medium SVI scores and have significant overlap with coastal flooding hazard areas (both permanent coastal inundation and temporary coastal flooding from storm surge), and wildfire hazard areas.

These maps show where vulnerable populations reside and do not link vulnerable populations to their intended destination when using public transit; therefore, additional areas with potential exposure to climate hazards outside of where vulnerable populations reside may also be critical. The impacts from climate hazards to VTA's assets and operations may disproportionately affect these vulnerable communities. These effects include reduced evacuation capacity, limited access to healthcare facilities and essential goods and services, and disrupted abilities to report to work. Consequently, these effects exacerbate existing inequities and increase hardships for these communities. The locations of higher social vulnerability shown in Figure 24 to Figure 27 highlight the importance of maintaining a reliable level of service for vulnerable populations within the service area.

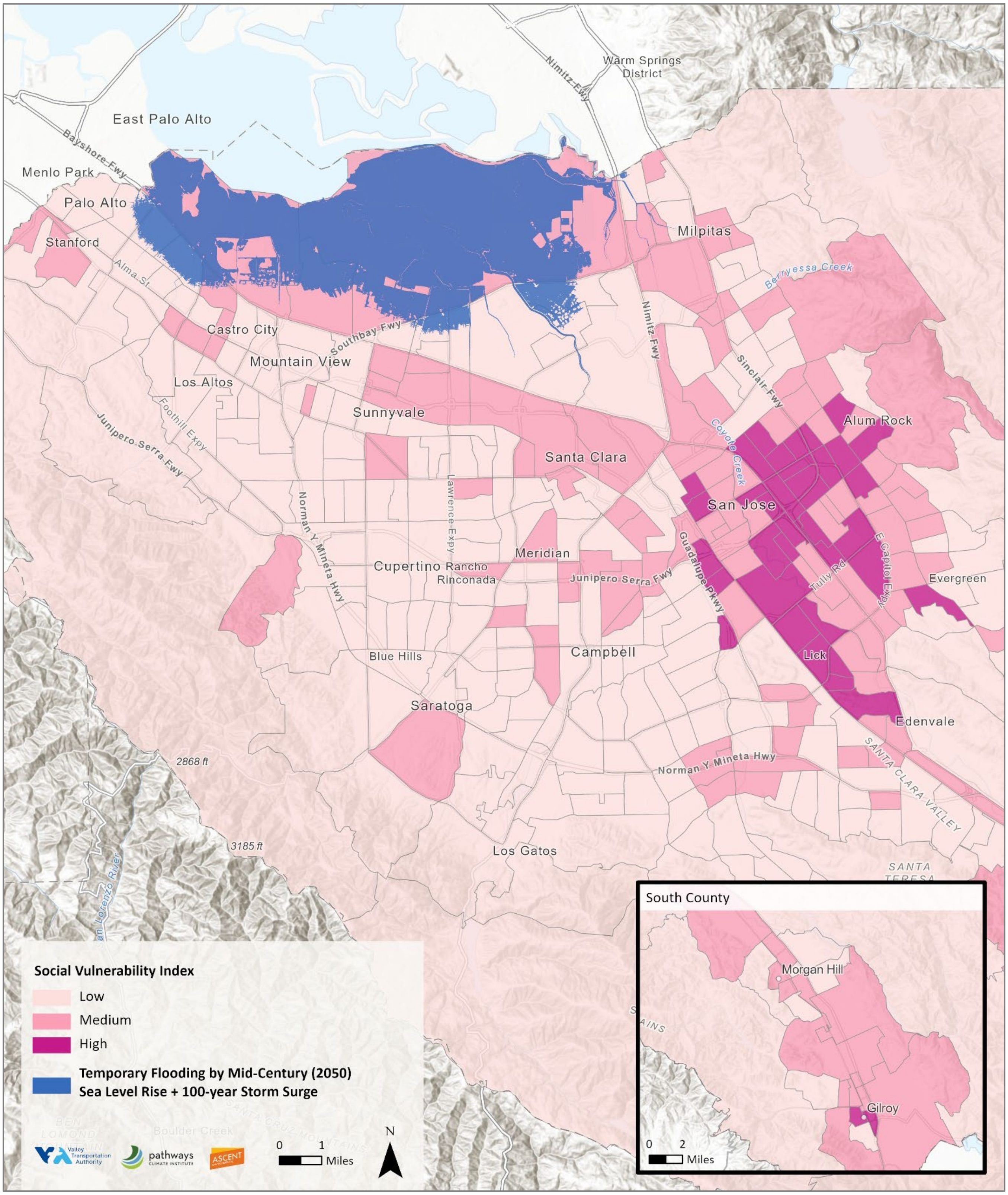
[16] https://siliconvalleytwopointzero.org/downloads/SiliconValley2.0_SOVI-Methodology.pdf



Note: SLR = sea level rise.

Source: Silicon Valley 2.0 Social Vulnerability Index; BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

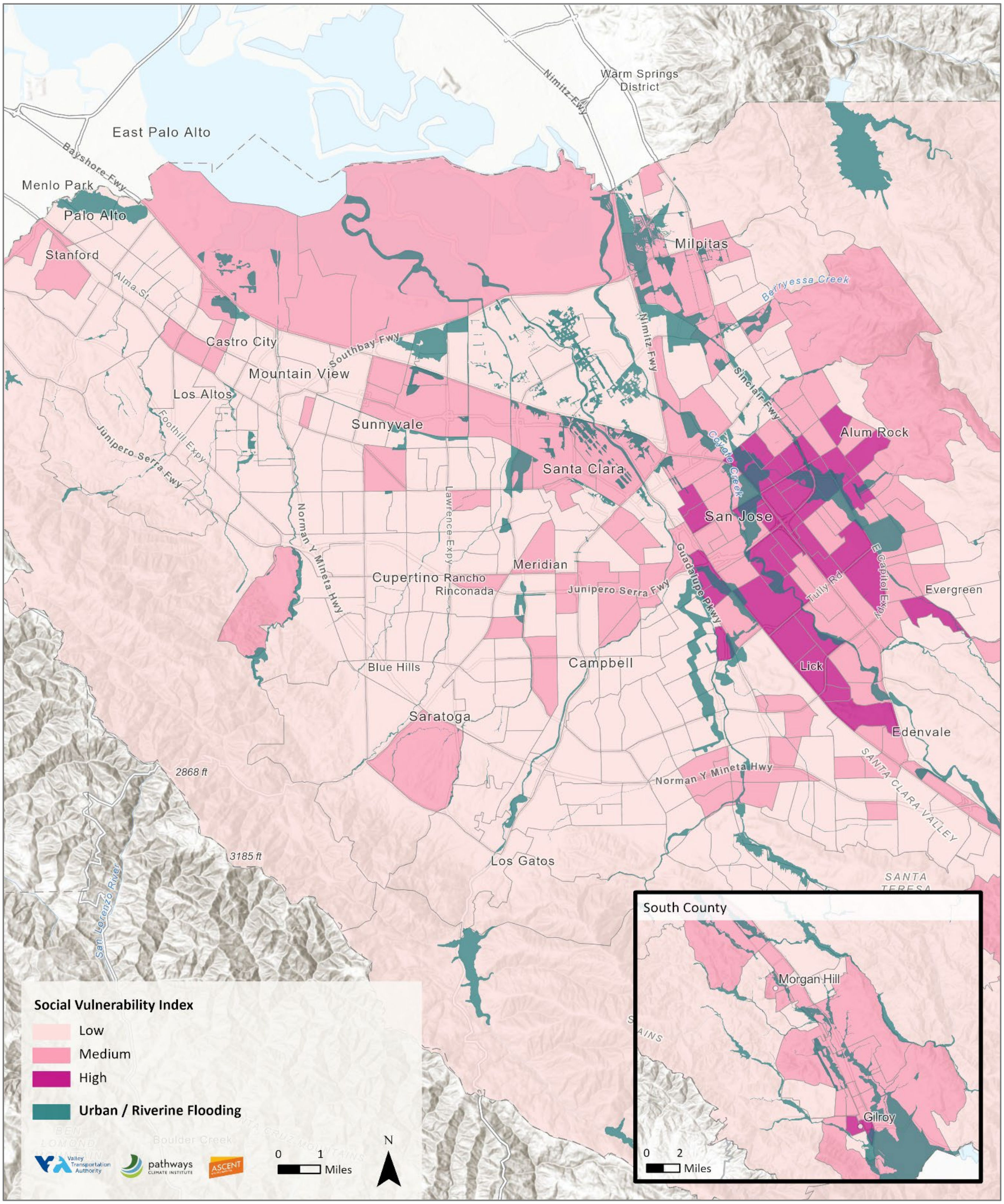
Figure 24 Social Vulnerability Index – Permanent Coastal Inundation by Mid-Century (Sea-Level Rise + Daily High Tides)



Note: SLR = sea level rise.

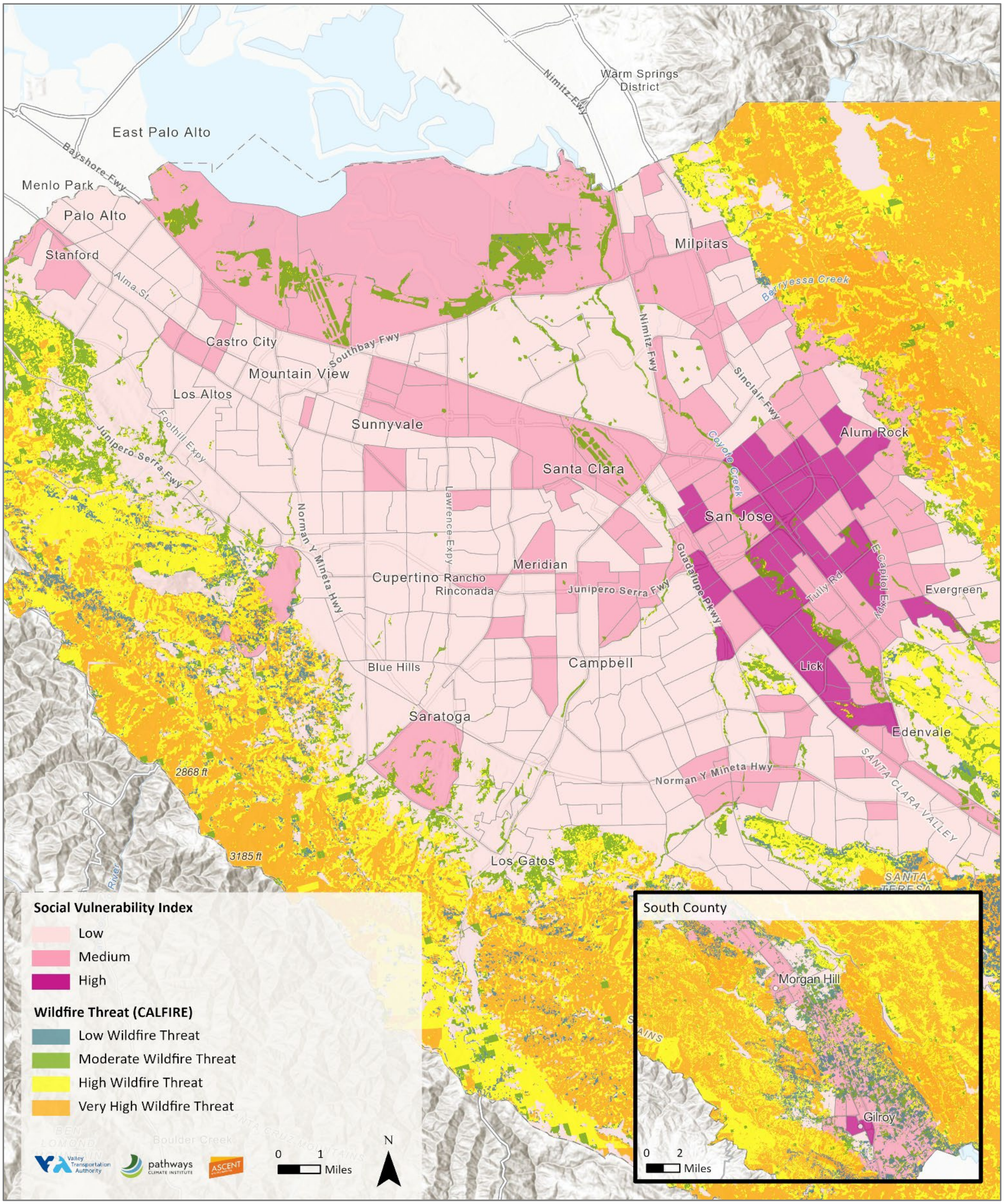
Source: Silicon Valley 2.0 Social Vulnerability Index; BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 25 Social Vulnerability Index – Temporary Coastal Flooding by Mid-Century (Sea-Level Rise + 100yr Storm Surge)



Source: Silicon Valley 2.0 Social Vulnerability Index; FEMA National Flood Hazard Layer

Figure 26 Social Vulnerability Index – Temporary Urban/Inland Flooding

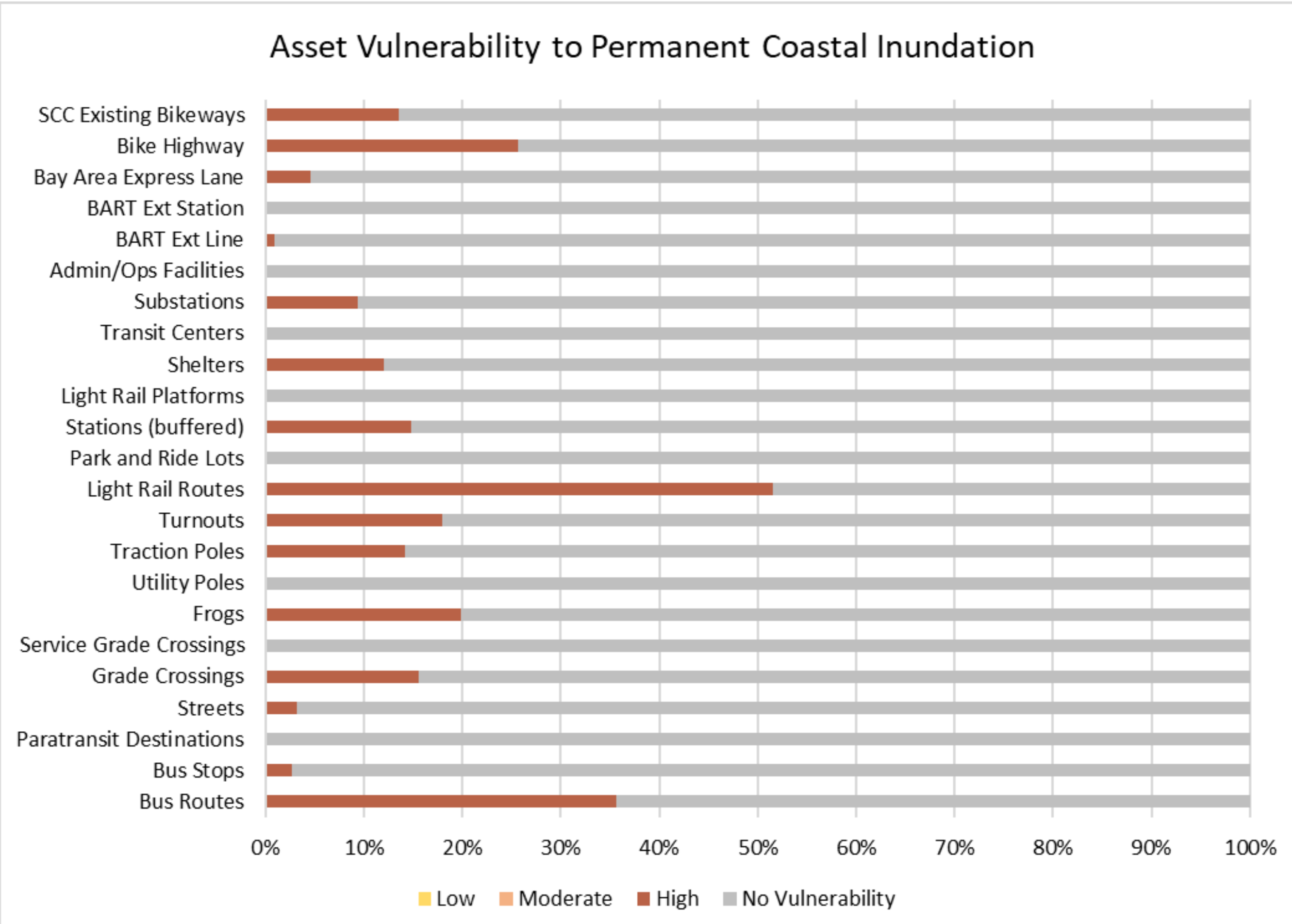


Source: Silicon Valley 2.0 Social Vulnerability Index; CALFIRE Wildfire Threat Class

Figure 27 Social Vulnerability Index – Wildfire Threat

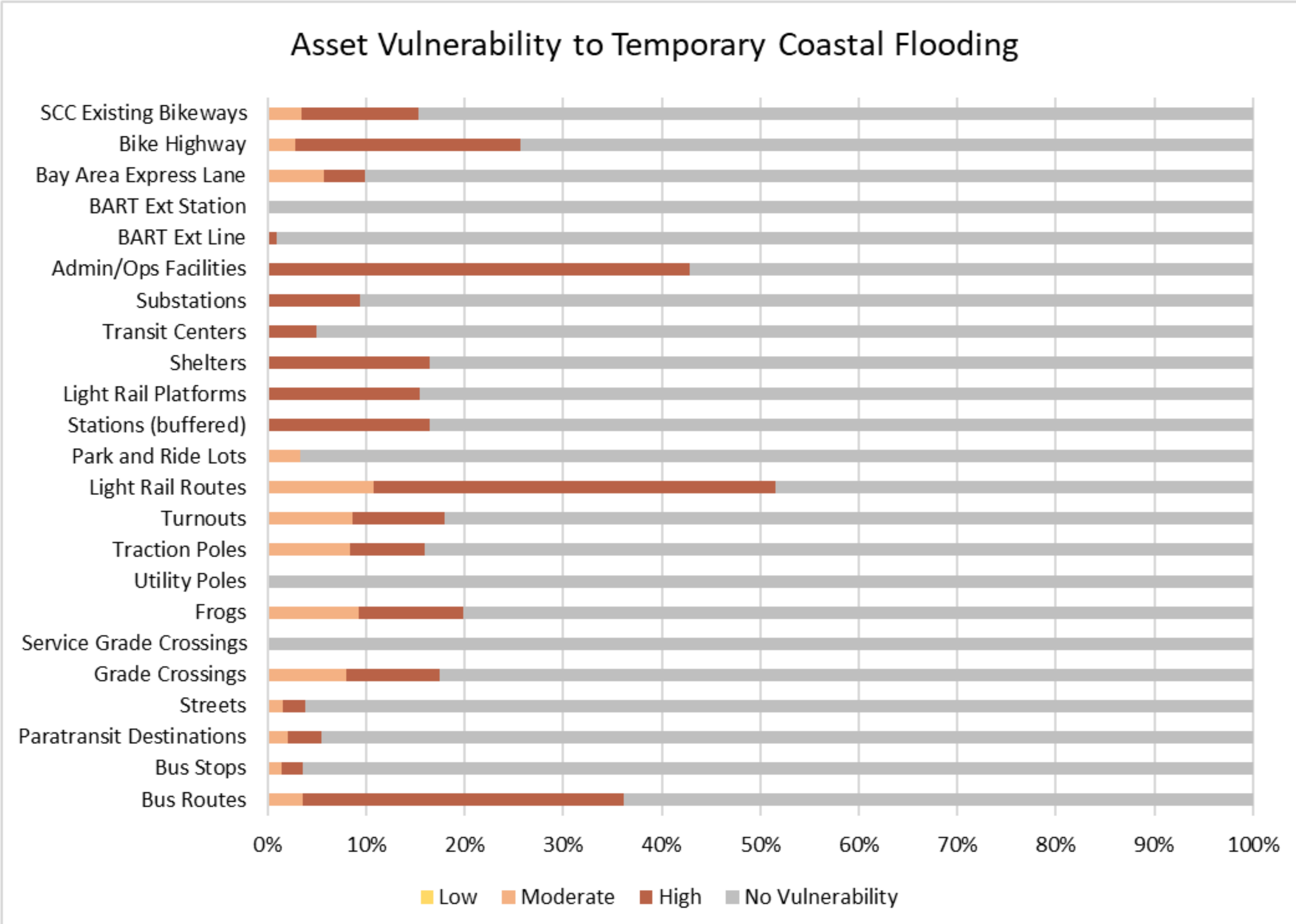
7.2 SUMMARY OF VULNERABILITY SCORES

Figure 28 to Figure 31 presents a summary of the vulnerability ratings for the VTA asset types. The vulnerability ratings consider the exposure, sensitivity, and adaptive capacity scores of individual assets. See Section 7.3 for the overall sensitivity and adaptive capacity ratings for the primary asset types, including justification for the ratings. For coastal flooding, the number of assets potentially exposed by the mid-century time horizon is presented. Findings for temporary urban/inland flooding and wildfire threat are based on historical climate conditions.



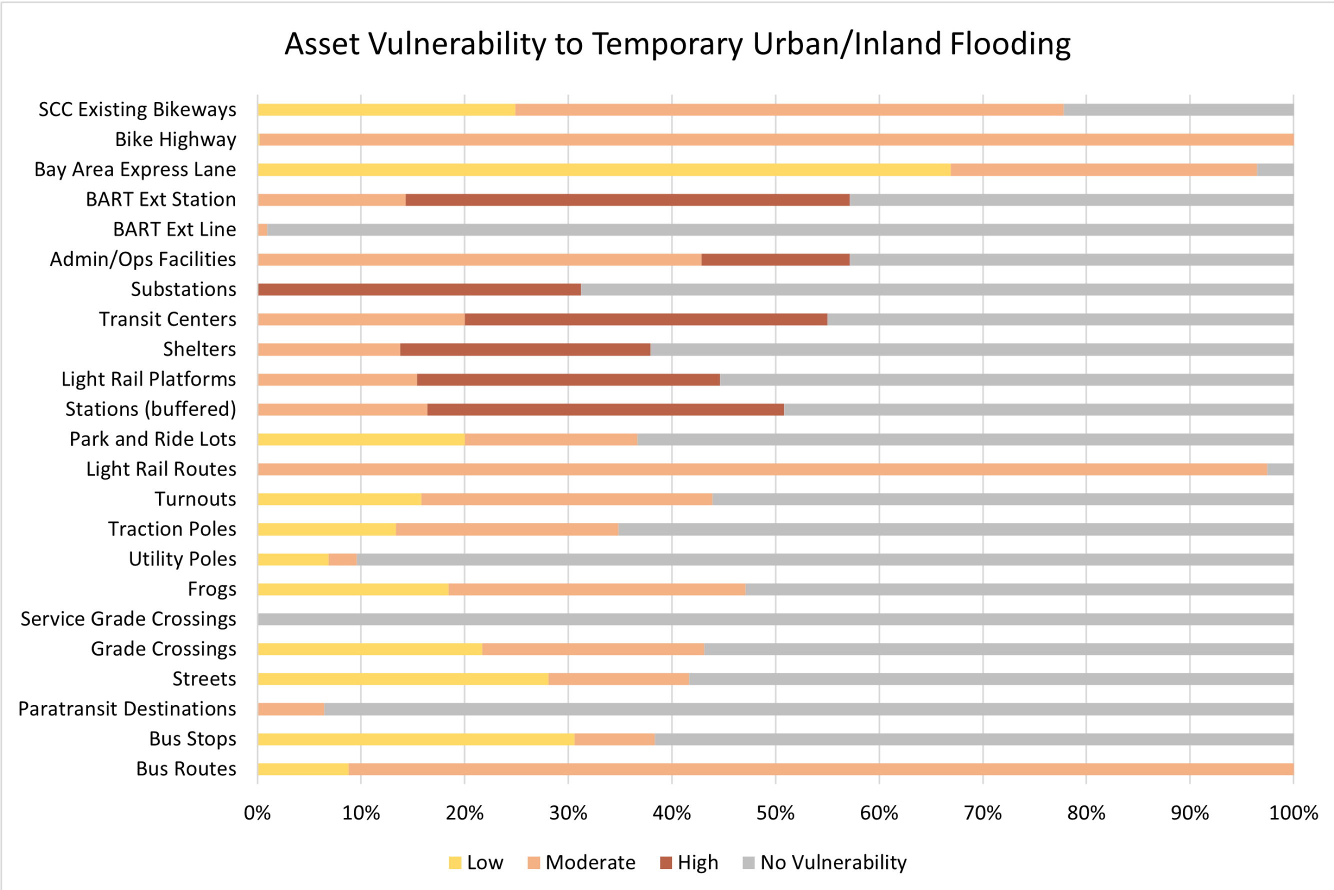
Notes: BART = Bay Area Rapid Transit; SCC = Santa Clara County.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 28 Vulnerability Summary for VTA Assets – Permanent Coastal Inundation (Sea-Level Rise + Daily High Tides)



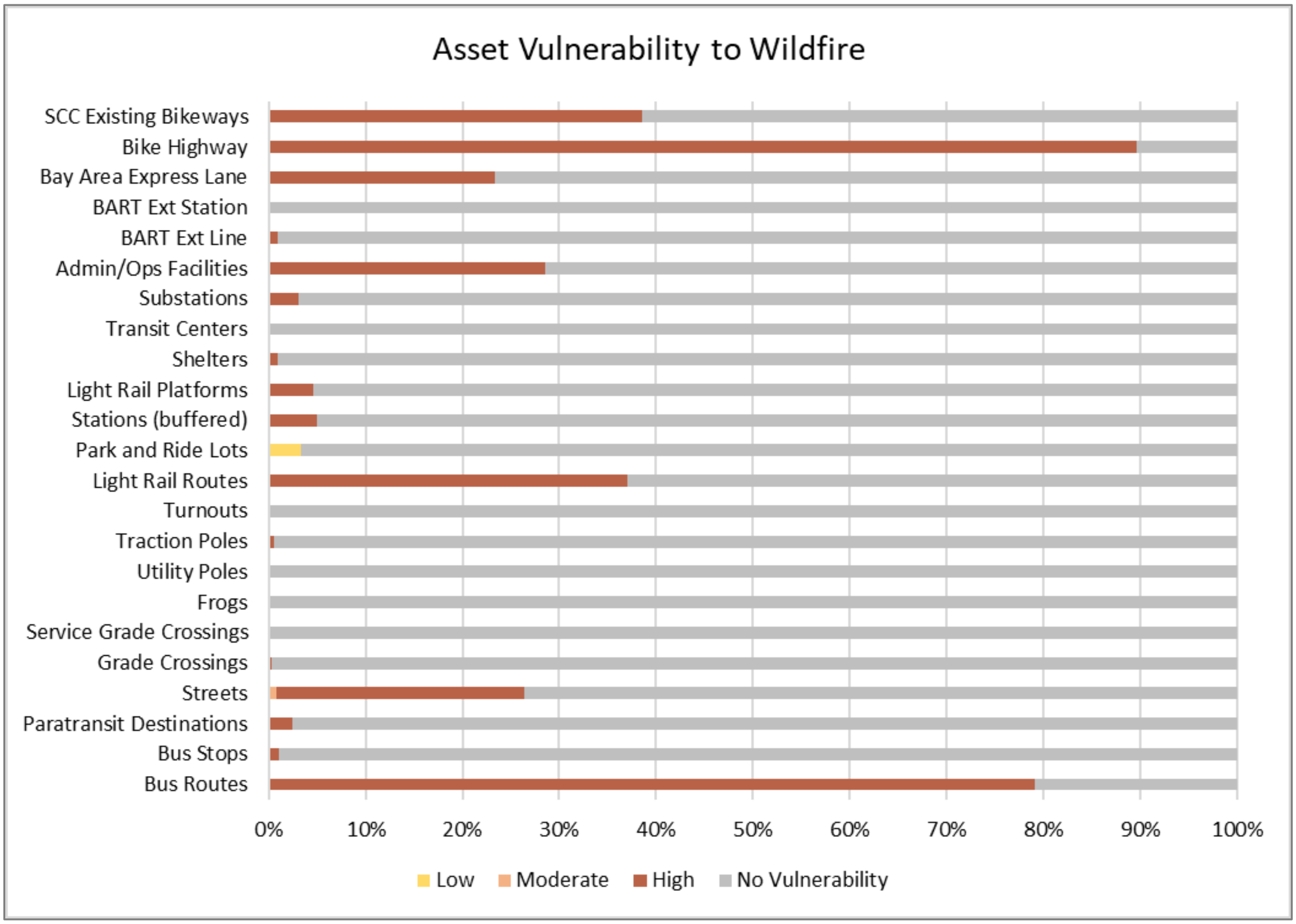
Notes: BART = Bay Area Rapid Transit; SCC = Santa Clara County.
Source: BCDC Adapting to Rising Tides (ART) Bay Area Sea Level Rise and Shoreline Analysis

Figure 29 Vulnerability Summary for VTA Assets – Temporary Coastal Flooding (Sea-Level Rise + 100yr Storm Surge)



Notes: BART = Bay Area Rapid Transit; SCC = Santa Clara County.
Source: FEMA National Flood Hazard Layer

Figure 30 Vulnerability Summary for VTA Assets – Temporary Urban/Inland Flooding



Notes: BART = Bay Area Rapid Transit; SCC = Santa Clara County.
Source: CALFIRE Wildfire Threat Class

Figure 31 Vulnerability Summary for VTA Assets – Wildfire

7.3 ASSET VULNERABILITY PROFILES

There are four asset profiles for the primary asset classes: Facilities, Light Rail, Bus and Paratransit, and Operations. The operations profile details service and ridership, maintenance, and rider and workforce safety. Each asset profile provides an overview of vulnerabilities and consequences from climate hazard impacts, and are presented in Attachment 3, Attachment 4, and Attachment 5. A summary of the key vulnerabilities and consequences detailed in these attachments is provided for each asset type and operations in the profiles below.

7.3.1 Vulnerability Profile - Facilities

ASSET CHARACTERISTICS

This profile includes Administration and Operation Buildings, which include seven facilities: the Cerone Bus Division-Repair and Warehouse, Cerone Bus Division – Maintenance and Operations, Chaboya Bus Division, North Yard Bus Division, Eastridge Paratransit Facility, Guadalupe Light Rail Division, and the River Oaks Administrative Campus. The

Cerone Bus Division is divided into two facilities for the purpose of this assessment: the Heavy Repair Shop, Paint Shop, Central Warehouse is one facility, and the Maintenance, Operations, Central Energy, and Revenue Building is another facility. Facilities also include 29 parking lots, 61 stations, and 19 transit centers. Stations serve light rail and Transit Centers serve bus lines.

KEY VULNERABILITY FINDINGS

- Critical Facility Vulnerability: According to VTA staff, the most critical facilities for VTA are the Cerone Bus Division, River Oaks Administrative Campus, and Guadalupe Light Rail Division. These three facilities also have the highest vulnerability to flooding and wildfire. The Chaboya and North Yard Bus Divisions, as well as the Eastridge Paratransit Facility, are also critical facilities for VTA but are minimally at risk to flooding and wildfire and have a lower vulnerability to heat and drought.
  - Cerone Bus Division is vulnerable to temporary coastal flooding, temporary urban flooding, and wildfire. The facility has underground and low-lying electrical equipment that are vulnerable to flooding. Both portions of the Cerone Bus Division are vulnerable to temporary coastal and temporary urban/inland flooding and only the Maintenance and Operations portion of the Yard is exposed to wildfire. VTA was awarded a grant by the California Energy Commission's Clean Transportation Program and will be installing new electric bus chargers, solar panels, and a microgrid at this facility.
  - River Oaks Administrative Campus is vulnerable to temporary coastal flooding, temporary urban/inland flooding, and wildfire. River Oaks contains Information Technology Equipment (IT), which is very sensitive to heat, fire, or flooding, and damage to the IT equipment could have widespread consequences.
  - Guadalupe Light Rail Division is vulnerable to temporary urban/inland flooding. The Guadalupe Light Rail Division is VTA's only rail yard providing all services from storage, parts, and maintenance for light rail transportation. VTA's core communications system and dispatching center is also located at this facility. Any disruption to the accessibility of this yard would effectively hinder light rail service as well as communication support for VTA's Bus service.
- Stations: Stations have a high vulnerability to flooding, wildfire, and heat. Of all the facility assets, stations have the highest vulnerability to permanent coastal inundation and temporary coastal flooding, with nine stations highly vulnerable to both flood hazards (Baypointe, Borregas, Champion, Crossman, Fair Oaks, Lockheed Martin, Reamwood, Tasman, and Vienna) and one additional station (River Oaks) highly vulnerable to only temporary coastal flooding. Over half of the stations have moderate or high vulnerability to urban/inland flooding. Three stations are highly vulnerable to wildfire (Bascom, Children's Discovery Museum, San Fernando). Extreme heat events can affect station equipment and systems, causing disruptions to all stations.
- Transit Centers: Lockheed Martin Transit Center is the only transit center vulnerable to permanent coastal inundation and temporary coastal flooding, and nine transit centers are vulnerable to temporary urban/inland flooding, with Great Mall Main Transit Center, Hostetter Transit Center, Morgan Hill Transit Center, Penitencia Creek Transit Center, Santa Clara Transit Center, Sunnyvale Transit and Tamien Transit Center having a high vulnerability score. None of the Transit Centers are vulnerable to wildfire. At the time of writing, VTA no longer operates buses at the Great Mall Main Transit Center, Hostetter Transit Center, and Penitencia Creek Transit Center. However, they still serve as connections to the light rail system and are part of the assessment because they remain under the responsibility of VTA. Additionally, the Milpitas Transit Center and Berryessa Transit Center are not included in this section to avoid duplication since they are already accounted for as part of the Milpitas BART Station and Berryessa BART Station in Section 7.4.3 Regional Transportation.

- **Park and Ride Lots:** Lots are highly vulnerable to extreme heat and moderately vulnerable to flooding. River Oaks lot is vulnerable to temporary coastal flooding, no lots are vulnerable to permanent coastal flooding, and about one-third of lots are vulnerable to temporary urban/inland flooding. The lot at Bascom Station is the only lot vulnerable to wildfire, with the overall vulnerability is low.

Note: Many of the impacts to facilities from climate hazards may cause service disruptions and increase required maintenance to maintain a state of good repair. These issues are discussed in detail in the Operations and Maintenance Vulnerability Profile. The permanent and coastal flooding vulnerability can be reduced by the completion of shoreline protection projects. For example, the South San Francisco Bay Shoreline Project, led by Valley Water, in partnership with the U.S. Army Corps of Engineers and the California State Coastal Conservancy, should reduce the vulnerability of VTA's facilities from flooding once completed. For more information on the project visit https://www.valleywater.org/shoreline.

KEY CONSEQUENCES

Table 10 below summarizes key consequences for facilities. Additional consequences for each asset and hazard can be found in Attachment 3.

Table 10 Key Consequences for Facilities

Consequence Statements	Consequence Sectors				
	Physical	Fiscal	Local/Regional Economy	Social	Environmental
Facility Damage: Hazards may degrade the physical condition, with frequent or permanent flooding resulting in condemnation of facilities. Underground utilities are very sensitive to floodwaters, and there is increased potential for contamination from maintenance areas with flood exposure. There may be reduced lifespan of equipment such as HVAC systems from extreme heat, increased costs associated with heat damages and repair for some facilities may take a long time.	X	X		X	X
Access Issues: Floodwaters and wildfires may block access and egress to all facility types, impacting staff and riders. It may cause riders to rely on private vehicles instead of VTA services. Hazards may also delay maintenance or construction-related activities at facilities such as installing charging stations at the Cerone Bus Division.	X	X	X	X	X
Electrical Impacts: Extreme heat and flooding can impact IT and communication systems, degrade electrical assets, and cause shortening with electrical equipment, leading to system-wide impacts.	X	X		X	

Notes: HVAC = heating, ventilation, and air conditioning; IT = information technology.

Table 11 lists the stations (in alphabetical order) with highest vulnerability to multiple hazards and their average daily ridership, based on data from February 2020.

Table 11 Highly Vulnerable Stations with Daily Ridership Data

Station Name	Total Average Weekday Boarding and Alighting	Total Average Weekend Boarding and Alighting	Climate Hazards Exposure
Baypointe	169	125	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Borregas	94	21	Permanent Coastal Inundation, Temporary Coastal Flooding
Fair Oaks	248	311	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Tasman	1,890	2,211	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Vienna	102	132	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Champion	195	64	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Crossman	96	30	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Lockheed Martin	204	67	Permanent Coastal Inundation, Temporary Coastal Flooding
Reamwood	104	82	Permanent Coastal Inundation, Temporary Coastal Flooding
San Fernando	169	250	Temporary Urban/Inland Flooding, Wildfire

7.3.2 Vulnerability Profile – Light Rail

ASSET CHARACTERISTICS

This profile includes light rail routes, which include the Blue, Green, and Orange service lines and the maintenance line in the Guadalupe Yard maintenance facility. The Orange line primarily operates on two main tracks: Tasman West (8.1 miles) and Tasman East (8.1 miles). The Orange line includes two smaller tracks: the Santa Clara Pocket Track (0.2 miles) and the Mountain View Double Track (1.2 miles). The Green and Blue lines utilize the Guadalupe North track (19.6 mi). The Green line extends to the Vasona track (5.3 miles), while the Blue line continues on the Guadalupe South track (19.6 miles). The Eastridge to BART Regional Connector Project, which will begin construction in 2024, will extend the existing Orange Line from its current terminus at Alum Rock Station to the Eastridge Transit Center with an elevated guideway primarily in the center of Capitol Expressway in the City of San Jose. While this extension Project was not included in the vulnerability assessment of the Orange Line, the footprint of the existing Eastridge Transit Center and park-and-ride lot was included in the Facilities Profile above.

The other supporting light rail infrastructure included are substations, grade crossings, service grade crossings, frogs, turnouts, utility poles, and traction poles. There are 32 substations, 327 grade crossings, 5 service grade crossings, 206 frogs, 139 turnouts, 73 utility poles, and 1,904 traction poles in the system. Substations are also critical assets for the functioning of light rail and are highly vulnerable to multiple climate hazards, including permanent and temporary flooding, wildfire, and extreme heat.

KEY VULNERABILITY FINDINGS

Light Rail Routes: Guadalupe North track division is the oldest, first built in 1983 and expanded in 1986 and 1987. Guadalupe South was built in 1992, and Tasman West was built in 1999. Figure 32 shows VTA's track chart and light rail system. With some tracks in service for several decades, the age of light rail infrastructure increases the sensitivity and overall vulnerability to all hazards due to degrading condition over time. VTA has an ongoing Rail Rehabilitation and Replacement program to ensure safety and reliability for the trackway and supporting systems (Valley Transit Authority 2023c). The system experiences additional stress due to the climate whiplash between hazards. It is worth noting that the current light rail design standards and operating plans do not adequately account for these temperature contrasts, highlighting increased vulnerability to the system's resilience to climate impacts.

According to VTA staff, the light rail system is most susceptible to impacts of flood and extreme heat events, posing significant risks to its operations and infrastructure. When one asset is affected, it may have adverse impacts throughout the entire system. Temporary urban/inland flooding is already an issue in multiple areas such as the community of Alviso, the NASA Depression located in the City of Mountain View, and the San Jose Diridon Station and the Bassett Tunnel located in the City of San Jose. VTA routes in these regions face the highest potential for exposure to temporary urban/inland flooding.

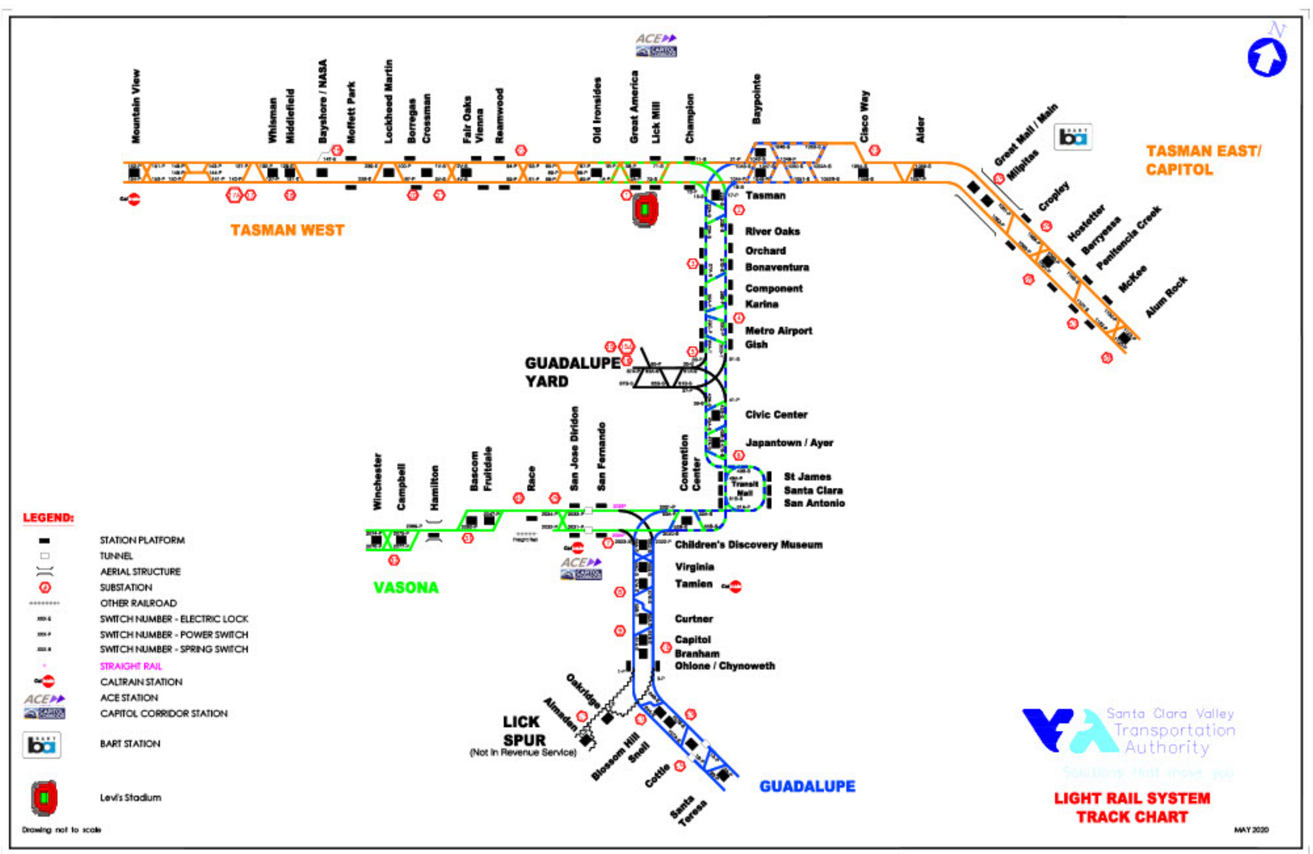


Figure 32 VTA's Light Rail System Track Chart

- **Green Line** - 5% (1,900 feet) of the Guadalupe North track is highly vulnerable to permanent coastal inundation by end of the century, and 3% (830 feet) of the Vasona track is highly vulnerable to current wildfire. 3% (900 feet) of the Guadalupe North track is moderately vulnerable to temporary coastal flooding by mid-century and temporary urban/inland flooding. 41% (14,400 feet) of the Green line on Guadalupe North is at risk from temporary urban/inland flooding by the end of the century.
- **Orange Line** - 4% (3,910 feet) of the Orange Line on Tasman West is highly vulnerable to permanent coastal inundation by end mid-century and 20% (18,190 feet) is highly vulnerable to temporary coastal flooding by mid-century. 4% (3,950 feet) of the Orange line on Tasman East and West is moderately vulnerable to temporary urban/inland flooding.
- **Blue Line** - 0.7% (355 feet) of the Blue Line is highly vulnerable to wildfire and moderately vulnerable to temporary urban/inland flooding. 19% (9,800 feet) of the Blue line on Guadalupe South is at risk from temporary urban/inland flooding by the end of the century.

Supporting Infrastructure:

- **Substations** (Sub #2, Sub #20, and Sub #21) are vulnerable to permanent inundation and temporary coastal flooding with an additional ten substations vulnerable to temporary urban/inland flooding. Substations are already experiencing impacts from heat. An increase in extreme heat days, with climate change, could lead to overheating of equipment and power outages, which could cause significant disruption throughout VTA's service area.
- **Grade Crossings**, intersections at which a roadway crosses a railroad at-grade, are highly vulnerable to permanent coastal inundation (51), temporary coastal flooding (31), and wildfire (1). There are 70 grade crossings moderately vulnerable to temporary urban/inland flooding.
- **Service Grade Crossings** are not vulnerable to any hazards.
- **Frogs**, or components of track placed where one rail crosses another, are highly vulnerable to permanent coastal inundation (41), temporary coastal flooding (22). There are 59 frogs moderately vulnerable to temporary urban/inland flooding.
- **Turnouts**, which enable trains to move from one track to another, are highly vulnerable to permanent coastal inundation (25), temporary coastal flooding (13). There are 36 turnouts moderately vulnerable to temporary urban/inland flooding.
- **Utility Poles** that support overhead power lines are moderately vulnerable to temporary urban/inland flooding (2).
- **Traction Poles** that bring electricity to light rail trains are highly vulnerable to permanent coastal inundation (270), temporary coastal flooding (145), and wildfire (10). There are 409 traction poles moderately vulnerable to temporary urban/inland flooding.

Sensitivity and adaptive capacity scores for each asset type, by hazard, are provided in Attachment 4. Supporting statements for sensitivity and adaptive capacity that were initially validated during the VTA vulnerability and consequences workshop were used to justify each score.

KEY CONSEQUENCES

Table 12 below summarizes key consequences for light rail assets. Additional consequences for each asset and hazard can be found in Attachment 4.

Table 12 Key Consequences for Light Rail

Consequence Statements	Consequence Sectors				
	Physical	Fiscal	Local/Regional Economy	Social	Environmental
System Damage: Extreme heat is already an issue for the light rail system, particularly affecting specific components like the Overhead Catenary System (OCS), brakes, and tracks. These heat-related consequences such as OCS sagging, brake systems overheating, or sun kinks in the tracks can lead to significant and costly damage, resulting in service disruptions until necessary repairs are completed.	X	X		X	
Loss of Power: The light rail system is critically reliant on electricity from PG&E and Silicon Valley Power (SVP); power outages during flood, storm, wildfire, and heat events will have significant impacts on service and have already impacted VTA operations and service in the past.	X		X	X	
Reliance on Bus Service: Light rail service disruptions during and after hazard events will increase reliance on bus bridges and bus service. However, bus service cannot replace all routes, would require substantial operator resources, and degrade regular bus services. Riders may opt for using private vehicles for travel, increasing emissions.		X		X	X

7.3.3 Vulnerability Profile – Bus and Paratransit

ASSET CHARACTERISTICS

This profile highlights the vulnerability rankings and key findings for bus stops and popular paratransit destinations. VTA has approximately 1,400 miles of bus routes and 3,300 bus stops. VTA provides ACCESS Paratransit services to eligible individuals with disabilities who are not able to use conventional bus and light rail service due to their physical, visual, or cognitive disabilities (https://www.vta.org/go/paratransit). ACCESS Paratransit area is within 0.75 mile around fixed VTA bus routes and light rail stations.

KEY VULNERABILITY FINDINGS

Bus Routes are highly vulnerable to permanent and temporary coastal flooding, wildfire, and heat. Routes could be disrupted if roads are flooded, if they are in an evacuation zone during a wildfire, or if pavement buckles during an extreme heat event.

Highest potential bus route exposure to climate hazards:

- 100% of Line 44, 85, 89, 288, 288L, 288M have potential exposure to temporary urban/inland flooding (within the FEMA 0.2% annual chance floodplain).

- Over 50% of Line 20, 21, 22, 40, 47, 51, 52, 53, 55, 59, 84, 87, 104, 287, 288, 288L, 288M, 522, ACE Purple, ACE Brown, and ACE Violet have potential exposure to temporary urban/inland flooding (within the FEMA 0.2% annual chance floodplain).
- **Bus stops** are highly vulnerable to permanent coastal inundation (88), temporary coastal flooding (70), and wildfire (27). A total of 252 bus stops are moderately vulnerable to temporary urban/inland flooding.

Paratransit destinations have the highest vulnerability to extreme heat (compared to other climate hazards) because all paratransit destinations are exposed to extreme heat. None of the popular destinations are vulnerable to permanent coastal inundation from sea-level rise, and very few are at risk from temporary coastal flooding (11) or temporary urban/inland flooding (13).

Streets in VTA's service area are most vulnerable to wildfire (compared to other climate hazards), with 26% of streets (1,815 miles) identified with high vulnerability to wildfire. Streets are also highly vulnerable to extreme heat, and moderately vulnerable to temporary/urban inland flooding (14% of streets have a moderate vulnerability rating and 28% have a low vulnerability rating). Although traffic signals and other related equipment are not included in this analysis, they face the same vulnerability to these hazards.

Sensitivity and adaptive capacity scores for each asset type, by hazard, are provided in Attachment 5. Statements for sensitivity and adaptive capacity to support the ratings were validated during the VTA vulnerability and consequences workshop.

KEY CONSEQUENCES

Table 13 below summarizes key consequences for bus and paratransit assets. Additional consequences for each asset and hazard can be found in Attachment 5.

Table 13 Key Consequences for Bus and Paratransit

Consequence Statements	Consequence Sectors				
	Physical	Fiscal	Local/Regional Economy	Social	Environmental
Climate whiplash: Oscillation between extreme heat to cold, drought to floods, as well as hazard exposure may degrade vehicles and equipment for bus and paratransit operations.	X	X			
Electrical Impacts: The bus and paratransit operations are reliant on electricity from PG&E sources for charging the electric fleet, and for traffic signals; power outages during flood, storm, wildfire, and heat events will have significant impacts on service and have already impacted VTA operations and service in the past. There are currently no backup power sources.	X	X	X	X	
Increased Strain: If the light rail system is impacted by hazards, it can lead to strain on bus operations due to additional bus bridges and reliant service. Cooling systems in buses can be difficult to maintain and are used during extreme heat events as free rides to cooling centers and operate as cooling centers themselves. Bus services may be provided in other disaster response events, creating additional strain on resources and revenue.	X	X	X	X	
Disproportionate Effects: Hazards may have higher impacts for riders with disabilities or access and functional needs who depend on VTA ACCESS Paratransit services. There may be more requests for service during hazard events.				X	

Table 14 lists bus stops (in alphabetical order) with the highest vulnerability to multiple hazards, narrowed down to include stops with average ridership of at least 50 people a day.

Table 14 Highly Vulnerable Bus Stops with Daily Ridership Data

Stop Name	Average Daily Boarding and Alighting	Climate Hazards Exposure
Fair Oaks & Tasman	66	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland flooding
Lakebird & Meadowlake	57	Temporary Coastal Flooding, Temporary Urban/Inland Flooding
Lockheed Martin Transit Center	339	Permanent Coastal Inundation, Temporary Coastal Flooding
Main & Centria	60	Temporary Urban/Inland Flooding, Wildfire
Tasman & Baypointe	275	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland flooding
Weller & Main	54	Permanent Coastal Inundation, Temporary Coastal Flooding, Temporary Urban/Inland flooding

7.3.4 Vulnerability Profile – Operations

ASSET CHARACTERISTICS

This profile includes critical operations for VTA, Service and Ridership, Maintenance, and Rider and Workforce Safety. The exposure ratings come from the climate trends analysis for overall regional projected climate trends.

KEY VULNERABILITY FINDINGS

Rainfall, wildfire, extreme heat, drought, and sea-level rise events are all projected to increase by mid-century, shown in Table 2. These climate hazards may have long durations or increased frequency, causing higher vulnerabilities and chronic consequences for VTA operations.

- **Service and Ridership** has the highest vulnerability to permanent inundation because of permanent loss of service, severely impacting riders' mobility in affected areas. Service and ridership is highly vulnerable to temporary flooding and wildfire due to service disruptions and delays, causing safety and access issues as well as additional cascading impacts (e.g., extended commute times or missed rides) for riders and the larger transportation network. It is also highly vulnerable to extreme heat because of slowed light rail service speeds and significant health risks for riders. There is low vulnerability to drought because there are no significant direct impacts.
- **Maintenance** has the highest vulnerability to permanent inundation because of permanent loss of assets or areas inundated. It is highly vulnerable to temporary flooding and wildfire because of delayed and increased maintenance during and after a hazard event. It is also highly vulnerable to extreme heat due to delayed maintenance and safety concerns for workers. It has a moderate vulnerability to drought because increased water use fines and cleaning and landscaping responsibilities due to debris build up and vegetation loss.
- **Rider and Workforce Safety** has the highest vulnerability to permanent inundation because there would be no workers or riders allowed in the flood zone or else flood protection would be required. Riders and VTA workforce are highly vulnerable to temporary flooding because of safety hazards such as dangerous driving conditions, and to wildfire because of air quality issues from smoke. There is a high vulnerable to extreme heat because of serious health impacts with heat exposure, such as heat stroke. There is low vulnerability to drought because there are no significant direct impacts.

Sensitivity and adaptive capacity scores and justification statements for each operation, by hazard, are provided in Attachment 6. Supporting statements for sensitivity and adaptive capacity that were initially validated during the VTA vulnerability and consequences workshop were used to justify each score.

KEY CONSEQUENCES

Table 15 below summarizes key consequences for operations. Additional consequences for each asset and hazard can be found in Attachment 6.

Table 15 Key Consequences for Operations

Consequence Statements	Consequence Sectors				
	Physical	Fiscal	Local/Regional Economy	Social	Environmental
Service Disruption: Hazards may cause major disruption due to permanent or temporary loss of infrastructure and service, impacting ridership. This loss of service affects the local community when stations and stops are inaccessible and may impact local jobs and add mental stress and anxiety for riders and staff.		X	X	X	
Limited Access to Maintenance Facilities and Increased Maintenance Demand: Maintenance may have major disruptions and limited access in the existing area impacted, along with increased efforts to maintain service or repair damage during and after hazard events. If the light rail system is down, providing bus bridges will cause a strain on resources for VTA staff.		X		X	
Safety: Exposure to climate hazards may impact safety if trying to operate or access impacted areas. Consequences can include short circuits with electrical equipment, threatening safety for both staff and riders.			X	X	
Staff Input: Two indirect consequences to daily operations during a hazard event are: 1. staff's inability to report to work during a hazard event because many live outside of Santa Clara County and 2. the increased workforce needed to assess and repair damages while supplying alternative service.		X	X	X	
Public Health: Extreme heat may cause slowdown in worker capacity or health impacts. There may be potential impacts to staff being able to report to work safely and external social impacts to the community if service is disrupted. Wildfire smoke can reduce air quality and be extremely harmful for children, older adults, and those with chronic health conditions.				X	X

7.4 CASCADING IMPACTS

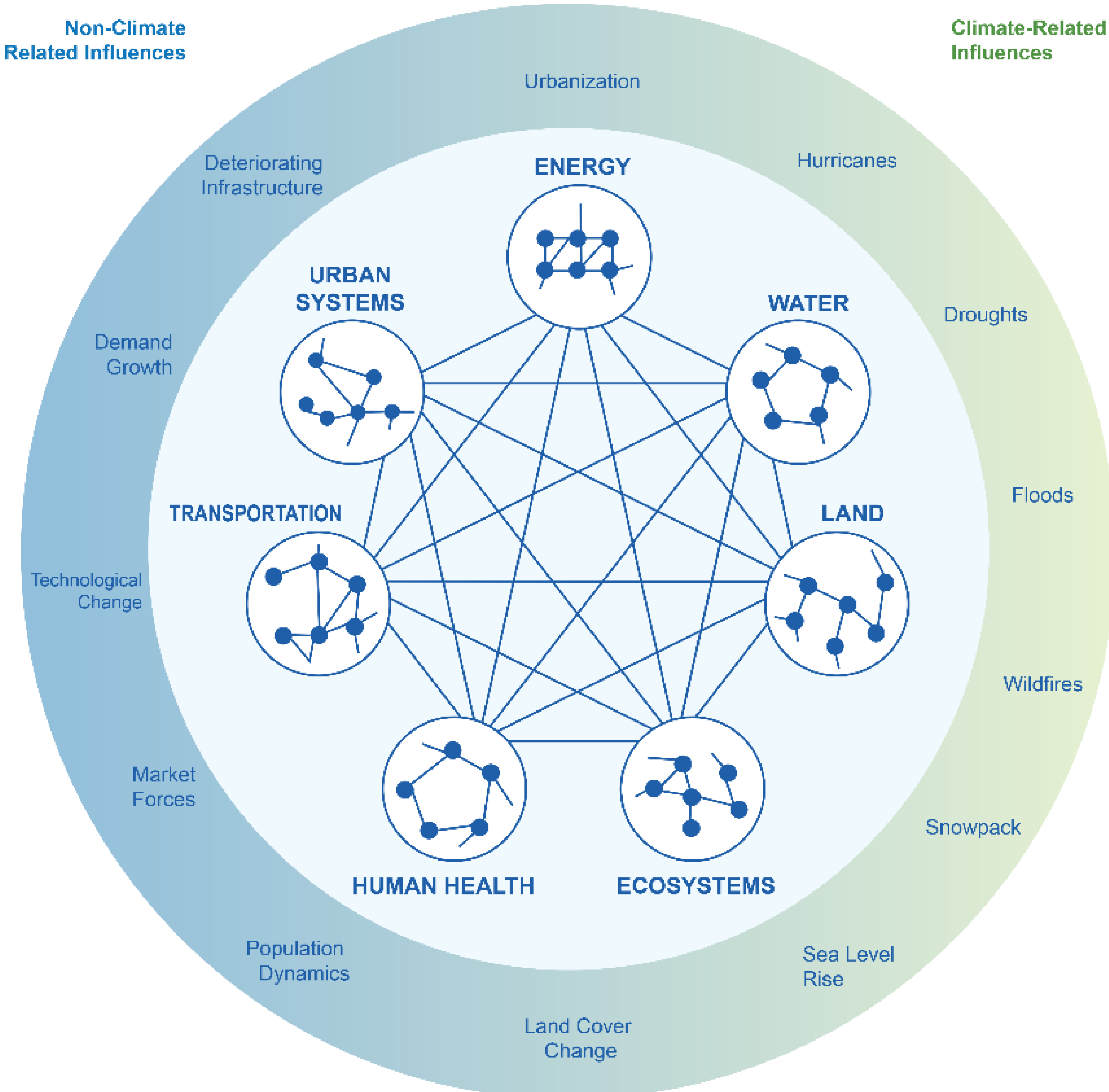
The VTA transportation system includes many linkages that are important for successful functioning of VTA services and operations. For example, for people to get where they need to go in Santa Clara County, there are connections between bikeways, buses, light rail, and regional transit, such as CalTrain, Bay Area Regional Transit (BART), and the Altamont Corridor Express (ACE). In addition, there are important electrical connections between PG&E and Light Rail substations, and the Light Rail tracks that are all critical pieces of a functioning system. If part of the system is affected by a climate hazard, such as extreme heat or flooding, a chain of events can occur that cause secondary and tertiary impacts in other parts of the system. Known as cascading impacts, or the "domino effect," these secondary or tertiary impacts can have consequences for the environmental, physical, social, local and regional economy, and fiscal health.

7.4.1 Sectors and Systems

VTA transportation systems are part of a broader network of sectors and systems that provide lifelines for communities in Santa Clara County, including human health, land use, water, energy, ecosystems, and urban systems. Climate change has the potential to affect each of these different sectors and systems, as well as cause cascading consequences throughout the sectors, including in unpredictable ways. In addition, the sectors are influenced by non-climatic stressors, which can compound impacts from climate change (Nichols et al. 2018). Figure 33 shows the many complex interactions between sectors, along with climate-related and non-climate related influences. Some of the non-climate related influences include deteriorating infrastructure, population dynamics, and market forces (Nichols et al. 2018).

For example, transportation systems are directly linked to public health because roads and transit services make it possible for workers and patients to arrive at hospitals, for goods and services to be delivered to their destinations, and for maintenance trucks and workers to travel where needed to ensure sanitary and water systems are functioning. Deteriorating infrastructure can compound impacts from climate change. VTA staff mentioned that while many substations are new, VTA's system is aging, specifically light rail tracks. Older equipment is harder to replace and repair because parts are often not available or hard to find. This could lead to service delays and make it harder to recover from a climate-related impact.

As part of the LA County Climate Vulnerability Assessment, the County mapped infrastructure interdependencies, building off work that Moser and Finzi Hart completed for the Fourth California Climate Assessment (Moser and Finzi Hart 2018). This network analysis provides some useful context for the VTA system. The mapping exercise found that the LA County infrastructure system is extremely complex and that failures in one sector can lead to magnified impacts in another sector. In addition, the mapping exercise showed that some sectors are critical to all others, with the electricity system being critical for the functioning of other infrastructure systems. The sectors also depend on one another. The transportation system depends on electricity to function and the electricity system depends on the transportation system. For instance, if the electrical grid is damaged in a storm event, repair crews will need functioning roads or highways to access the site. As shown in Figure 34 for VTA, electricity is a critical component for sump pumps, substations, cooling and filtration systems, signal equipment, IT and communications infrastructure, and disaster response services that VTA provides. A loss of these systems, in turn, has impacts on VTA's transit service, communications, public health and safety, and emergency services.



Notes: Figure shows how sectors are interacting and interdependent and are affected by climate-related and non-climate influences

Source: Fourth National Climate Assessment, Chapter 17: Sector Interactions, Multiple Stressors, and Complex Systems (Nichols et al. 2018).

Figure 33 Connectors between Sectors and Stressors (Climate and Non-Climate)

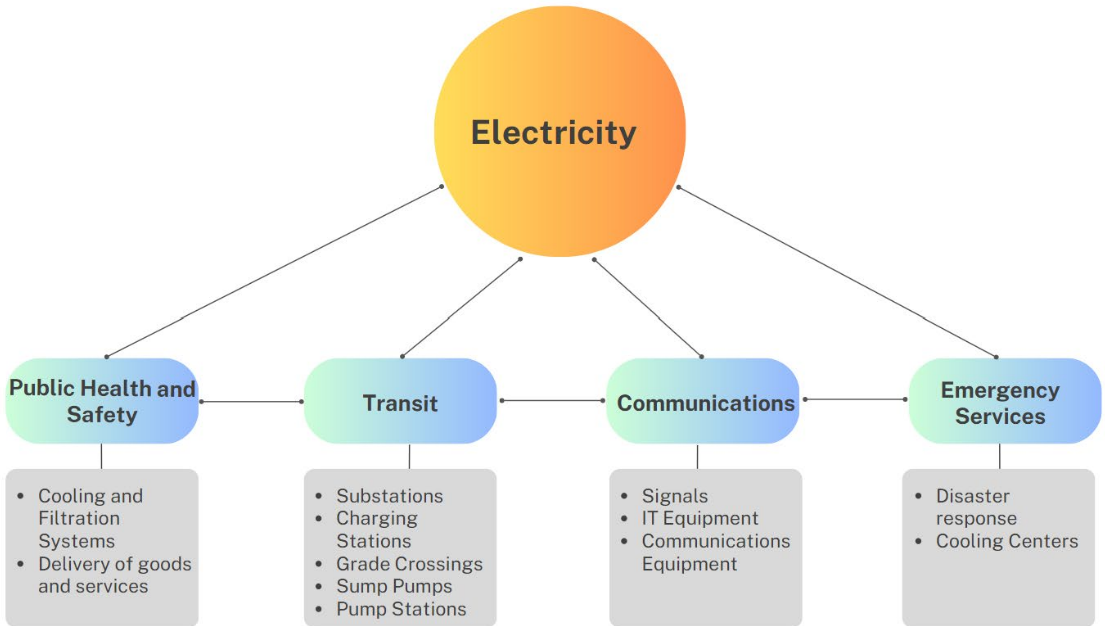


Figure 34 Cascading Impacts with Electricity and VTA Assets

7.4.2 Transit – VTA

During the workshop and vulnerability assessment analysis, the project team identified a range of potential cascading impacts that could occur based on anticipated climate impacts. Some of these impacts and the general categories of the secondary and tertiary impacts are shown in Table 16. Similarly to LA County, VTA's system is dependent on electricity from PG&E to operate many parts of its system, including for signal houses, substations, pump stations, IT equipment, lighting, maintenance equipment, grade crossings, and other functions. Some assets have backup generators but not all assets have power backup and power outages will cause significant disruption in VTA service, as well as cascading impacts as described in Table 16.

VTA has completed a Transit Asset Management Plan, which assessed the baseline functioning of assets, including condition of assets, and asset replacement and maintenance needs (CH2M 2017). Improving the condition of assets and adding additional redundancies where possible for current conditions will help improve VTA's resilience to climate hazards and reduce cascading impacts.

Table 16 Overview of potential cascading impacts for the VTA service area

Climate Hazard	Direct Impact to VTA System	Secondary/ Tertiary Consequences
Temporary Coastal Flooding	Substations flooded and not functioning	Local and Regional Economy, Public Health and Safety: VTA may not be able to pump out water; damage to electrical equipment; light rail is not operable, and people must use alternate forms of transportation to get to work or school. It takes longer to get to work and there is lost productivity and lost wages, leading to impacts on the local and regional economy; any loss of service could have impacts on emergency response capabilities as VTA provides mutual aid services to County of Santa Clara during times of disaster.
Temporary Urban/Inland Flooding	Flooding of maintenance yard	Environmental Impacts, Fiscal Health Impacts: Increase of stormwater runoff that carries trash and pollutants into storm drains and directly into creaks, rivers, and the San Francisco Bay without any treatment. VTA could incur financial impacts

Climate Hazard	Direct Impact to VTA System	Secondary/ Tertiary Consequences
		associated with implementation of greater stormwater management devices, monitoring, and other best practices to comply with permits.
Wildfire	Smoke reduces air quality in VTA service area and conditions are unsafe for outdoor workers	Public Health and Safety Impacts, Fiscal Health Impacts: Buses have unhealthy air quality because doors open and close frequently; leads to more people driving instead of taking the bus, and to adverse health consequences for drivers and those dependent on public transportation; leads to reduced fare revenue, an increase in traffic and greenhouse gas emissions. Outdoor and maintenance workers must stop work because of unsafe work conditions, could lead to fewer buses available for service, which could lead to reduced fare revenue and impacts on emergency response capabilities.
Extreme Heat	High temperatures cause work conditions to be unsafe for outdoor workers	Public Health and Safety Impacts, Fiscal Health Impacts: Maintenance workers must stop work because of unsafe conditions; Buses are not cleaned and removed from service; Buses are not available as cooling areas for vulnerable populations; Increase in adverse health impacts from extreme heat. There is also lost fare revenue; could have impacts on emergency response capabilities.
Drought	Dry/dead trees and vegetation, causing a fire hazard and unsafe conditions	Fiscal Health Impacts: Increase in maintenance costs to remove trees and plant new trees. Fines for water use during mandated restrictions.

7.4.3 Regional Transportation

Regional transit includes Express Lanes, bikeways, BART, Caltrain, Capital Corridor, Altamont Corridor Express, AC Transit, SamTrans, Santa Cruz Metro, and Monterey Salinas Transit (Silicon Valley 2.0 Guidebook). These transit networks provide important connections that help VTA users get to and from their destinations. Section 7.4.3 includes an overview of the direct vulnerabilities to regional transit systems in Santa Clara County from climate impacts as well as an overview of potential cascading impacts. This assessment evaluated the vulnerability of BART, bicycle superhighway (existing and proposed segments), bike trails and routes, and existing and proposed Express Lanes.

REGIONAL TRANSPORTATION VULNERABILITY

BART Stations: Milpitas and Berryessa Stations are highly vulnerable to temporary urban/inland flooding.

The BART Phase II extension line includes four new stations: 28th Street/Little Portugal, Downtown San Jose, Diridon, and Santa Clara. 28th Street/Little Portugal is highly vulnerable to temporary urban/inland flooding. Downtown San Jose, Diridon, and Santa Clara are vulnerable to extreme heat and drought.

BART Line: The existing BART line (Phase I) is highly vulnerable to permanent flooding from sea-level rise, temporary coastal flooding, wildfire, and moderately vulnerable to temporary urban/inland flooding. The planned 6-mile extension portion (Phase II) from the Berryessa Transit Center into downtown San Jose and ending in the City of Santa Clara is not exposed to permanent sea-level rise or coastal temporary flooding but is moderately vulnerable to temporary urban/inland flooding and highly vulnerable to wildfire.

Existing and Proposed Express Lanes:

All existing and proposed Express Lanes in Santa Clara County are vulnerable to temporary/urban flooding. Many are also vulnerable to wildfire. Five lanes are vulnerable to permanent coastal inundation and one more is vulnerable to temporary coastal flooding. The lane segments with the highest vulnerabilities to multiple hazards are listed below. Figure 35 shows the VTA Silicon Valley Express Lanes Program, which VTA is implementing in phases as funding becomes available. It is important to note that the lane segments listed below do not exactly correspond to the phases shown in Figure 35, as some segments overlap with one another.

- **State Route 237 (North First Street to State Route 85)** – highly vulnerable to permanent coastal inundation and temporary coastal flooding, and moderately vulnerable temporary urban/inland flooding. The segment between Mathilda Avenue in the City of Sunnyvale and North First Street in the City of San Jose is part of the State Route 237 Express Lanes currently in operation. The segment west of Mathilda Avenue to the State Route 85 interchange in the City of Mountain View is part of the future phase.
- **US Route 101 (South San Jose to Mountain View, State Route 85 and US Route 101 Direct Connector in San Jose, and Cochran Road in Morgan Hill to Bernal Road in San Jose)** – highly vulnerable to wildfire and moderately vulnerable to temporary urban/inland flooding. The segment on the US Route 101 between south San Jose and the City of Mountain View are in varying phases of completion, including Phase 3 (in operation), Phase 5 (planning), and Future Phase (environmentally cleared). The other two segments are part of the Future Phase which is environmentally cleared but not yet constructed or in operation.
- **State Route 85 (Bernal Road to San Mateo County Line)** – highly vulnerable to wildfire and moderately vulnerable to temporary coastal flooding and temporary urban/inland flooding.
- **State Route 237 (Dixon Landing/Interstate 880 to Mathilda Avenue) –** highly vulnerable to permanent coastal inundation, temporary coastal flooding, wildfire and moderately vulnerable temporary urban/inland flooding. This segment is part of the State Route 237 Express Lanes currently in operation.

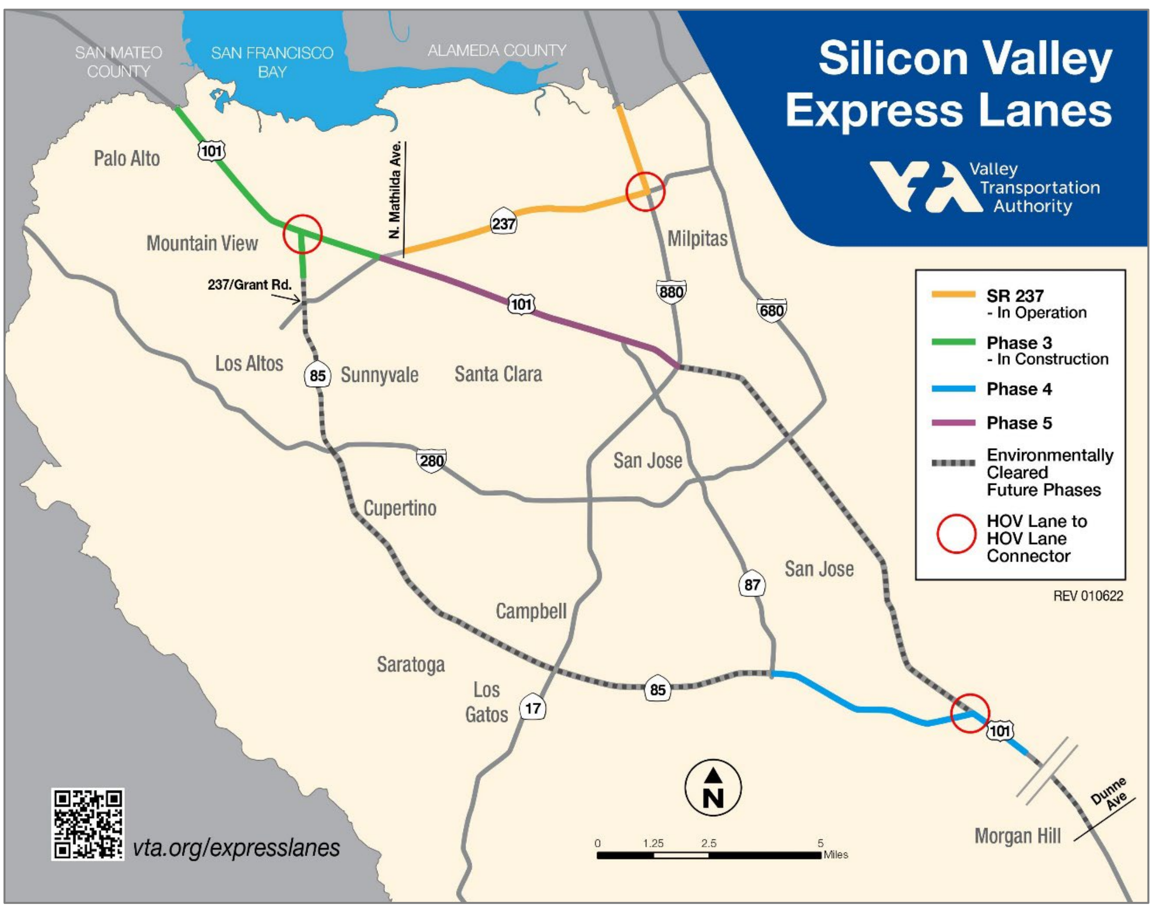


Figure 35 VTA Silicon Valley Express Lanes Program

Bicycle Superhighway: The Bicycle Superhighway Implementation Plan proposes specific alignments for a countywide network of 17 bicycle superhighways for Santa Clara County. It also describes the implementation status of each bicycle superhighway, summarizes active implementation efforts, and provides planning level cost estimates for building out remaining segments. The Plan will assist local agencies and VTA in funding, planning, designing, and building the superhighway network. Figure 36 shows the 17 potential bicycle superhighway alignments in various stages of completion.

All segments of the Bicycle Superhighway, existing and proposed, are vulnerable to temporary urban/inland flooding. Of the existing trails, half are vulnerable to permanent coastal inundation and temporary coastal flooding. The trails with the highest vulnerabilities to multiple hazards are listed below.

- **Bay Trail, Stevens Creek Trail/Homestead Road/Mary Avenue, Guadalupe River Trail, and East Channel Trail/Blaney Avenue:** Highly vulnerable to permanent coastal inundation, temporary coastal flooding, wildfire and moderately vulnerable to temporary urban/inland flooding.
- **San Tomas Aquino Creek Trail** - highly vulnerable to permanent coastal inundation, wildfire and moderately vulnerable to temporary coastal flooding, temporary urban/inland flooding.
- **Coyote Creek Trail, Junipero Serra Boulevard/ Foothill Expressway, Historic De Anza Trail/ Union Pacific Railroad Trail, Junipero Serra Trail/ Pruneridge Avenue/ Hedding Street/Berryessa Road, El Camino Real, Blossom Hill Road, Monterey Road, Story-Keyes Complete Streets Project, and Cochrane Road/Madrone Channel Trail/Tennant Avenue** - highly vulnerable to wildfire and moderately vulnerable to temporary urban/inland flooding.

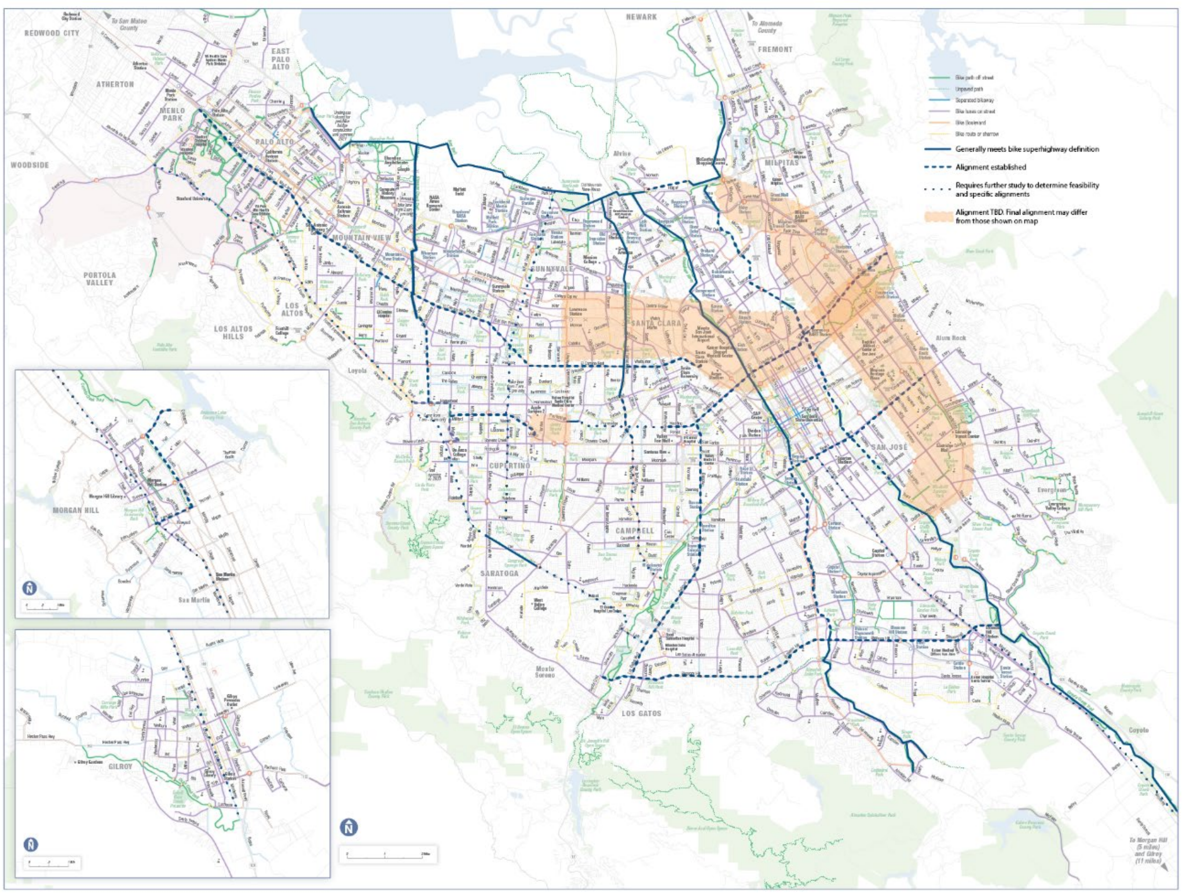


Figure 36 Map of Potential Bicycle Superhighway Alignments

REGIONAL CASCADING CONSEQUENCES

The vulnerability assessment shows that regional transportation networks are highly vulnerable to climate impacts in Santa Clara County, with the highest vulnerability to temporary urban/inland flooding. If regional transit service is delayed or out of service due to climate impacts, disruptions are passed onto VTA operations and service. Demand for VTA's transit services will increase, and VTA staff mentioned that this increase in "transit load" can overwhelm the VTA system. This could cause buses and trains to be overcrowded or have insufficient space for the ridership demand. In addition, the disruptions to regional transit service could lead to increased use of personal vehicles, increasing traffic and greenhouse gas emissions. In each of these scenarios, people may not be able to get to work in time, leading to lost productivity and lost wages.

In addition, power outages, extreme heat events, and flooding that affects VTA systems would likely also affect regional transit service as well. VTA may need to provide bus bridges to support both VTA light rail and BART at the same time and could lack capacity to do this, which could lead to people getting stranded, not able to get to work or other destinations, and an increase in people driving rather than taking public transportation.

8 ADAPTATION STRATEGIES

In response to the vulnerability assessment findings, this section includes a set of proposed adaptation strategies and actions that are intended to improve the resilience of VTA's physical assets and operations to climate hazards. In addition to the vulnerability assessment, the strategies were also informed by a combination of existing plans for other local or similar transportation agencies, VTA staff feedback, and general transportation-focused adaptation best practices. Though the strategies themselves are presented within this section, along with an overview of the framework and evaluation criteria used for the strategies, the Adaptation Strategies Workbook (attached as Attachment 8 to this memorandum) serves as the primary repository for the adaptation strategies, as the workbook also contains the evaluation criteria and co-benefits scoring for each potential action, along with other considerations.

8.1 FRAMEWORK

The structure and approach for identifying actionable adaptation strategies that can be included in the CAAP is based on a two-pronged framework that consists of high-level, overarching strategies and a suite of potential actions associated with each strategy. **Strategies** serve as the foundation for adapting and building resilience for VTA's assets and operations. Strategies are purposefully broad and overarching and tend to be expressions of goals or desired outcomes. **Potential Actions** serve as more specific activities, projects, policies, or steps that VTA can take to implement or support the goals of each strategy.

8.2 EVALUATION CRITERIA

Qualitative evaluation criteria were developed to inform VTA staff of considerations in addition to the adaptation benefits of each potential action. These evaluation criteria include conceptual cost, jurisdictional control, implementation timeframe, and a suite of five co-benefits related to environmental, equity, public health, quality of life, and engagement outcomes. The full set of evaluation criteria and each of their associated scoring rubrics are presented in Table 16 below. The full array of scoring results can be found in the Adaptation Strategies Workbook, which is attached as Attachment 8 to this memorandum.

Table 16 Evaluation Criteria and Scoring Rubric

Evaluation Criteria	Scoring Rubric
Conceptual Cost	▶ Low = This action can be implemented within VTA's current budget or with minimal additional funding. ▶ Medium = This action would require a moderate level of funding beyond VTA's existing budget but may be able to be accommodated with reallocation of resources or obtaining some external funding. ▶ High = This action would involve significant financial investments well beyond VTA's existing budget, as it would necessitate major capital expenditures or require long-term financial commitments or ongoing operational costs. May require substantial external funding.
Jurisdictional Control	▶ Low = For this action, VTA would be the "influencer." VTA would not have any direct control over action implementation, but VTA still has the ability to partner, coordinate with, encourage, or influence the efforts of others. ▶ Medium = For this action, VTA would be the "regulator" or "initiator." VTA would have some degree of jurisdictional control, either directly or indirectly, but is not solely responsible for enacting all efforts required to achieve the full potential of the action. For example, VTA may act as a regulator or initiator for some efforts, but the broader community or other agencies may also need to respond with some degree of action. ▶ High = For this action, VTA would be the "actor." VTA would likely have sole authority and full jurisdictional control over action implementation.
Implementation Timeframe	▶ Near-Term = This action should be initiated and fully implemented or adequately operationalized in the next 1-2 years. ▶ Mid-Term = This action should be initiated and fully implemented or adequately operationalized in the next 2-5 years. ▶ Long-Term = This action should be initiated and fully implemented or adequately operationalized 5+ years from now. ▶ Variable = This action may be an intrinsically ongoing action or may have multiple phases of implementation.
Co-Benefits	
Environmental	▶ No = This action would not result in any environmental (e.g., air, water, habitat, GHG emissions reduction) benefits OR unclear what environmental impact this action may have. ▶ Yes = This action would result in environmental (e.g., air, water, habitat, GHG emissions reduction) benefits.
Equity	▶ No = This action would not directly or indirectly enhance social equity OR unclear what impact this action may have on social equity. ▶ Yes = This action would directly or indirectly enhance social equity by providing benefits to vulnerable or disadvantaged populations.
Public Health	▶ No = This action would not enhance public health OR unclear what impact this action may have on public health. ▶ Yes = This action would enhance public health.
Quality of Life	▶ No = This action would not influence the quality of life of VTA staff, riders, and/or the broader community OR unclear what impact this action may have on quality of life. ▶ Yes = This action would improve the quality of life of VTA staff, riders, and/or the broader community.
Engagement	▶ No = This action would not require or facilitate engagement with internal staff, the general public, member agencies, and/or other stakeholders OR unclear what impact this action may have on engagement. ▶ Yes = This action would require or likely facilitate engagement with internal staff, the general public, member agencies, and/or other stakeholders.

Note: GHG = greenhouse gas.

8.3 STRATEGIES AND POTENTIAL ACTIONS

To better address the inherent multiscale, multifaceted nature of climate change adaptation, the proposed adaptation strategies (see Attachment 8) are distinguished as either **Cross-Cutting Adaptation Strategies** or **Focused Adaptation Strategies**. Cross-cutting strategies refer to strategies and potential actions that are inherently broad and that largely address or overlap with all climate hazards analyzed in the vulnerability assessment and most or all of VTA's asset classes and operations. Conversely, focused strategies refer to strategies and potential actions that are more tailored to address a particular asset or operations class, climate hazard, or other specific considerations.

There are a total of 14 adaptation strategies and 64 potential actions. Broken down further, there are eight cross-cutting strategies with 29 associated potential actions, along with six focused strategies with 35 associated potential actions. Each individual strategy presented here and in the Adaptation Strategies Workbook (Attachment 8) is classified by a unique combination of letters and numbers; the letters are either "CC" to denote a cross-cutting strategy, or "F" to denote a focused strategy, followed by a number. For example, the first cross-cutting strategy presented—"Bolster emergency preparedness and response to protect VTA's assets, minimize disruptions to operations, and foster a sense of community and safety"—is denoted as Strategy CC-1. Though this classification system is applied to each strategy for identification purposes, it should be noted that the presented order of strategies is random and not related to strategy importance, effectiveness, prioritization, or otherwise. A summary of all cross-cutting strategies, focused strategies, and their associated potential actions are presented in Tables 17 and 18 below. In the Adaptation Strategies Workbook, the scoring for the evaluation criteria and co-benefits discussed in Section 8.2 are displayed next to each potential action. Additionally, for the focused strategies, there are two additional sets of columns titled "Applies to…" and "Hazards Addressed." These column sets were used to tag each potential action with specific asset or operations class(es) that apply, along with which climate hazard(s) it addresses. These column sets were not included for the cross-cutting strategies in the Adaptation Strategies Workbook because, as mentioned previously, the cross-cutting strategies broadly apply to all the climate hazards and asset/operations classes.

Table 17 Cross-Cutting Strategies

Strategy Number	Strategy	Potential Actions
CC-1	Bolster emergency preparedness and response to protect VTA's assets, minimize disruptions to operations, and foster a sense of community and safety.	Engage with Cal OES and the Santa Clara County Office of Emergency Management and participate in planning and response coordination sessions related to climate hazards for the transportation sector.
		Develop, update, share, and coordinate emergency management plans with VTA member agencies. Conduct outreach to clarify response elements of plans and to highlight VTA's capabilities to support emergency response efforts within its service area.
		Review after-action reports from past evacuation efforts to identify targeted resiliency opportunities for communities in VTA's service areas and improve future evacuation efforts.
		Establish and maintain contingency contracts with relevant suppliers who provide prioritized access to resources to enable more reliable and rapid access to services and supplies needed during an emergency response effort.
		Maintain the organization, including staff roles and responsibilities, and procedures of the VTA Emergency Operations Center (EOC) to respond to emergency situations which may require deploying maintenance and repair teams to locations prior, during, or following a climate hazard event or as indicated in Incident Action Plans. Ensure the EOC is staffed and operated at a level proportionate to the emergency.

Strategy Number	Strategy	Potential Actions
		Develop climate hazard scenario-specific response plans with consideration of the unique set of circumstances related to each scenario and how they may affect VTA operations, power supply, and other considerations.
		Conduct emergency response exercises with both internal and external partners by inviting member agencies and other partners to join emergency management table-tops and full-scale exercises conducted by VTA and have VTA staff participate in drills and exercises being hosted by member agencies and other partners.
		Develop training for VTA staff and customer service representatives to better manage concerns of riders and the broader community during climate hazard events.
		Improve digital infrastructure to better communicate emergency and service disruption information to riders, which may include a suite of actions, including the installation of electronic signage in trains, buses, and at VTA facilities that displays real-time information, enhancing SMS-based alerting capabilities, further leveraging mobile applications (such as the "VTAlerts" app), and including audible indicators, where feasible.
CC-2	Develop a multi-pronged, community-focused climate resilience communications and informational campaign.	Develop content for and install multilingual signage at stations to inform riders about VTA climate resilience initiatives and personal climate hazard preparedness.
		In collaboration with member agencies, educate community neighbors on how to prepare for and respond to climate hazards. For example, underscoring the importance of shade and hydration during extreme heat events, or the need for vegetation control to reduce risk of wildfire ignition and spread.
		Create a web-based dashboard that underscores vulnerability assessment findings and actions that can be taken to improve resilience to better inform riders and the broader community about adaptation-related needs that would be mutually beneficial for all parties that use or otherwise rely on VTA's transportation network.
		Leverage and potentially modify existing mobile applications (e.g., "VTAlerts" app), along with social media accounts, to inform the public on climate hazards (e.g., extreme heat, flooding), alternative routes, and climate resilience initiatives, and to provide real-time reports from the public to help VTA respond to a hazard event.
CC-3	Ensure redundancy of VTA's transportation network.	Identify alternative transit routes and modes of transportation and develop protocols for service disruptions or temporary closures during climate hazard events (e.g., wildfire, flooding), ensuring effective communication with riders and VTA staff.
		Consider and fully understand all aspects of VTA's transportation network and how they will perform under evacuation scenarios (e.g., locations of chokepoints, expected roadway volumes and timing, potential evacuee characteristics, typical origin-destination numbers and patterns of travelers, capacity of roadways).
		Enhance intermodal connectivity between different forms of transportation to provide multiple options for riders and VTA staff, which can include improving transfer facilities, developing multimodal hubs, and optimizing transit schedules to facilitate seamless transfers.
		For any scheduled maintenance or repairs to improve safety and reliability within VTA's transportation network, continue to implement and expand efforts to ensure that riders can still efficiently get around. For example, VTA's Rail Rehabilitation and Replacement Program, which includes rehabilitation and replacement projects for overhead power wires, concrete panels, switches, rail, and special track work, also ensures that riders can still get around during these scheduled closures via bus bridges.

Strategy Number	Strategy	Potential Actions
		Bolster the capacity of VTA ACCESS Paratransit services to be prepared for potentially more frequent requests during future climate hazard events.
		Coordinate with member agencies to help identify roadways, bridges, and electrical signal equipment that may be damaged or deteriorating to help expedite repairs and ensure continued sustenance and minimal disruptions of VTA's bus and paratransit operations.
		Expand bus, paratransit, and light rail staff and fleets to account for enhanced intermodal connectivity and projected future ridership, and to minimize disruptions to VTA's transportation network. Consider resiliency in decisions related to future fleet planning and facility master plans.
		Collaborate with member agencies and other regional transportation partners to establish, update, and maintain cooperative agreements and mutual aid protocols, which can facilitate resource sharing, alternative routing, and coordinated response efforts during emergencies.
CC-4	Establish internal and external collaboratives to support climate resilience.	Create an internal technical advisory group or task force to oversee all climate resilience efforts and support internal and external collaboration, outreach, and implementation of strategies. The group should include a representative from relevant VTA departments and will be responsible for leading implementation of adaptation projects through dedicated budget allocation and applications for grants and other external funding (e.g., FEMA BRIC grants). Additionally, the group will be responsible for data sharing throughout VTA and beyond.
		Coordinate with VTA member agencies to explore the establishment of a countywide Climate Resilience District to fund or finance climate adaptation projects and programs, in line with SB 852.
CC-5	Take measures to reduce reliance on external power and ensure a redundant and more reliable power supply.	Conduct a feasibility study to determine where and how on-site renewable energy generation, battery storage, and/or microgrids could be implemented at VTA facilities and stations to provide more reliable, decentralized, grid-independent energy (Note: this adaptation action is very similar to and should be closely aligned with GHG Reduction Measures BF-1.2 and BF-1.3)
		Develop and implement load management strategies to optimize energy usage during peak periods or emergencies and to reduce the risk of power outages, such as rescheduling non-urgent maintenance activities, identifying non-essential loads that can be temporarily reduced (e.g., lighting levels, HVAC systems, other equipment not directly related to critical operations or safety), and analyzing historical energy data to identify trends and make informed load management decisions.
		Identify and seek funding to install backup power at VTA facilities and cabinets housing critical communication infrastructure. Ensure that all new and existing backup power sources are hardened and protected from potential hazard events, which may include wall structures to protect from wildfires and high winds or elevating systems out of flood-prone areas. Install redundant or failsafe air conditioning units in buildings and cabinets containing critical equipment and communication infrastructure where it does not already exist.
CC-6	Integrate climate adaptation and resilience considerations into design standards, criteria, and guidelines.	Update policies (e.g., Green Building Policy) and design manuals, such as VTA's Community Design and Transportation (CDT) Manual and the Design Criteria Manual for Stormwater and Landscaping, to further include climate change considerations based on vulnerability assessment findings and other known risks, to ensure that investments made now increase system resilience and sustainability. Consider including climate-resilient design features such as special sealants and other materials on roadways to help prevent roadways from softening during extreme heat and specific pavement options to reduce the heat island effect of parking lots, where applicable and in coordination with Caltrans and others. Improve the building envelope performance by increasing insulation value, glazing performance, window shading, thermal breaks, cool color technology on exterior building finishes, and other voluntary reach codes identified for non-residential projects in the California Green Building Standards Code

Strategy Number	Strategy	Potential Actions
		(CALGreen). Stakeholders should provide feedback so that updated policies and design standards are feasible, have buy-in, and will be implemented by staff and member agencies.
CC-7	Track climate impacts on assets and operations.	Monitor climate impacts on assets and operations, as well as resulting costs and economic impacts, to justify the need for climate adaptation strategy implementation. Determine data sources and streamlined tracking methods, as appropriate, for different assets, operations, and related departments (e.g., data collection tools, work orders, labor tracking systems, inspection routines) to contribute to regular reporting by monitoring items including, but not limited to: 1) rail temperatures and track alignment to identify patterns related to extreme heat; 2) storm events and related power shutdowns to understand service impacts; 3) ridership complaints related to hazard events and associated costs; 4) impacts of hazardous conditions (e.g., poor air quality from wildfire smoke) on VTA workers through missed work days, compensation claims, etc.
CC-8	Develop adaptation pathways for individual assets and operations.	Conduct detailed, tailored vulnerability assessments specific to key individual assets and operations and develop a series of adaptation actions that can be taken over time based on changing conditions. This series of actions, also known as "adaptation pathways," establish specific triggers and evaluation metrics that lead into the next appropriate action that should be taken. This approach is intended to be flexible and easily modified as conditions change, climatic or otherwise.

Table 18 Focused Strategies

Strategy Number	Strategy	Potential Actions
F-1	Implement cooling features to build resilience and ensure adequate access to amenities that help VTA staff and riders cope with extreme heat.	Install cooling amenities in areas where they do not yet exist and where feasible, such as: hydration stations on station platforms and in maintenance areas to ensure riders and VTA staff have access to drinking water; additional seating under pre-existing shade platforms; additional shaded areas at park-and-ride lots, bike racks, and platforms; air conditioning in indoor waiting areas; and misters in outdoor waiting areas.
		Where feasible, increase shading and use heat-mitigating materials around VTA facilities, such as in park-and-ride lots, bus and paratransit stops, stations, transit centers, facility entry areas, pedestrian walkways, and bicycle facilities. For example, build bus shelters or plant trees to provide shaded areas where transit users can wait for transit in more comfortable conditions. Prioritize plantings in high-traffic areas and/or areas identified as lacking canopy tree cover according to local surveys.
		Reduce wait times for transit service to reduce exposure to passengers during extreme heat events and poor air quality conditions during wildfires. This can be done by providing faster and more frequent service.
		Consider installing heat-reducing roofs or roof treatments such as green roofs, cool roofs, or using other high-albedo materials for VTA facilities, along with installing awnings on buildings and operator break rooms and ensuring buildings are well insulated, to help reduce cooling needs and costs and the urban heat island effect.
		Pilot "cool pavement" projects that use lighter materials or lighter colored aggregate in asphalt paving mixes. Monitor progress of achieving potential benefits like reduced ambient air temperatures, reduced maintenance, and increased longevity. Pilot success should help determine the feasibility of this as a solution that could be brought to scale across park-and-ride lots that are not exposed to temporary flooding where permeable pavement should be installed instead.

Strategy Number	Strategy	Potential Actions
		Ensure light rail, bus, and paratransit fleets are equipped with thermal insulation coatings and tinted windows.
		Increase natural ventilation and passive cooling of facilities through changes in operation and positioning of doors and windows and installing additional vents or louvers.
F-2	Protect and minimize disruptions to the light rail system from the effects of extreme heat.	Establish policies for when to perform zero-stress temperature adjustments based on temperature fluctuations, and stress newly installed and existing rail with a rail zero-stress temperature that is calculated based on projected temperatures for the lifetime of the rail, rather than on current or historic conditions.
		Develop official protocols for managing and protecting light rail operations during extreme heat events, such as frequent track walking inspections and adopting specific criteria for when to issue rail slow/stop orders to prevent or reduce overheating.
		Install sensors to indicate potential kinking and rail defects, which may include thermometers that can be remotely monitored (which can reduce operational rail costs associated with rail inspection requirements during hot weather), or motion sensors that can identify a thermal misalignment when it occurs and automatically halt trains.
		Reduce risk of thermal misalignment through a suite of actions, which may include: replacing wood ties with concrete ties, which are heavier and more resistant to movement; reducing tie spacing, which provides additional weight to the track structure and increased lateral resistance because of increased exposure to shoulder ballast; re-tamping ballast to increase ballast density, which increases lateral resistance; and/or increasing the width of the ballast shoulder, which will increase lateral resistance.
F-3	Reduce the risk of adverse temporary and permanent flooding-related impacts to VTA's assets and operations.	Prioritize nature-based solutions to address flooding. This may include coordination with other agencies to restore wetland and riparian habitats on floodplains to further slowdown the flow of floodwaters and hold soil in place. Additionally, this may also include drainage improvements, such as bioswales, bioretention basins, retention/detention ponds, incorporation of permeable surfaces, and improvements to culverts, as strategies for reducing peak stormwater flooding in locations where geotechnical conditions are appropriate and/or with adequate foundation/substrate. Choose low maintenance, non-invasive plant species. Improvements to drainage and stormwater infrastructure should be considered at park-and-ride lots, landscaping around VTA facilities, and along track in VTA's right-of-way, and in partnership with the County of Santa Clara and other agencies.
		Armor subgrade and sub-ballast with riprap or other materials to prevent light rail track structure from weakening because of saturation or washout. This can be done as new substructure is being placed and/or when older ballast is replaced.
		Where exposure to temporary flooding is prevalent, research and treat light rail system and track components, along with bus/paratransit stops and infrastructure components, with protective coatings or sealants to minimize the risk of potential rusting and promote stronger performance and longevity, where appropriate.
		Where feasible, explore elevating electrical (e.g., substations), mechanical, and information technology (IT) equipment (including Data Centers, Backup Data Centers, SCADA rooms, and IDF and MDF networking closets) that are vulnerable to current and future flood elevations, such as those at Cerone Bus Division and River Oaks. Some considerations should include accessibility and safety (e.g., ensuring maintenance personnel can access equipment), importance to VTA's operations, elevation techniques and engineering design, and compliance with building codes and regulations.

Strategy Number	Strategy	Potential Actions
		Install permeable pavement to minimize flood risk in park-and-ride lots that are exposed to temporary flooding, but also to reduce peak flows, lessen the strain on drainage systems, and recharge groundwater where it can be filtered naturally by the soil.
		Develop and practice a suite of post-wildfire debris removal strategies, in collaboration with others, to reduce the severity of flood-after-fire and other debris flow events, including replanting lost vegetation immediately after a wildfire event, establishing and continuing to maintain barriers in areas determined to be susceptible to future debris flows, and employing best-available data to predict future debris flows.
		Procure additional and appropriate temporary flood protection barriers for different types of assets (e.g., sandbags, Tiger Dam™, AquaFence®) to be better prepared during a temporary flood event. Where feasible and appropriate, explore more permanent forms of wet or dry floodproofing for facilities.
		Collaborate with member agencies and other partnering organizations to encourage and expedite shoreline protection and restoration projects (e.g., South San Francisco Bay Shoreline Project, led by the Santa Clara Valley Water Agency) to reduce the overall vulnerability of VTA's transportation system to the effects of permanent inundation and coastal flooding. Support community participation in these efforts.
		Incorporate future sea-level rise, permanent inundation, and precipitation projections into long-term infrastructure planning processes, influencing decisions on expansion, relocation, or retrofitting of assets. For example, many of VTA's facilities and other assets are highly vulnerable to future permanent inundation and coastal flooding, such as Lockheed Martin Transit Center, light rail routes and supporting infrastructure (e.g., grade crossings, frogs, turnouts), and bus stops, among others. Potential relocation of these assets should be considered and planned for well in advance of implementation.
F-4	Reduce water consumption at VTA facilities and across operations to address drought or other water supply availability issues.	Complete upgrades to vehicle washing facilities (e.g., replace original train wash facility at Guadalupe Yard), wastewater treatment systems, and irrigation equipment, targeting higher usage areas. This may include replacing traditional sprinkler systems with drip irrigation systems, retrofitting water fixtures in yards used for washing trains, buses, or other service/maintenance activities so that water sprays are at higher pressure but lower volume, and replacing water fixtures, toilets, and urinals in station and facility restrooms with low-flow options.
		Consider maintaining reduced vehicle washing and irrigation schedules imposed during drought emergencies as regular practice.
		Explore the feasibility of automated data communications and leak detection systems to provide real-time water consumption information and leak alerts to facility managers.
		Educate and engage relevant staff on ideas for water conservation in the workplace, which may include improvements to cleaners, manual scrubbers, and power washing, and ensuring that leaky hydrants are turned off.
		Explore opportunities for connecting station and facility irrigation systems to recycled water lines, collaborating with water agencies to determine feasible locations.
		Further integrate and regularly update water conservation approaches into contractor requirements to better mitigate water use impacts from construction through operations.
F-5	Strategically manage trees and vegetation to maximize site-specific aesthetics, promote resilience, and reduce the risk and potential impacts of climate hazards.	At VTA facilities that require significant irrigation for landscaping and aesthetics (e.g., park and ride lots, stations, and transit centers), identify and install non-invasive plant species that are native or climate appropriate and are more tolerant to climate hazards to reduce water use and improve resilience.

Strategy Number	Strategy	Potential Actions
		Support tree planting in lower wildfire risk, heat vulnerable areas where potential disturbances (e.g., fallen trees) would not greatly impact VTA assets and operations (e.g., not planting in locations directly adjacent to rail track). Ensure trees are properly maintained and watered to survive drought conditions.
		For VTA assets that are located in higher wildfire risk areas, manage adjacent trees and vegetation in a way that minimizes risk of wildfire ignition and spread. This may include removing and/or replacing trees with other forms of vegetation or hardening features (e.g., fire-resistant materials) that would reduce risk and ensuring adequate defensible space. Ensure this work aligns with the County's Community Wildfire Protection Plan, prepared by the Santa Clara Fire Safe Council.
		Install tree wells, where feasible, to promote long-term tree health.
F-6	Take measures to promote rider and workforce safety.	Shift outdoor physical labor hours to earlier in the morning during extreme heat events, and allow for flexible hours and remote work, in general (where possible), to ensure safety during other climate hazard events.
		Conduct safety audits and inspections across VTA's transportation system (e.g., facilities, buses) to identify and address potential safety risks to riders and VTA staff that would be caused or exacerbated by climate hazards.
		Develop and update trainings for VTA staff that promote safety during hazard conditions, which may include how to safely operate vehicles and equipment during flood conditions and how to recognize and respond to heat-related illnesses, among others. Provide tips to riders on how to stay safe during floods, heat waves, and other hazard conditions.
		Ensure indoor facilities, buses, and trains are equipped with air filtration systems to protect public health from wildfire smoke and the harmful effects of particulate matter pollution. Develop and share emergency preparedness tips and safety communications with employees.

9 NEXT STEPS

This memo, including the vulnerability assessment findings and proposed adaptation strategies, present the first steps in understanding how to adapt and increase the resilience of the VTA transit system. Because this memorandum is part of the CAAP, VTA already has several next steps planned. VTA will be working to integrate the key components of the memorandum into the Draft CAAP and conducting community engagement. Following adoption of the final CAAP in early 2024, VTA will begin implementation of the plan.

The project team also identified several next steps that VTA could take to further understand vulnerability of VTA's assets and operations and to assist with implementation. These include developing more detailed vulnerability assessment and adaptation actions for each critical facility. The detailed assessment could identify low spots at each facility that could be flooded first, specific components that could be vulnerable to heat, and cascading impacts related to loss of facility function. For example, during the workshop, VTA staff mentioned that a transformer may need to be elevated at Cerone Bus Division to reduce flood risks. These actions are included in the adaptation strategies matrix as well. To further adaptation efforts, VTA could develop specific adaptation pathways for key assets. An adaptation pathway outlines a series of adaptation actions that can be taken over time based on changing conditions. The adaptation pathway establishes specific triggers and evaluation metrics that spur the next adaptation action (which can span across physical, plans, policies, or program level actions). This approach is designed to be flexible and easily modified as climate conditions change. It also can be cost-effective since actions are often implemented overtime, and not all at once (Appendix 1 of the California Adaptation Planning Guide offers additional guidance on development of adaptation pathways (California Governor's Office of Emergency Services 2020)). For example, an adaptation pathway for a light rail station at risk from permanent sea-level rise could include first floodproofing the station to reduce risks from occasional flooding during storm surge events, then developing a relocation plan for the station, and finally relocating the station if it becomes permanently flooded.

In summary, the project team recommends that VTA take the following steps toward finalizing the CAAP and advancing resilience efforts:

- Incorporate additional climate hazard information (as new information becomes available) to update the assessment of VTA vulnerability to climate hazards, including shallow and emergent groundwater with sea-level rise, urban stormwater flooding with future rainfall conditions, and future conditions riverine flooding. Identify adaptation strategies to address any additional vulnerabilities from these hazards.
- Review, refine, and prioritize adaptation strategies with VTA staff, stakeholders, and community members.
- Take steps to ensure consideration and inclusion of race and social equity throughout project completion and implementation.
- Integrate the vulnerability assessment results and adaptation strategies into the CAAP and conduct community engagement.
- Develop a detailed vulnerability assessment and adaptation pathways for each critical facility, including a list of priority projects and funding needs.
- Further assess the interdependencies among VTA systems and other infrastructure systems in Santa Clara County and region. Using results, determine ways to increase redundancy and address weak points in the systems.
- Continue to coordinate with regional efforts, including the Santa Clara Climate Collaborative. Also coordinate with the Santa Clara Valley Water District and the United States Army Corps of Engineers on the planned flood protection improvements for the South San Francisco Bay Shoreline project.
- Initiate implementation of the CAAP by incorporating the key findings from this assessment.

9.1 DATA GAPS

This subsection highlights any data gaps identified during the assessment, or any refinements that could be accomplished but not possible within the current scope of this assessment.

The assessment identified additional information that can help better identify asset and operational vulnerabilities to climate hazards. This information can help refine the current findings and improve the adaptation planning process.

- Assets outside of VTA's governance (e.g., PG&E infrastructure) should be folded into the overall vulnerability assessment. VTA service relies heavily on the reliability of PG&E infrastructure and impacts to PG&E assets during climate stressor events has cascading consequences throughout the VTA network. A detailed evaluation of VTA system reliance on PG&E infrastructure, in coordination with PG&E, can help identify key links between the two systems and better plan detailed adaptation strategies to account for external factors outside of VTA governance.
- Asset condition was not available for all asset types to inform the climate sensitivity ratings. Condition of individual facilities can be included in a future refinement to the overall vulnerability assessment.
- This assessment does not quantify the consequence of individual assets or asset types to climate hazards. A future step in quantifying consequence ratings can be taken to help better prioritize the critical assets that should undergo more detailed adaptation planning.

- As described in Section 4.3, this assessment does not consider all hazards that can contribute to VTA's overall climate vulnerability, including shallow and emergent groundwater due to sea-level rise. Rising groundwater is expected to be a key hazard along with direct coastal flooding and should be considered in a future update to this assessment.
- Also described in Section 4.3, urban/inland flooding only considers riverine flooding linked to historical climate conditions. Information on future riverine flooding was a data gap.
- Information on urban stormwater flooding (direct flooding on city streets due to insufficient drainage or conveyance capacity of the storm drain system), and urban stormwater flooding in response to increased rainfall due to climate change was also not available, and therefore not incorporated into this assessment.

9.2 CAVEATS AND UNCERTAINTIES

Several caveats (and uncertainties) should be known in the interpretation of the assessment findings, appropriate use of the data, and adaptation strategies presented.

- The spatial footprint of VTA stations was used to identify potential exposure to climate hazards. The station footprints used in the assessment are a conservative estimate of the extent of station components that may be exposed. While this is appropriate for planning level assessments, additional refinements of the station footprints can be taken during detailed adaptation strategy development for stations identified as vulnerable to climate hazards.
- The sea-level rise projections for Santa Clara County were best matched to publicly available GIS layers depicting the landward extent of coastal flooding (Section 5.3.3). The differences between the sea-level rise projections and the closest matching GIS layers are within several inches or less, but in low-lying areas with gradual slopes these differences can result in additional assets that could be within the coastal hazard areas, or assets that could be removed. The topographic ground elevations used for the original coastal flood mapping are also based on site conditions during 2011. Changes in ground elevations since 2011 are not captured and can also impact the coastal flood extents. Therefore, the coastal flood layers are indented for planning level analysis only.
- The GIS exposure analysis did not account for the elevations of VTA assets or asset specific characteristics that may reduce exposure and vulnerability to climate hazards. Any assets that may be elevated above ground elevations may be less exposed to flooding.
- The GIS exposure analysis tagged exposure based on any percentage of a line exposed. Line assets such as a road, route, or trail are scored by degree of exposure based on time horizon, not the amount exposed. Therefore, if a very small percentage is exposed by 2030, it is marked as highly vulnerable. This is due to the assumption that a small percentage of a road, route, or trail at risk may still pose problems to the connectivity of the transit network. Attachment 4 may be referenced to see the actual percentage of each line exposed to each hazard scenario.
- Ridership load used in the vulnerability assessment is based on a one-month snapshot from February 2020, to capture typical ridership before the COVID-19 pandemic. It is uncertain whether future ridership will return to pre-pandemic levels, and future updates to the climate vulnerability assessment can reflect updated average ridership estimates.
- Paratransit addresses for pick up and drop off through the ACCESS program are subject to change over time.
- Climate science is continually evolving, with new projections of climate variables (e.g., rainfall and temperature) and sea-level rise published with increasing frequency. As new climate science is updated and adopted by local, state, and federal agencies, this vulnerability assessment can also be updated to reflect improving projections of climate hazards to come in the upcoming decades. This vulnerability assessment captures a snapshot of the best available science that was publicly accessible at the time the assessment started in 2022.

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Attachment 1

Climate Science Methodology

CLIMATE SCIENCE AND SCENARIO SELECTION

CLIMATE SCENARIOS AND TIME HORIZONS

The climate scenarios selected for this assessment aligns with Representative Concentration Pathways (RCP) 8.5, a greenhouse gas (GHG) concentration scenario adopted by the Intergovernmental Panel on Climate Change (IPCC) in 2014 (IPCC 2014). RCP 8.5 assumes anthropogenic global greenhouse gas emissions continue to rise over the next century (i.e., there are no significant efforts to limit or reduce emissions). RCP 8.5 was selected because global greenhouse gas concentrations have continued to follow this trajectory between 2005 and 2020.[17] The State of California guidance recommends that for critical infrastructure along the shoreline, sea-level rise projections associated with RCP 8.5 should be selected (OPC and CNRA 2018).

The climate exposure assessment relies on the best available climate science to estimate potential impacts to VTA assets and operations (including services) by the mid-century time horizon (selected to support the overall Climate Action and Adaptation Plan). For sea-level rise, the mid-century time horizon aligns to the year 2050. For climate trends evaluated using downscaled Global Climate Model (GCM) projections, the mid-century time horizon aligns to the 2035 through 2064 climate epoch, with the year 2050 at the mid-point of this period. The period of 2035-2064 aligns with a commonly used climate epoch to represent climate conditions for 2050 and is the same period of analysis used for Cal-Adapt's mid-century time horizon.

SEA-LEVEL RISE

The climate exposure assessment uses the sea level projections recommended in the State of California Sea-Level Rise Guidance, adopted in 2018 by the California Ocean Protection Council (OPC) (CCC 2018, OPC and CNRA 2018). The sea-level rise projections used for the exposure assessment are associated with the RCP 8.5 scenario. Under RCP 8.5, the "1-in-200" chance projection is used as a conservative exposure screening tool for VTA assets, over the "Likely" projection. The "Likely" projection is the upper end of the "likely range" (17% to 83%) of sea-level rise, including one standard deviation around the mean. There is an 83% chance that sea-level rise will fall below this value, and a 17% chance this value could be exceeded (for a specific RCP scenario). The "1-in-200" chance projection is a more extreme upper end estimate, with a 99.5% chance that the projected value of sea-level rise will be at or below this value (or a 0.5% chance that it would exceed this value) within the suite of projections associated with an RCP scenario. The State of California selected this as a reasonable "upper bound" for sea-level rise planning and design, particularly for projects that cannot be adapted over time. While the OPC "1-in-200" chance projection is the primary scenario used in the exposure assessment, the OPC "Likely" projection could factor in during the adaptation planning process. The State of California selected this as a reasonable value for sea-level rise planning and design, if the project can be adapted in the future in the event sea-level rise exceeds current projections. The OPC sea-level rise projections for San Francisco to the year 2100 is presented in Table A1 below.

Table A1 OPC Sea-Level Rise Projections for San Francisco (RCP 8.5)

Year	Likely Projection inches	1:200 Projection inches
2030	6	10
2050	13	23
2100	41	83

[17] Schwalm, C. R., Glendon, S., & Duffy, P. B. (2020). RCP8.5 tracks cumulative CO_2 emissions. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(33), 19656–19657. https://doi.org/10.1073/pnas.2007117117

COASTAL STORM SURGE

To evaluate temporary coastal flooding from storm surge events, the study team used a storm surge amount corresponding to a 1%-annual-chance (100-year) storm event. The 100-year storm surge above the average daily high tide elevation is 47 inches (BCDC, MTC, and BATA 2019). This is a temporary condition that could flood shoreline adjacent areas on the time scale of hours to days.

GCM MODEL SELECTION

Rainfall, temperature, humidity, and evapotranspiration projections from 1950 to 2050 used in the climate vulnerability assessment are taken from the Localized Constructed Analogs (LOCA) and LOCA-Variable Infiltration Capacity (LOCA-VIC) GCM ensemble. This assessment used the California Department of Water Resources (DWR) recommended subset of 10 GCM models (of the 32 CMIP5 models) for water resources planning and evaluation (given their proven performance of adequately representing California's historical climate)**2F**[18]. This subset provides a more scientifically defensible view of future conditions. The 10 GCMs evaluated include: ACCESS-1.0, CCSM4, CESM1-BGC, CMCC-CMS, CNRM-CM5, CanESM2, GFDL-CM3, HadGEM2-CC, HadGEM2-ES, and MIROC5.

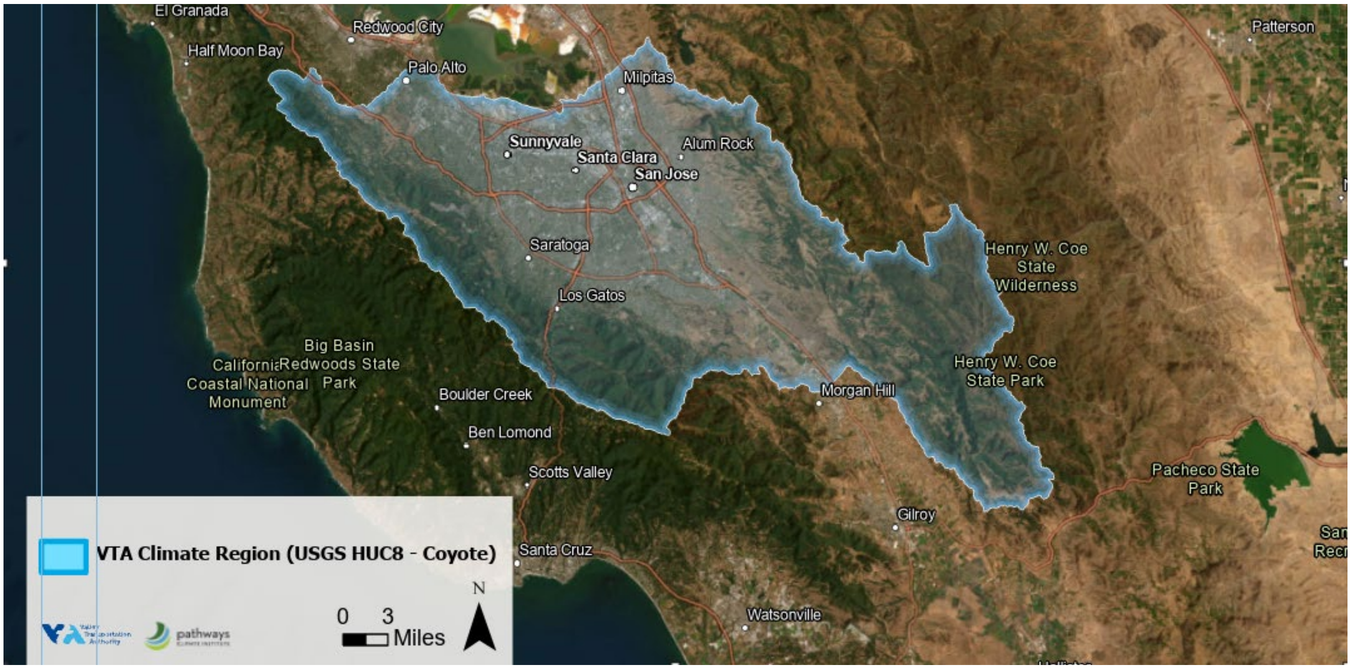
Both the LOCA and LOCA-VIC datasets have climate projections available for all 10 GCMs recommended by DWR, for the full geographic domain, time scales (1950 through 2064), and the climate scenario (RCP8.5) required for the VTA exposure assessment.

The UC Merced wildfire projections produced for the Fourth National Climate Change Assessment also aligned to the same time scales and climate scenarios, however only available for 4 GCMs (CanESM2, CNRMCM5, HadGEM2-ES, and MIROC5). Population and vegetation projections were aligned to three trajectories — Central, Low, and High. Only the central trajectory (Central – business as usual) was evaluated for the climate threats assessment.

CLIMATE REGION FOR VTA

A climate region was defined for the VTA service area to capture climate and hydrologic conditions that could affect operations of VTA assets. The climate region aligns with the USGS Hydrologic Unit Code 8 (HUC8) which includes Santa Clara County and extends beyond the VTA service area into the surrounding hydrologic regions. This allows for consideration of indirect impacts, for example upper watershed areas burned during wildfire. While climate projections such as temperature and areas burned by wildfire are spatially varying at a high resolution, they are not intended to be applied to singular assets at a local scale. Figure A1 below presents the coverage of the climate analysis region for this climate vulnerability and adaptation assessment.

[18] DWR Climate Change Technical Advisory Group. 2015 (August). *Perspectives and Guidance for Climate Change Analysis*.



Source: USGS Watershed Boundary Dataset

Figure A1 Overview of Climate Region for the Climate Vulnerability Assessment

FUTURE CHANGE APPROACH FOR CLIMATE PROJECTIONS (OPERATIONS EXPOSURE)

Future change in climate projections for the Climate Assessment Footprints were primarily identified using a percent change approach. This considers the change in GCM (modeled) output between the historical epoch (i.e., 1950-2005) and future epoch (e.g., 2035-2065). Percent change is used rather than directly reporting the absolute magnitude (e.g., degree Fahrenheit) of a climate variable projected by a GCM in a future epoch to reduce any bias potentially inherited from the historical epoch during the downscaling process between historical and future. If bias exists in the historical epoch between the observed training data and the GCM modeled output, this can be carried through the future epochs. Bias that can arise during the downscaling process can be attributed to serval factors (e.g., storm characteristics that only occur in the future, residual bias between the historical observed training data and the historical modeled simulations); an approach that looks at the relative difference between historical and future can reduce conclusions potentially skewed by this bias.

After summarizing the climate indicator of interest for each grid cell (within and intersecting the VTA climate assessment region), the historical and future values are averaged separately over the region, resulting in change values between historical and future time horizons at the basin level. This methodology is applied to calculate the future change for each GCM, from which a GCM ensemble average change is calculated and used for the climate threats exposure assessment.

CLIMATE INDICATORS (OPERATIONS EXPOSURE)

Table A2 below summarizes the climate indicators used to support the operations exposure analysis, including brief descriptions of the methods used to calculate the historical and future change values for each climate indicator. Table A3presents the historical and future change values for each climate indicator, and the individual exposure ratings assigned to each indicator and overall climate variable (e.g., rainfall and temperature).

Table A2 Summary of Climate Indicators to Evaluate Operations

Indicator	Description	Data Source
Extreme Rainfall (3-day total)	Annual average percent change in 3-day total precipitation from historical to future climate. Based on water year starting in October. Uses the LOCA output for precipitation.	LOCA
Extreme Rainfall (99^{th} Percentile)	Annual average percent change in 99^{th} percentile precipitation depth from historical to future climate. Referenced to the historical average 99^{th} percentile precipitation depth. Based on water year starting in October. Uses the LOCA output for precipitation.	LOCA
Temperature (Daily Maximum)	Annual average change (degrees Fahrenheit) in daily maximum temperature; average annual change in days above daily maximum temperature thresholds of 80°, 95°, and 104° F. Calculated between historical and future climate. Uses the LOCA output for temperature.	LOCA
Temperature (Daily Minimum)	Annual average change (degrees Fahrenheit) in daily minimum temperature; calculated between historical and future climate. Uses the LOCA output for temperature.	LOCA
Heat Index	Annual average change (degrees Fahrenheit) in heat index; calculated between historical and future climate. Uses the LOCA output for temperature and LOCA-VIC output for humidity.	LOCA, LOCA-VIC
Cooling Degree Days	Annual average change (days) in cooling degree days above the 98^{th} percentile temperature threshold; calculated between historical and future climate using daily average temperature. Uses the LOCA output for daily maximum and minimum temperature.	LOCA
Wildfire	Annual average change in wildfire area (hectares) burned from historical to future climate. Uses the wildfire simulations under the Central (business as usual) scenario derived by UC Merced. The projections are driven by LOCA climate variables coupled with a statistical model that is supported by historical data of climate, vegetation, population density, and past fire events.	UC Merced
Drought	Annual average change in frequency, intensity, and duration Standardized Precipitation Evapotranspiration Index (SPEI) >1.0. PET for SPEI calculated using the Hargraves equation. Calculated from historical to future climate. The Standardized Precipitation Evapotranspiration Index (SPEI) incorporates atmospheric water demand (ET) and water supply (precipitation) to calculate water deficit (or surplus) over a defined period. SPEI is a standard index that can also be calculated over several temporal scales (e.g., 3-month, 12-month, 24-month, etc.) to identify changes in drought characteristics as it relates to short term impacts, or a larger shift connected to climate change. Being a standardized index, SPEI can be compared across different regions. The SPEI is a current drought indicator used to support NOAA's U.S. Drought Monitor reports. The SPEI index presents the balance between deficit and supply as a simple index scale, similar to the SPI and PDSI indices. The SPEI index represents standard deviation from the normal, meaning an index value greater than +1 shows wetter than normal, less than -1 shows drought conditions, and between -1/+1 shows average conditions compared to normal. Using the daily output from LOCA and LOCA-VIC downscaled climate model datasets, potential future changes in drought duration, intensity, and frequency are calculated using the 12-month SPEI index. The 1-, 3-, and 6-month SPEI index values are also commonly calculated, however the 12-month was selected by the Study Team with a goal of detecting larger shifts in drought conditions connected to climate change. Drought events are defined as periods where the SPEI is negative and reaches a value of -1 or lower. Drought duration is the number of months where the SPEI is below zero. Drought intensity is the average SPEI value over the course of a drought event. Drought frequency is the average time of return between events.	LOCA, LOCA-VIC

Table A3 Summary of Climate Indicator Results and Exposure Ratings

Climate Indicator	Historical (1950-2005)[1] Observed	Early to Late Historical (1950-1977) to (1978-2005)[2] GCM Ensemble Mean	Future Change Historical to Mid-Century (2035-2065)[2] GCM Ensemble Mean	Future Change Historical to Late-Century (2065-2100)[2] GCM Ensemble Mean	Exposure Ratings Individual Indicator Rating	Exposure Ratings Overall Rating
Extreme Rainfall						
Avg. annual days > 99th percentile	2.1 in	+2.1%	+23%	+50.0%	High	High
Avg. annual max 3-day total	5.3 in	+1.71%	+11%	+27.0%	Mod	
Extreme Heat						
Avg. annual max daily temp	69 F°	0.7%	+6%	+10%	Mod	High
Avg. annual min daily temp	46 F°	1%	+8%	+15%	Mod	
Avg. annual days > 80 deg	40 days	+7%	+60%	+108%	High	
Avg. annual days > 85 deg	20 days	+7%	+91%	+173%	High	
Avg. annual days > 95 deg	2 days	+6%	+219%	+480%	High	
Avg. annual days > 104 deg	~ 1 (0.1) days	+3%	+658%	+2,010%	High	
Avg. annual days heat index > 80 deg	33 days	+7%	+71%	+132%	High	
Avg. annual days heat index > 90 deg	5 days	+7%	+173%	+381%	High	
Avg. annual number heat waves	~1 (0.13)	+15%	+423%	+1,026%	High	
Avg. annual max length of heat waves	~ 1 (0.4) days	+15%	+328%	+758%	High	
Avg. annual cooling degree days	304 days	+8%	+81%	+1,066%	High	
Wildfire						
Avg. annual area burned	21 hectares	-2%	+14%	+13%	Mod	Mod
Drought (Standardized Precipitation Index > 1)						
Epoch avg. drought duration	14.7 months	-	+15%	+48%	Mod	High
Epoch avg. drought intensity	0.89 (SPEI)	-	+40%	+77%	High	
Epoch avg. drought frequency	3.6 years	-	-19%	-32%	Low	

Notes: Low exposure rating = percent change between the historical and future epoch is less than 5%; Moderate exposure rating = percent change between the historical and future epoch is between 5 and 15%; High exposure rating = percent change between the historical and future epoch is greater than 15%

1 LIVNEH historical observed climate dataset

2 LOCA modeled climate dataset

Attachment 2

VTA Vulnerability and Consequences Workshop (5.12.2023)

SUMMARY NOTES FROM VTA WORKSHOP- FACILITIES

Facilities includes Buildings, Stations, Light Rail Platforms, Shelters, Transit Centers, Lots

ATTENDEES:

- Greg Beattie - Facilities Manager
- Marc DeLong - Transp. Engr
- Susan Lucero - Safety
- Antonio Tovar - System Safety
- David Mulenga - Asset Management
- Lani Lee Ho - Sr Env. Planner
- Erik de Kok - Ascent (consultant)
- Hilary Papendick - Pathways Climate Institute

ASSETS

1. Flooding
    a. Sensitivity:
        i. Participants agreed with the two sensitivity statements
        ii. Additional statements:
            1. Concern around gas lines and underground storage tanks, vaults, wiring systems, and fuel storage
            2. Impacts to access, ingress/egress
            3. Leaking roofs can affect critical rooms/ infrastructure
            4. Increase in rust/corrosion on the system
            5. Ability for assets to return to and from repair facilities, along with NRV vehicles
            6. Sea-level rise (depending on the level of increase) could potentially affect a small segment of the SR 237 EL on a permanent basis.
            7. Increase of vegetation on the system, causing blockages
        iii. Facilities
            1. Cerone:
                a. Site includes wetlands; issues include storm drainage backup, flooding on site, possible transformer at risk in area near tree. If Zanker Road is flooded, could lose access to yard. Building H has groundwater intrusion issues during rain events. Culvert connects Coyote Creek to wetlands, need to keep culvert clear to pump water into Coyote Creek when wetlands pond fills up.
            2. **Eastridge Paratransit Facility-** main electrical switch board and transformer are in basement and highly sensitive to flooding. Has sump pumps and sewage lift pump.
    b. Adaptive Capacity
        i. Access to facilities restored after flood water recedes.
        ii. Not sure if there will be a levy, especially between Great America and Lawrence Expressway (For Express Lanes).
        iii. Can increase the number of hours for UPS system (can be expensive though). Have the generators in the field to power the toll equipment.
        iv. Limited adaptability for maintenance facilities, bus lifts, storage, work bays unless protected by water, cannot be elevated.

c. Consequences
    i. Trees could fall on facilities, personnel or passengers
    ii. Condemned facilities if flood impacts are severe. Would have to identify a new location
    iii. Structural damage sustained by facilities from standing flood waters
    iv. Loss of VTA IT Technology infrastructure with any loss of the River Oaks Server
    v. Potential for chemical contamination from standing flood waters in maintenance areas
d. Critical Facilities/ Cascading Effects
    i. Chaboya Bus maintenance and operating facility
    ii. IT server room
    iii. Guadalupe Light Rail facility

2. Extreme Heat
    a. Sensitivity
        i. Extreme heat could significantly disrupt the ability of IT servers to function as well as bus operations.
        ii. Heat waves in summer and PSPS or rolling blackouts. A huge impact if fleet is dependent on battery electric. Chargers are dependent on PG&E.
        iii. Rolling Blackouts or PSPS's may trigger emergency lighting needs at larger light rail platforms to facilitate emergency egress, particularly at grade separated stations. This could also affect elevators, escalators, pa systems, and CCTV systems. All of which can affect passenger safety and system security (also listed in Safety Section)
        iv. Loss of power to facilities and charging stations
        v. Loss of power will ground all electric fleet
    b. Adaptive Capacity
        i. The toll systems equipment seem to be able to withstand extreme wind, heat or storms (hardened and/or designed by increased factor of safety)
        ii. Building management systems in place to address cooling demand
        iii. Acquisition of fallback power supplies such as generators
        iv. COVID response - public health requires more air changes per hour
        v. Diversifying power assets
        vi. Adding backup power systems can help mitigate impacts of power outages, but it needs to be deployed and maintained systemwide
    c. Consequences
        i. Loss of telecom and IT infrastructure
        ii. Damage to system wide infrastructure including power system
        iii. Reduction in air quality
        iv. Cerone - extreme heat conditions would affect ability to service vehicles
        v. Increased power consumption by facilities
        vi. Increase in breakdowns for mechanical systems including HVAC, rolling stock
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
        i. Participants agreed with statements
        ii. Impacts from smoke to buildings and from ash
        iii. Radio system - Black mountain system, repeaters, above Rancho San Antonio, definitely would be at risk from wildfire.

iv. If the River Oaks building burn down, the IT server room will be affected - affects server for many functions including EL. EL has redundancy for this from an off-site location

b. Adaptive Capacity
   i. There are emergency generators. But these are designed to handle the load of buildings. As we move to electrify fleet will dwarf the demand. Can put in CNG or diesel generators to restore power to fleets. In micro grid planning to put in a cam lock connection point to bring in a generator to keep operations going.

c. Consequences
   i. Limited direct risk to facilities from wildfire. Cerone has open fallow fields. Has done a good job of maintaining these. Nothing that sits near forest. Maintains a barrier around facilities to avoid burning.
   ii. Increased wear on facilities' HVAC Systems and filtration components
   iii. Potential for any dry high wind related damage to system components
   iv. Possible loss of Telecom if supporting infrastructure affected by wildfire
   v. HVAC filters on building and rolling stock will need more frequent maintenance and cost associated with parts and labor.
   vi. Loss of power to facilities from wildfire related activities or damage
   vii. Delay in construction related activities for various facilities
   viii. VTA will be relying on PG&E to provide construction and infrastructure support to VTA's bus yards in the coming years as we transition to ZEB's, and wildfires will divert PG&E resources during summer months and delay the delivery of PG&E infrastructure to VTA

d. Critical Facilities/ Cascading Effects

4. Drought
   a. Sensitivity
      i. Need to reduce usage of water including cleaning facilities for rolling assets
      ii. Reduction/elimination of landscaping, removal of dead trees
      iii. Trees that die due to drought / lack of water can pose a hazard of falling over during windstorms
   b. Adaptive Capacity
      i. Have smart weather-based irrigation controllers in place
      ii. Have drought tolerant landscaping
   c. Consequences
      i. Delay in construction related activities for various facilities
      ii. Increased urban fire risk due to dead/dry vegetation which could be exacerbated by unhoused encampments located in close proximity to VTA ROW or infrastructure or even City / Caltrans / JPB ROW
      iii. Possible increase in dust storms?
      iv. During construction that involves grading of dirt have to apply water to minimize dust and migration of soil. If there are severe water restrictions would have trouble controlling dust during construction. Would have to force people to use recycled water. Not sure about the availability of recycled water for this.
   d. Critical Facilities/ Cascading Effects

SERVICE AND RIDERSHIP

1. Flooding
   a. Sensitivity
      i. Disruption of EL operations until flood recedes

   b. Adaptive Capacity
      i. If flooding, the EL operations can be restored after the flood recedes. Sea-level rise will be a more permanent impact, not just to EL but the entire SR 237.
   c. Consequences
      i. Flooding or sea-level rise affecting EL operations can result in revenue loss. In addition, you lose offering travel time reliability to users.
      ii. Loss of power can affect operations of toll systems equipment
      iii. For operating division = could be impaired by roadway in front of or adjacent to could be blocked by flooding. Would hamper ability to get buses in or out of yard and operate light rail system
      iv. Loss of function of Eastridge Paratransit call center and dispatch facility if transformer floods in basement
   d. Critical Facilities/ Cascading Effects
2. Extreme Heat
   a. Sensitivity
      i. Poor conditions for bus stops and passenger facilities with no shade / coverage.
   b. Adaptive Capacity
   c. Consequences
      i. While the EL equipment might be able to take extreme heat, staff having to service or maintain equipment will not be able to work
      ii. VTA Offers free rides taking people to cooling centers. Buses themselves are cooling centers.
      iii. Extreme heat could impair VTA's ability to deploy revenue service via BEB's.
      iv. Loss of power to facilities from wildfire related activities or damage
      v. Delay in construction related activities for various facilities
      vi. VTA may experience higher numbers of employees and drivers calling in sick due to smoke / health issues, may affect VTA's ability to provide full levels of service
   d. Critical Facilities/ Cascading Effects
3. Wildfire
   a. Sensitivity
   b. Adaptive Capacity
   c. Consequences
      i. Any loss of our Operational Facilities would impact our ability to put service out and perform repairs
      ii. Impact of smoke and air quality. Bus drivers opening doors and hard to avoid smoke. Service workers are at platforms and bus stops and are affected by air quality.
      iii. Increased operating costs due to buying N95 masks for operators and field staff
      iv. Risks associated with AQI and impact on drivers
      v. VTA may be called on to provide mutual aid for evacuations
      vi. If buildings were affected by fire, would severely impact ability to provide service and mutual aid
   d. Critical Facilities/ Cascading Effects
4. Drought
   a. Sensitivity
   b. Adaptive Capacity
   c. Consequences
      i. Exterior vehicle washing is important to maintain even during drought because it ensures driver visibility
   d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

MAINTENANCE (FACILITIES AND ROUTES)

1. Flooding
    a. Sensitivity
        i. TA's maintenance bays are not air conditioned and the roll up doors do not provide much insulation; the mechanics are essentially outdoor workers with shade.
    b. Adaptive Capacity
    c. Consequences
        i. Could be impaired by roadway in front of or adjacent to could be blocked by flooding. Would hamper ability to get buses in or out of yard and operate light rail system
        ii. Any loss of our Operational Facilities would impact our ability to put service out and perform repairs
        iii. Risks associated with AQI and impact on field workers.
    d. Critical Facilities/ Cascading Effects
2. Extreme Heat
    a. Sensitivity
        i. Extreme Heat will slow down the charging rate for BEB's, thus impacting VTA's ability to return BEB's to service in a timely manner. Any BEB routes that require on-route charging may not be able to keep up with the electrical demand of the buses with the degraded charging rate.
    b. Adaptive Capacity
    c. Consequences
        i. Extreme Heat will decrease usable range of Battery Electric Buses (BEB's)
        ii. Buses may not be able to complete their service blocks due to charging issues
        iii. Impact to the working conditions of workers performing outdoor maintenance / services as well as functions out on the system.
        iv. Reduction in staff ability to perform maintenance duties on system wide assets, slow down in that work
        v. While the EL equipment might be able to take extreme heat, staff having to service or maintain equipment will not be able to work
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. Have to keep washing buses, might have to incur fines if water use is restricted
        ii. Reduction in the capability of cleaning / maintaining rolling stock, deactivation of wash stations
    d. Critical Facilities/ Cascading Effects

SAFETY (RIDERS AND WORKFORCE)

1. Flooding
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. Stranded employees with no way to travel home/ employees that can't get to work
        ii. Impacts VTA's ability to provide mutual aid for Santa Clara County Office of Emergency Services – applies to all hazards
        iii. Reduction of first responder capabilities to facilities or responses to medical emergencies
        iv. Slipping hazards for passengers at bus and light rail stations from flooding/mud/debris
        v. Impact to the working conditions of workers performing outdoor maintenance / services as well as functions out on the system.
        vi. Trees could fall on personnel or passengers
    b. Critical Facilities/ Cascading Effects

2. Extreme Heat
    a. Sensitivity
        i. There are a lot of outdoor workers. Required at a certain temperature to issue heat alerts and change work conditions based on heat index. Have a team of bus stop workers. 80% is outdoors.
    b. Adaptive Capacity
        i. Potential procedures to help reduce heat impacts on outdoor workers.
        ii. Adding structures / facilities to reduce the amount of employee exposure outdoors for some job classifications.
        iii. Worker safety measures are already in place; depending on what is going on, they are equipped with pop-up tents or extra water to deal with the heat.
    c. Consequences
        i. Rolling Blackouts or PSPS's may trigger emergency lighting needs at larger light rail platforms to facilitate emergency egress, particularly at grade separated stations. This could also affect elevators, escalators, pa systems, and CCTV systems. All of which can affect passenger safety and system security.
        ii. Heat related illness suffered by employees.
        iii. Regulatory requirements - heat thresholds for worker safety, workers must be sent home.
        iv. Increase for potential of human conflicts during hot weather.
        v. Slowdown in worker capacity of perform work in outdoor / workshop locations.
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. As experienced in previous conditions, the impact of work environment on all employees due to poor air quality
        ii. Slowdown in worker capacity of perform work in outdoor / workshop locations.
        iii. Slowdown or stoppage of outdoor employee work due to poor air quality
        iv. Increased roadway traffic due to local area evacuations / Loss of employees due to unable to come into work.
    d. Critical Facilities/ Cascading Effects

4. Drought
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. Illness related to lack of water.
        ii. Reduced ability to provide water for employee consumption.
    d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies
    a. All Impacts
        i. Create a plan to provide mobile maintenance solutions in the instances that there is a loss of maintenance facilities.
        ii. Move to cloud or have redundant back-up (disaster recovery site) elsewhere outside of the region?
        iii. Review age/status of current facilities and develop / implement a modernization of facilities to better harden facilities against potential severe conditions.
        iv. Drafting on procedures to help provide guidance for outdoor employee work in instances of high heat, severe rain and so forth, and revision and modernization of current plans/procedures.
        v. Through Emergency Operations Center, conduct tabletop exercises to work through different types of scenarios to see where the gaps are.
        vi. Update plans for dealing with situations when workers can't get home or to work due to weather/climate impacts.
        vii. Trial run on potential situations- e.g., limit water for a week, turn up heat to see how people relate and have the experiences lead to creative solutions and ideas. Have to experience the situations to understand them.
        viii. Education and outreach to VTA employees
        ix. Revision of VTA's Emergency Management plans, processes, staffing
        x. deploy additional backup power sources for all passenger facilities, UPS / generators, etc. to keep lighting and communications systems online.
        xi. Maintaining emergency supplies and equipment (food, generators) in a properly stored environment with the ability to use during events.
    b. Heat
        i. Could add resiliency by adding in solar, adding in micro grids, diversifying power assets.
        ii. Temperature controls for IT server room. HVAC redundancies? Provide redundant HVAC units.
        iii. Look at facility needs holistically - comprehensive retrofits including insulating buildings.
        iv. Look at planning new facilities and requirements to minimize impacts of heat and other impacts. Could update the Green Building Policy to include setbacks, etc.
        v. develop a funding strategy for building additional power and HVAC redundancies are facilities.
        vi. diversify energy sources at all facilities, including solar, microgrid, Bloom Energy, build in redundant energy sources, become less dependent on PG&E and avoid single points of failure.
        vii. Ensure Preventive maintenance and monitoring is completed - e.g., temp gauge is working.
    c. Wildfire
        i. Update facilities design standards to prohibit landscaping designs that promote the "fire ladder" effect that could lead to greater fire risks to buildings.
    d. Drought
        i. Battery operated rain sensor - switch out to hard wired.

SUMMARY NOTES FROM VTA WORKSHOP – LIGHT RAIL AND SUBSTATIONS

ATTENDEES:

- Chris Aguilar - Assistant Superintendent, Service Management
- Daniel Bustos - Assistant Transportation Engineer
- Mel G - Operation Manager-Maintenance of Way
- Diego Carrillo - Superintendent Way, Power, & Signal
- Michael Bates
- Manjit Khalsa
- Usman Husaini - Light Rail Projects
- Adolf Daaboul
- Michael Mak - Pathways Climate Institute
- Sierra Ramer - Pathways Climate Institute

ASSETS

1. Flooding
   a. Sensitivity:
      i. Existing statements were agreed with.
      ii. Fixed tracks mean there will be temporary or permanent disruption of service for flooded areas; some locations are already prone (Alviso, NASA Depression, Diridon, Bassett Tunnel).
      iii. Temporary flooding to guideway and structures can cause major disruptions to train service and permanent flooding can have permanent loss to critical structures.
      iv. Undermines soil stability, causing issues with structural foundation for track bed, OCS poles, signal houses, and other assets on the trackway.
      v. Age of substations will impact the ability to get replacement parts if they are damaged or submerged – they are old.
   b. Adaptive Capacity
      i. Bus service cannot replace all routes in case of light rail service interruption.
      ii. Flooding at a substation and pumping station can lead to inability of VTA to pump out water and damage to electrical equipment, elevators, escalators, culverts etc.
      iii. The equipment could be floodproofed.
      iv. Bus bridges for light rail require a lot of manpower and cause service loss to the bus.
   c. Consequences
      i. Foundation of light rail is increasingly eroding.
      ii. Equipment/ sump pumps are older structures.
      iii. Any train service interruption will offset all those riders to automobiles increasing emissions.
      iv. Some equipment below track (MTN view).
      v. The south line mostly has generators, only elevated stations have UPS.
      vi. Rusting on assets due to rain or saline exposure.
   d. Critical Facilities/ Cascading Effects
      i. Locations at risk: Alviso and OCC in Alviso, NASA Depression, Bassett Tunnel, Diridon
      ii. Fuel tanks on OCC site that would contaminate.
      iii. If OCC flooded, then it would severely impact service.
      iv. NASA depression - damage to equipment and preventing service to mountain view.

v. PGE power impacts power at stations and sump pumps. does not feed from a backup source from PGE like Bart has.
vi. Tracks go over creeks - bridges and overpasses are susceptible. These are vulnerable situations.
vii. Charging stations flooded, impacting bus services as well.
viii. Light rail structure - erosion increasing with foundation and piles.
ix. More frequent inspection/ back up equipment.
x. Diridon/NASA: In the past vegetation and flooding caused storm drains to back up - need sumps. These are used manually.
xi. No backup power for many stations/lines.
xii. With rainfall, there have been AC failures – need coverings and it can cause rust on roof.

2. Extreme Heat
   a. Sensitivity
      i. Extreme heat can cause damage to the track and OCS and electrical equipment.
      ii. Brake systems and resisters overheat - slow down speeds - tell operators for trains to slow down. motors are main breaking force for the trains, if resisters are hot then it impacts trains slowing down.
      iii. Stress is also put on VTA employees.
      iv. Kinks could occur from lower temps.
      v. Mandatory track walking - 105 deg to find hotspots.
      vi. OCS is designed for auto tension that can withstand some sustained heat.
      vii. Oscillation of extreme heat/cold causes more stress on the system.
   b. Adaptive Capacity
      i. Peak heat times are generally the late afternoon and evening commute with heaviest ridership.
      ii. Frequent inspections can be implemented during extreme weather events, including monitoring OCS sagging (15ft height needed).
      iii. Use of climate control and thermal management to control temperature can help alleviate impacts on the system.
      iv. Mandatory track walking is already being implemented.
      v. Air conditioners can be used on wayside systems such as signal cases and bungalows and substations.
      vi. Operators can reduce speeds when brake resistors get hot.
      vii. Transit bridging can assist in mitigating potential hazards.
      viii. Slow down trains and a team that can track the claim and monitor these events would be useful.
      ix. Prestress / counterweights used in Guadalupe south/north - Downtown is fixed termination (no room to expand).
      x. Current plans not in place in response to hazard events.
      xi. Current design light rail design standards and operating plans do not factor in extreme weather contrasts.
   c. Consequences
      i. There are some backup UPS for stations for things like lighting, but most do not have a backup generator.
      ii. Signal houses without climate control or overburdened with heat are exposed. Equipment can overheat and fail with loss of operational control.
      iii. Personnel issues - not enough crew to respond to these events.
      iv. Increased preventive maintenance crews.
      v. Increased need to get emergency contract work for some damages like heat kinks.

d. Critical Facilities/ Cascading Effects
    i. OCS and track are the most vulnerable assets to heat.
    ii. Extreme heat causes OCS issues which puts a strain on the entire system, causing bus bridges and lots of manpower.
3. Wildfire
    a. Sensitivity
        i. Power outages are due to wildfires.
        ii. Filtration systems deteriorate at a faster rate.
        iii. We can't keep smoke out of the facilities, demanding respiratory systems (adapting HVAC systems with filters for fumes is a possible solution but is not realistic).
        iv. Operators can't turn off HVAC system and doors opening will bring in smoke.
    b. Adaptive Capacity
        i. Can change out filtration in LRVs.
    c. Consequences
        i. After rainfall, overgrown vegetation can pose extra fire risk.
        ii. PGE ultimately feeds into VTA substations so any PGE outages causes disruptions.
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity
        i. It could affect the grounding of electrical system.
        ii. Maintenance / cleanliness of station platforms could be impacted by water availability.
        iii. Increased risk of fire at facility or ROW because of excessive weed growth.
    b. Adaptive Capacity
        i. Would have to dig deeper for electrical grounding if drought is affecting subsurface conditions.
    c. Consequences
        i. If we can't pressure wash, then stations can accumulate trash.
        ii. Dry vegetation in drought conditions can encourage wildfires.
    d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

SERVICE AND RIDERSHIP

1. Flooding
    a. Sensitivity
        i. May not have enough staff available, most live out of town.
    b. Adaptive Capacity
    c. Consequences
    d. Critical Facilities/ Cascading Effects
2. Extreme Heat
    a. Sensitivity
    b. Adaptive Capacity
        i. OSHA regulations for outside work
    c. Consequences
    d. Critical Facilities/ Cascading Effects

i. Heat causes most service disruptions.
    1. Ridership
    2. Vehicle itself (brake resistors need to cool off) slowed down speeds
    3. OCS sagging (also needs restricted speeds) below 15ft sagging causes disruption and damage.
    4. Less than 10mph through heat kinks and disruptions are dependent on severity - longer repair times and longer disruption to services.
    5. Heat kink can be reoccurring so operators would have to ensure that trains go through there at a slow speed.

3. Wildfire
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. Trees die off in drought conditions – then with extreme rain resulting in falls.
    d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

MAINTENANCE (FACILITIES AND ROUTES)

1. Flooding
    a. Sensitivity
        i. Agreed with the written statements.
        ii. A lot of staff lives out of town.
    b. Adaptive Capacity
        i. More frequent inspections to ensure washouts have not happened.
        ii. Ballast inspection to ensure efficient drainage.
        iii. Reallocation of staff resources for inspections and maintenance tasks.
        iv. Corrective actions/repairs on timely manner.
    c. Consequences
    d. Critical Facilities/ Cascading Effects
2. Extreme Heat
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
        i. Increased maintenance and inspections with kinks or OCS.
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
    b. Adaptive Capacity
    c. Consequences
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity

   b. Adaptive Capacity
   c. Consequences
   d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

SAFETY (RIDERS AND WORKFORCE)

1. Flooding
   a. Sensitivity
      i. Route adjustments need time to be planned well ahead in advance.
   b. Adaptive Capacity
   c. Consequences
      i. Dangerous conditions getting to work, especially for those traveling farther distances.
   d. Critical Facilities/ Cascading Effects
2. Extreme Heat
   a. Sensitivity
      i. Agree with written statements.
      ii. Employees and passengers are subject to the extreme heat conditions.
   b. Adaptive Capacity
      i. Adjust work hours to work in cooler temperature.
      ii. Increased and supplied hydration and shade.
      iii. Having good as built documentation.
   c. Consequences
      i. Increased agitated situations during heat events with riders or unhoused. Could use de-escalation training (there is a program but it has not started yet).
      ii. CalOSHA laws for extreme heat working conditions.
      iii. Extra service for riders to ride to cooling centers - cost associated with supplying service.
   d. Critical Facilities/ Cascading Effects
3. Wildfire
   a. Sensitivity
   b. Adaptive Capacity
   c. Consequences
      i. CARB air quality standards; compliance with these.
   d. Critical Facilities/ Cascading Effects
4. Drought
   a. Sensitivity
   b. Adaptive Capacity
   c. Consequences
      i. Increased risk of treefall starting with drought then exacerbated by rainfall.
   d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

Additional Information:

- SNOW/ICE HAZARD
  - Sometimes VTA runs extra service trains (ice breakers) so it would sweep OCS with pantograph, so ice won't affect OCS. So far there is no recorded damage with snow removal.

SUMMARY NOTES FROM VTA WORKSHOP - BUS AND PARATRANSIT

ATTENDEES:

- Lisa Vickery - Deputy Director for Bus Operations
- Seth Wright - Transit Safety
- David Kobayashi - Traffic Engineering
- Joseph Santiago - Transportation Planner
- Leo Dela Cruz - Transit Safety
- Michael Catangay - Passenger Facilities
- Taha Rao - GIS Specialist
- Patty Boonlue
- Chao Liu – Senior Transportation Planner
- John Steponick - Ascent
- Honey Walters - Ascent

ASSETS

1. Flooding
    a. Sensitivity:
        i. Salt degradation to light rail/bus infrastructure due to coastal flooding.
        ii. Although VTA does not operate and maintain traffic signals, electrical equipment in the cabinet can be impacted and cause delays.
        iii. Stations and stops will be affected.
    b. Adaptive Capacity
        i. Mobility/demand response needed to adapt.
        ii. Buses will be dependent on electrical grid.
        iii. Prolonged flooding events causing severe service disruptions would affect operating service hour assumptions.
        iv. Dependent on severity of flooding and if signal equipment is submerged.
        v. Difficulties with staff getting to work.
        vi. Efficiency of service will be tested.
    c. Consequences
        i. Damage to vehicles if caught in flash flood.
    d. Critical Facilities/ Cascading Effects
        i. OCS could be impacted by toppled trees and cause outages
2. Extreme Heat
    a. Sensitivity
        i. Although VTA does not maintain and operate traffic signals, electrical equipment in the cabinet can be impacted and cause delays.
        ii. Extreme heat can cause heat kinks in rail tracks for light rail which can lead to buses having to pick up more service.
        iii. Tires blowout.
        iv. Effects on operator safety.
        v. Can't keep up with cooling buses.

b. Adaptive Capacity
   i. The electrical equipment in the cabinet have an operating range of temperature, but there is possible that environmental temperature could spike beyond these ranges.
   ii. AC has negative impacts on vehicle efficiency.
   iii. Passenger experience affected; would need more stop amenities for cooling.
   iv. Lack of shelters and cooling centers near certain stops could lead to unsafe conditions.
   v. Using buses for cooling center transport/etc. can affect normal services
c. Consequences
   i. Heat kinks in light rail tracks require more service with bus bridges.
   ii. Reduced availability to generate fuel/electricity for buses.
d. Critical Facilities/ Cascading Effects

3. Wildfire
   a. Sensitivity
      i. Although VTA does not maintain and operate the traffic signals, wildfire smoke can impact the electrical equipment in the cabinet. If the traffic signal controller is down, it could cause delays to our service.
      ii. Wildfires can affect power grid; shut down electric infrastructure.
      iii. Transition to electric buses may be difficult with power grid.
   b. Adaptive Capacity
      i. It depends on the severity of the smoke and the air filters could provide some protection but may require more frequent replacements.
   c. Consequences
      i. Increased risk to vehicles during evacuation/emergency events that wouldn't otherwise be exposed.
      ii. Increased brownouts; required emergency backup generators.
      iii. Increased demand on resources for mutual aid.
      iv. Service delays and increased traffic.
   d. Critical Facilities/ Cascading Effects
4. Drought
   a. Sensitivity
      i. Bus cleaning during drought conditions is water intensive.
      ii. Cost efficiencies will go up with drought related to water use.
      iii. Power washing stations, bus stop shelters, and more may be impacted.
      iv. Hydrogen fuel cell technology is water intensive.
   b. Adaptive Capacity
   c. Consequences
      i. Increased potential for localized fire from less maintenance/weeds/etc.
   d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies
   a. Comprehensive hazard analysis for each asset class.
   b. Better capture/assess all VTA assets that are vulnerable.
   c. More battery storage - installed away from risk (e.g., flooding).
   d. Implementing heat shields.
   e. Regularly reevaluate assets to ensure compliance with current standards.
   f. Integrate resilience into general planning.
   g. Implement inflatable barriers.
   h. Identify training/programming for critical personnel/what their roles are.

- i. Should be more coordination/information sharing between control centers (e.g., VTA, cities, county, etc.)
- j. Proper liaison with proper knowledge for interagency coordination.

SERVICE AND RIDERSHIP

1. Flooding
   - a. Sensitivity
     - i. Flooding can cause sinkholes
     - ii. Service delays
     - iii. Multiple signals down will have great impact on service
     - iv. Trees/debris may have impacts
   - b. Adaptive Capacity
     - i. In some places they have established flood routes; this is something to consider.
   - c. Consequences
   - d. Critical Facilities/ Cascading Effects
2. Extreme Heat
   - a. Sensitivity
     - i. Increased heat-related medical costs for riders.
     - ii. Multiple signals going down because of heat can cause issues.
   - b. Adaptive Capacity
     - i. Potential misting stations at some bigger/more frequented stops (doesn't work with drought though).
   - c. Consequences
     - i. Extreme heat = slower trains = missed connections for riders (for example, connections to buses)
     - ii. Different peak loads at different times of day (potential for more evening passengers).
     - iii. VTA systems are interconnected with BART, CalTrain, etc. Hard to support transit loads from other transit systems if needed.
     - iv. More potential requests for paratransit during extreme heat conditions (?) - would cost more.
     - v. Average wait times may be affected for on-demand services due to the increase in demand.
   - d. Critical Facilities/ Cascading Effects
3. Wildfire
   - a. Sensitivity
     - i. More maintenance issues (e.g., filters)
   - b. Adaptive Capacity
     - i. Transit centers - staff had to scramble to find generators; lots of cascading effects.
   - c. Consequences
   - d. Critical Facilities/ Cascading Effects
4. Drought
   - a. Sensitivity
   - b. Adaptive Capacity
     - i. Drought can cause significant flooding/exacerbate other hazards. Lots of "combination effects"
   - c. Consequences
   - d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies
   - a. Plan for alternate routes.

b. Better data collection from customers
c. PG&E PSPS notices uploaded to internal portal, which is then communicated to the public
d. Ability to better communicate real-time information during emergencies / hazard events (e.g., buses being full)
e. Robust, yet simple, communication systems
f. Twitter & transit app has a lot of information regarding disruption updates, etc.

MAINTENANCE (FACILITIES AND ROUTES)

1. Flooding
    a. Sensitivity
        i. Making repairs during flood conditions will be added exposure.
    b. Adaptive Capacity
        i. Move controllers to higher ground.
    c. Consequences
    d. Critical Facilities/ Cascading Effects
2. Extreme Heat
    a. Sensitivity
        i. No way to restore certain critical routes.
    b. Adaptive Capacity
        i. Provide more cooling equipment, especially for outdoor workers.
        ii. Map for restoration priority
    c. Consequences
        i. Maintenance workers working in extreme heat will cause health issues.
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
        i. VTA has some responsibility to provide emergency vehicles/services during hazard events.
    b. Adaptive Capacity
        i. Need respirators/masks.
    c. Consequences
        i. Dust/PM can affect solar panel efficiency.
        ii. Effects of PM on maintenance personnel.
        iii. Understaffing during wildfire events.
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity
        i. Better/more water storage.
        ii. Maintenance costs are higher during drought conditions.
        iii. San Jose recycled water program = would be helpful for VTA (reducing costs, water access).
    b. Adaptive Capacity
    c. Consequences
    d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies
    a. Better plans, more exercises related to hazard preparedness.

b. Ensuring that proper equipment is procured to deal with hazard events.
c. Invest in Climate-Resilient Infrastructure.
d. Dedicated emergency manager(s) / better staffing - this is already in process.
e. Need to have a way to track how/what has been handled in the past to learn from the past.

SAFETY (RIDERS AND WORKFORCE)

1. Flooding
    a. Sensitivity
        i. Potential stranding.
        ii. Electrical equipment work cannot be done near water.
    b. Adaptive Capacity
    c. Consequences
        i. Increased housing costs for homes not in flood zones.
        ii. Increased congestion/additional delays on non-flooded roadways.
    d. Critical Facilities/ Cascading Effects
2. Extreme Heat
    a. Sensitivity
    b. Adaptive Capacity
        i. Cooling vests.
    c. Consequences
        i. Increased cost for future equipment (e.g., heat-resistant).
        ii. Cost for cooling vests.
        iii. Effects of heat on human behavior (e.g., physical violence).
    d. Critical Facilities/ Cascading Effects
3. Wildfire
    a. Sensitivity
        i. If VTA buses are needed for evacuation, there are increased safety concerns for applicable staff.
        ii. Need to consider what bus-types to send; some cannot be operated in wildfire/smoke conditions.
    b. Adaptive Capacity
        i. Guaranteed Ride Home program; can support rides home during times of poor air quality.
    c. Consequences
        i. Added congestion/delays on non-affected roads
        ii. Hard to plan where wildfires/flooding will happen; effects on rerouting.
    d. Critical Facilities/ Cascading Effects
4. Drought
    a. Sensitivity
        i. Localized fire from drought conditions, impacting safety.
    b. Adaptive Capacity
    c. Consequences
        i. Pavement degradation results from a combination of hazards.
    d. Critical Facilities/ Cascading Effects
5. Adaptation Strategies

Attachment 3

Asset Profile – Facilities

VULNERABILITY RATINGS CHART WITH ASSET LIST BY HAZARDS

Table C1 shows the vulnerability ratings for different facility types for each hazard. The vulnerability rating is calculated by combining the exposure, sensitivity, and adaptive capacity ratings for each asset. For more details on the vulnerability rating methodology, see Section 6. The vulnerability of individual assets to Extreme Heat and Drought hazards was not evaluated, therefore only the overall vulnerability of the overall facility types to these hazards are presented.

Table C1 Vulnerability Ratings – Facilities

Asset Type	Vul Rating	Permanent Coastal Inundation Flooding	Permanent Coastal Inundation Flooding	Temporary Coastal Flooding	Temporary Coastal Flooding	Temporary Urban/ Inland Flooding	Temporary Urban/ Inland Flooding	Wildfire	Wildfire	Extreme Heat Overall	Drought Overall
		Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total		
Administration and Operation Buildings	Low	0	0%	0	0%	0	0%	0	0%	Low	Low
	Mod	0	0%	0	0%	3	43	0	0%		
	High	0	0%	3	43%	1	14%	2	29%		
Parking Lots	Low	0	0%	0	0%	6	20%	1	3%	High	Mod
	Mod	0	0%	1	3%	5	17%	0	0%		
	High	0	0%	0	0%	0	0%	0	0%		
Stations	Low	0	0%	0	0%	0	0%	0	0%	High	Low
	Mod	0	0%	0	0%	10	16%	0	0%		
	High	9	15%	10	16%	21	34%	3	5%		
Transit Centers	Low	0	0%	0	0%	0	0%	0	0%	High	Low
	Mod	0	0%	0	0%	4	20%	0	0%		
	High	0	0%	1	5%	7	35%	0	0%		

SUMMARY TABLES BY HAZARD

The following tables provide an overview of key issues and consequences for facilities with Permanent Coastal Inundation (Table C2), Temporary Coastal Inundation (Table C3), Temporary Urban/Inland Flooding (Table C4), Wildfire (Table C5), Extreme Heat (Table C6), and Drought (Table C7). Note that an overall exposure rating of each asset type to each climate hazard was not assigned. Exposure ratings are only assigned to individual assets within each facility type and range from low to high exposure.

Table C4 Vulnerabilities and Consequences for Facilities - Permanent Coastal Inundation

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	No facilities are at risk.	▶ Although no administrative and operation buildings are at risk of permanent inundation, building functions could be impaired if access roads, utility equipment, and supporting infrastructure are flooded. ▶ Utility equipment may need to be relocated if permanently inundated. ▶ Buildings may be damaged if groundwater intrusion becomes permanent.
	Sensitivity	H	Building function and access roads may be blocked with permanent inundation and may damage infrastructure.	
	Adaptive Capacity	L	There is limited ability to adapt, implement flood protection measures or relocate. There is likely no redundancy for a specific facility.	
Stations and Transit Centers	Exposure	-	9 stations, 14 shelters, 0 platforms and 0 transit centers are at risk.	▶ Permanent inundation would cause stations and transit centers to be inoperable, and buildings would need to be relocated. ▶ Access roads could be permanently inundated, making it difficult for riders and personnel to access stations and transit centers. ▶ Utility equipment and infrastructure may become inoperable if permanently inundated and would need to be relocated.
	Sensitivity	H	Permanent inundation will eliminate use of exposed stations/transit centers.	
	Adaptive Capacity	L	There is limited ability to adapt, implement flood protection measures or relocate. There is likely no redundancy for a specific facility.	
Parking Lots	Exposure	-	0 park and ride lots are at risk.	▶ Although no parking lots are vulnerable to permanent flooding, access roads could be flooded, making it difficult for riders and personnel to access stations and transit centers.
	Sensitivity	H	Permanent inundation will eliminate use of lots.	
	Adaptive Capacity	L	There is limited ability to adapt; unless permanent flood protection measures are implemented; parking would need to be relocated.	
Substations	Exposure	-	3 substations are at risk.	▶ Permanent inundation of substations would lead to a loss of power, and electrical equipment, such as switches, gates, or signals, would no longer function.
	Sensitivity	H	Permanent flooding may have significant and permanent damage to electrical components, and high risk for power outages.	
	Adaptive Capacity	L	There is limited ability to adapt, implement flood protection measures or relocate. There is likely no redundancy for a specific facility.	

Notes: L = Low rating; M = Moderate rating; H = High rating.

Table C5 Vulnerabilities and Consequences for Facilities - Temporary Coastal Flooding

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	1 facility is at risk.	▶ Temporary coastal flooding could cause damage to buildings and equipment, including loss of first floor contents, damage to utilities and infrastructure, and increased risk of mold. This could lead to buildings needing to be repaired or replaced. ▶ Potential for sanitary sewer overflows that back up into and flood buildings. ▶ Potential for chemical contamination from standing flood waters in maintenance areas ▶ Potential damage to IT server equipment, resulting in loss of IT technology infrastructure. ▶ Trees could fall on facilities, personnel or passengers after soil is saturated from storm events. ▶ Specific consequences for Cerone Yard include storm drainage backup, flooding on site, groundwater intrusion, and loss of power if utility equipment is flooded. ▶ Eastridge Paratransit Facility could lose function if electrical switchboard and transformer in basement are flooded.
	Sensitivity	H	Buildings and facilities function and access may be blocked during a flood event and sustain damage.	
	Adaptive Capacity	L	Can implement flood protection measures such as seawalls, flood barriers, and relocation of critical equipment at a high cost, but may still experience damage or interruption of services. There is likely no redundancy for a specific facility.	
Stations and Transit Centers	Exposure	-	10 platforms, 10 stations, 17 shelters and 1 transit center are at risk.	▶ Temporary coastal flooding could lead to damage to stations and transit centers, including damage to utilities and infrastructure, such as power and communication lines.
	Sensitivity	H	Transit centers and stations may experience flooding and potential damage to electrical equipment and infrastructure, which can impact service and access. Exposure to saline water may also impact components.	
	Adaptive Capacity	L	Flood protection measures can be implemented which is costly; however other stations could be relied on if one is flooded; repairs likely needed after an event.	
Parking Lots	Exposure	-	1 facility is at risk.	▶ Temporary coastal flooding could lead to damage to parking lots and structures, causing increased maintenance costs. ▶ Potential loss of revenue due to decreased demand for parking during flood events. ▶ Potential damage to parked vehicles and equipment.
	Sensitivity	M	Parking lots are generally at grade and can withstand water without significant damage but cannot be accessed/used if flooded or can cause potential damage to vehicles.	
	Adaptive Capacity	M	Can develop plans to relocate or close parking lots in the event of coastal flooding and storm surge, and can also invest in flood protection measures; the asset can likely recover after an event	

Asset	Class Rating		Vulnerability	Consequences
Substations	Exposure	-	3 substations are at risk.	▸ Exposure to saline water may also impact components. ▸ Inundation of power system can cause shortening of electrical equipment such as switches, gates, and signals. ▸ Loss of power from substation flooding could also lead to pump stations not working, which could increase flooding. ▸ Potential for power outages affecting transit services.
	Sensitivity	H	Temporary flooding may have significant damage to electrical components, and high risk for power outages.	
	Adaptive Capacity	L	Substations may not have redundancy to maintain system function during a flood event; electrical/mechanical equipment could be elevated at a high cost.	

Notes: L = Low rating; M = Moderate rating; H = High rating.

Table C6 Vulnerabilities and Consequences for Facilities - Temporary Urban/Inland Flooding

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	4 facilities are at risk.	▸ Temporary coastal flooding could cause damage to buildings and equipment, including loss of first floor contents, damage to utilities and infrastructure, and increased risk of mold. This could lead to buildings needing to be repaired or replaced. ▸ Potential for sanitary sewer overflows that back up into and flood buildings. ▸ Potential for chemical contamination from standing flood waters in maintenance areas. ▸ Potential damage to IT server equipment, resulting in loss of IT technology infrastructure. ▸ Trees could fall on facilities, personnel or passengers after soil is saturated from storm events. ▸ Specific consequences for Cerone Yard include storm drainage backup, flooding on site, groundwater intrusion, and loss of power if utility equipment is flooded. ▸ Eastridge Paratransit Facility could lose function if electrical switchboard and transformer in basement are flooded.
	Sensitivity	M	Risk of building damage, interruption of services, and potential need for evacuation.	
	Adaptive Capacity	M	Can implement flood protection measures such as flood barriers, pumps, and emergency response plans, but not completely mitigate the impacts.	
Stations and Transit Centers	Exposure	-	29 platforms, 31 stations, 11 transit centers and 44 shelters are at risk.	▸ Temporary urban/inland flooding could lead to damage of stations and transit centers, including damage to utilities and infrastructure, such as power and communication lines.
	Sensitivity	M	Transit centers and stations may experience flooding and potential damage to electrical equipment and infrastructure, which can impact service. Structures/buildings may be less sensitive.	
	Adaptive Capacity	M	Temporary flood protection measures can be deployed; contingency plans for flood disruptions can be implemented.	

Asset	Class Rating		Vulnerability	Consequences
Parking Lots	Exposure	-	11 park and ride lots are at risk.	▸ Temporary urban/inland flooding could lead to damage to parking lots and structures, causing increased maintenance costs. ▸ Potential loss of revenue due to decreased demand for parking during flooding events. ▸ Potential damage to parked vehicles and equipment.
	Sensitivity	L	Parking lots are generally at grade and can withstand temporary flooding without significant damage but cannot be accessed/used during event or can cause potential damage to vehicles.	
	Adaptive Capacity	L	Temporary flood protection measures and develop contingency plans for closing or relocating parking lots in the event of flooding.	
Substations	Exposure	-	10 substations are at risk.	▸ Flooding of power system can cause shortening of electrical equipment such as switches, gates, and signals. ▸ Loss of power from substation flooding could also lead to pump stations not working, which could increase flooding. ▸ Potential for power outages affecting transit services.
	Sensitivity	H	Flooding will result in significant damage to electrical components, and high risk for power outages.	
	Adaptive Capacity	L	Can implement flood protection measures such as pumps, flood barriers, and vegetation management, but not completely mitigate the impacts.	

Notes: L = Low rating; M = Moderate rating; H = High rating.

Table C7 Vulnerabilities and Consequences for Facilities - Wildfire

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	2 facilities are at risk.	▸ Potential damage to buildings and equipment from wildfires. ▸ If River Oaks IT facility is exposed to wildfire, it could have widespread consequences to VTA functions, including Express Lane functioning. ▸ Potential impacts to radio system and repeaters located in high-risk wildfire area (Black Mountain) could result in loss of Telecom functioning. ▸ Increased wear on HVAC equipment and air filters from smoke and poor air quality, leading to increased costs for parts and labor. ▸ Wildfire could lead to a delay in construction related activities for various facilities, including a delay in installation of electric charging infrastructure at bus yards if PG&E resources are diverted to address wildfire impacts.
	Sensitivity	H	Risk of building damage or destruction, power outages, and potential evacuation orders.	
	Adaptive Capacity	L	Can implement fire-resistant materials, vegetation management, and evacuation plans, but cannot completely mitigate the impacts.	

Asset	Class Rating		Vulnerability	Consequences
Stations and Transit Centers	Exposure	-	3 stations, 1 shelter, 0 transit centers and 0 platforms are at risk.	▶ Potential damage to stations and equipment if burned in a wildfire. ▶ Stations and transit centers could be indirectly affected by wildfire through ash buildup. Ash could affect equipment performance and would require additional cleaning.
	Sensitivity	H	Transit centers and stations would be significantly impacted by fire damage, disrupting station access and function.	
	Adaptive Capacity	L	Evacuation plans can be developed in case of nearby wildfire events or fireproofing, but overall adaptive capacity for physical structures is limited (fire-resistant materials can be implemented).	
Parking Lots	Exposure	-	1 park and ride lot is at risk.	▶ Potential damage to parked vehicles and equipment from wildfires. ▶ Potential damage to parking structures and equipment from ash buildup.
	Sensitivity	L	Parking lots are generally low-risk areas for wildfires, but pavement or signs may be damaged.	
	Adaptive Capacity	L	Evacuation plans can be developed in case of nearby wildfire events; repairs can be made if damaged.	
Substations	Exposure	-	1 substation is at risk.	▶ Potential damage to equipment from wildfires. ▶ Potential for power outages affecting transit services. ▶ Smoke may damage electrical components.
	Sensitivity	H	Damage to equipment, power outages, and potential need to shut down power to prevent fires or ensure firefighter safety.	
	Adaptive Capacity	L	Can implement fire-resistant materials, vegetation management, and backup power sources, but not completely mitigate the impacts, and could be a high cost.	

Notes: L = Low rating; M = Moderate rating; H = High rating.

Table C8 Vulnerabilities and Consequences for Facilities - Extreme Heat

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	By mid-century, facilities will experience a high increase in extreme heat days.	▶ Potential overheating of equipment and facilities, leading to potential breakdowns and service disruptions; specifically, IT servers and telecom equipment could be impaired by heat. ▶ Potential damage to buildings and equipment from extreme weather events, including exterior cladding and roofing. ▶ Reduced life of HVAC equipment. An increase in heat events has already shortened the useful life of equipment at VTA buildings to around 18 months. ▶ Increased malfunction of HVAC equipment during heat events. For example, during current heat events, HVAC units in signal houses malfunction, causing signal room equipment to fail.
	Sensitivity	L	Can withstand extreme temperatures without significant damage or disrupted function.	
	Adaptive Capacity	H	Can implement energy-efficient cooling systems, and heat-resistant materials.	

Asset	Class Rating		Vulnerability	Consequences
				▶ Increased demand for cooling systems, leading to higher energy costs, and increased greenhouse gas emissions depending on energy source.
Stations and Transit Centers	Exposure	-	By mid-century, facilities will experience a high increase in extreme heat days.	▶ Increased demand for cooling systems, leading to higher energy costs. ▶ Potential damage to escalators and elevators from extreme heat.
	Sensitivity	M	High temperatures can cause discomfort and potential health risks for passengers and can also impact the performance of electrical equipment but overall stations are still functional.	▶ Potential damage to exterior cladding and roofing from extreme weather events. ▶ Power outages impacted station lighting and facilities at Guadalupe. The lack of a stand-alone backup UPS impacted various dispatching and timekeeping systems at Guadalupe Bldg. I.
	Adaptive Capacity	M	Shade structures and cooling measures can be installed but may require additional maintenance and may not be sufficient to mitigate all impacts of extreme heat.	▶ Additional future heat will necessitate more shelters at bus stops for purposes other than ridership justification.
Parking Lots	Exposure	-	By mid-century, facilities will experience a high increase in extreme heat days.	▶ Increased demand for shaded parking areas.
	Sensitivity	M	Surface temperatures of parking lots can become very hot, reducing passenger comfort, and increasing demand for shaded parking spots; cracking/damage can occur.	▶ Potential overheating and breakdown of parked vehicles. ▶ Potential damage to parking lots from soil subsidence.
	Adaptive Capacity	M	Shade structures can be installed but may require additional maintenance and may not be sufficient to mitigate all impacts of extreme heat; damaged pavement can be repaired.	▶ Damage to asphalt and concrete infrastructure, such as roads and parking lots, due to thermal expansion and contraction.
Substations	Exposure	-	By mid-century, facilities will experience a high increase in extreme heat days.	▶ Overheating of electrical equipment, leading to potential breakdowns and service disruptions. ▶ Increased energy demand for cooling systems, leading to higher operating costs. ▶ Potential damage to equipment from extreme weather events.
	Sensitivity	M	Loss of power or equipment failure due to high temperatures and increased demand for electricity for cooling	▶ Potential for power outages affecting transit services. ▶ Increased need for maintainers to run from each substation to cool it down due to the overheating alarm going off.
	Adaptive Capacity	L	Can implement load shedding, backup power sources, and heat-resistant materials, but not completely mitigate the impacts. Prolonged heat stress will result in more frequent maintenance/replacement.	▶ Heat may interfere with voltage, producing blackouts in the grid which causes loss of service and decreased reliability. ▶ Reliance on power grid increases potential for outages out of VTA control.

Notes: L = Low rating; M = Moderate rating; H = High rating.

Table C9 Vulnerabilities and Consequences for Facilities - Drought

Asset	Class Rating		Vulnerability	Consequences
Administration and Operation Buildings	Exposure	-	By mid-century, facilities will experience a high increase in drought conditions.	▶ Water shortages affect cooling systems and fire suppression. ▶ Potential damage to buildings from subsidence or shifting soil. ▶ Water shortages could affect construction and ability to apply water to minimize dust and migration of soil during grading of dirt. ▶ Delay in construction activities – limited watering/dust control
	Sensitivity	L	Minimal impact to physical facility due water usage for buildings being relatively low.	
	Adaptive Capacity	H	Can implement water conservation measures, alternative water sources, and efficient water fixtures, but may still experience reduced water availability.	
Stations and Transit Centers	Exposure	-	By mid-century, facilities will experience a high increase in drought conditions	▶ Water shortages may affect cooling systems and fire suppression. ▶ Potential damage to landscaping and outdoor areas. ▶ Potential impacts on the cleanliness and availability of restrooms if there are water shortages.
	Sensitivity	L	Reduced irrigation for landscaping may lead to dead or dying plants, which can negatively impact aesthetics and passenger experience.	
	Adaptive Capacity	H	Water usage can be minimized with xeriscaping and other water conservation efforts but may still experience negative impacts on aesthetics and comfort.	
Parking Lots	Exposure	-	By mid-century, facilities will experience a high increase in drought conditions	▶ Increased risk of wildfires near parking facilities. ▶ Potential damage to parking lots from soil subsidence. ▶ Potential damage to parked vehicles and equipment.
	Sensitivity	M	Reduced irrigation for landscaping may lead to dead or dying plants, which can negatively impact aesthetics and passenger experience with less shade.	
	Adaptive Capacity	H	Water usage can be minimized with xeriscaping and other water conservation efforts but may still experience negative impacts on aesthetics and comfort.	
Substations	Exposure	-	By mid-century, facilities will experience a high increase in drought conditions.	▶ Potential damage to equipment from wildfires due to heightened risk with drought. ▶ Potential for power outages affecting transit services.
	Sensitivity	M	Reduced power generation due to limited water availability for cooling systems, increased risk of equipment damage, and potential electrical grid strain.	
	Adaptive Capacity	H	Water conservation measures and demand response programs can be implemented, can but still susceptible to impacts.	

Notes: L = Low rating; M = Moderate rating; H = High rating.

Attachment 4

Asset Profile – Light Rail

VULNERABILITY RATINGS CHART WITH ASSET LIST BY HAZARDS

Table D1 shows the vulnerability rating for the different light rail assets, for each climate hazard. The vulnerability rating is calculated by combining the exposure, sensitivity, and adaptive capacity ratings for each asset. For more details on the vulnerability rating methodology, see Section 6. The vulnerability of individual assets to Extreme Heat and Drought hazards was not evaluated, therefore only the overall vulnerability of the light rail assets to these hazards is presented in Table D1.

Table D1 Vulnerability Ratings – Light Rail

Asset Type	Vul Rating	Permanent Coastal Inundation Flooding	Permanent Coastal Inundation Flooding	Temporary Coastal Flooding	Temporary Coastal Flooding	Temporary Urban/ Inland Flooding	Temporary Urban/ Inland Flooding	Wildfire	Wildfire	Extreme Heat Overall	Drought Overall
		Count/Length	% of Total	Count/Length	% of Total	Count/Length	% of Total	Count/ Length	% of Total		
	Low	0 mi	0%	0 mi	0%	0 mi	0%	0 mi	0%		
Light Rail Routes	Mod	0 mi	0%	4 mi	11%	39 mi	97%	0 mi	0%	High	Low
	High	21 mi	52%	16 mi	41%	0 mi	0%	15 mi	37%		
	Low	0	0%	0	0%	71	22%	0	0%		
Grade Crossings	Mod	0	0%	26	8%	70	21%	0	0%	High	Low
	High	51	16%	31	9%	0	0%	1	0%		
	Low	0	0%	0	0%	0	0%	0	0%		
Service Grade Crossings	Mod	0	0%	0	0%	0	0%	0	0%	High	Low
	High	0	0%	0	0%	0	0%	0	0%		
	Low	0	0%	0	0%	38	18%	0	0%		
Frogs	Mod	0	0%	19	9%	59	29%	0	0%	High	Low
	High	41	20%	22	11%	0	0%	0	0%		
	Low	0	0%	0	0%	22	16%	0	0%		
Turnouts	Mod	0	0%	12	9%	39	28%	0	0%	High	Low
	High	25	18%	13	9%	0	0%	0	0%		
	Low	0	0%	0	0%	5	7%	0	0%		
Utility Poles	Mod	0	0%	0	0%	2	3%	0	0%	High	Low
	High	0	0%	0	0%	0	0%	0	0%		
	Low	0	0%	0	0%	254	13%	0	0%		
Traction Poles	Mod	0	0%	159	8%	409	21%	0	0%	High	Low
	High	270	14%	145	8%	0	0%	10	1%		
	Low	0	0%	0	0%	0	0%	0	0%		
Substations	Mod	0	0%	0	0%	0	0%	0	0%	High	Mod
	High	3	9%	3	9%	10	31%	1	3%		

SUMMARY TABLES BY HAZARD

The following tables provide an overview of key issues and consequences for light rail and supporting infrastructure with Permanent Coastal Inundation (Table D2), Temporary Coastal Flooding (Table D3), Temporary Urban/Inland Flooding (Table D4), Wildfire (Table D5), Extreme Heat (Table D6), and Drought (Table D7). Note that an overall exposure rating of each asset type to each climate hazard was not assigned. Exposure ratings are only assigned to individual assets within each facility type and range from low to high exposure.

Table D2 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure - Permanent Coastal Inundation

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	With 24 inches of SLR, 0.7 miles of light rail routes may be at risk by mid-century.	▸ The route will have to be decommissioned and service will be lost within permanently inundated areas.
	Sensitivity	H	Light rail service may be disrupted due to permanent flooding on the tracks, cascading impacts on rest of light rail network.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	
Supporting Infrastructure	Exposure	-	51 grade crossings, 41 frogs, 270 traction poles, 25 turnouts may be at risk.	▸ Infrastructure will be lost to permanent inundation or assets will require relocation.
	Sensitivity	H	Light rail service may be disrupted due to permanent flooding on the tracks, with cascading impacts on rest of the light rail network.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table D3 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure - Temporary Coastal Flooding

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	With 24 inches of SLR and a 100-yr storm surge event, 3.6 miles of light rail routes may be at risk by mid-century.	▸ Temporary flooding may cause major delays and disruptions to tracks flooded. ▸ Potential damage to infrastructure and vehicles with increased maintenance and costs.
	Sensitivity	H	Light rail infrastructure has electrical equipment sensitive to floodwaters; service may be disrupted during flooding on the tracks, with cascading impacts to the rest of the network.	▸ Exposure to saline water and potential rust may impact the performance and lifespan of components. ▸ Increased risk of embankment erosion which will alter the structural integrity of tracks.
	Adaptive Capacity	M	Limited ability to adapt because of fixed tracks, may need to rely on bus service or suspend services; however, transit can likely recover after an event.	▸ Increased risk of power outages, exacerbating relief operations with equipment such as sump pumps.
Supporting Infrastructure	Exposure	-	57 grade crossings, 41 frogs, 288 traction poles, and 25 turnouts may be at risk.	▸ Switches and other electrical equipment may be submerged, causing shortening and failure.
	Sensitivity	H	Light rail infrastructure has electrical equipment sensitive to floodwaters; service may be disrupted during flooding on the tracks, with cascading impacts to the rest of the network.	▸ Flooding undermines soil stability, causing issues with structural foundation for poles, signal houses, and other assets along the guideway. ▸ Exposure to saline water and risk of rust may impact components.
	Adaptive Capacity	M	Limited ability to adapt because of fixed tracks, may need to rely on bus service or suspend services; however, transit can likely recover after an event.	▸ Underground equipment, (in areas like Mountain View) faces a higher degree of flood impacts.

Notes: L = Low rating, M = Moderate rating, H = High rating; SLR = sea-level rise

Table D3 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure - Temporary Coastal Flooding

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	12.9 miles of light rail routes may be at risk by mid-century.	▸ Temporary flooding may cause major delays and disruptions to tracks flooded.
	Sensitivity	H	Light rail infrastructure has electrical equipment sensitive to floodwaters; service may be disrupted due to temporary flooding on the tracks, with cascading impacts to the rest of network; tracks are otherwise not sensitive to rainfall driven flooding.	▸ Potential damage to infrastructure and vehicles with increased maintenance and costs. ▸ Potential rusting on track components. ▸ Increased risk of embankment erosion which will alter the structural integrity of tracks.
	Adaptive Capacity	M	Communication and route planning can minimize the impact of closures or detours with temporary flooding and possible reliance on bus service.	▸ Increased risk of power outages, exacerbating relief operations with equipment such as sump pumps. ▸ Potential AC system failures, as seen in past rain events.

Asset	Class Rating		Vulnerability	Consequences
Supporting Infrastructure	Exposure	-	141 grade crossings, 97 frogs, 7 utility poles, 663 traction poles, and 61 turnouts may be at risk.	▶ Switches and other electrical equipment may be submerged, causing shortening and failure. ▶ Flooding undermines soil stability, causing issues with structural foundation for poles, signal houses, and other assets along the guideway. ▶ Potential rusting on supporting infrastructure. ▶ Underground equipment, (in areas like Mountain View) faces a higher degree of flood impacts.
	Sensitivity	H	Light rail infrastructure has electrical equipment sensitive to floodwaters; service may be disrupted due to temporary flooding on the tracks, with cascading impacts to the rest of network; tracks are otherwise not sensitive to rainfall driven flooding.	
	Adaptive Capacity	M	Communication and route planning can minimize the impact of closures or detours with temporary flooding and possible reliance on bus service.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table D5 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure - Wildfire

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	0.2 miles of light rail routes may be at risk by mid-century.	▶ Major service disruptions could occur due to track closures and evacuation orders. ▶ Potential damage to infrastructure and vehicles with increased maintenance and costs. ▶ Ashfall on tracks may cause adhesion issues with vehicles on grade. ▶ Vehicles circulate smoke with HVAC system due to service doors opening at stations. ▶ Filtration systems deteriorate at a faster rate.
	Sensitivity	H	Light rail service may be disrupted due to road closures or evacuation orders; tracks can be damaged.	
	Adaptive Capacity	M	Route planning and communication with alternate services can minimize the impact of line closures; repair may require extended disruption.	
Supporting Infrastructure	Exposure	-	1 grade crossing and 10 traction poles may be at risk.	▶ Potential damage to infrastructure and with increased maintenance and costs.
	Sensitivity	H	Light rail service may be disrupted due to road closures or evacuation orders; tracks can be damaged.	
	Adaptive Capacity	M	Route planning and communication with alternate services can minimize the impact of line closures; repair may require extended disruption.	

Notes: L = Low rating, M = Moderate rating, H = High rating

Table D6 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure – Extreme Heat

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	By mid-century, light rail will experience a high increase in extreme heat conditions.	▸ Overhead Catenary System sags in extreme heat conditions which may cause damage to equipment such as the pantograph (power component on light rail roofs), impacts to service, and slowed speeds. ▸ Heat-related expansion places stress on ties, ballasts, and rail anchors which causes kinks or warping in the tracks. ▸ Reduced service speeds (less than 10mph) through kinks, with length of delays and disruptions dependent on severity of kinks. ▸ May have increased workloads with frequent preventative inspections and maintenance such as mandatory track walking. ▸ Brake systems and resistors may overheat, causing slowed speeds. ▸ Signal houses without climate control or overburdened by heat will be exposed and may cause equipment to fail with loss of operational control.
	Sensitivity	H	Light rail system and tracks are highly sensitive to impacts of overheating, with potential for permanent damage causing severe service delays and disruptions.	
	Adaptive Capacity	L	Permanent damage to tracks could impact service for an extended time; schedules can be adjusted, or bus services can be relied on.	
Supporting Infrastructure	Exposure	-	By mid-century, infrastructure will experience a high increase in extreme heat conditions.	▸ Increased demand for shaded areas and cooling stations. ▸ Interlocking systems (Vital Logic Controller), track circuits, crossing gates, and other critical equipment may fail.
	Sensitivity	H	Light rail system and tracks are highly sensitive to impacts of overheating, with potential for permanent damage causing severe service delays and disruptions.	
	Adaptive Capacity	L	Permanent damage to tracks could impact service for an extended time; schedules can be adjusted, or bus services can be relied on.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table D7 Vulnerabilities and Consequences for Light Rail and Supporting Infrastructure - Drought

Asset	Class Rating		Vulnerability	Consequences
Light Rail Routes	Exposure	-	By mid-century, light rail will experience a high increase in drought conditions.	▶ Potential damage to tracks due to soil subsidence.
	Sensitivity	L	Light rail is not significantly impacted by drought conditions, however there may be physical damage due to changes in subsurface conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	
Supporting Infrastructure	Exposure	-	By mid-century, infrastructure will experience a high increase in drought conditions.	▶ Potential water shortages may impact power washing and cause trash and dirt to build up at stops. ▶ Increased need to dig deeper for electrical grounding subsurface conditions are affected.
	Sensitivity	L	Light rail is not significantly impacted by drought conditions, however there may be physical damage due to changes in subsurface conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	

Notes: L = Low rating, M = Moderate rating, H = High rating

Attachment 5

Asset Profile – Bus/Paratransit

VULNERABILITY RATINGS CHART WITH ASSET LIST BY HAZARDS

Table E1 shows the vulnerability ratings for the different Bus and Paratransit assets, for each hazard. The vulnerability rating is calculated by combining the exposure, sensitivity, and adaptive capacity ratings for each asset. For more details on the vulnerability rating methodology, see Section 6. The vulnerability of individual assets to Extreme Heat and Drought hazards was not evaluated, therefore only the overall vulnerability of the Bus and Paratransit assets to these hazards is presented in Table E1.

Table E1 Vulnerability Ratings – Bus and Paratransit

Asset Type	Vul Rating	Permanent Coastal Inundation Flooding	Permanent Coastal Inundation Flooding	Temporary Coastal Flooding	Temporary Coastal Flooding	Temporary Urban/ Inland Flooding	Temporary Urban/ Inland Flooding	Wildfire	Wildfire	Extreme Heat Overall	Drought Overall
		Count	% of Total	Count/Length	% of Total	Count/Length	% of Total	Count/Length	% of Total		
Bus Routes	Low	0 mi	0%	0 mi	0%	13 mi	1%	1117 mi	79%	High	Low
	Mod	0 mi	0%	50 mi	4%	1388 mi	98%	0 mi	0%		
	High	503 mi	36%	461 mi	33%	0 mi	0%	0 mi	0%		
Bus Stops	Low	0	0%	0	0%	994	31%	0	0%	High	Low
	Mod	0	0%	44	1%	252	8%	6	0.2%		
	High	88	3%	70	2%	0	0%	27	1%		
Paratransit Stops	Low	0	0%	0	0%	0	0%	0	0%	High	Low
	Mod	0	0%	4	2%	13	6%	0	0%		
	High	0	0%	7	3%	0	0%	5	2%		
Streets	Low	0 mi	0%	0 mi	0%	1987 mi	28%	0 mi	0%	High	Low
	Mod	0 mi	0%	111 mi	2%	994 mi	14%	52 mi	1%		
	High	221 mi	3%	161 mi	2%	0 mi	0%	1814 mi	26%		

SUMMARY TABLES BY HAZARD

The following tables provide an overview of key issues and consequences for Bus and Paratransit with Permanent Coastal Inundation (Table E2), Temporary Coastal Inundation (Table E3), Temporary Urban/Inland Flooding (Table E4), Wildfire (Table E5), Extreme Heat (Table E6), and Drought (Table E7). Note that an overall exposure rating of each asset type to each climate hazard was not assigned. Exposure ratings are only assigned to individual assets within each asset type and range from low to high exposure.

Table E2 Vulnerabilities and Consequences for Facilities – Permanent Coastal Inundation

Asset	Class Rating		Vulnerability	Consequences
Bus Routes	Exposure	-	With 24 inches of SLR, 10 miles of bus routes are at risk by mid-century.	▶ Impacted routes would be decommissioned and permanently lost. ▶ Sea-level rise could eliminate ability of drainage channels to evacuate water in a timely manner, thus exacerbating flooding upstream, and limiting the ability to pump out water from roadways or low-lying areas.
	Sensitivity	H	Permanent loss of function/closure if permanently flooded due to sea-level rise.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	
Bus Stops	Exposure	-	88 bus stops are at risk.	▶ Impacted stops would be permanently lost and require relocation to maintain service.
	Sensitivity	H	Permanent loss of function/closure if permanently flooded due to sea-level rise.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	
Paratransit Stops	Exposure	-	0 paratransit stops are at risk.	▶ Impacted stops would be permanently lost and require relocation to maintain service.
	Sensitivity	H	Permanent loss of function/closure if permanently flooded due to sea-level rise.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	
Streets	Exposure	-	With 24 inches of SLR, 27 miles are at risk by mid-century.	▶ Impacted streets would be permanently lost or would need to be elevated. ▶ Sea-level rise will eliminate the ability of drainage channels to evacuate water in a timely manner, thus exacerbating flooding upstream, and limiting the ability to pump out water from roadways or low-lying areas.
	Sensitivity	H	Permanent loss of function/closure if permanently flooded due to sea-level rise.	
	Adaptive Capacity	L	There is limited ability to adapt unless permanent flood protection measures are implemented.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table E3 Vulnerabilities and Consequences for Bus and Paratransit – Temporary Coastal Flooding

<table>
<tr><th>Asset</th><th colspan="2">Class Rating</th><th>Vulnerability</th><th>Consequences</th></tr>
<tr><td rowspan="3">Bus Routes</td><td>Exposure</td><td>-</td><td>With 24 inches of SLR and a 100-yr storm surge event, 52 miles of bus routes are at risk by mid-century.</td><td rowspan="3">▶ Flooded bus routes could cause damage to buses and road assets.
▶ Sea-level rise and storm surge may impair the ability of drainage channels to evacuate water in a timely manner, thus exacerbating flooding upstream, and limiting the ability to pump out water from roadways or low-lying areas.
▶ Electric buses dependent on grid may be impacted by flood and outages.
▶ Prolonged flooding would cause severe service disruptions and would affect operating service hours.</td></tr>
<tr><td>Sensitivity</td><td>H</td><td>Assets may be damaged over time due to salt degradation. Operations may be disrupted due to road closures and flooding.</td></tr>
<tr><td>Adaptive Capacity</td><td>M</td><td>Limited ability to adapt, may need to reroute during a flood event or suspend services, but the route can likely resume function after an event.</td></tr>
<tr><td rowspan="3">Bus Stops</td><td>Exposure</td><td>-</td><td>99 bus stops are at risk.</td><td rowspan="3">▶ If charging stations are flooded, service may be delayed or disrupted.
▶ Saline water exposure to infrastructure may cause rust and impact components.
▶ Digital Bus Stops may be damaged by floodwaters.
▶ Access for riders and staff may be limited.</td></tr>
<tr><td>Sensitivity</td><td>M</td><td>Stops with infrastructure may be damaged over time due to salt degradation; operations may be disrupted due to road closures and flooding.</td></tr>
<tr><td>Adaptive Capacity</td><td>M</td><td>Limited ability to adapt, may need to reroute during a flood event or suspend services, but the stop can likely resume function after an event or be repaired after some time.</td></tr>
<tr><td rowspan="3">Paratransit Stops</td><td>Exposure</td><td>-</td><td>9 paratransit stops are at risk.</td><td rowspan="3">▶ Saline water exposure to infrastructure may cause rust and impact vehicles.
▶ Access for riders and staff may be limited.</td></tr>
<tr><td>Sensitivity</td><td>H</td><td>Stops with infrastructure may be damaged over time due to salt degradation; operations may be disrupted due to road closures and flooding.</td></tr>
<tr><td>Adaptive Capacity</td><td>M</td><td>Limited ability to adapt, may need to reroute during a flood event or suspend services, but the stop can likely resume function after an event or be repaired after some time.</td></tr>
<tr><td rowspan="3">Streets</td><td>Exposure</td><td>-</td><td>With 24 inches of SLR, 142 miles are at risk by mid-century.</td><td rowspan="3">▶ Electrical signal equipment (not VTA owned) can be impacted and cause delays.
▶ May increase development of sink holes and road damage.
▶ May cause unsafe driving conditions in flooded areas.</td></tr>
<tr><td>Sensitivity</td><td>H</td><td>Roads may be damaged over time due to salt degradation; operations may be disrupted due to road closures and flooding.</td></tr>
<tr><td>Adaptive Capacity</td><td>M</td><td>Limited ability to adapt, may need to reroute during a flood event or suspend services, but road function can likely resume function after an event.</td></tr>
</table>

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table E4 Vulnerabilities and Consequences for Facilities – Temporary Urban/Inland Flooding

Asset	Class Rating		Vulnerability	Consequences
Bus Routes	Exposure	-	670 miles of bus routes are at risk by mid-century.	▶ Potential damage to transit infrastructure and buses. ▶ Inland flooding may impair the ability of drainage channels to evacuate water in a timely manner, thus exacerbating flooding upstream, and limiting the ability to pump out water from roadways or low-lying areas. ▶ Electric buses dependent on grid may be impacted by flood and outages. ▶ Prolonged flooding would cause severe service disruptions and would affect operating service hours.
	Sensitivity	M	Bus and paratransit operations may be disrupted or detoured due to road closures or flooding; road function can likely resume function after an event.	
	Adaptive Capacity	H	Communication and route planning can minimize the impact of closures or detours with temporary urban flooding. Road function can likely resume function after an event.	
Bus Stops	Exposure	-	1,246 bus stops are at risk.	▶ If charging stations are flooded, service may be delayed or disrupted. ▶ Increased rainfall may cause rust and impact components. ▶ Digital Bus Stops may be damaged by floodwaters. ▶ Access for riders and staff may be limited.
	Sensitivity	M	Bus and paratransit operations may be disrupted or detoured due to road closures or flooding; stops can likely resume function after an event.	
	Adaptive Capacity	H	Communication and route planning can minimize the impact of closures or detours with temporary urban flooding.	
Paratransit Stops	Exposure	-	13 paratransit stops are at risk.	▶ Increased rainfall may cause rust and impact components. ▶ Access for riders and staff may be limited.
	Sensitivity	M	Bus and paratransit operations may be disrupted or detoured due to road closures or flooding; stops can likely resume function after an event.	
	Adaptive Capacity	H	Communication and route planning can minimize the impact of closures or detours with temporary urban flooding.	
Streets	Exposure	-	With 24 inches of SLR, 2,976 miles are at risk by mid-century.	▶ Electrical signal equipment (not VTA owned) can be impacted and cause delays. ▶ May increase development of sink holes and road damage. ▶ May cause unsafe driving conditions in flooded areas.
	Sensitivity	M	Bus and paratransit operations may be disrupted or detoured due to road closures or flooding; road function can likely recover after an event.	
	Adaptive Capacity	H	Communication and route planning can minimize the impact of closures or detours with temporary urban flooding.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table E5 Vulnerabilities and Consequences for Bus and Paratransit – Wildfire

Asset	Class Rating		Vulnerability	Consequences
Bus Routes	Exposure	-	17 miles of bus routes are at risk by mid-century.	▶ Service disruptions due to road closures and evacuation orders. ▶ Potential damage to routes due to wildfires.
	Sensitivity	H	Bus routes may be damaged or may be disrupted or detoured due to road closures or evacuation orders.	
	Adaptive Capacity	M	The physical route may require repairs; however, route planning and communication can minimize the impact of closures or detours.	
Bus Stops	Exposure	-	0 bus stops are at risk.	▶ Potential damage to stops due to wildfires. ▶ Access for riders and staff may be limited. ▶ Public Safety Power Shutoff (PSPS) and power grid outages can shut down charging stations, impacting electric bus fleet.
	Sensitivity	H	Bus stops may be damaged or may be disrupted or detoured due to road closures or evacuation orders.	
	Adaptive Capacity	M	The physical route may require repairs; however, route planning and communication can minimize the impact of closures or detours.	
Paratransit Stops	Exposure	-	5 paratransit stops are at risk.	▶ Potential damage to stops due to wildfires. ▶ Access for riders and staff may be limited.
	Sensitivity	H	Stops may be damaged or may be disrupted or detoured due to road closures or evacuation orders.	
	Adaptive Capacity	M	The physical route may require repairs; however, route planning and communication can minimize the impact of closures or detours.	
Streets	Exposure	-	With 24 inches of SLR, 1,268 miles are at risk by mid-century.	▶ Although VTA does not maintain and operate the traffic signals, wildfire smoke may impact the electrical equipment in the cabinet.
	Sensitivity	H	Streets may be damaged or may be disrupted or detoured due to road closures or evacuation orders.	
	Adaptive Capacity	M	The physical route may require repairs; however, route planning and communication can minimize the impact of closures or detours.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table E6 Vulnerabilities and Consequences for Bus and Paratransit – Extreme Heat

Asset	Class Rating		Vulnerability	Consequences
Bus Routes	Exposure	-	Bus and paratransit operations will experience a high increase in extreme heat conditions by mid-century.	▶ Potential overheating and breakdown of buses and paratransit vehicles, leading to service disruptions. ▶ Increased energy usage for air conditioning, leading to higher operating costs. ▶ Increased demand for shaded areas and cooling stations. ▶ Excessive heat will increase HVAC load on the fleet, thus reducing the usable range of the vehicles. ▶ Increased bus bridges and services due to physical damage from light rail tracks or system. ▶ Normal service may be affected by using buses for cooling center transports. ▶ The electrical equipment in the cabinet has an operating range of temperature, but there is possible that environmental temperature could spike beyond these ranges.
	Sensitivity	M	Buses and paratransit vehicles are susceptible to overheating and increased maintenance, roads can withstand extreme heat but can experience cracking and damage.	
	Adaptive Capacity	M	AC systems and schedules/routes can be adjusted to account for potential damage and comfort; roads can like recover after an event or be repaired after some time.	
Bus Stops	Exposure	-	Bus and paratransit operations will experience a high increase in extreme heat conditions by mid-century.	▶ Public Safety Power Shutoffs (PSPS) and power grid outages can shut down charging stations, impacting electric bus fleet. ▶ Potential health hazards (heat stroke, dehydration, and other heat-related illnesses) for riders and drivers at stops. ▶ Increased demand for shaded areas.
	Sensitivity	M	Buses and paratransit vehicles are susceptible to overheating and increased maintenance, roads can withstand extreme heat but can experience cracking and damage.	
	Adaptive Capacity	M	AC systems and schedules/routes can be adjusted to account for potential damage and comfort; stops can likely recover after an event or be repaired after some time.	
Paratransit Stops	Exposure	-	Bus and paratransit operations will experience a high increase in extreme heat conditions by mid-century.	▶ Potential health hazards (heat stroke, dehydration, and other heat-related illnesses) for riders and drivers at stops. ▶ Increased demand for shaded areas. ▶ Increased requests for service during heat events.
	Sensitivity	M	Buses and paratransit vehicles are susceptible to overheating and increased maintenance, roads can withstand extreme heat but can experience cracking and damage.	
	Adaptive Capacity	M	Schedules/routes can be adjusted to account for potential access issues and comfort; stops can likely recover after an event or be repaired after some time.	
	Exposure	-	Bus and paratransit operations will experience a high increase in extreme heat conditions by mid-century.	▶ The electrical equipment in the signal cabinet has an operating range of temperature, but there is possible that environmental temperature could spike beyond these ranges.

Asset	Class Rating		Vulnerability	Consequences
Streets	Sensitivity	M	Buses and paratransit vehicles are susceptible to overheating and increased maintenance, roads can withstand extreme heat but can experience cracking and damage.	▸ Damage to asphalt and concrete infrastructure due to thermal expansion and contraction.
	Adaptive Capacity	M	AC systems and schedules/routes can be adjusted to account for potential damage and comfort; roads can like recover after an event or be repaired after some time.	

Notes: L = Low rating, M = Moderate rating, H = High rating

Table E7 Vulnerabilities and Consequences for Bus and Paratransit – Drought

Asset	Class Rating		Vulnerability	Consequences
Bus Routes	Exposure	-	Bus and paratransit operations will experience a high increase in drought conditions by mid-century.	▸ Increased risk of wildfires. ▸ Potential damage to road and bridge infrastructure due to soil subsidence. ▸ Increased costs or fines during drought with water use.
	Sensitivity	L	Not significantly impacted by drought conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	
Bus Stops	Exposure	-	Bus and paratransit operations will experience a high increase in drought conditions by mid-century.	▸ Increased cleaning due to dust and debris.
	Sensitivity	L	Not significantly impacted by drought conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	▸ No significant impacts.
Paratransit Stops	Exposure	-	Bus and paratransit operations will experience a high increase in drought conditions by mid-century.	
	Sensitivity	L	Not significantly impacted by drought conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	
Streets	Exposure	-	Bus and paratransit operations will experience a high increase in drought conditions by mid-century.	▸ Increased dust and debris on roads, leading to service disruptions. ▸ Potential damage to road and bridge infrastructure due to soil subsidence.
	Sensitivity	L	Not significantly impacted by drought conditions.	
	Adaptive Capacity	H	Not significantly impacted by drought conditions.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Attachment 6

Asset Profile – Operations

VULNERABILITY RATINGS CHART WITH ASSET LIST BY HAZARDS

Operations Class	Permanent Inundation	Temporary Flooding	Wildfire	Extreme Heat	Drought
Service and Ridership	Very High	High	High	High	Low
Maintenance	Very High	High	High	High	Moderate
Rider and Workforce Safety	Very High	High	High	High	Low

Table F1 Vulnerabilities and Consequences for Operations – Permanent Coastal Inundation

Asset	Class Rating		Vulnerability	Consequences
Service and Ridership	Exposure	-	Refer to physical asset profiles for exposure to VTA infrastructure.	▸ Decreased ridership if routes and assets are inaccessible and permanently out of use.
	Sensitivity	H	Service disrupted temporarily with flooding on track line or roadways. Possibility of rerouting and delays for bus service.	▸ Increased costs for relocation or decommissioning stations, routes, or any associated assets.
	Adaptive Capacity	L	External flood protection would be required. Permanent changes in routes required.	▸ Loss of service may impact local jobs and add mental stress and anxiety for riders and staff.
Maintenance	Exposure	-	Refer to physical asset profiles for exposure to VTA infrastructure.	▸ Permanent loss of assets and associated maintenance tasks.
	Sensitivity	H	Permanent inundation would increase maintenance due to damage and disrupt abilities.	▸ Limits on access to certain areas for maintenance.
	Adaptive Capacity	L	External flood protection would be required, otherwise assets would likely not be functional.	▸ Increased manpower if light rail system is impacted and bus bridges must be relied on.
Rider and Workforce Safety	Exposure	-	Refer to physical asset profiles for flood exposure to VTA infrastructure.	▸ Potential impacts with accessibility for riders with disabilities. ▸ Potential safety impacts for staff and riders if operating in flooded areas; increased incidences in roadway accidents.
	Sensitivity	H	Permanent inundation would mean no riders or staff are allowed in flood zone.	▸ Potential impacts to staff being able to report to work safely.
	Adaptive Capacity	L	External flood protection would be required, otherwise riders and staff would not be in flood zone and would have to relocate outside of flood zone.	▸ External social impacts to communities with loss of mobility network. ▸ Inundation of electrical equipment may cause shortening which can threaten safety for both staff and riders.

Notes: L = Low rating, M = Moderate rating, H = High rating

Table F2 Vulnerabilities and Consequences for Operations – Temporary Coastal and Urban/Inland Flooding

Asset	Class Rating		Vulnerability	Consequences
Service and Ridership	Exposure	-	Refer to physical asset profiles for exposure to VTA infrastructure.	▸ Potential service disruptions and evacuation orders during flood event. ▸ Decreased ridership if routes and assets are temporarily inaccessible and service is disrupted. ▸ Loss of service may impact local jobs and add mental stress and anxiety for riders and staff.
	Sensitivity	H	Rider access or service may be blocked until floodwaters recede.	
	Adaptive Capacity	M	Ridership could remain the same with alternative service supplied, if not there may be major service disruption until floodwaters recede.	
Maintenance	Exposure	-	Refer to physical asset profiles for exposure to VTA infrastructure.	▸ Increased maintenance costs and workload due to damage from flooding. ▸ Limits on access to certain areas for maintenance. ▸ Increased workloads if light rail system is impacted and bus bridges must be relied on. ▸ Localized flooding may cause operations to become inconsistent and harder to manage or coordinate.
	Sensitivity	H	Limited or no access if flooded.	
	Adaptive Capacity	M	Access can be resumed after floodwater recede.	
Rider and Workforce Safety	Exposure	-	Refer to physical asset profiles for flood exposure to VTA infrastructure.	▸ Potential safety impacts for staff and riders if operating in flooded areas; increased incidences in roadway accidents. ▸ Potential impacts to staff being able to report to work safely. ▸ Increased hazardous conditions at bus and light rail stations from water, mud, or debris. ▸ External social impacts to communities with loss of mobility network. ▸ Inundation of electrical equipment may cause shortening which can threaten safety for both staff and riders.
	Sensitivity	H	Staff safety can be compromised during a flood event; dangerous operating conditions can persist.	
	Adaptive Capacity	M	Riders and staff would remain outside of flood zone (or at home) until floodwater subsides.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table F3 Vulnerabilities and Consequences for Operations – Wildfire

Asset	Class Rating		Vulnerability	Consequences
Service and Ridership	Exposure	M	By mid-century, VTA will experience a moderate increase in wildfires.	▶ Potential service disruptions and evacuation orders. ▶ Decreased ridership if routes and assets are temporarily inaccessible and service is disrupted. ▶ Power outages during wildfire events and high-risk weather could lead to service impacts.
	Sensitivity	H	Evacuation orders, damage, and hazardous conditions may cause sever disruptions to service and ridership.	
	Adaptive Capacity	M	Service and ridership can recover depending on damage or rerouting and using alternate service routes.	
Maintenance	Exposure	M	By mid-century, VTA will experience a moderate increase in wildfires.	▶ Increased maintenance tasks such as washing assets and associated damage costs. ▶ Limits on access to certain areas for maintenance. ▶ Increased manpower if light rail system is impacted and bus bridges must be relied on.
	Sensitivity	H	Maintenance would have impact but dependent on amount of damage; additional maintenance may be required for ashfall.	
	Adaptive Capacity	M	Maintenance may be delayed until wildfire subsides, or air quality improves.	
Rider and Workforce Safety	Exposure	M	By mid-century, VTA will experience a moderate increase in wildfires.	▶ Potential impacts to staff being able to report to work safely. ▶ Reduced air quality may cause potential health hazards for riders and staff.
	Sensitivity	H	Hazardous working conditions near wildfire; smoke pollution causes safety issues when operating outside.	
	Adaptive Capacity	M	Safety may recover quickly after wildfire subsides; K95 masks and filtration systems can be relied on to maintain safe conditions for staff and riders.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table F4 Vulnerabilities and Consequences for Operations – Extreme Heat

Asset	Class Rating		Vulnerability	Consequences
Service and Ridership	Exposure	H	By mid-century, VTA will experience a high increase in extreme heat conditions.	▶ Potential black outs can decrease productivity, interfering with paratransit scheduling and customer service. ▶ Average wait times may be affected by on-demand services such as paratransit. ▶ Extreme heat makes it less comfortable for riders to wait at bus stops and light rail stations, deterring ridership. ▶ May impact riders especially at-risk including children and elderly. ▶ Reduction in ridership and revenue due to shift in transit mode (private vehicle use) during heat events. ▶ Increased missed connections due to slower light rail speeds.
	Sensitivity	H	Impact to ridership during heat events (e.g., health impacts, reduced ridership, shift to private vehicles) and service may be impacted if there is heat damage.	

Asset	Class Rating		Vulnerability	Consequences
	Adaptive Capacity	M	Riders can reroute to stations with better cooling systems or use shade structures.	▸ May cause different peak loads at different times of the day due to an increase in evening ridership. ▸ Increase in service and reduced revenue because of free rides to cooling centers and providing buses as cooling centers.
Maintenance	Exposure	H	By mid-century, VTA will experience a high increase in extreme heat conditions.	▸ Increased costs for more frequent repair and replacement of equipment due to heat stress. ▸ Increased costs for cooling systems. ▸ The ability to service vehicles may be impacted during heat event. ▸ Facility maintenance bays are not air conditioned; conditions may not be viable for workers to complete maintenance in extreme heat conditions, which could lead to reduced productivity and delayed maintenance.
	Sensitivity	M	Maintenance crews' ability to work outside would be impacted during heat events.	
	Adaptive Capacity	M	Maintenance can resume after a heat event has subsided or indoor maintenance can be performed is cooling is operational.	
Rider and Workforce Safety	Exposure	H	By mid-century, VTA will experience a high increase in extreme heat conditions.	▸ Potential health impacts from heat exposure, especially for at-risk riders such as elderly and children. ▸ Increased heat-related illness, work-related injuries and availability of workforce and equipment. ▸ Increased costs for improving worker safety during heat events. ▸ Increased stress on staff and possible aggressive interactions with the public. ▸ May lead to poor air quality, affecting staff and rider health. ▸ Regulatory requirements may send staff home at a certain heat threshold.
	Sensitivity	H	Staff and riders outdoors are at risk to health impacts (e.g., heat exposure, stroke).	
	Adaptive Capacity	M	Cold water, shade structures, and cooling systems can be provided during heat events.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Table F5 Vulnerabilities and Consequences for Operations – Drought

Asset	Class Rating		Vulnerability	Consequences
Service and Ridership	Exposure	H	By mid-century, VTA will experience a high increase in drought conditions.	▸ No significant consequences to service and ridership.
	Sensitivity	L	No significant impact.	
	Adaptive Capacity	H	Could adapt if there is any impact.	
Maintenance	Exposure	H	By mid-century, VTA will experience a high increase in drought conditions.	▸ Less water availability for cleaning and maintaining rolling stock, platforms, and using wash stations. ▸ Increased build up with dust or debris, causing increased maintenance especially for vehicles.
	Sensitivity	M	Reduction on available water for maintenance; potential financial penalties for water overuse.	▸ Increased penalties/fines for water consumption during drought conditions.
	Adaptive Capacity	M	Water usage can be minimized with xeriscaping and other water conservation efforts.	▸ Additional maintenance required to clear fire-prone materials.
Rider and Workforce Safety	Exposure	H	By mid-century, VTA will experience a high increase in drought conditions.	▸ Increase in dry foliage and dead trees, causing reduction of shade by platforms and stops.
	Sensitivity	L	No significant impact.	
	Adaptive Capacity	H	Could adapt if there is any impact.	

Notes: L = Low rating, M = Moderate rating, H = High rating.

Attachment 7

Vulnerability Ratings (Excel)

Attachment 8

Adaptation Strategies Workbook (Excel)

Appendix E

CAAP Implementation Tables

Adaptation Actions Implementation Table

Action	Lead Division or Dept.	Implementation Timeframe
Cross-Cutting Adaptation Actions (CC)		
AD-CC-1.1: Engage with Cal OES, Santa Clara County Office of Emergency Management, and Valley Water and participate in planning and response coordination sessions related to climate hazards for the transportation sector.	System Safety & Security	Variable
AD-CC-1.2: Develop, update, share, and coordinate emergency management plans with VTA member agencies. Conduct outreach to clarify response elements of plans and highlight VTA's capabilities to support emergency response efforts within its service area, such as providing free rides to cooling and warming centers.	System Safety & Security	Near-Term
AD-CC-1.3: Review after-action reports from past evacuation efforts to identify targeted resiliency opportunities for communities in VTA's service areas and improve future evacuation efforts.	System Safety & Security	Near-Term
AD-CC-1.4: Establish and maintain contingency contracts with relevant suppliers who provide prioritized access to resources to enable more reliable and rapid access to services and supplies needed during an emergency response effort.	System Safety & Security	Variable
AD-CC-1.5: Maintain the organization, including staff roles and responsibilities, and procedures of the VTA EOC to respond to emergency situations which may require deploying maintenance and repair teams to locations prior to, during, or following a climate hazard event or as indicated in Incident Action Plans. Ensure the EOC is staffed and operated at a level proportionate to the emergency.	System Safety & Security	Variable
AD-CC-1.6: Develop climate hazard scenario-specific response plans with consideration of the unique set of circumstances related to each scenario and how they may affect VTA operations, power supply, and other considerations.	System Safety & Security	Mid-Term
AD-CC-1.7: Conduct emergency response exercises with both internal and external partners by inviting member agencies and other partners to join emergency management table-tops and full-scale exercises conducted by VTA and have VTA staff participate in drills and exercises being hosted by member agencies and other partners.	System Safety & Security	Variable
AD-CC-1.8: Develop training for VTA staff and customer service representatives to better manage concerns of riders and the broader community during climate hazard events.	External Affairs	Mid-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-CC-1.9: Improve digital infrastructure to better communicate emergency and service disruption information to riders, which may include a suite of actions, including the installation of electronic signage in trains, buses, and at VTA facilities that displays real-time information, enhancing SMS-based alerting capabilities, further leveraging mobile applications (such as the "VTAlerts" app), and including audible indicators, where feasible.	System Safety & Security	Mid-Term
AD-CC-1.10: In collaboration with member agencies, develop uniform methods to communicate to the public about the closure of bicycle and transit facilities and trails due to climate hazards, such as flooding and wildfire. Work collaboratively with member agencies and Valley Water to define best practices related to emergency and routine trail closures, detours, and reopening.	External Affairs	Mid-Term
AD-CC-2.1: Develop content for and install multilingual signage at stations to inform the public about VTA climate resilience initiatives and personal climate hazard preparedness.	External Affairs	Mid-Term
AD-CC-2.2: In collaboration with member agencies, educate community neighbors on how to prepare for and respond to climate hazards. For example, underscoring the importance of shade and hydration during extreme heat events, or the need for vegetation control to reduce risk of wildfire ignition and spread.	External Affairs	Mid-Term
AD-CC-2.3: Create a web-based dashboard that underscores vulnerability assessment findings and actions that can be taken to improve resilience to better inform riders and the broader community about adaptation-related needs that would be mutually beneficial for all parties that use or otherwise rely on VTA's transportation network.	External Affairs	Mid-Term
AD-CC-2.4: Leverage and potentially modify existing mobile applications (e.g., "VTAlerts" app), along with social media accounts, to inform the public on climate hazards (e.g., extreme heat, flooding), alternative routes, and climate resilience initiatives, and to provide real-time reports from the public to help VTA respond to a hazard event.	External Affairs	Mid-Term
AD-CC-3.1: Identify alternative transit routes and modes of transportation and develop protocols for service disruptions or temporary closures during climate hazard events (e.g., wildfire, flooding), ensuring effective communication with riders and VTA staff.	System Safety & Security	Mid-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-CC-3.2: Consider and fully understand all aspects of VTA's transportation network and how they will perform under evacuation scenarios (e.g., locations of chokepoints, expected roadway volumes and timing, potential evacuee characteristics, typical origin-destination numbers and patterns of travelers, capacity of roadways).	System Safety & Security	Variable
AD-CC-3.3: Enhance intermodal connectivity between different forms of transportation to provide multiple options for riders and VTA staff, which can include improving transfer facilities, developing multimodal hubs, and optimizing transit schedules to facilitate seamless transfers.	Operations	Long-Term
AD-CC-3.4: For any scheduled maintenance or repairs to improve safety and reliability within VTA's transportation network, continue to implement and expand efforts to ensure that riders can still efficiently get around. For example, VTA's Rail Rehabilitation and Replacement Program, which includes rehabilitation and replacement projects for overhead power wires, concrete panels, switches, rail, and special track work, also ensures that riders can still get around during these scheduled closures via bus bridges.	Operations	Near-Term
AD-CC-3.5: Bolster the capacity of VTA ACCESS Paratransit services to be prepared for potentially more frequent requests during future climate hazard events.	Operations	Mid-Term
AD-CC-3.6: Coordinate with member agencies to help identify roadways, bridges, and electrical signal equipment that may be damaged or deteriorating to help expedite repairs and ensure continued sustenance and minimal disruptions of VTA's bus and paratransit operations.	System Safety & Security	Variable
AD-CC-3.7: Expand bus, paratransit, and light rail staff and fleets to account for enhanced intermodal connectivity and projected future ridership, and to minimize disruptions to VTA's transportation network. Consider resiliency in decisions related to future fleet planning and facility master plans.	Operations	Mid-Term
AD-CC-3.8: Collaborate with member agencies and other regional transportation partners to establish, update, and maintain cooperative agreements and mutual aid protocols, which can facilitate resource sharing, alternative routing, and coordinated response efforts during emergencies.	System Safety & Security	Near-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-CC-4.1: Create an internal technical advisory group or task force to oversee all climate resilience efforts and support internal and external collaboration, outreach, and implementation of strategies. The group should include a representative from relevant VTA departments and will be responsible for leading implementation of adaptation projects through dedicated budget allocation and applications for grants and other external funding (e.g., FEMA BRIC grants). Additionally, the group will be responsible for data sharing throughout VTA and beyond.	Engineering & Program Delivery	Near-Term
AD-CC-4.2: Coordinate with VTA member agencies to explore the establishment of a countywide Climate Resilience District to fund or finance climate adaptation projects and programs, in line with SB 852.	Engineering & Program Delivery	Near-Term
AD-CC-5.1: Conduct a feasibility study to determine where and how on-site renewable energy generation, battery storage, and/or microgrids could be implemented at VTA facilities and stations to provide more reliable, decentralized, grid-independent energy (Note: this adaptation action is very similar to and should be closely aligned with GHG Reduction Measures BF-1.2 and BF-1.3)	Engineering & Program Delivery	Mid-Term
AD-CC-5.2: Develop and implement load management strategies to optimize energy usage during peak periods or emergencies and to reduce the risk of power outages, such as rescheduling non-urgent maintenance activities, identifying non-essential loads that can be temporarily reduced (e.g., lighting levels, HVAC systems, other equipment not directly related to critical operations or safety), and analyzing historical energy data to identify trends and make informed load management decisions.	Operations	Near-Term
AD-CC-5.3: Identify and seek funding to install backup power at VTA facilities and cabinets housing critical communication infrastructure. Ensure that all new and existing backup power sources are hardened and protected from potential hazard events, which may include wall structures to protect from wildfires and high winds or elevating systems out of flood-prone areas. Install redundant or failsafe air conditioning units in buildings and cabinets containing critical equipment and communication infrastructure where it does not already exist.	Operations	Mid-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-CC-6.1: Update policies (e.g., Green Building Policy) and design manuals, such as VTA's CDT Manual and the Design Criteria Manual for Stormwater and Landscaping, to further include climate change considerations based on vulnerability assessment findings and other known risks, to ensure that investments made now increase system resilience and sustainability. Consider including climate-resilient design features such as special sealants and other materials on roadways to help prevent roadways from softening during extreme heat and specific pavement options to reduce the heat island effect of parking lots, where applicable and in coordination with Caltrans and others. Improve the building envelope performance by increasing insulation value, glazing performance, window shading, thermal breaks, cool color technology on exterior building finishes, and other voluntary reach codes identified for non-residential projects in CALGreen. Stakeholders should provide feedback so that updated policies and design standards are feasible, have buy-in, and will be implemented by staff and member agencies.	Engineering & Program Delivery	Variable
AD-CC-7.1: Monitor climate impacts on assets and operations, as well as resulting costs and economic impacts, to justify the need for climate adaptation strategy implementation. Determine data sources and streamlined tracking methods, as appropriate, for different assets, operations, and related departments (e.g., data collection tools, work orders, labor tracking systems, inspection routines) to contribute to regular reporting by monitoring items including, but not limited to: 1) rail temperatures and track alignment to identify patterns related to extreme heat; 2) storm events and related power shutdowns to understand service impacts; 3) ridership complaints related to hazard events and associated costs; 4) impacts of hazardous conditions (e.g., poor air quality from wildfire smoke) on VTA workers through missed work days, compensation claims, etc.	System Safety & Security	Variable
AD-CC-8.1: Conduct detailed, tailored vulnerability assessments specific to key individual assets and operations and develop a series of adaptation actions that can be taken over time based on changing conditions. This series of actions, also known as "adaptation pathways," establish specific triggers and evaluation metrics that lead into the next appropriate action that should be taken. This approach is intended to be flexible and easily modified as conditions change, climatic or otherwise.	Engineering & Program Delivery	Variable

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-1.1: Install cooling amenities in areas where they do not yet exist and where feasible, such as: hydration stations on station platforms and in maintenance areas to ensure riders and VTA staff have access to drinking water; additional seating under pre-existing shade platforms; additional shaded areas at park-and-ride lots, bike racks, and platforms; air conditioning in indoor waiting areas; and misters in outdoor waiting areas.	Engineering & Program Delivery	Mid-Term
AD-F-1.2: Where feasible, increase shading and use heat-mitigating materials around VTA facilities, such as in park-and-ride lots, bus and paratransit stops, stations, transit centers, facility entry areas, pedestrian walkways, and bicycle facilities. For example, build bus shelters or plant trees to provide shaded areas where transit users can wait for transit in more comfortable conditions. Prioritize plantings in high-traffic areas and/or areas identified as lacking canopy tree cover according to local surveys.	Engineering & Program Delivery	Near-Term
AD-F-1.3: Reduce wait times for transit service to reduce exposure to passengers during extreme heat events and poor air quality conditions during wildfires. This can be done by providing faster and more frequent service.	Operations	Mid-Term
AD-F-1.4: Consider installing heat-reducing roofs or roof treatments such as green roofs, cool roofs, or using other high-albedo materials for VTA facilities, along with installing awnings on buildings and operator break rooms and ensuring buildings are well insulated, to help reduce cooling needs and costs and the urban heat island effect.	Engineering & Program Delivery	Long-Term
AD-F-1.5: Pilot "cool pavement" projects that use lighter materials or lighter colored aggregate in asphalt paving mixes. Monitor progress of achieving potential benefits like reduced ambient air temperatures, reduced maintenance, and increased longevity. Pilot success should help determine the feasibility of this as a solution that could be brought to scale across park-and-ride lots that are not exposed to temporary flooding where permeable pavement should be installed instead.	Engineering & Program Delivery	Variable
AD-F-1.6: Ensure light rail, bus, and paratransit fleets are equipped with thermal insulation coatings and tinted windows.	Operations	Mid-Term
AD-F-1.7: Increase natural ventilation and passive cooling of facilities through changes in operation and positioning of doors and windows and installing additional vents or louvers.	Operations	Near-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-2.1: Establish policies for when to perform zero-stress temperature adjustments based on temperature fluctuations, and stress newly installed and existing rail with a rail zero-stress temperature that is calculated based on projected temperatures for the lifetime of the rail, rather than on current or historic conditions.	Operations	Near-Term
AD-F-2.2: Develop official protocols for managing and protecting light rail operations during extreme heat events, such as frequent track walking inspections and adopting specific criteria for when to issue rail slow/stop orders to prevent or reduce overheating.	Operations	Near-Term
AD-F-2.3: Install sensors to indicate potential kinking and rail defects, which may include thermometers that can be remotely monitored (which can reduce operational rail costs associated with rail inspection requirements during hot weather), or motion sensors that can identify a thermal misalignment when it occurs and automatically halt trains.	Operations	Mid-Term
AD-F-2.4: Reduce risk of thermal misalignment through a suite of actions, which may include: replacing wood ties with concrete ties, which are heavier and more resistant to movement; reducing tie spacing, which provides additional weight to the track structure and increased lateral resistance because of increased exposure to shoulder ballast; re-tamping ballast to increase ballast density, which increases lateral resistance; and/or increasing the width of the ballast shoulder, which will increase lateral resistance.	Operations	Long-Term
AD-F-3.1: Prioritize nature-based solutions to address flooding. This may include coordination with other agencies to restore wetland and riparian habitats on floodplains to further slowdown the flow of floodwaters and hold soil in place. Additionally, this may also include drainage improvements, such as bioswales, bioretention basins, retention/detention ponds, incorporation of permeable surfaces, and improvements to culverts, as strategies for reducing peak stormwater flooding in locations where geotechnical conditions are appropriate and/or with adequate foundation/substrate. Choose low maintenance, non-invasive plant species. Improvements to drainage and stormwater infrastructure should be considered at park-and-ride lots, landscaping around VTA facilities, and along track in VTA's right-of-way, and in partnership with the County of Santa Clara and other agencies.	Engineering & Program Delivery	Mid-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-3.2: Armor subgrade and sub-ballast with riprap or other materials to prevent light rail track structure from weakening because of saturation or washout. This can be done as new substructure is being placed and/or when older ballast is replaced.	Operations	Mid-Term
AD-F-3.3: Where exposure to temporary flooding is prevalent, research and treat light rail system and track components, along with bus/paratransit stops and infrastructure components, with protective coatings or sealants to minimize the risk of potential rusting and promote stronger performance and longevity, where appropriate.	Operations	Mid-Term
AD-F-3.4: Where feasible, explore elevating electrical (e.g., substations), mechanical, and information technology (IT) equipment (including Data Centers, Backup Data Centers, SCADA rooms, and IDF and MDF networking closets) that are vulnerable to current and future flood elevations, such as those at Cerone Bus Division and River Oaks. Some considerations should include accessibility and safety (e.g., ensuring maintenance personnel can access equipment), importance to VTA's operations, elevation techniques and engineering design, and compliance with building codes and regulations.	Operations	Long-Term
AD-F-3.5: Install permeable pavement to minimize flood risk in park-and-ride lots that are exposed to temporary flooding, but also to reduce peak flows, lessen the strain on drainage systems, and recharge groundwater where it can be filtered naturally by the soil.	Engineering & Program Delivery	Mid-Term
AD-F-3.6: Develop and practice a suite of post-wildfire debris removal strategies, in collaboration with others, to reduce the severity of flood-after-fire and other debris flow events, including replanting lost vegetation immediately after a wildfire event, establishing and continuing to maintain barriers in areas determined to be susceptible to future debris flows, and employing best-available data to predict future debris flows.	System Safety & Security	Near-Term
AD-F-3.7: Procure additional and appropriate temporary flood protection barriers for different types of assets (e.g., sandbags, Tiger Dam™, AquaFence®) to be better prepared during a temporary flood event. Where feasible and appropriate, explore more permanent forms of wet or dry floodproofing for facilities.	Operations	Mid-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-3.8: Collaborate with member agencies and other partnering organizations to encourage and expedite shoreline protection and restoration projects (e.g., South San Francisco Bay Shoreline Project, led by the Santa Clara Valley Water Agency) to reduce the overall vulnerability of VTA's transportation system to the effects of permanent inundation and coastal flooding. Support community participation in these efforts.	Engineering & Program Delivery	Variable
AD-F-3.9: Incorporate future sea-level rise, permanent inundation, and precipitation projections into long-term infrastructure planning processes, influencing decisions on expansion, relocation, or retrofitting of assets. For example, many of VTA's facilities and other assets are highly vulnerable to future permanent inundation and coastal flooding, such as Lockheed Martin Transit Center, light rail routes and supporting infrastructure (e.g., grade crossings, frogs, turnouts), and bus stops, among others. Potential relocation of these assets should be considered and planned for well in advance of implementation.	Engineering & Program Delivery	Long-Term
AD-F-4.1: Complete upgrades to vehicle washing facilities (e.g., replace original train wash facility at Guadalupe Yard), wastewater treatment systems, and irrigation equipment, targeting higher usage areas. This may include replacing traditional sprinkler systems with drip irrigation systems, retrofitting water fixtures in yards used for washing trains, buses, or other service/maintenance activities so that water sprays are at higher pressure but lower volume, and replacing water fixtures, toilets, and urinals in station and facility restrooms with low-flow options.	Operations	Long-Term
AD-F-4.2: Consider maintaining reduced vehicle washing and irrigation schedules imposed during drought emergencies as regular practice.	Operations	Near-Term
AD-F-4.3: Explore the feasibility of automated data communications and leak detection systems to provide real-time water consumption information and leak alerts to facility managers.	Operations	Mid-Term
AD-F-4.4: Educate and engage relevant staff on ideas for water conservation in the workplace, which may include improvements to cleaners, manual scrubbers, and power washing, and ensuring that leaky hydrants are turned off.	Operations	Near-Term
AD-F-4.5: Explore opportunities for connecting station and facility irrigation systems to recycled water lines, collaborating with water agencies to determine feasible locations.	Engineering & Program Delivery	Long-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-4.6: Further integrate and regularly update water conservation approaches into contractor requirements to better mitigate water use impacts from construction through operations.	Engineering & Program Delivery	Near-Term
AD-F-5.1: At VTA facilities that require significant irrigation for landscaping and aesthetics (e.g., park and ride lots, stations, and transit centers), identify and install non-invasive plant species that are native or climate appropriate and are more tolerant to climate hazards to reduce water use and improve resilience.	Engineering & Program Delivery	Mid-Term
AD-F-5.2: Support tree planting in lower wildfire risk, heat vulnerable areas where potential disturbances (e.g., fallen trees) would not greatly impact VTA assets and operations (e.g., not planting in locations directly adjacent to rail track). Ensure trees are properly maintained and watered to survive drought conditions.	Engineering & Program Delivery	Near-Term
AD-F-5.3: For VTA assets that are located in higher wildfire risk areas, manage adjacent trees and vegetation in a way that minimizes risk of wildfire ignition and spread. This may include removing invasive species (e.g., stinkwort, eucalyptus, tree of heaven) and removing and/or replacing trees with other forms of vegetation or hardening features (e.g., fire-resistant materials) that would reduce fire risk, ensure adequate defensible space, and protect native, urban ecology. Ensure this work aligns with the Community Wildfire Protection Plan, prepared by the Santa Clara County Fire Safe Council.	Operations	Mid-Term
AD-F-5.4: Install tree wells, paired with permeable surfaces, where feasible, to promote long-term tree health.	Engineering & Program Delivery	Mid-Term
AD-F-6.1: Shift outdoor physical labor hours to earlier in the morning during extreme heat events, and allow for flexible hours and remote work, in general (where possible), to ensure safety during other climate hazard events.	Operations	Near-Term
AD-F-6.2: Conduct safety audits and inspections across VTA's transportation system (e.g., facilities, buses) to identify and address potential safety risks to riders and VTA staff that would be caused or exacerbated by climate hazards.	System Safety & Security	Variable
AD-F-6.3: Develop and update trainings for VTA staff that promote safety during hazard conditions, which may include how to safely operate vehicles and equipment during flood conditions and how to recognize and respond to heat-related illnesses, among others. Provide tips to riders on how to stay safe during floods, heat waves, and other hazard conditions.	System Safety & Security	Near-Term

Action	Lead Division or Dept.	Implementation Timeframe
AD-F-6.4: Ensure indoor facilities, buses, and trains are equipped with air filtration systems to protect public health from wildfire smoke and the harmful effects of particulate matter pollution.	System Safety & Security	Mid-Term
AD-F-6.5: Develop and share emergency preparedness tips and safety communications with employees.	External Affairs	Variable

GHG Reduction Measures Implementation Table

Measure	Lead Division or Dept.	GHG Reduction Potential	Implementation Timeframe
Transportation and Land Use (TL)			
GHG-TL-1.1: Assist VTA member agencies in implementing SB 743 and mitigating VMT from new land development projects and transportation projects.	Planning & Programming	Medium	Mid-Term
GHG-TL-1.2: Continue to build out the countywide Express Lane network to use roadway pricing as a tool to provide reliable travel options and generate a revenue stream for projects that improve the operations of HOV lanes and transit.	Engineering & Program Delivery	Medium	Mid-Term
GHG-TL-2.1: GHG-TL-2.1: Implement bicycle and pedestrian infrastructure that reduces VMT or improves the safety of existing facilities, prioritizing investments for disadvantaged communities.	Planning & Programming	Medium	Variable
GHG-TL-2.2: Encourage and support efforts to plan and build walkable and bikeable communities for people of all income levels, races, and abilities.	Planning & Programming	Low	Variable
GHG-TL-2.3: Support local, county, state, and federal efforts to promote use of electric bicycles/scooters (or similar devices) as an alternative to driving.	Planning & Programming	Low	Variable
GHG-TL-2.4: Support education and encouragement programs that promote replacing polluting travel with low-emission travel.	Planning & Programming	Low	Variable
GHG-TL-3.1: Improve reliability and convenience of existing transit services through increased frequency of service, extended service hours, and improved facilities at stops and stations, prioritizing improvements that serve disadvantaged communities.	Operations	High	Mid-Term
GHG-TL-3.2: Increase transit travel speed and reliability through transit-signal priority, dedicated bus lanes, and new or expanded Rapid bus service.	Planning & Programming	Low	Mid-Term
GHG-TL-4.1: Collaborate with member agencies in advanced planning efforts to increase residential and employment densities and expand mixed-use development potential near rail stations, along Frequent Network bus routes, and in priority development areas (PDAs).	Planning & Programming	Low	Variable
GHG-TL-4.2: Increase development around transit stations and along transit corridors to facilitate multi-modal, carbon-neutral neighborhoods that are sustainable and resilient.	Planning & Programming	Low	Variable

Measure	Lead Division or Dept.	GHG Reduction Potential	Implementation Timeframe
GHG-TL-4.3: Strategically repurpose underutilized parking lots or other vacant lots at or near VTA transit stations and major transit stops into lively mixed-use, transit-oriented communities with activated ground floor uses that increase transit ridership, help provide revenue for transit capital investments and operations, and reduce VMT.	Finance, Budget, & Real Estate	Medium	Variable
GHG-TL-4.4: Provide people of all generations and backgrounds with affordable housing and access to the necessities of daily life available within a short walk, bicycle ride, or transit trip.	Finance, Budget, & Real Estate	Medium	Variable
GHG-TL-4.5: Work with member agencies and other partners to focus development where it already exists (i.e., promote infill development) and reduce the impact of development and transportation infrastructure on the environment by protecting open space, conserving and restoring habitat, enhancing biodiversity, increasing carbon sequestration, and improving wildlife connectivity.	Planning & Programming	Low	Mid-Term
GHG-TL-5.1: Support local efforts to reduce or eliminate minimum parking standards and institute parking maximums, require "unbundling" of parking costs from commercial leasing or residential rental rates, support shared parking, and introduce demand-based parking pricing in public on- and off-street parking facilities.	Planning & Programming	Low	Variable
GHG-TL-5.2: Provide charging infrastructure at VTA parking facilities open to the public.	Engineering & Program Delivery	Low	Near-Term
GHG-TL-6.1: Increase participation in smart commute and mobility options throughout the County including bicycle sharing, ridesharing, car-sharing, mobility-as-a-service, guaranteed ride home programs, carpools, vanpools, and other emerging options.	Planning & Programming	Medium	Variable
GHG-TL-6.2: Expand TDM programs and services in partnership with member agencies, employers, schools, and residential communities.	External Affairs	Medium	Variable
Buildings and Facilities (BF)			
GHG-BF-1.1: Decarbonize existing VTA buildings by phasing out fossil fuel usage and electrifying water heating and space heating or using renewable fuels such as renewable natural gas where appropriate.	Engineering & Program Delivery	Medium	Mid-Term
GHG-BF-1.2: Increase renewable energy, battery storage, and microgrid installations in existing VTA buildings, and/or procure 100% renewable options through local CCE providers, where applicable.	Engineering & Program Delivery	Medium	Mid-Term

Measure	Lead Division or Dept.	GHG Reduction Potential	Implementation Timeframe
GHG-BF-1.3: Require all new VTA buildings to be 100% electric and include on-site renewable energy systems with battery storage and microgrids and achieve net-zero standards where feasible.	Engineering & Program Delivery	Low	Mid-Term
GHG-BF-1.4: Increase use of electricity and alternative fuels in construction equipment on VTA projects.	Engineering & Program Delivery	Low	Near-Term
GHG-BF-2.1: Upgrade outdoor lighting at VTA buildings, and at park-and-ride lots and stations to LEDs or other high-efficiency lighting.	Engineering & Program Delivery	Low	Mid-Term
GHG-BF-2.2: Reduce energy use in VTA buildings through conservation best practices consistent with LEED®, ENERGY STAR®, or other standards.	Engineering & Program Delivery	Low	Mid-Term
Fleet and Employee Commute (FE)			
GHG-FE-1.1: Replace VTA diesel trucks and other non-revenue VTA vehicles to ZEVs.	Operations	High	Variable
GHG-FE-1.2: Expand EV and electric bicycle charging infrastructure at VTA buildings to support VTA fleet EVs and employee bicycles.	Engineering & Program Delivery	Medium	Variable
GHG-FE-2.1: Use cleaner fuel, such as renewable diesel, for off-road equipment and construction equipment where feasible.	Engineering & Program Delivery	Low	Near-Term
GHG-FE-2.2: Require ZEV or LEV equipment in VTA projects.	Engineering & Program Delivery	Low	Near-Term
GHG-FE-3.1: Maximize the operational efficiency of VTA vehicles, including reducing vehicle idling.	Operations	Low	Near-Term
GHG-FE-4.1: Monitor employee commute patterns to understand employee behaviors, needs, and overall contributions to VTA's operational GHG inventory.	Human Resources	Low	Variable
GHG-FE-4.2: Encourage and enable VTA employees to use transit, carpool, bike, and telecommute to work to reduce single-occupancy vehicle commute trips and VMT.	Human Resources	Medium	Variable
Materials and Waste (MW)			
GHG-MW-1.1: Require procurement and operational practices that avoid generation of waste (e.g., reusable materials, reduced packaging, and compostable products).	Finance, Budget, & Real Estate	Low	Near-Term
GHG-MW-1.2: Increase recycling and organic waste diversion at all facilities.	Operations	Low	Near-Term
GHG-MW-1.3: Reduce the generation of construction and demolition waste in VTA projects, and increase sustainable materials use and recovery.	Engineering & Program Delivery	Low	Variable