From: VTA Board Secretary
Sent: Monday, May 13, 2024 4:33 PM
To: VTA Board of Directors
Cc: VTA Board Secretary
Subject: From VTA: Information Regarding the Future of Light Rail and Light Rail Research Project

VTA Board of Directors:

Please see attached memorandum from Derik Calhoun, Chief Operating Officer, addressing inquiries pertaining to the Future of Light Rail and Light Rail Research Project.

Thank you.

Office of the Board Secretary
Santa Clara Valley Transportation Authority
3331 North First Street, Building B
San Jose, CA 95134-1927
Phone **408-321-5680**

Santa Clara Valley Transportation Authority
Solutions that move you

Santa Clara Valley Transportation Authority

Date: May 9, 2024
Current Meeting: April 26, 2024
Board Meeting: May 2, 2024

BOARD MEMORANDUM

TO: Santa Clara Valley Transportation Authority Board of Directors

THROUGH: General Manager/CEO, Carolyn Gonot

FROM: Chief Operating Officer, Derik Calhoun

DocuSigned by: Derik Calhoun CED6B2388CE1420...

SUBJECT: **Future of Light Rail and Light Rail Research Project**

FOR INFORMATION ONLY

EXECUTIVE SUMMARY:

Members of the Board have presented Derik Calhoun with a series of questions and remarks regarding the Light Rail Vehicle Research Project. The questions and remarks were focused on the technology being researched on the Demonstration Vehicles. The team has responded to the questions and remarks which are listed in the discussion section below. The team is following up on cost evaluations, additional modeling (Eastridge Expansion), and autonomous vehicle technology.

BACKGROUND:

On April 26, 2024, at the Board of Directors Workshop Meeting Board Members and the Light Rail Research Project team presented the Future of Light Rail and engaged in extensive discussion on the Light Rail Research Project and other Light Rail related activities.

The Light Rail Research Project goal is to test new light rail technology for the purpose of evaluating the technology for future LR Vehicle use. The key technology being researched is operating off-wire with an onboard energy storage system (OESS). In addition, VTA wants to evaluate longer vehicles, better passenger amenities, new maintenance technologies, and new operation technologies. When the projects move past the initial stages, VTA sees the demonstration vehicles as a platform to continuously evaluate technology to stay up to date. One example would be testing autonomous vehicle technology as it changes and improves.

DISCUSSION:

The following are questions asked and remarks/points discussed during last month's Board Workshop and subsequent discussions with Board Members Suds Jain and Pat Burt. The

questions and discussion along with the guidance from the Board will help guide and strengthen the project.

Questions from Board Member Suds Jain (the two sets of questions are combined)

1. **How many other transit agencies are also considering adding batteries to their light rail vehicles? If none, why do we want to be so far ahead of the curve?**

    a. Metro St. Louis has already placed a firm order for such vehicles (Siemens will manufacture them in Elk Grove, CA.)

    b. Brookville Liberty streetcars operate in Dallas, Kansas City, Tucson, Tempe, Detroit are all capable of, and operate offline for a portion of every trip.

    c. In France: SCNF has signed contracts with Bombardier to provide dual battery/OCS trains for 5 French REGIONS.

    d. In 2019, the Schleswig-Holstein rail authority signed a 600 billion (Euro) deal with Stadler to provide 55 Flirk-Akku multiple unit trains, that went into service and offer 93 miles of battery range.

    e. Japan's JR East has a battery backup. The Katsayuma line operates using charging-bars and batteries Japan leads the work with at least 23.

    f. Liverpool, England Class 777 on the Merseyrail network. Stadler achieved 135 km range.

    g. Caltrain exercised an option order with Stadler for a single trainset for use on the line between Gilroy and Tamien. (2023)

    h. Trams/LRVs with OESS in the world: Newcastle (Australia), Zaragoza (Spain), Birmingham (UK), Granada (Spain), Taiwan, Luxembourg

    i. The agencies who have acquired or have expressed interest in off-wire technology is growing in the US and Europe.

VTA does not want to be the guinea pigs and is not the first test of this technology. VTA wants to be a leader and utilize new technologies to improve the future of public transportation. VTA is looking to see test results and history behind the technology.

2. **How many possible manufacturers are there for the LRVs? Domestic? Foreign?**

    a. Most manufacturers serving the US market are capable of meeting Built in America requirements.

        i. Stadler,
        ii. Siemens,
        iii. Kinkisharyo,
        iv. Alsom,

v. CAF,
vi. Hyundai Rotem.

b. There are more overseas.

i. Chinese,
ii. Korean,
iii. Japanese,
iv. European.

3. How many possible manufacturers are there for the battery packs? Domestic? Foreign?

a. ACTIA (USA),
b. Hoppecke Batteries, Inc. manufactures in Hainesport, NJ (USA),
c. ABB (Switzerland),
d. Medcom (UK),
e. Saft (France),
f. AKASOL (Germany).

4. Do we absolutely need to buy domestic LRVs and batteries?

Yes. VTA will need to buy domestic to meet Buy America requirements. VTA anticipates needing federal funds to complete fleet purchase.

a. The US has more LRV car manufacturers than bus manufacturers.
b. VTA will be able to meet Buy America requirements. The car builders VTA met with during the RFI process all have plants in the US and are familiar with the Buy America requirements.
c. To meet the accelerated timeline of the project, some manufacturers may not meet the buy America requires, as it relates to the federal funding. The reasons are the car builder has cars in production in a foreign country or the amount of work does not offset the battery (or other feign purchase).
d. Hoppecke Batteries, Inc. manufactures in Hainesport, NJ (USA).
e. With Buy America requirements, not everything has to be made or purchased in America. The percentage of Buy in America is high. For example, with a modernized LRV the battery cost could be high enough to push the modernization out of compliance for Buy America.

5. The presentation to the Board compares only LiTiO3/LTO to NMC. NMC has serious problems with fires. I did not see any consideration of LFP. Why?

The rolling stock provider will design the vehicle to meet NFPA requirements. The control system and fire protection system would be designed according to the appropriate regulations.

The RFP is written as a performance specification. The car builder will specify the

battery for the vehicle. Knowing and understanding the differences between battery chemistry is very important. VTA will push the demonstration vehicles to the limit of the OESS to see how well the vehicle and battery perform.

The RFP includes language requiring the OESS energy storage to be interchangeable. "The OESS shall be designed to be flexible and modular to allow the energy system to be interchangeable with alternate new or existing technologies as well as alternate battery chemistries. The interchangeability shall include the ability of the diagnostic and control systems to interface easily and accurately."

6. **I think we picked lithium titanate due to faster charging rates. On the Green Line I see the trip is 1 hour from Diridon to Old Ironsides and the trip time without catenary would be 25 minutes. Meaning half the time off catenary. This means to me that if we charge the batteries at a 1C rate which is very easy with any lithium battery technology (LFP, LiOn, LTiO3) we could maintain plenty of charge on the batteries. We would charge what is depleted in the 30 minutes on catenary for the 30 minutes off catenary-not counting dwell times at the ends of the line. From the presentation I see 44kWh is needed to go from Gish to Diridon which is actually only 40% of the usable energy of the proposed 144kWh LTO battery.**

    a. We chose to perform the analysis with NMC and LTO to get a general understanding of what could fit onboard a 3-section or 5-section Kinkisharyo as these LRV lithium batteries.
    b. For lithium-ion batteries: NMC and LTO batteries are on opposite sides of the spectrum. NMC batteries have higher energy density, lower power density, and lower life cycles. LTOs have lower energy, high power density, and higher life cycles. LFP batteries sit somewhere in the middle of LTO and NMC batteries (energy density between LTO/NMC, power density like NMC, and life cycles in the middle of LTO/NMC.)
    c. 43kWh is around 40% of the usable energy for 144 kWh. However, the roundtrip energy between Gish-Diridon is 79 kWh. 79kWh/(144*.8) ~ 70% of the usable energy. It is good to have spare capacity for your battery as this is better for the battery's health and cycles accumulated, which results in a smaller number of replacements. Also, in an emergency where terminal charging was not available and/or the OCS could not be used en route to charge the battery system, would require enough energy storage to make a round trip without using up 80% of the depth of discharge can be harmful to the health of a battery and damage the cells. Based on the roundtrip energy consumption between Gish-Diridon (43kWh + 37kWh=79kWh), the analysis indicates that~100kWh battery storage would be needed. Note, the 144kWh battery used for the analysis was based on what we could fit on the roof of a standard 5-section LRV.

7. **The density of Lithium Titanate (LTO) is half that of LFP which might explain why we have to use 5 modules instead of 3 modules making the cars longer and more customized. From the presentation:**

The current 3-module vehicle does not provide sufficient roof space for a new OESS that

can meet the desired OSC free range and vehicle performance requirements.

1. We can show more of the sizing calculations. The energy capacity for an LTO on three 3-section vehicles we calculated that would fit on a retrofitted vehicle was 29kWh, which is not enough for 10 miles of operation one way. We estimated we could fit a 100kWh NMC battery on a retrofitted 3-module VTA vehicle maximum. If OCS-free operation was only desired for 4 miles one way (i.e., Gish-Diridon), a 100kWh on a 3-module LRV may work, however, the vehicle would be limited in max power draw. The 100kWh NMC battery calculated for a 3-module LRV is only able to supply 100kW of continuous power and max discharging power 150kW for only 10 seconds, which is not close enough to the max power draw the LRV needs. NMC batteries can go up to a 5C rate (i.e. this would be 500kW) for shorter periods, but this is usually not recommended by battery suppliers as this can severely deplete the life cycle of an NMC battery.
2. One more point-about question #7. A 5-module car is PREFERABLE to a 3-module car as far as Operations is concerned. Coupling these vehicles is quite a risky moment, although it is done seamlessly most of the time, People do not understand how complex light rail vehicles are when compared to other vehicles. One operator sits at one end of a train, "keys on," and controls the entire vehicle- or coupled vehicles. The commands ("right side doors open", "B4 brake application," etc.) are all coordinated and simultaneous. The train is always trying to keep itself operating "as one," regardless of the number of cars. The "brains" of the train are looking at the axles and working almost constantly to make sure they are revolving at the same rate, whether accelerating or braking. That is just the start of the complexity.
3. Besides the mechanical coupling that occurs, the command signals are conveyed through the couplers. These are complicated vehicles. Eliminating risk happens when we eliminate routine coupling.

8. If the main issue is max power draw, many trains and buses use LFP with supercapacitors. Have we considered that?

Combinations of battery/supercapacitors are not as prevalent in the rail industry for distance off-wire VTA is interested in. Streetcar/LRV systems implemented in North Amercia with this type of system usually only operate 0.5-1.5 miles. For a longer range, (i.e., 10 miles), the overall energy capacity is more important, so a battery-only system often is more feasible for this type of scenario. It is just important to make sure the battery configuration is designed so both the continuous power, and the max power of the battery system can meet the LRV needs for the route.

Note, we can show sizing calculations. As discussed in the response to question 6, an LFP behaves and performs in between an NMC/LTO. It is another possibility for the LRV, but ultimately a rolling stock provider will decide which chemistry is best suited and will get it approved by the VTA. Note, the LFP battery is more mature in the EV market and bus market but is not as prevalent in the rail industry.

9. LFP is far more readily available than LiTO3 AND is probably one quarter the cost.

Can you confirm.

a. LTO batteries are more expensive than LFP. LFP are similar in cost to NMC batteries.
b. LFP are less mature in the rail industry.
c. They fall in between the spectrum from LTO to NMC, conclusions can be drawn about their performance from that.
d. LFP will have similar upfront cost, but more replacements than LTO.
e. Exercise with LFP is able to be done if required.
f. Ultimately, the rolling stock provider will specify the battery chemistry, which will need to be approved by VTA.

10. I see that the number of charge cycles for LTO is more than for LFP, but LFP charge cycles have been increasing dramatically.

From Wikipedia: LFP cycles are growing. Note, LTO is also rapidly growing. There are LTO batteries out in the market that can achieve 20,000+cycles.

11. Will the battery modules be specified to allow for swapping in of other technologies in the future as those mature like Solid State electrolyte Lithium? Can we specify them to be modular?

This may be possible but would need to be agreed upon with the rolling stock provider. Typically, the replacement is a one-for one replacement as the vehicle is designed for a specific battery system. If desired to replace battery type, this may lead to future retrofits and increased replacement cost if the system cannot be designed to be modular.

lithium-titanate battery

Specific energy	60–110 Wh/kg[1]
Energy density	177 Wh/L[1]
Cycle durability	6000–+10 000 cycles[1]
Nominal cell voltage	2.3 V[1]

A Lithium iron phosphate (LiFePO4) AA battery (right) shown next to a battery placeholder (left)

Specific energy	90–160 Wh/kg (320–580 J/g or kJ/kg)[1]
Energy density	325 Wh/L (1200 kJ/L)[1]
Specific power	around 200 W/kg[2]
Energy/ consumer-price	1-4 Wh/US$[3][4]
Time durability	> 10 years
Cycle durability	2,750–12,000[5] cycles
Nominal cell voltage	3.2 V

12. I believe there are 5 US manufacturers of LRVs. Who are they?

These are the manufacturers we talked with for the RFI. All of them are manufacturing in the US).

1. Siemens
2. Alstom
3. Stadler
4. Kinkisharyo
5. CAF

13. Someone mentioned that there are some CPUC regulations preventing us from using the same Kinkisharyo AmeriTRAM LRVs that Hudson-Bergen is already using. I see that NJT is already using longer 5 section LRVS. Can I get specifics on what those CPUC regulations are?

The crashworthiness specification is a test applying an axile load to the body of the vehicle two times the maximum load. The body of the vehicle cannot deform during the test. With the addition of the batteries and the extended length of the vehicle, Kinkisharyo does not think they will meet this requirement.

The European designed vehicles would have to do the same test, but their energy absorption design would deform prior to the limits of the test.

14. Can I get a (Board confidential) copy of the RFP that is going out for the design of the pilot vehicles?

Yes. We will make arrangements.

15. Can we make sure that the RFP includes interchangeable modular battery packs that are technology agnostic—Li-ion, NMC, LFP, LTO, solid state?

The language was added to be able to interchange energy storage units. As well as ensure the control and diagnostic systems could handle the change as well.

16. Can we get a simulation of the battery LRVs on EBRC with minimum catenary and charging at endpoints?

Yes. Modeling will be conducted for EBRC and extend to the whole Orange Line. Some of the goals of the modeling will be to determine the point when vehicle service is affected, where and how many charging stations may be needed on the line. Our activation plan and evaluation plan will be partially based on the modeling results.

Key takeaways/Reference Points or Remarks:

1. People Movers/Pods/Autonomous Systems:

a. VTA needs to do an in-depth study to see how they will fit with VTA and VTA's future goals.
b. The smaller the vehicle the slower the load times will be.
c. Grade separation is the best method to make these systems successful.
d. BART is basically an autonomous system with an operator.

e. These systems usually are seen in very specific applications, like airports.

2. Provide written reports in addition to the presentation slides:

The Project will work on providing a detailed report to accompany the slides from the Board Workshop.

3. Factors for analyzing Future of Light Rail:

a. Financial feasibility of Autonomous System
   i. Need to complete a study or research into Autonomous Systems to better understand the options and feasibility of Autonomous Systems.
b. Long term requirements of a fully autonomous system
   i. Need to complete a study or research into Autonomous Systems to better understand the options and feasibility of Autonomous Systems.
c. Staff onboard to ensure safety and provide passenger service.
   i. Safety and passenger service is paramount to any Transit Agency and would also be paramount to Autonomous System. In addition to the know safety system currently in use at VTA, additional software, hardware, and human safety measures would need to be put in place.
   ii. Copenhagen is upgrading their S-Tog system to fully automated, driverless operation. This system morphed out of the regular railway system serving the Danish capital, with which it still shares some stations, and some tracks.
   iii. There are no grade crossings in the system. Just like most railway systems in Europe, grade crossings were eliminated long ago. This reduces the complexity quite a bit compared to what VTA would be facing. And as Austin mentioned, there are doubts that such a system can reduce staff, it seems to just transfer staff from the cab to system (vehicle and wayside) maintenance, etc.

4. Elements to include in the RFP:

1) ADA accommodations
   a. Vehicles must be built to meet ADA standards.
   b. ADA enhancements will be video monitored to supply information.
   c. Improved audio with real time connectivity.

2) Operational implications
   a. The goal is to have these vehicles seamlessly integrate into the current system.
   b. They will have more eyes on them.

3) Operational flexibility
   a) These vehicles will have more flexibility and be able to travel when the overhead is de-energized or possible other power problems. The vehicle could take the place of two current vehicles.

4) Future Tech Advancement
   a. The tech advancement OCESS as the highlight tech. VTA wants to look at real time communication with the vehicles for operation information (route info, announcements, advertisement, rules, ridership, etc.) and maintenance (vehicle status, faults, etc.) and security (CCTV access).

b. WIFI improvement to handle increased CCTV traffic, maintenance system communication, operation system communication, the desire of the riders to use their phones and mobile devices.
c. Monitors for displaying real time information, advertisements, route info, news, etc.
d. USB charging.
e. More CCTV cameras and onboard CCTV monitor.
f. These vehicles would be a good platform for future tech.

5. There are concerns about testing a technology that may be outdated in the future and the need to future-proof it.

The Demonstration Vehicles are a good platform for continued testing and evaluation of technologies as they advance. Battery technology today may be obsolete in 5 years. With a platform to test the latest battery technology, VTA can formulate a plan prior to changing all the batteries in the fleet. This becomes more advantageous with complex technologies like autonomous vehicle technology.

6. How the Research Project can consider future advancement in battery and autonomy technologies.

a. The builder will determine the best battery system based on the performance specification.
b. Evaluation and research will provide a foundation to build from and make future choices.
c. Need to do a study and research for Autonomy technologies. These vehicles may be a great platform to test and research Autonomy Technologies.

7. Balance investment costs with future tech that may be obsolete.

Without researching OESS with the demonstration vehicles, VTA would be doing what most agency's do, buy 20+ vehicles and hope they work as expected, when they fall short, they adjust their operations or two vehicles in the last few blocks. With a physical vehicle and runs VTA will know what they will get and how to operate it. Plus, if needed VTA can adjust any future specs.

8. Car modules based on capacity needs and ridership projections.

a. VTA does have need for two cars consist, which a longer vehicle could replace.
b. Longer vehicles will reduce the need for a longer consist with less maintenance and future rail costs.

9. Modular designs and its impacts to operational flexibility; and

The design of LRVs is modular. Because of their modular design, LRV systems can be exchanged easily. The ease of changing out modules increases flexibility as the vehicles age.

10. How the new LRV can support a much more frequent service (e.g. shorter headways).

Frequent and reliable service will depend on maintenance, track speed, and number of trains on the system. The OESS LRVs will overcome the issue with the overhead and will be able to continue through areas with power loss.

11. Explore funding options to encourage cities to participate in grade separation projects and light prioritization initiatives.

a. VTA is exploring more funding options. Currently looking at funding options from the state.
b. There is interest from government leadership to invest in this technology and make it successful.

12. Consider the development of a separate government relations report to address city cooperation on light rail speed improvements.

a. VTA does work with other agencies and belongs to several transportation groups.
b. There have been efforts to address parts issues and supply line issues.
c. VTA has started to engage with St. Louis directly to develop a relationship around OESS operations.
d. We are open to working with other agencies on projects.

Prepared by: Michael Bates

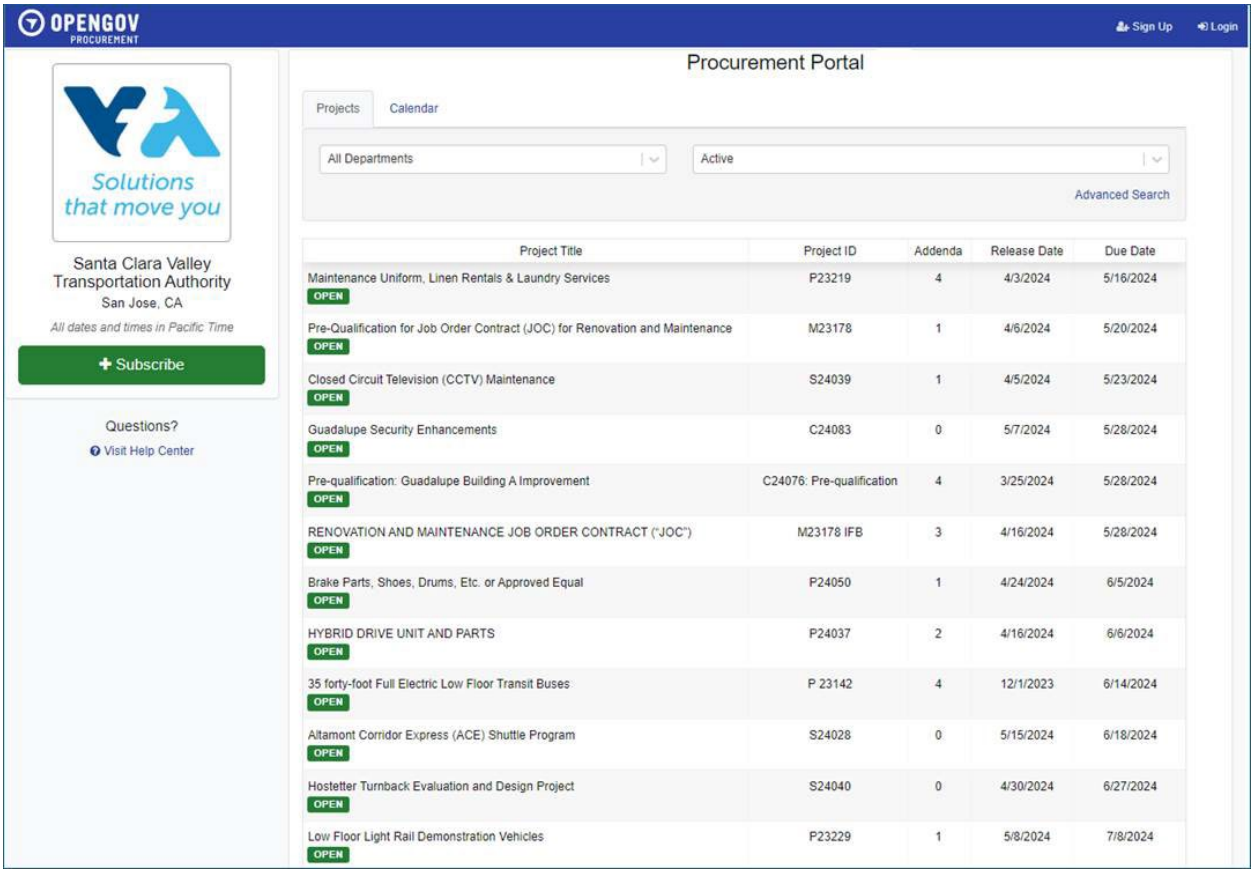
From: Baltao, Elaine
Sent: Wednesday, May 15, 2024 10:29 AM
To: VTA Board of Directors
Subject: From VTA: Response to referral re: open procurements

VTA Board of Directors,

Per the Board's request, staff will be sharing VTA's open procurements on a monthly basis.

VTA uses Opengov for its procurement portal. Here is the link to VTA's Procurement Portal: https://procurement.opengov.com/portal/vta. The document with step-by-step instructions on how to access and navigate the open procurements is attached. Also included in the attached document are the instructions on how to subscribe to follow projects and receive notifications. Please reply to this email if you need assistance in accessing the procurement portal.

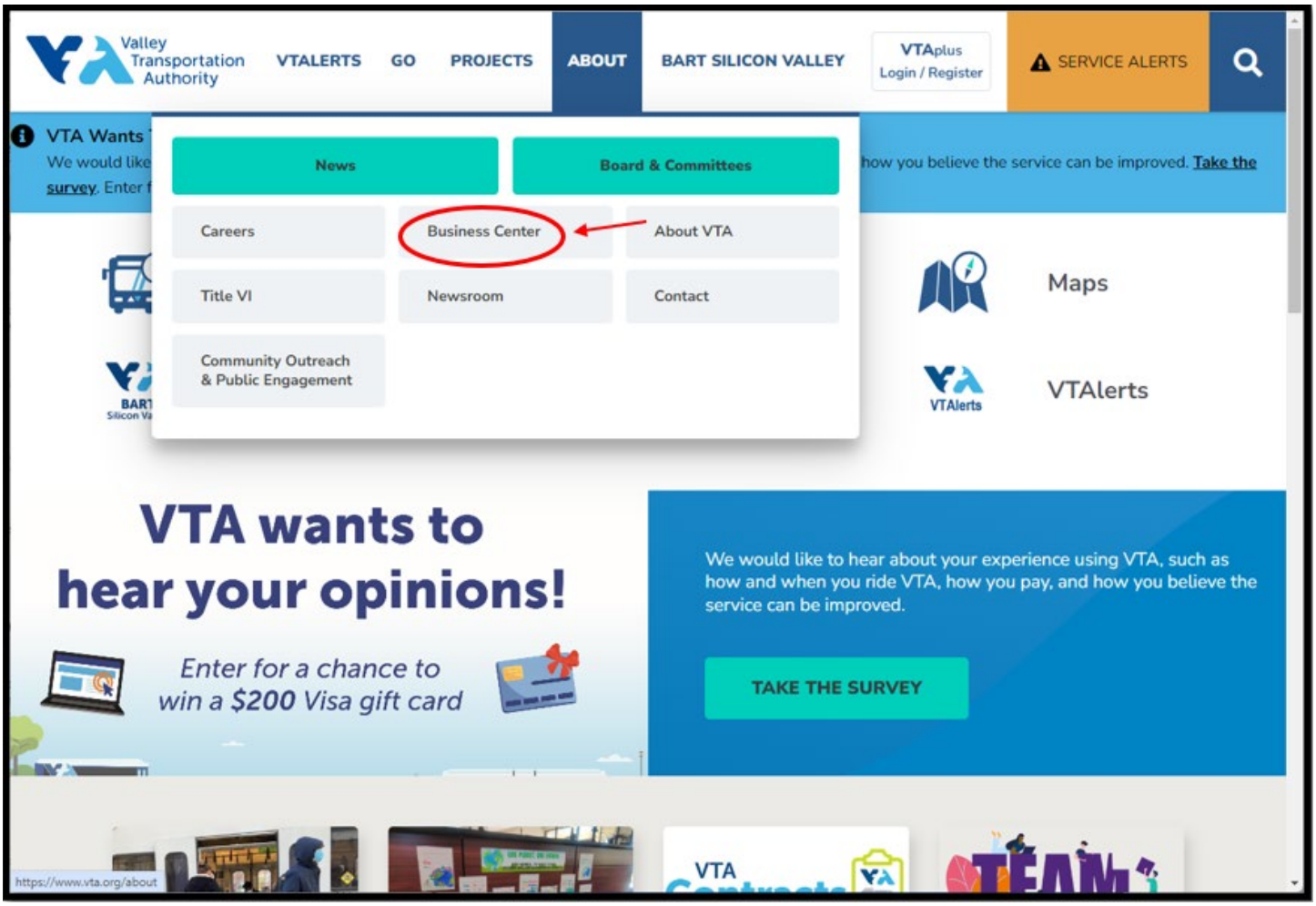
For your convenience, a screenshot of all open procurements as of today, May 15, 2024, is below. Thank you.



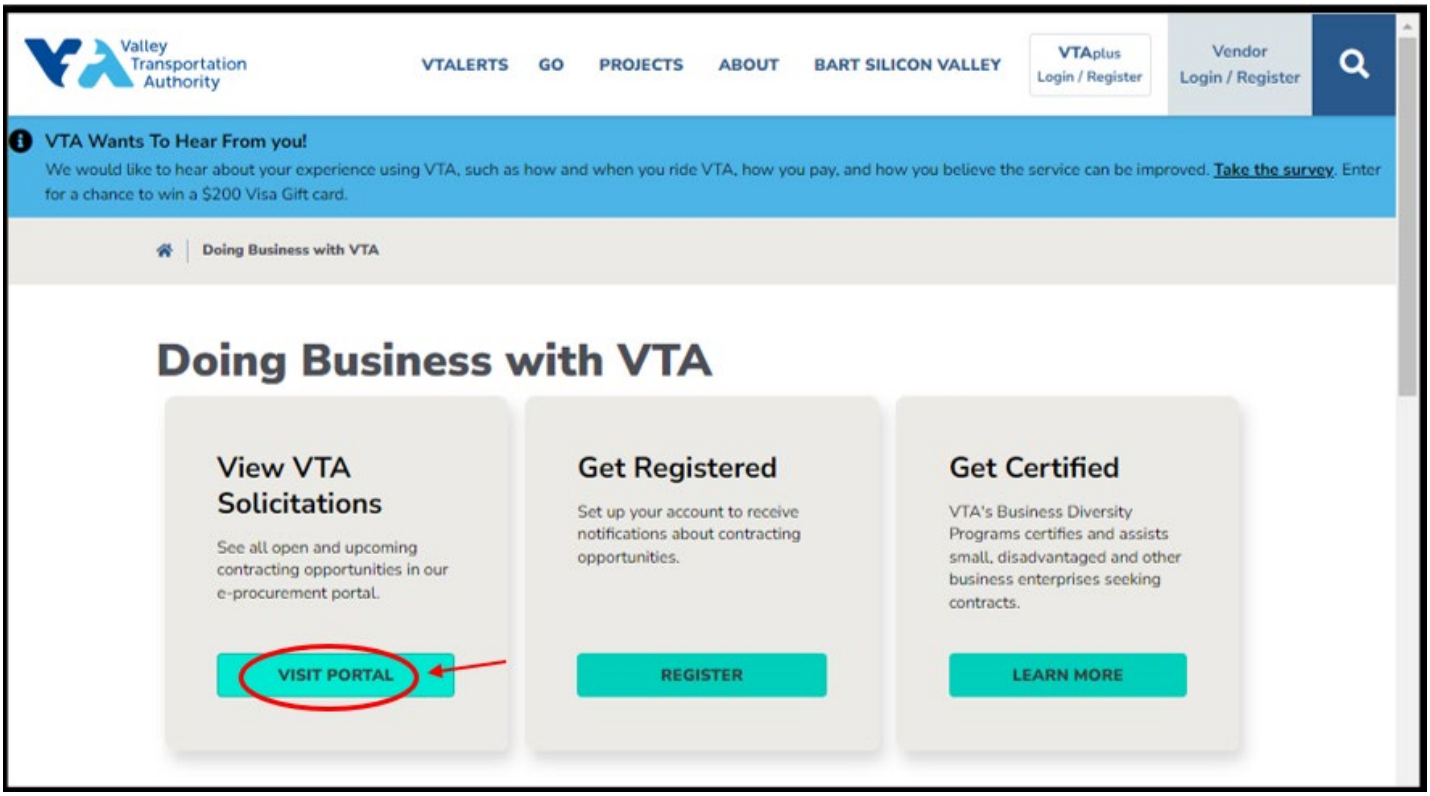
How to access the **VTA OpenGov Procurement Portal**

1. Visit **VTA.org**

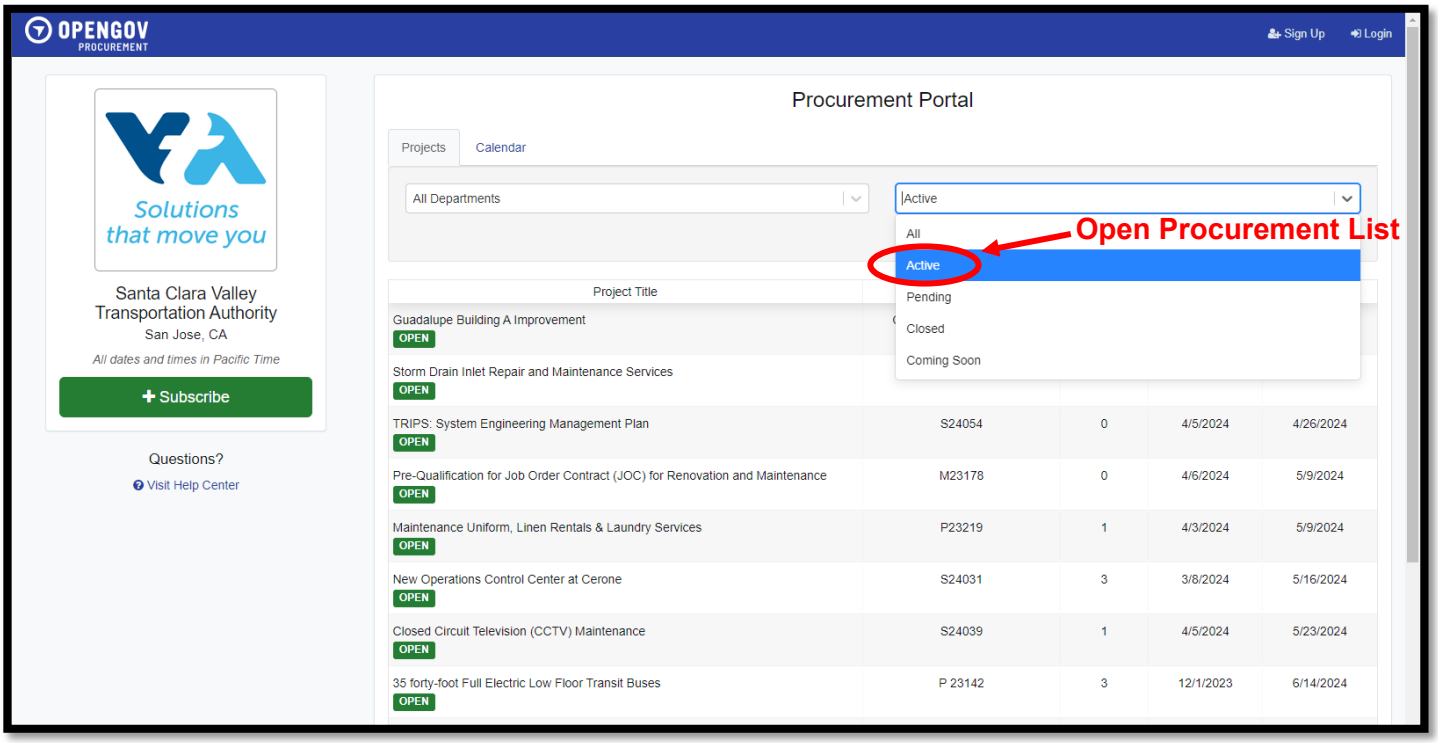
2. Under "**ABOUT**", click "Business Center"



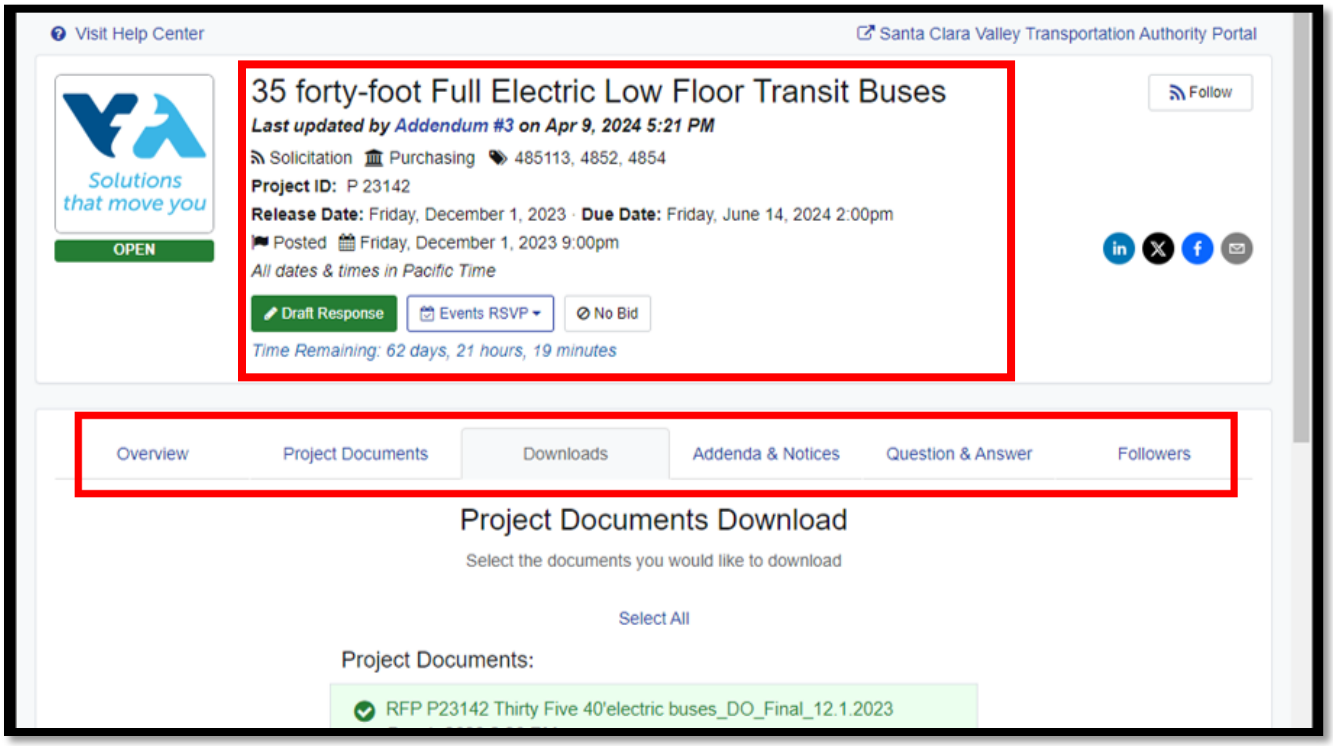
3. Click “VISIT PORTAL” in View VTA Solicitations



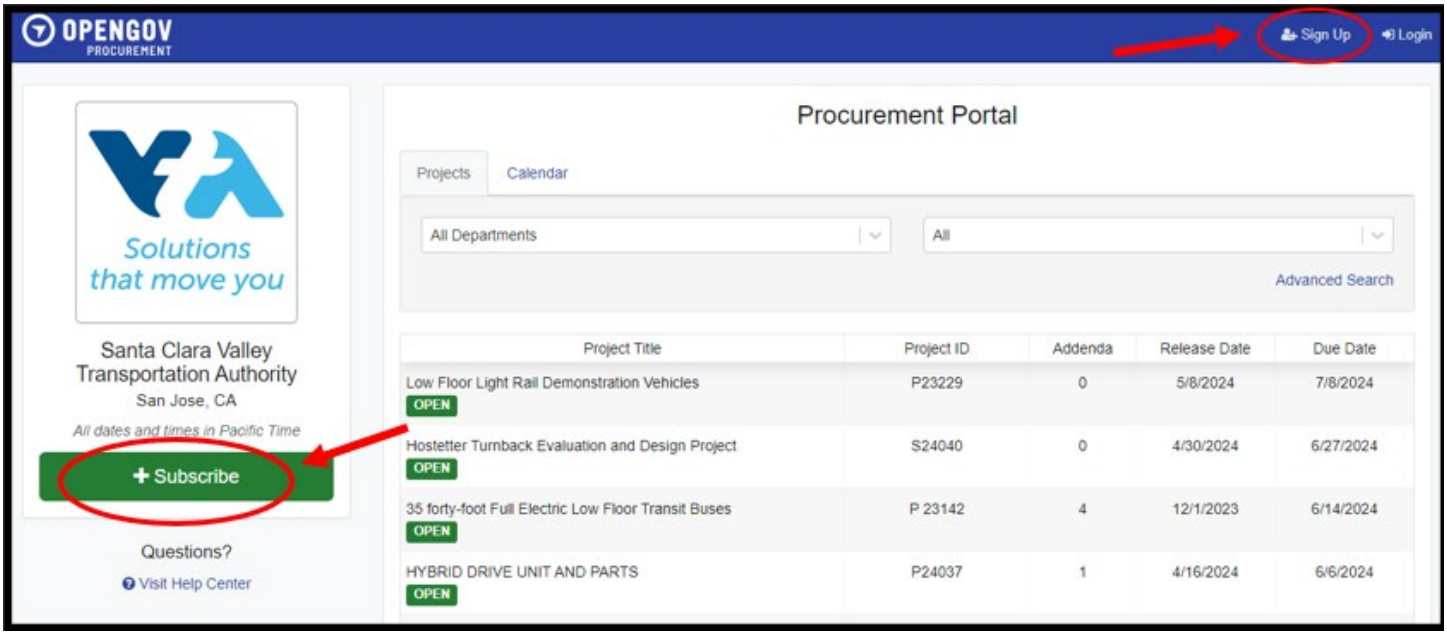
4. View projects by department and/or status. To view **VTA’s Open Procurements List**, select “All Departments” and “Active”



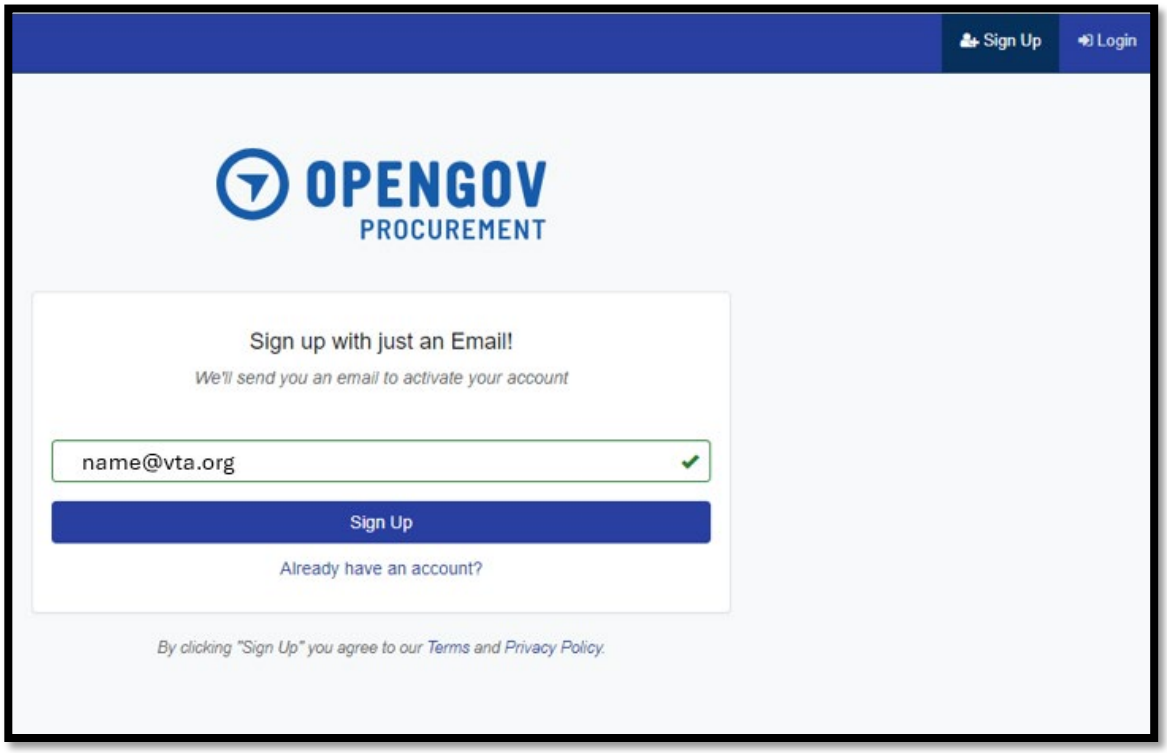
5. Click into any project to view the solicitation timeline and details. Click on the corresponding tab to view the Overview, Project Documents, Downloads *(must create an account to access downloads)*, Addenda & Notices, Q&A and Followers.



6. Create an account to **Subscribe** to VTA. ***Continue to view instructions on how to create an account.***



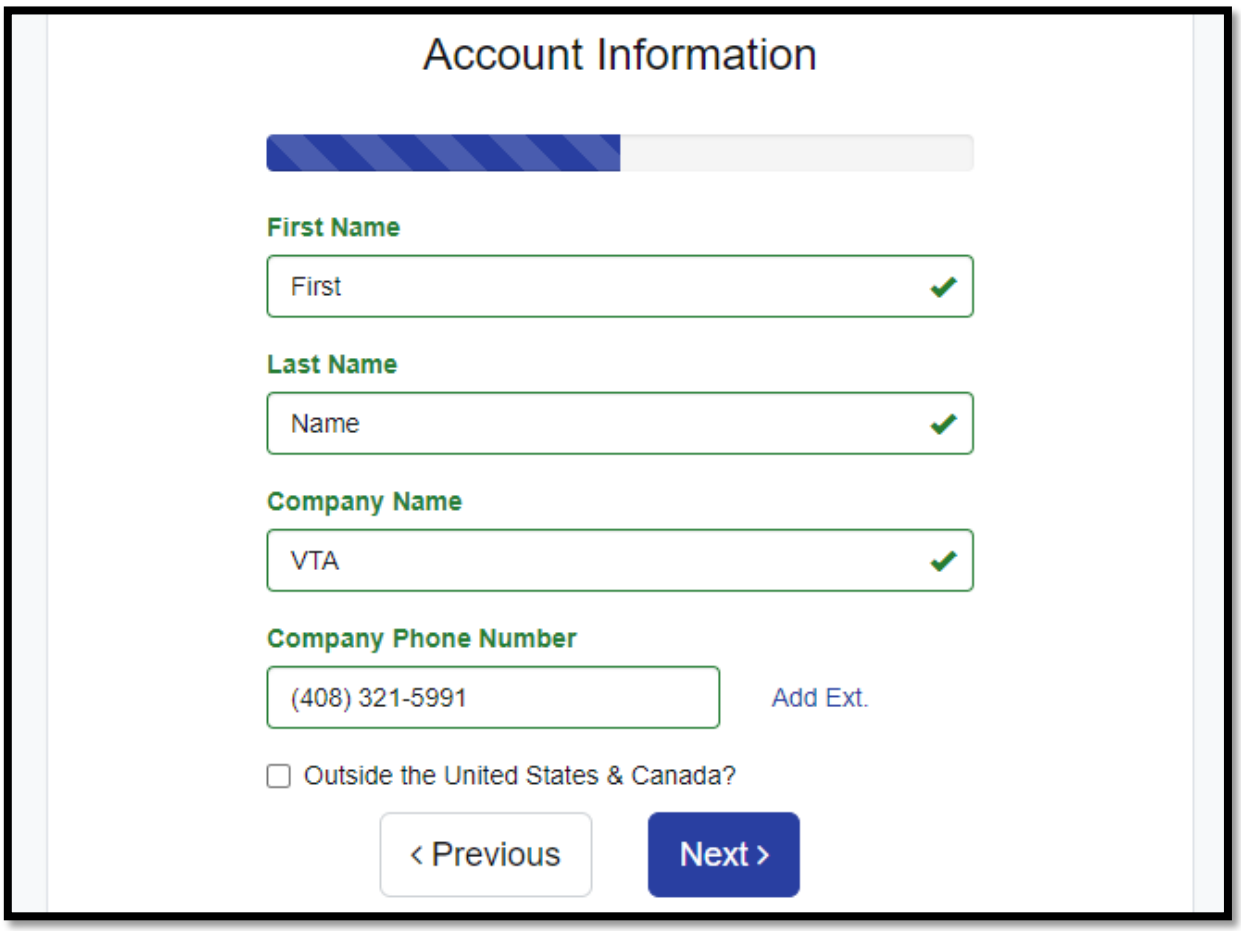
7. Enter your email and click **Sign Up**



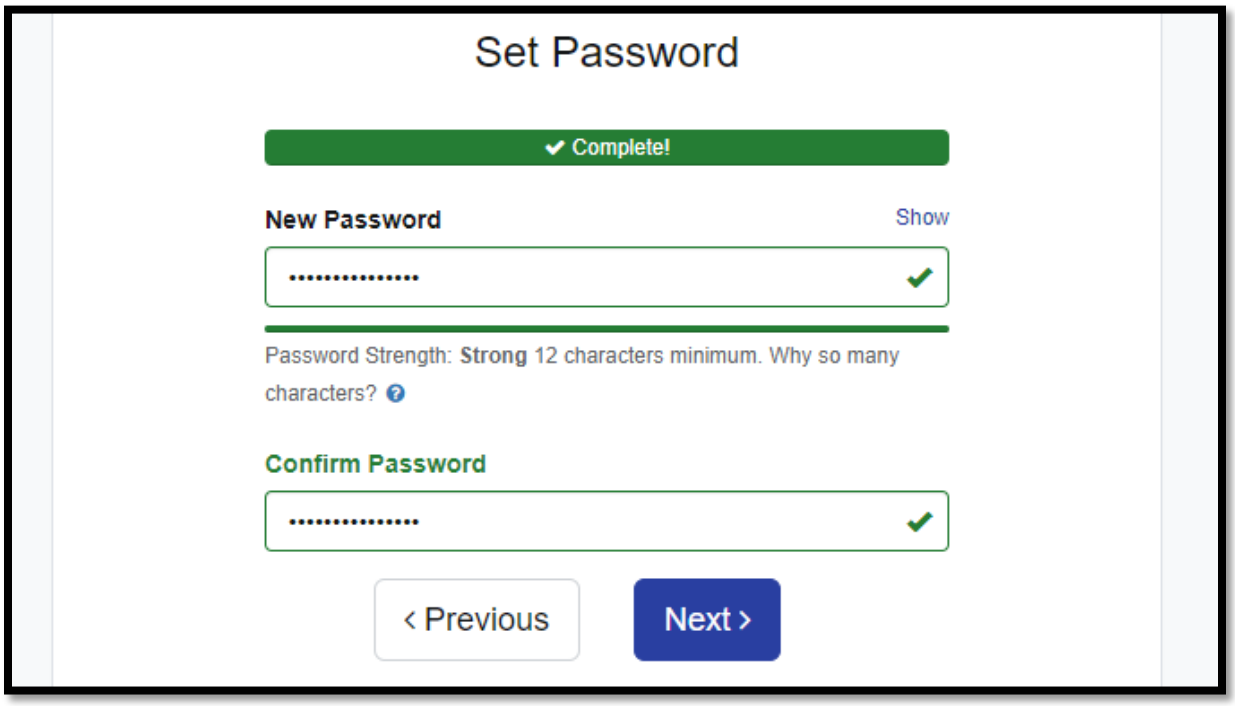
8. OpenGov will send an activation message to your ***email***. Find the message in your email, open it, and click **Activate Account** to be redirected back to the OpenGov website.

9. Click **Start** to begin setting up your account.

10. Enter your Account Information and click **Next**

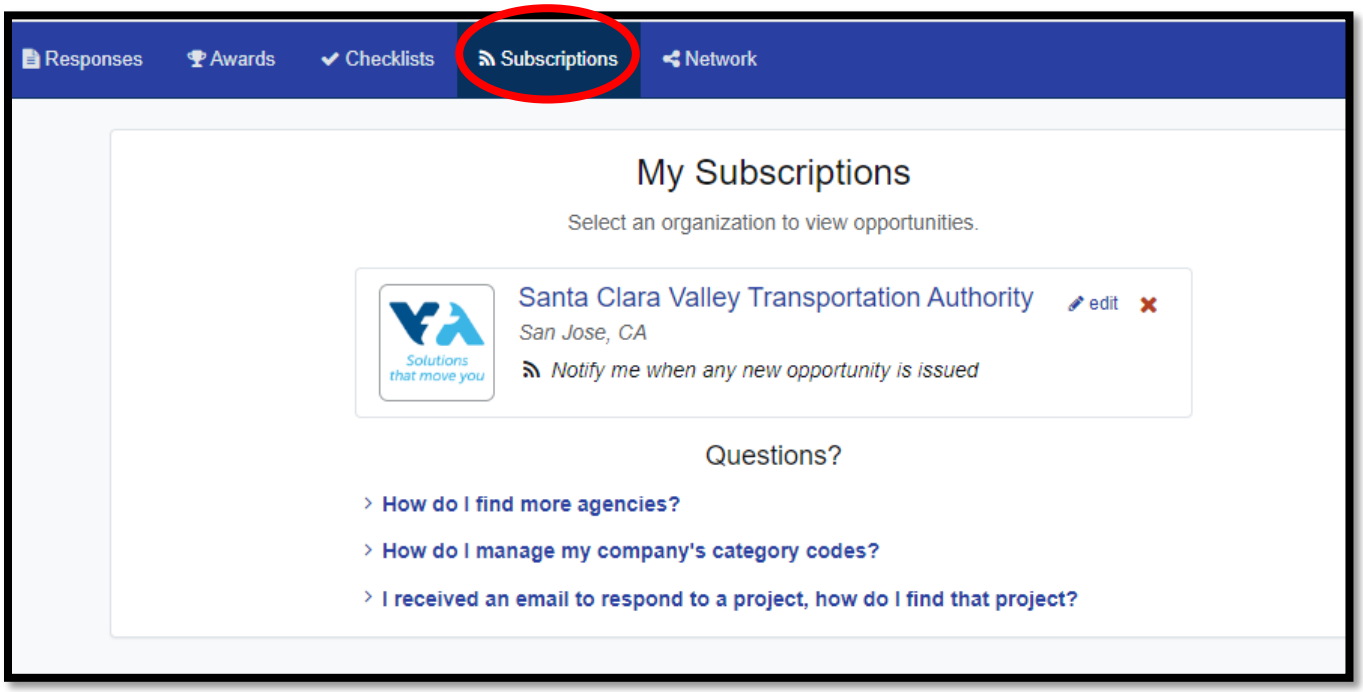


11. Set a password and click **Next**



12. Click **Activate**

13. With an account, you can “Subscribe” to VTA, follow projects, receive notifications, and download documents.



From: VTA Board Secretary
Sent: Friday, May 17, 2024 5:21 PM
To: VTA Board of Directors
Cc: VTA Board Secretary
Subject: VTA Correspondence: Week Ending 5/17/24

VTA Board of Directors:

We are forwarding to you the following correspondence:

From	Topic
David Dearborn, Member of the Public	Article pertaining to the BART Project

Thank you.

Office of the Board Secretary
Santa Clara Valley Transportation Authority
3331 North First Street, Building B
San Jose, CA 95134-1927
Phone **408-321-5680**

Santa Clara Valley Transportation Authority
Solutions that move you

From: David D
Sent: Saturday, May 11, 2024 12:59 PM
To: VTA Board Secretary <Board.Secretary@vta.org>
Subject: [EXTERNAL] re: Measure B and Phase II

Madam Secretary,

Please deliver this Dec. 11, 2008 article to the Chair, Vice Chair and members of the BSVII Oversight Committee; all VTA Board Directors and Alternates; and the Auditor General.

Thank you,

David Dearborn

The VTA priority: BART — and everything else will have to wait

By Gary Richards
Bay Area News Group

Posted: 12/11/2008 11:49:16 PM PST

Meeting for the first time since Santa Clara County voters gave a thumbs up to bringing BART to the South Bay, the Valley Transportation Authority on Thursday began mapping out future spending plans. The priority: BART, BART and BART.

That means, with sales tax revenues shriveling in the wounded economy, everything else — from express bus routes to electrifying Caltrain to extending light rail — likely will have to wait.

"Given that voters have endorsed BART not once, but twice," VTA General Manager Michael Burns said, "from the staff's perspective the priority is clear and that priority is BART."

The agency held a 2 1/2 hour workshop and, while no formal action was taken, it set the stage for critical decisions that will be made early next year. While the VTA hopes to land money for downtown BART stations in a federal stimulus package, it isn't clear there will be more federal help for other projects.

Bottom line: There's not enough cash to build the $6.1 billion BART extension along with the more than a dozen projects approved by voters eight years ago. That half-cent sales tax may produce $2 billion less than originally forecast, and there's more worrisome financial news.

VTA sales tax revenues fell $6 million from July through September. The one-eighth of a cent tax approved in Measure B last month can only be used to pay for BART operations, not building new train lines or expanding bus routes.

And, the VTA is spending $60 million of $150 million it takes in annually from the 2000 tax to cover operating costs and bond debt of the current transit system, leaving even fewer dollars to pay for BART and other projects.

Choices will have to be made and from Burns' view, there's only one choice.

"It's clear we can't see the BART project getting ($750 million in federal) money if we're spending our local money on other projects,'" Burns said in an interview earlier this week. "That just doesn't add up."

That means everything else could be in question unless other sources of money are found.

•Electrification of Caltrain: On hold until the impact of running high-speed rail along the Caltrain corridor is known.

•Light rail expansion to Eastridge and Vasona: May depend on federal stimulus.