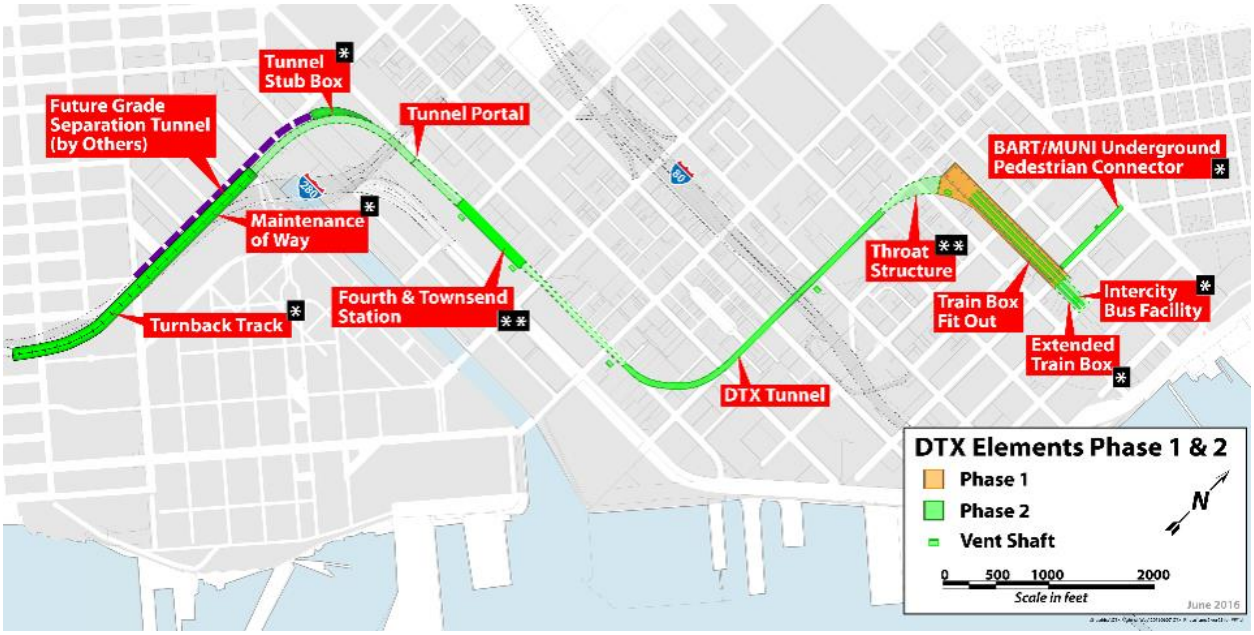
Peer Review Panel

Report on Findings

Review of Three Operations Studies for the Design of the Caltrain Downtown Extension (DTX)

for: San Francisco County Transportation Authority (SFCTA)



PEER REVIEW PANEL:

John Flint

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April 02, 2018

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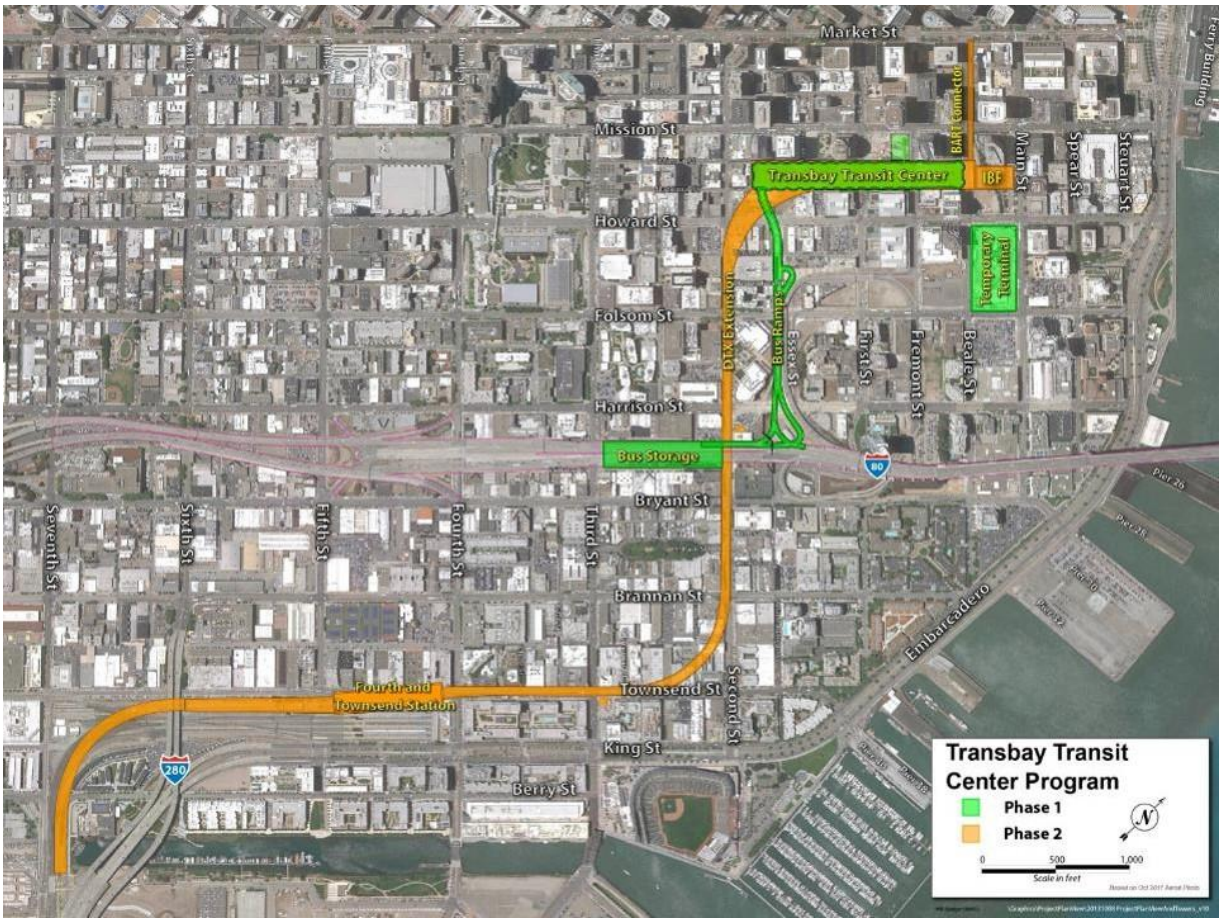
INTRODUCTION

Over the past several years there have been multiple independent studies and operating simulation models developed for the section of future tracks known as the Caltrain Downtown Extension (DTX). The DTX connects the Transbay Transit Center (TTC) [recently re-named the Salesforce Transit Center (STC)], being built in downtown San Francisco, to the existing Caltrain 4th and King station and beyond. The DTX is described by some as the "final leg" in bringing passenger rail to Downtown San Francisco. The DTX will carry the California High Speed Rail Authority (CHSRA) trains into their designated (by legislation) terminus in San Francisco at the STC. Sharing the tracks, Caltrain will extend its service from its current terminal station at 4th and King Streets into the STC, providing a downtown destination for its growing ridership.



The Transbay Program is nearing completion of Phase I Construction, primarily focused on the STC. The STC includes a grand hall and local bus service on the ground level, commercial

development space throughout the building, an intercity bus transit center on the next level, topped by a five-acre park with amenities including a restaurant and venue space at the roof level of the transit terminal. The STC also includes two levels below grade that are intended to provide rail passenger access, circulation and amenities on the lower concourse level, and the train platforms on the lowest level. STC construction created the "train box" which, in Phase 2, will be fitted with six terminal tracks and three center island platforms to serve the Blended Operations of CHSRA and Caltrain.

As operating plans become clear through their concept models, and as Caltrain and CHSRA consider the challenges of operating in the same corridor with both terminating at the STC, the question of two-track versus three-track alignment for the DTX appeared to be contested between various expert studies. In the fall of 2017, the San Francisco County Transportation Authority (SFCTA) was directed by its Board to engage an independent peer review panel to review three distinct Studies/Models that were circulating, related to how the DTX should be ultimately built. The peer review panel was asked to review these studies, consider the underlying assumptions and modeling parameters, and to opine on the conclusions drawn in each study/model.

This report summarizes the peer review effort. It begins with the Executive Summary, which is designed to be a pull-out summary of the charge, process and conclusions; followed by sections that describe in detail the people and the process involved. It includes summaries of the stakeholder presentations to the peer review panel, and the highlights of each study/model and their respective presentations, including their underlying assumptions. A brief analysis section follows. The peer review panel's major findings, additional findings and observations, and recommended immediate actions or next steps complete the report.

EXECUTIVE SUMMARY

A Peer Review panel was assembled by the San Francisco County Transportation Authority (SFCTA) to conduct a peer review of three operational studies related to the extension of Caltrain and the California High Speed Rail Authority (CHSRA) program to the Salesforce Transit Center (STC).

The operations studies included:

1. "Transbay Transit Center – San Francisco DTX – Value Engineering Study", prepared by SENER, September 2017
2. "Train Operations Analysis of Two Versus Three Mainline Tracks for the San Francisco Downtown Rail Extension", prepared by Parsons and Carl Wood, October 31, 2017
3. Railyard Alternatives and I-280 Boulevard Feasibility Study (RAB) Conceptual Planning Analysis developed on behalf of the San Francisco Planning Department by CH2M and SMA+, June 19, 2017

SFCTA selected a peer review panel consisting of the following professionals:

John Flint – Senior Vice President, Managing Director of Lines of Business for T Y Lin International

Les Elliott – President, The Elliott Group

David Nelson – Director of Transit for Jacobs

Eugene Skoropowski – Staff Consultant, T Y Lin International, former Senior VP for Rail Operations, All Aboard Florida

Individual CVs for the panel members are included in Appendix 1.

The peer review panel began its assignment by reviewing all three studies, followed by a day-long workshop with the Transbay Joint Powers authority, (TJPA), Caltrain and The California High Speed Rail Authority (CHSRA). This workshop was held for the peer review panel to get familiar with the current state of the STC and DTX projects, to understand the operating plans, physical features and potential risks associated with each of the operators, and to understand the level of collaboration taking place in completing plans for a blended service at the STC.

It was followed by a second day-long session, which consisted of presentations by the stakeholders and their consultants who prepared the three studies. Caltrain and CHSRA representatives were also present. The analyses by the three different teams were reviewed and discussed. Each team started with similar, but not identical, assumptions and methods. All used sketch-planning tools, and all limited their inquiry to the north end of the San Francisco–

San Jose corridor over which Caltrain and the CHSRA plan to offer blended services. One study was conducted with only publicly available information, and without the benefit of preliminary plans for the STC. The other two studies were conducted with full knowledge of the project's history and its current status. Only the TJPA study was developed with the full participation of, and input from, Caltrain and CHSRA.

All the studies concluded that, if all of the trains planned for berthing at the STC operated reliably (defined as within two minutes of scheduled arrival/departure), two tracks in the DTX tunnel would be sufficient to operate the train movements. However, the assumption of no operating delays is not a realistic assumption. Only one of the studies, completed by Parsons and Carl Wood for TJPA, performed a detailed service perturbation analysis. It shows that if there is a delay or track blockage in the tracks leading to the "throat" of the terminal, then three tracks are required to support reliable train service and to facilitate recovery from operational delays.

In addition, terminal operations plans, yet to be completed, need to provide for track, interlocking and signal maintenance, requiring periodic track outages, even during scheduled operating hours.

Based on the analysis and collaboration of the peer review panel, the following findings and observations are offered:

MAJOR FINDINGS

1. Three tunnel tracks are required to provide reliable and dependable service into the Salesforce Transit Center (STC).
2. The Salesforce Transit Center capacity plan of four high-speed trains and six Caltrain trains per peak hour cannot be assured unless both services can use all platforms.
3. The structural column configuration in the built STC limits the flexibility for changing the track geometry within the train box and at the throat leading into the Terminal, but options that entail adjustments to track design criteria at the throat to minimize right-of -way impacts should be explored with CHSRA, TJPA, Caltrain and SENER.

ADDITIONAL FINDINGS AND OBSERVATIONS

1. The STC will be operating at, or near, capacity when the Service Program of turning six Caltrain and four CHSRA trains per hour is fully implemented.

2. The new underground station at 4th/Townsend is likely to have strategic and tactical significance for rail operations.
3. The overall utility of the new station at 4th/Townsend might be improved with platform faces on all three tracks and reconfiguration of the switch plant providing access to all station tracks from the north and south.
4. There is significant residual operational value at Caltrain's terminal and yard at Fourth and King for staging, servicing and storing Caltrain and CAHSR trains. The RAB Study is exploring options for the use of this yard.
5. A consistent base DTX track configuration should be used at the outset of for all future modeling and simulation studies prepared by all parties.
6. All the simulation results considered by the peer review panel assumed a high-performance train control system that safely provided very short times between train movements through the DTX. The interlocking and train control software and hardware must be designed and implemented to minimize the times between when one route through the interlocking is cleared and when a conflicting route through the interlocking can be ready for the next occupancy.

Preliminary findings were presented to the stakeholders in writing, and a workshop was held on February 22, 2018 where all stakeholders were invited to offer comments on the preliminary findings of the peer review panel. These comments have been considered in preparing the final report and, where applicable, adjustments have been made. The final effort of the peer review panel and the stakeholders at the workshop was to agree on the following action items as the project moves toward completion.

RECOMMENDED IMMEDIATE ACTIONS (NEXT STEPS)

1. The operators need to finalize a workable "Blended Service Plan" for the harmonious joint operation of the shared line and terminal including: train schedules, required enhancements to the infrastructure south of the study area, and plans for vehicle servicing and storage. The plan should be reviewed, tested and verified with a proven and widely accepted railway simulation tool.
2. The two operators and TJPA need to identify and select a mutually acceptable and workable set of rolling stock and platform adaptations that will allow both services to berth at all platforms.

3. Properly evaluating the potential right of way impacts of constructing the DTX project is a critically important task in this phase of project development. Based on suggestions from SENER Engineering, the two operators and TJPA need to carefully review possible tradeoffs between track and switch design standards and practical limits for low-speed terminal operations, including the associated potential right-of-way impacts of constructing the DTX tunnel. The goal should be to provide a transit project that maximizes public benefit, while minimizing environmental and community impacts.
4. The two operators and TJPA need to revisit the operational program and design for 4th and Townsend station to improve the utility and flexibility of the station and associated switch plant.
5. Once the Blended Service plan is prepared and improved, the operators and TJPA need to identify an operating plan and design footprint for a storage and servicing facility on the existing 4th and King Caltrain parcel to identify which portions of the parcel can be released for non-railroad use.
6. The peer review panel observed that simulations reviewed were lacking in coordinated assumptions, likely due to a lack of collaboration between the parties. Operators, TJPA, City Planning and other interested parties should build on the open communications facilitated by the SFCTA during the review effort, and regularly meet with SFCTA to report and discuss progress on the Immediate Action Items above and to sustain momentum and cooperation toward the construction and operation of the proposed facilities.

SUMMARY OF STAKEHOLDER PRESENTATIONS

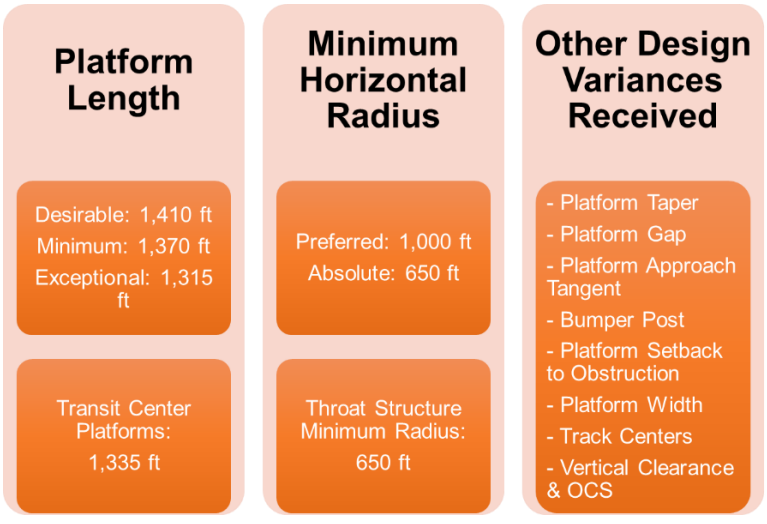
TJPA PRESENTATION

Joe Metzler, Meghan Murphy, Derik Penrice, Skip Sowko, Becky Wong

TJPA administers and manages the Transbay Project. Phase 2 of the Transbay project (DTX) improves commuter rail service by providing direct access to downtown San Francisco, enhances connectivity between Caltrain and other major transit systems, and brings future high-speed intercity passenger rail service to downtown San Francisco, resulting in environmental benefits. TJPA notes that numerous alignment studies have been prepared as the project evolved, and numerous alignment constraints, including those imposed by the CHSRA for high-speed trains, have led them to the current alignments.

TJPA provided a chronology of the project's development, leading to its current state. In 2008, The TJPA refined the DTX configuration starting from a two- track existing lead transitioning to the DTX tunnel portal, going to three tracks prior to the new 4th and Townsend underground station, and remaining three tracks to the STC. The STC is designed with six tracks and three center-island platforms, with six platform faces. TJPA noted that the 4th & Townsend Street Station remains a major design variable, dependent on the operating models adopted by the CHSRA and Caltrain.

CHSRA Design Guidance



By 2011, CHSRA had developed its design criteria, and negotiations with TJPA and Caltrain resulted in a series of design variances approved by CHSRA for the DTX. By September of 2013, TJPA had achieved sign-off from FRA, CHSRA and Caltrain on the train box geometry in the STC.

In December 2015, a Draft SEIS/EIR was published for the project for the purpose of clearing changes to the project resulting from the new geometry. In July 2016, Preliminary Engineering commenced and in 2017 a design variance was granted by Caltrain for grades.

Two types of underground construction are currently being evaluated for various portions of the project. Mined tunnel methods will be used over much of its length, and cut-and-cover methods will be used where tunneling is technically unfeasible or cost prohibitive. This is the subject of a separate Tunnel Options Study being conducted by TJPA, with the participation of the SFCTA, which is anticipated to complete in April 2018.

TJPA commissioned one of the Operations Studies being evaluated by the peer review panel. This study is discussed later in this document.

CALTRAIN PRESENTATION

John Funghi, Liz Scanlon, Matt Verhoff,

Caltrain is a commuter rail line on the San Francisco Peninsula and in the Santa Clara Valley. The northern terminus of the line is in San Francisco at a railyard at 4th and King streets; its southern terminus is in Gilroy. Caltrain is among the busiest commuter rail agencies in the US (Ref: American Public Transportation Association [APTA] "Ridership Report Statistics for the Fourth Quarter of 2016"), with a rapid growth history over the past two decades. Its history dates to 1860 when Southern Pacific operated a passenger service on the peninsula corridor between San Francisco and San Jose. After years of operation by the State, in the late 1980's

the Peninsula Joint Powers Board (JPB), composed of the City and County of San Francisco, San Mateo Transit District (SamTrans), and Santa Clara Valley Transit Authority (VTA), was created to take over the operations. SamTrans was designated as the managing agency. In 1992, the JPB acquired the right of way and assumed local control of the Caltrain service.

In 2004, Caltrain launched a "Baby Bullet" service, providing express service from San Jose to San Francisco. Caltrain currently operates three levels of service with 92 weekday trains. The service levels include express (the Baby Bullets), limited (including six Gilroy trains), and local. Local trains stop at 24 stations, while the express bullets stop at six or seven stations. Travel times are just short of one hour for express service and approaching two hours for local.

The Caltrain system is a 51-mile double-track system with some four-track segments dispersed along a rail corridor primarily owned by the JPB. There are many grade crossings and bridges, and a wide variety of traffic volumes at the grade crossings.

The fleet consists of 134 passenger cars (Gallery and Bombardier sets) and 29 diesel locomotives. The Central Equipment & Maintenance Facility (CEMOF) was opened in 2007 at a site just north of the Diridon station in San Jose. It includes service and inspection, maintenance, train wash, storage, fueling, and dispatching facilities.

Transit America Services, Inc. (TASI) operates and maintains the facility, under contract through 2022. Since 2008, JPB has delivered over $1.25 Billion in completed or in-process station and systems projects and State of Good Repair (SOGR) work.

Caltrain is embarking on a modernization program, which includes electrifying the alignment (from San Francisco to Tamien Station in San Jose), switching to Electrified Multiple Units (EMU) railcars, and installing a Positive Train Control (PTC) system. The electrification project is in the construction stages for the infrastructure designed for initial speeds of up to 79 mph with the new cars, although the cars are designed for speeds up to 110 mph which will be possible following future track modifications. Caltrain plans to increase service from five to six trains per

peak hour per direction between San Francisco and San Jose. Passenger service with electric trains is currently scheduled to begin in 2022.

Caltrain is engaged, along with CHSRA, in the planning and design efforts related to blended service along the alignment and at the STC. Caltrain also recognizes that a longer-term planning horizon is necessary to be consistent with the State Rail Plan. The Caltrain business plan, currently under development, is an essential part of current planning efforts toward 2040 and beyond.

The Caltrain equipment, and its entire current systems operate with low-level eight-inch platforms and boarding. The new EMU fleet is being manufactured with two sets of doors, at 25 in. and 51 in., that will allow the train to berth at different-height platforms. Caltrain recognizes that the platform heights of the bi-level cars create several challenges moving forward, and is diligently pursuing alternatives for managing the issue. Additional challenges remain with ADA compliance and Bicycle-friendly policies. Caltrain also recognizes that it is not likely to be able to manage six trains per direction per hour in the STC using only two platform faces. Caltrain is not opposed to use of additional platform faces, but has not yet finalized its plans for how different platform heights will be managed.

CALIFORNIA HIGH SPEED RAIL AUTHORITY (CHSRA) PRESENTATION

Bruce Armistead, Paul Hebditch, Melvin Thomas, Will Gimpel

The CHSRA anticipates a two-phased approach to its terminal operations in San Francisco. Before the DTX has been completed, an initial service of two trains per hour will be provided between the Central Valley and Silicon Valley. When service expands to San Francisco, four trains per hour per direction are planned. The trains will use a temporary terminal at the 4th and King Caltrain Station before the completion of the DTX, at which time service will continue to its terminus at the STC.

CHSRA has entered into a franchise agreement for an initial Train Operator with Deutsche Bahn, AG, while Caltrain will continue to own the route infrastructure. TJPA owns the STC and will be responsible for ongoing maintenance of the facility.

Regarding performance requirements, 95% on-time performance, defined by CHSRA as plus or minus five minutes from timetable schedule, is the minimum requirement. Actual performance metrics will be established as part of the franchise agreement with the selected initial operator.

Key criteria for CHSRA include the legislated requirements from Proposition 1A for operating headways of five minutes or less. However, CHSRA and Caltrain joint modeling currently demonstrates a need for operating headways of three minutes or less. Dwell times are being modeled for two minutes at intermediate stations and 20-minute turn times at terminal stations.

Services performed at the terminal station may include boarding and alighting, restocking of food and beverage items, bathroom supplies and cleaning, safety checks, and minor on-the-fly repairs.

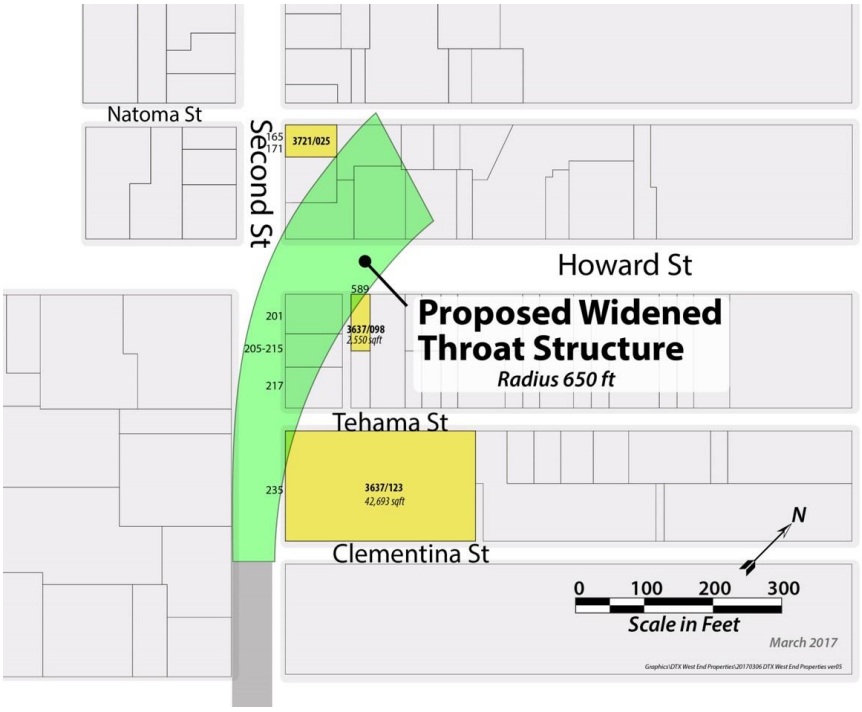
Based on the modeling that CHSRA has performed, and the modeling that is being reviewed by the peer review panel, CHSRA staff is of the opinion that a two-track DTX alignment will force them to terminate HSR services at locations other than the STC during any perturbed state of the operation. CHSRA also notes that delays will cascade throughout the system, causing reliability and operational risks in the Central Valley and in Southern California. Its analyses conclude that an incident on a two-track throat at the DTX would cause a service reduction at the STC of 70%.

SUMMARY OF STUDY/MODEL PRESENTATIONS

BIRMINGHAM PROPERTIES AND SENER PRESENTATION

Rob Birmingham, Alvaro Relano, Francisco Fernandez, John Barna

Mr. Birmingham is a property owner in the vicinity of the DTX throat structure. When he learned that his properties were potentially impacted by the proposed DTX alignment and construction methods, he voiced his concerns, suggested alternatives, and tried to learn more about how the DTX plans might impact his properties and the busy 2nd Street and Howard Street intersection during construction. Having witnessed other construction activities in the City that he felt had had a detrimental effect on the neighborhoods around the construction, and feeling that he wasn't getting the answers he needed, Mr. Birmingham retained SENER to perform an analysis of the DTX layout, to inform him whether or not a two-track DTX throat would avoid impacting his properties, especially 235 2nd Street, and whether alternative tunnel construction methods could be utilized to minimize impacts at the 2nd and Howard intersection.



The SENER study is a valid piece of work given the underlying information and available data they had to work with. The publicly available documents allowed SENER to assess potential changes to the alignment, numbers of tracks and construction methods. It assumed that the

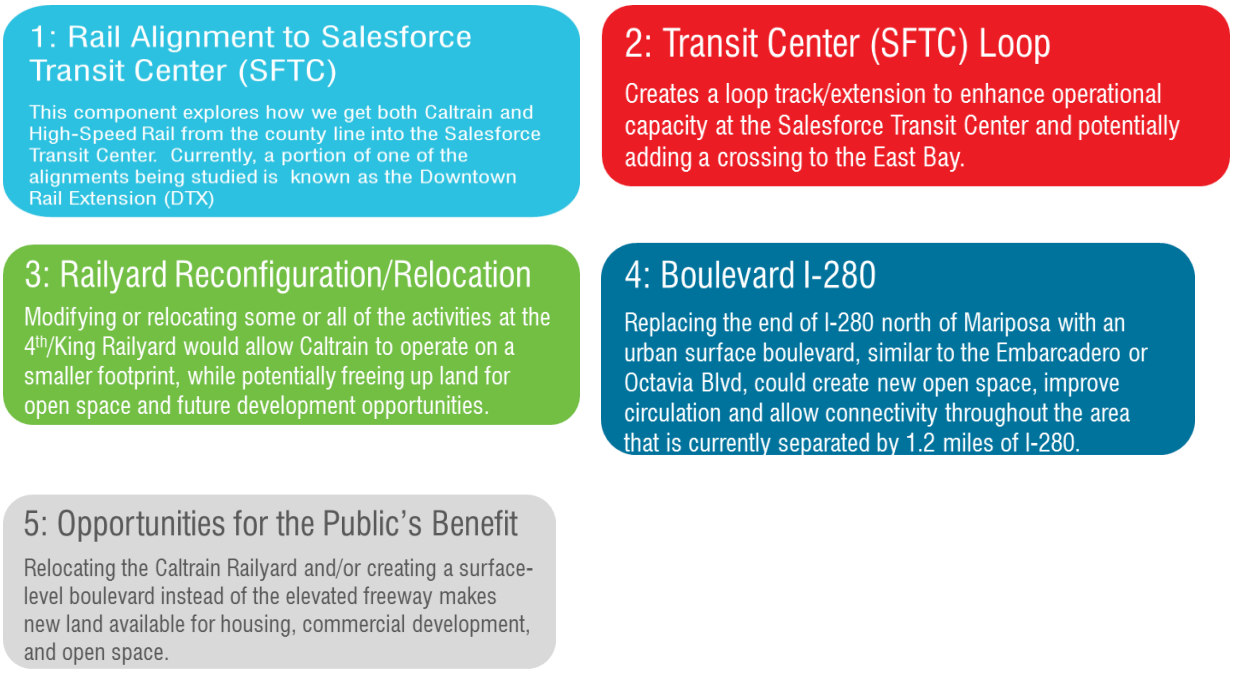
connection to the STC would be able to accept alternative alignments, and even switches added internal to the train box of the STC.

SENER performed a theoretical capacity analysis but did not conduct a perturbation analysis because it was not in its scope of work. SENER's representatives agreed with the other studies that planned operations of CHSRA and Caltrain, using only a two-track approach to the STC, would begin to breakdown and cause cascading delays over the system if any service delay from scheduled operations exceeds 120 seconds in duration.

SAN FRANCISCO PLANNING AND RAB STUDY PRESENTATION

Susan Gygi, Ulrich Leister (SMA) and Joe Speaks (CH2M)

The Railyard Alternatives and I-280 Boulevard Feasibility Study(RAB) is a planning effort being led by the San Francisco Planning Department that essentially takes a step back and considers the bigger picture and a longer planning horizon for the Caltrain railyard, DTX alignment alternatives, and the surrounding streets, urban fabric, and land uses. The RAB Study includes five distinct planning components, (1) The rail alignment to the STC (Salesforce Transit Center), (2) a Transit Center loop, (3) 4th and King Railyard reconfiguration/relocation, (4) explore the viability of converting a portion of I-280 to a Boulevard and (5) create opportunities for public benefit.



The RAB Study and modeling began in 2015 with a sketch planning analysis of a blended service scenario where all Caltrain and all CHSRA trains terminate at the STC, making the STC the only terminal for San Francisco. At that time, the sketch planning analysis concluded that up to 15 train movements per hour per direction were achievable at the STC. Most importantly, the analysis assumed the same height at all platforms at the STC, and "very quick" turn times (20 minutes for Caltrain and 20 minutes for CHSRA) as "Normal" for both train types.

Phase II of the modeling, in 2017, updated the analysis with the most recent available information on alignments and operational assumptions from the developing CHSRA / Caltrain blended service plan. It also looked at the potential of CHSRA trains stopping at 4th and Townsend station, and how that would affect the operations. The updated modeling revealed that up to 12 trains per hour per direction could be accommodated at the STC, and under "Normal" circumstances, only two tracks would be required at DTX, and at the 4th and Townsend station. It is noted that that updated analysis does not reflect a final blended service operations plan, as none currently exists. Like the SENER study, this study did not address major events, or perform service perturbation studies; but did provide platform occupancy rates.

TJPA AND PARSONS STUDY PRESENTATION

Carl Wood and Joe Metzler, Parsons.

The Train Operations Analysis of Two Versus Three Mainline Tracks for the DTX evaluates the effectiveness of a two-track and a three-track DTX tunnel alignment to support the preliminary blended service planned for Caltrain and CHSRA between San Jose and San Francisco. The author pointed out that this study is the latest in a long series of studies, conducted over a fifteen-year period, aimed toward achieving the most operationally successful, safe, and cost-effective DTX alignment. Simulations were made using the track segment from Bayshore to the STC. The author indicated that the effect of extending the model to San Jose would be negligible to the conclusions presented in his report. Study inputs are based on the September 2016 track layout for the train box/throat of the DTX, which was approved by the FRA, Caltrain, and CHSRA, along with TJPA, in 2013.

The modeling is based on 200-meter (656 feet) long CHSRA trainsets and 200-meter (656 feet) long Caltrain trainsets. It is noted that CHSRA has the option to operate 400-meter (1,312 feet) long train sets which can be fully accommodated on five of the six STC platform tracks, provided all the platforms are the same height. Double HSR trainsets can be accommodated on all platform tracks at the STC, but all doors may not be alongside the platform. The study points

out that the additional operating impact of travel through the interlockings for the 400-meter (1,312 feet) long double CHSRA consists is 22 seconds at 20 mph.

The analysis assumes that the blended service plan that results in 10 trains per peak hour per direction into San Francisco can be handled in a 4-4-2 pattern, where two Caltrain trains terminate at the 4th and King surface yard, which is the current Caltrain plan. Therefore, the model only places eight trains per hour per direction into the DTX tunnel and the STC. The study also acknowledges CHSRA's stated option to use the planned 4th and Townsend underground station platforms, recognizes that double consists would require special measures at the (currently planned at 700 ft.) short platforms, and recommends modifications to the interlockings north and south of the station to accommodate CHSRA's desired flexibility. The study concludes that the DTX can operate successfully, based on preliminary train control and tunnel ventilation zone concepts, under both 2-track and 3-track configurations.

The Parsons study examines the impacts to the DTX operation and systems under various perturbations and incident scenarios. The study concludes that an incident scenario at the 4th and Townsend station with a two-track alignment would cause an unacceptable delay that would have system-wide impacts, compared to a three-track alignment. In addition, an incident that occupies one track in any two-track configuration in the DTX would also cause system-wide impacts.

An incident scenario that blocks one track and reduces a three-track DTX to a two-track DTX can recover and sustain peak operations without system-wide impacts.

It was also noted that even with three tracks, the system cannot sustain the full blended system planned service of six Caltrain and four CHSRA trains per hour in each direction if the platforms are at different heights. The platforms would have to be at a uniform height to allow all trains to access any available platform to accommodate the full ten trains per hour in each direction during peak hours.

PEER REVIEW PANEL APPROACH TO ANALYSIS AND FINDINGS

As the details around years of data collection, analysis, study, engineering, and modeling became more visible to the peer review panel, it became clear that all parties involved in the project are passionate about having the best possible Salesforce Transit Center. The peer review panel defines success in this regards as a station that is efficient, reliable, safe, and designed to recover quickly from the inevitable incidents that occur daily on any mass transit system.

The peer review panel, and to some extent the presentations, because of the magnitude of the potential impacts, focused a great deal of time and detail on the throat of the DTX. In many ways that focus is appropriate because of the complexities of splaying the tracks as they approach the center island platforms in the STC. At the same time, however, it is only a short segment of a major construction project that extends over a long distance in a highly built-up and resurging section of San Francisco. Therefore, the peer review panel also spent some time looking at the details of the entire DTX (also known as Phase 2 of the STC) and other areas of the studies, making sure that it understood and considered the overall question of two tracks versus three in its report.

The panel tends to agree with the Caltrain view, that San Francisco in the long term could become a two-terminal city for passenger rail service. Growth in public transit ridership comes from great service: convenient, time saving, reliable and safe. In addition, as the STC will demonstrate, connectivity to feeder systems is an important part of generating intercity passenger rail growth. Finally, clearly designated trains to major event venues within short walking distance of a station are always popular.

When planning and designing a system like the STC and DTX, there are always pressures to reduce cost, avoid impacts, and minimize inconvenience. Many projects spend many years trying to manage all three. The engineers and architects, when faced with a potential impact in the form of a problem, immediately try to eliminate the conflict that has created the potential impact.

In the experience of the peer review panel, these areas of focus, while important, are never the issues that people remember. Nor are they the issues that a potential rider will use in making a modal choice for a trip.

It will always come down to the safety, reliability and convenience of the trip made today, or last week, that determines whether an occasional rider becomes frequent rider. As one member of the peer review panel aptly put it: “we are selling time in this business.”

Potential solutions that reduce operating flexibility, or preclude the ability to recover from an incident, or fail to provide for predicted future growth in order to save initial capital cost may not be the right solution for the long term. Consider the lane miles of additional highways being built now to provide for unanticipated demand. That kind of adjustment is much more difficult to do after the fact in a case like the STC, than on a highway out in the open.

The findings of the peer review panel reflect the combined experiences of planners, engineers and operators, all in the passenger rail business. Its findings represent a pragmatic approach to seeking the right balance between the infrastructure investment and the ability of the operator to deliver on the service promise to the public in a consistent and reliable way.

SUMMARY OF MAJOR FINDINGS

The following findings represent the collective views of the peer review panel as to the significant issues and recommendations moving forward:

1. **Three tunnel tracks are required to provide reliable and dependable service into the Salesforce Transit Center (STC).**
   Analyses by three different teams were reviewed. Each team started with similar, but not identical, assumptions and methods. All used sketch planning tools, and all limited their inquiry to the north end of the San Francisco–San Jose corridor over which Caltrain and the California High Speed Rail Authority (CHSRA) plan to offer blended services:

   - All the analyses found that if all trains operated reliably (within one or two minutes of schedule) two tracks in the DTX tunnel would be sufficient to sustain operations. While a two-track tunnel might be theoretically satisfactory provided there are no operational delays, the assumption of consistently operating without delays is not realistic. As an example, Caltrain currently operates at 95% On-Time Performance (OTP), but OTP is defined by Caltrain as within five minutes, 59 seconds of scheduled arrival time; not one to two minutes. A real-world example of metrics that are technologically and operationally possible is the Swiss rail system, considered by many to be the gold standard for on-time performance in the world. It operates 91% on-time, defined as plus or minus three minutes. Under this metric, if Caltrain and CHSRA were to operate at Swiss efficiency, at least one train per hour during peak hours would not be on-time at the STC (six per day during morning and evening peaks). It is not practical or productive to set an on-time performance standard for California that realistically cannot be achieved.
   - The more detailed perturbation analysis (completed by Parsons and Carl Wood for TJPA) shows that if there is a delay or track blockage in the tracks leading to the throat of the terminal or delays at the platform, then three tunnel-tracks are required to support reliable train service and to facilitate recovery from operational delays.
   - Terminal operation plans, yet to be completed, need to provide for performance of track, interlocking, and signal maintenance, which would require periodic track outages, even during scheduled operating hours.
   - Furthermore, three-tracks will be required to enable transition from the two mainline tracks into the six-track terminal. (Note: SENER's analysis and study included a two track to six track transition, although it used a 625-foot radius curve (CHSRA requires a

minimum 650-foot radius), and did not have the benefit of the already constructed STC train box alignments and construction details).

Only one of the three studies explicitly considered how a serious delay (20 minutes) would affect capacity utilization to test the utility of the third tunnel track in responding to service disruptions. The other teams acknowledged that their analysis did not consider the impacts of "off-schedule" operations and that such considerations would be required to truly to determine the utility of the third tunnel track for maintaining operational fluidity.

The analysis with delayed trains shows that the third track will provide several necessary operational functions including:

- Capacity for three parallel train movements when the terminal area is congested due to delays to inbound or outbound trains
- Capacity to simultaneously handle inbound and outbound trains when one of the three tracks is blocked due to a crippled train, maintenance outage or other circumstance. These concerns are heightened by the presence of several switches placed on curves in the throat of the DTX at the entrance to the STC
- Capacity to stage and hold inbound trains several minutes closer to the station when late outbound trains have tied up the station platforms necessary for their arrival

The analysis of delayed trains was limited to delays within the immediate vicinity of DTX. ***Together, CHSRA and Caltrain plan to complete service design, capacity and delay studies in the next six months that will better explore and explain how the third tunnel track will be used in regular and off-schedule service.*** The peer review panel suggests this blended service model be extended southward, to San Jose, to thoroughly evaluate reliable achievement of the service design.

The peer review panel understands that modeling for the blended system in is based on a two-track alignment with limited passing tracks in the peninsula and a three-track DTX. The peer review panel anticipates that the third track in the DTX tunnel will be only one of several capacity enhancements that will be necessary to reliably commingle the CHSRA and Caltrain services along the 50+ miles between San Jose and San Francisco.

Under these circumstances, the peer review team finds that the third tunnel track will be necessary for reliable, blended operations and meeting performance parameters, allowing the railroads to operate more dependable service at the STC.

2. **The Salesforce Transit Center capacity plan of four high-speed trains and six Caltrain trains cannot be assured unless both services can use all platforms.**
   Level boarding is mandated by the Federal Railroad Administration (FRA), the Federal Transit Administration (FTA) and California's State Rail Plan. The State Rail Plan specifically states "*Complete San Francisco to San Jose corridor capacity improvements, including grade separations, level boarding, and platform lengthening"*. CHSRA passengers will board from a passenger platform, constructed to match the height of the floor of the coach's passenger compartment, at 48 – 51 inches above the top of rail (TOR), depending on final equipment selections and loading profiles. The STC is currently planned to provide a future 24-inch platform serving station tracks 25 and 26. Tracks 21 through 24 will be served from two 48-inch platforms. This means Caltrain will offer passenger boarding in the STC at different platform heights, as two platform faces do not accommodate Caltrain's planned service level in STC. Caltrain's new electric multiple unit (EMU) trains will be bi-levels that provide two sets of doors for loading from both low (24 inches above top of rail) and high-level (48 inches above top of rail) platforms.

   Given the current car procurement design, the new Caltrain EMUs will be able to use all six platform faces with the extra 51-inch high doors. The CHSRA trains, however, will be restricted to four of the six tracks as they will not be able to berth with a 24-inch high platform.

   Caltrain anticipates that passengers will board from platforms retrofitted to match the height of the floor of the EMU's lower level, at 24 inches above (TOR). All existing Caltrain stations are currently built with eight-inch above top of rail platforms. The new Caltrain EMUs have additional doors that allow boarding at the 51-inch high transition level

between the upper and lower level of their cars to allow passengers to board and disembark at CHSRA platforms. With this feature in place, passengers boarding from a low platform will be able to disembark at a high platform (and vice versa). Passengers in wheelchairs will be able to access both types of doors by means of internal wheelchair lifts as provided for in the EMU specifications.

Caltrain also discloses that currently one in seven passengers boarding their trains is traveling with a bicycle. Caltrain is working to address this challenge, both in terms of how to manage the platform heights, and how theoretical station dwell times are impacted, as Caltrain contemplates how best to address the different platform heights currently planned in the STC.

There are also questions of car width compatibility between the proposed CHSRA and Caltrain cars. There have been discussions that CHSRA might use a car that is eleven feet wide, in contrast to a Caltrain car that is somewhat narrower. More information concerning the loading profiles of the two car fleets is clearly required. The Caltrain EMUs are being procured with bridge plates to account for the difference in car widths.

With CHSRA's recent change of operating assumptions which conclude that dwell times of 20 minutes are achievable, a prior concern that four HSR trains per hour could be restricted to four tracks is ameliorated. However, all three analyses find that six Caltrain trains per hour, each with 20 minutes of minimum turn time will not fit onto the two tracks reserved

for Caltrain's exclusive use. During peak hours, Caltrain would need to use at least three station tracks. With the current configuration, one of those tracks will be a high platform track requiring special accommodations. Alternatively, Caltrain and CHSRA may decide to utilize a 4-4-2 blended service schedule, as noted in the Parsons study, with two trains terminating in San Francisco at 4th and King Station.

If the CHSRA cannot meet its projected 20-minute turn time for all trains, its need for station tracks will grow. In 2015, a study conducted as part of the RAB project demonstrated that the six-track terminal would not have the practical capacity to receive ten trains per hour if it takes 45 minutes to turn every HSR train.

The peer review panel notes that continued joint work on loading profiles, turn times, blended service schedules and contingency plans by CHSRA, Caltrain and TJPA are clearly required to address car/platform interface compatibility between fleets and to maximize flexibility and availability of terminal capacity. The peer review panel notes that improvements in currently stated turn times by one or both operators improves terminal capacity.

3. **The structural column configuration in the built STC limits the flexibility for changing the track geometry within the train box and at the throat leading into the Terminal, but options that entail adjustments to track design criteria at the throat to minimize right-of-way impacts should be explored with CHSRA, TJPA, Caltrain and SENER.**
   All six track curves extend roughly 400 feet into the STC train box, which has recently been constructed. All six tracks appear to be designed using the CHSRA-required minimum 650-foot radius, which sets track alignments and the existent column locations at the interface with DTX. The six tracks, from the time they exit the tangent platforms required by CHSRA, transition from six to three over a distance of roughly 1,000 feet.

   Now that the station box and structural columns at the STC are in place, there is very limited opportunity to re-engineer the curves that link the station platforms with a re-configured divergent tunnel under 2nd Street. The transition from six tracks to two tracks contemplated in the SENER study reduces the track radius and places switches at the train box interface, which could interfere with existing columns. At this time, it appears that a transition from the STC train box to the end of the DTX throat along the required curved alignment creates the need to traverse below portions of 201, 215, 217 and 235 2nd Street properties, including buildings on some parcels, as shown in TJPA's Final Preliminary Engineering Track Plans dated September 28, 2017.

Further, with a two-track configuration, the peer review panel understands that a 625-foot radius of curvature would be required to completely avoid the building at 235 2nd Street. While some prospective rolling stock designs can support a radius of curvature perhaps as low as 492 feet, 650 feet was specified, by CHSRA for the DTX, to maximize compatibility with the full range of available rolling stock offerings.

The peer review panel understands that TJPA is studying alternative tunnel construction methods, and track design measures to mitigate impacts of the tunnel on 235 2nd Street. The peer review panel also understands that TJPA is evaluating alternative construction methods that might reduce cut-and-cover construction in the throat of the tunnel to decrease potential surface impacts on 2nd and Howard Streets.

During the workshop on February 22, 2018, SENER presented additional information regarding the track layout in the throat of the DTX. The presentation showed a configuration of tracks and switches that, according to their analysis, allowed three tracks to be built without directly impacting the structure on Birmingham property at 235 2nd Street. The peer review panel noted the proposal, as well as the statements of CHSRA that it appeared to offer sub-standard curve radii on one or more of the tracks. SENER provided their graphics and presentation to the peer review panel and the stakeholders.

The panel suggests continuing work and constructive discussions with the owner of the 235 2nd Street building, to address:

- Structural underpinning of the building
- Noise and vibration mitigation
- Any disruption to tenant access

Based on its current level of analysis, the peer review panel finds that, at this point in project development, there appear to be no realistic options to change track geometry at the throat leading into the STC. However, as noted in Recommended Immediate Actions, the two operators and TJPA need to continue to explore possible tradeoffs between practical low-speed track design standards and potential right of way impacts of constructing the DTX tunnel.

ADDITIONAL FINDINGS AND OBSERVATIONS

1. **The STC will be operating at, or near, capacity when the Service Program of turning six Caltrain and four CHSRA trains per hour is fully implemented.**

   All three studies reviewed by the peer review panel agree that, when a reasonable level of reality is applied to the service models, the STC will be operating near or at capacity when the service program of four CHSRA trains and six Caltrain trains per hour is fully implemented. Additionally, two of the three studies agree that Caltrain cannot reliably operate on two tracks and two platform faces. Therefore, solving the dedicated platform question is critical to completing a blended service plan.

   The peer review panel acknowledges that aspirations outlined in the State Rail Plan contemplate a future service extension across the Bay for HSR trains to Sacramento and for commuter rail service to various East Bay destinations. With no concrete proposals being considered, however, within the current planning horizon, it is not possible to determine how an eastern extension under the Bay might affect STC operations or configuration. Therefore, a goal of the TJPA design team (as demonstrated in the Value Management studies completed in 2007/8) remains to not preclude a future bay crossing.

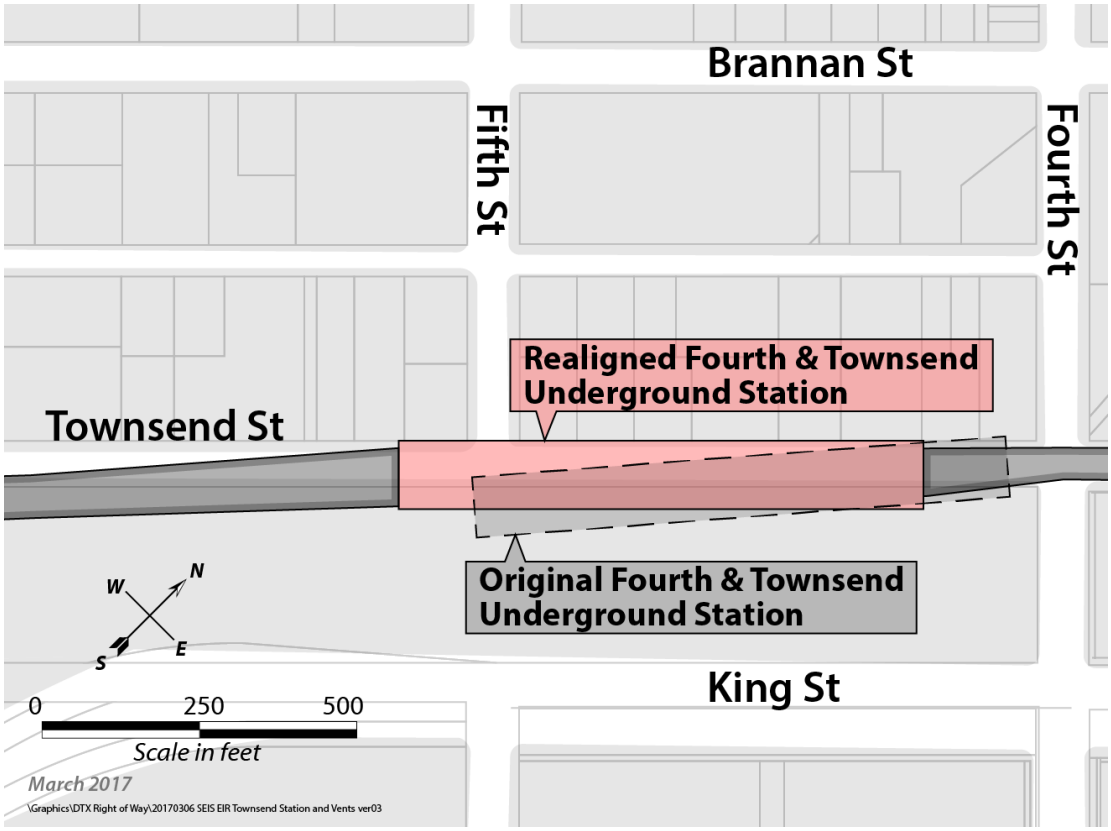
   Five of the six platform tracks in the STC could, in theory, be extended east to create a through station at the STC in the future, should a new transbay rail crossing be built. The ability to run through-trains on these five tracks could improve capacity, allowing for more frequent service than in the initial stub-end station. Current plans do not preclude a future additional bay crossing; a future extension can be oriented such that a through station at the STC becomes the preferred concept.

   The investments being made at the STC and the DTX are large and it is vital that they provide an expected level of service and reliability resulting from today's investments. It is also vital that those investments support a broader vision and strategy for future rail developments in the Bay Area.

   The peer review panel again emphasizes the importance of completing a reliable blended service plan for STC to operate as it is currently legislated and contemplated, taking into account the future growth of passenger rail in the Bay area.

2. **The new underground station at 4th/Townsend is likely to have strategic and tactical significance for both rail operations.**

   The new underground station will allow trains to and from the STC to also serve large regional entertainment venues near Fourth and Townsend. In its proposed location, the new station does not preclude future economic development, including commercial, office, and housing in this currently under-developed area.



   Three tracks at the station will allow CHSRA trains bypassing Fourth and Townsend to overtake Caltrain trains serving passengers at Fourth and Townsend.

3. **The overall utility of the new station at 4th/Townsend might be improved with platform faces on all three tracks and reconfiguration of the switch plant providing access to all station tracks from the north and south.**

   The third track through the station will allow trains to stand and turn from NB to SB when the six-track capacity of STC is taxed.

The peer review panel notes that CHSRA is also contemplating the use of this station, which could cause the need for an additional platform face. A platform configuration that allows trains on all tracks to serve passengers at the station would be preferred for operational flexibility. Uniform platform heights should also be part of the final solution for maximum operational flexibility. This operational flexibility could be further enhanced if the side platform serving Track MT5 was redesigned as an island platform serving both Track MT2 and Track MT5.

It is noted that the TJPA, in recent work addressing the alignment, track work and station layout, may have already adjusted certain features discussed in the peer review panel comments.

The peer review panel recommends that TJPA, CHSRA and Caltrain consider including three platform faces as they update conceptual designs for the 4th/ Townsend underground station to increase operational flexibility at the station, and to address finalized blended service plans.

4. There is significant residual operational value at Caltrain's terminal and yard at Fourth and King for staging, servicing and storing Caltrain and CHSRA trains. The RAB Study is exploring options for the use of the yard.

When the STC and the new underground station at 4th/Townsend open for Caltrain service, utilization of the current surface terminal with 12 platform tracks at 4th and King may be reduced. However, Caltrain will still need a nearby layover and maintenance base to stage operations in and out of the STC. The STC will be too constrained for Caltrain to service or store trains in the terminal during operating hours.

Additionally, Caltrain contemplates continued rapid ridership growth, and a continuing need for facilities at Fourth and King. The location provides room to stage trains serving the substantial number of special events in the vicinity without disrupting service on the main lines serving STC. The RAB Study is investigating options for the use of the yard.

CHSRA also may need to utilize the location to charge the system for early morning pull-outs, and as a backup during service disruptions at the STC.

Re-development of the land currently occupied by Caltrain's 4th and King terminal and yard must be balanced with the needs of the CHSRA and Caltrain to stage, store and manage trains near the STC.

The peer review panel notes that a properly designed limited-capacity layover/storage/ running maintenance facility at-grade at or near 4th and King should not inhibit development, should it be proposed. Development can straddle, be combined with, or be built over train facilities as is demonstrated at the STC. Any future site re-development obviously needs to be cognizant of the DTX in general and the 4th and Townsend station in particular.

5. A consistent base DTX track configuration should be used at the outset for all modeling and simulation studies prepared by all parties.

Among the operations planning analyses reviewed by the peer review panel, there are significant differences in base assumptions concerning the configuration of switches and crossovers proposed for the DTX. Some of the differences may be due to timing of modeling studies and report preparation. Two studies were complete prior to the track changes by TJPA in September 2017. The peer review panel acknowledges that ongoing work by TJPA, Caltrain and CHSRA will address many of the differences noted.

The peer review panel recognizes that the track alignment reflected in the Parsons study (Figure 1), including switch locations, has been reviewed and agreed to by Caltrain and CHSRA and has been signed off by FRA. This alignment is understood to reflect the current operational thinking of CHSRA and Caltrain, and considers the ventilation zones established for fire safety.

It is also understood that the alignment is a Preliminary Engineering concept (15% design), so adjustments can be expected as the plans are finalized to reflect operating plans and the resolution of the dedicated platforms question. At this stage in project development, the peer review panel recommends that the configuration of switches and crossovers at the throat of the STC be finally established based on the resolution of these parameters.

Figure 1 shows the base track configuration of the throat of the terminal as modeled by the Parson's team in the fall of 2017.

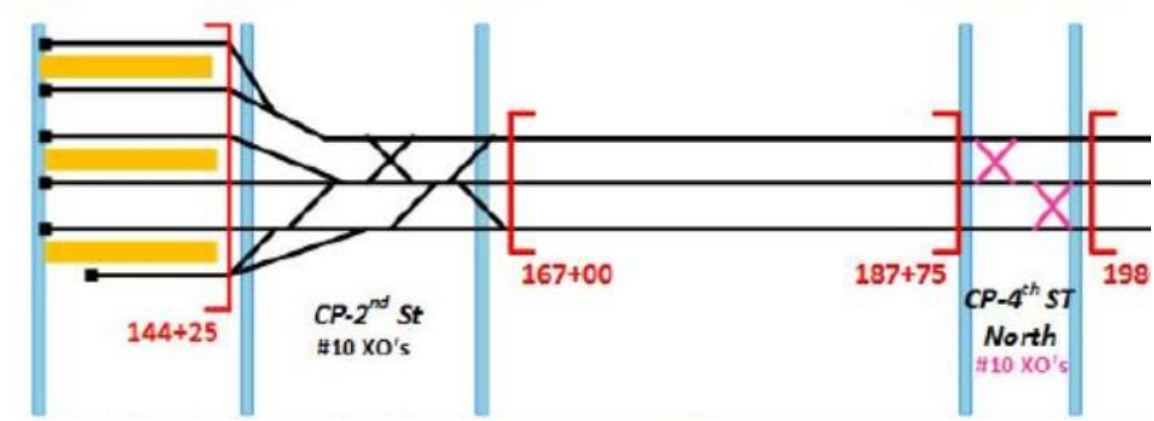


Figure 1

Track Configuration from the Parsons Report (October 31, 2017 Page 4)

Figure 2 shows the base track configuration of the throat of the STC as depicted by the RAB report team in the Spring of 2017. It calls for one interlocking and seems to support high turnover on station tracks 24, 25 and 26. Tracks 21 and 22 appear to be designed for a much lower level of traffic with movements to or from either track blocking access to the other.

The two diagrams are clearly very different. Access to and from the low numbered station tracks is improved in the approved Parsons layout.

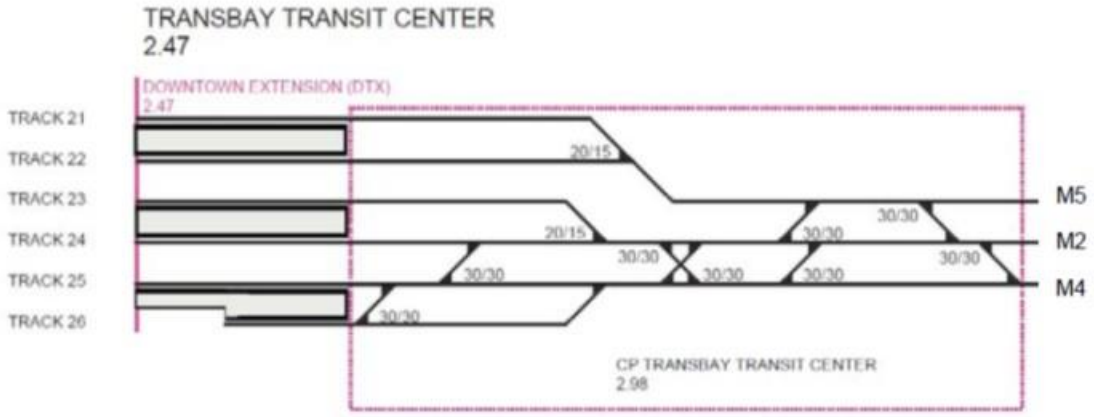


Figure 2

Track Configuration from the RAB Report (June 19, 2017 Page 52)

The peer review panel also notes that the "topology" of tracks, switches and crossovers to be built in the DTX tunnel will have a dramatic effect on how the STC can be used and what options will be available when the STC is operating under the stress of delays.

The peer review panel notes that continued joint work by CHSRA, Caltrain, and TJPA to identify and agree on the most operationally flexible track and switch configuration, based on shared use of the STC and achieving all operating parameters, is essential before final railroad track designs proceed.

6. **All the simulation results considered by the peer review panel assumed a high-performance train control system that safely provided very short times between train movements through the DTX. The interlocking and train control software and hardware must be designed to minimize the times between when one route through the interlocking is cleared and when a conflicting route through the interlocking can be ready for the next occupancy.**

   All the studies tendered for review by the peer review panel presume a high-functioning state-of-the-art train control system for the STC and DTX. Movements through the tunnel will face constraints in the density of operations due to fire safety-related limitations. Reliability, redundancy, and minimizing the effects of human error in train operations are all critical to achieving the levels of service our citizens deserve.

   The blended service planned for the San Jose-San Francisco corridor will not support the density of operations required for effective joint use by the CHSRA and Caltrain trains, at comparable speeds, without an advanced train control system that performs in the manner currently outlined by CHSRA specifications.

   The simulations assumed a high-performance switch and signal control system that safely provided very short times between movements through the switching plant. The implementation must support this operating premise. The interlocking and train control software and hardware must be designed and implemented to minimize the times between when one route through the interlocking is cleared and when a conflicting route through the interlocking can be ready for the next occupancy.

   The peer review panel notes that final signal designs for the tunnel and terminal must be carefully vetted to ensure that the logic and performance of the designs will support the short headways, quick route sets, and fast responses assumed when the sketch level service plans and capacity studies were prepared

RECOMMENDED IMMEDIATE ACTIONS (NEXT STEPS)

1. The operators need to finalize a workable "Blended Service Plan" for the harmonious joint operation of the shared line and terminal including: train schedules, required enhancements to the infrastructure south of the study area, and plans for vehicle servicing and storage. The plan should be reviewed, tested and verified with a proven and widely accepted railway simulation tool.
2. The two operators and TJPA need to identify and select a mutually acceptable and workable set of rolling stock and platform adaptations that will allow both services to berth at all platforms.
3. Properly evaluating the potential right of way impacts of constructing the DTX project is a critically important task in this phase of project development. Based on suggestions from SENER Engineering, the two operators and TJPA need to carefully review possible tradeoffs between track and switch design standards and practical limits for low-speed terminal operations, including the associated potential right-of-way impacts of constructing the DTX tunnel. The goal should be to provide a transit project that maximizes public benefit, while minimizing environmental and community impacts.
4. The two operators and TJPA need to revisit the operational program and design for 4th and Townsend station to improve the utility and flexibility of the station and associated switch plant.
5. Once the Blended Service plan is prepared and improved, the operators and TJPA need to identify an operating plan and design footprint for a storage and servicing facility on the existing 4th and King Caltrain parcel to identify which portions of the parcel can be released for non-railroad use.
6. The peer review panel observed that simulations reviewed were lacking in coordinated assumptions, likely due to a lack of collaboration between the parties. Operators, TJPA, City Planning and other interested parties should build on the open communications facilitated by the SFCTA during the review effort, and regularly meet with SFCTA to report and discuss progress on the Immediate Action Items above and to sustain momentum and cooperation toward the construction and operation of the proposed facilities.

APPENDIX 1 – PEER REVIEW PANEL BRIEF CVS

PEER REVIEW PANEL MEMBERS:

John Flint – Senior Vice President, Managing Director of Lines of Business for T Y Lin International. Mr. Flint previously served as National Director of Rail and Transit for T Y Lin International, where he led the firm's growth in rail and transit projects in the Americas. He is a former Senior Vice President of Rail Infrastructure for All Aboard Florida, where he was responsible for developing the overall rail infrastructure plans for this 240 mile privately owned, higher speed, inter-city rail line that recently opened limited service along the east coast of Florida. Mr. Flint has served in senior project management positions for the design of metro systems in Panama City Panama, Caracas Venezuela, and Lima Peru. He also served as the project manager for SEPTA's Ninth Street Operations Study evaluating the most feasible and cost effective phasing for the $180 million commuter rail reconstruction program.

Les Elliott – The Elliott Group president. Mr. Elliott has a wide-ranging background in the planning, development and operation of commuter and high speed rail programs around the world. He has completed several assignments for the California High Speed Rail Authority along the Peninsula Corridor, including peer reviews of the system design, ridership and revenue forecasts and proposed technology. He served as the Managing Director of a $3billion, 80 km greenfield rail concession in Pretoria and Johannesburg South Africa and is currently working as part of the team advising BART on their new communications based train control program. Prior to forming his own company Mr. Elliott served as the Managing Partner for Booz-Allen & Hamilton's worldwide transportation business where he was directly involved with projects around the world including Los Angeles, United Kingdom, Greece, Australia, and the Netherlands

David Nelson – Director of Transit for Jacobs. Mr. Nelson is a nationally and internationally recognized expert in urban public transport planning, operations and economic analysis. He has led planning and operational studies for commuter rail, inter-city rail and transit properties in Boston, Miami, Denver, Honolulu and New Jersey. He also serves as a visiting professor of Transportation and Logistics at the Conservatoire National des Arts et Meitiers in Paris. He is the author of more than 10 papers published by the Transportation Research Board.

Eugene Skoropowski – Staff Consultant for T Y Lin International. Mr. Skoropowski is the Former Managing Director for the Capital Corridor JPA, which provides a 170-mile rail connection between the Bay Area and Sacramento. Mr. Skoropowski served as Senior Vice President for Rail Operations at Florida East Coast Industries for the last five years , which operates freight and passenger services (All Aboard Florida/Brightline) along the east coast of Florida. Prior to FECI/AAF, Mr. Skoropowski has served as Director of Rail Projects for HNTB and Fluor Corporation in key management roles on a number of notable rail projects, including Florida High Speed Rail, LOSSAN Corridor, LA Metro, the FOX project in Florida and the DBOM HSL Zuid Project in the Netherlands for high speed trains from Brussels to Amsterdam. He previously served as the Assistant General Manager at SEPTA in Philadelphia and the Chief Railroad Services Officer for MBTA in Boston.

APPENDIX 2 – STAKEHOLDER PRESENTATIONS

Transbay Program Phase 2 Train Operations Analysis of Two vs. Three Tracks

January 25-26, 2018

TJPA
TRANSBAY JOINT POWERS AUTHORITY

Agenda

- Project Overview and History
- Rail Operations Studies
  - Key Issues and Goals
  - Simulation History
  - Inputs
  - Results
  - Conclusions
- Phase 2 Costs, Schedule and Next Steps

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Project Overview and History

Context

1999 Proposition H

- Extend Caltrain to a new or rebuilt regional transit station on the site of the Transbay Terminal

Transbay Joint Powers Authority

- Created under State law in April 2001
- Charged with design, construction and operation of a new Transit Center and associated facilities

Member agencies

- City & County of San Francisco
- Alameda-Contra Costa Transit District
- Peninsula Corridor Joint Powers Board:
  - City & County of San Francisco
  - San Mateo County Transit/Caltrain
  - Santa Clara Valley Transportation Authority

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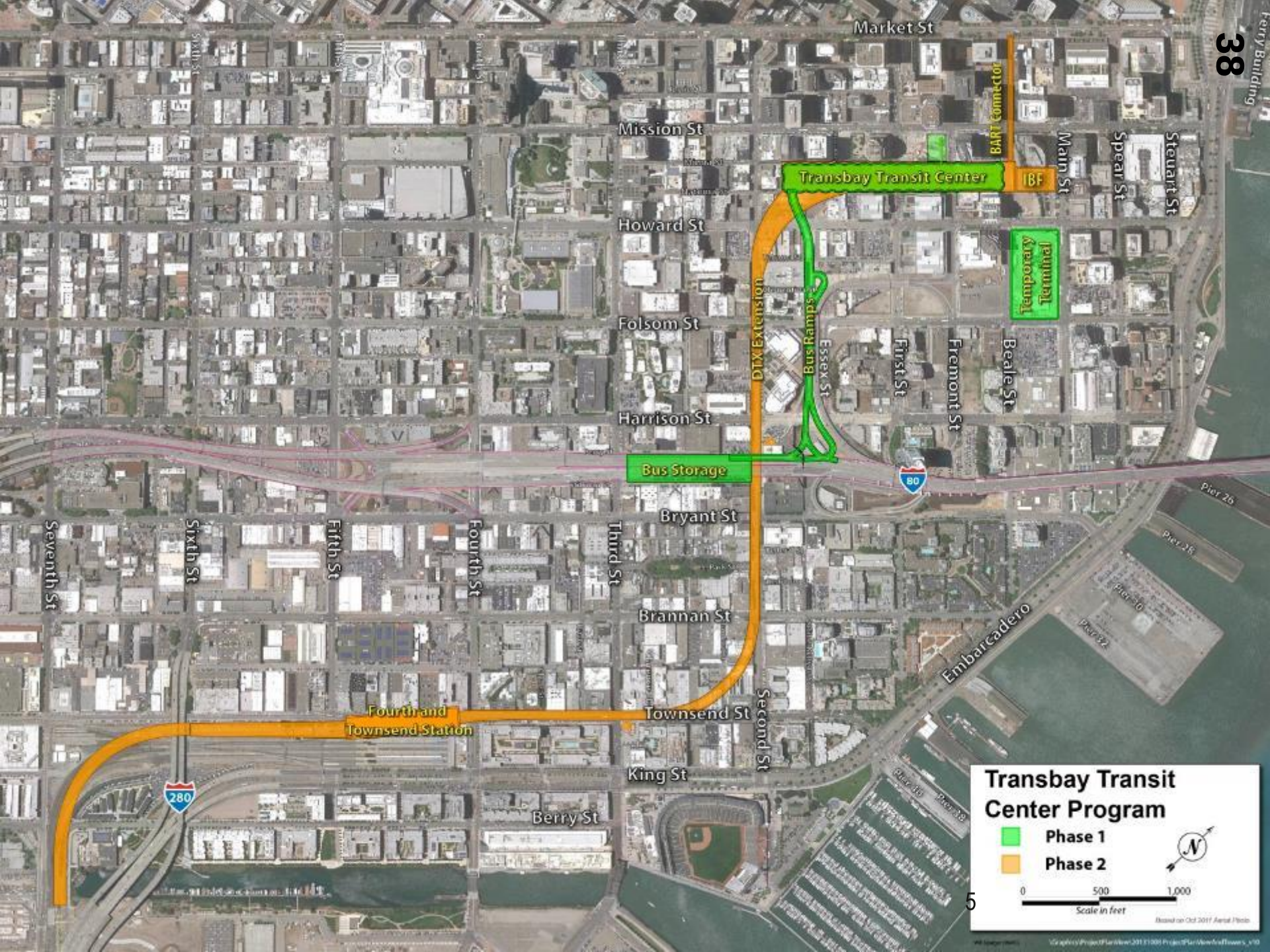
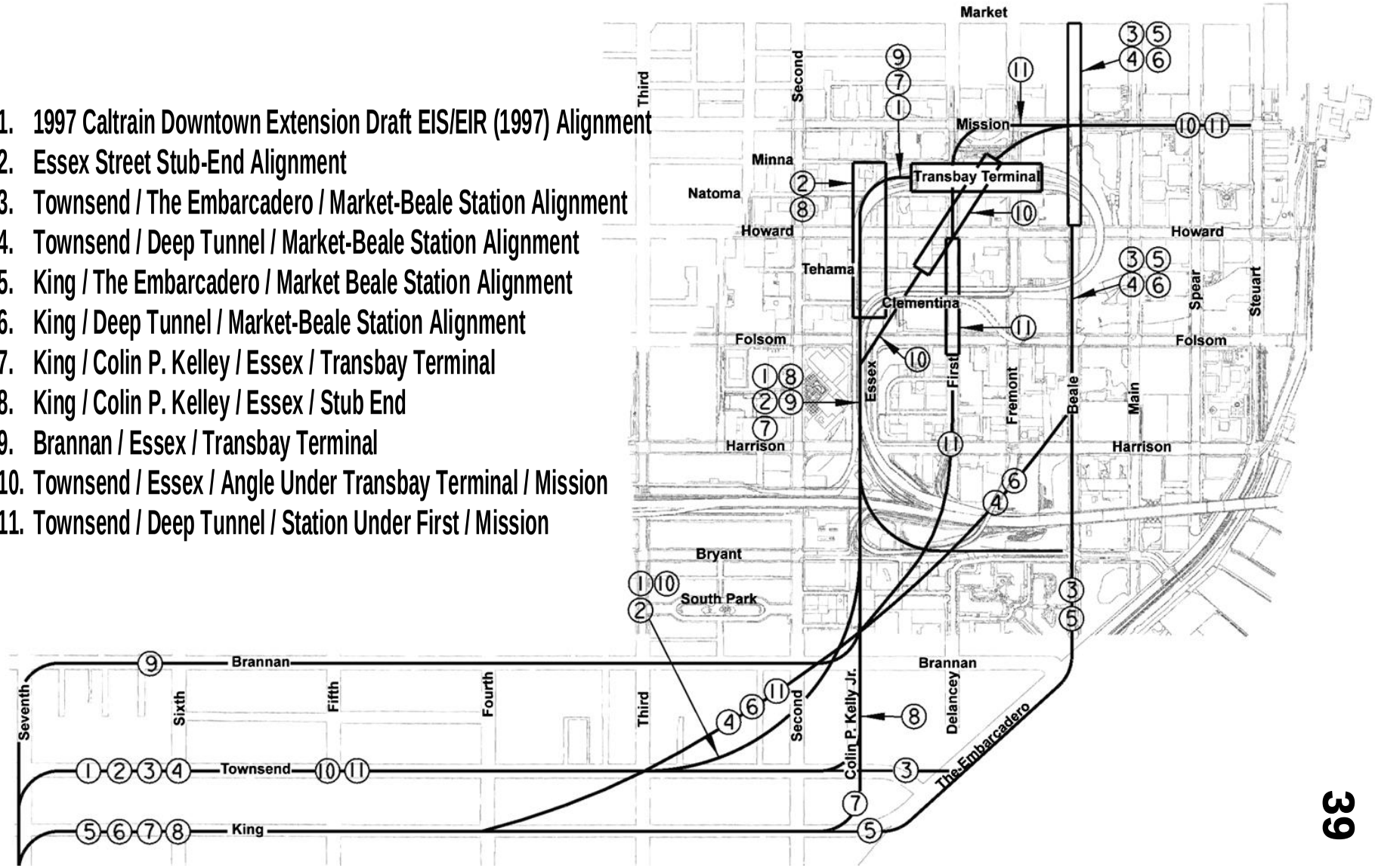

Market St
Mission St
Howard St
Folsom St
Harrison St
Bryant St
Brannan St
Townsend St
King St
Berry St
Fourth and Townsend Station
BART Connector
Transbay Transit Center
TBF
Temporary Terminal
DTX Extension
Bus Ramps
Essex St
First St
Fremont St
Beale St
Main St
Spear St
Steuart St
Bus Storage
Seventh St
Sixth St
Fifth St
Fourth St
Third St
Second St
Embarcadero
Pier 26
Pier 30
Pier 32
Pier 38
Ferry Building
80
280
Transbay Transit Center Program
Phase 1
Phase 2
N
0
500
1,000
Scale in feet

DTX Project Background: Alternatives Considered and Withdrawn

1. 1997 Caltrain Downtown Extension Draft EIS/EIR (1997) Alignment
2. Essex Street Stub-End Alignment
3. Townsend / The Embarcadero / Market-Beale Station Alignment
4. Townsend / Deep Tunnel / Market-Beale Station Alignment
5. King / The Embarcadero / Market Beale Station Alignment
6. King / Deep Tunnel / Market-Beale Station Alignment
7. King / Colin P. Kelley / Essex / Transbay Terminal
8. King / Colin P. Kelley / Essex / Stub End
9. Brannan / Essex / Transbay Terminal
10. Townsend / Essex / Angle Under Transbay Terminal / Mission
11. Townsend / Deep Tunnel / Station Under First / Mission



DTX Project Background: Other Alignments (2010)

- Seventh St. reviewed in 2010
- Determined that conflicts with Central Subway and buildings along Minna/Natoma required alignment to be up to 130 ft deep.
- New required Throat Structure would require demolition of buildings between the Transit Center and Third St. including SF MOMA.

Phase 2: Transit Center

Phase 2 Project Objectives

- Improve Caltrain commuter rail service by providing direct access to downtown San Francisco
- Enhance connectivity between Caltrain and other major transit systems
- Bring future intercity and high-speed rail service into downtown San Francisco
- Reduce traffic volumes, vehicle miles traveled, and delays on US 101 and I-280
- Improve regional air quality through reduced auto emissions
- Increase property values around the TTC

Bay Area Regional and State Rail

DTX Project Timeline

2005 – 2008

- Purpose, Organization, Scope
- Configuration and construction methods
- Criteria development with Caltrain/CHSRA
- March 2006 VM exercise to reduce costs and improve function
- November 2006 DLPA Cost Report
- May 2007 DB CHSRA Criteria Review
- June 2008 CPUC approval of clearances approach
- July 2008 Risk Assessment
- July 2008 Revised Caltrain Design Variance Request for grade submitted by TJPA

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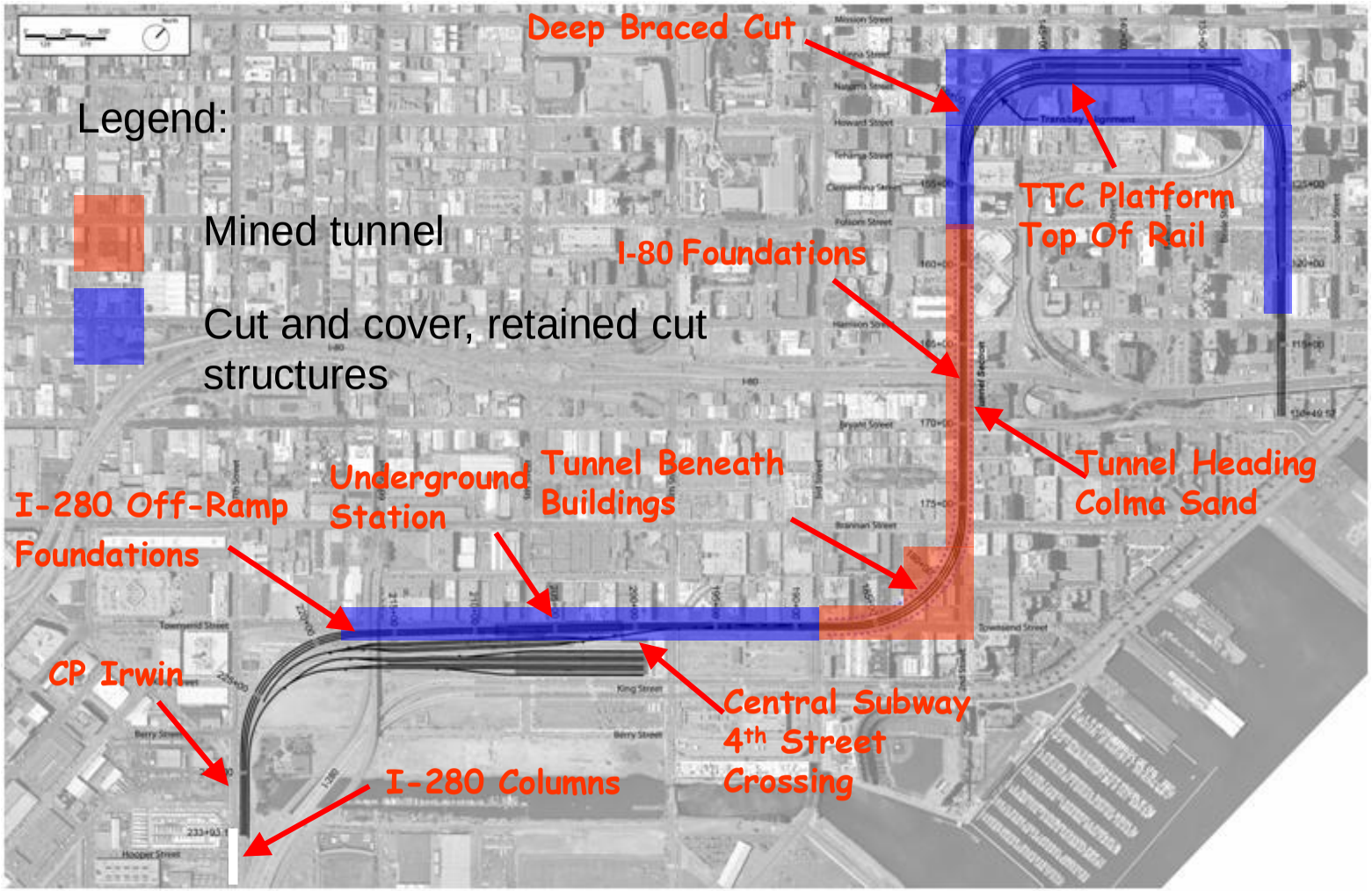
11

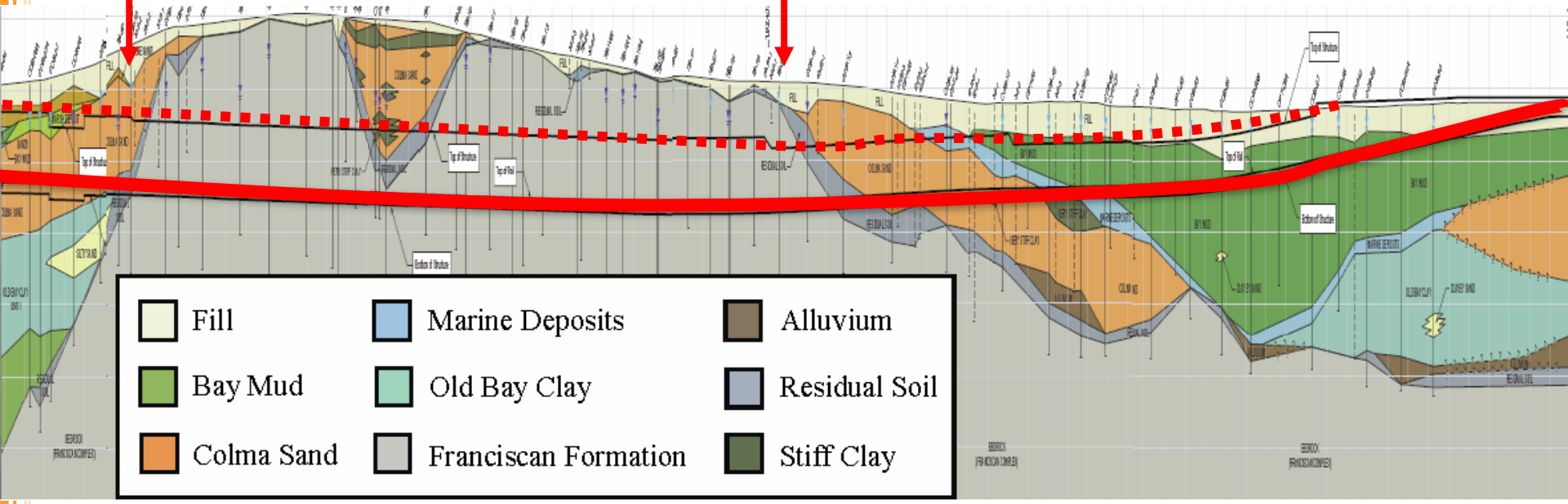
Alignment Constraints



Ground Conditions

Geotechnical Soil Profile

Limits of mined tunnel segment



Tunnel Crown

Tunnel Invert

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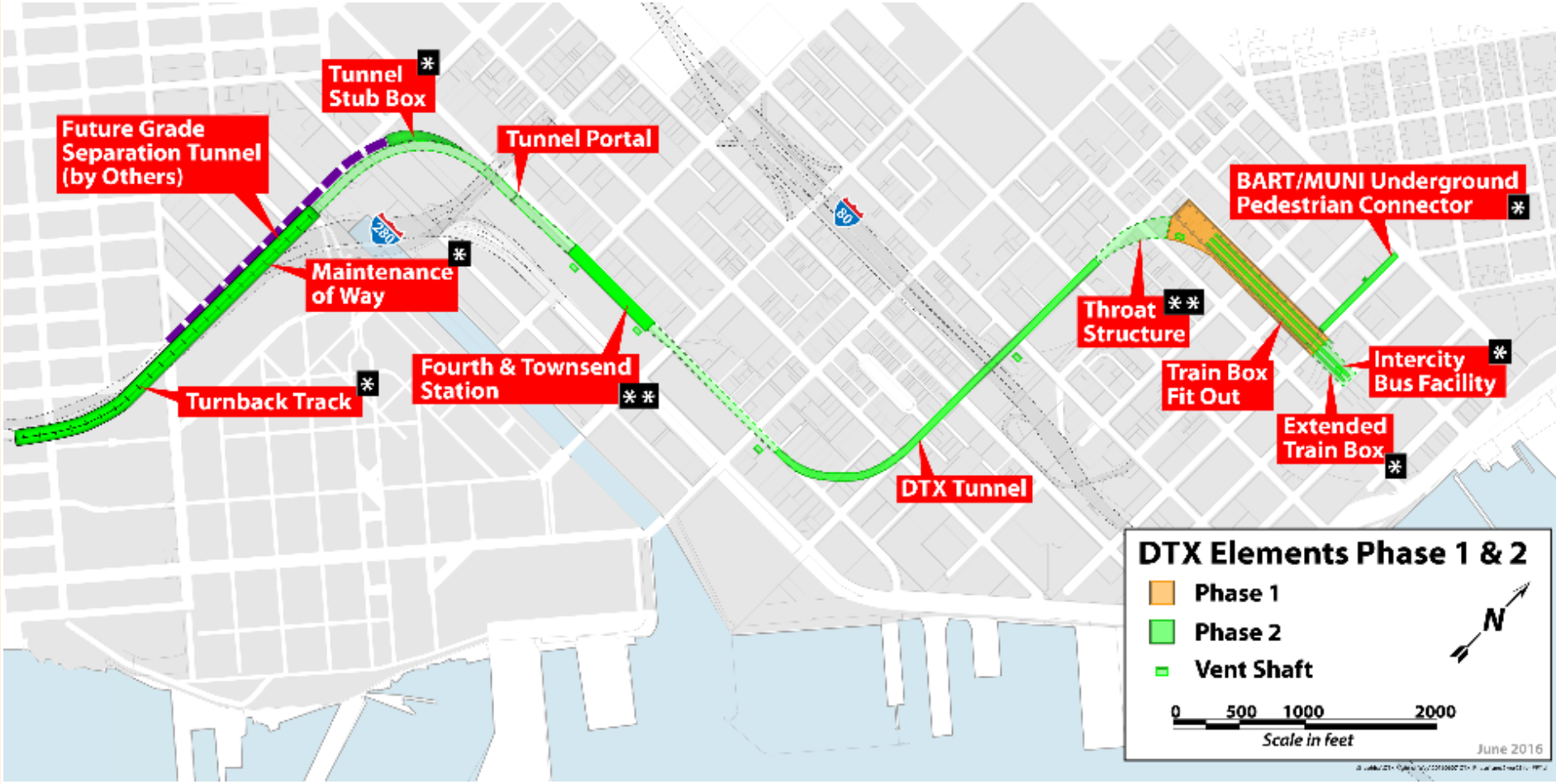
Additional Constraints

- Predefined ROW - Limit Property Acquisition
- Contract Packaging – Limited Staging Areas
- Operator Requirements
  - Caltrain Design Criteria
  - HSR Design Criteria
- Operator Compatibility - Rolling Stock Undefined

Phase 2 Scope



Element added (*) or modified (**) in the SEIS/EIR

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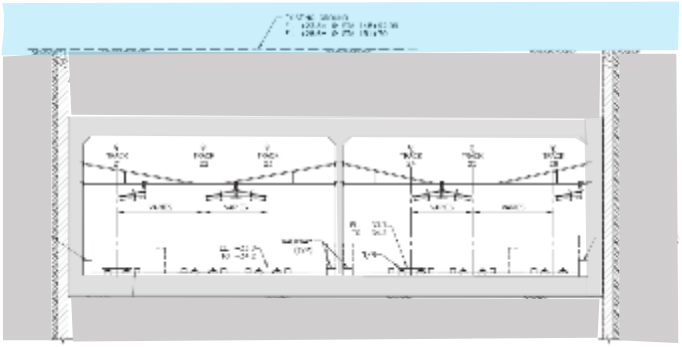
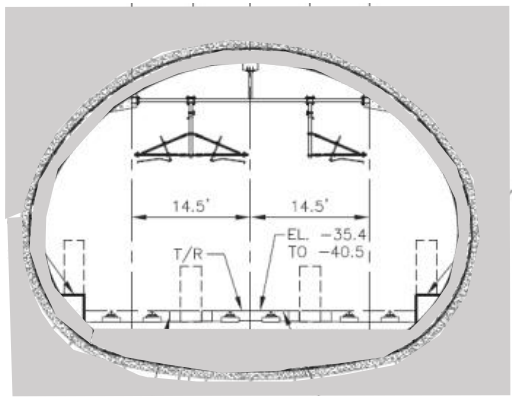
DTX Tunnel Sections

Cut-and-Cover
Throat Structure
Expands from three to six tracks



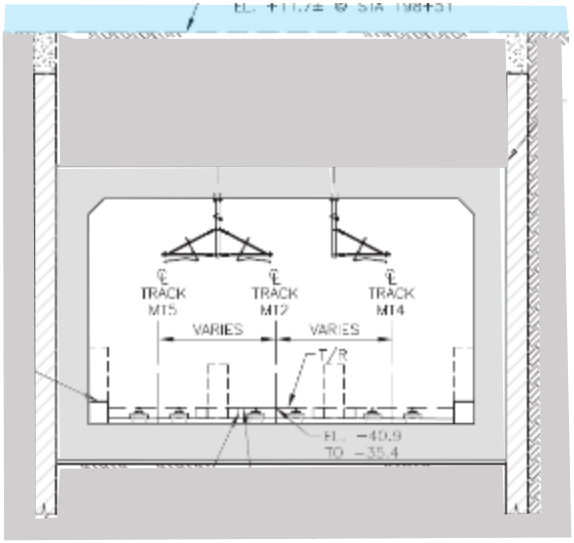
~155’

Mined Tunnel
(sequential excavation method)
Three tracks



~55’ typical

Cut-and-Cover
in Townsend Street
Expands from two to three tracks



~62’

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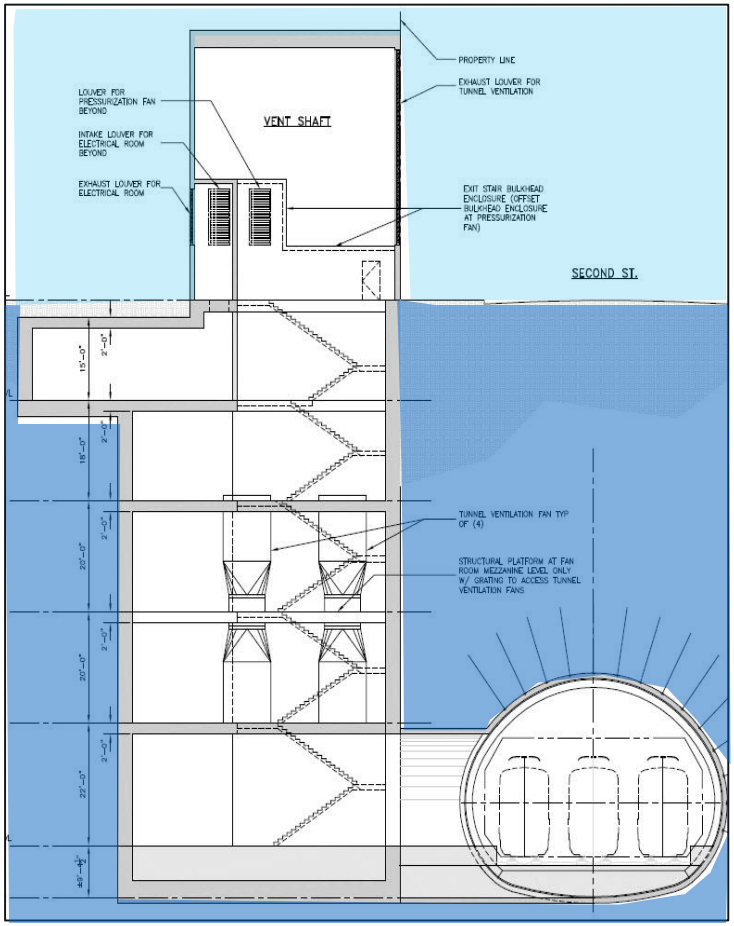
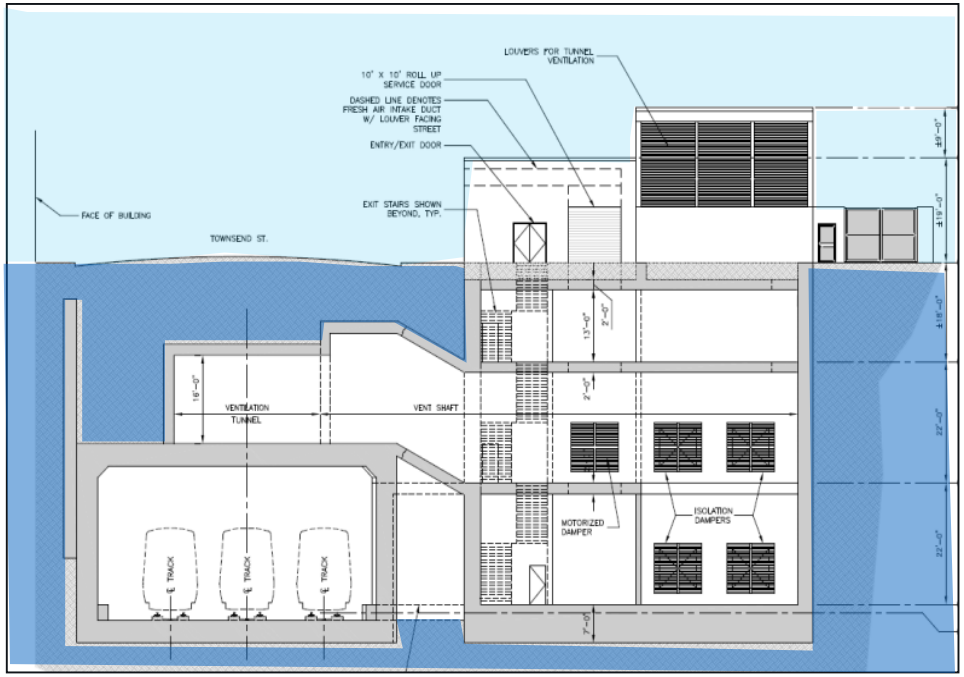
Emergency Exit/Ventilation Structures

Vent Structure at Second & Harrison



Vent Structure at Third & Townsend



** Additional Vent Shafts at the Transit Center and Fourth & Townsend Station*

Required by code: NFPA 130

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DTX Project Background

- LPA Preliminary Eng. Phase 1
  - *February 2005*
- Developed LPA estimate
  - *January 2006*
- VM Initiatives/Studies
  - *February 06 – March 07*
- Refined LPA
  - *April 2007*

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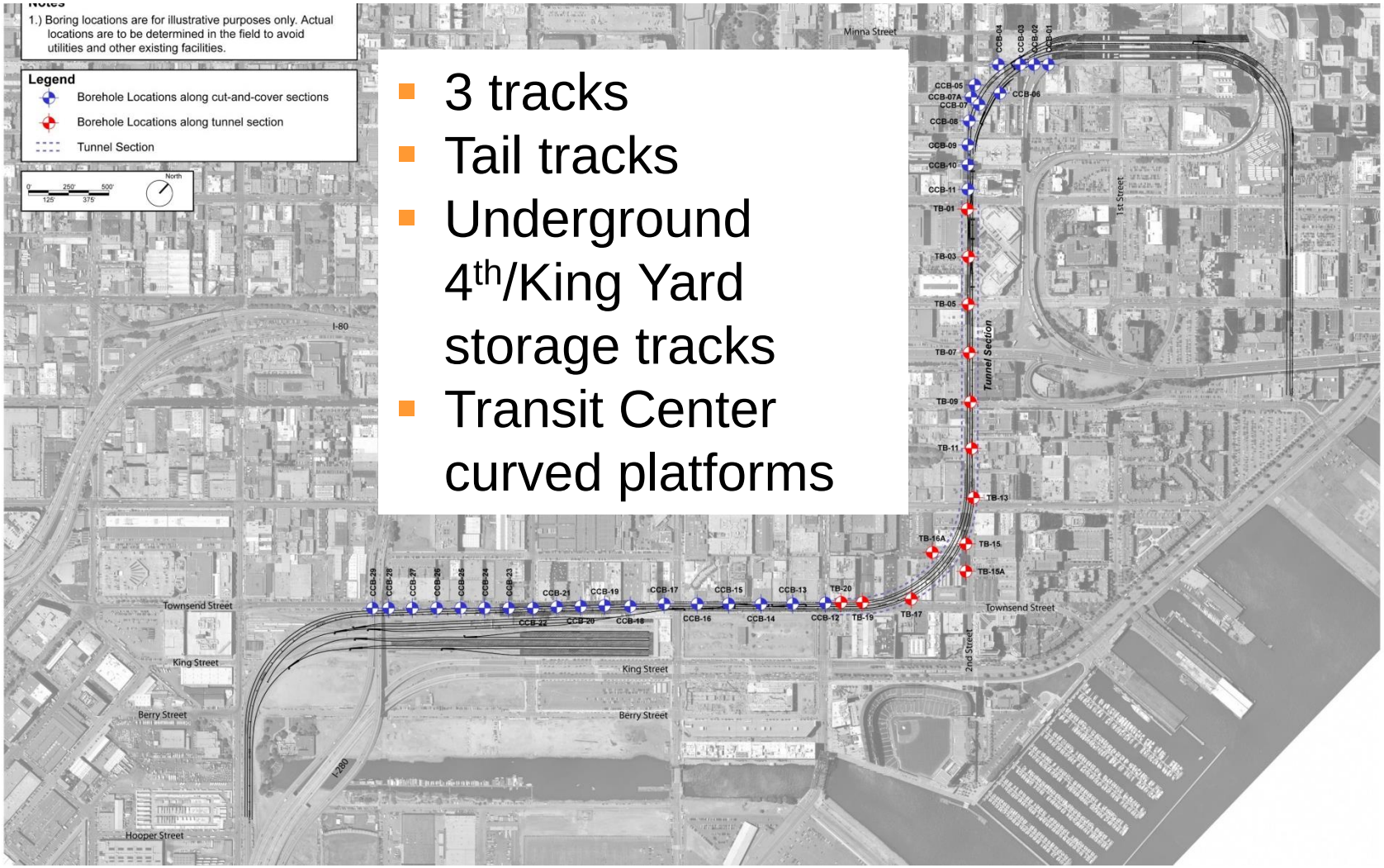
DTX Project Background: Locally Preferred Alternative (2005)



- 3 tracks
- Tail tracks
- Underground 4th/King Yard storage tracks
- Transit Center curved platforms

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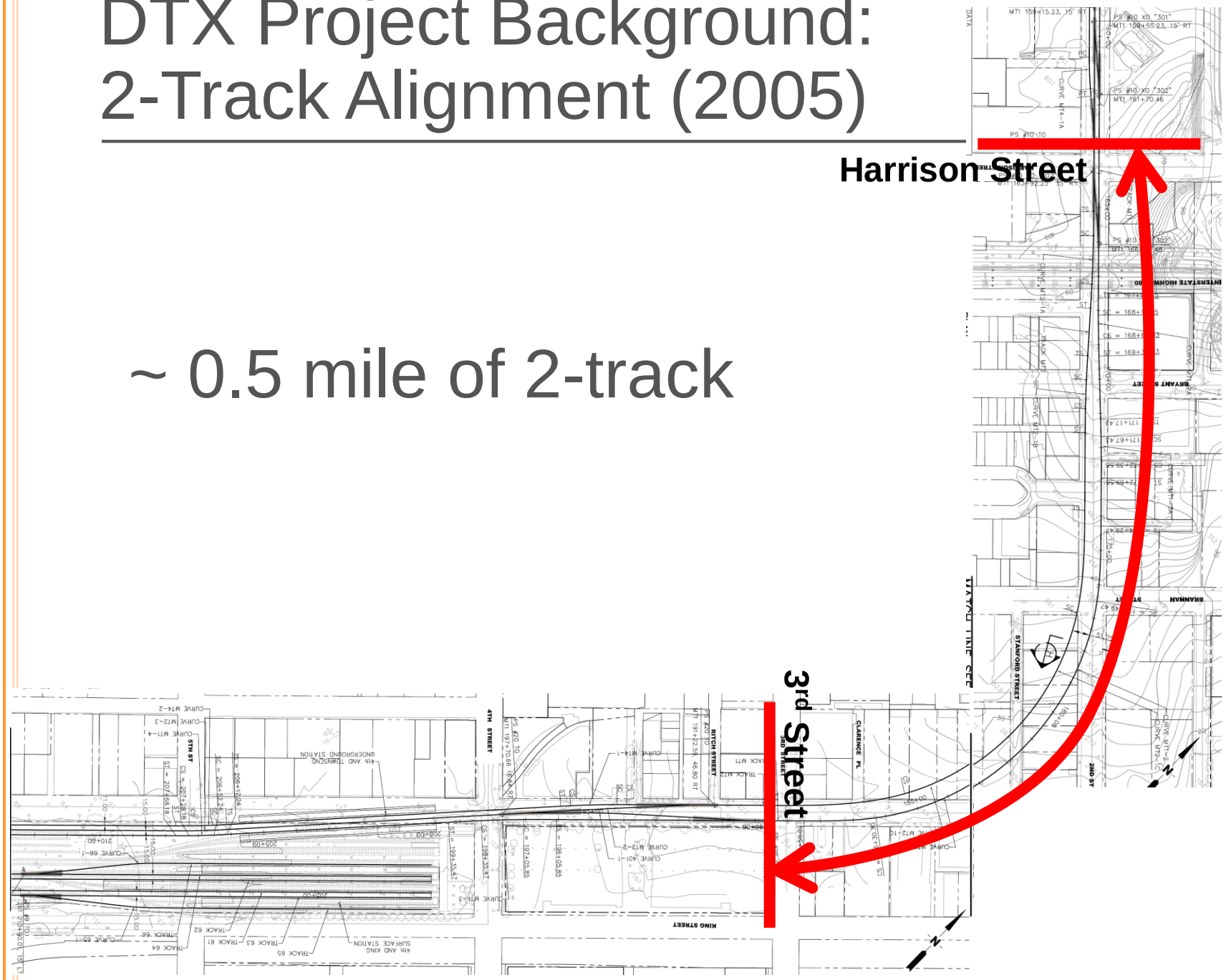
DTX Project Background: 2-Track Alignment (2005)

~ 0.5 mile of 2-track



DTX Project Background: Value Management Exercise (2006)

- March 30/31, 2006
- Distinguished Panel
- Approx. 30 recommendations
  - Railroad
  - Tunnel
  - Cut & cover
  - Constructability
- Independent implementation report
- Formal review process
- Provided recommendation for implementation: incorporate, defer, reject
- Provided record of decisions

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Loop Track VM Studies

Rail Operations: 3 Alternatives Studied

Alternative No. 1 *(1 Track Loop)*

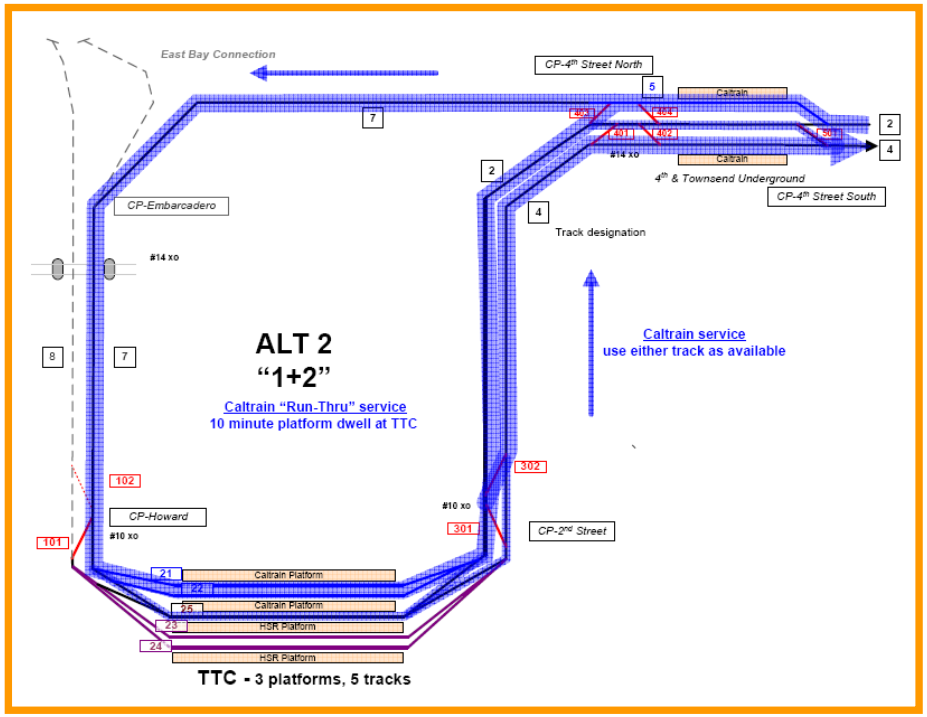
Single track loop w/ 4/5 track TTC

Alternative No. 2 *(1+2 Track Loop)*

Single track loop, two tracks on Second Street, w/ 5/6 track TTC

Alternative No. 3 *(2+2 Track Loop)*

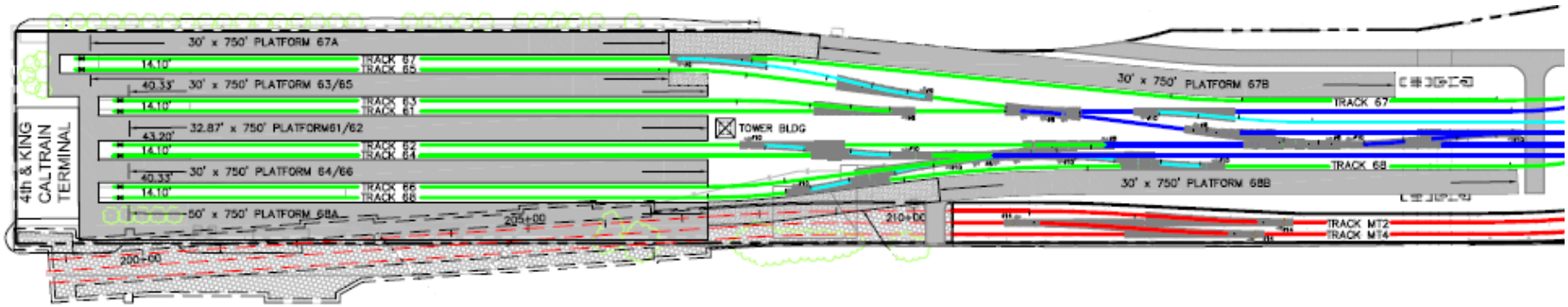
Double track loop w/ 5 track TTC



DTX Project Background:
Role of 4th & King Street Station/Yard

Caltrain Storage

- LPA / EIR included underground storage box
- Structure construction cost approx. $130 million
- TJPA-Caltrain coordinated to provide storage at-grade
- Significant cost saving in excess of $100 million



DTX Project Background: Value Management Conclusions (2006)

- Successful - $600-million in cost savings
  - Removed underground storage tracks at 4th/King
  - Removed tail tracks
  - Reviewed design assumptions for: communications, hazardous waste quantities
  - Reduced fill depth, make structural box taller
  - Included advance utility packages to advance construction
- Value Management: Early implementation a key to success; opportunity/flexibility to incorporate changes; obtain operator/third party concurrence
- Risk Management: Validated the construction approach; gained owner confidence in budget; offered scope for further cost reduction

Independent Design Validation

DB International GmbH

DB Group

- DB AG as Management Holding
- Vertically integrated Group structure
- Rating: Aa1 / AA

Turnover (billions of euros)	25.1
Employees (1000s)	216
Gross investments (billions of euros)	6.3

Passenger Transport

- No. 1 for European rail passenger transport
- No. 1 for European local public transport services
- No. 1 for bus transport in Germany

Turnover (billions of euros)	11.3
Employees (1000s)	53.8
Gross investments (billions of euros)	0.7

Infrastructure and Services

- No. 1 European transport infrastructure company
- No. 1 for rolling stock maintenance services in Europe

Turnover (billions of euros)	1.2
Employees (1000s)	76,3
Gross investments (billions of euros)	5.1

Transportation and Logistics

- No. 1 for European rail passenger transport
- No. 1 for European land transport
- No. 2 for air freight worldwide
- No. 3 for sea freight worldwide

Turnover (billions of euros)	12.4
Employees (1000s)	63,7
Gross investments (billions of euros)	424

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Independent Design Validation

DB International GmbH Design Validation

- Review Concept Design for:
  - Reasonability, Int'l Best Practice and Feasibility
- Provide Data on other Similar Configurations
- Provide Professional Opinion on:
  - Operational Concept
  - Alignment Geometry
  - Trackwork
  - Platforms
  - HSR Vehicles
- Recommendations

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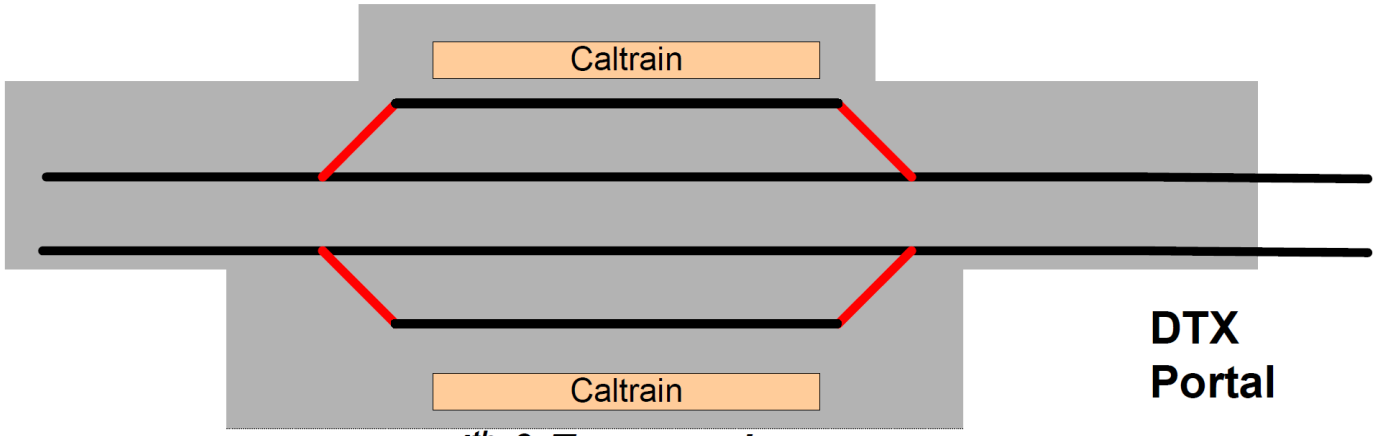
DTX Project Background: 4-track 4th/Townsend St Station (2008)



4th & Townsend Underground

The ***4th & Townsend Underground Station*** is a major design variable. Stopping the Caltrain off-peak and "local" trains there means that a third track **must** be constructed to bypass the station. Without the third track, the delays to following trains are excessive. A complex interlocking is needed at CP 4th Street if there is a transition from three tracks to two tracks or if storage at 4th Street is also provided. Stopping at *4th & Townsend Underground Station* means that at least half the total tunnel length will be three tracks, no matter what the tunnel construction techniques used.

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DTX Project Background: Refined LPA Recommendation (2008)

Refined DTX LPA Configuration included:

- 2 Track lead to DTX tunnel system
  (until just before 4th & Townsend Street Station)
- 3 Track Tunnel System on Townsend & 2nd St.
- 3 Platforms with 6 Tracks in TTC
- At-Grade Rail Car Storage within Caltrain Yard
- A Fourth/Townsend Underground Station
- Defer Tail Tracks until operationally required by HSR

DTX Project Background: Refined LPA (2008)

- Adopted by TJPA Board in April 2008

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DTX Project Timeline

2009 – 2011

- May 2009 DTX Design Criteria
- July 2010 Preliminary Engineering on RLPA complete
- Preparation of CHSRA Design Variance Requests
- April 2011 Preliminary Engineering on Tunnel-to-Tunnel Connection complete
- May 2011 CHSRA Design Variance Requests first batch submitted by TJPA
- June 2011 CHSRA Design Variance Requests first batch approved by CHSRA

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CHSRA Design Guidance

Platform Length

Desirable: 1,410 ft

Minimum: 1,370 ft

Exceptional: 1,315 ft

Transit Center Platforms:

1,335 ft

Minimum Horizontal Radius

Preferred: 1,000 ft

Absolute: 650 ft

Throat Structure Minimum Radius:

650 ft

Other Design Variances Received

- Platform Taper
- Platform Gap
- Platform Approach Tangent
- Bumper Post
- Platform Setback to Obstruction
- Platform Width
- Track Centers
- Vertical Clearance & OCS

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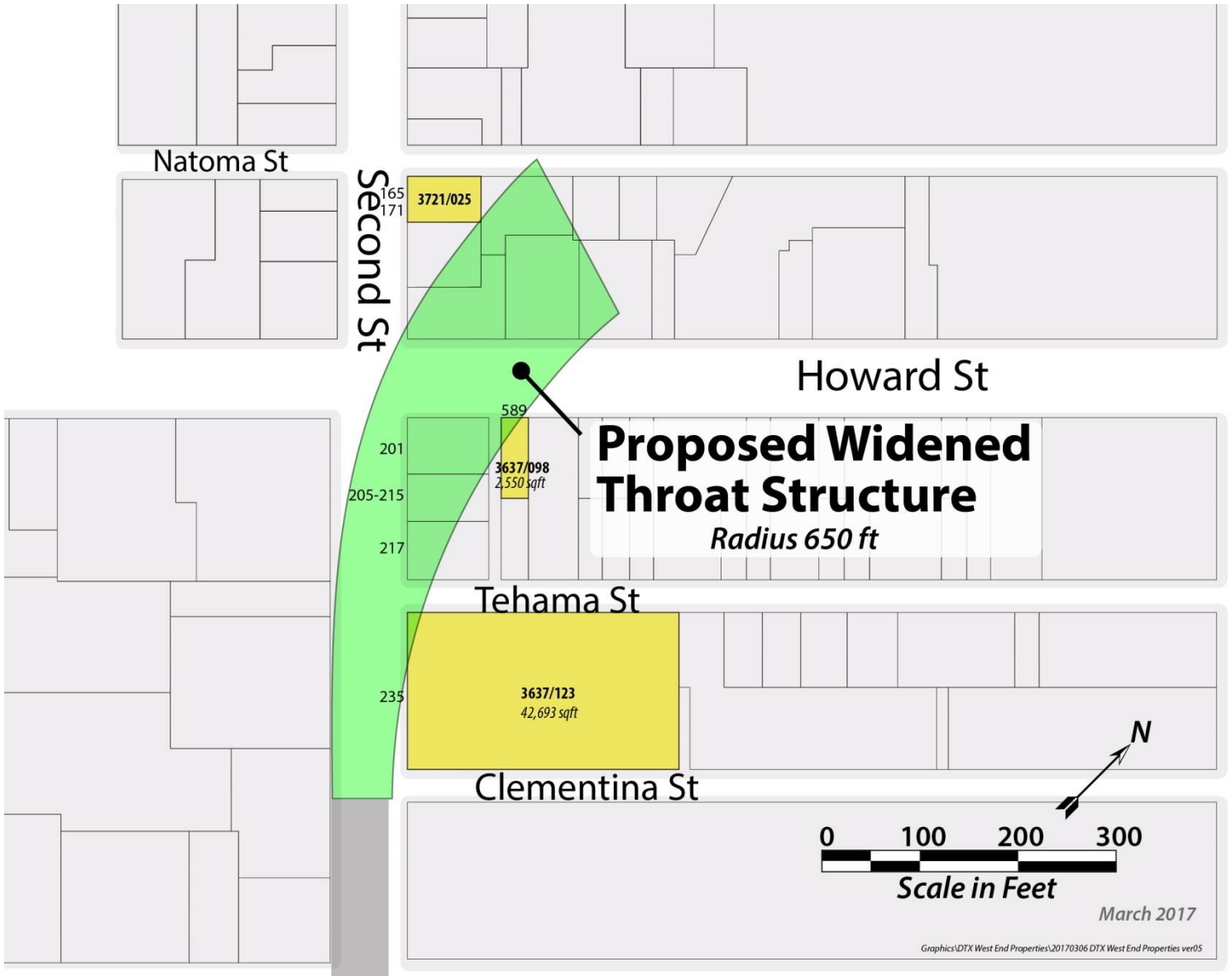
Right-of-Way



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DTX Project Timeline

2012 – 2017

- January 2013 SPUR alternate alignments presentation
- March 2013 CHSRA Design Variance Request 2nd batch submitted by TJPA
- May 2013 CHSRA Design Variance Request 2nd batch approved by CHSRA
- September 2013 Caltrain, CHSRA and FRA sign-off on trainbox geometry
- January 2014 Railyard Alternatives and I-280 Boulevard Feasibility Study RFP & TJPA response
- 2014 Coordination with Caltrain on realigned Fourth and Townsend St Station – center platform established
- December 2015 Draft SEIS/EIR published for public comment
- July 2016 PE Update started
- January 2017 Caltrain Design Variance on Grade approved by Caltrain

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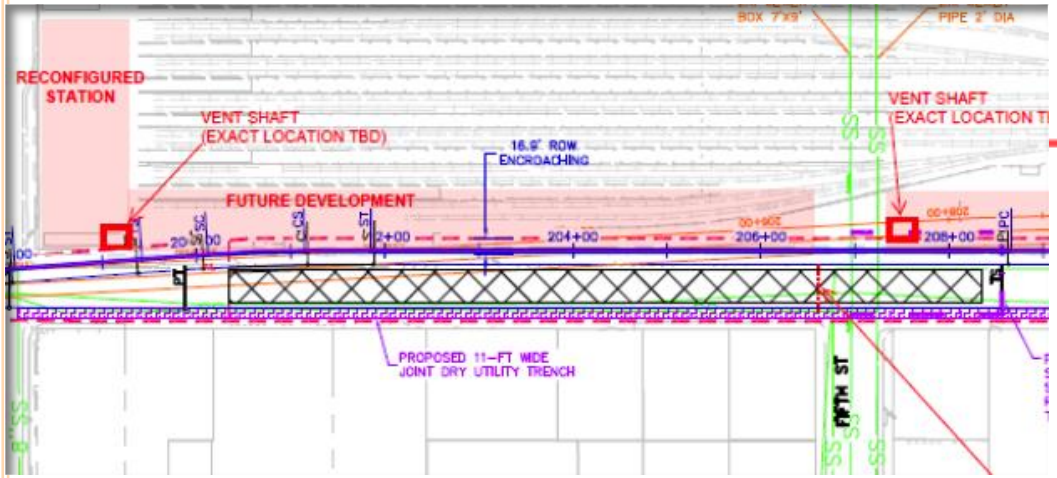
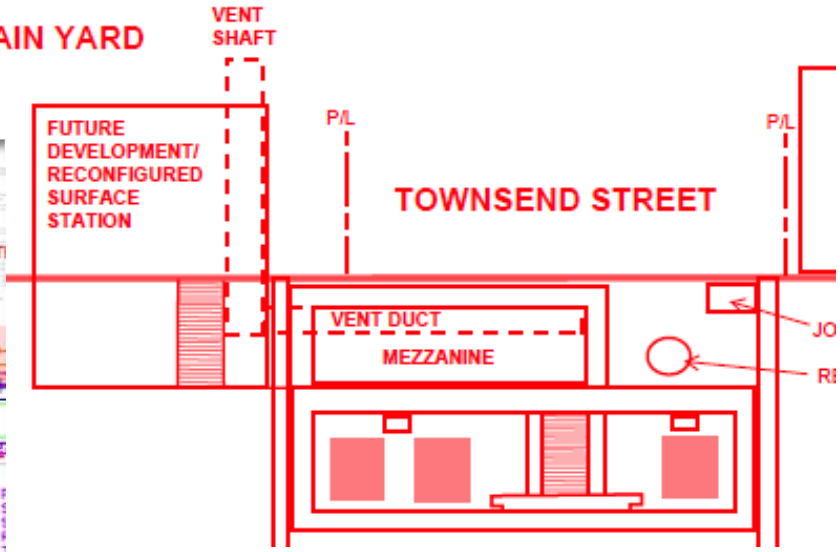
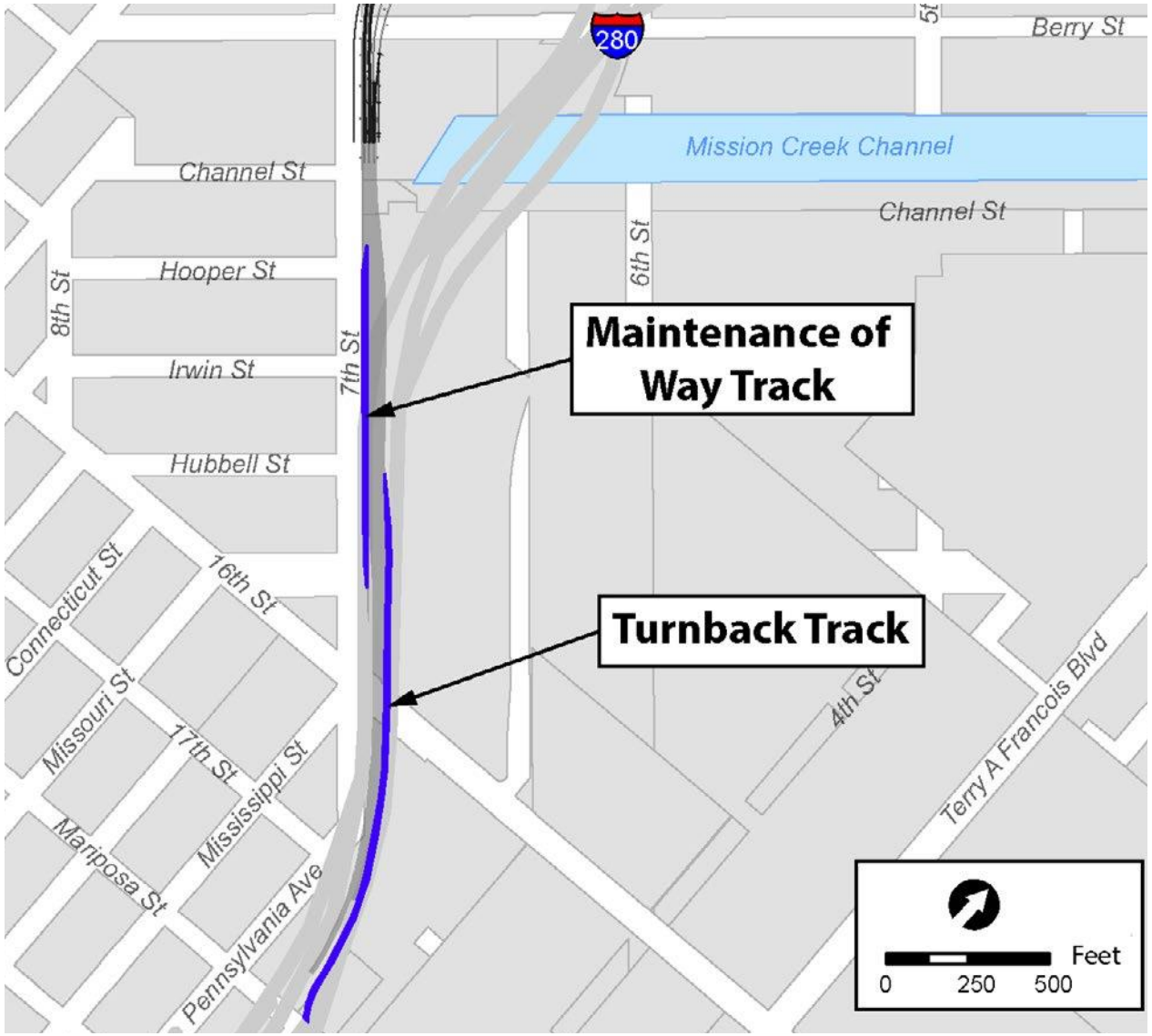
Fourth and Townsend Street Station

- Center platform between two northernmost tracks
- Station aligned within Townsend Street
- Developable frontage property in Caltrain Yard
- Mezzanine would connect with surface station/development





Maintenance-of-Way & Turnback Track



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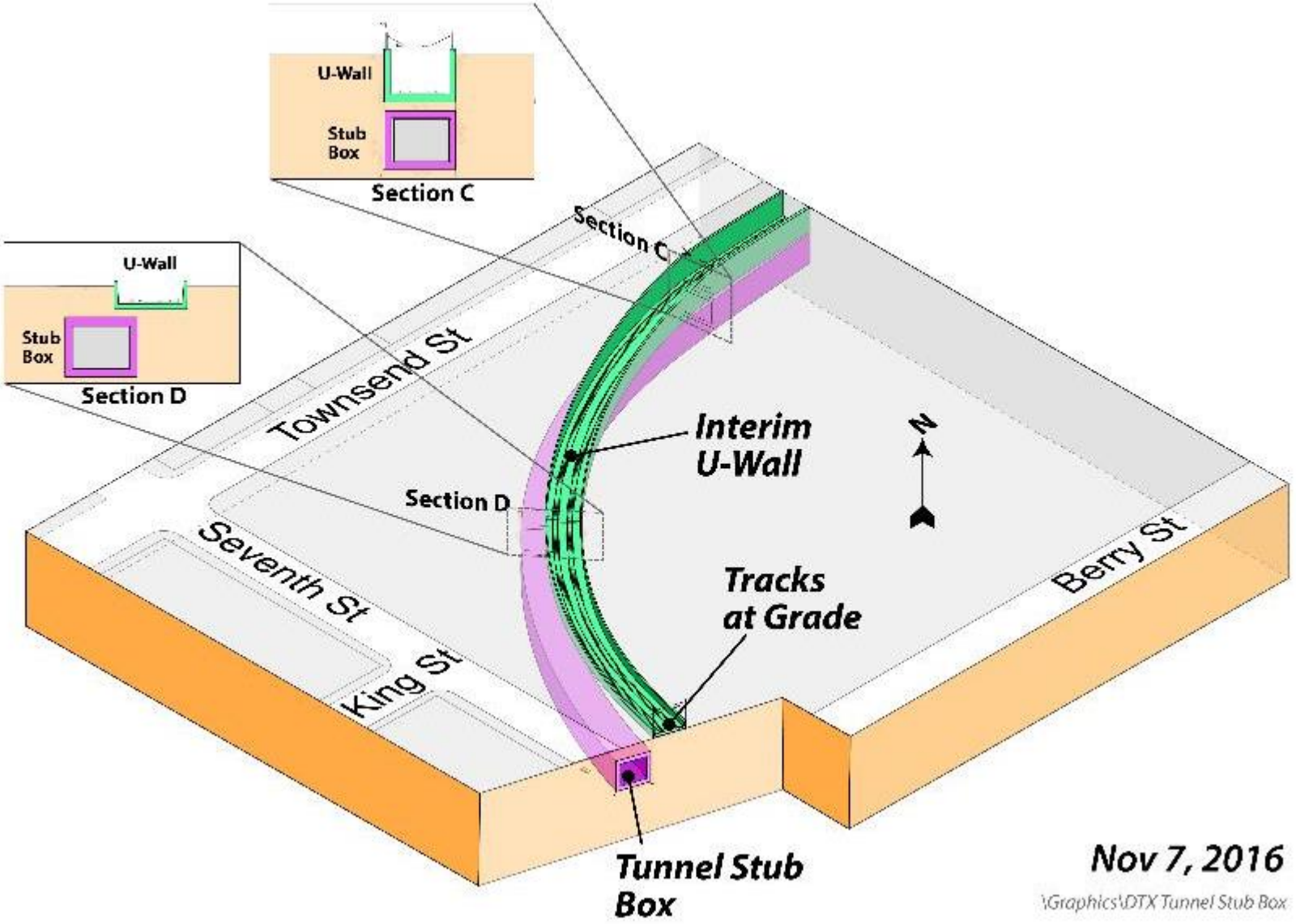
Tunnel Stub Box Provision for Future Grade Separation Tunnel



Tunnel Options Study Purpose & Goals

- Initiated to address potential impacts resulting from cut-and-cover construction
- Goals:
  - Minimize surface disruption and socio-economic impacts
  - Reduce cut-and-cover tunnel extent
  - Identify feasible mined tunnel construction methods for further study
  - Identify major infrastructure constraints

Relative Cut-and-Cover Extents (Baseline vs. Tunnel Options Study)

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Rail Operations Studies

Rail Operations Key Issues

- Service
  - Number of Trains
  - Peak Period Headways
  - Schedule Performance
- Engineering
  - Number of Tracks
  - Tunnel Construction
  - Platform Assignments
  - Tail Tracks
  - Storage Tracks
  - 4th & Townsend Station

Rail Operations

Simulation Inputs:

- Consist Length
- # Trains
- Train headways
- Platform dwell time
- Platform allocation
  - shared /dedicated
- 4th & Townsend Stn.
  - stop/bypass

Output: Configuration

- Tunnels
  - 2 track v 3 track
- Storage Needs
  - Tail tracks
  - Underground Storage Box
- 4th & Townsend Stn.
  - 1 v 2 bypass tracks

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Rail Operations Study Goals

- Determine the infrastructure needs to deliver a modern rail terminal for both current and future train service
  - Allow for future expansion of rail service
- Work in collaboration with CHSRA and Caltrain

DTX Project History

- Continuous progression of analyses
  - 2/3-track alternatives
  - Service levels for operators
  - Equipment types
  - Shared/dedicated platforms
  - Station dwells at Transit Center
  - “buildability” of alternatives
  - NFPA 130 ventilation-signal coordination
  - Impacts of the Operators’ Blended Service plans on the Transit Center and DTX

LPA Analysis (2003)

- 6 Transit Platform tracks
  - Tail tracks behind Tracks 21-24
  - Dedicated or shared platform tracks
- 6 HSR TPH in the peak
  - 30/20 minute Dwells
- 6 Caltrain TPH in the peak
  - 20/15 minute dwells
- 3-Track tunnel
  - 2-track alternative
- #14, 30 mph crossovers at all locations
- Outside platforms at 4th & Townsend
- 4 tracks to DTX from Bayshore (new tunnel)

Stress Analyses of the LPA (2005-2008)

- Dedicated/shared platforms evaluated
- Stressed conditions
  - delays at 2nd Street and Transit Center (45 minute)
  - Estimated recovery times
- Different Caltrain Equipment types
  - EMU
  - ALP-46 push/pull
    - Grade recovery at portal
- 2/4 Track alternatives at 4th & Townsend Station

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Alternatives to LPA Alignment

- Loop track under the Embarcadero and Townsend Street
  - Run-through Transit Center station
    - 4 platform tracks
- Two-Level Transit Center (viz., East Side Access)
  - 12 platform tracks
- Alternative alignments
  - 3rd Street
  - 7th Street/Mina
  - Operationally similar to the LPA, but engineering issues
  - Ventilation (NFPA 130) considerations
    - Shorten interlocking limits, #10 crossovers at 2nd Street

Blended Service 2011 to 2017

- Increasing involvement of the operators-CHSRA and Caltrain
- Development of the Blended Service concept
  - 2 tracks from Bayshore to DTX
  - 10 trains per hour on the Peninsula Subdivision
  - 6 Caltrain/4 HSR in peak
  - Dedicated platforms at Transit Center
  - Center platform at 4th & Townsend
  - Caltrain selection of Stadler EMU train sets
    - Door height compatibility issues with HSR train sets
  - HSR service with 200-meter trains sets to start
  - NFPA 130 ventilation-signal coordination

Current Rail Operations Simulations

- Analyzed both two- and three-track alignments for DTX
- Operators provided:
  - Train set inputs
  - Proto-typical timetable that includes blended service to San Jose
  - Dwell times
  - Assumed incident durations

Train Sets

- CHSRA
  - 200-meter (656') bi-level EMU's
  - 400-meter "double train sets" in the future
  - "high level" door height
- Caltrain
  - Stadler KISS bi-level EMU's
  - 8-unit train sets, 200-meter (656')
    - 4 power cars, 4 idler cars
    - "low level" doors

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Train Performance

Prototypical Schedule Operating Assumptions

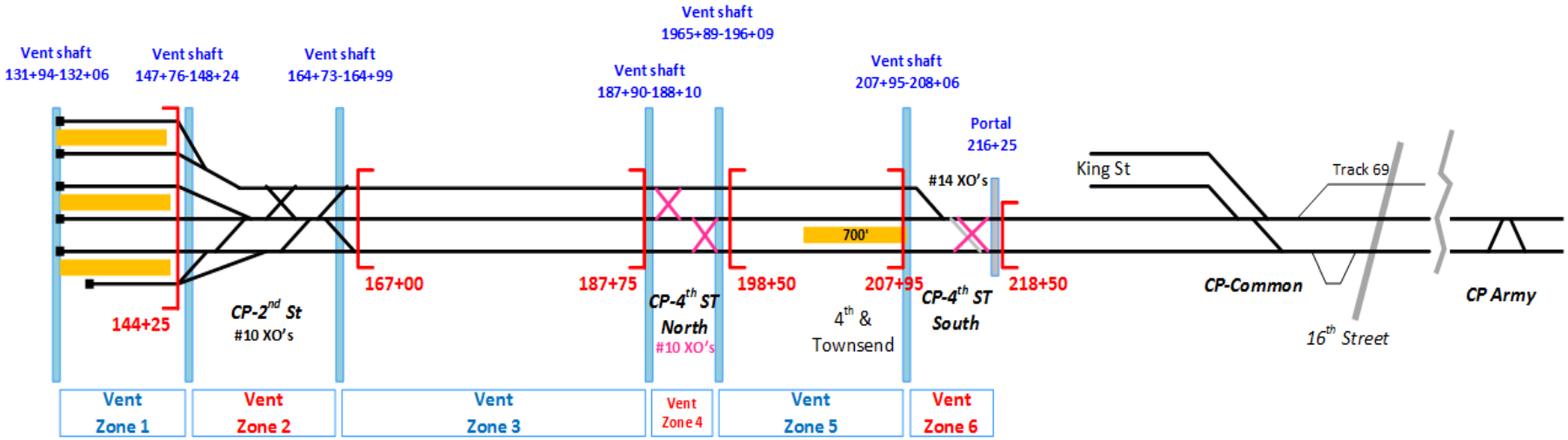
- Turn Times and Dwell Times
  - Transit Center Turn Times
    - High-speed Rail
      - Peak schedules, **35-43** minutes
      - Minimum **24 minutes***
    - Caltrain
      - Peak schedules, **20-24** minutes
      - Minimum, **16** minutes
  - 4th & Townsend Dwell Times
    - High-speed Rail, 2-minutes
    - Caltrain, 2-minutes
  - 22nd Street Dwell Times
    - Caltrain only, 1-minute

** A sensitivity analysis was performed using turn times of 20 minutes for CHSRA, the results indicated that 3 tracks were still required.*

Operating Assumptions

- Crossover speeds
  - #14 turnouts, 30 mph
  - #10 turnouts, 20 mph
- Signal-Ventilation coordination
  - NFPA 130 guidelines
  - 1 train per Vent Zone, per track
- “Comfort” Braking rate
  - 1.563 mph per second

Signal-Ventilation Coordination



DTX Tunnel Ventilation
and required Signal coordination 3-Track Tunnel

- Trains cannot stop in Zones 2-4-6
- Home signals are clear of ventilation shafts
- Trains cannot advance unless next vent zone ahead is open

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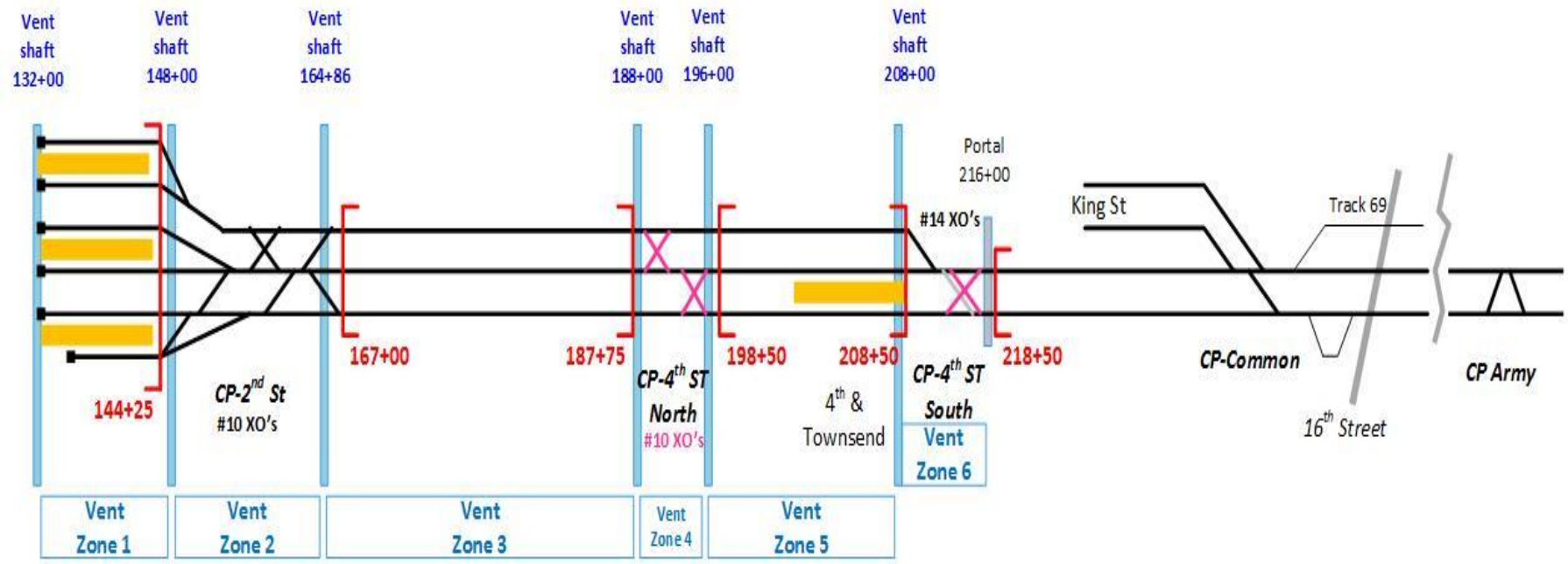
Rail Operations Simulations

- "Unacceptable delay" is anything that impacts the ability to deliver at least 95% on time performance.
- "Systemwide delays" means that single-tracking in San Francisco yields delay to **all** trains on the system, meaning all passengers are affected by a single event.
- Incidents that cause train delay are to be expected; they are not exceptional:
  - Medical issues
  - Longer dwells caused by bike loading/unloading or disabled passenger loading/unloading

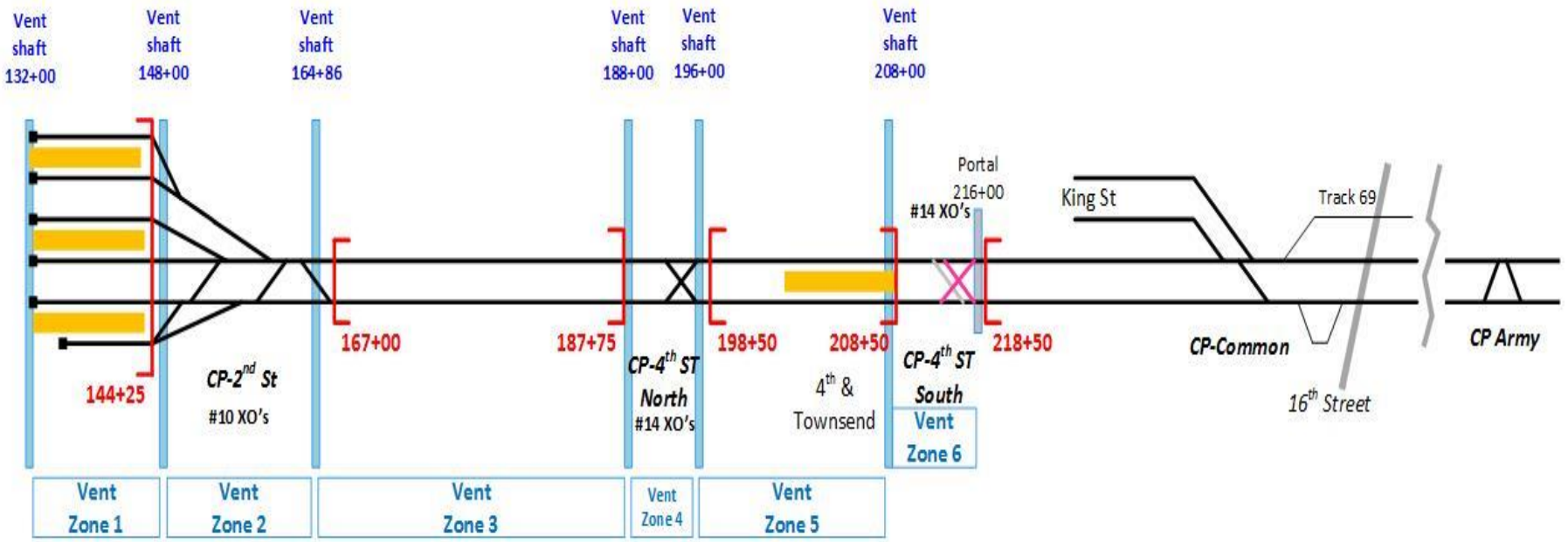
Study Infrastructure: 3 Track Tunnel



DTX Tunnel Ventilation

and required Signal coordination 3-Track Tunnel

Study Infrastructure: 2 Track Tunnel



DTX Tunnel Ventilation

and required Signal coordination 2-Track Tunnel

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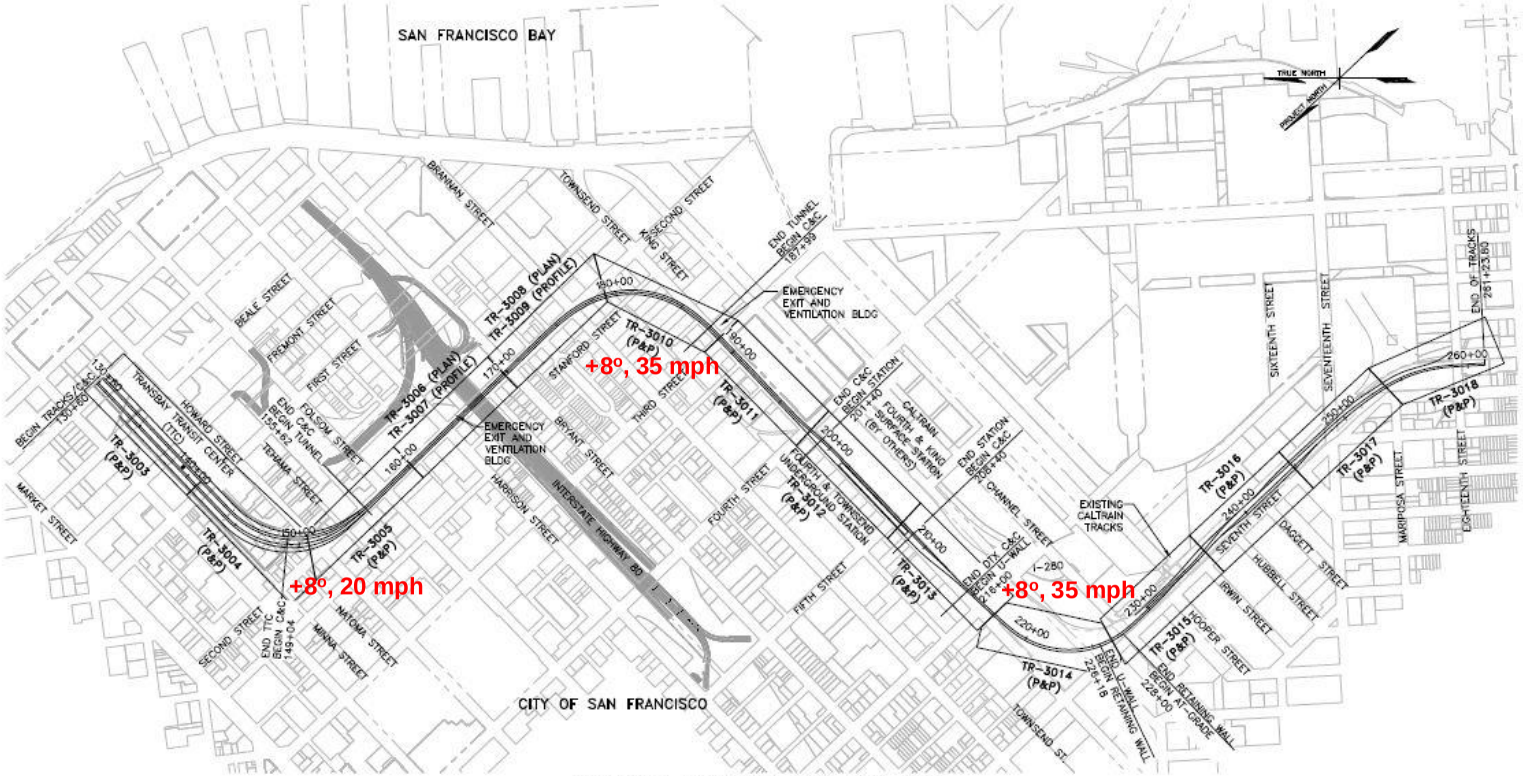
DTX Horizontal & Vertical Alignment

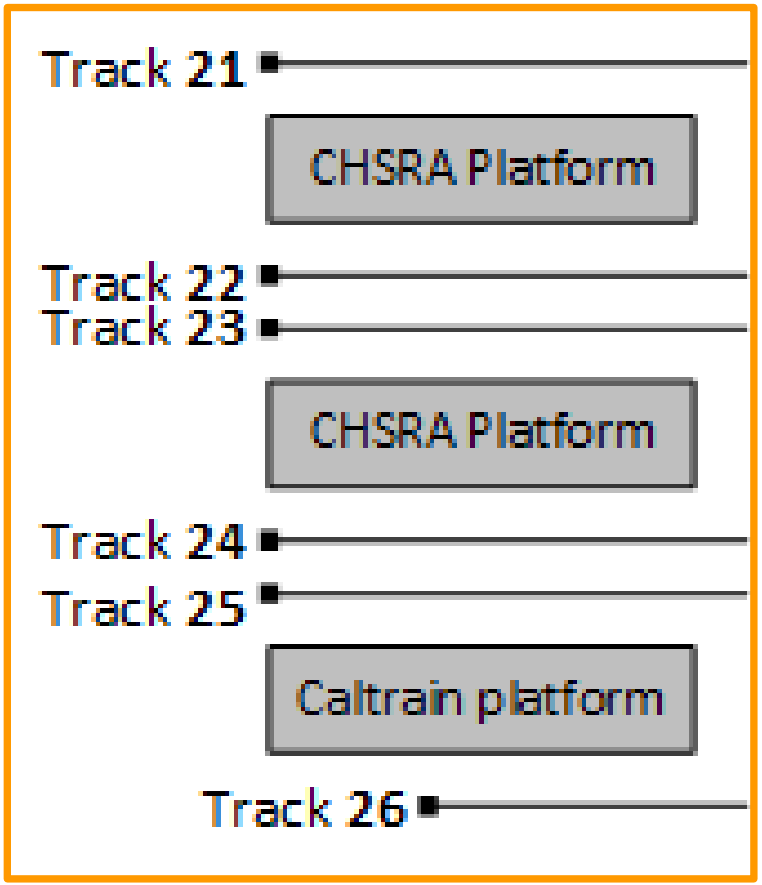


Timetable Inputs (4-4-2)

Direction	Time	Trains	To CHSRA-TC	To Caltrain -TC	To Caltrain-King St
North	6AM-7AM	8	4	4	
North	7AM-8AM	10	4	4	2
North	8AM-9AM	10	4	4	2
			From CHSRA-TC	From Caltrain-TC	From Caltrain-King St
South	6AM-7AM	10	4	4	2
South	7AM-8AM	10	4	4	2
South	8AM-9AM	10	4	4	2

Platform Assignments: Transit Center

- Dedicated Tracks

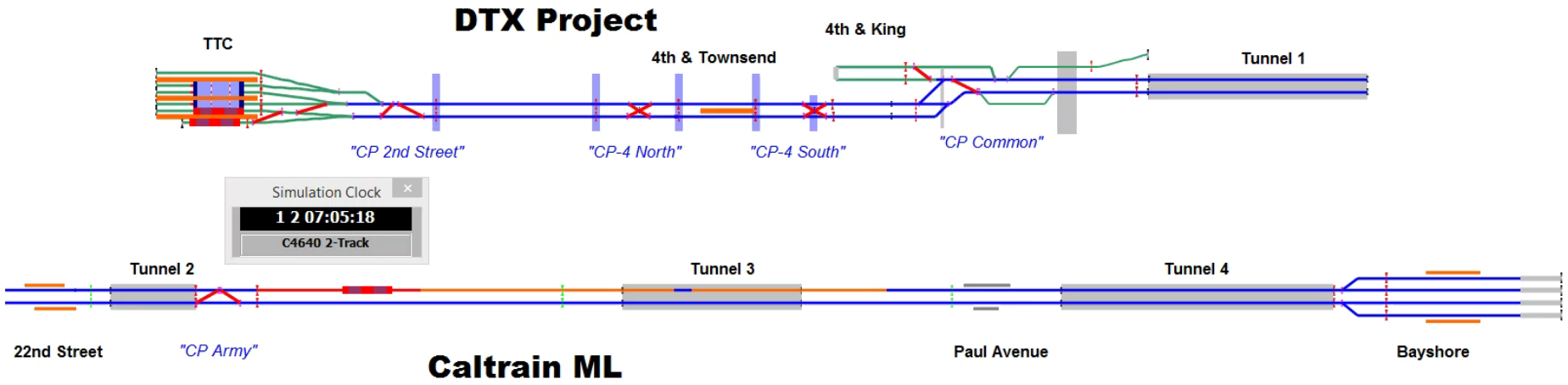


Simulations

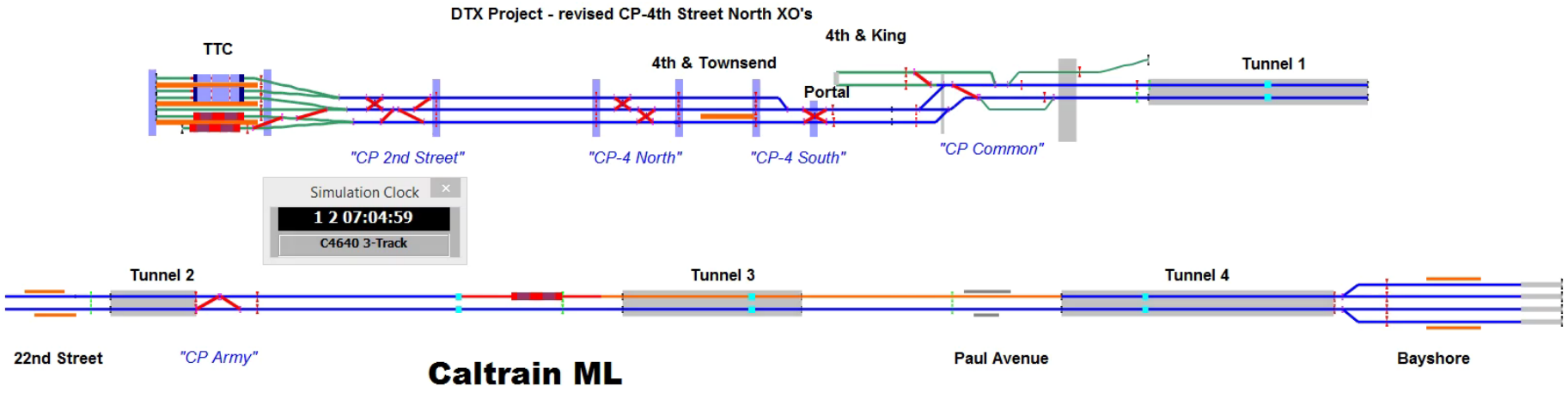
Calibration Run Results

- 3 Track
  - All trains on-time at Bayshore southbound
  - 2 Caltrain trains 14-16 seconds late arriving at the transit center inbound
- 2 Track
  - All trains on-time at Bayshore southbound
  - 2 Caltrain trains 14-16 seconds late arriving at the transit center inbound
  - 4 CHSRA trains delayed 1:08—1:14 entering the transit center

2-Track Operation



3-Track Operation



Simulation Results: Perturbed

- 20-minute incident event on Caltrain Track 25 at the transit center
- 20-minute incident event on in the inbound platform track at (MT2) 4th and Townsend Street Station
- 20-minute incident event on in the outbound platform track (MT4) at 4th and Townsend Street Station
- 20-minute event that closes the DTX tunnel MT4 for train movements between *CP-2nd Street* and *CP-4th Street North*

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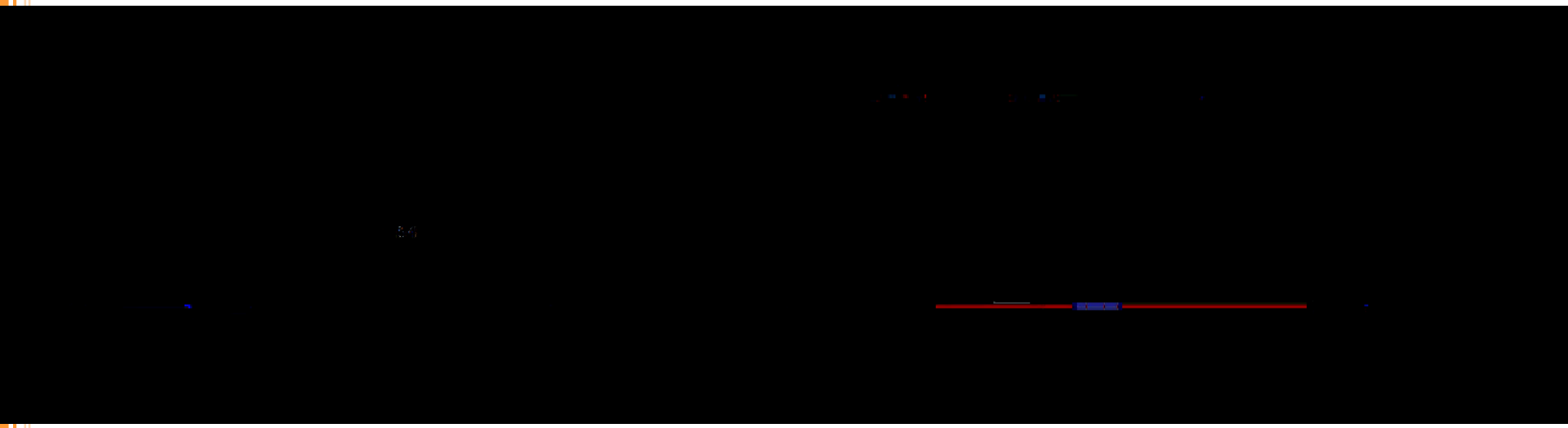
20-minute Delay at Transit Center

20-minute Emergency at Transit Center	2-Track Dedicated	3-Track Dedicated
Trains per Hour	4-4-2	4-4-2
Inbound Caltrain trains delayed	4	4
Inbound Caltrain delay minutes: seconds	14:47	15:03
Inbound HSR Trains Delayed	5	0
Inbound HSR delay minutes	18:25	0:00
Outbound Caltrain Trains Delayed	2	2
Outbound Caltrain Delay minutes:seconds	24:01	23:57
Outbound Caltrain, non-incident Delay minutes:seconds	5:56	5:55
Outbound HSR Trains Delayed	1	1
Outbound HSR Delay minutes:seconds	4:39	4:36
Outbound HSR, non-incident Delay minutes:seconds	4:39	4:36

20-minute Delay on Caltrain Track 25

2-Track



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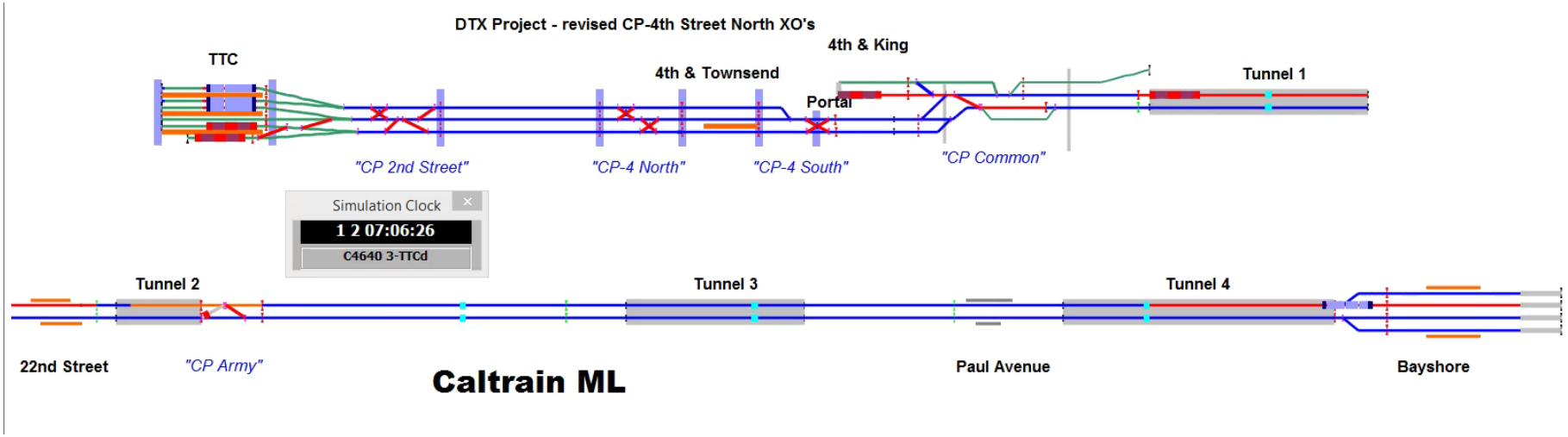
20-minute Delay on Caltrain Track 25

- 3-Track



20-minute Delay at 4th & Townsend Inbound

20-minute Emergency hold at 4th & Townsend St. Station	MT2 Inbound	MT2 Inbound
Timetable	C4640	C4640
Tunnel tracks	2-Track	3-Track
Transit Center platforms	Dedicated	Dedicated
Trains per Hour	4-4-2	4-4-2
Inbound Caltrain trains delayed	3	3
Inbound Caltrain delay minutes:seconds	26:23	21:58
Inbound HSR Trains Delayed	6	1
Inbound HSR delay minutes:seconds	22:01	2:59
Outbound Caltrain, Trains Delayed	3	1
Outbound Caltrain Delay minutes:seconds	12:49	8:44
Outbound Caltrain Delay, non-incident minutes:seconds	2:34	0:00
Outbound HSR, Trains Delayed	1	0
Outbound HSR Delay minutes:seconds	1:33	0:00
Outbound HSR Delay, non-incident train minutes:seconds	1:33	0:00

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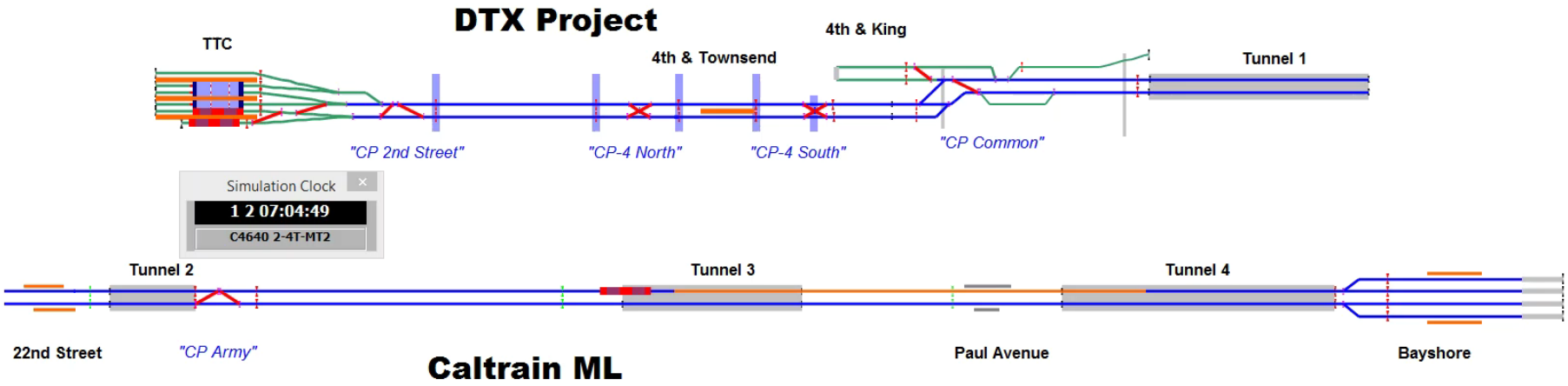
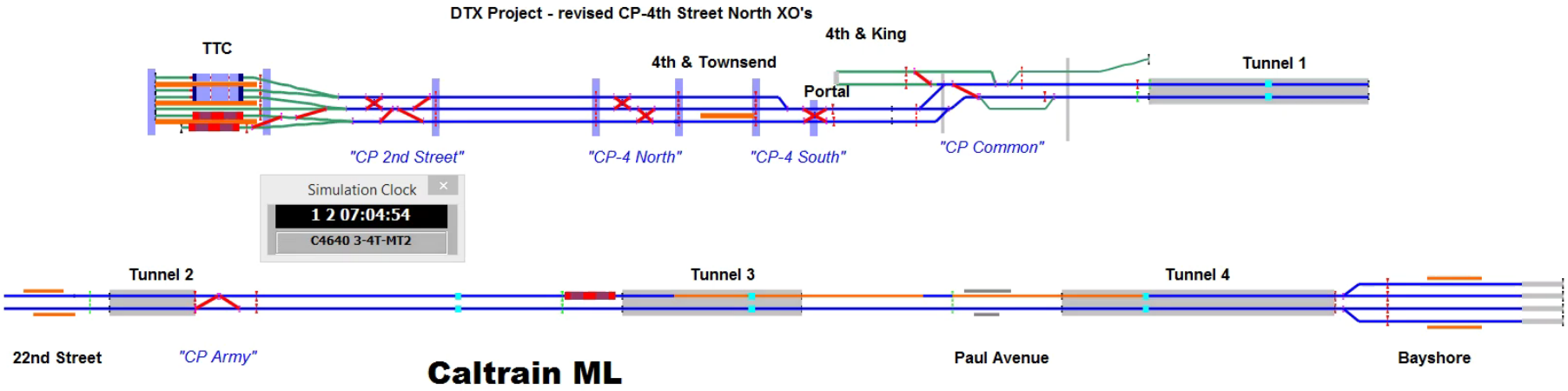
20-minute Delay at 4th & Townsend, Track 2 (Inbound)

- 2-Track



20-minute Delay at 4th & Townsend, Track 2 (Inbound)

- 3-Track



20-minute Delay at 4th & Townsend Outbound

104

20-minute Emergency hold at 4th & Townsend St. Station	MT4 Outbound	MT4 Outbound
Timetable	C4640	C4640
Tunnel tracks	2-Track	3-Track
Transit Center platforms	Dedicated	Dedicated
Trains per Hour	4-4-2	4-4-2
Inbound Caltrain trains delayed	1	1
Inbound Caltrain delay minutes:seconds	0:16	0:16
Inbound HSR Trains Delayed	4	1
Inbound HSR delay minutes:seconds	5:56	2:09
Outbound, CaltrainTrains Delayed	2	2
Southbound Delay minutes:seconds	20:36	17:37
Southbound Delay, non-incident train minutes:seconds	4:39	1:40
Outbound, HSR Trains Delayed	2	1
Southbound Delay minutes:seconds	2:39	1:39
Southbound Delay, non-incident train minutes:seconds	2:39	1:39

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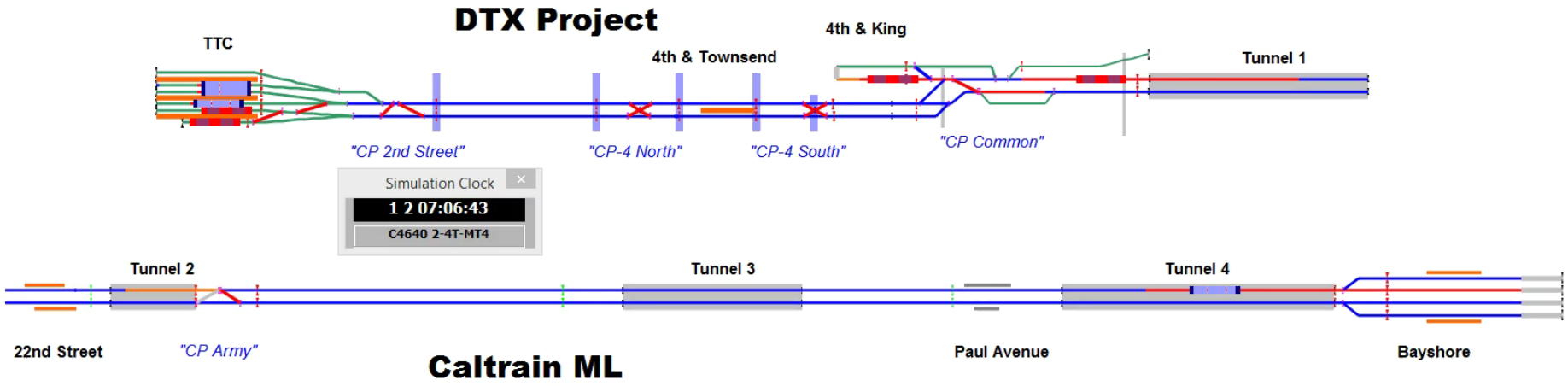
20-minute Delay at 4th & Townsend, Track 4 (Outbound)

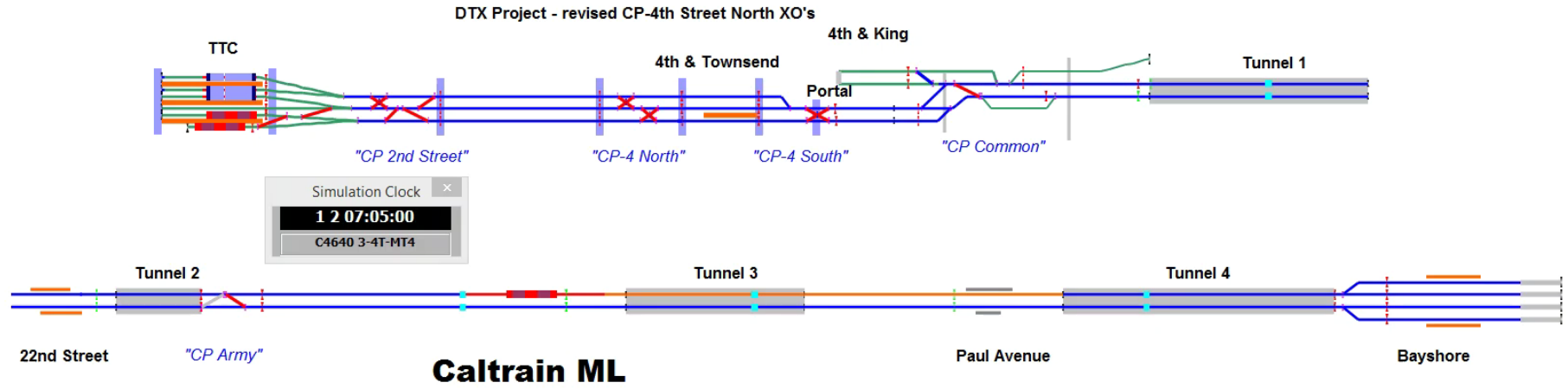
- 2-Track



TJPA
TRANSBAY JOINT POWERS AUTHORITY

20-minute Delay at 4th & Townsend, Track 4 (Outbound)

- 3-Track



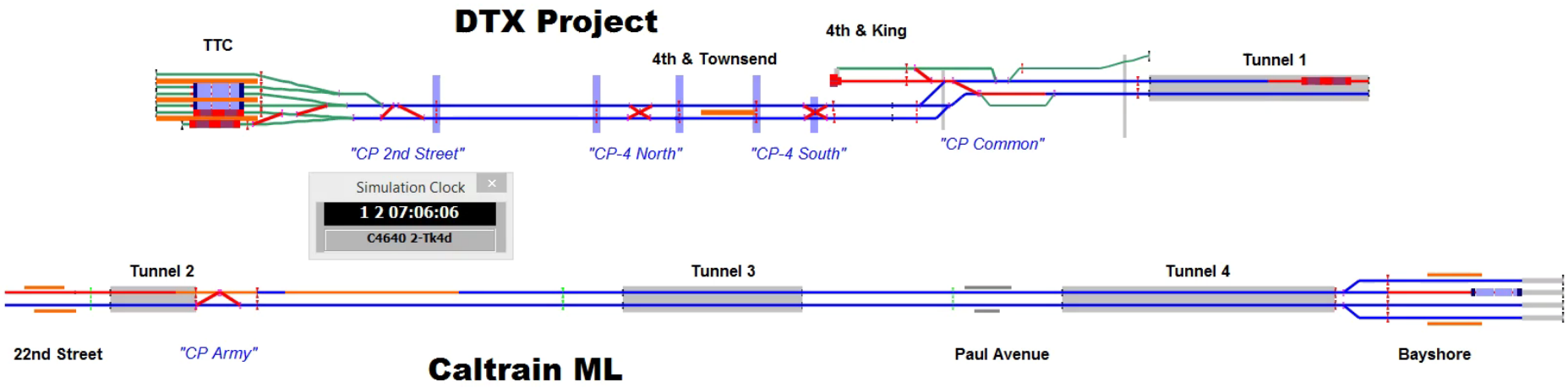
20-minute Tunnel Closure on MT4 between *CP-2nd St & CP-4th St North*

20-minute tunnel track delay	MT4 188+00	MT4 188+00
Timetable	C4640	C4640
Tunnel tracks	2-Track	3-Track
Transit Center platforms	Dedicated	Dedicated
Trains per Hour	4-4-2	4-4-2
Inbound Caltrain trains delayed	2	1
Inbound Caltrain delay minutes:seconds	0:45	0:16
Inbound HSR Trains Delayed	4	0
Inbound HSR delay minutes:seconds	3:45	0:00
Outbound Caltrain Trains Delayed	0	0
Outbound Caltrain Delay minutes:seconds	0:00	0:00
Outbound HSR Trains Delayed	2	1
Outbound HSR Delay minutes:seconds	7:10	1:50

TJPA
TRANSBAY JOINT POWERS AUTHORITY

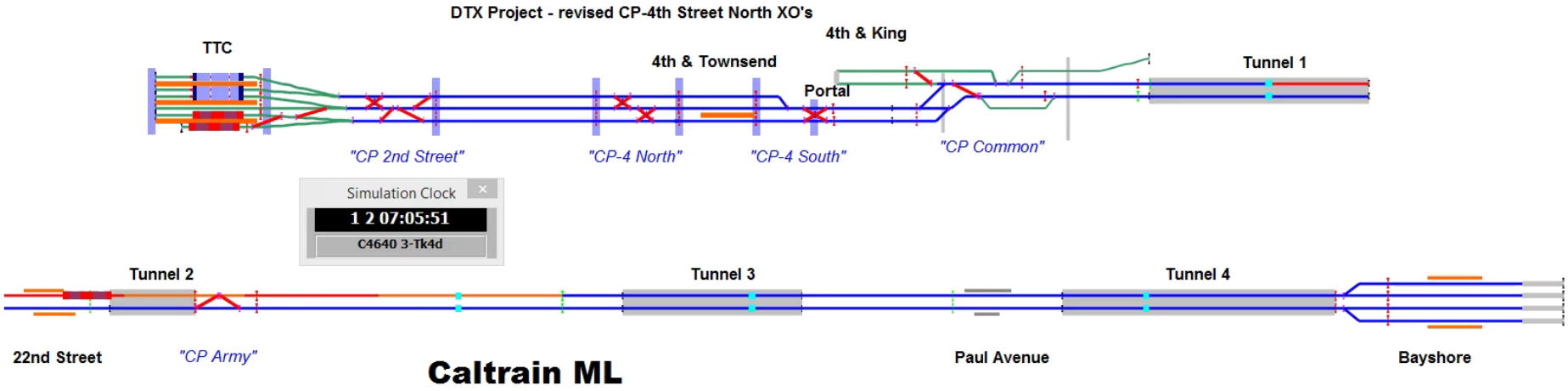
20-minute Tunnel Closure on MT4 between *CP-2nd St & CP-4th St North*

- 2-Track



20-minute Tunnel Closure on MT4 between *CP-2nd St & CP-4th St North*

- 3-Track



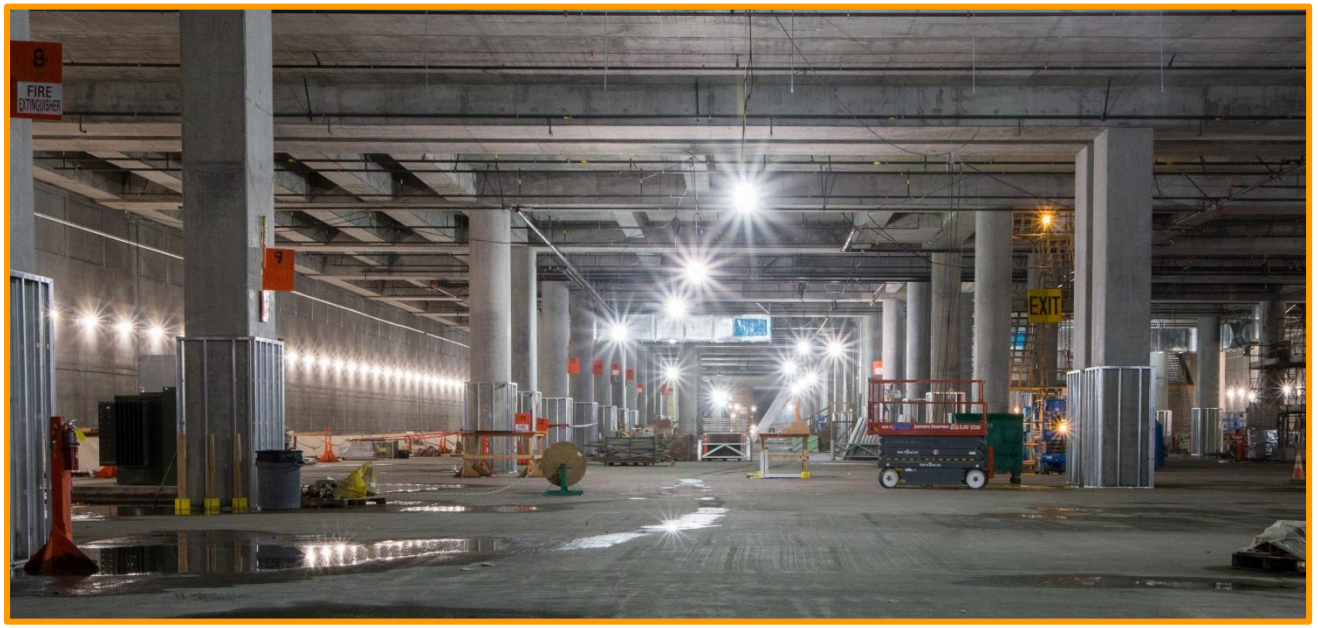
Conclusions

- Precision scheduling of the CHSRA/Caltrain *Blended Service* between San Francisco and San Jose requires 3-Track in DTX to meet “95% on time” schedule performance
- Delay scenarios all recover more quickly using a 3-track DTX
- A 3-track DTX allows for future growth

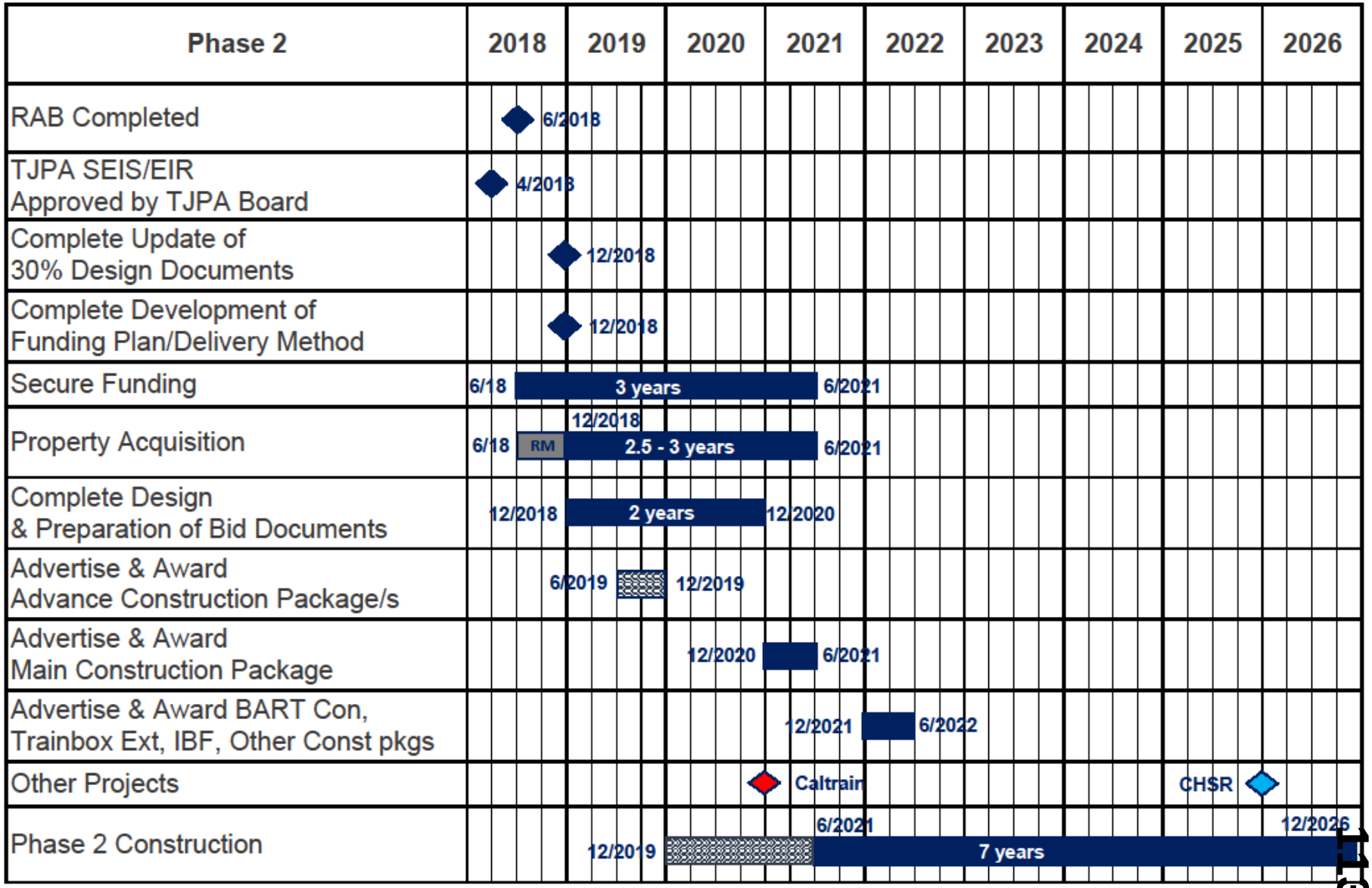
Next Steps

Phase 2 Next Steps

- Complete updates to Preliminary Engineering design and tunnel options study addenda
- Receive TJPA Board approval of SEIS/EIR
- Update funding plan with results from ridership study
- Develop delivery plan based on the results of the RAB Study



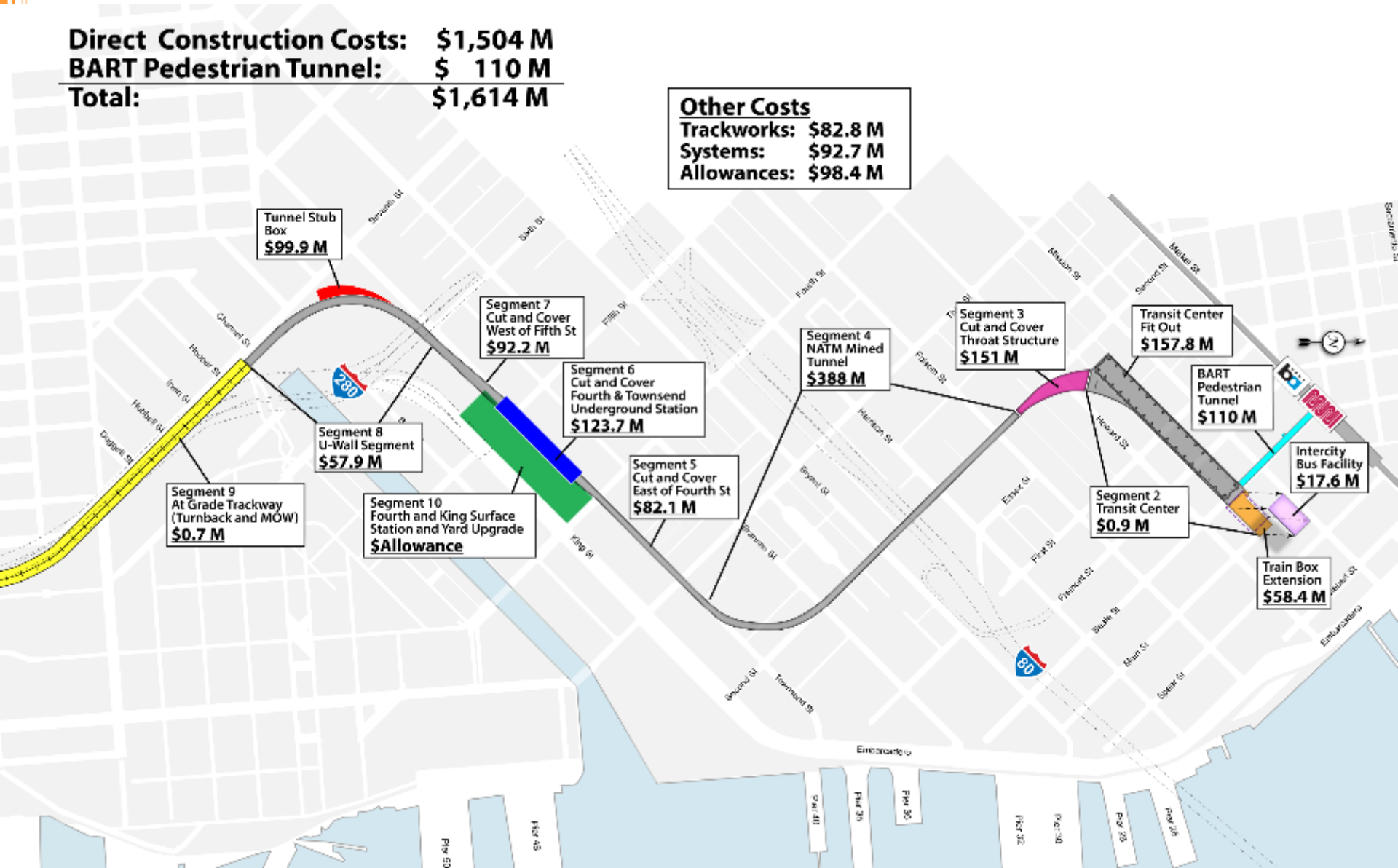
Phase 2 Timeline

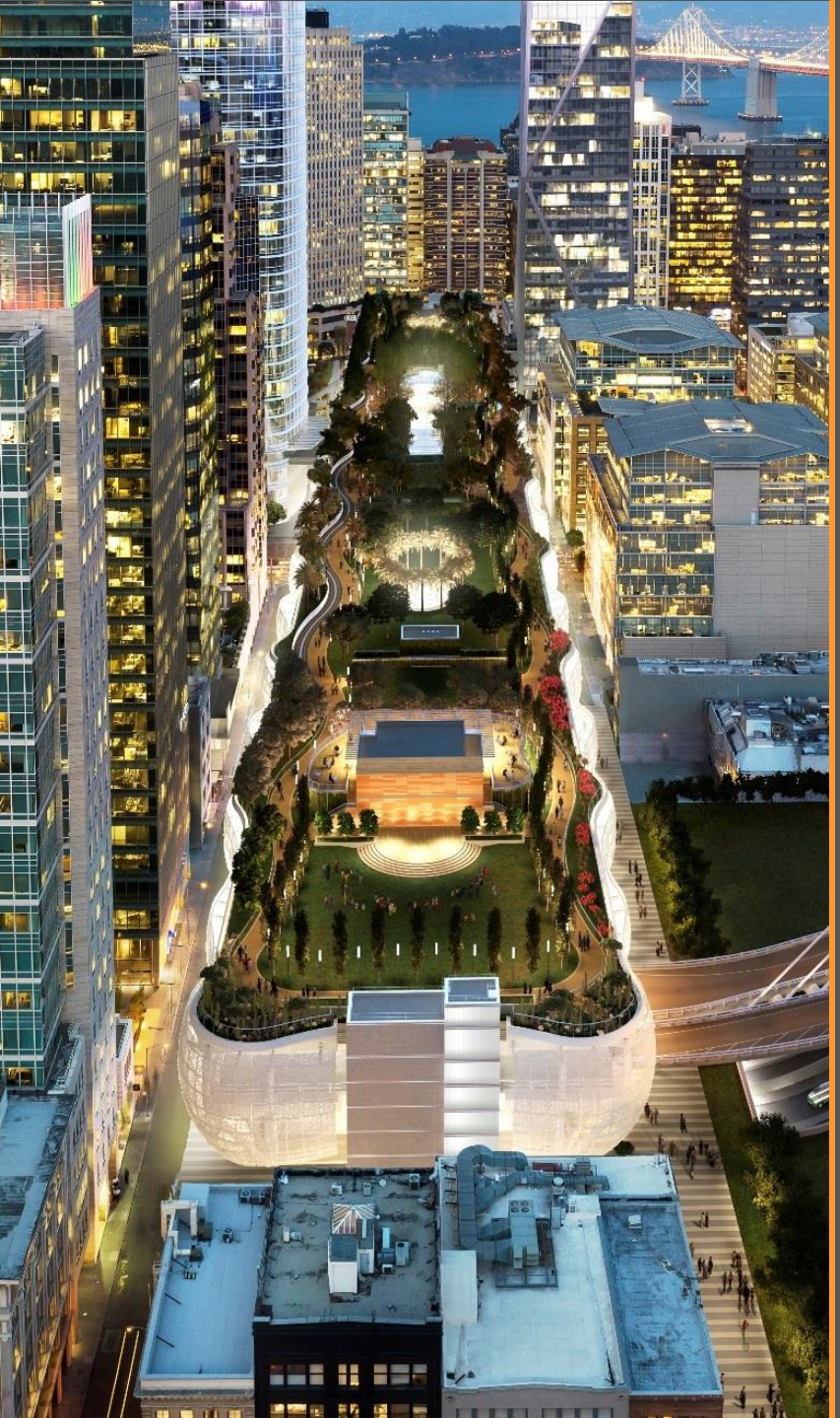


Phase 2 Direct Construction Cost Estimate Breakdown

Direct Construction Costs: $1,504 M
BART Pedestrian Tunnel: $ 110 M
Total: $1,614 M

Other Costs
Trackworks: $82.8 M
Systems: $92.7 M
Allowances: $98.4 M





Questions?

TJPA
TRANSBAY JOINT POWERS AUTHORITY

201 Mission Street, Suite 2100 San Francisco, CA 94105 • 415.597.4620 • www.tjpa.org

Peninsula Corridor Joint Powers Board Overview

SFCTA Peer Review
January 25, 2018

Overview

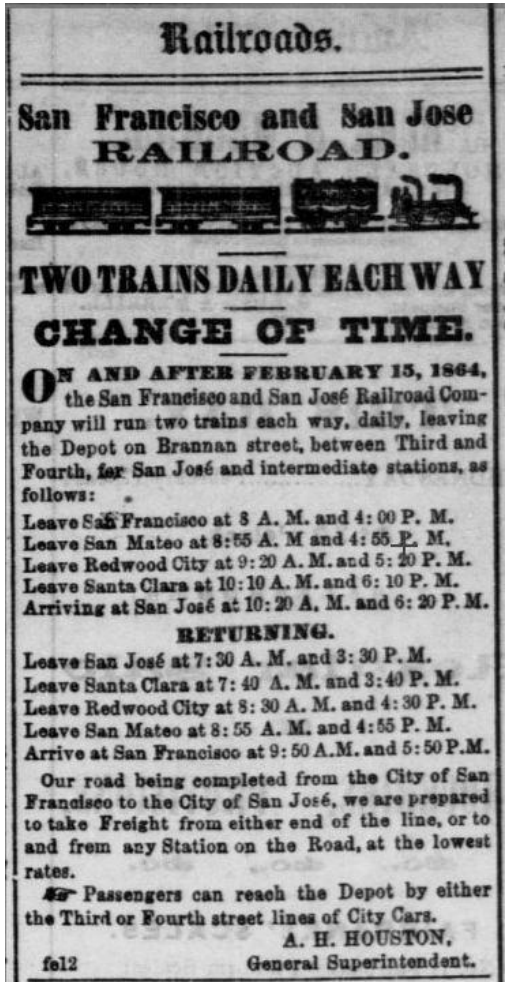
- Organizational History and Milestones
- Corridor, Fleet and Service
- Ridership and Funding
- Peninsula Corridor Electrification Project
- Planning Context
- Key Criteria

Caltrain Team

- Michelle Bouchard – Chief Operating Officer
- Matt Verhoff – Manager, Operations Planning
- Elizabeth Scanlon – Director, Caltrain Planning
- John Funghi – Chief Executive Officer, CalMod

History and Milestones

- **1860's – 1970's:** Southern Pacific (SP) operated commercial passenger service on the Peninsula corridor between San Francisco and San Jose
- **1980 -1992:** Caltrans assumes responsibility for the passenger service in concert with the three local partners (SamTrans, Santa Clara County Transit District and the City and County of San Francisco). SP operates the service under contract with Caltrans



Railroads.

San Francisco and San Jose RAILROAD.

TWO TRAINS DAILY EACH WAY

CHANGE OF TIME.

ON AND AFTER FEBRUARY 15, 1864, the San Francisco and San José Railroad Company will run two trains each way, daily, leaving the Depot on Brannan street, between Third and Fourth, for San José and intermediate stations, as follows:

Leave San Francisco at 8 A. M. and 4:00 P. M.
Leave San Mateo at 8:55 A. M and 4:55 P. M.
Leave Redwood City at 9:20 A. M. and 5:20 P. M.
Leave Santa Clara at 10:10 A. M. and 6:10 P. M.
Arriving at San José at 10:20 A. M. and 6:20 P. M.

RETURNING.

Leave San José at 7:30 A. M. and 3:30 P. M.
Leave Santa Clara at 7:40 A. M. and 3:40 P. M.
Leave Redwood City at 8:30 A. M. and 4:30 P. M.
Leave San Mateo at 8:55 A. M. and 4:55 P. M.
Arrive at San Francisco at 9:50 A.M. and 5:50 P.M.

Our road being completed from the City of San Francisco to the City of San José, we are prepared to take Freight from either end of the line, or to and from any Station on the Road, at the lowest rates.

☞ Passengers can reach the Depot by either the Third or Fourth street lines of City Cars.

A. H. HOUSTON,
General Superintendent.

fe12

History and Milestones

- **Late 1980's:** State decides to withdraw its oversight role and financial support for "Caltrain Service"
- **1988:** Creation of Peninsula Corridor Joint Powers Study Board (JPB) and execution of first JPA to prepare for local takeover. SamTrans designated as managing agency
- **1992:** JPB acquires rail corridor from SP for $212 million and assumes local control of Caltrain Service
  - $120 million funded by State
  - Balance fronted by SamTrans
  - Amtrak awarded contract to manage/ operate Caltrain Service

History and Milestones

- **2004:** Launch of the “Baby Bullet” express service
- **2008:** ROW Reimbursement Agreement
  - Developed plan with MTC for SF and VTA to reimburse SamTrans for their shares of ROW acquisition price (principal only)
  - Designated SamTrans as the Managing Agency of the JPB for as long as SamTrans desires to retain the role
- **2012:** Transit America Services Inc. awarded contract to operate and maintain the Caltrain Service

Corridor

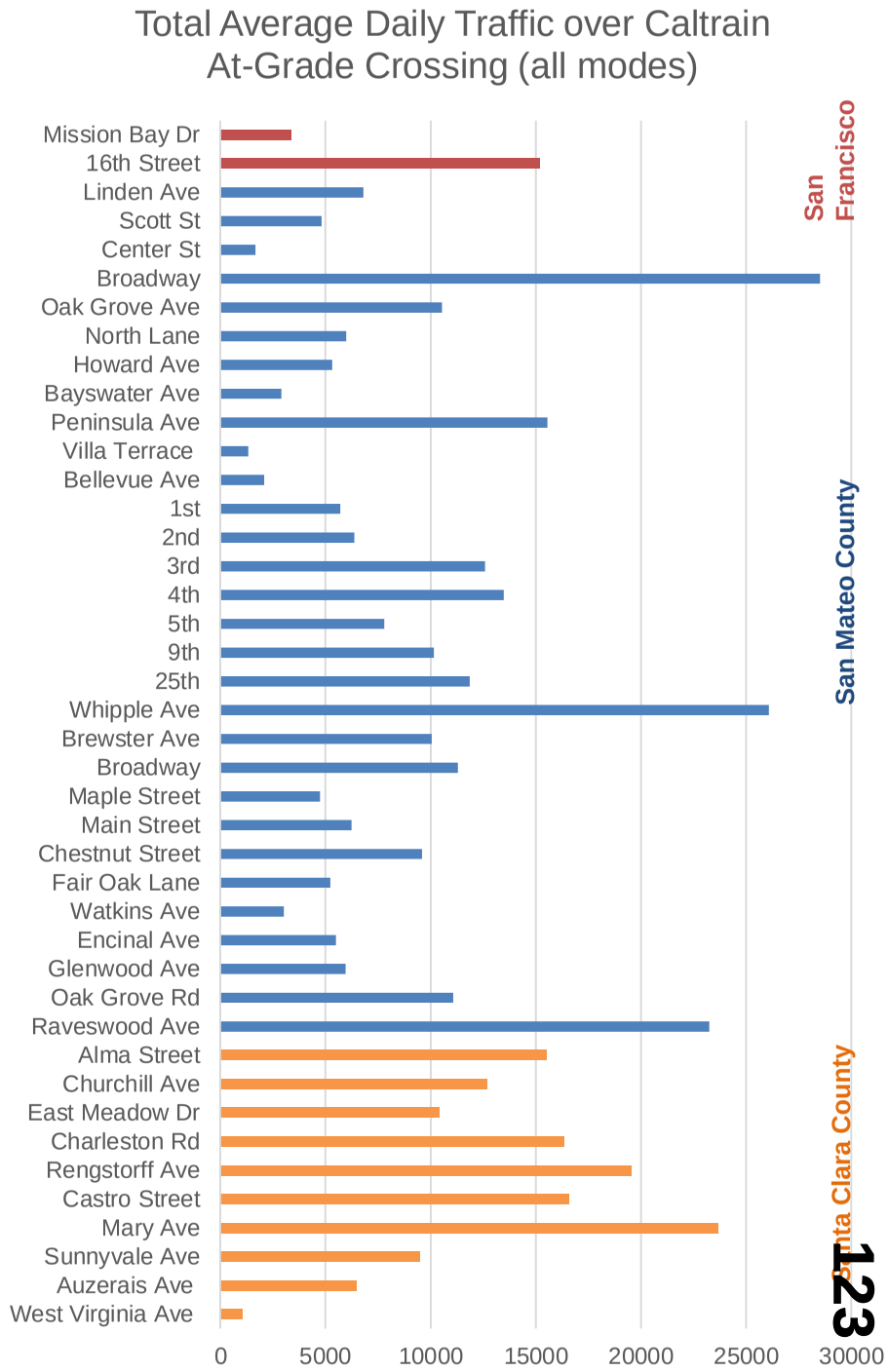
JBP owns right-of-way from SF to San Jose (51 miles)

UP owns corridor. JPB has limited trackage rights

- Primarily two track system with some 4-track segments
- Varying right-of-way widths throughout corridor
- At-Grade crossings, viaducts, and bridges
- Primarily JPB owned but with exceptions and variation (especially at and around stations)

Grade Crossings

- 42 at grade crossings on main line
- Over 400,000 vehicle crossings per day
- Wide variation in traffic levels
- 62 crossings already separated



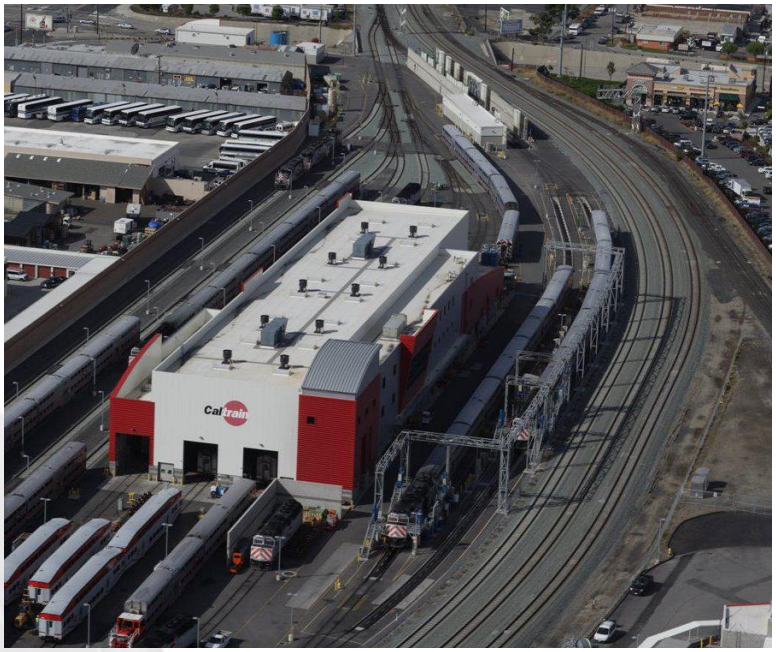
Fleet

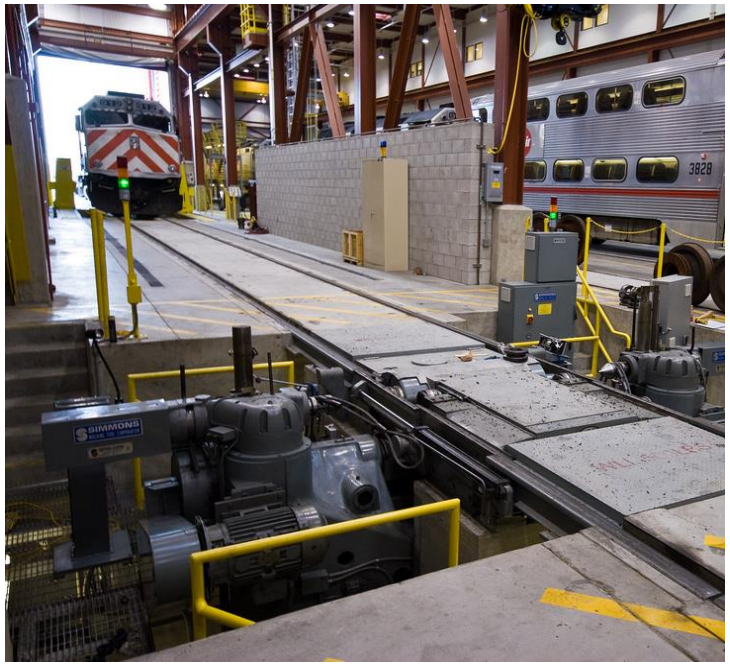
- 134 Passenger Cars
  - Gallery and Bombardier Sets
  - 54% past 30-year life
- 29 Locomotives
  - F40PH-2s and MP36-3Cs
  - 69% past 30-year life

Gallery Set

Bombardier Set

Central Equipment & Maintenance Facility (CEMOF)





- Primary site for inspection, maintenance, train washing, storage, fueling and dispatching

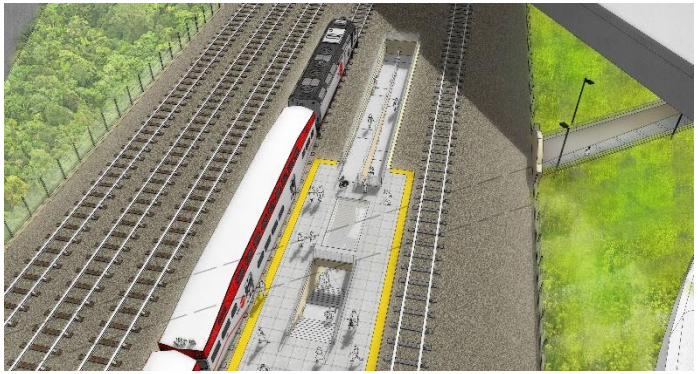
- Completed in 2007
- 20 Acre site north of Diridon in San Jose

People

- Managed by SamTrans
- Operation of service and maintenance of trains and facilities contracted to Transit America Services Inc (contract through 2022)
- Staffing
  - 65 Rail Division staff + 19 seconded consultants
  - 60 FTE support staff from other SamTrans divisions
  - 485 TASI staff
  - 11 unions represented

Projects

- Since 2008 the JPB has delivered over $1.25 billion in completed or in-process capital projects:
  - Major SOGR work
  - Station improvements
  - Systems projects
- Future (non-electrification) projects
  - South San Francisco Station
  - 25th Ave Grade Separation
  - Guadalupe Bridge Replacement
  - Various platform and crossing improvements



Current Service

- 92 Weekday Trains
  - Express (“Baby Bullets”)
  - Limited (incl 6 Gilroy trains)
  - Locals
- 28 / 24 Weekend Trains
- Travel times (mainline)
  - <60 min for “bullets”
  - >100 min for locals
- Station Stops (mainline)
  - 6 to 7 for “bullets”
  - 24 for locals

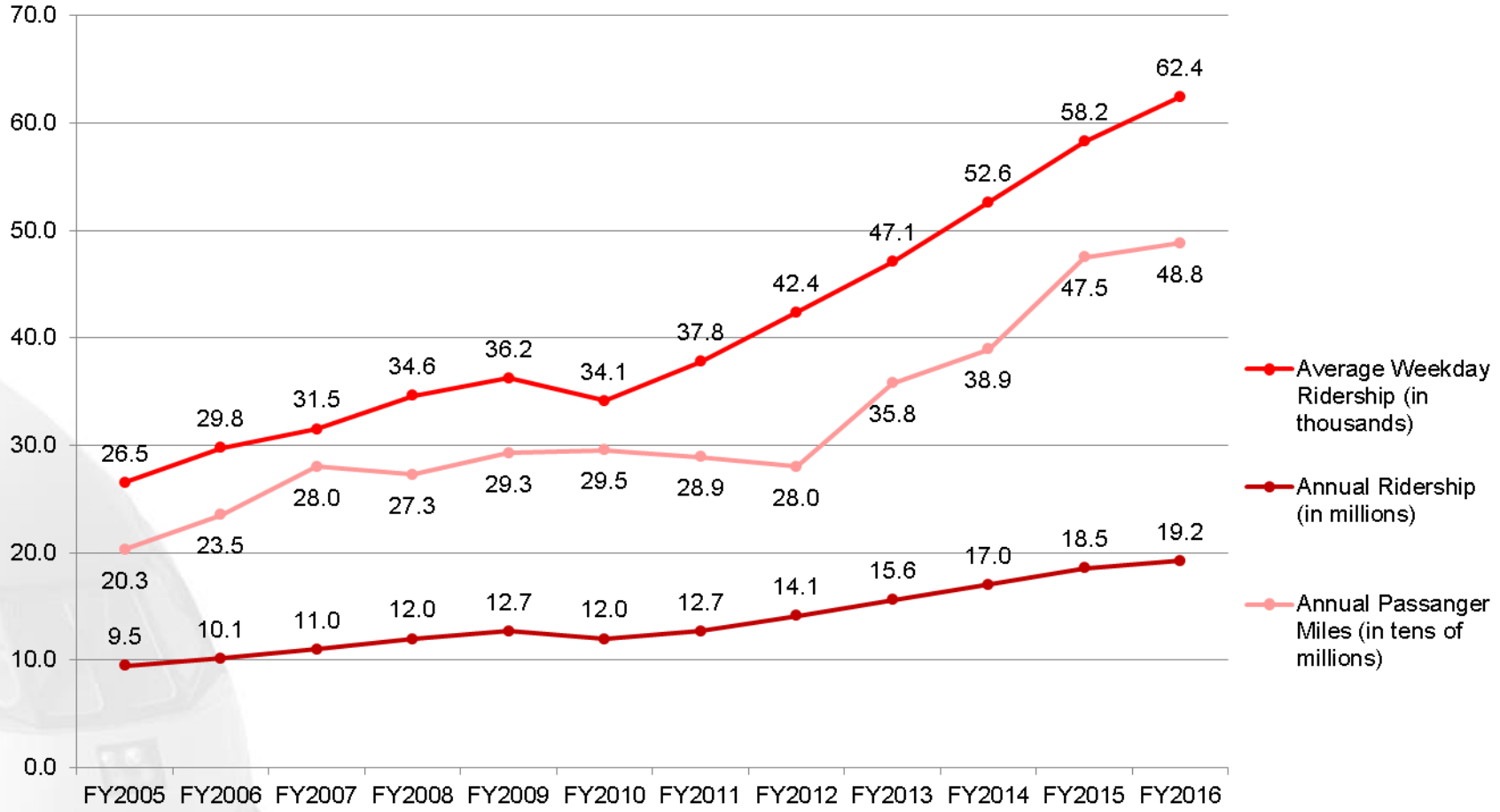
3	Sunnyvale	4:43	5:18	–	6:20	6:14	6:36	–	7:00	7:20	7:14	7:36	–	8:06	8:21	8:14	8:36	8:52	9:20	10:05
3	Mountain View	4:46	5:21	6:09	6:25	–	6:42	7:09	7:11	7:25	–	7:44	8:04	8:11	8:27	–	8:42	8:57	9:25	10:10
3	San Antonio	4:52	5:27		6:29					7:29					8:31			9:01	9:37	10:14
3	California Ave	4:57	5:31	–	6:34	–	6:48	–	7:17	7:34	–	7:49	–	8:17	8:35	–	–	9:06	9:41	10:18
3	Palo Alto	5:01	5:36	6:18	6:38	6:28		7:12	7:21	7:38	7:26		8:12	8:21	8:40	8:26		9:11	9:45	10:22
3	Menlo Park	5:04	5:39	–	6:41	–	6:54	–	–	7:41	–	7:54	–	–	8:43	–	8:51	9:14	9:48	10:26
2	Redwood City	5:10	5:44	–	6:47	6:32	6:59	–	–	7:47	7:32	8:00	–	–	8:49	8:32	8:57	9:20	9:55	10:31
2	San Carlos	5:15	5:49				7:04					8:05		8:39			9:02	9:24	9:58	10:35
2	Belmont	5:18	5:52	–	–	–	7:07	–	–	–	–	8:08	–	–	–	–	9:05	9:28	10:03	10:39
2	Hillsdale	5:22	5:56	6:38	6:54	–	7:11	7:31	7:14	7:54	–	8:12	8:23	8:54	8:57	–	9:09	9:31	10:06	10:43
2	Hayward Park	5:25	5:59				7:14					8:15					9:12		10:09	
2	San Mateo	5:28	6:03	–	–	6:43	7:18	–	7:38	–	7:43	8:19	–	8:38	–	8:43	9:15	9:36	10:12	10:48
2	Burlingame	5:32	6:06				7:21		7:43			8:22		8:43			9:19	9:39	10:15	10:52
2	Millbrae	5:36	6:11	6:26	7:03	6:51	7:26	7:31	–	8:03	7:51	8:27	8:31	–	9:06	8:51	9:24	9:44	10:20	10:56
1	San Bruno	5:41	6:16	–	–	–	7:30	–	7:50	–	–	8:31	–	8:50	–	–	9:28	9:49	10:25	11:01
1	So. San Francisco	5:45	6:20		7:08		7:34			8:08		8:35			9:13		9:32		10:29	
1	Bayshore	5:51	6:26	–	–	–	7:41+	–	–	–	–	8:43+	–	–	–	–	9:39	–	10:35	–
1	22nd Street	5:57	6:32				7:50+					8:01+					9:46		10:41	
1	San Francisco	6:03	6:38	6:47	7:24	7:00	7:57	7:51	8:07	8:24	8:11	8:56	8:51	9:07	9:29	9:11	9:52	10:05	10:46	11:19

SF Giants Special Service Click HERE

Southbound Service

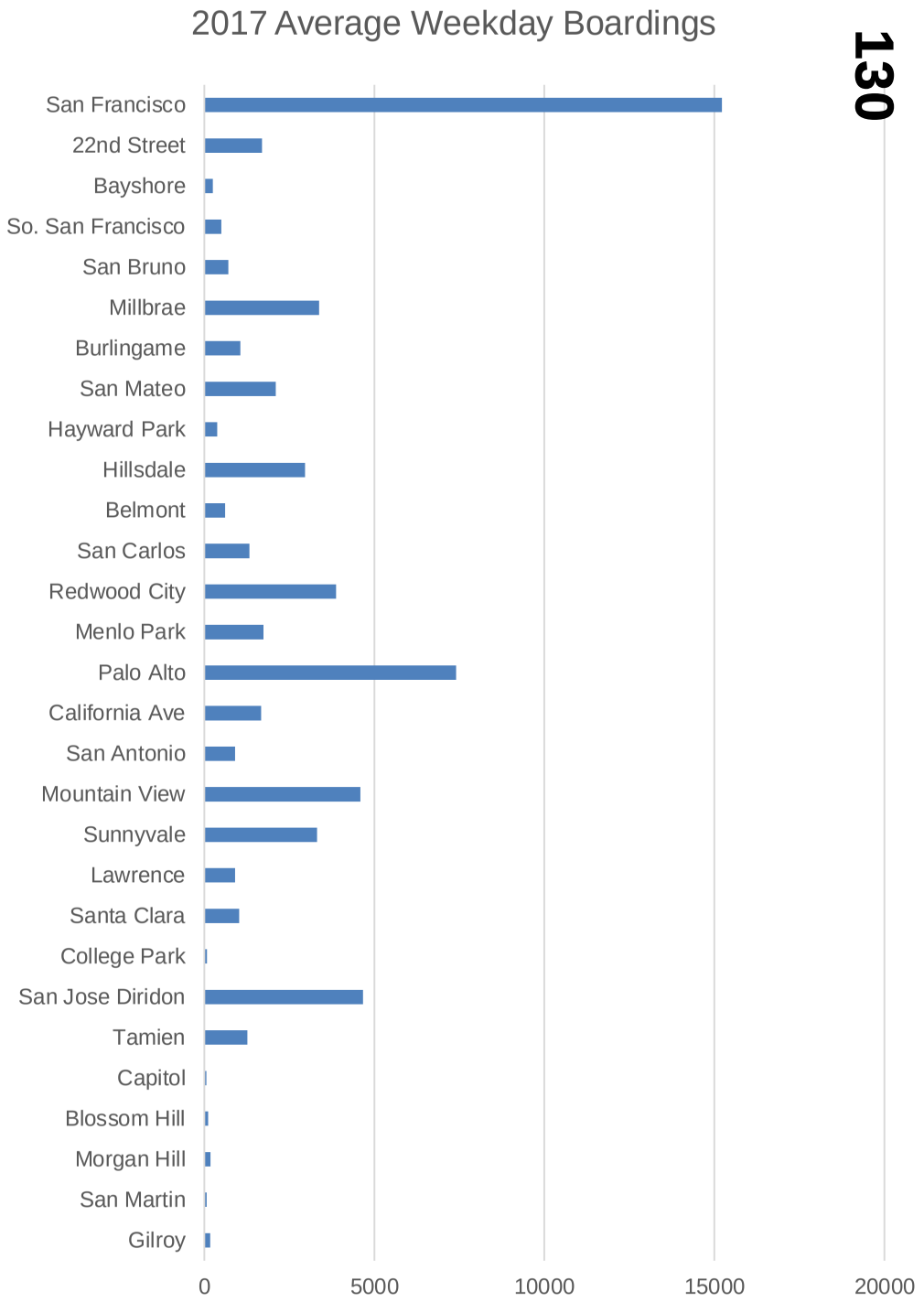
Zone	Southbound Train No.	102	104	206	208	310	212	314	216	218	320	222	324	226	228	330	232	134	236	138	142
1	San Francisco	4:55	5:25	6:05	6:15	6:05	6:45	6:59	7:05	7:15	7:35	7:45	7:59	8:05	8:15	8:35	8:45	9:30	9:45	10:00	11:00
1	22nd Street	4:58	5:29	6:09	6:19	6:09	6:51	7:03	7:10	7:19	7:39	7:51	8:03	8:10	8:19	8:39	8:51	9:35	–	10:04	11:04
1	Bayshore	5:04	5:34		6:24					7:24					8:24			9:40		10:09	11:08
1	So. San Francisco	5:10	5:40	–	6:31	–	–	–	–	7:31	–	–	–	–	8:31	–	–	9:47	–	10:16	11:16
1	San Bruno	5:14	5:44	–	6:35	–	–	–	7:20	7:35	–	–	–	8:20	8:35	–	–	9:51	9:57	10:20	11:20
2	Millbrae	5:18	5:48	6:22	6:39	6:52	7:04	7:16		7:39	7:52	8:04	8:16		8:39	8:52	9:02	9:55	10:01	10:25	11:25
2	Burlingame	5:22	5:53	6:26	6:44	–	–	–	7:27	7:44	–	–	–	8:27	8:44	–	–	9:29	10:06	10:29	11:29

Context: Ridership

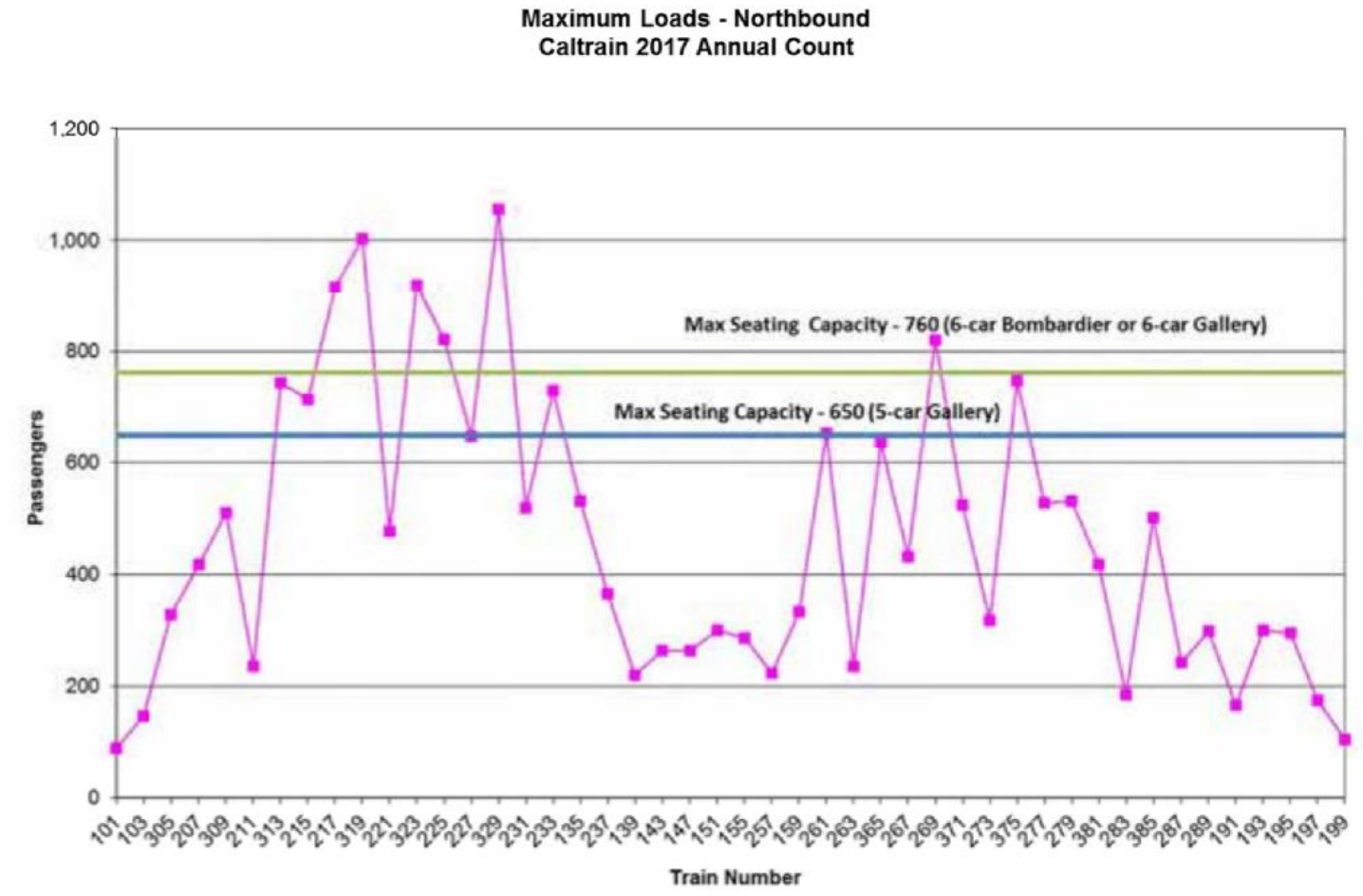


Ridership

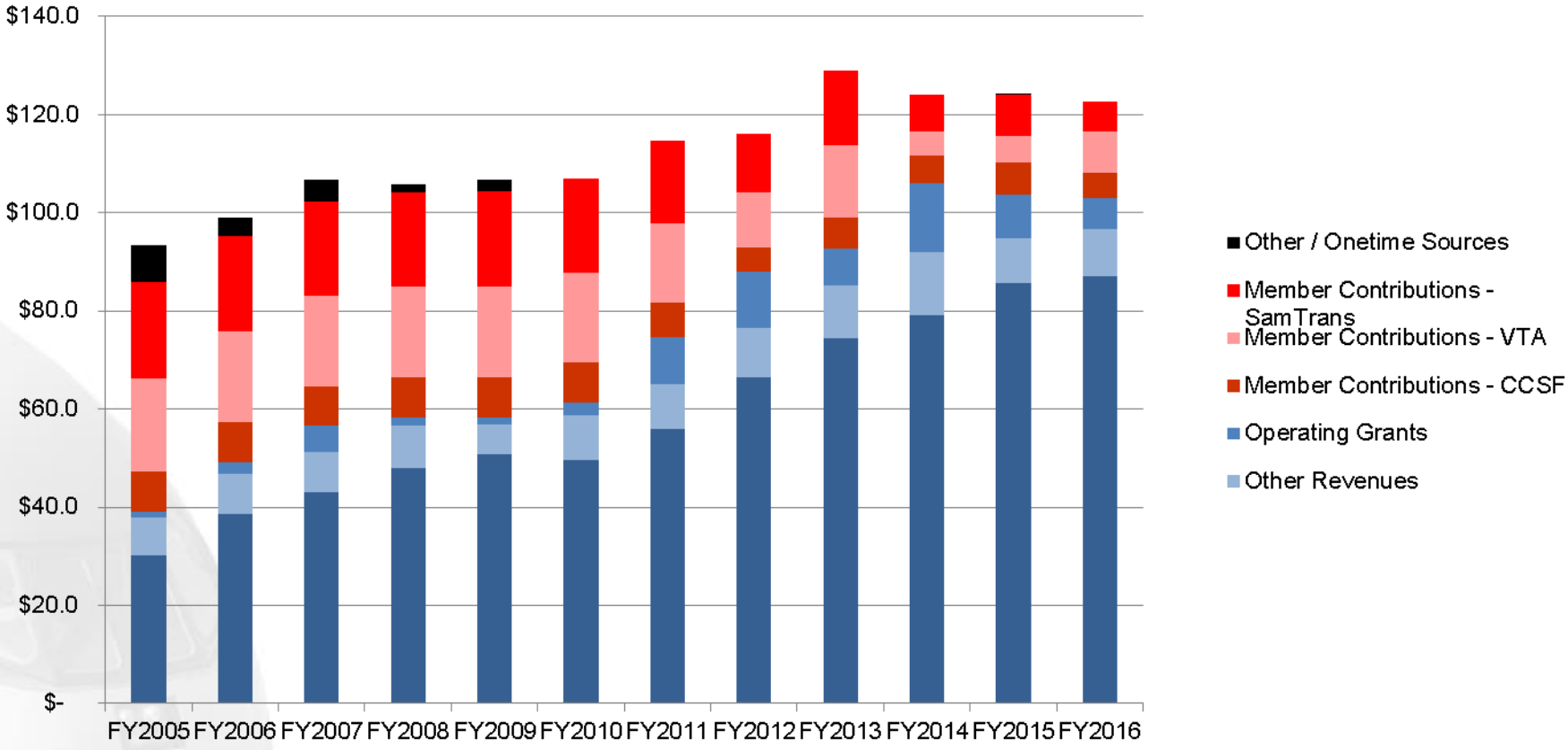
- 62,000 average weekday boardings
- Distribution
  - 52% traditional peak
  - 31% reverse peak
  - 12% midday
  - 5% evening
- 22.8 mile avg trip-length



Ridership and Capacity

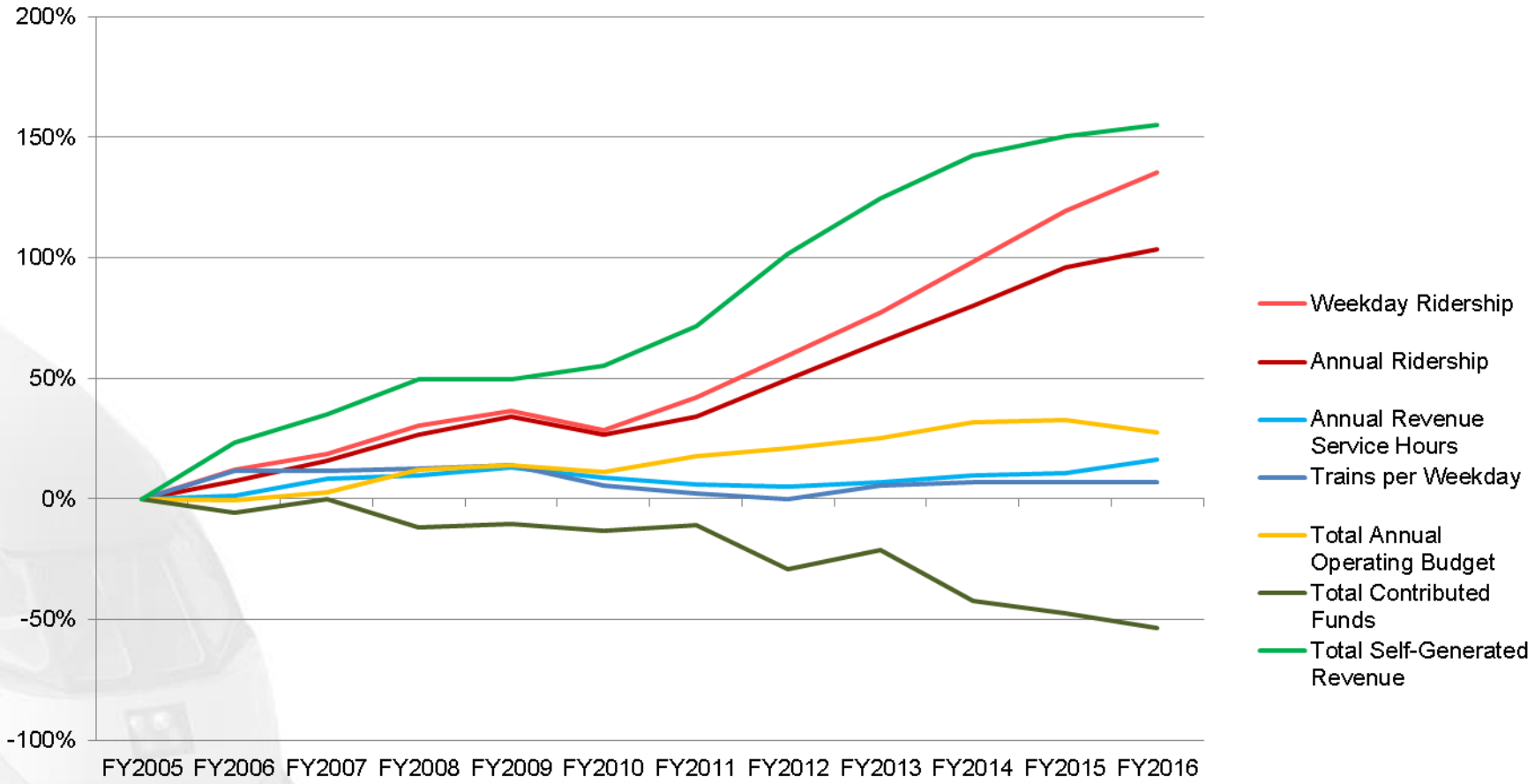


Operating Funding



CPI Adjusted to millions of FY2016 Dollars

Business Metrics



Percentage Change in Key Operating Metrics - CPI Adjusted

Electrification - Overview

Area	Project	Service
51 miles San Francisco to San Jose (Tamien Station)	Electrification: • Overhead Contact System (OCS) • Traction Power Facilities Electric Trains (EMUs) • 75 percent of fleet	Up to 79 mph Service Increase • 6 trains / hour / direction • More station stops / reduced travel time • Restore Atherton & Broadway service Mixed-fleet service (interim period) Continue tenant service • ACE, Capital Corridor, Amtrak, Freight

Electrification – Service Benefits

Example: Baby Bullet Train

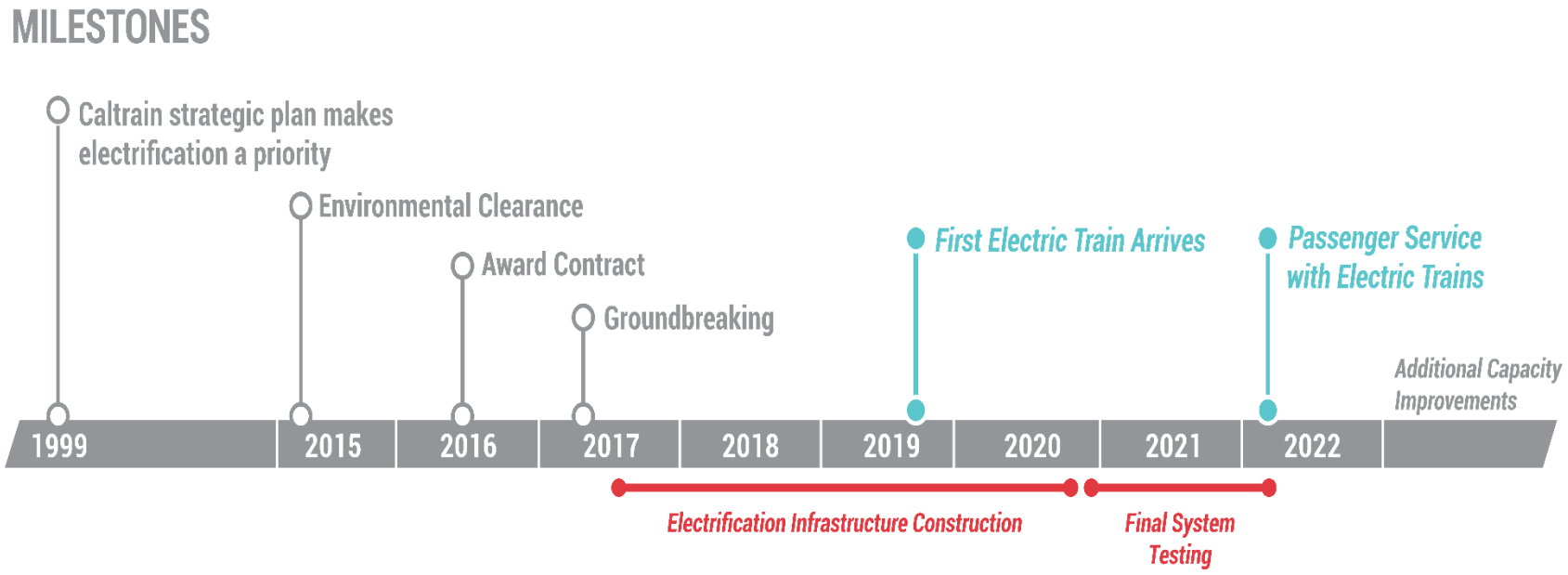
Metric	Today	Electrification (Mixed Use)
Time: 60 min (SF to SJ)	6 stops	13 stops
Stations: 5-6	60 min.	45 min.

Example: Redwood City Station

Metric	Today	Electrification (Mixed Use)
Train Stops (Peak Hour)	3	5

Note: Based on Prototypical Train Schedule

Electrification – Schedule



*Please keep in mind that testing and construction will overlap as each Segment will be tested individually, prior to final system testing.

Planning Context

- Caltrain involved in planning DTX since the beginning
- Planning has evolved as discussions with HSR matured
- Design assumptions for Terminal have always been constrained
- Caltrain Planning has embarked on various planning efforts that involve eventual service to the transit center including:
  - Blended service with CAHSR
  - North Terminal Study
    - New effort to coordinate with SF, Caltrain, CalSTA
  - Caltrain Business Plan

Planning Context

Consistency with 2018 State Rail Plan:

- Working toward 2040 Vision
  - 2022 projects are moving
  - 2027 timeframe
  - 2040 vision
- Integrated statewide rail networks
- Easy, fast connections
- High frequency service
- Customer focus to move easily within the network

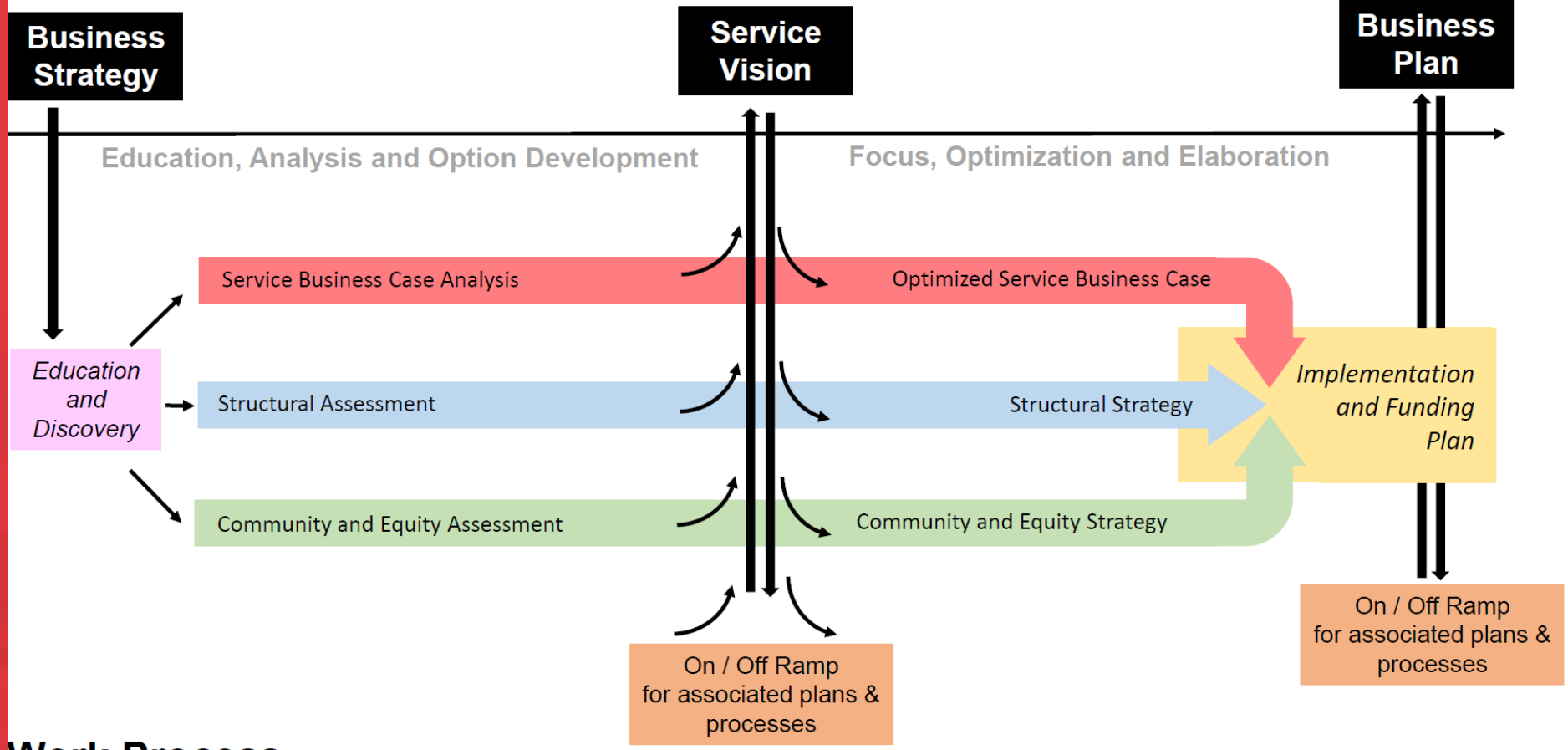
Planning Context: Blended Planning

- 2012/2013 joint studies proof of concept for “blended” Caltrain and high speed rail service on the Peninsula corridor
- 2016 Joint Schedule Working Group (JSWG) convened to further blended service operational planning
- 2017 Blended planning “reset” contemplates corridor service in the context of the State Rail Plan (2040)
  - Service levels to study “max case” levels of service per peak hour per direction
  - Focus on Terminal movement planning for San Jose and San Francisco
  - Study of service options south of San Jose to Gilroy

Caltrain Business Plan
Key Questions

- Stakeholder outreach helped identify three “big picture” interrelated questions

Caltrain Business Plan



Work Process

Key Guiding Principles/Criteria

Infrastructure and Facilities planned in a manner that support:

- Reliability and On-time Performance
  - Both Revenue and non-revenue services
- Recoverability, Contingency and Resiliency
- Future growth potential
- Schedule performance is defined as 95% on-time

Key Caltrain Goals/Objectives

- Fully electrify Caltrain fleet
- Service Vision: Future Growth of Service
  - How many trains per hour can we run on the corridor?
- System-wide Operational Study
- Platform capacity in San Francisco critical to delivering mainline service
  - Considerations for uses at transit center, 4th & Townsend and 4th/King
  - How best to achieve the elements needed to support service, i.e., maintenance/storage
- Location of maintenance facilities/layover
  - Mainline capacity
  - Minimize non-revenue movement over long distances
  - Considers larger corridor needs

Key Guiding Principles/Criteria

Parameter	Requirement/Assumptions
Headways	Signal progression compliant with NFPA-130 requirements for tunnel operations and minimum train separation between vent zones
Turn Time	20 minutes
Dwell Time	Variable
Rolling Stock	Stadler “KISS” EMU sets; 8-car consists All bi-level

Caltrain North Terminal Study

- Grant funded by Federal Transit Administration
- Identify and define the current and future operational needs of Caltrain for operations in the Northern end of the Peninsula Corridor
- How to optimize and modernize the 4th & King site?
  - Passenger amenities
  - Revenue and Non-Revenue train facilities to accommodate the growth, operational changes, and future site development
  - Crew facilities
- Examine the interface with other key projects
  - Downtown Rail Extension Project (DTX) to the new Salesforce Transit Center (TC)
  - Potential high speed rail terminal

Contact Information

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CALIFORNIA
High-Speed Rail Authority

DTX Operational Studies Peer Review

Bruce Armistead, Director of Operations and Maintenance
Paul Hebditch, Lead Operations Planning

January 25, 2018
San Francisco, CA

PROPOSED OPERATING PLANS

- **Before completion of DTX**
  - » Valley to Valley Extended
    - Initial operation of 2 trains per hour (tph), per direction
    - Temporary terminal at 4th and King
  - » Phase 1
    - Increasing to 4tph, per direction
    - Temporary terminal at 4th and King

- **After completion of DTX**
  - » All HSR services to use Transbay Transit Center (service levels, as above)
  - » In Phase 1, 2tph, per direction, to call at 4th and Townsend

PERFORMANCE CRITERIA

- **Currently, acceptable schedule performance is defined as at least 95% on-time**

- **Actual performance requirements still subject to consultation and agreement**
  - » in franchise with HS Train Operator
  - » with Caltrain, as infrastructure owner
  - » with DTX infrastructure owner

KEY CRITERIA

- **HSR Trainset Lengths:**
  - 205-meter (656') per trainset
  - Option to operate 410-meter (1312') "double" trainset
- **Minimum curve radii – 198m (650')**
- **Headways**
  - Prop 1A: achievable operating headway shall be 5 minutes or less
    - Modeling demonstrates need for 3 mins, or better
  - Impact of ventilation zones on headways not critical
- **Dwell times**
  - 2 mins at intermediate stations
  - 20 min minimum turns at terminal stations
- **Operational services at TTC**
  - Passenger alighting and boarding
  - Re-stocking of food and beverage service items
  - Coach cleaning and re-stocking of bathroom supplies
  - Train safety system pre-departure preparation
  - Minor equipment repairs that can be accomplished during turn

IMPACTS OF 2-TRACK DTX

- **2-track alignment allows for unperturbed operation of proposed schedules, however:**
  - » does not allow for future service growth
  - » performs poorly under perturbed operation
  - » impacts HSR reliability and introduces risk to operations in Central Valley and Southern California
  - » would require continued use of 4th and King as alternative SF terminal during perturbation
  - » would require HSR to terminate services, short of SF, during perturbation

SINGLE TRACK OPERATION OF 2-TRACK DTX

- **Scenario: 2-track DTX alignment, with an incident blocking 1 track**
- **Single track section is approximately 1.25 miles long**
- **Assumptions**
  - track speed to be 25mph
  - re-occupation time of 3 mins
  - trains stopped prior to entering single track
- **Trains take 8 mins to traverse and clear single track**
- **Capacity for 6tph (3 per direction)**
- **Service reduction of 70% required**

THANK YOU

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Railyard Alternatives & I-280 Boulevard (RAB) Feasibility Study

SFCTA Peer Review Briefing

San Francisco Planning Department
Briefing – January 26, 2018

San Francisco Planning

RAB Study Components

- Each component represents a major transportation and/or land use decision that needs to be determined in the next 1-15 years that will affect San Francisco for the next 100+ years.
- Each component is independent of the others.
- All components need to be considered as each decision moves forward. – Taking the Long Look

1: Rail Alignment to Salesforce Transit Center (SFTC)

This component explores how we get both Caltrain and High-Speed Rail from the county line into the Salesforce Transit Center. Currently, a portion of one of the alignments being studied is known as the Downtown Rail Extension (DTX)

2: Transit Center (SFTC) Loop

Creates a loop track/extension to enhance operational capacity at the Salesforce Transit Center and potentially adding a crossing to the East Bay.

3: Railyard Reconfiguration/Relocation

Modifying or relocating some or all of the activities at the 4th/King Railyard would allow Caltrain to operate on a smaller footprint, while potentially freeing up land for open space and future development opportunities.

4: Boulevard I-280

Replacing the end of I-280 north of Mariposa with an urban surface boulevard, similar to the Embarcadero or Octavia Blvd, could create new open space, improve circulation and allow connectivity throughout the area that is currently separated by 1.2 miles of I-280.

5: Opportunities for the Public's Benefit

Relocating the Caltrain Railyard and/or creating a surface-level boulevard instead of the elevated freeway makes new land available for housing, commercial development and open space.

Infrastructure Impacts

- Current plans divide the City
- The Downtown Rail Extension (DTX) doesn't solve the issue at 16th Street
- People/Transit/Vehicles MUST be able to continue to move from east to west across the City
- Salesforce Transit Center MUST be able to accommodate AT LEAST the anticipated 10 trains/hour for success

We Need a FULL Solution

1. Rail Alignment to Salesforce Transit Center (SFTC)

Source: TJPA 2016

Objectives for all Components

- Study set to identify and discuss tradeoffs
- Fully understand decisions moving forward
- Set up policy discussions
- Costs will need to be taken into account moving forward

- As the land owner jurisdiction of record, the agencies operating inside the City boundaries MUST NOT degrade the City. We must work together towards common goals.

Operational Studies

- Originally anticipated to include Blended Service Operations completed by Caltrain/CHSRA. Delays of more than 12 months necessitated moving forward with something.
  - **Sketch Planning Analysis** (2015)
    - COULD all trains utilize SFTC and what would be necessary to make that happen.
    - Are there opportunities to free up space at 4th/King and make SFTC THE terminal for San Francisco
      - Only from Millbrae north
      - Used existing assumptions at that time (including turnaround times, etc)
      - Clockface approach – slots for movements only
      - Only one platform height for SFTC
        - » Up to 15 train movement slots/direction/hour with some minor changes to track layouts and switches (and very quick turnaround times at SFTC – 20 HSR/12 Caltrain)
  - Phase II of modeling (2017) looked at two things:
    - Update 2015 analysis with new info from Alignments and operational assumptions (turn times for HSR, etc)
    - Could HSR trains stop at 4th/Townsend? What did that do to the system?
    - Investigate the **functional** benefits from the 3rd Track.
      - Three service plans used as an input (LTK 2013, No Additional Passing Track (NAPT-HSR), and Generic)
      - With some modifications to flexibility of 4th/Townsend, may lead to different conclusions
        - » All 10 trains/hour can be accommodated at SFTC and in some cases up to 12 trains/hour/direction
        - » As a WORST CASE SCENARIO – looked at dedicated platforms
        - » Under NORMAL operating conditions, only 2 tracks are required in DTX (including 4th/Townsend)
        - » Because charging/decharging the system happens in off-peak hours, there is the ability to utilize slots for non-revenue movements to/from storage/maintenance yard.
    - BUT still missing a blended service operations plan, perturbation studies, major events, and train simulations. These should be the subject of future analysis.
- If left alone, may cost much more than required with no co-benefits to City

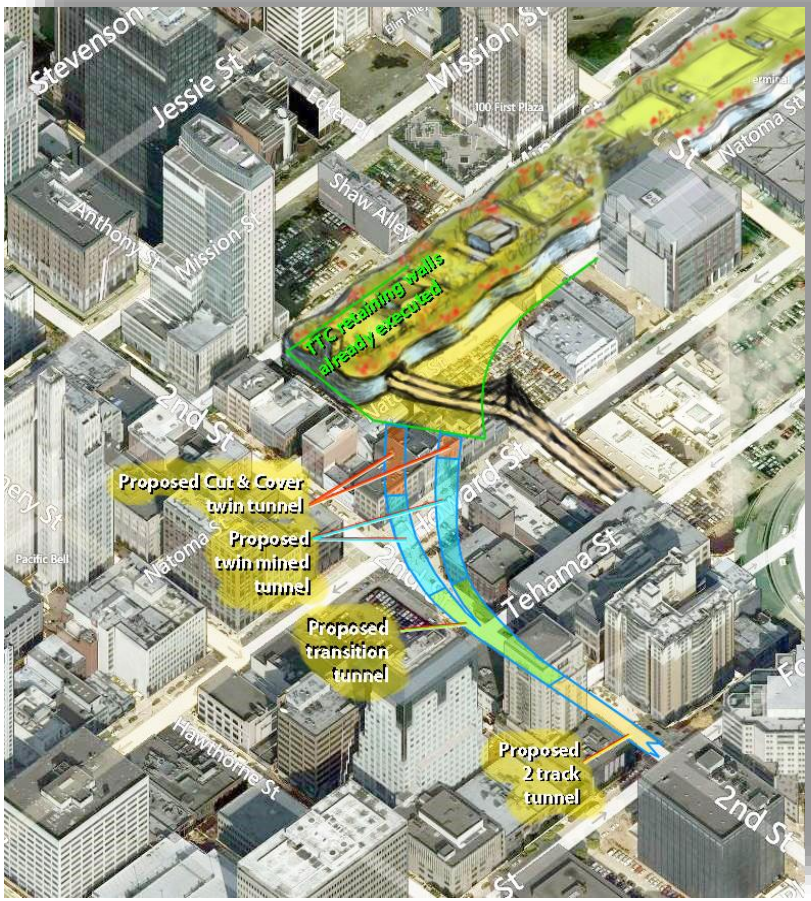
QUESTIONS?

- Basis for 20-minute scheduled HSR dwell time and what services are expected to occur? Other assumptions/results?
- June RAB presentation mentions need for further study or more detailed analysis – is this being done?
- Analysis shows Caltrain being held up to allow HSR to pass. This can increase the travel time from SFTC to Millbrae from 19-29 minutes (trains 417 & 427). Is this acceptable to Caltrain and what will impact to ridership? Limits of operation with the proposed number of tracks (maximum trains per hour)? Other policy questions?
- How has the RAB operations analysis incorporated the Blended Service Operations assumptions/outcomes?
- What are the major tradeoffs being considered by the City? (e.g., temp/permanent street closures, major conflict points, transit oriented development opportunities)
- Others?

Transbay Transit Center - San Francisco DTX - Value Engineering Study

SENER

BIRMINGHAM DEVELOPMENT LLC



January 2018

TTC – DTX - Value Engineering Study (SENER, Jan 2018) Assumptions/Source of information

The **main source of information** has been the **SEIS-2015**.

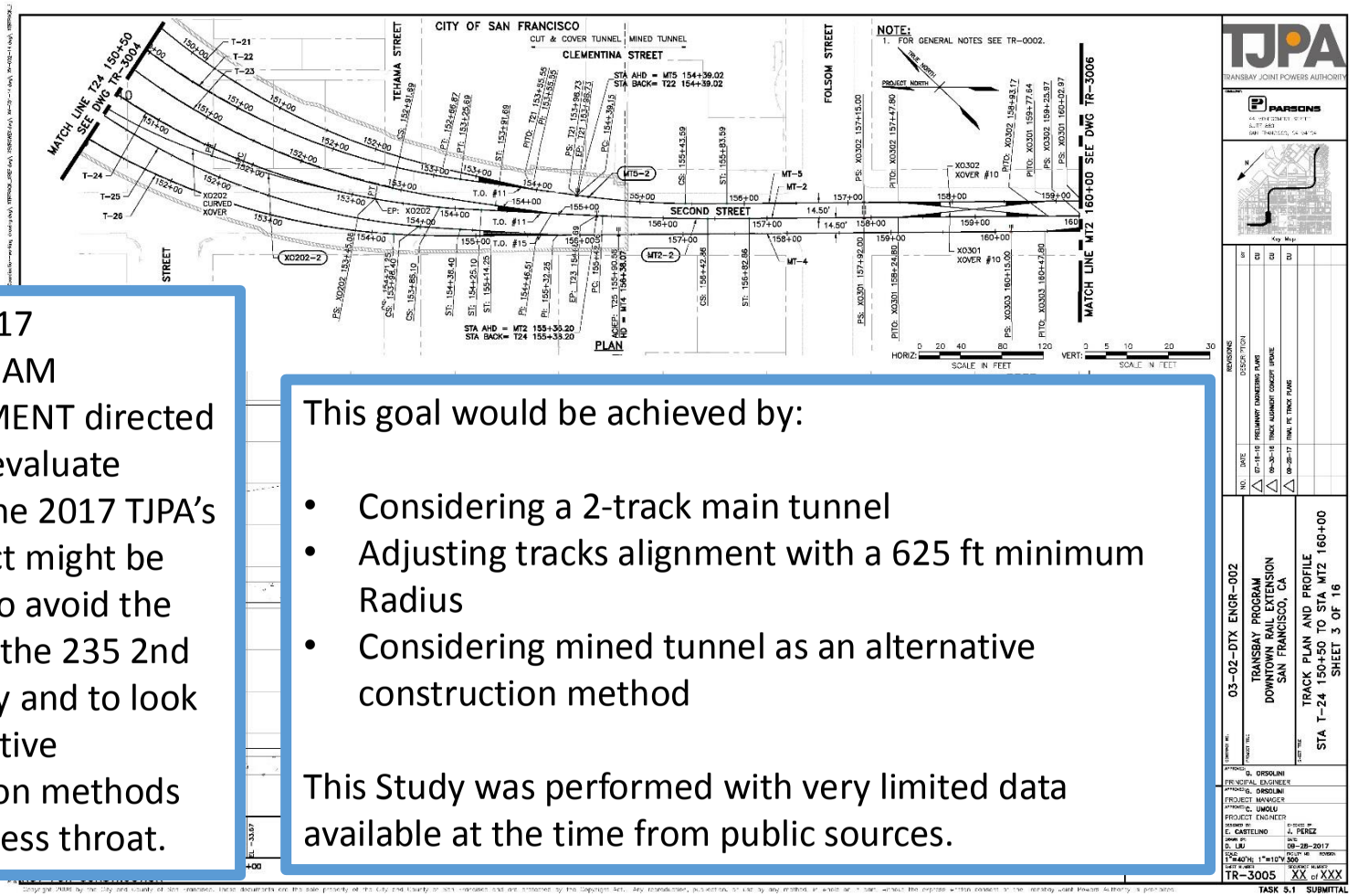
The operating plan/service assumptions were taken from the SEIS-2015 Section 2:

> *The blended system envisions up to10 trains per peak hour per direction to and from San Francisco.The10 trains per peak hour for the blended operations assume a service level of six Caltrain trains per peak hour per direction (tpph/d) and four HSR tpph/d.*

The assumptions on the geology of the project area were taken from the SEIS-2015 Sections 3.6 Historic and Cultural Resources and 3.9 Geology.

For assumptions made to perform the TTC capacity analysis, please refer to the section TTC – Station Capacity Analysis / Main assumptions.

TTC – DTX - Value Engineering Study (SENER, Jan 2018) Intro



In April 2017 BIRMINGHAM DEVELOPMENT directed SENER to evaluate whether the 2017 TJPA's DTX Project might be modified to avoid the impact on the 235 2nd St property and to look for alternative construction methods for the access throat.

This goal would be achieved by:

- Considering a 2-track main tunnel
- Adjusting tracks alignment with a 625 ft minimum Radius
- Considering mined tunnel as an alternative construction method

This Study was performed with very limited data available at the time from public sources.

TJPA's DTX Project Evolution and Chronology

Year / Document	2002 Draft EIS/EIR	2004 Final EIS/EIR	2010 ROD, FRA reevaluation	2010 CHSRA Regional Manager review	2012 CHSRA Business Plan	2014 CHSRA Business Plan	2015 Draft SEIS/SEIR
# tracks Main tunnel	2-track	3-track	3-track	3-track	3-track	3-track	3-track
Min access Radius to TTC	498 ft	493 ft	545 ft	650 ft	650 ft	650 ft	650 ft
# TPHPD (peak hour) at TTC		6 TPHPD	8 TPHPD		10 TPHPD (6 Caltrain) (4 HSR)	10 TPHPD (6 Caltrain) (4 HSR)	10 TPHPD (6 Caltrain) (4 HSR)
Impact to 235 2nd St property	NO	NO	YES	YES	YES	YES	YES

TTC – DTX - Value Engineering Study (SENER, Jan 2018) Benefits

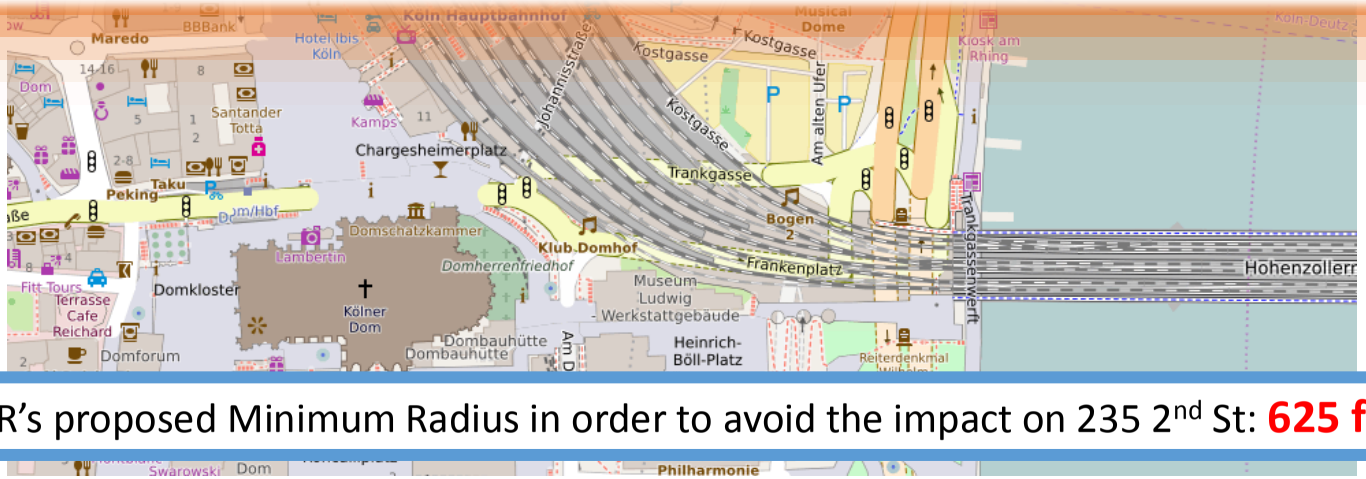
- **Avoid the impact** on the 235 2nd St property
- **Avoid the impact** on the 589 Howard St property
- Reduce the **Eminent Domain costs**
- **Avoid the impact** on 2nd St and Howard St **on surface** during construction
- **Reduce** the construction and maintenance **cost of the DTX main tunnel**

Minimum horizontal radius

According to a review performed by the **CHSRA** Regional Manager, March 17th, 2010:

Horizontal Radius

Horizontal radius of 650-foot is commensurate with the tightest radii (622-foot / 190 m) that the EMT has found in revenue service at Cologne Central Station. This will require a design variance for it to be accepted as part of the HST system.

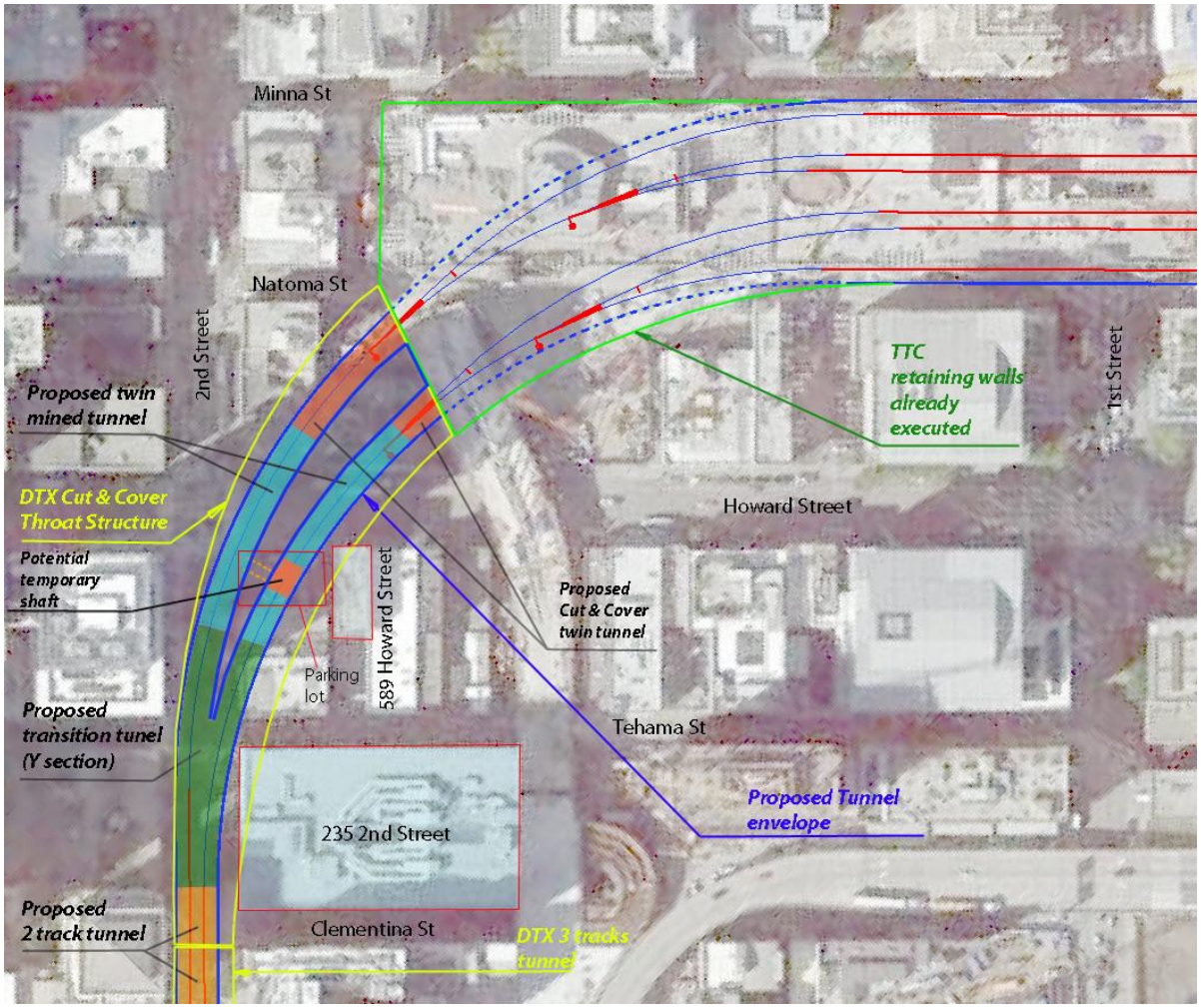


SENER's proposed Minimum Radius in order to avoid the impact on 235 2nd St: **625 ft**

SENER's proposed alternative

Refined Value Engineering Alignment:

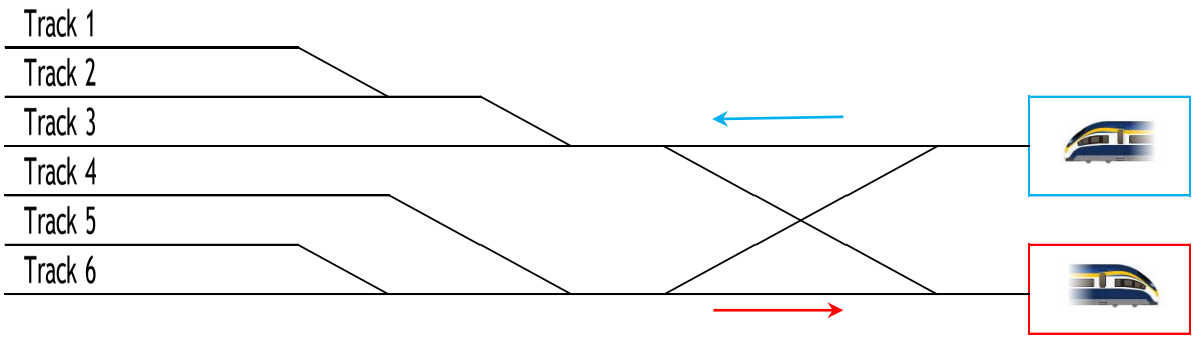
- Minimum Radius **625 ft**
- **2-track main tunnel under 2nd St**
- **Mined tunnel** to connect the DTX main tunnel to the TTC retaining walls in order to avoid impact on surface during construction (2nd St, Howard St)



TTC – Station Capacity Analysis
Intro

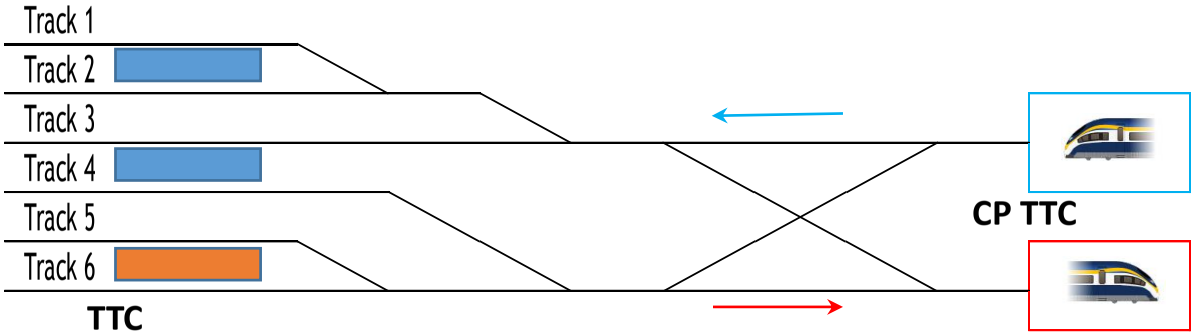
A preliminary railway operation analysis has been performed to demonstrate that a **two-track** configuration in the main DTX **tunnel** can meet the current operation assumptions:

Six CalTrain and **four HSR** trains **per (peak) hour and direction at the Transbay Transit Center (designed with six tracks and three platforms).**



TTC – Station Capacity Analysis
Main assumptions (1 of 2)

2-track main DTX tunnel.
The **area of study** was limited to the section between the TTC and a control point right south of the crossover in the 2-track main tunnel (see figure below).
Maximum train speed in this area of study: **25 mph**.
Maximum train acceleration/deceleration: **1.62 ft/s^2**.
Reconfiguration time for turnouts and crossings: **10 seconds**.
HSR trains would operate using the **four southerly tracks** of the TTC (tracks 1, 2, 3, 4 in the figure below).
Caltrain trains would operate using the **two northerly tracks** of the TTC (tracks 5, 6 in the figure below).



TTC – Station Capacity Analysis
Main assumptions (2 of 2)

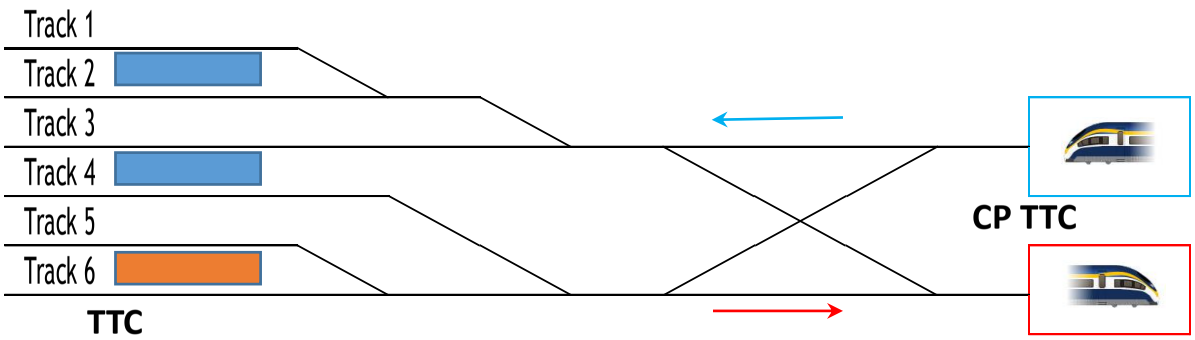
Six CalTrain trains and four HSR trains per (peak) hour and direction at the **Transbay Transit Center** (designed with **six tracks** and **three platforms**).

Minimum **dwell time** considered:
- HSR: 22 minutes
- Caltrain: 12 minutes

Time **between consecutive departures**:
- HSR: 15 minutes
- Caltrain: variable, 9-11 minutes

The analysis has been focused on a **typical peak hour**. The operation pattern proposed can be replicated as needed.

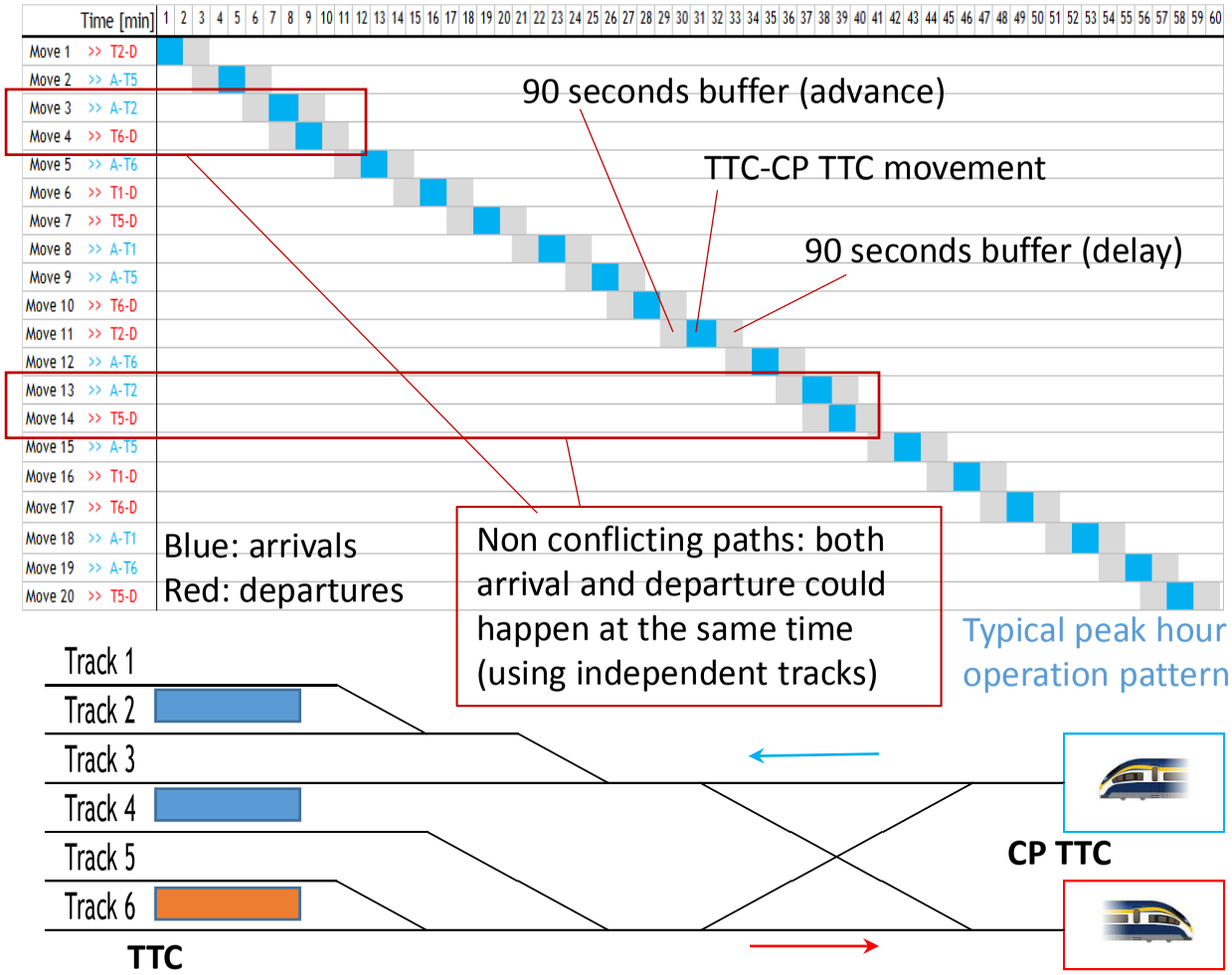
It's been assumed that each train can arrive/depart **90 seconds ahead or 90 seconds later** than scheduled in normal operation mode without disturbing other scheduled arrivals/departures.



TTC – Station Capacity Analysis Findings

The proposed schedule and station track layout allows to **accommodate 10 TPHPD in the peak hour without using the two central platform tracks** (tracks 3 and 4 in the figure below).

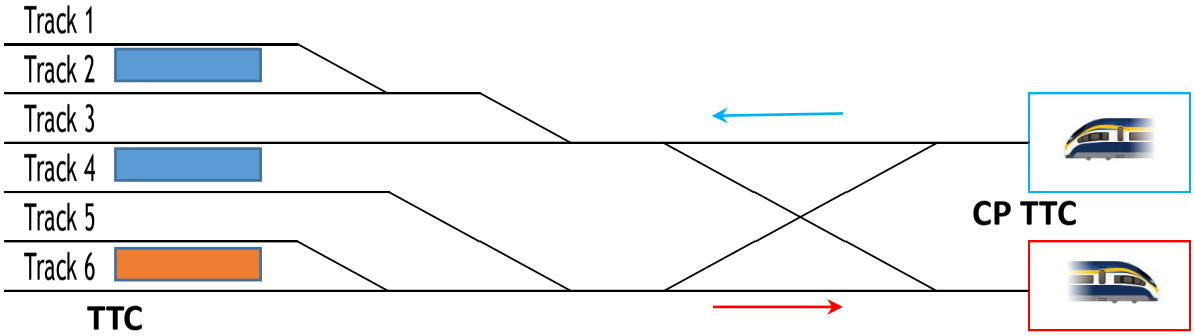
The use of this two spared platform tracks might be considered if there were a need to increase the HSR train dwell times (To be confirmed).



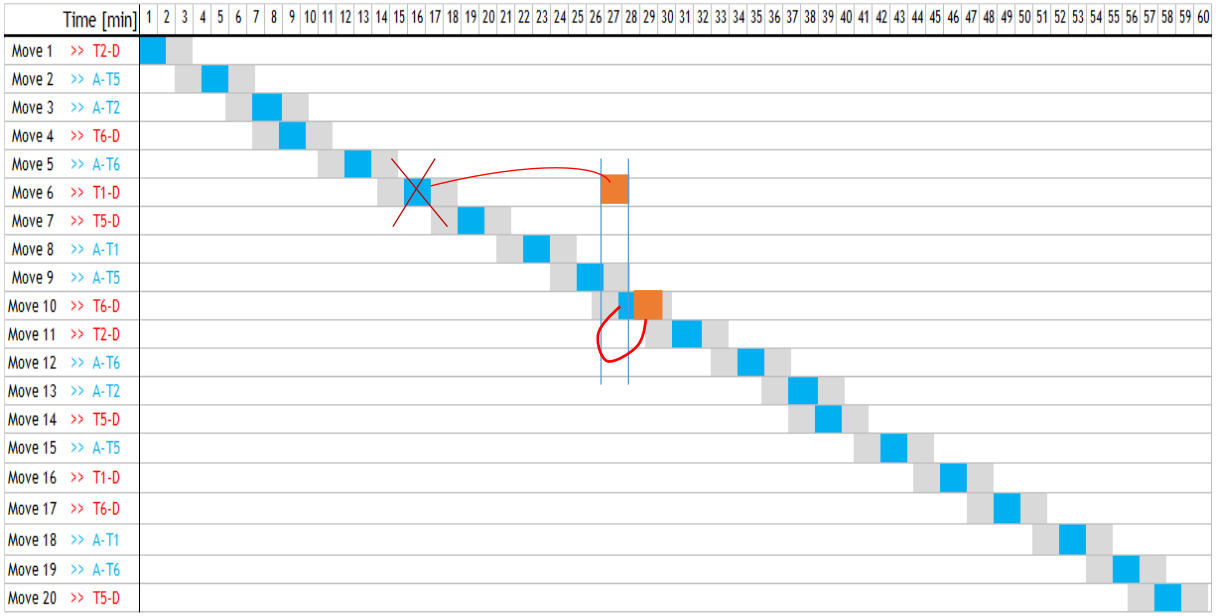
TTC – Station Capacity Analysis
Station occupation diagram (typical peak hour)

Time [min]	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
T1	HST2 — HST4 — HST2
T2	HST1 — HST3 — HST1
T3	Spare track
T4	Spare track
T5	CALT2 — CALT4 — CALT6
T6	CALT1 — CALT3 — CALT5 — CALT1

Station occupation diagram



Maximum train delay that can be supported with the proposed configuration

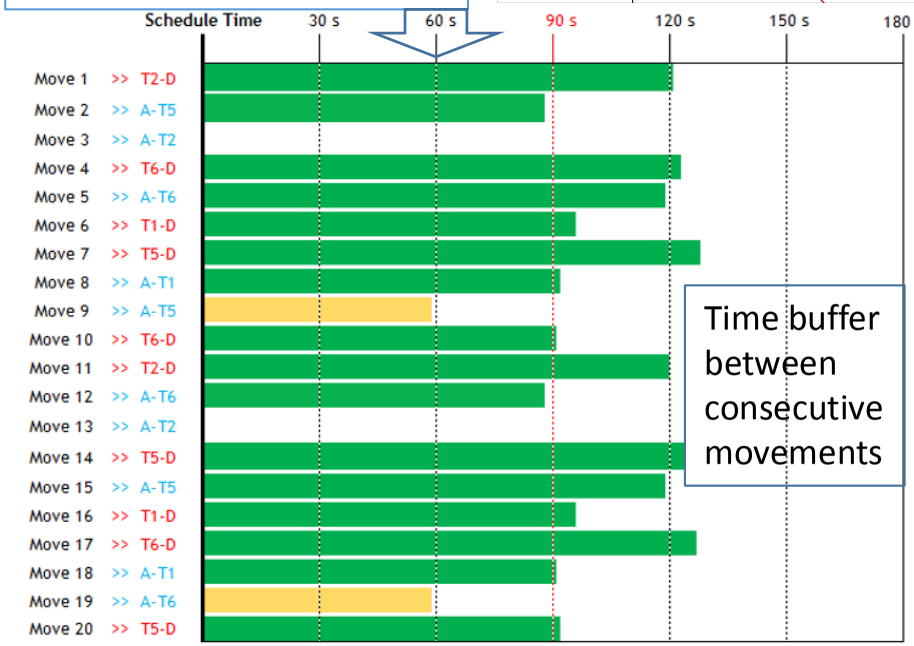


The proposed Schedule (variable regularity) maximizes the buffer times between train movements allowing to absorb the delays due to minor failures/incidents. The system presents capacity to accommodate delays of 90-120 seconds without any impact on the normal train operating schedule.

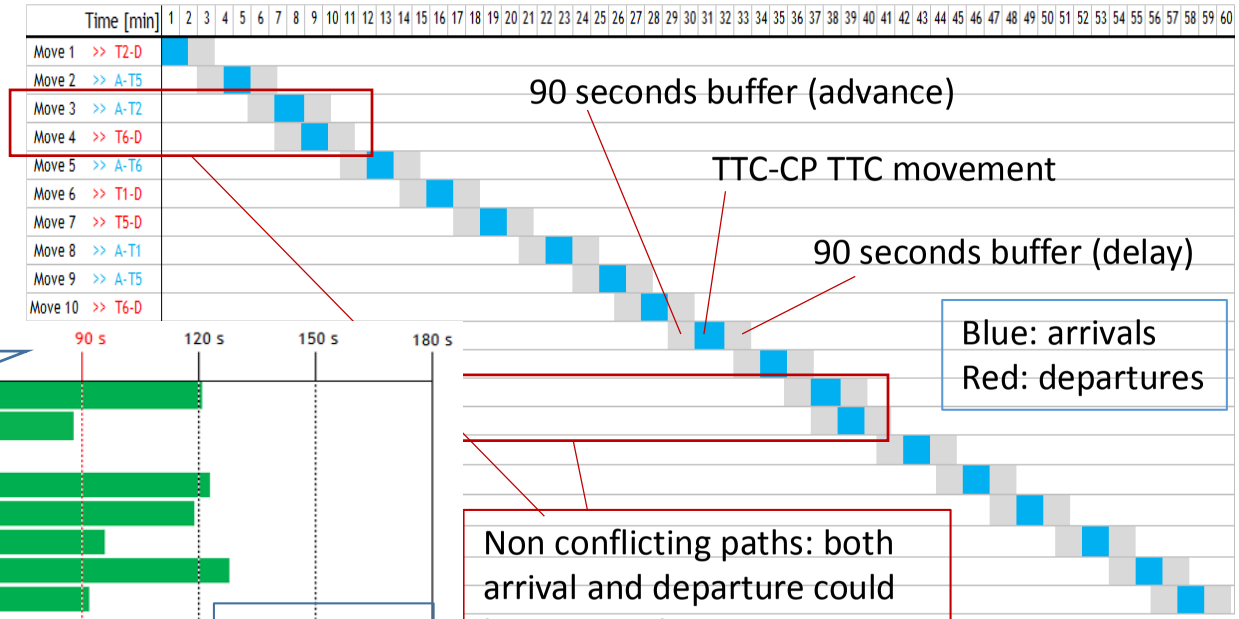
In case a given train is delayed more than the available buffer (90-120 seconds), this train may be rescheduled to perform the corresponding movement using other buffers (e.g. **Move 6 is delayed and rescheduled** to be performed in between the Move 9 and 10; using the buffer of Move 10 it would be feasible to execute Move 6 without any further impact on the overall train operating schedule: **only Move 10 would be slightly delayed**).

TTC – Station Capacity Analysis
Maximum allowable train delay in normal operation

All train movements are able to accommodate 60 seconds delay of previous trains and almost all movements are able to absorb a 90 seconds delay of previous trains.



Time buffer between consecutive movements



90 seconds buffer (advance)

TTC-CP TTC movement

90 seconds buffer (delay)

Blue: arrivals
Red: departures

Non conflicting paths: both arrival and departure could happen at the same time (using independent tracks)

Typical peak hour operation pattern

The proposed normal operation pattern for the peak hour allows to accommodate 90-120 second delays without any impact on other arrival/departures.

2-track main access to terminus station
Some international examples

UK. HS1 Channel Tunnel-London.
Access to Saint Pancras.
Six stub platform tracks.

UK. HS2 London-Birmingham.
Access to London Euston.
Twin single-track tunnels (main track)
Eleven stub platform tracks
17 TPHPD

Norway. Follo Banen Oslo-Ski.
Access to Oslo Station.

Questions & Answers

Basis for the statement on Page 17 of 42 that "the bulk of traffic can and probably will be dealt with the 4th/King Station."

SENER's study was **focused on the access to the TTC station and the operation of the terminus station itself**.

It was **assumed that no train delays originated south of 4th/Townsend would impact on the TTC operation**.

That assumption implied that other **stations south of TTC** (4th/Townsend, 4th/King) **would work as a buffer to regulate the operation flow to/from TTC**.

Also, some of the assumed 10 TPHPD might be bouncing at 4th/King instead of all of them reaching the TTC. This would provide some additional flexibility to SENER's proposed operation pattern at TTC.

The SEIS-2015 states that only two tracks of the TTC will be dedicated to Caltrain services.

Basis for the 23 minute scheduled HSR dwell time and what services are expected to occur during that period (1 of 2)

The capacity analysis of the San Francisco Transbay Station was performed considering a minimum of 20 minutes for the Dwell Time of High Speed Rail trains.
The estimation of a 20 minutes Dwell Time takes into account the various terminal turnaround train servicing and passenger processing functions. Moreover, it is considered that some of the activities can be performed in parallel and that others must depend upon completion of prior activities.
The basic processes occurring **during the turnaround** period layover are the following:

- **Passenger alighting;**
- **Restocking of food and beverage service items;**
- **Coach cleaning and re-stocking of bathroom supplies;**
- **Train safety system pre-departure preparation.**
- **Minor equipment repairs**

Hence, the 20 minutes estimated for the HST terminal station minimum turnaround time results from the sum of the following critical activities:

1. **Passenger alighting (5 min);**
2. **Interior cleaning, restocking and servicing (10 min);**
3. **Passenger boarding (5 min).**

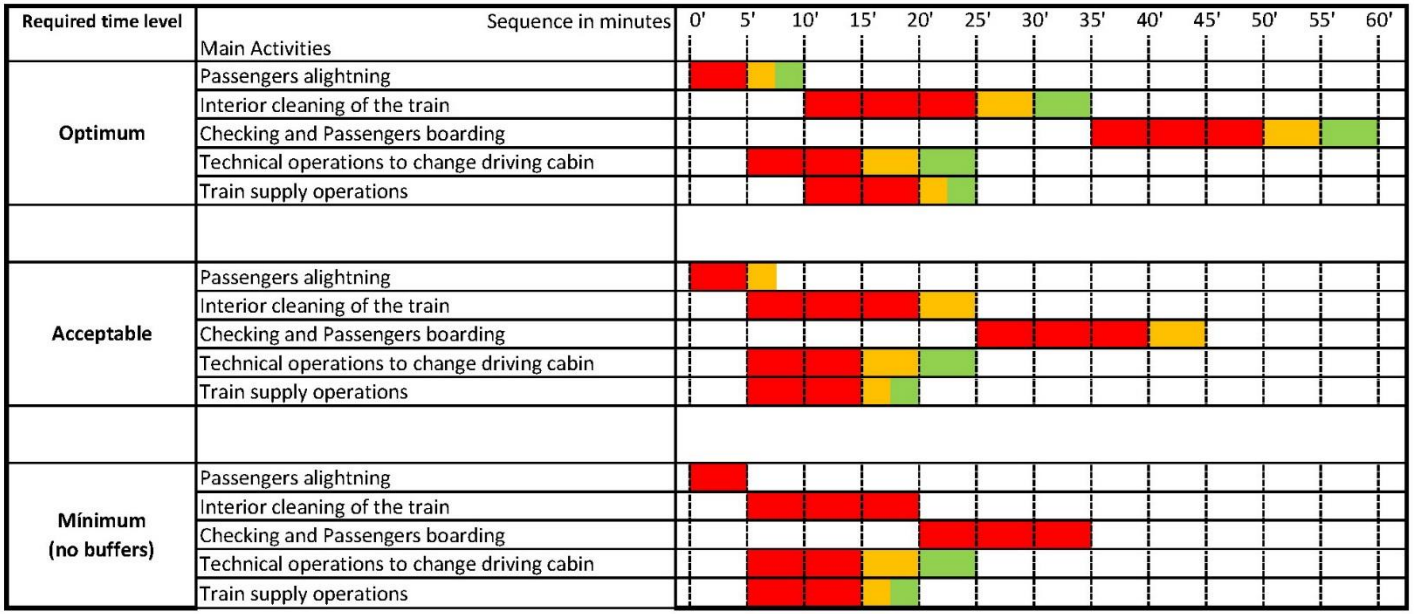
The proposed Schedule and station track layout allows to accommodate the 20 train movements in a peak hour without any occupation of the two central platforms of the station. In case there is a need to increase the HST Dwell Time (from 20 min to 30/40 min), the use of one of the spare tracks would allow to accommodate this increment without any impact on the service plan.

Basis for the 23 minute scheduled HSR dwell time and what services are expected to occur during that period (2 of 2)

A **longer dwell time** can be achieved for HSR services (**35 to 40 minutes**) with the proposed service pattern by **using also tracks 3 and 4** (spare tracks in SENER's Study, Jan 2018). That would increase the number of HSR trains required for operation, but, on the other hand, it would provide **more comfortable times for alightning, boarding, cleaning, supplying and other tasks to be performed during the dwell time.**

Sequence of activities in a terminus station for a high speed train turnaround *

*Based on the operating experience of the High Speed service of Renfe Operadora (Spain). 200 m length HS Trainset.



Minimum time
Acceptable time
Optimum time

Assumptions on how will failures/incidents and recovery be addressed

SENER's Study does not include a failure and recovery analysis addressing the resilience of the system against the occurrence of different failures/incidents and the computation of the respective recovery times.

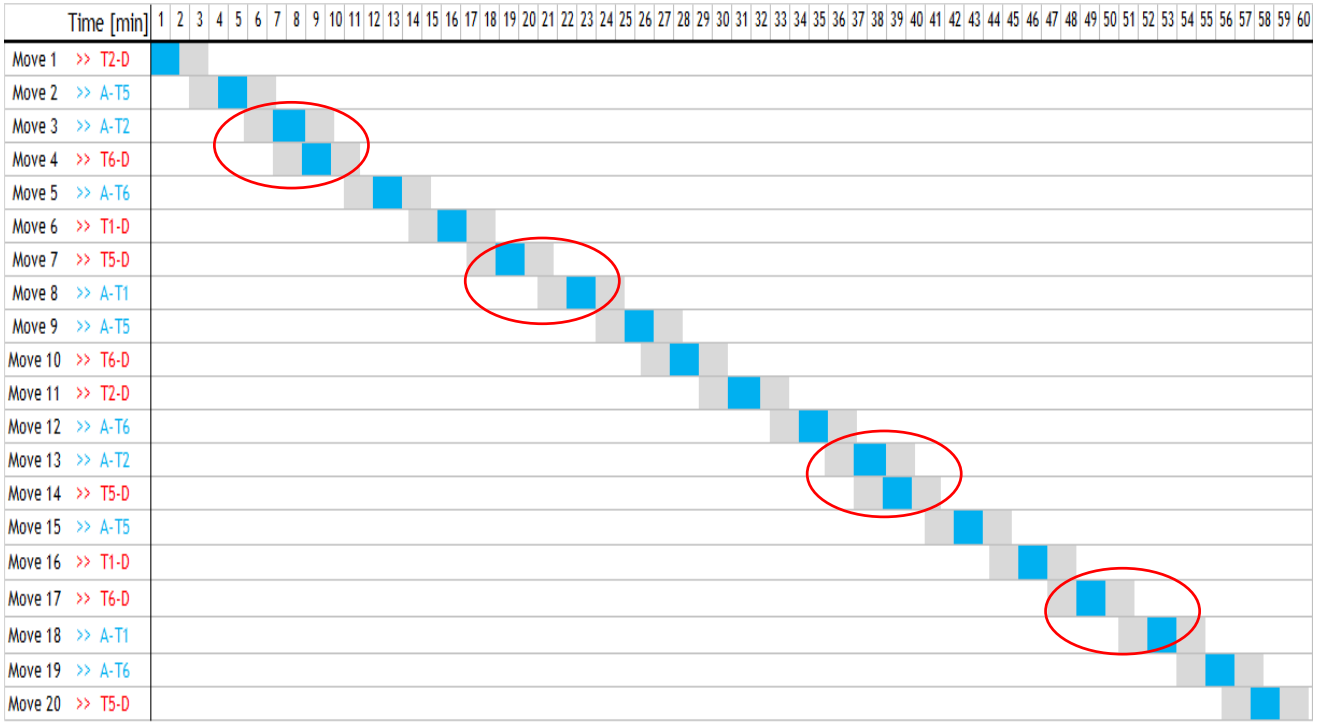
However, the definition of the Schedule (variable regularity) optimizes/maximizes the buffer times between train movements which allow to absorb delay due to minor failures/incidents. **The system presents capacity to accommodate delays of 90-120 seconds without any impact on the normal train operating schedule**. See Slide "TTC – Station Capacity Analysis / Maximum allowable train delay in normal operation" within this presentation for further explanation.

The proposed Schedule and station track layout allows to accommodate 20 TPHPD (peak hour) without any occupation of the two central platform tracks of the station. **The use of this spared platform tracks can be used to manage limited service disruptions, including failures/incidents and recovery of trains. Further analysis would be required to support this point.**

Limits of operation with the proposed number of tracks (maximum trains per hour)

A 2-track DTX main tunnel can accommodate delays between 90-120 seconds for the different train movements associated to a normal service plan (10 trains TPHPD: 4 HST trains and 6 Caltrain trains).

Given that there are 4 independent movements in the schedule proposed (Moves 3&4, Moves 7&8, Moves 13&14 and Moves 17&18), it would be possible to operate up to 12 TPHPD (TBC).



Potential impacts and concerns of the current DTX alignment on the businesses along 2nd Street and Howard Street

The current DTX project foresees a **cut-and-cover construction method** to build the throat access to the TTC. This would likely require to **temporarily close (partial or totally) the intersection of 2nd and Howard St**. for a significant period **(4+ years)**. This intersection is one of the city's busiest corridors and closing it would have significant consequences for this South of Market Neighborhood. Likewise, other business in this area between Clementina St and Howard St would be also disturbed during a cut-and-cover tunnel construction (accessibility, dust, heavy machinery, visual and noise impacts). **Other construction methods (i.e. mined tunneling) would avoid or mitigate these impacts on surface during construction**.

The **Eminent Domain costs** associated with 235 2nd Street and 589 Howard St. with the current DTX project would exceed $105 Million. 235 2nd Street is San Francisco headquarters for CBS Interactive and Apple, Inc. (the only Apple office in the City). 235 2nd would be shut down for a minimum of 2 years. Also, the taking of the area under the building arises significant points of concern about perceived vibration, noise and sound under the tunnel operation phase. 589 Howard St. would have to be demolished, it is a UMB and there simply is no chance it can be "shored up" and saved. It is a historical building and is on the city register as such.

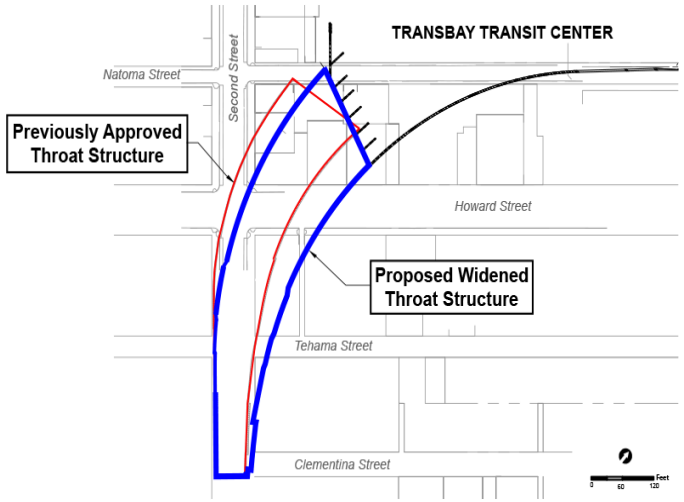
Basis for the recommended changes to the minimum curve radius approaching the TTC and has CHSRA or Caltrain accepted this proposal? (1 of 2)

The minimum radius proposed in SENER's Study (**625 ft**) is based on a **review performed by the CHSRA Regional Manager, dated March 17th, 2010**, which stated that the "Horizontal radius of 659-foot is commensurate with the tightest radii (622-foot / 190 m) that the EMT has found in revenue service at Cologne Central Station. This will require a design variance for it to be accepted as part of the HST system."

Following the statement above, SENER's proposed alignment included a minimum radius of 625 ft. **SENER does not have evidence of CHSRA or Caltrain acceptance of this proposal.**

According to the **Supplemental Environmental Impact Statement/Environmental Impact Report** (Downtown Rail Extension – DTX):

The 2004 FEIS/EIR-approved design for the DTX includes a connection between the underground tracks in Second Street and the train box below the Transit Center (referred to as the "throat structure"). Existing development constrains where the throat structure alignment must widen from the three-track tunnel in Second Street to six tracks entering the west end of the Transit Center, and the width of the alignment depends on the curvature of the tracks. ***The previously approved design has a curvature radius of less than 545 feet. The proposed Widened Throat Structure calls for a 650-foot radius curve, which has been approved by the California High-Speed Rail Authority.***



Basis for the recommended changes to the minimum curve radius approaching the TTC and has CHSRA or Caltrain accepted this proposal? (2 of 2)

Standard **HSR rolling stock** (Siemens' ICE-2, ICE-3, etc.) are designed to negotiate minimum curve radii as low as **492 ft (150 m)** in main tracks (commercial service). This value is even smaller in access tracks to depots and workshops.

This main track minimum radius (492 ft = 150 m) **is a mandatory design parameter to meet European Technical Specifications for Interoperability (TSI)**.
See TSI Rolling Stock (section 4.2.3.6):
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0291&rid=10
And TSI Infrastructure (section 4.2.3.4)
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1299&from=EN

SENER Conceptual Alternate Alignment