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CAHSRA-CIT-02106

November 11, 2011

Mr. Hans F. Larsen
Director of Transportation
City of San Jose
200 East Santa Clara Street
San Jose, CA 95113-1905

Subject: Modified Tunnel Option for Downtown San Jose

Dear Mr. Larsen,

On behalf of the California High Speed Rail Authority (Authority), we appreciate the support of the City of San Jose (City) in bringing the California High Speed Train (HST) system to San Jose in a responsible, feasible, and environmentally sensitive fashion that is mindful of HST project criteria.

This partnership has been demonstrated multiple times over the past several years. As you are well aware, the Authority has previously evaluated the tunnel options and various alignments for the HST through San Jose. The Alternatives Analysis studied and eliminated the deep tunnel option as well as the HST Programmatic Alignment through the neighborhoods immediately south of downtown. Subsequently, the Authority analyzed the shallow tunnel at your request and committed to a community process to establish visual design guidelines for the HST facilities in San Jose.

Over the past year, the San Jose community members, City staff and project staff partnered in developing San Jose Visual Design Guidelines. We are confident that the Guidelines will better inform the proposed HST improvements through the City of San Jose, acknowledge local aesthetic concerns, and therefore enhance the HST facilities through this segment. We look forward to their adoption by the City Council and Authority Board.

Thank you for your May 18, 2011 letter in which you requested the Authority to consider a modified tunnel option. We have prepared a detailed response to address the points raised in your letter and as subsequently clarified in meetings with your staff and local community members, see attached "Technical Responses to City of San Jose's Proposal for Modified Tunnel Option for HST Design in Downtown San Jose Area".

We value your continued efforts and collaboration as we jointly address solutions to help build the HST system and we look forward to working with you and your staff to better inform the community and the region of this recent analysis.

Please contact me at (415) 243-4609 should you have any questions.

Sincerely,

Gary Kennerley
Regional Manager San Jose to Merced Section
Program Management Team, California High-Speed Train Project

cc: Dan Leavitt, Deputy Director, CAHSRA, Environmental & Planning
Ben Tripousis, City of San Jose, Transportation Planning Dept.

Attachment 1 - Responses to City of San Jose's Proposal for Modified Tunnel Option for HST Design in Downtown San Jose Area, dated 10/14/2011 with Appendix A.

Attachment 1

Responses to City of San Jose's Proposal for Modified Tunnel Option for HST Design in Downtown San Jose Area

Prepared by
PARSONS BRINCKERHOFF

Date: October 14, 2011

The Authority and its project consultants appreciate the City of San Jose's efforts in researching tunnel design and construction options in this location. The Authority welcomes and will continue to promote public and agency dialogue and collaboration as we develop the HST system throughout the State of California. This document strengthens and confirms our understanding of the underground alignment options in the Downtown San Jose area. In response to a letter by the City of San Jose, written May 18th 2011, much thought has been given to the suggested "Modified Tunnel Option". This document provides a direct response to the specific concerns in the letter and draws from the Technical Study Report for Modified Tunnel Option in City of San Jose (Appendix A).

The Preliminary AA Report presented to the Authority Board on June 3, 2010 studied several tunnel alternatives as initially identified as part of our scoping process in 2009. Specifically, we found the deep tunnel alternative with a mined station – whose profile is set to avoid the I280/SR87 piles and meet HST alignment criteria – to be unreasonable and unrealistic due to unsafe mining conditions (poor soils combined with high groundwater), construction schedule impacts, settlement potential, extensive surface disruptions, and very high construction costs. Please refer to Chapter 4 of the PAA. Additional detail regarding the below-ground alternatives was provided in Appendix C of that report.

Subsequently, at the request of the San Jose Downtown Association in its September 29, 2010 letter, the Authority and its project consultants analyzed a shallower cut-and-cover option with the proposed BART station 140 feet deep below the HST station. In our response letter dated November 1, 2010 and as further described during the City of San Jose Community Town Hall on November 4, 2010, the shallower cut-and-cover option was also found to be impractical. On top of the construction challenges noted above, this alternative was found to also involve possible groundwater infiltration, potential settlement issues, closure of cross streets, channelization of Los Gatos Creek during construction, reduction of parking areas for sports facilities, various utility relocations, extended construction periods and high construction costs, and associated delays in downtown redevelopment. Lastly, the challenges of constructing a mined station 140 feet deep in such poor soil conditions would be transferred to the approved BART project, which would need to be redesigned accordingly.

The City's Modified Tunnel Option (MTO) generally includes a medium-depth station approximately 100 feet below ground level. Similar to the deep tunnel option, it would be underneath and perpendicular to the proposed BART Diridon Station. The station configuration for the Modified Tunnel Option would consist of a three-tunnel system (two station platform tunnels and a center concourse tunnel). As part of this technical response, we have studied the following issues:

- Requirements, dimensions, and configuration of a medium-depth high speed rail station
- Basis of proposed BART station design and configuration
- Interface between BART station and high speed rail station
- Future development limitations
- Existing ground and groundwater conditions
- Methods of ground pretreatment, excavation, and initial ground support for tunneling
- CHSTP operational requirements, including bypass station tracks
- Sequence of construction
- Location of south portal

In reviewing the letter, the information has been presented in the same sequence to align our analysis with your suggestions.

1. Optimizing the Downtown San Jose Underground Station (Diridon Station) with respect to Alignment, Depth, and Construction Method

a. Locate HST Station Tunnel at a "Medium Depth" Below the Planned BART Station and Integrate the Design and Construction of Both Stations

The City of San Jose has proposed a medium depth station at approximately 100 feet below ground level which would be underneath and perpendicular to the proposed BART Diridon Station.

As was the case for the Deep Tunnel Alternative, we continue to assume the BART alignment/station as it currently stands (all facilities located below ground per BART's current plans). Considering the 4FT separation between BART and HST tunnels, the depth of the HST alignment would then be approximately 114FT. However, based on the alignment as shown, anticipated configuration (width footprint), and nearest portal location at the exiting Tamien Station, the I280/SR87 piles still represent the controlling factor for the depth of the profile south of the Diridon area. Despite the higher profile of the Medium Depth station, the alignment would still need to clear under these piles.

Integrating the HSR Station with BART Station will present its own challenges, starting with vertical circulation issues. In subsequent meetings, it was suggested that connections to the surface at Diridon would be via high speed elevators, which would be located in three separate shafts identified on the plan attached to the City's letter. These three shafts would be required to house high speed elevators, emergency exit staircases, ventilation, and systems. Upon analysis it was found that these shafts could be 100 feet or more in diameter and would be constructed in a similar way to the proposed BART station. Essentially, the groundwater cutoff walls for these shafts may need to extend to depths of more than 200 feet depending on ground and groundwater conditions, and the construction of slurry diaphragm walls at these depths can be problematic when located in unstable ground with high water pressures. In addition to these three vertical circulation shafts, ventilation shafts may be required at the either end of the station platforms to provide ventilation for the train tunnels. From a station operations,

passenger movement, fire/life safety, and engineering perspective, this situation presents extreme difficulties and is considered a fatal flaw.

Given the assumption that elevators shafts going to the surface will be used and the difficulties in integrating the BART station with the HSR station, other basic facilities need to be created to support the operations of a station. With three separate elevator shafts, a central ticketing concourse must be created, ideally at the surface connecting all three elevator shafts. The main function of this room would be for ticketing passengers and allowing them an area to wait for the train. With the tightly constrained existing and proposed developments on the surface, a creative solution must be devised to fulfill this necessary operation.

In comparing BART's vertical circulation plan, we can see that they have incorporated a more feasible design. The BART station configuration is a center platform at the lower level which is 28 feet wide, with escalators and stairs leading up to a below ground concourse level, and then another set of escalators and stairs leading to the ground surface. Likewise, the Tottenham Court Road Station depicted in Exhibit 4 also uses a series of escalators for vertical circulation.

b. Align Underground Station to Minimize Physical and Construction Conflicts with Priority Development Areas

Similar to the Tottenham Court Road Station in London (see Exhibit 4), the proposed station configuration is comprised of three tunnels (two station platform tunnels and a center concourse tunnel.) This is a typical station configuration for transit systems around the world, and indicative, scaled drawings have been prepared showing a dimensioned plan for this configuration (see Exhibit 5). This is a much wider and longer station than the previous deep and shallow options due to the need to provide a center concourse tunnel. As a result, the underground construction would unfortunately impose severe limitations on locations of foundations for future developments. These foundations would need to be located between tunnels and extend below the tunnels so as not to impose loads on the subsurface facilities.

c. Use Worldwide Best Practices for Underground Station Construction

It has been suggested that the Authority should consider the SEM tunneling method used for the new Tottenham Court Road Crossrail Station in London, for the Diridon Station. However, though the existing station and urban infrastructure in London will be similarly very complex when the project commences, the ground and groundwater conditions at this location are certainly not comparable to those in San Jose. Using the proposed SEM tunneling method given the geologic conditions at San Jose would be considered an impractical, high risk operation which must be avoided.

To elaborate, according to the graphic at the link below (and Exhibit 4), the geology is London Clay at the level of the station tunnels for the proposed Tottenham Court Road Crossrail Station in London. London Clay is the ideal tunneling medium, as it is soft, impermeable, and self-supporting for extended periods of time. In addition, the water table is below the tunnels.

http://tunneltalk.com/Crossrail-Apr11-Station-contract-shortlists.php

As shown in Exhibit 1 (BART Diridon Station Ground Investigations) these conditions are very different to those in San Jose, where we have an initial (shallow) layer of clay and then alternating layers of water-bearing gravels, sands, and silts at the deeper elevations. These conditions are far more challenging for mined underground construction.

For a more detailed description of the ground and groundwater conditions at Diridon, please refer to our MTO Study Report. These conditions were studied during design of the BART/ SVRT project, where the designers of this project concluded that the most appropriate method for station construction at this location and with these conditions was a cut and cover box with groundwater cutoff walls extending to a depth of 145 feet and ground treatment of the base plug by jet grouting from the surface. We agree with their conclusion that this is the most appropriate method of construction for these ground and groundwater conditions.

Secondly, we also note that part of the reason tunnels were constructed at Tottenham Court Road was because of the limitations imposed by existing above ground developments. Due to the dense urban infrastructure, feasible surface or above ground alignment alternatives could not be identified, forcing a below ground construction. At Diridon, there is a more cost effective solution in the aerial option.

Furthermore, despite a history of tunneling in London which dates back nearly 200 years and has yielded hundreds of miles of bored and mined tunnels under the city, the introduction of modern tunneling techniques such as SEM/NATM for mined station construction resulted in a well publicized collapse in London Clay at Heathrow Airport in 1994. This prompted a detailed report by the Health and Safety Executive in the United Kingdom to address the incident. This raises a concern when considering SEM/NATM in San Jose.

2. Reducing the Cost of Tunnel Construction

a. Modify Assumptions for Tunnel Diameter from 35 Feet to 25 Feet

Please refer to Exhibit 3 (Diridon Station Exhibit 1 & 2). The preliminary internal tunnel diameter assumed on CHSTP is 29.5 feet (not 35 feet), which is an appropriate size considering that the trains have not yet been selected. As dictated by CAHSR project criteria, trains will be wide bodied trains commonly used in Asia and new high speed rail lines in Europe, rather than the narrow European trains that have to fit into existing infrastructure.

The link provided by City of San Jose is to a technical paper from the Czech Republic on a proposed underground high speed rail link between Czech Republic and Germany. It includes a summary of other high speed rail tunnels worldwide including speeds and tunnel diameters. This table is reproduced as Figure 1 below.

Tunnel	Location	Length	Speed	Commissioning	Internal diameter
Gotthard	Switzerland	57 km	250 kph	2015	8.30 m
Eurotunel	France - England	50 km	160 kph	1994	7.60 m
Lotschberg	Switzerland	34.6 km	250 kph	2007	8.40 m
Guadarrama	Spain	28.4 km	350 kph	2007	8.50 m
Pajares	Spain	24.7 km		2010	8.50 m
CTRL	United Kingdom	19 km (36.8 km)	270 kph	2007	7.15 m
Katzenberg	Germany	9.4 km	250 kph	2012	9.40 m
Perthus	Spain - France	8.3 km		Construction	8.70 m
Storebaelt	Denmark	8 km	160 kph	Operation	7.70 m
Abdalajis	Spain	7.3 km	350 kph	Construction	8.80 m

Figure 1 – Summary of European High Speed Rail Tunnel Diameters
Source: LONG RAILWAY TUNNELS – COMPARISON OF MAJOR PROJECTS, Matous Hilar, Martin Srb
(http://www.ctta.org/FileUpload/ita/2009/papers/O-12/O-12-09.pdf)

In order to define a basis of comparison, we do acknowledge that at Diridon Station the design speed will be 125 mph. The tunnel diameters in Figure 1 confirm that the maximum internal diameter of 29.5 feet for twin tunnels on CHSTP is appropriate for 15% design when the rolling stock has not yet been selected. Six of the ten rail tunnels are in the range of 8.3m to 8.8m (27.2 feet to 28.9 feet). The other four tunnels are not comparable.

In Figure 1, there is a misinterpretation of information for the CTRL entry. Speeds are limited to 160kph in the single track twin tunnels in London, therefore warranting the smaller tunnel diameters. The speeds shown in Figure 1 are 270 kph in the North Downs tunnel which is a single tunnel containing twin tracks. As such, it cannot be compared to the proposed tunnel configurations at Diridon Station. Furthermore, the trains on CTRL are smaller than the European standard UIC gauge hence the smaller tunnel size. Eurotunnel is not comparable because this is a three tunnel configuration with the center service tunnel routing utilities and providing emergency ventilation, enabling the train tunnel size to be reduced. The Katzenberg tunnel diameter is larger than proposed on CHSTP possibly because it is a combined passenger and freight train tunnel. It is possible that this tunnel is sized for double stacking of freight containers.

b. Evaluate Other Operational Strategies to Reduce Need for 4 Tracks (and 4 Tunnels) at Diridon Station

The two strategies proposed by the city are:

1) Operate a basic 2 trackway configuration in the underground Diridon Station and either locate bypass tracks at-grade in low cost and low impact areas, or use the existing surface Caltrain tracks to accommodate express trains to bypass the station.
2) Operate a basic 2 trackway configuration in the underground Diridon and construct a 3rd tunnel to use as a bypass track for two-way operation with a positive train control system to ensure safe operations.

These solutions pose a few operational issues and unfortunately, will not fulfill our current service criteria for the following reasons:

- The number and frequency of the HST bypass movements at San Jose would not be served by a single track "express train by-pass track" design. In this scenario, CHST would be required to share track with Caltrain and require CHST to operate next to existing UPRR traffic, which is considered a fatal flaw as the FRA does not allow it.
- The single tunnel track, two-way operation would require a slow speed and would impact Proposition 1A mandated running times
- The single tunnel track, two-way operation forces the scheduling for the entire HST system to be oriented on San Jose Express train "meet / pass" constraints.
- San Jose station will function, for some time, as a terminus for the CHST system. As such it will be necessary to store and turn trains within the confines of the station area. A two track station configuration would not support a terminal operation.

We refer you to our MTO Study Report for a more detailed explanation of the operating requirements of the CHSTP regarding station bypass tracks. Furthermore, this question is also addressed in our response to the subsequent discussions with the city where the "Javelin" High Speed Trains in London was raised as a possible solution. This discussion can be found at the end of this paper.

3. Evaluating Optimal Location and Construction Method for the Southern Tunnel Portal

a. Consider Options to Locate Southern Tunnel Portal at Tamien, to Curtner or Monterey Highway

Due to a combination of cost constraints, operational constraints, additional property takes, alignment constraints, and environmental concerns, there is simply no appropriate place to locate the southern tunnel portals. Before evaluating the potential portal locations of Curtner or Monterey Highway, we must first understand the implications of having a station with two station tracks and two bypass tracks, as dictated by HSR project criteria.

With station track centers of 200 feet (compared with track spacing of 50 feet with previous cavern alternative) and the requirement for bypass tunnels outside station tunnels, turnouts have to be located at a much further distance from the station than with the previous deep tunnel cavern option. Considering the profile shown in the AA Report which places the portal around Tamien Caltrain station, the turnouts and crossover are relocated onto the inclined portion of track going out to the portal just below Guadalupe River. At these turnout locations, the two alignments will separate into four, and the walls will grow wider apart. The major issue here is that the Tunnel Boring Machines (TBMs) cannot support this operation, and it will be necessary to create a large mined cavern. Not only will this be highly disruptive in this developed urban area, but as explained previously, a mined cavern is not feasible given the unstable ground conditions. Furthermore, ROW procurement is a major concern. Assuming the necessity to place turnouts and crossovers on the surface, a four track tunnel will need to be carried from Diridon Station to the southern portal, as shown in Exhibit 5. With four separate tunnels, the portal would be expanded to 200 foot wide and would cause extensive property takes in this dense residential and commercial development area, around Tamien Caltrain Station.

To answer the original question of locating the portal locations at Curtner or Monterey Highway, we must consider the conclusions stated above along with the operational project criteria of having turnouts and crossover within two miles of the station platform as shown in the EMT technical memo (Exhibit 2). Assuming the unlikely scenario that a 200 feet wide four track tunnel portal would be considered for further development, the turnouts and crossovers would be placed just south of the tunnel portals. As Curtner and Monterey Highway are more than two miles away from the station platforms, this idea is made invalid.

Likewise, at the north end, underground turnout caverns would be required at an increased distance from the station, and this in turn increases the length of the bypass tunnels.

b. Locate All Tunnel Construction Operations at Northern Tunnel Portal

Due to constructability reasons, it would not be possible to locate all tunnel construction operations to the Northern Tunnel Portal. From a construction standpoint, the intermediate shafts would be located to the north of the station from which TBM tunneling could be carried out in both directions. TBM's would then exit at the south portal, as once the tunnel lining is installed as part of the tunnel boring operations, the complete TBM cannot be removed back through the newly constructed tunnel.

Construction of the three station elevator/ emergency exit/ ventilation shafts would be carried out from the surface at Diridon. Likewise, pretreatment of the station footprint at Diridon by jet grouting would be carried out from the surface prior to TBM tunneling. Other surface works would include construction of the surface station concourse connecting the three shafts on the surface and connections to other transit facilities, as this is anticipated to be a major interchange station.

Excavation of the station platform tunnels could be executed primarily from the running tunnels after the TBM's have finished. The station concourse tunnel and cross-passages would be carried out from either the shafts or the station platform tunnels depending on the sequence of construction.

Locating the majority of construction activity would be difficult as the current alignment locates the north portal in the sports field at Bellarmine College, where there is very limited space available for a staging area. An alternative location for the north portal closer to Newhall yard would need to be investigated.

Review of Technical Reference Materials Provided For Underground Transit Stations and Tunnels

Reference materials were provided by the City of San Jose to justify the logic behind the suggested tunnel modifications. The reviews of the first two references have already been incorporated in the above responses, and are repeated here for completeness.

Reference 1: Underground Station Construction Methods in adverse soil conditions

While the mined and bored tunnel construction for the new Tottenham Court Road Crossrail Station under the existing station and urban infrastructure in London will be very complex when it commences, we do not consider ground and groundwater conditions at this location to be comparable to those in San Jose in general, and Diridon Station specifically.

According to the graphic at the link below (and Exhibit 4), the geology is London Clay at the level of the station tunnels for the proposed Tottenham Court Road Crossrail Station in London. London Clay is the ideal tunneling medium, as it is soft, impermeable, and self-supporting for extended periods of time. In addition, the water table is below the tunnels.

http://tunneltalk.com/Crossrail-Apr11-Station-contract-shortlists.php

These conditions are very different to those in San Jose, where we have an initial (shallow) layer of clay and then alternating layers of water-bearing gravels, sands, and silts at the deeper elevations. These conditions are far more challenging for mined underground construction and geology.

We also note that because of the existing developments at Tottenham Court Road, there was no surface or above ground alternative alignment to the mined construction which is proposed at that location. At Diridon, both surface and above ground alignment options do exist.

Furthermore, despite a history of tunneling in London which dates back nearly 200 years and has yielded hundreds of miles of bored and mined tunnels under the city, the introduction of modern tunneling techniques such as SEM/NATM for mined station construction resulted in a well publicized collapse in London Clay at Heathrow Airport in 1994. This prompted a detailed report by the Health and Safety Executive in the United Kingdom to address the incident. This raises a concern when considering SEM/NATM in San Jose.

Reference 2 High Speed Rail Tunnel Diameters

Please refer to Exhibit 3 (Diridon Station Exhibit 1 & 2). The preliminary internal tunnel diameter assumed on CHSTP is 29.5 feet (not 35 feet), which is an appropriate size considering that the trains

have not yet been selected. The trains will be wide bodied trains commonly used in Asia and new high speed rail lines in Europe, rather than the narrow European trains that have to fit into existing infrastructure.

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Source: LONG RAILWAY TUNNELS – COMPARISON OF MAJOR PROJECTS, Matous Hilar, Martin Srb (http://www.ctta.org/FileUpload/ita/2009/papers/O-12/O-12-09.pdf)

In order to define a basis of comparison, we do acknowledge that at Diridon Station the design speed will be 125 mph. The tunnel diameters in Figure 1 appear to confirm that the maximum internal diameter of 29.5 feet for twin tunnels on CHSTP is appropriate for 15% design when the rolling stock has not yet been selected. Six of the ten rail tunnels are in the range of 8.3m to 8.8m (27.2 feet to 28.9 feet). The other four tunnels are not comparable.

There is an error for the CTRL entry. Speeds are limited to 160kph in the single track twin tunnels in London, therefore warranting the smaller tunnel diameters. Speeds are 270 kph in the North Downs tunnel which is a single tunnel containing twin tracks. The trains on CTRL are smaller than the European standard UIC gauge hence the smaller tunnel size. Eurotunnel is not comparable because this is a three tunnel configuration with the center service tunnel routing utilities and providing emergency ventilation, enabling the train tunnel size to be reduced. Katzenberg tunnel diameter is larger than proposed on CHSTP possibly because it is a combined passenger and freight train tunnel. It is possible that this tunnel is sized for double stacking of freight containers.

Reference 3: Two-Track High Speed Rail Stations

The report on proposed high speed rail underground station options at Heathrow Airport in London validates the preliminary cost estimates of $1 billion to $2 billion which were previously prepared for the underground station options in San Jose. Section 6 (page 38) of Appendix III Station Design, Table 7 of the report summarizes preliminary estimated station costs for different underground station locations as ranging from UK Pounds 0.8 billion to 1.2 billion (US dollars 1.3 billion to 2 billion). This is in the same order of magnitude as the preliminary cost estimates for Diridon underground station options.

Reference 4: Cost Comparisons of High Speed Rail Tunnels and Elevated Viaducts

The first report is a cost comparison and risk report presentation for recent high speed rail infrastructure projects in western European countries which all have extensive experience of building high speed underground rail projects over the past 20 to 30 years. The report is a high level financial type report. Underground stations are not included so the report is not applicable in discussing costs for underground station construction. The report does, however, show the large range in costs for underground works which are possible (page 78). The most expensive project, HS1 in UK (formerly CTRL), was 5 times more expensive on a route km basis than the cheapest unnamed project.

The second report is on the proposed HS2 project in UK connecting London and the Midlands. The report is of limited use because it includes train tunnel costs but not underground station construction costs.

Technical Responses to
Subsequent Discussions on "Javelin" High Speed Trains

In subsequent discussions and a particular meeting between the City of San Jose, Downtown Owners Association, and Authority staff on June 28th 2011, it was suggested that underground bypass tracks could be replaced by a local service running at ground level on the current Caltrain alignment. Reference was made to the new "Javelin" high speed trains operating on the HS1 (formerly CTRL) route in London in support of this proposal.

In theory, passengers bypassing San Jose would need to transfer to a separate train which would operate on above ground bypass tracks. This is not an acceptable operating condition as the transfer stations would need to be at Gilroy to the south and Redwood City to the north. The bypass train service, operating on non-high speed tracks would be even slower in comparison to the main HSR service stopping in San Jose.

It was also suggested that this surface service could provide redundancy should a train become stranded in the tunnels. This is unacceptable because of the extended journey times. If this scenario were carried through, Caltrain service would need to be upgraded from Diridon to Gilroy, which is not currently planned.

We have further researched the "Javelin" service, which is named after the Olympic event. It is designed to provide a 7 minute service for the 11 mile distance between St Pancras and Stratford, at approximately 100 mph. This is because the Eurostar trains, which share the same tunnels, are limited to 100mph in the tunnels for aerodynamic reasons. As such, the Javelin trains are also limited to this speed, although both types of train run much faster on above ground sections of the HS1 route. A link is provided below which explains the Javelin train in more detail:

http://en.wikipedia.org/wiki/British_Rail_Class_395

In fact, this is not a supplementary or redundant service for Eurostar trains, but an entirely new high speed "commuter service" operating on the HS1 route between Dover and London. Therefore, the service is not a valid comparison with the operating service requirements of the CHSTP. However, an assessment could be made between CHSTP and Eurostar. We also agree that at some future point, a high speed commuter service similar to the "Javelin" trains could potentially run on parts of the same route as CHSTP. If this was the case, the bypass tracks would be essential to allowing shared use of the tracks.

Appendix A

To: Gary Kennerley, Regional Manager, San Jose-Merced Section

CC: Moises Gutierrez, James Tung, Regional Engineers, San Jose-Merced Section

From: Jimmy Thompson (PB CHSTP EMT/PMT)

Date: August 2011

Re: Technical Study Report for Modified Tunnel Option in City of San Jose

Summary of Exhibits:

Exhibit 1 - Large scale section showing ground conditions and investigations at Diridon Station for the BART project.

Exhibit 2 - Typical intermediate station track arrangement, as shown in PMT Technical Memo.

Exhibit 3 – Cross Section of Diridon Station Tunnel

Exhibit 4 – Crossrail Exhibit of Tottenham Court Road Station

Exhibit 5 – Plan view of Modified Tunnel based on interpretations from CSJ suggestio**ns.**

Introduction

In response to the City of San Jose's proposed Modified Tunnel Option (MTO), a medium depth station at approximately 100 feet below ground, CHSTP has prepared a brief technical study report to assess the proposal for a medium depth high speed rail station below the proposed BART station. The report will begin with a brief summary of project criteria, and then address specific technical features.

Brief Summary of Project Criteria

- Length of station platforms – 1,410FT
- Width of station platforms – 20FT (minimum) for side platforms and 30FT (minimum) for center platforms.
- Total length of station trackwork (i.e. switch point to switch point for station turnouts) – 6,000FT (note that station turnouts are symmetrically located 3,000FT on each side of the platform centerline)
- For assumed 125mph through-speed along mainline:
- 80mph crossovers. The distance along mainline is 1,660FT (830FT for each leg of the crossover). For 220mph through-speed along mainline, the crossover length along the mainline is even longer.

- Crossovers are required on each end of the station special trackwork. These need to be located as close as possible to the station turnouts, subject to geometric/speed limitations, but within 2 miles of the station turnouts.
- 60mph turn-outs to station tracks.
- Limits of grades under special trackwork:

  For Ballasted Track: Desirable: 0.25% or less, Maximum: 0.50%
  For Non-ballasted track: Desirable: 0.25%, Maximum: 1.00%

The primary technical issues addressed by the study report are as follows:

- Method of Construction
- Shafts to Surface
- Proposed BART station
- CHSTP Station Requirements
- Ground and Groundwater Conditions
- Grouting Trials
- Control of Groundwater and Treatment of Ground to Improve Stability
- Previous Deep Station Configuration
- CHSTP Intermediate Station Operational Requirements
- Four Train Tunnel Configuration (Two Station Tunnels and two bypass tunnels)
- Construction Interface with BART Tunnels
- Operating Connectivity with BART/Station Design
- Right of Way/Subsurface Easements

Method of Construction

The City has suggested that the method of construction for the mined station could be the Sequential Excavation Method (SEM) which is also known as the New Austrian Tunneling Method (NATM).

This method involves excavation of the tunnel cross section in separate smaller headings which are enlarged and connected to form the final cross section in a defined sequence. Initial support is provided by sprayed concrete which is known in the industry as shotcrete. Water pressure relief holes are provided in the shotcrete lining as the shotcrete is not designed for water pressure. The shotcrete is typically reinforced with fibers and steel reinforcement and light weight steel beams known as lattice girders. Soil nails are also drilled into the ground from the tunnel headings to reinforce the ground. A permanent watertight reinforced concrete lining is cast in place to complete the tunnel structure and this lining is designed for full water pressure and all ground loads.

The main disadvantage of the SEM/ NATM construction method is that it is not suitable for unstable ground with water pressure and large inflows, without pretreatment of the ground. This pretreatment would likely be jet grouting from the surface, which would be required over the entire footprint of the station.

Mined cavern construction was also considered along Santa Clara Street in downtown San Jose during preliminary design of the SVRT project and rejected in favor of cut and cover construction due to adverse ground conditions and risk.

Shafts to Surface

Three shafts would be required to house high speed elevators, emergency exit staircases, ventilation and systems. These shafts could be 100 feet or more in diameter and would be constructed in a similar way to the proposed BART station. The groundwater cutoff walls for these shafts may need to extend to depths of more than 200 feet depending on ground and groundwater conditions at these depths. Construction of slurry diaphragm walls at these depths in poor ground can be problematic in unstable ground with high water pressures.

Additional ventilation shafts may be required at the either end of the station platforms to provide ventilation for the train tunnels.

Proposed BART Station

The design of the proposed SVRT BART station at Diridon is a cut and cover box 800 feet long, 70 feet wide and 70 feet deep. The support walls for the excavation will be slurry diaphragm walls which will extend to a depth of 145 feet below ground level. The slurry walls are designed as groundwater cutoff walls. The base of the excavation will be treated for a depth of 20 feet by jet grouting from the surface prior to excavation. The purpose of the jet grouting is to strengthen the ground and reduce the permeability of the base of the excavation prior to installation of the permanent concrete reinforced base slab. No lowering of the groundwater table by dewatering outside the excavation is planned because the permeability of the ground and potential volumes of water are considered to be too high by the designers.

The station configuration is a center platform at the lower level which is 28 feet wide, with escalators and stairs leading to a below ground concourse level. Another set of escalators and stairs leads the ground surface. This is a similar station configuration to other underground BART stations on the system.

CHSTP Station Requirements

Each station platform requires a width of 20 feet exclusive of vertical circulation (elevators, escalators, stairways). Mined tunnels to accommodate station platform would therefore be 40 to 45 feet internal diameter. Allowing 24 inches for final lining and the same for primary lining gives 8 feet of liner so the excavated diameter would be about 48 to 53 feet. The central concourse tunnel would have a similar diameter.

A pillar of ground equal to one tunnel diameter in width is required between each tunnel for structural support so total width for the two station platform tunnels and the central concourse tunnel would be 250 feet. Track centers would be about 200 feet.

Each bypass train tunnel having an excavated diameter of 33 feet would require a ground pillar of 50 feet (equivalent to the tunnel diameter of the adjacent station tunnel) which would add 166 feet to give a total width of 416 feet approximately.

The station platforms would be 1400 feet in length to accommodate the longer high speed trains, compared with BART station platforms of 800 feet.

Ground and Groundwater Conditions

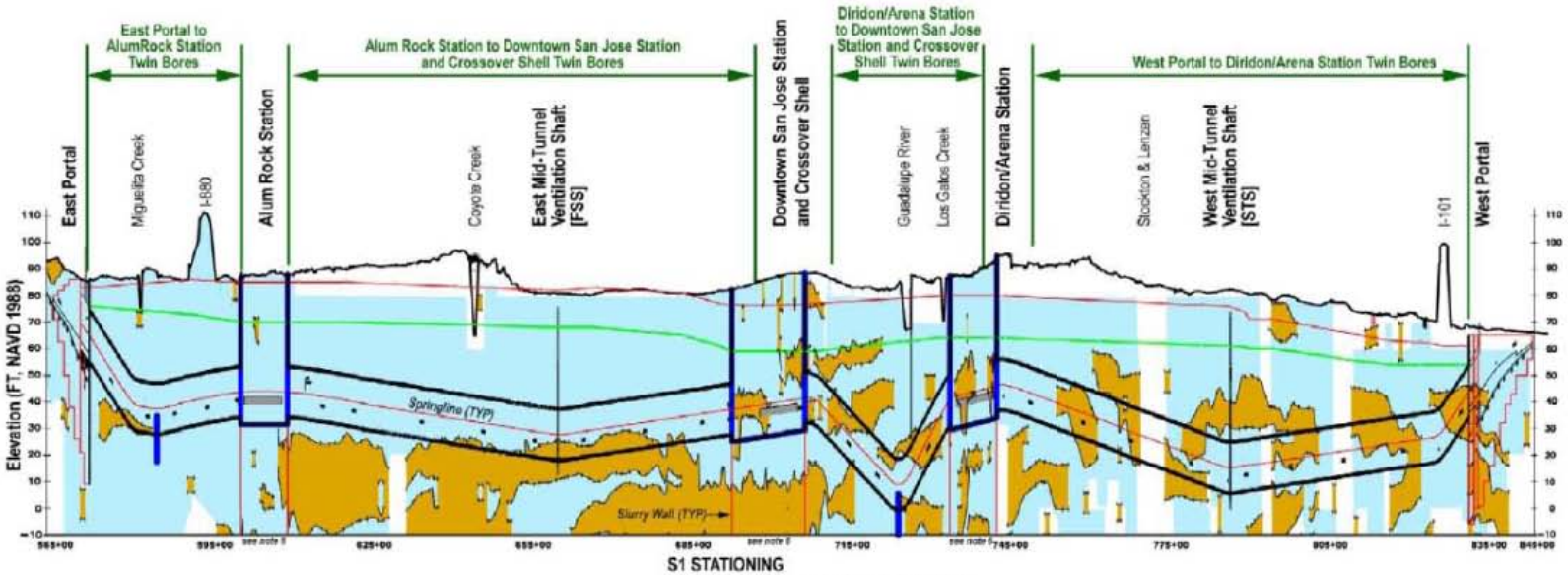
Extensive ground and groundwater investigations have been carried out for the proposed underground BART Extension to San Jose (references can be found in the Alternatives Analysis Report - Appendix C - Downtown Station Alternatives Report – June 2010). These investigations have included boreholes, pump tests and a grouting trial to assess the suitability of the ground to be treated by consolidation grouting.

Due to San Jose's past as an agricultural area, a large numbers of deep water wells exist in the area and the presence of aquifers holding large quantities of water is well known. As a result, the anticipated ground and groundwater conditions are well understood even though very little underground construction has been carried out at depth in San Jose to confirm these conditions.

Ground conditions consist of a capping layer of clays which are underlain by inter-bedded deposits of clays, sands silts and gravels. The sands, silts and gravels are water bearing.

The sands and gravels have been eroded from the hills around San Jose over millions of years and deposited by rivers in the San Jose basin. The deposits extend many miles to the edges of the level ground in the basin and upstream to Gilroy and beyond. These deposits are interconnected and extend up to 600 feet in depth.

A summary long section showing ground conditions on the BART Alignment is shown in Figure 1.



DESIGN WATER LEVELS:

MAXIMUM PIEZOMETRIC LEVEL FOR TBM TUNNEL CONSTRUCTION.

MINIMUM PIEZOMETRIC LEVEL FOR TBM TUNNEL CONSTRUCTION.

SVRT GENERALIZED SOIL CLASSIFICATION

UNIT	PRIMARY STRATUM DESCRIPTION	INCLUDED IN THIS LAYER (SEE NOTE 1)
1	SILTS, CLAYS AND ORGANIC SOILS. SOIL BEHAVIOR TYPE (SBT) ZONES 1 THROUGH 4, AND 9, AS CLASSIFIED BY CPTS USING ROBERTSON, 1990.	• MAN-MADE FILL CONSISTING OF ASPHALT CONCRETE AND AGGREGATE BASE ENCOUNTERED MOST OFTEN WITHIN FIVE FEET BELOW GROUND SURFACE • THIN LAYERS OF COARSE-GRAINED SOIL AS DESCRIBED IN NOTE 2
2	SANDS AND GRAVELS. AND SBT ZONES 6 THROUGH 8, CLASSIFIED BY CPTS USING ROBERTSON, 1990.	• COBBLES • THIN LAYERS OF FINE-GRAINED SOIL AS DESCRIBED IN NOTE 2

NOTES:

1. THE SBT ZONE 5 - 'SAND MIXTURES - SILTY SAND AND SANDY SILT' CONSISTS OF BOTH FINE-GRAINED AND COARSE-GRAINED SOILS. THEREFORE, IT MAY BE INCLUDED IN EITHER SOIL UNIT.
2. LAYER THICKNESS. DUE TO THE VARIABILITY IN SOIL PROFILE ON THE PROPOSED TUNNEL ALIGNMENT, FIVE FEET WAS SELECTED AS A THRESHOLD THICKNESS FOR THIN SOIL LAYERS.
3. MEASURED WATER LEVELS SHOWN ON THESE SUBSURFACE PROFILES REPRESENT THE PIEZOMETRIC LEVELS EXPECTED AT THE DEPTH OF THE TBM TUNNEL. THE WATER LEVELS SHOWN ARE NOT APPLICABLE FOR THE DESIGN OF OTHER SVRT PROJECT EXCAVATIONS AND STRUCTURES.
4. ALIGNMENT SHOWN ON PROFILE CORRESPONDS TO APRIL 2008 QUARTERLY UPDATE ALIGNMENT SUBMITTAL.
5. HYDROGEOLOGICAL INFORMATION FROM HMMB HYDROGEOLOGY REPORT P0503-0300-RPT-DE-020 MAY 2008.
6. BOTTOM OF SLURRY WALLS TRUNCATED. REFER TO GBR DRAWINGS D300-S-TR-C305 TO C307 FOR FURTHER DETAILS.

THIS FIGURE IS PRELIMINARY AND WILL BE REVISED BASED ON ADDITIONAL GEOTECHNICAL INVESTIGATION RESULTS AND REVISED MATERIAL DESCRIPTIONS.

Figure 1 – Interpretative Geologic Profile – Summary Sheet

Note: Dimensions shown are approximate and do not reflect recent profile changes.

Ground Conditions

In the vicinity of Guadalupe River and Los Gatos Creek, particularly at their confluence close to the Diridon Station, much variability in the ground conditions has been found and this can be seen in the long sections in Figure 1 and Exhibit 1. This is normal in the vicinity of rivers as they are high energy environments with erosion and deposition occurring simultaneously.

Generally speaking the ground conditions become more variable moving west and north of these rivers. The amount of sands, silts and gravels also increases in these directions.

At Diridon Station, sand and gravel lenses and layers have been identified in boreholes from depths of 30 feet to depths of 150 feet below ground level, extending over the full 800 feet length of the proposed BART Station. Ground conditions do not improve with a medium depth station located at 110 feet below ground level compared with a deep station at 140 feet depth, as sand and gravel lenses are still present although the water pressure is reduced.

Groundwater Conditions

Pump tests were carried out at Diridon Station to determine the permeability and water bearing capacity of the ground. The ground was found to have a permeability of up to 10-1 cm/s, which is the highest level of ground permeability, and corresponds to unconsolidated gravels with large voids. Boreholes samples confirm that the gravels are clean and loose, and contain large quantities of water.

Grouting Trials

As part of the ground investigations for the SVRT project, specifically the construction of mined cross-passages between the train tunnels, there was concern about whether consolidation grouting of the ground could be achieved from the train tunnels, to improve ground stability and reduce water inflows to allow excavation to be carried out.

A grouting trial was carried out at Newhall Yard in Santa Clara by Hayward Baker from March through May 2008 under the direction of VTA and its SVRT consultant HMM/Bechtel. The method chosen was consolidation grouting which involves injecting chemical and cement grouts under pressure into the surrounding ground from cased boreholes. Sophisticated, computerized, mixing, injection and monitoring equipment was used. After completion of the work, boreholes were drilled into the treated zone to identify the degree of treatment. Unfortunately, the consolidation grouting was unsuccessful in treating the ground, and only traces of grout were found in the ground. This is a typical result when voids in the ground are too large and water is travelling through the ground. The grout simply gets diluted and washed away. A photograph of the grouting trial is shown in Figure 2.

Figure 2 – Photograph of grouting trial at Newhall Yard in San Jose (2008)

Control of Groundwater and Treatment of Ground to Improve Stability

The types of gravels present in the Diridon station area cannot easily be dewatered or treated by consolidation grouting. Water from dewatering operations would also have to be treated prior to discharge, and the ground at the Diridon location has some history of contamination which may impact the groundwater.

However, loose ground such as gravels do respond well to targeted ground treatments carried out from the surface such as jet grouting and deep soil mixing which have both been used extensively in the Bay Area.

Whilst the groundwater pressures would be slightly less with a medium depth station rather than a deep station, ground treatment from the surface would still be necessary to maintain stability during excavation and reduce water inflows and prevent potential settlement to adjacent properties. This ground treatment would likely be by jet grouting. Photographs of similar construction at the BART Warm Springs extension near Lake Elizabeth in Fremont and on the UNWI sewer project in Sacramento are shown in Figure 3.

Figure 3 – Jet Grouting method of ground treatment for BART's Warm Springs extension near Lake Elizabeth in Fremont (2010), and on UNWI sewer project in Sacramento (2008)

Previous Deep Station Configuration

A single mined cavern with a span of 70 feet was proposed as the preferred deep station alternative configuration previously (Downtown San Jose Alternatives Report prepared in 2010) which was included in the Preliminary Alternatives Analyses (AA) Report Appendix C. The board recommended that this alternative not be carried forward in the AA report. This configuration had track centers of about 50 feet.

CHSTP Intermediate Station Operational Requirements

The current layout of San Jose Diridon Station California High-Speed Train (CHST) platform is based on the standard directive drawing produced by the Project team for the guidance of the Project Regional design engineers to build an intermediate station that meets the following operational criteria:

- Allows for the stopping of trains at an intermediate high speed train passenger station while maintaining following train headways of 5 minutes as per the requirements of Proposition 1A.
- Allows for the overtaking of trains stopping at intermediate stations by faster express trains.
- Allows express train to maintain Proposition 1A mandated running time between city pairs.

All intermediate stations in the CHST system are directed to be configured as follows:

- Four track configuration at the station to allow overtaking of stopped trains
- Station siding that is 6,000 feet long interlockings (3,000 between center of the station and the diverging interlocking) to allow the stopping trains to exit the main line at a high rate of speed so as not to impact following train movements.
- A universal crossover must be sited within two miles of the end of the station siding to handle operating contingencies. Two miles is specified so that trains can maintain speed (up to 110 mph crossovers are specified for intermediate stations) as they cross over to far side platforms and this distance optimizes the amount of track "tied up" when making shifting moves allowing train dispatchers to maintain movements in the opposite direction.

Overtakes are designed to accommodate the blended service concept that allows for the joint operation of express trains and local trains. It does this by maximizing the ability to service intermediate stations by local trains while minimizing the following headway for express trains thus preserving viable run times between city pairs and end terminals. This configuration allows faster trains not making a station stop to pass slower trains at intermediate locations in optimum manner. Since the trains pass while the slower train is completely stopped it minimizes the length of the four -track section at the passenger station. Placing overtake trackage away from the station stop is not feasible because the overtaking can only occur once the slower train is stopped.

The options that are offered in place of our standard configuration will not fulfill our current service criteria because of the following:

- The number and frequencies of the HST movements at San Jose would not be served by a single track "express train by-pass track" design that would force CHST to share track with Caltrain and force CHST to operate next to existing UPRR traffic which the FRA does not allow.
- Slow speed would impact Proposition 1A mandated running times
- Forces the scheduling for the entire HST system to be oriented on San Jose Express train "meet / pass" constraints.
- San Jose station will function, for some time, as a terminus for the CHST system. As such it will be necessary to store and turn trains within the confines of the station area. A two track station configuration would not support a terminal operation.

Four Train Tunnel Configuration (Two station tunnels and two bypass tunnels)

For preliminary design, CHSTP has prepared a directive drawing showing a typical surface intermediate station track arrangement (see Exhibit 2). Although this is for side platforms, with through center tracks, the following logic would also apply to the four train tunnel configuration:

- 110mph turnouts and through train speeds (same as previous deep tunnel option).

- 3000 feet minimum station approach track after turnouts to allow for deceleration of stopping trains.
- Symmetrical approaches to allow for changed direction of travel on any line.

With station track centers of 200 feet (compared with track spacing of 50 feet with previous cavern alternative) and the requirement for bypass tunnels outside station tunnels, turnouts have to be located at a much further distance from the station than with the previous deep tunnel cavern option (which had track centers of 50 feet). At the south end, turnouts would have to be located at the surface which requires the portal to be 200 feet wide to accommodate four separate tunnels. This would cause significant property take at this location. At the north end, underground turnout caverns would be required at an increased distance from the station, and this in turn increases the length of the bypass tunnels.

Construction Interface with BART tunnels

The proposed BART station box has excavation support walls which also function as groundwater cutoff walls by extending 75 feet below the base of the station box. These are combined with a jet grouted base plug which extends 20 feet below the base of the station box.

These concrete slurry walls present an obstruction to the high speed rail train and station tunnel excavations. To enable excavation through the slurry walls, “soft eyes” would be installed in the slurry walls during their construction consisting of lower strength concrete. Steel reinforcement would be replaced by fiberglass reinforcement in these locations to enable the tunnel boring machines to bore through the slurry walls. Ground treatment by jet grouting would also be required around these locations.

Operating Connectivity with BART/ Station Design

The connections from the high speed rail station direct to the surface would bypass the BART station box.

Ideally the interchange between the proposed BART station and the high speed rail would have escalators between BART center platform and the high speed rail center concourse tunnel to enable easy interchange for passengers. However this would be difficult with the current configuration because the station platforms are perpendicular.

It is likely that passengers on BART would have to travel up to the concourse level of the proposed BART station before traveling back down to the high speed rail station platforms either by the high speed elevators or preferably by escalators. Put simply passengers would need to travel both up and down to interchange between platforms. Escalators would also require a wider shaft to accommodate them. This is not an ideal interchange configuration.

Right of Way/ Subsurface Easements

Typically another 10 feet is required for subsurface easements either side of the tunnels so a total subsurface easement width of 436 feet would be required.

At the surface, the permanent property take would be the 50 feet shaft diameter and 20 feet minimum for future repairs total 90 feet width.

Surface building would be two floors high to allow for elevator machinery and ventilation ducts

Alignment of the underground station to minimize physical and construction conflicts with priority development areas has not yet been fully executed. Aside from such priority areas, there are other conflicts to be addressed, such as the foundations for the I-280 freeway overpasses. The tunnel alignment will be assumed to be straight at the station location and approaches.

Proposed Layout Widths

Facility	Dimension	Cumulative Total Width
Station tunnels	50FT pillars between each tunnel and three (3) tunnels at 50FT OD each	250FT
Bypass tunnels	50FT pillars and two (2) tunnels at 33FT OD each	416FT
Subsurface easement	10FT on each side	436FT (subsurface easement)

At the surface:

Facility	Dimension	Cumulative Total
Access shaft	50FT and 20FT min for future repairs on each side	90FT width
Location of access shafts (evenly spaced along the concourse – note that shafts may also be required at end of platforms)	375FT centers	840FT (assume 900FT)

Locating all Tunnel Construction Operations to the North Portal

The City's MTO suggested that TBM tunneling be carried out from the north portal. This would be difficult as the current alignment locates the north portal in the sports field at Bellarmine College where there is very limited space available for a staging area.

An alternative location for the north portal closer to Newhall yard would need to be investigated or an intermediate shaft to the north of the station from which TBM tunneling could be carried out in both directions.

TBM's would exit at the south portal, as once the tunnel lining is installed as part of the tunnel boring operations, the complete TBM cannot be removed back through the newly constructed tunnel.

Construction of the three station elevator/ emergency exit/ ventilation shafts would be carried out from the surface at Diridon. Likewise, pretreatment of the station footprint at Diridon by jet grouting would be carried out from the surface prior to TBM tunneling. Other surface works would include construction

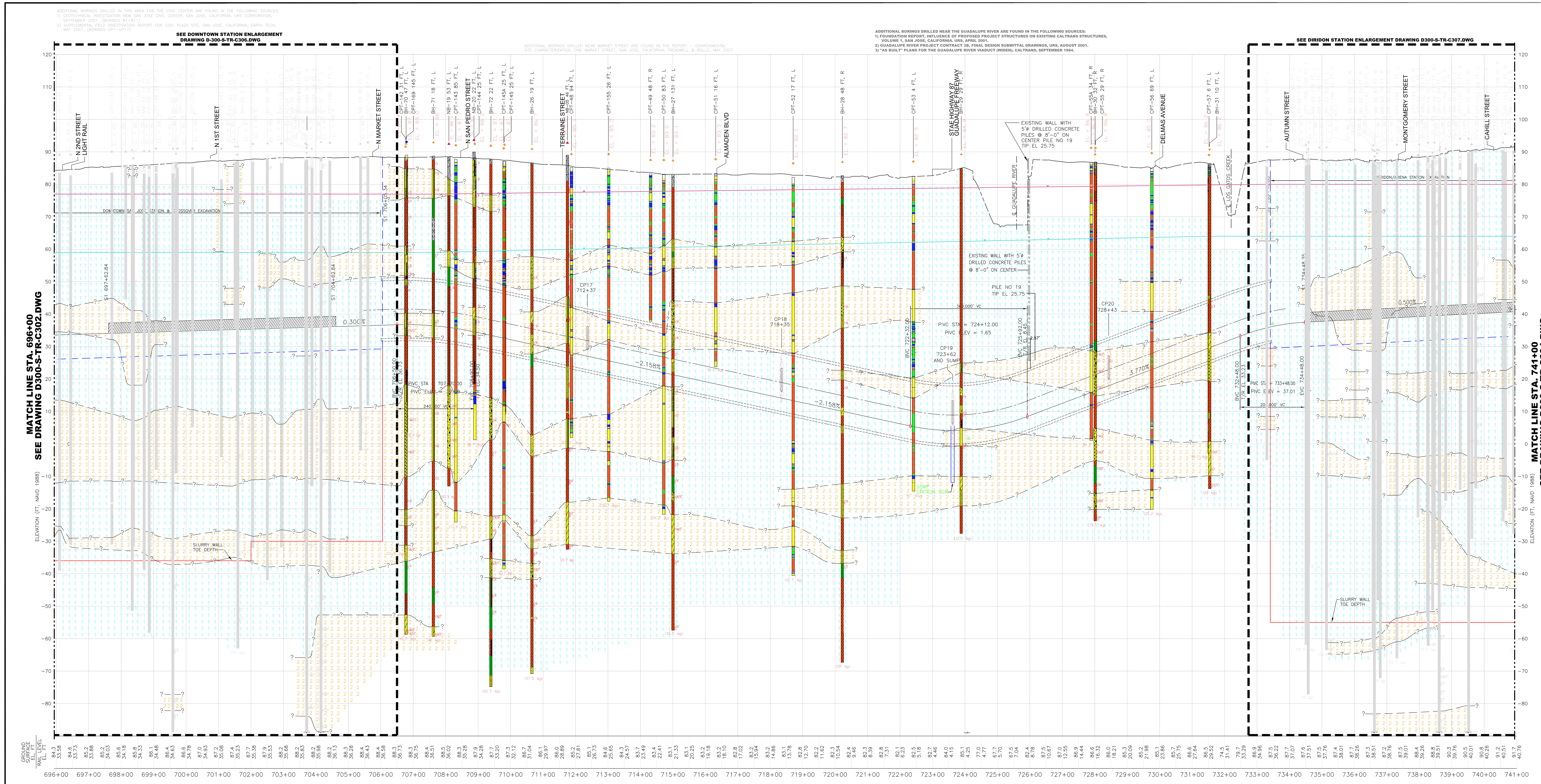
of the surface station concourse connecting the three shafts on the surface and connections to other transit facilities as this would be a major interchange station.

Excavation of the station platform tunnels could be carried out primarily from the running tunnels after the TBMs have finished. The station concourse tunnel and cross-passages would be carried out from either the shafts or the station platform tunnels depending on the sequence of construction.

Conclusion

Our conclusions are as follows:

1. The elimination of the bypass tracks at Diridon station imposes an unacceptable operating constraint on both the interim terminal station and final through station configuration.
2. With station track centers of 200 feet (compared with track spacing of 50 feet with previous cavern alternative) and the requirement for bypass tunnels outside station tunnels, turnouts have to be located at a much further distance from the station than with the deep tunnel option. At the south end turnouts would have to be located at the surface which requires the portal to be 200 feet wide to accommodate four separate tunnels. This would cause significant property take at this location. At the north end, underground turnout caverns would be required at an increased distance from the station, and this in turn increases the length of the bypass tunnels.
3. The medium depth underground station (below the proposed BART station) has the same level of extreme technical difficulty and extreme risk as a deeper underground station which was previously studied and rejected by the CHSRA board in 2010, because ground conditions are similar.



LIMITATIONS:

THE GEOTECHNICAL INFORMATION ON THESE SUBSURFACE PROFILES IS SIMPLIFIED AND DOES NOT CONTAIN ALL THE INFORMATION PRESENTED IN THE BORING LOGS PREPARED FOR THE 10% PRELIMINARY ENGINEERING PHASE, 35% ENGINEERING DESIGN PHASE AND THE 65% ENGINEERING DESIGN PHASE OF THE PROJECT. THEREFORE, THE REVIEW OF THE PROFILES MUST BE DONE IN CONJUNCTION WITH THE BORING LOGS.

THE SOIL UNIT BOUNDARIES SHOWN IN PROFILES ARE BASED ON INTERPOLATION AND EXTRAPOLATION OF GEOTECHNICAL INFORMATION FROM ADJACENT BORINGS AND CPT PROBES. THE LOCATIONS OF THESE BOUNDARIES CAN ONLY BE INFERRED APPROXIMATELY AND DO NOT REPRESENT BASELINE CONDITIONS. REFER TO DRAWINGS D300-S-TR-C308 TO D300-S-TR-C342 FOR BASELINE CONDITIONS AT CROSS PASSAGES.

STATIONING SHOWN IN ESTIMATED PARAMETERS ALONG PROFILE ARE BASED ON INTERPOLATION AND EXTRAPOLATION OF GEOTECHNICAL INFORMATION FROM ADJACENT BORINGS AND CPT PROBES AND IS THEREFORE APPROXIMATE. STATIONING AND BOUNDARIES SHOWN ARE NOT BASELINES BUT THE ESTIMATED PARAMETER DATA SHOWN IS USED TO DEVELOP AVERAGE BASELINES AS PRESENTED IN THE TEXT OF THE 65% COMBINED GBR, AUGUST 2008.

SVRT SOIL CLASSIFICATION:

UNIT	PRIMARY STRATUM DESCRIPTION	INCLUDED IN THIS UNIT (SEE NOTE 3)
1	SILTS, CLAYS AND ORGANIC SOILS. SOIL BEHAVIOR TYPE (SBT) ZONES 1 THROUGH 4, AND 9, AS CLASSIFIED BY CPTS USING ROBERTSON, 1990.	• MAN-MADE FILL CONSISTING OF ASPHALT CONCRETE AND AGGREGATE BASE ENCOUNTERED MOST OFTEN WITHIN FIVE FEET BELOW GROUND SURFACE • THIN LAYERS OF COARSE-GRAINED SOIL AS DESCRIBED IN NOTE 4
2	SANDS AND GRAVELS, AND SBT ZONES 6 THROUGH 8, CLASSIFIED BY CPTS USING ROBERTSON, 1990.	• COBBLES • THIN LAYERS OF FINE-GRAINED SOIL AS DESCRIBED IN NOTE 4

DESIGN WATER LEVELS:

MAXIMUM WATER LEVEL FOR CONSTRUCTION (BASED ON HISTORIC MAXIMUM)
MINIMUM WATER LEVEL FOR CONSTRUCTION (BASED ON HISTORIC MINIMUM)

NOTES:

1. SOIL TYPE GRAPHICS PRESENTED ON THESE SUBSURFACE PROFILES VARY SLIGHTLY FROM THE SOIL TYPE GRAPHICS SHOWN ON THE PLAN AND PROFILES IN THE GEOTECHNICAL DATA REPORT. HOWEVER, THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAMES HAVE NOT BEEN MODIFIED.
2. ALL DESIGN, CONSTRUCTION, AND MEASURED WATER LEVELS SHOWN ON THESE SUBSURFACE PROFILES REPRESENT THE PIEZOMETRIC LEVELS EXPECTED AT THE DEPTH OF THE TBM TUNNEL. THE WATER LEVELS SHOWN ARE NOT APPLICABLE FOR THE DESIGN OF OTHER SVRT PROJECT EXCAVATIONS AND STRUCTURES.
3. THE SOIL BEHAVIOR TYPE ZONE 5 – 'SAND MIXTURES – SILTY SAND AND SANDY SILT' CONSISTS OF BOTH FINE-GRAINED AND COARSE-GRAINED SOIL. THEREFORE, IT WAS INCLUDED IN EITHER SOIL CLASSIFICATION UNIT. IT IS REPRESENTED BY BLUE COLOR ON CPT STICKS.
4. LAYER THICKNESS: DUE TO A HIGH VARIABILITY IN SOIL PROFILE ENCOUNTERED VERTICALLY WITH DEPTH, AND HORIZONTALLY ALONG THE PROPOSED TUNNEL ALIGNMENT CAUSED BY THE ALLUVIAL SOIL DEPOSITIONAL ENVIRONMENT DESCRIBED UNDER REGIONAL GEOLOGY IN THIS REPORT, FIVE (5) FEET WAS SELECTED AS A 'THRESHOLD THICKNESS (th)'. THE ALTERNATING OR INDIVIDUAL SOIL LAYERS BELONGING TO EITHER SOIL CLASSIFICATION UNIT 1 & 2 THINNER THAN th WERE GROUPED ACCORDING TO A SET OF CRITERIA AND JUDGEMENT AS DESCRIBED IN APPENDIX C OF THE 65% COMBINED GBR, AUGUST 2008.
5. OFFSET DISTANCE PERPENDICULAR TO ALIGNMENT S1 TUNNEL. DIRECTION LOOKING UP STATION.
6. DEEPER BORINGS TRUNCATED.
7. LENGTH OF PENETRATION RESISTANCE SYMBOLS PROPORTIONAL TO RECOVERY.
8. CHANGES IN STATIONING AT NOTED LOCATIONS OCCUR DUE TO EQUATIONS PROVIDED ON THE APRIL 2008 QUARTERLY UPDATE ALIGNMENT.

SOURCES OF INFORMATION:

1. ALIGNMENT SHOWN ON PROFILE CORRESPONDS TO APRIL 2008 QUARTERLY UPDATE ALIGNMENT SUBMITTAL.
2. CROSS PASSAGES: EMAIL FROM A. BARNGROVER, FEB. 22, 2008
3. BOREHOLE AND CPT INFORMATION PROVIDED BY A. JAIN VIA EMAILS APRIL 10 TO APRIL 14, 2008.
4. HYDROGEOLOGICAL INFORMATION FROM HMMB HYDROGEOLOGY REPORT P0503-D300-RPT-DE-020 MAY 2008.
5. SLURRY WALL AND DSM WALL INFORMATION FROM HMMB HYDROGEOLOGY REPORT P0503-D300-RPT-DE-020 MAY 2008.

SOIL TYPE:

WELL-GRADED GRAVEL (GW)
POORLY-GRADED GRAVEL (GP)
WELL-GRADED GRAVEL WITH SILT (GW-GM)
WELL-GRADED GRAVEL WITH CLAY (GW-GC)
POORLY-GRADED GRAVEL WITH SILT (GP-GM)
POORLY-GRADED GRAVEL WITH CLAY (GP-GC)
CLAYEY GRAVEL (GC)
SILTY GRAVEL (GM)
SILTY, CLAYEY GRAVEL (GC-GM)
WELL-GRADED SAND (SW)
POORLY-GRADED SAND (SP)
WELL-GRADED SAND WITH SILT (SW-SM)
WELL-GRADED SAND WITH CLAY (SW-SC)
POORLY-GRADED SAND WITH SILT (SP-SM)
POORLY-GRADED SAND WITH CLAY (SP-SC)
SILTY SAND (SM)
CLAYEY SAND (SC)
SILTY, CLAYEY SAND (SC-SM)
SILTY SAND/SANDY SILT (SM-ML)
CLAYEY SAND/LEAN CLAY (SC/CL)
SILT (ML)
LEAN CLAY (CL)
SILTY CLAY (CL-ML)
LOW PLASTICITY ORGANICS (OL)
ELASTIC SILT (MH)
FAT CLAY (CH)
CLAY (CH-MH)
HIGH PLASTICITY ORGANICS (OH)
PAVEMENT WITH OR WITHOUT AGGREGATE BASE
FILL
NO DATA

SOIL BORING LITHOLOGY

OFFSET FROM S1 TUNNEL ALIGNMENT TYP SEE NOTE 5
BOREHOLE NUMBER
BH-14 98 FT, LEFT EL = 94.6
AS-BUILT SURFACE ELEVATION TYP
45 61 39 54 57 99/11" 96/10" 50/6" 50/5.5" 50/4" 75 Ref/3" 91
BOREHOLE DEPTH BELOW GROUND SURFACE — 127' bgs

CPT SOUNDING WITH INTERPRETED LITHOLOGY

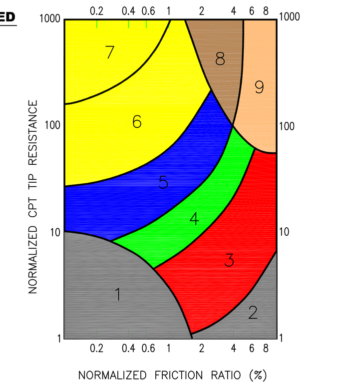
OFFSET FROM S1 TUNNEL ALIGNMENT TYP SEE NOTE 5
CPT NUMBER
CPT-156 18 FT, LEFT EL = 86.2
AS-BUILT SURFACE ELEVATION TYP
SBT ZONE NOT EVALUATED
CPT DEPTH BELOW GROUND SURFACE — 109.4' bgs

PENETRATION RESISTANCE SYMBOLS

= MEASURED SPT BLOW COUNT (BLOWS PER FOOT, Bpf)
= MEASURED MODIFIED CALIFORNIA SAMPLER BLOW COUNT (Bpf)
U = DAMES & MOORE U-SAMPLER BLOW COUNT (Bpf)

SUBSURFACE EXPLORATIONS

CPT-XX CPT 10% PHASE
BH-XX BOREHOLE W/OUT PIEZOMETER 10% PHASE
BH-XX BOREHOLE W/ PIEZOMETER 10% PHASE
CPT-XX CPT 35% PHASE
BH-XX BOREHOLE W/OUT PIEZOMETER 35% PHASE
BH-XX BOREHOLE W/ PIEZOMETER 35% PHASE
CPT-XX CPT 65% PHASE
BH-XX BOREHOLE W/OUT PIEZOMETER 65% PHASE
BH-XX BOREHOLE W/ PIEZOMETER 65% PHASE



ZONE	SOIL BEHAVIOR TYPE (SBT)
1	SENSITIVE FINE-GRAINED
2	ORGANIC MATERIAL
3	CLAY TO SILTY CLAY
4	CLAYEY SILT TO SILTY CLAY
5	SILTY SAND TO SANDY SILT
6	CLEAN SANDS TO SILTY SANDS
7	GRAVELLY SAND TO SAND
8	VERY STIFF SAND TO CLAYEY SAND*
9	VERY STIFF FINE-GRAINED*

*OVERCONSOLIDATED OR CEMENTED

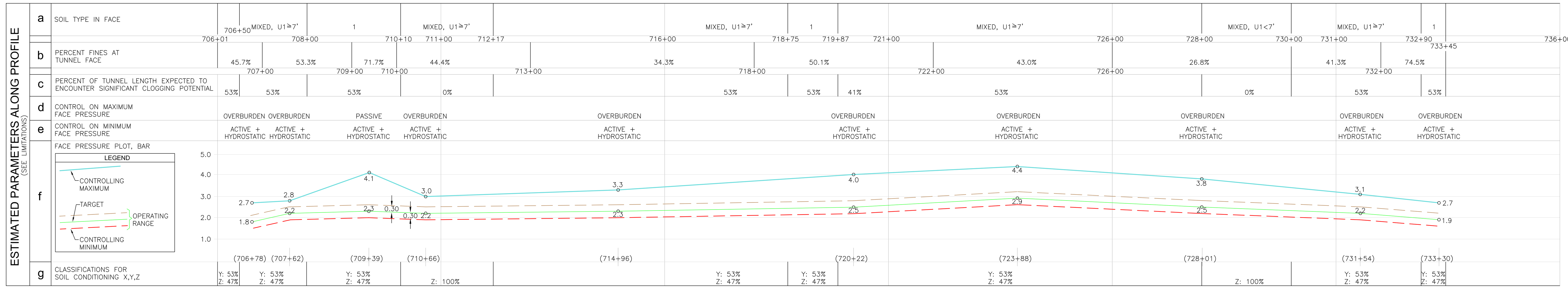
CPT CORRELATION CHART (MODIFIED FROM ROBERTSON, 1990)

LEGEND

APPROXIMATE UNIT BOUNDARIES
TUNNEL EXTENTS
EXISTING GROUND SURFACE <SUGGESTED>
DENOTES UNCERTAINTY ABOUT CONTINUITY OF UNIT BOUNDARY
EXCAVATION BOUNDARY
SLURRY WALL TOE DEPTH

THIS FIGURE IS STILL IN PROGRESS AND WILL BE REVISED BASED ON ADDITIONAL GEOTECHNICAL INVESTIGATION RESULTS AND REVISED MATERIAL DESCRIPTIONS

Exhibit 1 – BART Diridon Station Ground Investigations



REV	DATE	BY	SUB	APP	DESCRIPTION
A	20080919	DY			ISSUED FOR REVIEW

DESIGNED BY D. YOUNG
DRAWN BY N.PURIFICACION
CHECKED BY R. BALL
IN CHARGE J. HAWLEY
DATE 20080919

HMM / BECHTEL
A Joint Venture of Hatch Mott MacDonald T&T, Inc. and Bechtel Infrastructure Corp.

SUBMITTED ______ APPROVED ______

BART
VTA Silicon Valley Rapid Transit Corridor 2000 Measure A Project
BART to Milpitas San Jose Santa Clara

SILICON VALLEY RAPID TRANSIT PROJECT P0503 TUNNEL SEGMENT
INTERPRETIVE GEOLOGICAL PROFILE - STUDY SECTION 5
DOWNTOWN SAN JOSE STATION AND CROSSOVER SHELL TO DIRIDON / ARENA STATION

CADD FILENAME D300-S-TR-C303.dwg
SIZE – SCALE 1"=100'H; 1"=10'V
CONTRACT NO. D300 REV. A
AREA CODE TR SHEET NO. C303 PAGE NO. 3

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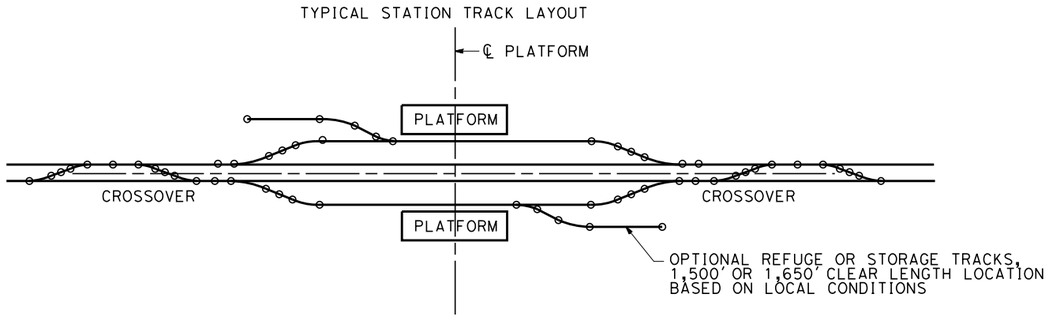
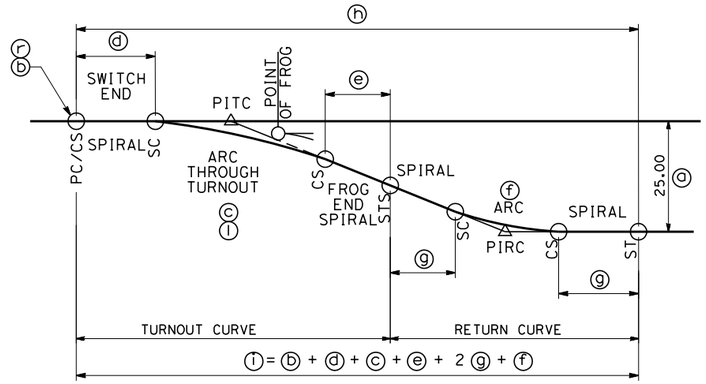
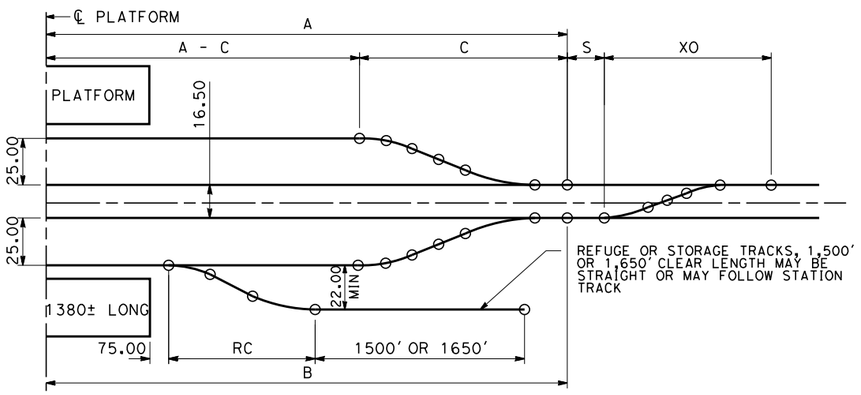


TYPICAL TRACK LAYOUT, INTERMEDIATE STATION WITH HIGH SPEED TURNOUTS



DETAIL OF STATION CONNECTING TRACK WITH SPIRAL POINT TURNOUTS



DETAIL OF INTERMEDIATE STATION TRACK LAYOUT

EXPLANATION OF UNDIMENSIONED DATA:

A: DISTANCE FROM CENTER OF PLATFORM TO APPROACH TURNOUT, NORMAL ARRIVAL DIRECTION. SET BY OPERATIONAL REQUIREMENT, BUT WITH A MINIMUM DISTANCE OF C PLUS HALF PLATFORM LENGTH PLUS 85 FEET WITHOUT REFUGE/STORAGE TRACK, OR C PLUS HALF PLATFORM PLUS LENGTH OF REFUGE TURNOUT PLUS 75 FEET WITH REFUGE/STORAGE TRACK.

B: DISTANCE FROM CENTER OF PLATFORM TO APPROACH TURNOUT, NORMAL DEPARTURE DIRECTION. SET BY OPERATIONAL REQUIREMENT, BUT WITH A MINIMUM DISTANCE OF C PLUS HALF PLATFORM LENGTH PLUS 85 FEET WITHOUT REFUGE/STORAGE TRACK, OR C PLUS HALF PLATFORM PLUS LENGTH OF REFUGE TURNOUT PLUS 75 FEET WITH REFUGE/STORAGE TRACK.

C: DISTANCE REQUIRED BY GEOMETRY OF THE CONNECTION. SEE DISTANCE LABELED "TOTAL LENGTH ALONG MAIN TRACK" IN TABLE 1.

S: MINIMUM DISTANCE BETWEEN END OF STATION TURNOUT AND CROSSOVER TURNOUT WHERE THEY ARE IN THE SAME TRACK. 1.5 SECONDS RUN TIME DESIRABLE, 1.0 SECONDS MINIMUM.

XO: LENGTH OF CROSSOVER. SEE "TOTAL LENGTH ALONG MAIN TRACK" IN TABLE XX.

RC: LENGTH REQUIRED TO ACHIEVE OFFSET FOR STORAGE/REFUGE TRACK. DETERMINED BY MEDIUM/LOW SPEED TURNOUT SELECTED FROM TABLE XX.

TABLE 1: STANDARD STATION CONNECTION TURNOUTS AND CURVES, 25 FEET TRACK CENTERS

STATION CONNECTING TRACKS WITH SPIRAL POINT TURNOUTS			
PART 1: GEOMETRY OF TURNOUT AND ITS SEGMENTS, IN FEET UNLESS STATED OTHERWISE			
	DESIGN SPEED	60 MPH	80 MPH	110 MPH
ⓐ	PLATFORM TRACK OFFSET	25.00	25.00	25.00
ⓑ	TURNOUT ENTRY RADIUS	10,000.00	18,000.00	34,000.00
ⓒ	TURNOUT BODY RADIUS	5,000.00	9,000.00	17,000.00
ⓓ	SWITCH SPIRAL LENGTH	90.00	120.00	160.00
ⓔ	FROG SPIRAL LENGTH	90.00	120.00	160.00
ⓕ	RETURN CURVE RADIUS	4,000.00	7,000.00	13,500.00
ⓖ	CURVE SPIRAL LENGTH	90.00	120.00	160.00
ⓗ	C. TOTAL LENGTH ALONG MAIN TRACK	743.65	991.80	1,364.60
ⓘ	TOTAL LENGTH ALONG PLATFORM TRACK	744.25	992.25	1,364.92
ⓙ	ANGLE AT STS	3d44m07s	2d48m04s	2d02m17s
ⓚ	LENGTH OF ENTRY CURVE	0.00	0.00	0.00
ⓛ	LENGTH OF TURNOUT BODY CURVE	213.47	290.02	404.71
ⓜ	LENGTH OF RETURN CURVE	170.78	222.24	320.21
PART 2: UNBALANCED SUPERELEVATION AND TRANSITION RATES, INCHES OR IN./SEC AS APPLICABLE			
	UNBALANCE AT TURNOUT ENTRY (Ea)	1.44	1.42	1.42
	UNBALANCE IN TURNOUT BODY (Ea)	2.88	2.84	2.85
	SUPERELEVATION IN RETURN CURVE (Ea)	1.25	1.25	1.25
	UNBALANCE IN RETURN CURVE (Ea)	2.35	2.41	2.34
	VIRTUAL TRANSITION TIME	0.68	0.51	0.37
	VIRTUAL TRANSITION RATE AT ENTRY	2.13	2.80	3.86
	VIRTUAL TRANSITION RATE 59.50 FEET IN	3.54	4.20	5.30
	ACTUAL TRANSITION RATE IN SWITCH	1.41	1.39	1.44
	TRANSITION RATE AT FROG END	2.82	2.78	2.87
	TRANSITION RATE IN CURVE SPIRALS	2.30	2.35	2.35

Exhibit 2 - Intermediate Station Track Layout

REV	DATE	BY	CHK	APP	DESCRIPTION
					INTERNAL DRAFT

DESIGNED BY L. MANITI
DRAWN BY T. DOUNG
CHECKED BY G. HARRIS
IN CHARGE J. CHIRCO
DATE 03/08/11

PARSONS BRINCKERHOFF

CALIFORNIA HIGH-SPEED RAIL AUTHORITY

CALIFORNIA HIGH-SPEED TRAIN PROJECT
TRACK STANDARD

HIGH-SPEED CROSSOVERS
STATION ENTRY/EXIT TRACK
TURNOUT AND CURVE

CONTRACT NO. 13259
DRAWING NO. SD-TT-103
SCALE NO SCALE
SHEET NO.

CAD4 8/16/2011 9:01:25 AM $PENTBLS$ $PLTDRVS$ z:\ENG\CHSTP\CADD\PMT\CADD\Standard Drawings\Track\SD-TT-103.dgn

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES:

1. FREE TUNNEL CROSS-SECTIONAL AREAS COMPLY WITH TSI MEDICAL HEALTH CRITERIA, TO MINIMIZE AERODYNAMIC DRAG EFFECTS IN THE TUNNELS. SEE DIRECTIVE DRAWINGS FOR REQUIRED FREE TUNNEL CROSS-SECTIONAL AREAS FOR DESIGN TRAIN SPEEDS AND TUNNEL LENGTH.
2. TYPES, LOCATIONS AND DIMENSIONS OF TEMPORARY SUPPORT AND/OR GROUND TREATMENT NOT DESIGNED.
3. PERMANENT TUNNEL LINING ASSUMED WATERTIGHT/UNDRAINED IN PERMANENT CASE.
4. RUNNING TUNNELS TO BE DRIVEN BY TUNNEL BORING MACHINE.
5. STRUCTURAL COMPONENTS ARE NOT DESIGNED.

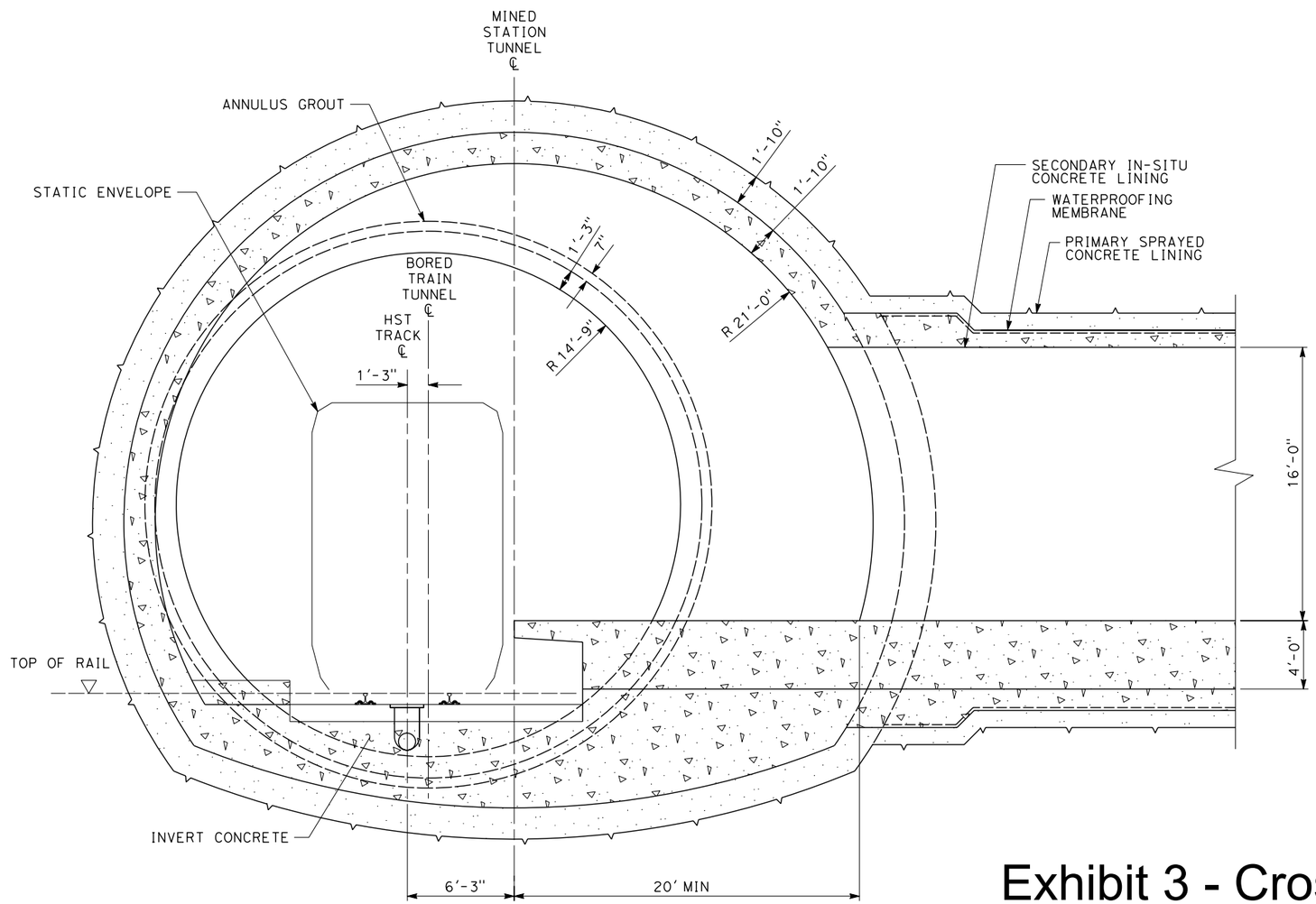


Exhibit 3 - Cross Section of Diridon Station Tunnel - Station 1

4 0 4 8
1/4"=1'-0"

DATE: 09/09/11

CALIFORNIA HIGH-SPEED RAIL AUTHORITY

PARSONS BRINCKERHOFF

CALIFORNIA HIGH-SPEED TRAIN PROJECT
BAY SUBDIVISION

DIRDON STATION 1
MODIFIED TUNNEL OPTION (MTO)
TYPICAL CROSS SECTION

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PRELIMINARY
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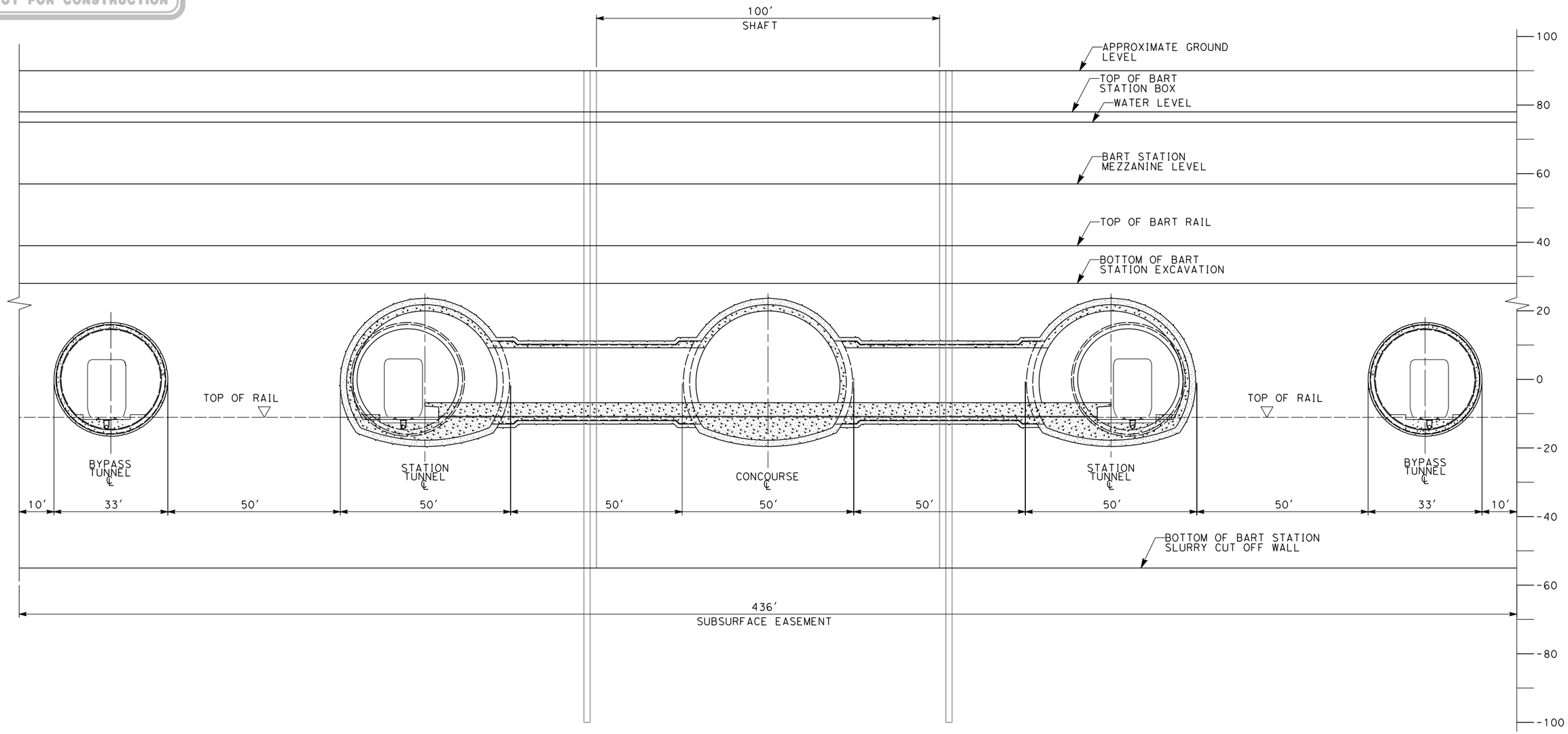

CROSS SECTION OF CHSTP MTO STATION
AT PROPOSED BART/SVRT STATION
NO SCALE

Exhibit 3 - Cross Section of Diridon Station Tunnel - Station 2

DATE:

CALIFORNIA HIGH-SPEED RAIL AUTHORITY

PARSONS BRINCKERHOFF

CALIFORNIA HIGH-SPEED TRAIN PROJECT
BAY SUBDIVISION

CONCOURSE PROFILE
MODIFIED TUNNEL OPTION (MTO)
DIRDON STATION 2

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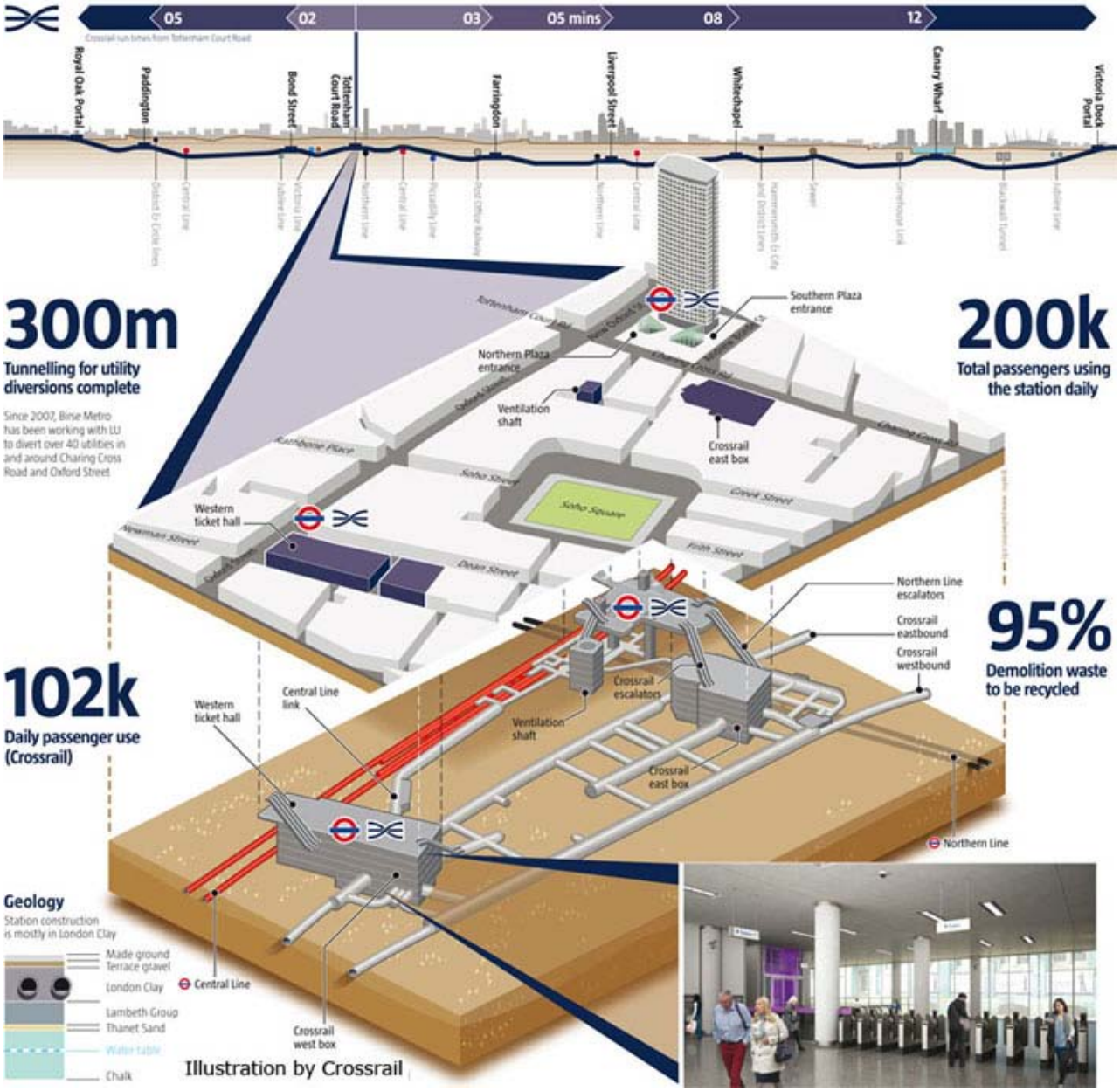
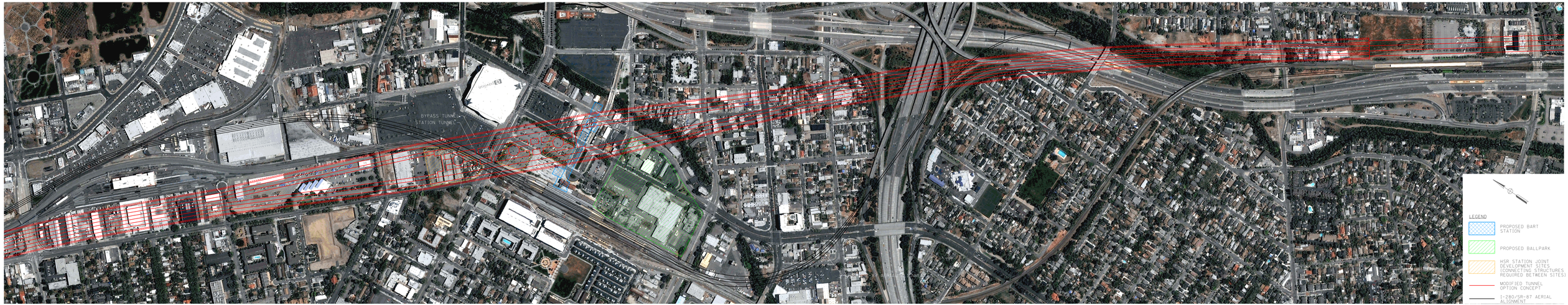
Exhibit 4 – Crossrail Exhibit of Tottenham Court Road Station





CALIFORNIA HIGH-SPEED RAIL AUTHORITY

PARSONS BRINCKERHOFF

CALIFORNIA HIGH-SPEED TRAIN PROJECT

SAN JOSE TO MERCED SECTION

DIRIDON STATION

CITY OF SAN JOSE

MODIFIED TUNNEL OPTION (MTO) PLAN