APPENDIX 2-H: CONSTRUCTABILITY ASSESSMENT REPORT

California High-Speed Rail Authority

San Francisco to San Jose Project Section

Constructability Assessment Report – RECORD PEPD

April 2019

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation Federal Railroad Administration

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ACRONYMS AND ABBREVIATIONS

Authority	California High-Speed Rail Authority
C&M	Construction & Maintenance
CAMUTCD	California Manual on Uniform Traffic Control Devices
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CIP	cast-in-place
DTX	Downtown Extension Project
EIR	environmental impact report
EIS	environmental impact statement
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HSR	high-speed rail
LMF	light maintenance facility
MAS	Maximum allowable speed
NEPA	National Environmental Policy Act
OCS	overhead contact system
PEPD	Preliminary Engineering for Project Definition
RC	Regional Consultant
ROE	Right of Entry
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SFTC	Salesforce Transit Center
UPRR	Union Pacific Railroad
VdB	decibel vibration velocity level

1 EXECUTIVE SUMMARY

1.1 Scope and Approach

The HNTB Team studied constructability of the San Francisco to San Jose Section (Project Section) of the California High-Speed Rail (HSR) project. Information used included preliminary designs with plans, profiles, and cross-sections at the Draft Preliminary Engineering for Project Definition (PEPD) submittal stage.

The study was approached with the mission to understand the project and provide feedback on concerns that a construction contractor or manager may have. Numerous factors were identified that could challenge designers, contractors, and agency construction managers. The HNTB team's discussion, set of risks, and recommendations for action or further study have been provided.

1.2 Conclusions and Recommendations

The HNTB team concluded that each of the two alternatives, as currently presented, can be built, but they present varying degrees of complexity, cost, duration, and impact on the environment and the public. Physical and other constraints on each alternative will vary the expense, duration, and impacts.

"Big ticket" concerns that should be addressed in detail before the project is procured are:

- Both Alternative A and Alternative B are buildable.
- The project site is constrained by many factors, including its crowded urban setting, narrow right of way (ROW), and active train traffic where work must occur. Constraints will adversely affect the efficiency, speed, and cost of the project.
- Property acquisition will be long and complex. The California High-Speed Rail Authority (Authority) should carry out property acquisitions itself and not delegate it to the design-build contractors.
- Construction work should not commence before all property acquisitions are made for the route segment to be built.
- Responsibility, processes, and payment mechanisms for dealing with unforeseen environmental contamination should be established in construction contract documents.
- Construction and maintenance (C&M) agreements with stakeholders, including local jurisdictions, California Department of Transportation (Caltrans), and utilities should be comprehensive, detailed, and executed before beginning construction.
- Reflect stakeholder agreements in the construction contract documents and bind contractors to perform in accordance with the stakeholder agreements.
- Accommodation of Caltrain and Union Pacific Railroad (UPRR) train operations will constrain construction operations and increase construction costs and duration.
- At-grade and viaduct cross-sections are the most buildable cross-sections.
- Embankment cross-sections present the most difficult staging challenges, mostly due to constrained ROW width, earthmoving operations, and difficulties stemming from maintaining Caltrain and UPRR operations without modification.
- Extent of track shifting and methods to perform and time required to construct those sections will greatly impact cost and schedule.
- Construction schedule is based on work windows and operating assumptions established for the Caltrain Peninsula Corridor Electrification Project (PCEP).

2 INTRODUCTION

2.1 Purpose

The purpose of this Constructability Assessment Report is to provide a general overview of the different types of construction elements involved in this section of the project, identify potential construction concerns, and provide insight into the activities and general sequencing necessary to complete the project.

The report provides information stipulated in the Authority's Technical Manual 0.1, Preliminary Engineering for Project Definition Guidelines.

This report is divided into various sections with each section describing a separate topic:

Section	Topic
Section 3	General overview and existing conditions of the project
Section 4	Options and recommendations for a series of construction contract packages
Section 5	General construction elements with probable production rate estimates
Section 6	Additional insight into individual subsection construction elements, challenges and general sequencing of construction
Section 7	Identifies construction staging areas
Section 8	Casting yard layout
Section 9	Construction sequencing
Section 10	General discussion on traffic control and detours
Section 11	Construction pollution control
Section 12	List of probable construction permits that may be required for the project
Section 13	Third party coordination and agreements
Section 14	Potential excavation hazards
Section 15	Right-of-way acquisition
Section 16	Summary conclusions
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2.2 Project Overview

The California High-Speed Rail Authority (Authority) proposes to construct, operate, and maintain an electric-powered HSR system in California. When completed, the nearly 800-mile train system would provide new passenger rail service to more than 90% of the state's population. More than 200 weekday trains would serve the statewide intercity travel market. The HSR would be capable of operating speeds of up to 220 miles per hour (mph), with state-of-the-art safety, signaling, and automated train control (ATC) systems. The system would connect and serve the state's major metropolitan areas extending from San Francisco to Los Angeles and Anaheim in Phase 1 with extensions to Sacramento and Anaheim in Phase 2. The HSR System will be designed to be capable of a nonstop operational service time between San Francisco and Los Angeles of 2 hours and 40 minutes.

The statewide California HSR Project has been divided into a number of geographic sections for the planning, environmental approval, design, and implementation of the project. This Constructability Assessment focused on the section of the HSR System between San Francisco and San Jose and specifically covers the section from the 4th and King Station in San Francisco to Scott Boulevard in the City of Santa Clara. The subsection from Scott Boulevard to San Jose Diridon Station is described in the San Jose to Central Valley Wye Section.

2.3 Project Description

The San Francisco to San Jose Section (Project Section) of the HSR System extends approximately 43 miles from the Salesforce Transit Center (SFTC) in San Francisco to Scott Boulevard in Santa Clara, passing through portions of San Francisco, San Mateo, and Santa Clara counties and 16 cities on the San Francisco Peninsula. The Project Section would operate as a blended system that uses the existing Caltrain regional passenger rail service tracks and remains substantially within the existing Caltrain right-of-way (ROW). The tracks would also be shared with Union Pacific Railroad which operates local freight service within the corridor. HSR stations would be located at 4th and King Station[1] in San Francisco and at Millbrae. The Project Section would also include an approximately 100 to 110-acre light maintenance facility in the City of Brisbane on either the east or west side of the tracks to provide storage capacity for trains and accommodate light maintenance activities, and a passing track option.

The project would utilize existing and in-progress infrastructure improvements developed by Caltrain for its Caltrain Modernization Program, including electrification of the Caltrain corridor between San Francisco and San Jose under the Caltrain Peninsula Corridor Electrification Project (PCEP), and the installation of an advanced signal system under the Communications Based Overlay Signal System Positive Train Control Project.

The blended system would require modification of the existing Caltrain tracks and infrastructure subsequent to the Caltrain Modernization Program to support higher speeds of up to 110 mph. These modifications would include curve straightening, track spacing modifications, and superelevation of existing Caltrain tracks. Additional equipment upgrades would be required to support the blended system, including installation of a radio-based communications network to maintain communications and share data between the trains and the operations control center and additional radio towers at intervals of approximately 2.5 miles. Station modifications will be required to accommodate HSR trains and passengers. The project will also require additional safety and security improvements for at-grade crossings and at existing Caltrain stations.

The approximate alignment of the Project Section is shown in Figure 2-1 and is broken down into four subsections: (1) San Francisco to South San Francisco, (2) San Bruno to San Mateo, (3) San Mateo to Palo Alto, and (4) Mountain View to Santa Clara.

[1] The 4th and King Station would serve as an interim station until completion of the proposed Downtown Extension Project (DTX). DTX would extend the electrified peninsula rail corridor in San Francisco from the 4th and King Station to the SFTC. HSR would utilize the track constructed for the DTX to reach the SFTC.

Source: Authority 2018a

Figure 2-1 San Francisco to San Jose Project Alignment and Subsections

Station Modifications

Depending on the alternative selected, the Project Section requires varying degrees of modification to the existing Caltrain stations to accommodate track adjustments, remove the hold-out rule, and construct project features such as the Brisbane Light Maintenance Facility (LMF) and passing track. The two existing Caltrain stations proposed to be shared by HSR and Caltrain — 4th and King and Millbrae would require more extensive modifications to accommodate HSR trains and additional passenger services, as described below.

Safety and Security Modifications

The blended system would implement safety improvements at at-grade crossings to create a “sealed corridor.” These would include the installation of four-quadrant gates extending across all lanes of travel, median separators or channelizers, pedestrian crossing gates, and fencing at all at-grade crossings and along the perimeter of the Caltrain corridor.

Alternatives

Two alternatives have been developed for the Project Section.

1. **Alternative A** provides an end-to-end alternative that would involve limited track modifications predominantly within the existing Caltrain corridor, construct the East Brisbane LMF, modify eight existing stations or platforms to accommodate HSR, and install safety improvements and communication radio towers. No new passing tracks would be constructed under Alternative A; HSR and Caltrain would use existing passing track areas of more than two tracks (Fair Oaks Avenue to Bowers Avenue and Brisbane) for passing. The Authority would improve two platforms for dedicated HSR use at the 4th and King Station and expand the Millbrae Station to a four-track station, which would allow for new passing opportunities. This alternative would require modifications at the Bayshore, San Bruno, and Hayward Park stations to support improved track geometry and rework the platform configurations at Broadway and Atherton to eliminate their “hold-out rule” status.
2. **Alternative B** provides for design options to those proposed under Alternative A for the West Brisbane LMF and the Short Middle Four-Track Passing Track. The Short Middle Four-Track Passing Track Option would require construction of an approximately 6-mile four-track passing section between 9th Avenue in San Mateo to just north of Whipple Avenue in Redwood City. This section is entirely grade-separated at present, except for 25th Avenue in San Mateo which will be separated through the Caltrain 25th Avenue Grade Separation Project. This alternative would require reconstruction of the elevated Belmont and San Carlos Caltrain stations, with the Belmont Station being reconfigured with outboard platforms to minimize ROW impacts, and the San Carlos Station being relocated approximately 2000 feet south of its current location, as well as the at-grade Hayward Park Station. The elevated Hillsdale Station would be widened to accommodate four tracks, and modifications would also be required to the Bayshore Caltrain Station to accommodate the LMF lead track.

2.4 Infrastructure Improvements and Phasing

HSR blended service on the peninsula will be phased per the Authority’s 2018 Business Plan. This stipulates that improvements will be phased to meet 2027 and 2033 operating requirements as follows:

2027 Peninsula Service

- Raise and extend two platforms at the San Francisco 4th & King Station for HSR use;
- Construct Brisbane LMF with grade-separated northerly rail access towards the terminal facility;
- Convert all at-grade crossings to four-quadrant gates with channelization to permit operations up to 110 mph;
- Improve Caltrain stations at Broadway, and Atherton to eliminate the Hold-out rule;

- Maintain current maximum allowable speed (MAS) of 79 mph; and
- Provide completely access controlled ROW using fences, trespass guards and quad-gates.

2033 Peninsula Service

- Increase MAS to 110 mph; and
- Add HSR Millbrae Station.

3 EXISTING CONDITIONS

The existing Caltrain corridor is a non-electrified, two track configuration with shared commuter service (operated by Caltrain) and freight service (operated by UPRR). The main purpose of the existing corridor is to provide a service for commuters and short distance journeys. Construction of the PCEP prior to the construction of HSR will provide electrification to the Caltrain service from 4th and King to Michael Yard south of Tamien and to control systems to CP Lick.

The Caltrain corridor runs in a high-density urban environment between San Francisco's 4th and King Station and San Jose's Diridon Station then continues south to Gilroy.

Other railway infrastructure systems, such as UPRR, Bay Area Rapid Transit (BART), and Santa Clara Valley Transportation Authority (VTA) Light Rail Transit (LRT) run within and adjacent to portions of the corridor.

Caltrain currently has 25 existing railway stations with the main ones being:

- San Francisco 4th and King (northern terminus)
- Millbrae (connection point with BART and access point to San Francisco International Airport)
- Mountain View (connection point with VTA LRT)
- San Jose-Diridon

The route is generally at-grade with a large number of at-grade crossings with local and arterial roadways. Crossings with major arterials, freeways, and expressways are grade separated. Numerous improvement projects are planned or under construction, including the 25th Avenue Grade Separation Project (currently under construction) that will grade separate 25th, 28th, and 31st avenues in San Mateo.

Along the railway corridor there are several railway yards and tie-ins; such as the connection to the UPRR Coast Subdivision (with service from Oakland) and the railway facilities (workshops, garages, etc.) associated with the Caltrain Centralized Equipment Maintenance and Operations Facility north of the San Jose Station. The BART Silicon Valley Phase II Rapid Transit Project will extend BART underground from the Berryessa Station through Diridon to Santa Clara with a new yard area adjacent to the Caltrain corridor north of I-880.

4 SEGMENT CONSTRUCTION PACKAGING

HSR construction activities can be performed geographically (by physical area); by trade (per the type of construction to be done), or by end-use (to achieve interim operational goals upon completion). The Authority must also decide whether it wants to have the work performed in smaller or larger increments.

Per our understanding of the project goals, how the project will be segmented will be determined by considering the following factors:

- Incremental improvements needed to meet 2027 and 2033 operational requirements.
- Caltrain passenger and UPRR freight operations must be maintained.
- Type of construction (at-grade, aerial, earthwork, buildings).
- Phasing of precedent preparatory activities (e.g., environmental and utilities clearance).
- Earthwork balance for overall project and within contract packages.
- Funding limits from cash flow and budget restrictions.
- Set project size limits to attract bidders of desirable size and experience.
- Local jurisdictional boundaries.
- Determining appropriate locations for track tie-in and other joins at contract boundaries.
- Station locations for Caltrain and HSR.

Geographical contract packaging would establish route lengths that end at specific boundary locations that are selected according to criteria deemed suitable by the Authority. Selection of contract limits would factor in the predominance of the type of work and the ability to achieve useable track segments.

Trade contract packaging brings designers and contractors with specialty experience within a certain construction type into their field of expertise. At the extreme end of the scale, in a multiple prime contractor delivery method, a project owner would hire a series of specialty contractors to deliver a particular scope of work.

Stations - Transit agencies try to build a certain consistency into their stations while also making them unique to their locations. Consistency typically extends to technical details and equipment to make buildings and other facilities easily maintained by the agency workforce.

A **combined** contracting method with features from both geographic and trades could be considered. This would make the geographic general contract the fundamental method but use trades contracts for portions of the work. Work that is appropriate for separate contracts includes:

- Environmental remediation
- Demolition
- Utilities potholing and relocation
- Roadway relocations
- Utility relocations
- Initial track and signal relocation
- Stations and other buildings

There could be benefits to doing other preparatory work in advance of the general contractor mobilizing, such as drilling piers for station trench walls.

There may also be benefits to contracting for certain items for the entire project rather than leaving them for the individual contractors to arrange. These include:

- Disposal sites for remediated materials
- Disposal sites for clean spoil
- Rail freight for material delivery and spoil removal

The Authority has stated an intent to have rail and systems (power, controls, communications, signals) installed by specialty contractors separate from the civil and utilities infrastructure contractors. Within the project corridor, this will involve modifications to the existing PCEP infrastructure, which will likely be performed by Caltrain.

4.1.1 Risks

- Projects need to be carefully scoped to integrate with other contract packages; otherwise, they can become difficult to coordinate leading to conflicts, delays, and extra costs.
- Agency staffing should have the ability to manage large amounts of information, requests, and claims that can overwhelm agency staff that do not have sufficient resources.
- A single issue that blocks work (such as ROW holdouts preventing certification, bankruptcy, or court order to stop work) may inordinately delay large contract packages for lengthy route segments.
- Short contract packages increase the need for coordination and the likelihood of conflicts that must be resolved by the Authority.
- A general contractor may not have expertise in certain construction types leading it to rely heavily on its subcontractors for that work creating communication issues that inhibit problem solving.
- Multiple prime contractors assigned work in a single location also increases the Authority’s coordination duties and liability for coordination issues that delay contractors.

4.1.2 Recommendations

- Use a single contractor for infrastructure work of the entire Project Section.
- Use a single contractor to install rail and systems.
- Create an overall critical path method master schedule for the Project Section that includes realistic durations for all the work and considers preliminary design, ROW, remediation, utilities, maintenance of existing operations, and temporary facility processes.

5 GENERAL CONSTRUCTION METHODS

The entirety of the Project Section construction will occur next to operating UPRR and electrified Caltrain tracks. The construction process must accommodate these facilities remaining operational during construction.

5.1 Demolition

The first stage of construction will involve the demolition of building and roadway structures directly impacted by HSR. Before demolition work can commence, the building occupants and roadways will need to be relocated. There will be a considerable amount of planning required prior to commencing demolition work. A demolition survey will need to be carried out and a plan developed on how the structures will be demolished. If any hazardous materials such as asbestos are identified, a specialist will need to be brought in to remove and dispose of them in a safe and controlled manner.

In the project area, demolition is controlled and permitted by the Bay Area Air Quality Management District. The permitting process is extensive and must be adequately accounted for in the construction schedule. Generally, once permits are obtained and the structures are ready to be demolished, the actual demolition activity can be completed expeditiously. However, demolition in densely populated areas must be done carefully to avoid releasing matter into the air.

5.2 Clearing and Grubbing

After mobilizing and setting up the construction staging area(s), the contractor will commence with clearing and grubbing new ROW in advance of the major building, roadway, and utility relocations.

This activity consists of the removal of top soil, trees, minor physical objects, and other vegetation from the construction site with use of specialized equipment for raking, cutting, and grubbing.

Production rates for clearing and grubbing can vary from one to ten acres a day depending on the following:

- Utility relocations required
- Urban areas
- Dedicated construction equipment and resources

5.3 Earthwork

5.3.1 Discussion

Earthwork consists of both excavation and embankment. Excavation is the removal of soils by mechanical equipment. Embankment is the placement and compaction of soils for the construction process by mechanical equipment.

Earthwork activities for the Project Section will be minor in comparison to other sections of the HSR alignment, since much of the route will be on existing at-grade Caltrain alignments. The exception will be earthwork required for construction of the Brisbane LMF and relocation of the Tunnel Avenue grade separation. Earthwork will also be required for embankment areas associated with the passing tracks in Alternative B.

Excavation and off-hauling the earth materials will likely cause impacts to off-project stakeholders. Strategies for managing this activity are needed so that collateral damage to streets and vibration, noise, dust, and other impacts can be minimized.

Disposal Sites

The most likely method of transporting the excavation spoils will be by truck. Contractors will endeavor to avoid double handling the materials, meaning that once trucks are loaded, it will unload only at its final destination. If taken outside of the Bay Area, the travel times will be considerable. For instance, the Altamont landfill site in Alameda County is a possible disposal location.

For purposes of assessing impacts, we have assumed that all off-haul operations for both environmentally-contaminated materials and clean excavation spoils will be removed from the site and taken to their disposal sites by truck. Truck hauling is elected as the baseline off-haul method because it is the most flexible and can be implemented quickly by any contractor using established routes; therefore, no specialty equipment, new ROW, or use rights are typically needed.

5.4 Roadway

The proposed HSR alignment will require some roadway reconstruction. Portions of Tunnel Avenue and the existing Tunnel Avenue grade separation will require relocation under both Alternatives A and B. After the earthwork operations are performed, roadway subgrade, base, and final pavement sections will be constructed. It is assumed major diversions to the existing roadways to be grade separated will be avoided or minimized if necessary. Detours and temporary traffic control measures will be required so traffic circulation can remain during construction. Construction duration for the grade separations will vary depending on the type of temporary traffic control measure used; for example, general detours provide a shorter construction duration.

It is anticipated that full and partial street closures will be needed for the reconstruction of roadways. The type of closures will be based on the proximity of alternate routes (these are analyzed in further detail in the Environmental Transportation Technical Report). In general, a full roadway closure could result in a significantly shorter overall construction period compared to a partial closure, which could be up to a 50% reduction in duration depending on the location.

Two potential methods of construction for the new pedestrian undercrossings at Caltrain stations without affecting existing rail service are “Jacked Box” and “Micropile Wall” methods. A top-down approach is also possible with a shoofly. See Appendices B and C for further detail.

It is anticipated that highway and roadway work associated with the Project will be done using conventional methods, in the following sequence as necessary:

- Demolition
- Utility relocations (utility relocation timing may influence highway work schedule
  - Could require trenching, segmental pipe construction, concrete pipe or conduit poured in situ, storm drain catch basins poured in situ, or precast unit placement.
- Excavation
- Grading.
- Placing aggregate base
- Constructing concrete curb and gutter (in some cases it may be carried out before the previous stage)
  - Can be done by building forms and pouring concrete in place or by using a curb and gutter placing machine.
- Placing concrete or asphalt concrete top surface base and top surfaces

Coordination with all local agencies and Caltrans (for state highways) will be required as final design progresses by the design-builder.

Assumed Production Rates

- Subgrade ranges from 1,400 square yards to 1,800 square yards per day.
- Base construction ranges from 1,000 square yards to 4,500 square yards per day.
- Asphalt pavements ranges from 500 tons to 2,000 tons per day. Thickness of pavement section must be factored to determine the square yards that can be placed per day.
- Concrete pavements range from 3,000 square yards to 5,000 square yards per day.

5.5 Drainage

Drainage will involve both permanent and temporary systems for track and road construction. Temporary systems will be developed to allow for construction activities that must be performed dry. Temporary dewatering means and methods could include well point systems, sock drains, and bypass pumping from one retention area to another. Groundwater considerations will need to be taken into account for all operations involving dewatering.

Permanent drainage features are anticipated to include closed pipe systems, open channels, swales, box culverts, inlets, and manholes. Production rates for installing permanent drainage will vary depending on depth of cut, soil conditions, installation methods, and type of structures.

The drainage requirements of the HSR project are as follows:

- Maintain existing drainage flow patterns.
- Disperse on-site runoff to encourage local infiltration.
- Improve existing drainage capacity if the HSR exacerbates existing drainage problems or flooding at a location where the existing system is known to be undersized.
- Treat runoff from pollution-generating impervious surfaces to the maximum extent practicable to meet water quality objectives and water quality standards set forth by the California Regional Water Quality Control Board (RWQCB) before discharging to receiving waters.

The at-grade or track on embankment segments will require modification of drainage ditches or swales on both sides of the track to collect rainfall. The emphasis will be placed on on-site retention of runoff which may require the construction of detention basins or infiltration basins. These basins will be unlined and will be designed to remove litter, settleable solids (debris), total suspended solids, and pollutants and encourage infiltration. For embankment segments supported by retaining walls, trackbed drainage will be collected and conveyed in a pipe system. Storm drains may also be incorporated behind the top of the retaining walls to accommodate peak events. All concentrated flow will be addressed in a noneroding manner.

5.6 Structures

Structures within the Project Section to Scott Boulevard are limited to a new overhead for the Tunnel Avenue relocation, and either widening existing bridges or constructing parallel bridges through the four-tracking areas of Millbrae Station and the passing tracks under Alternative B. The Tunnel Avenue roadway bridge would likely be a cast-in-place (CIP) prestressed concrete box girder. Track structures would typically be precast-prestressed concrete box girders.

5.6.1 Aerial Structures

There are various means and methods the contractor can utilize to construct the HSR viaduct structures. The Regional Consultant (RC) has assumed CIP methods for the standard structures, although use of full span precast launching method is being explored as well. Other methods could potentially include the precast segmental span by span method and balanced cantilever construction. The type of construction method selected by the contractor will depend on the geometry and location of the structure. The typical aerial sub-structure consists of CIP bent cap, column(s), and a pile cap supported by structural steel, precast/pre-stressed piles, or cast-in-drilled hole piles.

Precast/Prestressed Box Girder Construction (Full Span – Crane Method)

In this construction method, the box girder is precast as a full span and transported via state highway and local roadways to the guideway.

For railroad bridges shorter than 80 feet, the bridge cross-section can be sub-divided transversely into precast-prestressed concrete box girders that are transported and erected in an economical fashion. An 80-foot-long beam would be approximately 6’-6” deep by 4’-0” wide and weigh less than 160 kips. Practical shipping limits are generally 120 feet in length, 160 kips in weight, and 12 feet in width/depth.

Since the 80-foot-long beams can be transported on state highways and local roads, there is no requirement to acquire in-line staging areas. The locations for this type of bridge are where the guideway crosses over local roadways. A temporary lane or road closure would be needed to accommodate the single-crane or dual-crane lifts of the girders from the truck to the final bridge location. This type of structure has no CIP deck that connects the parallel girders so once the girders are in place, the remaining work (below the rail bridge) can be completed with the roadway open to traffic.

City of Fairfield, CA

Figure 5-1 Precast-Prestressed Box Girder Construction (Full Span - Crane Method)

The typical construction sequence is as follows:

1. The substructure (footings and columns) is constructed using traditional methods.
2. Precast girders are cast and pre-stressed in advance and stored at the casting site.
3. The precast girders are delivered by truck to the bridge location then the roadway closure is put in place. The crane(s) are placed in position and the girders are hoisted from the delivery trucks onto the abutments/columns. The construction proceeds by progressively installing each precast girder. A minimum of four girders can be erected per day.

The advantages of the precast-prestressed box girder (full span – crane method) construction method are:

- Fabricate the box girder at the precast plant.
- Rapid installation.
- Temporary roadway closures while the girders are being placed.
- Independent of weather conditions.
- No inline casting yard required.

The disadvantage is that road access is required for girder delivery.

Sequence of construction and estimated construction duration is illustrated in Figure 5-2 Precast-Prestressed Box Girder (Full Span) Sequence and Production Rate that shows multiple spans; however, the duration for each specific location can be determined based on the number of abutments/columns and spans.

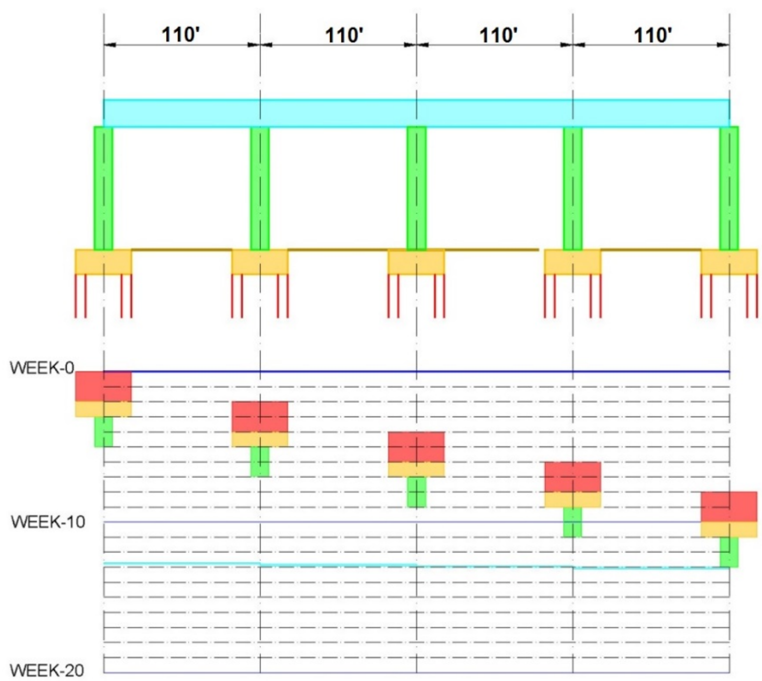


Figure 5-2 Precast-Prestressed Box Girder (Full Span) Sequence and Production Rate

Cast-in-Place/Prestressed Box Girder Construction on Stationary Falsework

Roadway and pedestrian bridges over HSR can be comprised of either precast or CIP concrete superstructures with little difference in roadway profile or temporary construction easement footprint between the two methods. Whereas precast bridges would be constructed using the "Full Span – Crane Method" described in the previous section, CIP bridges would be constructed using the Stationary Falsework Method described herein.

The most common method of roadway bridge construction in California is CIP on stationary falsework, but there is nothing to prevent any bridge from being converted to a precast type. On multi-span bridges, the intermediate supports are almost always comprised of an integral connection with the superstructure continuous over the supports. Bridges over 800 feet long require intermediate expansions joints, which are usually accomplished with quarter-span hinges.

When choosing between precast and CIP girders, the typical comparison of bridge depth is that precast bridges are generally deeper than CIP but CIP bridges need extra clearance to accommodate the temporary falsework. However, for bridges over HSR the permanent vertical clearance of 27 feet allows for falsework to be placed over adjacent active railroad corridors without any profile raise. To span an active 2-track corridor with 15-foot track centers, the Caltrain clearance envelope would require a falsework span length of 35 feet and the difference between final and temporary vertical clearances allows an ample falsework depth of 5'-6". Per the Caltrain Design Standards, the minimum temporary construction clearances shall be 21'-6" vertical and 10'-0" horizontal (per Clearances Note 5). See Figure 5-3 Caltrain Overhead Grade Separation Minimum Requirements.

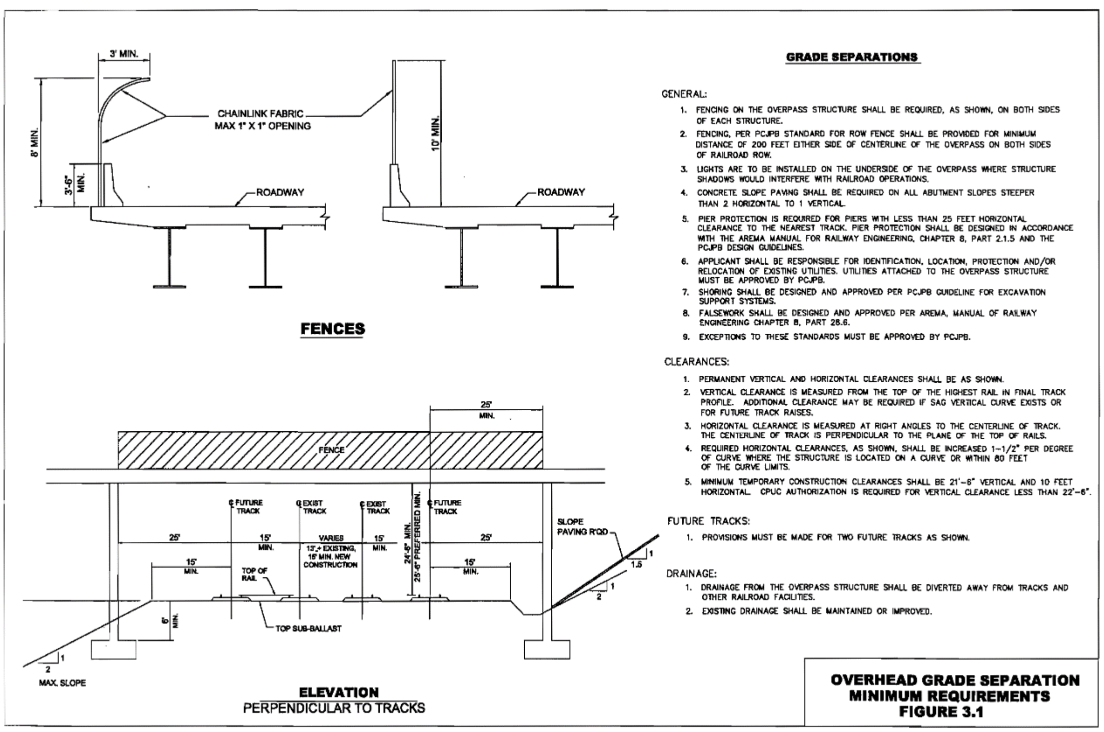


Figure 5-3 Caltrain Overhead Grade Separation Minimum Requirements

The typical construction steps include:

1. Substructure is constructed using traditional methods.
2. Stationary falsework (formwork) is erected.
3. Reinforcement and prestressing are placed.
4. Concrete is poured.
5. Prestressing is stressed.
6. Formwork is stripped and advanced to the next segment.

The estimated production rate for CIP concrete construction on falsework is two weeks per span, as illustrated in Figure 5-4 CIP Concrete Construction Sequence and Production Rate.

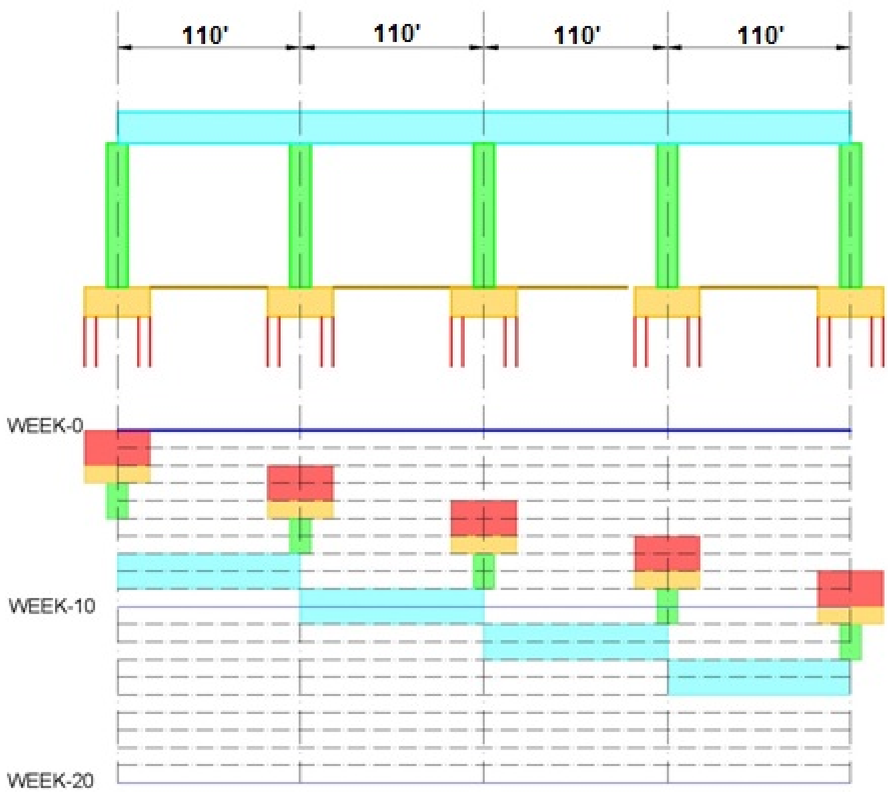


Figure 5-4 CIP Concrete Construction Sequence and Production Rate

5.6.2 Open Trench Excavations

No open trench guideway will be built in the Project Section.

5.6.3 Cut-and-Cover Tunnel

No cut-and-cover tunnels will be built in the Project Section.

5.6.4 Bored Tunnels

No bored tunnels will be built in the Project Section. At the time of this report, existing tunnels on the Caltrain corridor are being modified by Caltrain, and are not a part of the project.

5.6.5 Retaining Walls

Retaining walls will be required where ROW is too constrained for embankment slopes. Within the Project Section, retained earth walls will likely be used. These require straps or rods connected to the backside of wall panels and placed in the embankment for stability of the walls. Since the walls are placed as panels with the embankment, this method of construction expedites the overall embankment sequence.

5.6.6 Trackwork

Within the blended Caltrain corridor, trackwork will follow Caltrain practices and standards for conventional ballast track for at-grade alignments.

Since the Caltrain tracks will be upgraded to meet the Federal Railroad Administration's (FRA) Class 6 Track standards, the construction methods and track tolerance testing (FRA's Track Safety Standards Compliance Manual, Chapter 6) will follow 49 CFR 213 Subpart G requirements.

Conventional Ballast Track

Worldwide the most common system is the ballasted track system, which includes the track roadbed, sub-ballast, ballast, ties, and rail with rail fasteners. Construction rates depend on the rail equipment and skill level of the contractor's team.

Figure 5-5 Ballast Track - Schotteroberbau

Curve Straightening

The primary trackwork construction will be for curve straightening to allow for increased operational speeds on the corridor. This work has been categorized into four types of track shifts:

1. **Less than one foot** – Existing track is shifted in one work window and the existing overhead contact system (OCS) poles will remain.
2. **More than one foot and less than 10 feet** – Existing track is shifted over several work windows and the existing OCS poles will need to be relocated (via construction of new OCS poles to maintain existing operations during non-work windows).
3. **More than 10 feet and less than 21.34 feet** – New OCS poles and tracks are constructed alongside the existing tracks to maintain existing service. Temporary OCS poles may be required where existing OCS poles need to be removed to construct new track.
4. **More than 21.34 feet** – New OCS poles and tracks are constructed alongside the existing tracks while existing service remains unaffected.

See Appendices D, D.1, and D.2 for additional information on track shift work and approach.

Vertical Alignment Adjustments

The existing track profile will need to be modified to allow for increased operational speeds on the corridor. With an assumption that the existing ballast layer is 18 inches deep, this work has been categorized into three types of vertical adjustments:

1. **Raising or lowering up to 6 inches**: The track profile will be adjusted through changes to the ballast layer only. The subballast layer would remain intact. The OCS poles can remain in place and only the contact wire would be adjusted.
2. **Raising greater than 6 inches**: The track profile will be adjusted through reconstruction of the trackbed (ballast and subballast layers). The OCS poles will need to be reconstructed.
3. **Lowering greater than 6 inches**: The track profile will be adjusted through reconstruction of the trackbed (ballast and subballast layers). The OCS poles will need to be modified by lowering the hanger heights and/or the cantilever frame rebuilt.

See Appendices D, D.1, and D.2 for additional information on Track Shift Work and approach.

OCS Adjustments

The existing OCS system will need to be modified based on the alignment modifications to allow for increased operational speeds on the corridor. This work has been categorized into four types of OCS modifications:

1. **New OCS System**: As noted above, based on the horizontal and/or vertical adjustment to the track profile, new OCS poles would need to be constructed.
2. **OCS Pole Displacement**: As noted above, based on the horizontal and/or vertical adjustment to the track profile, new OCS poles would need to be relocated.
3. **OCS Contact Wire Displacement**: As noted above, based on the horizontal adjustment to the track alignment, the OCS contact wire would be adjusted, and the existing OCS pole would remain.
4. **OCS Contact Wire Vertical Displacement**: As noted above, based on the vertical adjustment to the track profile, the OCS contact wire would be adjusted, and existing OCS pole would need to be reconstructed if the adjustment was more than could be accommodated on the existing pole.

See Appendix A for additional information on electrification and OCS adjustments and approach.

5.6.7 Utility Relocation/Adjustments/Construction

Since the blended HSR operations will be within the existing Caltrain ROW, HSR standards and criteria for utility clearances and protection will not be applied. Although some relocation of high-risk gas and oil lines will be required, most utility work will be limited to protection-in-place or extending sleeves and casings in areas of track realignment. New utility connections for HSR facilities, stations, and the LMF are anticipated to be constructed during the site preparation stage. Detailed information for utility relocation/adjustments is contained in the High-risk and Major Utilities Conflict Memorandum. Schedule and contract arrangements will need to be developed for utility relocation of oil pipelines, high-pressure gas lines, fiber optic and telecommunications, water mains, and wells.

6 SUBSECTION CONSTRUCTION

Specific subsection construction challenges and issues are described in this section. The Engineering Drawings included in the Appendices will provide construction staging and phasing plans. The drawings will also underline how some of the constructability issues are proposed to be resolved.

6.1 San Francisco to South San Francisco

6.1.1 Alternative A

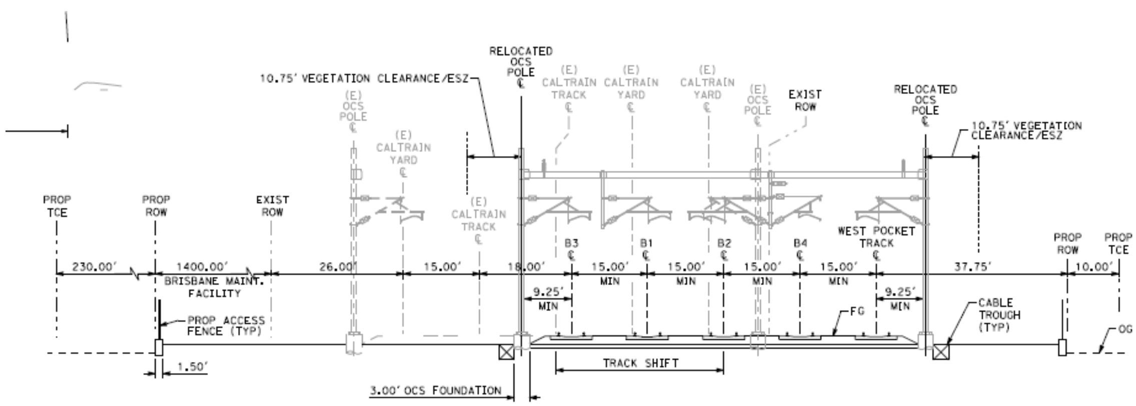
This is an at-grade section starting at the Caltrain/HSR 4th and King Station and ending at Linden Avenue in South San Francisco. The two platforms in the middle of the 4th and King Station will be dedicated HSR platforms, and will be raised and lengthened to approximately 1400 feet and 1000 feet, respectively. This work will need to be completed while the existing station remains operational with Caltrain accessing platforms on either side of the work zone.

The Caltrain Bayshore Station in Brisbane will be shifted along with the four mainline tracks and one siding track to allow for the construction of the LMF on the east side of the tracks. The north end yard leads will connect to the existing mainline tracks just south of existing Tunnel 4. This work will need to be completed while the existing station remains operational (discussed in Section 10.3 of this report). The existing tracks along the Brisbane Lagoon will be reused and reassigned to avoid construction in San Francisco Bay: any additional tracks and construction will be to the west. See Appendix D.3 for additional information on the track work staging of the Brisbane LMF (East).

The existing Tunnel Avenue Overcrossing will be reconstructed along a new alignment within the limits of the track shift required for the LMF. There is an existing fire station in the vicinity of Tunnel Avenue that will need to be relocated, but remain in service during construction. The relocation site has been selected to allow for the in-service requirements.

There are several at-grade crossings where quad-gate improvements will be constructed.

There are several curves within this subsection that will be straightened.

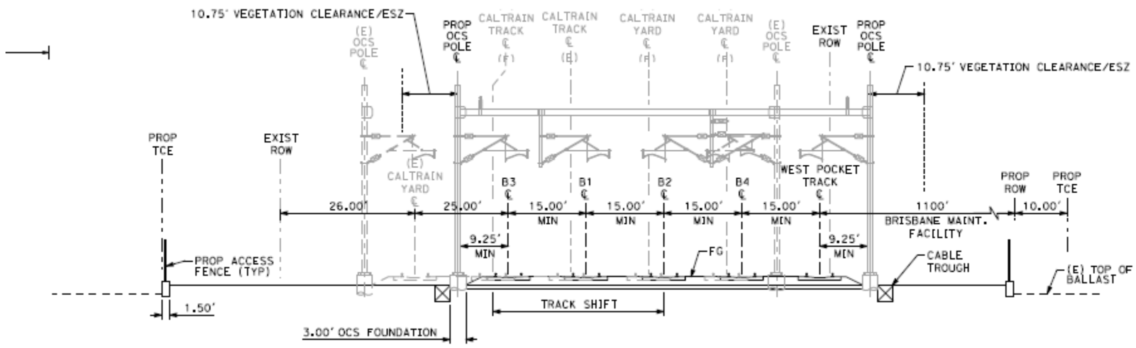


AT GRADE 5 TRACK SHIFT
SCALE: 1"=20'
"B" 445+00

Figure 6-1 Typical Section - San Francisco to South San Francisco Subsection Alternative A

6.1.2 Alternative B

This alternative is similar to Alternative A, with the main difference being that the LMF is on the west side of the existing alignment. See Appendix D.4 for additional information on the Brisbane LMF (West).



AT GRADE 4 TRACK SHIFT
SCALE: 1"=20'
"B" 430+00

Figure 6-2 Typical Section - San Francisco to South San Francisco Subsection Alternative B

For both Alternatives A and B, temporary traffic controls will be required on the local roadways to construct the HSR. In some instances, significant changes to the local street movement, such as two-way traffic control or full street closures and detours, will be required. Coordination with the local cities will be required in the next project phase to develop detailed traffic management plans.

6.2 San Bruno to San Mateo

6.2.1 Alternative A

This is an at-grade section starting at Linden Avenue in South San Francisco and ending at 9th Avenue in San Mateo. The existing Caltrain Millbrae Station will be expanded to include a new 800-foot-long center HSR platform between the existing Caltrain tracks. The HSR track alignment will be capable of accommodating a 1400-foot-long HSR platform in the future. The northbound Caltrain platform will remain as-is. The rail corridor will be widened to the west to accommodate the new tracks so BART will not be impacted. This work will need to be completed while the existing station remains operational with Caltrain accessing platforms on either side of the work zone. See Appendix D.5 for additional information on the track work staging at Millbrae Station.

The existing Caltrain Broadway Station will be reconstructed to eliminate the current hold-out rule by adding a new northbound platform. The existing southbound platform will remain. This work will need to be completed while the existing station remains operational with Caltrain accessing platforms on either side of the work zone.

There are several at-grade crossings where quad-gate improvements will be constructed.

There are several curves within this subsection that will be straightened.

Temporary traffic controls will be required on the local roadways to construct the HSR. In some instances, significant changes to the local street movement, such as two-way traffic control or full street closures and detours, will be required. Coordination with local cities will be required in the next project phase to develop detailed traffic management plans.

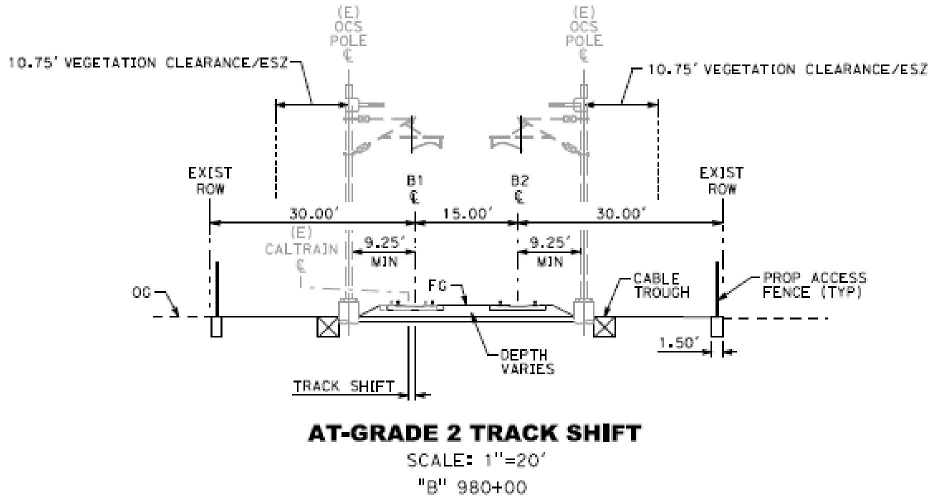


Figure 6-3 Typical Section - San Bruno to San Mateo Subsection

6.2.2 Alternative B

Same as Alternative A.

6.3 San Mateo to Palo Alto

6.3.1 Alternative A

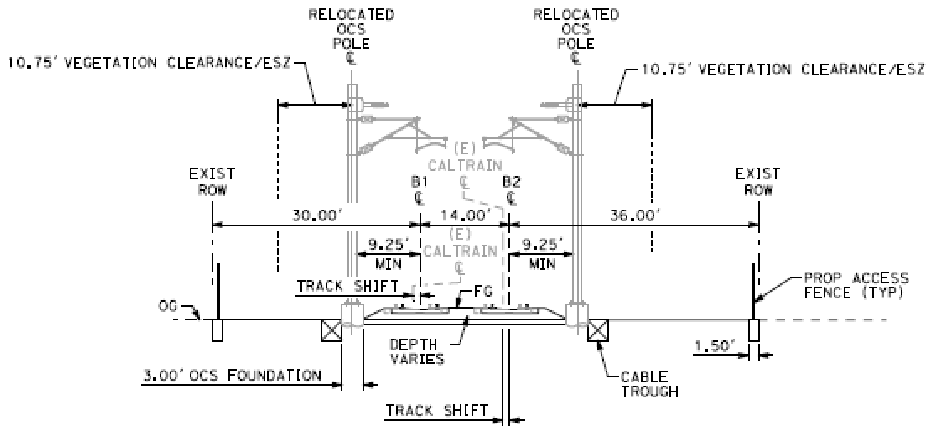
This is an at-grade section starting at 9th Avenue in San Mateo and ending at San Antonio Road at the south end of Palo Alto. The 25th Avenue Grade Separation Project is in this subsection and is currently under construction. HSR and Caltrain have been coordinating the design of this project so as not to preclude HSR improvements in the future.

The existing Caltrain Hayward Park Station will be reconstructed due to curve straightening. This work will need to be completed while the existing station remains operational with Caltrain accessing platforms on either side of the work zone.

The existing Caltrain Atherton Station will be reconstructed to eliminate the current hold-out rule by adding a new northbound platform. The existing southbound platform will remain. This work will need to be completed while the existing station remains operational with Caltrain accessing platforms on either side of the work zone.

There are several at-grade crossings where quad-gate improvements will be constructed.

There are several curves within this subsection that will be straightened.



AT-GRADE 2 TRACK SHIFT
SCALE: 1"=20'
"B" 1237+00

Figure 6-3 Typical Section - San Bruno to San Mateo Subsection Alternative A

6.3.2 Alternative B

This is the same as Alternative A except the limits of the new passing tracks start south of 9th Avenue in San Mateo and end just north of Whipple Avenue in Redwood City. The 25th Avenue Grade Separation Project is in this subsection and is currently under construction. HSR and Caltrain have been coordinating the design of this project so as not to preclude HSR improvements in the future.

The existing Caltrain Hayward Park, Belmont, and San Carlos stations will be reconstructed due to the additional passing tracks. This work will need to be completed while these existing stations remain operational (discussed in Section 10.3 of this report).

The new passing tracks will include the construction of retaining walls resulting in a retained fill section for most of the length of the passing tracks. See Appendix D.6 for additional information on the track work staging of the passing tracks.

There are several at-grade crossings where quad-gate improvements will be constructed.

There are several curves within this subsection that will be straightened.

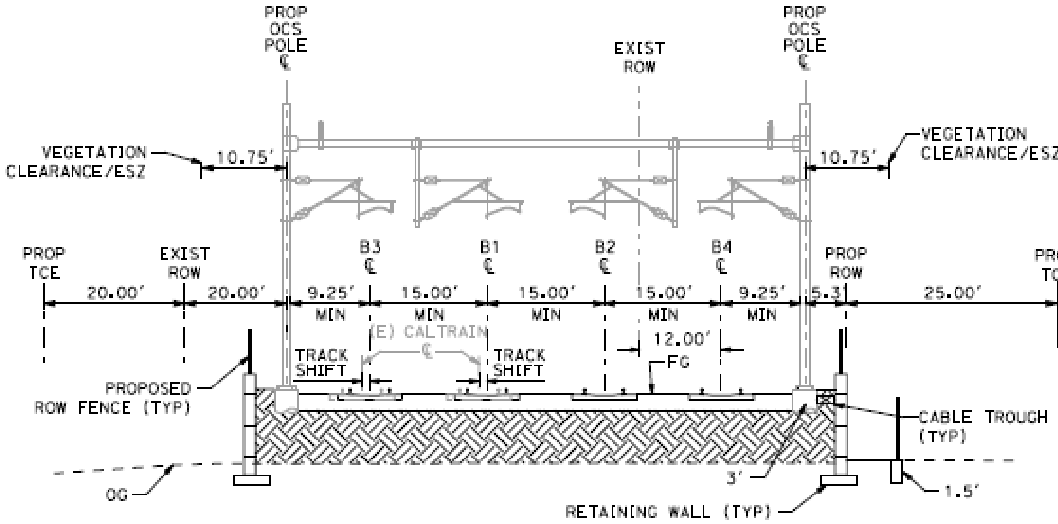


Figure 6-3 Typical Section - San Mateo to Palo Alto Subsection Alternative B

For both Alternatives A and B, temporary traffic controls will be required on the local roadways to construct the HSR. In some instances, significant changes to the local street movement, such as two-way traffic control or full street closures and detours, will be required. Coordination with the local cities will be required in the next project phase to develop detailed traffic management plans.

6.4 Mountain View to Santa Clara

6.4.1 Alternative A

This is an at-grade section starting at San Antonio Road at the north end of Mountain View and ending at Scott Boulevard in Santa Clara.

There are several at-grade crossings where quad-gate improvements will be constructed.

There are several curves within this subsection that will be straightened.

Temporary traffic controls will be required on the local roadways to construct the HSR. In some instances, significant changes to the local street movement, such as two-way traffic control or full street closures and detours, will be required. Coordination with local cities will be required in the next project phase to develop detailed traffic management plans

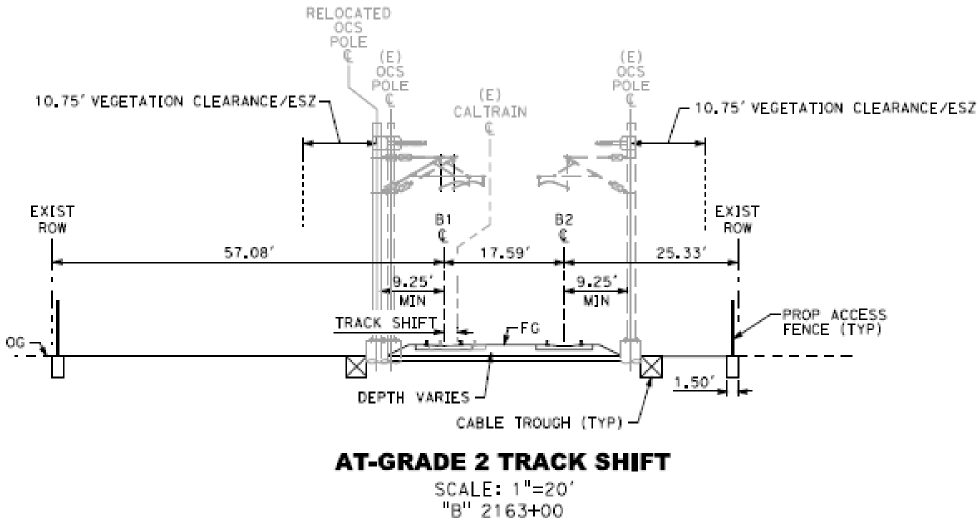


Figure 6-4 Typical Section - Mountain View to Santa Clara Subsection

6.4.2 Alternative B

Same as Alternative A.

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7 CONSTRUCTION STAGING AREAS

7.1 Construction Staging Areas

The construction staging areas will house incoming materials; provide areas for material preparation, storage of equipment, maintenance of equipment, operations preparation, and construction offices; and allow for good housekeeping throughout the alignment.

7.1.1 Staging Area Criteria

The following four criteria are the guidelines for selecting construction staging areas.

7.1.1.1 Traffic

Selected areas should have direct access to arterials from major highways. Direct access to the corridor affords direct transport of materials and equipment to construction sites with minimal impacts on traffic. Also, sites should be selected to minimize interference with pedestrians, bicyclists, and transit if possible.

The load and volume capacity of existing structures and roads would need to support construction operations. An analysis of these existing roads and structures would be undertaken by the contractor prior to final site selection. Similarly, a site-specific investigation of horizontal and vertical clearances and of existing geometric road conditions, as they pertain to construction equipment mobility and transport, would need to be undertaken by the contractor.

7.1.1.2 Area

A large area is desirable for construction staging operations. The size of the staging areas depends on the areas available in each location. Sites must meet the minimum area requirements because the amount of available space affects the production schedule especially for the storage of precast structural sections produced off-site.

7.1.1.3 Location

Construction staging areas should be evenly distributed along the alignment and spaced 15 to 25 miles apart to minimize travel distance between construction sites. Locations within the Caltrain ROW would minimize land acquisitions. Floodplains and environmentally sensitive areas should be avoided because being in a floodplain is a risk to the contractor. All sites should observe the minimum 25-foot offset from Caltrain or UPRR tracks/operations.

7.1.1.4 Accessibility

The locations should be close to major roadways and to on- and off-ramps. Access to major roadways would aid in shipping to and receiving from the construction site and would minimize travel on side roads.

Minimizing impacts on average daily traffic is a main consideration in the selection of suitable sites. Where traffic impacts are foreseen, the contractor should put in place a location- specific, activity-based trip schedule to minimize those impacts. Accessibility to these sites is a key factor for efficient rates of production.

In addition, access to existing utilities is beneficial because it reduces construction-site development time and costs.

In the highly-developed area surrounding the project, these conditions will be difficult to meet.

7.2 Construction Laydown Areas

The San Francisco to San Jose corridor is a heavily urbanized area with limited vacant sites for construction laydown areas. Therefore, the entire existing Caltrain ROW has been identified as available to support construction; however, each location would need to be approved by Caltrain.

This ROW includes the rail alignment, siding tracks, and other work areas in addition to the existing Caltrain stations and associated parking lots.

The types of construction include curve straightening, Caltrain station platform improvements, gate crossing improvements, and new bridges primarily associated with Alternative B. The curve straightening work is performed using mostly track-mounted equipment with rail delivery of materials (such as rail, ties, and ballast); therefore, separate construction staging areas are not required. The Caltrain station platform improvements are isolated to each Caltrain station and portions of the existing station parking lots can be used to support the work. The grade crossing improvements are isolated to each crossing location with no separate construction staging area, and they can be supported by using portions of the existing Caltrain station parking lots that would be used for other types of work. Lastly, the new bridges associated with Alternative B can be constructed using the space needed for the additional tracks along with portions of the existing station parking lots to support the work.

There are two locations where significant construction staging areas would be needed.

7.2.1 Brisbane Light Maintenance Facility and Tunnel Avenue Realignment

The site for the LMF is large enough to function as its own construction staging area in conjunction with supporting the Tunnel Avenue realignment and the new roadway overcrossing without the need for additional space.

7.2.2 Millbrae HSR Station

The site for the Millbrae HSR Station is large enough to function as its own construction staging area without the need for additional space due to the rerouting of existing streets and parking areas.

8 PRECASTING OPERATIONS AND YARD REQUIREMENTS

There are no precasting yards required for the San Francisco to San Jose Section.

9 CONSTRUCTION SEQUENCING

9.1 Construction Timing Constraints

Environmental constraints, including nesting bird season and seasonal flooding, can constrain the timing of certain construction activities. Tree removal would ideally be conducted during the non-breeding season to avoid potential impacts to actively nesting birds. Dewatering for foundation construction in sensitive areas may be restricted to dry months.

Key activities that may constrain the construction schedule and impact the critical path if not properly sequenced:

- ROW acquisitions (permanent and temporary)
- Utility relocations
- Railroad realignment
- Roadway rerouting
- Order and delivery of long lead items.

Critical path construction activities include:

- Standard bridge construction (for Alternative B only)

9.2 Enabling Works

Enabling works include:

- ROW acquisitions.
- Obtaining necessary construction permits.
- Setting up staging areas.
- Setting up worker health, safety, and welfare facilities.
- Setting up contractor administration offices.
- Site clearance and demolition.
- Critical utility relocations and protection works.
- Railroad relocations.

Temporary construction facilities should be acquired and cleared early in the construction schedule to provide flexibility.

Utility relocations, if possible, should be done before the main work commences to allow for more efficient excavations, grading, and foundation construction. The staging areas will need to be connected to the utility network (water, electricity, telecommunications) as early as possible.

9.3 Typical Construction Sequencing and Durations

Typical construction sequencing will include:

- Permanent and temporary ROW acquisitions by the Authority.
- Contractor mobilization – staging area(s) and supporting offices.
- Critical area utility relocations (by contractor and/or third parties).
- Railroad relocations.
- Roadway relocations.

- Hydraulic crossings.
- Berm construction.
- Demolition – buildings and roadway structures.
- Roadway overcrossing structures.
- Roadway modifications.
- HSR at-grade earthwork construction.
- HSR retained fill construction.
- HSR bridge construction (Alternative B).
- Demobilization.

A preliminary version of the project contract schedule, that will be provided in the environmental documentation can be found in Appendix E. This version is subject to change.

9.4 Construction Staging and Sequencing

Construction staging and sequencing of work within the blended Project Section will differ from other dedicated HSR sections due to existing Caltrain operations. Furthermore, criteria established by the Authority for dedicated service will likely not be mandated within this section. The following sections provide for general considerations and detailed considerations are discussed in the various appendices.

10 TRAFFIC CONTROL AND DETOURS

Impacts to traffic must be minimized during construction and efficient movement through and around construction zones must be maintained throughout the duration of the construction. Extensive coordination with Caltrans, Caltrain, and Cities will be required. Detours allow for the most expeditious approach to completing the construction; however, they can cause public relation concerns with the local communities. Detours require current studies to determine traffic volumes and movements that will be affected. Signal timing for proposed detour routes will need to be evaluated. Signal phasing at intersections along the detour routes will need to be adjusted to accommodate the new traffic volumes. Durations of detours must be held to a minimum to avoid prolonged disruptions to the traveling public. These are analyzed in further detail in the environmental Transportation technical report.

10.1 Construction Access and Traffic

The project is in a dense urban environment with heavy vehicular, bicycle, and pedestrian usage. Impacts to traffic must be minimized during construction and efficient movement through and around construction zones must be maintained throughout construction. Extensive coordination with Caltrans, UPRR, and local cities will be required. Detours allow for the most expeditious approach to completing the construction; however, they can cause public relation concerns with local communities. Detours require current studies to determine traffic volumes and movements that will be affected. Signal timing for proposed detour routes will need to be evaluated. Signal phasing at intersections along the detour routes will need to be adjusted to accommodate the new traffic volumes. Durations of detours must be held to a minimum to avoid prolonged disruptions to the traveling public.

Local and interstate highways, arterials, and local streets will be affected by the movement of materials and equipment, and the contractor will be required to develop a Construction Transportation Plan to minimize this issue. This plan will address, in detail, the activities to be carried out in each construction phase with the requirement of maintaining traffic flow during peak travel periods. Such activities include, but are not limited to, the routing and scheduling of material deliveries, material staging and storage areas, construction employee arrival and departure schedules, employee parking locations, and temporary road closures, if any. The plan will provide traffic controls pursuant to the California Manual on Uniform Traffic Control Devices (CAMUTCD) sections on temporary traffic controls (Caltrans) and will include a traffic control plan. Refer to the Final Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for additional details on the minimum requirements for traffic control plans.

During development of the Project Section design, the RC has been involved in high-level discussions with Caltrans and various local jurisdictions. These discussions focused on the details of the design and did not include specific restrictions regarding construction access and traffic control. The assumptions made in the Traffic Analysis portion of the EIR/EIS regarding roadway overpass construction is that two consecutive overpasses would not be constructed simultaneously to minimize traffic impacts.

The Project Section crosses a region with a well-defined road network making site access easy and flexible. The job site consists of the Caltrain permanent ROW, which is typically between 60 and 100 feet wide. In addition, a temporary construction footprint ranging between 0 to 15 feet on either side of the alignment has been included in the environmental footprint. For safety, security, and logistics reasons, this ROW area will be fenced wherever possible and access will be controlled. Access to the site will be via specific gates along the ROW and strategically located with easy access to roads and freeways.

10.2 Pedestrian Detouring and Access

The project area is densely urban with high volumes of pedestrian and bicycle traffic occurring in numerous locations, particularly in areas with grade crossings. Traffic safety plans will need to reflect this and provide specifics for the protection and facilitation of pedestrians and cyclists.

Local agencies are protective of these stakeholders and can be expected to demand a high degree of detail in traffic plans submitted as part of the final design phase.

10.3 Caltrain Station Access

There are 23 existing Caltrain stations that will need to remain operational during construction.

No work will be done at the following Caltrain stations:

- Alternative A
  - 22nd Street, South San Francisco, Burlingame, San Mateo, Hillsdale, Belmont, San Carlos, Redwood City, Menlo Park, Palo Alto, Stanford, California Avenue, San Antonio, Mountain View, Sunnyvale, and Lawrence
- Alternative B
  - None

The following 10 Caltrain stations will be reconstructed, reconfigured, or modified:

- Alternative A
  - 4th and King, Bayshore, San Bruno, Millbrae, Broadway, Hayward Park, Atherton
- Alternative B
  - Bayshore, Hayward Park, Hillsdale, Belmont, San Carlos

The following three Caltrain stations will be reconstructed, reconfigured, or modified as part of the San Jose to Merced Section and are therefore excluded from the San Francisco to San Jose Section:

- Santa Clara, College Park, and Diridon.

Caltrain 4th and King, San Bruno, Millbrae, Broadway, Hayward Park, and Atherton Stations (Alternative A)

The 4th and King, San Bruno, Millbrae, Broadway, Hayward Park, and Atherton stations would remain in service and not require relocation. To ensure the safety of the public, the construction of the passing tracks through each station would require either temporary closure of one platform for single-track operations or temporary closure of one platform for two-track operations. In either case, it is not anticipated that the entire station would need to be closed. Some of these stations may be temporarily relocated nearby so existing parking and access can be maintained. These relocations will be in conjunction with the trackwork associated each alternative. The station relocations will need to be coordinated with Caltrain since they operate and maintain them.

Caltrain Bayshore Station (Alternatives A and B)

The existing Caltrain Bayshore Station is located within the limits of the Brisbane LMF and under the new North Yard Lead flyover and pergola structure. The alignment of the North Yard Lead is at the south end of the existing station. To ensure public safety, the construction of the flyover and pergola structure over the existing station would require either falsework over the station should the construction be done with CIP methods or the closure of south of the existing platforms should the construction be done with precast elements. In either case, it is not anticipated that the station would be closed or a temporary station would need to be constructed.

Caltrain Hayward Park, Belmont, and San Carlos Stations (Alternative B)

The existing Caltrain Hayward Park public, Belmont, and San Carlos stations are located within the limits of the new 4-track (passing track) section in Alternative B. To ensure public safety, the construction of the passing tracks through each station would require either temporary closure of one platform for single-track operations or temporary closure of one platform for two-track operations. In either case, it is not anticipated the entire station would need to be closed.

Caltrain Hillsdale Station (Alternative B)

The existing Caltrain Hillsdale Station is located within the limits of the new 4-track (passing track) section in Alternative B. The existing (center platform) station would remain in service with no closures as a second center platform station was constructed alongside the existing station.

Additionally, roadway construction will impact local transit (non-rail) facilities, such as bus services, that will need to remain operational throughout the construction duration. Temporary facilities will be provided (e.g. temporarily relocated bus routes and stops) with consideration for key transit locations and will be factored into the overall temporary traffic handling measures.

Traffic control features such as construction signs and pavement makings must be installed and maintained per current CAMUTCD Standards. Clearly identified construction zones and associated hazards must be in place prior to commencement of any construction activities to warn motorists and avoid potential liability claims from the traveling public. All traffic control measures must be reviewed twice daily, once at night and once during the daytime. Reports documenting all devices in use and the current status of the devices must be completed and submitted to the design-build team so deficient items can be immediately corrected.

To avoid logistical inconveniences for both construction crews and for the public, movements of materials and equipment will be made using the HSR ROW wherever practical.

Local and interstate highways will be affected by the movement of materials and equipment, and the contractor will be required to develop a Construction Transportation Plan to minimize this issue. This plan will address, in detail, the activities to be carried out in each construction phase with the requirement of maintaining traffic flow during peak travel periods. Such activities include, but are not limited to, the routing and scheduling of materials deliveries, materials staging and storage areas, construction employee arrival and departure schedules, employee parking locations, and temporary road closures, if any. The plan will provide traffic controls pursuant to the CAMUTCD sections on temporary traffic controls (Caltrans 2014) and will include a traffic control plan.

Major construction traffic components are as follows:

- Import of construction materials, such as
  - Fuel, oil
  - Water
  - Concrete
  - Steel
  - Cement
  - Aggregates
  - Fill material
- Mobilization/demobilization of equipment.
- Daily movements of craft labor.
- Export of earth or other unsuitable materials.

Planned traffic detours and modifications to existing traffic flows will be required for construction of roadway overpasses and for periodic hauling operations.

For safety, security, and logistics reasons, this ROW area will be fenced, and access will be controlled. Access to the site will be via specific gates along the ROW that are strategically located with easy access to roads and freeways.

11 CONSTRUCTION POLLUTION CONTROL

Dust, chemicals, noise, and vibration generated from construction will pose significant concerns to local communities. Control measures will be put in place to control these according to the mitigation and permit requirements outlined in the EIR/EIS.

11.1 Air Quality

Air quality mitigation measures and permit requirements are detailed in the EIR/EIS and include:

- Wet down stockpiles and areas of incomplete construction for road beds and tracks.
- Dust palliative application.
- Provide soil tracking devices to remove built up dirt on construction equipment tires at access points to construction. Soil devices would consist of broken rock and/or rubble placed on filter fabric to vibrate off loose mud and dirt.
- Provide street cleaning equipment.
- Provide temporary sediment barriers.

11.2 Noise and Vibration

The noise and vibration limits chosen for construction and operation of the HSR System satisfy the federal guidelines of the FRA and Federal Transit Administration (FTA) for train and HSR facility operations and the Federal Highway Administration (FHWA) as defined for California application by Caltrans for traffic noise

During construction, some equipment may cause ground-borne vibrations, most notably pile driving equipment. Pile-driving is only expected to occur where there is the need for a bridge, aerial structure or road crossing and is only one of the several proposed construction methods. Construction equipment can produce vibration levels at 25 feet that range from 58 VdB (decibel vibration velocity level) for a small bulldozer to 112 VdB for a pile driver. With pile driving, there is potential for severe vibration impacts during construction that would have substantial intensity under the National Environmental Policy Act (NEPA) and would be significant under the California Environmental Quality Act (CEQA). Without pile driving, the impact would have moderate intensity under NEPA and would be less than significant under CEQA.

Mitigation measures and permit requirements for noise and vibration levels are detailed in the EIR/EIS and include:

- Restricting certain activities such as pile driving and hauling of borrow material to day time operations only.
- Provide sound walls around generators and other stationary equipment.
- Require monitoring of noise levels to ensure proper measures are taking place.
- Perform vibration and settlement monitoring.
- Cease operations with excessive vibration and evaluate alternative construction methods.

11.3 Water Quality

Water quality mitigation measures and permit requirements are detailed in the EIR/EIS and include:

- Prepare and adhere to approved Stormwater Pollution Prevention Plan.
- Comply with water quality permits (401/WDRs, 402, 404, dewatering).

11.4 Hazardous Materials

The project area has been in use for many decades for transportation, industrial, and commercial purposes. These uses have caused soils to contain pollutants in many locations, some of which may have been deposited or migrated into groundwater to the project area.

Contaminated materials that must be removed or reused by the project will need to be tested to assure that disposal or reuse is proper and legal. The soil adjacent to operating rails is often contaminated with either lead or petroleum products. Some of the material from the abated structures and contaminated soils may require removal to a Class 1 landfill. For California, this kind of material is usually transported to Kettleman City or Coalinga — about 200 miles southeast of the project. Cost of the disposal is high at the Class 1 landfills and the Authority could have future costs from the Class 1 landfill disposal, since generators are responsible for the materials in perpetuity.

In the San Francisco Bay Area, there are specialty contractors that undertake abatement of toxic materials and obtain regulatory permits to clear the property. These specialty contractors can either work as prime contractors or as subcontractors for the prime rail contractor.

11.5 Dust Control

Much of the project will take place near residential and commercial land uses. Contract documents should include stringent provisions requiring that contractors minimize dust emissions.

12 CONSTRUCTION PERMITS

All construction permits must be obtained before starting construction. The contractor must identify what permits will be necessary for the construction, ROW, easements, environmental protection, etc. for the execution of the contract.

Below is a preliminary list of anticipated permits that may need to be acquired:

Table 12-1 Construction Permits

Jurisdiction	Possible Permit(s) Required
California Department of Water Resources	Encroachment Permit
California Public Utilities Commission (CPUC)	Authority to Construct
Caltrain/PCJPB	Right of Entry (ROE) - Survey Permit, Building Permit
Cities of: ▪ San Francisco ▪ Brisbane ▪ South San Francisco ▪ San Bruno ▪ Millbrae ▪ Burlingame ▪ San Mateo ▪ Belmont ▪ San Carlos ▪ Redwood City ▪ Town of Atherton ▪ Menlo Park ▪ Palo Alto ▪ Mountain View ▪ Sunnyvale ▪ Santa Clara ▪ San Jose	Building Permit, Construction Management Plan, Demolition Permit, Encroachment Permit, Maintenance Agreement, Water Connection, Building Permit Geological Hazard Clearance, Grading and Erosion Control, Maintenance Agreement, Memorandum of Understanding (MOU), Utility Permit
Counties of: San Francisco, San Mateo, and Santa Clara	Building Permit, Construction Detours, Encroachment Permit, Environmental Health Permit, Maintenance Agreement, MOU
RWQCB, San Francisco Bay Region 2	National Pollutant Discharge Elimination System (NPDES) permit in association with Stormwater Pollution Prevention Plan
Santa Clara Valley Water District	Encroachment Permit
South County Airport	Encroachment Permit
VTA	Construction Access Permit, Restricted Access Permit
UPRR	ROE - Survey Permit

13 THIRD PARTY COORDINATION AND AGREEMENTS

13.1 Caltrans

The project crosses Caltrans property and facilities in approximately a dozen locations. This entire Project Section from San Francisco to San Jose is within Caltrans District 4, which has its main offices in Oakland, California. In the construction of the HSR facilities, regardless of the alignment chosen from San Francisco to San Jose, the rail construction will require a working relationship with Caltrans and a binding agreement.

Interagency agreements between Caltrans and the Authority prior to construction would clearly identify and reach agreement on several issues for both the construction and ongoing operations and maintenance of both rail and highway facilities.

In these interagency agreements, the joint use of ROW with HSR either under or over Caltrans highway facilities needs to be accurately defined. Once defined, it must be recorded with the State of California State Lands Commission pursuant to the provisions of Section 101.5 of the Streets and Highway Code.

The impact of the rail construction on Caltrans facilities and highway traffic must be evaluated. The evaluation should include, but not be limited to, the resulting change in the seismic safety of the highway structures that may occur from modified earthwork around bridge columns or abutments. If the highway structure is affected by the rail construction, the correctional mitigations should be included in the rail construction bid documents.

For the HSR project, it is possible a number of Caltrans divisions would be involved in developing an interagency agreement, and conflicting recommendations are possible. Caltrans headquarters in Sacramento has charge of the legal aspects of any agreement and usually final approval. Given this complex structure for decision-making, development of any agreement with Caltrans typically takes several months and with this complex agreement it could take years.

In the development of the interagency agreement or agreements, the following are some of the issues that may arise. Since the design is not yet fully developed, they most likely are not the only issues but provide a basic understanding of issues that have arisen in the past:

- Caltrans has required that structures built over state highways be built to Caltrans specifications.
- Design of a structure spanning a state highway could require multiple reviews by the Caltrans Bridge Department.
- Erection of the structure over the state highway will be dictated by Caltrans. Seven to ten locations will require construction of the rail line below a Caltrans bridge structure.
- Design of Caltrans bridges has been performed using planned site conditions.
- Planned rail construction can affect state highway ancillary facilities.
- When there is active construction under a Caltrans structure, Caltrans would have several concerns and demand an oversight role.
- Should address the future maintenance responsibilities for the project's constructed facilities and maintenance of the joint ROW in a section of the agreement.

13.2 Utilities

Constructability will be affected by the presence, characteristics, and handling of utilities within the project. Handling includes planning and executing both temporary and permanent changes to utility configuration. Each utility crossing that will be affected should be the subject of a definitive plan for construction. Utilities, being predominantly placed underground, are often the subject of claims for unforeseen conditions. Contractors also lodge claims when utility companies fail to act promptly and cause delay to the contractor's progress.

Utilities have certain rights to have and maintain facilities in easements within the Caltrain ROW and the project vicinity. Utilities services must be kept in continuous operation except for short and well-planned outages related to cutovers and emergency repairs. For purposes of this discussion, a utility in the ROW is any non-railroad pipeline, conduit, channel, or other conveyance including electrical or telecommunications.

In some cases, utility companies may own rights via easements, licenses, and permits to use property even where they do not have existing physical facilities. In nearly every case where utilities lines exist in the ROW, they are subject to being moved and altered to accommodate the new construction of the HSR project. ROW expansion will encompass utilities that are not currently in the ROW.

The mutual duties established between the Authority as project owner with each utility should be established in formal agreements that will provide rules for what work is to be done, by whom, when, and how.

City and county jurisdictions operate utility enterprises as financial entities distinct from their general funds. Some utilities, notably telecommunications, may run in joint facilities such as duct banks and trenches. Relocation of these facilities requires multiparty negotiation and coordination that may be time-consuming as various parties review proposals by others. Utilities sharing facilities may also have different design standards that may conflict and require resolution.

Relocation of utilities that make use of the ROW for conveyance (longitudinal utilities) may require extensive design, including temporary relocations and tie-ins. These utilities may include telecommunications, electrical power, fuel and gas pipelines, and others.

The construction drawings should have detailed and accurate depictions of the utilities in the project vicinity. It is important to pothole critical utilities to assure the utilities are where they are believed to be.

13.3 Railroads

13.3.1 Caltrain

Constructability will be affected by the timeliness and provisions of agreements made with the PCJPB/Caltrain which operates commuter rail service along the San Francisco Peninsula. Amtrak, under contract with PCJPB, operates Caltrain service and provides other services including maintenance of systems and safety operations. UPRR has rights to use Caltrain ROW for the operation of freight rail trains.

Under the blended system concept, HSR will operate using the same main tracks as Caltrain trains, so the HSR project will require thorough and detailed coordination of design, systems integration, construction planning, construction coordination, operational testing, and operations when HSR is in service.

Construction of the PCEP will precede the HSR project. The PCEP will install electrification and controls systems that will be compatible with and jointly used with HSR. When HSR becomes operational, Caltrain will exercise central control over the system including HSR trains.

Track construction along the Project Section consists mainly of track realignment and track layout reconfiguration at some stations. Maintaining electrified Caltrain service during construction will be required for the blended system implementation. This will involve shifting existing track and OCS poles and temporary shoofly tracks and OCS poles. Extensive coordination and planning will be needed to minimize the impact of construction activities on Caltrain and freight operations. It is anticipated the most difficult portions of the Project Section to construct will be:

- Brisbane LMF to Bayshore Station
- I-380 Crossing near San Bruno Station

- Millbrae Station
- Broadway Station
- Hayward, Belmont, and San Carlos stations
- Atherton Station

The approach assumes staging requirements will fall within the criteria developed for the PCEP, mainly construction activities will occur in single-track segments; no more than two, non-adjacent segments are constructed at a time; and use only weekend and night closures. Temporary speed restrictions and limited crossover functionality will be necessary.

Construction of the OCS also presents special considerations since electrified Caltrain service will be in use when the blended system is implemented.

For construction of new tracks outside the existing mainline, further considerations are needed to maintain existing service during construction. New turnouts, switches, crossovers, and other installations on existing main track will require several hours of train outages. Without agreed on regular days and hours of operational outages, bidders will be unable to provide a realistic bid and would most likely increase their bids to account for scheduling uncertainty.

Without detailed and mutually agreed upon policies and procedures for joint usage of track areas during construction, HSR contractors will face unexpected and unscheduled interruptions in the work, causing delays and extra cost. Before construction, it is necessary to establish thorough and complete plans for site safety coordination in the form of a project safety plan reviewed and interactively developed with Caltrain. During construction, the team should practice joint planning for specific work through Site Specific Work Plans. The team should investigate and troubleshoot any and all failures of safety planning, communication, and execution.

The team should establish a joint operations safety board that includes representatives from Caltrain, UPRR, HSR construction managers, and contractors that meets regularly and confines its discussion to operations and safety. The board should disseminate lessons learned to project participants and the Authority for general distribution.

13.3.2 Union Pacific Railroad

Constructability will be affected by the timeliness and provisions of agreements made with UPRR. UPRR has retained certain rights for use of the Caltrain ROW that include revenue-producing ownership of utility easements and operation of freight rail trains. HSR construction will require that UPRR's utility easements be altered or bought to allow both temporary and permanent relocation. Our investigation of rail conditions and spurs indicates that a low volume of freight traffic runs along the Caltrain ROW; however, the Authority should expect UPRR to vigorously defend any ROW rights they possess. In our experience, negotiations with UPRR can be protracted and difficult.

HSR construction will require UPRR agreement and cooperation in five areas:

1. **Freight Operations Schedule**: Without agreed upon days and hours of operation by UPRR in this corridor, the contractor will be unable to provide a realistic bid and would most likely increase the bid to account for uncertainty.
2. **Freight Operations Accessibility**: Maintaining continuous access to spurs, sidings, and junctions during construction will be important to UPRR.
3. **Material Transportation**: An umbrella agreement would stabilize freight pricing in advance of bidding, giving contractors reliable costs and ground rules. Negotiation of prices and terms by the Authority could also be advantageous by motivating UPRR to cooperate on other issues.
4. **Using Off-route ROW**: The Authority may find using UPRR ROW outside the HSR/Caltrain route as paths for non-rail methods of material movement advantageous. These could include spur tracks at Quint Street in San Francisco, the junction leading to the old Dumbarton railroad bridge, and the Milpitas and Oakland Subdivisions.

5. **Utilities Relocation**: Some UPRR-owned third-party easements will have to be relocated or purchased by the Authority or Caltrain to accommodate construction.

It is recommended the Authority complete a full and accurate study of all utilities running in the Caltrain ROW, conduct multi-party negotiation, and finalize multilateral binding agreements that will provide a basis for utilities relocations into new easements and for interim relocations appropriate for staging during construction process.

13.4 Local Jurisdictions

The San Francisco to San Jose HSR route passes through 14 cities and three counties. Although the work itself will be performed in the Caltrain ROW and be subject to FRA/PUC regulations, practically, contractors will need to access the site through these jurisdictions. Issues, including utility relations, street conforms, property takes, and many others, will need to be agreed upon, preferably before awarding contracts. Detailed agreements with jurisdictions prior to a construction bid would serve to fully inform and formalize the project's proposed construction details, environmental mitigations, and operating parameters.

Municipal codes and policies will vary in each jurisdiction, affecting rules involving working hours, haul routes, noise, and other factors in construction. Failure to obtain binding and detailed legal agreement with the local jurisdictions will result in possible additional cost and delay in the project. Uncooperative cities and counties have the power to close haul routes, restrict traffic movements, restrict movement of oversize loads, and place weight limits on streets necessary for import and export of material.

Cities and counties may have locally-owned utilities that will be affected by HSR construction. These often include sewer, storm drain, and traffic signal conduits. The protection or rerouting of these utilities where they are affected needs to be detailed in the agreement, including who will be responsible for the work and how payment will be made if the city or county does the required work. Since both sewer and storm drainage systems rely on gravity for flow, the utility relocation or protection cost could be extensive, requiring rerouting or pump stations, in some cases.

The following are some of the most important local construction work concerns that should be included in the local agency agreements.

- Building permits
- Haul routes and traffic
- Street closures
- Work hours
- Use of city standards
- Dust, air pollution, and odor control
- Sound control
- Project appearance

13.6 Coordinating Betterments and Adjoining Third Party Work

Constructability will be affected by work the Authority agrees to undertake on behalf of other agencies and stakeholders. For instance, a city may wish to increase the size of a sewer pipeline crossing the ROW that must be rerouted to clear a bridge footing. The sewer increase in size is mandated by its sewer master plan. The cost difference between the smaller pipe and the larger one would normally be borne by the city since it is only owed a replacement by the Authority not a better facility.

Likewise, any major project is often accompanied by work done by other agencies and adjoining landowners at that stakeholder's expense. Although this can be referred to as "adjoining work", in some cases this work takes place within the HSR project limits. Both kinds of work are prone to disagreements on cost and can affect the schedule.

The construction agent (i.e., the stakeholder's design and construction representative) for this work may be the Authority through a negotiated agreement, the stakeholder, or another party. Most betterments are best incorporated into contracts for a major project for unified coordination of the schedule and budget.

A good interagency C&M agreement must be thorough and clear about the financial responsibility for all betterments. The costs should be agreed upon prior to beginning work. In a design-build contract without unit price bids this will be difficult, but it will be better to establish costs at the beginning rather than after the work is performed when it cannot be modified. Agreements should provide for additional payment to the Authority for price escalation, unforeseen conditions, and other possible occurrences that increase costs.

14 POTENTIAL EXCAVATION HAZARDS

14.1 Flammable Gasses and Hydrocarbons

The geotechnical investigations to date have not uncovered any excavation hazards related to flammable gasses and/or hydrocarbons.

14.2 Surface Soils

The project area is underlain by sedimentary soils from the surface to below the likely depth of project excavations. Soils include combinations of sands, gravel, cobbles, silts, and clays. Granular soils can “run”, pouring from excavation surfaces and creating instability. Fine sands can also be saturated with water and be difficult to compact without using methods to drain the water or chemically stabilize them with cement or lime. These conditions should be expected, and there should be provisions made in the contract documents for remedies.

14.3 Deep Excavations

With deep excavation, the contractor is likely to encounter site conditions that differ from those depicted in the contract documents. Groundwater may also differ from what is shown in soil borings. Differing site conditions often result in disputes and then change orders or claims. Deep cuts will require that soft native soils be shored and reinforced to avoid settlement of soil structures. Groundwater intrusion and settlement can be minimized by specifying means of shoring at the trench boundaries that create a water seal that keeps drawdown at a minimum in areas adjoining the trenches. These might include overlapping drilled piers, slurry walls, and watertight sheetpile walls.

In the project area, the water table can be high enough to seep into excavations, requiring collection and disposal of groundwater. Flowing groundwater can cause settlement in the ground above drawn-down soil volumes. The groundwater also may include contaminants and it may require treatment and/or costly disposal. Likely contaminants and volumes to be disposed of should be estimated and methods of disposal agreed upon before beginning construction.

Reinforcing methods such as anchors or soil nailing may require that ROW actions be taken where they will be placed under adjoining properties. When the final railroad alignment is determined (early in the 30% design phase), a survey of engineering solutions to prevent ground movement should be undertaken with a constructability review and a detailed estimation of probable costs to aid in decision-making regarding which methods to use.

Most of the areas adjacent to the project are densely populated with residential and commercial structures that could sustain damage if the ground under them subsides or moves laterally. A pre-construction condition survey should be performed to document the condition of adjacent properties.

14.4 Tunneling

There are no new tunnels to be built in this Project Section.

15 RIGHT-OF-WAY ACQUISITION

The Authority plans to acquire all needed ROW including temporary construction easements prior to the start of construction. Property acquisition for the HSR Section from San Francisco to San Jose will involve over 1,000 parcels for each of the alternatives. Under both state and federal rules and statutes, property acquisition is time-consuming and unpredictable as to method or timeliness. Properties that will have to be acquired include private properties, state and local ROW, and utility property.

HNTB gathered existing ROW information from the counties within this section from digital assessor's parcel map data, including the assessor's parcel number and the parcel size. ROW and parcel boundaries, parcel information, and the HSR footprint were displayed in a geographic information system format, and the areas of acquisition, remnant, and excess parcels were calculated.

The majority of parcels will require a partial acquisition of their total area resulting in a remnant that is not needed for the project. In some cases, a full acquisition of the parcel was determined to be necessary. This will be the case if the RC observed that either: (a) the remainder is not a viable economic unit that retains its highest and best use or (b) the impact to remaining land and improvements is too great to continue to function. In other cases, damages to an area of a parcel were determined to be necessary. An area was classified to be damaged if the RC observed that there will be no legal access, in addition to the criteria used for full acquisitions.

Property acquisition for HSR has taken place in Merced, Fresno, Kings, and Kern counties. Lessons learned from this process are expected to help establish and improve the Authority's guidelines and practices.

Failure to acquire ROW for the project will delay both the start and the progress of construction. If construction is commenced without cleared ROW, it is most likely to result in costly ROW delay claims and a project delay. Because of the large amounts of ROW that must be acquired, there is a risk that a lack of qualified ROW engineers, appraisers, title professionals, and acquisition staff will result in a project delay.

In the past, the taking of too many properties has caused a backlash of public opinion and has resulted in more restrictive and time-consuming ROW practices which will further slowdown the acquisition process.

The acquisition of property from the railroad and other governments can be lengthy. If acquisition work on those properties is not started early, it will delay the project.

ROW acquisition is likely to be on the critical path for the start of construction for segments that have numerous properties to acquire. When prioritizing construction projects, it may be wise to select those construction segments with the most difficult acquisitions.

As soon as an option is decided and approved, the Authority should begin negotiations with the cities and counties for their properties needed for the rail construction and operation. See Section 13.4 Local Jurisdictions in this report.

As soon as an option is decided and approved, the Authority should start negotiations with each identified utility that will be affected by the project. These negotiations should include the party that would be performing relocation or protection of the utility, when the relocation would be accomplished, and who would be paying for the required work. See Section 13.2 Utilities in this report.

16 CONCLUSIONS

This phase of project development for the Project Section does not lend itself to concrete technical conclusions and recommendations about constructability, project delivery, and contract packaging. Rather, this report has focused on issues of constructability that are appropriate to the current stage of plan development.

The HNTVB Team concluded that each of the two alternatives as currently presented can be built, but they present varying degrees of complexity, cost, duration, and impact on the environment and the public. Physical and other constraints on each alternative will vary the expense, duration, and impact of each alternative.

“Big ticket” concerns that should be addressed in detail before the project is procured are:

- Both Alternative A and Alternative B are buildable.
- The project site is constrained by many factors, including its crowded urban setting, narrow ROW, and presence of active train traffic where work must occur. Constraints will adversely affect the efficiency, speed, and cost of the project.
- Property acquisition will be long and complex. The Authority should carry out property acquisitions itself and not delegate this to the design-build contractors.
- Construction work should not commence before all property acquisitions are made for the route segment to be built.
- Responsibility, processes, and payment mechanisms for dealing with unforeseen environmental contamination should be established in construction contract documents.
- C&M agreements with stakeholders, including local jurisdictions, Caltrans, and utilities should be comprehensive, detailed, and executed before beginning construction.
- Reflect stakeholder agreements in the construction contract documents and bind contractors to perform in accordance with the stakeholder agreements.
- Accommodation of Caltrain and UPRR train operations will constrain construction operations and increase the construction cost and duration.
- At-grade and viaduct cross-sections are the most buildable cross-sections.
- Embankment cross-sections present the most difficult staging challenges, mostly due to constrained ROW width, earthmoving operations, and difficulties stemming from maintaining Caltrain and UPRR operations without modification.
- Extent of track shifting and the methods to perform and time required to construct those sections will greatly impact cost and schedule.

The construction schedule is based on work windows and operating assumptions established for the Caltrain PCEP.

17 REFERENCES

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APPENDIX A: SPECIAL CASE 1 – ELECTRIFICATION (OCS ADJUSTMENTS)

CALIFORNIA HIGH SPEED TRAIN PROJECT
CONSTRUCTABILITY ANALYSIS

APPENDIX A: SPECIAL CASE 1 – ELECTRIFICATION (OCS ADJUSTMENTS)

March 2019

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APPENDIX A: SPECIAL CASE 1. ELECTRIFICATION (OCS ADJUSTMENTS)

The purpose of this document is to describe the different procedures available to adapt the electrification of railway lines in use to modifications of their. The proposed methods start from the premise of not interrupting railway traffic.

In general, the catenary has a greater capacity for transverse displacements than the track itself. This is due to the existence of a series of tolerances that are listed below:

- Tolerance of the catenary supports
- Decentralization of the contact wire to avoid localized wear of the pantograph
- Pantograph tolerances

The sum of these tolerances, as a general rule, is estimated at one foot. This margin can be used to carry out transverse displacements of the track without being necessary to modify poles and gantries to re-electrify the railway line. In this case it would only be necessary to adjust the position of the contact wire.

When the displacement of the track is greater than one foot, it is necessary to move the supports inside the frames or construct new structures for the catenary adaptation. Figures provided in this document show the adaptation of the catenary system. They do not include the intermediate subphases of partial displacements of both the track and the contact wire.

The existing corridor is not electrified, but construction of the CalMod project in the near future will install electrification and control systems. Subsequently, the main tracks (currently used exclusively by Caltrain) will be adapted for High Speed services. This adaptation will mean changes in the existing track configuration, requiring relocation of both tracks and catenary system elements.

There are apparent benefits to coordinating the CalMod and High-Speed Rail projects, so that locations were fixed elements (poles and gantries) can be designed compatible for both projects would be the most economically beneficial and ensure the least amount of railway service interruption during construction. The approach means that when High-Speed Rail is implemented the gantries will be perfectly valid and only an intermediate period it will be necessary to relocate the track and the catenary supports. This case is called as process 0.

For the remaining situations the following describes potential construction processes:

<u>Process 1.</u> The first procedure is where the OCS portals are not able to house both track distributions (existing and future) so the portals must be enlarged. Depending on

portal structural resiliency and foundation characteristics, it could be enlarged or directly substituted.

The process of portal enlargement is as follows:

Phase 1: New OCS pole placement. It must be aligned with the existing one.

Phase 2: Portal beam, temporary support installation.

Phase 3: Removal of the existing OCS pole. Portal beam enlargement and connection with the new pole.

Phase 4: Commissioning of the railway line.

Phase 5: Displacement of the tracks and of the OCS supports to their final location.

Phases 2, 3 and 4 must be made in the same night-time period with traffic cut. The temporary support used in phases 2 and 3 can be replaced for a crane.

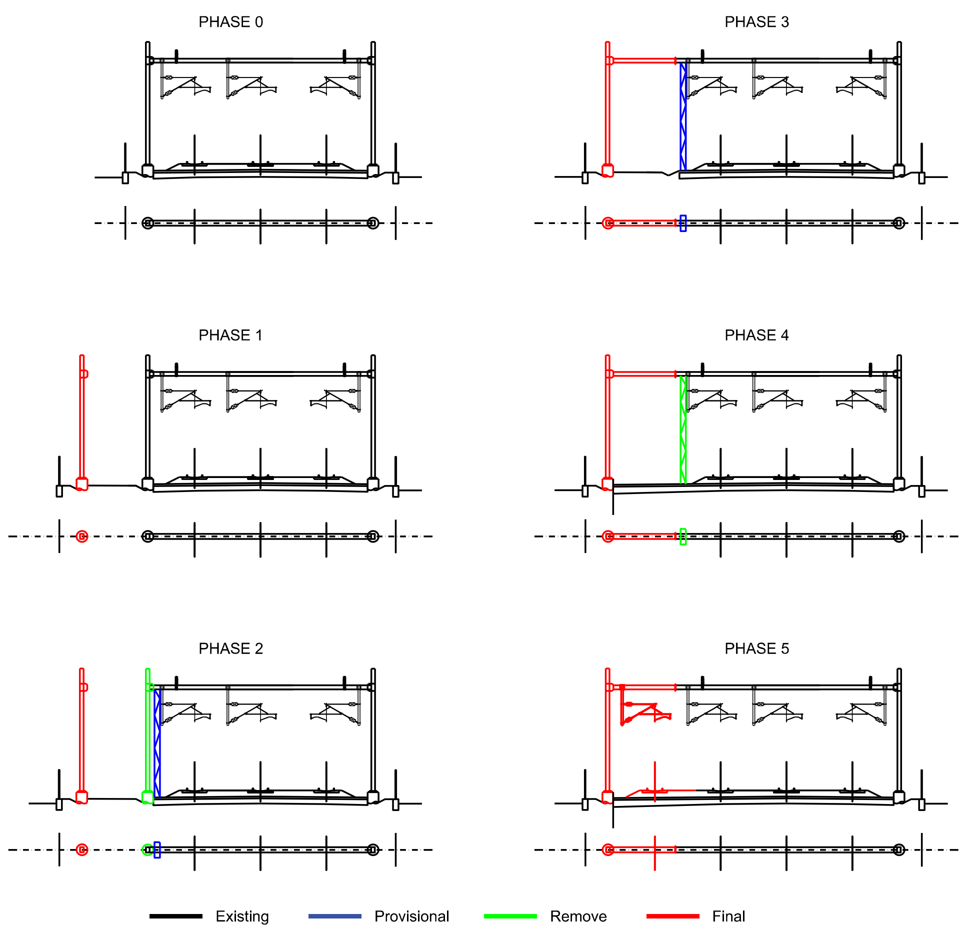

Figure A1-1. OCS portal beam extension – Portal Enlargement

Process 2. The second process consists of designing enough long OCS portals that are able to house both track distributions (existing and future). In this case, it is necessary to build a flexible gantry located between temporary poles. This example is also suitable for the replacement of the portal beam. The working stages are:

Phase 1: Install temporary poles, outside of existing.

Phase 2: Flexible gantry is laid between temporary poles.

Phase 3: OCS and flexible gantry are linked. Existing OCS supports removed.

Phase 4: Existing OCS portals removed.

Phase 5: Placement of the new tracks in its final location.

Phase 6: Placement of the new portal in its final location.

Phase 7: Temporary flexible, gantry removed.

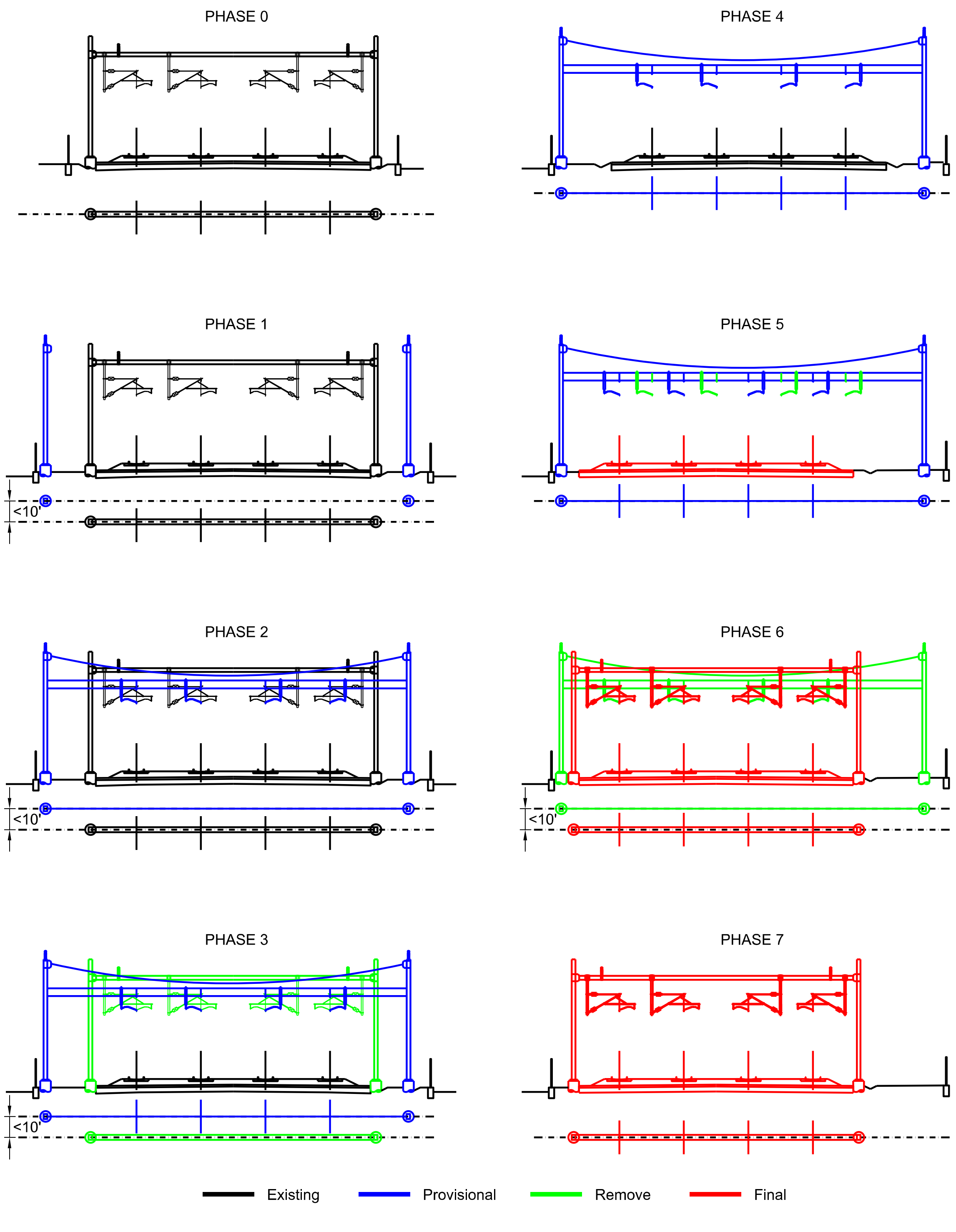

Figure A1-2. OCS portal replacement

Process 3. Displacement of an OCS pole outside of the future clearance

Phase 1: Placement of the final, parallel pole.

Phase 2: Placement of the temporary OCS support. Removal of the existing OCS pole.

Phase 3: Placement of the OCS support in its final location.

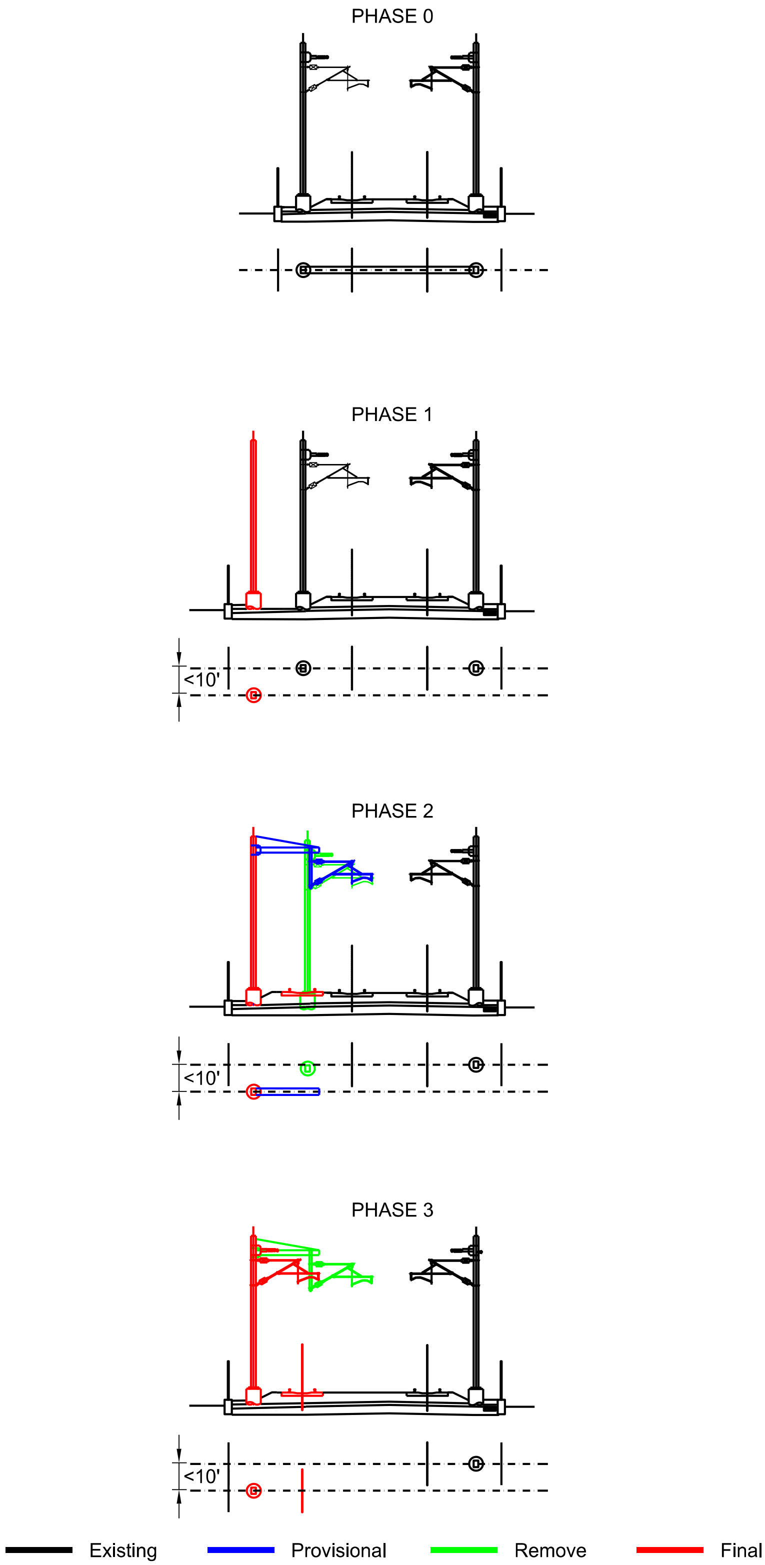

Figure A1-3. OCS pole displacement

Process 4. Displacement of poles outside the future clearance and displacement of two tracks.

Phase 1: Assembly of a new, parallel pole in a temporary placement

Phase 2: Removal of the existing OCS pole. Positioning of the support for two cantilevers and placement of the cantilever next to the pole.

Phase 3: Removal of the cantilever to displace and assembly of the second cantilever over its support.

Phase 4: Removal of the existing pole. Assembly of two, new parallel poles in their permanent location.

Phase 5: Placement of cantilevers. Removal of the temporary pole.

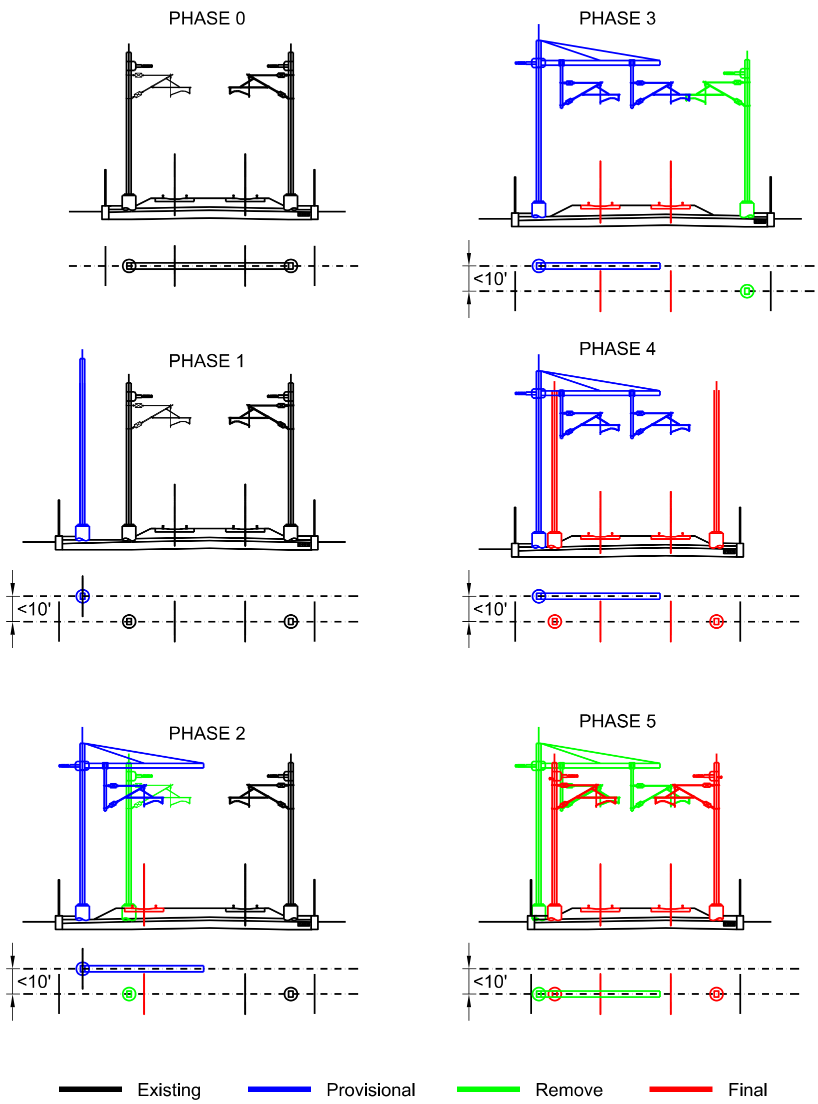

Figure A1-4. OCS poles displacement

Process 5. Extension of the existing OCS portal beam, using one of the existing poles, in case that the existing poles and foundations are able to support the new loads. Otherwise a new portal shall be built.

Phase 1: A new OCS portal is assembled parallel to existing poles.

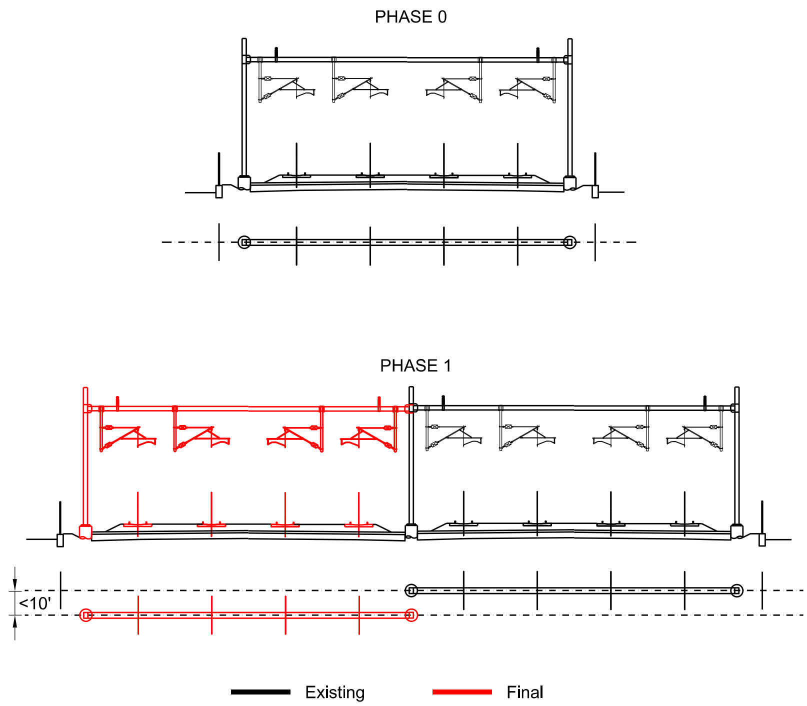

Figure A1-5. OCS portal beam extension

Process 6. Pole modification with a double cantilever. For this situation there are two possibilities, depending on if the permanent configuration is a pole with double-cantilever or the use two poles with single catenary support.

For the case of executing a pole with a cantilever for two catenary supports, the construction phases are:

Phase 1: Placement of the new pole.

Phase 2: Installation of a temporary, cantilever parallel to the existing one.

Phase 3: Placement of the catenary supports on the temporary cantilever and removal of the existing ones.

Phase 4: Removal of the existing pole and cantilever.

Phase 5: Displacement of the track and the catenary closest to the pole.

Phase 6: Displacement of the track and the catenary farthest from the pole.

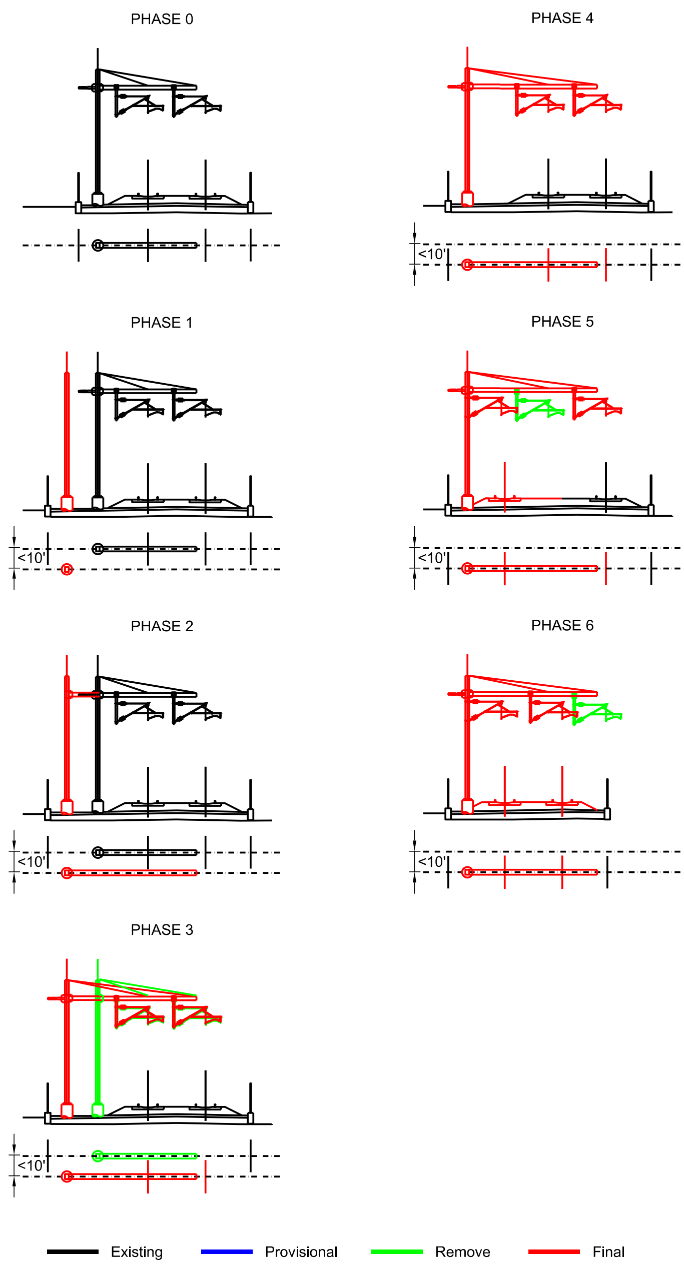

Figure A1-6. OCS modification from double cantilever to double cantilever

For the case of executing two sets of pole and catenary support, the construction phases are identical to the previous solution until phase 5. The construction phases are:

Phase 1: Placement of the new pole.

Phase 2: Installation of a temporary cantilever parallel to the existing one.

Phase 3: Placement of the catenary supports on the temporary cantilever and removal of the existing ones.

Phase 4: Removal of the existing pole and cantilever.

Phase 5: Displacement of the track and the catenary closest to the pole.

Phase 6: Displacement of the track and the catenary farthest from the pole. Assembly of the new pole in its permanent position.

Phase 7: Assembly of the catenary support on the new pole and disassembly of the support and temporary cantilever.

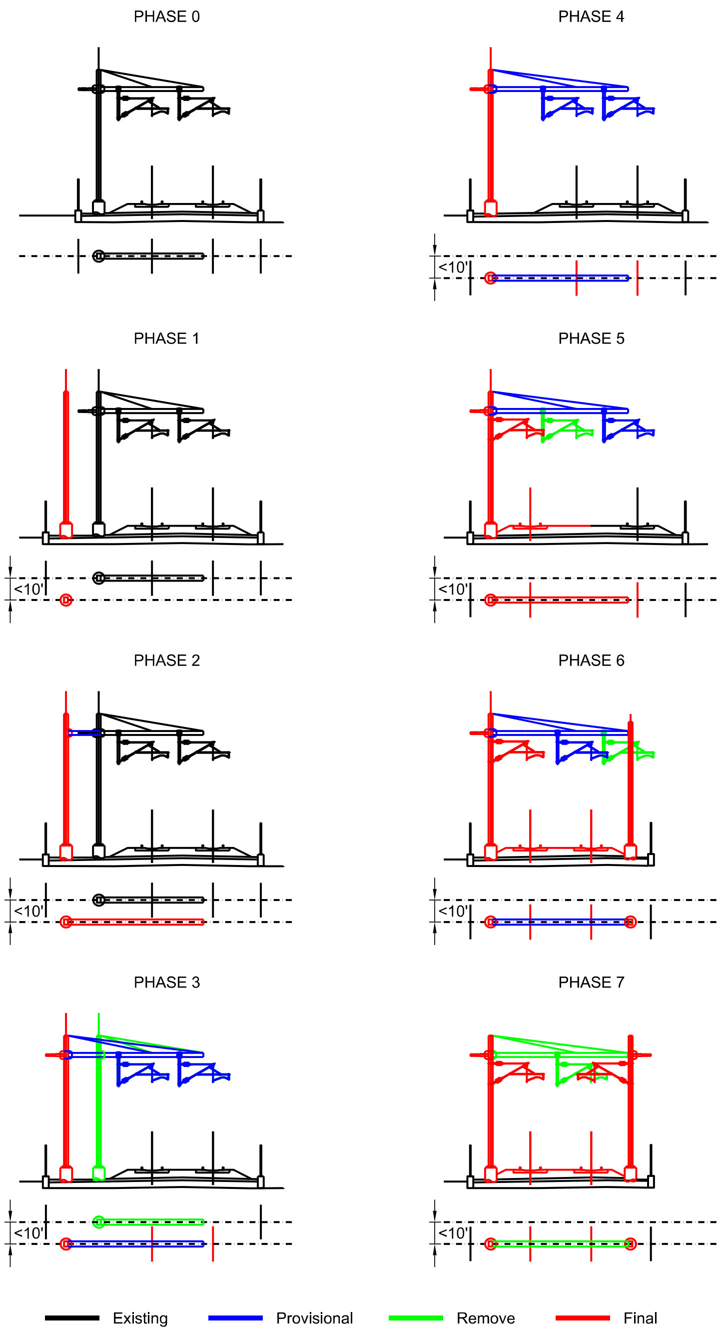

Figure A1-7. OCS modification from double cantilever to two sets of pole and catenary support

In the cases described above, temporary elements are used. The foundations of these temporary elements can be made in the same way as a permanent element (using a pile) or using a temporary foundation simply supported on the existing ground.

Figure A1-8. OCS temporary foundation

In case of reuse existing OCS elements, like foundations, poles or portals it will be necessary to check the structural capacity of reclaimed parts, considering the new working structural conditions.

In general, the proposed construction methods define new portals wich are parallel to existing poles or portals. In this case, the OCS elements will be designed to withstand the more restrictive conditions of construction phases.

APPENDIX B: SPECIAL CASE 2 – JACKED BOX UNDERCROSSING

CALIFORNIA HIGH SPEED TRAIN PROJECT
CONSTRUCTABILITY ANALYSIS

APPENDIX B: SPECIAL CASE 2 - JACKED BOX UNDERCROSSING

March 2019

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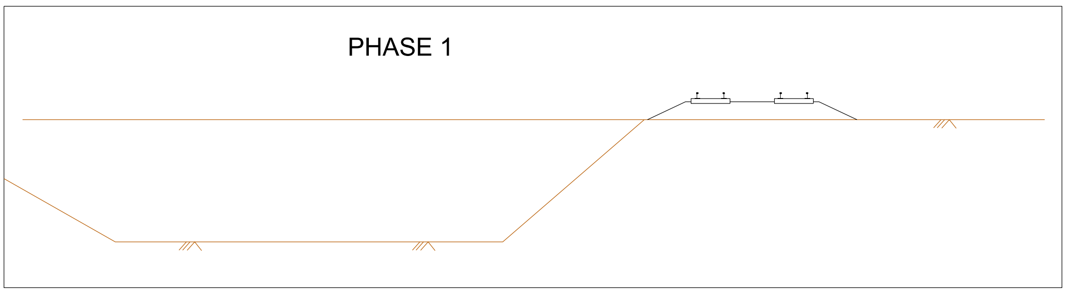
APPENDIX B: SPECIAL CASE 2. JACKED BOX UNDERCROSSING

The method of constructing an underpass by continuous jacking generally consists of the construction of the structure in an area adjacent to the installation site and then hydraulically pushing the structure into its final position at right angles to the track, with minimum disturbance to both rails and train circulations.

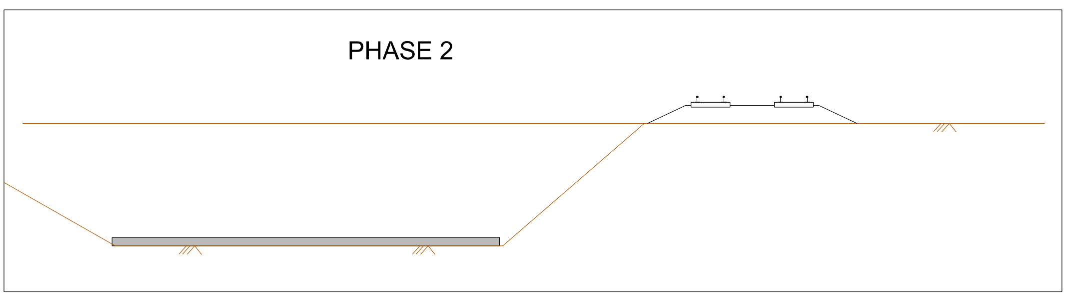
The structure is built on a concrete launch pad in the vicinity of the track and on obtaining suitable strength, is then jacked by hydraulic cylinders; which transfer the stresses to a reaction frame or the ground itself. The excavation is simultaneously carried out from within the structure or box and there is, subsequently, no risk to track stability.

The construction process is:

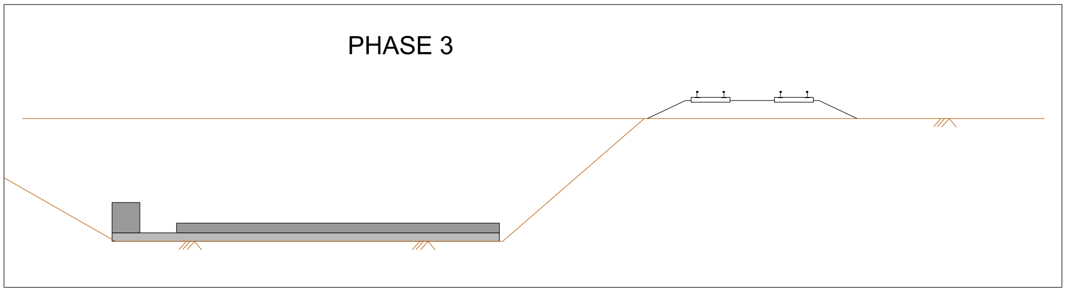
Phase 1: Ground excavation adjacent to the structure's permanent location.



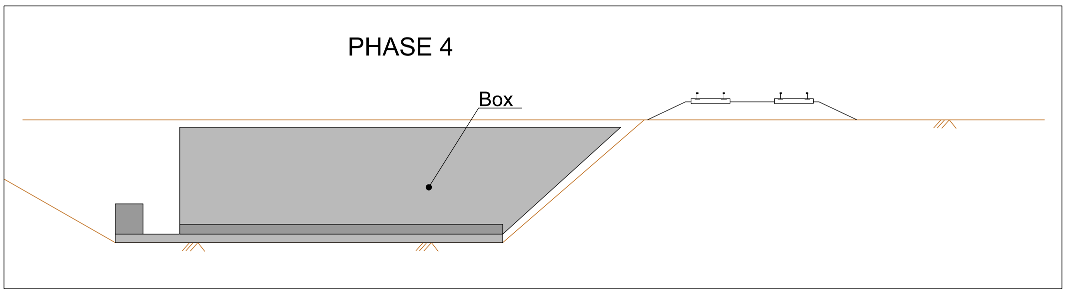
Phase 2: Concrete slab and launch pad construction. The main goal of this slab is to support box movement. This slab must be smooth and covered with a polyethylene sheet to ease the movement of the structure (Figure 1, 2 and 3).



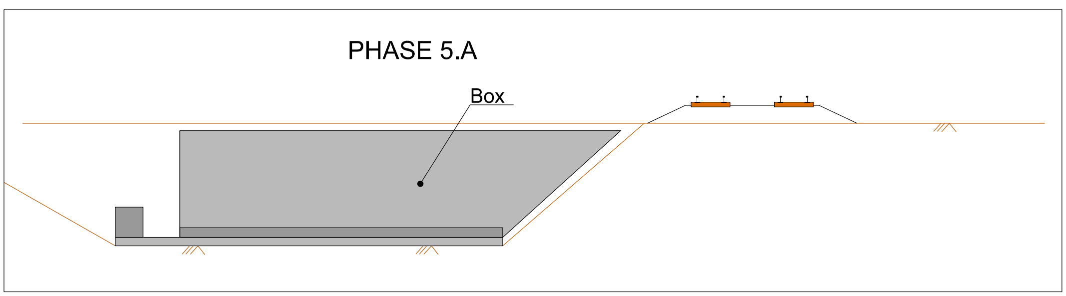
Phase 3: Construction of guiding walls. These are needed to assist with box alignment while jacking (Figure 4 and 5).

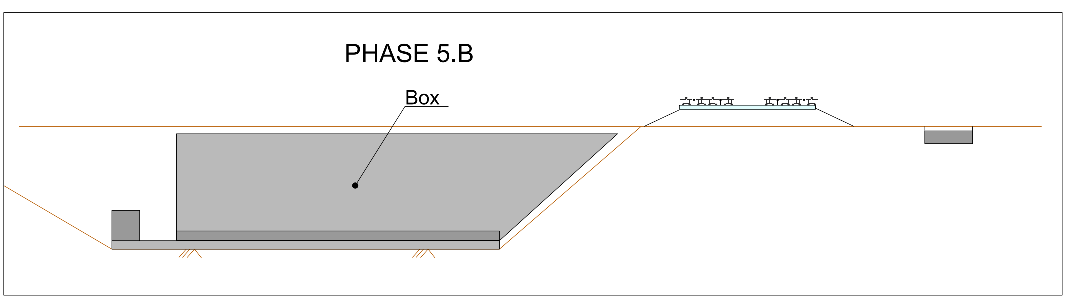


Phase 4: Reinforced concrete box construction. Box should be shaped as shown in the following figure to the jacking process (Figure 6, 7 and 8).

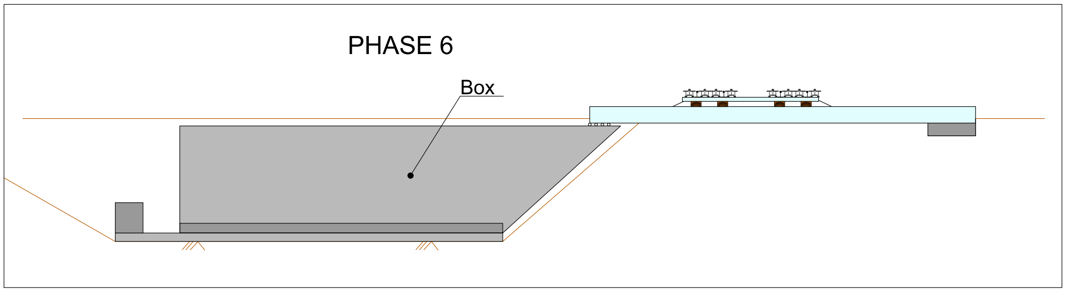


Phase 5: The subgrade will suffer limited deformations during the box movement, so it is necessary to change concrete ties to wooden ties, to provide flexibility. Additionally, a reinforcement of the track, parallel to the box movement, will designed by a special fastening system to unify rails with adjacent steel profiles to add inertia. (Figure 9, 10 and 11). Construction of a provisional foundation parallel to tracks.





Phase 6: Steel beams should be placed parallel to the track ties and placed every 6 feet. These beams are supported by the box, the provisional foundation and the existing ground. Support over the box is made by a roll in order to maintain the beam placement during works. Traffic is maintained in this stage but speed is limited (Figure 12, 13, 14 and 15).



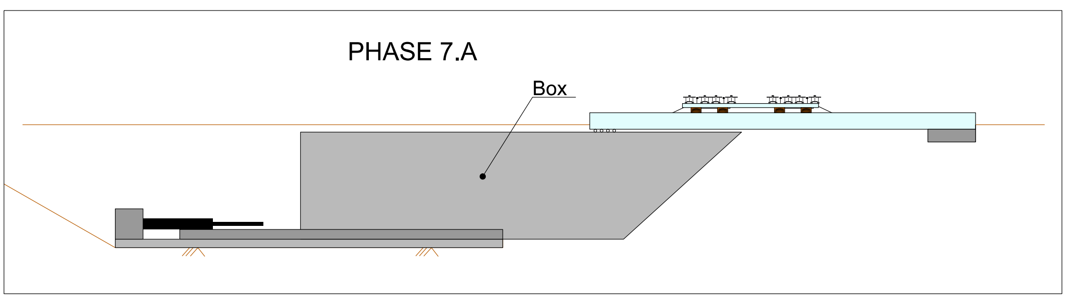
Phase 7: Box jacking by a hydraulic jacks series. This stage is subdivided into:

a. Excavation under the existing tracks during nighttime closures, for tie and beam placement.

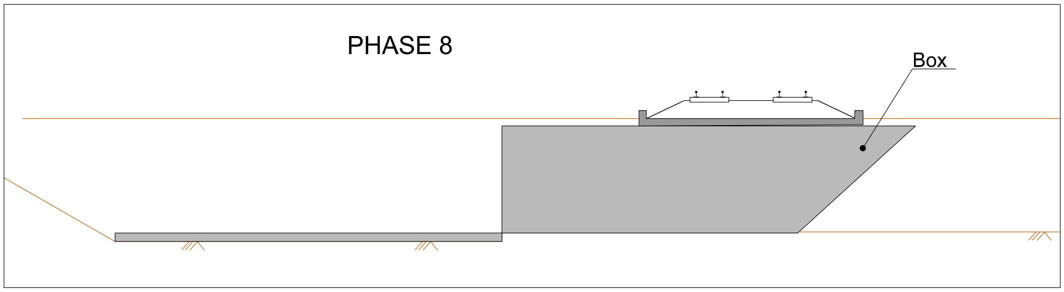
b. In-box excavation. Rate of excavation is directly related with daily rate of box jacking (Figure 16 and 17).

c. Jacking. Hydraulic jacks transfer homogeneous pressure to the box; which slips along the concrete slab and hammers itself in the soil (Figure 18, 19, 20, 21 and 22).

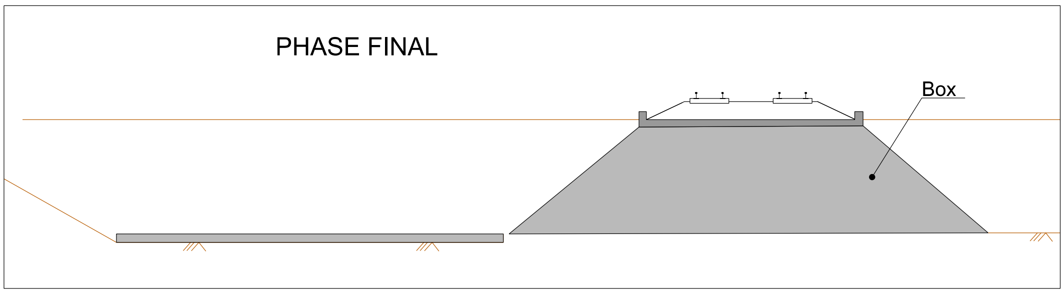
d. Left space concreting to support jacks when box has moved enough.



Phase 8: Material spreading between railway superstructure and box.



Phase final: Reshape the box to its final shape and landscape (Figure 23, 24 and 25).



Following pictures show several generic stages during works and the final result.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

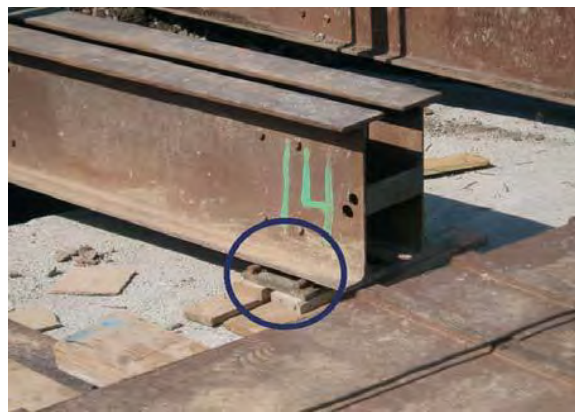


Figure 12

Figure 13

Figure 14

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

Figure 20

Figure 21

Figure 22

Figure 23

Figure 24

Figure 25

APPENDIX C: SPECIAL CASE 3 – MICROPILES WALL UNDERCROSSING

CALIFORNIA HIGH SPEED TRAIN PROJECT
CONSTRUCTABILITY ANALYSIS

APPENDIX C: SPECIAL CASE 3 - MICROPILES WALL UNDERCROSSING

March 2019

prointec

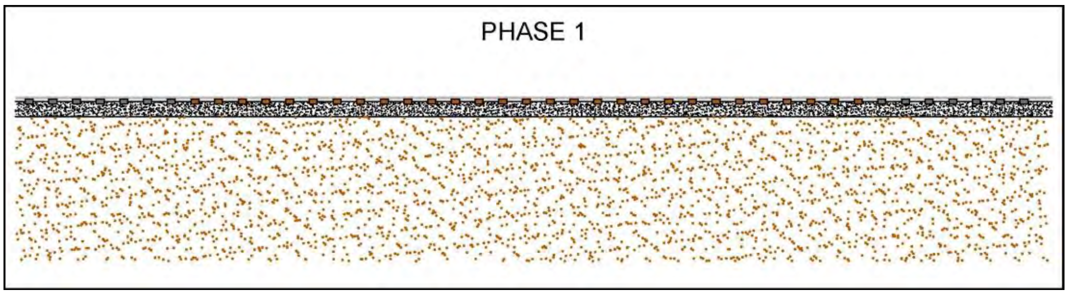
APPENDIX C: SPECIAL CASE 3. MICROPILES WALL UNDERCROSSING

An alternative method to build an underpass without affecting the railway traffic is based on the execution of two groups of two parallel micropiles walls from the track. The object of these walls is to achieve two safe working places without needing a railway traffic cut for the execution of the lateral walls of the underpass. When the lateral walls are built, it is possible the positioning of the precast top slab during an extraordinary traffic-cut that may take time during a weekend time.

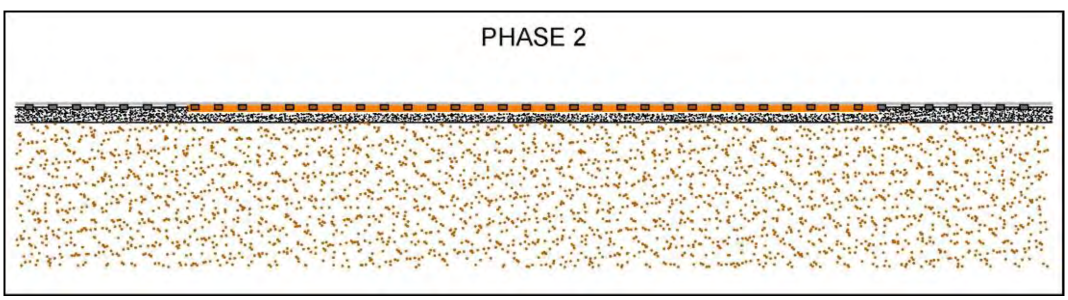
Working processes are:

Phase 0: Current situation

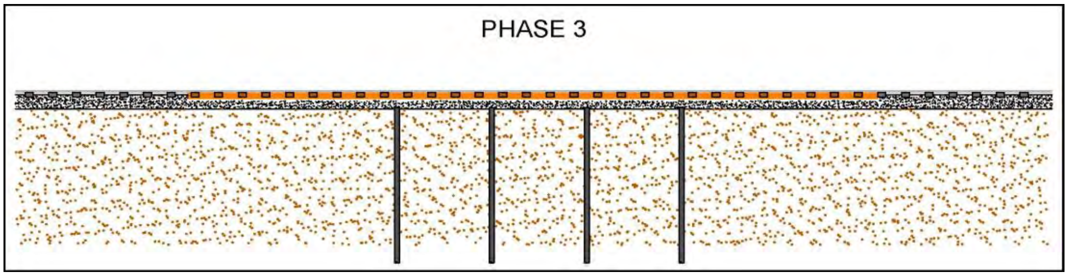
Phase 1. Replacement of the concrete sleepers for wooden sleepers. This activity will be carried out in a night traffic interruption period and when the railway traffic is restored a speed limit of 20 mph will be established.



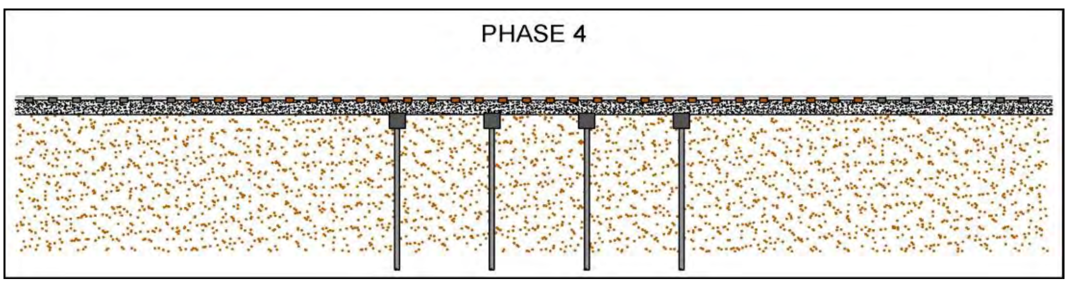
Phase 2: Track planking. In this phase, a track planking is placed in the space between rails. The aim is build a workable building surface for the micropile-driving equipment without disturbing the railway traffic and without affecting the existing rail track components. This activity will be carried out in a night traffic interruption period and when the railway traffic is restored a speed limit of 20 mph will be established.



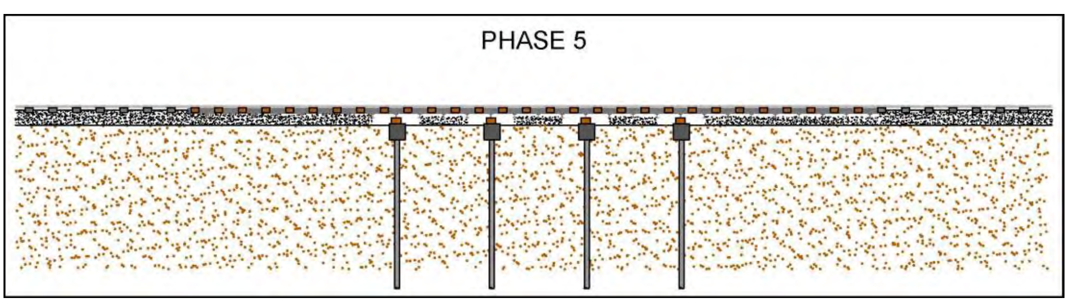
Phase 3: Construction of two groups of two micropiles retaining walls. Micropiles will be installed from the construction plank, through the ballast bed. Micropiles outside of safety area can be made when railway traffic is active. Micropiles inside of the safety area must be installed during a traffic interruption period and when the rail traffic is restored, a speed limit of 20-mph will remain in place.



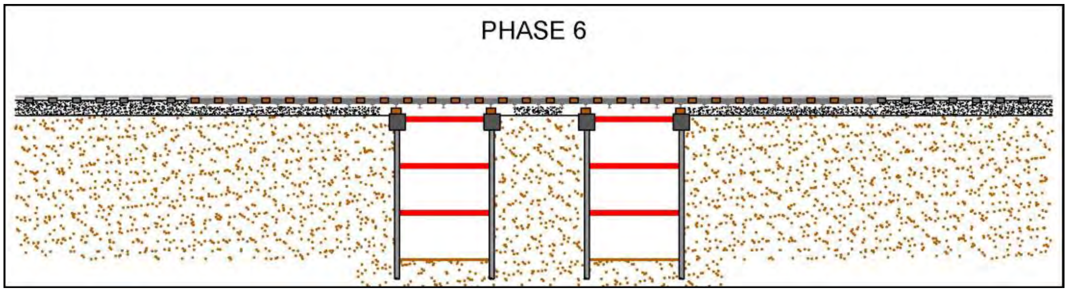
Phase 4: Building of cap beams between the micropiles. In this phase, it is necessary to remove some of the ballast for building the cap beams. This activity will be carried out during a night traffic interruption period and when the railway traffic is restored a speed limit of 20-mph will remain in place.



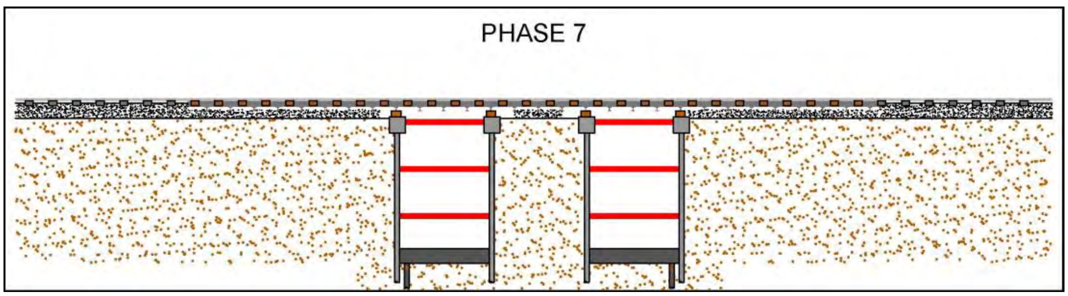
Phase 5: Reinforcing of the existing tracks. After the completion of the cap beams between the micropiles, the rails are reinforced by the grouping of rails. These groups of rails are supported over the cap beams. This reinforcement allows small segments of track to remain active without ballast (at maximum 6' section) but with restrictions in traffic speed. This activity will be carried out during a night traffic interruption period and when the railway traffic is restored a speed limit of 20 mph will remain in place.



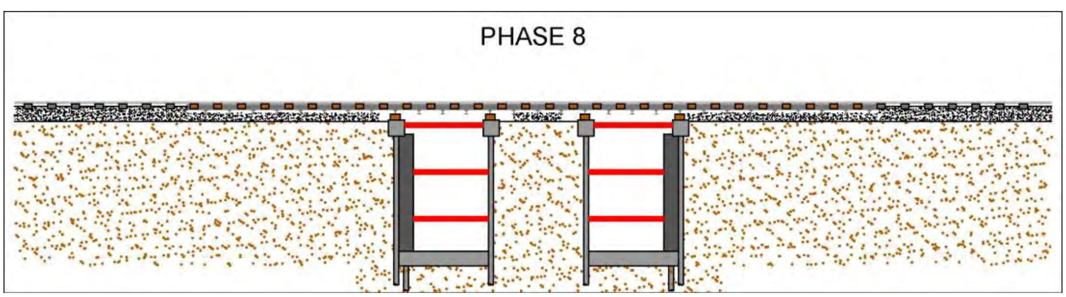
Phase 6: Excavation between retaining walls and positioning of provisional struts between retaining walls. This activity is compatible with railway traffic if safety measures are implemented. The 20-mph speed limit will remain in place.



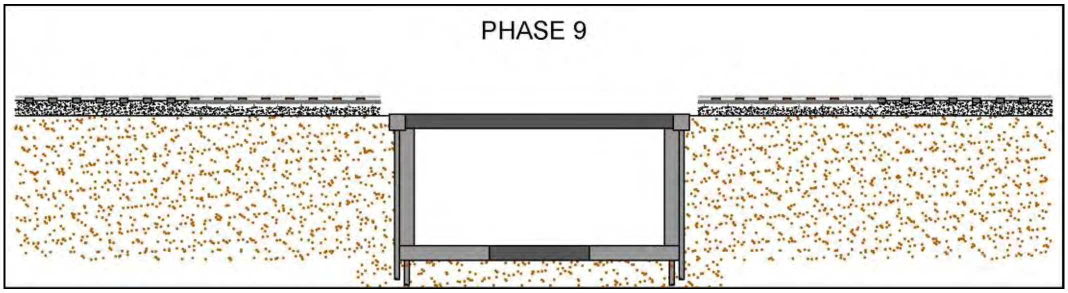
Phase 7: Partial construction of the underpass foundation slab. This activity is compatible with railway traffic if safety measures are implemented. The 20-mph speed limit will remain in place.



Phase 8: Erection of the underpass lateral walls. This activity is compatible with railway traffic if safety measures are implemented. The 20-mph speed limit will remain in place.



Phase 9: Track removal in the working area. Excavation of the soil between the lateral walls of the underpass. Completion of the foundation slab and positioning of the precast top slab of the underpass. This activity is incompatible with railway traffic, so it is necessary to make an extraordinary traffic-cut, anticipated to be a weekend closure.



Phase 10: Return tracks to their original state. This work must be made in a traffic interruption period. When this phase is finished, speed limits will be canceled.