

## APPENDIX 2-A: HIGH-SPEED RAIL SYSTEM INFRASTRUCTURE

This appendix provides general information about the performance criteria, infrastructure components and systems, and function of the proposed California High-Speed Rail (HSR) System as a whole, including information specific to the Merced to Fresno Section: Central Valley Wye (Central Valley Wye). It incorporates, as necessary, information that has been updated since the *2012 Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS).

The HSR system would be a state-of-the-art, electrically powered, high-speed, steel-wheel-on-steel-rail technology that would employ the latest technology, safety, signaling, and automatic train control systems. The trains would be capable of operating at speeds of up to 220 miles per hour (mph) over fully grade-separated, dedicated tracks.

The infrastructure and systems of the HSR system consist of trains (rolling stock), tracks, stations, train control, power systems, and maintenance facilities. The Central Valley Wye alternatives do not include stations and maintenance facilities; therefore, this appendix discusses these facilities as background information only.

The design of each HSR alternative includes a double-track rail system to accommodate planned operational needs for high-capacity rail movement. Additionally, the HSR safety criteria recommend avoiding at-grade intersections on dedicated HSR alignments, so the system must be grade-separated from any other transportation system. This means that planning the HSR system would also require grade-separated overcrossings or undercrossings for roadways or roadway closures and modifications to existing systems that do not span planned rights-of-way. In some situations, it would be more efficient for the HSR system to be elevated over existing facilities.

### SYSTEM DESIGN PERFORMANCE, SAFETY, AND SECURITY

The California High-Speed Rail Authority (Authority) designed the proposed California HSR System for optimal performance and to conform to industry standards and federal and state safety regulations (Table 1). The HSR system would be a fully grade-separated and access-controlled guideway with intrusion detection and monitoring systems where required. This means that the Authority would design the HSR infrastructure (e.g., mainline tracks and maintenance and storage facilities) to prevent access by unauthorized vehicles, persons, animals, and objects. The capital cost estimates in the *Merced to Fresno Project Section: Central Valley Wye Supplemental EIR/EIS Capital Cost Estimate Report* (Authority 2016) include allowances for appropriate barriers (fences and walls), state-of-the-art communication, access control, and monitoring and detection systems. Not only would the Authority design the guideway to keep persons, animals, and obstructions off the tracks, but the ends of the HSR trainsets (train cars) would include a collision response management system to minimize the effects of a collision. All aspects of the HSR system would conform to the latest federal requirements for transportation security. The HSR trainsets would be pressure-sealed to maintain passenger comfort regardless of aerodynamic change, much like an airplane body does. Volume 1 of the Draft Supplemental EIR/EIS, Section 3.11, Safety and Security, provides additional information about system safety and security.

**Table 1 HSR Performance Criteria**

Category	Criteria
System design criteria	<p>Electric propulsion system</p> <p>Fully grade-separated guideway</p> <p>Fully access-controlled guideway with intrusion monitoring systems where required</p> <p>Track geometry to maintain passenger comfort criteria (smoothness of ride, lateral or vertical acceleration less than 0.1 g [i.e., acceleration due to gravity])</p>
System capabilities	<p>Capable of traveling from San Francisco to Los Angeles in approximately 2 hours and 40 minutes</p> <p>All-weather/all-season operation</p> <p>Capable of sustained vertical gradient of 2.5% without considerable degradation in performance</p> <p>Capable of operating parcel and special freight service as a secondary use</p> <p>Capable of safe, comfortable, and efficient operation at speeds over 200 mph</p> <p>Capable of maintaining operations at 3-minute headways</p> <p>Equipped with high-capacity and redundant communications systems capable of supporting fully automatic train control</p>
System capacity	<p>Fully dual-track mainline with off-line station stopping tracks</p> <p>Capable of accommodating a wide range of passenger demand (up to 20,000 passengers per hour per direction)</p> <p>Capable of accommodating normal maintenance activities without disruption to daily operations</p>
Level-of-service	<p>Capable of accommodating a wide range of service types (express, semi-express/limited stop, and local)</p>

HSR operation would follow safety and security plans developed by the Authority in cooperation with the Federal Railroad Administration (FRA), including the following:

- A System Safety Program Plan, including a Safety and Security Certification Program, which the Authority would develop during the preliminary engineering phase and refine during final design and construction phases to address safety, security, and emergency response as they relate to the day-to-day operation of the HSR system
- A Threat and Vulnerability Assessment for security and a Preliminary Hazard Analysis and Vehicle Hazard Analysis for safety, which the Authority would develop during the preliminary engineering phase to produce comprehensive design criteria for safety and security requirements mandated by local, state, and federal regulations and industry best practices
- A Fire Life Safety Program and a System Security Plan, which the Authority would develop during the preliminary engineering phase. Under federal and state guidelines and criteria, the Fire Life Safety Program would address the safety of passengers and employees in relation to emergency response. The System Security Plan would address design features of the project intended to maintain security at the stations, within the right-of-way, and onboard trains. Compliance with these measures would maximize the safety and security of passengers and employees of the HSR project so that adverse safety and security impacts would be less than significant.

Design criteria would address FRA safety standards and requirements and a possible Petition for Rule of Particular Applicability that addresses specifications for key design elements for the system. The FRA is currently developing safety requirements for HSRs for use in the United States. The FRA would require that the HSR meet safety regulations prior to revenue service

operations. The following sections describe those system components pertinent to the Central Valley Wye alternatives.

## VEHICLES

Although the Authority has not yet selected the exact vehicle type, the environmental analyses considered the impacts associated with any of the HSR vehicles produced in the world that meet the Authority’s criteria. All of the HSR systems in operation worldwide today use electric propulsion with power supplied by an overhead system. These HSR systems include, among many others, the Train à Grande Vitesse in France, the Shinkansen in Japan and Taiwan, and the InterCity Express in Germany. Figure 1 shows examples of typical HSRs.



Source: Authority and FRA, 2012

**Figure 1 Examples of Japanese Shinkansen High-Speed Trains**

The Authority is considering an electric multiple unit concept that would equip several train cars (including both end cars) with traction motors compared to a locomotive-hauled train (i.e., one engine in the front and one in the rear). Each train car would have an active suspension and each powered car would have an independent regenerative braking system (which returns power to the power system). The body would be made of lightweight but strong materials and would have an aerodynamic shape to minimize air resistance, much like an airplane body.

A typical train would be 9 to 11 feet wide, consisting of two trainsets. Each trainset would be approximately 660 feet long and consist of six to eight cars. A train of two trainsets would seat up to 1,000 passengers and be approximately 1,320 feet long with 12 or 16 cars. The overhead contact system (OCS) (a series of wires strung above the tracks) would distribute power to each train car via a pair of pantographs that reach like antennae above the train (Figure 2). Each trainset would have a train control system that could be monitored independently with override control and systemwide Operations Control Center communication. Phase 1 HSR service is expected to need 72 trainsets.



Source: Authority and FRA, 2012

**Figure 2 Example of an At-Grade Profile Showing Contact Wire System and Vertical Arms of the Pantograph Power Pickups**

## INFRASTRUCTURE COMPONENTS

The dedicated, fully grade-separated infrastructure needed to operate HSRs has more stringent alignment requirements than those needed for lower-speed trains. The Central Valley Wye alternatives would use five different track types. These track types have varying profiles: low, near-the-ground tracks are at-grade; higher tracks are elevated or on retained fill (earth); and below-grade tracks are in a retained cut or cut-and-cover tunnel. Possible types of bridges include full channel spans, large box culverts, or, for some wider river crossings, limited piers within the ordinary high-water channel. The following sections describe the various track profiles.

The Central Valley Wye alternatives project footprint, which includes HSR and roadway right-of-way,<sup>1</sup> temporary construction easements, permanent access and utility easements, is determined based on design criteria, as well as other factors including existing local conditions, track profile type, operating speed, HSR facilities, and construction methods. Table 2 shows the design criteria used to define the minimum horizontal buffer for the right-of-way and various types of easements of the project footprint of the Central Valley Wye alternatives.

**Table 2 Design Criteria for Project Footprint of the Central Valley Wye Alternatives**

Feature Type	Design Approach/Criteria	Deviations from the Criteria
Right-of-Way Track on Embankment	The design uses 25 feet typical distance from the toe of fill to the edge of right-of-way. The criteria recommend 15-foot desirable and 10-foot minimum.	The 10-foot minimum is maintained when the track is on embankment.
Right-of-Way Track in Cut	The design uses 30 feet typical distance from the top of cut to the edge of right-of-way. The criteria recommend 15-foot desirable and 10-foot minimum, unless the cut slope is greater than 30 feet, then the right-of-way is 20 feet from the top of cut.	The 20-foot minimum right-of-way is maintained when the track is in cut.
Right-of-Way Track on Structure	The design uses 25 feet typical distance from the outside edge of the structure to the edge of right-of-way. The criteria recommend 15-foot desirable and 10-foot minimum.	The 10-foot minimum right-of-way is maintained when the track is on structure.
Right-of-Way Track in Trench	The design uses 25 feet typical distance from the outside wall of a trench to the edge of right-of-way. The criteria recommend 15-foot desirable and 10-foot minimum.	No deviations from the criteria, a 15-foot minimum right-of-way is maintained when the track is in trench.
Right-of-Way Roadway	The design uses 25 feet typical distance from catch point <sup>1</sup> to the edge of permanent right-of-way. Caltrans recommends 25-foot right-of-way.	No deviations from the criteria
Temporary Construction Easement	The design uses 25 feet typical distance from the edge of right-of-way for the temporary construction easement.	A 25-foot temporary construction easement is maintained, except in locations adjacent to freight rail right-of-way or where proposed permanent easements or roadway right-of-way are adjacent to the HSR. At these locations, additional temporary easements would not be needed.

<sup>1</sup> The corridor along a roadway or railway that a transit or transportation agency/authority controls.

Feature Type	Design Approach/Criteria	Deviations from the Criteria
Access Easements	The design uses 40-foot width typical distance for permanent access easements. The design does not recommend a specific width.	A 40-foot permanent access easement is applied for property access along HSR or roadway right-of-way. HSR facilities also have access easements (greater than 40 feet) that are based on the designed access roads.
Utility Easement	The design uses 100-foot-width typical distance for permanent utility easements. The design does not recommend a specific width.	100-foot permanent utility easements are utilized where potential utility mitigation has been identified. In most cases these easements are not adjacent to the right-of-way, but cross and extend beyond it. Utility easements that house relocated irrigation canals are less than 100-feet wide and are defined per canal.

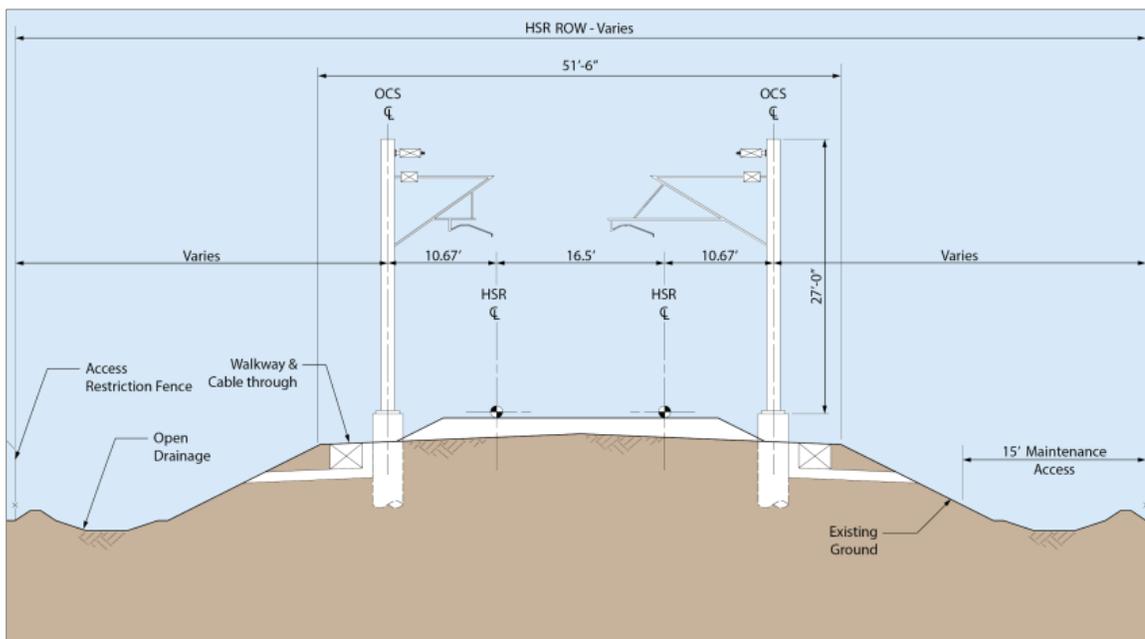
Caltrans = California Department of Transportation

HSR = high-speed rail

<sup>1</sup> A catch point is defined as the outer edge of the track grading.

### At-Grade Profile

At-grade track profiles (Figure 3) are best suited in areas where the ground is relatively flat, as in the Central Valley, and in rural areas where interference with local roadways is infrequent. The at-grade track would rest on compacted soil and ballast material (a thick bed of angular rock of selected grade) to accommodate subsidence or changes in the track surface from soil movement. To avoid potential disruption of service from floodwater, the Authority would construct the rail above the 100-year floodplain in rural areas or small communities or above the 200-year floodplain in urban or urbanizing areas. The height of the at-grade profile may vary to accommodate slight changes in topography, provide clearance for stormwater culverts and structures in order to allow water flow, and in some cases for wildlife movement.

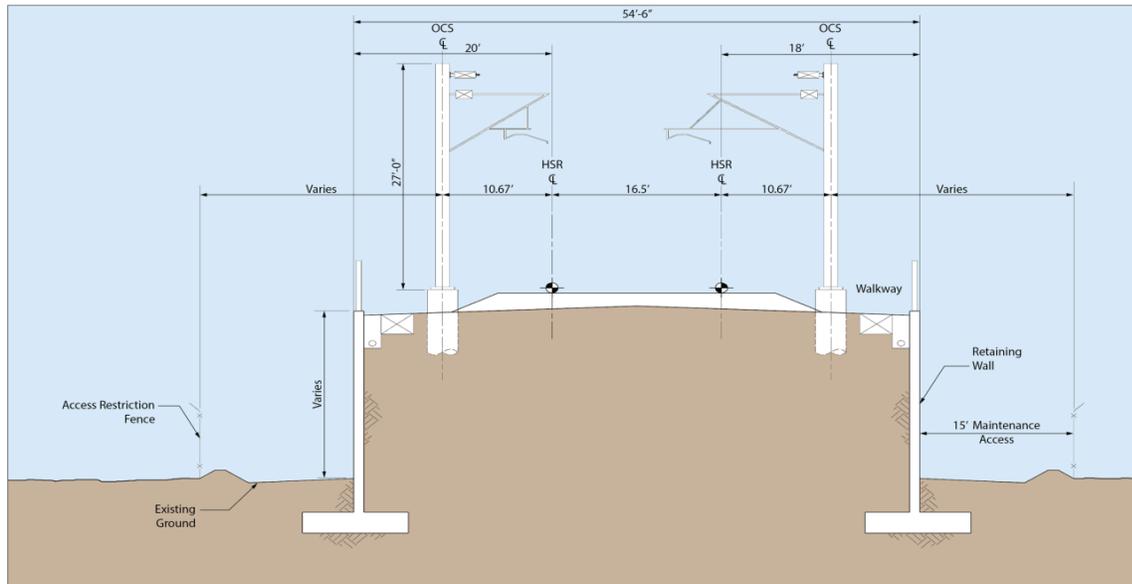


Source: Authority and FRA, 2018

Figure 3 At-Grade Typical Cross-Section

## Retained-Fill Profile

Retained-fill profiles (Figure 4) are used when it is necessary to narrow the right-of-way within a constrained corridor to minimize property acquisition or to transition between an at-grade and elevated profile. The guideway would be raised off the existing ground on a retained fill platform made of reinforced concrete walls, much like a freeway ramp. The maximum height of the retained fill would be approximately 30 feet. Short retaining walls would have a similar effect and would protect the adjacent properties from an embankment slope extending onto adjacent property.

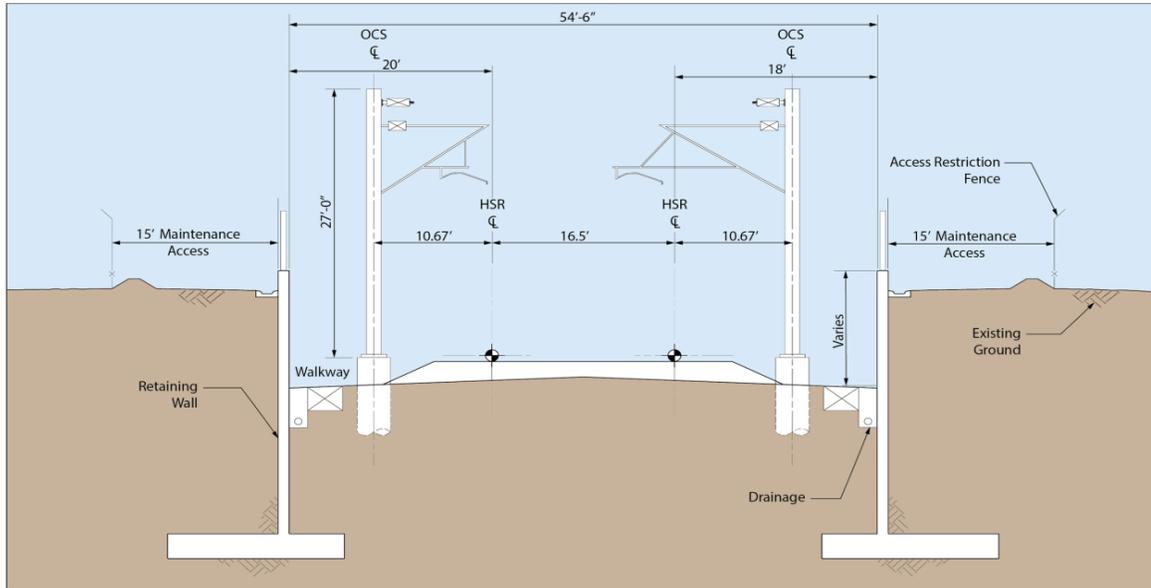


Source: Authority and FRA, 2018

**Figure 4 Retained-Fill Typical Cross-Section**

## Retained-Cut Profile

Retained-cut profiles (Figure 5) are used when the HSR alignment transitions from at-grade to underground or crosses under existing rail tracks, roads, or highways that are at-grade. The Authority would use this profile type only for short distances in highly urbanized and constrained situations. In some cases, it is less disruptive to the existing traffic network to depress the rail profile under these crossing roadways. Retaining walls would typically be needed to protect the adjacent properties from a cut slope extending beyond the rail guideway. Retained-cut profiles are also used for roads or highways when it is more desirable to depress the roadway underneath an at-grade HSR alignment.

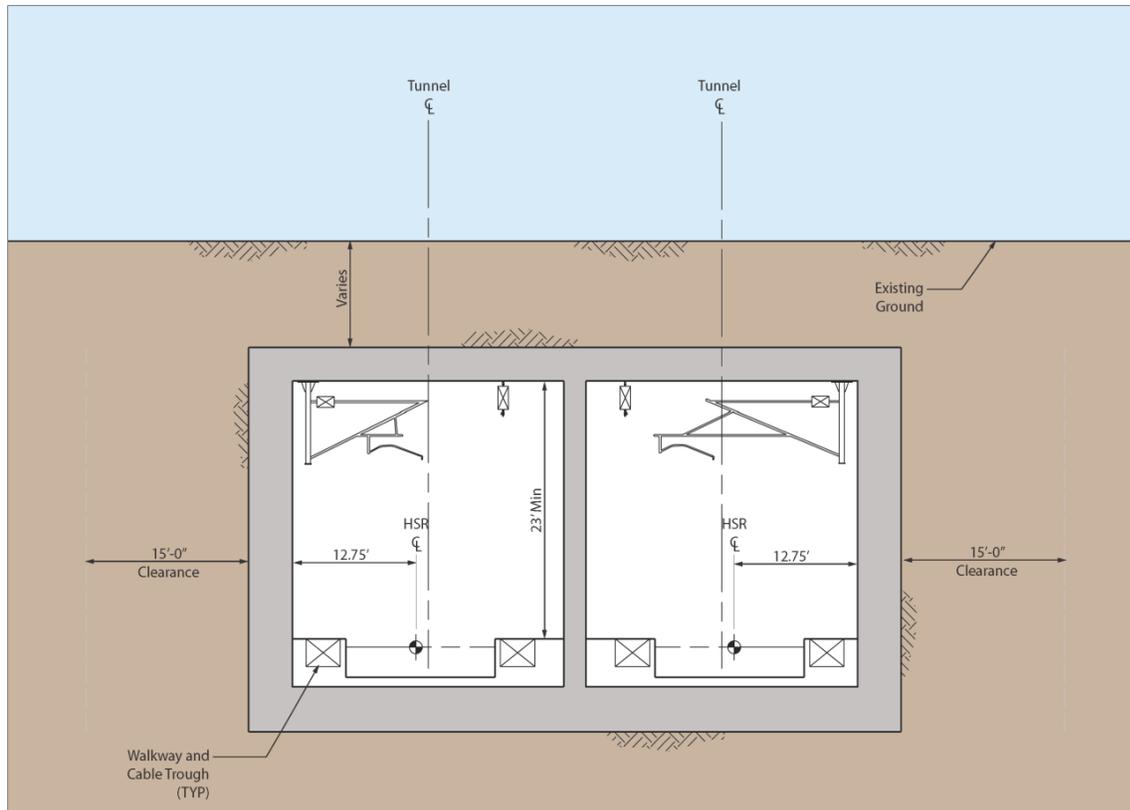


Source: Authority and FRA, 2018

**Figure 5 Retained-Cut Typical Cross-Section**

### Cut-and-Cover Tunnel Profile

A cut-and-cover profile (Figure 6) places the HSR track in a covered trench, more commonly known as a cut-and-cover tunnel. As shown on Figure 6, cut-and-cover is used when the continuous width of surface activity is sufficiently large to require continuous support by a tunnel roof slab. This profile can be necessary where the track crosses under a street, passes at an oblique angle under a wide highway or freeway, or where future conditions enclose the trench for overlying development or park uses. The Authority would evaluate use of cut-and-cover profiles on a case-by-case basis in the more detailed design stage as the environmental process progresses.



Source: Authority and FRA, 2018

**Figure 6 Cut-and-Cover Typical Cross-Section**

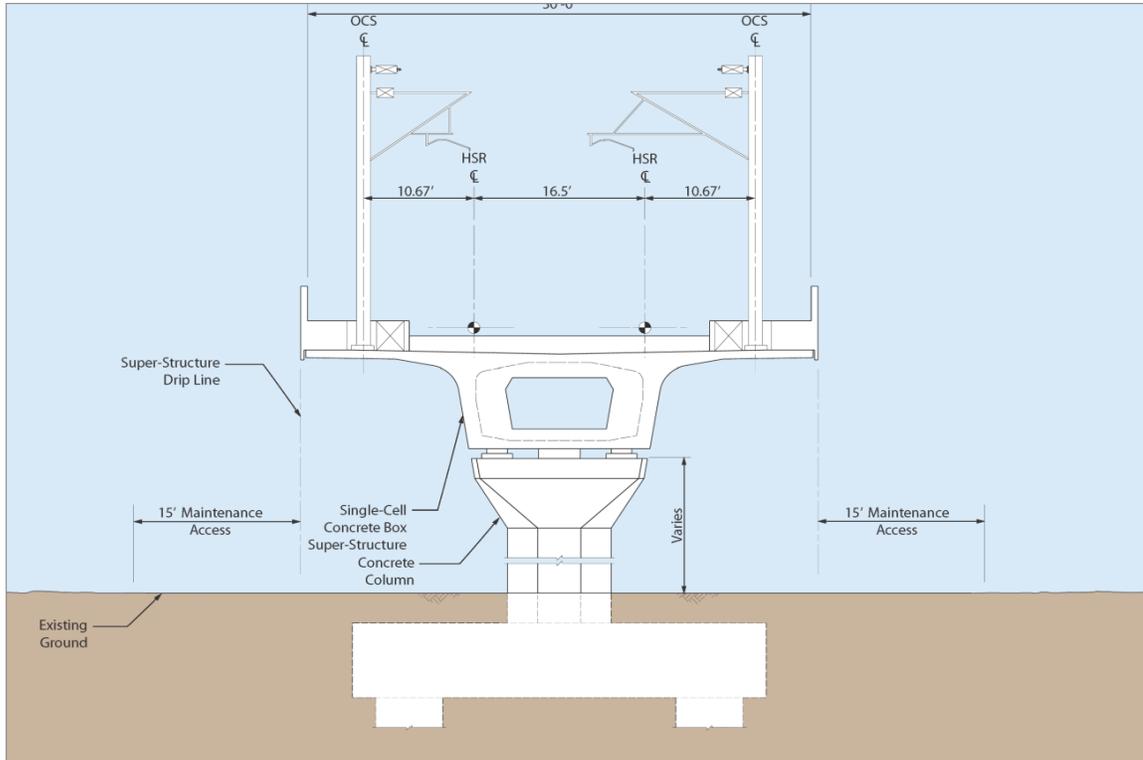
## Elevated Profile

Elevated profiles (Figure 7) are appropriate in urban areas where extensive road networks must be maintained. An elevated profile must have a minimum clearance of approximately 16.5 feet over roadways and approximately 24 feet over freight railroads. Pier supports are typically approximately 10 feet in diameter at the ground. Such structures could also be used to cross water bodies.

## Straddle Bents

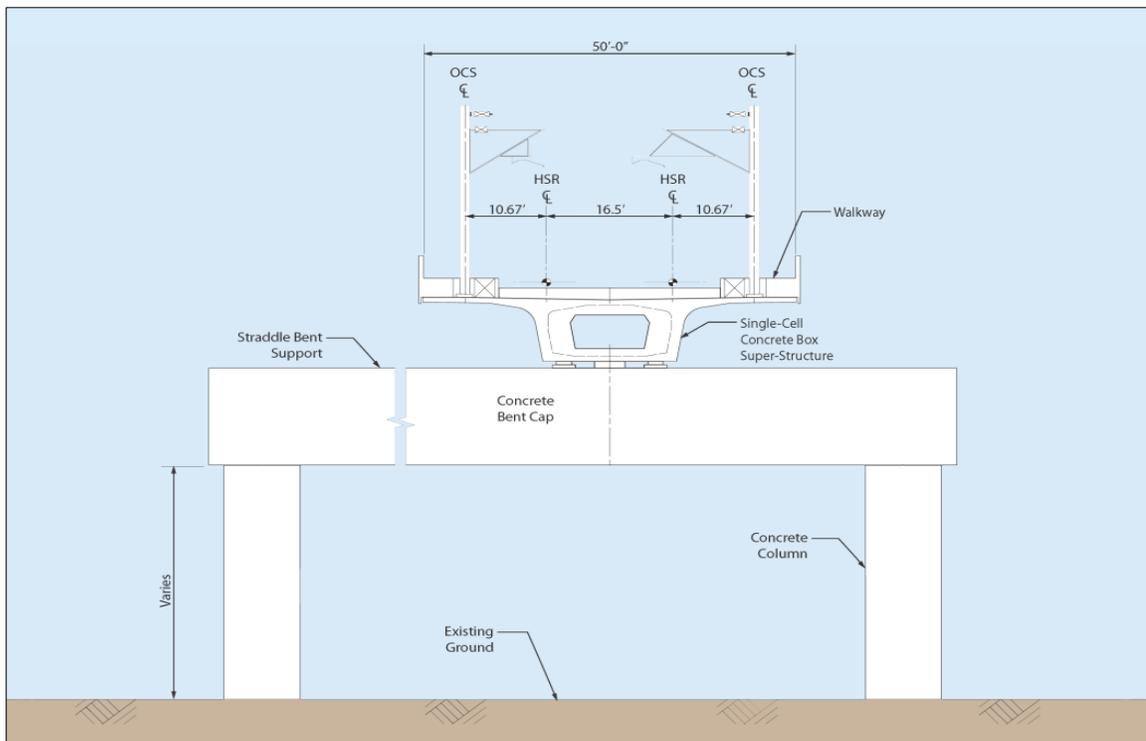
When the HSR elevated profile crosses over a roadway or railway on a very sharp skew angle (degree of difference from the perpendicular), a straddle bent confirms that the piers are outside of the functional/operational limit of the roadway or railway.

As Figure 8 shows, a straddle bent is a pier structure that spans (or “straddles”) the functional/operational limit of a roadway, highway, or railway. Typical roadway and highway crossings that have a smaller skew angle (i.e., the crossing is nearly perpendicular) generally use intermediate piers in medians and span the functional right-of-way. However, for larger-skew-angle crossing conditions, median piers would result in excessively long spans that are not feasible. Straddle bents that clear the functional right-of-way can be spaced as needed (typically 110 feet apart) to provide feasible span lengths for bridge crossings at a larger skew angle.



Source: Authority and FRA, 2018

Figure 7 Elevated Structure Typical Cross-Section

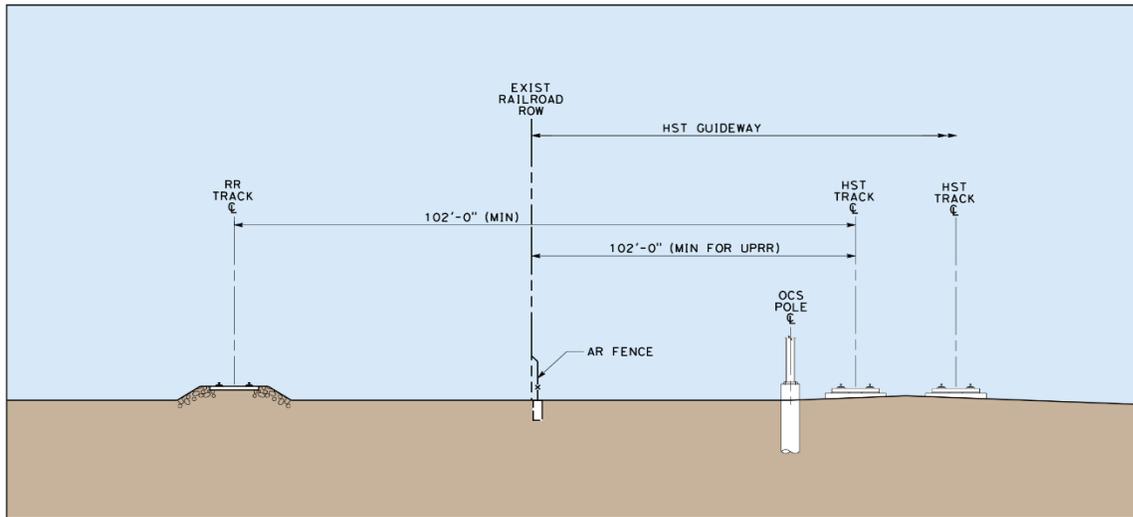


Source: Authority and FRA, 2018

Figure 8 Straddle Bent Typical Cross-Section

## ADJACENT RAILROADS

The HSR cross-sections include provisions for a 102-foot separation of the HSR track centerline from conventional rail systems right-of-way. The purpose of this separation is to avoid intrusion without the need for any physical element of protection from rail cars operating on adjacent freight lines, as shown in Figure 9. In areas where it is not feasible to provide this separation distance, protection is required to prevent encroachment on the HSR right-of-way. Protection would consist of a swale, berm, or barrier (wall), depending on the separation distance.



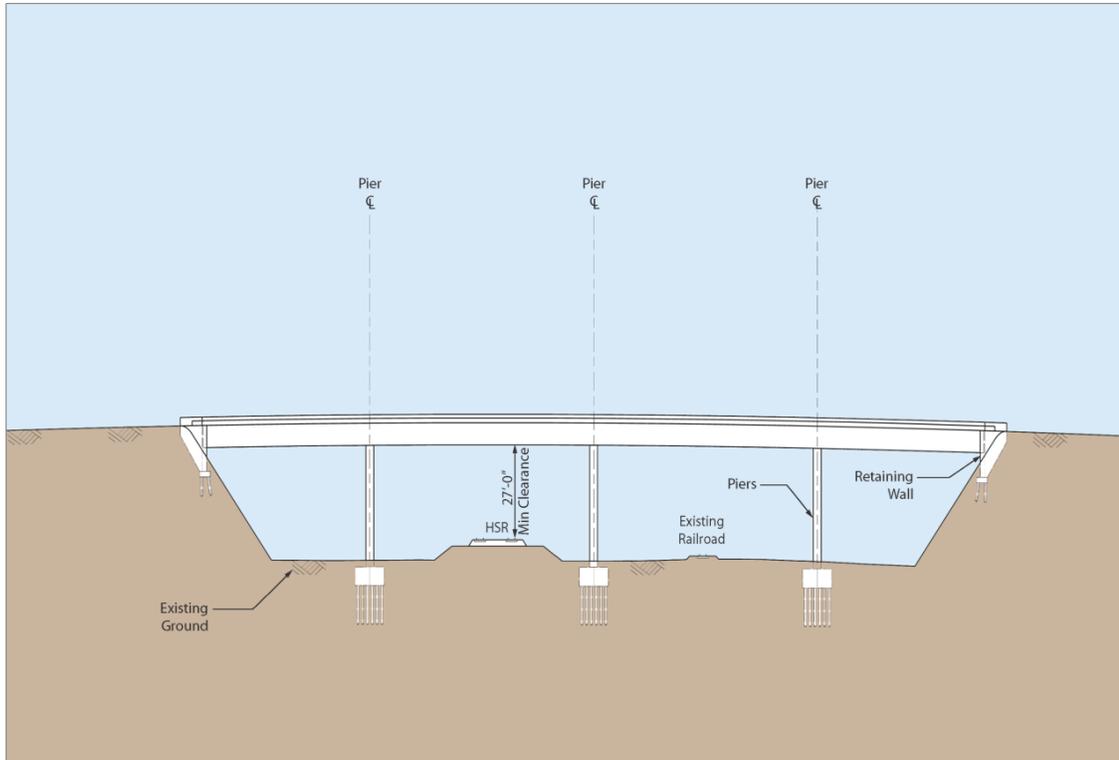
Source: Authority and FRA, 2018

Figure 9 Adjacent Railroad Cross-Section

## GRADE SEPARATIONS

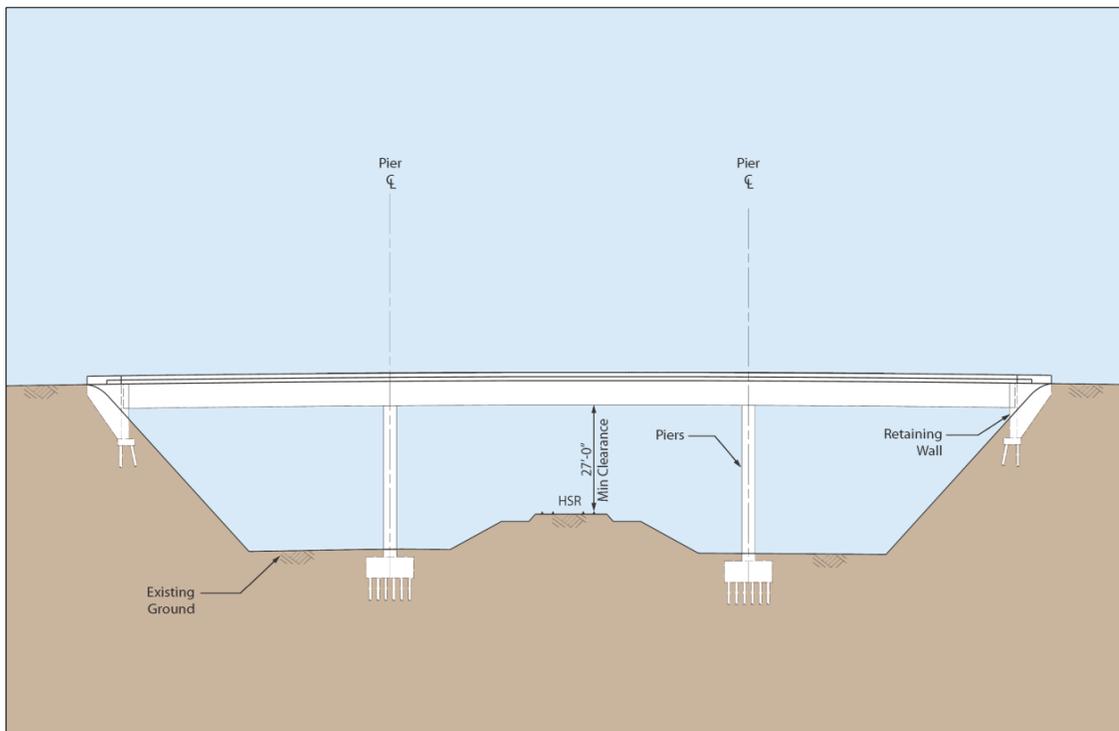
An optimal operating HSR system consists of a fully grade-separated and access-controlled guideway. Unlike existing passenger and freight trains in the region, there would be no at-grade road crossings, nor would the HSR system share its rails with freight trains. The following list describes possible scenarios for HSR grade separations for roadways, irrigation and drainage facilities, and wildlife:

- **Elevated HSR Road Crossings**—In urban areas, it may be more feasible to raise the HSR as shown previously on Figure 7 and Figure 8. This is especially relevant in urban areas where use of an elevated HSR guideway would minimize impacts on the existing roadway system.
- **Roadway Overcrossings**—There are many roadway and state route facilities that currently cross at-grade with or over the Union Pacific Railroad and BNSF Railway tracks. Where the HSR alignment affects these roads, the Authority would shift and reconstruct them to maintain their function. Figure 10 illustrates how a roadway would be grade-separated over both the HSR and the railroad in these situations. Similar conditions occur when an at-grade HSR alignment crosses rural roads used by small communities and farm operations. Where roads are perpendicular to the proposed HSR, HSR design includes overcrossings or undercrossings every 2 miles to provide continued mobility for local residents and farm operations. Some roads may be closed in the intervals between grade-separated crossings. Figure 11 is an example of a typical roadway overcrossing of the HSR tracks. Overcrossings would have two lanes, each with a width of 12 feet. The shoulders would be 4 to 8 feet wide, depending on average daily traffic volumes. The paved surface for vehicles would therefore range from 32 to 40 feet wide. Minimum clearance would be 27 feet over the HSR. Specifications are based on local road standards.



Source: Authority and FRA, 2018

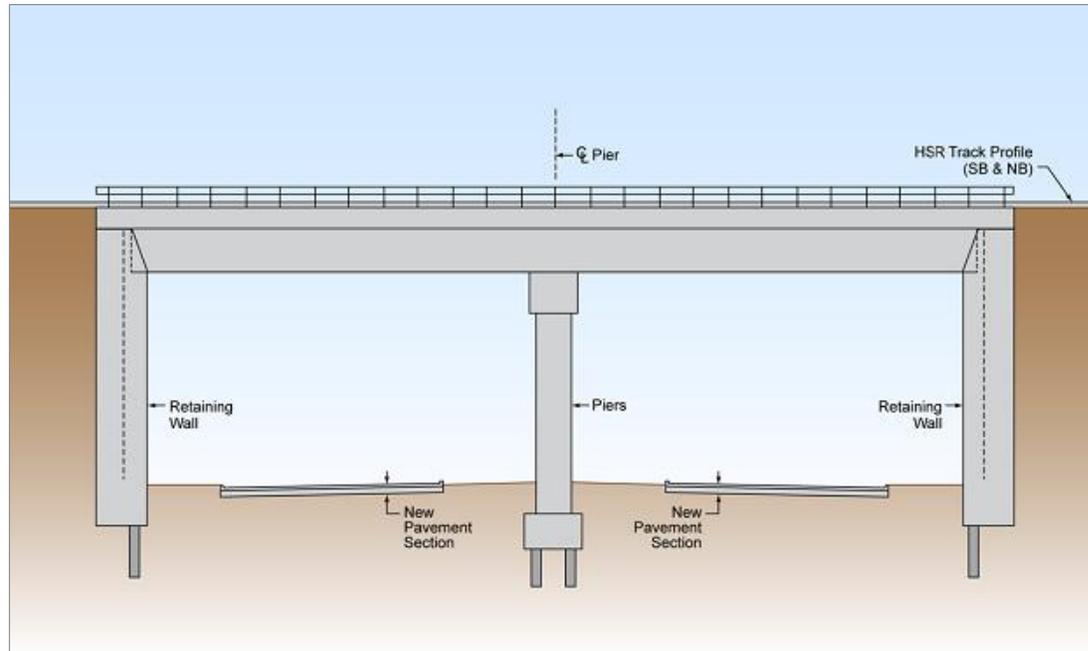
**Figure 10 Roadway Overcrossing of HSR Guideway and Existing Railroad Trackway**



Source: Authority and FRA, 2018

**Figure 11 Roadway Overcrossing of HSR Guideway**

- **Roadway Undercrossings**—HSR alternatives may require undercrossings for the HSR to travel over roadways. Figure 12 illustrates how a roadway would pass below the HSR guideway.

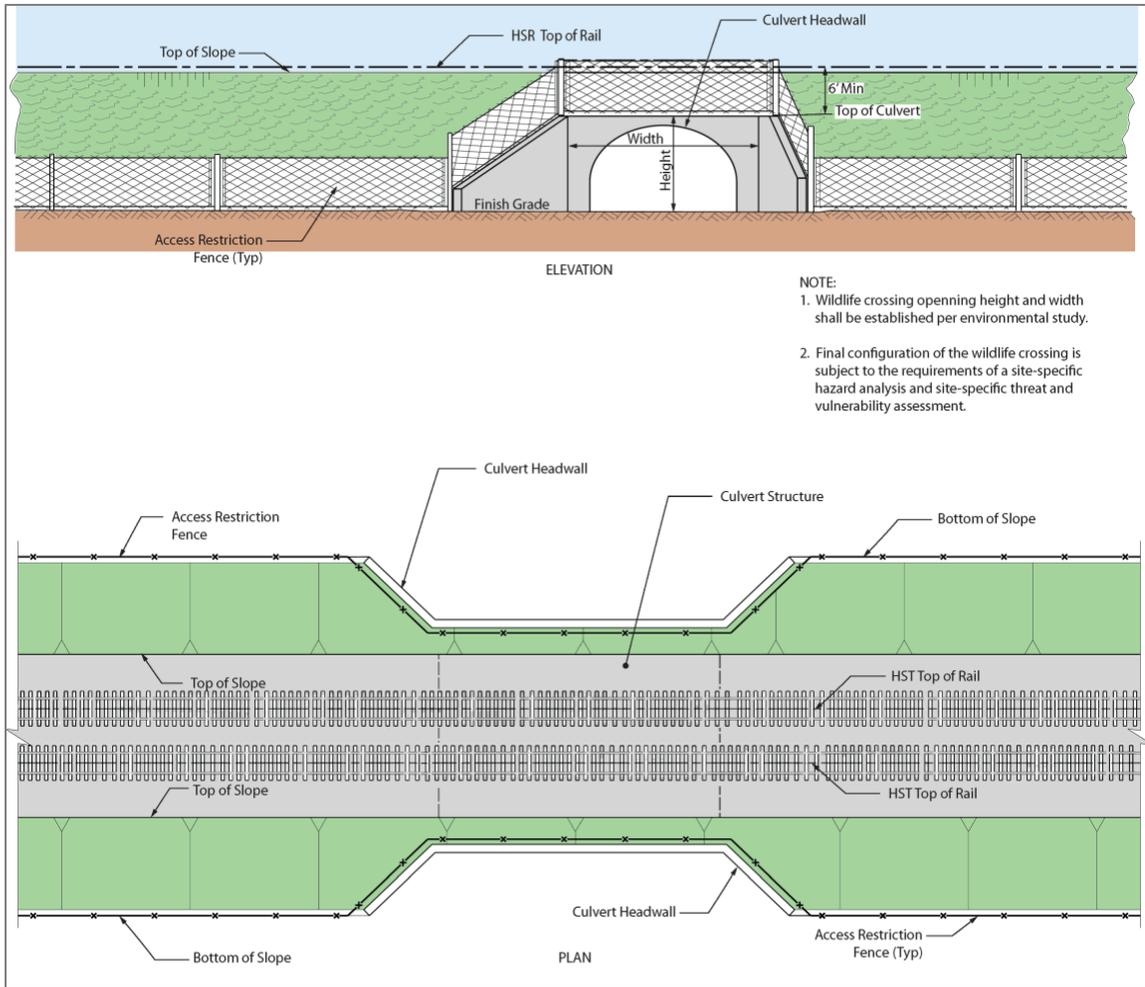


Source: Authority and FRA, 2012

**Figure 12 Typical Cross-Section of Roadway Grade-Separated Beneath HSR Guideway**

- **Irrigation and Drainage Facilities**—The HSR alignment would affect some existing drainage and irrigation facilities. Depending on the extent of the impact, the Authority would modify, improve, or replace existing facilities as needed to maintain existing drainage and irrigation functions and support HSR drainage requirements.
- **Wildlife Crossing Structures**—A variety of engineered structures would facilitate wildlife crossing opportunities. In addition to dedicated wildlife crossing structures, wildlife crossing opportunities would also be available at elevated portions of the alignment, bridges over riparian corridors, road overcrossings and undercrossings, and drainage facilities (i.e., large diameter [60–120 inches] culverts and paired 30-inch culverts). Figure 13 shows the wildlife crossing elevation and cross-section, as well as the drainage detail.

The Authority would provide wildlife undercrossing structures in at-grade embankments as the alternative extends through wildlife corridors. Where bridges, aerial structures, and road crossings coincide with proposed dedicated wildlife crossing structures, such features would serve the function of, and supersede the need for, dedicated wildlife crossing structures. The Authority would further refine design plans to identify optimal wildlife-friendly crossing locations to maintain or enhance crossing, dispersal, and migration opportunities for wildlife across the alternatives.



Source: Authority and FRA, 2018

**Figure 13 Wildlife Crossing Typical Cross-Section**

The preliminary wildlife crossing structure design consists of modified culverts in the embankment that would support the HSR tracks. The typical culvert from end-to-end would be 73 feet long (crossing-structure distance), would span a width of approximately 10 feet (crossing-structure width), and provide 3 feet of vertical clearance (crossing-structure height), resulting in a calculated openness factor (Bremner-Harrison et al. 2007) of 0.41.<sup>2</sup> To accommodate variations in the topography, the height of the at-grade profile may require depressing wildlife crossing structures no more than 1.5 feet (half of the vertical clearance) below-grade.

At locations where stormwater swales parallel the embankment, the Authority would design the approach to wildlife crossing structures in such a way as to minimize the amount of surface water runoff entering the structure. The design would include a small berm (or lip) at the entrance of the wildlife structure to prevent water from entering during small storm events. This lip would direct swales around it. To allow wildlife free passage through the crossing structures, HSR design would include right-of-way fencing at the toe of the slope, up the embankment, and around the

<sup>2</sup> (Height x Width)/Distance = Openness Factor; for example, (4 feet x 8 feet)/72 feet = 0.44

entrance of the structure. At locations where an intrusion protection barrier<sup>3</sup> parallels a proposed wildlife crossing structure, an extended crossing structure would pass through the barrier to allow wildlife free passage.

Additional wildlife crossing structure designs would include circular or elliptical pipe culverts typically 100 feet in length, and larger (longer) culverts with crossing-structure distances in exceedance of 100 feet. However, any changes to wildlife crossing structure design must have a minimum of 3 feet of vertical clearance (crossing-structure height), extend no more than 1.5 feet below-grade (half of the vertical clearance), and meet or exceed the minimum 0.41 openness factor.

Additionally, the Authority would place dedicated wildlife crossing structures to the north and south of several river and creek crossings. These wildlife crossing structures would be between 100 and 500 feet from the banks of each riparian corridor.

## RAILROAD WYE

Another component of HSR track alignment is configuration of the tracks to serve multiple terminal stations in different directions. The transition to a wye requires splitting two tracks into four tracks crossing over one another before the wye legs can diverge in opposite directions to allow bidirectional travel. Based on HSR design criteria, this transition would require approximately 2 miles, with an estimated 120-foot-wide right-of-way for the transition before the tracks fully diverge from each other. Figure 14 shows how the wye would transition the HSR tracks from the east-west alignment to the north-south alignment. As shown, some of the tracks must cross over the opposite northbound or southbound track.

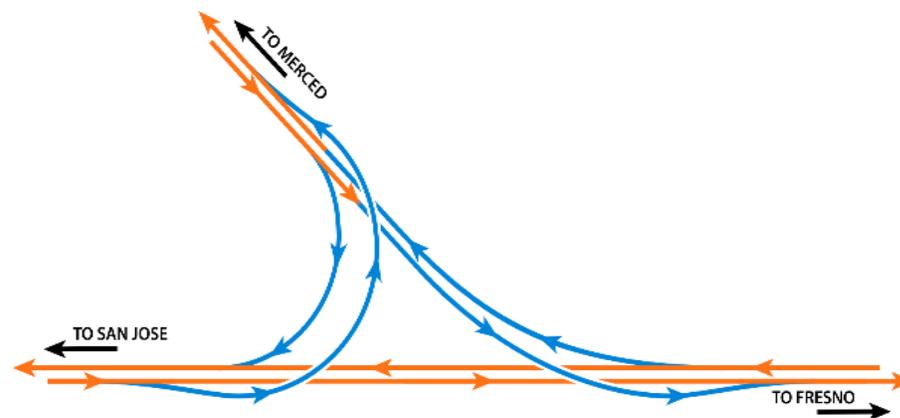
Figure 15 shows an example of an HSR guideway crossing another leg of the HSR track.

### Railroad Wye Connections

The Central Valley Wye would connect two HSR sections:

- Merced to Fresno Section – north-south alignments
- San Jose to Merced Section – east-west alignments, also referred to as the *Pacheco Pass connection*

The connection between the east-west alignments of the San Jose to Merced Section and the north-south alignment of the Merced to Fresno Section would require a railroad wye.



Source: Authority and FRA, 2018

Figure 14 Wye Schematic

<sup>3</sup> The HSR cross-sections include provisions for a 102-foot separation of the HSR track centerline from conventional rail systems right-of-way to avoid intrusion without the need for any physical element for protection from rail cars operating on adjacent freight lines. In areas where it is not feasible to provide this separation distance, protection is required to prevent encroachment on the HSR right-of-way. Protection would consist of a swale, berm, or barrier (wall), depending on the separation.



Source: Authority and FRA, 2012

**Figure 15 Photograph Showing an HSR Wye Configuration with One Wye Leg Crossing Another**

## TRACTION POWER DISTRIBUTION

California’s electricity grid would power the proposed HSR system. The HSR system is expected to require less than 1 percent of the state’s future electricity consumption. In 2008, Navigant Consulting, Inc. performed a study that found that while the California grid would supply the HSR with energy, it is not feasible to physically control the flow of electricity from particular sources (Navigant Consulting, Inc. 2008). However, it would be feasible for the Authority to obtain the quantity of power required for the HSR from 100 percent clean, renewable energy sources through a variety of mechanisms, such as paying a clean-energy premium for the electricity consumed.

The HSR system would not include the construction of a separate power source, although it would include the extension of underground or overhead power/ transmission lines to a series of traction power substations positioned along the HSR corridor. These traction power substations are necessary to even out the power feed to the train system. Working in coordination with power supply companies and per design requirements, the Authority and FRA have identified frequency and right-of-way requirements for these facilities.

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### *Electricity Consumption*

The high-speed rail system is expected to require less than 1 percent of the state’s future electricity consumption.

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Source: Authority and FRA, 2012

**Figure 16 Traction Power Substation**

Trains would draw electric power from an OCS with the running rails acting as the other conductor. The contact system would consist of a series of mast poles approximately 27 feet higher than the top of the rail, with contact wires suspended from the mast poles between 17 to 19 feet from the top of the rail. The train would have an arm, called a pantograph, to maintain contact with this wire to provide power to the train. The mast poles would be spaced approximately every 200 feet along straight portions of the track to every 70 feet in tight-turn track areas. The OCS would connect to the substations, required at approximately 30-mile intervals. Statewide, the power supply would consist of a 2 by 25 kilovolt OCS for all electrified portions of the statewide system.

## Traction Power Substations

Based on the HSR system's estimated power needs, traction power substations (TPSS) would each need to be approximately 32,000 square feet (200 feet by 160 feet) and be located at approximately 30-mile intervals. Figure 16 shows a typical TPSS. Figure 17 shows a typical TPSS OCS feeder gantry.

TPSSs would have to accommodate the power substations and would require a buffer area around them for safety purposes. For the Central Valley Wye alternatives, the Authority would construct TPSSs at locations where high-voltage power lines cross the HSR alignment. A perimeter wall or fence could screen the TPSS and associated feeder gantry from view. Each TPSS site would have a 20-foot-wide access road (or easement) from the street access point to the protective fence perimeter at each parcel location. Each site would require a parcel of up to 2 acres. Each TPSS would include an approximately 450-square-foot control room (each alternative design includes these facilities, as appropriate). Each TPSS may include a lattice steel microwave tower, up to 120 feet tall, to support communication with the electric utility provider.

## Switching and Paralleling Stations

Switching and paralleling stations work together to balance the electrical load between tracks, and to switch power off or on to either track in the event of an emergency. The HSR system would require switching stations (Figure 18) at approximately 15-mile intervals, midway between the TPSSs. These stations would be approximately 14,400 square feet (160 feet by 90 feet). The HSR system would generally connect to the PG&E electrical grid at the switching stations.

The HSR system would require paralleling stations (Figure 19 and Figure 20) at approximately 5-mile intervals between the switching stations and the TPSSs. The paralleling stations would be approximately 9,600 square feet (120 feet by 80 feet). Each station would include an approximately 450-square-foot (18 feet by 25 feet) control room.



Source: Authority and FRA, 2014a

**Figure 17 Traction Power Substation Overhead Contact**



Source: Authority and FRA, 2012

**Figure 18 Switching Station**



Source: Authority and FRA, 2012

**Figure 19 Paralleling Station**

A perimeter wall or fence could screen the switching and paralleling stations and associated feeder gantries from view. Each alternative design includes TPSS, traction power switching, and paralleling stations as appropriate.

### Backup and Emergency Power Supply Sources for Stations and Facilities

During normal system operations, the local utility service or TPSS would provide power. Should the flow of power be interrupted, the system would automatically switch to a backup power source, through use of an emergency standby generator, an uninterruptible power supply, or a direct current battery system.

For the Central Valley Wye alternatives, permanent emergency standby generators are anticipated to be located only at TPSSs. These standby generators must be tested (typically once a month for a short duration) in accordance with National Fire Protection Association 110/111 (standards for emergency and standby power and stored electrical energy emergency and standby power systems) to guarantee their readiness for backup and emergency use. If needed, portable generators could also be transported to other trackside facilities to reduce the impact on system operations.

### Network Upgrades

A 2016 Technical Study Report completed by PG&E determined what network upgrades would be required to existing infrastructure to meet the projected power demands of the HSR system within the 345-mile portion of the train corridor located within PG&E's service territory.<sup>4</sup> The Technical Study Report assumed maximum load during commercial operation at each TPSS location and normal system operation of all substations and transformers in its service area. The results are being reviewed by the Authority and its technical consultant to assure recommendations are necessary to support the HSR and that no benefit to PG&E would occur. Based on the PG&E Technical Study Report, network upgrade consisting of reconductoring existing power/transmission lines, and expansion/reconfiguration of existing substations would be required to support the Central Valley Wye alternatives.

### SIGNALING AND TRAIN-CONTROL ELEMENTS

A computer-based, enhanced automatic train control system would control the trains. The enhanced automatic train control system would comply with FRA-mandated positive train control requirements, including safe separation of trains, over-speed prevention, and work zone protection. This control system would use a radio-based communications network that would include a fiber optical backbone and communications towers at intervals of approximately 1.5 to 3 miles, depending on the terrain and selected radio frequency. Signaling and train control elements within the right-of-way would include 10-foot by 8-foot communications shelters or signal huts/bungalows that house signal relay components and microprocessor components, cabling to the field hardware and track, signals, and switch machines on the track. Communications towers within these facilities would use a 6- to 8-foot-diameter, 100-foot-tall pole. The communications facilities would be near track switches and grouped with other traction power, maintenance, station, and similar HSR facilities where possible. Where the Authority cannot locate communications towers with TPSSs or other HSR facilities, it would locate the communications facilities near the HSR corridor in a fenced area of approximately 40 feet by 25 feet with road access for maintenance purposes.



Source: Authority and FRA, 2014a

**Figure 20 Paralleling Station Overhead Contact System Gantry**

<sup>4</sup> Pacific Gas and Electric (PG&E). May 14, 2016. California High Speed Train Project – Technical Study Report, Evaluation of Proposed Traction Power Substation Interconnections for Sites 6 – 13

## TRACK STRUCTURE

The track structure would consist of either a direct fixation system (with track, rail fasteners, and slab—typically known as “slab track”), or ballasted track, depending on local conditions and decisions to be made in later design. Ballasted track requires more frequent maintenance than slab track, but is less expensive to install.

For purposes of environmental review, this analysis assumes slab track for long HSR structures and ballasted track for at-grade sections and short HSR structures. The Authority and FRA would perform a subsequent environmental review if there is a significant change in the type of track structure following additional design and technical review.

## STATIONS AND MAINTENANCE FACILITIES

This section provides information about stations and maintenance facilities for the California HSR System. This section is background information only, because the Central Valley Wye alternatives do not include any stations or maintenance facilities.

### STATIONS

The design of stations would provide intermodal connectivity, drop-off facilities, an entry plaza, a station house area for ticketing and support services, an indoor station room where passengers wait and access the HSR, and parking facilities. Figure 21 shows examples of station components from existing systems overseas. Figure 22 shows a potential “functional” station and a plan view of various station components. The functional station is a basic design that could be more elaborate with cooperation from the local jurisdiction; the station has the potential to be an iconic building that would help define the downtown transit core. The following sources inform preliminary station planning and design:

- Dimensional data from guidance in *Station Platform Geometric Design* (Authority 2008a)
- Volumetric data from *Station Program Design Guidelines* (Authority 2009)
- *California High-Speed Train Project Urban Design Guidelines* (Authority 2011)
- Americans with Disabilities Act Accessibility Guidelines (36 C.F.R. Parts 1190 and 1191)

The Merced to Fresno Final EIR/EIS (Authority and FRA 2012) selected the Downtown Merced Station and the Downtown Fresno Station.

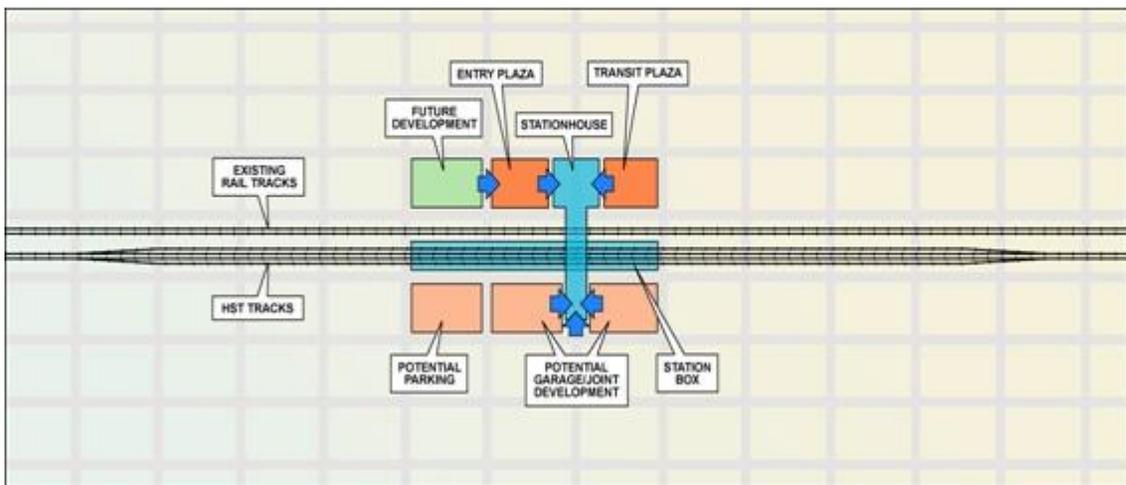


Source: Authority and FRA, 2012

**Figure 21** Examples of HSR Stations

### Station Platforms and Trackway (Station Box)

The station would provide a sheltered area and platforms for passenger waiting and circulation elements (stairs, elevators, escalators). Of the four tracks passing through the station, the two express tracks (for trains that do not stop at the station) would be separated from those that stop at the station and platforms. To allow enough distance for safe deceleration of trains, a platform track would diverge from each mainline track, beginning 3,000 feet from the center of the 1,410-foot station platform. The acceleration track from platform to mainline requires a shorter distance. The station would provide an additional stub end refuge track to temporarily store HSR trains in case of mechanical difficulty, for special scheduling purposes, and for daytime storage of maintenance-of-way work trains during periods when structure and track maintenance is being performed along the line around the station. The combination of deceleration, acceleration, and refuge track extends the wider footprint of the four-track section to a total distance of 6,000 feet.



Source: Authority and FRA, 2012

**Figure 22 Simulated and Plan Views of a Functional Station and its Various Components**

## Station Arrival/Departure Facility (Station House)

The station house would be adjacent to the primary entrance and plazas. The station house would be open to patrons and visitors. Services within the station house may include initial ticketing and check-in, traveler's aid and local information services, and concessions. Circulation linkages between the station house and the station platforms may include hallways, an access bridge to cross over railroad tracks, stairs, escalators, elevators, and moving sidewalks.

Forecasted annual ridership and peak-period ridership affect the design of some station components, such as the capacity of components required for public access to and egress from the HSR system. The 2040 ridership forecasts from the Authority's *Connecting California 2014 Business Plan* (Authority 2014a) formed the basis for the conceptual service plan, which in turn influenced the station designs by ensuring the station facilities could accommodate the anticipated future use of the HSR system, due to increases in ridership over time.

## Ridership and Station Area Parking

HSR system ridership, parking demand, parking supply, and development around HSR stations are intertwined, and would evolve from commencement of revenue service in 2022 to full system operations in 2040. The Authority's goals are to support HSR ridership by promoting, in partnership with local agencies, transit-oriented development around HSR stations and expanding multimodal access to the HSR system including the expansion of local transit to bring riders to HSR stations. This would be a delicate balance that would evolve over time and vary by station, because some cities and regions would develop their station areas and local transit systems more than others by 2022 and 2040.

Research suggests that the percentage of transit passengers arriving and departing transit stations by car and parking decreases as land use development and population around the stations increases. The Authority's adopted station area development policies recognize this inverse relationship between parking demand and HSR station area development. The HSR would be most successful if stations are placed where there is or will be a high density of population, jobs, commercial activities, entertainment, and other activities that generate trips. The Authority's policies, therefore, encourage dense development around HSR stations, which supports system ridership while reducing parking demand.

Land use development around HSR stations would not occur immediately, however. While the HSR would be a catalyst for such development, local land use decisions and market conditions would dictate actual construction. The Authority would encourage station area development in partnership with local government, as exemplified by the station area planning grants it has provided to the City of Fresno and the City of Bakersfield, but the Authority's power in this regard is limited. The actual demand for parking facilities, moreover, would depend on how HSR ridership grows over time.

In light of the uncertainty over the need for station area parking, the Authority has conservatively identified parking facilities to meet the maximum forecast parking demand in the immediate vicinity of the HSR stations. The Authority used the 2040 high-ridership scenario to capture the maximum potential parking demand and to allow for an analysis of where and how parking demand might be accommodated near the HSR station (Authority 2014a). This scenario is an upper bound on actual needs and discloses the maximum potential environmental impact. The Authority and FRA would have flexibility to make decisions about what parking facilities to construct initially, and how additional parking might be phased or adjusted depending on how HSR system ridership increases over time. For example, it is possible that some parking facilities

### Station Parking Facilities

High-speed rail system ridership forecasts provide the basis for parking demand estimates that assume, initially, parking availability is unconstrained—meaning 100 percent of parking demand is assumed to be met. These projections provide a “high” starting point to inform discussions with cities where stations are proposed. Development of station access facilities would occur over time in phases, while also prioritizing access to the high-speed rail system through modes such as transit, which could lead to lower parking demand.

might be constructed at the 2022 initial operating section (IOS) opening year, only to be replaced in whole or in part, or augmented later with development of other parking facilities.

## **HSR, Land Use Patterns, and Development around HSR Stations**

In November 2008, California voters approved Proposition 1A, the Safe, Reliable, High-Speed Passenger Train Bond Act, essentially approving the California HSR System. Voters specifically mandated that HSR stations “be located in areas with good access to local mass transit or other modes of transportation. The HSR system also shall be planned and constructed in a manner that minimizes urban sprawl and impacts on the natural environment” including “wildlife corridors.”

In submitting Prop 1A to the voters, the California State Legislature went further:

*"The continuing growth in California's population and the resulting increase in traffic congestion, air pollution, greenhouse gas emissions, and the continuation of urban sprawl make it imperative that the state proceed quickly to construct a state-of-the-art high-speed passenger train system to serve major metropolitan areas."*

The Authority has embraced this voter and legislative direction. Figures 23, 24, and 25 show how the HSR system connects with existing transit service areas throughout the State of California. As the Authority's Program EIR/EIS documents<sup>5</sup> show and the Draft Supplemental EIR/EIS supports, operation of the HSR system would reduce traffic congestion, air pollution, and greenhouse gas emissions. The Authority believes, however, that this is not enough. The HSR would be most successful, and best fulfill the intent of the voters and Legislature, if it coordinates with sprawl-reducing and environment-improving land use development patterns. Accordingly, the Authority has adopted HSR Station Area Development Policies based on the following premise (Authority 2008b):

*"For the high-speed train to be more useful and yield the most benefit, it is important that the stations be placed where there will be a high density of population, jobs, commercial activities, entertainment, and other activities that generate personal trips. The success of HSR is highly dependent on land use patterns that also reduce urban sprawl, reduce conversion of farm land to development, reduce vehicle miles traveled by automobiles, and encourage high-density development in and around the HSR station."*

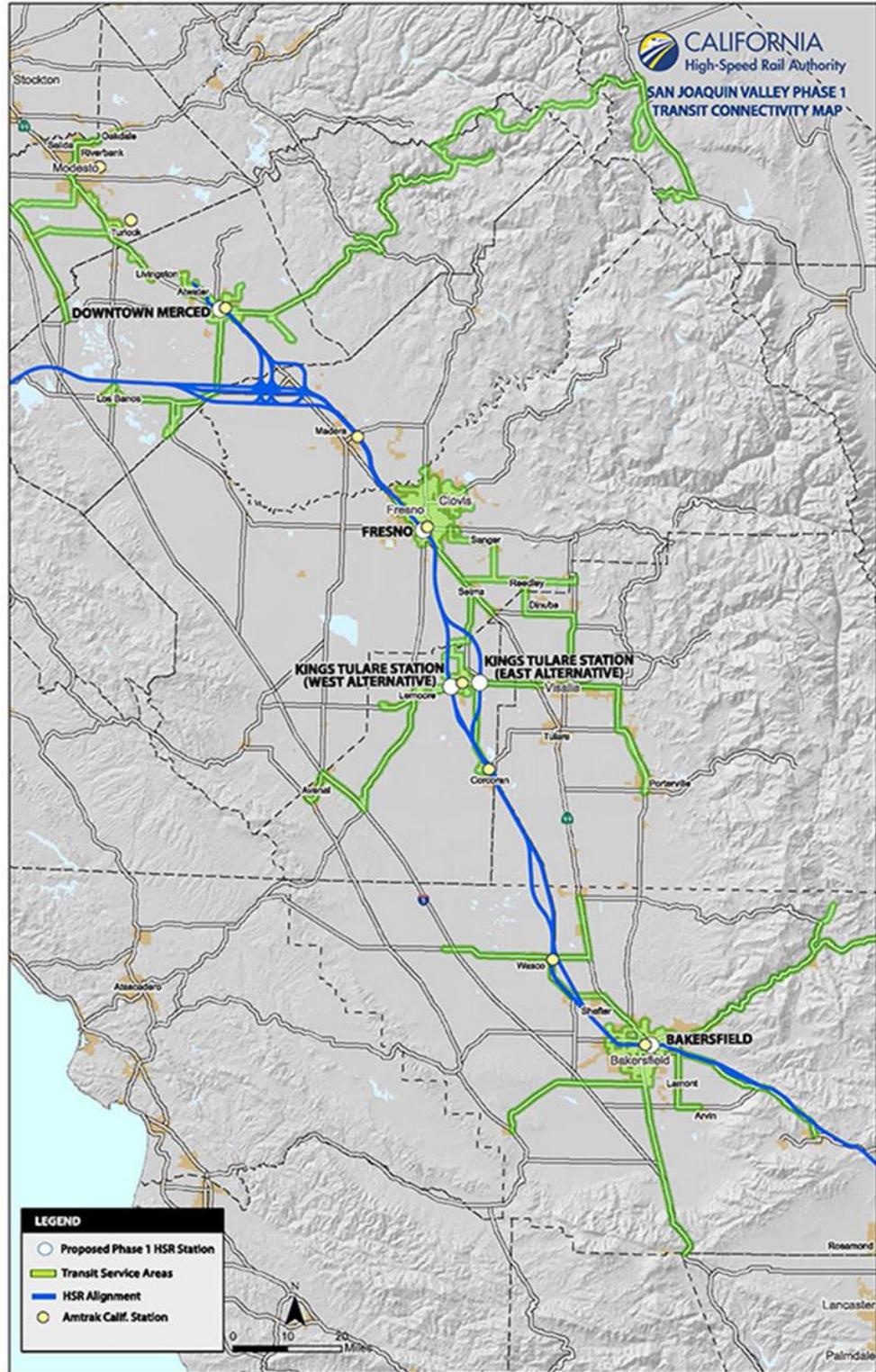
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<sup>5</sup> The Program EIR/EIS documents are: *Final Program EIR/EIS for the Proposed California High-Speed Train System* (Authority and FRA 2005), *San Francisco Bay Area to Central Valley High-Speed Train Final Program EIR/EIS* (Authority and FRA 2008), and *2012 Bay Area to Central Valley High-Speed Train Partially Revised Final Program EIR* (Authority 2012).



Source: Authority and FRA, 2014b

Figure 23 Northern California Phase 1 Transit Connectivity Map



Source: Authority and FRA, 2014b

Figure 24 San Joaquin Valley Phase 1 Transit Connectivity Map



Source: Authority and FRA, 2014b

Figure 25 Southern California Phase 1 Transit Connectivity Map

The Authority and its Station Area Development Policies specifically advocate:

- Higher density development in relation to the existing pattern of development in the surrounding area, along with minimum requirements for density
- A mix of land uses (e.g., retail, office, hotels, entertainment, residential) and a mix of housing types to meet the needs of the local community.
- Compact pedestrian-oriented design that promotes a walking, bicycle and transit access with streetscapes that include landscaping, small parks, and pedestrian spaces.
- Limits on the amount of parking for new development and a preference that parking be placed in structures. Transit-oriented development areas typically have reduced parking requirements for retail, office, and residential uses due to their transit and bicycle access, walkability, and potential for shared parking. Sufficient train passenger parking would be essential to the system viability, but this would be offered at market rates (not free) to encourage the use of access by transit and other modes.
- Infill development—namely, development around HSR stations on land that is already disturbed by existing development, parking lots, pavement, etc., rather than development on previously undisturbed land or on farmland. The Authority, therefore, prefers to locate its stations in existing developed areas, particularly city centers.

The Authority recognizes that local government and the market control land use development around HSR stations, and that public interest groups influence that development. The Authority also recognizes that regional and local transit agencies control local transit. The Authority commits, therefore, to working cooperatively with local government, transit agencies, public interest groups, and the development community to realize a shared vision for land use and transit development around HSR stations, consistent with the Authority's Station Area Development Policies (Authority 2008b) to the maximum extent possible.

Good land use planning helps guarantee good land use development. Planning for infill development, however, is particularly complicated. Infill areas (e.g., established downtowns) typically involve numerous small parcels with different property owners. Therefore, no single property owner exists to pay for the planning, so typically government funds planning. The economic downturn and the State of California's elimination of redevelopment agencies, however, have left local government resources particularly limited. Accordingly, the Authority has committed to utilize its resources, both financial and otherwise, to encourage local government land use planning around HSR stations consistent with these principles.

The Authority believes that implementation of its Station Area Development Policies, and cooperative work with local governments (including funding for planning), would result in the types of environmental benefits voters and the Legislature contemplated in 2008. The Draft Supplemental EIR/EIS forecasts that the HSR would reduce vehicle miles traveled and related greenhouse gas emissions, reduce energy use, reduce traffic congestion, and improve air quality. To be conservative and consistent with National Environmental Policy Act and California Environmental Quality Act requirements, these forecasts generally do not account for the additional benefit to these areas expected from more compact development patterns. The Authority started the Vision California study effort, with funds provided by the California Strategic Growth Council and the Authority, to help account for the additional sustainability benefits that would exceed benefits reported in the Draft Supplemental EIR/EIS. The program concluded in 2010.

The Vision California project was a first-of-its-kind effort to explore the role of land use and transportation investments in meeting the environmental, fiscal, and public-health challenges facing California over the coming decades (Calthorpe Associates 2011a, 2011b, and 2011c). The project produced new scenario development and analysis tools to examine the impacts of varying policy decisions and development patterns associated with accommodating the expected dramatic increase in California's population by 2050. Vision California's tools quantitatively illustrated the connections between land use patterns, water and energy use, housing

affordability, public health, air quality, greenhouse gas emissions, farmland preservation, infrastructure investment, and economic development. These tools allowed state agencies, regions, local governments and the nonprofit community to measure the impacts of land use and transportation investment scenarios (Calthorpe Associates 2011a, 2011b). More information about the Vision California project and the final Vision California Report is available online: [www.hsr.ca.gov/docs/programs/green\\_practices/sustainability/Vision%20California%20-%20Statewide%20Scenarios%20report.pdf](http://www.hsr.ca.gov/docs/programs/green_practices/sustainability/Vision%20California%20-%20Statewide%20Scenarios%20report.pdf).

The Vision California project involved two different models developed by Calthorpe Associates. An open source geospatial model called Urban Footprint was map based, and analyzed detailed base and scenario data at the 5.5-acre level across most parts of the state. The model was scalable to conduct analyses of local and regional land use and infrastructure decisions. The Sacramento Area Council of Governments used Version 1 of the Urban Footprint model for updating their regional transportation plans and preparing sustainable communities strategies. Another tool, called RapidFire, has been deployed statewide and in regions across California. Vision California developed two statewide growth scenarios—Business as Usual and Growing Smarter—using RapidFire (Calthorpe Associates 2011c). Business as Usual assumes continuation of the past trend of less compact development patterns. Growing Smarter assumes an increasing proportion of urban infill and compact growth.

The Growing Smarter scenario is closely linked to the implementation of the HSR system and supportive feeder services. This is particularly true in regions of the state that currently lack high-quality transit facilities, such as the San Joaquin Valley, where realization of the level of urban and compact growth envisioned in the Growing Smarter scenario would not occur without the significant investment and mobility enhancements represented by the California HSR System.

RapidFire predicts that by 2050, implementation of more compact growth of the Growing Smarter scenario would:

- Save over \$7,300 per household annually on automobile costs and utility bills
- Save \$1.1 billion per year from lower infrastructure costs for new homes
- Save 18 million acre-feet of water by 2050—enough water to fill Hetch Hetchy reservoir 50 times
- Cut residential and commercial building energy use by 15 percent—enough to power all homes in California for 8 years
- Save over 3,700 square miles of land by 2050—more than Rhode Island and Delaware combined
- Reduce fuel consumption through 2050 equivalent to 2 years of the United States' oil imports, which amounts to a household savings of \$2,600 per year per household
- Reduce greenhouse gas emissions equivalent to the emissions offset by a forest a quarter the size of California
- Reduce pollution-related respiratory disease, saving more than \$1.6 billion annually
- Reduce passenger vehicle travel by more than 4 trillion miles, the equivalent of taking all cars off of California's roads for 15 years

Construction of the California HSR System, coupled with successful implementation of the Authority's Station Area Development Policies, would serve to reinforce cities as hubs of our economy and future growth and would save land and water, reduce energy use, improve air quality, and save money. The initial findings of the Vision California study suggest that these benefits could be tremendous and would help California meet its sustainability goals.

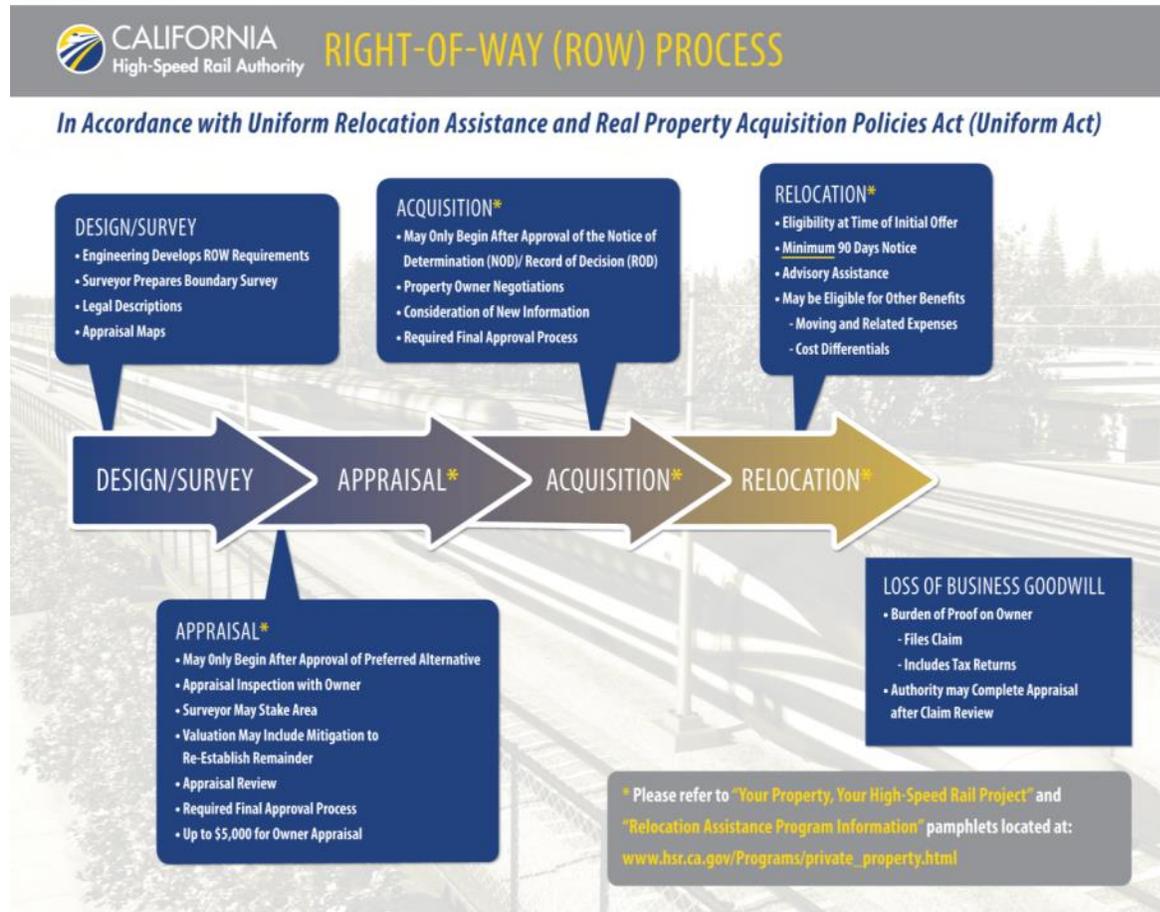
## Right-of-Way Acquisition for Construction, Operation, and Maintenance of HSR

To ensure compliant and consistent application of federal and state mandates, the Authority is developing policies and procedures that would lead to the acquisition and management of property rights in a legally compliant, fiscally sound, and publicly acceptable manner. Such procedures would provide for acquiring and managing property rights through purchase, easement, lease or other legal instruments, including condemnation when necessary, that support the Authority objectives. The Authority would apply these policies and procedures consistently throughout the statewide project and would strive for these activities to be judged by the public, stakeholders, and other third parties as being conducted in a fair and transparent manner.

Development of the IOS would involve the design and construction of civil infrastructure and track work in the Central Valley for a distance of about 130 miles, which requires the acquisition of property rights on more than 1,100 parcels of land. In order to proceed with acquisition of these property rights, the Authority must implement a set of proven standards and procedures for acquisition and management of property rights in a timely manner that supports the required construction schedule.

The California Department of Transportation Right-of-Way Manual establishes uniform procedures for acquiring property rights for projects that are, in many respects, similar to those projects the Authority is developing. However, there are some requirements that are unique to the HSR system; therefore, the Authority has developed its own procedures that are documented in the *California High-Speed Rail Authority 2017 Right of Way Manual* (Authority 2017).

The right-of-way process the Authority has adopted, explained in Figure 26, is in accordance with the federal Uniform Relocation Assistance and Real Property Acquisition Policies Act. The initial phase of the right-of-way process is the design/survey phase where engineers develop right-of-way requirements and surveyors prepare the boundary survey, legal descriptions, and appraisal maps. Once the Authority and FRA select and approve the preferred alternative, an appraisal inspection with the owner would take place. During the appraisal phase of the right-of-way process, the surveyor may stake the area and mitigation may be required to re-establish the remainder. Before any action can take place on land acquisitions, the California Environmental Quality Act Notice of Determination and National Environmental Policy Act Record of Decision must be issued. The Authority must also participate in property owner negotiations and consider new information before receiving the required final approval to move forward with acquisitions. The final phase of the right-of-way process includes assisting residents and businesses to relocate as a result of project displacement and eligibility at time of initial offer. The Authority must give residents a minimum of a 90-days notice of their displacement and provide advisory assistance.



Source: Authority, 2014b

**Figure 26 Right-of-Way Process**

## Construction Plan

The general construction plan is common to all of the alternatives. The Authority has slightly modified the construction plan described in the Merced to Fresno Final EIR/EIS to reflect the opening dates for the components of Phase 1. To maintain its eligibility for federal American Recovery and Reinvestment Act funding, the Authority started final design in fall 2013 and began work in 2014. Work on the IOS is to be completed by December 2018. Service on the IOS is expected to start in 2022.

## Design/Build Project Delivery

The Central Valley Wye alternatives would be built using a design-build approach. This method of project delivery involves a single contract between the Authority and the contractor to provide both design and construction services. This differs from the design-bid-build approach, where separate contracts manage design and construction services and the design is completed before the project is put out for construction bids. The design-build approach offers more flexibility to adapt the project to changing conditions. The contract with the design-build contractor would require compliance with standard engineering design and environmental practices and regulations, as well as implementation of any design features and applicable mitigation measures included in the Draft Supplemental EIR/EIS.

The Authority plans to construct the first construction segment of the HSR between Madera and Shafter that would ultimately extend south to the San Fernando Valley. The Central Valley portion

would be part of the backbone of the HSR system that would tie major regions of California together. The first construction segment consists of a number of Construction Packages (CP):

- CP 1 extends from Avenue 19 in Madera County to East American Avenue in Fresno County. The Authority awarded the design-build contract for the construction of CP 1 in August 2013. CP 1 includes associated infrastructure and civil works.
- CP 2/3 extends from East American Avenue to 1 mile north of the Tulare/Kern County Line. CP2/3 crosses Fresno, Kings, and Tulare counties and the Authority awarded the design-build contract in June 2015. CP 2/3 includes associated infrastructure and civil works.
- CP 4 extends from 1 mile north of the Tulare/Kern County Line to Poplar Avenue north of the city of Shafter in Kern County. The Authority awarded the design-build contract for CP 4 in May 2016. CP 4 includes associated infrastructure and civil works.
- CP 5 has not yet been awarded but is anticipated to extend from the northern terminus of CP 1 in the Merced to Fresno Section (Avenue 19 in Madera County) to the southern terminus of CP 4 for the Fresno to Bakersfield Section (Poplar Avenue north of the city of Shafter). CP 5 includes the railroad infrastructure, OCS, and positive train control and track and would be limited to the footprint covered by CP 1, CP 2/3, and CP 4.

## MAINTENANCE FACILITIES

The California HSR System includes three types of maintenance facilities. Each section would have maintenance-of-way facilities and a number of overnight layover and servicing facilities would be distributed throughout the system. In addition, the HSR system would have a single heavy maintenance facility (HMF). The Central Valley Wye alternatives would not have any maintenance facilities; however, the following section provides a general description of the maintenance facilities of the HSR system as a whole.

### Maintenance-of-Way Facilities

Maintenance-of-way facilities provide for equipment, materials, and replacement parts storage and support quarters and staging areas for the HSR system subdivision maintenance personnel. Each subdivision would cover about 150 miles; the maintenance-of-way facility would be centrally located in the subdivision.

The facility would sit on a linear site adjacent to the HSR tracks with a maximum width of seven tracks, and would be approximately 0.75 mile long for a size between 28 and 38 acres. For lengths of mainline track that are relatively distant from stations with refuge tracks or maintenance-of-way facilities, a refuge track would be sited to provide temporary storage of work trains as they perform maintenance in the vicinity of the track. The track would be approximately 1,600 feet long and would connect to the mainline track. Access to the refuge track would be provided, along with enough space to park work crew vehicles while working from the site and to drive the length of the track. The track and access area would be within the fenced and secure area of the HSR mainline track.

In April 2013, the Authority released an updated summary of requirements for HSR project operations and maintenance facilities (Authority 2013). This operations and maintenance facilities memorandum describes requirements for HSR facilities for the phased implementation of the HSR system, updates facilities terminology, and informs engineering design. The memorandum introduces new terminology, but does not introduce new facilities. For example, the maintenance-of-way facilities are now named “maintenance of infrastructure facilities” and the refuge track facilities are now termed “maintenance of infrastructure siding.”

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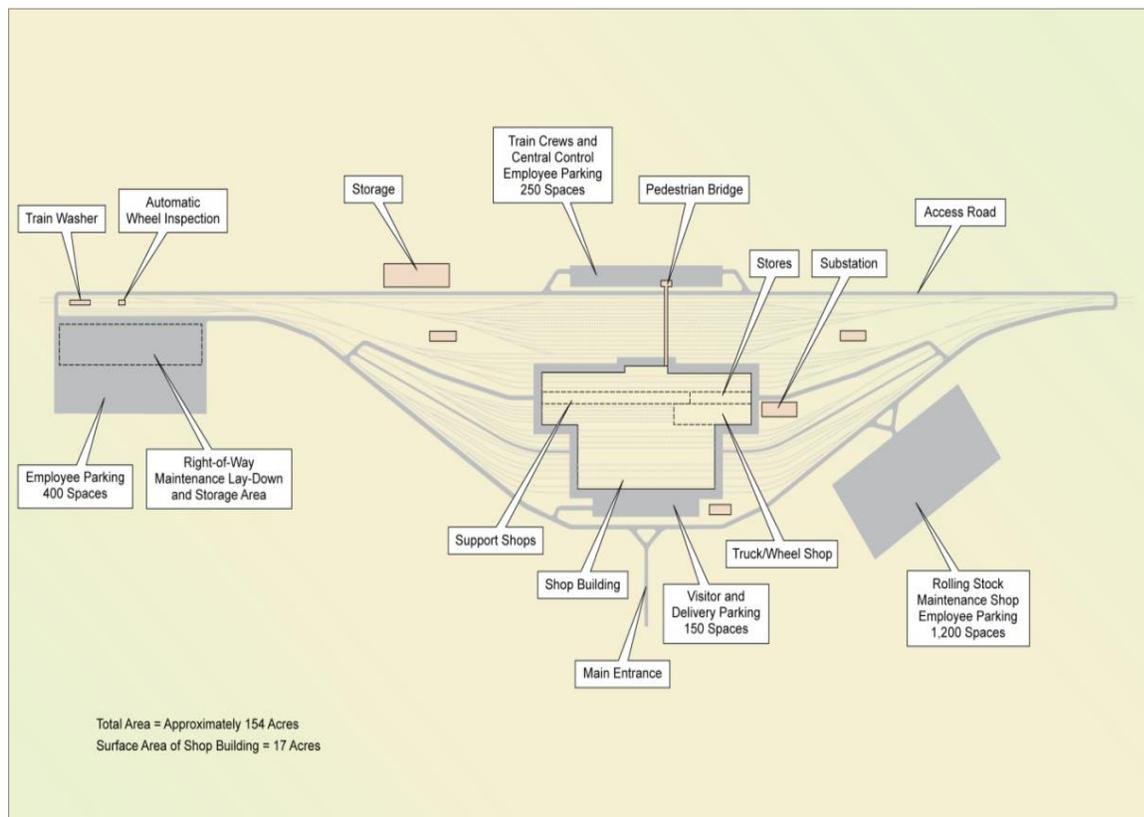
#### *Maintenance-of-Way*

A train industry term that refers to repair and maintenance activity concerning the right-of-way and track, including track and roadway, buildings, signals, and communication and power facilities.

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## HSR Heavy Maintenance Facility

An HSR heavy maintenance and layover facility would be sited within either the Merced to Fresno Section or Fresno to Bakersfield Section; the environmental documents for both sections evaluated impacts of facility alternatives. This facility would require approximately 154 acres with space for all activities associated with train fleet assembly, disassembly, and complete rehabilitation; all onboard components of the trainsets; and overnight layover accommodations and servicing facilities. The site would include a maintenance shop, yard, Operations Control Center building, one TPSS, other support facilities, and a train interior cleaning platform. Figure 27 shows a conceptual HMF layout. The property boundaries for each HMF site would be larger than the acreage needed for the actual facility because of the unique site characteristics and constraints of each location.



Source: Authority and FRA, 2012

**Figure 27 Conceptual Heavy Maintenance Facility Layout**

The HMF would have two primary functions. First, it would support train arrival, assembly, testing, and commissioning to operations. Later, the HMF would become the HSR systemwide heavy maintenance workshop. The HMF is likely to support the following activities:

- Assembly, Testing, and Commissioning**—During the pre-revenue service period, the HMF would be responsible for the assembly, testing, acceptance, and commissioning of the HSR system's new trains. Implementation of the testing, acceptance, and commissioning activities would require a mainline test track between 80 and 105 miles in length, connected directly to the HMF. This would also accommodate the equipment decommissioning or retirement of equipment from the system to make way for the future generations of trains.
- Train Storage**—Some trains would be dispatched at the HMF prior to start of revenue service.

- **Service Monitoring**—Service monitoring would include daily train testing and diagnostics of certain safety-sensitive apparatus on the train in addition to automatic onboard and on-ground monitoring devices.
- **Examinations in Service**—Examinations would include inspections, tests, verifications, and “quick” replacement of certain train components on the train. Examples include inspection and maintenance tasks associated with the train’s pantographs and running gear, such as bogies<sup>6</sup> and underbody elements.
- **Inspection**—Periodic inspections would be part of the planned preventive maintenance program requiring specialized equipment and facilities. Examples include examination of interior fittings and all train parts, passenger environment, in-depth inspection of axles and underbody components critical to train safety, and wheel condition diagnostics and re-profiling (wheel truing).
- **Rolling Stock Modifications and Accident Repair**—Rolling stock modifications and accident repair would include major design modifications for improving safety, reliability, and passenger comfort.
- **Overhaul**—Part of the planned life cycle maintenance program, overhauls require a specialized heavy maintenance shop with specific heavy-duty equipment. Activities would include the complete overhaul of train components. Overhauls may be completed on each trainset every 7 to 10 years (30-day duration per trainset).

The HMF would require approximately 154 acres, including buildings, outdoor service areas, storage, roadways, and parking. The proposed HMF site is centrally located along the HSR system to accommodate direct connection with 80 to 105 miles of high-speed mainline test track for HSR fleet testing, acceptance, and commissioning. A single, gated entry would control road access to the HMF. A two-way, 24-foot-wide circulation road would follow the facility’s interior perimeter and a 50-foot-wide asphalt apron would surround the main shop building to provide emergency vehicles access to the structure. Exterior lighting would be angled toward the ground to limit reflectance and light pollution/spillage outside the facility grounds, and would incorporate fixture hoods/shielding, cutoff angles, and minimum necessary brightness standards consistent with operational safety and security requirements. Where both physically feasible and operationally appropriate, HMF exterior lighting would also include the use of switches, timer switches, or motion detectors, as necessary, to minimize the duration of outdoor lighting.

About 1,200 to 1,500 employees could be accommodated during peak shifts, including overlapping personnel departures and arrivals. The HMF would require parking for approximately 1,200 vehicles based on an estimate of 80 percent automobile share; and assuming 20 percent of employees would use public transportation or ride-share. In addition, up to 150 parking spaces near the facility would be available for management and administrative personnel, visitors, and deliveries. Some crew, rolling stock preparation personnel, and train yard employees would park their automobiles near the yard tracks. Thus, HMF parking plans would include parking spaces for approximately 50 crew, 50 rolling stock preparation personnel, and 150 yard support employees at full build-out.<sup>7</sup> A pedestrian bridge over the train yard tracks would connect the employee parking lot to the main shop building.

In the Merced to Fresno Section, five potential HMF site alternatives were under consideration, four of which are located in the vicinity of the Central Valley Wye alternatives. The site sponsor withdrew one of these four alternatives from consideration, the Harris-De Jager HMF site alternative, leaving three HMF site alternatives along the Central Valley Wye alternatives that would be further evaluated: the Kojima, Gordon-Shaw, and Fagundes HMF sites. The Authority

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<sup>6</sup> A bogie is the assembly that carries the wheels, brakes, suspension, etc. of the train.

<sup>7</sup> The contractor would build the HMF to meet the necessary requirements for rolling stock and a variety of maintenance activities needed. The entire site would be acquired, but the internal functions may be constructed over time.

and FRA evaluated another five potential HMF site alternatives in the Fresno to Bakersfield Section.

Selection of the HMF location would occur after completion of the Draft Supplemental EIR/EIS. From an engineering, planning, and logistics perspective, the ultimate selection of the HMF site must be consistent with Authority and FRA decisions on the north-south alignment through the Central Valley and the Central Valley Wye alternatives. This is because the approximately 290 miles of track constituting the north-south alignment in the Merced to Fresno and Fresno to Bakersfield Sections and the Central Valley Wye in the Merced to Fresno Section are subject to greater siting limitations than an HMF facility site. The selected north-south and alternative alignments are the drivers for establishing the HSR system, and a decision on these alignments would greatly influence the process for determining which HMF alternatives continue to be viable. Conversely, the location of any one HMF alternative does not influence selection of HSR alignment alternatives.

### **Operations Control Center**

The HMF could house the Operations Control Center on its second floor and provide space for employee parking, pedestrian access/egress, and appropriate bathroom and lunchroom facilities. Housing the Operations Control Center in the HMF would minimize costs and impacts because it would not increase the HMF's footprint or require a separate building. If not housed on the HMF site, the Operations Control Center would be housed in an office building where adequate and reliable electronic data are permitted for up to 200 employees.

### **Terminal Storage and Maintenance Facility**

Terminal stations of the HSR system would include storage and maintenance facilities to supply inspected and serviced trainsets at the beginning of each day of revenue service. The development of terminal storage and maintenance facilities is based upon implementation of the current phases of the HSR system. Changes in service plans and phasing may alter the development of terminal storage and maintenance facility sites. For example, an incremental phasing step toward the IOS may operate a temporary terminus at Palmdale. In this case, a terminal storage and maintenance facility at Palmdale may not be necessary if the HMF could maintain equipment, provided there were adequate storage tracks at the Palmdale terminus. Terminal stations would evolve with build-out of the system operating service segments, as follows:

- **IOS**—San Fernando
- **Bay to Basin**—San Jose (Gilroy) and San Fernando
- **Phase 1 Blended Service**—San Francisco, San Jose (Gilroy), Palmdale, and Los Angeles (San Fernando)

There would be no terminal storage and maintenance facility in the vicinity of the Central Valley Wye alternatives because the alternatives are not near an HSR terminus.

## REFERENCES

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