



setec ferroviaire



**Evaluation of an Alignment
for the California High-Speed
Rail Project Bay Area to
Central Valley Segment**

**Submitted to the
California Rail Foundation
Sacramento, CA**

April 25, 2010



setec ferroviaire

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To Richard Tolmach

Subject : California HSR

Dear Richard,

The California Rail Foundation has retained SETEC to provide research on technical issues in connection with public comments on the Bay Area – Central Valley High Speed Rail Final Program Level EIR.

I thank you for having chosen SETEC.

Please find enclosed the proposed SETEC final report (version 4 dated April 25, 2010).

I hope this report will be helpfull.

Yours sincerely,

Signature

**Philippe Voignier
General manager**

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1. Introduction

A public comment period is proceeding on the Bay Area–Central Valley High Speed Rail Program Level Environmental Impact Report, which considers alternative alignments on the San Francisco to Merced portion of the California High Speed Authority (CHSRA) project.

The following map shows alternative high-speed rail routes in Northern California as they were originally presented by CHSRA.



The California Rail Foundation has retained SETEC to provide research on technical issues in connection with public comments on the Bay Area–Central Valley High Speed Rail Final Program Level EIR. Two main issues are at stake:

- ✓ Altamont Corridor alternative route
- ✓ Viability of train-splitting

2. Altamont Corridor alternative route

2.1 Caveats / Preliminary Remarks

Our professional opinion on a proposed alignment is based on the assumption that California procedures and regulations will permit modern railway design and operation. The figures we have developed are reliable for European economic conditions and are given for comparison. Their absolute values are not to be considered reliable at this stage.

SETEC have sought to develop an alternative high speed route worthy of consideration for program level environmental review, by examining basic feasibility from engineering, operations and environmental points of view. The alignment presented is not to be considered a fully developed plan, but one that appears entirely feasible and that deserves further, more detailed studies.

To determine feasibility, we have examined a range of relevant issues including

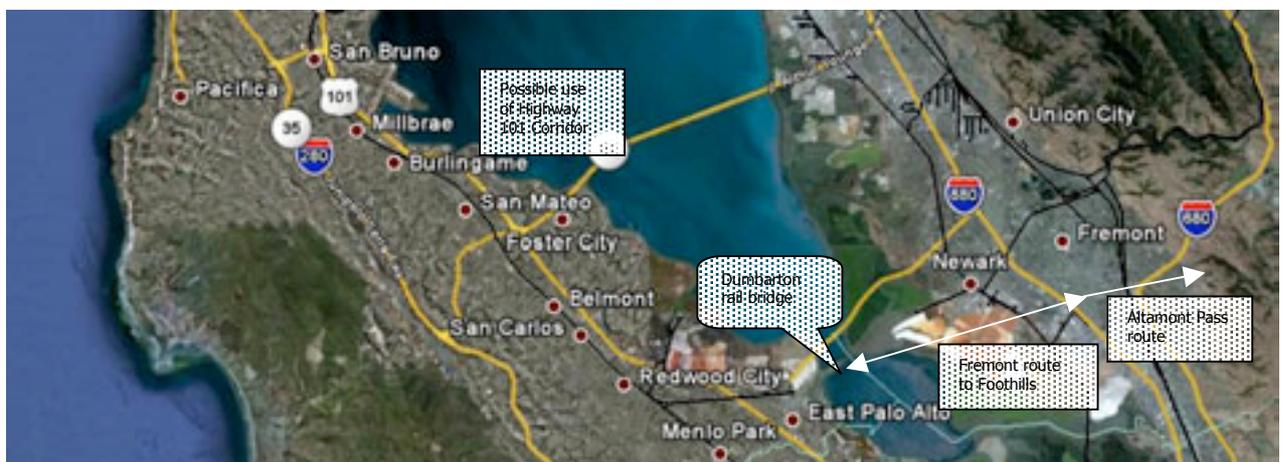
1. Constructability
2. Adequate commercial speed
3. Cost-effectiveness
4. Lack of fatal flaws
5. Compatibility with adjoining land uses
6. Positive environmental characteristics compared to other alternatives

On this last matter of environmental impacts, we have done significant comparison of the proposed new alternative with the characteristics of the Pacheco Line previously advocated by the California High Speed Rail Authority.

2.2 Altamont Route

The Altamont route includes the following components:

- ✓ Possible use of Highway 101 Corridor from So. San Francisco to Redwood City
- ✓ Dumbarton Rail Bridge and line to junction at Redwood City;
- ✓ San Jose rail connection from Fremont;
- ✓ Fremont route alternatives between Bridge and foothills;
- ✓ Route from Fremont to Altamont Pass area.



2.3 *Dumbarton Rail Bridge*

The existing Dumbarton railway bridge is a short 0.5 mile structure, but the alignment makes a 4.0 mile crossing primarily on an embankment over bay wetlands bisecting former saltworks. The facility was originally intended to be a double-track passenger line and has sweeping 6000 foot curves approaching the Bay on each side. The steel bridge was built in 1910 but has been unused and unmaintained since 1982. 1400 feet of its western approach collapsed in a fire in 1998. It is a double track bridge with a non-ballasted metal deck, but had only the north track installed. Its swing span has been left in the open position.



Subject to condition diagnosis, the existing bridge would likely require a complete rebuild:

- ✓ deck structures approaching the metal bridge allow for only one track, aimed at the north side of the structure,
- ✓ the structure would have to be reworked to sustain current traffic loads, dynamic and seismic requirements.

Two solutions are possible for a new rail bridge across the San Francisco Bay at Dumbarton:

- ✓ a lift-span or a draw-bridge,
- ✓ a high central pier structure like the adjacent Dumbarton highway bridge (photo below).



The Dumbarton highway bridge carrying Route 84 has a central span of about 104 m (341 ft) which allows a marine channel of 90 m (295 ft) wide and 35 m (115 ft) high. This bridge is situated not far north of the existing rail bridge. Although the rail bridge has a maritime channel of less than 140 ft, and we have received information from the U.S. Coast Guard that there is no significant commercial traffic of any sort through the narrow opening, some have asserted that a replacement bridge would need to provide a clear 295 ft marine channel.

A 295 ft maritime channel access would be too wide for a drawbridge. If this requirement is sustained by authorities, the most reasonable solution may be to build a lift-span bridge or a high-central pier bridge similar to the Route 84 bridge.

Prospects for workability of the lift span on such a high structure are very unlikely. The lift speed of the span is about 0,5 to 0,7 m/s. The duration of a lifting operation is for example in Europe:

- ✓ 5 minutes for the new motorway bridge over the Seine in Rouen: a 100 m (328 ft) span to be lifted 55 m (180 ft),
- ✓ 10 minutes for the Bastide Bacalan bridge over the Garonne in Bordeaux: a 120 m (393 ft) span to be lifted 55 m (180 ft).

The capital expenditure of construction of a lift-span for a bridge of 800 m (2625 ft) is about 20% more expensive than the cost of high central piers. The operation expenditure of a lift-span bridge is also higher.

For these reasons, the small incremental capital cost of a high central pier structure, similar in form to the nearby bridge of SR-84, appears worthwhile, especially in light of the relatively low cost of upgrading the remainder of the 4.0 mile crossing. From a European perspective, it seems inconceivable that such a simple and short bridge would be considered a financial or technical hurdle. There appear to be no significant design, engineering or seismic issues which would make the cost of this short bridge a prohibitive factor or fatal flaw.

2.4 Altamont – San Jose Connection

The focus of this SETEC consultation was to investigate the feasibility of connecting San Francisco to the Central Valley via the Altamont Pass. However, trains coming over the Pass will also need to be able to access San Jose as well. While our study of this issue has been only superficial, we suggest further review of the following options:

- 1). The HSRA, in conjunction with the San Joaquin County Rail Authority, recently conducted a scoping process for a project to improve the Altamont Commuter Express. Any option being considered there should be studied to complete the Fremont to San Jose leg of an Altamont HSR Alternative.
- 2). The public already owns an unused rail right-of-way stretching from Fremont to San Jose. With the costs for the proposed San Jose BART extension continuing to grow, perhaps the time has arrived for civic leaders to reconsider this project. The right-of-way could be shared by both High-Speed Rail and regional transit, if the project were redesigned to use HSR-compatible equipment similar to the EMUs Caltrain is planning to use. A three-track structure should be considered, to allow HSR trains to overtake regional trains.
- 3). If a joint project were considered, a route variant should be explored that would pass through the population center of North San Jose, providing access to the Golden Triangle employment area and the San Jose Airport. This would greatly improve ridership.
- 4). In the previous FEIR, HSRA rejected as infeasible a Fremont-San Jose route running along Interstate 880, an existing impacted corridor with adequate space for elevated structures within its right-of-way. Given our analysis of the feasibility of the Highway 101 Corridor, this potential HSR route also deserves reconsideration. It appears that it would allow a rapid trip to downtown San Jose downtown, within an existing high-volume transportation corridor.

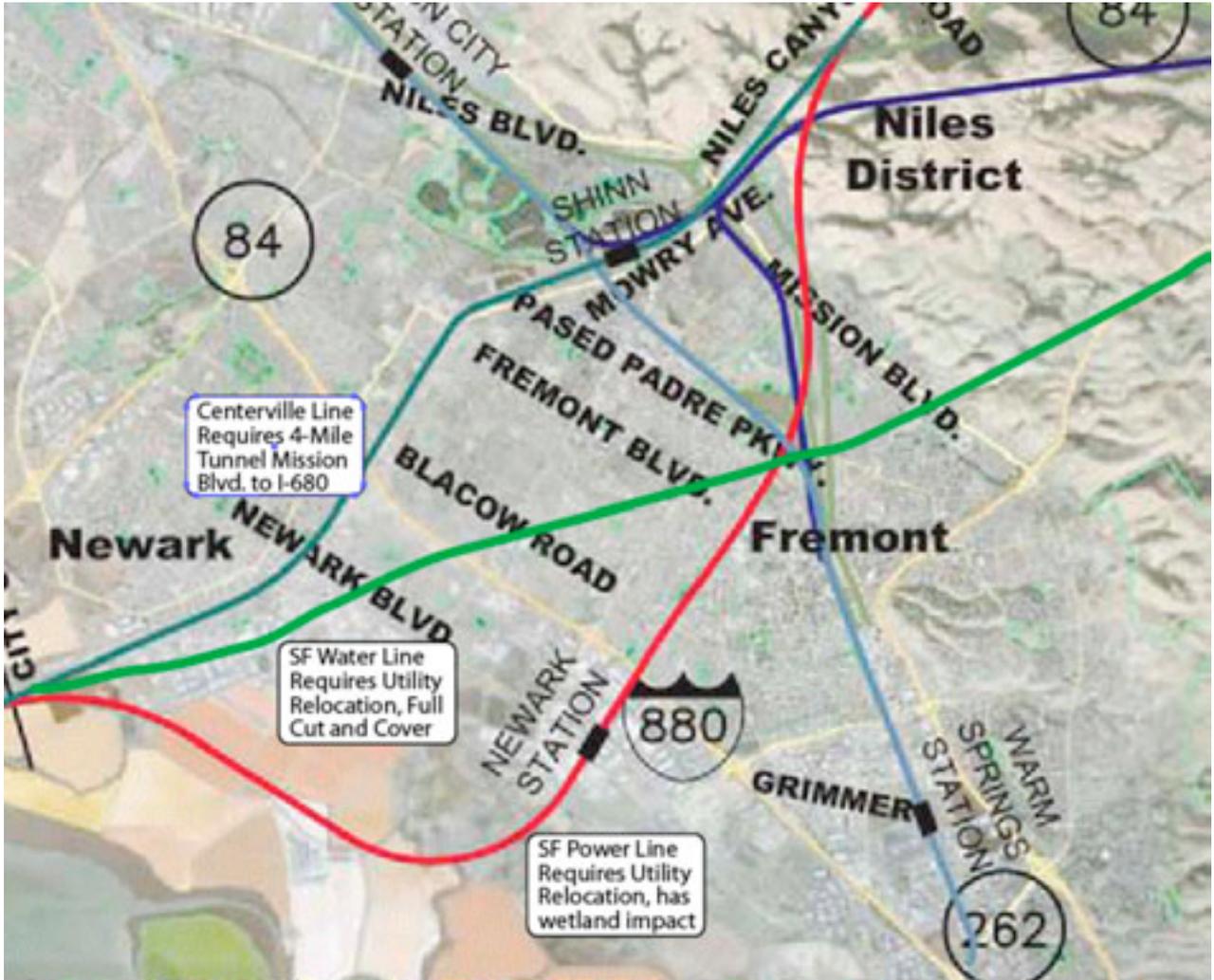
An Altamont connection to San Jose provides a real advantage for the commercial operation and appears to be a valuable corridor. Indeed, the population of San Joaquin and Sacramento Counties would be able to go to the San Jose region without making a long detour through Modesto, Merced, Los Banos, Gilroy and Morgan Hill.

No matter which route is selected to connect Fremont with San Jose, later in this report we have demonstrated the benefits of splitting trains to achieve frequent yet cost-effective HSR service to San Jose.

2.5 Routes through Fremont

There are three likely routes through Fremont between the Bay and the foothill crossing:

- ✓ Fremont route along San Francisco PUC power lines ;
- ✓ Fremont route via Centerville Line ;
- ✓ Fremont route along the San Francisco PUC water line.



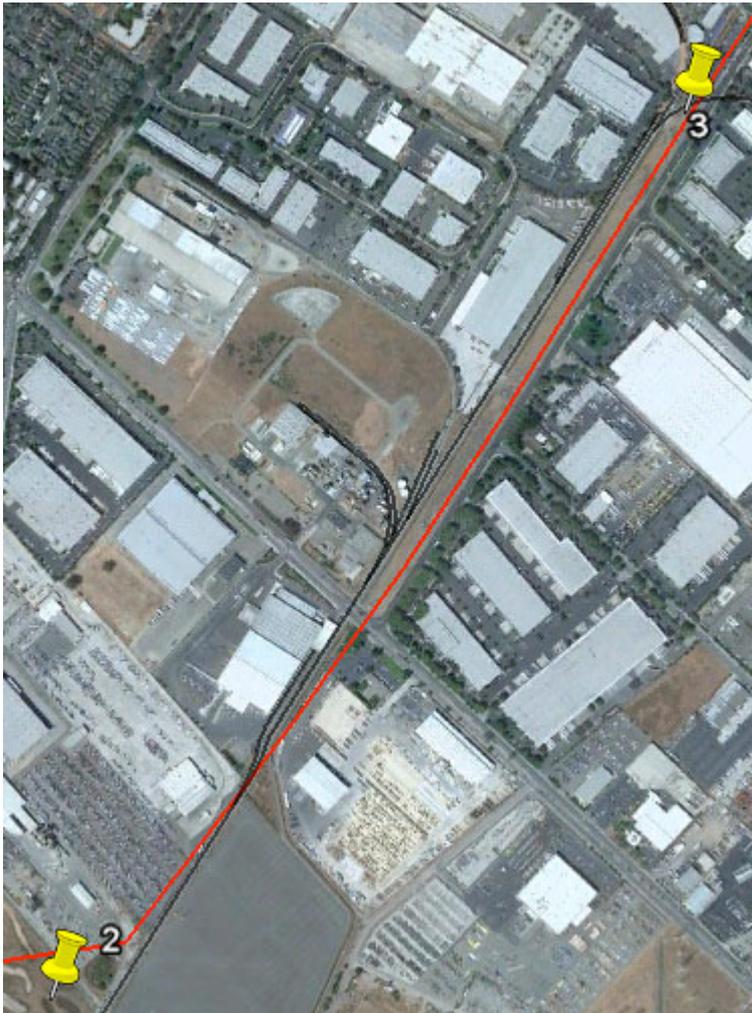
2.5.1 Fremont route along power lines



The route along power line is divided into several steps:

1) Between point n°1 and n°2: the route would go along power lines through abandoned salt ponds.





2) From point n°2 to point n°3 the route would require an over-crossing of an existing railway route.

The alternative high speed route could take this existing route along about 1 mile (until point n°3).

The width of the path is about 74ft.

Traversing the Mulford Union Pacific line involves avoiding a diamond crossing.

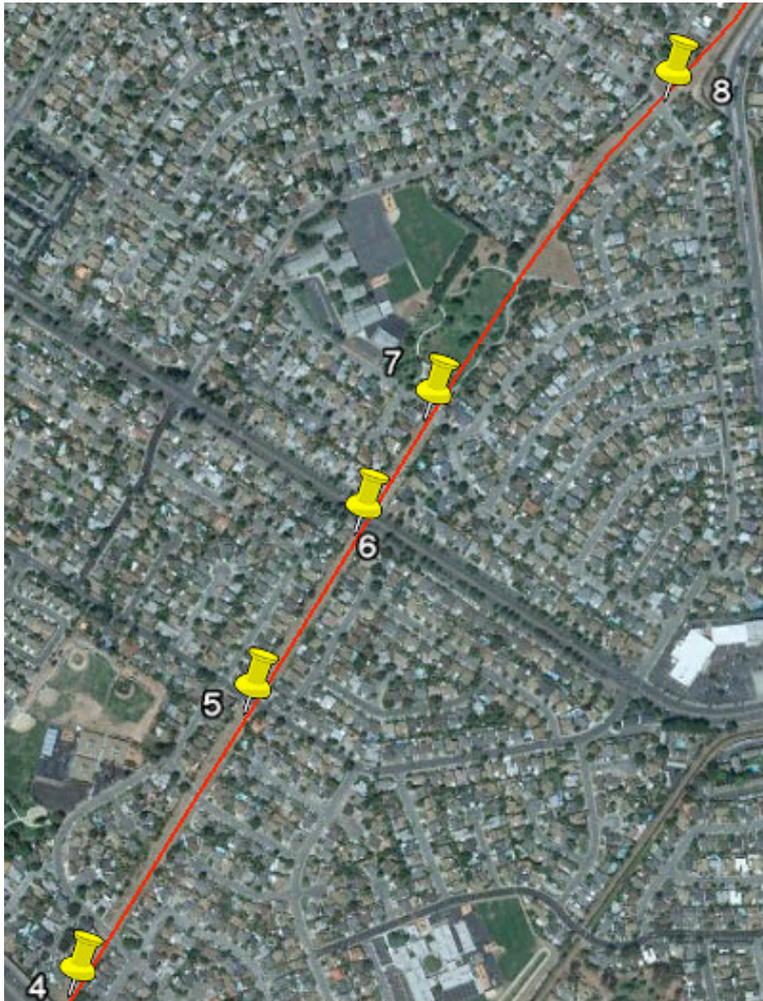
An elevated structure through this area would largely avoid agricultural impacts and should virtually entirely avoid habitat fragmentation impacts.

This option also solves the problem of aquatic impacts.

3) From point n°3, the existing rail route goes toward the southeast and the HSR route continues toward northeast direction through light industrial land uses.

Then, from point n°3 to point n°4, the route has to cross highway 880. Because of the configuration of this area, from this point eastward a tunnel would be very advantageous. Further study is required to determine relative costs.





4) From point n°4 to point n°8, the pillars of the high voltage grid take up all the path width. Hence, there is no simple way to a cut and cover section on this alignment without rebuilding the power structures with modern pole infrastructure.

A cut and cover section would have the least negative impacts on the neighborhoods surrounding this line, but it clearly would be a higher cost solution than the water line alternative.

5) At points 5, 6, 7 and 8: four major streets would require special measures to retain traffic flow during construction of a cut and cover section.

6) Then, between points 8 and 9, the HSR route has to cross an extended set of commercial parking lots for about 0,6 miles, best done via cut and cover.

7) At point n°9, an undercrossing of *Fremont Boulevard*, a high volume arterial would be required. From this point eastward to point n°10, an enclosed structure emerging from the ground could be considered because an unbroken 1800 foot path appears available for this transition.

East of point°10, the line traverses the Hayward Fault and can come very close to the planned BART Irvington station, so there are advantages to being above ground for a few hundred yards before finding a path for a beginning of a drilled tunnel into the hills.



8) Like at point n°9, a level crossing is not possible for the crossing of *Paseo Padre Parkway* (point n°10).

Another elevated structure may be taken into account, with the potential impacts it involves.

Alternatively, in order to avoid impacts on neighborhoods a tunnel could be drilled all the way from points 3 to 11. Indeed, this option avoids the high voltage line if it is infeasible to revise its supports to do a cut-and-cover section. Moreover, a drilled tunnel would significantly decrease the noise and visual impacts.

9) Between 11 and 12, the HSR route has to be:

- ✓ built either on a golf course or a set of houses, parallel to the existing railway track,
- ✓ linked to this existing railway track,
- ✓ built on elevated structure.

The choice of the solution depends on additional study.

Then, for the crossing with the Mission Boulevard (point n°12), the extension of the existing structure has to be foreseen if the HSR route is built next to the existing track.



10) To finish, from point n°13 to the link to the existing track East of Fremont, the HSR route goes, for the first time since the entrance of Newark, through an uninhabited area.

In conclusion, the HSR route along the power line seems to have greater problems than the two next alternatives discussed, because of the current configuration of the affected area.

For this alignment of approximately 9 miles the induced costs could be very significant because of the need for structures to avoid freight tracks and for work to modify power lines to allow passage of the line.

Maximum operation speed should be less than 124 mph according to the Technical Specifications for Interoperability (TSI) of the European railway network.

2.5.2 Fremont route via Centerville Line

This route has a potential connection to the BART network at Shinn, which had been studied as a connection with commuter trains and the Capitol Corridor, but because of potential conflicts with freight uses, it should only be seriously considered if an accommodation can be reached with Union Pacific, to allow conversion of this 5 mile segment to an exclusive passenger line.

At present, the Union Pacific tracks are used by up to about 20 daily passenger trains but only occasional freight. It is perhaps a convenient location for the railroad to store equipment, but generates no significant freight and is not the best connection between any key facilities. From the point of view of operation, freight interaction would be a major negative impact, slowing speeds and reducing slots.

Joint use would also entail unnecessary maintenance problems and should be resisted.

On the other hand, if the line were to become available for purchase, it might prove an attractive opportunity. In the 1990's Southern Pacific attempted to sell the track to the State of California because it lacked economic importance to the railroad.

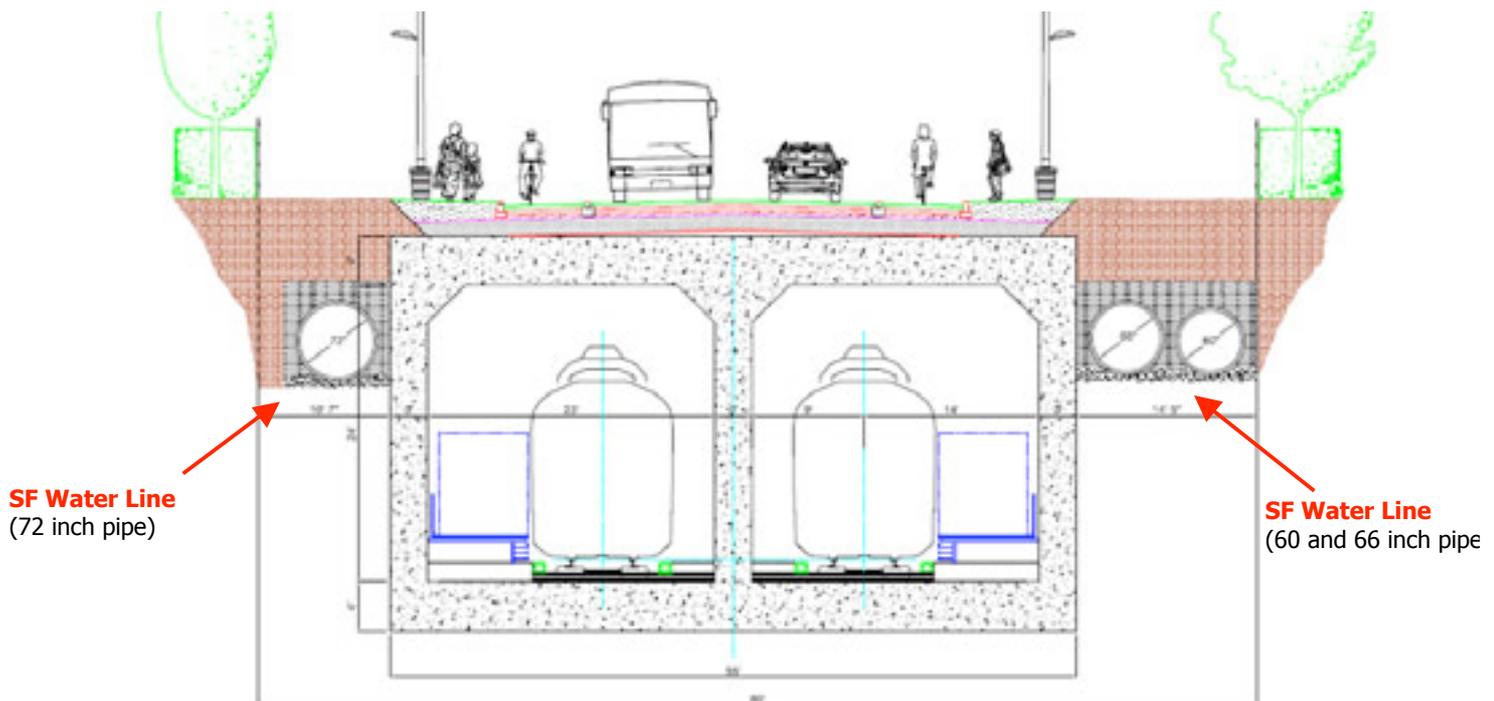
2.5.3 Fremont route along Pipeline Easement

This route alternative would use an existing impacted corridor and a space where the only current use is two to three pipelines of the San Francisco Water District. So no homes would be taken for the construction, and there appears to be adequate vertical and horizontal space to allow both trains and water pipes in the right of way, with the water lines fully available for maintenance. Construction could be staged for continuous availability of the water facilities.

One of the main advantages of this route along the water line is that it is relatively straight. Consequently:

- ✓ Maintenance cost for the railway infrastructure would be significantly reduced,
- ✓ Speed may be significantly boosted.

Cross section of Fremont route along SF PUC Water Line according to Section AP-4 (EIR/EIS – Appendix 2E):



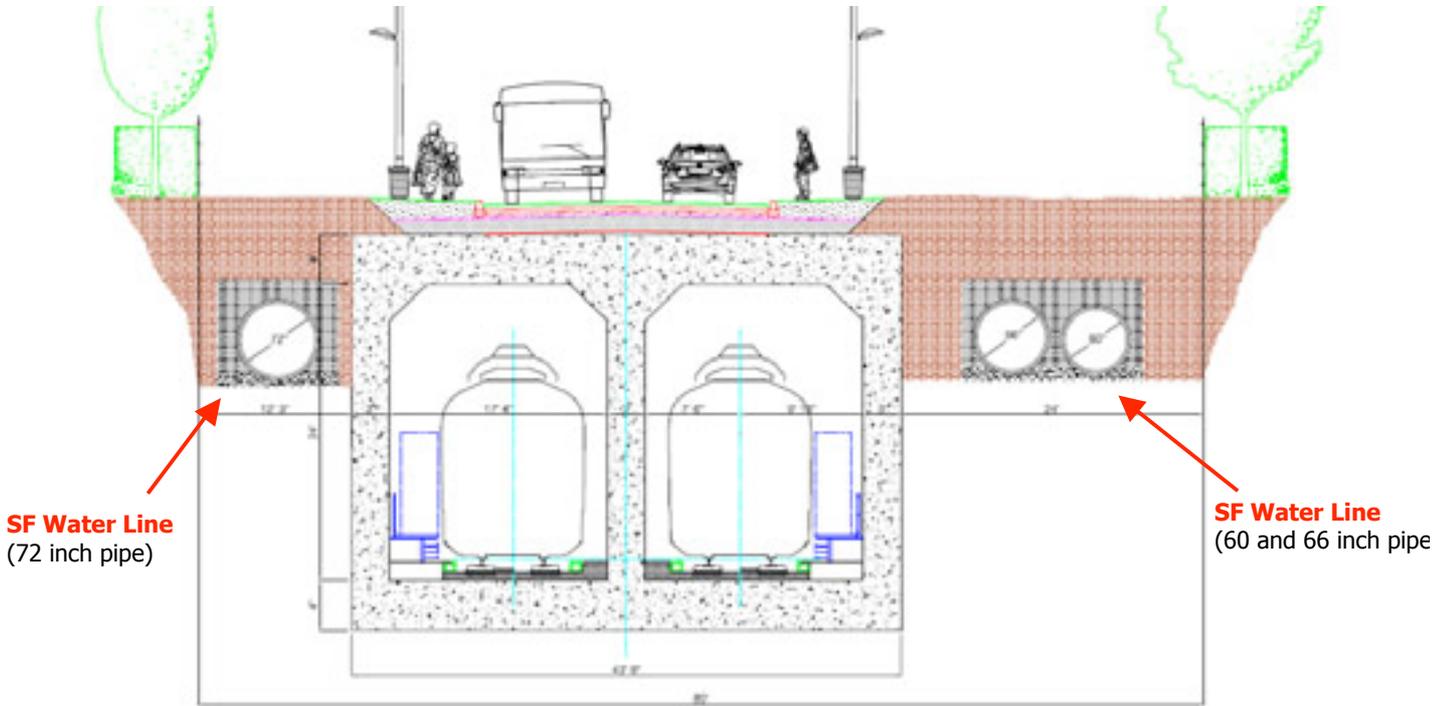
(See appendix B)

The SF Water Line right-of-way is owned outright by the San Francisco Water District, which is interested in retaining it, because it is the optimum path toward its newly planned transbay water tunnel. The path is approximately 24 m (80 ft) wide; and two water lines of 60 and 66 inches occupy a section of the right of way. A new 72 inch water line is being constructed to provide redundant capacity.

To make the cross section on the above drawing we used the plans of the Appendix 2E of the Program EIR/EIS. However, according to various similar situations in the railway network in

Europe, the space allowing the passage of trains can be narrowed. So the released space would be a bigger zone for water facilities.

According to French standards, the cross section of Fremont route along SF Water Line could be the following one:



(See appendix C)

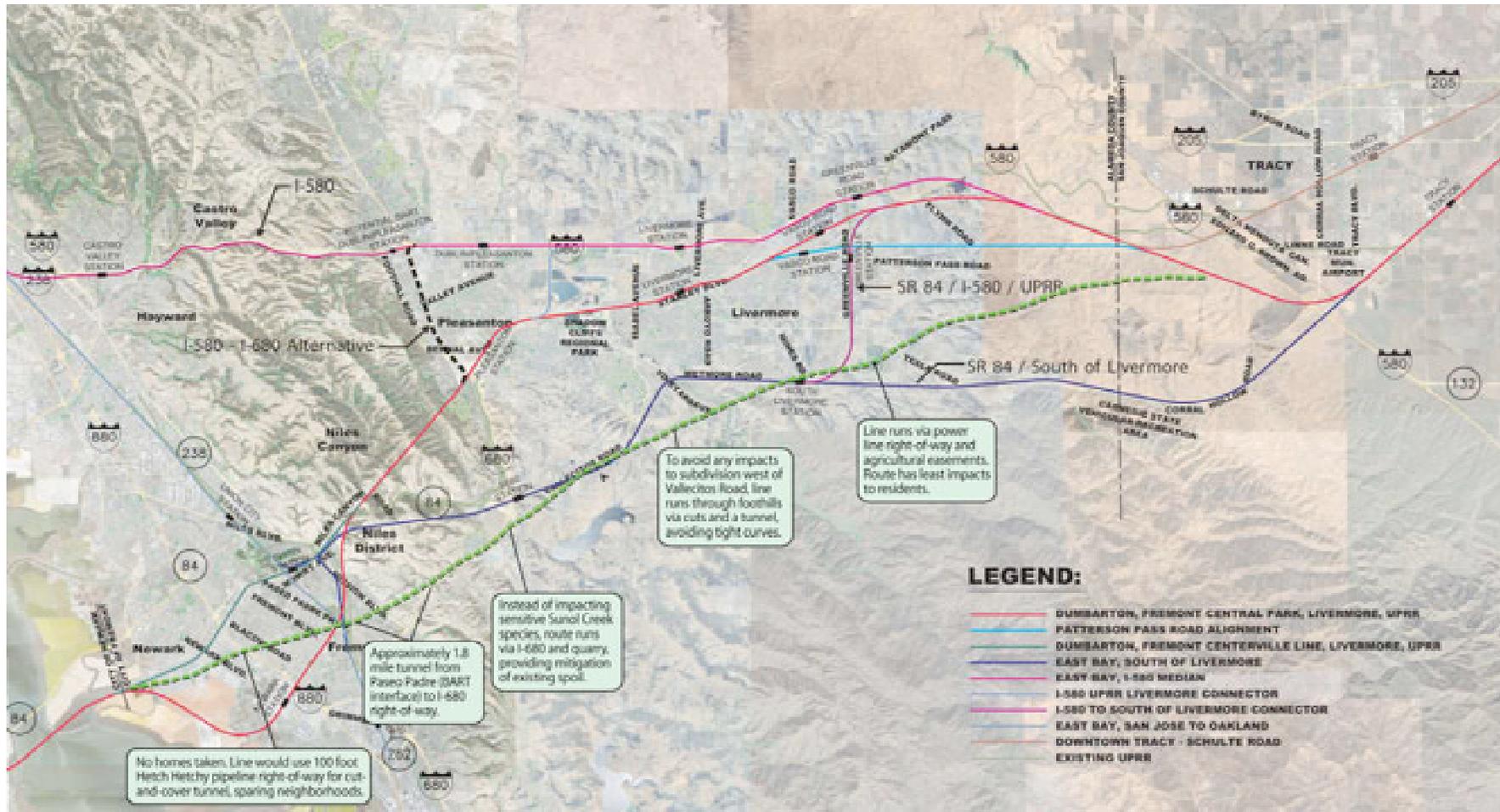
2.6 Synthesis

Criteria		Altamont route		
		Inside Fremont		
		Along power line	Centerville line	SF water line
Operation criteria	Traffic mix	The HSR route is near an existing railway route for approximately 1 mile in an industrial area (freight transport).	The HST will have to run on the Union Pacific track where freight transports and interurban trains run.	It is a new railway alignment so HSR trains are going to be the unique category of transport on this route.
	Maximal speed	It is approximately 125 mph if we consider only the circulation of HSR trains. But the speed is limited due to structures, curves and grades.	It is approximately 93 mph if we consider only the circulation of HSR trains.	It is approximately 170 mph.
	Travel time			
	Station	Newark Station	Shinn Station	A station may be built between the bridge and the boundary of Fremont. There is enough space for a station with car slots for the passengers.
Environmental criteria	Impacted corridors.	The HSR route follow an existing impacted corridor (the power line)	With this route, there is no additional nuisances because the HSR trains will be firstly on the Union Pacific tracks and then in a 4-Mile tunnel.	This corridor already exists. And the additional nuisances due to the HST traffic will be reduced because the HST route will be in cut-and-cover tunnel.
	Visual impact	Little visual impact due to HST being mostly underground		No visual impact because the HST route will be under the ground.
	Noise	Sound impacts for the closest residents.	No	No
	Real estate impact	There is a real estate impact, for example, when the route will run through the countryside (entrance of Fremont) or between Davis Street and Fremont Boulevard.	No, because the HST route will join an existing line.	The corridor is already occupied by the SF water line. So HST route and SF Water Line will have to share the same ground coverage.
Investments	Conditions of realization	Major sections of cut-and-cover tunnel are required. Some structures have to be designed.	Negotiations with the railroad would determine if purchase of the route is possible.	A full cut-and-cover tunnel has to be designed.
	Infrastructures and length	The construction of 2 tunnels or several elevated structures is necessary for the crossing of the highway 880, the crossing of Paseo Padre Parkway or between Davis Street and Fremont Boulevard.		
	Elevation			
	Tunnel or cut-and-cover tunnel	Approximately a 4 mile cut-and-cover tunnel		Approximately a 5 mile cut-and-cover tunnel.

2.7 Altamont Pass Route

In order to realize current European standards of operation in developing the design of a new Altamont Pass route (between Fremont and Tracy), we have made the following design assumptions:

- ✓ To provide the fastest Fremont to Tracy travel time, the new line would not deviate to serve the centers of Livermore or Pleasanton.
- ✓ To allow these two centers to be served by planned Bay Area Rapid Transit extensions,
- ✓ To limit the length of tunnels or elevations,
- ✓ To follow existing impacted corridors if possible (highways and power lines) and avoid the new impacts that would be caused by traversing residential areas,
- ✓ To bypass existing Union Pacific rights-of-way to avoid operation conflicts and to avoid being dependent on other services.



Proposed Altamont Pass Alternative Alignment
Green Route: A Higher-Speed, Lower Impact Alternative

HSR Infrastructure Expertise

Consequently: the route which is considered by SETEC is a route which will eventually allow a 215 mph speed. However, the preliminary design alignment delivered by SETEC today allows a speed of 185 mph. We are confident that this route could be optimized in subsequent design refinement in order to reach a speed of 215 mph.

VITESSE	Coeff. K	Dévers Max	Insuffisance		Variation Dévers : g		Variation Insuffisance:dl/dt	
			normale	exceptionnelle	180/V	216/V	normale	exceptionnelle
350	1100000	180	65	80	0,51	0,62	30	50

Flèche	Rayon	Dévers					I	LONGUEUR RP						
		théorique	K/R	fonction g (R-100)/2; (R-150)/2; (R-250)/3	RETENU			fonction ? d/? L	fonction ? d/? L (except.)	fonction dl/dt	fonction dl/dt (except.)	max normal	max except.	RETENU
7,7	6500	222	169	3200	169	53	329	274	171	103	329	274	330	274

On this preliminary design alignment, there are approximately:

- ✓ 3.56 miles of embankment,
- ✓ 7.75 miles under tunnels and 5.10 miles of cut-and-cover section.

It may be possible in subsequent design refinement to increase the amount of embankment and structures, while decreasing the length of tunnels, particularly in the Patterson Pass area.

Instead of impacting sensitive Sunol Creek species, the proposed route runs via I-680 and a quarry, providing mitigation of existing spoil.

This route parallels a high voltage grid for the majority of the mileage between Fremont and Tracy. Thus, an impacted corridor is used, particularly through the southern Livermore Valley (nevertheless, this corridor will have to be widened); the HSR route will use earth berms or other noise barriers to mitigate any sound impacts to residents closer than 1 mile.

Finally, with this route, the distance between Fremont and Tracy is approximately 31.5 miles, while the HSRA's most recent route linking Fremont Centerville, and Livermore via UPRR rights of way is approximately 40 miles.

See the attached documents (Appendix A).

HSR Infrastructure Expertise

Criteria		Altamont Routes	
		East of Fremont	
		Dumbarton, Fremont Centerville, Livermore, UPRR	SETEC's proposed alignment
Operation criteria	Traffic mix	HST will have to share an existing route with freight and passenger trains.	It is a new railway alignment so HSR is going to be the unique category of transport on this route.
	Maximum Speed	Maximum speed is approximately 217 mph (between Vasco Rd. and Tracy) but there are many sections where the speed has to be reduced (for instance, around Pleasanton Station : V=80mph).	The route is relatively straight, and allows maximum speed of 217mph on the entire alignment between Fremont and Tracy
	Travel Time		
	Station	3 stations : Pleasanton, Livermore and Vasco Rd. but these are very closely spaced: 7 miles and 3 miles respectively.	No new stations for minimum impact. Or, if necessary, a station may be designed south of Livermore.
Environmental criteria	Impacted Corridors	A new impacted corridor between Vasco Road Station and Tracy.	New railway route, so a new impacted corridor is created, but this route follows existing impacted highway and power line corridors.
	Visual impact		
	Noise		
	Real estate impact	Only between Vasco Rd. and Tracy	Important real estate impacts because HST route does not adjoin an existing railway.
Investments	Conditions of realization		
	Infrastructures and length		
	Elevation	Approximately 3.48 miles of embankment	Approximately 3.56 miles of embankment
	Tunnels	Approximately 6.34 miles of tunnels.	Approximately 7.75 miles of tunnels.

2.8 Dumbarton Bridge – SFO Airport route via Highway 101

Using the Altamont Corridor from Tracy to Redwood City would provide more rapid access to the Bay Area than Pacheco, meaning that conventional-speeds (79 mph) operation would become feasible between Redwood City and San Francisco.

If Altamont is used, construction of a four-track grade separated line would not be required on the Peninsula, but the additional trains would still have some impacts upon neighborhoods north of Redwood City. Because of these impacts, San Mateo County communities are interested in study of feasible alternatives, which have not been specifically examined in regard to Altamont.

Of the two highway corridors (Interstate 280 and Highway 101) preliminarily examined as an alternative to Caltrain between Redwood City and northern San Mateo County, Highway 101 appears to have more promise because it intersects the Dumbarton Bridge Caltrain tracks and also offers the potential of directly serving the San Francisco International Airport before rejoining the Caltrain corridor.

San Francisco International Airport (SFO) is located 13 miles south of downtown San Francisco in San Mateo County. SFO is the largest Bay Area airport and the tenth largest in the United States. In 2008 the airport served over 36 million annual passengers (boardings and arrivals) and future demand is projected to be more than 60 million passengers by 2035.

Access to SFO is presently a major source of traffic congestion on Bay Area highways and is one of the most significant traffic generators on Highway 101. A railway solution that would provide a direct link to SFO's AirTrain peoplemover system seems to be essential to serve regional transportation needs.

Connecting the San Francisco Transbay Transit Center directly with SFO and a 125 mph line to the East Bay, Stockton, Modesto and Sacramento would greatly increase the value of HST service to Northern California.

Using SFO as the hub has especially significant commercial benefits for HST, because of the possibility of code-share travel combining air and rail segments. The airport hub would also enhance the connectivity and accessibility of through HST connections with other transportation services.

The US-101 alignment between Dumbarton Bridge and the SFO Airport is constrained by existing bridges at 12 locations that would have to be traversed by the 15 mile HST alignment. However this highway-alignment solution appears viable (more workable than Caltrain or the other proposed alternative routes) and represents a more advantageous option for several reasons, and above, all in order to optimize HST operation:

- ✓ A dedicated way solely for the high speed train traffic allows the operation to be totally independent from highway crossings, freight trains, and commuter train traffic.

Indeed, no operational conflict would take place, contrary to the option that recommends sharing infrastructure in the Caltrain corridor.

- ✓ Traffic on an elevated structure prevents all the problems of interference with existing CalTrain infrastructure (no level crossing or diamond crossing).

In the French railway network, when a new HST line is designed and built, sharing infrastructure with other train services is avoided as much as possible. The HST is perfectly compatible with the conventional line, but track maintenance tolerances for HST are much more restricted than usual. Other trains quickly damage track geometry and rail surface. Joint use means frequent maintenance works would increase costs and decrease available slots for commercial operation.

So the option of a route on an elevated structure above US-101 allows an optimized HST operation and allows the requirements of project acceptability (especially travel time) to be achieved.

Furthermore, relatively few constraints are induced by the US-101 alignment. Indeed, only two curves just south of SFO airport would require a small decrease of the HST speed. Then, after this zone, the US-101 route is not a limiting factor to reach 125 mph between SFO airport and Redwood City.



An advanced study would allow the possible speed and the required infrastructure to be determined exactly in these two curves, approximating 4000 ft radius and 2500 ft radius. But, even if a reduced speed must be imposed on this short section, this option is nevertheless more advantageous than a route with numerous level crossings and restricted speed areas (as in the Caltrain corridor).

Theoretically, with European standards of superelevation and operation, no slowing of a train from 200 kph (125 mph) would be necessary on a 4000 ft radius, and a train with a speed of 177 kph (approximately 110 mph) may take a 2500 ft radius curve. However, current Caltrain standards are lower, and would further restrict speeds on both curves of such radius below 125 mph.

In conclusion, the most important point which has to be taken into account is the advantages in operation and maintenance cost, as described above. It is true that this solution is going to involve significant construction costs and an urban redevelopment of the US-101 zone during the construction. But, after the works and when the HST will be in use, the maintenance of this line will be reduced in cost because the infrastructure will not be damaged by the freight or other passenger trains (which have greater axle loads).

3. Environmental issues

3.1 Caveats / Preliminary Remarks

First of all, it must be stated that the following considerations are presented according to our impressions, our knowledge and understanding of this project.

Moreover SETEC is very aware of European law and practice, but we do not have the benefit of specific knowledge of USA environmental laws or environmental protection practice.

Data used for this analysis are from:

- ✓ Bay Area to Central Valley Final Program EIR/EIS,
- ✓ Habitat Conservation Plan developed by San Francisco Public Utilities Commission and Alameda Creek Alliance comments,
- ✓ www.fws.gov/desfbay,
- ✓ www.ramsar.org/cda/en/ramsar-activities-wwds-two-new-us-ramsar-sites/main/ramsar/1-63-78%5E22428_4000_0__,
- ✓ www.maps.google.com,
- ✓ www.parks.ca.gov

The impacts of the Altamont alternative performed by SETEC are described from the Caltrain right of way in Redwood City to Highway 99 in Manteca.

Two kinds of impacts may potentially generate issues: impacts upon the natural environment and impacts upon human settlement.

3.2 Natural Environment

3.2.1 *Potential impacts identified for the project and recommended measures*

Major potential negative impacts of a high speed line on the environment (wetlands, parks, forest, etc.) are:

- ✓ destruction of habitats
- ✓ severing of ecological connections

From the west to the east, the observed probable impacts of the Altamont alternative proposed by SETEC are the following.

To begin with, the project has to cross San Francisco Bay in an environmentally sensitive manner. The old Dumbarton rail bridge still exists, but is not currently in use. The Altamont alternative will use the same alignment to reduce impacts on the Bay, unless it can be shown that adjusting the alignment could reduce biological impacts even more. The potentially significant impacts during construction must be handled in a very sensitive way. If it is possible to work entirely from the bridge structure, that would eliminate the need for access roads and the disturbance of sensitive lands. Construction work would be scheduled to avoid breeding and nesting periods.

Cap and beam structures (example photo below) are the predominant bridge crossing type used for San Francisco Bay crossings south of San Francisco.



About 2.5 miles of wetlands in San Francisco Bay, are traversed by existing tracks. Replacing existing rail embankments with cap and beam structures such as the one above would be a significant improvement for the wetland environment.

This new proposed Altamont alternative entirely avoids Niles Canyon and sensitive Sunol Creek areas. The line would cross Sunol Valley between Interstate 680 and quarries south of the Sunol valley golf course. This route follows a corridor that is already heavily impacted by highway noise. Habitats of endangered species according to Alliance Creek area are not located in this area but an existing ecological corridor (red-legged frog and tiger salamander) has to be maintained, which could be handled by a plan to use a viaduct structure, to entirely avoid wet areas in the creekbed.

Only one Park is crossed by the project: Sycamore Grove Park in Livermore. Several solutions will be established to mitigate the impact on this park:

- ✓ paralleling the power lines that go through the park,
- ✓ crossing the park on an elevated structure in order not to sever paths (for riders, hikers and animals): A 0.8 mile viaduct would have only about 0.3 miles crossing the park.

It is important to note that the new proposed Altamont alternative also avoids the other potential environmental issues of the Sunol Regional Wilderness, Alameda Creek, Lake Del Valle State Recreation Area and San Antonio Reservoir.

Moreover, the Altamont alternative parallels road corridors (I-680, SR84,) high-voltage power alignments or existing tracks (approaching Tracy) in order to avoid new fragmentation and to avoid sensitive lands.

3.2.2 Additional measures

Ecological connection

In order to preserve the ecological connection and the hydrologic connection, specific structures would have to be provided. Moreover, the extent of tunnels between Fremont and Tracy and wildlife passages could reduce potential negative impacts upon wildlife corridors. Different types of pathways could be used: culverts, box culverts or more significant engineering such as cap and beam structures or viaducts.

For example, in France, in addition to restoration of primary ecological corridors, it is usual to provide smaller structures to have one wildlife path every 0.2 miles. These kinds of measures improve the ecological transparency of the track.

Examples of wildlife paths under railway:



Conservancy lands and offsetting

Loss of habitats has to be offset by residential developments and conservancy lands.

French practice on this issue is to offset impacted acreage with an equivalent mitigation. The purpose is to find the same habitat to protect or a damaged one to restore. These areas are bought by the client and are given back to local organizations for management.

It could also be to improve kinds of habitats not impacted by the route but which is considered by scientists or environmental activists to be threatened.

Ratio used changes depending on quality or value of the impacted habitat and lands availability.

3.3 Human Environment

3.3.1 Urban area

3.3.1.1 Issues

Several cities are located along the study corridor, including Fremont, Pleasanton, Livermore and Tracy. Many environmental effects are possible issues, but the primary one is noise pollution. Many residences and other activity centers affected by noise pollution (schools, hospitals) are present.

The aesthetic issue is also a potential concern, with the necessity not to create a major disturbance in the landscape.

3.3.1.2 Impacts and measures

The creation of new high-speed rail infrastructure can be a significant source of noise pollution unless projected impacts are carefully mitigated. Although this new proposal is designed to avoid intermediate urbanized areas, there are zones, such as the segment from the Dumbarton Bridge to the foothills east of Fremont where it is necessary to cross about 5 miles of residential neighborhoods.

One measure to mitigate this impact would be to follow the easement of the San Francisco PUC water line traversing the city of Fremont, from South West to North East.

Under this alternative, tracks would be located in a cut-and-cover tunnel. This structure will be approximately five miles long. Thus, there won't be any noise pollution nor visual impacts. Moreover, with this option, there won't be any circulation interruption other than what is necessary for work construction.

However, with this alternative careful planning will be needed to ensure that neighborhoods at the potential East entrance of the cut and cover tunnel are properly isolated from a potential BART-HST transfer station at that site.

Alternative routes through Fremont involve either lower speed service on a converted Centerville Line or a drilled tunnel under the PUC power line easement or another path. These have primarily benign environmental effects but involve higher cost and lower speed. There is a potential that use of the power line easement would entail additional wetland mitigation problems.

A drilled tunnel from the city of Fremont to the south side of Interstate 680 would extend through the foothills: about 2.2 miles if the PUC water line or PUC electric line is used, about 4 miles if the Centerville Line alternative is used.

Most of other urban areas close to the project are entirely avoided. However some districts south of Livermore could be impacted by the proposed alignment:

- ✓ Housing development southwest of Livermore: Ruby Hill, located at about 0.3 miles from the project track. It is important to note that SR-84 is close to this urbanized area and already causes noise and visual impacts,
- ✓ a wastewater treatment plant is located on the track project, after the Ruby Hill development,
- ✓ Individual houses south and southeast of Livermore could be impacted on a segment of about 0.4 miles.

A part of the hills located between Livermore and Tracy are crossed via a cuts or fills.

Tracy would be skirted on its southern extremity, south of the Union Pacific freight right of way.

Many scattered houses or farms are identified along the project corridor particularly in the Central Valley after Tracy.

Other scattered houses or facilities would be encountered:

- ✓ Between Fremont and Pleasanton: quarry and its facilities,
- ✓ Isolated houses south of Ruby Hill (about half a mile),
- ✓ Several isolated houses would have to be taken by eminent domain.

To mitigate noise pollution, berms or other noise barriers could be used.

3.3.2 Cultivated area

3.3.2.1 Issues

Many cultivated areas surround Livermore city. It is principally high valued cultures as vineyard or orchards.

An ambitious program (Tri Valley Conservancy) has been established to preserve agriculture acreage. As well, the project would have to respect the local legislation about agricultural easement.

3.3.2.2 Impacts and measures

South of Livermore, portions of agricultural holdings are impacted by the track. Most of these are vineyards, which are highly valued agricultural uses, and not easily relocated. However, new high-speed lines have been successfully constructed in areas such as Burgundy and other European wine regions running through highly prized vineyards.

A bit more than 17 linear miles of proposed line are adjacent to croplands:

- ✓ 0.4 miles near the Ruby Hill development (primarily vineyards),
- ✓ 4.1 miles south and southeast of Livermore (primarily vineyards),
- ✓ 14.3 miles between Tracy and the connection with the proposed Sacramento – Merced high-speed rail line (primarily row crops and orchards).

A project to conserve agricultural uses has not been formally defined to date; however, it is clear that some compensation measure could be taken, such as establishing as much new cropland as has been taken for high-speed rail (an acre for an acre or more).

Agriculture easements in Livermore could be compared to “Appellation d’Origine Contrôlée-AOC (high valued lands and products with guarantee of origin like vineyards). The French practice is to reduce acreage impacted in these areas with reduction of embankments. However, it is not usual to provide civil engineering structures like viaducts. For this kind of lands, it could be required to offset impacted lands. It is necessary to find equivalent lands (soil, weather conditions) that guarantee the same origin for the product.

For lands under agricultural easements, a similar approach could be used. For each acre impacted, the Client could try to find an acre of equivalent land. Moreover, it is important to provide connection between fields which are cultivated by farmers. For example in France, it is usual to provide one path every 0.7 miles in agricultural areas.

3.4 Comparison of Altamont and Pacheco Environmental Impacts

The segment between San Francisco and Redwood City is not considered because impacts are approximately the same.

3.4.1 Potential of biodiversity

Lacking geographic documentation that precisely locates habitats or endangered species, this comparison couldn’t be about ecological habitat issues but only about potential of biodiversity via a land use analysis.

Firstly, the length of new Pacheco Pass route is two times longer between Redwood City and the future High Speed Rail between Sacramento and Los Angeles. While Pacheco Pass route needs to create more than 60 miles of new route, not following existing corridors, Altamont needs less than 40 miles.

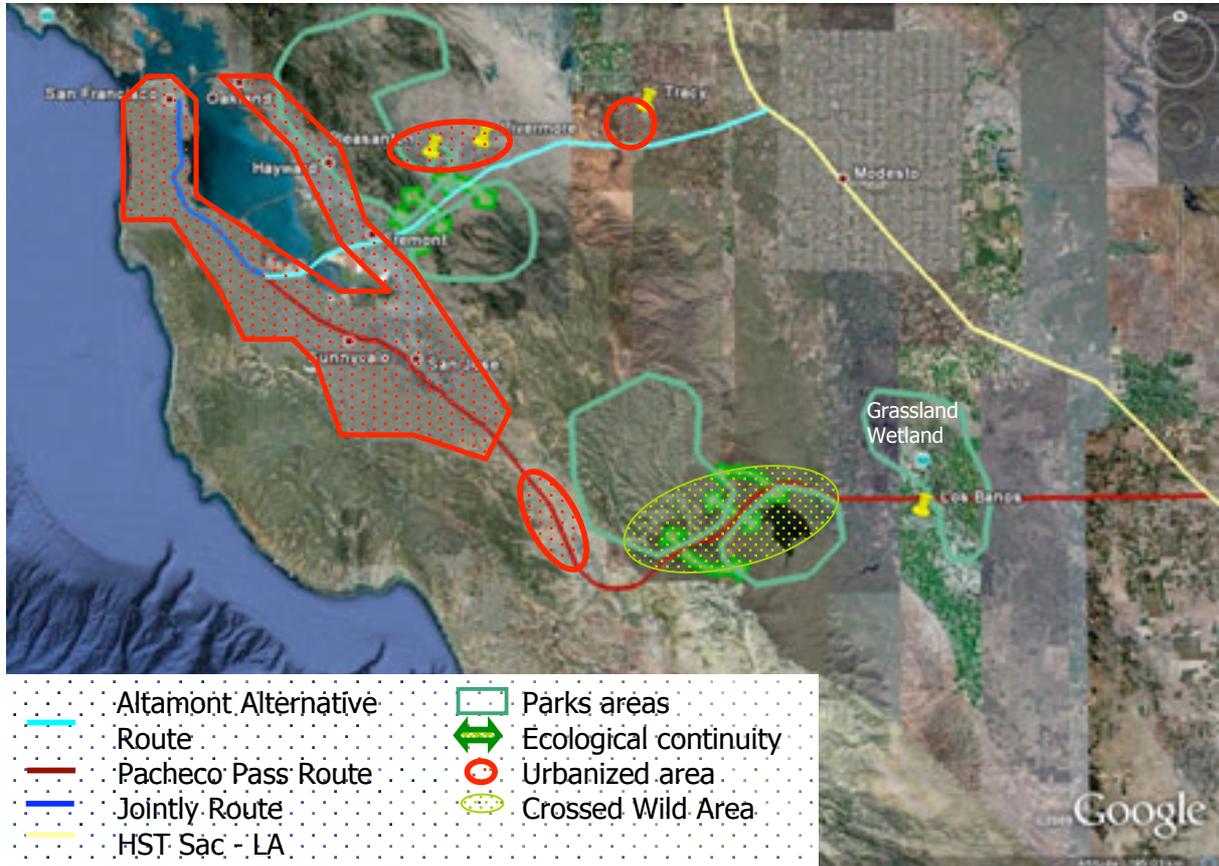
Within protected wilderness zones, areas affected by the Pacheco route are more wooded than those which are concerned by Altamont Area (oak, sycamore, pine). A much more developed biodiversity can be expected from these areas with various habitats.

Although the Altamont alternative route also impacts wetlands (majority on San Francisco Bay) Pacheco Pass route is much more harmful for this high sensitive habitat. The routes go through the Grassland wetlands, internationally protected by the RAMSAR convention. More than 5 miles of this protected area are crossed. In spite of the fact that more than half of this distance is crossed by elevated structure, the route strongly impacts the sustainability of this habitat mostly for the surrounding of protected area. No RAMSAR wetlands are impacted by the Altamont Alternative.

In addition, to join the future HST line between Sacramento and Los Angeles, the Altamont Alternative route goes by an already urbanized way. Many cities are located along the route: Fremont, Dublin, Pleasanton, Livermore, Tracy. Thus, this route will not create a new urbanization spreading across hills, parks and valleys, whereas the Pacheco route crosses a wild area with only occasional human activity presence in a 30-mile segment (from San Felipe to Santa Nella). This fact could induce a new development of urbanization in this area that would be harmful for local biodiversity.

3.4.2 Ecological connections

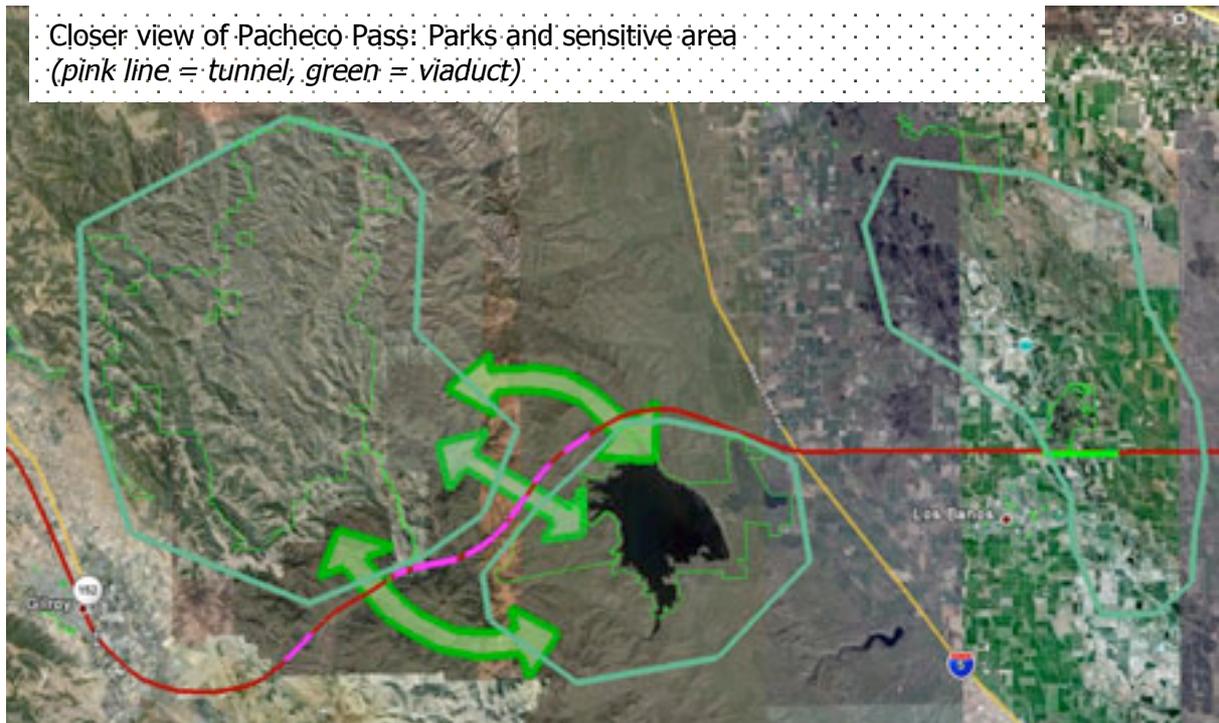
This comparison is also about ecological connection issues that could be approached with the location of main parks and a land use analysis.



The Pacheco Pass route traverses a significant extent of undeveloped lands, located between two large parks:

- ✓ Henry W Coe State Park,
- ✓ Pacheco State Park.

Although these two parks are not completely contiguous and are separated by an unprotected area, an ecological continuity does exist between these two wilderness areas.



The Pacheco Pass route crosses this area in tunnel that reduces the wildlife corridor-severing impacts between the parks. However, part of tracks in wilderness area and close to the area of parks should be considered as an ecological connection. In these parts, Pacheco Pass alternative would extend without any structure and should cut the ecological connections.

The Altamont Alternative also passes near areas of parks. South of the Altamont route, is located the park of Sunol Regional Wilderness. On the North of the Altamont route, the parks are much more scattered, and really smaller. Most identified parks are recreation areas, likely with smaller biological importance than the southern large parks.

The Altamont Alternative also proposes to have segments of tunnel or viaduct or to cross sensitive identified areas.

Zoom Altamont Alternative: Parks and sensitive area
(pink line = tunnel or cut and cover, green = viaduct)



First the Altamont Alternative route crosses between these two areas on a location that is already damaged by a quarry and by an eight-lane highway (I-680). West of the quarry, the Altamont alternative would run in tunnel and then come between I-680 and the quarry. That place should be a less sensitive ecological area. Specific structures should be provided to restore a potential wildlife connection.

Then Altamont alternative would extend through the Sycamore Grove Park on a viaduct that considerably reduces the potential of severing any wildlife corridor.

3.4.3 Agricultural issues

From Gilroy to Chowchilla, the Pacheco Pass route crosses more than 50 miles of agricultural lands. A part of the route (less than a third) uses an existing corridor: Henry Miller Road, but the land division impact caused by a two-lane road is not as significant as a new one caused by a rail infrastructure.

To compare, Altamont Alternative crosses about 18 miles of agricultural lands, on elevated structures for a part of these lands. The design proposed for Altamont takes into account the necessity of connections for farmers and the reduction of impacted acreage. This preliminary design could be refined to mitigate agricultural impacts.

3.4.4 Urban issues

The Pacheco Pass route crosses more than four times the linear mileage of residential areas as the new Altamont Alternative. The Pacheco route runs from Redwood City to Gilroy, impacting residential communities for about 45 miles, versus about 10 for Altamont including about 5 miles through Fremont and 5 miles adjacent to Highway 880 on access to San Jose). Whereas Altamont Alternative considers approaching cities without going through them or by using cut and cover structures (in Fremont), the Pacheco Pass route proposes to repeatedly cross residential neighborhoods at grade or by elevated structures. As well, the new Altamont Alternative is far less damaging from the standpoint of noise pollution and visual impacts, because of the lack of contact with residential neighborhoods.

3.4.5 Conclusion

As a conclusion, the Altamont Alternative may be considered by far the less impacting alternative for biological diversity, agricultural and urban issues.

4. Outcome

The Altamont route will provide an improved rail corridor between the northern San Joaquin Valley and the Bay Area to support passenger service between the Bay Area, the Tri Valley area, and the Northern San Joaquin Valley.

In addition, this route will offer a travel alternative that is competitive with the travel costs and time of auto, intercity bus and regional air modes.

It offers a route that avoids or minimizes impacts to the environment by sharing joint use infrastructure, depending on the chosen route (between the different proposed alternative alignments).

Potential stations should include Stockton, Tracy, Livermore, Fremont (vicinity), Milpitas and San Jose.

This project will provide several connections to numerous San Joaquin Valley and Tri-Valley cities (Stockton, Merced, Turlock, Modesto, Manteca, Tracy, Livermore, Pleasanton, Dublin, San Ramon and Fremont) where over one million people live.

5. Viability of Train-splitting

5.1 Definition and Economic Benefits of Train-Splitting

A typical European high-speed train is made up of two independently operable segments, each with control cabs at each end. Coupled together for most of the journey, they can be driven by a single operator. A second operator added at a junction allows the coupled sets to divide to serve different origins or destinations. This process, called train-splitting, allows service to multiple locations to be more economical than using full-length trains, because ridership per vehicle is increased, while fleet power and maintenance costs are reduced. Driving labor becomes much more productive by freeing the second driver to run repeated trips on the branch line.

The following text gives examples of where train-splitting is frequently done on European high speed trains under circumstances similar to the S.F. Bay Area proposed service, as well as explaining conditions in which its economics are especially favorable.

5.2 European Examples

There are many places on the French TGV network where this type of operation is very frequent, especially diverging lines which can share most of their mileage.

Domestic traffic in France

On the TGV–South East network coupled-set trains from Paris arrive in the following junctions:

- ✓ Dijon, splitting for trains:
 - to Besançon and Switzerland;
 - Southward on the old PLM line up to Chalon.
- ✓ Lyon Saint Exupéry TGV splitting for trains:
 - to Grenoble ;
 - to Avignon ;
- ✓ Lyon Part Dieu (central station), splitting for trains:
 - to Marseille ;
 - to Montpellier.
- ✓ Lyon, Part Dieu (central station), splitting for trains:
 - to Saint- Etienne
 - running to Lyon Perrache terminal station
- ✓ Marseille Saint Charles (central station), splitting for trains:
 - to Côte d’Azur up to Nice ;
 - ending in Marseille terminal.

On the TGV–Atlantique network, coupled set trains from Paris split in:

- ✓ Rennes : fifteen coupling and splitting operations are daily carried out in Rennes station
 - to Quimper;
 - to Brest.

On the TGV–Inter-secteur network, coupled set trains from Marseilles split in:

- ✓ Le Mans: splitting for trains:
 - to Rennes;
 - to Nantes.

International traffic

On the Thalys network, coupled set trains from Paris arrive in:

- ✓ Brussels, splitting for trains:
 - to Amsterdam;
 - to Köln.

On the German ICE Network, coupled set trains from Frankfurt arrive in:

- ✓ Cologne, splitting for trains:
 - to Bruxelles;
 - to Amsterdam;
 - to Dortmund.

On the German ICE Network, trains from Berlin arrive in:

- ✓ Hamm, splitting for trains:
 - to Cologne;
 - to Düsseldorf and Cologne Airport.

The reverse operation is similar when SU (single unit) trains coming from different destinations are coupled into MU (multiple units).

In the French railway network, splitting and coupling operations on high-speed rail are common. These basic operations generate no hazard in trains' operation.

5.3 Train-splitting at the Conceptual Level

The economics of train-splitting make it advantageous for the carrier to couple two trains together on a route in the following cases:

1st case: when two trains towards different final destinations have a common route on a long distance,

2nd case: when two trains from different origins end at a common final route, with a significant length.

The third case takes place when the traffic on the a portion of a route does not merit the capacity of a two-unit train.

Coupling trainsets together in all of the above cases allows more frequent service than would otherwise be economically justified. These same advantages of train-splitting appear to pertain to California as well as Europe because of the relatively long common routes on the CHSRA network.

These 3 cases are illustrated below:

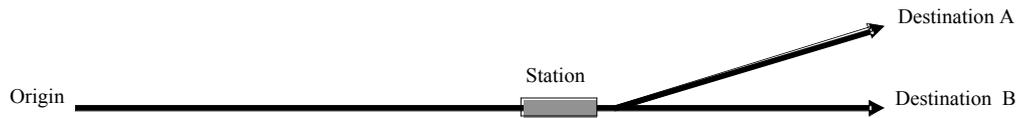


Figure 1: Case 1



Figure 2: Case 2

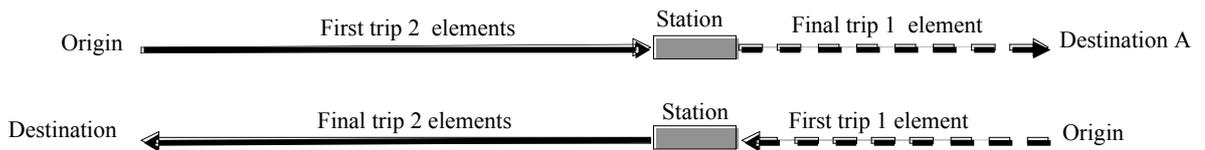


Figure 3: Case 3

Note: The configuration of convoys depends on the commercial demand.

5.4 The sequence of coupling and splitting operations

Train-splitting and train-coupling take place in the following way:



Figure 4: Train coupling

At H+ 0 minutes, the 1st train from A arrives at the station. As soon as the train stops, access to and egress from the train are permitted.

At H+5 minutes, the 2nd train from B arrives slowly because the platform is already partially occupied by the first parked train. Signaling for access to this platform must be adapted for this operation.

At H+10 minutes, after tests (of functioning, motorization, braking, etc.) have been completed, the two-segment train can leave the platform with just one operator driving it.

The figure below summarizes diagrammatically the operation:

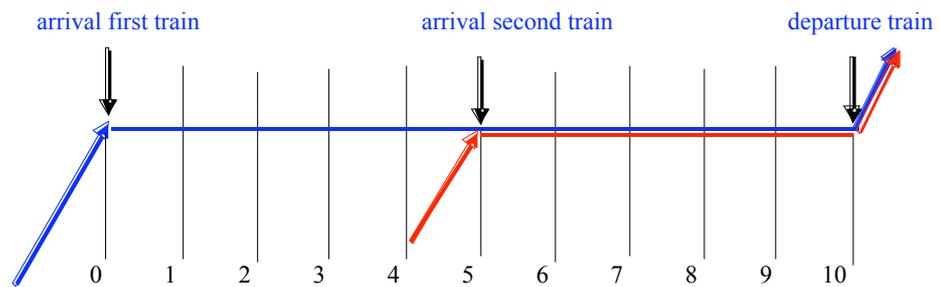


Figure 5: Graphic figure of a coupling operation

For the passengers of the first train, this operation increases travel time by 5 minutes. Trip times for passengers of the second train are unaffected.

The delay for one of the two trains requires the other one to wait. The limit of a reasonable waiting time must be evaluated on a commercial level. Beyond this maximum, the first unit should leave without waiting for the second unit. Special scheduling of extra board drivers is necessary for the departure of two separate trains.

The coupling system is well designed. It is a well-used and perfectly mastered technique. And the coupling operation does not generate delays in train traffic.

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The following example illustrates the splitting operation for a train:

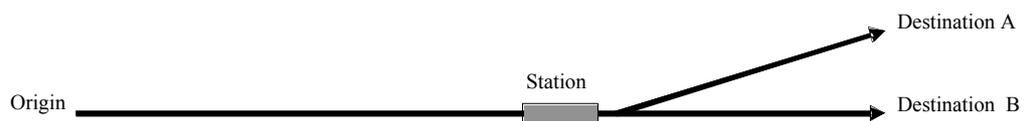


Figure 6: Train-splitting

At H+0 minutes the two-unit train arrives at its junction. As soon as the train stops, access to and egress from the train are permitted.

At H+3 minutes (minimum duration of the travelers' service) the first train set can leave its platform,

At H+6 minutes (spacing time between 2 trains; according to the facilities and to the route signaling, this time can be reduced): departure of the second train.

The figure below summarizes diagrammatically the operation:

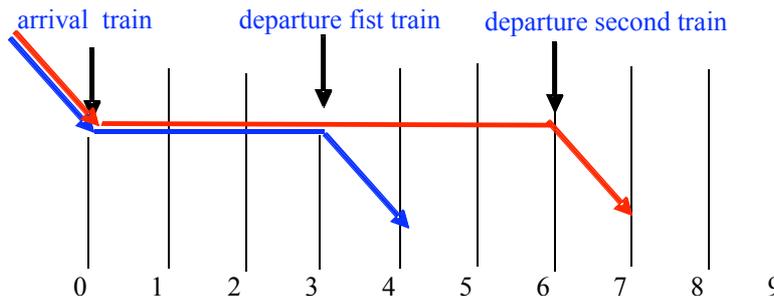


Figure 7: Graphic figure of the operations

At least one operator has to be at the station at the arrival of the coupled units to drive the second train. Hence scheduling of the drivers' has to be arranged in the aforementioned way.

As with the coupling operation, the splitting operation of two trains does not present any significant problems.

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For both of these two operations, to completely take advantage of a single operator driving, and the use of a single path, the station where these operations take place has to be located as close as possible to the divergence/convergence point of the different destinations.

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In case 3, there is a splitting and coupling operation; however, the difference from the previous cases comes from the fact that in the splitting case a segment (the second one) stays in the station after the departure of the first segment. In the coupling operation, the first segment is placed on the track, waiting for the second segment.

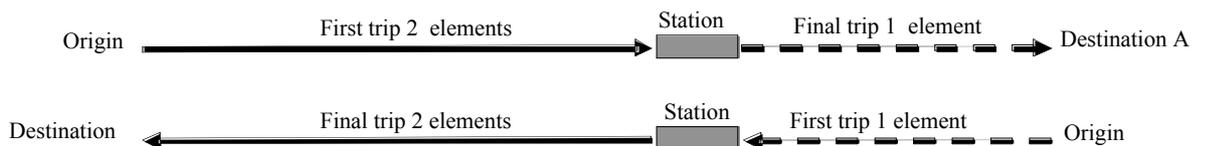


Figure 8: splitting/coupling of one segment or "element."

5.5 The Pacheco and Altamont Routes

Two alternate routes have been studied connecting the San Francisco Bay Area and the Central Valley. On the schematic figure below:

- ✓ The Pacheco Route is in red
- ✓ The Altamont Route is in green

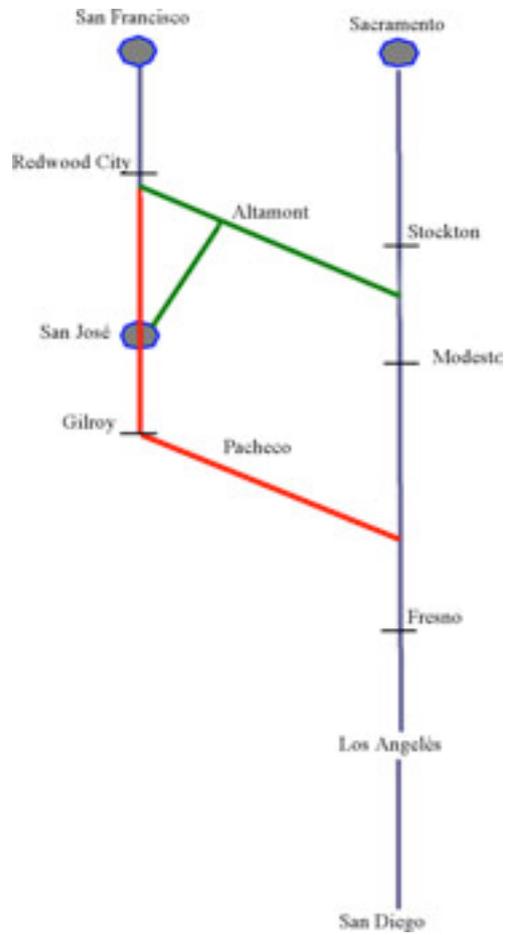


Figure 9: schematic plans of the routes

This report will make a comparison between the two routes according to the following criteria:

- ✓ Operational criteria
- ✓ Commercial criteria

Operational Criteria

High speed trains are foreseen for the journeys: Anaheim ⇔ San Francisco Bay Area and Sacramento ⇔ San Francisco Bay Area.

All High-Speed Trains:

The current preferred plan of the High-speed Rail Authority is for HSR trains to use existing Caltrain rights-of-way for access to San Francisco. On this network, hundreds of high-speed trains would have to share infrastructure with Caltrain commuter trains. These commuter trains have frequent station stops, so their average speed is relatively slow. The faster long-distance trains must match the speed of the slow trains; hence their paths are impeded unless the High-Speed Rail Authority builds additional tracks between Gilroy and San Francisco, adding significant costs and environmental consequences.

With the Pacheco plan, the route on or adjacent to the commuter rail network between Gilroy and San Francisco is about 79 miles.

With the Altamont plan, which would join the conventional line at Redwood City, the common route from and to San Francisco will be about 26 miles (a savings of 53 miles).

These 53 miles of track are freed up for circulation of Caltrain. Thus this configuration allows for market development of commuter trains and significantly reduces the number of conflicts between slow and fast trains. It also represents a decrease of 53 miles of traffic in a railroad environment not well suited to HST.

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Bay Area/Sacramento ⇔ Anaheim/Los Angeles

It is not compulsory that every train is composed of 2 segments, one to the Bay Area and the second one to Sacramento. But for the trains established in that way, operation of a single MU train on the larger part of the route seems to be judicious.

With the Pacheco plan, splitting and joining operations would have to take place in Fresno, the first common station to both Bay Area and Sacramento branches.

With the Altamont plan, these operations could take place at Modesto or Tracy station depending upon system configuration.

There are 94 miles from Fresno to Modesto, and over 120 miles from Fresno to Tracy.

Thus, there is a saving of at least 94 miles per operator, per schedule, per day and per direction, a significant sum on a continuing basis.

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San Francisco ⇔ Sacramento

The distance between San Francisco and Sacramento:

- ✓ With the Pacheco plan, because of recent changes near Merced is about 300 miles.
- ✓ With the Altamont plan, approximately 150 miles (+/- 3 %)

The saving of travel mileage per train run is about 150 miles (50 %).

This important distance-saving reduces travel time between the two cities in the same proportions. This time saving reduces by about half the necessary fleet to operate this service. **The route through Altamont offers a distance saving of approximately 150 miles with valuable cost savings on rolling stock.**

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San Jose ⇔ Sacramento

The distance between San Jose and Sacramento:

- ✓ With the Pacheco plan, because of recent changes near Merced is about 250 miles.
- ✓ With the Altamont plan, approximately 130 miles (+/- 3 %)

The saving of travel mileage per train run is about 120 miles (45 %).

Splitting Altamont trains in either Fremont or Redwood City would allow shorter service to Silicon Valley and San Jose, as compared to the longer Pacheco route through Chowchilla and Merced.

The route through Altamont offers a distance saving of approximately 120 miles with valuable capital and operating cost savings on rolling stock.

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Dedicated San Jose ⇔ Anaheim/Los Angeles trains

Altamont also provides the potential of dedicated San Jose – Anaheim/Los Angeles trains via a join or split in either Redwood City, Fremont, or Tracy. Using Pacheco, southbound passengers from San Jose may find it difficult to obtain prime seating, because trains may already be filled with San Francisco passengers. With the Altamont alternative, San Jose passengers would have first choice of seating and more direct service than current Pacheco plans would offer.

The route through Altamont offers superior management of available seating for San Jose passengers.

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Conclusion: all the criteria described above favor of the route through Altamont.

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Commercial Criteria

The travel time is compared for both plans.

San Francisco Bay Area ⇔ Anaheim/Los Angeles

With the current Pacheco plan, the distance from San Francisco-Fresno about 194 miles. With the new Altamont plan, this distance is estimated to be essentially identical (+/- 3 %). Even if Altamont route is a little bit longer (as much as 5 miles), the route through Altamont is nevertheless more favorable, with a quicker travel time from/to Southern California, because of the avoidance of 53 miles of shared track with Caltrain local trains.

The route through Altamont allows a time savings on the travel between Anaheim/Los Angeles and the Bay Area.

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San Francisco ⇔ Sacramento and San Jose ⇔ Sacramento

The circuitous nearly 300-mile Pacheco route produced by newly imposed line detours near Merced has increased the travel time of service between San Francisco and Sacramento to approximately 1 hour 55 minutes. Even with a projected average speed of 158mph, the service would provide slower travel than Highway 80..

The Altamont plan allows a nearly 50 % time savings. Hence, the travel time is approximately 1 hour, about 30 percent faster than driving.

The route through Altamont allows a time savings on the travel between Sacramento and the Bay Area.

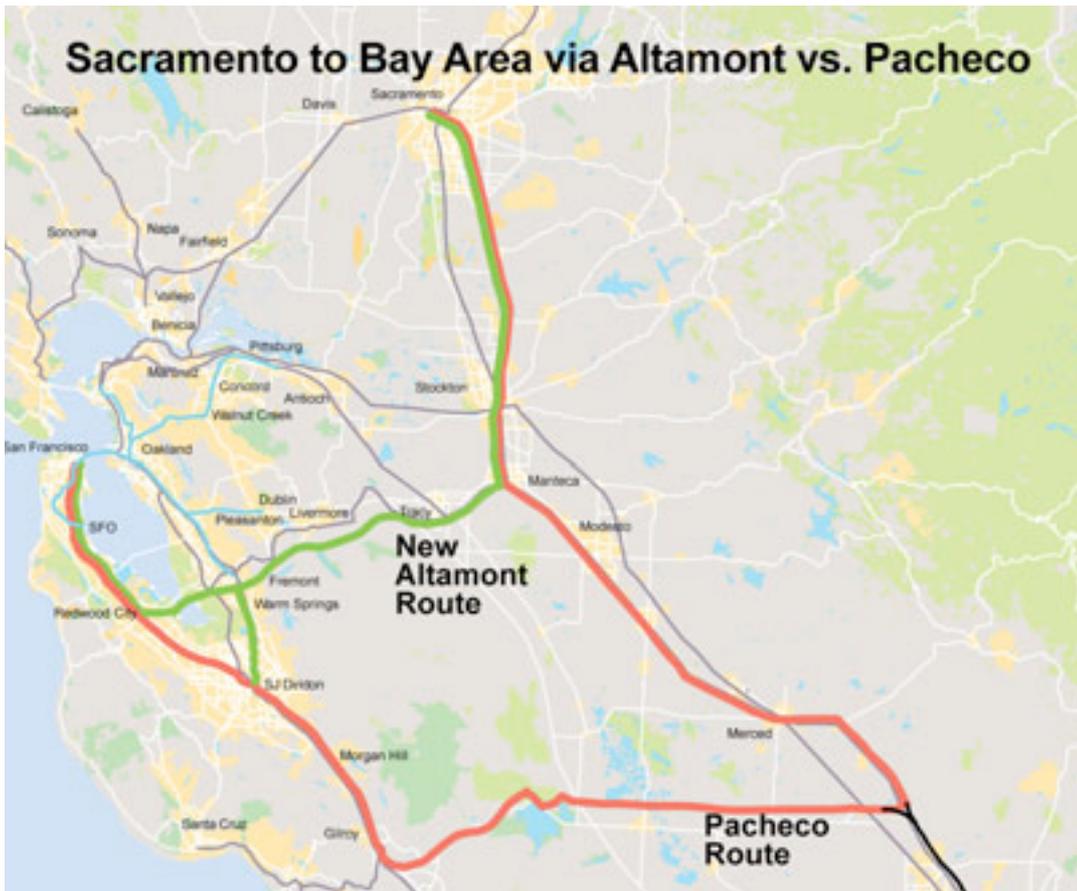


Figure 10: Figure Comparing Regional Travel via Altamont and Pacheco

The new Altamont route is capable of producing much more Bay Area – Sacramento traffic than the Pacheco route especially if trains are split in Fremont or Redwood City to allow direct connections to Silicon Valley and San Jose as well as SFO International and San Francisco.

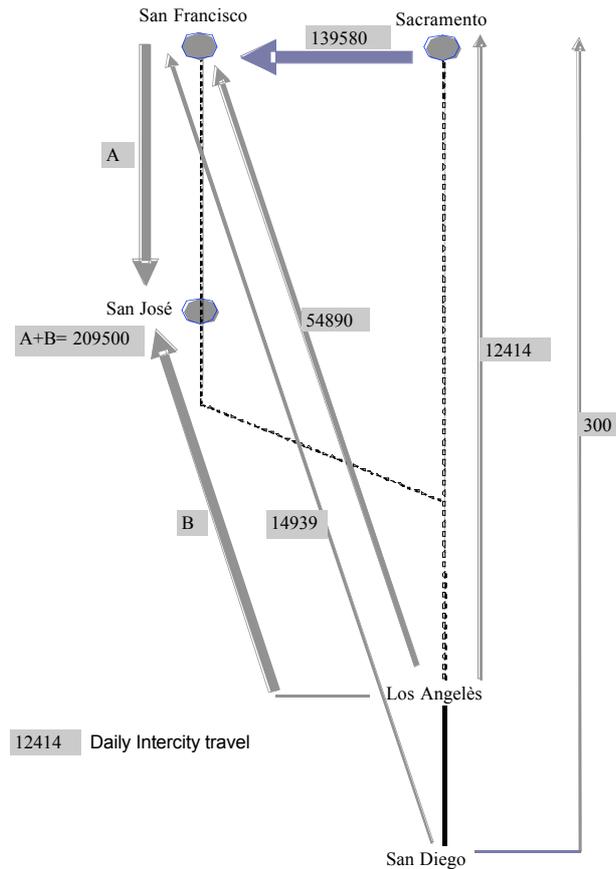
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Traffic potential of the network

The figure 11 below shows the flows of circulation (road, airplane and railway) between areas.

The Altamont plan, from the operator's point of view, has important and undeniable benefits to its advantage:

- ✓ Reduction of the shared route along the commuter railway line,
- ✓ Saving of travel time,
- ✓ Saving of rolling stock,
- ✓ Saving of number of drivers,
- ✓ The key San Francisco – Sacramento travel market shows a very large available traffic flow (140,000 journeys / day) which will contribute to the economic success of the project.



Source: California Statewide High-Speed Rail Model run for 2000 "base year" conditions

Figure 11: Daily moves

5.6 Positive and negative impacts

As mentioned above, to save time it is important that the coupling (or splitting) operation is as quick as possible. An automatic coupling system between trains must be very efficient and reliable which means that it is protected by a cover during travel to avoid pollution or obstacles which may compromise the good process of the operation.

Another requirement is to have a trained assistant waiting at the splitting station to assist the driver during merging and coupling. He or she is not required to be a driver, just an operations assistant, able to open the cab and providing the required information/instructions to the driver.

Another way to facilitate the operation is to have 2 drivers, one for the front train who stays and drives the coupled train after, and a second driver who helps during the coupling but stays inside the station afterwards for another departure. Their time schedule is adapted to the service they must perform.

It should be noted that the time of coupling and splitting is not equivalent: coupling takes more time than splitting.

The main reasons are:

- ✓ The process of coupling takes more time because the second train behind the first train parked in the station must pull in at low velocity and usually with restricted signalling.
- ✓ In order to make up little delays and to stabilize the robustness of the paths diagram, dwelling time at station must be artificially increased by the first train waiting to be coupled by the second train behind it. In this case the track occupation time is mechanically increased.

Of course the time required for a coupling depends on the station of coupling: the bigger the station is, the more the time of coupling will be. Basically in France, depending on the station the time needed for coupling varies between six minutes to ten minutes, but rarely more.

In France the National Railway Company (SNCF) permits the train awaiting another train delayed by a significant amount to leave the station in order not to be affected by the delay.

Obviously also, in order to have an efficient splitting and coupling operations, the switch moving has to be efficient too.

In term of cost, the saving is also obvious because only one driver is needed instead of two in case of coupling. In case of splitting, 2 drivers are needed wherever the splitting takes place, which means the service is adapted with reduced time schedule for the second and potential re-use on other service.

The main saving is coming from the fact that the operator can tailor the service to demand, planning multiple trains where it is really required by the number of customers, and limiting the service of trains where the number of passengers is reduced to a single unit. If 2 trains are coupling, only one schedule slot is required while it is possible to transport twice as many passengers. This is very advantageous on lines subject to heavy demand where schedule slots are limited. This allows release of infrastructure capacity so slots are available for another train.

To conclude, considering the 3 cases of splitting and coupling operations (illustrated in chapter 5.3), the benefit of these operation plans arises from:

- ✓ The reduction of the operation cost, because the two trainsets are driven by just one crew instead of two,
- ✓ The capacity consumption of the line is decreased by 50%, as a single schedule slot is needed instead of 2 on the common route,
- ✓ The presence of 2 sets of power cars on the common route, which practically excludes any failure of the equipment.

5.7 Passenger information

On board high speed trains, all passengers have to be seated for safety reasons. Booking is mandatory with designated coaches and seats. In addition on the coaches side the destination and services are clearly displayed which helps customers to cross-check with their ticket and coach numbering (on each issued ticket is mentioned the number of the coaches and seats).

Before the boarding and at the access to the platform and also in the station, the cities served by the train are displayed on information screens. Painted numbers on the platform show where the coaches will stop inside stations, helping the passengers to wait in front of the proper coach and facilitating the boarding.

Passenger confusion is extremely rare. A systematic reminder of the train destination after every stop, through the on-board sound system and in the station, is made in order to avoid any confusion.

5.8 Frequency to San Francisco Bay Area

As mentioned earlier in this chapter, trains coupling or splitting is a source of large savings on operating costs, adapting the service to the demand. Customers' confusion risks are extremely minor. It rationalizes also the use of the route and it is facilitated by the high performance signalling and public information system which is anyway required for High Speed train operation. Moreover, we have a power reserve in case of mechanical failure.

Indeed, California like France has major urban destinations (especially Los Angeles, San Francisco and San Diego) and the distance between them are similar to the largest cities of France. California, as a State similar to France in term of density of population and area, is well appropriate for this kind of service

6. Conclusion

For the operation of a high-speed rail service, the route through Altamont has many more advantages than the Pacheco plan. Providing a service which employs trainsplitting could increase those advantages for the Altamont corridor. This is particularly because that configuration of a common line from Los Angeles to San Joaquin County with branches serving Sacramento, San Jose and San Francisco has the classic dividing corridors pattern which characterizes much of the southeast of France, home of the most efficient rail service in Europe.

7. Setec team

This report has been developed by:

Philippe Voignier: Head of expertise
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8. Appendices

Appendix A : Altamont Pass plans (General plan and plans 1 to 5)

Appendix B : Fremont route along SF Water Line

Appendix C : Fremont route along SF Water Line – Cross Section according to French Standards

Appendix D : SETEC's railway references

Appendix E : Individual CVs
