

Summary of Evaluation

Meadow-Charleston Evaluation of City Council-Adopted Criteria

Evaluation Criteria		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
A	Facilitate movement across the corridor for all modes of transportation	- ■■■■ ■■■■+ Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.	- ■■■■ ■■■■+ Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.	- ■■■■ ■■■■+ Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open. Viaduct provides opportunities for additional crossings for all modes.	- ■■■■ ■■■■+ Meadow Drive and Charleston Road will be grade separated from the railroad for all modes and will remain open.	- ■■■■ ■■■■+ Meadow Drive and Charleston Road will be grade separated from the passenger train traffic only for all modes and will remain open. Meadow Drive and Charleston Road will not be grade separated from the freight train traffic. Alma Street will be limited to one lane in each direction within the trench sections leading up to the tunnel entrance.	- ■■■■ ■■■■+ East/West (through) traffic on Meadow Drive and Charleston Road will be grade separated from the railroad and Alma Street for all modes. Some turning movements on Meadow Drive to/from Alma Street will be prohibited. All turning movements on Charleston Road to/from Alma Street will be permitted; however, some movements will be facilitated via a roundabout approximately 600 feet west of Alma Street, resulting in longer routes for all modes.
B	Reduce delay and congestion for vehicular traffic at rail crossings	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will remain for the freight at-grade crossing. Freight train service is limited to just a few trains at night.	- ■■■■ ■■■■+ With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates. Pedestrian and cyclist mode separation will also help reduce intersection congestion.
C	Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles	- ■■■■ ■■■■+ Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.	- ■■■■ ■■■■+ Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.	- ■■■■ ■■■■+ Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.	- ■■■■ ■■■■+ Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.	- ■■■■ ■■■■+ Pedestrians/cyclists will be separated from train traffic only. Bike lanes will be added to Meadow Drive and Charleston Road intersections. Additional pedestrian/cyclist separations routes can be explore on the next phase of design.	- ■■■■ ■■■■+ Pedestrians and cyclists traveling east/west will be completely separated from train and vehicular traffic on Alma Street. Full pedestrian and cyclist movement is maintained. Pedestrians and cyclists will have more circuitous routes traveling east/west across the corridor because the pedestrian/bike path is located on one side of the street only: on the south side of Meadow Drive and on the north side of Charleston Road. For example, cyclists traveling eastbound on Charleston Road near Ruthelma Street will have to cross Charleston Road to get onto the north side of the road, then cross Charleston Road again at the roundabout near Mumford Place to get back onto the right/south side of the road.
D	Support continued rail operations and Caltrain service improvements	- ■■■■ ■■■■+ A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated. With the pump stations, there will be potential risks to train operations from flooding.	- ■■■■ ■■■■+ A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated.	■■■■ ■■■■+ New railroad tracks can be built without a temporary track, and a crossover track located north of the San Antonio Caltrain Station will be relocated.	- ■■■■ ■■■■+ A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Avenue Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.	- ■■■■ ■■■■+ A temporary railroad track will be required at the boring pit areas to the north and south. A siding track will be relocated north of the California Avenue Caltrain Station. Due to the pump stations, there will be potential risks to train operations due to flooding.	- ■■■■ ■■■■+ A temporary railroad track is likely to be required unless an alternate construction methodology and sequencing is acceptable to Caltrain.



The color of the matrix is comparative between each alternative at this location.

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E	Finance with feasible funding sources (order of magnitude cost)	- + The trench will require greater levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.	- + The hybrid would require lower levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.	- + The viaduct would require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.	- + The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs.	- + The tunnel will require the greatest levels of local funding in the form of fees, taxes or special assessments, the feasibility of which are still being studied in the context of overall citywide infrastructure funding needs. However, this alternative would not be eligible for grade separation funding as the at-grade crossing for freight would remain.	- + The underpass will require substantial local funding resources more than the hybrid alternative, but less than the trench and tunnel alternatives.
F	Minimize right-of-way acquisition (Private property only)	- + Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.	- + No acquisition of private properties is required; however, driveway modifications will be required.	+ No acquisition of private properties is required.	- + Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.	- + Subsurface acquisition will be required for the ground anchors for the trench retaining walls and private properties will be required for creek diversion pump station.	- + Multiple private property acquisitions are required, and driveway modifications will be required. Some (sliver) acquisition of residential properties immediately adjacent Alma Street, Meadow Drive and Charleston Road will be required.
G	Reduce rail noise and vibration	- + Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel locomotives will also reduce noise. Trains operating in trench will reduce noise in neighborhoods. Acoustically treated trench walls will eliminate acoustical reflections. There would be a slight reduction to vibration levels at nearby receptors.	- + Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. Six-foot high parapet sound barriers will help reduce propulsion and wheel/rail noise. There would be a slight reduction to vibration levels at nearby receptors.	- + Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. Six-foot high parapet sound barriers will help reduce propulsion and wheel/rail noise. There would be significant reduction to vibration levels at nearby receptors.	- + Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing EMU trains instead of diesel engines will also reduce noise. In the trench section, train noise would be partially reduced with acoustically absorptive materials. In the tunnel section, train noise will be contained. There would likely be a slight reduction to vibration levels at nearby receptors.	- + Train horn noise and warning bells will remain for the at-grade crossings to accommodate a limited number of freight trains. Utilizing EMU trains instead of diesel engines will also reduce noise. In the trench section, train noise would be partially reduced with acoustically absorptive materials. In the tunnel section, train noise will be contained. Reduced traffic lanes on Alma would also reduce noise levels in the community. There would be slight reduction to vibration levels at nearby receptors.	- + Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing EMU trains rather than diesel engines will also reduce noise. Modern rail bridge design will reduce excess structural noise. Sound barriers will also help to reduce propulsion and wheel/rail noise. There would be little to no change to vibration levels at nearby receptors. An optional 6-foot high noise barrier near the tracks and on the overpass structure could significantly reduce wheel/rail and propulsion noise.
H	Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets	- + No diversion of regional traffic with construction of grade separations.	- + No diversion of regional traffic with construction of grade separations.	- + No diversion of regional traffic with construction of grade separations.	- + No diversion of regional traffic with construction of grade separations.	- + Diversion of regional traffic with the permanent lane reduction on Alma Street will impact residential streets.	- + Regional traffic will be diverted due to the restricted turning movements; however, travel in all directions will be possible, but may require a longer route and take more time. Turning movements at Ely Place will be limited to right turns on northbound Alma Street only. Pedestrian and cyclist access will improve due to mode separation.

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Evaluation Criteria		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
I	Minimize visual changes along the corridor	- + Railroad tracks will be below grade with high fencing at grade. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench retaining walls.	- + Railroad tracks will be approximately 15 feet above grade. Landscaping with trees will be incorporated for screening where feasible.	- + Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.	- + Railroad tracks will be below grade with high fencing at grade in the trench section. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.	- + Passenger tracks will be below grade and freight tracks will be at-grade with high fencing. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench section.	- + Railroad tracks will remain at-grade. On Charleston Road, removal of the planting strip on both sides of the road will be required along with the planting strip on the east side of Alma Street between Charleston Road and Ely Place.
J	Minimize disruption and duration of construction	- + Extended road closures at Meadow Drive and Charleston Road are required. Construction would last for approximately 6 years.	- + Extended lane reductions at Alma Street, Meadow Drive, and Charleston Road will be required. Construction would last for approximately 4 years.	- + The viaduct will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.	- + Extended lane reductions on Alma Street are required. Construction would last for approximately 6 years.	- + Extended Lane reductions on Alma Street are required. Construction would last for approximately 6 years.	- + Lane reductions and temporary closures (nights/weekends only) on Alma Street, a closure of Meadow Drive between Emerson Street and Park Boulevard, and a closure of Charleston Road between Alma Street and Park Boulevard will be required for the majority of construction. The total duration of construction will be approximately 3.5 to 4 years; however the durations are subject to change depending on the construction methodologies used.
Order of magnitude cost		\$800M to 950M*	\$190M to \$230M*	\$400M to 500M*	\$1,218M to \$1,827M*	\$1,173M to \$1,759M*	\$340M to \$420M*

Meadow-Charleston Evaluation of Engineering Challenges

Engineering Challenges		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
L	Creek/Drainage Impacts	- + <ul style="list-style-type: none"> Requires diversion of Adobe and Barron creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench. Increased risk of flooding due to pump stations. 	- + <ul style="list-style-type: none"> Pump stations required for lowered roadways. Increased risk of flooding due to pump stations. 	- + <ul style="list-style-type: none"> No significant creek or drainage impacts. 	- + <ul style="list-style-type: none"> Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench and tunnel. Increased risk of flooding due to pump stations. 	- + <ul style="list-style-type: none"> Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations. Numerous regulatory agency approvals required for creek diversion. Pump stations also required to dewater the trench and tunnel. Increased risk of flooding due to pump stations. 	- + <ul style="list-style-type: none"> Pump station required for lowered roadways. Increased risk of flooding due to pump station.



* Total Preliminary Construction Cost for infrastructure of both railroad crossings includes escalation to 2025 (Subject to Change).

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Meadow-Charleston Evaluation of Engineering Challenges

Engineering Challenges		Trench	Hybrid	Viaduct	South Palo Alto Tunnel Passenger and Freight	South Palo Alto Tunnel with At-Grade Freight	Underpass
M	Long-Term Maintenance	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment. 	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for trench dewatering. Above ground railroad alignment with embankments and undercrossing structures. 	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Above ground railroad alignment with embankments and viaduct structures. 	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment. 	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for creek diversions. Pump stations for trench dewatering. Below ground railroad alignment as well as at-grade railroad alignment. 	- + Increased maintenance cost due to: <ul style="list-style-type: none"> Pump stations for underpass dewatering. Above ground structures for both road and rail.
N	Utility Relocations	- + <ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	- + <ul style="list-style-type: none"> Moderate amount of utility relocations for utility relocations for lowered roadways. 	- + <ul style="list-style-type: none"> Some utility relocations required. 	- + <ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	- + <ul style="list-style-type: none"> Major utility relocations for lowered railroad. 	- + <ul style="list-style-type: none"> Major utility relocation due to the fully lowered roadway.
O	Railroad Operations Impacts during Construction	- + <ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required. 	- + <ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required, but a bit shorter than the trench shoofly. 	- + <ul style="list-style-type: none"> No temporary track (i.e., shoofly) required. 	- + <ul style="list-style-type: none"> Temporary track (shoofly) is required. 	- + <ul style="list-style-type: none"> Temporary track (shoofly) is required. 	- + <ul style="list-style-type: none"> Temporary track (i.e., shoofly) likely required unless an alternate construction methodology and sequencing is acceptable to Caltrain.
P	Local Street Circulation Impacts during Construction	- + <ul style="list-style-type: none"> Removal of right turn lanes on Alma Street at Meadow Drive and Charleston Road; however, traffic will still be able to flow as needed despite lane reduction. Closes Meadow Drive while Charleston Road roadway bridges are constructed and visa versa. 	- + <ul style="list-style-type: none"> Removal of right turn lanes on Alma Street at Meadow Drive and Charleston Road; however, traffic will still be able to flow as needed despite lane reduction. Alma Street, Charleston Road, and Meadow Drive reduced to 2 lanes. 	- + <ul style="list-style-type: none"> Reduced lane widths on Alma Street, north of Meadow Drive and south of Charleston Road. Possible night time closures of Meadow Drive and Charleston Road. 	- + <ul style="list-style-type: none"> Alma Street will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue. From Charleston Road to Ferne Avenue, there will be only one southbound lane on Alma Street. 	- + <ul style="list-style-type: none"> Alma Street will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue. 	- + <ul style="list-style-type: none"> Lane reduction on Alma Street during construction of the shoofly and bridge. Closure of Meadow Drive and Charleston Road throughout excavation and construction of the undercrossing and related features.
Q	Caltrain right-of-way Impact (Acquisition of Caltrain ROW currently unconfirmed.)	- + Caltrain right-of-way will be required to accommodate pump station(s) for the alternative	+ No Caltrain right-of-way acquisition expected.	- + No Caltrain right-of-way acquisition expected with the alternative. However, options of linear park or dual use under the viaduct would require Caltrain approval.	- + Caltrain right-of-way will be required to accommodate pump station(s) for the alternative. Additionally Caltrain surface right-of-way for City usage would require Caltrain approval.	- + Caltrain right-of-way will be required to accommodate pump station(s) for the alternative. Additionally Caltrain surface right-of-way for City usage would require Caltrain approval.	+ No Caltrain right-of-way acquisition expected.
R	Caltrain Design Exceptions Needed	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	Temporary vertical clearance of 12 feet at undercrossing structures during construction. Minimum vertical clearance allowed by Caltrain is 15.5 feet.	1.4% grade on track required. Maximum grade allowed by Caltrain is 1%.	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	2% grade on track required. Maximum grade allowed by Caltrain is 1%.	No Caltrain design exceptions required.



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Summary of Evaluation

Churchill Evaluation of Engineering Challenges

Engineering Challenges		Closure with Mitigations	Viaduct	Partial Underpass
L	Creek/Drainage Impacts	- + <ul style="list-style-type: none"> Pump station required for lowered pedestrian/bike undercrossing. Increased risk of flooding with pump stations. Relocation of the pump house at Embarcadero Road required to accommodate widening of Alma Street. 	- + <ul style="list-style-type: none"> No significant creek or drainage impacts. 	- + <ul style="list-style-type: none"> Pump station required for lowered roadways. Increased risk of flooding due to pump station.
M	Long-Term Maintenance	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Pump stations for undercrossing dewatering. 	- + Increased maintenance costs due to: <ul style="list-style-type: none"> Above ground railroad alignment with embankments and viaduct structures. 	- + Increased maintenance cost due to: <ul style="list-style-type: none"> Pump stations for underpass dewatering. Above ground structures for both road and rail.
N	Utility Relocations	- + <ul style="list-style-type: none"> Potential utility relocations in Alma Street and Churchill Avenue for pedestrian/bike undercrossing. Minor utility relocations for Embarcadero Road/Alma Street improvements. 	- + <ul style="list-style-type: none"> Minimal impacts to utilities. 	- + <ul style="list-style-type: none"> Major utility relocations for lowered roadways.
O	Railroad Operations Impacts during Construction	- + <ul style="list-style-type: none"> No temporary track (i.e., shoofly) required, only single tracking during nights and weekends. 	- + <ul style="list-style-type: none"> Temporary track (i.e., shoofly) is required. 	- + <ul style="list-style-type: none"> Temporary track (i.e., shoofly) likely required unless alternate construction methodology and sequencing is acceptable to Caltrain.
P	Local Street Circulation Impacts during Construction	- + <ul style="list-style-type: none"> Path along Palo Alto High School will temporarily be impacted during construction. Temporary night and weekend closures of lanes on Churchill Avenue, Alma Street and Embarcadero Road. 	- + <ul style="list-style-type: none"> Alma Street, reduced to two lanes. Removal of right turn lanes on Alma Street at Churchill Avenue; however, traffic will still be able to flow as needed despite lane reduction. Temporary night and weekend closures of lanes on Alma Street and Churchill Avenue. 	- + <ul style="list-style-type: none"> Lane reduction on Alma Street during construction of the shoofly and bridge. Likely closure of Churchill Avenue throughout the excavation and construction of the undercrossing and related features. Likely closure of Kellogg Avenue for the duration of the pedestrian underpass construction; driveway access from one direction only.
Q	Caltrain right-of-way Impact (Acquisition of Caltrain ROW currently unconfirmed.)	- + Potential for Caltrain right-of-way impact with the construction of the pedestrian/bike undercrossing.	- + No Caltrain right-of-way acquisition expected.	- + Requires encroachment inside Caltrain's right-of-way, especially during construction.
R	Caltrain Design Exceptions Needed	None required.	1.6% grade on track required. Maximum grade allowed by Caltrain is 1%.	No Caltrain design exceptions needed.

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