What is a trench?
For the trench alternative, the railroad tracks will be lowered in an U-shaped box below Meadow Drive and Charleston Road. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin lowering south of Loma Verde Avenue, remain lowered under Meadow Drive and Charleston Road, and return to the existing elevation north of the San Antonio Station.

The roadways at Meadow Drive and Charleston Road will remain at their existing grade and have a similar configuration to what exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 6 years.

Engineering Challenges
- A non-standard grade of 2% will be required on the tracks. Caltrain's preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Barron creeks, resulting in the need for pump stations/siphons and numerous regulatory agency approvals.
- Pump stations will also be needed for dewatering because the trench will be below the ground water level.
- Increased long-term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

Cost Breakdown
<table>
<thead>
<tr>
<th>Item</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway &amp; Railroad Items</td>
<td>$462M to $548M</td>
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<tr>
<td>Structure Items</td>
<td>$10M to $13M</td>
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<tr>
<td>Right-of-way &amp; Utilities</td>
<td>$10M to $12M</td>
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<td>Support Costs</td>
<td>$168M to $200M</td>
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<tr>
<td>Escalation from 2018 to 2025 dollars</td>
<td>$150M to $177M</td>
</tr>
<tr>
<td>TOTAL PROJECT COSTS</td>
<td>$800M to $950M</td>
</tr>
</tbody>
</table>

Maintenance costs not included.

Neighborhood Considerations
- During construction, Meadow Drive will be closed while the Charleston Road bridge is constructed and vice versa; right turn lanes on Alma Street at Meadow Drive and Charleston Road will be removed.
- Vertical clearance of Meadow Drive and Charleston Road over the railroad will be 24.5 feet.
- Subsurface acquisitions will be reused for ground anchors for the trench retaining walls and only vegetation with shallow root vegetation will be allowed.
- The railroad tracks will be approximately 30 feet below the existing street between Meadow Drive and Charleston Road. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact-sheets/
**Evaluation with City Council-Adopted Criteria**

- **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.

- **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 rail crossing gates.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  Pedestrians/cyclists will be separated from train traffic and bike lanes will be added in Charleston Road.

- **Support continued rail operation 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 due to flooding.

- **Finance with feasible funding sources**
  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.

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**Concept Plan and Profile**

- **Reduce rail noise and vibration**
  Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the lowered track, train noise could reflect off walls and impact properties farther away; however, this can be mitigated.

- **Minimize visual changes along the corridor**
  Railroad tracks will be below grade. Landscaping options will be limited to bushes or plants with shallow roots in areas where ground anchors are required to the trench retaining walls.

- **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 a grade separations.

- **Minimize right-of-way acquisition**
  Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right-of-way acquisitions will be required to construct pump stations.

- **Minimize disruption and duration of construction**
  Extended road closures at Meadow Drive and Charleston Road are required. Construction would last for approximately 6 years.

- **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.

- **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 rail crossing gates.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  Pedestrians/cyclists will be separated from train traffic and bike lanes will be added in Charleston Road.

- **Support continued rail operation 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 due to flooding.

- **Finance with feasible funding sources**
  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.
Meadow-Charleston Hybrid

**What is a hybrid?**
For the hybrid alternative, the railroad tracks will be raised above Meadow Drive and Charleston Road. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin rising near El Verano Avenue, remain raised above Meadow Drive and Charleston Road, and return to the existing elevation north of the Ferne Avenue.

Between Park Boulevard and Alma Street, the roadways at Meadow Drive and Charleston Road will be lowered and will have a similar configuration that exists today, with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the underpass of the railroad and to accommodate the new column supporting the railroad structure.

**By the numbers**
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on roadway is 5%.
- Caltrain’s preferred maximum grade is 1%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 4 years.

**Engineering Challenges**
- A non-standard temporary vertical clearance of 12 feet will be required on tracks. Caltrain’s minimum allowable clearance is 15.5 feet.
- Lowering of the roadways will require a pump station.
- Increased long-term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations will be required for the lowered roadways.

**Neighborhood Considerations**
- During construction, Alma Street, Meadow Drive, and Charleston Road will be reduced to two lanes, and right turn lanes on Alma Street at Meadow Drive and Charleston Road will be removed.
- Vertical clearance of Meadow Drive and Charleston Road under the railroad will be 15.5 feet.
- The railroad tracks will be approximately 15 feet above the existing street between Meadow Drive and Charleston Road.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

**Cost Breakdown**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost Breakdown</th>
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</thead>
<tbody>
<tr>
<td>Roadway &amp; Railroad Items</td>
<td>$92M to $115M</td>
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<tr>
<td>Structure Items</td>
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<td>Right-of-way &amp; Utilities</td>
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<td>Support Costs</td>
<td>$37M to $45M</td>
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<td>Escalation from 2018 to 2025</td>
<td>$37M to $45M</td>
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<tr>
<td><strong>TOTAL PROJECT COSTS</strong></td>
<td><strong>$200M to $250M</strong></td>
</tr>
</tbody>
</table>

Maintenance costs not included.

For more Rail Fact Sheets visit: [https://connectingpaloalto.com/fact-sheets/](https://connectingpaloalto.com/fact-sheets/)
Evaluation with City Council-Adopted Criteria

- **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.

- **Reduce rail noise and vibration**
  Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out; however, this can be mitigated with a sound barrier.

- **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 gates coming down.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  Pedestrians/cyclists will be separated from train traffic, and bike lanes will be added Charleston Road.

- **Support continued rail operation 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.

- **Finance with feasible funding sources**
  The hybrid would require lower levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.

**Concept Plan and Profile**

- **Reduce rail noise and vibration**
  Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out; however, this can be mitigated with a sound barrier.

- **Minimize visual changes along the corridor**
  Railroad tracks will be approximately 15 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

- **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.

- **Minimize right-of-way acquisition**
  No acquisition of private properties is required; however, driveway modifications will be required.

- **Minimize disruption and duration of construction**
  Extended lane reductions at Alma Street, Meadow Drive, and Charleston Road will be required. Construction would last for approximately 4 years.

**Facilitate movement across the corridor for all modes of transportation**

**Reduce rail noise and vibration**

**Reduce delay and congestion for vehicular traffic at rail crossings**

**Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**

**Support continued rail operation and Caltrain service improvements**

**Finance with feasible funding sources**

**Concept Plan and Profile**

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For more renderings, plans and animations visit: [https://connectingpaloalto.com/renderings-plans-and-animations/](https://connectingpaloalto.com/renderings-plans-and-animations/)
What is a Viaduct?

For the viaduct alternative, the railroad tracks will be elevated on a structure over Meadow Drive and Charleston Road. The new electrified railroad tracks will be built between the existing railroad tracks and Alma Street (east side) and will begin rising north of Loma Verde Avenue, remain elevated over Meadow Drive and Charleston Road, and return to the existing elevation south of Ferne Avenue.

The roadways at Meadow Drive and Charleston Road will remain at their existing grade and have a similar configuration to what exists today, with the addition of Class II buffered bike lanes on Charleston Road. This addition will require expanding the width of the road to maintain bike lanes through the underpass of the railroad and to accommodate the new column supporting the railroad structure.

By the numbers

- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 1.4%.
- Maximum grade on roadway is 5%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 2 years.

Engineering Challenges

- A non-standard grade of 1.4% will be required on the tracks. Caltrain’s preferred maximum is 1%.

Neighborhood Considerations

- During construction, Meadow Drive and Charleston Road will be closed intermittently at night and on weekends.
- During construction, Alma Street will have narrow lanes for the portions north of Meadow Drive and south of Charleston Road.
- Vertical clearance of the railroad over Meadow Drive and Charleston Road will be 15.5 feet.
- The railroad tracks will be approximately 20 feet above the existing street between Meadow Drive and Charleston Road.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Cost Breakdown

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost Range</th>
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<td>Structure Items</td>
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<td>Support Costs</td>
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<tr>
<td><strong>TOTAL PROJECT COSTS</strong></td>
<td><strong>$400M to $500M</strong></td>
</tr>
</tbody>
</table>

Maintenance costs not included.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact_sheets/
Evaluation with City Council-Adopted Criteria

- 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. Viaduct provides opportunities for additional crossings for all modes.

- 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 electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out, which can be mitigated with a sound barrier.

- Minimize visual changes along the corridor
  Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

- Support continued rail operation and Caltrain service improvements
  New tracks can be built without a temporary railroad track, and a crossover track located north of the San Antonio Caltrain Station will be relocated.

Concept Plan and Profile

- Finance with feasible funding sources
  The viaduct would require substantial local funding resources above the hybrid alternative, but less than the trench.

- Reduce delay and congestion for automobile 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 gates coming down.

- Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from automobiles
  Pedestrians/cyclists will be separated from train traffic and bike lanes will be added to Charleston Road.

- Minimize right-of-way acquisition
  No acquisition of private properties is required.

- Minimize disruption and duration of construction
  The viaduct will have minimal road closures (nights/weekends only). Construction would last for approximately 2 years.

- Minimize visual changes along the corridor
  Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

- 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 a grade separations.

- 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. Viaduct provides opportunities for additional crossings for all modes.

- 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 electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out, which can be mitigated with a sound barrier.

- Minimize visual changes along the corridor
  Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

- Support continued rail operation and Caltrain service improvements
  New tracks can be built without a temporary railroad track, and a crossover track located north of the San Antonio Caltrain Station will be relocated.

For more renderings, plans and animations visit: https://connectingpaloalto.com/renderings-plans-and-animations/
South Palo Alto Tunnel – Passenger & Freight

What is a tunnel with passenger and freight?
For the tunnel alternative, the railroad tracks will be lowered in a trench south of Oregon Expressway to approximately Loma Verde Avenue. The twin bore tunnel will begin near Loma Verde Avenue and extend to just south of Charleston Road. The railroad tracks will be then be raised in trench to approximately Ferne Avenue. The new electrified northbound railroad tracks will be built at the same horizontal location as the existing railroad track; however, the southbound track will be moved to the east within the limits of the tunnel to accommodate the spacing required between the twin bores. The railroad tracks will carry both passenger and freight trains as it does today.

The roadways at Meadow Drive and Charleston Road remain at their existing grade and will have a similar configuration that exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers
- Diameter of twin bores is 34 feet.
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.

Engineering Challenges
- A non-standard grade of 2% will be required on tracks. Caltrain’s preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Matadero creeks resulting in the need for pump stations/siphons and numerous regulatory agency approvals.
- Pump stations will also be needed for dewatering since the tunnel will be below the ground water level.
- Increased long term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

Cost Breakdown

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway &amp; Railroad Items</td>
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</tr>
<tr>
<td>Structure Items</td>
<td></td>
</tr>
<tr>
<td>Right-of-way &amp; Utilities</td>
<td></td>
</tr>
<tr>
<td>Support Costs</td>
<td></td>
</tr>
<tr>
<td>Escalation from 2018 to 2025 dollars</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL PROJECT COSTS</strong></td>
<td></td>
</tr>
</tbody>
</table>

Maintenance costs not included.

Neighborhood Considerations
- During construction, 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.
- The train tracks will be approximately 60 feet below the existing grade in the tunnel section. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact-sheets/
Evaluation with City Council-Adopted Criteria

- **Facilitate movement across the corridor for all modes of transportation**
  - Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.

- **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 electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated. In the tunnel section, train wheel noise will be contained.

- **Minimize visual changes along the corridor**
  - 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.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  - Pedestrians/cyclists will be separated from train traffic.

- **Support continued rail operation and Caltrain service improvements**
  - 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.

- **Minimize right-of-way acquisition**
  - Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.

- **Minimize disruption and duration of construction**
  - Extended lane reductions on Alma Street are required. Construction would last for approximately X years.

**Concept Plan and Profile**

- **Facilitate movement across the corridor for all modes of transportation**
  - Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.

- **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 electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated. In the tunnel section, train wheel noise will be contained.

- **Minimize visual changes along the corridor**
  - 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.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  - Pedestrians/cyclists will be separated from train traffic.

- **Support continued rail operation and Caltrain service improvements**
  - 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.

- **Minimize right-of-way acquisition**
  - Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.

- **Minimize disruption and duration of construction**
  - Extended lane reductions on Alma Street are required. Construction would last for approximately X years.

**For more renderings, plans and animations visit:** https://connectingpaloalto.com/renderings-plans-and-animations/
South Palo Alto Tunnel with At-Grade Freight

What is a tunnel with at-grade freight?
For the tunnel alternative, the railroad tracks will be lowered in a trench south of Oregon Expressway to approximately Loma Verde Avenue. The twin bore tunnel will begin near Loma Verde Avenue and extend to just south of Charleston Road. The railroad tracks will be then be raised in trench to approximately Ferne Avenue. The new electrified northbound railroad tracks will be built at the same horizontal location as the existing railroad track; however, the southbound track will be moved to the east within the limits of the tunnel to accommodate the spacing required between the twin bores. The railroad tracks in the trench and tunnel will carry only passenger trains. The freight trains will remain at-grade.

The roadways at Meadow Drive and Charleston Road remain at their existing grade and will have a similar configuration that exists today with the addition of Class II buffered bike lanes on Charleston Road. This will require expanding the width of the road to maintain bike lanes through the overpass of the railroad.

By the numbers
- Diameter of twin bores is 30 feet.
- Railroad track is designed for 110 mph.
- Meadow Drive and Charleston Road are designed for 25 mph.
- Maximum grade on railroad is 2%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.

Engineering Challenges
- A non-standard grade of 2% will be required on tracks. Caltrain's preferred maximum grade is 1%.
- Lowering of the tracks will require diversion of Adobe and Matadero creeks resulting in the need for pump stations/siphons and numerous regulatory agency approvals.
- Pump stations will also be needed for dewatering since the tunnel will be below the ground water level.
- Increased long term maintenance costs and risk of flooding due to pump stations.
- Major utility relocations are required for the lowered railroad.

Neighborhood Considerations
- Alma Street will permanently be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue and from Charleston Road to Ferne Avenue.
- The train tracks will be approximately 70 feet below the existing grade in the tunnel section. A high fence will be required along trench walls.
- With grade separations at Meadow Drive and Charleston Road the traffic at nearby intersections is expected to improve.

Cost Breakdown
- Roadway & Railroad Items
- Structure Items
- Right-of-way & Utilities
- Support Costs
- Escalation from 2018 to 2025 dollars

TOTAL PROJECT COSTS
Maintenance costs not included.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact-sheets/
Evaluation with City Council-Adopted Criteria

- Facilitate movement across the corridor for all modes of transportation
- Meadow Dr and Charleston Rd will be grade separated from the passenger trains for all modes and will remain open. At-grade crossing will remain for the freight trains.
- Reduce delay and congestion for vehicular traffic at rail crossings
  The railroad crossing gates and warning lights at Meadow Drive and Charleston Road will be remain. Thus, the traffic will be interrupted by railroad crossing gates.
- Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles
  Pedestrians/cyclists will be separated from passenger train traffic only.
- Support continued rail operation and Caltrain service improvements
  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.
- Finance with feasible funding sources
  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.

Concept Plan and Profile

- Reduce rail noise and vibration
  - Train horn noise and warning bells will remain for the at-grade crossings to accommodate the freight trains. Utilizing electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated. In the tunnel section, train wheel noise will be contained.
- Minimize visual changes along the corridor
  - 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.
- Maintain access to neighborhoods, parks, and schools along the corridor while reducing regional traffic on neighborhood streets
  - Diversion of regional traffic with the permanent lane reduction on Alma Street will impacted residential streets.
- Minimize right-of-way acquisition
  - Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.
- Minimize disruption and duration of construction
  - Extended lane reductions on Alma Street are required. Extended lane reductions on Alma Street will impacted residential streets. Construction would last for approximately X years.

For more renderings, plans and animations visit: https://connectingpaloalto.com/renderings-plans-and-animations/
Churchill Closure

What is a closure?
For the closure alternative, the railroad tracks will remain at their existing location and elevation. Churchill Avenue will become a T-intersection with Alma Street on the east side and will end at Mariposa Avenue on the west side. A pedestrian/bike only undercrossing will be constructed. Two options are proposed: one crosses under the railroad tracks only (Option 1) and the other crosses under both the railroad tracks and Alma Street (Option 2). Ramps and stairs in varying configurations will provide access to the undercrossing for pedestrians and cyclists.

There are several intersection improvements associated with the Churchill Avenue closure to mitigate the anticipated diversion in traffic. These improvements will include:

- **Embarcadero Road/Alma Street**: constructing a pedestrian/bike bridge over Embarcadero Road, widening Alma Street Bridge, adding a right turn lane from eastbound Embarcadero Road and left turn lane from southbound Alma Street, and installing a new signal at Embarcadero Road/Kingsley Avenue/High Street. Two options are proposed: one that provides full connectivity to/from High Street (Option A) and the other that keeps the movements to/from High Street as they are today (Option B).

- **El Camino Real/Embarcadero Road**: optimizing signal timing and installing an additional westbound left turn lane and northbound right turn lane.

- **Alma Street/Oregon Expressway**: signalizing both on/off ramps with one controller.

- **El Camino Real/Oregon Expressway-Page Mill Road**: optimizing signal timing and installing a westbound right turn lane and northbound right turn lane from Oregon Expressway to El Camino Real Road.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact-sheets/
By the numbers
- Churchill Avenue is designed for 25 mph.
- Maximum grade on pedestrian/bike ramp is 8% with 5-foot landings.
- Pedestrian/bike ramp width is 8-10 feet.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 2 years.

Engineering Challenges
- Pedestrian/bike undercrossing will require a pump station.
- Relocation of pump house at Embarcadero Road will be required to widen Alma Street.
- Utility relocations will be required for pedestrian/bike undercrossing.

Neighborhood Considerations
- During construction, Embarcadero Road, Alma Street, and Churchill Avenue will be closed intermittently at night and on weekends.
- Vertical clearance of the pedestrian undercrossing will be 8-10 feet.
- The railroad tracks will remain at the existing grade at Churchill Avenue.
- Traffic mitigations will be implemented to improve traffic at nearby intersections and reduce traffic on residential streets.

Cost Breakdown
- Roadway & Railroad Items: $26M to $33M
- Structure Items: $6M to $8M
- Right-of-way & Utilities: $6M to $8M
- Support Costs: $6M to $8M
- Escalation from 2018 to 2025 dollars: $6M to $8M
- TOTAL PROJECT COSTS: $50M to $65M
- Maintenance costs not included.
- Intersection improvements included.

Evaluation with City Council-Adopted Criteria
- Facilitate movement across the corridor for all modes of transportation
  Churchill Avenue will be closed to vehicles at the railroad tracks.
- Reduce rail noise and vibration
  Train horn noise and warning bells will be eliminated with the removal of the at-grade crossings with roadway closure. Utilizing electric engines instead of diesel engines will also reduce noise.
- Reduce delay and congestion for vehicular traffic at rail crossings
  With closure of Churchill Avenue, the traffic at nearby intersections will be impacted; however, this can be mitigated.
- Minimize visual changes along the corridor
  Railroad tracks remain at existing grade. Residual roadway areas from closure provide opportunities for landscaping.
- Minimize right-of-way acquisition
  No acquisition of private properties is required; however, there will be impacts to Palo Alto High School property and potentially Caltrain. There also may be some parking loss on the east side of Churchill Avenue for the pedestrian/bike undercrossing.
- Minimize disruption and duration of construction
  The closure will have minimal road closures (nights/weekends only). Construction would last approximately 2 years.

By the numbers
- Churchill Avenue is designed for 25 mph.
- Maximum grade on pedestrian/bike ramp is 8% with 5-foot landings.
- Pedestrian/bike ramp width is 8-10 feet.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 2 years.
Churchill Viaduct

What is a Viaduct?
For the viaduct alternative, the railroad tracks will be elevated on a structure over Churchill Avenue. The new electrified railroad tracks will be built at the same location as the existing railroad tracks and will begin rising near Homer Avenue, remain elevated over Churchill Avenue, and return to the existing track elevation near the California Avenue Station. Stanford game day station will be eliminated.

The roadway at Churchill Avenue will remain at its existing grade and have a similar configuration to what exists today. This will require expanding the width of the road through the underpass of the railroad to accommodate the new column supporting the railroad structure.

By the numbers
- Railroad track is designed for 110 mph.
- Churchill Avenue is designed for 25 mph.
- Maximum grade on railroad is 1.6%.
- Travel lane widths are 10-12 feet.
- Bike lane widths are 5-6 feet.
- Construction period approximately 2 years.

Engineering Challenges
- A non-standard grade of 1.6% will be required on the tracks. Caltrain’s preferred maximum is 1%.

Cost Breakdown
- Roadway & Railroad Items: $50M to $65M
- Structure Items: $128M to $170M
- Right-of-way & Utilities: $3M to $5M
- Support Costs: $63M to $85M
- Escalation from 2018 to 2025 dollars: $56M to $75M
- TOTAL PROJECT COSTS: $300M to $400M

Maintenance costs not included.

Neighborhood Considerations
- During construction, Alma Street and Churchill Avenue will be closed intermittently at night and on weekends.
- During construction, Alma Street will be reduced to two lanes and right turn lanes on Alma Street at Churchill Avenue will be removed.
- Vertical clearance of the railroad over Churchill Avenue will be 15.5 feet.
- The railroad tracks will be approximately 20 feet above the existing street at Churchill Avenue.
- With grade separations at Churchill Avenue the traffic at nearby intersections is expected to improve.

For more Rail Fact Sheets visit: https://connectingpaloalto.com/fact-sheets/
Evaluation with City Council-Adopted Criteria

- **Facilitate movement across the corridor for all modes of transportation**
  Churchill Avenue will be grade separated from the railroad for all modes of transportation and will remain open. Viaduct provides opportunities for additional crossings for all modes.

- **Reduce rail noise and vibration**
  Train horn noise and warning bells will be eliminated by the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the elevated track, train wheel noise could radiate out; however, this can be mitigated with a sound barrier.

- **Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles**
  Pedestrians/cyclists will be separated from train traffic.

- **Support continued rail operation and Caltrain service improvements**
  A temporary railroad track will be required. Stanford game day station will be eliminated.

- **Reduce delay and congestion for vehicular traffic at rail crossings**
  With construction of the grade separation, the railroad crossing gates and warning lights at Churchill Avenue will be removed. Thus, the traffic will not be interrupted by the railroad crossing gates.

- **Finance with feasible funding sources**
  The viaduct would require substantial local funding resources significantly above the closure alternative.

**Concept Plan and Profile**

- **Minimize right-of-way acquisition**
  No acquisition of private properties will be required.

- **Minimize disruption and duration of construction**
  Extended lane reductions at Alma Street will be required. Construction would last for approximately 2 years.

- **Reduce delay and congestion for vehicular traffic at rail crossings**
  No diversion of regional traffic with construction of a grade separation.

- **Minimize visual changes along the corridor**
  Railroad tracks will be approximately 20 feet above grade. Landscaping with trees will be incorporated for screening where feasible.

- **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 a grade separation.

- **Facilitate movement across the corridor for all modes of transportation**
  Churchill Avenue will be grade separated from the railroad for all modes of transportation and will remain open. Viaduct provides opportunities for additional crossings for all modes.

- **Minimize right-of-way acquisition**
  No acquisition of private properties will be required.

For more renderings, plans and animations visit: https://connectingpaloalto.com/renderings-plans-and-animations/
<table>
<thead>
<tr>
<th>Engineering Impacts</th>
<th>Meadow / Charleston</th>
<th>South Palo Alto Tunnel</th>
<th>Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Facilitate movement across the corridor for all modes of transportation</td>
<td>Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.</td>
<td>Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.</td>
<td>Meadow Dr and Charleston Rd will be grade separated from the railroad for all modes and will remain open.</td>
</tr>
<tr>
<td><strong>B</strong> Reduce delay and congestion for vehicular traffic at rail crossings</td>
<td>With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.</td>
<td>With construction of the grade separation, the railroad crossing gates and warning lights at Meadow Dr and Charleston Rd will be removed. Thus, the traffic will not be interrupted by railroad crossing gates.</td>
<td>With closure of Churchill Ave, the traffic at nearby intersections will be impacted; however, this can be mitigated.</td>
</tr>
<tr>
<td><strong>C</strong> Provide clear, safe routes for pedestrians and cyclists crossing the rail corridor, separate from vehicles</td>
<td>Pedestrian/ cyclo routes will be separated from train traffic and bike lanes will be added to Churchill Ave.</td>
<td>Pedestrian/cyclists will be separated from train traffic.</td>
<td>Churchill Ave will be closed to vehicular traffic at the railroad tracks.</td>
</tr>
<tr>
<td><strong>D</strong> Support continued rail operations and Caltrain service improvements</td>
<td>A temporary railroad track will be required, and a crossover track located north of the San Antonio Caltrain Station will be relocated.</td>
<td>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 boring activities, there will be potential risks to train operations due to flooding.</td>
<td>A temporary railroad track will not be required.</td>
</tr>
<tr>
<td><strong>E</strong> Finance with feasible funding sources</td>
<td>The trench will require greater levels of local funding, with a substantial portion of capital costs covered by Regional, State and Federal sources.</td>
<td>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.</td>
<td>The viaduct would require substantial local funding resources, significantly above the closure alternative.</td>
</tr>
<tr>
<td><strong>F</strong> Minimize right-of-way acquisition</td>
<td>Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and right of way acquisitions will be required to construct pump stations.</td>
<td>Subsurface acquisitions will be required for the ground anchors for the trench retaining walls and additional land will be required to construct pump stations.</td>
<td>No acquisition of private properties will be required; however, there will be impacts to Palo Alto High School property and potentially Caltrain. There also may be some parking loss on the east side of Churchill Ave for the pedestrians/bike undercrossing.</td>
</tr>
<tr>
<td><strong>G</strong> Reduce rail noise and vibration</td>
<td>Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. With the lowered train, train noise could reflect off walls and impact properties farther away which can be mitigated.</td>
<td>Train horn noise and warning bells will be eliminated with the replacement of the at-grade crossings with grade separations. Utilizing electric engines instead of diesel engines will also reduce noise. In the trench section, train noise could reflect off walls and impact properties farther away, which can be mitigated.</td>
<td>Train horn noise and warning bells will be eliminated with the removal of the Ralph Marlin Caltrain Station. Utilizing electric engines instead of diesel engines will also reduce noise.</td>
</tr>
<tr>
<td><strong>H</strong> Maintain access to neighborhoods, parks, and schools along the corridor, while reducing regional traffic on neighborhood streets</td>
<td>No diversion of regional traffic with construction of grade separations.</td>
<td>No diversion of regional traffic with construction of grade separations.</td>
<td>No diversion of regional traffic with Churchill Ave closure will be mitigated.</td>
</tr>
<tr>
<td><strong>I</strong> Minimize visual changes along the corridor</td>
<td>Railroad tracks will be below grade with high fencing at grade level, and landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench retaining walls.</td>
<td>Railroad tracks will be below grade with high fencing at grade level. Landscaping options will be limited to plants with shallow roots in areas where ground anchors are required for the trench retaining walls.</td>
<td>Railroad tracks remain at existing grade. Residual roadway areas from closure provide opportunities for landscaping.</td>
</tr>
<tr>
<td><strong>J</strong> Minimize disruption and duration of construction</td>
<td>Extended roadway reallocations at Meadow Dr would last for approximately 5 years.</td>
<td>Extended roadway reallocations at Meadow Dr would last for approximately 2 years.</td>
<td>Extended roadway reallocations at Meadow Dr would last for approximately 5 years.</td>
</tr>
</tbody>
</table>

| Order of Magnitude Cost | $800M to $950M* | $200M to $250M* | $400M to $500M* |

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* Total Preliminary Construction Costs in 2018 dollars with escalation to 2025 (Subject to Change)
## Summary of Engineering Challenges

<table>
<thead>
<tr>
<th>Engineering Impacts</th>
<th>Meadow / Charleston</th>
<th>Church</th>
<th>Churchill</th>
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</thead>
<tbody>
<tr>
<td>L Creek/Drainage Impacts</td>
<td>• Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations.</td>
<td>Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations.</td>
<td>• Pump station required for lowered pedestrian/bike way.</td>
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<tr>
<td></td>
<td>• Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations.</td>
<td>• Requires diversion of Adobe and Matadero creeks resulting in the need for pump stations.</td>
<td>• Pump station required for lowered pedestrian/bike way.</td>
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<tr>
<td></td>
<td>• No significant creek or drainage impacts.</td>
<td>• No significant creek or drainage impacts.</td>
<td>• No significant creek or drainage impacts.</td>
</tr>
<tr>
<td>M Long-Term Maintenance</td>
<td>Increased maintenance costs due to:</td>
<td>Increased maintenance costs due to:</td>
<td>Increased maintenance costs due to:</td>
</tr>
<tr>
<td></td>
<td>• Pump stations for creek diversions.</td>
<td>• Pump stations for creek diversions.</td>
<td>• Pump stations for creek diversions.</td>
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<tr>
<td></td>
<td>• Pump stations for trench dewatering.</td>
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<tr>
<td></td>
<td>• Below ground railroad alignment.</td>
<td>Above ground railroad alignment with embankments and viaduct structures.</td>
<td>Below ground railroad alignment.</td>
</tr>
<tr>
<td></td>
<td>• Major utility relocations for lowered roadways.</td>
<td>No major utility relocations.</td>
<td>Minor utility relocations for Embarker Rd/Alma St improvements.</td>
</tr>
<tr>
<td>O Railroad Operations Impacts during Construction</td>
<td>• Temporary track (i.e., shoofly) is required.</td>
<td>No temporary track (i.e., shoofly) required.</td>
<td>No temporary track (i.e., shoofly) required.</td>
</tr>
<tr>
<td></td>
<td>• Temporary track (i.e., shoofly) is required, but a bit shorter than the trench shoofly.</td>
<td>Temporary track (i.e., shoofly) is required.</td>
<td>Temporary track (shoofly) is required.</td>
</tr>
<tr>
<td>P Local Street Circulation Impacts during Construction</td>
<td>• Removal of right turn lanes on Alma St at Meadow Dr and Charleston Rd; however, traffic will still be able to flow as needed despite lane reduction.</td>
<td>Reduced lane widths on Alma St, north of Meadow Dr and south of Charleston Rd.</td>
<td>• Path along Palo Alto High School will temporarily be impacted during construction.</td>
</tr>
<tr>
<td></td>
<td>• Charleston Rd; however, traffic will still be able to flow as needed despite lane reduction.</td>
<td>• Charleston Rd will be reduced to one lane in each direction from south of Oregon Expressway to Ventura Avenue.</td>
<td>• Possible night time closures of lanes on Churchill Ave, Alma St and Embarker Rd.</td>
</tr>
<tr>
<td>Q Caltrain Design Exceptions Needed</td>
<td>2% grade on track required. Temporary vertical clearance of 12 feet at undercrossing structures during construction. Minimum allowed by Caltrain is 15.5 feet.</td>
<td>1.4% grade on track required. Maximum allowed by Caltrain is 1%.</td>
<td>No temporary track (i.e., shoofly) is required.</td>
</tr>
<tr>
<td></td>
<td>2% grade on track required. Maximum allowed by Caltrain is 1%.</td>
<td>2% grade on track required. Maximum allowed by Caltrain is 1%.</td>
<td>1.6% grade on track required. Maximum allowed by Caltrain is 1%.</td>
</tr>
</tbody>
</table>